BEST MANAGEMENT PRACTICES AS A MEANS TO ENVIRONMENTAL IMPROVEMENT: FACT OR FANTASY?

By

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DEDICATION

This work is dedicated to my wife Tara Michelle, and to my three sons, Benjamin James, Brantley Matthew, and Brian Josiah.

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ABSTRACT

Regulatory best management practice (BMP) programs are developed in a negotiation environment. Committees of regulators and agricultural representatives develop sets of alternative management methods expected to improve an environmental problem. After program inception, regulated farms implement their preferred practices from the choice of program BMPs. This research gauges BMP program effectiveness from the standpoint of negotiated outcomes by determining whether parties exercise bargaining power during program design. Data from committee participant interviews and farm expert surveys are applied to three conceptual two-party negotiation models to demonstrate that negotiations highly favor agricultural parties for two BMP programs in Arizona.

Keywords: Agricultural Regulation, Bargaining, Best Management Practices (BMP), Environmental Regulation, Particulate Matter (PM), Regulatory Negotiation, Water Conservation

CHAPTER 1: INTRODUCTION

1.1 Environmental Quality and Concerns

The interface between human society and the environment consists of complex relationships. Natural resources provide the necessities for life and support human existence. Society in turn uses resources to improve the quality of life. In the process, humans generate waste and deplete natural resources, influencing the quality of the environment and resource base. Over time, especially in progressive societies, public awareness and scrutiny of natural resource use and environmental impacts have increased on both local and global levels.

A discussion of natural resource concerns cannot be conducted without considering the role of government. Environmental policy is necessary due to the nature of government and the wide range of environmental issues surrounding government decision making. Governments define property rights, allowing private access to some resources and public protection of others. Privatizing resources allows industries and markets to emerge, while public protection allows the distribution of life-sustaining goods or the long-term preservation of resources. In addition to property rights, governments create the laws that regulate resource use and protect public interests.

Environmental policy can be viewed as the broad spectrum of historical and current policies which have some sort of impact on the environment. Policies which affect growth, development, trade, industry, transportation, and defense all have direct or indirect environmental impacts. The U.S. government, by design, is a group of different public sector agencies. The agencies involved in developing certain rules may have a different agenda or set of goals than other agencies, creating a complex web of policies, some of which directly conflict with one another.

Environmental issues can be different from other public policy issues in several regards. First, they are often met by opposing parties. Environmental conflicts can occur between private entities, between public agencies, or between public and private interests. Secondly, shared use of resources creates interdependence between involved parties. As a result, property rights systems, economic interests, and political influences are typically an integral part of environmental problems and policy formation. Third, many collective users can deplete or degrade abundant resources (i.e. tragedy of the commons), requiring careful planning in policy formation. Fourth, an increasingly informed public places pressure and scrutiny on policy decisions. In the past half century, public opinion on environmental concerns has elevated, especially where individual health is concerned. Finally, natural resource policy decisions can be politically sensitive and contestable, especially if damage or loss of public goods result. Policy makers must be aware of these considerations when developing environmental or resource regulations.

Environmental regulation generates public scrutiny concerning the problem, the role of government in forming a policy, and the role of the policy in society. When developing policy, the government must define which agency or agencies should be involved and the extent of involvement. The public authority must compare and consider individual and collective interests, provide justifiable proof of the need for a policy, determine the policy instruments to use, and specify the organization of the agency such that it can enforce the regulatory requirements. Government also must manage transactions costs, accept the risk of misinformation or other problematic behavior from regulated parties (e.g. moral hazard), and work within time constraints when developing rules (Andrews, Sterner).

Environmental interventions can be classified as policies that (1) create new markets, (2) manipulate existing markets, (3) provide environmental regulation, or (4) engage the public (Sterner). New markets are created by policy instruments such as property rights and tradable allowances (permits, quotas, or rights). For example, designating national parks or establishing tradable fishing quotas and emissions permits may stimulate new markets. Existing markets can be manipulated by instruments such as subsidy programs, environmental taxes, user fees, and licenses. Agricultural or fishing subsidies, taxes on pollutants, fishing licenses, and forestry performance bonds serve as examples. Environmental regulations consist of standards for performance, standard-setting permits, liability, or bans on use of inputs or resources. Detailed regulation such as zoning, bans on protected species trading or specific chemicals, water or air quality emissions standards, and direct liability for externalities are a few illustrations of environmental regulation. Finally, public engagement occurs when governments allow public participation or information sharing. Voluntary environmental agreements and voluntary certification fall into this category, as well as committee-based rule design. The agreements resulting from public participation may include policy tools that fall into one of these other categories.

1.2 Agriculture and Environmental and Natural Resource Policy

Within the larger scope of environmental policies lies the interface between agriculture and the environment. Many of the environmental policy approaches just listed apply to issues affecting agriculture. Early public attention to environmental concerns in the U.S. exempted agriculture. In recent years, however, the impact of agriculture on the environment has become a more prominent political issue. As a result, the agricultural sector has been met with increased environmental regulation, and the provisions of policies affecting agriculture have shifted with changing political landscapes (Andrews).

U.S. agricultural enterprises have had widespread impacts on the environment, yet have been historically treated with less stringent regulation when compared with industries and firms of similar size or scope. Explanations range from the public notion that agriculture consists of small family farms to the political influence of the farm lobby. This influence is demonstrated by economic regulation, including price supports and production controls for agricultural products. Such programs have been in place dating back to the 1930s, and have led to increased production intensity, more concentrated industrialized farms, and arguably decreased use of environmentally sound practices. The agricultural sector has received consistent congressional support for these programs, even as new legislation toward protecting the environment emerged in agricultural policy (Andrews, Kazmierczak and Hughes).

1.2.1 A Historical Review of Environmental Policies Affecting Agriculture

Early agricultural-environmental policies were aimed at soil management and wetland conservation. The 1935 Soil Conservation Act was unique in its creation of the Soil Conservation Service (now the Natural Resource Conservation Service) and its provisions for protecting and maintaining environmental quality. The Act promoted better land practices, which can be considered the forerunners of today's best management practice programs. The 1935 Act's provisions were expanded with the 1956 Soil Bank Act, which began a conservation reserve programs for farmers to remove lands from production for three to ten years. The 1977 Soil and Water Resource Conservation Act increased federal involvement in soil and water conservation by creating programs to take nationwide inventories of conservation practices and needs.

In the past three decades, federal agricultural policies have expanded environmental protection incentives. The 1985 Farm Security Act (FSA) added incentives to reduce intensive production such as the low-impact sustainable agriculture program employing conservation methods in farming and the Conservation Reserve Program (CRP) allowing for environmentally sensitive acreage to be removed from production. The FSA contained provisions intended to reduce conversion of wetlands to agriculture (swampbusting), to protect grasslands from tillage (sodbusting), and to encourage soil conservation. The Food, Agriculture, Conservation, and Trade Act of 1990 (FACTA) contained provisions that represented a break from traditional farm policy. FACTA expanded the programs created under the FSA and incorporated cost-sharing incentives for conservation practices or land restoration. These incentives included the Environmental Quality Incentives Program (EQIP) which allowed cost-share funds for specific resources and for specific, priority-based geographic areas; the Wildlife Habitat Incentives Program which allowed cost-share funding in protecting specific habitats or protected species; the Water Quality Incentive Program which provided incentive payments for reducing water pollution; and the Wetlands Reserve Program which incorporated cost sharing and land retirement methods for wetlands preservation as an extension of the CRP. The 1996 Federal Agricultural Improvement and Reform Act (FAIR) broke from traditional agricultural policy by phasing out long standing price support systems for field crops. However, FAIR eased the stringency of some of the environmental protection programs established under FACTA and authorized the USDA to administrate most of the established environmental programs.

Beyond these agricultural policies, environmental policies have also directly affected producers. Air and water pollution, deforestation, wetland removal, and depletion of groundwater supplies are regulated at both the state and federal levels. Federal examples include the Air Pollution Control Act of 1955 (Clean Air Act), which established air quality standards, the Safe Drinking Water Act of 1974, and the Toxic Substances Control Act of 1976, which inventoried and controlled industrial chemicals. Many federal laws of this nature establish standards and charge states with enforcement of standards. States are primarily responsible for oversight of public health and environmental quality. As a result, a wide variety of state environmental policies have emerged. These policies have direct impacts on agriculture, requiring producers to reflect on the costs and risks imposed on the public by their actions and to adjust their operations accordingly.

1.3 Negotiation and BMPs as Policy Tools

The regulatory process has traditionally offered little public participation and consisted of imposing technologically limiting rules on agricultural producers. As a result, the agricultural sector has contested these regulations as a threat to globally competitive production. This has prompted regulators to search for alternatives to traditional policy measures for conflict resolution (Kazmierczak and Hughes).

Conflicts between the agricultural sector and environmental proponents have generally taken the following form: First, there is identification of a potential harm, observed by the public or other private firms. Secondly, the source, either a producer or group of producers that are causing the potential harm, is identified. Finally, a formal grievance is claimed with the source of harm. The characteristics of these disputes validate negotiation as a promising alternative to traditional conflict resolution procedures (e.g. litigation). Negotiation is attractive due to the existence of multiple competing interests, multiple contributors to the problem, and public interest in the policy or agreement outcomes. Proponents of negotiation claim that the process will resolve environmental conflicts in a mutually agreeable manner and provide reduced transaction costs (Kazmierczak and Hughes).

The use of negotiation for solving environmental problems in agriculture emerged alongside the adoption of negotiation as a policy-formation tool in government. In 1913, institutional economist John R. Commons foresaw negotiation as a unique means to solving conflict between the public and private sectors. Commons anticipated that it would provide a satisfactory solution for all parties. He perceived that negotiations could provide a solution that meets the criteria of both efficiency and equity (Kazmierczak and Hughes). Similar lines of thought continued in the public policy and economic literatures, but serious legislative interest in negotiation didn't blossom in the U.S. until the mid-1970s. During this period, many administrative regulatory processes became more difficult and politicians perceived a need for creative approaches to regulation (Ryan).

Throughout the 1980s, research concerning negotiation increased in the U.S. because of rising costs of litigation, lack of public policy effectiveness, and an increase in public disapproval towards conventional processes (Kazmierczak and Hughes). Due to increased use and support for regulatory negotiation (reg-neg), the Negotiated Rulemaking Act of 1990 was developed to provide support and guidelines for negotiated processes in agency rulemaking.

The widest use of regulatory negotiation in the U.S. has been to address environmental concerns. The U.S. Environmental Protection Agency (EPA) has taken the lead role among federal agencies in using negotiation as a policy tool. The EPA first used the technique in 1984 (Fiorino), embracing it as a potential solution to a wide range of environmental conflicts. The EPA's cases are frequently investigated by researchers, evidenced by bodies of work on negotiated agreements, in which virtually all case studies have some form of EPA involvement.

In addition to reg-neg, several other negotiated processes are prevalent in dispute resolution and policy development. Negotiation as a policy tool has roots in the European process of planning and consultation, which became widely used by the 1960s. This process allows a government interest and two competing public or private interests to engage in a negotiation for a broad social agenda, such as labor reform (Hadden). In contrast, negotiations in the U.S. have allowed more parties and tend to approach issues of a narrower scope. Voluntary environmental agreements (VEA) have emerged simultaneously with regulatory negotiation. VEAs differ from negotiated rulemaking in several ways. Only a few affected parties are usually involved in VEAs, whereas in reg-neg, all identifiable interests are asked to be included. Also, VEAs do not serve a regulatory purpose, although they may be utilized as an alternative to regulation. In agriculture, firms can develop VEAs in conjunction with regulators, typically specifying a quality goal, a control strategy, and a deadline for attainment. In addition, regulators may encourage firm participation in VEAs with incentive programs, including payments, technical assistance, or educational programs. As opposed to reg-neg, firms that fail to meet VEA requirements are not penalized, except with the loss of incentives or with future regulation.

Best management practices (BMPs)[1] have become a popular form of agricultural regulation. Farmers can meet requirements through the lowest cost, or least interfering, alternatives available in the program. Also, the public is given opportunity to participate through committee consensus, allowing agricultural producers and other affected interests to contribute to the regulatory decision making process. The BMP consensus agreement is expected to lead to fewer disputes over the final rules. Through this process, BMPs are considered a useful political tool, as the resulting programs potentially reduce environmental damage while preventing disapproval from affected parties (Leathers).

BMP programs have usually been developed in a negotiation environment. Committees of interested stakeholders, agencies, and experts typically convene to develop farm management programs to improve environmental quality (Ice). The committees determine a set of practices and the terms by which farms are to use them. The practices may include management methods or technologies. Farms are given a choice from these control methods, allowing for flexibility in implementation.

BMP committees consist of private sector farmers and public sector agency representatives, who determine the practices to use in the program. It is expected that these representatives have competing objectives (Leathers). On one hand, agricultural parties desire regulations that minimally interfere with production. On the other hand, environmental policy makers aim to achieve environmental objectives. Resolving these competing interests, satisfying the needs of multiple players, and attaining an effective, practical set of controls represents a complicated task for those that develop BMP programs.

1.4 Research Objectives

BMP programs are a unique policy approach to managing environmental quality. Regulations are developed in a negotiation where management practices and implementation plans are designed. The expected outcome of this negotiation process is the achievement of environmental goals. Given the wide range of interests, political power, knowledge, and time in this negotiation, I hypothesize that a negotiated BMP process may lead to a program that fails to reach environmental objectives. Negotiated agreements may favor a specific interest (i.e. agriculture), and lead to little or no environmental improvement. In this case, BMP programs would represent a substantial net cost to society. The objective of this thesis is to test for this possibility through an in-depth evaluation of the BMP design process and an estimate of the expected environmental benefit of these programs.

This study is a theory-based program analysis consisting of three parts. First is a review of academic and regulatory literature for BMP design decisions and the reg-neg process. Secondly, conceptual models are presented to capture the basic issues in the BMP program design process. Finally, two case studies for regulatory agricultural BMPs in Arizona are presented. In 2001, the Agricultural PM_{10} Best Management Practices were implemented as a mandatory regulation in Maricopa County by the Arizona Department of Environmental Quality (ADEQ) to control for dust emissions from agricultural sources. In 2002, the Arizona Department of Water Resources (ADWR) implemented a voluntary best management practice program statewide as an alternative for water conservation for irrigated agriculture throughout Arizona. After evaluating the negotiated outcomes of these programs, I conclude with lessons learned from each case study, as well as thoughts for the future design of BMPs.

CHAPTER 2: LITERATURE REVIEW

2.1 Regulatory Negotiation

2.1.1 Background

Problems involving the often-competing objectives of agricultural and environmental interests are met with the challenge of obtaining a process that allows fair and equitable engagement. In contrast to the polluter-pays framework typical of conventional rulemaking, negotiation allows the agricultural sector to assist regulators in finding solutions that reach environmental objectives. Pursuing negotiated rules is expected to reduce government costs and achieve an environmental standard with little litigation. Negotiations are expected to result in realistic rules with some costs of implementation imposed on firms (Kazmierczak and Hughes).

Federal negotiated rules in the U.S. are required to follow the guidelines of the Negotiated Rulemaking Act of 1990. BMPs are usually developed at a local level, and program design typically adheres to the requirements of local or state statutes, unless directed by a federal agency. There has been some adaptation of the legislative negotiated rulemaking (also regulatory negotiation or reg-neg) process at state and local levels (Hadden), but interviews of BMP committee members for the case studies in this thesis found little awareness of the Negotiated Rulemaking Act or its guidelines. Nonetheless, BMPs are a negotiated form of rule and can be viewed as a special case of reg-neg agreements. A thorough overview of what is required and expected under federal reg-neg guidelines is provided here, shedding light on the committee dynamic expected for BMP design and the administrative efficiencies or shortcomings in specific BMP cases when compared to the federal negotiated rulemaking process.

2.1.2 Definition and Purpose of Negotiated Regulation

Negotiated rulemaking, as defined in the Negotiated Rulemaking Act (NRA) of 1990 (PL 101-648; 5 USC §§561-570), allows participation of affected parties in rulemaking processes. The NRA is expected to encourage increased participation from regulated parties, provide more acceptable and substantive rules, and result in reduced litigation or conflict as compared to traditional rules (5 USC §561). According to Pritzker and Dalton, the regulatory negotiation process allows all interests affected by a proposed regulation or rule to jointly solve a problem both creatively and resourcefully through a negotiation and consensus approach. Proponents suggest that negotiation provides solutions that satisfy each participating party's interests, resulting in a policy that is easy to implement and enforce. In general, the purpose of negotiated rulemaking is ex-ante in nature-- designed to influence future behavior rather than to resolve current disputes. As a policy tool, reg-neg incorporates the ideas and goals of a number of previous attempts at revising or improving rulemaking processes, including risk assessment, paperwork reduction, cost-benefit analysis, public participation, and flexibility (Kerwin).

2.1.3 Historical Overview: The Negotiated Rulemaking Act and Supporting Legislation

The Administrative Procedure Act of 1946 (APA) establishes the process federal agencies can follow to reach both rulemaking and adjudication decisions. Rulemaking as defined in the APA is the definition and implementation of a proposed rule by an agency, and is used to uphold or prescribe policies. Adjudication is issuance of an order which establishes rights and liabilities. The APA also distinguishes informal rulemaking from formal rulemaking. Under informal rulemaking, the APA requires public participation. Negotiated agreements are therefore considered an informal process, as agencies must allow public input on the proposed rule during the rulemaking process.

The standard practice for writing rules, according to the APA, is conventional notice-and-comment rulemaking. Under this type of rulemaking, the agency consults affected parties or representatives to gather appropriate and necessary information when drafting the rule. The agency provides a public notice of the proposed rule, printed in the *Federal Register*, and allows for public commentary prior to implementing the rule. Finally, the agency must respond to each comment and consider commentary when writing the final rule (Pritzker and Dalton).

The Federal Advisory Committee Act of 1972 (FACA) allows agencies to appoint committees to negotiate terms, reach a consensus, and write proposed rules. The FACA sets standards in three areas. FACA provides a guide to the operations of committees in the executive branch of government, establishes oversight of committee activities, and contains provisions allowing public access to committee proceedings. The General

Services Administration (GSA) is established as responsible for oversight and coordination of FACA committees. Any negotiated rulemaking committee's charter must be reviewed and approved by the GSA prior to proceeding with negotiation. The GSA then submits the charter to the Office of Management and Budget for further review.

In 1980, Congress held joint congressional hearings on the reg-neg process. The findings of these hearings resulted in reg-neg endorsement as a potential means to reduce judicial review and litigation in rulemaking (Coglianese). In 1982, the Administrative Conference of the United States (ACUS) commissioned a study on negotiated rulemaking, which led to formal recommendations for promoting reg-neg and developing standards for the process. Congressional hearings in 1987 for the proposed Negotiated Rulemaking Act eventually led to the passage of the Act in 1990.

The Negotiated Rulemaking Act of 1990, and its subsequent revision in 1996, was a supplement to the APA, and gave federal agencies the authority to use the negotiation process for rulemaking. NRA does not grant new authority, but provides a framework for rulemaking with flexibility of application, including a consistent set of guidelines for negotiation processes. The Act requires that agencies adhere to FACA procedures for establishing rulemaking committees except where modified by the NRA. Such modifications include additional public notices concerning the committee, the designations of committee chairs, and guidelines for termination of the committee (Pritzker and Dalton). Additionally, the Administrative Dispute Resolution Act of 1990

(PL 101-552) gives federal agencies the authority to address public disputes with processes such as negotiation, consensus, and mediation (Wondolleck and Ryan).

The Clinton Administration's National Performance Review, headed by Vice President Gore in 1993, found that

> 'Even if agency experts choose wisely, the traditional [rulemaking] model has very little buy-in from outside the agency, which undermines the rules effectiveness…'(Harter p. 37)

The National Performance Review called for an increase in the use of negotiated rulemaking as a solution to disputed regulatory cases (Harter). It encouraged the adoption of negotiation strategies by federal agencies, referencing the EPA as a model for federal agencies to follow (Ryan).

2.1.4 The Process for Negotiated Regulatory Agreements

Negotiated rulemaking involves a three-stage procedure. First, prenegotiation includes making the decision to use reg-neg and making preparations for the negotiation process. Second, negotiation takes place and the committee meets regularly to address issues and determine and write the rule. Finally, rule implementation includes the regulatory agency issuing the final draft of the rule and institutionalizing support for its provisions. The NRA details the responsibilities for federal agencies and the committees involved in reg-neg. These responsibilities, as well as roles and expectations for agencies and committees, are reviewed here following this chronological sequence.

2.1.5 Prenegotiation

A. The Role and Requirements of the Agency

The NRA provides considerations for agencies determining whether to use reg-neg. To pursue negotiation, the agency must establish the need for a rule and have adequate resources to support the process. It must also be able to identify affected interests and establish a committee consisting of representatives of these interests. The agency needs to determine whether the committee can negotiate in good faith to reach a consensus within a fixed time frame, so that rulemaking is not substantially delayed. Also, the agency must be willing to accept the consensus of the committee as the basis for the rule. The agency is afforded the opportunity to use conveners to assist with determining whether negotiations are a feasible form of regulation, but the final decision is made by the agency head (5 USC §563).

The ACUS Negotiation Sourcebook offers some other reasons and requirements for adopting reg-neg procedures. An agency has incentive to use reg-neg when there are a limited number of interests, when the issues at stake are well known and understood, when the outcome of the rulemaking process or acceptability of an agency-designed rule is difficult to determine, and when parties who will be affected by the rule request the reg-neg process. The Sourcebook specifies that agencies designate a deadline for consensus, allow no party to dominate discussions, and require no party to sacrifice a fundamental value at the negotiation table. If many or all of these conditions are met, the rule may be suitable for the reg-neg process (Pritzker and Dalton).

Once the agency head establishes reg-neg as the proper course for regulation, the agency is responsible for forming the committee and providing administrative or technical support. The committees may consist of up to 25 members, and the membership and operations must comply with the FACA. If the committee cannot be established due to noncompliance with FACA regulations, the agency must report this to those who would be actively engaged in the process, as well as publish the reasons for the decision in the *Federal Register* (5 USC §565).

Prior to negotiation, the agency must afford an opportunity for additional parties to join the process. The agency publishes the intent to develop the rule in the *Federal Register*. Publication includes a notice of the proposed committee and agenda, the subject and scope of the rule, a summary of affected interests, an overview of support which will be provided to the committee, and a request for both public comment on the proposal as well as instructions for application or nomination to the committee. The agency must review and respond to any comments, applications, or nominations received and establish any changes as needed within 30 days (5 USC §564). Kerwin suggests that publication in the *Federal Register* is critical because the substance and quality of the final rule depends on the extent of public awareness and participation in the process.

In addition to complying with NRA requirements, the agency should prepare for its role in negotiation. Preparation includes determining how it will participate in the negotiation, which issues will be discussed, how issues will be managed, the desired outcomes of negotiation, the agency's definition of consensus, the timeline for consensus, the management and coordination of meetings, and the resources the agency will provide to committee. The NRA provides the agency additional funding to that of standard rulemaking, including federal funds for conveners, facilitators, and expenses of committee members, or use of other agencies' resources as appropriate (5 USC §568).

B. The Role and Requirements of the Committee

Once committee membership is finalized, committee members familiarize themselves with other participants and collectively establish guidelines for committee operation and negotiation. The committee determines meeting schedules and operations, sets the agenda for the course of the negotiations, creates guidelines for communication and record keeping, provides a definition of committee consensus, establishes deadlines for negotiations, and specifies how resources will be used. After determining the bounds and rules of the negotiation, the committee begins collection and dissemination of information. This information-sharing stage allows participants to understand the interests of other committee members and the strengths and weaknesses of their bargaining positions (Raiffa). In addition, the committee may establish subcommittees or additional advisors for committee assistance if deemed necessary.

2.1.6 Negotiation

Kazmierczak and Hughes define a single purpose for the negotiation phase: to establish a potential set of solutions that will lead to gains or an increase in overall welfare for all parties involved (i.e. mutual gains). Once a set of solutions is reached by consensus, the tentative document is then drafted by the committee.

A. The Role and Requirements of the Agency

During negotiation the agency has several distinct roles. As the agency has a member at the table, the agency endorses the rule upon reaching consensus (Harter). While any party can withdraw from negotiation, agency withdrawal entails a traditional course of action for setting the regulation. This veto feature of reg-neg sets the agency representative apart from the rest of the committee (Fiorino).

Ryan states that agency personnel require a different set of skills and approaches in reg-neg from those required of traditional rulemaking. The frequency of meetings and consultation with sources outside the agency create obstacles and relationships that don't exist in conventional rulemaking. Agency representatives may have a variety of roles in the committee, including (1) expert, due to their knowledge of the issues at hand, (2) rational decision maker, as they intend to maximize net benefits for social gain, (3) stakeholder, as they have preferences for policy and implementation, (4) facilitator, in their need to balance policy decisions with public perception, and (5) leader, as they direct the policy design process.

Wondolleck and Ryan discuss the behaviors of agency participants, using responses from agency and non-agency participants covering a total of 65 agreements addressed through a collaborative process. The authors find that three distinct roles for agency participants emerge: those of leader, stakeholder, and partner. Leadership by agency representatives is important due to the agency's authority over decisions and the rule, but the authors find that agency representatives often failed to recognize their responsibility for assuming this role. According to Wondolleck and Ryan, leadership by agency participants can be ascribed to three areas within the negotiation: to the process of the negotiation, to the issues being addressed by the rule, and to the decisions made along the way. The authors find that effective leadership sets a clear direction for negotiation that includes a timeline, a positive tone, and clearly stated goals, obligations, and mandates of the agency. The agency should also provide the framework for developing the rule by identifying opportunities, setting limitations, and ensuring accuracy in discussion of the issues at hand. Finally, in decision making, effective agency leadership includes keeping other negotiators informed of what can and cannot be done, as well as the agency's commitment to the rule.

To be effective as a stakeholder, agency representatives must be clear on the unique interests and responsibilities of the agency. Agency negotiators must also keep the interests of others in perspective prior to and during negotiations. Clear communication with other agency personnel is essential. The authors suggest that participants keep their stakeholder role clear and avoid assuming a facilitator role because facilitators are often perceived as maintaining the rulemaking process without holding a stake in the issues or final result.

The role of partner creates the most conflict for agency representatives according to Wondolleck and Ryan. As a partner, the agency representative must have an interest in working together with others, sharing information, and utilizing the resources of other participants. Agency players are exposed to new information, engage in trust building, and participate in processes that are different and riskier than those of traditional rule development. The partner role exposes the participating regulator to a multi-objective dilemma: they must lead the rule development process while simultaneously participating as partner and stakeholder.

B. The Role and Requirements of the Committee

The reg-neg committee is encouraged to consider all matters proposed and attempt to reach consensus. The committee may choose to include a facilitator to chair its meetings in order to assist negotiations in an impartial manner (5 USC §566). Despite the agency representative's place in the negotiation process, each participating member in negotiation has some veto power over decisions, giving some balance of power to the committee. In rule design, participants are each limited in their bargaining position to the amount of information available to them and the extent of their persuasive abilities. Studies of the reg-neg process have shown that within committee operations, smaller groups are often formed by committee members. Some may be official sub-committees which are formed to address specific or technical issues in the rule development process, while others are coalitions informally formed by members with aligned interests to increase bargaining power or refine positions (Kerwin). Polkinghorn finds that negotiation participants constantly test others to support their own agendas. They may engage in labeling other parties to undermine their positions or expertise. Similarly, expertise or asymmetry of information may be used to assert one's own advanced credibility over others. As the level of conflict increases, several changes tend to occur in the group dynamic. First, parties with similar interests seem to be more likely to form coalition groups in more competitive negotiations. Secondly, as conflict escalates, negotiators choose professional identities or relationships over personal identities when communicating.

The negotiation process can be demanding, as participants simultaneously juggle the goals of the committee and the goals of their organizations. Committee deliberations are often lengthy and difficult due to conflicting interests and complexity of the issues. To overcome these barriers to successful rule development, the committee must focus on the issues, not the individuals or their respective office or employer. Issue rather than identity focus encourages trust and participation among members. Committee members should explore options that take into account each of the negotiating parties' interests and objectives. They should also work to distribute the gains from negotiation among interests and develop self enforcing agreements. Finally, the committee's decisions must be based on information that is both factual and objective in nature (Kazmierczak and Hughes; Susskind, Levy, and Thomas-Larmer).

Upon reaching a consensus or dissolving the negotiations, the committee must provide a report of its activities to the overseeing agency. If a consensus is reached, the report contains the committee's findings and the proposed rule. If the committee abandons negotiations, the report reveals areas in which agreement was reached and the committee's recommendations for readdressing the rule. The committee must also submit records of proceedings to the agency as directed under FACA (5 USC §566). Termination of the committee occurs after the final rule is in place, or at another time previously specified by the committee (5 USC §567).

2.1.7 Implementation of the Rule

Implementation is primarily the responsibility of the agency, with a limited committee role. The procedural guidelines of the APA must be followed by the agency prior to writing the final rule. As in traditional notice-and-comment rulemaking, the proposed rule must be published for public review and commentary. Any comments are to be reviewed and responded to by the committee or the agency prior to the agency's drafting of the final rule. Monitoring agreements may be made during negotiation, but it is generally the agency's responsibility to establish a performance monitoring system after rule implementation (Kazmierczak and Hughes). If challenged, the final rule determined by the committee is subject to judicial review, although the agency process of establishing and overseeing the committee and its negotiations is given exemption (5 USC §570).

2.1.8 Advantages and Disadvantages of Reg-Neg

Most policy literature concerning reg-neg compares the process to conventional or traditional forms of rulemaking. Some of these works are empirical in nature while others are discussions of negotiation, but all incorporate case study data as evidence for their claims. This literature compares outcomes of rulemaking procedures or the perceptions of participants for each type of rule. Among authors, there are some common perspectives on the comparative advantages or disadvantages of reg-neg, while there are some claims that remain under debate.

The negotiated approach to rulemaking provides a number of advantages to conventional rulemaking. First, the committee affords regulated parties direct representation in an early stage of the rulemaking process, which is expected to provide reduced commentary on the final rule and higher compliance rates (Langbein; Pritzker and Dalton). Negotiation usually results in long lasting and improved relationships between regulators and regulated parties, and more balanced power among affected interests (Hadden; Harter). Secondly, improved information flow between agencies and other participants is expected to provide several advantages. Agency investment of time and resources for information gathering is expected to be less than conventional rules (Harter). Inaccurate information is more likely to be identified and dispelled due to the public, multi-party nature of negotiation (Hadden). Information exchange also allows affected parties a better understanding of other parties' interests and objectives (Langbein). Third, there are some aspects of reg-neg that generate public support of the process. Participants tend to find the process more responsive to their interests than traditional rulemaking procedures (Langbein).Industries utilize negotiation as a part of day-to-day business operations; in reg-neg, industry representatives find themselves included in a process they are familiar with (Polkinghorn). Reg-neg has also succeeded in some conflicts where traditional rulemaking was unsuccessful (Pritzker and Dalton).

Several disadvantages to the process are discussed in the literature as well. First, the committee dynamic can create problems for rulemaking. It is possible that not all affected parties will be included in the process (Coglianese), and opposing parties often have disproportionate influences on the final rule. Small business and public interest groups may feel they are not well represented in the process, and final rules have been found most responsive to the interests of large or politically influential firms (Langbein).

Poor public representation can occur as a result of this disparity, as interest groups generally assume the responsibility of representing the public (Polkinghorn). Influential or inflexible participants may have their objectives met before other criteria which should be of more importance, such the interest of overall social benefit (Fiorino). These criticisms suggest that there is no reason to assume that negotiation will lead to more equitable rules. Secondly, a number of authors find that in reg-neg, short term expenditures of time, effort, and money are greater for regulators and much greater for other participants than conventional forms of rulemaking, unless the agency provides funding. Agency costs include increases in man hours and expenditure on facilitation during rule design (Coglianese; Pritzker and Dalton). Other participants must dedicate man hours and efforts not required by traditional rules in order to be represented during rulemaking (Coglianese). Finally, the process can be riskier for agencies. The agency is expected to endorse the committee consensus. Thus, given the number of affected parties involved, comments on the proposed rule are less likely to lead to agency changes to the consensus agreement (Coglianese). If the agency changes the final rule it may damage agency reputation and make it hard to engage in future negotiations. Changing the rule usually incurs litigation as well (Hadden).

There are also some issues that remain inconclusively disputed by policy theorists. Some claim that there is reduced litigation associated with reg-neg (Harter). However, others find that there are new sources of litigation, which lead to no noticeable reductions in contested rules for reg-neg (Langbein; Coglianese). Reg-neg can generate conflicts over committee membership (i.e. excluding stakeholders), the committee definition of consensus, and any portions of the final rule that result in an adverse impact on negotiating parties. A second dispute is whether there are time savings associated with rule design in reg-neg. Different researchers have arrived at different conclusions on whether rule development saves time, some using the same set of rules in their analyses (Harter, Coglianese). As these subjective assessments are conducted by comparing sets of reg-neg rules of sets of other rules, and definitions for time expenditure may differ, results can be different between different studies (Coglianese). So far, it is inconclusive whether a time savings actually occurs.

2.2 Best Management Practice Programs and Background

2.2.1 Introduction

Best Management Practices (BMPs) are, to say the least, a broad concept. As a very general definition, they are a set of practices deemed by an authoritative party to be the most effective controls for meeting some particular goal. These controls can be either management methods or specific technologies. BMPs may be employed in the private sector by firms seeking to maintain uniformity of production or reduce costs, or instituted by government as regulation to control for externalities. There is little academic literature which directly analyzes BMPs or BMP program design. Most publications are BMP adoption studies that attempt to evaluate adoption rates with programmatic and farm-level variables. These empirical studies have increased our understanding of how farmers react to BMP programs and what incentives are necessary to encourage BMP adoption. There is a small body of literature that surveys design and implementation of BMPs, although much of these analyses are more than a decade old.

2.2.2 Definitions of BMPs

BMP definitions within the literature generally follow from 1972 Federal Water Pollution Control Act wording. Ice gives one such definition:

[A BMP is]'…a practice or combination of practices that are determined (by state or designated…agency) through problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with … quality goals.'(Ice, p. 685)

Few analysts deviate from this definition, although some extend the best anagement practice concept further. Murphy suggests that BMPs should be practices that are adaptable to site-specific conditions, serving as a means to achieve an environmental quality goal at each site, and resulting in overall quality increases within a geographic region. Leathers requires the BMP concept to include a combination of policy objectives and incentives for adoption. He states that a BMP should result in a socially optimal tradeoff between agricultural objectives and resource or environmental objectives, whereby a socially optimal practice satisfies an optimal level of input (or output) taking into account both policy objectives. This results in an optimal tradeoff between these objectives. Leathers recommends that BMP programs should be designed to encourage farmers to adopt economically feasible BMPs while reaching the overall environmental objective of the program.

2.2.3 A History of Legislation and Evolution of BMPs as a Policy Tool

The earliest legislation passed in the United States that called for practicable management methods was the 1935 Soil Conservation Act, which included land management practices for soil conservation. These early practices were adopted on a voluntary basis. The 1956 Soil Bank Act continued emphasizing soil conservation practices and included subsidy incentives. The programs established by these acts were aimed at stabilizing on-farm productivity and were not necessarily environmentally friendly. The programs contained incentives for converting wetlands to agricultural production and applying chemicals intensively (Shogren). Not until the 1970s did legislation directly linking BMPs to environmental improvement emerge.

Best management practices have been implemented on an informal basis to tackle various environmental challenges across agriculture at local, state, and federal levels. At the federal level, several acts were passed in 1972 that encouraged alternative practices for mitigating environmental pollution from multiple sources. The Coastal Zone Management Act, as well as its future amendments, called for measures to handle nonpoint agricultural pollution within coastal regions. The Federal Water Pollution Control Act (PL 92-500), renamed the Clean Water Act (CWA) in 1977, was the first piece of legislation specifically calling for best management practices, and included a definition of BMPs. The overall goal of the act was to improve and maintain water quality. The CWA contained provisions for research and development into pollutant reduction and elimination, guidelines for agencies and firms to conduct operations, and wording that separated out nonpoint source pollution from point source pollution. CWA amendments to the act (PL 95-217) authorized the USDA and EPA to jointly develop a set of BMPs for water pollution control. Section 319 of the CWA specified that states were required to identify nonpoint pollution sources which decrease water quality. The CWA defined threshold standards, and delegated states to (1) identify sources of pollutants in excess of these standards, (2) create a means to identify BMPs and other programs to control these sources, and (3) to implement the programs.

Additional legislation has contributed to the use of BMPs for regulating agriculture. The Soil and Water Resources Conservation Act of 1977 (PL 95-192) called for analyzing resource problems as well as the identifying and evaluating alternative methods for environmental protection or improvement. The potential use of BMPs for managing soil and water was included. More recently, the 1996 Federal Agricultural Improvement and Reform Act (FAIR) created farm programs authorizing the Secretary of Agriculture to provide technical assistance and subsidies. These programs encouraged farm adoption of voluntary BMPs.

2.2.4 BMP Program Design and Evaluation

Most regulatory BMP programs directed at the agricultural sector in the U.S. are developed for environmental problems specific to a geographic region (i.e. a specific watershed location). For this reason, the programs are usually developed by state or other local agencies. BMPs are generally chosen for environmental problems with multiple affected parties or multiple contributing sources, such as nonpoint pollution abatement, soil and water conservation, or wetlands protection. As a result, most of the literature discussing agricultural BMPs draws from these types of programs.

A. Overview of Program Design

BMP program development typically follows several stages (Ice). First, there is recognition of an environmental quality problem. The appropriate agency is then mobilized to resolve the issue. If BMPs are identified as the suitable control strategy by the agency, the agency usually relies on local advisory committees to determine practices to be used. The committee considers and refines alternative management practices, leading to those that are feasible for use in the program. Next, program implementation leads to the on-farm adoption of BMPs. Finally, continuous testing and modification of practices ensures that the BMPs reach the program's goals. During the implementation period for agricultural BMP programs, education programs are used to encourage participation. If costs are significant, NRCS personnel may work with farmers to develop site specific programs using EQIP or other funding mechanisms. Beyond Ice's brief discussion, there are no reports within the BMP literature concerning the political development process behind agricultural BMP programs, nor are there impact evaluations of program effectiveness.

B. Designing BMPs for Control of Environmental Quality

Bailey and Waddell present five evaluation criteria as a framework for the design and implementation of BMP programs. First, BMPs must be agronomically effective, promoting agricultural operations by increasing farm productivity or product quality. Secondly, BMPs must prevent, control, or reduce pollutants emitted by agricultural practices. Thirdly, the BMPs must be economically feasible. Fourth, the program must garner public support or be popular enough that the BMPs will be socially acceptable when implemented. Finally, BMP programs must be supported by the legal system and by existing organizations, or it must be feasible to implement new institutions to support them. Bailey and Waddell, however, pass over another important criterion, namely using benefit-cost analysis to determine the set of practices and incentives that provide the greatest environmental benefit per dollar of investment (Feather and Cooper). Benefit-cost analysis is expected to increase BMP program efficiency.

Murphy states that identifying and maintaining the environmental goal is the most important issue in the BMP design process. The quality goal must be constantly in the minds of the regulators as they develop the program to meet the management and physical heterogeneity of the agricultural sector. Murphy argues that BMPs are never free; someone must pay to have a BMP program that works. In other words, the agricultural sector or regulating agency (i.e. the public) must bear the cost of implementation and program support. Murphy's position is in contrast with Bailey and Waddell, who suggest looking for BMPs that benefit all parties such that costs are minimal. These conflicting points of view suggest some early, and perhaps ongoing, inconsistencies in definitions of and expectations for BMP programs.

Leathers suggests two decisions in program design: first, determining the BMPs that should be adopted, and secondly, the incentives that should be provided to stimulate adoption. The author argues that discovering the appropriate tradeoff between the policy objectives of environmental quality and farm profitability is critical. Leathers states that some early BMP proponents ignored this difficult tradeoff and focused instead on promoting programs that would improve, at least in theory, both environmental quality and farm profitability (again see Bailey and Waddell).

The challenge of competing objectives is modeled as:

$$\underset{x}{Max} W[V^E(x), V^A(x)],$$

where the vector *x* contains the level of input for all farmers. V^E and V^A are the objective functions for environmental policy and agricultural policy, respectively. The marginal effects for costs and benefits are contained in these functions, while society's weight on these costs and benefits are contained in the welfare (*W*) function. BMP policy should maximize one of the two objective functions subject to a constraint, such as an abatement standard, on the other. However, Leathers suggests that environmental issues managed with BMPs often lack the concrete information necessary to pursue this approach.

Profit maximization is usually considered the farm policy objective, but other aspects of farm decisions should be considered when designing BMP regulations (Leathers). Equity (whether a practice or program allows transfer of economic rents), risk and uncertainty (especially concerning practices that influence crop yield), and financial stress (mandatory practices carry more likelihood of this than voluntary) are issues that policy makers often ignore. In establishing any particular practice, policy makers must consider the multi-dimensional impact on farmers.

C. Program Incentives for BMP Adoption

Some BMP literature discusses including incentives in program design to encourage farmer adoption. Several authors argue that incentives are a necessary part of any BMP program. Incentives may either be positive (e.g. a subsidy for farmers who meet requirements) or negative (e.g. an alternative tax or background threat of stricter regulation if requirements under the programs are not met) (Segerson, Centner et al, Leathers). In voluntarily programs, farmers are unlikely to adopt some measures because program compliance in the absence of, or with limited, government compensation usually leads to reduced returns to the farm (Centner et al). Leathers argues that only when the government has all relevant information about benefits and costs can the agency prescribe a set of practices that will be socially optimal. As this information is difficult to obtain, some combination of subsidies or taxes can be used to direct environmental improvement toward a socially optimal level.

Feather and Cooper review types of incentive mechanisms to stimulate BMP program adoption. Cost-sharing programs allow partial or full payment to farmers to assist with the cost of adopting a specific practice. Incentive payments are similar to cost sharing, but are not practice specific. These direct payments are intended to induce the farmer to adopt program requirements by reducing farmer risk or cost. Educational programs inform farmers of practices that exist and the benefits of adoption. One example is the USDA's Demonstration Project Areas Program, which provides producers with tours of nearby farms that are utilizing specific practices. Similarly, technical assistance programs through NRCS or farm extension services provide education for specific technologies. These educational programs can serve as voluntary incentives by improving farmer awareness and encouraging BMP program adoption.

2.2.5 BMP Program Needs, Strengths, and Weaknesses

A. Evaluating Specific Programs and Practices

Ice asserts that testing the effectiveness of specific BMPs can be challenging when initially designing programs. The author suggests comparing studies of environmental quality prior to BMP implementation to studies after the fact. He states that BMPs, when reevaluated after implementation, are useful tools because they can continuously evolve. As such, evidence on practices should be reviewed and updated as an ongoing process. According to Ice, if approached this way, BMP programs are adaptable to change, as laws, environmental changes, or public wants may require further innovation.

Leathers argues that the monetary benefits from improvements in environmental quality are usually immeasurable, even though private benefits and costs are measurable. Measurability creates problems in assessing the value of environmental returns for a program or a specific BMP. There also are issues that complicate defining optimal BMPs. For any particular practice, private benefits, environmental impacts, and cost of implementation will differ from farm to farm (the heterogeneity problem). Also, the more practices a program includes, the harder it becomes to distinguish the environmental impacts of one particular practice from another.

B. Evaluating the Concept of BMP Programs

Murphy calls for ongoing analysis and refinement of the idea of best management practices. As a partial remedy to the problem of measuring benefits and costs of programs, the author suggests that early BMP efforts should be used to 'get smarter' about BMP programs and their implementation. Policy makers should learn from impact evaluation of BMP programs. Murphy also suggests that BMP research should define the data needs and the appropriate analytical methods required for this learning process. Although Murphy's recommendations were published in 1979, there has been little work in agriculture that evaluates the impact of BMP programs, specifically reviewing early programs to refine later ones.

Researchers requires that multiple parties collaborate to develop and assess BMP programs. Centner et al suggest that an interdisciplinary approach is needed to accurately measure emissions, to create models that identify and measure the effects of emissions, and to determine different strategies that result in maximized returns to producers while meeting environmental quality goals. Shogren points out that an interagency approach to evaluation of programs should be used, requiring that personnel from a variety of agencies be constantly evaluating program effectiveness.

Leathers offers several strengths and weaknesses of current BMP programs Two benefits of BMP programs are that they (1) focus farmers' attention on the environmental impacts of their business practices and (2) provide an indirect method for obtaining information on costs and benefits of practices at the farm level. One drawback is that BMPs do not meet the social optimum. In the program design process, some program issues that need to be considered or included are ignored and some are set aside due to a lack of information. Leathers also suggests that BMP evaluations and BMP program design processes are more political than technical or economic. The implementation of BMPs as policy can be characterized as a political balancing act for regulators, namely finding some level of environmental improvement without incurring an outcry of disapproval from the farming sector.

CHAPTER 3: ECONOMIC NEGOTIATION MODELS

3.1 Introduction

This chapter introduces several approaches to two-party BMP negotiations and their environmental outcomes. These models will be applied to the two Arizona case studies in their respective chapters. First, a decision tree explores the expected conditions for selecting negotiated BMPs as a policy tool. Secondly, the mutual gains framework reveals potential outcomes of the negotiation process. Thirdly, Nash's cooperative solution demonstrates the importance of bargaining power in negotiation. Finally, an environmental safeguarding/damage model adapted from Porter illustrates the expected environmental impacts of the negotiated agreement.

BMP negotiations include representatives from a variety of affected parties. Committees are usually comprised of any of the following: producers or other agricultural sector representatives, the overseeing government agency, other agencies affected by the rule, academic or government-employed technical experts, and municipal or public interest groups. There may also be technical committees which provide advice on useful or acceptable BMPs for the negotiated rule. For simplicity in this analysis, a two-party approach to BMP negotiation will be taken, condensing the committee composition to two representatives: agricultural and regulatory. These two representatives are intended to capture the predominant interests present on BMP committees. The agricultural representative (A) assumes the interests of any negotiators that are supportive of agricultural objectives. These supporters may be public sector, technical, or government agency representatives. Similarly, the regulatory representative

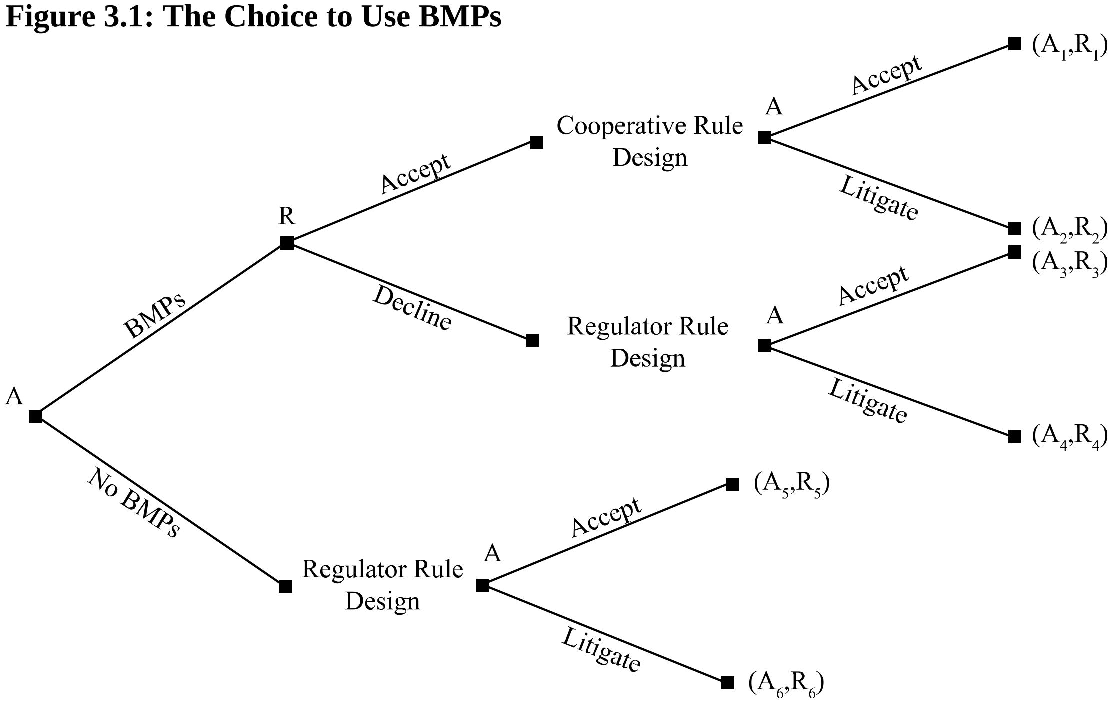
(R) serves as a proxy for negotiation participants who are sympathetic or supportive of environmental and agency goals. In this discussion, reference to 'agency welfare' is the combination of these factors. Social welfare is measured by the combined outcomes of the two parties. An improvement in outcome for one party, keeping the other party's outcome constant, represents a Pareto improvement.

3.2 Environmental Regulation with BMPs: A Decision-Tree Analysis

A straightforward decision tree approach captures the choice to use a negotiated process to develop BMPs. Raiffa notes that when deciding whether to negotiate, each party must determine the expected costs and benefits associated with pursuing negotiation, and compare them to the costs and benefits associated with their best non-negotiated alternative. Decision tree analysis captures this thought process and whether parties can expect gains from negotiation. Raffia also notes that these costs and benefits are usually uncertain and can be expensive to determine. Nonetheless, by exploring alternatives for each party in a simple two-player game, some realistic assumptions can be made about when regulators and agriculture will opt for BMPs.

This decision tree (Figure 3.1) begins after agriculture is identified as the source of harm for the environmental problem. In any rulemaking process the regulating agency is required to inform the public of any changes or new regulations. As a result, assume all parties are informed about the environmental problem, and that the overseeing agency is considering a new regulation. Also assume both parties believe BMPs are a feasible means to resolve or mitigate the environmental problem. Additionally, assume the regulator has authority and justifiable proof to regulate for an environmental improvement (i.e. the agricultural sector cannot overturn regulator jurisdiction through litigation). However, after the regulator imposes a new rule, agriculture can litigate to reduce or change the requirements. Note that any form of rule other than the use of BMPs can be considered an alternative, regulator-designed rule (this does not exclude other forms of negotiation in designing the alternative rule). Next, assume payoffs to the agricultural sector are expected payoffs in terms of cost (they are negative), while the expected payoffs to the regulator are positive in terms of agency welfare. Finally, assume that the regulator will design the same alternative rule, regardless of the course that leads to the regulator-designed rule. This means the expected payoffs A_4 and A_6 are equivalent outcomes in terms of costs

Figure 3.1: The Choice to Use BMPs



imposed on agriculture (assuming no transactions costs), as are expected payoffs A_3 and A_5, the only difference being the path by which those outcomes are reached. It is expected that payoffs A_5 and A_6 are the preferred alternatives for A over payoffs A_3 and A_4 if transactions costs associated with requesting BMPs are included.

Looking at the initial decision node, the agricultural sector representative (A) may choose to request that BMPs be used to improve the environmental problem (the branch noted 'BMPs' in fig. 3.1), or allow the regulatory representative (R) to use a traditional process to address the problem (noted 'No BMPs')[1]. If A chooses the latter, R will go through its own rulemaking process, which may or may not involve agriculture. When R designs the rule, A can choose to accept the agency-defined rule or choose to litigate.

There are several noteworthy outcomes of the lower branch. A should only be expected to choose 'No BMPs' in two cases. The first case occurs if A anticipates a lower cost rule by letting R design the rule than by pursuing BMPs. A will choose 'No BMPs' and 'Accept Rule', given that the rule satisfies:

$A_5 < A_1, A_2; A_5 < A_6$

In the second case, if A anticipates that a court victory will overturn or reduce the stringency of the rule and that A's expected costs for litigation and the improved rule are less than accepting BMPs, then A will also choose 'No BMPs'. In this case:

$A_6 < A_1, A_2; A_6 < A_5$

Here, A believes to have an excellent chance at reducing the terms of the rule designed by R[2]. If R wins, the R-designed rule remains in place. By backward induction, R may recognize this. If A chooses 'No BMPs', R must weigh the terms of the expected rule against the expected court outcome. To prevent a court battle, R can design the rule such that it is lower cost to A than the court battle scenario in which A wins. This effectively restructures the payoffs and gives A incentive to accept the R-designed rule.

Next is the case that A requests BMPs. After A proposes BMPs, R may accept or decline. In order to accept, R must perceive $R_1>R_3, R_4$. R must expect better results from collaborative BMPs than designing the rule by another means. If R declines, it will be with the expectation of court victory or a better agency outcome than accepting the proposal for BMPs ($R_3>R_1$). At this point, R may design the rule such that $A_3<A_4$ to give A incentive to accept (as discussed above). This thought process holds for both cases on this tree where R designs the rule. Also note that there is an additional 'litigate' branch following cooperative rule design. Failed negotiations or changes in the final rule from the committee consensus agreement will lead to this result. Negotiation literature shows that this can occur, although it is unlikely. Only if the final rule results in $A_1>A_2$ will A take this action.

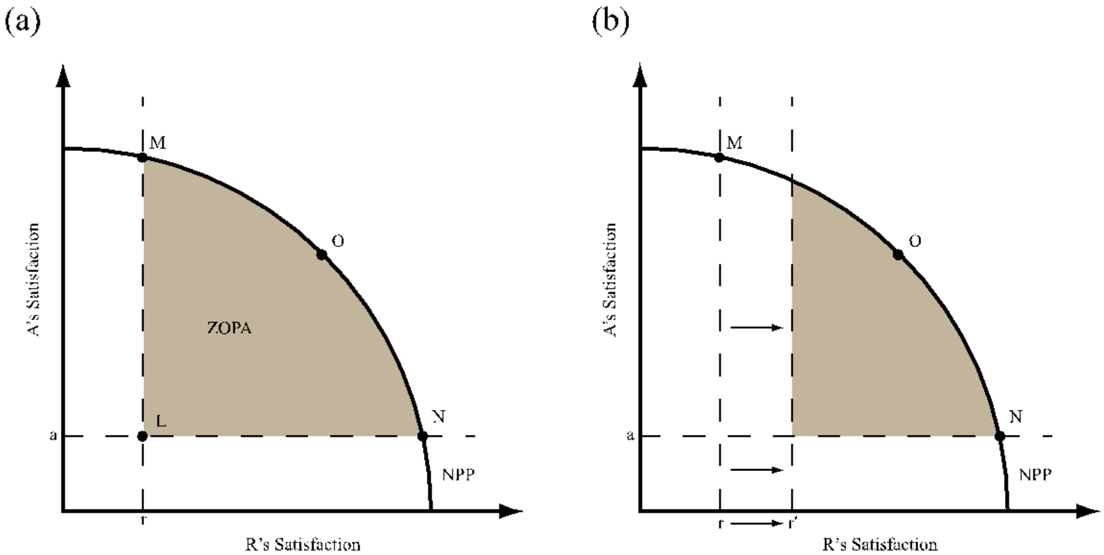
In summary, several scenarios emerge by walking through the decision tree. First, A has several reasons not to choose BMPs. A can believe a court battle will result in a lower cost rule than BMPs or the alternative R-designed rule. In this case, A will not request BMPs and will use litigation if necessary. Also, if A believes that an R-designed rule will come at lower cost than BMPs, A again will request 'No BMPs'. Secondly, A can propose BMPs if they are the preferred alternative. This gives R two choices. First, R can decline, in which case (1) R must have a clear case for court victory (or $A_4>A_3$ and A will not litigate) or (2) design a rule that affords a better outcome for A than a court battle in order to avoid litigation (again $A_4>A_3$). Secondly, R can accept the BMP proposal and both parties can enter into the cooperative negotiation process to design the BMP rule.

This decision-tree analysis suggests several key points about the two parties' expectations for the negotiated BMPs. First, the use of cooperative BMP design to control environmental problems is acceptable to agriculture only if the expected cost to agriculture is lower than allowing the regulating authority to develop the rule alone. This cost must be lower than either accepting the regulator's rule or litigating to reduce the terms of the rule (including the costs associated with litigation). Secondly, the negotiated BMPs are only appealing to the regulator if they are expected to provide greater agency welfare than a rule designed solely by the regulator. Note that designing the rule through a process other than BMPs forces the regulator to satisfy the concerns of both the agricultural (rollback induction imposes regulator consideration for agricultural cost concerns) and public sector as well as achieve agency goals. In short, for BMPs to be the preferred policy for meeting the environmental goal, they must provide a mutually beneficial outcome to both parties.

3.3 The Mutual Gains Model

Susskind, Levy, and Thomas-Larmer promote the mutual gains model as an analytical framework for negotiated agreements. The concept hinges on negotiating parties understanding each other's interests and creating agreements that result in net gains for all involved. A successful negotiation is illustrated in Figure 3.2(a). Each axis is the satisfaction index of the negotiating parties. Satisfaction may also be referred to as ‘gains’, ‘welfare’, or ‘well-being’. A movement northward on the *y*-axis is an increase in the welfare of player A. Likewise, movement to the right on the

Figure 3.2: The Mutual Gains Model



x-axis is an increase in the R player’s welfare. Each party has a reservation value, their best alternative to negotiated agreement (BATNA), represented as lines *a* and *r* in Figure 3.2a. In order for the two parties to enter into negotiation, they must expect that the resulting BMP program will be no worse than either of their BATNAs. Otherwise, the adversely affected party will choose not to negotiate. At the point of intersection of *a* and *r* (L) lies the worst case scenario that can be achieved through negotiation. L represents equivalent mutual return from negotiation as from simply not negotiating. Beyond L (to the “northeast”) lies an area for which both parties increase their satisfaction by negotiating. This region is referred to as the zone of potential agreement (ZOPA). The ZOPA is bounded by the set of efficient agreements, for which the maximum possible gains are achieved (the negotiation possibilities frontier, or efficient frontier (NPP)).

Along the NPP, there can be different sets of agreements, some which may favor A (e.g. point M on the NPP curve) and some of which may favor R (e.g. point N – although M and N are the extreme cases). All points on this NPP between M and N are pareto-efficient, such that maximum possible gains are incurred and neither party can do better without making the other party worse off.

During a negotiation, the BATNA of one party may change (Figure 3.2(b)). This occurs when a party uses an information advantage, threats, or better negotiating skills to influence an opposing party's belief about the negotiation. A party using these tactics can either (1) increase the position of their own BATNA or (2) decrease the position of the opposing party's BATNA. For example, take the case that R is able to increase the position of *r* to *r'* during negotiation. As *r* increases, the set of efficient agreements are constrained, and A's potential gains from negotiation become smaller (note that M is no longer an available agreement as A's opportunity decreases because R's BATNA has increased). The opposite effect occurs if *r* decreases through efforts from A to reduce R's BATNA. Thus, prior to and during negotiations, each party should assess their BATNA and attempt to strengthen their own BATNA or convincingly argue that the other party's BATNA is overvalued.

As the previous decision tree approach revealed, the two parties will enter into the negotiation for BMPs if each expect that their gains from negotiated BMPs will be greater than their BATNAs. If agriculture chooses to pursue BMPs, we can expect that litigation is not an option unless it is utilized in the wake of unsatisfactory rule development (i.e. after the fact). Thus, given our assumptions, agriculture's BATNA for

BMPs is the regulator-designed rule. For the regulator, this rule is also the best alternative to BMPs.

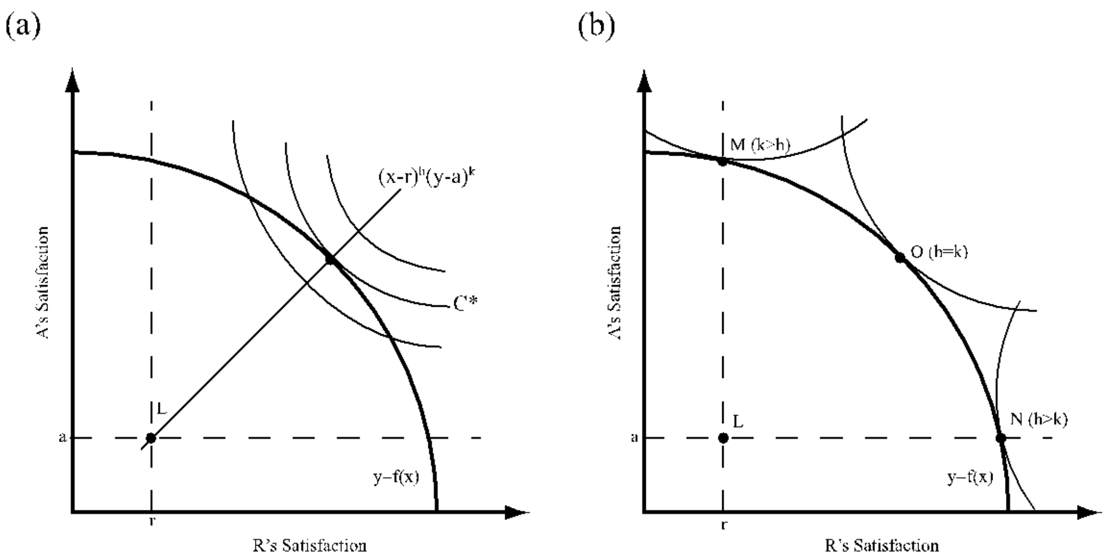
The gains for each of the parties can also be recognized here. A moves northward along the satisfaction index as the cost of abating environmental damages (i.e. the cost of implementing BMPs) goes down. For the regulator, the satisfaction index consists of a culmination of reduced agency costs, decreased environmental damages, and any other factors that increase the regulator's value from specific BMP agreements. In addition, there will be a variety of influences on each party's gains during the deliberations over the final agreement. These include the specific BMPs considered by the committee, the BMPs included in the final rule, the rule's specific concerning agricultural compliance to the BMP program, and the terms for monitoring the agreement.

3.4 Nash's Cooperative Solution: The Importance of Bargaining Power

A Nash cooperative solution demonstrates the importance of bargaining power in the mutual gains model (Dixit and Skeath). The Nash bargaining model imposes several requirements on negotiation. First, the outcomes are invariant to positive affine transformations in payoffs. This means that outcomes do not change if the two parties' payoffs both increase by the same proportion. Secondly, the outcome of bargaining will be both feasible and efficient (the NPP is achieved). Thirdly, irrelevant alternative outcomes are ignored, meaning that other feasible alternatives are eliminated and the negotiated agreements are defensible against possible objections. Fourth, assume that the players are rational and will not choose any outcome that makes them worse off than their initial position (their BATNA). Finally, the players' relative bargaining positions, and the resulting solutions, are treated as symmetric.

As illustrated in Figure 3.1, A's BATNA is to accept an alternative rule designed by R. Let the costs associated with this outcome be designated as *a* (Figure 3.3(a)). The gains available to A are associated with moving northward on the *y*-axis.

Figure 3.3: Nash's Cooperative Solution



If negotiations fail, A cannot expect a better outcome from the R-designed rule than *a*. R's BATNA is also the alternative rule, which will be designated *r*. A's gains can take any increase (cost decrease) above the BATNA *a*. Let this be designated *y*, as A's gains lie on the *y*-axis. Similarly, R's gains from negotiating will be designated *x*. There will also be a set of efficient agreements available from the bargaining process, the NPP, taking the functional form of *y=f(x)*. Along this function lies the set of maximum possible allocations of gains from negotiation available to either party. Thus, any negotiated agreement will be represented by the following gains for the two parties:

A receives a total payoff of y-a.

R receives a total payoff of x-r.

Finally, there is some division of gains received by each of the bargaining parties, a fraction of the total gains received, such that R receives an h-proportion of the surplus, A receives a k-proportion of the surplus, and the two proportions sum to one. Maximizing

$$(x-r)^h(y-a)^k \text{ subject to } y=f(x) \tag{3.1}$$

gives the unique Nash cooperative solution:

$$(x-r)/h=(y-a)/k \tag{3.2}$$

The final negotiated outcome is dependant on the bargaining power of either party (h and k). The objective function $(x-r)^h(y-a)^k$ contains the possible contract curves available to the two parties. If the values for bargaining power are set constant, but gains from negotiation are allowed to fluctuate, a single set of contract curves which represent contours of the objective function emerge, one of which is tangent to the $y=f(x)$ efficient frontier (C* in Figure 3.3(a)). It is at this point of tangency that the efficient outcome is achieved. Note that this corresponds to an outcome on the NPP in the mutual gains model. One final note for figure 3.3(a) is that an increase in r only, such as in figure 3.2(b), will result in the point of tangency between the contract curve and the objective function shifting to the right on the NPP, as the objective function will maintain its slope in the x,y space.

The proportions of bargaining power affect the shape of the objective function, so there are a range of efficient, optimal solutions for the negotiation. Each of the possible optimal solutions lies along the efficient frontier (see Figure 3.3(b)) and all are possible Nash solutions to the cooperative agreement. As one party's bargaining power increases, they are able to influence the objective function such that the set of available contract curves (and optimal agreement) is moved in their favor. Captured in the bargaining power variables, *h* and *k*, are the abilities of opposing parties to change one another's perception of the BATNAs, interests, and satisfaction received from the agreement. An increase in *h* decreases *k*, corresponding to an increase in *(x-r)* and a decrease in *(y-a)*. As *h* increases, the set of efficient agreements available become more attractive, or more opportune, to R and less so to A. Assume here that point O represents the case that *h* and *k* are equivalent. Then any increase in *h*, or movement southeast away from O on the NPP, means the regulator fares better. If *h*=1, point N would be the resulting outcome, as all bargaining power belongs to the regulator. Similarly, as *k* increases, the efficient agreement shifts northwest along the NPP, improving the outcome for agriculture. When *k*=1, agriculture holds all bargaining power and the agreement ends up at point M. Each party will seek to change the perception of the opposing party and use bargaining power in their favor. Each party will attempt to increase the value of their BATNA and decrease value of the BATNA of the opposing party during negotiation.

3.5 Bargaining Power in BMP Committees

Agreements or rules produced by the mutual gains framework depend on the relative bargaining power of negotiating parties. Power within the negotiating environment can come from a variety of sources, including negotiating skills, better information, or any other advantage of one party over another (Raffia). A detailed analysis of the committee composition, background threats, and information available to negotiators will generate an understanding of bargaining power in BMP negotiations.

Committee composition will be different under different BMP programs. The stated environmental goals of the program and political savvy of involved parties can influence the selection of the negotiation committees and how issues are prioritized from the outset. In addition, the number of members in the actual committee that are sympathetic or supportive of specific goals will influence the consensus agreement. This may be especially true of those individuals who are utilized to fulfill the role of expert in the negotiation process. Very different outcomes on the final rule are likely to occur from the negotiation if the representation is strongly pro-agriculture or pro-regulation. The composition of the committee will influence how the final rule is written, whether it is balanced among the competing objectives, and whether the rule is ultimately effective in achieving its stated goals.

Background threats consist of claims intended to shift the negotiated outcome in the claimant's favor. The overseeing regulatory agency can withdraw from BMP design and create its own rule. The agency also has the authority to amend or change the final rule. Agriculture traditionally has some political influence, which may be used as a background threat; namely imposing political pressure from outside the negotiation on the regulating parties involved. Time constraints are an additional background threat. Depending on the conditions under which the rule is made, negotiating parties may each use time demands to their advantage, threatening delayed decision-making to affect the agreement.

The status of technical knowledge and information pertinent to the negotiating parties can produce information asymmetries. As suggested in the negotiation literature, shared knowledge, data, and information yields a more efficient bargaining process and final rule (e.g. Harter, Kerwin). However, unshared information can also be used by parties as bargaining power when opposing parties are uninformed. Negotiators often depend on experts for analysis and information. Experts may or may not have the scientific information required for sound decision-making and these individuals may or may not be biased toward one of the parties in the negotiation.

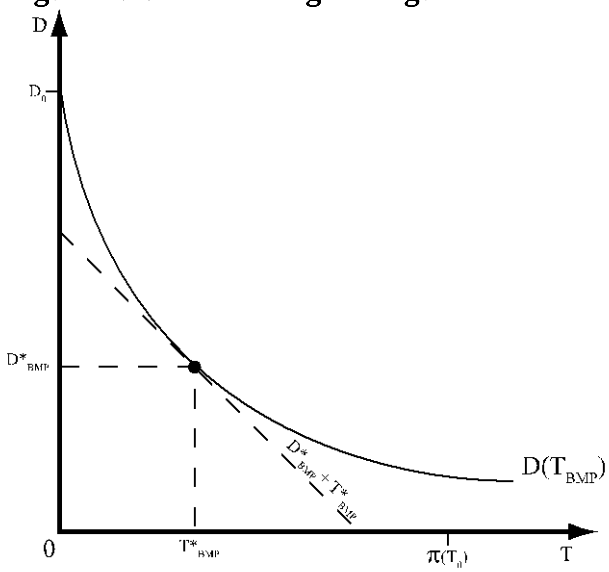
Technical and cost-benefit data can also influence bargaining power. The availability of data to support claims for environmental benefit, the reliability of data, and the methods to monitor the benefits of specific practices will have an impact on the rule. As Ice notes, this information is often unavailable *a priori*. The costs to implement or support the rule can be used strategically by parties who are aware of the implementation costs but are unwilling to share this knowledge with other negotiators. Both the regulated sector and the regulator may not know or may not choose to share the costs of implementing the negotiated rule.

3.6 Expected Environmental Improvements

Porter's economic framework for environmental disputes provides an additional useful model for analyzing the impact of negotiated rules. A convex relationship between environmental damages and safeguards adopted is assumed (Figure 3.4). Given a convex damage function, there are decreased damages (D) but diminishing returns to damage reduction as the level of environmental safeguarding (T) increases. The damage function can take other forms as well. For example, it may take a specific amount of safeguards or abatement to cause an initial loss of damages (a threshold form), multiple thresholds may occur (a step function), or a single amount of safeguarding may reduce damages entirely.

For this BMP model, assume the firm already exists; there will be some level of damage prevention in place and the firm will have existing profits that are influenced by the new agreement. There will also be some damages and safeguards that take place if the alternative rule to BMPs is put in place. Determining the level for each of these makes a difference whether negotiation is feasible and whether an efficient outcome can be achieved.

Figure 3.4: The Damage/Safeguard Relationship



In the negotiation, the safeguards imposed by the agreement are technologies or management methods (T_{BMP}), and will come at additional cost to agriculture. Agriculture currently generates some profit ($\pi(T_0)$), from operating with the existing technology (T_0). The present value of profit for agriculture is:

$$PV_A = \pi(T_0) - T_{BMP} \tag{3.3}$$

The regulator will be concerned about environmental damages (D). Damages from current agricultural production are D_0. The regulator derives present value from the functional relationship of damages to BMPs ($D(T_{BMP})$). As damages decrease, the utility from negotiation increases for the regulator's environmental preferences. Thus:

$$PV_R = -D(T_{BMP}) \tag{3.4}$$

Finally, as a result of negotiation, society will receive a present value of:

$$PV_{SOC} = \pi(T_0) - T_{BMP} - D(T_{BMP}) \tag{3.5}$$

An important note for the BMP case is that program costs are possibly borne by both parties, but this should not affect the choice of technologies. The regulator may take into account the costs associated with program design and support (i.e. additional agency goals). Fixed costs (such as transactions cost of negotiation, which occur regardless of outcome) can be ignored, and variable costs (such as evaluation, implementation, and support) are related directly to the stringency and requirements of the program, and are thus absorbed into the damage function.

There are two conditions that allow for a socially efficient outcome. First is the optimal level of safeguarding (T_{BMP}*). By taking the first derivative of the PV_{SOC} with respect to T_{BMP}, there are three possible solutions:

1) Given a convex damage function, the optimal BMPs will satisfy the least-cost solution along the damage function. This is where $D'(T_{BMP}*) = -1$ (Figure 3.4).
2) The optimal level of new safeguarding technology is none. The damage function takes a form such that no least-cost solution can be obtained. This occurs when $T_{BMP}* = 0$, and damages remain at the initial level, D_0.
3) Finally it is possible that the optimal BMP choice places damages at zero, or $D'(T_{BMP}*) = 0$.

Note that these outcomes depend on the shape of the damage function, and two possible corner solutions (cases 2 and 3) can result.

The second condition that must be determined is whether the negotiations will lead to an outcome that is feasible from a social point of view. The costs to society must be less than the benefits accumulated, or $PV_{SOC} > 0$. Thus, it must hold that:

$$\pi(T_0) - T_{BMP}* - D(T_{BMP}*) > 0, \text{ or} \quad (3.6)$$

$$\pi(T_0) > T_{BMP}* + D(T_{BMP}*). \quad (3.7)$$

Thus, existing firm profit must be greater than the least cost combination of damages and selected BMPs in order for the negotiated solution to have an acceptable social outcome.

A few more useful notes can be made about the damage/safeguard relationship. By selecting a BMP process, the regulator rules out all possible alternatives (such as tax/subsidy approaches), other than the slate of BMPs the committee initially determines as the set of available management alternatives. As a result, the decision to negotiate

BMPs reduces the possible control methods and serves to change the damage/safeguard relationship (from all available control methods to all available BMPs) prior to negotiation. Additionally, Porter states that the producer usually has some 'built in', or originally planned safeguards. The BMP negotiation allows for any practices which may lead to improvement in environmental quality to be included in negotiations, including the 'built in' practices that are already used on some farms. Thus, there may be some available practices that provide minimal abatement at the farm level (and possibly over the agricultural sector). Also, the slate of BMPs considered by the committee may range in effectiveness at controlling the environmental problem and may range from low cost to very expensive to implement. Finally, the shape of the damage-safeguard relationship going into the negotiation will depend on the structure of the agricultural sector and the BMPs considered. The outcome of the negotiations will reshape this relationship as the possible farm management alternatives are further narrowed in the negotiation process.

CHAPTER 4: STUDY METHODS AND INTERPRETATION

4.1 Case Study Evaluation: Requirements and Description

A case study approach is appropriate for an assessment of the BMP design process. Case studies provide an opportunity to research events, of a cause and effect nature, that are out of the investigator's control (Yin). The approach is useful for studying how or why a program, or an objective within a program, operates as it does, and how or why it does or does not work. Also, multiple case studies of a specific phenomenon can provide generalized findings. Each of these features of a case study support its use for the evaluation of BMP-based regulatory programs.

Multiple sources of data provide a triangulated method of analysis for this thesis. First, historical documents, interview data, and literature for each BMP case provide background information. This program history reveals both the political context of rule development and important details about the problem. Secondly, committee interviews produce an in-depth understanding of the negotiation environment for each case. Thirdly, a scoring survey evaluates technical experts' opinions on the use of BMPs at the farm level before and after program implementation. These three sources of data are analyzed using the conceptual models (see chapter 3) to reveal predicted environmental outcomes. This assessment process generates guiding principles for designing more effective BMP programs.

This research project is not intended as a full-fledged program evaluation. Currently, there are several ongoing program evaluation efforts for Arizona's Agricultural PM_{10} and Water Conservation BMPs. Researchers from the USDA and

University of Arizona Extension Service are currently assessing the impacts of the water conservation program and the effectiveness of several of the BMPs in the program. In addition, the EPA is revisiting the agricultural PM_{10} BMP program. These well-funded studies include a wider range of data collection and the potential to contribute to a full program evaluation.

In contrast, this research narrowly analyzes how a negotiated process produces a regulatory program, and the probability that the program will produce desirable impacts. The two BMP programs analyzed in this study are framed in the context of the negotiation process, their design, and their environmental outcomes.

4.2 The Importance of a Qualitative Approach

Chapters 2 and 3 demonstrate that there is a clear, causal linkage between the negotiation process and the rule or program produced by negotiation. The unique interaction that occurs in negotiation, with multiple interests and multiple complex issues, is a highly behavioral process. In negotiation, participant behaviors influence the outcomes and are influenced by the negotiation environment (Polkinghorn). This process complexity and the human influence on outcomes supports the use of a qualitative research approach (Marshall and Rossman). All of the negotiation literature reviewed for this study used qualitative methods in research, primarily direct interviews or document review. These methods were applied to topics including strengths and weaknesses of reg-neg (Harter, Coglianese, Hadden), respondent perception of the process (Ryan, Langbein, Wondolleck and Ryan), and social identity theory (Polkinghorn).

As of yet, there is no evidence that BMP negotiation has been discussed or researched in literature. Negotiated outcomes remain largely dormant as a topic even as BMP programs continue to emerge in agricultural regulation. For this study, data revealing the perceptions and influences of participants takes two forms: document review and interviewing. Document review for the two case studies is limited to historical information, agency publications, and incomplete meeting minutes. The meeting minutes and available documentation fail to fully capture the bargaining dynamic as thoroughly as an interview approach. As a result, direct, focused interviews capture the interests and perceptions of program design participants.

There is a direct link between the directives of a BMP program and its expected environmental impacts. The regulatory assumption is that the BMPs will balance the interests of multiple parties and result in improvements in environmental quality. An important component of impact analysis is discovering how results derived from program implementation compare to results if no program were put in place, in essence comparing the *a priori* state of the world (agriculture without the program) to the *ex post* world (agriculture with the program) (Mohr). Impact assessment evaluates both the "before and after" change and the difference between planned outcomes and actual outcomes.

4.3 BMP Committee Interview and Methods

The interview portion of this study is an in-depth evaluation of the negotiation process. Interviewees were asked to recall the process in order to determine how participant behaviors influenced the bargaining process and outcome. The committee interview provides insight into the political environment, organizational structure, and participant interests in the BMP negotiation process.

Negotiation participants were selected using several criteria. The respondent sample is a representative cross section of identifiable interests from each committee. At least one agricultural representative, one regulator from a governing agency, and one technical expert were chosen for interviews in each case study. In addition, an attempt was made to include the committee chairman in the interview process. A list of expected first-best respondents was constructed based on agency affiliation, expected participation, and expected expertise, with flexibility to amend the list as interviewing progressed. Those interviewed early in the process were asked for their recommendations for essential interviewees, thus expanding the potential interview pool. The list of final interviewees was determined by their willingness to be interviewed. Original committee appointments (i.e. those that designed the program) are contained in Appendix 1, sections A, B, and C, and lists of interviewees are contained in Appendix 3, sections A and B.

Interview questions were composed through a two stage process. First, a list of all relevant questions about the negotiation process and BMP design decisions was constructed. Secondly, the questions were reviewed and revised following the chronological sequence expected for reg-neg design, as outlined in chapter 2. This included six open-ended focus interview questions and a series of probing follow-up questions. The open-ended questions were designed so the respondents could provide their input on the negotiation process and decision making as they viewed it. The probing questions were reserved for determining details and pacing the interview.

Interview questions concerned processes that occurred five to six years prior to the interview. In the interest of allowing participants time to reflect on events, each respondent received a copy of the questions several days before the interview (Appendix 3C). They were also informed that they would be asked to give their own view on the negotiating process. Each respondent was requested to provide an hour of their time for the interview.

Little background documentation exists for the development of the water conservation program. To overcome this deficiency in historical information, the respondent list for water conservation included several members who were instrumental developers and supporters of the BMP program. These participants were given extended interviews. The extended interviews required up to three hours each and included the open-ended questions asked of all respondents.

The committee interview results for each case were assessed in a collective manner and compiled as a narrative. Interview data was analyzed as follows: First, each respondent's answers were reviewed for relevance to the questions and reconstructed following the chronological interview format. Secondly, to assess the negotiation process and design decisions, the responses for all interviewees were aggregated to each open-ended question, and regrouped to subtopics. Third, a review of emergent themes within the interviews was constructed to capture key components of the negotiated BMP process in a single narrative for each case study.

The feedback provided by the collective respondents illustrates the concerns, interests, and persuasive capacity of the parties at the table. Compiled interview data provides assessments of the relative bargaining power and the availability of information in the committees. This data leads to an evaluation of the committee and program design decisions utilizing the economic models presented in chapter 3. These narratives are provided for each case study in chapters 5 and 6.

4.4 BMP Scoring Survey and Assessment Methods

A. Expert Survey Design

The expert survey approach was utilized because accessible data for BMPs used on farm prior to the regulation does not exist. Ideally, a farm-level survey would reveal the BMPs used before and after the regulation and capture the cost of meeting regulatory requirements (i.e. the adoption cost). As the BMP literature notes, obtaining farm-level information is often difficult, especially where costs are concerned (Leathers, Murphy). While farmer-generated data would be ideal, the survey reviews operations before a regulated period, and would ask farms to reveal technology in this period and essentially reveal the cost (or technology change) incurred by implementation. It was expected that a farm level survey would be unsuccessful in capturing *a priori* farming and irrigation practices. Therefore, a survey of agricultural experts was utilized as a 'second best' approach.

Experts were selected using two criteria. First, the survey panel of experts share an in-depth knowledge of farming operations. Experts include university extension personnel and government agents who participate in field work or farm-level assessments. These individuals were active in Arizona's agricultural sector prior to development of the BMP programs in this case study. Specifically, the experts had regular involvement with farmers, an understanding of farm equipment and operations, and responsibilities in the agricultural sector. Secondly, only experts with work experience in Maricopa, Pima, and Pinal Counties were selected. The water conservation program was developed primarily within the Pinal Active Management Area, and the majority of adopters of water conservation BMPs are concentrated in Pinal and Maricopa Counties (Hanrahan, ADWR). Also, the agricultural PM_{10} program regulated only Maricopa County and a portion of Pinal when developed. The names and positions of the experts are listed in Appendix 3D.

Each expert was asked to provide an estimated percentage of farms in the central Arizona that would have used each BMP before 2001. The respondents were asked to give their best judgment for this percentage based on their knowledge of agricultural sector. The 2001 time period was selected as it falls prior to the implementation period for both programs; it marks the implementation of the Agricultural PM_{10} program and is one year prior to implementation of the water conservation program. Within the survey instrument, the BMPs from each program are listed and categorized in accordance with the formal program enrollment guidelines. The scores recorded by each respondent are intended to capture the degree of BMP use for the agricultural sector. A copy of the expert survey can be found in Appendix 3E.

Several concerns were expressed by some of the experts surveyed. First, a number of the BMPs were defined in terms that they believed to be vague or wide-ranging in application. Secondly, for some of the BMPs, a percentage of acreage or fields would be easier to quantify than a percentage of farms. Finally, the six-year difference in time between the survey and the period of study made expert judgments difficult for some of the BMPs. In these cases, respondents were asked to give a conservative estimate. In addition, several experts felt that they could not speak to all of the BMPs, and one stated that they could only provide assessment for Pinal County (Expert 7 in survey results; Appendix 3F and 3G).

B. Scoring Models

The experts' survey results were evaluated separately for each BMP program. The percentages were placed in scoring models and the resulting scores compared to the criteria for BMP program qualification. The scores provide an estimate of the agricultural sector's ability to meet program requirements.

The two BMP programs have different adoption requirements for program qualification. The Agricultural PM_{10} BMP Program requires that all farms adopt at least one BMP from each of three categories, Tillage and Harvest, Non-Cropland, and Cropland. Translating this to a point-scoring model is quite simple. Each BMP receives a point score of one, and a farm must achieve at least one point from each category to qualify.

The water conservation BMP program requirements are more complex. Based on a point scoring system, each enrolled farm must achieve ten points. Farms can receive a maximum of three points toward their total from any of the four categories: Irrigation Water Management, Agronomic Management, Farm Irrigation Systems, and Water Conveyance Systems. The BMPs in the Irrigation Water Management and Agronomic Management categories are each given a point value of one, and each of these categories require a minimum of one point to qualify for enrollment. The Farm Irrigation Systems category has a range of point values from one to three, depending on the expected efficiency of the BMP, and a minimum of two points must be achieved. Finally, the Water Delivery Systems category is based on percent of acreage using a particular BMP. The point score ranges from one point for 50 percent of on-farm acreage using the BMP to three points when 100 percent of on-farm acreage uses the BMP. The worksheets provided by each BMP program are provided in Appendix 4.

The scoring models apply category by category. For categories requiring at least one BMP with each BMP receiving a point score of one, a sum of high percentage responses from an expert constitutes that expert's point total for the category. This includes all categories in the Agricultural PM_{10} program and the Irrigation Water Management and Agronomic Management categories from the water conservation program. For each high percentage score, the agricultural sector scores one point toward meeting program requirements. It is expected that the remaining percentage will be captured by farm heterogeneity. Two thresholds were set for the high scores, at 80 percent and 90 percent, to allow for sensitivity and comparison in the analysis. Even with a number of remaining BMPs in some categories scored at 50 or 60 percent, the subjective nature of the survey does not allow for a far-reaching predictive capacity beyond this sensitivity analysis. The scoring model for these categories takes the form:

If $BMP_i \geq 80\%$ then x_i=1, otherwise x_i=0, and the category point total is the sum $\sum_{i=1}^{n} x_i$,

where *BMP* is the percentage score attributed by the expert to the i^{th} BMP in the category, and x_i is the one point score the program awards the farmer applicant. The calculation at the 90 percent threshold takes the same form, where $BMP_i \geq 90\%$.

For the Farm Irrigation Systems category, a different scoring technique is used. Within the category, a range of point scores apply, so a weighted average calculation provides an average category point score for the agricultural sector from each expert. There is some strength in this weighted average assumption. The majority of experts give comparatively high percentages to two BMPs (relative to other BMPs in the category) that receive high scores (2.5 and 3) toward the category point total. Thus, the weighted average gives a conservative category compliance estimate for the farm population. This category is scored as $\sum_{i=1}^{n} BMP_i x_i$, where x_i is the point score of the i^{th} BMP as defined in the program requirements.

The remaining category, Water Delivery Systems, is also unique. All but one expert qualified the agricultural sector for concrete ditches at 90 percent or greater. The remaining expert qualified the sector at 80 percent. Several of the experts also noted that this BMP, if implemented, is likely implemented with coverage of the entire farm. The ditches usually supply water to all fields, so farms are likely to qualify 100 percent of acreage and receive a full three points for the category score. As the experts verified high implementation of this BMP, the category receives a three point score at both levels of confidence. Scoring results will be further discussed in subsequent case study chapters.

CHAPTER 5: ARIZONA'S AGRICULTURAL PM_{10} BMP PROGRAM

5.1 Introduction

5.1.1 Nonpoint Pollution

Nonpoint pollution can be defined as emissions generated in small loads from a number of single sources (Ice). Controlling nonpoint pollution is more complicated than traditional controls for single point sources for several reasons. First, it is difficult to identify polluters and the amount that each source contributes to the overall pollutant level. Secondly, many nonpoint pollutants exist at some ambient level when no polluters are present at all, and this level may naturally fluctuate, complicating the regulator's role in controlling pollution (Segerson). Finally, regulators attempting to control agricultural nonpoint pollution face a farm heterogeneity problem. Land acreage, technologies, inputs, and crop composition are just a few of the factors that may influence a farm's contribution to overall ambient pollution levels.

5.1.2 Particulate Matter

Particulate matter (PM) is a type of small-particle pollutant that is usually considered nonpoint in nature. PM is composed of small dust particles or large liquid droplets that are smaller than 100 micrometers. When soil surfaces are disturbed, smaller particles can be suspended in the air and transported by wind. This soil-based atmospheric PM is called fugitive dust. PM emissions in a specific region depend on soil conditions (moisture, organic particles, and soil type), climatic factors (wind speed and number of wind events), and the amount of physical soil disturbance that occurs. Due to lower rainfall levels, finer soils, and higher wind speeds, the western U.S. faces more problems with PM emissions than the rest of the country (Kennedy).

Externalities created by PM emissions include financial burdens to homeowners and businesses in the form of physical property damage and clean up costs. In addition, PM poses some health risks. Particulates can be inhaled due to their small size, which can lead to development or intensification of cardiovascular problems or asthma, and even premature death (ADEQ 2001a, Kennedy).

5.1.3 The Clean Air Act and Particulate Matter Controls

The Air Pollution Control Act of 1955 (Clean Air Act, CAA), and its subsequent amendments, delegates authority to states to control air pollution problems and grants federal authority to provide support to states and guidelines for abatement. When the U.S. Environmental Protection Agency (EPA) was established in 1972, it assumed responsibility for administrating the provisions of the CAA. As part of this responsibility, the EPA develops National Ambient Air Quality Standards (NAAQS), which define acceptable levels of airborne pollutants. A set of standards for each pollutant are defined under the corresponding NAAQS. Primary standards are set for protecting public health and secondary standards are set for protecting public welfare and the environment. The NAAQS are national standards and all states must meet NAAQS requirements under the oversight of the EPA. Air quality standards are updated when research supports revised regulations (ADEQ 2001b; Kennedy).

Geographic regions that fail to meet primary NAAQS are designated as nonattainment areas by the EPA. In order to adhere to NAAQS, states are charged with developing State Implementation Plans (SIP) for controlling pollutants in areas of nonattainment. CAA Sections 110 (a)(2)(C) and 110 (a)(2)(E) require states to use adequate funding, personnel, and authority to implement the terms of the SIP. The states must develop the SIP and the plans must be approved by the EPA before the SIP can be put into effect. If the SIP is not approved, the state must revise its SIP, while the EPA begins developing its own Federal Implementation Plan (FIP). The FIP is implemented within two years if an adequate SIP is not developed.

There are currently two NAAQS for particulate matter. The NAAQS apply to (1) particulates of size 10 micrometers in diameter or smaller (PM_{10}), and (2) those smaller than 2.5 micrometers in diameter ($PM_{2.5}$). The primary standard for particulate matter that must be met to attain NAAQS consists of two parts, 24-hour standards and annual standards, controlling for short and long term exposure, respectively. Both of these standards must be met by states. The first instance of nonattainment within a region is classified as a 'moderate nonattainment area', and the state is given six years to reach NAAQS standards. After six years, if the area is still classified as a nonattainment region, the region becomes classified as a 'serious nonattainment area'. States are given an additional four years (ten years total from first instance of nonattainment) to achieve the air quality goal in serious nonattainment areas.

When a region is designated as nonattainment, states must show reasonable further progress (RFP) toward air quality improvement. The stringency of control methods differ for each type of nonattainment area. In moderate regions, measures to control pollutants are specified as reasonably acceptable control methods (RACM). Once an area is classified as severe, the regulatory approach is revised to include only best available control methods (BACM). Monitoring systems for PM include networks of air quality monitors that are utilized by both state and federal agencies. These networks generate data on air quality and ensure RFP of control methods within areas of nonattainment (Kennedy).

5.2 The Maricopa County PM_{10} Nonattainment Area

The 1990 revisions to the Clean Air Act resulted in new NAAQS for particulate matter (ADEQ 2001). These revisions led to EPA classification of portions of Maricopa and Pinal counties in Arizona as a moderate PM_{10} nonattainment area. The 2,916 square mile area, the majority of which is in Maricopa County (2,880 square miles), and which encompasses the entire Phoenix metro area, was classified as a nonattainment area in November of 1990. The Maricopa Association of Governments (MAG) and Arizona Department of Environmental Quality (ADEQ) were responsible for developing and implementing the Maricopa PM_{10} SIP. MAG worked to achieve the annual standard while ADEQ developed a plan to meet the 24-hour standard. The SIP and its revisions were incorporated into Arizona or Maricopa County law prior to EPA review (ADEQ 2001b).

The Maricopa County nonattainment area has a turbulent history. In 1991, the EPA officially designated Maricopa County as a moderate PM_{10} nonattainment area. The deadline to attain NAAQS was set for December 31, 1994. In November of 1991, the state submitted a PM_{10} SIP to the EPA, but it was determined incomplete by the EPA in March of 1992. The EPA began working on an FIP to reduce emissions in the nonattainment area. In August of 1993 and March of 1994, two revisions to the initial SIP were submitted to the EPA. Under the second revision (1994), the state included statements that NAAQS would not be met despite RACMs put in place. A demonstration showed that the annual standard for PM_{10} could not be achieved. The revision also showed that localized sources of PM_{10} failed compliance with the 24-hour standard and that the assessment of these site-specific sources was immeasurable.

In April of 1995, the EPA approved the revised SIP. In May of 1996, the Arizona Center for Law in the Public Interest (ACLPI) filed a petition for review of the 1995 EPA SIP approval (*Ober v. EPA* 84F.3d 304) in the 9th Circuit Court. The court determined that the SIP was incomplete for the following reasons: (1) the SIP contained no analysis of violations of 24-hour PM_{10} NAAQS and (2) the SIP failed to create requirements based on the sources of these violations. The court decision renewed the EPA's FIP obligation. This required the state to correct these SIP shortcomings, to demonstrate RFP, and to show attainment of the 24-hour PM_{10} NAAQS in order to implement an SIP. Also, in May of 1996, the EPA reclassified the Maricopa nonattainment area as serious (effective June 1996).

In response to the court ruling, the EPA required the state to create a limited localized (microscale) plan to assess sources of PM_{10}, to demonstrate and establish BACMs with RFP, and to meet CAA requirements for both moderate and serious areas. This microscale plan was required by May 1997, with an expanded regional plan (developed from the results of the microscale plan) required by December 1997. The combination of plans was intended to correct moderate area requirement deficiencies of the SIP as noted by the 9^{th} Circuit Court. As the original 1994 area attainment date had passed, the EPA set a new deadline for attainment for December 31, 2001.

The microscale study was commissioned by ADEQ as the basis for the 24-hour plan. Five monitoring sites were included in the study: Salt River, Maryvale, Gilbert, West Chandler, and East Chandler. These locations were historical violators of the 24-hour NAAQS. Two of these locations (Gilbert and West Chandler), were on the fringe of urban sprawl and near agricultural operations. For each site, the study attempted to review the following: (1) identify emissions sources and quantify their contributions with emissions inventories and air quality models, (2) specify and evaluate the performance of RACMs, BACMs, and additional means to reduce emissions from identified sources, and (3) demonstrate feasible attainment of the 24-hour standard by the December 31, 2001 deadline.

In May, 1997, ADEQ submitted the Final Plan for Attainment of the 24-Hour PM_{10} Standard (Final Plan) to the EPA. The Final Plan contained the results of the microscale study, including contributors at each site. The study determined each site contributed to PM_{10} as represented in Table 5.1. The Final Plan identified RACMS and BACMS for these sources, and showed attainment was feasible.

The Final Plan also contained a BACM study by ENSR, an environmental consulting group. ENSR identified other nonattainment areas in the western U.S., and control methods utilized in those regions. ENSR also noted that states usually exempt agriculture from requirements for air quality permits. Two California regions were cited as exceptions, the South Coast Air Quality Management District (South Coast), and the

San Joaquin Valley Unified Air Pollution Control District (San Joaquin). Both of these areas were regulated under dust control rules as of 1997. The ENSR report recommended utilizing control methods from these areas as well as working with NRCS and ADA to identify additional agricultural PM_{10} control methods.

Table 5.1: Final Plan Microscale Study Results

SITE	Contributors to PM_{10} 24-Hour NAAQS Nonattainment	
Salt River	earth moving industrial haul roads	unpaved parking lots unpaved roads
Maryvale	disturbed cleared areas	
Gilbert	agricultural field aprons	unpaved parking lots
West Chandler	agricultural fields agricultural field aprons	disturbed cleared areas vacant lots
East Chandler	emissions sources inconclusive	

In August, 1997, EPA partially approved the Final Plan. The Final Plan failed in two areas: (1) it did not include the extent of implementation required for the recommended RACMS and BACMS to be effective over the entire nonattainment region, and (2) it did not provide assessments of the effectiveness of these measures at this geographic scale. RFP and attainment plans for Salt River and Maryvale were approved, as well as RACMs and BACMs for disturbed cleared areas, earth moving, and industrial haul roads. However, RFP and attainment for the West Chandler and Gilbert sites were not approved, and neither were the RACMs and BACMs for agricultural aprons, vacant lands, unpaved parking lots, and unpaved roads.

As the state plan was not fully approved, a court order required an EPA FIP by July 1998 that would assure CAA requirements were met. As part of FIP development, the EPA collaborated with the agricultural community and ADEQ to develop PM_{10} control strategies from agricultural sources. BMPs were identified as a reasonable control strategy (ADEQ 2001b).

In May 1998, Governor Hull signed a law, ARS §49-457 (originating as Senate Bill 1427), establishing an agricultural BMP committee (PM_{10} BMP Committee). The law required the state to adopt an agricultural general permit rule, based on BMPs, by June 10, 2000, and farms to adopt the BMPs required by the rule within 18 months of rule implementation. In August 1998, the EPA promulgated a FIP, including a commitment to propose a RACM for agricultural dust sources by September of 1999, to finalize the RACM by April 2000, and implement the control measures by 2001. In September of 1998, ADEQ submitted ARS §49-457 to EPA for meeting the RACM requirements of the CAA. ADEQ requested that the EPA approve ARS §49-457 in the SIP to replace the FIP. In December 1998, the EPA proposed approval of ARS §49-457. In June 1999, EPA finalized this approval, and withdrew the FIP commitment.

ADEQ, in conjunction with MAG, submitted a serious area plan for PM_{10} reduction as a revision to the Final Plan SIP (Revised Final Plan) in February of 2000. This plan included BMPs and controls that met FIP requirements, including modeling for emissions under the BMP program, at both low-end scenarios and high-end scenarios. Also, ADEQ requested a five year extension to attainment (from 2001 to 2006). The EPA requirements under a FIP for determining control methods (as outlined in Revised 1999 MAG Plan) are: (1) develop emissions inventories for PM_{10} (2) evaluate control measures, and (3) select BACMs. For the second step, ADEQ contracted with Sierra

Research to produce a report on PM_{10} control measures. Forty-one potential cost effective PM_{10} control measures were identified, with five related to agriculture. The five measures that applied to agriculture were: (1) Food Security Act soil conservation requirements, (2) reduced operations that disturb soil during high wind events, (3) treatment of fallow fields, (4) comprehensive dust control plans for large farms (640 or more acres), and (5) increased control of ammonia and nitrate use on farms. For the third step, MAG initially identified eight new and existing measures for BACMs for agricultural PM_{10} sources. The Revised Final Plan contained six measures following recommendations by the Maricopa County Farm Bureau.

In April, 2000, the EPA proposed approval of the state's Revised Final Plan, and for an extension of the serious area attainment date from December 31, 2001 to December 31, 2006. The Agricultural PM_{10} permit was adopted by the PM_{10} BMP Committee in June 2000 and was included in an SIP revision the following month. In support of the BMP program, ADEQ sponsored a study for expected BMP impacts on PM_{10} emissions. In November, 2000, URS Corporation and Eastern Research Group, Inc. jointly prepared a Technical Support Document for Quantification of Best Management Practices (TSD). The TSD assessed emissions by (1) determining how each BMP would be applied to major crops in Maricopa County (2) ranking BMPs given their likelihood of use (3) applying control efficiencies for individual BMPs (either maximum, minimum, or mid-point control level), and (4) estimating emissions reduction from BMP implementation. The study consisted of two estimates for emissions reduction: (1) expected agricultural lands removed from agricultural production and (2) expected reductions from applying a range of BMPs. The study estimated a 37 percent reduction from lands going out of agricultural production and 36.6 percent reduction from BMP implementation on operating farms, leading to an estimated 60.3 percent overall reduction in PM_{10} emissions.

5.3 Agricultural PM_{10} Best Management Practices (ARS §49-457)

ARS §49-457 establishes committee members and specifies requirements for the PM_{10} BMP permit. ARS §49-457 defines BMPs as "techniques verified by scientific research, that on a case by case basis are practical, economically feasible, and effective in reducing PM_{10} particulate emissions from a regulated agricultural activity" (ARS §49-457, (N)(3)). The statute details the committee membership as follows: the director of ADEQ (or director's designee), the director of Arizona Department of Agriculture (ADA) (or director's designee), the dean of the College of Agriculture and Life Sciences (CALS) at the University of Arizona (or dean's designee), the state director of the U.S. NRCS (or director's designee), a soil taxonomist from the University of Arizona, and five agricultural producers representing a specific crop: alfalfa, citrus, cotton, grain, and vegetables. Specific appointments are made by the governor and include a six year term. The committee is required to appoint a chairman who can be reelected after a two year term, and the committee can also establish a technical committee. The committee meets by request of either the chairman or a majority of the committee members. The members of the original PM_{10} committee are attached in Appendix 1A.

Within the statute, the committee is charged with developing a BMP general permit for controlling agricultural PM_{10} emissions. The committee is also given permission to examine, evaluate, and revise the requirements of the permit over time. The ADEQ is required to provide support staff to the committee, and the University of Arizona CALS, ADA, and ADEQ are to provide any technical assistance required by the committee. Finally, the committee is required to develop an educational program for the permit, to be implemented by ADEQ (this education program eventually resulted in the Guide to Agricultural PM_{10} Best Management Practices) (ADEQ 2001a).

According to ARS §49-457, the committee must create a schedule of alternative BMPs and require that at least one be adopted by a producer to obtain the general permit. Selected BMPs are allowed to vary due to farm heterogeneity. The statute mandates deadlines for compliance: for farms in existence prior to June 10, 2000, compliance must take place by December 31, 2001, while any new farming operation is given 18 months to comply with the permit. For a first instance of farm violation, the ADEQ director will inform the farm, in writing, with a notice of noncompliance and an order to meet general permit reqirements. This written notice gives the farm "a reasonable period" (no more than six months) to comply and the farm must submit a plan for compliance to the local Natural Resource Conservation District (NRCD) (ARS §49-457, (I)). If the reasonable period has passed and the farm still fails to comply, the director issues a second order, again notifying the farm of permit requirement deficiency. The farm receives a second reasonable period (again, no more than six months) and must submit a plan for compliance to ADEQ. The farm is also afforded the right to a hearing (as required under Arizona's Administrative Procedure Act) concerning failure to comply (ARS §49-457, (J)). After this second order, if the farm still fails to meet permit requirements under the

BMP permit, the ADEQ may remove the farm from the general permit program and require that the farm purchase an individual permit, which can cost the farm upwards of $25,000 (ARS §49-457, (K), Kennedy).

The PM_{10} BMP Committee identified 30 BMPs expected to reduce emissions in three categories: Tillage and Harvest, Non-Cropland, and Cropland. The Tillage and Harvest category relates to farm management during periods of increased activity when cropland is physically disturbed. Non-Cropland management consists of land that is not in agricultural production. This may include farm roads, ditches, equipment or storage yards, or land that is no longer used for crop production. The Cropland category accounts for land that falls in the time period between harvest and new growth of crop, for lands that are in production but are being left fallow, and for turn-rows. In order to qualify for the Agricultural PM_{10} general permit, farms must enroll and document the use of at least one BMP from each of these categories. The BMPs contained in each category are listed in Appendix 2A.

5.4 PM_{10} Best Management Practices Case Study Results

5.4.1 Committee Interview Results

Interview participants stated that ADEQ, MAG, and EPA initially approached the Arizona farming community in late 1997 during a Farm Bureau meeting. The purpose of this meeting was to begin talks with the agricultural community concerning the developing PM_{10} FIP. According to committee participants, the EPA was taking FIP measures toward controlling PM_{10} emissions from agricultural sources. The agricultural community mobilized itself and convinced the legislature to establish the PM_{10} BMP committee. Members of the Farm Bureau and the vegetable and cotton grower's associations were instrumental in writing and lobbying for ARS §49-457. Participants suggested that the BMP concept was borrowed from an existing Nitrogen BMP rule, ARS §49-248, developed and established in the late 1980s. The two committees (Nitrogen and PM_{10}) are structured similarly, with both containing growers from the five major crops in Arizona. The governor chose the specific PM_{10} BMP Committee members according to the requirements of ARS §49-457. Prior to the negotiations, the PM_{10} BMP Committee received some preparation, including technical materials and a history of PM_{10} and the Maricopa nonattainment area, as well as mandatory ethics training required of all state committees.

According to participants, all parties worked together in a collaborative manner to produce a feasible set of controls. During the first meeting, the PM_{10} BMP Committee selected a chairman and decided to create an Ad-Hoc Technical Advisory Committee (Ad-Hoc Committee). The first meeting also included reports on the rulemaking process, the timeline for rulemaking, and background on the PM_{10} problem. Spectators at committee meetings were usually representatives from the EPA (not formal members of the committee as the rule was a state-sponsored regulation), agricultural lobbyists, and members of the Ad-Hoc Committee. The meetings were conducted in an informal manner, allowing spectator input and debate.

Interviewees provided consistent descriptions of participant interests. The dominant interests on the PM_{10} BMP Committee, in number and in persuasive power, were agricultural in nature. Agricultural members provided most of the leadership on both the PM_{10} BMP Committee and the Ad-Hoc Committee. Agricultural members knew each other, while agency representatives and technical experts were mostly unfamiliar with other committee members. One participant noted that familiarity may have contributed to the decision to elect an agricultural producer as the committee chair. The goal of agricultural representatives was to control the costs imposed by the BMPs. Experts provided technical expertise on which BMPs would be effective at reducing dust emissions. Some of the technical experts were strongly supportive of agricultural concerns during the discussions. Regulatory agency representatives facilitated the negotiation and design process. Agencies mostly provided regulatory information to the PM_{10} BMP Committee during the negotiations.

Interviewed participants provided an in-depth discussion of the deliberation process. The Ad-Hoc Committee developed a comprehensive list of 65 BMPs from research from the following sources: an NRCS Technical Guide, the South Coast region, the San Joaquin Valley region, University of Arizona research projects, University of Washington Columbia Plateau project, the ENSR report, and the Sierra Research study (Table 5.2). The Ad-Hoc Committee also was responsible for reviewing questions from the PM_{10} BMP Committee as to effectiveness or applicability of specific BMPs. Most participants agreed that the BMPs selected by the committees were measures that were determined to be effective at reducing dust, practical to implement, and enforceable. The consensus was that practices selected by the committees had to be within economic reason and had to reduce visible dust emissions. In selecting BMPs, the experts on the committees were relied on to determine whether the practices would reduce dust. The agricultural representatives were relied on as farming experts. These individuals informed the committees whether a practice could be implemented, on the basis of cost of implementation and how applicable the BMP was to Arizona agriculture.

Table 5.2: Initial BMPs Proposed by the Ad-Hoc Committee

Access Restriction	Heavy Use Area Protection	Row Arrangement
Access Road	Hedgerow Planting	Soil Salinity Management
Air Fan Deflectors	Herbaceous Wind Barriers	Spoil Spreading
Artificial Wind Barriers	Irrigation Land Leveling	Stripcropping, Field
Chiseling/Subsoiling	Irrigation System, Sprinkler	Surface Roughening
Conservation Cover	Irrigation System, Surface/Subsurface	Tillage Equipment Modification
Conservation Crop Rotation	Irrigation System, Trickle	Tillage Pre-irrigation
Controlled Drainage	Irrigation Water Management	Track-out Control System
Cover and Green Manure Crop	Land Smoothing	Track-out Prevention
Critical Area Planting	Limited Activity with High Wind Event	Tree/Scrub Establishment
Cross Wind Ridges	Modifying Egress/Ingress	Tree/Shrub Pruning
Cross Wind Stripcropping	Mulching	Unpaved Road Treatments
Cross Wind Trap Strips	Nutrient Management	Use Exclusion
Dust Suppressants (other)	Pasture/Hayland Planting	Vehicle Restriction for Access/Trip
Dust Suppressants (inorganic)	Pest Management	Waste Management System
Dust Suppressants (organic)	Precision Land Forming	Waste Utilization
Emergency Tillage	Prohibition of Tillage	Watering
Fence	Reduce Vehicle Speed	Wildlife Upland Habitat Management
Field Border	Residue Management, Mulch-till	Windbreaks/Shelterbelt Establishment
Filter Strip	Residue Management, No-till, Strip-till	Windbreak/Shelterbelt Renovation
Firebreak	Residue Management, Ridge-till	
Forage Harvest Management	Residue Management, Seasonal	
Harvest & Equipment Modification		
Source: Final Revised Background Information, MAG/ADEQ 2001		

There were several points of contention debated by PM_{10} BMP Committee members during the negotiations. First, several participants remarked that there was no quantitative data available to determine which practices would be more effective at reducing dust emissions. BMP decisions were made without evaluative criteria for making the choices. Some interviewed participants suggested that an assessment of each BMP's effectiveness was not necessary because the state requested an improvement in agricultural dust emissions without any specific quantity required. So, the committee simply searched for the best practices that could improve air quality. A second point of contention was that monitoring requirements and specification of general permit requirements were more lenient than the regulators and some experts wanted. Some participants wanted more prescriptive language for adoption in the permit and a more detailed record keeping system on how the farm had achieved compliance with the permit.

5.4.2 Expert Survey Results

Ten agricultural experts were surveyed to determine the extent of BMP technology and management implementation on farms in Arizona. For the survey, each expert provided an estimated percentage of farms in Arizona using each BMP prior to 2001. This predates the enactment of the PM_{10} BMP program and provides an *a priori* look at farm structures. Each expert survey was applied to the scoring model, as described in Chapter 4, to obtain aggregate results for each category at two levels of sensitivity (80 and 90 percent). Table 5.3 illustrates the aggregate responses for the PM_{10} BMPs by category at each sensitivity level. For each category, the numbers provided are the total number of BMPs that the expert scored at or above the sensitivity percentage. Any BMP scored less than the sensitivity is dropped from this composite analysis. Full survey responses from each expert are attached in Appendix 3F.

Table 5.3: Expert Scoring Summary for PM_{10} BMPs

		Expert									
	BMP Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BMPs Scored at 80 Percent	Tillage and Harvest	5	2	4	3	3	5	2	4	1	1
	Non Cropland Management	3	0	0	1	0	0	-	0	0	0
	Cropland Management	4	2	4	4	4	4	0	1	0	0
BMPs Scored at 90 Percent	Tillage and Harvest	4	0	3	3	3	3	2	3	1	1
	Non Cropland Management	2	0	0	1	0	0	-	0	0	0
	Cropland Management	4	0	1	2	4	0	0	1	0	0

Two of the experts, 1 and 4, scored the agricultural sector as meeting the program requirements at both the 80 and 90 percent levels for all three PM_{10} BMP categories. Each of these experts also had more than one category with multiple BMPs above both levels of sensitivity.

The scores provided by experts 2, 3, 5, 6, and 8 suggest that the Non-Cropland category was likely not met by the Arizona agriculture sector, as this category did not qualify at either level of sensitivity. At the 80 percent level, all of these experts show that farms met the minimum criteria for program adoption for the two remaining categories. At the 90 percent level, experts 3, 5, and 8 show the minimum requirements as met in these categories. At 90 percent sensitivity, the results of expert 6 indicate only one category, Tillage and Harvest, was met by the sector, while expert 2 shows that the sector qualified for no categories.

Expert 9 provided one BMP at 90 percent, thus showing agriculture met the program in only one category for both levels of sensitivity. Experts 7 and 10 only partially completed the PM_{10} portion of the survey, each citing a lack of technical knowledge sufficient to provide a score with confidence. Although incomplete, each of these respondents scored one category as qualifying at the 80 and 90 percent level, both in the Tillage and Harvest Category.

While only two of the ten expert responses suggest agriculture automatically qualified for the BMP program at its inception, the remaining results still reveal that there are multiple BMPs included in the program's requirements that were widely used prior to 2001. Experts consistently scored several BMPs high for two categories. For the Tillage and Harvest category, six of the experts gave scores of 90 percent or higher to the 'Chemical Irrigation' BMP, and four met this sensitivity for the BMPs 'Planting Based on Soil Moisture' and 'Reduced Tillage'. For the Cropland Management category, four experts gave 90 percent or higher scores to 'Planting Based on Soil Moisture', and three to 'Residue Management'. Two additional experts scored both of these BMPs at the 80 percent level. The two experts that qualified agriculture for the Non-Cropland Management category both identified 'Critical Area Planting' as a high-scoring BMP.

The results suggest the PM_{10} BMP Committee incorporated BMPs that were already in practice on commercial farms into the BMP program in at least two of the categories. There were a number of consistently low-scoring BMPs in each category (meaning some approved practices were not widely used), but the number of expert scores above the 80 and 90 percent sensitivities gives an indication that the program was very accommodating to farm conditions at the time of program design. The agricultural sector was likely to qualify their farms into the BMP program by using common practices such as application of chemicals through irrigation systems, planting according to soil moisture content, or reducing the number of passes during tillage (a practice several experts noted was becoming popular for economic reasons prior to program inception). It appears that the majority of agriculture in Arizona had to do little more than meet the requirements of a single category (i.e. implement one BMP) in order to meet the full requirements of the PM_{10} BMP program.

5.5 Survey and Interview Interpretation

Interview results point to the existence of bargaining power favoring agricultural interests. The PM_{10} BMP Committee was comprised of five agricultural members, one interest representing the regulatory agency, and three other public-sponsored interests. Some of the public attending the meetings also were supportive of agriculture, according to interview data. The structure of the committee alone suggests influence of the committee toward agricultural interests. Several committee members reported that contentious issues, though few, were decided by popular vote, so any issues opposed by agricultural members were overturned. Deliberations over some reporting and specific wording for the rule did not end up the way the regulators (or those arguing for them) would have preferred. Another source of agricultural influence on the rule stems from the political savvy of the farming sector's leadership. Members of the agricultural community developed the legislation behind the rule, giving agriculture a strong bargaining position from the start. In addition, agricultural members steered committee discussions and directed the negotiating process.

The PM_{10} rule design process was characterized by asymmetric information, indicated by several case-study results. First, agriculturalists were the primary source of information for whether practices could be implemented on farms and if farmers would adopt them. Secondly, the expert survey data suggests many practices already common to farms were included. Many BMPs were scored highly by experts, and some of these were consistent among the experts as well. This establishes that there were few requirements imposed on farmers after the regulation went into effect, as many of the

BMPs in the program were already common practice. Third, program compliance does not require that qualifying BMPs be new; farms only have to verify which approved practices they are using. Also, a farm must only qualify for each category as a whole, so the entire farm qualifies with a BMP implemented on only one field (ADEQ 2001a). These factors all point to significant bargaining power in farmers' favor, leading to a rule with technology and management standards that were mostly existing on regulated farms.

Returning to figures 3.2 and 3.3, the evidence from committee interviews and expert surveys indicate that the negotiated outcome reaches close to the 'northwest' corner of the ZOPA. First, r, the regulator's BATNA, can be defined as the FIP. However, the terms of the BATNA were undefined as the EPA, ADEQ, and MAG were working with agriculture to identify a suitable control method prior to the approval to use BMPs (ADEQ 2001b). Since the regulator's BATNA was not fully established, the regulator entered negotiations without a firm bargaining position. Secondly, once entering into negotiation, the committee composition, requirements of the program, and the list of approved BMPs indicate a strong bargaining position by agriculture. In Figure 3.3, these identify a solution to the bargaining process where *k* is greater than *h* and the negotiated outcome is close to the corner of the NPP (point M). As the resulting agreement falls close to point M, agricultural representatives negotiated an outcome where program costs for agriculture were minimal, and the regulator's outcome is equivalent or only slightly better than pursuing the BATNA.

Few farms had to adopt new technologies or change management practices to comply with the PM_{10} rule, so there is little change in dust emissions from the 2001 implementation period. Returning to figure 3.4, the damage function that emerges from the PM_{10} rule entails a corner solution. Recall that the $D(T_{BMP})$ curve consists of all the management techniques and technologies included in the program. Here, the negotiated outcome provides a damage function such that $D(T_{BMP}*) \approx D(T_0)$, and little mitigation can be expected. By including common practice BMPs into the program, initial farm adoption of program BMPs results in little reduction of environmental damages (as, in fact, the technologies most farms are 'adopting' are already in use). From the perspective of all farmland in the nonattainment area, the relationship may take a downward slope, but it is only slight and gradual as most farms will make few changes that actually reduce emissions. For the regulator, this means that agency expenditure on negotiating and rule enforcement is a poor choice, as the socially efficient outcome for the resulting damage function occurs where $T_{BMP}* \approx 0$.

CHAPTER 6: ARIZONA'S AGRICULTURAL WATER CONSERVATION BMP PROGRAM

6.1 The Groundwater Management Act

The 1980 Groundwater Management Act (GMA) was instrumental in establishing conservation as an important part of Arizona's water use and management. At the time of its implementation, it is estimated that annual consumption of groundwater was about twice the amount than could be renewed annually by natural forces; usage was some 4.8 million acre feet (maf) per year, an overdraft of an estimated 2.5 maf per year (Sheridan). The main goal of the GMA was to achieve and maintain safe yield by the year 2025. Safe yield means using no more groundwater than is naturally replenished annually. The GMA established the Arizona Department of Water Resources (ADWR) to oversee all aspects of the program. For the areas of high overdraft, the GMA originally specified four Active Management Areas (AMAs) for ground and surface water control. There are currently five AMAs currently in place, for Phoenix, Pinal, Prescott, Santa Cruz, and Tucson. Each AMA is charged with maintaining a plan for each of five specified time periods (1980-1990, 1990-2000, 2000-2010, 2010-2020, and 2020-2025), building on prior periods and developing further requirements and goals over time.

For each management plan, ADWR develops and specifies conservation practices or requirements for industrial, municipal, and agricultural operations in each AMA, with the assistance of regulated interests. The Pinal AMA serves a primarily agricultural base, while Pheonix, Prescott, and Tucson AMAs are largely municipalities. The Santa Cruz AMA has neither of these qualities, but was incorporated in 1994 when the region fell short of safe yield. These AMAs collectively contain 80 percent of the state's population and 70 percent of Arizona's overdraft.

6.1.1 Programs for Agricultural Water Conservation

As of this writing, Arizona is in the Third Management Plan. The rule governing agriculture for the Pinal AMA in the third plan period is discussed here, due to the agricultural nature of the Pinal AMA and the fact that agricultural guidelines for the AMAs are uniform. The GMA specifies water rights and usage for agricultural users in AMAs. Farmland was granted an irrigated grandfathered right (IGFR) based on a historic use of cropped acreage between 1975 and 1980, prior to the inception of the management plans. The IGFR established the amount of water that the farm operator may pump annually. There are three alternatives available to agricultural producers to meet ADWR conservation requirements. First, there is the Base Program, a traditional program that is the foundation of the agricultural water conservation program. Unless an IGFR owner is accepted into one of the remaining two programs, they must adhere to Base Program requirements. The second program is the voluntary Historic Cropping Program. The Base Program and Historic Cropping Program are similar, with the Historic Cropping program allowing less stringent irrigation requirements (lower irrigation efficiency) in exchange for limitations on benefits accrued by participants. Not a single farm has enrolled in the Historic Cropping Program to date (Hanrahan). The final program is the Best Management Practices Program. The BMP program is entirely voluntary during the Third Management Plan period (ARS §45-566, 566.01, 566.02).

Growers regulated under the Base program must adhere to the following requirements: Each IGFR within an AMA receives a maximum annual groundwater allotment based on the historic land use period between January 1, 1975 and January 1, 1980. The allotment is calculated by ADWR and consists of two parts: a water duty and the number of water duty acres for each IGFR. The water duty is the annual requirement of water to grow crops that were historically in place, measured in acre-feet per acre, divided by the farm's irrigation efficiency. Water duty acres are the maximum amount of acreage irrigated in the IGFR during the historical land use period. This can be represented as:

$GWA = W*L$ and $W = I/E$

where *GWA* is the allotment, *W* is the water duty, *L* is the water duty acres, *I* is the irrigation requirement, and *E* is the irrigation efficiency (Anderson, Wilson, and Thompson). The irrigation efficiency requirement is the crop water requirement divided by the volume of water applied, or:

$E = CWR/w$

where *w* is actual water volume applied and *CWR* is the crop water requirement. The crop water requirement consists of a consumptive use value for the crop with allowances for crop and soil types, less the effective precipitation accumulated during the season. The irrigation efficiency is assigned depending on the crop farmed under the IGFR. For the Base Program, the irrigation efficiency for the third management plan is required to be at 80 percent for most farms, with an exception of 75 percent for farms with limiting soils or excessive slopes.

Under the Base Program, flexibility accounts are afforded to farmers to balance water supplies over changing market and climatic conditions. In periods when less than the maximal allotment is used, farmers may receive credits for an unused portion of their assigned allotment. The credit bank is unlimited-- farms may continue to accumulate credits each year. In periods of short supply, farms may debit their flex account. Farms may have a total debit on their account of up to 50 percent of their maximal allotment.

The Best Management Practices program was initiated at the start of the Third Management Plan and did not go into effect until 2002. Farmers trade the allotment requirements of the Base Program and the ability to build or utilize their flex credit balance for the opportunity to 'unconstrained' water use given their participation in the BMP program. Enrollment in the program initially was high, with 39 farms enrolling in 2004, but has tapered off as 13 enrolled in 2005 and 9 in 2006 (Hanrahan, ADWR). Only two farms have been de-enrolled for failing to maintain the program requirements. The BMP program for agricultural water conservation is entirely voluntary under the Third Management Plan, with plans to review it at the end of the period and assess its performance.

6.2 Further History of the BMP Program

A significant portion of the the water conservation BMP program was designed prior to formation of the Governor's BMP Advisory Committee (Appendix 1C) (Hanrahan, Kimberlin). In the late 1990s, several ADWR employees began working with agricultural producers and irrigation district personnel in the Pinal AMA on ideas for a substitute water conservation plan for agriculture. This effort responded to farmers calling for an alternative to the Base Program since as early as the late 1980s. A BMP program was identified as an ideal alternative to the Base Program by this informal group of farmers and AMA personnel.

Interview respondents cited several issues that lead to the development of an alternative plan for agricultural water conservation. First, the majority of agricultural producers in the state were using water at levels below the requirements of the Base Program. As a result, Arizona's farmers had banked over 15 million acre feet in their flex credit accounts since the Base Program's inception. Municipal interests feared that industry would lobby the state legislature to make these banked credits legally transferable to developers to meet Assured Water Supply rules. Also, water regulators concluded that the high number of flex credits indicated that the Base Program's water conservation requirements were largely ineffective. Secondly, irrigation district personnel and farms were required to provide annual reports for each IGFR under the Base Program. Some farms contained multiple IGFRs, so these agricultural interests pursued an alternative plan with less intensive reporting. Thirdly, some producers were upset with the historical period of 1975-1980 for the Base Program. Some farmers felt that to be globally competitive producers they needed new crop mixes that did not reflect the crops grown during the historical period. In addition, farmers argued that if farmable land were left fallow during the historical period, the water allotment defined under the Base Program excluded that land and they were unfairly penalized. Finally, some agriculturalists felt that poor water managers were rewarded with larger allotments and good water managers received lower allotments based on their water management during the historical use period. These interests wanted a program that would reward good water managers.

During the development of the Third Management Plan ADWR began looking at different possibilities to meet these grower concerns. In December of 1999, under pressure from the agricultural community in Arizona, ADWR postponed adopting the Base Program for the Third Management Plan. The primary concern was cited as stringency of the irrigation efficiency requirements for the Third Management Plan (ADWR 2001). Three letter agreements took place between ADWR and a group of agricultural interests in Arizona, dated December 10, 1999, February 28, 2000, and April 13, 2000. These letter agreements established advisory committees to review the Base requirements of the Third Management Plan and to propose alternatives to the plan. The Pinal AMA advisory group and Pinal AMA ADWR staff were recognized for jointly developing the BMP program as an alternative measure during this period (ADWR 2001). As noted earlier, some BMP program design had taken place prior to the letter agreements, as early as the mid-1990s. These early developments may have contributed to political pressure that led to the postponement of the implementation of the Base Program in the Third Management Plan. A fourth letter of agreement was drafted September 18, 2001, consisting of signatures from agricultural representatives, irrigation district representatives, agricultural water associations, and the acting director of ADWR. This fourth letter called for changes in GMA legislation to enact a BMP program, and specified the wording for this new legislation.

House Bill 2022 was passed on March 25, 2002, amending ARS §45-566.02 to include a BMP program in the Third Management Plan as an alternative to Base Program requirements. This legislation specifies that a BMP program must be determined by the ADWR director to be at least as conservative for water as the Base Program. ARS §45-566.02 also states that IGFR owners have the right to participate in the BMP Program in lieu of Base Program. According to interviews, the agricultural community was primarily responsible for drafting the legislation and specifying composition of the committee. The Arizona Cotton Grower's Association and Arizona Farm Bureau were primary players in this development phase. On May 15, 2002, Executive Order 2002-9 was signed by Governor Jane Hull. This order appointed membership to the Governor's BMP Advisory Committee and defined the length of members' terms. It established the committee's role as advisors to the director of ADWR. The Order also provides requirements for the evaluation and ongoing research concerning best management practices, program performance evaluation, and the relative efficiencies of the Base and BMP programs.

During the informal design period (prior to legislation), the Pinal AMA working group had used a combination of materials to develop a program. The development included use of EQIP and NRCS documents, a review of conservation programs from other states, and farm and irrigation district personnel expertise. Interview participants that were involved in this phase state that there was very little farm-level data available to the working group and BMPs were not assessed for their effectiveness. BMPs were selected based on personal expertise. For this reason, the BMP program was initiated as a ‘test program’ to be reviewed during the Third Management Plan. The BMP program will be permanently put in place for the Fourth Management Plan if determined effective by ADWR. By 2001, the informal group had completed the basic design of a BMP program. All interviewees stated that the large majority of the work for the BMPs was completed prior to the request to use BMPs (the fourth letter of agreement) and the establishment of the advisory committee. The definitions of BMPs and categories, the scoring requirements of the program, the scores attributed to specific BMPs, scoring worksheets, and land-use permission forms were already complete before Executive Order 2002-9 went into affect.

The informal group that developed the majority of the program disbanded (though members of this group appear in the BMP Advisory Committee meeting minutes as public observers) after the BMP Advisory Committee appointed by the governor began meeting. Interview data suggests that the BMP Advisory Committee did little to change the program designed by the Pinal AMA working group. After the BMP Advisory Committee finalized development of the program, the requirements of the program were incorporated into the Third Management Plan.

6.3 The Water Conservation Best Management Practices Program

The intent of the BMP Program was to create an alternative to the Base Program that is as effective at water conservation, but without restrictions on annual allotments (ADWR 2003). By employing the practices specified under the plan, farms were expected to achieve at least the same level of efficiency as that of Base Program allotments with an 80 percent efficiency requirement.

To join the BMP Program, the owner of an IGFR must submit an application to ADWR showing that the farmed area under the IGFR qualifies for the program, including a map of farming operations detailing the qualifying technologies (ADWR 2001). The farm manager must also specify the BMPs used, and once enrolled, the farm must continue to use the selected BMPs. Owners of multiple IGFRs contained on one farm or in one farming area may simultaneously enter all the IGFR acreage into the program. This allows reduced reporting requirements compared to the Base Program because the Base Program requires reporting for each IGFR. Those farmers leasing land must also submit a statement of approval for BMP Program enrollment from the land owner. Currently, a farmer enrolling in the BMP Program is expected to remain in the program until the end of the Third Management Plan. Any flex credit balance the farm held prior to enrollment is frozen upon BMP program entry. If the farm withdraws from the BMP program or is removed by ADWR for noncompliance (i.e. returns to the Base Program) they retain their previous flex credit balance.

The BMPs in the program fall into four categories. Each category attempts to incorporate a different aspect of water conservation. The first is Water Conveyance System Improvements, and consists of water delivery methods from the irrigation district to the fields. The second is Farm Irrigation Systems, irrigation practices consisting of different slope types, recovery methods, and sprinkler system types. These two categories are physical technologies that must be specified and in place prior to a farm's entry into the program. The remaining categories are management BMPs. Irrigation Water Management consists of educational programs and irrigation scheduling and management processes expected to improve on-farm water efficiency. The Agronomic Management category pertains to management of crops and soils such that they are conducive to efficient irrigation. Practices from these two categories can be interchanged with another in the same category provided that farms submit to ADWR a letter of intent to change practices. Additionally, these categories allow for substitute practices beyond those outlined in the program. These substitutes must be specified by the farm and approved by ADWR prior to enrollment. ADWR must determine that the substitute has water savings equivalent to, or better than, the existing practices in the category.

As noted in Chapter 4, enrollment qualification consists of a tallied point system. Each BMP takes a value of one to three points depending on its perceived effectiveness as a conservative practice. The final point values were determined by the Pinal AMA working group, ADWR, and the BMP Advisory Committee during program design. In order to qualify, a farm must obtain a composite score of ten points. A qualifying farm will have at least two points in the Farm Irrigation System category and one point in each of the other categories. A farm may not accumulate more than three points from any given category toward their total. This ensures that the point totals have some balance across categories for each qualifying farm.

6.4 Water Conservation Best Management Practices Case Study Results

6.4.1 Committee Interview Results

Since the majority of the BMP program was developed prior to the formal formation of the BMP committee, there is limited knowledge of how decisions were made about the initial list of BMPs designed by the Pinal AMA working group.

Interviews reveal that those not involved in the working group viewed the Governor's BMP Advisory Committee as a means to put a seal of approval on the working group's design. Although there were extensive discussions of the proposed BMP program design, very little was changed by the BMP Advisory Committee.

According to interviews, the main goals of committee members were to (1) finalize the program and (2) to balance ADWR goals with a program that was flexible and represented reduced reporting for growers and irrigation districts. The regulatory goal, at least on paper, was to identify and implement practices that would conserve water. As noted previously, several of the working group members were included on the committee or were regular spectators at committee meetings. Respondents reveal that these members were the perceived leaders. They controlled committee discussions and steered the committee to finalize the program.

Several program shortcomings were reported by respondents. First, there was a lack of data for both the Pinal AMA workgroup and the Governor's Advisory BMP Committee on the effectiveness of water management practices. Although the point-scoring system suggests that some practices are more effective than others, especially in the Farm Irrigation Systems category, there was little data available as evidence to support the awarded weight (i.e. points received) for each practice other than "common sense". Secondly, several interviewees mentioned that some of the BMPs can be interpreted differently by regulators and agriculture, or even by different farmers. Even though there were some perceived deficiencies, both ADWR and farmers reported satisfaction with the results of the program and the design process.

6.4.2 Expert Survey Results

The ten expert surveys provide a comparison of *a priori* farm-level use of program practices with the BMP program's requirements. This analysis provides an assessment of the program's potential for water conservation. The surveys were assessed for each expert by category, using the scoring models discussed in Chapter 4. The Agronomic Management and Irrigation Water Management categories are each scored as a sum of the BMPs given an expert score at least that of the assessed sensitivity (80 or 90 percent). The Water Delivery Systems category is scored at 3 points for all experts at 80 percen, and all but one expert at 90 percent, given the experts' opinion about the use of the 'Concrete Ditches' BMP. The Farm Irrigation Systems score is a weighted average of all BMPs, using the program-defined point score as the weight on the expert percentage score for each BMP. The scoring results are summarized in Table 6.1, with full results reported in Appendix 3G.

Only nine of the ten experts provided full input for the water conservation program. Expert 2 only answered for two categories, and scored three points to Water Delivery Systems (the 'Concrete Ditches' BMP) and two points to Agronomic Management at both levels of confidence. Those omitting BMPs from their responses cited a lack of information about specific BMP implementation at the farm level.

Table 6.1: Expert Scoring Summary for Water Conservation BMPs

		Expert									
	BMP Category	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
BMPs Scored at 80 Percent	Agronomic Management	5	2	4	4	2	4	2	5	2	4
	Water Delivery Systems	3	3	3	3	3	3	3	3	3	3
	Farm Irrigation Systems*	2.6	-	2.5	2.8	2.7	2.4	2.6	1.9	3	2.8
	Irrigation Water Management	6	-	0	6	1	0	0	3	1	1
	Sum/Sector Score	16.6	5	9.5	15.8	8.7	9.4	7.6	12.9	9	10.8
BMPs Scored at 90 Percent	Agronomic Management	3	2	4	4	2	0	0	4	1	4
	Water Delivery Systems	3	3	3	3	3	3	0	3	3	3
	Farm Irrigation Systems*	2.6	-	2.5	2.8	2.7	2.4	2.6	1.9	3	2.8
	Irrigation Water Management	3	-	0	2	1	0	0	2	1	1
	Sum/Sector Score	11.6	5	9.5	11.8	8.7	5.4	2.6	10.9	9	10.8

*Farm Irrigation average rounded to nearest tenth.

At the 80 and 90 percent levels, six of the nine responses show that the agricultural sector meets the minimum requirements for all four categories prior to the passage of the regulation. Experts 1, 4, 5, 8, 9, and 10 describe the Arizona farm sector as meeting the program's minimum requirements, with each of these experts showing that more than the minimum was met in several categories. The remaining three expert responses show that minimum requirements for three out of the four categories were met at the 80 percent level. The exception in all three cases was the Irrigation Water Management category.

A composite sector score (Table 6.1) was developed from the scoring models from each category, suggesting each expert's expectation of agricultural sector program compliance at program implementation. This takes the form: If $BMP_{i,j,k} \geq 80\%$ then $x_{i,j,k}$=1, otherwise $x_{i,j,k}$=0, and $\sum_{i=1}^{n} x_i + \sum_{j=1}^{n} x_j + \sum_{k=1}^{n} BMP_k x_k + \sum_{l=1}^{n} BMP_l x_l$, where *i, j, k,* and *l* represent the Agronomic Management, Irrigation Water Management, Water Delivery Systems, and Farm Irrigation Systems categories, respectively. Note that the weight

BMP_k takes a value of three points due to the widespread implementation of concrete ditches as discussed in Chapter 4. Also recall that x_l is the weight attributed to the score of the l^{th} BMP in the Farm Irrigation Systems category, as these values range from one to three points.

This composite score indicates that four of the nine experts (experts 1, 4, 8, and 10) believe the agricultural sector met the requirements of the BMP program without any changes in water management (at both levels of confidence). At the 80 percent level, three additional experts' composite scores are within one point (experts 3, 6, and 9) and one (expert 5) is within two points of the required ten points for program implementation. At the 90 percent level, three experts (3, 5, and 9) show agriculture within two points of meeting program requirements.

There were several BMPs that received high scores from most experts. In the Agronomic Management category, 'Crop Rotation', 'Residue Management', 'Surface Conditioning', and 'Shaping of Bed or Furrow' were all consistently scored high. For Irrigation Water Management, the 'Laser Touch-Up' and 'Alternate Row Irrigation' received high scores. However, some experts identified several common practices that are used but the BMP definition requires stricter practice than is usually observed. These include 'Soil Moisture Monitoring', for which farmers generally use a "feel method" (if the soil is moist, no need to irrigate), and 'Flow Rate Measurement', which irrigators generally are skilled at determining through practice, using an "eyeball method". The BMP definitions specify using a device or strict measuring. ADWR personnel reported being willing to accept the "feel method" as acceptable, if the farm was consistent in irrigation practices over time. Thus, the experts may have expected lower qualification for these BMPs than the scoring a farm might receive on a program application (depending on the farm's level of communication with ADWR). As noted, in the Water Deliveries category the 'Concrete Ditch' BMP was identified at 90 percent of farms or higher for all but one expert. In the Farm Irrigation Systems category, most respondents reported a combination of 'Near Level Systems' and 'Level Systems' at 60 percent or greater (these receive 2.5 and 3 points, respectively). There was much confusion among experts concerning this particular category. Several experts believe that most fields are engineered so the fields can fit into 'Level Systems' or 'Near Level Systems' BMPs and another of the 'Uniform Slope' BMPs in the category. ADWR, however, will not allow any field to apply to more than one BMP in this category. The BMP definitions provided by ADWR may not adequately differentiate the BMPs, and provide the basis for this confusion.

Again this evidence suggests that most farms were at or near the requirements of the BMP program before the program was implemented. The BMP program was designed such that farmer compliance was inexpensive (low or no cost), and nearly universal.

6.5 Survey and Interview Interpretation

The behind-the-scenes development of most of the water conservation BMP program precludes, for most part, discovering participants' perceptions of BMP program design decisions. The rule development by the Pinal AMA working group has little historical background and meeting minutes for this group are limited to the time period after the fourth letter agreement. In addition, all interview participants present at those early meetings claimed a balanced approach between ADWR and farmers, although farmers were relied on for providing information on whether practices could be feasibly implemented on farms. Despite the limited program design information, expert surveys are substantial evidence that agriculture had a predominant role during the water conservation BMP program design. The BMP program, according to expert opinion, includes existing on-farm practices for most farms in Central Arizona. This result indicates that agricultural interests enjoyed significant bargaining power during the negotiation and design process. There should be low expectations about the ability of this program to produce any water savings in the agricultural sector.

One possible consequence of the BMP program is an increase in water use by enrolled farms. Farms that failed to meet Base Program requirements, or were burdened by Base Program reporting requirements, are likely adopters of the BMP program. However, once under the wing of the BMP program, farms are free to use any amount they need as long as they meet program requirements. This means that crops with higher consumptive use (e.g. alfalfa) can replace existing crops, driving on-farm water use upward. The Governor's BMP Advisory Committee discussed this possibility, but reached the consensus that efficient users are aware of their costs and will work to decrease their water costs (i.e. decrease usage). As the program was expected to document efficiency, the committee concluded that enrollees were proving their efficiency, and thus their capacity for conservation. Most interviewees stated that if farms adopt, it proves that the farms are efficient at using water, as the approved practices are efficient practices. However, efficiency in water use does not imply conservation; conservation means that farmers use less water over time, effectively becoming more efficient users. Some respondents used the terms 'efficiency' and 'conservation' interchangeably. Thus far, ADWR has found that some farms have increased their water use, some decreased, and some stayed stable. However, it is not clear that this change in water use can be attributed to participation in the BMP program.

In addition, the program initially had a high enrollment rate, which has declined to very few new enrollees. This indicates that the program was popular among farmers who needed its reduced reporting requirements or water flexibility. The agricultural sector now has two water conservation programs to choose from, and farmers will be expected to adopt the program most appropriate to the farm and its operating conditions. This "*à la carte*" program choice indicates that there were gains acquired for Arizona's agricultural sector through negotiation, specifically for farmers who needed the flexibility associated with adoption. Again, this could potentially result in increased water use across the sector.

Returning to the conceptual models, it is clear that agriculture orchestrated a negotiated outcome in their favor (close to point M in figure 3.2). The negotiated agreement contains a number of BMPs existing on Central Arizona farms. This result points to a low-cost program in terms of adoption requirements, which places A's negotiated gains near the 'northwest' corner of the ZOPA.

The regulator in this case had the existing Base Program as a BATNA. Water conservation associated with the approved BMP practices was unknown during program design due to a lack of data. This indicates an unclear bargaining position from the regulator's standpoint; ADWR could not calculate BMP water savings or compare expected potential conservation derived from each program (Base and BMP) before negotiations. Without data, there was no way for ADWR to determine whether negotiations would be beneficial when pursuing a BMP program. Long term effects of the BMP program are not known yet, and the program is currently in an evaluation stage (Hanrahan). There are three possible scenarios for the regulator's negotiated outcome, which can only be determined after years of collecting water usage data (Figure 3.2): (1) If there is an equivalent water savings and agency expense associated with the BMP program as the Base Program, then the negotiated agreement was purely for the benefit of agricultural producers (point M). (2) If there is a continued water savings associated with the BMP program, the regulator may have negotiated an agreement within the ZOPA (somewhere between points M and O on the NPP). Reduced reporting requirements may also provide some benefit to the regulator, and ongoing program evaluation and revision may correct program deficiencies, allowing for this result. (3) The outcome may be lower for R than the BATNA (r) if there is less conservation associated with the BMP program than the Base Program in the long run (enough to offset any reporting benefits derived by the regulator). This raises the concern that R may have negotiated an inefficient agreement (somewhere between *r* and 0 on the NPP curve), indicating a cost to society in terms of increased water use at a statewide level. If farms do use more water under the BMP program, then one of the key criteria of the program, to be at least as efficient as the Base Program requirements, does not hold. In any of these cases, expert survey results make it clear that $k>h$ (Figure 3.3), and the resulting outcome lies 'northward' of A's BATNA and 'west' of point O on the NPP.

The expert surveys also indicate that a low-slope or nearly horizontal damage/safeguard relationship resulted from the negotiation (Figure 3.4). However, the historic water use requirements and high flex credit balance associated with the Base Program suggest that this was likely the case already. Many farms in Arizona were maintaining operations below the Base Program's required water use level, thus banking flex credits. The damage function represents the relationship between water use and the level of safeguarding, or conservation effort, applied by the state. Under the Base Program, this function was near a natural level that would have existed without regulation. The question concerning the negotiated damage function for the BMP program is whether it is an improvement from the Base Program. If very little or no environmental improvement occurs, the BMP program comes at a net cost to society given the time and effort expended on developing, supporting, and evaluating the program. If environmental conditions decline (e.g. higher water use), then an increase in damages occurs, shifting $D(T_{BMP})$ upward in the BMP model. Even if the BMP program is found to have more water conservation than the Base program, it doesn't hold that an efficient program was negotiated. Given the expert survey results, the damage function has only a slight downward slope at best and provides a corner solution, where T_{BMP}* is at or near zero. As the optimal level of BMP implementation is zero after the negotiation is complete (as damages remain mostly unchanged), designing and enforcing the program comes at a net cost to society.

CHAPTER 7: SUMMARY AND CONCLUSIONS

7.1 Research Summary

Best management practices (BMPs) have emerged as a popular way to control environmental externalities created by agricultural sources. Regulators, agricultural producers, experts, and public interests convene in committees to design BMP programs. This design process is representative of a mutual gains negotiation, as the committees are composed of competing interests and work to find an agreeable solution to the environmental problem. In program design, the committee develops a set of practices that are each expected to help control an environmental problem and are collectively intended to account for farm heterogeneity. In addition, the committees establish the adoption and qualification requirements by which regulated producers must abide. BMPs are a popular political tool since they are flexible and involve multiple stakeholders in the committee. In this thesis, I tested the assumption that rule design affords participants the opportunity to take advantage of bargaining power and direct the negotiated outcomes in their favor. As the outcomes are the control strategies imposed by the rule, the end result is potentially an ineffective rule.

Two case study BMP programs developed in Arizona were evaluated to determine 1) how committee participants influence the decision making process, and 2) expectations for the program's environmental effectiveness. The first case, the Agricultural PM_{10} Best Management Practices program, was implemented in 2001 to control emissions of particulate matter (dust) from agricultural sources in the Maricopa County nonattainment area. The second case, the Agricultural Water Conservation Best

Management Program, was created in 2002 as an alternative to Arizona's existing Base Program's water conservation regulations. The intended effects of the water conservation program included flexibility for producers and equivalent or better water savings than the Base Program.

The case studies synthesized data and information from several sources. First, historic documents and literature reviews allow an understanding of the framework for negotiation, expectations for BMP programs, and background histories for each of the programs studied. Secondly, for theoretical support to this study, four economic conceptual models were developed from existing literature on bargaining. The models represent the decisions to use BMPs (a decision-tree analysis), the negotiating process (the mutual gains model), the importance of bargaining power (Nash's cooperative solution), and expected environmental impacts (a damage/safeguard model). Third, program committee members were interviewed to determine participant behaviors, sources of bargaining power, and the committee's organization and goals. Each participant received an identical set of focused interview questions and their responses were evaluated using qualitative grouping methods. Fourth, a group of experts with extensive knowledge of agricultural operations in Central Arizona were asked to provide an estimated percentage of agriculture that qualified for each BMP prior to program implementation. Scoring models for the expert surveys provide an impact analysis for each program, indirectly discovering the program's environmental effectiveness by directly identifying the changes that occurred on farms following program implementation.

This research approach determines program outcomes from three important angles. First, the participant interviews provide a perspective of what happened prior to the rule taking effect and how the rule was influenced. Second, the expert surveys provide an after-the-fact evaluation of the rule's effectiveness, which is further evidence for any influences on the rule. Finally, the economic models provide a framework for understanding the breadth of possible results. When the data from the interviews and surveys is applied to these conceptual models, the potential for negotiated outcomes that favor one specific interest or group becomes very clear.

7.2 Summary of Findings

Both BMP program case studies produced similar results. In each case, the programs resulted in regulatory practices that were already implemented on farms before the regulation went into effect, to a degree that many farms would likely qualify before program enrollment.

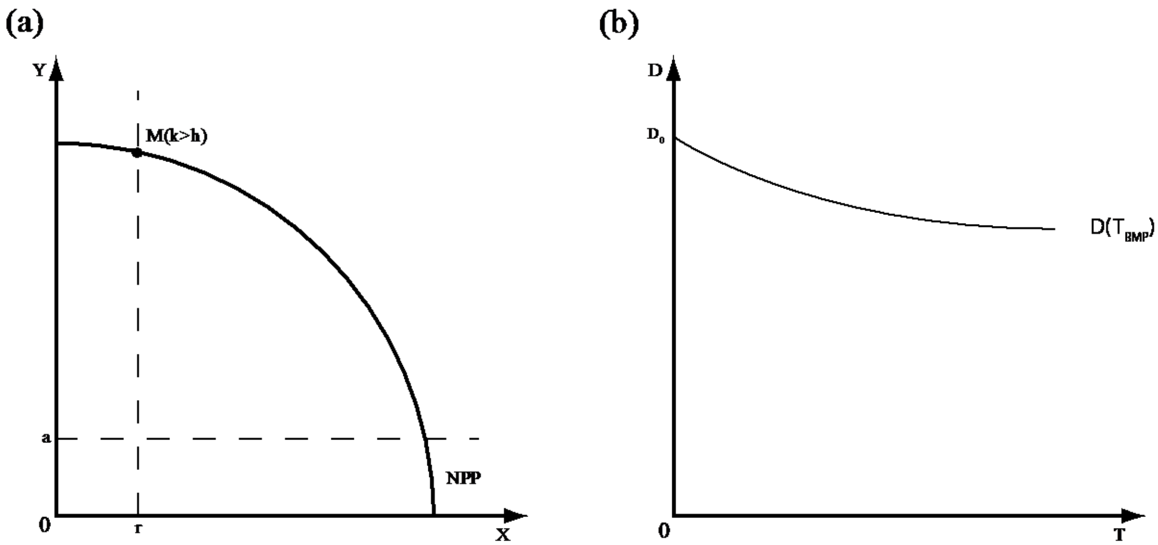
How does this happen? The source of this regulatory failure begins with the legislation that specified BMP committee composition. In both cases, agricultural parties were largely responsible for writing and establishing the legislation. The legislation established committee membership and gave agriculture a strong bargaining position, by numbers alone, from the start. Additionally, interview data reveals that the committee deliberations highly favored agriculture. The agricultural members were in control of discussions (both committees elected agricultural parties as committee chair). Regulators were identified as facilitators rather than stakeholders by other committee members, an undesirable result from a regulatory standpoint (see Wondolleck and Ryan, Chapter 2).

Regulators also did not have clearly stated goals from the outset. In both cases, a regulatory BATNA was not clearly established. In the PM_{10} case, the regulator's BATNA was a FIP, but no steps had been taken to define the FIP. In the water conservation program, the Base Program was the BATNA, but it had already proven widely ineffective. Both programs also lacked data to support the effectiveness of the BMPs. Without information, agricultural parties were relied on as experts in committee deliberations (in terms of whether specific practices were feasible) and other experts simply offered sound advice.

Expert surveys indicate that a number of BMPs in each case study were widely implemented on farms in Pinal, Pima, and Maricopa Counties, and most farms likely qualified for the program prior to enrolling. As very little was done to control the environmental problem, the resources spent on developing and maintaining the programs come at a net cost to society. While this result is not strictly quantifiable, all of the data lead to this conclusion.

The negotiating conditions produced a one-sided outcome and the data indicates general results for the conceptual bargaining models. First, the agricultural party (A) enjoyed significant bargaining power (Figures 3.2 and 3.3). If the assumptions for the models hold, this means that $k>h$, where k and h are the bargaining abilities of A and the regulatory party (R), respectively, and that the negotiation outcome is very close to R's BATNA (r) (Figure 7.1 (a)). The end result is an agreement near point M on the NPP curve. Since r was not well defined in either case, it is possible that r is close to zero.

Figure 7.1: BMP Negotiation Results



In terms of the decision tree analysis (see Figure 3.1), R should have determined that using BMPs would be more profitable to society than any other control method before engaging in the negotiated BMPs. However, agreeing to use BMPs also means that as far as damage controls are concerned, the regulator starts with an 'empty slate'. Each BMP included in a program imposes some level of control on an adopting farm (but this may change from farm to farm). Program effectiveness is also determined by the number of BMPs required for farm enrollment and the program's guidelines. Thus, the more effective the collective set of BMPs and the mandates for adoption, the better the program controls the problem. All of these program features are part of the negotiation. This means the regulator is essentially negotiating the shape of the damage/safeguard relationship (Figure 7.1 (b)). The damage function $D(T_{BMP})$ is a horizontal line (set at D_0)

when entering the negotiation, and the regulator attempts to adjust the $D(T_{BMP})$ curve downward until a suitable agreement is reached. In both case studies, the regulator negotiated, at very best, a $D(T_{BMP})$ curve that had only a slight downward slope. This occurs not because the BMPs included in the program were ineffective at controlling the problem, but rather because many of the regulated farms qualified for the program (or some portions of the program) at enrollment.

7.3 Lessons Learned and Thoughts for BMP Program Design

On one hand, Arizona's agricultural community can be applauded for their ability to protect their own interests and for their political savvy. On the other hand, Arizona's regulators can be criticized for spending the state's resources to develop regulatory programs that come with little or no benefit to society. Ultimately, program requirements and effectiveness are the responsibility of the regulator. The regulator acts on behalf of the public, working to include all interests in regulatory decision making. Although agriculture and public interests may be represented on committees, agency welfare depends on how these interests are affected. If a program is too lenient, and little environmental change takes place, the agency faces increased public pressures. However, if regulated parties find the rule too stringent or unjustified, regulators will face lawsuit or political pressure. No matter the outcome from a BMP negotiation, the regulator faces the music both during rule design and after the rule goes into effect, as regulator participation provides agency endorsement of the rule. Here, lessons learned from this research are offered to the future regulator seeking advice for BMP program design.

A. Establish Committee Guidelines at State or Agency Level

BMP program development can be viewed as a special case of reg-neg, the federally designed process defined in the Negotiated Rulemaking Act (NRA) of 1990. However, BMP programs are typically implemented at the state level and committees are required to follow state guidelines, rather than these federal standards, for rule development.

In Arizona, BMP committees may not be as closely scrutinized or carefully considered as the federal process. In federal rulemaking, a proposed committee must be reviewed and approved by an outside federal agency, the General Services Administration. For BMP programs, the committee appointments are specified by legislation and finalized by the Governor in accordance with the legislation's requirements. In both case studies, I found that agriculture was instrumental in writing the legislation and pushing it through the legislative process. Without a formal state process to review and approve committee membership, agricultural interests were able to establish a strong bargaining position before the committees even convened.

Without reg-neg guidelines incorporated into state law, process direction is only available if agency personnel are willing to research and provide negotiating materials. Interviews showed that there was little awareness, by regulatory parties or otherwise, of the Negotiated Rulemaking Act or its mandates. Any understanding of the negotiation process may give regulators a better grasp of what is required to accomplish agency goals. If state agencies are going to engage in negotiated processes, the state, or the agency itself, should develop guidelines similar to the NRA. This ensures consistency in committee processes, an equitable negotiation environment, and it prevents affected parties (i.e. agriculture) from defining the scope and definition of the process through legislative (or other) means.

Regulatory representatives in the negotiation have to realize that they face a complicated task. They are charged with representing their agency as a decision-maker, building relationships, leading and facilitating the process, and supporting decisions. They are also accountable for the final rule. As a result, some guidelines for negotiation must be established before engaging in the process. The remaining suggestions for BMP process improvement consist of ideas that can be incorporated into negotiated program guidelines of this sort.

B. Ensure BMPs are a Feasible Problem Approach

Looking at the decision tree (Figure 3.1), regulators must decide that $R_1 > R_3, R_4$ when they decide whether to pursue BMPs. A benefit cost analysis must be performed (involving at least an estimated benefit for BMP-based regulation) before engaging in the BMP process. This means the agency must define an alternative or set of alternatives (thereby establishing a BATNA) and compare them to the scope of possible BMP agreements. Given farm heterogeneity and the wide range of BMPs that will be available to the committee, regulators should establish some minimum criteria for an acceptable BMP program during prenegotiation (based on a better overall benefit than potential alternatives), and ensure agency representatives are aware and supportive of this goal. If BMPs are preferred, regulators should also very clearly define the mandates that will be imposed on regulated parties if negotiations fail. This is essentially establishing a well-defined BATNA.

B. Identify and Include All Relevant Interests

One important guideline defined in the NRA is including all relevant interests in negotiating committees. The BMP committees in each of the case studies seem to lack a full set of relevant interests, and interviews provided potential interests that may have been missing from the process. For the PM_{10} program, the Arizona Center for Law in the Public Interest (ACLPI) was highly active in SIP development. ACLPI sued over the EPA approval of the SIP, and also brought commentary and lawsuit over the BMP general permit. Thus, ACLPI was a relevant interest in BMP design. Similarly, the Natural Resource Conservation Service (NRCS), although a federal agency, was a relevant interest in the water conservation program. The NRCS is responsible for administrating federal funding for on-farm irrigation improvements through EQIP. This is an important factor, considering that the BMP program focuses on improving water efficiencies through management and technologies. NRCS field staff members are highly knowledgeable about irrigation practices. Although NRCS information was utilized during the design process, NRCS staff members were not directly involved in program design.

In the case studies, regulators also relied on agriculture as experts during the negotiation. While they are the true experts for understanding the costs of the agreement, they also are protective of this information. Outside experts, that have an understanding of farm costs and operating practices, must be engaged in the process.

Overall, the regulators must work to establish a committee that is allows participation by all affected interests and develops the information sharing as best as possible. In future BMP cases, the agency should consider these points to develop a more balanced committee, and more equitable outcome.

C. Establish the Agency's Stake, Program Goals, and a Leadership Role

During negotiation, the regulatory participant must define the stake that the agency has in the negotiation. Clear goals need to be stated for both program expectations and resulting environmental conditions. BMP programs should 1) encourage farmers to adopt economically feasible practices and 2) reach the overall objective (Leathers). To achieve this, the objective must be defined at the outset. Also, the most important thing for BMP committees to keep in mind is the problem they are controlling for (Murphy). If the negotiated rule is to result in potential improvements, the regulator needs to set a goal and help move the negotiations toward that goal.

Additionally, Wondolleck and Ryan specify that the regulator needs to accept the role of leader over facilitator. In the PM_{10} committee interviews, several parties identified the major role of the regulators as facilitators in rule development. Wondolleck and Ryan warn that this can reduce the ability of the regulator to bargain. In both case studies agricultural interests directed the course of negotiations and acted as committee leadership, even with regulators present. The agencies were clearly involved, but it was agriculture in the driver's seat. In order to reach an established goal, agency participants have to direct the process, even if they are also charged with providing administrative. If facilitators are necessary, the agency should establish additional personnel or use a facilitator from outside the agency. As a leader, it is the regulator's job to ensure that the environmental goals are clearly established and to reach an agreement that is acceptable to the agency from an overall social perspective.

D. Develop Methods for Quantifying BMPs and Collecting Data

Before engaging in the negotiation process, the agency must develop a research process to determine the effectiveness of practices, and begin collecting data. Regulators must invest in data collection and examination, even if in a controlled or theoretic setting. In both case study instances, data limitations presented an obstacle for determining the environmental effectiveness of specific practices. There must be some means to determine the potential effectiveness of a program in order to know if the program is a feasible course of action (refer back to the discussion of cost-benefit analysis). Regulators should perceive that there is little incentive to engage in a program if they cannot determine that the program will generate some benefits.

In addition, the agency needs to require committees to build data collection and research methods into the program. Some authors suggest evolving BMP programs where the BMPs and the program are constantly revisited through research and performance measurement (Ice). The executive order that initiated the water conservation program contains wording that specifies ongoing research of this nature, but as of this writing, these measures are still being developed. In order to justify the program is working toward environmental improvement, committees need to establish a means to show that approved BMPs work. The committee should establish and support research to prove BMP effectiveness and adjust the program when findings reveal the need to amend particular BMPs or guidelines. Regulators should require committees to identify evaluation methods and monitoring criteria that will continuously refine the program and determine its effectiveness.

E. Research and Understand Agriculture

On the surface, it appears that regulators face a great deal of heterogeneity when developing a program. This is true, but this research finds that many on-farm practices are almost universal in their application. It was evident that PM_{10} researchers developed expected BMP performance research without realizing this (Appendix 5).

On one hand, it stands to reason that cost effective farming entails using many practices that are environmentally friendly. For example, reducing the number of tillage passes reduces labor requirements and fuel costs, and installing concrete ditches reduces the amount of water that leaches into groundwater. These are practices that could be considered effective at improving environmental quality. On the other hand, however, farms will utilize these practices regardless of whether a program exists, so including them in a program does nothing to increase the program's effectiveness in controlling the environmental problem. Allowing them in the program lets farms automatically qualify for part, if not all, of the program.

In order to develop a reasonable program, the regulators must become familiar with the composition of the agricultural sector they are regulating, to avoid passing regulations that are highly inclusive of common practices. If the stated goal of the BMP program is to control an environmental problem, it hardly makes sense to add these practices to the program. If they are included in program criteria, the only way to ensure improvement is to require that farms implement something new.

Understanding agriculture also includes understanding the costs that will be imposed by the program. Agriculture will face a variety of costs with BMPs. Recall that BMPs can be either technologies or management methods. With technologies, there are costs associated with investment in physical capital, as well as training and education concerning the newly implemented technology. With management methods, training and education will also be required. The regulator must understand agriculture to avoid concentrating on practices that are simply not feasible, or are too costly to implement.

Understanding agriculture will allow regulators to avoid using the agricultural parties as experts, and to save time overall. One means to achieve this is to utilize an interagency approach, incorporating a variety of experts from other agencies and the public sector that may better understand agriculture than the agency (this relates to including relevant interests). This will improve the flow of information and the knowledge base of both the agency and the committee. These experts should be consulted both before and during the negotiation process.

7.4 Potential Improvements and Suggestions for Future Research

One important future research project would include developing a set of criteria, or design standard, for BMP program evaluations. In order to guarantee that BMP programs work, it is important to establish multi-disciplinary, multi-agency teams that can evaluate the control efficiencies of different practices and their relative costs and benefits (See Centner, et al, and Murphy). Results of these efficiency studies would be required to evaluate an entire program or to compare a program to alternatives.

Individual program evaluations are also important pieces of research. For any existing or developing BMP program, evaluations will prove tremendously beneficial to regulators. While it would be most appropriate to engage in this research prior to rule implementation, these studies can also improve existing BMP programs. Determining what practices actually work and how well they perform should be at the front of all parties' minds when developing these programs. By creating mechanisms for evaluation, negotiation participants will have a more uniform understanding of program costs and benefits.

The research I have offered cannot be extended to full generalizations about BMP programs because they only represent BMPs used in Arizona. It would be interesting to see similar studies in other regions of the U.S., to determine if agriculture takes a similar role and leads the charge in program development. So, similar studies carried out in other regions within the U.S. could help develop a sense of the extent to which these results take place.

A better analysis of how BMP programs are developed and who holds bargaining power could be conducted by a researcher willing to participate (as a member of the public) and view the process firsthand. At the same time, it could be easier to collect much-needed *a priori* farm-level implementation data if gathered prior to initiation of a BMP program. One drawback to qualitative program evaluation is that it generally takes place after the program is developed. Such is the case here. A study that captures data beforehand and follows the process directly may have more insight than a study five year after the fact.

7.5 Concluding Thoughts

Although BMP programs have been around, in concept at least, for nearly four decades, there clearly remains work to be done to achieve the results that early researchers thought the programs would provide. The programs reviewed here resulted in unbalanced outcomes, and will require quite a bit of face-lifting before they are shown to be effective, if they even achieve that end. It seems a lofty goal for now, given the results of this study. They continue to require a great deal of the state's resources in redesign, research, and support. This is not to say that BMP programs are all bad either. In both cases studied, committee members reported that they gained insight about other participants' positions and motives, and better understanding of agricultural or regulatory processes. Even so, with results in hand it is clear that the net cost to society is too great to justify improved relationships and a better perception of opposing parties as the major benefit from the design process. Although these programs are politically popular, they must also be effective enough to justify their use, a condition that clearly has not been met in Arizona's programs.

This body of work should provide a lesson and a bit of background for regulators who engage in a similar process in the future. Future BMP programs must take more into account and provide a more desirable outcome from a regulatory standpoint. When reflecting on the evidence in this body of work, the question that remains is whether that is at all possible.

APPENDICES

APPENDIX 1: Best Management Practices Committees

1A: Agricultural Best Management Practices Advisory Committee (PM_{10})

Representative For:	**Appointee:**
Air Quality Division Director, Arizona Department of Environmental Quality	Wrona, Nancy (Designee)*
Dean, College of Agriculture and Life Sciences, University of Arizona	Kaltenbach, Colin (Designee)
State Director of U.S. Natural Resource Conservation Service	Somerville, Michael
Soil Taxonomist, University of Arizona	Walworth, James L.
Alfalfa Producer	Accomazzo, Wade T.
Citrus Producer	Lopez, Alfred V.
Cotton Producer	Rogers, Kevin G.
Grain Producer	Thelander, Dan**
Vegetable Producer	Rousseau, Will

Source: Governor's Appointments of State Officials and Members of Boards and Commissions
*Designee indicates committee member replaces official governor's appointment.
**Indicates committee chair

APPENDIX 1: Best Management Practices Committees

1B: Ad-Hoc Agricultural PM_{10} Technical Advisory Committee

Representative For:	Appointee:
Arizona Department of Environmental Quality	DeNee, Phil Rodgers, Ross Sedlacek, Randy
U.S. Environmental Protection Agency, Region IX	McKaughan, Colleen Ungvarsky, John
College of Agriculture and Life Sciences, University of Arizona	Coates, Wayne Kaltenbach, Colin Walworth, James L.
U.S. Natural Resource Conservation Service	Camp, Phil Schmidt, Jeff*
Agricultural Research Service	Adamsen, Floyd
University of Arizona Cooperative Extension	Farlin, Stan
Arizona Farm Bureau Federation	Klinker, Jim
Arizona Cotton Growers Association	Lavis, Rick
Western Growers Association	Giclas, Hank
Cotton Producer	Rogers, Kevin G.

Source: Guide to Agricultural PM_{10} Best Management Practices
*Indicates committee chair

APPENDIX 1: Best Management Practices Committees

1C: Agricultural Water Conservation Best Management Practices Advisory Committee

Representative For:	Appointee:
Director of Arizona Department of Water Resources	Kimberlin, Dennis+ (Designee)**
Director of Arizona Department of Agriculture	Brett Cameron (Designee)
Director of USDA's Water Conservation Laboratory*	Clemmens, Bert
Municipality Representative (Phoenix AMA)	McCain, John R. (Bob)
Agricultural Improvement District Representative	Sullivan, John
Irrigation District Representative (Phoenix AMA)	Ashby, Stanley H.
Irrigation District Representative (Pinal AMA)	Ward, Grant R.
Agricultural Producer (Pinal AMA)	Hartman, Bryan M.
Agricultural Producer (Pinal AMA)	Riggins, Scott***
Agricultural Producer (Pima AMA)	Wong, Ron
Agricultural Producer	Rayner, Ronald F.

Source: Governor's Appointments of State Officials and Members of Boards and Commissions
*Additional Source: ADWR Annual Report
**Designee indicates committee member replaces official governor's appointment.
***Indicates committee chair
+Replaced by Michael Hanrahan

APPENDIX 2: Best Management Practices

2A: PM_{10} Best Management Practices by Category

A. Tillage and Harvest

- Chemical Irrigation: application of fertilizers, pesticides, or other agricultural chemicals to cropland through irrigation systems.
- Combining Tractor Operations: performing two or more operations, for tillage, harvesting, planting, or cultivation, in a single tractor or harvester pass.
- Equipment Modification: modifying agricultural equipment with shields, deflectors, dust shrouds, or spray bars to reduce dust emissions.
- Limited Activity During a High Wind Event: performing no tillage or soil preparation when on-site wind speed measured at six feet above ground is in excess of 25 mph.
- Multi-Year Crop: crops that are grown continuously for more than one year.
- Planting Based on Soil Moisture: water is applied to soil prior to planting.
- Reduced Harvest Activity: reducing the number of passes when using mechanical means to cut and harvest crops.
- Reduced Tillage System: reducing the number of times tillage is performed for crop production.
- Tillage Based on Soil Moisture: water is applied to soil before or during tillage operation, or tilling immediately after a precipitation event.
- Timing of a Tillage Operation: performing tillage operations at times that will limit PM_{10} generation from soil.

B. Non-Cropland

- Access Restriction: using signs or physical obstructions to prevent public access to non-cropland areas.
- Aggregate Cover: using gravel, concrete, recycled road base or similar material to cover non-cropland.
- Artificial Wind Barrier: creating a physical barrier to the wind.
- Critical Area Planting: planting or allowing trees, grasses, shrubs, or other vegetative cover on non-cropland.
- Manure Application: incorporating animal waste or biosolids into the soil surface.
- Reduce Vehicle Speed: limiting farm vehicles to less than 20 mph on unpaved farm roads.
- Synthetic Particulate Suppressant: applying a manufactured product to soils to control PM_{10} emissions.
- Track-Out Control System: installing a system to remove mud and soil from farm equipment tires before entering public paved roads.

APPENDIX 2: Best Management Practices

2A: PM_{10} Best Management Practices by Category

B. Non-Cropland (continued)

- Tree, Shrub, or Windbreak Planting: planting and maintaining a vegetative wind barrier.
- Watering: applying water to non-cropland.

C. Cropland

- Artificial Wind Barrier: constructing an artificial barrier device to impede winds.
- Cover Crop: plants that are grown between crops and protect or improve soils.
- Cross Wind Ridges: tilling such that ridges remain, recommended perpendicular to prevailing wind direction.
- Cross Wind Strip Cropping: planting strips of alternating crops in the same field.
- Cross Wind Vegetative Strips: vegetative cover crop applied in at least one strip on a field.
- Manure Application: applying animal waste or biosolids.
- Mulching: applying plant material produced offsite to soils.
- Multi-Year Crop: crops that are, or will be, grown continually for more than one year.
- Permanent Cover: vegetative cover that remains long term on non-producing cropland.
- Planting Based on Soil Moisture: applying water to soil prior to planting operations.
- Residue Management: maintaining crop and other residues, with managed distribution of residue on soil surface.
- Sequential Cropping: growing crops in sequence, such that soil is exposed for minimal periods of time.
- Surface Roughening: roughening soil surface by tilling such that clods form.
- Tree, Shrub, or Windbreak Planting: planting and maintaining a vegetative wind barrier on fields.

APPENDIX 2: Best Management Practices

2B: Water Conservation Best Management Practices and Point Scoring

A. Water Conveyance System Improvements

Farms may accrue up to three points for these systems, depending on the percent of irrigated acreage on the farm that uses the practice. There must be a minimum of 50 percent of acreage receiving water by any combination of the distribution methods in order to qualify for the program in this category. At 50 to 54 percent acreage, the farm qualifies for one point. Increments of 0.2 points are added to the farm's score for each additional 5 percent increase in the percent of acreage covered by the practice, such that 55 to 59 percent receives a 1.2 score, 60 to 64 percent receives a score of 1.4, and so forth. A maximum of three points is awarded if 100 percent of irrigated acreage is covered by the delivery method. When multiple delivery methods are reported for this category, no single acre may be reported twice in the scoring calculation, such that no more than 100 percent of irrigated acreage may be accounted for in the total category score.

- Concrete-Lined Ditch: The use of concrete ditches to transport water to fields in order to minimize the loss of water to seepage.
- Pipelines: The use of PVC, ABS, concrete, aluminum, or steel pipes to transport water to a field, reducing water loss. May be high or low pressure.
- Drainback System: This technology uses level systems which are designed and maintained to transport excess water from one irrigated field to another through use of channels.

B. Farm Irrigation Systems

For this category, farms can combine processes toward their cumulative point total, depending on the total acreage applicable to each practice. The BMPs 'slope systems without uniform grades with tailwater reuse' and 'uniform slope systems without tailwater reuse' each earn a total of one point. The remaining field types receive a score of two points, with the exception of 'near level systems' and 'level systems', which receive point scores of two and a half and three, respectively. For sprinklers, high pressure systems accumulate two points, low pressure systems three points, and trickle irrigation systems receive three points as well.

- Slope Systems without Uniform Grades with Tailwater Reuse: These are fields that are sloped, but the slope is not uniform, and the fields have a system in place to capture and reuse the water that comes off the field following an irrigation event.

APPENDIX 2: Best Management Practices

2B: Water Conservation Best Management Practices and Point Scoring

B. Farm Irrigation Systems (continued)

- Uniform Slope Systems without Tailwater Reuse: These are fields that have been engineered to have an even, uniform slope, with no recovery system in place to capture and reuse water.
- Uniform Slope Systems with Tailwater Reuse: These are fields that have a uniform slope and have a system in place to capture and reuse water that comes off the field following an irrigation event.
- Uniform Slope within an Irrigation District that Captures and Redistributes Return Flows: These are uniform-sloped fields that are engineered to allow the irrigation district to recover and reuse water coming off the field following irrigation, returning the collected water to another field.
- Modified Slope Systems: These are fields engineered with changing slope in order to retain irrigation water on the field. The fields have uniform grades in the upper portion, with a slope that represents 0.0 to 0.2 feet of total fall in the direction of irrigation over the bottom portion of the field.
- Near Level Systems: These fields are sloped to a total fall of 0.2 to 0.5 feet for the entire length of the field, with uniformed grades. All irrigation water is retained on the field.
- Level Systems: Fields that are sloped to a total fall of 0.0 to 0.2 feet across the length of the field, again with uniform grades. All irrigation water is retained on the field.
- High Pressure Sprinkler System: Systems that run at a mainline pressure of 10 pounds per square inch or more, generally of side-roll, linear, center-pivot, or solid set design.
- Low Pressure Sprinkler System: Systems that run at no greater than 10 pounds per square inch mainline pressure, including linear or center-pivot.
- Trickle Irrigation System: Drip irrigation systems that are used to apply water to crops at the root of plants with precision.

C. Irrigation Water Management

Each of these practices is worth one point toward the total points to qualify for the program. At least one and no more than three of the practices may be counted toward the point total.

- Laser Touch-Up: A minimum of 20 percent of near-level and level irrigated acreage must be touched up each year, using precision laser leveling.

APPENDIX 2: Best Management Practices

2B: Water Conservation Best Management Practices and Point Scoring

C. Irrigation Water Management (continued)

- Alternate Row Irrigation: Every other cultivated row is irrigated to minimize water application. This must be done during at least one irrigation event annually, on a minimum of 20 percent of irrigated acreage.
- Furrow Checks: Devices are placed in the row to raise in-row water levels. The practice must be applied during at least one irrigation event annually, on a minimum of 20 percent of irrigated acreage.
- Angled Rows/Contour Farming: On at least 20 percent of irrigated acreage annually, rows are angled or contoured to increase infiltration rates and minimize tailwater.
- Surge Irrigation: Applying water in surges or pulses in lieu of a continuous flow. This technique must be used on at least 20 percent of irrigated acreage annually.
- Temporary Sprinklers: Applying water for pre-irrigation, germination, or pre-harvest irrigation with use of sprinklers. Must occur on at least 20 percent of irrigated acreage annually.
- Participation in Educational Irrigation Water Management Program: Enrollment in ADWR or private water management programs that focus on irrigation management.
- Participation in a Consultant or Irrigation District Sponsored Irrigation Scheduling Service: Enrollment in ADWR or consultant service which provides advice pertaining to irrigation management and scheduling based on soil moisture or evapotranspiration.
- Participation in an Irrigation District Program to Increase the Flexibility of Water Deliveries: Enrollment in an irrigation district program which provides water order guidelines for the district.
- Measure Flow Rates to Determine the Amount of Water Applied: Measuring flow rates to determine water quantities applied during irrigation events, in order to increase irrigation efficiency.
- Soil Moisture Monitoring: Using soil testing to monitor moisture in assistance with scheduling and application of irrigation events during the entire crop season.
- Computer-Based Model Using Meterological Data: Using a computer based program that uses meteorological data to determine the scheduling of irrigation events during the entire crop season.

APPENDIX 2: Best Management Practices

2B: Water Conservation Best Management Practices and Point Scoring

D. Agronomic Management

Each of these practices is worth one point toward the total points to qualify for the program. At least one and no more than three of the practices may be counted toward the point total.

- Crop Rotation: Rotation of crops on at least 20 percent of irrigated acreage between seasons.
- Crop Residue Management: On at least 20 percent of irrigated acreage annually, crop residue is incorporated into the soil.
- Soil and Water Quality Testing: Annual soil testing on at least 50 percent of irrigated acreage to determine chemical composition and water intake rates and holding capacity. Regular water testing to determine leaching requirements and chemical composition.
- Pre-Irrigation Surface Conditioning: Mechanical means to prepare rows or borders on at least 20 percent of irrigated acreage annually.
- Transplants: Transplanting of established seedlings into fields in lieu of germination on at least 20 percent of irrigated acreage annually.
- Mulching: Using organic matter, plastic mulch, or floatable row covers on at least 20 percent of irrigated acreage annually.
- Shaping Furrow or Bed: On at least 20 percent of irrigated acreage annually, use of mechanical means to make bed profiles shallow, minimizing water infiltration time.
- Planting in Bottom of Furrow: On at least 20 percent of irrigated acreage annually, planting in the bottom of the furrow rather than on top of row beds, reducing water needed for germination.

APPENDIX 3: Surveys and Interviews

3A: BMP Committee Survey Participants: PM_{10} BMPs

Participant:	Position:	Date Interviewed
Accomazzo, Wade T.	Alfalfa Producer	5/16/2007
Clay, Pat*	Area Extension Agent, University of Arizona (Formerly)	4/27/2007
Kaltenbach, Colin	Vice Dean, College of Agriculture and Life Sciences, University of Arizona	5/4/2007
McKaughan, Colleen	Assistant Director, U.S. Environmental Protection Agency	5/25/2007
Thelander, Dan	Grain Producer	5/14/2007
Walworth, James L.	Soil Taxonomist, University of Arizona	4/18/2007

3B: BMP Committee Survey Participants: Water Conservation BMPs

Participant:	Position:	Date Interviewed
Clemmens, Bert	Director, USDA Water Conservation Laboratory	5/9/2007
Hanrahan, Michael	BMP Program Director, Arizona Department of Water Resources	6/19/2007
Kimberlin, Dennis	Pinal AMA Director (Formerly), Arizona Department of Water Resources	5/7/2007
McCain, John R.	Arizona Municipal Water Users Association (Formerly)	6/25/2007
Wong, Ron	Grower in Tucson AMA	5/11/2007

*Appointed to PM_{10} Technical Advisory Committee 2001

APPENDIX 3: Surveys and Interviews

3C: BMP Committee Survey

1) Prior to the BMP selection process, please share with me how the governor's advisory committee was established and what it did to prepare for the meetings.

2) Please compare and contrast the interests of the committee members going into the meetings.

3) Please describe the rulemaking process, how the committee reached consensus on the BMPs, as you remember it.

4) What was the role of the technical advisory committee, and its influences on the drafted rule?

5) Please describe any proceedings that took place after the advisory committee drafted the rule.

6) Do you have any other insights about the process?

APPENDIX 3: Surveys and Interviews

3D: Expert Survey Participants

Participant:	Position:
Clay, Pat	Area Extension Agent, University of Arizona (Formerly)
Ellsworth, Peter	Professor and Extension Specialist, Department of Entomology, University of Arizona
Gomez, Johnny	Soil Conservationist, U.S. Natural Resource Conservation Service
Husman, Steve	Resident Director of Campus Agricultural Centers, University of Arizona
Martin, Ed	Professor and Extension Engineer, Department of Agricultural and Biosystems Engineering, University of Arizona
Roth, Bob	Director, Maricopa Agricultural Center
Teegerstrom, Trent	Extension Specialist, Agricultural and Resource Economics, University of Arizona
Tronstad, Russell	Professor and Extension Specialist, Agricultural and Resource Economics, University of Arizona
Umeda, Kai	Area Extension Agent, University of Arizona

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

Please indicate the estimated percent of farms using each practice in Maricopa, Pima, and Pinal Counties prior to 2001.

TILLAGE AND HARVEST OPERATIONS	**Percent of Farms in Pinal, Maricopa, and Pima Counties**
Chemical Irrigation: Applying agricultural chemicals to cropland through irrigation systems.	
Combining Tractor Operations: Combining two or more tillage, cultivation, planting, or harvesting operations into a single equipment pass.	
Equipment Modification: Modifying equipment to use dust shrouds, spray bars, exhaust deflectors, etc. to reduce particulate matter emissions.	
Limited Activity During High Wind Event: No tillage or soil preparation activity when winds are in excess of 25 mph.	
Multi-Year Crop: Crops, orchards, or pastures that remain more than one year.	
Planting Based on Soil Moisture: Application of water to soil prior to any planting operations.	
Reduced Harvest Activity: Reducing the number of equipment passes during harvest operations.	
Reduced Tillage System: Reducing the number of tillage activities in crop production.	
Tillage Based on Soil Moisture: Application of water prior to tillage operations.	
Timing of a Soil Operation: Timing tillage operations such that PM_{10} emission is minimized. Example: Reducing time between leveling and bedding.	

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

NON-CROPLAND MANAGEMENT	Percent of Farms in Pinal, Maricopa, and Pima Counties
Access Restriction: Using signs or obstructions to prevent public access to non-cropland.	
Aggregate Cover: Applying a cover to non-crop areas, such as roads. Application is four inches deep and cover material pieces are at least one inch in diameter.	
Artificial Wind Barrier: Physical barriers placed perpendicular to prevailing wind direction in non-cropland areas.	
Critical Area Planting: Use of vegetative materials to cover at least 60% of non-cropland surface.	
Manure Application: Application of animal waste to influence soil composition.	
Reduce Vehicle Speed: Farm vehicle speeds kept less than 20 mph on all unpaved roads.	
Synthetic Particulate Suppressant: Use of a manufactured chemical intended to control particulate matter emissions.	
Track-Out Control System: Devices used to remove mud and soil from farm vehicle tires prior to entering paved roadways.	
Tree, Shrub, or Windbreak Planting: Planting vegetative wind barriers perpendicular to prevailing wind direction.	
Watering: Application of water to non-cropland during peak usage periods.	

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

CROPLAND MANAGEMENT	**Percent of Farms in Pinal, Maricopa, and Pima Counties**
Artificial Wind Barrier: Physical barriers placed perpendicular to prevailing wind direction on cropland.	
Cover Crop: Use of vegetative materials to cover at least 60% of cropland surface between crops.	
Cross-Wind Ridges: Tilling soil such that ridges lie perpendicular to prevailing wind direction (applies to soil types which are stable enough to sustain ridges).	
Cross-Wind Strip-Cropping: Planting alternating crop strips of 25-330 ft width across a field. Strips should be perpendicular to prevailing wind direction.	
Cross-Wind Vegetative Strips: Implementing vegetative cover in one or more strips across a field.	
Manure Application: Application of animal waste to influence soil composition on cropland areas.	
Mulching: Application of organic materials produced off-site to soil surfaces.	
Multi-Year Crop: Crops, orchards, or pastures that remain more than one year.	
Permanent Cover: Application or maintenance of long-term vegetative cover to cropland.	
Planting Based on Soil Moisture: Application of water to soil prior to any planting operations.	
Residue Management: Allowing crop and other vegetative residue to remain on cropland after harvest.	
Sequential Cropping: Minimizing bare soil exposure to 30 days or less by growing rotating crops in sequence.	
Surface Roughening: For applicable soil types, manipulating ground surface to induce the forming of soil clods during tillage.	
Tree, Shrub, or Windbreak Planting: Planting vegetative wind barriers perpendicular to prevailing wind direction on cropland.	

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

AGRONOMIC MANAGEMENT	Percent of Farms in Pinal, Maricopa, and Pima Counties
Crop Rotation: At least 20% of irrigated acreage contains periodically rotated crops.	
Crop Residue Management: Soil on at least 20% of irrigated acreage is enhanced with crop residue.	
Soil and Water Quality Testing: Soil is tested annually on at least 50% of irrigated acreage for residual fertilizers, soil salinity, and water intake rates and holding capacity.	
Pre-irrigation Surface Conditioning: Prior to initial irrigation, rows and borders are prepared by mechanical means on at least 20% of irrigated acreage annually.	
Transplants: Transplantation of established seedlings on at least 20% of irrigated acreage annually.	
Mulching: Use of organic matter, plastic mulch, or floatable row covers to reduce evaporation on at least 20% of irrigated acreage annually.	
Shaping Furrow or Bed: Use of mechanical means to make the bed profile shallow. Applied on at least 20% of irrigated acreage annually.	
Planting in Bottom of Furrow: Planting in furrow instead of top of row bed for at least 20% of irrigated acreage annually.	

WATER DELIVERY SYSTEMS	Percent of Farms in Pinal, Maricopa, and Pima Counties
Concrete-Lined Ditch: Conveyance of water to fields by the use of a concrete-lined ditch.	
Pipelines: Use of low or high pressure pipelines made of PVC, ABS, concrete, aluminum, or steel to transport water to fields.	
Drainback System: Use of drainback irrigation technology to convey excess water from an irrigated field to a down gradient field.	

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

FARM IRRIGATION SYSTEMS	Percent of Farms in Pinal, Maricopa, and Pima Counties
Slope System, Non-Uniform with Tailwater Reuse: Sloped field *without* uniform grades, with a constructed recovery system to capture water runoff after irrigation.	
Slope System, Uniform without Tailwater Reuse: Sloped field engineered *with* uniform grades, but without a designed recovery system.	
Slope System, Uniform with Tailwater Reuse: Sloped field engineered *with* uniform grades, with a constructed recovery system to capture water runoff.	
Uniform Slope, in Irrigation District, with Recovery: Sloped field engineered *with* uniform grades within irrigation district, which allows the district to recover excess water after irrigation.	
Modified Slope Systems: Sloped field engineered to uniform grade in the upper portion and slight to zero grade in the bottom portion, such that irrigation water is retained on the field.	
High Pressure Sprinkler Systems: Side-roll, linear, center-pivot, and solid set design, with 10 psi or more mainline water pressure.	
Near Level Systems: Sloped fields engineered with uniform grades with only slight slope (0.2 to 0.5 ft total fall in direction of irrigation over entire field). All irrigation water is retained on the field.	
Level Systems: Sloped fields engineered with uniform grades with near-zero slope (0.0 to 0.2 ft total fall in direction of irrigation over entire field). All irrigation water is retained on the field or captured by drainback.	
Low-Pressure Sprinkler Systems: Linear or center-pivot designs operating at no more than 10 psi at high end of mainline.	
Trickle Irrigation Systems: Pressurized drip or subsurface irrigation which provides precise water delivery.	

APPENDIX 3: Surveys and Interviews

3E: Expert Survey

IRRIGATION WATER MANAGEMENT	**Percent of Farms in Pinal, Maricopa, and Pima Counties**
Laser Touch-Up: Annual establishment of precision laser grades to a minimum of 20% of near-level and level acreage irrigated the prior year.	
Alternate Row Irrigation: Irrigating every other cultivated row, on at least 20% of irrigated acreage, during at least one irrigation event annually.	
Furrow Checks: Devices placed in rows to raise water level in rows on at least 20% of irrigated acreage, during at least one irrigation event annually.	
Angled Rows/Contour Farming: Applied for reducing row fall, and employed on at least 20% of irrigated acreage.	
Surge Irrigation: Applying water in surges rather than constant flow during irrigation events. Must be used on more than 20% of irrigated acreage.	
Temporary Sprinklers: Portable, roller, or solid set systems used on more than 20% of irrigated acreage.	
Participation in Educational Irrigation Water Management Program: Participates in program through entire season annually.	
Participation in a Consultant or Irrigation District Sponsored Irrigation Scheduling Service: Participates in program through entire season annually.	
Participation in an Irrigation District Program to Increase Flexibility of Water Deliveries: Participates in program through entire season annually.	
Measures Flow Rates to Determine Amount of Water Applied: Achieves application efficiency by monitoring flow rates required on each field.	
Soil Moisture Monitoring: Monitoring or measuring soil moisture on each field to determine water replacement needs, application rates, and irrigation scheduling.	
Computer-Based Model Using Meteorological Data: Use of such a program for determining irrigation event schedules through entire season.	

APPENDIX 3: Surveys and Interviews

3F: Expert Survey Results: PM_{10} BMPs

	Respondent's Percentage Score									
BMP	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Tillage and Harvest										
Chemigation	90	40	10	30	100	99	98	100	5	90
Combining Tractor Passes	65	25	99	5	10	95	65	100	60	-
Equipment Modification	80	20	0	75	0	40	-	5	1	-
Limited High Wind Activity	40	20	90	90	10	75	-	30	50	-
Multi-Year Crop	20	80	25	35	90	75	30	60	50	25
Planting Based on Moisture	90	30	80	90	90	75	90	50	25	25
Reduced Harvesting	90	60	15	5	50	75	-	80	1	0
Reduced Tillage	90	80	99	40	50	90	70	70	90	10
Tillage Based on Moisture	20	10	0	95	50	80	0	100	1	25
Timing of Soil Operation	20	20	0	-	40	80	-	40	15	0
Non Cropland Management										
Access Restriction	-	10	50	60	25	60	-	50	10	0
Aggregate Cover	10	5	0	10	10	50	-	0	1	0
Artificial Barrier	10	10	0	5	50	30	-	20	1	-
Critical Area Planting	90	5	0	95	10	20	-	5	1	25
Manure App	20	10	0	5	25	20	-	50	5	25
Reduced Speed	20	10	0	1	10	30	-	0	75	0
Synthetic Partical Suppressant	10	5	0	2	10	20	-	0	1	-
Track-Out Control	90	10	0	-	10	10	-	0	1	0
Vegetative Windbreak	40	20	0	20	30	30	-	10	1	-
Watering	80	-	0	0	10	30	-	10	2	0
Cropland Management										
Artificial Barrier	20	10	1	2	25	5	-	10	1	-
Cover Crop	90	20	5	95	10	60	50	10	2	40
CW Ridges	30	-	0	25	75	70	-	0	1	0
CW Strip-Cropping	20	-	0	1	10	10	-	0	1	0
CW Vegetation	30	-	0	1	10	10	-	0	1	0
Manure App	30	20	80	3	50	80	50	50	60	25
Mulching	20	10	5	5	10	20	30	5	2	0
Multi-Year Crop	40	80	25	35	90	60	30	60	50	25
Permanent Cover	20	10	0	30	20	10	-	10	1	30
Planting Based on Moisture	90	30	80	90	90	80	60	100	50	25
Residue Management	90	40	100	80	90	85	70	30	10	10
Sequential Cropping	20	80	25	60	40	30	30	10	10	10
Surface Roughening	90	-	80	80	90	85	-	0	5	0
Vegetative Windbreak	30	20	1	70	50	3	-	10	1	0

APPENDIX 3: Surveys and Interviews

3G: Expert Survey Results: Water Conservation BMPs

	Respondent's Percentage Score									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Agronomic Management										
Crop Rotation	95	90	100	90	90	80	80	100	80	100
Residue Management	80	50	100	90	90	80	80	80	60	100
Soil and Water Testing	60	30	25	95	40	40	70	40	60	50
Surface Conditioning	90	100	100	95	75	85	70	100	90	100
Transplants	40	5	5	2	5	10	10	0	5	5
Mulching	60	0	15	5	5	10	10	90	5	10
Shaping Furrow or Bed	95	-	99	30	50	80	-	90	30	100
Planting on Bottom of Furrow	85	0	15	2	5	60	0	0	5	5
Water Delivery Systems										
Concrete-Lined Ditch	100	90	90	100	95	95	80	95	90	93
Pipelines	100	-	1	20	75	40	10	20	1	5
Drainback System	70	-	10	70	40	20	5	0	70	1
Farm Irrigation Systems										
Slope, Non-Uniform, Tailwater	1	-	5	2	0	10	-	0	10	5
Slope, Uniform, No Tailwater	2	-	2	0.5	5	70	0	20	5	1
Slope, Uniform, Tailwater	5	-	5	5	10	10	0	30	50	5
Slope, Irrigation District	20	-	5	1	0	10	0	30	15	5
Modified Slope	5	-	5	3	5	-	5	3	5	1
High Pressure Sprinklers	1	-	1	0.5	2	10	10	0	2	2
Near Level Systems	10	-	40	20	15	20	50	10	20	40
Level Systems	50	-	30	65	60	5	25	5	20	40
Low-Pressure Sprinklers	5	-	2	1	0	10	-	1	5	3
Trickle Irrigation	1	-	5	2	3	2	10	1	5	5
Irrigation Water Management										
Laser Touch-Up	100	-	25	80	75	70	30	80	60	50
Alternate Row Irrigation	90	-	60	90	90	20	10	100	90	50
Furrow Checks	5	-	0	25	10	20	-	30	40	100
Angled Rows/Contour Farming	10	-	0	1	10	10	10	60	1	5
Surge Irrigation	25	-	15	20	10	5	0	0	1	0
Temporary Sprinklers	25	-	10	2	10	20	5	10	5	20
Educational Irrigation Program	80	-	20	85	10	10	10	5	15	5
Irrigation Scheduling Service	80	-	20	80	10	-	10	5	10	5
Flexibile Deliveries Program	80	-	-	80	-	-	10	-	15	-
Flow Rate Measurement	100	-	5	90	25	5	30	100	10	30
Soil Moisture Monitoring	20	-	70	5	25	50	20	35	-	10
Computer-Based Model	40	-	5	5	25	-	5	15	5	20

APPENDIX 4: Scoring Worksheets
4A: Agricultural PM_{10} Best Management Practices General Permit Record

Agricultural Best Management Practices General Permit Record

The following is an example of a form that you can use or duplicate. You are not required to use this form.

Name of commercial farmer________________________________ Date______________

Mailing or physical address of the commercial farm

____

____

City________________ State________ Zip______

Selected Best Management Practices. A commercial farmer must implement at least one practice from each category.

Tillage and Harvest
- [ ] Chemical irrigation
- [ ] Combining tractor operations
- [ ] Equipment modification
- [ ] Limited activity during a high wind event
- [ ] Multi-year crop
- [ ] Planting based on soil moisture
- [ ] Reduced harvest activity
- [ ] Reduced tillage system
- [ ] Tillage based on soil moisture
- [ ] Timing of a tillage operation

Notes:

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Non-Cropland
- [ ] Access restriction
- [ ] Aggregate cover
- [ ] Artificial wind barrier
- [ ] Critical area planting
- [ ] Manure application
- [ ] Reduce vehicle speed
- [ ] Synthetic particulate suppressant
- [ ] Track-out control system
- [ ] Tree, shrub, or windbreak planting
- [ ] Watering

Notes:

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Cropland
- [ ] Artificial wind barrier
- [ ] Cover crop
- [ ] Cross-wind ridges
- [ ] Cross-wind strip cropping
- [ ] Cross-wind vegetative strips
- [ ] Manure application
- [ ] Mulching
- [ ] Multi-year crop
- [ ] Permanent cover
- [ ] Planting based on soil moisture
- [ ] Residue management
- [ ] Sequential cropping
- [ ] Surface roughening
- [ ] Tree, shrub, or windbreak planting

Notes:

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Signature____

Source: Arizona Department of Environmental Quality

APPENDIX 4: Scoring Worksheets
4B: Water Conservation BMP Worksheet and Instructions (1)

INSTRUCTIONS FOR BMP WORKSHEET

Please use this instruction sheet when completing the BMP Worksheet. Refer to the attached BMP definitions when determining your BMP point values.

A. BMP Worksheet

The BMP Worksheet is organized in 4 categories. Each category allows the accumulation of up to 3 points. Category 2 (Farm Irrigation Systems) requires a minimum value of 2 points to be eligible for entering the BMP program. A total value of 10 or more points is required to be eligible for enrollment in the BMP program.

BMP Category 1: Water Conveyance System Improvements

A farm's water conveyance system allows water to be conveyed from an irrigation district delivery point or a well head for irrigation of each field. This category includes water conveyance system improvements that qualify as approved BMPs.

In the BMP Worksheet, Category 1 evaluates the condition of the water conveyance system that carries irrigation water from a district delivery point or well head to the farm field. Refer to the **Water Conveyance System - Point Table** in Part B below to determine point value in Category 1 for the farm or farm unit. The maximum number of points allowed in this category is 3.

BMP Category 2: Farm Irrigation Systems

Farm irrigation systems are the methods by which a farm field is irrigated. Farm irrigation systems include slope, modified slope, level or near level, sprinkler, trickle or drip, or any combination thereof. This category includes farm irrigation systems that qualify as approved BMPs.

In the BMP Worksheet, Category 2 evaluates the type of irrigation system(s) currently employed on your farm. The percentage of irrigation system(s) used for this category cannot exceed 100 percent. This category requires a minimum of two points to be eligible for enrollment in the BMP program. The maximum number of points allowed in this category is 3.

BMP Category 3: Irrigation Water Management (IWM)

Irrigation water management practices include management practices that, when implemented properly, will increase a farm's overall efficiency of water application in a growing season. This category includes irrigation water management practices that qualify as approved BMPs.

In the BMP Worksheet, Category 3 evaluates the irrigation water management practices that will be implemented on-farm. The applicant must identify which of the approved BMPs will be implemented on an annual basis while enrolled in the program. The maximum number of points allowed in this category is 3.

BMP Category 4: Agronomic Management

Agronomic management practices include combinations of plant and soil management practices that, if implemented properly, will conserve water over the length of the growing season. This category includes agronomic management practices that qualify as approved BMPs.

In the BMP Worksheet, Category 4 evaluates the agronomic management practices that will be implemented on-farm. The maximum number of points allowed in this category is 3.

++

Note: Applicants may elect to exclude a portion or portions of an IGFR when enrolling in the BMP Program. The excluded portion will not count towards the calculation of irrigable acreage in Category 1 or the Farm Irrigation System percentage in Category 2. However, the excluded portion may not be irrigated so long as the IGFR is enrolled in the BMP Program. A farm map designating the excluded acreage must be submitted with the application.

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B. Water Conveyance System - Point Table

This Table is to be used to complete Category 1 in the BMP Worksheet

Percent of Water Conveyance System Improvements	Point Value
50-54	1.0
55-59	1.2
60-64	1.4
65-69	1.6
70-74	1.8
75-79	2.0
80-84	2.2
85-89	2.4
90-94	2.6
95-99	2.8
100	3.0

APPENDIX 4: Scoring Worksheets
4B: Water Conservation BMP Worksheet and Instructions (3)

AGRICULTURAL BEST MANAGEMENT PRACTICES PROGRAM
BMP WORKSHEET

(Refer to the attached Instructions and BMP Definitions while completing this worksheet)

Farm Name:________________ **Associated IGFR 58–Number(s):**____________	**Percentage of Farm Served by Conservation Practice**				**Points**
Category 1: Water Conveyance System Improvements (Total Allowable Points = 3)					
Enter the total percentage of irrigable acreage that is served by any combination of the following types of water conveyance systems: Approved BMPs are concrete-lined ditches, pipelines, or drainback systems.					
1a. **Total Percentage:**	%				
1b. *Enter the BMP point value from the Water Conveyance System - Point Table (found on Part B of the BMP Worksheet Instructions) for the total percentage entered on* ***line 1a*** *above.*					
Category 2: Farm Irrigation Systems (Minimum Allowable Points = 2; Total Allowable Points = 3)					
Enter the percentage of each type of irrigation system on your farm and calculate the points accordingly. Total cannot exceed 100 percent.					
Slope systems without uniform grades = **0 points**.	%	X	0	=	0
2.1 Slope systems without uniform grades with tailwater reuse = **1 point**	%	X	1	=	
2.2 Uniform slope systems without tailwater reuse = **1 point**.	%	X	1	=	
2.3 Uniform slope systems with tailwater reuse = **2 points**.	%	X	2	=	
2.4 Uniform slope systems within an irrigation district that captures and redistributes return flows = **2 points**	%	X	2	=	
2.5 Modified slope systems = **2 points**.	%	X	2	=	
2.6 High pressure sprinkler systems = **2 points**.	%	X	2	=	
2.7 Near level systems = **2.5 points**	%	X	2.5	=	
2.8 Level systems = **3 points**.	%	X	3	=	
2.9 Low pressure sprinkler systems = **3 points**.	%	X	3	=	
2.10 Trickle irrigation systems = **3 points**.	%	X	3	=	
Enter the total point value from Category 2. Subtotal must be a minimum of 2 points and cannot exceed 3 points. ***(If subtotal is less than 2, the farm or farm unit is not eligible for enrollment in the BMP Program)***	**100%**				
Add the point value from Category 1 (line 1b) to the subtotal from Category 2 and enter here.	**SUBTOTAL:** (Categories 1 & 2)				

BMP Worksheet DRAFT 10-01-02

APPENDIX 4: Scoring Worksheets
4B: Water Conservation BMP Worksheet and Instructions (4)

BMP Worksheet Page 2

Category 3: Irrigation Water Management (IWM) (Total Allowable Points = 3)		**POINTS**
Enter points based on the following IWM Practices used or to be implemented.		
3.1 Laser touch-up = **1 point**		
3.2 Alternate row irrigation = **1 point**		
3.3 Furrow checks = **1 point**		
3.4 Angled rows/contour farming = **1 point**		
3.5 Surge irrigation = **1 point**		
3.6 Temporary sprinklers = **1 point**		
3.7 Participation in an educational irrigation water management program = **1 point**		
3.8 Participation in a consultant or irrigation district sponsored irrigation scheduling service = **1 point**		
3.9 Participation in an irrigation district program to increase the flexibility of water deliveries = **1 point**		
3.10 Measure flow rates to determine amount of water applied = **1 point**		
3.11 Soil moisture monitoring = **1 point**		
3.12 Computer based model using meteorological (e.g. AZMET) data = **1 point**		
Enter the total point value from Category 3 (up to a maximum of 3 points).	**SUBTOTAL:** (Category 3)	
Category 4: Agronomic Management (Total Allowable Points = 3)		
Enter points based on the following Agronomic Practices used or to be implemented.		
4.1 Crop Rotation = **1 point**		
4.2 Crop Residue Management = **1 point**		
4.3 Soil and/or Water Quality Testing = **1 point**		
4.4 Pre-Irrigation Surface Conditioning = **1 point**		
4.5 Transplants = **1 point**		
4.6 Mulching = **1 point**		
4.7 Shaping Furrow or Bed = **1 point**		
4.8 Planting in Bottom of Furrow = **1 point**		
Enter the total point value from Category 4 (up to a maximum of 3 points).	**SUBTOTAL:** (Category 4)	
Add the subtotals from Categories 3 and 4 above.	**SUBTOTAL:** (Categories 3 & 4)	
Enter the subtotals from Categories 1 and 2 from page 1.	**SUBTOTAL:** (Categories 1 & 2)	
Add subtotals of Categories 1,2,3, & 4 and enter total points. Total points must equal 10 or greater to be eligible for the Best Management Practices Program.	**TOTAL:** (Categories 1,2,3,4)	

BMP Worksheet DRAFT 10-01-02

Source: Arizona Department of Water Resources

APPENDIX 5: Research Missing the Mark:

PM_{10} Rule Research that Allowed Practices Already Used on Farms

There are two points during PM_{10} BMP program development that regulators were presented with information that either crossed over the fact that BMPs were already used, or led them close to the fact and they missed it.

First, Eastern Research Group, URS Corporation, and ADEQ developed a paper explaining the earlier TSD, which estimated the effectiveness of the BMP program (Fields, et al). The TSD report used three components, including 1) a survey of farms to determine most likely adopted BMPs, 2) a series of control efficiency (percent emissions reduction) calculations, and 3) implementation scenarios for different crop types. The report concluded that agriculture would reduce emissions by 36.6 percent from BMP implementation. The report stated that:

> "Since a farmer can select from a list of BMPs for each category, it cannot be determined with certainty which specific BMPs will actually be implemented. However, knowing the most likely BMPs to be implemented…and the control efficiency or range of control efficiencies associated with each of those BMPs, the percentage of emission reduction can be estimated… The assumed compliance factor for each BMP is 80%." (Fields, et al)

The TSD report assumed that 80 percent of agriculture would implement the BMPs. The report regarded any adopted BMP under program requirements as a new BMP, without regard for the use of BMPs already in place. This may have led regulators to quantify emission reductions at a much greater amount than actually took place.

Secondly, the commentary on the proposed rule (after committee approval) compared the Agricultural PM_{10} BMP Program with the South Coast Air Quality Management District in California. One of the comments noted that the South Coast district placed a mandatory restriction on tilling during high wind events, while the BMP program in Arizona only included the measure as an optional BMP. The comment proposed that SIP measures were not as stringent as expected under CAA regulations. The rule commentary also found some of the state's claims concerning dust mitigation suspect. According to ADEQ's commentary responses, a commenter stated:

> "the state's contention that "the application of more than one BMP at a time for a selected category would only provide for incremental PM_{10} reductions sometimes at an uneconomical cost," is not supported by any competent data and improperly delegates virtually all regulatory discretion to the regulated community.(EPA 2001)"

The state's official response to both of these comments was a citation of the findings of the TSD document, suggesting technical support of the rule. The state reported the findings of the TSD, an estimated 36.6 percent reduction in dust emissions from BMP implementation. However, the TSD was flawed in its assumptions, as demonstrated in the last section.

In both cases, regulators were presented with information that narrowly missed a singular fact, which the crux of this research hinges on: BMPs already in use on farms were implemented in the program, allowing farms to easily qualify.

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

There are a number of acronyms and abbreviations used throughout this thesis. For the convenience of the reader, this is a list of many of the common acronyms or abbreviations found in the work.

ACLPI – Arizona Center for Law in the Public Interest

ACUS – Administrative Conference of the United States

ADA – Arizona Department of Agriculture

ADEQ – Arizona Department of Environmental Quality

ADWR – Arizona Department of Water Resources

AMA – Active Management Area

APA – Administrative Procedure Act (Federal, 1946)

ARS – Arizona Revised Statutes

BACM – Best Available Control Method

BATNA – Best Alternative to a Negotiated Agreement

BMP – Best Management Practice

CAA – Clean Air Act, Air Pollution Control Act (Federal, 1955)

CRP – Conservation Reserve Program

EPA – U.S. Environmental Protection Agency

EQIP – Environmental Quality Incentives Program

FACA – Federal Advisory Committee Act (1972)

FACTA – Food, Agriculture, Conservation, and Trade Act (Federal Farm Bill, 1990)

FAIR – Federal Agricultural Improvement and Reform Act (Federal Farm Bill, 1996)

FIP – Federal Implementation Plan

FSA - Farm Security Act (Federal Farm Bill, 1985)

GMA – Groundwater Management Act (Arizona, 1980)

IGFR – Irrigated Grandfathered Right

MAG – Maricopa Association of Governments

NAAQS – National Ambient Air Quality Standard

NPP – Negotiation Possibilities Frontier

NRA – Negotiated Rulemaking Act (Federal, 1990)

NRCS – Natural Resource Conservation Service

PL – Public Law

PM – Particulate Matter (subscript indicates regulated particulate size – e.g. PM_{10})

RACM – Reasonably Acceptable Control Method

RFP – Reasonable Further Progress

Reg-neg – Negotiated Rulemaking; Regulatory Negotiation

SIP – State Implementation Plan

TSD – Technical Support Document for Quantification of (PM_{10}) BMPs

USC – United States Code

USDA – United States Department of Agriculture

VEA – Voluntary Environmental Agreement

ZOPA – Zone of Potential Agreement

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