INTERVIEWS WITH GROUND WATER EXPERTS IN TWENTY REGULATED RIPARIAN STATES: SELECTED RESULTS

By

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ABSTRACT

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Michigan, like many other states, is concerned that current ground water regulations are not adequate for addressing increasing demands placed upon the state's aquifers and is currently revising its ground water policies. In order to identify components of effective ground water policies, we interviewed (via telephone) 70 ground water experts in 20 regulated riparian states which have a history of managing ground water within a riparian doctrine. Our respondents were from agencies, extension, universities, water resource institutes, and special interest groups, as well as legislators. Our sample includes experts who were involved in policy design as well as experts who work with ground water regulations on a daily basis. The questions in our semi-structured interview and the analysis were guided by an economic criteria framework for evaluating effective policy instruments. The findings from this project provide advice for water policy design based upon extensive experience.

DEDICATION

This work is dedicated to my family and friends who have supported me while pursuing this master's degree and the generation that arrived while I was at MSU, Kartik Jindal and Noah Branch.

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Interviews with Ground Water Experts in Twenty Regulated Riparian States: Selected Results

I. - INTRODUCTION

Riparian states are traditionally characterized as those states where water has been abundant, water is viewed as a shared resource, the combination of water rights and property ownership is viewed as inseparable, and any conflicts over water use are decided in the courts based upon the concept of "reasonable use" (Cox, 1994; Dellapenna, 1994; Miller *et al*, 1996; American Society of Civil Engineers (ASCE), 2004). Unlike Western water laws, most riparian doctrines prohibit moving water away from riparian land because removing water is thought to diminish other's opportunity to use it and thus would be contrary to the ideal of shared use-- an important aspect of reasonable use (Kundell and Tetens, 1998). While most Eastern states, including Michigan, have had some form of riparian water law, the riparian doctrine has been in decline for several decades and states have experimented with alternative allocation systems (Dellapenna, 1994; Cox, 2001; American Society of Civil Engineers (ASCE), 2004). Some regulated riparian states like Florida and Hawaii revised their ground water regulations in the 70's; others like Wisconsin and Michigan have only recently begun such a revision.

Riparian law was originally based on British ground water laws and the "absolute ownership doctrine" subject to "reasonable use" (Cox, 1994). Numerous authors (for example: Cox, 1994; Kundell and Tetens, 1998) have explored the history of changes in

riparian law. Riparian law does not allow the separation of water rights from real estate rights with the result that landowners are unable to sell their water rights separately from their land rights. In contrast, prior appropriation states allocate specific amounts of water, based upon seniority of use, and allow those allocations to be bought and sold as long as the new diversion does not harm junior users (Dellapenna, 1994).

Traditionally, because riparian doctrine is common law, reasonable uses were decided by the courts; however, reasonable surface water uses and reasonable ground water uses are not viewed as the same thing in the courts (Cox, 1994; Kundell and Tetens, 1998). Reasonable use, as it applies to surface water, allows for riparian users to use the water for beneficial purposes so long as it does not interfere with other riparian users and their beneficial uses (Kundell and Tetens, 1998). Reasonable use, as it applies to ground water, may allow users to interfere with each other causing disputes that often end up being resolved in court (Kundell and Tetens, 1998). According to Maloney *et al*, (1979):

> The Restatement (Second) of Torts has identified nine factors which courts have taken into consideration in determining whether a use is "reasonable use." These are: (1) the *purpose* of the respective uses; (2) the *suitability* of the uses to the water course or lake; (3) the *economic value* of the uses; (4) the *social value* of the uses; (5) the *extent and amount of the harm* caused; (6) the *practicality of avoiding the harm* caused; (7) the *practicality of adjusting the quantity* of the water used by each proprietor; (8) the *protection of existing values* of land, investments and enterprises; and (9) the *burden of requiring the users* causing the harm to bear the loss. (p 256)

Kundell and Tetens (1998) have noted that leaving disputed decisions to be decided on a case by case basis creates a high amount of uncertainty for new endeavors. (This same argument has arisen in Michigan (Schneider, 2003) where there has been an ongoing legal battle between the Michigan Citizens for Water Conservation (MCWC)

and Nestle Corporation surrounding a water bottling plant in Mecosta, Michigan.) The traditional riparian doctrine has been criticized for not providing a mechanism to protect certain water uses, such as sufficient in-stream flow for existing aquatic ecosystem, nor does it provides a mechanism for water use to be transferred to higher valued uses (Deason *et al*, 2001). These omissions have also created a context for change as the need for the states to actively manage their ground water has grown (Dellapenna, 1994; Kundell and Tetens, 1998).

As riparian states have modified their legislation and regulations to require either reporting or permitting of water withdrawal (Foran, 1995; Kundell and Tetens, 1998; Cox 2001) they have moved into what Dellapenna (1994) has termed "regulated riparianism." Regulated riparianism describes the water doctrines of states that have moved from the traditional form of riparianism and have now established some form of regulations. In contrast to the prior *riparian* doctrine, *regulated riparian* polices are based upon the state's need to protect the public welfare, safety and health (ASCE, 2004).

Michigan's recent ground water legislation (for example four proposed revisions in 2008, to Senate Bills 212, 723,727, and 860 in 2007) are part of a long line of riparian states' efforts to modify traditional riparian doctrines. For example, in 1968 The Great Lakes Basin Compact was approved by Congress and it created a commission, The Great Lakes Commission, which, among other duties, was charged with recommending laws, ordinances and regulations to the members (the Great Lakes States as well as Quebec and Ontario) for the protection and enhancement of the Great Lakes (Great Lakes Commission, 2003). In 1985, the Great Lakes Charter was signed and then in 2001, the Great Lakes Charter Annex, 2001 (Annex 2001) was created (Council of Great Lakes

Governors, 2006). Relatively recently, in 2005, the Great Lakes-St. Lawrence River Basin Sustainable Water Resources Agreement (Agreement) and The Great Lakes-St. Lawrence River Basin Water Resources Compact (Compact) were signed. These two documents include a ban (with limited exceptions) on diversions of water outside the Basin and also called for an increase in technical data development (Council of Great Lakes Governors, 2006). However, the ability of a state to ban diversions is dependent on having state management of water resources.

Several of the proposed revisions to laws in Michigan stem from these agreements. For example, Senate Bill 212 (2007) provides for the implementation of the Great Lakes- St. Lawrence River Basin Water Resources Compact and Senate Bill 858 (2007) is intended to satisfy some of the requirements in the Compact (Cassidy, 2008). The Great Lakes Basin Compact and Annex 2001 have prompted Michigan's Public Act 148 of 2003 which created the Ground Water Advisory Council and charged the Council with monitoring the implementation of Annex 2001 as well as providing suggestions for Michigan's statutory conformance with Annex 2001. Additionally in 2003, the new Generally Accepted Agricultural Management Practices (GAAMPs) for irrigation water

[1] The Great Lakes Basin Compact is an agreement between the states of Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania, and Wisconsin and the provinces of Ontario and Québec to mange the development, use, and conservation of the water resources of the Great Lakes Basin. Dating back to 1955, Article V of the Compact created the Great Lakes Commission which provides a vehicle for members to bring forth concerns and negotiate agreements. In 2001 a number of issues, including the threat of significant water withdrawals from the basin, were negotiated and a supplemental agreement, the Great Lakes Annex Waters Agreement (Annex 2001) was developed. In general, Annex 2001 states that there will be "no significant individual or cumulative adverse impacts to the quantity or quality of the waters and water-dependent natural resources" of the Great Lakes Basin (http://www.glu.org/english/annex_2001/summary_background.htm, accessed May 2008).

use were approved to work with Michigan's Right to Farm Act. The need to revise Michigan's water laws, coupled with the knowledge that the number of conflicts over ground water in riparian states has increased in frequency in recent years (Kundell and Tetens, 1998; An and Eh**e**art 2006) led our team to begin to examine what other regulated riparian states have done.

There is a paucity of literature to assist policy makers with updating their water laws. An exception is the American Society of Civil Engineers' (ASCE's) *ASCE Regulated Riparian Model Water Code* (2004) which was written to facilitate the development of enabling legislation for water management. However, the implementation of the legislation suggested by the code was largely unaddressed by that document (Eheart, 2002). This deficit was addressed by the Task Committee on Water Rights Allocation and Trading in Humid Areas of the Water Regulatory Standards Committee of the Environmental and Water Resources Institute of the American Society of Civil Engineers. The Committee developed the *Riparian Water Regulations Guidelines for Withdrawal Limitations and Permit Trading* (Eheart 2002). Together, these two documents address regulated riparian management of both surface water and ground water.

There are a few publications to complement these two reports and which provide suggestions for revising water laws. For example, Bulkey *et al* (1987) describes numerous institutional options at the state, regional and local levels. Kundell and Tetens (1998) examine states that have adopted registration requirements as well as states that have adopted administrative permitting programs. The difference between registration and permitting is that, with registration programs, ground water withdrawers are only

required to inform the state of what they are doing. With permitting, potential ground water users must apply to the state for permission to use the water and the designated state agency has the power to approve, modify or deny the request to withdraw water. Eheart *et al* (1989) developed a report exploring water management trade offs and options. These three publications were targeted at specific states, but have generalized conclusions about water resource policy choices for other states. A complementary paper, "Institutions for Interstate Water Resources Management," (Mandarano *et al, 2008)* examines the institutions for interstate water resources management. However, these works do not solicit extensive advice from ground water experts in regulated riparian states.

Studies which do solicit advice through in-depth interviews, focus groups, and surveys, tend to focus on a specific state or region or a specific issue. For example, O'Connor *et al* (1999) surveyed 506 community water system managers in the Pennsylvania Susquehanna River Basin, to learn more about community water system sensitivity to weather and climate changes. Rumps *et al* (2007) reported on interviews with 47 project participants in the Pacific Northwest regarding the restoration of freshwater habitat.

However, there is a literature gap with respect to states' experiences and lessons from moving from the traditional riparian doctrine to regulated riparianism. This paper addresses this gap by synthesizing interviews with ground water experts in other 20 other regulated riparian ground water states and by gleaning information about components of effective ground water policies.

ASCE (2004) identified 20 states as being regulated riparian surface water states.[2] While other lists of regulated riparian states have been generated, (Kundell and Tetens, 1998; Cox, 2001) we decided to use the most recent list for our survey of regulated riparian states with a history of decisions based upon "reasonable use." Thus, we interviewed ground water experts from: Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Mississippi, New Jersey, New York, North Carolina, Virginia, South Carolina and Wisconsin. Our interest was specifically in ground water because many of the proposed legislative updates in Michigan include ground water (for example, Senate Bills 212, 342, 723, 858, and 860.)

[2] The decision about which riparian states to include in our survey was problematic. Some authors such as Kundell & Tetens (1998) have organized riparian states into categories such as:
1. States that Depend on Common Law Doctrines (Louisiana, Vermont, Rhode Island, West Virginia)
2. States Requiring Registration of Major Water Users (Michigan, Missouri, Ohio, Tennessee, New Hampshire)
3. States with Targeted Permitting Programs (Alabama*, Arkansas*, Illinois*, Indiana*, Maine, Mississippi*, New York*, North Carolina*, Pennsylvania, South Carolina*, Virginia*)
4. States with Comprehensive Water Permit Programs (Connecticut*, Delaware*, Florida*, Georgia*, Iowa*, Kentucky*, Maryland*, Massachusetts*, Minnesota*, New Jersey*, Wisconsin*)
States that we interviewed are noted with *. We chose to follow the determinations made by ASCE and interviewed riparian states that had moved to comprehensive groundwater withdrawal permitting programs with states that only had partial permitting programs because we thought that it would better provide us with an overview of the various paths that other regulated riparian states have followed and allow us to better discover the relative strengths and weaknesses of other programs.

II. - RESEARCH OBJECTIVES

Overall our research objective was to obtain advice from ground water experts in other regulated riparian states with respect to changes in their water law that was relevant to ground water management. Sub-objectives were:

- To select a framework of analysis to guide the choice of questions of experts.
- To interview at least three experts from each of the 20 identified regulated riparian states.
- To organize the results of the interviews in a manner to provide policy advice to states – such as Michigan – considering revisions to their current water allocation legislation.

III. – FRAMEWORK AND METHODS

We needed a framework which would provide an overarching foundation that would allow for an easy comparison of policies from multiple states. There are many alternatives to evaluating environmental policy instruments and we reviewed six (Bohm and Russell, 1985; Krarup, 1999; Russell and Powell, 1999; Richards, 2000; Mickwitz, 2003; An and Eheart, 2006). In addition, we reviewed the comparison of 6 environmental policy instrument frameworks by Richards (2000). For this article, we chose the evaluative policy framework developed by Russell and Powell (1999) because it was relatively comprehensive and based on economic theory.

We used an adapted Russell and Powell (1999) framework to identify common concerns, institutional requirements, and political dimensions of the respective ground water laws that our respondents revealed in their interviews. This article synthesizes this

information and provides advice for the revision of water legislation from that of riparian law to regulated riparian law from an environmental economic's perspective.

Numerous authors (for example, Weersink *et al*, 1998; Eheart, 2002) have pointed out how economic analysis can better inform stakeholders and decision makers. Our selected framework provided us with five distinct areas that we could examine for commonalities and recommendations from our experts. These five areas are: 1) Static concerns 2) Dynamic Concerns 3) General Institutional Demands 4) Political Dimensions 5) Perceived a-priori risks. The adapted Russell and Powell framework is reproduced in Figure 1.

Figure 1: Criteria For Evaluating Policy Instruments

Static Concerns

1. Efficiency in meeting policy objectives (cost–effectiveness)
2. Information/computational demands
3. Relative ease of monitoring and enforcement

Dynamic Concerns

4. Flexibility in the face of exogenous changes
5. Incentives for environment-saving technical change

General Institutional Demands

6. Overarching Institutional Needs
7. Institutional Demands on the Agency : honesty, technical capabilities (including data gathering, model building and solving, monitoring and enforcement, and revenue handling)

Political Dimensions

8. Distributional implications
9. Perceived ethical message
10. Perceived fairness

Perceived *a-priori* risks

11. To agency: failure to achieve goals, freezing current technology for too long, possible perverse responses
12. To regulated or otherwise impacted parties: false convictions, 'ratcheting down' of requirements

(Adapted from: Russell, C.S., and P.T. Powell, 1999. Practical Considerations and Comparison of Instruments of Environmental Policy. In: *Handbook of Environmental and Resource Economics*. Jeroen C.J.M. van den Bergh (Editor): Edward Elgar Publisher p 321)

In addition to questions suggested by the Russell and Powell framework, we developed questions about the history of the state and the role of scientists in developing policy as well as general questions to solicit advice. We chose to do so because we thought that it was important to contextualizing the state's situation and because we wanted to know more about the role of science in adopting alternative water allocation systems.

III. A. - Respondent Selection

We were particularly interested in advice applicable to Michigan's situation, so we focused on the 20 states that, like Michigan, have a heritage of a riparian ground water doctrine. We interviewed at least three ground water experts in each of these states and we used a judgment sample, which is a purposeful selection of respondents we felt were best qualified to answer our questions (Marshall, 1996), and conducted 66 in-depth interviews in 2006 and 2007, averaging over an hour in length.

We began by contacting people in each state's Institute for Water Research, University Extension, and the state agency that issued ground water permits. Thus we had three initial points of contact in each state and we solicited referrals for additional potential participants from all of these initial contacts. We provided respondents with an overview of the interview guide (see Figure 2: Overview of Interview Guide) and asked if they were an appropriate participant or if they would recommend someone who was appropriate. Approximately a third of our initial contacts were not interviewed as they provided more relevant potential respondents.

Figure 2: Overview of Interview Guide

1. The words "*ground water regulation"* can mean a number of things. Please describe your current ground water regulations and any changes made to them in the past.

2. How does your ground water regulation system work? What is the difference between what is on paper and what actually happens? Does it serve agricultural interests? Industrial interests? Environmental interests?

3. Do you have a permit system of some sort? If not, how does your state's ground water protection system control, enforce, and administer your state's resources?

4. Do you think that your state's current water resource regulations as they concern ground water use adequately balance human use and healthy aquatic ecosystems?

5. Who do you think benefits from your state's current approach to ground water regulations? What are some of the ways that they benefit?

6. Can you share with me your perspective on the process behind putting your ground water (water resource) regulations into place?

7. We are particularly interested in learning more about the extent to which your state's ground water regulations consider ecosystems with a hydrological connection to ground water. Is protection of the environment specified or otherwise addressed as part of your state's ground water resource regulations and laws?

8. Are there special "protected areas" in your state where ground water regulations are more strict than others? (ie. Wetlands, trout) What are the key threats to maintaining ground water quantity? What are the key threats to maintaining ground water quality?

9. In your state, how is it determined who gets to withdraw ground water? Is a permit required? Are there tiers of use? First to apply?

10. Can you tell us about how ground water permits/regulations are enforced and whether the enforcement mechanisms are effective?

11. If you could change one thing about ground water laws what would that be?

12. What else should we know about your experiences with ground water regulations?

13. Do you have any advice for us as we contact other programs to learn about ground water regulations?

In some states like Connecticut, we were given numerous referrals immediately. In other states like Hawaii, our initial contacts all agreed to talk with us, and we did not need to pursue additional referrals. Almost half of our respondents also provided additional referrals. Three respondents gave us referrals to colleagues who could represent an opposing point of view on some controversial issues in their state. We did contact these three referrals, however we did not contact approximately 15% of our identified potential respondents, because we met the goal for the number of respondents in that state. (Interviews with two or three respondents only counted as one interview in meeting our minimum of three interviews per state criteria.) Almost 80% of our respondents were male and over 90% had 10 or more years experience.

Rubin and Rubin (1995) have identified three requirements for selecting respondents: respondents must be knowledgeable, willing to be interviewed and hold a range of perspectives. Once we confirmed that a contact met these three requirements, we set up a time for our telephone interview. Our respondents included representatives from agencies such as the Departments of Natural Resources, U.S. Geological Survey, Environmental Quality Departments, Health Departments, Water Districts and Divisions. Their job titles included: directors, chiefs, supervisors, department heads and university faculty. Seven respondents were present during and participated in updating their respective state's legislation/regulations. A disposition table of our respondents follows:

Table 1: Categorization of Contacts and Respondents

Number of potential respondents we sent introductory letters to (via either e-mail or snail mail):	122
Number of people contacted who did not participate in the survey, but referred us to one or more other people:	50
Total number of potential respondents we identified or were given a referral to:	193
Total number of potential respondents we contacted in some manner:	164
Number of contacts that we did not pursue because we met goal for the number of interviews for the state:	29
Total number of respondents:	70
Total number of interviews:	66 (Two interviews had two respondents and one interview had three respondents at the same time.)
Number of people we contacted who refused:	11
Number of respondents who participated in the survey and gave us a referral:	31
# of male respondents:	53 (76%)
# of female respondents:	17 (24%)
# of respondents with 10 or more years of experience:	64 (91%)
# of respondents who talked about their participation in updating their state's legislation or regulations during the interview:	7 (10%)

Note: These categories are based upon the AAPOR's 2006. *Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys.* [3]

3 Table 1, The Categorization of Contacts and Respondents is based upon categories and definitions developed by The American Association For Public Opinion Research (AAPOR) and published in their 2006, "Standard Definitions, Final Dispositions of Case Codes and Outcome Rates for Surveys. The American Association for Public Opinion Research, 2006. Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys. Lenexa, Kansas, AAPOR." However we felt that while some of the definitions developed by AAPOR are appropriate for random surveys, they were not as useful for a series of 66 in-depth interviews with subject matter experts. For example, the AAPOR definitions distinguish between completed and incomplete interviews. We found those categories to be too restrictive as some of our questions were not appropriate for all

In Table 1, The Categorization of Contacts and Respondents, we categorized the potential subject matter experts into those who participated in our answering some or all of the questions in our guide, those who provided us with referrals, and those who declined to participate and did not provide referrals. These categorizations provide readers with an accurate overview of our participation level and show how we were able to obtain a high level of participation from experts with over 10 years of experience. Also, even with an average interview length of over an hour, we were not always able to touch on all topics. Thus it is important to note that a low number of responses in a specific area is not indicative of the importance level of the area and in fact, we chose to do in-depth interviews because it is a format that allows us to identify and pursue interesting comments and perhaps cutting edge ideas that would be overlooked in a standard survey.

In some states, we interviewed more than three experts. (See Table 2: Number of Contacts and Interviews in Each State). The decision to interview additional experts was based on the first three interviews. If, during the first three interviews, we were referred to an expert who was a key participant in updating their state's ground water regulations, we made every effort to contact that person. Additionally, in some states, the responsibilities for ground water management are shared between many agencies and it was necessary to contact several agencies to gain a fuller understanding of the overall perceived effectiveness of the state's ground water policies. In two states we

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states and all respondents so we did not ask all the respondents the same questions. For example, questions about the process of changing the ground water laws were relevant in states that had recently updated their laws, but not appropriate to pursue with an expert who was not present when the law changed 30 years ago and who primarily works with monitoring and modeling aquifers.

interviewed individuals who work for environmental organizations or provided legal services for environmental organizations relating to ground water and in three other states we interviewed elected officials because of the important role that they played in developing their water allocation legislation.

Table 2: Number of Contacts and Interviews in Each State:

State	# of Contacts	# of Interviews	# of Respondents Interviewed Who Have 10 or More Years of Experience	Year Regulated Riparian System For Surface Water was Enacted (ASCE, 2004), as of 2002
AL	7	3	3	1993*
AK	13	3	3	1985*
CT	18	3	3	1982
DE	6	4	3	1959
FL	7	3	3	1972
GA	9	3	3	1977 -surface 1972 ground water
HI	4	3	3	1987
IA	8	4	4	1957
IL	9	3	2	1983**
KY	6	3	3	1966
MA	14	4	2	1985**
MD	15	3	2	1957
MN	15	4	4	1973
MS	5	3	3	1985
NC	7	3	3	1973***
NJ	9	3	3	1963
NY	9	3	3	1979*
SC	11	6	6	1969**
VA	10	5	4	1989 – surface 1973 ground water
WI	10	4	4	1959
Total	183	67	61	

ASCE noted:

***Less completely developed or implemented than for other regulated riparian states.**

****Applicable to underground water only and requiring permits in capacity use areas only.**

*****Applicable to critical management areas only.**

III. B. - Interview Questions

Prior to each interview, we mailed our respondents a summary of our interview guide (see Figure 2: Overview of Interview Guide) so that s/he would have a chance to think about our questions prior to the interview. However, during the actual interview, not every respondent was asked every interview guide question. The design of our interview matches the approach outlined by Carter and Henderson (2005) and is a mix of 'open ended' and 'closed' questions. 'Open ended' questions are those questions which elicit a narrative response, while 'closed' questions are those that generate simple "yes" and "no" answers. We described the purpose of our research during the first part of the interview and reminded the respondents of the confidential nature of the interviews. During the second part of the interview, we asked respondents to describe their professional background and expertise. The third and longest part of the interview consisted of guided questions where we let the interview evolve as the respondent expanded on what s/he thought important, although we probed for answers relating to static and dynamic concerns, general institutional demands, political dimensions, and perceived a-priori risksto agencies or impacted parties, as listed in Figure 1. The majority of our questions during the third phase were open ended, and the few closed questions were paired with an open ended question such as "Please describe." or "Why do you think that happened?" During the final part of the interview, we asked if there was anything else that the respondent thought that we should know as well as asked for several pieces of advice for policy makers considering updating their riparian ground water legislation. Our open ended questions included all three types of evaluative questions as described by Gysen *et al* (2006) (descriptive, causal linkages, and normative).

III. C. - Data Analysis

We recorded and transcribed our interviews; this transcription allowed us to use the Atlas software program (Friese, 2004) to code our respondents' answers. The Atlas program allowed us to select phrases or paragraphs in our transcriptions and attach a code to the selection. In analyzing the data we went through three main stages in coding our information. The first time we coded the answers for each of our main questions. We then went through the interviews again and coded them using the adapted Russell and Powell framework. Finally, we reexamined the interviews and identified the specific quotes that supported the general themes we identified in the second coding process. It is important to reiterate that our research method was chosen to allow us to introduce relevant advice from our ground water experts regardless of the number of times that it was or was not mentioned and that some topics were not introduced in some conversations due to time constraints.

In addition to the codes directly relating to the adapted Russell and Powell framework, five particularly useful codes in our analysis were: advice, history, threats, scientist, and catalysts. The additional codes allowed us to identify issues that would not otherwise emerge from the use of our framework.

IV. - SELECTED RESULTS

Using the adapted Russell and Powell framework, we analyzed our results under the general headings of: static concerns, dynamic concerns, general institutional demands, political dimensions, and perceived *a-priori* risks. Within these headings, we further present both common and unique responses addressing each item in Figure 1.

IV. A. - Static Concerns

Static concerns include, efficiency, informational and computational demands, as well as the relative ease of monitoring and enforcement (Russell and Powell, 1999). These three areas remain constant concerns throughout the life of the policy (Bohm and Russell, 1985).

IV. A. I. - Efficiency In Meeting Policy Objectives

Efficient policies are those that are designed and implemented in such a way that the perceived net social benefits from the policies are as high as possible, given the resources available (Bohm and Russell, 1985; Perman, 2003). If benefits are assumed, efficient policies are those that are cost-effective in that they obtain their objectives at least cost (Bohm and Russell, 1985). Thus we coded comments as to whether the policy was perceived as achieving the objectives of the state's at least cost, if the administration of the policy was perceived to be streamlined; if the respondent believed that ground water in their state was being used in a technically efficient manner. Open ended questions like "Please tell me about your application process and how well do you think it is or isn't working?" were used to invite comments about our respondents perceptions of how efficient is their ground water policy.

Eight of our sixty-three interviews talked specifically about cost effectiveness, and several mentioned strategies for cost sharing. Along the lines of using ground water efficiently, thirteen of our respondents in nine states assumed that the objective of their state's policy was the conservation of the ground water resource while allowing for high valued development and the provision of drinking water. Our respondents described policies that were effective in reducing consumption as well as protecting the supply. Thirteen respondents in nine states made comments about using ground water efficiently

so that it is reserved for the times when there is not enough surface water available. Their comments included preserving water for anticipated future drinking water demands.

When asked about efficiency issues, eleven respondents talked about paperwork. Six voiced concerns about onerous and/or redundant reporting requirements as well as duplicative applications. Respondents also described the need for policies and regulations that are easy to interpret by both the regulator and the permittee. Five respondents talked about the importance of having enough staff to effectively meet the application demands or actively monitor ground water usage. Sporadic funding levels were also seen to hamper effectiveness, because money was spent starting up and then stopping monitoring programs instead of providing some level of consistent monitoring and consistent data collection.

Fifteen respondents also mentioned that permits themselves can be a tool to increase water use efficiency in the long term--as permits can require efficient use of water as defined by the best management practices at the time the permit is issued. A respondent recommended that permits should be issued on a cycle, such as 10 years, to allow businesses to plan their investments with some certainty, but without permanently locking the state or the firm into certain water uses. This same respondent also described how the sheer act of forcing permittees to document their process and describe how they plan to use the water, encouraged conservation and innovation. He said that the process provided a motivation to identify ways to improve their production processes and save water. The respondent thought that improving permittees' production processes often saves both energy and water, thereby improving their profits.

IV. A. 2. - Informational / Computational Demands

Informational and computational demands are described by Bohm and Russell (1985) as the amount of information necessary to implement the policy in a satisfactory manner as evaluated by the citizenry. Information obtained from the modeling of aquifers may be required. The majority of our respondents felt that they needed adequate data to be able to model their ground water aquifers accurately so that they could effectively manage the state's ground water resources. We asked open ended questions such as, "Please tell me about the modeling in your state" to gain insights into the role of modeling and the type of data that modelers and scientists need, as well as any advice that they had for policy makers in creating policies that would provide the data collection and modeling resources that they felt were necessary to adequately manage the state's ground water resources.

When asked about the role of modeling, 27 of our respondents described their experiences with modeling. There was consensus amongst our respondents that ongoing monitoring is crucial for understanding and managing ground water aquifers. For example, one respondent mentioned that his state has established a cap for maximum water withdrawals that is based upon scientific models that predict ground water recharge rates and surface flow as well as assuring that the amount of ground water used does not exceed the recharge rate nor negatively impact aquatic ecosystems. This outcome can only be accomplished with adequate information provided by ongoing monitoring.

Eight experts in six different states noted that the lack of consistent data over time prevents the development and use of reliable models and that sporadic data collection is relatively useless for modeling efforts. Additionally, three respondents noted that robust

models with good graphics can be excellent educational tools for politicians, stakeholders, and potential permittees.

Eighteen of our respondents described the important role of scientists in their states with regards to ground water legislation and/or regulation. Their comments were consistent with Nadeau and Rains' (2007) conclusion that strengthening the interaction between scientists and policy makers is crucial for achieving effective water policies. Nine respondents described scientists as being involved in an advisory capacity (usually as part of a committee or task force) in the development of either legislation or regulations. It was also noted that a lack of funding for the research deemed necessary by the scientific committees or state agencies was a significant constraint to improving the scientific basis for their ground water management policies.

A second constraint, the need for accurate and complete reporting of data caused two states to revise their regulations, according to two respondents. Other respondents also noted a disparity of available information, where, due to differing geology, they had considerable information about the aquifers in one area in the state but almost nothing about other areas. To increase the completeness of their data, several other respondents echoed Glennon's (2002) proposed elimination of the reporting exemption for domestic wells.

Accurate recording of drilling logs were also described as an important component of adequate information being required by the state. One agency person described the need to gain well drillers' "buy-in" to the importance of accurately maintaining their well drilling logs. This respondent recommended continuously educating and partnering with well drillers and their associations. He suggested that when

well drillers were shown how their data contributed to accurate models of the local aquifers, the incidence of negligent reporting (purposefully turning in inaccurate reports) went down significantly. It was also mentioned that the ability to revoke a well driller's license for intentionally misreporting was also viewed as a useful enforcement tool.

Several respondents also had ideas about how to take better advantage of existing institutions. One respondent suggested that states' universities could mirror the National Academy of Science's role with respect to Congress and provide important policy-relevant scientific information to state legislatures. Another respondent suggested that states may wish to create a certification program so that citizen volunteers who want to help monitor water levels can be involved in collecting viable data and stipulate that the agency can use the data provided by these "certified citizens." And finally, it was suggested that policy makers need to explicitly recognize and incorporate into their policies the interconnectedness between ground water and surface water.

IV. A. 3. - Relative Ease of Monitoring And Enforcement

Bohm and Russell (1985) describe this category as the relative ease in judging compliance, preparing bills, and auditing. They write, "these measurements are complicated not only by the features of invisibility and inherent "fugitiveness" already mentioned, but by the … equipment malfunctions, operator actions, imprecision of measurement devices and discreet sampling techniques" as well as the awkwardness of obtaining the samples. During the second phase of the interview, we directly asked respondents a question like, "Please tell me about your background" to learn if they had experience monitoring, enforcing, developing policy and/or advising.

Although our open ended question was formulated to learn about our respondent's experiences with monitoring and/or enforcement, many of our respondents comments moved from talking about themselves to talking about other concerns or suggestions, and so we allowed the interviews to move on to addressing things like flexibility to update requirements or provide incentives for conserving ground water. Thus the results in this section are sparse when compared with other sections.

Thirteen of our 67 respondents are/were involved in monitoring, while only 10 of our 67 respondents described their role as enforcement. It is important to note that most states have purposefully separated the monitoring and enforcement responsibilities. All but one respondent who talked about the separation of monitoring and enforcement related to it positively. Four respondents specifically described how this separation gave them more options in achieving their desired goals. For example, when ground water use problems were discovered by the monitors, the monitors felt that they were better able to work with the permittees to achieve an acceptable solution because they had the motivating threat of eventually reporting the permittee's violation to the enforcement personnel. Further, a respondent in Kentucky mentioned the corrective measures process in the Agricultural Water Quality Code in the Kentucky Public Health Statutes (KY Rev. Stat. Ann § 224.71-100 to 224.71-140 West 2008). Many farmers in Kentucky are active participants in state cost-sharing programs. If they are found to be a "bad actor," they face losing this financial assistance (Henken and Kirk, 1998). (A summary of the policy is available at: http://www.ca.uky.edu/enri/cd/pdf/correcti.pdf.) Another respondent commented, that the enforcing authority should be empowered with a full

arsenal of options to be used against “bad actors” and to encourage the regulatees to work with agencies to comply.

IV. B. - Dynamic Concerns

Dynamic concerns as they relate to ground water policies include looking for flexibility in the face of exogenous changes as well as identifying incentives and disincentives for environment saving technical changes (Russell and Powell, 1999). Exogenous changes include changing weather patterns, population demographics, social policies, consumption patterns and land use, which can be significant components of changing water demands (Slaughter and Wiener, 2007). Technological innovations can radically change both the cost of compliance with regulations and the demand for ground water (Perman, 2003).

Improvements in technology can also change the demand for ground water and sometimes regions undergo a shift in ground water use prioritization. A respondent in Minnesota told us that their region has taken the step of reserving the highest quality aquifer for human consumption and now prohibits the use of potable ground water for inefficient cooling systems. Previously, some buildings had cooling systems that were originally designed to only use the water once, instead of recirculating and reusing it.

IV. B. 1. - Flexibility in the Face of Exogenous Changes

Bohm and Russell (1985) describe flexibility as the relative ease with which the state maintains its desired environmental quality as the economy changes. In addition to economic changes, we included flexibility to environmental changes, like drought. To

learn if environmental protections standards were fixed into the policy or if they were flexible, we asked paired questions like "Is protection of the environment specified or otherwise addressed as part of your state's ground water regulations and laws?" followed by the open prompt of "Please tell me about it." Our respondents mentioned planning for the future and potential changes in hydrology, as well as ground water's connection to the economic well being of the state, and updating Safe Minimum Standards (SMS) in response to new scientific information or increased pressures on water by economic uses. Three respondents in different states told us that some experts try to plan for potential changes in hydrology accompanying development. For example, some ground water managers consider how development may result in land use changes that will cause changes in the area's hydrology and/or potentially impact the aquifers' recharge rate.

A common theme in water management is that of "one size does not fit all," (Richards, 2000). Thus it was not a surprise that ten respondents told us that, because of varying geology and local politics within the state, single solutions are inappropriate. These ten respondents spoke spoke positively for the idea of creating specific polices addressed to specific, unique areas of the state. Some states have done this targeting by creating special ground water protection areas which have a set of rules specific to managing that area.[4]

In addition, five respondents talked about how the use of ground water is inextricably tied to the economic health of their area/state. One respondent suggested that land use zoning should incorporate considerations of the hydrology of the area, especially by states considering intensive ethanol production. If an area wishes to remain friendly to

4 Bowman (1990) provides us with an extensive survey of states with ground water protection areas.

agriculture, there needs to be sufficient water remaining for irrigation purposes. Conversely, if farming ceases in an area, it may affect aquifer recharge rates, and potentially affect the water table. Several respondents suggested that water use planning be integrated with land use planning and zoning. Zoning can be used as an institutional tool to help achieve the desired balance between recharge and withdrawal in some areas.

It should be noted that situations such as droughts and flooding can often be predicted and therefore can be included in plans. For these predictable situations, one respondent noted that his state requires that permittees plan for surplus water as well as water scarcity. However, some events are truly unpredictable, and those events are often the times when some states give their governors (or emergency councils) the authority to make decisions to deal with the immediate needs. Another respondent noted that the laws in his state gave his governor the ability to decree measures such as water rationing, while two respondents in another state noted that their state provided legislative guidelines for prioritizing use.

One respondent advised that legislation and regulations be carefully constructed so that agencies would have the flexibility they need to make changes indicated by new scientific data. For example, if the salinity level is increasing in an aquifer, ground water managers should have the ability to address the situation and institute changes they feel are necessary to obtain the state's water quality goals.

When respondents were asked about maintaining safe minimum standards (SMS) to protect ecosystem functioning, we received a variety of responses. While one respondent asserted that permits are issued based upon regulations, not on environmental outcomes, nine experts in six other states told us that if the ground water level falls below

a predetermined SMS, then the permits can be suspended or revoked. A respondent advised that, for this reason, a permit should not be granted as a permanent right to a certain quantity of water and that the allocation should be contingent upon the aquifer being able to maintain its designated uses, including the protection of fish habitat.

Additionally, three respondents also talked about pumping ground water to supplement surface water flow. For example, if a river level fell so much that it was endangering native fish populations, ground water might be pumped to supplement the streamflow.

IV. B. 2. - Incentives For Environment- Saving Technical Changes

Bohm and Russell (1985) suggest identifying and examining the actions that are encouraged or discouraged by the chosen instrument in the long run. We directly asked respondents about incentives and disincentives embedded in their legislation and regulations with questions such as "When thinking about your state's current ground water policies, what do you think are the incentives to conserve ground water? Incentives to maintain the same rate of usage? And are there any incentives to waste ground water?" These questions seemed to take many respondents by surprise as they were not explicitly included in our overview so the vast majority of respondents said that they had not thought about it and were unable to think of any at the moment.

Respondents in two states told us that permittees in their states lobby for retaining their water allocations even if they are not currently using all of their water allocations. State agencies also work with permittees so that permittees are not penalized for conserving water at the time of permit renewal. In contrast, respondents in two other

states mentioned that “use it or lose it” regulations, where failure to use water in the present could result in losing the right to use the water in the future, potentially contributed to wasting water as permit holders used water in low value uses to maintain a history of use. An example given was when a municipality would run its emergency ground water pumps even in wet years so that they would not lose their permit to pump ground water in dry years. This example supports Ward *et al.’s* (2007) conclusion that one of the potential barriers to water conservation is a lack of secured right to use the conserved water.

Another respondent noted that water companies may have a disincentive to promote conservation among users as it could negatively affect their profits in the short term. He suggested requiring public water suppliers to document their water conservation measures/programs as part of the permit application process. This requirement would create an incentive to promote conservation and perhaps help to counteract any short term economic incentives that run counter to the goal of sustainable use.

IV. C. - General Institutional Demands

At a basic level, institutions are described as the set of formal and informal rules that govern society (North, 1990; Schmid, 2004). Thus institutional demands are the demands placed upon agencies and regulated parties by policies (Bohm and Russell, 1985). We wanted to avoid economic jargon like “institutions” in our conversations, however, we repeatedly asked “What advice do you have for legislators with regard to ground water policy?” Five respondents offered overarching institutional advice. Fifty one respondents described general institutional demands such as agency technical

capabilities and the need for data gathering for building and maintaining their models, however issues such as inadequate staffing and revenue issues were only mentioned by fifteen respondents. General institutional demands also relate to regulated parties experience in markets, reliance on government regulations, and technical skills (Bohm and Russell, 1985). Because we did not directly ask about reliance on government or technical skills, our respondents did not address these issues.

IV. C. 1. - Overarching Institutional Needs

Overarching components of effective policies can be generalized as institutional needs. When asking our experts for advice, five respondents noted specific necessary components of effective ground water policies. They talked about establishing clear goals, definitions, special protection areas, and documenting ground water use.

One respondent advised doing the political work to ensure that there are clear goals for the legislation. Possible goals include: returning aquifers to pristine condition, returning the water level to some previous level but not pristine condition, maintaining the current level and preventing additional drawdown, only allowing a certain level of drawdown, protecting a ground water dependent resources (e.g. trout) or depleting the aquifer completely.

Two respondents noted that precise definitions are vital to effective regulations and 18 others mentioned definitions in passing. According to our respondents, two states, had to go back and revise their regulations to provide definitions that were omitted from the original legislation. For example, what is a “reasonable consumptive use?” Are instream uses “reasonable consumptive uses?” What are “human consumptive uses?” Our

experts suggested that, where possible, definitions should be based on science (e.g. when defining a “spring.”)

Taking the importance of quantifiable definitions further, in another example, two respondents in different states acknowledged that drawing boundary lines around special protection areas can be challenging and is sometimes arbitrary. However, these two respondents still recommended using a scientifically based criteria whenever possible and further that any arbitrary definitions only be used until it was possible to have a scientifically based replacement. For example, a temporary boundary line might be used until enough data was collected and resources were obtained to accurately model the hydrology of the area.

Recalling that these interviews were conducted in 2006 and 2007, it should be noted that Florida, Georgia, and Alabama were involved with litigation over water use and one respondent felt that documenting use would to be important for any court challenges. He believes that the courts will consider history, because although traditional riparian law is not based on the “first in time, first in right” principle, it does consider harm to neighboring riparian users. Thus he thinks that if you document your use, it would be easier to prove harm in court, should the need ever arise.

IV. C. 2. - Institutional Demands on the Agency

In probing for institutional information, our questions focused on the adequacy of funding and asked respondents about the fee structure of their respective state. For example, we asked “Who pays for the state’s costs to process and research the applications?” One respondent mentioned that nominal fees ended up costing the state

more money to collect than they generated in revenues. Foster *et. al*. (2005) suggest that ground water use fees should be imposed to generate financing for aquifer monitoring and modeling as well as provide an incentive to conserve; one of our respondents made the same suggestion during our interview.

Markets are also sometimes considered an option for meeting institutional demands. We asked respondents if they were aware of any ground water market or allocation trading activity or consideration of such in their respective states. One respondent told us that Georgia considered market based approaches in their 2003 legislation. The idea was that authorizing the transfer of water use allocations directly amongst the permittees (without or with minimal agency oversight) would create the opportunity for water to be used in the most economically advantageous way for the permittees. A comment that reflects these concerns follows:

"Now what happens if a new company comes in and says, We'd like to locate here but we've got to have half a million gallons per day? Or an existing company says, We want to expand and we need a half a million gallons per day, right? Well, you basically have three choices. You can say, Well, no, we don't have the water, go away. And so your economy is hurt. Or you can say, Well, we really wanted to keep that much water in the stream or in the aquifer, but, hey, taking a little bit more isn't gonna hurt it THAT much, so yeah, you can have it. Well, then the environment is hurt. And then the third option is you figure out some way of reallocating water among the users. So if you think of it that way it becomes really critical that you figure out what water isn't in that trading arena. That's the water you've got to keep in the streams or in the aquifers. And until you've got a good feeling for how much you need in that system, you've got to be pretty careful about a trading system, because you're gonna cause more trouble than you solve."

As the respondent mentions, accurate models would be critical for this plan to work. Additionally, it is worth noting that this approach would rely on the permittees' ability to use markets effectively. However it has been observed by Seedang *et al* (2008) that depending on where the water is taken from, such removals can have an affect on the

local ecosystems. For example, reducing flow in a headwaters stream will warm up the entire length of the stream much more so than removing water from further downstream. Thus water quantity trades should occur in such as way as to increase the amount of water upstream, as the number of potential traders upstream is often quite small, water trading markets will probably remain very thin.

Furthermore, Shabman *et al* (2002) cautions that water allocation trading requires active policy work so that decentralized decisions can be made and the situation must be effectively monitored and enforced, thus when considering the creation of water markets, a decision of who must pay for monitoring and enforcement will also be necessary.

IV. D. - Political Dimensions

Political dimensions include distributional implications, perceived ethical messages and perceived fairness. Cox (2001) notes that sharing the water supply is an essential component of riparian regulations. Changing the regulations has the potential to disrupt existing distributional dynamics, create unintended ethical messages and it would be easy for new regulations to be perceived as unfair. These three issues are crucial components of identifying effective policies (Russell and Powell, 1999).

IV. D. 1. - Distributional Implications

When thinking about distributional implications, it is useful to identify both who bears the costs as well as who benefits from the policy. Bohm and Russell (1985) remind us that when we choose the environmental policy goal, we are choosing a distributional benefit of that policy. They focus on the political implications of the distribution of costs

of policy implementation and point out that a policy which directs costs toward a powerful interest group will probably meet great opposition. Cox (2001) points out that the redistribution of water rights, prompted by scarcity, also has significant distributional implications. Thus we wanted to learn three things. First, we wanted to identify the interest groups in each respective state so that we would better understand who would be affected by the distributional implications of the ground water policies in our respondents' states. Second we wanted to better understand who paid for the costs of administrating the current policy. And third, we wanted to examine who benefited from the redistribution of water rights.

To identify the affected parties, we asked questions like "Who pays for administering the current ground water regulations?" and "Who benefits from the current ground water regulations?" We also asked, "We've identified the following common interest groups: municipal and private water systems, agriculture, development, industrial, environmental groups. Can you think of any others in your state?" Only one respondent suggested an additional interest group: banking and investment. Overall, respondents' answers included considerations and planning for the future as well as the previously mentioned allocation of application processing costs. Our respondents also brought up the issue of defacto redistribution of water rights like drawdown and well interference and shared their concern over the implications for the state's economy as a result of policy makers' water distributional choices.

The question of who bears the cost burden of reviewing permit applications as well as monitoring elicited responses that provided both institutional and distributional insights. According to respondents, most states bear the full cost of monitoring, although

many states do require permittees to report water use to the relevant agency. A respondent in one state suggested that agency employees could use a "means" test and provide small landowners with grants for the permit application costs that were funded by taxpayers (via the agency), but require large corporations with greater available resources to bear many of the costs. The justification behind this idea could be similar to state grants for initial start up businesses; as the state would benefit by increasing the number of small landowners who were economically successful.

Overall, our respondents' answers confirmed that states have chosen a wide variety of approaches to distribute costs, ranging from states that charge relatively nothing so that the taxpayers bear the full cost of the permitting, to others that try to make every applicant pay the full cost of the permit. Also, one respondent told us that their office used to require high capacity well applicants to hire consultants to provide models for their permits, however it was just as much work for the agency to verify the consultants work as it would have been had the agency done the modeling. This particular state changed its procedure and now applicants are given a cost estimate for modeling. If the applicant wishes to apply for the ground water permit, they then pay the agency to do the modeling work instead of an outside consultant.

We also heard from our respondents that policy makers were concerned with the actual distribution of water as well as water scarcity, due to droughts. Indeed, distributional issues were the primary motivation for some policy makers to re-examine the current allocation of water rights. Respondents in two states described requiring cities, townships, and counties to develop "water use" plans. One of those states went further and required "water allocation in times of scarcity" plans as well. These plans

were then brought together to form a larger, state-wide plan. Respondents told us that other states have developed state-wide plans to allocate ground water in times of scarcity while four other states have some type of a drought task force.

Ten respondents in nine states mentioned concerns about future distributional issues. A respondent told us that their state's DNR asks their municipal permittees to look 5 years ahead. Additionally, the majority of respondents voiced their concern that if all the water is currently allocated, then what mechanism will be used to provide water for future beneficial uses? An example of this concern is ethanol production. According to The Institute for Agriculture and Trade Policy in Minneapolis, Minnesota, ethanol plants in Minnesota used 4.2 gal of water on average per gallon of ethanol produced in 2005, (Keeney and Muller, 2006). A respondent queried: If ground water is used to produce millions of gallons of corn ethanol, can aquifers in the region sustain that type of ground water pumping? Ethanol production issues were mentioned as a concern for respondents in 3 states. Another respondent noted the concern of potential ground water conflicts with the old private power plants that are being revitalized to deal with the current energy situation.

IV. D. 2. - Perceived Ethical Messages

In developing their framework for evaluating alternative policy instruments and the topic area "Perceived Ethical Messages," Bohm and Russell (1985) described a spectrum of ethical stances. On one end of the spectrum is the ideal that regulatees should be able to choose how they are going to affect the environment. On the other end of the spectrum is the ideal that any environmental damage is immoral. Interestingly, none of

our respondents talked about perceived ethical messages, but perhaps this omission is because the majority of our respondents were agency officials whose job is to follow the directives of their state as well as Federal legislation. In the literature, we find that agency employees strive to not impose personal moral judgments into policy issues (for example, Eheart *et al*, 1989).

I.V. D. 3. - Perceived Fairness

Raiser (1998) notes that the perceptions of fairness are vital for establishing creditability for formal institutions. Again, we used a paired question technique and we asked seven respondents[5] if they thought that the current legislation and regulations were perceived as being fair. We followed up the question by asking "why?" The most common response was "yes," however several others responded that their regulations were a compromise and that everyone felt that they were giving something up. Occasionally, respondents described a regulation as arbitrary. For example, the set-back distance (1200 feet) between high capacity wells and trout streams in Wisconsin was described by a respondent as arbitrary. However those respondents acknowledged that arbitrary distances were adopted because there was a lack of science upon which to base the decision; choosing an arbitrary distance was politically expedient.

Doremus and Tarlock (2005) explore science's role in natural resource regulation and conclude that "unless science can provide some level of confidence that management actions are both necessary and effective, those decisions will be widely perceived as unfair (p.2)." One respondent supported this assertion by describing how the ability of

5 Due to time constraints we only asked seven respondents.

the ground water modelers to illustrate what was happening to the aquifer and to share those illustrations with the general public, stakeholders, agency personnel, and policy makers helped people in their state to feel that the process was more transparent and increased the perception of fairness.

IV. E. - Perceived A-priori Risks

Fourteen respondents described their experiences contributing to legislative/regulatory changes however they only identified four a-priori risks to the agencies and three a-priori risks to the regulated parties. We did not directly ask about perceived *a-priori* risks to either the agency or the regulated/affected parties but instead asked the respondents to describe their experience and the discussions that they recall around the proposed policy changes. For the purposes of our research, regulated parties are ground water pumpers including municipalities, farmers, industry, and well-drillers. We asked questions like "Do you recall any concerns that were voiced at the time?" and if so, "What were they?" When policy makers consider new potential policy, both the perceived potential benefits and risks are weighed (Bohm and Russell, 1985). Many times a potential policy is abandoned because a group perceives the potential risks to themselves to be too great (Bohm and Russell, 1985).

IV. E. 1. - Agency

The most common a-priori risk voiced by agency personnel was about legislative requirements that were not accompanied by adequate funding or which were not supported adequately by existing user data or scientific information. Additionally, two respondents mentioned the risk that new legislation could be viewed by some as a

"government taking." However, comments from other respondents countered this concern by noting the importance of reminding permittees that they were being given a permit *to use* ground water, not *ownership* of ground water. We also had a respondent who, while explaining that it was appropriate to have permits issued on a cyclical basis, suggested that the permit renewal process was a tool that the agency could use to encourage the use of new technologies and help to avoid the risk of freezing technology in place.

Six respondents noted that ground water crosses political boundaries, thus, a mechanism to facilitate coordination helps to provide effective management and protection of the resources. The risks associated with such transboundary issues were identified by respondents who raised cautions about duplication of monitoring and reporting requirements and overlap of jurisdictions. Additionally, they described a need for adequate communication between agencies (like the health department and the DNR) regarding ground water to avoid duplicative and onerous reporting requirements for the regulated parties as well as adequate and efficient monitoring overall. They described a need for adequate communication between states with shared aquifers to avoid costly litigation and a general need to improve communication between parties with shared and complementary responsibilities. For example, coordinating additional monitoring efforts with any on-going United States Geological Survey monitoring projects could be beneficial for state or local agencies with permitting responsibilities. Our respondents recommended establishing and supporting coordinating councils to assist those agencies or political units with shared responsibilities to improve communication and coordination and reduce the risk or costly litigation and wasting resources on redundant monitoring.

Along these lines, the National Water Quality Monitoring Council has tracked the efforts of 13 state and regional water monitoring councils and documented their mutual assistance and cost savings through coordination (May 2007).

IV. E. 2. - Regulated Parties

Three a-priori risks to regulated parties were mentioned by our experts. The first was onerous or confusing reporting requirements and a difficult application process which were seen as both an efficiency issue (previously discussed) and a risk to the regulated parties because it would hamper their ability to obtain permits. Our experts told us that if the reporting or application process was too difficult, the risk is that many small businesses would be out of compliance because they would not bother with the paperwork. Agency respondents expressed the understanding that the forms needed to be easy to fill out and file, and that it should be the agency's responsibilities to work together to share the information instead of requiring the applicant/permittee to file the same or similar reports with multiple agencies. A respondent in Alabama described how applicants there only needs to submit one application and copies are shared amongst the relevant agencies. This is an example where the previously advised adequate communication between agencies is beneficial. A respondent in another state also described a program that he felt was successful in getting his agency the information that they needed. He told us that in his state they rely on well drillers to file the appropriate applications. He explained that they did this because it was easier to educate a small group that they had a relationship with instead of trying to educate the larger general public. He also pointed out that a well driller who did not fill out and file the forms correctly risked losing their license and as such had a strong motivation to provide

adequate information in a timely manner. A respondent in another state suggested that applicants for new developments should be required to demonstrate a reliable water supply for their new proposed land use. (This suggestion is similar to that of Glennon, 2002.)

The second *a-priori* risk mentioned was leaving policies to be decided by the courts. This concern relates to Kundell and Tetens' (1998) assertion that leaving policies to be decided in the courts leave both business and environmental advocates vulnerable because they are unable to adequately plan.

The third a-priori risk described by a respondent was the perceived possibility of municipality failure to meet the new environmental regulatory requirements and the consequences of that failure to the taxpayers. To deal with this concern, the municipalities joined forces and hired a consultant from another state. This consultant was hired to identify ways to meet the new environmental requirements. His suggestions were then presented at numerous public meetings and funds were allocated to implement the suggestions that seemed the most cost-effective.

In addition to a-priori risks, we directly asked respondents what they perceived to be the greatest risks to ground water quality and quantity in their state. Fifteen replied "development." This response suggests the importance of creating policies that have the necessary flexibility to respond to changes in land uses as well as the importance of land use planning that incorporates environmental objectives. (Numerous land use and planning textbooks incorporate environmental objectives, including, Ortolano, 1984; Kaiser *et al* 1995; Randolph, 2004).

V. - SUMMARY & CONCLUSION

When viewed in the aggregate, the information gained from our interviews identifies important factors to be considered when a formerly riparian state redesigns its ground water policies. We wanted to know what ground water managers and policy makers have learned from their experiences in their respective states. We did not find any surprising results. This extensive collection of in depth interviews with ground water experts in 20 regulated riparian states supports earlier literature and suggests that the previous smaller surveys have been effective in identifying important components of ground water policies.

Advice that we received included suggestions for writing the legislation, involving scientists and modelers, funding, monitoring, enforcement as well as considerations for issuing permits. Key outcomes of a well designed policy appear to include: the use of ground water resources in such a manner as to protect the critical resources of the state as well as a legislation that removes uncertainty about what can be done, by whom, and when. The necessary components to achieve that outcome are to be able to accurately model ground water use, the ability to maintain SMS through a drought condition, the efficient use of water and of state resources, the distribution of costs and benefits in such a way that the incentives work toward the goal of the legislation, and a process that is transparent and understandable by current and potential ground water users. Overall these suggestions and advice have illuminated a collection of applicable components for effective ground water policies in the literature.

We looked at static and dynamic concerns, general institutional demands, political dimensions and *perceived a-priori* risks. The highest responses in each framework area follows: In talking about on-going concerns within the state, such as getting the most

cost-effective outcomes, respondents in 14 of our states (70% of surveyed states), talked about why their regulations had been updated and scientific involvement in the development of their legislation or regulations. Along the lines of being as efficient as possible, respondents in 13 states (65% of surveyed states) talked about the importance of definitions in their legislation and the most common lesson learned from our experts is to carefully define terms in the legislation. In looking for policies that are able to deal with dynamic concerns, like exogenous changes (for example, changing weather patterns or economic circumstances) we found that respondents in 18 states (90% of surveyed states) described or suggested using zoning, land management, or policies targeted toward preventing harm to specific at risk areas. The most commonly reported ingredient for a successful policy was to create policies that are tailored to a specific area to address a specific need and avoid a "one size fits all" type of solution. All of the respondents who talked about the creation of and uses for policy that are based upon special protection areas related to it positively because it allows the state to establish policies that were perceived as necessary without impeding water use and protection in other areas of the state. This conclusion was especially true for states with heterogenic geology. In looking at the institutional demands placed upon the agencies, respondents in all states (100% of surveyed states) mentioned the gathering the necessary date to model the aquifers and manage the state's water resources. Respondents in 16 states (80% of surveyed states) were concerned about having adequate funds to cover the agency's monitoring costs. Respondents in 14 states (70% of surveyed states) mentioned creating water use and water allocation plans at the local level. To address perceived a-priori risks, respondents in 14 of our states (70% of surveyed states) suggested or described some type of a

coordination council that could lower risks by prioritizing monitoring areas and activities as well as pooling resources and expertise. For example, other state agencies could work with the health department to identify which areas of the state and which aquifers were at greatest risk for being susceptible to well contamination. Overall, in 14 states (70% of surveyed states) the greatest perceived threat to ground water quality and quantity is development.

This research did not test hypotheses, but can be viewed as generating them. We chose to conduct qualitative interviews because it allowed for the capture and reporting of exceptional individual responses as well as finding larger commonalities. Future researchers might wish to investigate if the creation and use of internal coordinating councils for ground water management within a state are effective. Future researchers might further investigate the role of scientists in developing legislation or regulations, and they might also examine the stated goals for new legislation and monitor how effective the chosen tools are. As we used an economic evaluative criteria to identify commonalities of effective ground water policy, future researchers may wish to narrow the scope of their research to only one or two of the framework elements (like static concerns or perceived *a-priori* risks) because the limited time that these type of experts are willing to spend assisting with a survey. Future researchers might examine which policies are perceived as being most efficient at using resources within the state, including universities' resources. Future researchers might also wish to more thoroughly identify "use it or lose it" ground water policies and document their intended and unintended effects. And finally, based on several respondents' suggestions, future researchers might also focus on comparing only those areas with the same types of

geology. These suggestions for future research complement the existing literature as the findings from our project illustrate advice for effective water policy design based upon extensive experience.

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