TECHNICAL NOTES

US DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

ECONOMICS NO. CA-6 October 1989

ECONOMICS AND PLANNING FOR NON-POINT POLLUTION CONTROL
ECONOMICS TECHNICAL NOTE No. CA-6

Forward

The following technical note is intended to serve as a general introduction to planning and economic considerations for Non-Point Source Pollution (NPSP) abatement. It includes an overview of concepts reflective of the kinds of problems and planning considerations peculiar to NPSP and builds upon field office conservation plannning experience by relating general on-farm planning concepts and water resource planning concerns to economics and NPSP. The information provided was extracted and modified from two sources: (1)"Non-Point Source Pollution And Planning For Water Quality Improvements In Western Stanislaus County" (March 1989); and (2)"Integrating Economics Into The Planning Process - A Report of the Economics Application Work Group" (June 1989). The first report was prepared by the Patterson field office with state office assistance for the State Water Quality Control Board of California. The second report grew out of a national work group appointed by the Chief to re-examine the process of delivering planning services, especially taking into account economic and social impacts from the decision-makers (farmers/ranchers) perspective.

Prepared by David L. Faulkner, Agriculture Economist, Ecological Sciences, Soil Conservation Service, Davis, California

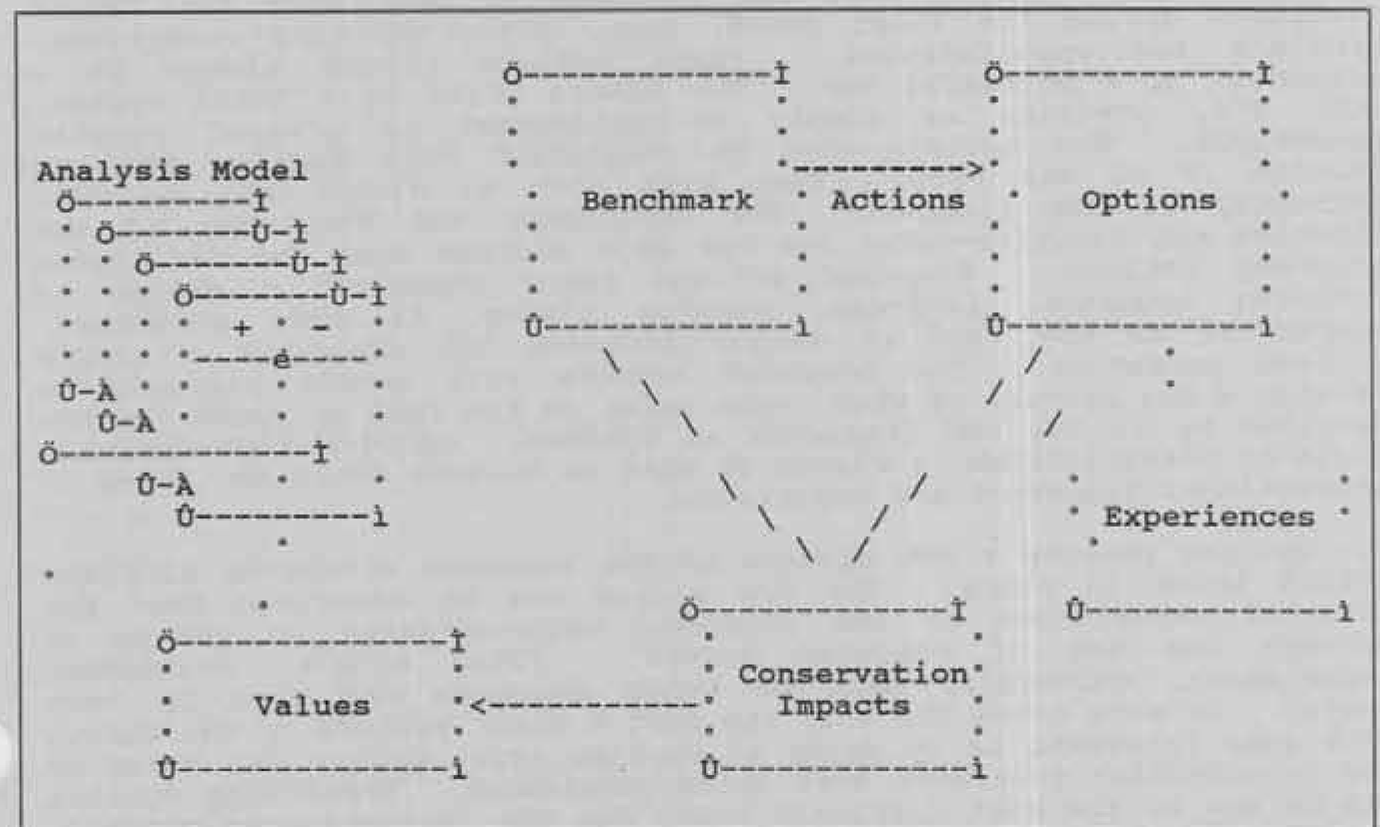
INTRODUCTION AND SUMMARY

Conservation planning and application is an intricate but logical process of identifying and solving natural resource problems by providing technical assistance to appropriate decision-makers through SCS programs. The same planning concepts used in field office planning are also applicable to water resource, RCD and program nuetral hydrologic unit planning. The specifics of each type of application do, however, vary considerably.

The ultimate goal of conservation planning and application in a field office setting is to implement resource management systems (RMS') that meet the short and long-term objectives of both the land-user and society. To achieve this, systems must be technically adequate, economically and financially feasible and environmentally sound. To help insure that we make progress towards long-term resource use sustainibility we employ the planning and application process which at a minimum must identify and define problems, determine objectives, inventory resources, develop and evaluate alternatives, implement a selected alternative and evaluate its effectiveness.

The standardized planning format used by field offices was developed to guide the planning process to consider all relevant natural resource/land-use elements and activities and to document assistance efforts (see the National Conservation Planning Manual - NCPM and the attached foreward to the NCPM for more information on planning goals and process details). **In essense, the planning process results in the identification of conservation effects for decision-making (CED).** The idea of CED imerged from the economics work group as a conceptual framework linking the planning process and economic input with emphasis on the end objective, i.e., the identification of the expected effects from applied conservation which allows decisions and actions to be taken. The CED framework is applicable to all SCS programs and is pictorally represented on the following page.

CONSERVATION EFFECTS FOR DECISION MAKING
(CED)



Our initial efforts should always first identify the **current condition or benchmark situation.** The planner and the land-user work together to develop a picture of existing conditions, trends, problems, opportunities and objectives. Generally, assistance provided by the SCS is based on soil, water and other natural and cultural resource information. The picture of current conditions also includes other inventories and evaluations as needed. These may include a description of current crops, farming practices, livestock, available equipment, etc. The planning objectives and problem complexity will influence the detail of inventories and evaluations needed. It is important to remember that the objectives of society as well as those of the land-users need to be considered as a picture of the current conditions is painted. The planning process should also identify opportunities. This will direct us to have a broader view that sees beyond our search for resource problems. Even if a given situation is evaluated to not have a significant resource problem opportunities may exist to make further on-farm improvements which could also reduce negative offsite effects.

After a picture of the current situation and expected future trends is developed planners next consider what **actions** will be appropriate to meet individual and societal objectives. Actions are those changes to the existing situation that are proposed to deal with the issues developed during the first phase, i.e., given existing conditions, problems and opportunities. These actions should always be a component of a potential RMS. The action might be a total system, ACS, BCS, practice or simply an adjustment to present farming operations. The actions must be consistent with Section III and Section IV of the FOTG. They must also be within the approval authority of the planner. The experience and knowledge of the planners and decision-maker are the main sources used for developing proposed actions. Proposed actions could represent a change in cropping sequence, land-use, seeding timing, tillage, structural components of the farm or simply lowering the speed of a single tillage operation. The proposed actions will enable planners to develop a new picture of what could exist on the farm or ranch and are decribed by in the CED framework as **options.** Options represent the world of possibilities, a vision of what we believe could be, based on professional judgement and experience.

The options provide a new picture of the resource situation with the action items in place. The new vision can be described from the personal experiences of the planner, decision-maker or others or through the use of computer models. Field trials, successful experiences, university data or other research can also be very useful. In some cases the only way that a clear picture of the future with some treatment is by doing an on-farm trial with a few acres on the conservation treatment unit being considered. Describing options can be one of the most difficult tasks for the inexperienced planner. The more experience one has the better the options picture can be described.

Each individual has a different experience base which can be increased by OJT, specialized training courses, field trials, the use of models, etc. One of the most useful learning tools is for the planner to visit operators with successful experiences. Technology transfer through exposure in this manner can rapidly broaden an employee's perspective and improve his/her expertise. If successful on-farm experiences are documented and shared as case studies, the knowledge base of others within and outside of the agency could readily be enhanced. Such experiences should be recorded first in physical and biological terms rather than monetary terms because monetary values are simply a translation of the former and can be derived in current dollars at any time. The completed options picture is then compared with the current conditions picture to estimate the **impacts** of the actions.

The impacts or effects of applied conservation treatments are the difference between the current condition and trends and the options picture. Quantification of the impacts is dependent upon the degree of detail used to describe/measure current and expected option

ATTACHMENT

FOREWORD

The National Conservation Planning Manual (NCPM) contains policy, procedures, and guidelines for providing effective technical assistance through all SCS programs. Technical assistance is provided to individuals, groups, and units of government who plan and implement conservation decisions affecting soil, water, and related plant and animal resources. The principles set forth in the NCPM support the conservation objectives and priorities of the USDA National Conservation Program.

The conservation planning process is a flexible and continuing process of identifying problems, determining objectives, inventorying resources, analyzing resource information, developing and evaluating alternatives, and making and implementing decisions. Employees who understand the process outlined in this manual can help to insure proper use of our resources to meet the food, fiber, environmental, and other needs of this and future generations.

Our goal is to help land users:

- Recognize natural resource problems;
- Plan and implement cost-effective resource management systems that allow for a profitable agriculture as well as good conservation;
- Understand potentials of soil, water, and related plant and animal resources;
- Use resources to meet their goals in a way that is compatible with the broader interests of all citizens;
- Plan and implement resource management systems needed to protect, restore, and improve the resource base;
- Understand the effects of their decisions and actions on the resource base and the environment, both onsite and offsite; and
- Serve as examples to other land users in their respective communities.

To help land users achieve that goal we must understand people and be able to communicate with them. We must be able to deal with changing situations, including economic conditions, changing technology, social and community influences, and world situations as some of the major variables affecting resource conservation decisions.

The NCPM focuses on guiding and encouraging deliberate actions that result in applying conservation systems on the land.

The conservation planning process is used to provide land users with resource information and followup assistance needed to achieve their conservation objectives. This process recognizes the need for flexibility to accommodate an ever-changing situation.

SCS works, in cooperation with conservation districts, to help land users combine their goals with scientific use and treatment of land according to its potential and needs.

conditions. The impacts should be described in narrative and quantitative terms to the extent possible. Differences in erosion rates, habitat values, water quality, acres, bushels, labor requirements, fuel, pesticides, etc. should all be documented. The time frame when the impacts occur should also be identified. Certain activities such as range improvements often result in immediate costs with yield increases delayed for some period of time.

Given that any interpretation of the impacts is subject to **value** judgements, each individuals value system will affect the evaluated merits of change. For example, conservation treatment induced improvements in pheasant habitat sufficient to support ten additional pheasants could be a very positive impact for one cooperator while for another individual this could be very negative. Some impacts may be neutral or have both negative and positive attributes. The individual's value set may conflict with societal values in some cases. In all cases the **net effect** of conservation impacts should be estimated at some level of detail in order to facilitate land-user decision-making.

As value judgements are made regarding impacts they may be distributed into two lists, positive and negative. The listing could range from being purely narrative and relatively simple to quite complex and quantitative. The degree of detail and complexity should be scaled to provide only enough information for the land-user to comfortably make a decision. The process will usually begin with narrative information then progress, if needed, to more and more information about the entire set of changes or only regarding those variables which are considered most important. In most cases it is expected that the planner will identify the cost of any actions and describe neccessary maintenance for the system. In many cases one or two analytical levels of definition will be sufficient. Occasionally, a very complex analysis will be neccessary to carry all elements to the same analytical level. There are no specific guidelines to identify level one, two, three, etc. Professional judgement must be developed and exercised in the planning process. The important concept to remember is the iterative planning process itself.

The CED process as described here is completely consistent with the NCPM and it is not a new system, but a different method of thought organization. The CED system provides a conceptual methodology to handle the most simple or complex planning task. The process will also work for other programs, although differences in terminolgy may be found, e.g., water resource work typically uses the analogous terms present conditions, future without treatment and future with treatment with the difference between the last two constituting the expected conservation impacts. The CED process is adaptable to a building block approach to increased use of technology and information and will hopefully help to keep planning considerations and resource/landuse relationships clearer in the minds of planners and cooperators alike. The CED process is intended to make conservation planning and application more efficient, effective and rewarding.

General Planning Considerations for Non-Point Source Pollution Abatement:

Natural resource planning for decision making is a complex and dynamic process. It is often a process analogous to dissection whereby the constituent parts of the whole are separated and analyzed to better understand their individual functions. In natural resource planning, the individual components are then placed back within the context of the whole system to gain as clear an understanding, as necessary, of the physical and biological relationships at work.

Problem definition as well as determining the scope and detail of analysis needed is the most critical part of natural resource planning. Determining the level of effort needed goes along with the initial assessment of existing conditions and trends and the magnitude of related problems. The main objective of this initial scoping process is to begin definition of the situation and scale the subsequent level of analysis effort to a degree commensurate with the expected benefits from intervention. Intervention is here used to mean a change in the future situation as a direct result of some action being taken, e.g., a project, policy changes, an information campaign, implementation of a single practice, structure or resource management system, etc.

However, it should be noted that intervention is not the objective of planning. Any initial analysis effort is based upon some condition that needs attention. Effective planning should help local decision makers to: (a) determine the nature of their problem; (b) decide whether the problem is likely to continue, worsen or diminish; (c) explain whether or not the problem is sufficiently damaging so as to call for some type of intervention; and (d) indicate which of the possible alternative means of intervening would most likely produce desirable results at a justifiable cost.

Any analysis presupposes that conclusions can be made and that technically, economically and socially acceptable alternatives will be sought which either reduce the size of the problem, solve it or mitigate negative effects by developing positive effects elsewhere. Although not common, the most desirable alternative in some situations could be acceptance of the existing condition given current technological capabilities and social values. In addition, the nature of human/environmental interactions often presents a major obstacle to achieving improvements through planning based on technical analysis and local decision making. Natural resource systems and human uses of them are often found to have very complex and interactive relationships. Although human understanding and ability to evaluate natural resource/landuse interactions has made tremendous progress and continues to improve, there remain significant information needs, gaps in our understanding and technological limits to treat natural resource problems.

For example, the irrigated agriculture focus of many NPSP efforts usually has a well founded basis, but in some cases there remain serious questions as to whether or not the damage caused by NPSP from irrigated lands is more significant than damages caused by NPSP loadings from rangeland within the same watershed or other sources such as geologic erosion and chemical loadings from nature or contributions from roadsides sprayed with chemical herbicides, etc.. This concern can usually be sorted out during the analysis phase of planning. A more challenging information gap presently exists as to whether or not partial or even a complete clean-up of an entire watershed would result in significant measurable and economically justifiable improvements in the quality of a given impaired waterbody and it's beneficial uses. Loadings from other sources upstream of a given study area could render clean-up efforts within the study area ineffective.

To attempt to answer this last question, the impaired beneficial uses resulting from NPSP loadings within and offsite of a particular hydrologic unit must be identified, evaluated and linked to the sources that cause the damages. If sediment is the main problem and rangeland is identified as the main source then the logical focus of future implementation efforts should be directed accordingly. If damage from agricultural chemicals is the main problem then the irrigated agriculture lands would be the appropriate focus. If upstream or other sources are found to be more important than previously believed, then the relevant focus would be on whether or not NPSP reductions wihin the study area would still contribute significantly to stated water quality objectives or move towards achievement of a "critical mass" level of reductions.

The idea of critical mass is here intended to relate problem complexity and importance with necessary and sufficient levels of treatment to result in desired change, e.g., a problem could be so large and complex that no single action nor group of actions could reasonably be expected to result in significant improvements. In such a case we simply don't sufficiently understand the problem and relations among constituent parts, but the gravity of the situation could require that we begin treatment to begin to deal with the problem and learn more. Toxic NPSP loadings from a given area is a specific example. Such pollutants could present a sufficient human health hazzard to warrent clean-up efforts even when other sources are as important or more important; even when economic justification can not be found, etc.

These questions may currently exist in a given situation and may or may not be completely resolved during advanced phases of analysis depending on the complexity of the problems. However, advanced levels of analysis do generally move us towards answering, if not answer, such concerns and determine what possible interventions could be made to achieve water quality objectives in view of all NPSP sources and the comingling of pollutants that often occurs. To the extent practical, advanced planning should also determine at what point significant improvements to the receiving water body's quality could be expected from land treatment, structural, managerial, regulatory and local policy alternatives and would such efforts be worth their costs, i.e., can one or more interventions with positive benefit/cost ratios be found. If not, then cost effectiveness analysis could be employed to analyze the least costly alternative to achieve a given level of NPSP loading reductions.

Benefit/cost analysis entails and understanding of the present situation and the development of two future scenarios: (1) future NPSP loadings and water quality without some type of intervention, i.e., what current conditions and trends relative to the impaired beneficial uses are likely to continue; and (2) what would be the expected future with some type of intervention. The difference between these two visions of the future must be determined in order to ascertain expected change, and in particular, expected benefits attributable to the intervention. Understanding the impacts of contemplated policies and or programs and projects before implementation is the main goal of pre-project planning.

Planning should begin with an interdisciplinary team reconnaissance of the entire hydrologic unit under study to identify and estimate pollutant transport mechanisms, sources and rates of erosion, sedimentation and the delivery of <u>selected</u> key NPSP pollutants of major concern. A survey of impaired beneficial uses both onsite and downstream must also be made with quantified estimates, to the extent practical, of their individual and collective average annual dollar values. Such an approach should naturally build upon any existing knowledge/experience/data base regarding land use in the area and proven BMP technologies and consider other sources as well.

The discussion above is intended to recognize existing limitations, highlight the complexity of NPSP problems and emphasize some important questions that should be addressed in the analysis phase of planning. Much is already known about NPSP movement within and off of agricultural land areas and regarding the efficacy of BMPs to reduce or control NPSP. It is noteworthy that even if the broader questions raised above are not answered after advanced planning efforts due to the complexity of the problem, invariably information will be generated which contributes to greater understanding of the physical and biological causality and the area's impact on the broader issues. Completion of advanced planning should lead to, if not determine whether or not economically justifiable recommendations and actions at one level or another (farm, subwatershed, watershed-wide, etc.) could be made and if not, the results will point the way for establishing reasonable NPSP abatement goals.

Interdisciplinary/Participative Nature of Planning

In order to effectively evaluate natural resource/landuse condition, problems and trends, an interdisciplinary team of specialists in close consultation with local decision makers, landusers and other interested parties is needed. Ainterdisciplinary team is essential in order to assess what is going on with respect to the seven main variables analyzed in natural resource inventories and environmental planning: (1) land use; (2) soils; (3) rainfall; (4) topography; (5) vegetative cover; (6) streams and landuse-altered hydrologic characteristics; and (7) transportation infrastructure (erosion, sedimentation and the hydrology altering effects of associated roads, highways, and railroad lines). All of these variables represent focal points requiring different analytical training and skills to be able to define the resource problems and understand a given hydrologic unit's landuse/resource interactions.

The planning process essentially involves all concerned in an interactive, repetitive dialogue which generates information and understanding with an increasing degree of detail over time that leads to decision making. This process is especially important in natural resource planning in general and specifically within a state such as California due to the complex and dynamic nature of NPSP, the great diversity in natural resource settings in the state and the large number of landusers and landuses involved. Any successful effort to reduce NPSP loadings must also employ inter-agency communication and public participation. Inter-agency coordination is desirable to draw upon the different expertise and perspectives of existing local, state and federal agencies in the area. Coordination among agencies is also desirable to achieve complementarity of efforts. Any possible special funding should be coordinated with other existing fund sources such as the Agricultural Conservation Program (ACP) dollars through the ASCS of the USDA, the Agricultural Drainage Fund and Water Conservation Bond Act of the state, etc.

Public involvement through Resource Conservation Districts is crucial for the success of any analysis effort and prepares the way for possible project or other intervention in the future. This point deserves special attention, because ultimately it is up to local interests to implement needed changes and it is our role to lead the process towards those ends. Water-bodies usually receive pollutants from multiple sources, from surface run-off as well as groundwater and co-mingling of pollutants from variuos sources (and the various landuses which produce the pollutants) inevitably occurs to one degree or another. For example, the irrigated agricultural lands adjacent to a particular river would be the most likely source of NPSP and quickly be presumed the most critical to the river's water quality. Analysis of other sources and jointly used surface and subsurface drainage ways might well indicate that the most important source of a given pollutant is upper-slope rangeland or stream channels themselves. Given such a situation, priorities for implementation of future RCD/SCS implementation would be redirected from the apparent to the real source of the problem.

The planning for implementation process as a whole and ideally may be summarized as follows:

- Preliminary review/investigation of a resource concern;
- Natural resource inventory and problem definition (including initial formulation of at least one technically viable alternative, i.e., collective judgement at this stage indicates that a problem exists and something can be done about it);
- Setting planning goals and objectives;
- More detailed investigation and formulation of alternative plans;
- Selection of the recommended plan(s);
- Acquisition of funding, if needed;
- Establish before implementation data collection needs and mechanisms for monitoring progress;
- Guide and monitor implementation;
- Collect after project data to measure actual results;
- Evaluate results;
- Make recommendations for future efforts, if any, and share lessons learned with decision makers and those implementing other efforts;

Keeping the public informed and involving them in the planning process via steering committees, public meetings, interviews, newsletters, etc. is of great importance for establishing priorities. Priorities should be established to target those areas, landuses and BMPs that will yield the best NPSP abatement results. Within areas defined to be critical to water quality a certain number of landusers will be present. Given limited funds for implementation, it may be considered desirable to identify high priority farms. High priority status would mean that they would be the first to receive funds after water quality plans are approved. Low priority farms would be funded as available, if possible and would otherwise have to rely on ACP monies or other sources for implementing recommended BMPs.

Regulatory vs. Voluntary Program Approaches

NPSP planning and project implementation experience to date suggests that the complex, diffused nature of NPSP and further complicating effects from commingled pollutants from both wihin a given study area and from other sources, implies that no single unambiguously superior policy or program approach or mix of policies can be considered the best approach before detailed analysis has been conducted. However, the same experience suggests that the complex nature of NPSP generally renders all but predominantly voluntary programs extremely costly, if not un-implementable.

Regulatory type approaches work best when direct responsibility can be assigned to a small number of individuals and or groups for specific actions contrary to acceptable behavior. Many agricultural settings do not meet such criteria for a regulatory approach to be successful. For example, irrigation applications occur at different times with varied quantities of water used, with different systems and on many different soils and crops. Each crop and sometimes each field is treated with different fertilizers and pesticides with distinct active ingredients, that persist for varied lengths of time and whose decay functions are often very dependent upon changing environmental conditions. Furthermore, with common and commingled outlets for surface and subsurface drainage the viability of a wholly regulatory approach in such an area is especially doubtful, i.e., assignment of direct responsibility for one action or another as with point sources is extremely difficult to document and prove.

Wholly regulatory approaches, under circumstances as described above, tend to require masses of detailed information not currently available, have high monitoring and enforcement costs, including litigation costs and are therefore generally difficult to administer and are generally less effective. Programs/policies relying on voluntary participation, but also involving a mixture of economic and legal incentives/disincentives appear to be preferable. Regulatory disincentives become the method of last resort to deal with those few individuals that occasionally misapply substances or conduct practices that disproportionately contribute to NPSP loadings.

Voluntary participation approaches combined with economic incentives to participate are viewed by growers and the general public as more socially acceptable (see the following section for additional information regarding private economic incentives to achieve public objectives). When combined with economic analysis, voluntary programs can establish reasonable estimates of achievable and justifiable NPSP abatement goals. Coupled with implementation oversight, such efforts can adapt to unforeseen changes to adjust cost/share rates to gain wider participation, to adjust to targeted areas or landuses, favor some BMPs over others as land use changes occur, etc.

Irrigated agricultural areas often are a focus of NPSP debate which might tend toward regulatory approaches given continued rapid population growth in the state and demands for improved water quality by the public at large who are ilprepared to understand natural resource issues. Many areas of the state, including small towns are experiencing rapid population growth and urbanization. On a statewide basis, the rural population as a whole is expected to continue a relative decline in numbers as urban expansion continues. These parallel trends, population growth and increased urbanization, will continue to increase competition with agriculture for land and water. It is therefore in the interest of the agricultural sector to find ways to avoid regulation through means such as voluntary adoption of BMPs and self-regulation if necessary in order to maximize self determination. Competant natural resource planning can effectively provide agricultural interests and public policy makers with information and the means to achieve common goals and minimize rural/urban conflicts.

Economics and Natural Resource Planning

The purpose of this section is to provide some additional more specific information on economics and planning for NPSP abatement. The purpose of the economic dimension of planning is fundamentally to answer the following simplified questions: (a) Is there an economically justifiable alternative to the present condition? (b) If the answer to (a) is yes, then can or will the neccessary change be achieved without public leadership or financial assistance? If not, then is there a need for some sort of public coordination, works or publicly funded compensation of private citizens to achieve certain public objectives and if yes, then how much and for which items? and (c) If there isn't an economically justifiable option, which alternative will achieve a given water quality objective at least cost? Of course many related questions must also be addressed during the planning process. For example, there may be more than one justifiable alternative, with one or more being better than the rest. In addition, given limited resources to solve problems, priorities have to be established, etc.

Economics can play a very important role in addressing these planning concerns taking in to consideration both the farmer and public perspectives. The two perspectives are complementary because any successful policy, program or project should serve societal objectives, at as low a cost as possible. To do this, changes in private, farm level decision-making and operations must be made. Without an understanding of farm level decision-making about BMP adoption or rejection, the public objectives can't be attained in an efficient and socially acceptable manner.

Farmers, like most business persons are interested in maximizing profits. To do this farmers in general attempt to minimize costs and maximize returns. Product prices, input costs and operational expenses are the variables they monitor to guide their decisions. All ascertainable and relevant benefits and costs of production will be included in their decision calculations only to the extent that the farmers enjoy all benefits and/or bear all costs of production. Unfortunately, the nature of NPSP from agricultural lands usually means that other individuals located down-slope have to bear the societal costs of production which the farmer generally does not have to deal with. In other words, others unrelated to the farm enterprise, have to deal with part of the consequences (costs usually) associated with farming practices.

If collective action can result in a more equitable and efficient outcome where the costs to society as a whole are lower than the total benefits (damage reductions or cost savings, plus net farmer income, etc.) then action is clearly justifiable. Stated differently, for various reasons private market forces alone are not funtioning completely to reflect all costs and benefits to farm in ways that result in excessive NPSP loadings. This suggests a role for government and underlies the justification for the existence of agencies such as our own. Private organizations, markets and government are simply alternative forms of social organization. Government activities obviously should be complementary to the former and special interventions should only be undertaken when there is a clear rationale.

When public intervention is clearly advantagous, implementation efforts should target those changes in private behavior which support public interests at minimum cost. This approach has been termed the public use of private interests and is considered the most efficient and prefered way to achieve societal objectives in a non-conflictive manner. In essense, successful intervention brokers a mutually satisfactory compromise where excessive conflict of interests and competing resource useage previously existed.

The public use of private interests in planning for water quality improvements directly addresses the fact that private economic incentives to achieve conservation and NPSP objectives are usually weak, i.e., it is often less costly to erode, dump drain and surface waters, than to not do these things. Especially when irrigation water is very inexpensive as in many areas of the state. This situation provides a reason for exploring justifiable compensatory mechanisms, such as cost sharing, tax incentives, and regulatory disincentives to achieve mutually agreed upon goals. Specifically, the reduction of NPSP from upstream sources as a result of cost shared BMPs in any given area may be less expensive than removing and/or nuetralizing the pollutants downstream via water treatment facilities, the dredging of canals, etc.

In order to deal in practical terms with the theoretical issues mentioned above, an interdisciplinary team of technical specialists (hydrologists, geologists, agronomists, soil scienctists, etc.) along with economists have to define the resource situation and assess the magnitude of present damages resulting from NPSP loadings to recieving water bodies. Assuming that a reasonable degree of understanding can be made of the present situation, current trends must be evaluated to project their probable impact on the present condition.

This allows the team of specialists to define the area's future without any special project or other intervention. The future with some sort of intervention is then developed. Alternative treatments are evaluated for their technical effectiveness and economic implications. The future without project is then compared to the future with project scenario. The difference between the two is the impact of the project. If the net effect is positive overall, then a justifiable project has been found. If the net effect is negative, then cost effectiveness criteria could still be pursued to achieve benefits which can't be quantified due to problem complexity, i.e., movement towards achievement of a critical mass nature could justify intervention to deal with problems with many unknown relationships and outcomes.

Numerous justifiable alternatives could be found each with different total cost and benefit levels, but favorable benefit/cost ratios. Alternatively, several cost-effective alternatives could be found, one for each level of NPSP abatement being analyzed, e.g., 50%, 75%, or 90% reductions. This is were decision makers should provide guidance to establish water quality goals, i.e., choose between the alternative plans to decide what level of NPSP abatement should be targeted given budget constraints and other considerations. It is worth noting here that, in general, the greater the NPSP reduction sought, the higher the cost to achieve this will be.

As stated before, it is crucial that on-site evaluations be made to understand farm level operations before component practices (BMPs) of a resource management system or subsystem are selected. This is essential during implementation. During planning this presents a special challenge because site specific evaluations of all farming units can not nor should be made. To deal with this, representative situations can be evaluated to assess specific BMP technical, economic and financial viability for typical farm resource/landuse/financial situations. Those practices that can be expected to pay for themselves should be the focus of information campaigns. Those which, on the average, will not pay for themselves or will cause cash-flow dificulties naturally become the focus for possible cost sharing.

The Economics of Selected Irrigated Agriculture BMPs

Ten BMPs will be discussed based on previous work in Stanislaus county and information extracted from the technical appendix to "Farming and Water Quality: A Handbook for the Lower San Joaquin River Basin", November 1983. The average annual costs presented for each BMP have been updated to present values using index numbers of prices paid by farmers for production items, interest, taxes and wage rates reported in "Agricultural Prices", 1985 and "Agricultural Outlook", November, 1988 (1988 index divided by the 1983 index = 162/159 = 1.02 = price adjustment factor). The BMP costs are assumed to be generally representative of irrigated agriculture farming conditions. This assumption should be validated before using this information in any other area given the varied and site specific nature of agriculture.

This last point deserves additional commentary. The physical/biological effects and resultant economic consequences of soil and water conservation efforts are very site specific due to variation in soils, slope, rainfall, crops, amount of irrigation water applied, management level, etc. In addition, there are many possible combinations of BMPs and the order in which they may be applied. In addition, changes in management are very difficult to assess and yet they could be the most important factors relating to the relative success or failure of a given practice or system of practices. Maintenance can also be critically important to the continued proper performance of some practices. Therefore, the degree to which changes in operations would impact a given farmer's net income is highly variable and also dependent upon each ones fixed and variable cost structures, changing market prices for inputs and products, government programs, etc.

The following information on ten selected BMPs will suffice to summarize their economic and NPSP abatement characteristics. A rationale for setting water quality objectives and developing implementation strategies will also be discussed. The ten BMPs are:

(1) Cover crops;
(2) Permanent solid-set sprinkler irrigation;
(3) Shortened irrigation runs (800' to 600'as an example);
(4) Land leveling;
(5) Tailwater recovery systems;
(6) Non-irrigated pasture improvement (rangeland planting and fertilizing);
(7) Sediment control basins;
(8) Irrigation water management evaluation followed by management changes;
(9) Irrigation scheduling services; and
(10) Drip irrigation systems;

Other irrigated agriculture BMPs that should be reviewed individually and in combination with others include:

- Irrigation Evaluations;
- Irrigation Water Management;
- Conservation Cropping Sequence;
- Irrigation Land Leveling;
- Irrigate Alternate Furrows;
- Closed-Border Irrigation;
- Border-Strips, Non-tilled;
- Tailwater Reuse Downslope;
- Grassed Drainage Ditches;
- Vegetative Filter-Strips;

- Cover Crops;
- Irrigation and Drainage Pipelines;
- Gated-Surface Pipe;
- Automated Surge Irrigation Systems;
- Solid-Set Irrigation Systems;
- Drip Irrigation Systems;
- Micro-Spray Irrigation Systems;
- Debris Basins with Outlets; and
- Debris Basins with Tailwater Recovery Systems;

The following table rank orders the ten selected BMPs by average annual cost/acre assuming average to above average management skills:

BMP	Average Annual Cost/Acre
1.Sediment control basin	$5
2.Non-irrigated pasture improvement	$6
3.Tailwater recovery system	$9
4.IWM evaluation	$10 - $15
5.Irrigation water scheduling	$15
6.Cover crop	$26
7.Land leveling	$32
8.Shortened furrows	$78
9.Sprinkler irrigation system	$300 - $500
10.Drip irrigation system	$300 - $500

The following table rank orders the ten selected BMPs by percent reduction in surface water sediment, a pollutant itself and a proxy for others that attach to sediment particals:

BMP	Reduction in Surface Water Sediment
1.Drip irrigation systems and 2.	90%
Sprinkler irrigation systems	90%
3.Sediment control basins	70%
4.Tailwater recovery systems	60%
5.Land leveling	50%
6.Cover crops	40%
7.Non-irrigated pasture improvement	30%
and 8. IWM evaluations	30%
9.Irrigation water scheduling	20%
and 10. Shortened furrows	20%

Given that many other NPSP pollutants, DDT for example, are attached to soil particles, it is reasonable to assume that significant reductions of these will also occur with the above practices. If sediment delivery is controlled and tailwater recovery systems are also employed, then substantial improvements to surface water quality can be expected. However, groundwater could be impacted negatively. This points out that BMPs alone or in combination can be very effective, but care must be taken to formulate solutions to surface water quality problems that minimize other possible detrimental impacts. It also implies that planning emphasis be made to analyze the potential for widespread use of two of the BMPs above, in combination; sediment basins and tailwater recovery systems. Finally, it is also noteworthy that those BMPs which represent long-term capital improvement investments, and also result in substantial sediment delivery reductions, should be given special attention from the perspective that they would tend to minimize project exposure to future risks associated with unforseen changes in landuse.

The data presented above regarding costs and effectiveness does not address two related issues of great importance, economic and financial feasibility of BMPs. Fundamentally, growers have to be convinced that a given BMP or combination of BMPs will pay for themselves (economic feasibility question) and improve operations before they will consider adoption. However, being convinced that the benefits of a given practice or combination exceed their costs is not sufficient to assure adoption. The considered change must also fit within the individual firms financial capabilities. In other words, the economic feasibilty could be positive, but the grower might be unable to adopt the desired change due to high initial costs and subsequent cashflow limitations.

Of the above practices analyzed in "Farming and Water Quality: A Handbook for the Lower San Joaquin River Basin", November 1983, only two were found to have a negative impact on average annual net income, sprinkler irrigation on walnuts when converting from flood irrigation and sediment control basins. However, sprinkler irrigation on almonds when converting from furrow irrigation was found to have a positive net effect on income. All but two of the above mentioned BMPs, IWM evaluations and irrigation scheduling, were analyzed in the study from a partial budget analysis perspective which focusses only on those items affecting costs and returns which change as adoption is made. These results therefore suggest that the economic feasibility of most of these BMPs is positive. This may or may not still be true today, but the absense of predominant application of these practices on the West-side implies that some other factors have not been accounted for; perhaps the financial feasibility is questionable for some, maybe associated management skills and levels of effort required are more demanding, etc.

These concerns should be addressed before any implementation begins. Once they have been given due consideration, then BMP application can be linked with high priority areas and landuses. This will allow planners to aggregate expected participation and effectiveness up to the entire target area and estimate total project cost, expected total cost share dollars needed, etc. The expected results will then have associated levels of NPSP reduction and their respective price tags which will facilitate establishment of NPSP abatement goals that are reasonable and achievable.