SECTION I

INTERSTATE WATER ALLOCATION ECONOMICS

RESOLVING INTERSTATE WATER ALLOCATION CONFLICTS: TOOLS, STRATEGIES, AND ADMINISTRATIVE OPTIONS

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Introduction

Interstate water disputes are an increasingly common occurrence throughout the United States, as the demands on transboundary water resources continue to increase in magnitude and diversity. These disputes can involve a variety of water-related issues. In the arid and semi-arid West, the interstate allocation--or "apportionment"--is normally the central and often only concern. In the more humid East, issues such as water quality, environmental protection, and water development are also often featured; however, even in these disputes, allocation of the resource is often a major component of the underlying dispute. A current example can be found in the Apalachicola-Chattahoochee-Flint and the Alabama-Coosa-Tallapoosa River basins (ACF/ACT). A Corps of Engineers' plan to augment municipal water supplies in Atlanta through a reallocation of storage in Lake Lanier (in northern Georgia) is being challenged by downstream interests in Alabama and Florida, fearful that additional Upper Basin water consumption will reduce downstream flows and degrade water quality, to the detriment of agricultural, navigation, and environmental interests (Vest, 1993; Erhardt, 1992). Recreation interests and landowners near Lake Lanier also oppose the reallocation plan. By unanimous consent of the four involved parties (the three states and the Corps), judicial proceedings before the Supreme Court have been placed in an inactive docket while a negotiated solution is pursued. In this report, the major tools used to resolve and implement interstate water allocation disputes are summarized. This discussion covers three related topics: an examination of the legal mechanisms available for making interstate apportionments; an overview of some of the allocation formulas and philosophies that can be used to quantify the apportionment; and finally, an examination of the administrative arrangements that can be used to implement the interstate apportionment. While this discussion is equally applicable to all American River basins, the ACF/ACT controversy is periodically referenced to illustrate some salient issues involved in interstate water disputes.

The Legal Tools of Interstate Water Allocations

Until the landmark Supreme Court decision in Arizona v. California (1963), it was generally assumed that only two mechanisms existed for allocating interstate water resources: the interstate compact, and litigation before the Supreme Court. In the 1963 case, the Court ruled that Congress also has the independent authority to make interstate apportionments, a power Congress unknowingly exercised in the Boulder Canyon Project Act of 1928 which contained a "recommended" apportionment of the Lower Colorado River (Hundley Jr., 1975). Due to the obvious political costs of allocating a finite resource, the authority to apportion interstate water resources is something Congress has chosen not to deliberately exercise.

Instead, Congress' involvement in interstate water disputes is normally limited to ratifying compacts, or in providing water project authorizations (and other benefits) to the states as

a way of encouraging negotiated interstate settlements.

The selection of the legal device for fashioning the interstate apportionment is largely determined by the political context of the dispute. Two nonexclusive factors are generally associated with the origination of interstate water allocation disputes: (1) one state develops and grows at a faster rate than another, causing the slowly developing region to worry about the adequacy of future water supplies; and (2) the upstream state exploits--or it is feared it will exploit--its natural geographic advantage by consuming or degrading the shared resource before it can reach users downstream. When the upstream state is the faster developing jurisdiction, such as in the ACF/ACT River Basins controversy, then a highly asymmetrical situation exists. While this can discourage negotiation and compromise, at least three considerations can entice an upstream party in this position to seek a negotiated solution. First, there is always a strong desire to control ones own destiny, something that is forfeited when decisions are made by a third party. The Supreme Court generally issues opinions that favor existing water demands over potential future needs; however, this is not always the case, and the Court frequently reopens and modifies decisions as conditions change over time. Second, litigation in the Supreme Court can be much more time consuming and costly than a well-paced negotiation--e.g., Kansas and Colorado have litigated the allocation of the Arkansas River off-and-on for over ninety years (Matthews, 1994). And third, it is undoubtedly valuable to foster amiable interstate relations, since additional interstate water management disputes (and other types of controversies) are likely to occur in the future.

When the downstream state is the faster developing jurisdiction, then the parties are in a more balanced political situation, and the opportunities for bargaining are more obvious. This is perhaps best illustrated by the Colorado River Compact, in which the states of the rapidly developing Lower Basin and the sparsely populated Upper Basin were able to fashion a compromise that guaranteed continued water deliveries to the Lower Basin, but limited the amount of allowable Lower Basin consumption in order to ensure that sufficient water existed for later Upper Basin development. A negotiated allocation does not necessarily mean that litigation will be avoided, however, as many interstate compacts--including the aforementioned Colorado River Compact--have spawned lengthy judicial battles where key compact language has been interpreted (Hundley Jr., 1975).

Interstate Litigation: The Equitable Apportionment Doctrine

Litigation between states is the sole domain of the U.S. Supreme Court. In interstate water disputes, the Court appoints a Special Master, an impartial water expert, to collect evidence, hear arguments, and make a recommended decision that the Court can either accept, reject, or modify as desired. In the absence of a compact or congressional water allocation, the Court since 1907 has chosen to base its decisions on the doctrine of equitable apportionment (Kansas v. Colorado, 1907). Although "equitable apportionment" is a rather ambiguous term, the philosophy of the doctrine is quite simple; i.e., interstate allocation decisions should be based on notions of fairness and practicality, rather than deriving from inflexible rules or from the potentially inappropriate precedents and arrangements found in state water law. The classic articulation of the philosophy is found in New Jersey v. New York (1931):

> A river is more than an amenity, it is a treasure. It offers a necessity of life

> that must be rationed among those who have power over it. ....Both states have real and substantial interests in the River that must be reconciled as best they may be. The different traditions and practices in different parts of the country may lead to varying results, but the effort always is to secure an equitable apportionment without quibbling over formulas. (286 U.S. 336, at 342-343).

Matthews (1994) identifies seven major cases in which the Supreme Court was asked to resolve an interstate water quantity dispute where no compact or other federal legislation was in effect to establish an interstate allocation: Kansas v. Colorado (1902, 1907, current), involving the Arkansas River; Wyoming v. Colorado (1922), involving the Laramie River; New Jersey v. New York (1931, 1954), involving the Delaware River; Connecticut v. Massachusetts (1931), involving the Connecticut River; Washington v. Oregon (1936), involving the Walla Walla River; Nebraska v. Wyoming (1945, 1993), involving the Platte River; and, Colorado v. New Mexico (1982, 1984), involving the Vermejo River. The trends identified in these cases are of interest to parties involved in the ACF/ACT River Basins controversy, in that they help to identify the relative merits of judicial and negotiated settlements. Three trends deserve special attention. First, the Court normally will not block proposed diversions and consumptive uses unless the protesting state can demonstrate that three conditions are satisfied: (1) the proposed diversions will cause real and immediate injury to the protesting state; (2) that restricting the proposed diversions will actually provide tangible relief to the protesting party; and (3) the benefits associated with restricting diversions outweigh the potential costs that will be borne by the enjoined party. Not only is it often very difficult to satisfy these conditions, but failure to do so greatly reduces the chances that the Court will formulate an apportionment of any kind. In most cases, no formal apportionment is made until an immediate need is demonstrated. Second, the decisions of the Court have a limited life span, and are likely to be revisited and modified by the Court as water demands change. Unlike compacts that cannot be unilaterally modified, victories won in equitable apportionment disputes are vulnerable if a disgruntled party can later earn the sympathy of the Court (Kenney and Gregg, 1991). And third, while the Court often attempts to formulate allocations that are compatible with state water law and administrative traditions (e.g., prior appropriation, riparianism, modified riparianism), state water law does not take precedence over the broad "fairness" notion upon which equitable apportionment is founded.

Interstate Water Allocation Compacts

An interstate compact is a legally binding agreement among states. Largely due to the technical and administrative challenges associated with formulating and administering interstate allocations, the Supreme Court has been one of the most ardent supporters of the compact tool:

> The reason for judicial caution in adjudicating the relative rights of States in such cases is that, while we have jurisdiction of such disputes, they involve the interests of quasi-sovereigns, present complicated and delicate questions, and, due to the possibility of future change of conditions, necessitate expert administration rather than judicial imposition of a hard and fast rule. Such controversies may appropriately be

> composed by negotiation and agreement, pursuant to the compact clause of the federal Constitution. We say of this case, as the court has said of interstate differences of like nature, that such mutual accommodation and agreement should, if possible, be the medium of settlement, instead of invocation of our adjudicatory power. (Colorado v. Kansas, 320 U.S. 383, at 392 (1943).)

Generally, the compacting process involves five steps: (1) Congress authorizes the negotiation of the compact; (2) the state legislatures appoint commissioners to negotiate the compact; (3) the commissioners meet, usually along with a federal chairman, to negotiate and sign the compact; (4) the state legislatures ratify the compact; and (5) Congress ratifies the compact, giving the document the status of federal law.

Interstate water allocation compacts are primarily a western phenomenon, where no fewer than twenty-two rivers are apportioned using this tool (McCormick, 1994). In the more humid areas of the United States, compacts for pollution control, resource planning, flood control, and related issues can also be found. The most comprehensive compacts are the nation's two federal-interstate compacts, found in the Delaware and Susquehanna River Basins (GAO, 1981). Unlike regular compacts that require congressional ratification but do not provide for formal federal participation or require continued federal involvement, federal-interstate compacts join the states and the federal government in a fairly equal partnership. The popularity of compacts is attributable to several factors, including the strong legal standing of this type of agreement, the requirement of unanimous agreement (which ensures that the interests of all states are addressed), the flexibility of compacts to address a diversity of subjects (using a variety of strategies), the state orientation of these agreements, and the opportunity to create a commission to implement the compact (Hill, 1992; Muys, 1971).

Allocation Strategies

An interstate water apportionment can be based on any philosophy (or combination of philosophies) that is agreeable to the involved parties, whether they be state-appointed compact negotiators, Supreme Court justices, or even federal legislators. The most obvious source of "guiding principles" for an interstate apportionment is state water law, where a variety of philosophies are seen (Apogee, 1992). The prior appropriation system, for example, is based on the timing of use, with the first appropriator of water having rights that are senior to all subsequent water users. Many other systems, such as the riparian doctrine for surface water and the absolute ownership doctrine associated with groundwater, base water use on the requirement of land ownership. How water is used is also factored into many state allocation doctrines, including those that prioritize domestic uses over commercial uses or require that water consumption be limited only to "reasonable" or "beneficial" uses, and federal provisions that require the reservation of sufficient supplies in perpetuity to maintain desired land-use and water-use characteristics. Finally, many states are becoming increasingly reliant on market-based systems, where the summed preferences of individual consumers are utilized to shape allocation patterns. All of these approaches, with the notable exception of the market-based approaches, are commonly utilized to resolve interstate disputes.

Once it is determined that a formal apportionment is needed and a general agreement is reached regarding the appropriate allocation principles, it is necessary to fashion a quantitative apportionment. In designing the apportionment formula, the negotiators (or the Court's Special Master) must be prepared to address the fact that water is mobile, its availability naturally fluctuates from year to year, and that shortages--and the risk of shortages must be allocated in addition to dependable water supplies. In some cases, the allocation of surplus flows is also important. Equally important is the fact that all water systems have unique physical constraints that limit where and when water can be stored and diverted, and in what quantities and rates. Other important concerns are the need to respect established water uses, the importance of the groundwater-surface water interface, and the presence of federal reserved water rights--factors that if not considered, can later derail an otherwise viable allocation strategy. Further complicating matters is the desire to fashion an apportionment formula that relies on easily obtainable data, such as reservoir storage elevations or stream flows at a given point.

A tremendous variety of interstate apportionment formulas can be found in compacts and Supreme Court decrees. For purposes of discussion, five types of apportionment strategies are identified in this study: (1) minimum flows, (2) accounting of uses, (3) storage maximums, (4) long-term deliveries, and (5) other mechanisms. These are not exclusive categories, but are tools that are combined in a variety of creative ways in several complicated apportionments.

1. Minimum Flows. Most apportionment formulas, in one way or another, utilize flow information as part of the data requirement in the calculation of interstate water rights. The simplest from an administrative standpoint--of the flow-based approaches calls for certain stream flow minima to be maintained at a predetermined gaging station, ideally located at the interstate border. Two examples of this approach can be found in the Delaware River Basin, in formulas originating in Supreme Court decrees in 1931 and 1954 (Kenney and Gregg, 1991). The Montague formula, established in the 1954 decree after the initial 1931 formula proved to be unworkable, requires releases from Upper Basin reservoirs to maintain a minimum basic rate of flow at the Montague gaging station (in New Jersey near the New Jersey-Pennsylvania-New York border) of 1525 cubic- feet/second (c.f.s.). Among the compacts prominently featuring a flow minimum standard is the Big Blue River Compact (between Nebraska and Kansas), which requires Nebraska (the upstream state) to regulate diversions made by appropriators with rights junior to the compact in order to "maintain minimum mean daily flows at the state-line gaging stations" during the summer months (Article V). On the Big Blue mainstem, flow minimums range from 45 c.f.s. in May to 90 c.f.s. in August.

2. Accounting of Uses. The most common allocation strategy distributes the rights to divert or deplete the full flow of the resource among the participating states. The quantity of the right can be a fixed amount (either a specific volume or a percentage of a fixed total such as average annual yield), or can be designed to fluctuate either through the use of percentages or hydrologic inflow-outflow models--from year to year in accordance with natural hydrologic variability. Numerous examples of "accounting-based strategies" exist, including the Belle Fourche River Compact (1943) which allocates 90 percent of all unappropriated waters in the basin to South Dakota and the remaining 10 percent to Wyoming. Percentages are also utilized in the accounting-based strategies found in the Upper

Colorado River Compact of 1948 and the Arkansas River Basin Compact (between Arkansas and Oklahoma) of 1970, among others, while the Republican River Compact of 1943 allocates fixed quantities of water among Colorado, Kansas, and Nebraska. The accounting-based strategies differ from the "minimum flow strategy" discussed above in three important ways: (1) the accounting-based strategies generally feature proportional sharing of water shortages, whereas the minimum flow approach has the effect of a "call on the river" in which the upstream entity must cease diversions for the benefit of the downstream party; (2) the administrative demands of the accounting-based strategies are generally much greater than the minimum flow strategy, the former generally requiring an annual accounting of diversions and/or consumption in each of the participating states and a determination of how much virgin flow is available in any given year, while the latter simply requires the periodic monitoring of a specific stream gage; and (3) the accounting-based strategies normally function over an annual time frame, while the minimum flow strategy is concerned with daily hydrologic conditions.

3. Storage Maximums. The simplest approach from an administrative standpoint is one that limits the amount of water that can be stored in upstream reservoirs, defined either as a volume or a reservoir elevation. Perhaps the best example of the storage-based approach is found in the Canadian River Compact of 1950, which places a specific upper limit on how much water New Mexico and Texas (the upstream states) can store, while not restricting or otherwise limiting the use of water released downstream to Oklahoma. The agreement limits New Mexico to 200,000 acre-feet of storage on the Canadian River, while Texas is limited to 500,000 acre-feet of storage on the North Canadian River until Oklahoma constructs at least 300,00 acre-feet of storage downstream, at which time storage in Texas can increase at the same rate as storage capacity in Oklahoma is increased. (An acre-foot is that quantity of water necessary to flood one acre of land to a depth of one foot, approximately 326,000 gallons.) Other storage-based apportionments can be found in the Arkansas River Compact (between Kansas and Oklahoma) and the Upper Niobrara River Compact (between Nebraska and Wyoming).

4. Long-term Deliveries. In some cases it may not be necessary to maintain a given flow rate at a selected location at all times, however, it is desirable to ensure that the total flows over longer time frames (such as a year) meet some minimum fixed standard. In these cases, an apportionment formula can be designed that requires the upstream-to-downstream delivery of certain quantities of water over a season, a year, or in the case of the Colorado River Compact of 1922, a ten-year period. The Colorado River Compact requires the delivery at Lee Ferry (near the Arizona-Utah border) of a ten-year moving average of 75 million acre-feet. When the compact was drafted, it was assumed that this would provide an equal allocation between the Upper and Lower Basin; however, it has since been determined that the original estimate of the river's flow was at least 10 percent too high, a discrepancy that is borne entirely by the Upper Basin states (Young, 1994). The states of the Upper Basin also bear the full brunt of any drought shortages. Primarily due to these drawbacks, this element of the allocation strategy used in the Colorado has not been copied elsewhere, and is undoubtedly responsible for the choice of an accounting-based strategy in the Upper Colorado River Basin Compact of 1948 that utilizes percentages.

5. Other Mechanisms. A few of the other allocation strategies seen in various river basins include at least two approaches that generally ignore state lines, but instead provide for allocations to specific users. The prior appropriation doctrine is applied across state lines by the Costilla Creek Compact of 1944 and 1963, which addresses the particular administrative challenges posed by the Rio Grande tributary that wanders back and forth across the Colorado-New Mexico border. The priority principle is also occasionally applied across state borders by the Court in the context of equitable apportionment, the best example being found in Wyoming v. Colorado (1922) involving the Laramie River. A less traditional form of prior appropriation is found in the Klamath River Compact of 1957, which provides for the allocation of all water in the basin to individual appropriators in Oregon and California, but with the understanding that in times of shortage, all domestic and irrigation rights, regardless of their priority date, will be considered senior to water rights for all other purposes, which are administered in accordance with their priority dates. The Belle Fourche River Compact of 1943 also considers type of use in the allocation formula by excluding all domestic and stock water uses in Wyoming from the accounting-based allocation of the river. Another interesting arrangement can be found in the Arkansas River Compact of 1948 (between Colorado and Kansas), which allocates summer releases from water stored in the winter months in John Martin Reservoir, a Corps of Engineers' facility in Colorado. The subject of drought emergencies is addressed in the Bear River Compact (1955, 1978) and the Delaware River Basin Compact (1961), both of which establish commissions with the authority to temporarily modify allocation patterns after declaring drought emergencies. Given the unique physical and institutional features of each American river basin, this level of variability is not surprising.

Administrative Arrangements

Regardless of the allocation formula used, an administrative arrangement of some kind must exist to implement the interstate apportionment. Hydrologic variables must be measured and recorded, and reservoir operating schedules must be coordinated to satisfy the terms of the apportionment. If the formula is technically sound and water shortages do not exist, then administration of the interstate apportionment can be a relatively routine exercise. However, situations inevitably arise that test the limits of the administrative arrangements in place. Typically, the most serious test of an allocation formula and the corresponding administrative arrangements is drought, and the failure rate is high (McCormick, 1994). If there is any ambiguity in the meaning of the formula or the intent of the drafters, or any questions regarding the quality of the data used to calculate the allocations, then the party most harmed by the drought (or other low flow situation) is likely to protest. In general, formulas that call for the maintenance of minimum downstream flows place the drought burden on the upstream states, whereas approaches that only place a maximum limit on upstream storage (or consumption) transfer the drought burden downstream. Percentage systems can allocate the burden in any possible manner, but normally are designed to distribute risk evenly. When the burdens of drought are not borne equally, then the interpretation and implementation of a controversial allocation scheme can become a highly politicized exercise, often leading to litigation. In addition to the several equitable apportionment cases listed earlier, the Supreme Court has been called upon to interpret or enforce the terms of allocation compacts in the Arkansas, Canadian, Colorado, La Plata, Pecos, and Rio Grande River Basins (McCormick, 1994).

Several types of administrative arrangements exist for managing interstate water resources. Kenney (1993, 1994) identifies seven forms of regional "coordination mechanisms" that have been prominently utilized in American river basins: (1) interstate compact commissions, (2) interstate councils, (3) basin interagency committees, (4) interagency-interstate commissions, (5) federal-interstate compact commissions, (6) federal regional agencies, and (7) the single federal administrator approach. These types are primarily distinguished by two parameters: the legal basis of the organizations, and the presence or absence of state and federal members. While this typology is useful for reviewing the full range of administrative arrangements that are found in the general arena of interstate water management, it is not highly useful for a consideration of arrangements for the administration of interstate water apportionments--a single component in an overall water management program. The majority of interstate apportionments are administered by compact commissions, with the remainder being the purview of court-appointed River Masters, federal water bureaucracies, and in some cases, by existing state agencies. These administrative arrangements are discussed in the following paragraphs.

Compact Commissions

A central feature of most interstate water allocation compacts is the establishment on a compact commission to administer the apportionment. Normally, the commission is responsible for the collection and analysis of the relevant hydrologic information, often in cooperation with existing state and federal agencies, and the determination of what schedule of diversions and releases are consistent with the administration of the agreement. Most commissions include one or more voting representatives (i.e., commissioners) from each of the signatory states, and usually provide for a non-voting federal member that acts as chairman. The budgets and staffing of most commissions is modest--with the notable exception of those commissions with extensive responsibilities in other subject areas--and is normally provided in its entirety by state appropriations, with the exception of the federal member's expenses which are a national obligation.

Among the most important features of a compact commission are the rules for making and enforcing decisions, an area where considerable variability is seen. Although many commissions use hydrologic models and other sophisticated tools to predict the hydrologic performance of the river system, it is normally impossible to avoid areas of discrepancy that can only be resolved by a vote. A one-state, one-vote system with a decision-rule of unanimity is the most common arrangement. Only a few commissions, including the Bear River Commission and Upper Colorado River Commission, utilize a decision-rule that does not require unanimity. Since most allocation compacts are between only two states, stalemates are a frequent and often highly problematic feature of many commissions, especially in those situations in which the inaction associated with a stalemate works to the advantage of one party--normally the upstream state.

Three major strategies can be utilized to resolve stalemates: (1) arbitration, (2) empowering the federal representative to cast a deciding vote, and (3) litigation (McCormick, 1994). Voluntary arbitration is featured in the Arkansas River Compacts of 1949 and 1970, while the Klamath River Compact of 1956 requires mandatory arbitration. The deciding-vote approach is utilized by the Snake River Commission and the Yellowstone River Commissions, while the

federal commissioner has the unusual authority to cast votes in all matters in the Upper Colorado River Commission, something that is a standard feature in the federal-interstate compact commissions. If arbitration and the deciding-vote approaches both fail, or are unavailable--a common situation since about half of all compacts do not provide any mechanism for resolving stalemates--then most compacts provide for disgruntled parties to initiate litigation before the Supreme Court, with the understanding that any relevant findings made by the Commission will generally be considered by the Court as prima facie evidence.

Other Arrangements

In those situations where the Court is been delegated the primary responsibility for designing or implementing the interstate apportionment a River Master is frequently considered, but only rarely appointed. Unlike a Special Master who is a legal expert that helps the Court collect, analyze and interpret hydrologic information prior to deciding a case, a River Master is an individual familiar with the operation of water systems appointed by the Court to implement the terms of the apportionment by ordering (and prohibiting) releases. Just as the Court disdains the responsibility of determining interstate apportionments, it only begrudgingly accepts responsibility for appointing River Masters to implement its decisions--an action that is more appropriately handled by other branches of government. The subject of River Masters is featured prominently in Wisconsin v. Illinois (1930), New Jersey v. New York (1954), Vermont v. New York (1974), and most recently in Texas v. New Mexico (1987, 1988), a case in which a River Master was appointed to administer the terms of the Pecos River Compact even though a Commission--comprised of two voting members who were hopelessly deadlocked--had been established by the agreement.

Since compacts and court decisions are where apportionments are normally made, only those regional administrative arrangements that can be crafted through these vehicles--namely, compact commissions and River Masters--typically have formal responsibilities for implementation. (Occasionally the Court and compact negotiators will delegate implementation of an apportionment to existing state agencies, but with the knowledge that future interstate disputes will likely require additional intervention by the federal courts or will require the negotiation of a modified compact.) Most other forms of coordination mechanisms seen in the history of American river basin administration are limited to roles of interagency and intergovernmental coordination and water development planning, with significant decisions being reserved by more established bodies (Kenney, 1993, 1994). Interstate councils, for example, are typically established by consistent multi-state legislation or by a joint agreement of two or more governors, legal tools that are often adequate to promote voluntary and coordinated action among the states, but too informal for adopting or enforcing binding interstate agreements. Basin interagency committees, such as the "firebrick" committees of the 1940's and 1950's, can bring together the combined resources of several federal and state water agencies and can therefore be a formidable administrative entity. The same was true for the interagency-interstate commissions established using Title II of the Water Resources Planning Act of 1965. However, federal administrative bodies cannot independently establish binding interstate apportionments, and Congress has never knowingly chosen to assume this responsibility. These qualities make basin interagency committees and interagency-interstate commissions bad candidates for administering interstate water apportionments. Among the potential exceptions are the Tennessee Valley Authority,

the only example of the administrative form known as the "federal regional agency," which has the independent authority to build and operate reservoirs to satisfy goals associated with navigation, flood control, and power production. The other major exception is the role the Secretary of the Interior plays in implementing the interstate apportionment of the Lower Colorado River. The arrangement, known as the "single federal administrator" approach, was formalized by the Supreme Court in the Arizona v. California (1963) litigation, and is highly similar to the River Master approach.

Summary and Conclusions

When it becomes apparent that an interstate apportionment is desirable in a region, three decisions must be made: What legal device should be utilized? What allocation strategy should be used to craft the formula? And, what administrative arrangement should be employed to implement the agreement? In this paper, each of these issues has been examined, and some general conclusions have emerged. These conclusions are reviewed below, and then considered in the context of the ACF/ACT River Basins controversy.

Legal Tools

What legal approach is best for making an apportionment is largely determined by whether or not a bargain can be reached, which requires an examination of the stakes and resources of each party. If unanimity can be reached, an interstate compact is the preferred approach; however, if the parties involved cannot find common ground, then litigation may be the only viable option. If the only obstacle standing between the states and unanimous agreement is a water project, then Congress might to willing to finance the bargain. Interstate compacts, especially when married to a well conceived administrative arrangement, offer a proven blend of stability and flexibility, something that is more difficult to achieve through other dispute resolution mechanisms. The compacting process is not simple, however. The Second Hoover Commission (1955) found that compacts take approximately nine years on average to successfully negotiate and ratify, a time frame that is similar to judicial resolutions. If a compact route is chosen, then a decision must be made whether or not the federal government should be included as an equal partner through the use of a federal-interstate compact. Factors that encourage this approach are the high presence of federal lands and interests in a basin, and the desire to establish an administrative body with a scope much broader than simply interstate allocation.

Allocation Strategies

Most allocation strategies are based upon a combination of five different strategies: (1) minimum flows, (2) accounting of uses, (3) storage maximums, (4) long-term deliveries, and (5) other mechanisms. No one approach is best in all circumstances, and most formulas feature a combination of these elements. Among the important case-specific factors that must be considered in the design of an allocation formula is the hydrologic character of the system (including storage capacity), the quality of the region's hydrologic records, the institutional environment and the desired patterns of water use, the rights of existing water users, the likelihood of hydrologic fluctuations and the corresponding allocation of risk, and the

administrative demands. In theory, regional economic efficiency should also be considered--something that is frequently seen in equitable apportionment cases, but not in compacts since the involved parties must answer to provincial, not regional, constituencies. Unfortunately, the strategies that are the easiest to monitor--namely, approaches based on minimum flows, storage maximums, and long-term deliveries--generally do not allocate the risk of shortages in an equal manner. Risk can be more equitably apportioned using accounting-based approaches based on percentages, rather than absolute values; however, this can complicate administration. Experience in the Pecos and Rio Grande Basins suggests that the administrative demands of dynamic apportionment formulas are not necessarily simplified by the use of hydrologic models. The inflow-outflow model utilized in the Pecos River Compact proved to be inaccurate, predicting a level of downstream flows that was erroneously high. The Rio Grande model failed when flooding caused major changes to the stream channel.

Administrative Arrangements

Failed allocation formulas emphasize the importance of providing administrative arrangements to implement the apportionment in the face of changing hydrologic conditions and technical uncertainty, all in a highly charged political environment. Good arrangements facilitate the skilled application of technical data, which in turn, is reliant on the establishment and use of hydrologic monitoring systems. In the design of compact commissions, it is imperative that arrangements be made for resolving disputes, and more specifically, stalemates. If every dispute requires intervention by the Supreme Court, then the efficiency of the administrative arrangements are seriously compromised--although "equity," as defined by the Court, is ensured. Arbitration systems can be desirable, but only if the arbitrator is endowed with sufficient authority to make enforceable decisions. Empowering the federal chairman of a compact commission to cast a deciding vote has several advantages, but can be controversial in that it delegates a "state issue" to a federal actor, and can compromise the impartiality of the federal chairman. The federal chairman of the Yellowstone River Commission, an employee of the U.S. Geological Survey, has pledged not to exercise his tie-breaking power for this very reason (McCormick, 1994). Through the use of a court-appointed River Master, the problem of reaching decisions is largely avoided; however, it is difficult to expect a River Master to bring the same breadth of scope and technical sophistication to resource management that is possible through the establishment of a commission.

Implications for the ACF/ACT River Basins

The Supreme Court and Congress have both consistently demonstrated a preference for negotiated solutions to interstate water allocation controversies. The current ACF/ACT River Basins controversy is a continuation of this trend, as illustrated by the Court's willingness to place the interstate litigation in an inactive docket pending the results of studies and negotiations primarily funded by congressional appropriations. Although the conflict is highly asymmetrical, several incentives exist to encourage a negotiated settlement. All parties involved are interested in fostering good interstate relations, avoiding the costs (and delays) typically associated with litigation before the Supreme Court, and perhaps most importantly, all parties want to be in a position to control their own destiny in determining an allocation. In addition to these general incentives, Georgia is highly interested in a process that leads to

a quick resolution (since water demands in Atlanta continue to grow), Florida has repeatedly expressed a desire for a process that leads to comprehensive resource management, and Alabama would like to see an allocation that respects anticipated future demands in addition to current needs. These considerations strongly encourage the pursuit of a compact (or other federal legislation reached through bargaining) rather than litigation, especially since the lack of a demonstrable water supply crisis in the region lessens the probability that the Court would fashion an apportionment at this time. Given the relative abundance of water in the region, the availability of federal storage facilities, and the wealth of data being generated by the ongoing Comprehensive Study, a variety of allocation formulas are available and potentially applicable. The potential structure of a coordination mechanism to implement the agreement, and to perform any other desired tasks, is another area where the states enjoy considerable flexibility.

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INCORPORATING ECONOMICS INTO WATER MANAGEMENT MODELS IN THE CASE OF THE COLORADO BASIN

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Introduction

Investigators from several Colorado River Basin states have been engaged for about a decade in a major program of research designed to evaluate the capability of the region's water management structures and institutions to cope with a severe sustained drought (SSD). The studies which made up this program include tree ring reconstructions of historic runoff conditions, hydrologic analyses of the probability distribution of river flows, engineering simulations of the functioning of the water management facilities and institutions under various runoff scenarios, legal and other institutional analyses of current interstate water allocation rules, and possible changes in them, studies of potential environmental impacts of different hydrologic scenarios, economic projections of water-related benefits and costs of such scenarios, and a set of gaming exercises in which researchers playing the roles of state and federal water decision makers attempted to cope with the unfolding drought through collective action in changing the rules for system management. The findings of all of these studies, many of them cited throughout this paper, are described in individual sections of the completion report for the entire research program (Young, 1984).

The purpose of this paper is to describe and critique the approaches to incorporating economics into the water management models employed in the SSD program of research. Water management models have long been used in water resource development planning and related efforts to understand water resources systems and to design facilities and operating rules for them. Economics has become an ever more prominent part of such exercises in the past half century. Still, monetary aspects of water resource systems have usually been treated as separate parts of such analyses, not as integral parts of the systems models themselves. Similarly, so-called institutional analyses have become accepted, but almost invariably separate and unintegrated planning tools.

The SSD research program was designed explicitly to evaluate water management institutions, and to do so through the use of water management models which incorporated economics and institutions as integral parts. To do otherwise is to fail to take full advantage of the analytical power of modern computers and modeling techniques. At best, such failure entails costly inefficiency. At worst, it compromises the value of the results of the analyses.

The SSD research program referred to herein was supported in part by the U.S. Department of State, the U.S. Geological Survey, the U.S. Army Corps of Engineers, the Metropolitan Water District of Southern California, and the Upper Colorado Rivers Basin Commission.

The paper begins with a brief review of the conceptual framework which underlies the SSD approach. It then proceeds to a summary of the relevant aspects of the Colorado River water management system. Then, the three water resource systems models used in the SSD program are described and compared. Finally, the strengths and weaknesses of the approach are examined. Space does not permit a more detailed discussion of the system or the three models, nor does it permit any discussion of the results of the analyses. The reader is referred to the final report (Young, 1994), where such matters are presented in detail.

Economics

Thirty years ago I became the economic advisor to what is today the Assistant Secretary of the Army for Civil Works. My job was initially described as one of increasing the numbers and influence of economists within the Corps of Engineers. At the time, the principal (if unprincipled) task of economists in the Corps' water resource planning activities was to find enough monetary benefits to raise the benefit-cost ratio of politically desired projects to at least unity.

We've come a long way in the succeeding decades, due in no small measure to the contributions of some of those present here today to the development of the Principles and Standards. The economic evaluation procedures employed in such federal water resources planning activities as remain are far more sophisticated and conceptually sound than they were then, and they occupy a more prominent place in decision making documents. At the same time, they remain largely concerned with the evaluation of monetary benefits and costs, and those external and/or indirect benefits and costs which can be assigned **?**as if" monetary values through shadow pricing, contingent valuation, or other techniques.

At about that same time a conceptual expansion was occurring within the discipline of economics. An outward sign of this expansion was a return to use of the term **?**political economy". Our discipline went by this name in the eighteenth and nineteenth centuries, but the **?**political" was dropped with the advent of neo-classical economics. For nearly a century, most economists had concentrated their efforts upon improving their models of the functioning of markets, and in the process underplaying, if not ignoring, the institutional prerequisites to the existence and functioning of such markets. It is not that we didn't realize that such institutions as well-defined property rights and freedom of contract were preconditions to the existence of markets, but that most of us took such institutions as **?**given", and not essential subjects for our investigations.

Institutional economists, as those in the Veblen and Commons traditions were called, protested what they perceived to be the tunnel vision of the mainstream, but they failed to offer a convincing alternative paradigm, and their intellectual influence fell far short of their practical influence upon national policy in the New Deal era. But for the last three decades, many economists have turned their attention once again to institutional concerns, but now using the more rigorous and formalist tools of the neo-classical mainstream. Furthermore, the formalist approach which characterizes modern economics has been increasingly taken up by political scientists, psychologists, and other social scientists. The revolt against formalism which characterized much of early twentieth century social

science (White, 1957) appears quite misguided from a current methodological perspective. We now expect less of our formal models, and we no longer reject formalism because it fails to provide complete and completely valid explanations for social phenomena.

Today, it is difficult to draw disciplinary boundaries which separate economics from parts of these other social sciences. This is all to the good, and areas known by such names as the new political economy, new institutional economics, public choice, collective choice, property rights economics, and the new resource economics, are some of the most rapidly developing and exciting of the profession.

All of this is a long way of getting around to restating a definition of economics which most of us have long used in our teaching, but have less often honored in our research. That definition states that economics is the study of the allocation of scarce resources among competing ends. When you think about it, it includes not only markets but, at least implicitly, all social mechanisms (institutions) for resolving potential and existing conflicts over resource use. In this paper I will take this broader view of what constitutes economics.

Economists have long distinguished between positive economics and normative economics, the former being a value-neutral elucidation of how economic systems work and the latter a prescription for how they can be improved. This distinction has been questioned, but it remains a useful one, provided that one recognizes that neither economic behavior nor economic analysts are value-free, and that any economic system emphasizes some values and de-emphasizes others. The SSD research program used economic analyses of both the positive and normative kinds.

Institutions

Institutions are those social arrangements which govern how human interactions take place. It is convenient to think of them as rules, and that is the way in which most scholars use the term. These rules can be as formal and explicit as those found in statutes and regulations. But they can also be informal and implicit. Many of the rules which govern human interaction in families and social groups are never documented, but they are well-understood anyway.

I follow Elinor Ostrom's agenda for institutional analysis in defining an action situation as a system composed of three broad classes of variables (Ostrom, 1986). Those three categories are actors, institutions, and environment. Actors are all of the individuals and groups involved in the situation. Institutions are the rule sets which apply to their interactions. The environment is simply a catchall for all of the relevant system variables which are neither actors nor rules.

Our concern today is with interstate water management problems. Institutions have evolved for addressing such problems, although they vary widely from river basin to river basin. The federal government has generally deferred to the states involved to make their own arrangements, and has taken a more prominent role only when the states themselves could not resolve their conflicts or when matters of truly national concern were involved.

This, together with the great diversity of interstate water management problems to be solved, accounts for both the diversity of interstate institutional arrangements, as shown by Doug Kenney's paper, and the relative lack of well-defined institutions in some basins, such as those of the ACT and ACF.

Water Management

Managing water resources is fundamentally a task of institutional adoption and implementation. We have long concentrated upon the often impressive physical facilities which symbolize man's domination over nature, and which loom large as political currency in a federal system. Such physical water management facilities are usually involved, because one cannot move water without them, but they must be operated according to rules. Reservoirs, diversion ditches, navigation locks and dams, hydroelectric power generation facilities, wastewater treatment plants, dredges, and pumping stations are all only inert physical objects until the rules for their use are established and followed.

Today, as we move out of the era of building physical water management facilities, and into an era of searching for better ways of managing the facilities we have, we see a new focus upon water management institutions. Institutional planning and design assume the central role which construction once held (Lord, 1984).

Two concerns emerge with renewed importance as we turn our attention to improving water management through creating better institutions. The first of these concerns is with the objectives which we strive to attain. Building structures sometimes seemed to be an end in itself, and too little attention was often given to the ends which those structures would serve long after their completion had met its immediate political purpose. I have argued elsewhere that the stated purposes of national economic development (NED) and environmental quality protection (EQ) actually functioned as national constraints on the measures taken to solve essentially local, or at most regional, water problems (Lord, 1981). The solution of such local or regional water-related problems is, and always has been, the primary purpose of water resource management and, for federal projects, the secondary purpose has been to provide political currency in a locally-responsive Congress.

Both history and logic show that NED and EQ are not purposes at all, but constraints established to limit the extent to which the spoilsmen may subordinate national interests to local ones, or development interests to environmental ones. Preoccupation with NED and EQ as planning objectives has diverted planners' attention from the essential task of problem definition, through which the real objectives of water management are established. In the present non-structural era it is doubly important to focus on problem definition and setting the real objectives of water management, since we need no longer be preoccupied with heading off such costly and environmentally damaging capital-intensive projects as the late and unlamented Cross-Florida Barge Canal.

The second concern of importance in achieving better water management is with what we economists often call sub-optimization. This is really a correlate of the first concern. Even as excessively broad and general objectives, such as NED and EQ, can misdirect the

planning process, so can excessively narrow ones. The title of our symposium today refers to interstate water allocation. This title accurately reflects the major current preoccupation in the ACT and ACF basins. But a review of the history of interstate water conflicts in these basins quickly shows that water allocation is but one of the issues which have been troublesome. Water quality control, navigation, hydroelectric power generation, fish and wildlife enhancement, and water-based recreation have also emerged as sources of conflict. That doesn't mean that water allocation is necessarily too narrow a definition of the problems which planning ought to address, but it raises the suspicion that it may be. Possible interrelationships between water allocation and other interstate water issues ought to be examined now if we are to avoid sub-optimization, and a resultant need to again resort to collective action to revise and expand such institutional arrangements as we now create.

Models

Models, a term which I use broadly to mean the intellectual structures which we use to describe and cope with the world around us, are needed for defining problems and discovering solutions to them. We all carry models around in our heads, for we can't interpret the stimuli which we encounter without them. Most of these models are not articulated (Polanyi, 1962), most are simple, and most are at best only partially tested and verified. Psychologists tell us that human reasoning capabilities limit us to simple models with no more than five or six interacting variables. Dealing with such complex problems as interstate water management requires models which are sufficiently broad in scope and sufficiently reliable to yield useful conclusions for institutional design. It is not sufficient to employ the simple models which we carry in our minds and which we call common sense or conventional wisdom. But such more complex models must be explicit and reproducible, and they must embody a systems approach.

Economists know all of this. One of the strengths of our discipline has been its use of comprehensive systems models; explicit formal models which can include more variables and more complex interrelationships between variables than can be included in the less explicit models so common in the other social sciences and the humanities. **?**Comprehensive" and **?**systems" are good words, of course, but words which mean nothing except in context. I want now to provide some of that context which is specifically related to interstate water management problems.

The highly abstract and very general structure of the action situation (it is not yet a model because it lacks any relationships between variables) at first seems almost trivial. But consider how often our problem solving discussions omit or gloss over at least one of the classes of variables. I have already alluded to the tendency of mainstream economists to take institutions for granted for much of the last century. Another familiar example is the failure of nineteenth century economists to be explicit enough about the environment in which economic behavior occurs. This failure led directly to the birth of our own sub-discipline of agricultural economics (first as farm management) a hundred years ago.

The model of the actors most often used in economics is the familiar utility-maximizing rational decision maker. We sometimes modify it to incorporate limitations upon

information and other decision making resources, in which case we call it the model of bounded rationality (Simon, 1957). Some have proposed different models, such as Maslow's model of basic need satisfaction (Lutz, 1988). The beauty of the rational decision maker model is that it can subsume all of the alternatives, given a sufficiently broad definition of the utility function, although such broadening is apt to render the model non-operational.

The model of the environment will be situation-specific. In water resources situations it must take cognizance of the fugitive nature of water, which limits the assignment of property rights, and of the tendency of water to flow downhill, thus creating the asymmetric social situations which economists call externalities. Any institutional analysis or evaluation should begin with the model of the environment, because it provides the specifics upon which problem definition ultimately rests.

The institutional model should recognize several types of rules, and the ways in which they can expand or constrain actors' options. Following Ostrom, we may distinguish seven types of such rules. The first is the scope rule, which defines the domain of applicability of the rule set. The second is the position rule, which defines the roles which the actors or parties may occupy. The third is the boundary rule, which defines how actors can enter or leave positions. The fourth is the authority rule, which defines the actions which occupants of positions may, may not, must, or must not take. The fifth is the information rule, which defines what information shall be provided by whom and to whom. The sixth is the aggregation rule, which maps the actions of occupants of individual positions into collective or aggregate outcomes. The seventh is the payoff rule, which defines how outcomes or impacts (benefits and costs, broadly speaking) shall be distributed. These rule categories supply the vocabulary for institutional analysis. Planners can look for each of these rule types in the existing social environment, and they can use these categories to design new water management options.

Levels of Action and Analysis

It is helpful, for analytical purposes, to distinguish three levels of decision making. The first has been called the operational choice level. The decisions made at this level directly determine how resources shall be used. Decision makers at the operational choice level are often water users of some sort. They decide upon actions to divert and store water, to operate reservoirs, to maintain minimum streamflows, and the like. But they do so in an environment which contains rules which allow certain actions and forbid others. These rules are called the operational choice rules. Existing water rights in a situation constitute an example of a set of operational choice rules.

Operational choice rules are made and revised at a second, and higher, decision making level. It is called the collective choice level. This rule-making activity at the collective choice level normally occurs in group settings, unlike the frequently individual decision making which occurs at the operational choice level (hence its name). A variety of such group settings can be found, including legislatures, courts, and committees and commissions of various kinds. The kind of behavior which occurs in these settings usually involves bargaining, voting, litigating, or other interactive modes. Water resource

planners will recognize that water resource planning is, itself, an activity carried out at the collective choice level.

The collective choice rules, which are those which define the game of making operational choice rules, are in turn made and changed at the third, or constitutional choice level. The name given to this level reflects the analytical assumption that this is the highest decision making level to be considered. Furthermore, the constitutional choice rules, which are the rules which govern action at this third and highest level, are not considered to be open to change. Constitutions are open to change, of course, but not within the context of water resource planning and decision making.

The Colorado River Case Study

The Colorado River System

The federal government has constructed a series of major reservoirs on the Colorado River and tributaries over the last seventy years. The two largest units in that system, Lake Mead and Lake Powell, are each capable of storing nearly two years' flow of the entire river. The role of the substantial carryover storage represented by Lakes Mead and Powell, and by the other system reservoirs, is twofold. First, this system stores water during the spring runoff period for delivery later in the year when natural streamflow would be low. Second, it mitigates drought impacts by storing water in wet years and delivering it in dry years.

From 1922 onward the basin states and the federal government have created the "Law of the River", a set of rules for operating the system. The Law of the River consists of an amalgam of interstate compacts (the 1922 Colorado River Compact and the 1948 Upper Colorado River Basin Compact), the 1944 treaty between the United States and Mexico, acts of Congress (such as the 1928 Boulder Canyon Storage Project Act, the 1956 Colorado Storage Project Act, and the 1968 Colorado River Basin Project Act), several U.S. Supreme Court decisions (most notably, the 1963 decision in Arizona v. California), and the operating criteria for project facilities promulgated and sometimes implemented by the Secretary of the Interior. We will refer to this complex rule set henceforth as the operating rules.

The process of devising the operating rules has been a long and contentious one, involving many parties interacting with each other in at least five different arenas. The first of those arenas is that of direct interstate negotiation, such as the negotiations which led to the adoption of each of the two interstate compacts. The second arena is that of federal legislative action, where the several laws to which we have referred were enacted. The third arena is the judicial one, principally the U.S. Supreme Court. The fourth arena is that of international negotiations, in which the Mexican Treaty and Minute 242 of the International Boundary and Water Commission, were adopted. The fifth arena is that of executive branch rule making, where a less formally structured process permits short term fine tuning within the bounds established in the other four arenas.

The collective decision making to establish or revise operating rules which occurs within these five arenas is itself subject to certain rules. We will call the rules which govern that collective decision making process the collective choice rules. The collective choice process of making operating rules for interstate water allocation and management in the Colorado Basin is fragmented and difficult to describe, in part because it takes place in at least five different arenas and in part because some of the collective choice rules are poorly documented. This is especially true of the executive branch rule making which produces the reservoir operating criteria. It is an often obscure process of melding technical and political information from a variety of sources, with no clear *a priori* definition of whose views count and how heavily conflicting views are weighted .

The initial explorations of the ability of the current operating rules for interstate allocation and management of Colorado River water revealed that a severe, sustained drought would cause significant damages (Harding and Sangoyomi). These damages consisted of reductions in deliveries of Colorado River water to consumptive uses in most basin states, effects of increases in salinity levels, and reductions in hydroelectric power generation. Subsequent studies would show losses in recreational opportunities (Booker et. al., 1994), adverse impacts upon endangered species and other environmental values (Hardy, 1994), and would provide estimates of the monetary value of all damages save those in the environmental category (Booker, 1994).

Water Management Models

Three models of the Colorado River hydrologic-economic-institutional system were constructed and used for separate, but closely related, purposes in the overall SSD research program. The first of these models was CORN, or Colorado River Network Model (now called simply CRM). It is a network optimization model with over 300 inflow and outflow nodes, corresponding to the high degree of spatial disaggregation which characterizes the Bureau of Reclamation's Colorado River System Model (CRSM). Like CRSM, CORN is a monthly model. Unlike CRSM (an ad hoc simulation model), CORN is an linear optimization model, based upon the out-of-kilter algorithm for solving a network optimization problem. Its high degree of disaggregation makes CORN an excellent choice for providing fine detail on the operation of the system (Harding & Sangoyomi, 1994). The objective function in CORN was specified by weighting water rights by seniority, rather than by monetary value, as one would do to find the economically optimal allocation of available water among competing uses. Water allocation institutions were partly expressed in CORN as weights in the objective function and partly as constraints on the use of resources.

The linear character of CORN ruled out using economic demand functions for allocating water, thus CORN is incapable of showing how freely functioning markets would allocate Colorado River water or, of greater consequence, what the monetary value of any particular water allocation pattern might be. A second model, the non-linear Colorado River Institutional Model (CRIM), was used to simulate water markets and to estimate willingness to pay, as a basis for deriving estimates of consumers' surplus (Booker, 1994). CRIM is a quadratic programming model, and suffers from the size limitations imposed by

that technique. It is an annual model with fewer nodes than has CORN.

Although CRIM can solve for the economic optimum, that optimum is a static, single-period one. Consequently, there is some question as to how significant its determinations may be. Ideally, one would choose a dynamic programming or optimal control model rather than quadratic programming, but such techniques are even more seriously afflicted with what Richard Bellman called **?**the curse of dimensionality". Using one of them would have exacted too heavy a price in the oversimplification of a complex system.

The third of our Colorado River system models was AZCOL, a simulation model like CRSM, but one constructed with the aid of a simulation modelling tool, the STELLA II computer program from High Performance Systems, Inc. STELLA II is based upon formulating and solving a system of first order difference equations. It is extremely flexible, easy to use, has a graphical interface, and has an excellent interactive capabilities. Representation of basin hydrology, of management facilities, and of current operating rules follows CORN, while estimation of benefits from Colorado River water use and salinity damages is based upon CRIM (Lord et. al., 1994). Environmental impact indicators (missing in both CORN and CRIM) were developed by Hardy (1994).

AZCOL is more visual, faster, and more easily manipulated than are the CORN and CRIM models, each of which is in some respects more powerful analytically. It is an annual model of the basic hydrology of the basin, with at least one withdrawal point for each of the seven states which use Colorado River water, basically the same level of aggregation as that of CRIM. Allocation of the river is governed by the operating rules for storage and delivery of water. The priorities and operating criteria which make up these rules are incorporated into AZCOL using basic logic statements to govern reservoir operations and withdrawal. AZCOL also models salinity throughout the basin, evaluates the dollar benefits from the use of Colorado River water in each state, along with hydropower and recreational benefits, and provides general indicators of the condition of environmental resource elements, such as threatened or endangered species.

CORN was run initially using the existing operational choice rules (the law of the river) and a single scenario incorporating current water demands and the inflows which characterized the severe sustained drought. This provided the data base for defining the problems which such a drought might create, and thus permitted the lawyers and institutional analysts to design institutional changes which might permit the basin states to better cope with a severe drought. These institutional options, and others devised during the gaming exercises, were then evaluated through gaming, as described below, and using a moderate demand growth scenario in conjunction with the SSD. Next, the most successful changes were evaluated through returning to CORN for more detailed and definitive impact projections. Finally, these changes, and a few additional ones, were compared with an economic quasi-optimum produced by running CRIM with the same scenario, but with institutional constraints relaxed, as appropriate. In this way, the analyses utilized the advantages of each of the three models, while by-passing at least some of their drawbacks.

The Operational Choice Rules

A menu of possible changes in operating rules for the interstate allocation and management of Colorado River water was developed by SSD institutional specialists (MacDonnell et. al., 1994)). In addition, the SSD team recognized early on that the basin states were not limited to revising interstate water allocation rules to cope with drought. A state could change the water allocation and management rules within its own boundaries without the need for interstate negotiations. An earlier SSD report had described some of these intrastate possibilities (Gregg and Getches, 1991). Consequently, although our principal focus was upon interstate water allocation rules, three intrastate options were provided to permit states the additional flexibility of adapting internally to drought. Those three options were (1) a rigid interpretation of appropriation doctrine, in which water was allocated strictly by seniority, and no transfers were permitted, (2) a system of proportional sharing of shortages, regardless of seniority, and no transfers were permitted (rather like a riparian system or somewhat loosely resembling the procedures followed for administrative allocation within many water districts and (3) free marketing of water during shortages, in which water was distributed according to marginal value in use. The upper basin states were assumed to follow option 1 initially, while Arizona and California were assumed to follow option 2 (Nevada has only one Colorado use, that of Las Vegas, so allocation of shortages is predetermined).

Finally, the research team recognized that one of the most interesting responses to crisis is the ability of participants to learn, to collaborate, and to create new solutions which may not have appeared obvious beforehand. Therefore, subjects in the gaming experiments were permitted and encouraged to devise additional rule changes in the course of playing the games; rule changes which might be more responsive to emerging drought-related problems than were those devised by the research team.

Institutional changes, or alternatives to the law of the river, originating both from the analyses of team members and from the deliberations of the players in the gaming exercises were expressed appropriately in the CORN, CRIM, and AZCOL models.

The Collective Choice Rules

By collective choice rules we mean the rules which govern how decisions are made about operating rules (which, in turn, are in this case the rules for operating the Colorado River water management facilities, mostly composed of federal reservoirs and desalination projects). They are called *collective choice* rules because the decision making process conducted pursuant to them involves multiple decision makers who must act together, rather than individually. The meeting held at Bishop's Lodge, near Santa Fe, in 1922, at which the scheme for dividing the use of the river’s water between the upper basin and lower basin states, and which later became the Colorado River Compact, is an example of the collective choice process.

One of the rules of that process was that the agreement of all of the basin states was required. When Arizona subsequently repudiated the Bishop's Lodge agreement, the remaining states took another tack and referred the matter to the Congress, something which the higher *constitutional choice* rules permitted them to do. The Congress, in passing the Boulder Canyon Project Act in 1928, acted under a different set (or perhaps

simply different provisions) of the collective choice rules, which did not give Arizona a veto. Years later Arizona accepted the *fait accompli* and ratified the Colorado River Compact, in order to pave the way for authorization of the Central Arizona Project.

The Supreme Court has also played a major role in allocating use of the waters of the Colorado, as is most evident in Arizona v. California. The collective choice rules which govern such court actions are quite different from those of the legislative process. The members of the Court may vote, but the parties at interest do not. Their roles are to present evidence and arguments for the court to consider.

Today's collective choice rules are complex and manifold. The rules for negotiating any division of the waters of an interstate river by interstate compact remain as they were in 1922. The rules for authorizing, constructing, operating, and allocating water from a federal water project have been changed in detail since 1922, but like the rules for negotiating an interstate compact, they still require Congressional action. The procedural rules of the Supreme Court are basically as they were in 1922, as well.

Other existing collective choice rules are less formalized and do not require legislative or judicial action. The Secretary of the Interior has the authority to promulgate rules for operating the Colorado River management facilities, so long as he observes the provisions of international treaties, interstate compacts, and federal statutes in doing so. The Secretary's operating criteria are published in the form of federal regulations, but the process for deciding upon them is not clearly specified. Nominally, the Secretary need only obey existing law, make his intentions public, and provide for public and Congressional review and comment. An informal process of political negotiation precedes the issuance of such regulations, and the accession of the principal affected interests is almost always needed. But just what the rules governing this informal part of the process may be is something which is unrecorded, however well it may (or may not) be understood by the participants themselves.

Gaming and Game Theory

Gaming is the technique of placing subjects in an environment which requires them to make joint or collective decisions among hypothetical options, the prospective consequences of which are shown to them as their interaction proceeds. Repeated "plays" of these games, under differing scenarios, allow subjects to explore the likely impacts or consequences of their collective options by playing "what if?" games. Studies have shown that it is usually possible to discover options which can perform substantially better than existing operating rules in coping with drought or other system-wide water problems (Sheer et. al., 1989). Participants in the sort of gaming exercises which were used in the SSD gaming study can evaluate their alternatives at far less cost, whether in time, money, or other resources, by gaming than by trying out these options in a real setting. Furthermore, repeated trials enable otherwise irreversible mistakes to be discovered within the gaming environment, and avoided outside of it. Gaming has become a more practical tool for both research and decision-making since scenario con-struction and display has been greatly facilitated by the advent of electronic computers .

One of the most attractive features of gaming is that participants may be less guarded and more cooperative when interacting in a non-binding and hypothetical decision making environment than in one where they must live with the consequences of collective decisions which are reached. Real decision makers can interact with each other in a non-threatening situation in which they do not have to live with the consequences of bad decisions. By removing this risk, decision makers can be more innovative, and can together discover options which would constitute too great a gamble to try when every mistake carried potentially serious consequences. Gaming may thus be thought of as a simulation of the collective choice process, in which improved operating rules may be discovered and evaluated.

It is possible, when conducting gaming exercises, to carefully specify the collective decision rules which apply. Most gaming exercises have not done so, because the objective of the gaming was to discover operating rules which perform better than those currently in place. The unstated underlying assumption is that in the real world decision makers can actually adopt and implement any superior operating rules which may be uncovered through gaming. But the risk in such a procedure is that what was discovered in the gaming and what can actually be adopted and implemented in reality are quite different things. It may be impossible to adopt and implement superior operating rules because the existing collective choice rules make such decisions impossible to achieve. The results of gaming experiments may show great gains to cooperation, but these gains may not be attainable in reality if they do not meet the Parieto-optimal condition in which all participants emerge better off than without a change. But this is a function of the prevailing collective choice rules, such as whether decisions are made by the majority or unanimity rules, and whether potential winners are able or required to compensate potential losers.

A somewhat different use of the gaming technique is to specify the collective choice rules and to require group decision making to follow these rules. In this approach, which was the one we followed in this study, differing collective choice rules can be compared and evaluated. It is then possible to see which of *these* rule sets lead to the adoption and implementation of the "best" sets of operating rules (as measured by the consequences of adopting and implementing them). In this way, gaming can be used to discover superior rule sets (institutions) at *both* the operating and collective choice levels.

The theory of games (von Neumann and Morgenstern) provides a mathematical basis for analyzing collective choice behavior, in which the participants pursue their separate interests but are, at the same time, bound together by a shared or common interest (in resolving conflict, if nothing else). The collective choice deliberations among the Colorado River Basin states and the federal government may be thought of as an n-person, partially cooperative, dynamic game. The collective choice rule sets to be compared in this study were so characterized (the basic difference between them being the extent of information sharing and other forms of cooperation permitted). Gaming is a learning process, in which the participants' information about their possibilities and consequences increases over time. Therefore, the payoff functions may change over time, based upon both learned information and the results of coalition formation. Our game-theoretic analyses helped us to define the three collective choice rule sets which

distinguished the three gaming experiments.

We selected three sets of collective choice rules for evaluation in the SSD gaming experiments. All three were believed by institutional specialists to be applicable without legislation or judicial action. The first of those three sets of collective choice rules was the *status quo*, here used to mean the rules governing those collective choice processes which have already been used. Essentially, this is the process by which the Department of the Interior, in consultation with the seven basin states, settles upon operating criteria for the water management facilities. We interpreted this to mean that any appreciable changes in current operating rules would have to be agreed to by the Secretary of the Interior and all of the seven basin states. Gaming participants representing these eight entities are often called "players" in the following discussions. Limited information about water management and its impacts would be provided to each basin state by the Department, but no basin state would have detailed information about the economic impacts to other states or their assessments of those impacts. In other words, collective decision making would resemble a poker game, with ample opportunity for bluffing and misunderstanding, although the unanimity voting rule would still apply. These rules governed player interaction during the first gaming experiment, which was conducted by e-mail, thus preventing the players from conducting face-to-face, and possibly bilateral, negotiations. Game theorists would call this a noncooperative game with incomplete information.

The second of our collective choice rule sets was intended to simulate the essential aspects of a river basin commission. Several scholars, including some on our own SSD team (MacDonnell et. al., 1994) have suggested that such a commission (not a conventional federal-state interstate river basin commission under federal law) could be established by the basin states without legislative or court approval, should they decide to do so. Its powers could be more limited than might those of a federal-state commission, but it could still address many of the deficiencies of the existing institutional arrangements. In particular, such a commission could provide more extensive and more objective information to the states than they now receive, and it could provide a setting in which they could interact regularly and with the advantage of a shared data base. The aggregation rule used by such a commission would continue to be the unanimity rule which now obtains in most such interstate situations. The second SSD gaming experiment was conducted pursuant to such rules. The players were assembled in a single location, and the information which was produced was essentially available to all. Their interaction was facilitated by the possibility for group discussion. No bilateral discussions were permitted, however. This is a partially cooperative game, in the language of game theory.

The third collective choice rule set was much like the second, with one very substantial difference. It was intended to simulate an environment in which states could make bilateral decisions, provided that those bilateral decisions did not affect other parties. In particular, individual states were permitted to bank unused water allotments, up to the limit imposed by existing storage capacity, and to sell or lease water between states. We called this the water banking and water marketing option. The aggregation rule no longer called for unanimity in decision making, although it did safeguard third party interests

through making the Secretary of the Interior the referee who could veto any bargain which produced such external costs. In the language of game theory, this was a cooperative game in which coalition formation was possible (each set of buyer and seller, or lessor and lessee, is, in effect, a coalition). For this, the third gaming experiment, the players were again assembled in a single location, were allowed to make collective decisions exactly as in the second experiment (in fact, they made virtually the same collective decisions), and received the same type of information. However, subsets of players were allowed to confer privately, as they liked, and to reach agreements which could then be submitted to the Secretary of the Interior for his approval before taking effect.

Evaluation

The SSD research program was remarkable and, we believe, unprecedented in the degree to which economics was incorporated into its water management models and the analyses which were based upon those models. However, it was far from perfect in this respect.

Positive Analyses of Water Allocation Institutions

The interstate water allocation institutions at the operational choice level, what we and many others call the law of the river, were quite well represented in all three of the water management models employed. Lawyers, engineers, and institutional analysts cooperated, with considerable consultation with advisory committee members and others, in providing detailed descriptions of the complex law of the river, including its ambiguities. These descriptions were then transformed into logic statements usable in CORN, CRIM, and AZCOL. Finally, the logic statements were reviewed by those who had provided the original descriptions before incorporation in the three models. Considerable effort and discussion went into this process, and we believe that the existing interstate operational choice level rules are as well represented as is possible, given the several ambiguities and controversial interpretations which still exist. The notable exception to this somewhat sanguine conclusion is that Indian water rights were not represented in the models at all. In part, this is because those rights remain largely unquantified, since so few adjudications have been completed. Another reason is that the Supreme Court announced in Arizona v. California that Indian rights should be included in the state allocations established by the law of the river, and not be apart from those allocations.

Existing intrastate operational choice rules were not nearly as well-captured in our models as were interstate rules. Of course, the point of the research was to evaluate interstate rules, so this is not as serious a matter as a corresponding failure in that arena would have been. Some states lack a complete and current compilation of water rights, so that it is simply impossible at this time to provide a satisfactory definition of the intrastate operational choice rules. In lieu of such a description (which would have been unwieldy, due to the thousands of individual rights involved in such states as Colorado), we adopted the convenient fiction that agricultural rights were homogeneous at each node, and senior to any municipal and industrial rights at that node. Thus, any shortfall in ability to satisfy existing rights was born by municipal and industrial users, except in those situations when water transfers were permitted by intrastate rules, in which case shortages were born

entirely by irrigators.

In fact, agricultural rights are not universally senior to M&I rights, although that is usually the case. Furthermore, water transfers do now occur in all states, so that some shortages would inevitably be born by irrigators. Much of the water in the upper basin states (Colorado, New Mexico, Utah, and Wyoming) is allocated by appropriative rights, and the barriers to free transfer range from minimal (New Mexico) to substantial (Colorado, where the transactions costs inherent in the water court system can delay and discourage transfers, but in all of these states, restrictions on transfers to protect other appropriators and, to varying degrees, public interests, are in place. The upshot is that some transfers do now occur under unmodified appropriation doctrine, and adopting state policies to encourage and facilitate transfers would still not result in the economically desirable end of shifting shortages entirely to the lowest valued uses.

Water allocation in lower basin states (Arizona, California, and Nevada) generally occurs through administrative actions by water districts, and not directly through appropriative rights. It is even harder to predict how shortages will be apportioned under such circumstances. Some districts cut users back in uniform proportions. Others impose more substantial cutbacks on irrigators than on municipalities. Still others permit water banking, and some allow for ground water availability. As a practical matter, lower basin drought impacts in our studies fell only upon Central Arizona Project water users (CAP is junior to other lower basin rights), and we initially assigned such shortages entirely to agriculture, since non-agricultural uses remain small and agricultural users must be subsidized to persuade them to use costly CAP water in any case. This latter consideration caused the Arizona player to refuse to use his CAP entitlement (we assumed that he could avoid the cost of CAP water by so-doing, an unrealistic assumption), and by consequence, all lower basin shortages disappeared.

Hydroelectric power presented another difficulty to the system modelers. Peaking power produced by hydropower installations is much more valuable than is base load power. However, the degree of peaking use of federal facilities on the Colorado River is highly variable. We know that we failed to estimate the current proportions accurately, and no one can tell what those proportions will be in the future.

In addition, load centers throughout the western states are now interconnected through high voltage transmission lines. This permits substantial savings through routing surpluses at some locations to locations of scarcity elsewhere, on both diurnal and seasonal bases. An accurate estimation of the true economic value of Colorado River hydropower would have to be based upon a regional analysis, using an electric power supply and demand systems model no less complex than our hydrologic-institutional-
economic models of water allocation. We had no such model, although steps are now being taken to remedy that deficiency.

Our salinity analyses, too, suffer from approximations. We believe that we have a reasonable quantification of salinity sources and of salinity transport and dilution within river reaches. The difficulty arise with predicting the effects of system reservoirs upon the

salinity of releases from those facilities. To predict the transport, mixing, and capture of salinity in reservoirs such as Lakes Mead and Powell requires three dimensional models of those reservoirs; models which far exceeded our capabilities and data sources for their construction. Consequently, we devised approximations which remain unverified, although we believe them to be reasonable.

Normative Evaluations Of Water Allocation Institutions

Our normative evaluations of operational choice water allocation institutions must be viewed with even more caution than our positive analyses of the functioning of those institutions. First, any normative evaluation rests in part upon the behavioral, or positive, analyses which form a necessary part of it. If the predictions of water uses are in error, then the evaluation of those uses will be correspondingly in error. And, there is the inevitable problem of the other basis for normative evaluation, which is the validity of the representations of the underlying values to be served. Economic models in general assume, at least implicitly, that the distribution of claims on scarce resources, as represented by the distribution of income and wealth, is optimal from a societal perspective. Otherwise, willingness to pay, the foundation for all demand curves, does not reflect society's values. Furthermore, economic models usually assume that individuals' values, as expressed through market behavior, are all that count, and that collective or societal values, such as those expressed through political behavior, can be ignored. These two concerns, of course, are not unique to the SSD studies, as they characterize all normative economic analysis.

The SSD normative evaluations rest upon other weak reeds, as well. I have already alluded to the assumption that all water uses of a given type were homogeneous at each node. Although our quadratic programming (CRIM) and simulation (AZCOL) models utilized negatively sloping demand curves rather than point estimates of future water demands, and they further accounted for prevailing crop mixes, they are still far too aggregative to provide more than very approximate estimates of marginal water values. More serious still is the static nature of the optimization carried out by both the CORN and CRIM models. The whole essence of drought management on a highly regulated system like the Colorado is optimization over the full extent of the drought period, not individual optimizations for each of thirty eight years. There is great doubt in my mind, although that doubt is not shared by some of my colleagues, that year by year optimization tells us much that is useful, in such a long term evaluation. As I have said, an optimal control or dynamic programming analysis would have been far sounder conceptually, but would have forced such a high degree of aggregation as to have invalidated the analysis on that ground.

Another source of error in the SSD economic evaluations was the complete neglect of the transactions costs of water transfers, whether between individual water users (known to be high in Colorado, for example) or between states (obviously even higher, as the protracted negotiations over possible use of CAP water outside of Arizona demonstrate). We also failed to deduct the costs of delivering irrigation water on a site-specific basis, except in the case of CAP water, where those costs are very large indeed. However, the marginal water values used are already at least partially net of delivery costs.

It is certain that some external costs of consumptive water uses were not included in the analyses. Some of those externalities were deliberately not expressed in monetary terms, as was true of impacts upon threatened and endangered species, either because we did not believe that monetary estimates would be appropriate in the first instance, or because we did not believe that we could find or construct valid monetary estimates in any event. They were, however, displayed in the gaming analyses, so that players would have the facts upon which to base their own value judgments. But other external costs were surely missed. And, in any case, these external costs did not enter into the optimization (CRIM) analyses, casting further doubt on the validity and utility of those analyses. Finally, we neglected any and all indirect benefits and costs of water use. Although most economists believe that such indirect effects have often been over-valued, there are few who would argue that they are never real.

Two more major points deserve discussion under the heading of normative analysis. First, the SSD research was concentrated upon consumptive water uses. Although such non-consumptive uses as hydroelectric power generation, water quality control, environmental protection, and water-based recreation were included, they received somewhat cursory treatment when compared with that given to consumptive water uses. In part this reflects the preoccupation with consumptive uses that SSD researchers shared with Colorado Basin state water decision makers. In the gaming experiments, in particular, the players were instructed to make their decisions as they thought real state water decision makers would do, and not to let their own values and preferences intrude upon the process. To the extent that they succeeded, the positive analysis is realistic and its results reliable. However, the corollary is that the biases of western water leaders drove the analysis, biases which are well-known to have favored consumptive uses historically.

The final criticism of the analyses of the SSD research program is that they were confined to looking at the implications of a severe, sustained drought. This initial and continuing focus is quite in line with the preoccupations of the natural hazards researchers who initially suggested the project. Taking this limited approach certainly exposed quite dramatically some of the chief drawbacks of the current law of the river. However, it did so at the cost of possible credibility (many decision makers feel justified in ignoring the potential impacts of so improbable an event as a five-hundred year drought) and at the cost of failing to expose other system drawbacks which may be more chronic and more fundamental, such as the undervaluation of non-consumptive water uses.

In closing, I would like to reiterate my enthusiasm for integrating economics, broadly conceived to include institutions at both the operational and collective choice levels, in water management models. The SSD program, for all of its shortcomings, demonstrated clearly the advantages of such integrated models. Without them, we could not have evaluated as successfully institutional options in terms of their effects upon water users. We would not even have discovered some institutional options which merit consideration unless we had the systems models to reveal potential problems. The Colorado River water management system behaved under stress in ways that were not completely predictable, and no one had devised options for addressing those ?surprises." The gaming experiments added a further dimension to this capability, by stimulating the creative thinking of the players. Their interaction with each other proved to be a powerful advance over the usual

independent and so-called objective analyses of academic research. Gaming cannot and should not take the place of detailed professional analysis, but it is a powerful complement to it.

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PANEL REMARKS FOR SRIEG-10 MEETING
Auburn, AL, May 18, 1995

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I will organize my remarks for today's panel by making five assertions, followed by four implications. My purpose is to generate discussion.

Assertion 1

Water policy analysts now acknowledge and promote the legitimacy of "deal making" for socially responsible water allocation.

Over the years the dominant presence of negotiation and bargaining--deal making--in water resources management was often described with the pejorative term "pork barrel." In turn, the asserted bankruptcy of interest group politics was cited as justification for using carefully constructed technical analysis to expose the inefficiency and inequity of the water deals that were being struck. In the past, the "deal" was the enemy of the public interest, while technical analysis divorced from interest group influence could define that public interest.

Today the focus of water allocation is on negotiation and agreement among interests ("stakeholders" is the buzz word) as the best way to discover the value of water in alternative uses. This is seen as a substitute for the increased reliance on litigation. Today, the consummated "deal" defines the public interest. The "deal" is said to be just and equitable, because compensation for losses borne by all affected interests is made. If the "deal" happens at all, that is evidence that the resulting decision is economically efficient, much as we presume voluntary exchange relationships in markets yield efficiency. And "the deal" is the way to gain political acceptance in situations that have too frequently been characterized by stalemate.

Assertion 2

Physical scarcity of water has not been, is not now, and will not become a dominant challenge for Southeast water management.

In general, the engineering hardware now in place will let us manage around potential conflicts--for example, by creative use of reservoir storage re-allocation and system re-operation. In this sense, water conflicts are conflicts over the management of capital

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*These remarks are based upon "Conflict over Eastern U.S. Water Transfers: Toward a New Era of Negotiation?" (Leonard A. Shabman and William E. Cox) and "Bargaining and Water Disputes: A Perspective on the Coming Decade" (Leonard A. Shabman), both in Water Quantity/Quality Management and Conflict Resolution: Institutions, Processes, and Economic Analyses, Ariel Dinar and Edna Tusak Loehman, eds., Praeger Publishers, 1995, 515 pp.

facilities. Conflicts associated with low frequency dry weather events (droughts) will be managed on an emergency basis or in the context of drought contingency plans. However, the general abundance of water will make the urgency of such planning disappear as the water returns.

Still, perceptions of physical water scarcity will remain strong, especially in economically poor, but water rich, areas. In these places a misconception about water availability and future economic growth potential will be especially strong. Of course, in small geographic areas of urban concentrations, scarcity is a reality, and the need to transfer water for consumptive purposes will remain.

One qualification to all that I have said above may be in South Florida, ***if*** hydrologic restoration of the Everglades is pursued. In that case there may be a genuine competition for limited water in a ***routine*** water year.

Assertion 3

Water law *per se* is of limited influence in water allocation.

This assertion rests on the observation that the certainty and specificity of use rights are strongly influenced by ancillary laws such as Section 404 of the Clean Water Act (CWA) and the Endangered Species Act (ESA) , more than by state water codes. This is the case even where administrative permitting of water use has replaced common law doctrines.

Assertion 4

Aspects of ancillary laws that have been severe restrictions on the exercise of water rights, and on deals for water allocation, will soon be modified.

The best alternative to negotiated agreement for many stakeholders in water conflicts was to employ the machinery of Section 404 of the CWA, the ESA, and similar laws as a non-negotiable position. One particular aspect of these laws is that compliance *in the recent* past has defied a technical fix. You could comply with certain water quality standards by building a waste treatment plant. You might appease recreational stakeholders by building a recreational marina to replace one that was destroyed or by building a fish hatchery. However, the administrative application of 404 and the ESA, and judicial interpretation, frowned on this trade-off logic. Protection of geographic sites became the focus and the possibility of loss mitigation where a site was altered was dismissed as impractical and compensation for losses was considered impossible. These laws became constraints--very tight one--on the water allocation process.

These Federal laws will be reformed and the rigidity reduced. Drier end wetlands and small habitat patches will be exempted from federal regulation. Also, wetlands and critical habitat will be traded across the landscape, as mitigation opportunities are considered as part of the compensation offered in deal making. However, there will continue to be numerous decision points, so the process of reaching agreement will remain cumbersome.

Assertion 5

Southeastern water allocation and use disputes are frequently not about water availability.

In my experience there often are multiple political jurisdictional issues on the table and among these is water. Often the question is who wholesales water to whom, because the water wholesalers can use surplus of receipts over costs to pay for the school expansion, the police or the library. In other cases the issues are related to who bears the costs for a beneficial water reallocation, even one that meets a potential parieto efficiency test.

Implications

Implication 1: Deals will increasingly be multiple issue, where water allocation considerations are only a part of an agreement.

Along the Virginia-North Carolina border the Lake Gaston pipeline controversy continues. The prospect of settlement between the states has now been significantly increased as Virginia has agreed to seek highway improvements for roads leading into North Carolina and has provided assurance to North Carolina that they can have access to the pipeline. The highway construction component of this agreement illustrates that deals will be multi-issue. However, the City of Norfolk, which wholesales water to the region, has objected to the agreement because it limits Norfolk's ability to sell water at a "profit." The Norfolk concern about this agreement illustrates how financial factors, not water scarcity, often are barriers to agreements.

Implication 2: Environmental aspects of deals will be watershed and landscape management oriented and not site protection oriented.

The best example is the deviation from the current approach to wetland mitigation. In the future, the quality of the wetland mitigation offered will be an early influence on regulatory decisions, and mitigation that is off-site and is placed in a watershed setting will be favored. Also, environmental regulations will be met by making cash payments that can be dedicated to environmental restoration at a watershed scale, whenever a water allocation decision is deemed to have adverse environmental effects.

Implication 3: Technical analysis, as we heard of it today, will be in support of deal making.

There will be a need for continuing development of economic, biological, chemical, physical and engineering analysis of water resource systems. Economic analysis must focus on such matters as demand and supply elasticity estimation, water conservation cost effectiveness and the potential for tax increment financing. There will now be a need to make the findings of those efforts accessible to all parties to a negotiation. Shared vision planning, as discussed elsewhere in this workshop, can make a critical contribution. In general, analysis is intended to help the various participants in the decision process form and reveal preferences in order for the trade to proceed.

These analytic efforts may not bring immediate agreement. Agreements that are reached will be temporary and will be revisited and revised (often with renewed conflict) over time. However, what is not needed is for economic analysts to tell participants the values to them of the water and related resources over which they are bargaining. This is why the current infatuation by the economics profession with non-market valuation methods is a concern to me. An economic valuation of the services of a water resource is a substitute for, not a complement to, the bargaining process. Such analysis cannot anticipate or capture all the possible tradeoffs that will be considered and created in the process of deal making.

Implication 4: Economists need to pay increased analytical attention to rules for structuring the bargaining process

Market organization is a special case of a bargaining relationship among individuals. In markets there are many buyers and sellers and from the numerous interactions terms of trade which apply to all of them emerge. In markets face to face negotiation is eliminated and traders become price takers, but the prices are still the result of voluntary agreements among traders. Markets are therefore one way to play the bargaining game, but not the only way. What is needed is work to describe how all sorts of organizational rules (even when true markets are not possible) affect bargaining processes and the efficiency and equity of outcomes.

Some of this work is underway. For example, one study shows that negotiated solutions may not achieve equity and economic efficiency if there are limits on the use of side payments. The point about side payments is more of a caution than a condemnation of a bargaining process, but support the advantage of multi-issue bargaining.

Others have noted the efficiency and equity consequences of cost shifting or, in the current jargon, “rent seeking” behavior. To discourage rent seeking beneficiaries must bear the costs of an action, otherwise the potential for cost shifting to others, especially Federal taxpayers, will make the outcomes of the negotiation optimal for the parties to the negotiation, but will come at a cost to the society at large.

Still others have noted that the negotiation outcome will not be “fair” or “just”, unless there is consideration of the relative power of those who are represented. Finally there are some who are concerned that the negotiated solution will not result in the correct outcomes. For these people, the nature of the outcomes themselves must be a criterion for judging the bargaining process. Therefore, no matter how well a negotiation process is structured, there will be some who will reject the validity of the “deal.”

SECTION II

Incentive-Based Approaches to Environmental Regulatory Reform

OVERVIEW OF INCENTIVE-BASED APPROACHES TO ENVIRONMENTAL POLICY

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Regulatory reform is almost always a popular policy issue in election years, and 1996 is no exception. However, the ongoing discussion of regulatory reform, especially environmental regulatory reform, in which we find ourselves participating seems to have begun in earnest around 1990. It has continued, fueled by debate over the Clean Air Act Amendments, Vice-President Quayle's Competitiveness Council, Vice-President Gore's environmental policy position and reinvention of government, the Republicans' Contract with America, and works such as Philip Howard's book *The Death of Common Sense.*

Economists in general have been excited that debates over reform have included recommendations and initiatives which suggest more market-oriented approaches for achieving environmental policy goals as alternatives to traditional command and control regulations. Natural resource and environmental economists who work closely with agriculture and related resource issues are watching developments in this area closely, interested in the implications for nonpoint water pollution control programs, wetland and habitat protection issues and other resource issues closely tied to agricultural production. Most of those who have watched the evolution of environmental policy would acknowledge that agriculture has, by and large, lost its status as a protected industry. However, although agriculture as an industry will be treated more like other industries in terms of requirements for environmental protection, agriculture will not necessarily find itself subject to the kinds of command and control regulations under which other industries have operated for more than 25 years. Because of the growing interest in and acceptance of more flexible incentive-based approaches, those are the models to which agriculture should be looking as it ponders its future with regard to environmental policy. It is fitting, then, that our group explores this area.

An Introduction to Environmental Regulatory Reform

At the 1996 SAEA meetings, SRIEG-10 sponsored a general session on the topic of environmental regulatory reform. In that session, Roy Carriker presented an overview of environmental policy beginning with the National Environmental Policy Act (NEPA) signed into law in 1970. Carriker's presentation provided a good background check on how we've gotten to where we are in our array of federal environmental laws. Next, Craig Infanger discussed the way in which much of the environmental regulation reform debate has centered around the issues of property rights, unfunded mandates, and risk assessment. Infanger's thesis is that the congressional wrangling over these issues, as well as activity taking place in state legislatures, does not reflect questioning of the fundamental goals of environmental policies, but rather an attack on the methods or means by which goals are being pursued--methods that appear to ignore any balancing of interests. My observation is that debate over each of these issues arises from three fundamental questions: 1) how much is the American public willing to pay to meet

environmental quality goals? 2) how are these costs to be distributed? and 3) are there more cost-effective methods which might be implemented?

Finally, Leonard Shabman, Kurt Stephenson and Paul Scodari addressed the role that economists have played and can play in helping to design more market-oriented environmental policies. However, their central theme is that economists, as a discipline, do not necessarily agree on how incentive-based approaches should be designed or implemented. They placed economists' perspectives into four categories:

1) Rational analysts--who rely largely on cost-benefit analysis to determine the appropriate environmental policy tool with environmental quality goals set so as to maximize net benefits.

2) Cost analysts--who conduct comprehensive accounting of costs of alternative approaches, seeking that alternative which minimizes the total cost of achieving a given environmental goal.

3) Market managers--who view design of the institutional framework for market approaches as the critical problem in environmental policy, once environmental goals are established and responsibility for the cost of controlling environmental problems is assigned.

4) Free market environmentalists--who argue that unattenuated property rights to all environmental resources and liability rules based in common law will stimulate a bargaining process which will assure the efficient level of environmental quality.

Fundamentally, then, economists may disagree about how and by whom environmental goals should be set, how rights to the environment should be assigned, and how and whether benefit-cost analysis should be used. In the final analysis, Shabman, et. al. concluded that, while economists agree that price incentives are a more effective way to design environmental programs than traditional command and control, there are different perspectives on how economists, in research and policy advising, can make a contribution.

An Overview of Incentive-based Approaches

What are the approaches that can be used to establish a price signal or foster a market for environmental protection activities? Hahn and Stavins describe five types of incentive-based options:

1. Market barrier reductions
2. Government subsidy elimination
3. Deposit refund systems
4. Pollution charges
5. Marketable permit systems

Many policy-induced market barriers and government subsidies can promote inefficient and environmentally unsound decisions. In the absence of voluntary exchange of water rights, for example, scarce water resources are often used inefficiently, and costly and unnecessary water supply projects are undertaken. Similarly, subsidies can encourage excessive use of resources; an example is U.S. Forest Service below-cost timber sales which encourage excessive timber cutting and lead to loss of other resources. Market barriers and government subsidies both function to send improper price signals to decision makers.

Deposit refund and pollution charge systems reflect attempts to identify the right price for certain resources. With deposit-refund systems, surcharges are paid by consumers when they purchase potentially polluting products. The deposit is refunded when pollution is avoided or prevented. Thus, in theory, the cost of pollution is set. Bottle bills are a common example. Pollution charge systems ideally impose a tax or fee on pollution, not just on pollution-generating activities, and cause firms to internalize previously external pollution control costs. Charges can minimize the total costs of pollution control, since each discharger has the incentive to control up to the point where the marginal cost of control just equals the fee. However, a disadvantage is that the regulatory agency cannot know for certain what level of control will result from any given fee.

Finally, with marketable permit systems an overall level of pollution is set and allocated in the form of permits among firms. Firms trade permits among themselves according to their individual pollution-control costs. Those dischargers with less costly emission controls can take responsibility for a larger portion of total emission reduction, thereby reducing the total cost to society of meeting pollution control requirements.

Systems of marketable permits are receiving the most attention currently. They also represent some of the most interesting and innovative new environmental policy directions. Our meeting agenda today focuses primarily on these kinds of programs. Because of the interest in and activity related to marketable permits for various kinds of environmental-impacting activities, and because that is largely what we will talk about today, I want to raise a few issues related to the implementation of permits systems. Some are red flags and some are white flags. But all deserve some thought as we hear from the speakers today and proceed with our discussions.

Issues in Permit Markets

What do we know about how well the existing markets for emission permits have functioned? For that matter, how do we determine whether the markets are achieving the desired outcomes? The relatively small number of trades occurring in the market for SO_2 emissions has led some critics to suggest that the program is not working. Reasons for the low number of trades are severa--a central one is that the flexibility provided to utilities by the introduction of performance standards has enabled many to achieve savings in pollution control costs so that discharges are reduced at lower cost and discharge permits are not needed (Burtraw). In the absence of former technology-based standards, the incentive for trading is reduced.

The existence of considerable transaction costs may be another factor limiting the number of trades occurring. Transactions costs in discharge permit market sales may arise either from the search for a trading partner or from costs associated with bargaining -- resource, information, brokerage and legal and other service fees. Transaction costs lower the gains from trade for buyers and sellers (Stavins).

A third source of transaction costs is the monitoring and enforcement of permit trades. These costs which are borne by the public rather than the permit buyer or seller and which can be significant, are in addition to the set-up and administrative costs that the managing government agency must bear. Market-oriented approaches are generally hailed as more cost-effective than other, more traditional approaches. However, where the costs of managing the program are particularly high, especially in the early years of the program, an incentive-based program, such as the marketable discharge permit system, can be more costly than other approaches. Those who are certain that these alternatives are less costly than traditional command and control programs may be disappointed, especially early in the program's life.

Some critics have pointed to the very low prices brought by SO_2 permits recently as evidence that the program is not achieving the optimal level of pollution control. They argue that initial allowable levels of discharge, based on a given marginal benefit and marginal cost of pollution control, were set too high. With the flexibility of the program and the ability of dischargers to seek low-cost control technologies, the intersection of marginal benefits with the new, lower marginal cost curves occurs at a lower level of discharge and reveals that a greater level of pollution control is the true optimum.

How should these market dynamics be handled? In theory, if the regulating agency wishes to further restrict the allowable level of emissions, it can reduce the number of permits available or reduce the amount of emissions allowed with each permit. However, the uncertainty associated with how the regulating agency may choose to make this change can be detrimental to the functioning of the permit market. First, if a firm considers investments in pollution control technology based on a given permit value, it requires some degree of certainty as to that permit value. If future market conditions are unstable, firms may retreat to a pollution control system outside the market. Second, the impacts on the market differ widely if the regulatory agency chooses to purchase permits to tighten discharge allowances or if it chooses to somehow reduce the amount of emissions allowable with each permit. There are interesting legal implications associated with changing permit values. If a company purchases the right to discharge a given amount of SO_2, for example, it may well claim a taking has occurred if the allowable discharge is reduced.

Finally, the design of the marketable permit system is of interest. Stavins has identified five points in the "product cycle" at which pollution can be regulated or market-oriented approaches can be applied. At the simplest level, *inputs* to production processes are the focus. In increasingly more complex and costly programs, *emissions*, *ambient concentration*, *exposure* and *risk* may be targeted by a regulatory or permit trading (for example) approach. Theory tells us that we move closer to the optimal level of polluting activity as we move along this continuum, but public monitoring and enforcement costs

and private transaction costs increase as well. This is one reason that we have, to date, seen functioning markets only for input and emission permits. Ongoing efforts to establish markets in which point and nonpoint dischargers to water trade discharge allowances under a Total Maximum Daily Load (TMDL) move us closer to a system in which rights to ambient concentration are traded. The complexity of this kind of system, and the costs it carries, have worked to limit the implementation and success of such programs to date. Such issues are rightly the focus of ongoing research.

In 1981, a survey of congressional staff members found that Democrats generally did not favor economic-incentive approaches to environmental protection. Nor did they really understand them. The survey found that Republicans did support incentive-based approaches although they did not understand them either (Kelman). Hahn and Stavins suggest that, if we checked today, we would likely find considerable support for incentive-based systems among both Democrats and Republicans. However, we would not necessarily find a significant increase in understanding. While economists bear the responsibility to provide research in the area of environmental policy tools, we also bear an educational responsibility. The advantages of alternative approaches can be described, but policy makers must also be aware of limitations and understand those factors that limit the successful implementation of market-oriented approaches.

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Wetland Mitigation Banking: Regulatory Conditioning and Financial Aspects of Entrepreneurial Banking

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Introduction

Fill permits issued under Section 404 of the Clean Water Act may require the permit recipient to restore or create other wetland areas to compensate for the filled wetlands. This compensatory mitigation can secure no-net-loss of wetlands function and acreage. Section 404 permit review for a proposed wetlands fill is, by formal regulation, expected to follow a logic based on "sequencing". An applicant for a fill permit must first show that the proposed activity has been designed to avoid wetlands to the maximum extent practicable. If avoidance is not possible, then the minimization of wetland impacts must be achieved. Finally, if a permit is granted, compensatory mitigation through the restoration of degraded wetlands or the creation of wetlands from uplands is required to replace the unavoidable wetland effects of fill permitting.

Traditionally, compensatory mitigation has been subject to priorities, where the first priority is to make the wetlands replacement on-site (as close as possible to the permitted activity). However, some permit recipients have been allowed to develop a single off-site restoration or creation project to offset wetland losses caused by one or more of their own development projects. These off-site projects can be understood as a "deposit" of mitigation credits made by an economic agent, and the deposit is drawn down as wetland fills requiring compensation by the agent are permitted. This is the general understanding of a *single user mitigation bank.*

More recently, private (or government) entities have proposed to restore or create wetland credits for sale to permit recipients. In some instances permit recipients have been allowed to satisfy their mitigation requirements by paying these credit suppliers to provide the required compensation. Such a commercial credit sales venture is distinguished from a mitigation bank, because the venture assumes the legal and financial responsibility for executing the mitigation. Federal guidelines published in the Federal Register (November 28, 1995) are intended to encourage private firms to create wetland credits (as measured by acres or some index of wetland function) for sale to recipients of fill permits. With increasing federal and state support for such ventures, the number of ventures has been expanding in many parts of the country (Scodari, Shabman and White 1996; Scodari 1996).

In order to ensure that commercial wetland credit option provides viable compensatory mitigation, success must be achieved in both ecological and economic terms (Shabman, King, and Scodari 1994). Ecological success means that a venture's replacement wetlands will successfully reproduce the desired functions of the filled wetland. Early critics noted that the state of the science would not allow for ecological success. Recent evidence suggests that technical knowledge is not the primary barrier to ecological success. Instead failed mitigation is more often the result of poor site planning and limited regulatory oversight. It now appears that wetlands restoration and creation can be ecologically successful if regulators impose quality controls on credit ventures to ensure that replacement wetlands will be constructed, monitored, maintained and protected in perpetuity.

Success also must include an economic dimension. The economic success is achieved at two levels - venture (firm) level and market level. For the investor who is creating wetland credits, *venture level success* means that credit sale revenues are sufficient to cover costs of producing credits. Quality controls to assure ecological success will impose costs on credit ventures which will be reflected in the prices they charge for credits. Therefore, the establishment of ecological quality controls must be sensitive to the economic viability of credit ventures. At some level of costs, credit prices will be raised beyond the level at which permit applicants will be willing to pay for credits. Achieving ecological success is not independent from achieving economic success. Only if private (and public) commercial ventures are economically viable will they be able to, or indeed want to, continue providing ecologically successful mitigation.

Market level success means that the total output of all ventures is able to meet the demand for credits for the area being served, at prices that recover all production costs. A vigorous market is one where competition among sellers is possible. Such competition can raise the quality of mitigation, force the search for new creation and restoration approaches and offer regulators a wide array of wetland types and locations for mitigation. Market level success requires that rules apply uniformly to different types of commercial ventures, to mitigation done by commercial ventures, and to permit applicants who seek off-site compensatory mitigation.

This paper examines three issues particularly important to the venture level economic success of commercial wetland credit ventures. These issues are: 1) the timing of credit sales, 2) the costs to the wetland credit venture to gain regulatory approval to construct and sell credits from a mitigation site, and 3) demand uncertainty. The financial consequences of these three issues for the commercial wetland credit venture are illustrated using a hypothetical wetland restoration. A financial simulation program is used to calculate the minimum credit price the commercial mitigation venture would have to charge to achieve a target rate of return (20 percent) under different policy and cost scenarios (Shabman and Stephenson 1995). This calculation is made because commercial ventures are concerned that regulatory requirements can increase credit prices beyond what permit applicants are willing and able to pay. The results of this analysis will be used to highlight current developments in the wetland credit market and to discuss the current opportunities and obstacles for achieving market level economic success.

A Financial Simulation

For the illustration, assume a commercial wetland mitigation venture undertakes construction of a 150 acre agricultural re-conversion project. The regulator agrees that the site when fully successful will generate 150 credits. The investor adopts a 15-year time horizon for the project. Due to risky nature of this investment, the financial objective of the wetland mitigation venture is to achieve a 20 percent internal rate of return after taxes. During the first two years, various planning and site preparation costs (pre-construction activities) are incurred. During the third year, actual wetland credit creation costs are incurred (construction). In the remaining 12 years, site monitoring and maintenance are done until the regulator determines the wetland mitigation is successfully completed. The planning, construction, and monitoring/maintenance costs are derived from actual studies of restoration projects for prior converted (now farmed) wetlands. When the project is deemed successful and complete in year 15, the credit supplier donates the wetland site to a public or conservation organization. The credit supplier also funds an endowment that generates an annual interest payment sufficient to cover annual longer term management and maintenance costs of the site after the project is completed. The key cost and descriptive data for this illustration are summarized in Table 1.

Table 1: Given Conditions For Hypothetical Wetland Mitigation Project

Description	Conditions
Project Time Frame	15 years
Target Internal Rate of Return	20 percent
Total Number of Credits Generated	150 credits
Pre-Construction Costs (2 years)	$25 per acre
Construction Costs (1 year)	$500 per acre
Post-Construction Costs (12 years)	$15 per acre
Price of purchased land (150 acres)	$700 per acre
Endowment for Long-term Site Management	$32,150
Arrangements for Permanent Wetland Status	Yes

Timing of Credit Sales and Financial Assurances

One of the important determinants of the economic success of private commercial wetland mitigation ventures is the timing of permitted credit sales relative to the time when replacement wetlands are constructed. For example, if credit sales are not made until replacement wetlands have been certified as ecologically successful, then the investor will need to wait for a substantial time after the investment is made in order to recover costs. The wetland credit venture incurs a cost for waiting. This might be understood as the foregone value of returns on other investments that have less waiting time before returns can be realized. Therefore, as the time between project construction and the first credit sales increases, credit prices will need to rise to cover these costs. And if sales are postponed, the credit price a mitigation venture would need to charge to ensure a competitive, risk adjusted, rate of return may be above the price permit applicants would be willing to pay for mitigation credits. Indeed, waiting increases the investment risk

because future demand for credits is unpredictable given current uncertainties about wetland regulation and patterns of future economic development.

Conversely, credit sales made soon after the investment in the wetlands project, while financially advantageous to the commercial ventures, may not offer sufficient incentive to successfully complete the wetlands project once credits have been sold. This is one source of mitigation failure. Financial assurances in the form of some type of performance bonds, however, can provide incentives against mitigation failure even after credits have been sold from the site. The performance bond requirement provides a strong incentive for the credit supplier to create a functional wetland. During the course of wetland construction, unexpected developments can arise which increase the costs of meeting the criteria for ecological success. Since return of the bond is contingent on meeting these performance criteria, the commercial venture has an financial stake in undertaking the remedial measures at the wetland site. In the event of complete mitigation failure, the regulatory agency has money from the defaulted bond to pay for the development of wetland credits. Requiring the wetland venture to post performance bonds as a condition of early credit sales, however, can improve the financial position of the venture *while at the same time* providing assurances for ecological success.

Five different scenarios were simulated to examine the consequences of timing of credit sales and assure bonding requirements on the wetland credit prices (see Table 2). The "No Assurance Case" in Table 2 yields the best financial situation from the credit supplier's perspective: the wetland venture would sell wetland credits as early as possible and would not be required to post financial assurances. In this scenario, the wetland credit supplier sells 45 credits (30 percent of the total) in the first sale period (year 3) and all remaining credits sales are sold uniformly through year 15 (see Figure 1). On the other hand, the objective of the regulator is to assure ecologically viable wetlands. The

Figure 1

"Wait-to-Sell Case" in Table 2 is one approach the regulator can use to ensure the wetland mitigation is an ecological success. In this case, the wetland mitigation venture is allowed to sell credits only in year 13 when the functional success of the mitigation is nearly certain (see Figure 1 and Table 2). Since the postponement of sales is the means to ensure ecological success, no bond is posted.

As an alternative to these two scenarios, the regulator might require the wetland credit supplier to post performance bonds to reduce the possibility of mitigation failure (Scodari 1995). Three different performance bond scenarios were examined (Bonding Cases 1, 2, and 3 in Table 2). In each scenario the credit supplier is required to post one bond for each mitigation credit sold during any given period. No bond service fee is charged for issuing the bond. The regulator holds the bond as a financial assurance that the mitigation will be successfully completed in a timely manner. When the whole mitigation project is declared fully functional in year 15, the regulator returns the bond (without interest).

Table 2: Time of Credit Sales & Performance Bond Requirements

Scenario	Timing of Credit Sales	Bond Amount
No Assurances Case	Year 3	None
Bonding Case 1	Year 3	(1.5) x (present value of all costs)
Bonding Case 2	Year 4	Present value of all costs
Bonding Case 3	Year 8	(0.5) x (present value of all costs)
Wait-to-Sell Case	Year 13	None

The three bonding cases differ by allowing a tradeoff between the timing of the first credit sale and the bond amount (see Table 2). In Bonding Case 1, the regulator requires the credit supplier to post a bond amount one and a half times the present value of all pre-construction, construction, and post-construction costs. In exchange, the regulator allows the venture to sell 45 credits during the construction phase of the project (year 3) with the remaining credits sold uniformly through year 15 (see Figure 1). In all five cases, the sale of credits is assumed as known and certain.

Given the pre-construction, construction, and post-construction costs in this example, the present value of all relevant costs is $550.60 per acre. Thus, the bonding requirement for Bonding Case 1 is $825.9 ($550.60 x 1.5). Then as wetland credit sales are postponed (Bonding Cases 2 and 3), the bond amount is lowered to reflect the higher probability that the mitigation project is going to be successful (see Table 2 and Figure 1).

The wetland credit price needed to generate a 20 percent internal rate of return is calculated for each of the five scenarios. The results in Figure 2 show that the timing of credit sales has a significant impact on credit prices. In the no assurances-early sale scenario a credit supplier would have to charge $3,041 per credit to achieve a 20 percent internal rate of return. If, however, the credit supplier was required to wait until year 13 to sell credits (Wait-to-Sell Case), the credit price would have to increase 315 percent to achieve the same financial objective. The opportunity cost of waiting-to-sell significantly drives up the cost of credit creation and reduces the financial returns to the credit sales

venture. In Bonding Case 1, the credit supplier would charge $3,701 per credit to achieve its target rate of return, despite having to post bonds that more than cover the total cost of constructing the wetland. As credit sales are postponed to year 4 and year 8 (Bonding Cases 2 and 3), the credit prices increase to $3,966 and $6,562 respectively. It appears that early credit sales, coupled with a strong performance bond requirement, provides a mechanism to meet both the ecological success objective of the regulator ***and*** the financial objective of the wetland credit supplier.

The results reported in Figure 2 assume that the credit supplier does not have to undertake any remedial mitigation measures during the course of the project. In essence the bond is assumed to be refunded to the wetland credit supplier in year 15 (a net bond refund of 100 percent). How much would the price of wetland credits have to increase to maintain a 20 percent rate of return if additional costs were incurred as a condition to getting the bond back in year 15?

Figure 2

To examine this question, the price of wetland credits for all three bonding strategies is recalculated assuming that half of the bond amount is used for remedial measures at the wetland site (net bond refund of 50 percent). The results shown in Figure 3 indicate that the change in the net bond refund has a relatively small impact on credit prices. In all three cases, wetland credit prices increased less than $100 from the change in the net bond refund. Thus, the conclusion that the bond requirement is a more financially viable way to

ensure ecological success than postponing credit sales is not significantly altered even if the commercial credit supplier spends half of the bond amount on remedial or corrective measures.

Figure 3

Wetland Mitigation Venture's Application Approval Costs

In the previous examples, pre-construction planning, engineering, and approval costs were set at $25 per acre or $3,750 per year for the site. Pre-construction include several tasks include background research, the development of plans and specification, and selection of contractors. Although some costs must be incurred in the process of setting up a wetland mitigation venture, high costs of gaining regulatory approval to sell credits may severely limit the financial viability of commercial ventures. Recent experience with private wetland credit markets suggests that a number of ventures who are supplying wetland

credits have borne substantial costs for gaining approval to operate a commercial mitigation venture. These costs include: the costs of negotiating the performance criteria, securing approval from the various agencies involved, and securing the right to sell wetland credits before project completion. To demonstrate the financial sensitivity of changes in regulatory approval costs on credit suppliers, additional simulations are conducted with increasingly higher application approval costs.

Credit prices necessary to generate a target rate of return of 20 percent were recalculated assuming the credit supplier must incur an additional $150,000, $250,000, and $500,000 over two years to gain regulatory approval to sell credits. For comparison purposes, the Bonding Case 1 (early sales with a bonding requirement) is used as the reference case. The results shown in Figure 4 illustrate how increases in the regulatory approval costs increases the price the credit supplier must charge per credit to achieve the target rate of return. If the credit supplier must incur an additional $150,000 in approval costs during the pre-construction phase of the project, credit prices must increase 63 percent ($3,701 to $6,061 per credit) to cover the additional expense. If regulatory approval costs jump to $500,000 during the pre-construction period, then the credit supplier must receive $11,572 per credit to generate the same target rate of return. If economically successful commercial wetland mitigation ventures are to develop, these results suggest that regulators should be sensitive to the financial costs of the application approval process. Just as the bonding requirement can be used as a mechanism to allow early credit sales, is it possible that the same strategy could be refined to reduce the costs of approving a wetland credit venture.

Figure 4

Demand Uncertainty

The above simulation results demonstrate the consequences of increasing the cost of

waiting to sell credits and application approval on the wetland credit prices. Each issue influences the supply of credits to the market. Yet, the simulation results may understate the economic importance of sales timing and approval costs to the wetland mitigation ventures. Implicit in the above analysis is the assumption that all credits generated from the mitigation site will be sold at the given price. The wetland mitigation venture, however, faces greater demand uncertainty as sales are stretched out into the future.

The market demand for commercially-produced mitigation credits is derived from the demand for wetland discharge permits when the permit is conditioned by a compensatory mitigation requirement. Without a regulatory program there is no demand for wetland credits. Two implications follow from this reality. First, any regulatory constraints on the level of demand will diminish the potential for economic success. Second, because credits sales must be made in future years for an adequate return on investment there must be certainty about the future demand--this means certainty about the future of the regulatory program that creates future demand.

There are several sources of potential demand for wetland credits. The individual federal fill permit subject to "mitigation sequencing" is the one demand source. However, if the sequencing rules are applied rigidly this will make off-site venture mitigation the option of last resort, limiting the demand for credits. As a result, the possibility of relaxing the rigidity of the sequencing rules, if the commercial venture is offering superior mitigation, is acknowledged in the new federal guidelines. Second, federal general permits, particularly Nationwide Permit No. 26 (NW 26), authorize the discharge of dredge or fill material into 10 acres or less of isolated waters or headwater streams. For nationwide permits "...discharges of dredge or fill material must be minimized or avoided to the extent practicable at the project site, unless the District Engineer has approved a compensation mitigation plan for the specific regulated activity" (56 Fed. Reg. 59132; November 22, 1991). If regional administrators of the federal permit programs seek compensatory mitigation under general permit provisions, then a demand for credits is created. A final source of demand for commercial credits involves wetland impacts that fall outside federal regulatory jurisdiction or mitigation requirements. In some states and local jurisdictions there is a strong commitment to wetlands no-net-loss. In these cases state or local permit programs may require compensation and these programs create a demand for credits.

A more fundamental barrier to future economic success may be the uncertain demand for wetland credits. Under some legislation being considered in the Senate and passed by the House of Representatives the land area defined as wetlands subject to fill placement regulation as a wetlands would be dramatically reduced. Only certain "categories" of wetlands would be subject to regulatory wetland compensation. If these bill provisions become law the demand for credits will be sharply reduced and the economic viability of

investing in commercial mitigation sales ventures becomes questionable and the interest in private mitigation ventures will rapidly decline.

To illustrate the consequences on wetland credit prices from severe demand side uncertainty, again consider our hypothetical wetland credit venture. If market participants consider the future status of the wetland regulatory program in serious doubt,

wetland ventures may attempt to account for this uncertainty by meeting their financial objectives during the first sales of credits. In such a case, the wetland credit venture would charge a credit price high enough to cover all costs *while selling only a fraction* of total allowable credits generated by the bank.

In the previous scenario, the credit prices were calculated assuming different approval costs, but also assuming all the 150 credits generated by the site were sold (see Figure 1). Given significant demand uncertainty, however, the wetland credit venture may expect only to be able to sell credits during the first sale period (in this case 45 of the 150 allowable credits). Figure 5 shows the price a wetland credit venture would have to charge to achieve their financial objective (20 percent internal rate of return) if only 45 credits are expected to be sold. In every cost scenarios, price per credit would nearly double to cover the foregone revenue from potential future sales. Thus, the presence of substantial regulatory uncertainty could price many potential permit applicants out of the market and deter potential credit suppliers who do not have certain sales from entering the market.

Figure 5

Implications for Venture Level and Market Level Economic Success

Financial simulations provide strong confirming evidence that regulatory rules on the conditions of wetland credit sales do have a significant effect on the financial feasibility of

a wetland mitigation venture. The simulations illustrate that a wetland mitigation venture would prefer substantial bonding requirements over postponed credit sales as a means to ensure ecological success. The bonding requirement provides strong incentives for a wetland mitigation venture to construct a successful wetland and provides the regulatory agency a financial means to complete the construction in the event of mitigation failure. Thus, the probability of achieving both ecological and economic success is enhanced if early sales are coupled with a sufficient bond requirement.

The simulation also illustrates common experiences found in the market for wetland mitigation credits. Currently, the cost of creating wetland credits is being driven up by the high costs of gaining regulatory approval to sell credits. To cover these costs, the venture must charge higher prices for wetland credits. Demand side uncertainty also increases the price of wetland credits ventures have to charge since ventures may need to cover all production costs from the secured sale of only a fraction of total allowable credits. Despite these realities, however, wetland ventures are receiving high prices for wetland credits. Anecdotal evidence suggests that these high prices are more than sufficient to meet the financial objectives of the commercial mitigation venture.

Ironically, the economic success many ventures are experiencing is being enhanced by the absence of market-level success. Market level success requires enough competing credit sellers to drive credit prices close the cost of credit creation. Currently, credit prices are not being determined by competitive pressure among sellers. In most cases, commercial ventures are the lone supplier of off-site compensatory mitigation for a specified watershed or for a specific type of wetland. Such ventures exercise monopoly pricing powers. Prices being paid are based on a permit applicant's next best alternative mitigation option, and their willingness to pay a premium to expedite the regulatory permitting process. Without vigorous competition and an ample supply market supply of credits, the next best alternative for the permit applicant is (often) expensive on-site mitigation.

For the wide-spread emergence of a wetland credit *market* to emerge, ventures must be able to recover production costs at credit prices permit applicants are willing and able to pay *and* adequate competition must exist among credit suppliers. A number of changes in the current situation are needed to improve the probability that both venture and market level economic success can be achieved. First, streamlining the regulatory process to gain approval to sell credits will lower the cost of generating credits. Second, there must be adequate stability and predictability in the credit demand so that credit suppliers can make well-reasoned long term investment decisions. Demand can be stabilized with assurances that the current wetland delineation criteria are maintained. Third, competitive market conditions could be facilitated by expanding both the demand and supply for wetland credits. Demand can be enhanced by relaxation of the preference for on-site mitigation. For lower valued wetlands, the compensation requirements might be minimal and expected to be off-site. Furthermore, all wetland fills, including small sites under the general permit, should require compensation. On the supply side, the competition between wetland credit suppliers can be expanded by increasing geographic sale area and providing overlap of sale areas. Also regulatory agencies should be willing to allow certain out-of-type wetland trades across these areas. Taken together these suggestions would increase competition,

lower production costs, and drive down the prices for credits toward cost of production.

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EPA'S POLICY ON FLEXIBLE STATE ENFORCEMENT RESPONSES TO SMALL COMMUNITY VIOLATIONS

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Introduction

The issue of unfunded federal mandates has been a focal point in much of the debate over environmental regulatory reform that has taken place in the mid-1990s (Infanger). Initially, attention centered on the huge price tag facing large cities and the aggregate impact nationally. A study by Ohio and the City of Columbus claimed 14 different mandates would cost city governments $1.6 billion over the 1990-2000 period (Hall). A U.S. Conference of Mayors study, based on a survey of 314 cities, estimated the cost of unfunded mandates at $11.3 billion for FY93. However, due to the economies of size associated with most of the infrastructure investments dictated by various mandates, small communities in rural areas have found themselves at the greatest disadvantage, facing in many cases an overwhelming fiscal burden. For example, EPA estimated the average annual incremental household cost of compliance with the 1986 amendments to the Safe Drinking Water Act to be about $145 for the smallest regulated systems, versus $12 for larger systems (Tiemann).

In response to the outcry, Republicans made unfunded mandates a key feature of their "Contract With America" and ultimately the Unfunded Mandate Reform Act was passed and signed into law in March 1995. While this law does require documentation of the cost impacts of new mandates and benefit-cost evaluations of new regulations, it does little regarding existing mandates except to establish a commission to consider paring them back (Infanger). However, a less visible movement has been occurring within a number of states since 1992 that seeks to provide effective relief to small communities. This movement culminated in a formal EPA policy statement in November 1995 that provides relief in the form of flexibility for states to enter into agreements with local communities allowing an extended time period for reaching compliance. As a prerequisite to such agreements, a process must be undertaken at the local level to prioritize among competing environmental mandates on the basis of comparative risk. Historical perspective on what led to establishment of this "small communities policy" is provided in the next section.

Historical Background on EPA's Small Communities Policy

The movement that eventually led to EPA's formal policy reform began, it appears, with a speech and an article in 1992. The speech was given by Mayor Reuben Miller of the City of Fairfield, Idaho (pop. 408) at an EPA Region 10 workshop in Portland entitled "Reaching Out: Improving Environmental Services to Small Communities." Mayor Miller emphasized the need for a community-determined long-range plan and an extended time period for compliance with environmental regulations that represented an overwhelming burden to small communities such as Fairfield. Other local officials on the program echoed his message. After further expressions of concern to the State Rural Development

Council and the Governor, the "Community Mandates Pilot Project" was developed jointly between the Idaho DEQ and EPA Region 10. The project was initiated in the summer of 1993, with a final report published on May 16, 1995. In the mean time, the Idaho legislature passed a bill authorizing the Idaho DEQ to enter into negotiated long-term compliance orders with local governments. Governor Cecil Andrus signed the bill into law on March 23, 1994. A more detailed discussion of this pilot project in Idaho is provided later in a comparison of initiatives across a number of states.

The article referred to above was written by an Oregon Department of Environmental Quality staff member and published by the Western Governors' Association in "Our Lands: New Strategies for Protecting the West--Blueprints for Action." The article laid out the need for a program to help small communities set priorities and develop long-term strategies for compliance with environmental regulations. A year later the Oregon legislature funded an "Environmental Project Team" with $383,000 for a two-year pilot effort to: (1) help local communities rank environmental protection requirements on the basis of risk and cost, (2) provide for compliance orders with extensions where necessary and (3) provide protection from undue fines and legal liability. This effort was renewed in 1995 and as of May 1996, memorandums of agreement had been signed with six communities, specifying extended compliance orders but also representing in essence a local environmental protection plan. More details on the Oregon approach are provided later as well.

While a few other states were also initiating efforts along these lines in 1994 and 1995, Idaho and Oregon, in cooperation with EPA Region 10, were clearly out in front. In June of 1994, these three parties asked the Program Evaluation Division of EPA's Office of Policy, Planning and Evaluation (OPPE) in Washington, D.C. to assess their experiences in implementing what came to be called in the OPPE report "community environmental compliance flexibility projects." The OPPE report, published March 28, 1995, is generally positive about the potential for such projects to better enable small communities to achieve compliance. The report also concludes, however, that the experience of the projects raised a number of policy issues related to inter-governmental relations, public participation, prioritization processes, the legal agreement, and the role of EPA. And, in particular, the report notes that "ambiguity on the part of EPA about how it may react to the agreements represents . . . a serious barrier . . . for States in implementing these pilots." On November 22, 1995, the Policy on Flexible State Enforcement Responses to Small Community Violations (Small Communities Policy) was announced. In the accompanying memorandum it was stated that the policy implements parts of Reinventing Environmental Regulation Initiatives 13 and 21 announced by President Clinton on March 16, 1995. The lead paragraph of the policy statement reads as follows:

This policy expresses EPA's support for States' use of enforcement flexibility to provide compliance incentives for small communities. EPA acknowledges that States and small communities can realize environmental benefits by negotiating, entering into, and implementing enforceable compliance agreements and schedules that require communities to correct all of their environmental violations expeditiously while allowing the community to prioritize among competing environmental mandates on the basis of comparative risk. States may provide small communities an incentive to request compliance assistance by

waiving part or all of the penalty for a small community's violations if the criteria of this policy have been met. If a State acts in accordance with this policy and addresses small community environmental noncompliance with compliance assistance in a way that represents reasonable progress toward compliance, EPA generally will not pursue a separate Federal civil administrative or judicial action for penalties or additional injunctive relief.

State-level Small Community Policy Initiatives

As noted above, initiatives in Idaho and Oregon, with the cooperation of EPA Region 10, were instrumental in leading to the announcement of the Small Communities Policy. However, parallel initiatives were arising in four other states in 1994 and 1995: Colorado, Nebraska, South Dakota, and Washington. Brief summaries of each states approach and experience are presented below, with attention to distinctive features.

Idaho

The Idaho project was designed to assist specific "self-selected" Idaho communities, but also to provide a model for other states to consider. The project approach required a partnership among a number of state and federal agencies, including research and extension personnel from the University of Idaho. The project's formal objectives were as follows:

(1) Identify the mandates which needed to be addressed.

(2) Examine the administrative, financial and technical capabilities of the communities.

(3) Work with the communities to prioritize projects to meet the mandatory requirements.

(4) Develop alternative ways that the mandates could be met within the constraints of the law.

(5) Where possible, initiate agreements between the communities and the federal and state governments which would allow a community to undertake mandates according to a ranked priority order.

(6) Create a methodology based on the findings of this pilot project which could be used to develop mandate priorities in other Idaho communities.

(7) Present findings to the State Legislature and Idaho Congressional Delegation as supporting documentation for further changes in state and federal policy.

Several analyses were conducted to achieve the first two objectives. An extensive community profile was developed for each of the four communities involved. An assessment of each communities infrastructure needs was made, in light of the mandates faced. An assessment of each community administrative and financial capacity was also made. Then, a priority-setting

exercise was conducted for the City of Hagerman (1993 population 641). Of particular note is the fact that the scope of the priority-setting exercise included both environmental and non-environmental mandates from the federal and state levels, as well as other non-mandated community funding priorities. Non-environmental mandates might include regulations stemming from laws such as the Americans with Disabilities Act, for example. Non-mandated community funding priorities that surfaced during the three public hearings conducted over a two-month period included improving roads and streets, enhancing the city's administrative capacity, upgrading of schools, establishing youth programs, building a new city hall and library, and improving public transportation. Project staff also provided information from the infrastructure needs assessment for citizens to consider in the public hearings. Seven "needs" were presented, most but not all related to existing or likely federal regulations covering drinking water and wastewater treatment. For each need, a description of the health or environmental concerns was given, followed by an outline of viable options and projected costs. The project staff also assigned point values for each of the seven needs, up to 50 points based on the criteria of "benefits as a function of cost" and up to 50 points based on the "time line for regulatory compliance." Citizens were then asked to integrate the infrastructure needs related to federal mandates with the other non-mandated community funding priorities into a single prioritized list. The City of Hagerman was not actually out of compliance at the time the prioritization exercise was conducted, so no extended compliance agreement was necessary. However, the notion is that the capacity analyses and prioritized listing of infrastructure needs would provide the basis for development of such an agreement if and when one is needed.

While the Idaho pilot project was viewed as being quite successful, to the extent that it was awarded one of Al Gore's Hammer Awards for Reinventing Government, the project team within the Idaho DEQ was essentially disbanded following completion. As of January 1996, the state had committed no specific resources to provide assistance to small communities on a continuing basis, though there were plans to explore ways to conduct the prioritization process on a less resource-intensive basis.

Oregon

Oregon's program, now termed "Environmental Partnerships for Oregon Communities," is fundamentally similar to the approach taken in the Idaho pilot project, but also differs in several important ways. In contrast to Idaho, the approach in Oregon has been to focus the prioritization process upon only environmental issues with existing compliance problems, with sensitivity toward broader local concerns. Participation by communities is voluntary, but to be selected communities must have "multiple environmental mandates, definable issues, clear jurisdiction to address the mandates and resolve issues, small population, limited resources and a commitment to resolve issues through public participation." (OPPE) State agencies involved in the process in addition to the Department of Environmental Quality (DEQ) include the Health Division and the Economic Development Department. Linkages with the latter agency have been recognized as extremely important, given the expectation that infrastructure improvement can be an important economic development strategy and the fact that this agency is involved with funding drinking water and wastewater infrastructure projects.

The process in Oregon begins with informational and educational meetings for citizens conducted by either DEQ, community leaders, or both. Before going further, a community agreement is

signed, laying out the responsibilities of each party in the project. The next step is a diagnostic review of the city's compliance status with all potential environmental requirements. Following this, an evaluation is undertaken to determine the ecological, public health, and financial significance associated with compliance. Further education/information efforts take place at this stage, as well as elicitation of input from residents and interested parties. An "urgency analysis" is then conducted through which the State agencies assist the city in setting priorities for actions required to achieve compliance. The outcome of the process is a "Mutual Agreement and Order," a legally binding document that includes a time schedule for achieving compliance.

In the process of working with small communities under this program, DEQ staff recognized that, in addition to limited administrative, technical, and financial capacity, there is also limited leadership capacity in many cases. In an attempt to remedy this, DEQ recently completed a series of seven workshops across the state, targeted at administrative and elected officials, and designed to enhance their understanding and ability to deal with the range of environmental requirements facing small communities. A companion effort to the workshops has been the publication of "Oregon Guide to Environmental Requirements for Small Governments," patterned after a similar 1993 EPA report.

Colorado

In its 1995 session, the Colorado General Assembly passed the Small Community Environmental Flexibility Act, enabling the Department of Health and Environment to approve Integrated Environmental Compliance Agreements with municipalities, as well as counties and special districts, with a population of less than 2,500. Of the 268 municipalities in the state, 198 are eligible, as well as eight counties. The agreements "provide up to 10 years for small communities to phase-in compliance with applicable requirements, once a local planning and priority-setting process has been completed and a need is demonstrated based upon the adequacy of resources" (CML Newsletter). In addition, the Department of Local Affairs is required by the act to provide assistance to small communities in the preparation of environmental priorities plans. The focus was expected to be on drinking water and wastewater issues, but as of June 1996 no communities have requested assistance in preparing a plan.

Nebraska

The effort in Nebraska has been termed the Mandates Management Initiative and "uses an inter-governmental team process to help local leaders better understand regulations, analyze local issues to determine which pose the greatest risk to public health and environmental quality, prioritize them and find cost-effective, appropriate solutions for the problems identified. This approach is intended to increase regulatory flexibility and balance local fiscal and human resources with mandated requirements" (Yost). The Initiative originated in the Office of Governor E. Benjamin Nelson, but now is operated out of the Department of Environmental Quality. The focus is strictly upon water and environmental quality, given that most of the 484 communities in Nebraska with populations below 2,500 provide public services only in the areas of drinking water, wastewater, and streets. The Initiative has involved more than a dozen partners, from state and federal agencies, to university departments and centers, to regional and statewide organizations. As many as 50 different people from these partners have devoted some time to the Initiative. While the criteria for targeting communities for participation now includes the presence

of two or more regulatory issues, the focus of the process is not so much on arriving at a legal compliance agreement as it is assisting communities by coordinating technical and financial assistance, and identifying appropriate cost-effective technologies. Communities have also been selected in part on a geographic cluster basis, to enhance the possibilities of collaboration, e.g., sharing of workers or equipment. As of June 1996, the process has been nearly completed with 15 communities, while another 20 communities are in line to begin. Case study summaries have been completed for at least two communities, illustrating both the process and product of the Initiative.

South Dakota

The state of South Dakota operates what is called the ACTIVE Cities Program. This cooperative effort involves the Department of Environment and Natural Resources, EPA, and the non-profit Midwest Assistance Program, which is based in Minnesota. As of June 1996, five communities were participating on a voluntary basis in a process designed to provide them with a greater degree of flexibility and control, as well as an opportunity to establish local priorities with regard to meeting environmental mandates. A move was recently made to increase the resources devoted to the program by placing a person in the Watertown field office, thus allowing more of the almost 300 communities with populations under 2,500 to participate.

Washington

The state of Washington just recently launched its Environmental Partnership with Washington Communities, based on careful review of the Oregon model and experience. Currently, efforts are being made to develop interest among communities and gain the support of the Washington State Association of Cities. However, the Department of Ecology has been applying methods from the Small Towns Environment Program (STEP) for about four years to assist communities with their wastewater treatment systems. STEP is coordinated by the Rensselaerville Institute in Rensselaerville, New York and promotes methods that involve use of local resources, controlling costs, and choosing the simplest technology. The Institute reports that the cost of "Self-Help Support System" water and wastewater projects averages 35 percent less than standard estimates, and that using STEP methods had saved more than $150 million in nearly 150 communities as of 1994 (Jensen). In Washington, four communities have completed the STEP process, while eight more are in the early stages. The emphasis in Washington communities has been on use of volunteers, securing donations of materials or equipment, and consideration of alternative small-scale technologies.

Conclusions and Implications

The announcement of EPA's Small Communities Policy in 1995 and the experience of a number of Midwestern and Western states over the past three years signals a significant reorientation in our approach to environmental regulation as it relates to small communities. This reorientation reflects a recognition that (1) opportunity costs are real and significant factors in the context of the allocation of limited fiscal resources by small communities, (2) analysis of benefits and costs at

the margin may suggest that expensive upgrades in infrastructure can not be justified by the marginal benefits to be gained, at least not at the present time, and (3) providing the incentives of a time extension for compliance and protection from penalties can encourage communities to undertake what may be a valuable local environmental planning and prioritization process. What appears to be the critical uncertainty in the policy from the standpoint of practical implementation is exactly how communities are to "prioritize among competing environmental mandates on the basis of comparative risk." A related uncertainty has to do with exactly how "public notification and public participation" is to be incorporated into the process. An objective of the Idaho pilot project was to develop a model approach for other states and local communities to employ, but to what extent that has been accomplished is unclear.

According to the Small Communities Policy coordinator for EPA Region 4, there has been little interest shown on the part of states in the Southern region regarding the policy to date. Part of the explanation for this may be simple lack of awareness. However, there are surely hundreds, if not thousands of small communities in the South that are facing the kind of dilemma that this policy is intended to address. Perhaps the lack of interest is due to the different "culture" of environmental regulation that exists in the South. It may be that, as a result of the limited resources devoted to environmental regulation in many Southern states and the relatively weaker environmental values in the region, small communities are already being allowed on an informal basis the flexibility and time extensions that are intended to be the products of the formal process called for by the policy. If so, then why go to all the trouble of an environmental planning and prioritization process, the kind of exercise small Southern communities are not particularly inclined to do anyway? If so, then why raise a "red flag" by explicitly calling attention to a compliance problem? This disincentive was noted by some of the contacts for the six states discussed above, as a factor limiting interest or participation. In any case, the Region 4 coordinator is scheduling workshops in each state to publicize the policy and assess the potential level of interest.

What role then might natural resource and community development specialists in the Southern region or elsewhere play in relation to EPA's Small Communities Policy and state efforts to implement programs consistent with it? First, applied economists could potentially contribute to developing an approach to the risk-based prioritization process that would have economic validity and provide for consistency within and among states. Second, this process is essentially one of collective choice at the local level and might well be analyzed with some of the constructs from the literature on collective choice. Third, research and extension personnel might participate in the process at the community level, as they have in at least Idaho and Nebraska and perhaps others of the states discussed above. This, it seems to me, could occur in some form or fashion whether or not a formal program is developed by the state regulatory agency, and in fact might come as an initiative from the land grant university in the interest of helping rural communities meet the needs of their citizens and protect the environment. This is not to say, of course, that some kinds assistance are not already being provided to small communities with respect to these matters, only that a focused or refocused initiative might be appropriate given the new EPA policy stance.

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SRIEG-10 No. 33 **June 1997**

SRDC No. 206