ANNUAL REPORT
FOR 1997

STATUS OF IMPLEMENTATION OF
SENATE BILL 90-126
THE AGRICULTURAL CHEMICALS AND
GROUNDWATER PROTECTION ACT

Colorado Department of Agriculture
Colorado State University Cooperative Extension
Colorado Department of Public Health and Environment

AGRICULTURAL
CHEMICALS
AND
GROUNDWATER
PROTECTION

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AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

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Annual Report For 1997

Status of Implementation of Senate Bill 90-126 Agricultural Chemicals and Groundwater Protection Act

In the annual report for 1996, several goals for 1997 were identified by the cooperating agencies. The progress made toward each of the goals is detailed in the following pages.

Memoranda of Understanding

Memoranda of Understanding as provided in Section 25-8-205.5 (3)(f) and (g) of the Act have been signed for fiscal year 1997/98 between the Colorado Department of Agriculture and: 1) Colorado State University Cooperative Extension, and 2) the Colorado Department of Public Health and Environment. The objectives for 1998 for this program are stated on pages 10 and 11.

Education and Communication

Communication is a vital component of the program. Numerous methods are used to provide information to individuals and organizations affected by the program as well as the general public. Fact sheets are prepared to provide information on the program and are being distributed at meetings, conferences and trade shows. Also, a display board is being utilized at conferences and trade shows to provide information on the program. Videos entitled Protecting Colorado's Groundwater and Best Management Practices for Colorado Agriculture are available to inform the general public on groundwater quality, agricultural chemicals and the Act. These videos may be borrowed from the Department of Agriculture or copies may be purchased from the CSU bulletin room. Information on the program is continually being presented to the public through radio shows, mass media, press releases and at presentations at meetings throughout the state.

Development pressures in once rural outlying areas have heightened public awareness of the potential for impacts to water quality. The program has responded to these concerns by offering technical assistance to water conservancy districts, groundwater management districts, and other local entities interested in evaluating water quality in their area. Presentations of how the program works, past and present water quality projects, and plans for future projects with request for local input are made at every opportunity. We consider this type of outreach an important part of the customer service component of the program.

The initiation of the National Certified Crop Advisor program in Colorado has dovetailed into this program to provide a mechanism for training and education regarding the correct use of agricultural chemicals. Over 180 crop consultants and advisors have passed the national and state exam and proven sufficient experience to be certified as crop advisors in Colorado. These individuals and others to be certified in the future are required to obtain continuing education units to maintain their certification. This affords an ideal opportunity to provide information concerning pesticides and fertilizers and groundwater protection to those making recommendations to farmers.

Best Management Practices

Best Management Practices (BMPs) are being developed at the user level through extensive local input. A general BMP notebook for Colorado Agriculture has been completed and consists of eight subject specific BMP chapters and one booklet providing an overview of the BMP process. The notebook has been provided to producers, pesticide and fertilizer dealers, CSU Cooperative Extension offices, and all USDA Natural Resources Conservation Service offices. All of the BMP chapters are available through the CSU Bulletin Room.

In 1996, an economic analysis of the BMPs was performed to determine the cost of implementing the BMPs that required purchasing a service or product to adopt the practice. This information has been condensed into two fact sheets that agricultural chemical users can easily utilize. The two fact sheets are titled, Economic Considerations of Nutrient Management BMPs and Economic Considerations of Pest Management BMPs (Appendix I).

The statewide notebook is being utilized to guide local work groups through the BMP development process for regionally specific BMPs. Localized BMP development is continuing in the San Luis Valley, the South Platte River Basin from Denver to the Nebraska state line, and the Uncompahgre Valley of the western slope.

In the San Luis Valley, a booklet entitled Best Management Practices for Nutrient and Irrigation Management in the San Luis Valley was completed in 1994 and published in cooperation with the San Luis Valley Water Quality Demonstration Project. The group then began developing pesticide management BMPs for specific crops in the San Luis Valley. They have published their findings in two booklets entitled: Best Management Practices for Potato Pest Management in the San Luis Valley and Best Management Practices for Small Grain Pest Management in the San Luis Valley.

A local group centered in the Montrose area of the Uncompahgre Valley, headed by the Shavano Soil Conservation District, developed and published practices appropriate to this area on the western slope entitled: Best Management Practices for the Uncompahgre Valley.

Localized BMPs for the Front Range/South Platte Basin have also been completed. A document entitled Best Management Practices for Irrigated Agriculture was published from this group's efforts. In addition, a booklet was developed of BMPs specifically for irrigated barley production. This booklet was published and is entitled Barley Management Practices for Colorado: A Guide for Irrigated Production. (Appendix I)

Based on groundwater monitoring results through 1994, it was determined that additional resources also needed to be focused on the South Platte Basin. The legislature funded one additional FTE to focus on water quality educational activities in this area. This has greatly enhanced the programs ability to provide information and work with farmers in this area.

To assess program progress, we surveyed approximately 3500 irrigated crop producers state wide in the winter of 1997. We wanted to learn the status of BMP adoption and possible barriers to change. The confidential survey instrument asked producers questions about what specific BMPs and irrigation management and technology they used, and what information sources they utilized for production decisions. Producers returned more than 1300 surveys for a 40%

response. We evaluated BMP adoption with respect to farm size, livestock type and number, land ownership, irrigation experience, and educational level. We also learned about what water quality concerns producers have and their perceptions of CSU's work on water management.

In an effort to provide increased access to the BMPs as well as articulate the need for farmers to adopt water quality protection practices, a 20 minute instructional video was produced entitled: "Best Management Practices for Colorado Agriculture". The video show farmers speaking to why they have adopted practices and the need for continued diligence on their part to protect water quality. The video is available from the CSU Bulletin Room.

The use of pesticides and commercial fertilizers in urban areas also has the possibility to impact groundwater resources. Four fact sheets describing BMPs for urban pesticide and fertilizer have been developed and distributed. The four fact sheets are entitled: Homeowner's Guide to Protecting Water Quality and the Environment, Homeowner's Guide to Pesticide Use Around the Home and Garden, Homeowner's Guide Alternative Pest Management for the Lawn and Garden, and a Homeowner's Guide to Fertilizing your Lawn and Garden. These fact sheets are available from the CSU Bulletin Room or the Colorado Department of Agriculture.

Demonstration Sites and Field Days

Field demonstrations continue to be an integral part of the program to demonstrate BMPs to farmers. In 1997, work focused on crediting nitrogen in irrigation water. Four demonstration sites were used to show this practice.

The objective of these demonstration trials was to compare crop yields where the fertilizer rate was reduced by accounting for (or crediting) the NO3-N supplied from the irrigation well water. Three different crops were grown at the sites: field-corn for grain and silage and hard red winter wheat. The irrigation nitrogen credits at the sites ranged from 30 to 50 pounds per acre. Irrigation water quantity was measured at each site to determine if the full amount of the credited nitrogen was applied. At three of the four sites atmometers were installed to demonstrate a simple method of keeping track of crop water use (ET) for more efficient irrigation scheduling. A fact sheet is being developed to explain the demonstrated practice, describe the trial objectives, and provide the results with information on fertilizer cost savings.

A new technology known as in-season nitrate testing was highlighted for demonstration. This tool may help farmers improve nitrogen recommendation accuracy and minimize the use of "insurance" fertilizer. Demonstration plots and field days will be utilized in the South Platte River Basin in 1998. In the future, locations for these plots will be expanded to other regions of the state. (Appendix II).

Groundwater Monitoring

The 1997 monitoring program began a regional groundwater quality baseline study for the Colorado High Plains region. The Colorado High Plains, Ogallala aquifer is the largest aquifer in the state and is a sole source water supply for the 12,000 square miles it underlies. The Ogallala aquifer is recharged solely by precipitation and withdrawals exceed recharge. Therefore, the aquifer is essentially a nonrenewable resource. The High Plains is one of Colorado's major agricultural regions and the economy of the region is based upon irrigated agriculture.

One hundred twenty four samples have been collected to date with a goal of 150 samples. All sample points to date are existing wells that are privately owned and permitted as domestic wells. The samples were analyzed for nitrate and 45 pesticides. Preliminary analysis of the nitrate and pesticide data indicates that ground water in the majority of the area sampled has been impacted by current agricultural practice but the levels of contamination are manageable. The major inorganic contaminant of concern in this area is nitrate. Nitrogen analysis indicated that no wells tested for a level of nitrate / nitrite as nitrogen below the laboratory detection limit of 0.5 mg/L (parts per million). Ninety four percent of the wells tested in the range of 0.5 to 9.9 mg/L, indicating nitrogen present but below the drinking water standard of 10 mg/L. Six percent of all the wells exceeded the nitrate drinking water standard of 10 mg/L. The majority of these seven wells fell in the range of 13 to 15 mg/L with a high of 33 mg/L. The drinking water standard is used as a benchmark for nitrate levels in all wells regardless of use. Pesticide data revealed three pesticides, Atrazine, Bromacil, and Prometon present in the well samples. The breakdown product of Atrazine, Deethyl Atrazine was also present. The pesticide levels ranged from the laboratory detection limit of 0.1 ug/L (part per billion) to 1.4 ug/L. Seven wells tested positive for Atrazine, five for Deethyl Atrazine, and two each for Bromacil and Prometon. One well exceeded the water quality standard for Atrazine at 4.2 ug/L. This well is not currently being used as a drinking water supply.

Nineteen ninety seven was the third year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. From June through August, 1997, 78 wells located in Weld County were sampled. Two types of existing wells were used, 21 monitoring wells operated by the Central Conservancy District and 57 irrigation wells sampled in 1989, 1990, 1991, 1994, 1995, and 1996. All wells were analyzed for nitrate / nitrite as nitrogen. The 21 monitoring wells were analyzed for the complete suite of 45 pesticides. The pesticide analysis for the irrigation wells was a immuno assay screen for the triazine herbicides. Nitrogen analysis indicated that 71% of the monitoring wells and 74% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels ranged from a low of 1.9 mg/L nitrate as nitrogen to a high of 46.4 mg/L. In the irrigation wells, nitrate levels ranged from below our detection level of 0.5 mg/L nitrate as nitrogen to a high of 43.5 mg/L. Pesticide data revealed four pesticides, Atrazine, Metolachlor, Metalaxyl, and Prometone present in the monitoring well samples. The breakdown product of Atrazine, Deethyl Atrazine was also detected. Atrazine was present in 33% of the wells, Deethyl Atrazine in 52% of the wells, Metolachlor in 24% and Prometone in 52%. Metalaxyl was detected in only one well. The level of Metolachlor reached 6.6 ug/L (ppb) in one well. Detection levels for the other pesticides averaged around one ppb. (Appendix III)

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, and Prometone. The results are calibrated in units of Atrazine equivalent but may be actually composed of one or more of the components. In 1997, triazine herbicides were detected in 95% of the irrigation wells. Levels ranged from 0.05 ug/L to 1.30 ug/L (ppb).

In cooperation with a major manufacturer of Atrazine, Novartis Crop Protection Company, all samples collected in Weld County this year were analyzed by Novartis's laboratory for all the metabolites (break down products) of Atrazine. Recent research has suggested that the ratios of these break down products to the parent may be an indicator of the amount of time the contaminate has been in the environment. If this proves to be true we will have the data on file for this special type of analysis.

The monitoring program included sample collection, laboratory analysis, and data analysis and storage. This survey, in combination with concurrent work, (Appendix III) should establish a current baseline for agricultural chemicals in ground water in this area. Upon completion of the sampling and a full analysis, which should include integration with previous and current studies by other agencies, the resulting sampling program will provide the basis for determining a groundwater quality baseline for this region.

Groundwater Vulnerability Determination

In the initial years of the program, vulnerability analysis was performed to prioritize groundwater monitoring and education efforts. To perform this analysis, current information was synthesized and priorities were developed; however, maps were not developed. The requirements of the proposed rule for State Management Plans for Pesticides being promulgated by EPA requires development of a sensitivity analysis/vulnerability assessment map of the state in a Geographic Information System (GIS) format by which to determine where to focus education and monitoring activities. Through grant funds from EPA, a sensitivity analysis pilot project was conducted to determine the sensitivity of groundwater to impact by pesticides for the northeastern part of the state. The process was received favorably by EPA. Additional grant funds were requested and have been received from EPA to complete the sensitivity analysis for the remainder of the state. This will be completed in 1998.

Groundwater Data Management System

The collection, evaluation and entering of existing groundwater quality data from all available sources is ongoing. The data that is currently available has been or is in the process of being entered into the groundwater quality database at the Department of Public Health and Environment. Other data has been generated, however it remains unavailable due to concerns about privacy and future use of the data (Appendix III).

Advisory Committee

The advisory committee continues to be an integral part of the implementation of this program by providing input from the many facets of the agricultural community and the general public that they represent (Appendix V). The committee met two times during 1997. All major program activities are discussed with the committee prior to implementation. The committee has been essential in providing input on program strategy by helping to determine which issues to address first, where geographically to focus efforts, critiquing drafted documents, providing ideas about the most effective means of distributing materials, and giving comments on how the information will be received, in addition to many other items.

Coordination

Coordination with other projects and programs relating to agricultural chemicals and groundwater is an essential part of the implementation of the program. All three agencies work continually to keep abreast of other programs both governmental and private so information can be incorporated into the implementation of the Act as well this programs information passed on to other agencies and organizations. Input is sought in all phases of the implementation of this program to avoid duplication of efforts, costs, conflict or duplication of regulation and to insure decisions are made with the most complete knowledge available.

Storage Regulations

The rules and regulations as required in section 25-8-205.5 (3) (b) became effective September 30, 1994 (Appendix IV). Owners of pesticide facilities were required to have their operations in compliance by September 30, 1997. Fertilizer facilities are required to be in compliance by September 30, 1999.

As in 1995 and 1996, the first nine months of 1997 was spent educating and providing information about the requirements of the rules and the time line for implementation. Generic design plans for small to medium sized facilities have been developed and are available to assist operators of smaller facilities. In addition, inspection forms were developed and an initial database was designed to track compliance of facilities.

In 1997 the Colorado Department of Agriculture received approval from the General Assembly to hire one FTE to perform the facility inspections. Inspections began in late 1997 and are progressing well.

State Management Plan for Pesticides

EPA is developing a program which would require states to produce management plans for pesticides thought to be a significant groundwater hazard. If a state wants to allow continued use of any of the pesticides identified, it must produce an EPA-approved management plan specific to that pesticide.

The program is continuing to develop a generic State Management Plan for EPA concurrance. This plan can then be adapted to different pesticides once EPA formally identifies these compounds. A draft plan was submitted to EPA for review in late 1996. Comments from EPA were received in early 1997.

In September a meeting was held with pesticide managers from the six Region VIII states and EPA personnel to discuss the concerns and issues relating to the lack of concurrence by EPA on generic plans. Some issues were resolved and it was agreed that Colorado would submit another draft of the generic plan for review in January 1998.

One requirement of the State Management Plan is to have county level pesticide use data. This data has never been developed for Colorado. To meet this need, grant funds from EPA have been obtained and the Colorado Agricultural Statistics Service was contracted to perform a pesticide use survey. The survey began in October of 1997 and will be completed in mid 1998. This should provide excellent data regarding pesticide use in Colorado.

Major Issues

The SMP is still a major concern. In the comments developed regarding the proposed rule, the program expressed its many concerns. In addition, the Colorado Department of Agriculture worked with the National Association of State Departments of Agriculture and the Association of American Pesticide Control Officials to provide comments and input to EPA on the proposed rule.

As mentioned above, there are also concerns with regional concurrance of the plan. Hopefully as a result of the pesticide managers meeting held in September some of these issues can be resolved.

Objectives for 1998 Determined

The following objectives for 1998 have been established:

- Continue the development and implementation of localized BMPs for irrigated crops in the South Platte River Basin;
- Continue demonstration plots in the South Platte River area for displaying improved nitrogen and water management to farmers;
- Coordinate an interagency program to deal with water quality issues in the South Platte River Basin;
- Continue the implementation of localized BMPs in the San Luis Valley and complete development of the localized pesticide use BMPs for the major crops;
- Continue BMP demonstration work in the San Luis Valley;
- Begin BMP implementation and demonstration in the Uncompahgre Valley;
- Continue the distribution of the BMP video;
- Continue distribution of the fact sheets on the economic considerations of BMP adoption for nutrient and pest management;
- Complete the report summarizing the data on the number of producers who have implemented best management practices and which practices they are adopting;
- Continue developing educational resource materials for groundwater education;
- Continue distribution of urban BMPs to encourage improved agricultural chemical and water management in urban areas;
- Continue to hold in-service training for chemical applicators, agency personnel, etc.;

- Participate in the Certified Crop Advisor program;
- Continue to provide information and training on the containment rules and regulations;
- Continue performing inspections of facilities requiring compliance with the containment regulations;
- Complete collection and analysis of groundwater samples in the Ogallala aquifer for pesticides and nitrate;
- Collect and analyze groundwater samples in western Colorado for pesticides and nitrates;
- Continue the long term monitoring program in Weld County by collecting and analyzing groundwater samples for pesticides and nitrate;
- Complete the sensitivity analysis of groundwater to impact by pesticides for all of Colorado;
- Complete the pesticide use survey for Colorado;
- Obtain concurrence from EPA on the generic State Management Plan for pesticides;
- Obtain and input results of other groundwater monitoring for agricultural chemicals into the Agricultural Chemicals and Groundwater database;
- Integrate results of other projects to achieve goals in the Act;
- Continue disseminating information on the Act and groundwater protection to special interest groups in Colorado;
- Continue publishing and distributing fact sheets;
- Continue using the display board to provide information on the program at trade shows and professional meetings.

APPENDICES

TABLE OF CONTENTS

APPENDIX I

Documents Produced and Disseminated for the Agricultural Chemicals and Groundwater Protection Program

Program Information

- ☐ Agricultural Chemicals and Groundwater Protection Program Brochure
- ☐ Annual Report - Status of Implementation of Senate Bill 90-126, The Agricultural Chemicals and Groundwater Protection Act
- ☐ Rules and Regulations Pertaining to Commercial Fertilizers and Pesticides at Storage Facilities and Mixing and Loading Areas and Related Sections of the Colorado Water Quality Control Act - Effective September 30, 1994
- ☐ Summary of Rules and Regulations for Bulk Storage Facilities and Mixing and Loading Areas for Fertilizers and Pesticides - Fact Sheet #8
- ☐ Agricultural Chemical Bulk Storage and Mix/Load Facility Plans for Small to Medium-Sized Facilities
- ☐ Web sites:
  www.ag.state.co.us/DPI/programs/groundwater.html
  www.ColoState.EDU/Depts/SoilCrop/extension/WQ

General Best Management Practices

- ☐ Best Management Practices for Colorado Agriculture: An Overview #XCM-171
- ☐ Best Management Practices for Nitrogen Fertilization #XCM-172
- ☐ Best Management Practices for Irrigation Management #XCM-173
- ☐ Best Management Practices for Manure Utilization #XCM-174
- ☐ Best Management Practices for Phosphorus Fertilization #XCM-175
- ☐ Best Management Practices for Crop Pests #XCM-176
- ☐ Best Management Practices for Agricultural Pesticide Use #XCM-177
- ☐ Best Management Practices for Pesticide and Fertilizer Storage and Handling #XCM-178
- ☐ Best Management Practices for Private Well Protection #XCM-179
- ☐ Best Management Practices for Water Quality - Fact Sheet, January 1993
- ☐ Best Management Practices for Turfgrass Production - Fact Sheet, June 1993
- ☐ Best Management Practices for Agricultural Chemical Handling, Mixing and Storage - Fact Sheet #7, April 1994
- ☐ Soil, Plant, and Water Testing Fact Sheet #11, April 1997
- ☐ Economic Considerations of Nutrient Management BMPs Fact Sheet #13, July 1997
- ☐ Economic Considerations of Pest Management BMPs Fact Sheet #14, July 1997
- ☐ Pesticide Record Book for Private Applicators

Local Best Management Practices

- ☐ Best Management Practices for Nutrient and Irrigation Management in the San Luis Valley - March 1994
- ☐ Best Management Practices for Irrigated Agriculture: A Guide for Colorado Producers - August 1994
- ☐ Best Management Practices for Integrated Pest Management in the San Luis Valley: Small Grains #XCM-195
- ☐ Best Management Practices for Integrated Pest Management in the San Luis Valley: Potato #XCM-196
- ☐ Best Management Practices in the Uncompahgre Valley: Making Vital Decisions
- ☐ Barley Management Practices for Colorado: A Guide for Irrigated Production

Homeowner's Guides

- ☐ Homeowner's Guide to Protecting Water Quality and the Environment
- ☐ Homeowner's Guide: Alternative Pest Management for the Lawn and Garden
- ☐ Homeowner's Guide to Fertilizing Your Lawn and Garden
- ☐ Homeowner's Guide to Pesticide Use Around the Home and Garden

Groundwater Monitoring

- ☐ Ground Water Monitoring Activities South Platte River Alluvial Aquifer 1992-1993 Report
- ☐ Ground Water Monitoring Activities San Luis Valley Unconfined Aquifer 1993 Report
- ☐ Ground Water Monitoring Activities Arkansas River Valley Alluvial Aquifer 1994-1995 Report
- ☐ San Luis Valley Fact Sheet #9, February 1995
- ☐ South Platte Valley Fact Sheet #10, March 1995
- ☐ Arkansas Valley Fact Sheet #12, April 1997

Videos

- ☐ Protecting Colorado's Groundwater
- ☐ Best Management Practices for Colorado's Agriculture

To request any of these educational materials please call the Colorado Department of Agriculture at (303) 239-4180 or the CSU Cooperative Extension at (970) 491-6201.

A Guide for Irrigated Production

BARLEY

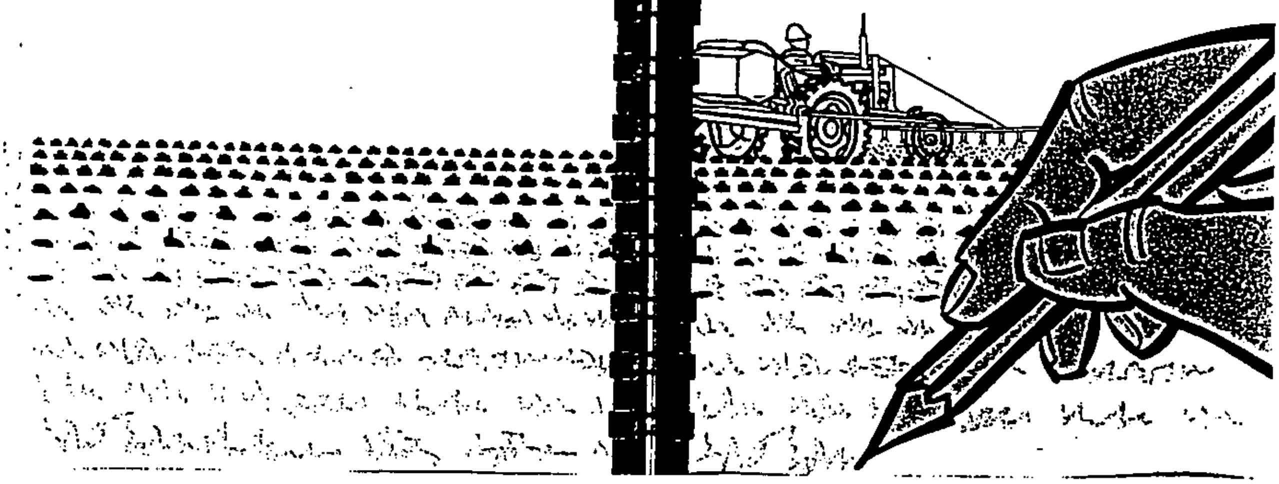
Management Practices for Colorado

Colorado State University

Colorado State University Cooperative Extension

Published with support from the Colorado Department of Agriculture.

Pesticide Record Book
for Private Applicators



PERSONAL INFORMATION

NAME ____________________

ADDRESS ____________________

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TELEPHONE # ____________________

MOBILE # ____________________

PESTICIDE APPLICATOR'S CERTIFICATION NUMBER ____________________

CERTIFICATION EXPIRATION DATE ____________________

OTHER INFORMATION ____________________

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PESTICIDE RECORD BOOK FOR PRIVATE APPLICATORS

The USDA requires private pesticide applicators to keep a record of all restricted use pesticide (RUP) applications. The objective of this pocket record book is to provide you with a simple method to meet the federal record keeping requirements.

This booklet can also be used to jot down other (non-RUP) chemical applications as well. Keeping good records can help save you money and improve farm management.

Guidelines in this booklet are not intended to meet the Colorado record keeping requirements for commercial applicators. Commercial applicators must record additional information beyond what is specified here.

Tables are provided (pages 8 through 47) to record field location, crop, date, pesticide brand name, EPA registration number, acres treated, and total amount (see example on pages 6 and 7). By completing these tables, you are meeting all the federal record keeping requirements for RUPs. This guide has the space to keep records on 20 individual fields.

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Colorado State University Cooperative Extension

In cooperation with the
Colorado Department of Agriculture

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Survey of Irrigation Management in Colorado

Sponsored by:

The Water Center at Colorado State University
Colorado State University Cooperative Extension
Colorado State University Agricultural Experiment Station
Colorado Department of Agriculture

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

Arkansas River Valley Monitoring
Fact Sheet #12
April 1997

Ground Water Monitoring in the Arkansas Valley

The Water Quality Control Division of the Colorado Department of Public Health and Environment (CDPHE) has responsibility under the Agricultural Chemicals and Ground Water Protection Program (SB 90-126) to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. The Agricultural Chemicals Program has been established to provide current, scientifically valid, ground water quality data to the Commissioner of Agriculture. Prior to passage of SB 90-126, a lack of data had prevented an accurate assessment of impacts to groundwater quality from agricultural operations. This program will assist the Commissioner of Agriculture in determining to what extent agricultural operations are impacting ground water quality. The program also assists the Commissioner in identifying those aquifers that are vulnerable to contamination. The philosophy adopted is to protect ground water and the environment from impairment or degradation due to the improper use of agricultural chemicals, while allowing for their proper and correct use.

The ground water quality sampling program is intended to fulfill the following objectives:

- Determine if agricultural chemicals are present in the ground water.
- Provide data to assist the Commissioner of Agriculture in the identification of potential agricultural management areas.

The factors considered in selecting an area for monitoring are:

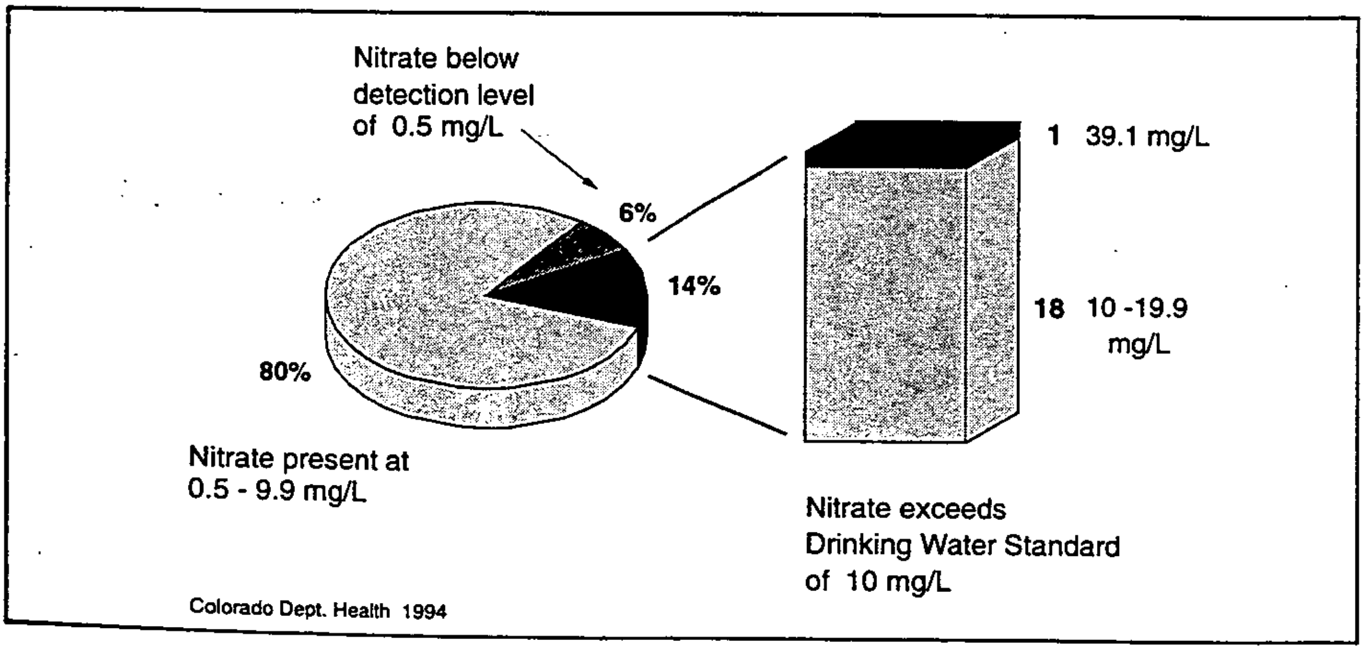
- Agricultural chemicals are used in the area.
- The ground water in the area is shallow in depth or vulnerable to contamination.
- The majority of the agricultural production in the area is irrigated.
- The soil types are prone to leaching.
- The alluvial and /or shallow bedrock aquifers are utilized for domestic water supplies.

The 1994 monitoring program focused on groundwater quality monitoring in one of Colorado's major agricultural regions, the Arkansas River Valley. The monitoring program included sample collection, laboratory analysis, and data analysis and storage. Upon completion of the full analysis, which will include integration with previous and current studies by other agencies, this sampling program will provide the basis for determining a groundwater quality baseline for this region.

The Ag Chemicals Program of the Water Quality Control Division sampled one hundred thirty nine (139) domestic, stock, and irrigation wells throughout the shallow alluvial aquifer that lies along the Arkansas River. The Arkansas valley sampling program was the first effort to screen the entire shallow aquifer to establish the possible impacts and magnitude of agricultural chemical contamination. The Arkansas valley is characterized by intense irrigation agriculture encompassing both surface water diversions and large capacity irrigation wells for irrigation water supplies. The wells supply surface and center-pivot irrigation systems from the shallow unconfined aquifer. This shallow aquifer is also a significant source for domestic and municipal water supplies throughout the valley.

All wells were sampled once between July and December, 1994. Wells were selected for sampling based on the following factors: located within the unconfined valley fill aquifer, cooperation of the well owner, no known construction deficiencies, history of contamination or other local factors that would render the sample unrepresentative of regional ground water quality. All field sampling was performed by Brad Austin and John Colbert of CDPHE. Field sampling procedures followed the protocol developed by the Ground Water Quality Monitoring Working Group of the Colorado Nonpoint Source Task Force.

Well samples were analyzed for basic water quality components (calcium, sodium, sulfate, etc.) dissolved metals, and selected pesticides. The basic and metals analysis was performed by the Soils Laboratory at Colorado State University with all samples split with the Colorado Department of



Nitrate levels in domestic wells in the Arkansas Valley, July - December 1994. Values are given in milligrams per liter or parts per million.

Agriculture Standards Laboratory for nitrate for quality control evaluation.

In addition to the inorganic parameters, all of the groundwater samples collected were analyzed for selected pesticides. The pesticide analysis was performed by the Colorado Department of Agriculture Standards Laboratory. A listing of pesticides was compiled for analysis based on those substances that have recently been, or are currently being utilized in the Arkansas Valley according to agricultural officials there. Budget restrictions would not allow testing for all pesticides used in the study area. To reduce the analysis cost, each pesticide was weighted according to its chemical properties of persistence and mobility in the environment, amount of active ingredient used per acre, and the amount of acreage within the study area that pesticide was used on. Pesticides were then selected according to their final score and the ability of the laboratory to detect their presence.

The results from this sampling program have been entered into the CDPHE Groundwater Quality Data System, a database located at CDPHE. A detailed report describing the area sampled, the protocol for sampling and analysis, and the results of the analysis was provided to the Commissioner of Agriculture in early 1997.

Analysis of laboratory results for the Arkansas Valley indicates that ground water in parts of the study area has been impacted by various agricultural chemicals. The major inorganic contaminant of concern is nitrate. Nineteen of the one hundred thirty nine wells sampled (14%) showed nitrate levels in excess of the EPA standard for drinking water (10 mg/L). The drinking water standard is used as a benchmark for nitrate levels in all wells regardless of use because the alluvial aquifer is a significant source of drinking water in the valley. Twelve of the one hundred thirty nine samples (9%) showed positive for the herbicide Atrazine. One sample detected the herbicide Metolachlor and one sample detected the herbicide 2,4-D. All pesticide detections where well below the drinking water standard.

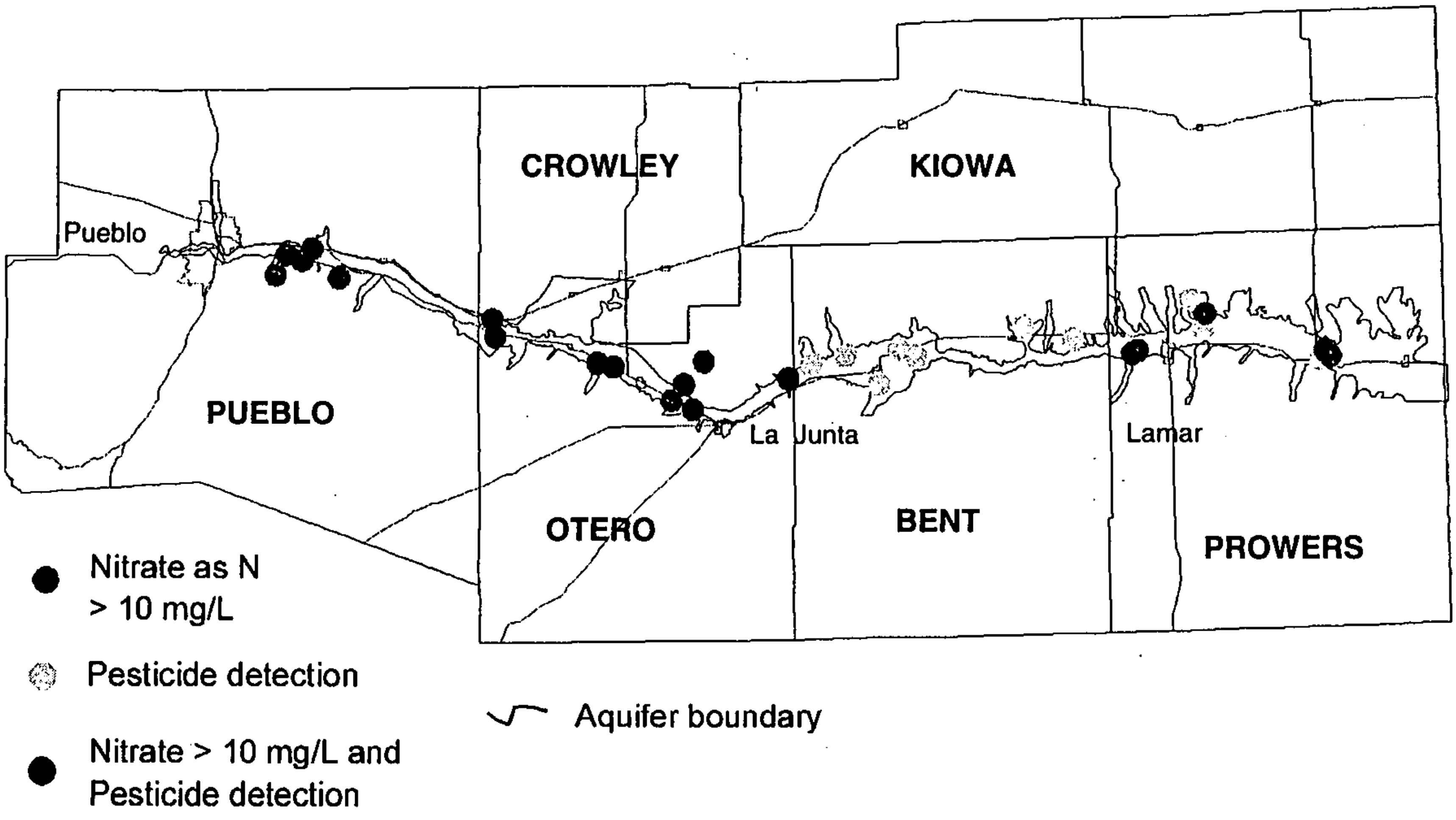
A confirmation sampling was performed on those wells that had a nitrate level above 10 mg/L, or a pesticide detection in 1994. The confirmation sampling tested 32 wells and found little change from 1994, indicating a high level of confidence in the initial work. Nitrate levels were statistically unchanged and the only pesticide detected was Atrazine. One well did contain Atrazine at a level above the standard of 3.0 ug/L.

Results of Pesticide Analysis, Arkansas Valley Aquifer, 1994.

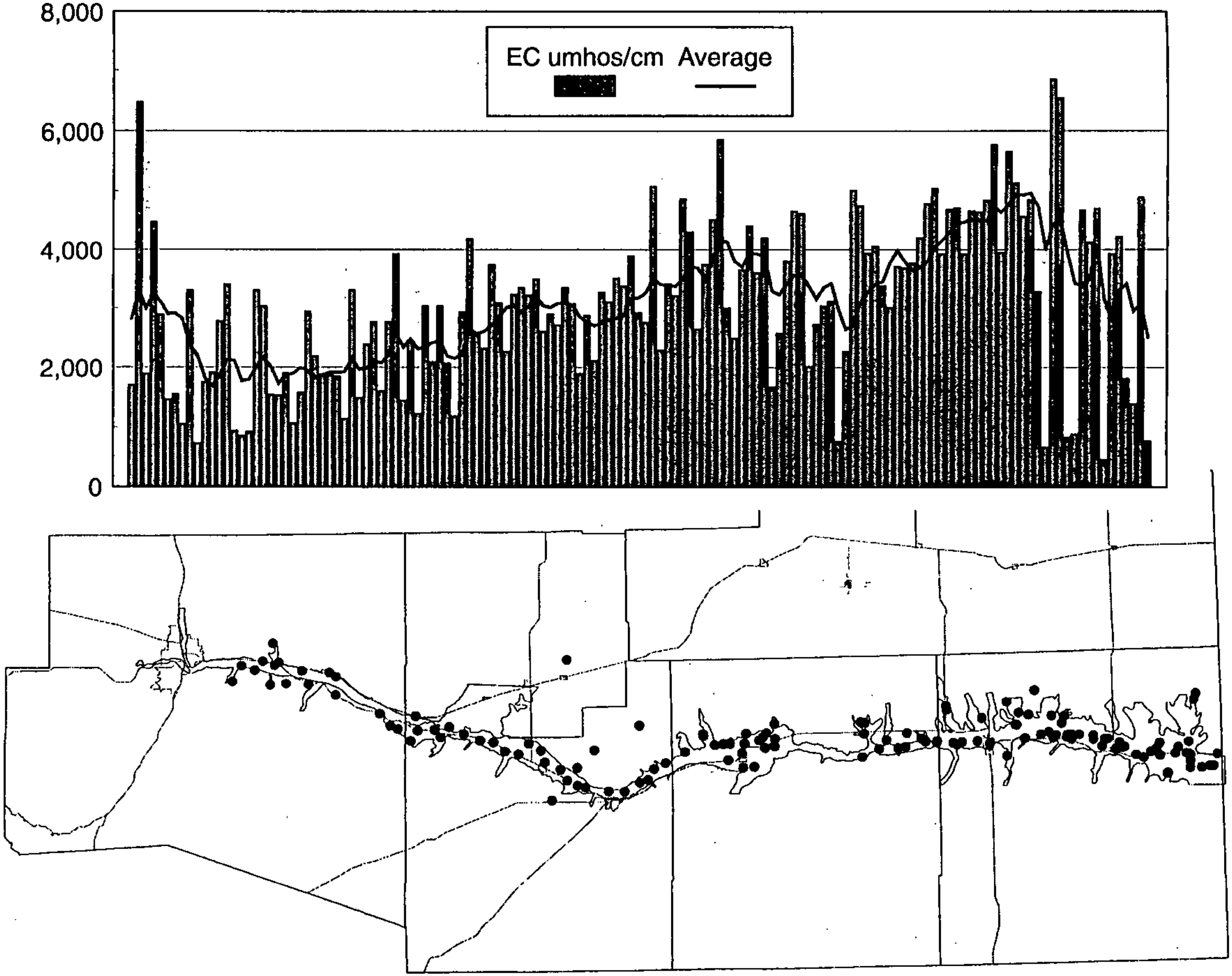
Pesticide	Use	No. Detections	DL	MCL
Atrazine	Herbicide	12	0.05	3.0
Metolachlor	Herbicide	1	0.05	100
2,4-D	Herbicide	1	0.02	70

Amounts are given in micrograms per liter or parts per billion
DL - Minimum concentration that can be detected by the laboratory
MCL - The maximum amount allowed in drinking water

Lower Arkansas Valley aquifer 1994 nitrate and pesticide results



Map showing locations of wells with either Nitrate as Nitrogen greater than 10 mg/L or a pesticide detection. Data collected by the Colorado Department of Public Health and Environment 1994.



Electrical conductivity in umhos per centimeter and corresponding well locations, Arkansas Valley alluvial aquifer, 1994.

The Lower Arkansas River in Colorado, is the most saline stream of its size in the United States. The average salinity levels increase from approximately 300 ppm Total Dissolved Solids (TDS) east of Pueblo to over 4,000 ppm TDS near the Kansas state line. The shallow alluvial wells in the area have similar TDS concentrations. Water containing more than 2,000 ppm TDS has often been assumed to be unsuitable for irrigation. As a result of these conditions, the salinity hazard of ground water pumped for irrigation is of great interest to the agricultural producers in the valley.

Total soluble salt content of irrigation water generally is measured either by determining its electrical conductivity (EC), which is reported as micro mhos per centimeter, or by determining the actual salt content in parts per million (ppm). The figures on page 5 of this fact sheet show the EC measured in ground water as you move downstream from just east of Pueblo to the Kansas state line. The index map below the EC graph shows the well locations. Water with measured EC values above 1500 may have adverse effects on many crops and requires careful management practices. Water with EC values above 3000 can be used on salt-tolerant crops on permeable soils with careful management practices and only occasionally for more sensitive crops.

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AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

July 1997
Fact Sheet #13

Economic Considerations of Nutrient Management BMPs

Concern about nutrients from fertilizers and manure degrading water supplies has resulted in a search for nutrient management approaches that protect water quality. A number of practices (known as Best Management Practices or BMPs) have been identified which can help maximize nutrient efficiency while minimizing environmental problems.

Due to the economic risks inherent in agriculture, producers need incentives to change proven ways of doing business. These incentives may include increased profits, decreased costs, cost-share funding, enhanced water quality, or even improved public perception. Producers should evaluate the potential environmental benefits versus the costs and returns of BMPs as they determine which practices are most appropriate for their operation. Not all practices are equal in their environmental or economic benefit. This publication is intended to help producers think through some of the economic considerations associated with adopting BMPs.

The adoption of BMPs may require changes from existing management and cultural practices. Economic analysis of these changes involves calculation of the costs and benefits of the new system versus the old system. Consideration of new practices can be a complicated decision; there may not be a single factor by which to judge the appropriateness of any particular practice. The economic and financial considerations of BMPs are important parts of the decision process.

The complexity of the economic analysis depends on the particular practice and situation being analyzed. The basic partial budgeting framework can be adapted for any of the BMPs. The calculation of particular costs and returns will be specific to the BMP under consideration and the particular farming situation where it is to be applied. In all cases, only those costs and returns that will be impacted by the change will be relevant to the partial budget decision.

Categories of BMPs

For purposes of economic analysis, BMPs may be divided into four categories. While the basic economic principles of calculating additional costs and additional

BMP Categories

Best Management Practices for nutrient management may be divided into four categories, depending on which types of changes are involved.

1. Changes in fertilizer usage or changes in soil management
2. Changes in cropping practices
3. Changes in tillage or fertilizer application practices
4. Changes in or additions of structures

returns holds for each of the categories of BMPs, the application of these principles can be quite different. It could be as basic as calculating the cost and returns associated with changing fertilizer rate, or as complicated as calculating the costs and benefits associated with investing in secondary containment structures. Secondary containment structures have a considerable lifetime and involve the economics associated with investment analysis. Economic analysis for each of these categories will be discussed.

■ Category 1: Changes in fertilizer usage or changes in soil management

The economic assessment of these types of changes is straightforward. The expected benefits for most of these BMPs will be realized fairly quickly, most often in the first production year. Thus, benefits from this type of BMP will be easy for the farm operator to calculate.

Likewise, the costs of implementing BMPs in this category will also occur in the first production year. The economic analysis involves comparing the added costs with the expected benefits in a straightforward application of the partial budgeting process.

For example, a wheat producer may be considering two alternative levels of nitrogen fertilizer applications. The first involves applying 90 pounds of nitrogen per acre. The yield associated with this level of fertilizer is expected to be 50 bushels per acre. As an alternative, the producer may apply 50 pounds of nitrogen per acre and expect a yield of 47 bushels per acre. If nitrogen fertilizer costs $0.25 per applied unit, the price of wheat is expected to be $3.00 per bushel, the partial budget format can be used to determine the economic consequences associated with reducing nitrogen fertilizer. In the benefits section, there is no additional income as yields are reduced. Expenses are reduced by $10.00 per acre [(90 pounds x $0.25 per pound) compared to (50 pounds x $0.25 per pound)]. Total benefits are $10.00 per acre. In the costs section, income is reduced by $9.00 per acre [(50 bushels x $3.00 per bushel) compared to (47 bushels x $3.00 per bushel)]. There are no additional expenses. Thus, the difference associated with reducing nitrogen fertilizer is a net benefit of $1.00 per acre.

Example Partial Budget for BMP: Fertilizing for optimum economic returns

BENEFITS:

1. Additional Income $ -
2. Reduced Expenses $ 10.00 (40 lb less N/A)

3. Benefits Subtotal (1 + 2) $ 10.00 /A

COSTS:

4. Reduced Income $ 9.00 (-3 bu/A)
5. Additional Expenses $ -

6. Costs Subtotal (4 + 5) $ -9.00

DIFFERENCE: (Benefits - Costs) $ 1.00 /A

Partial Budget: Soil Testing & Reduced Phosphorus Rates

	40 Acre Field	130 Acre Field
Benefits		
Additional Income	0.00	0.00
Reduced Expenses (3 lbs P_2O_5 /ac @ $0.44)	52.80	171.60
Total Benefits	$52.80	$171.60
Costs		
Reduced Income	0.00	0.00
Additional Expenses (soil test)	51.00	51.00
Total Costs	$51.00	$51.00
Difference (Benefits - Costs)	$1.80	$120.60

Soil Sampling

Soil sampling of fields used for crop production can provide valuable information regarding nutrients, soil texture, salinity, pH, and organic matter. Sampling protocol indicates that each sample should contain about 20 cores of soil from a reasonably uniform area of each field. Fields without uniform soil types should be divided into separate sampling units.

Costs associated with soil testing include taking the sample and submitting it to a laboratory for analysis. One person can collect 20 cores of surface soil from a uniform field and mail the sample to a laboratory in about one hour. Labor costs would be $10.00 and postage would be $3.00. Some crop consultants include soil sampling with their per acre charge for all provided services.

A routine soil test averages $30.00 with a range of $9.50 to $60.00 according to a 1995 survey. If a soil analysis costs $38.00, total soil sampling costs would total $51.00 per field or $1.28 per acre (40 acre field).

Soil testing can result in better fertilizer management, higher yields, and improved profits. A savings of about 5 pounds of nitrogen or 3 pounds of phosphorus per acre would pay for the costs of soil sampling a 40-acre field.

Deep soil sampling (2 - 4 ft. deep) is important to determining proper fertilizer application levels. Residual soil NO_3-N that leaches below the root zone is not available for plant growth and increases the potential for ground water contamination. Deep soil sampling usually results in reduced application levels of N fertilizer due to additional N credits. Research at Akron, Colorado found that the nitrogen application rate could be reduced by as much as 50 percent in one year as a result of crediting subsoil nitrate.

Costs of deep soil sampling on a 40-acre field will be an additional $25.00 for collection of the samples (if surface soil is being sampled at the same time) and $15 for the additional test. The total of $40 can be offset by a savings of 4 pounds less nitrogen per acre applied to a 40-acre field.

■ Category 2: Changes in cropping practices

Crop rotation can enhance nutrient utilization, particularly when deep rooted crops are included in the rotation. Corn following plow-down of a full stand of alfalfa rarely responds to N fertilizer. Winter cover crops can also be useful in the rotation to scavenge excess nutrients in a vegetable crop system or following any shallow-rooted crop. Changes in the mix of crops grown on the farm or the rotation of crops grown will involve a more detailed economic analysis. If new crops are to be grown on the farm, a detailed enterprise budget that allows for the determination of net income from the crop will be required. Enterprise budgeting, while not difficult, can be tedious. CSU Cooperative Extension has procedures available to assist producers with enterprise budgeting. The farm manager will need to know very specific information about the production process and practices required for the new crop. The results of the enterprise budgeting activity would then be used in the partial budgeting format to determine the economic impact of the BMP under consideration.

Changes in crop rotations may also involve a two-step economic analysis. The first step would determine the impact on net income of changing rotations. Because rotations occur over time, the analysis needs to make the appropriate adjustments in costs and returns for different years so that they may be compared at the same point in time. The adjusting of time differences is usually referred to as compounding or discounting.

An important consideration in this process is the selection of the appropriate interest rate. The appropriate rate will be a "real" rate of interest rather than a "nominal" rate.

Nominal Interest Rate - Inflation Rate = Real Interest Rate

The nominal rate is typically considered to be the rate that lenders charge borrowers. A real interest rate of approximately five percent is often used in these calculations. These results would then be used in the partial budgeting analysis to determine the economic impact of BMPs.

■ Category 3: Changes in tillage or fertilizer application practices

The economic assessment of BMPs in this category may involve the analysis of changes in equipment. Both economic and financial considerations will need to be included in this analysis. The economic analysis will include the consideration of the investment requirements if a change in machinery will be necessary. The financial analysis will include an evaluation of the cash flow impacts of changes in the machinery complement. Farm managers will want to weigh both of these analyses in their decision regarding the adoption of BMPs in this category. In many cases, changes in tillage practices will also result in changes in inputs such as nutrients and pesticides.

Machinery investment analysis involves the use of compounding and discounting principles in a manner similar to crop rotation decisions. The major difference is that with machinery investment decisions, there are often subsequent replacement decisions that must be considered. The costs associated with the new machinery will be a major portion of the partial budget analysis for these BMPs. Farm managers can still use the partial budget framework for this analysis, but must carefully consider the benefits and the timing of those benefits.

It is essential to examine all inputs that may change when analyzing alternative tillage systems. Input changes may relate to purchased inputs within an enterprise, the addition or deletion of an entire enterprise, or a change in equipment that will impact all crop enterprises on the farm.

Fertilizer Application Methods

Proper timing of fertilizer application can enhance plant uptake of nitrogen and other nutrients necessary for plant growth. Split applications of fertilizer can reduce the amount of nutrients lost to the environment and ensure that nutrients are available at those times critical to maximum plant growth.

Split application of nitrogen requires an additional trip over the field unless it is applied through irrigation.

Costs of Nitrogen and Phosphorus Fertilizer Applications (for irrigated corn)

	Nitrogen Application		Phosphorus Application	
	Single	Split (2)	Broadcast	Band
Revenue Increases (per acre)	0.00	0.00	0.00	0.00
Fertilizer Costs (per acre)	68.00	68.00	44.00	22.00
Application Costs	6.00	12.00	4.00	6.50
Total Costs	74.00	80.00	48.00	28.50

The actual application cost would increase from \$4.00/A (dry) or \$6.00/A (anhydrous) to \$8.00 or \$12.00 per acre. The cost of nitrogen would probably not change, because 50 percent of the fertilizer would be applied in each of the two applications. In some cases, producers can actually decrease total N applied in splits.

Band application of phosphorus typically involves application of only 50% of the fertilizer that would be applied on a broadcast basis. In the example below, there would be a savings in fertilizer costs of \$22.00 per acre with band application of P fertilizer compared to broadcast application. This analysis does not include net benefits from increased crop yields for either split applications of nitrogen or band application of phosphorus. In some cases, there may be crop yield increases. However, the amount of increase varies due to management, tillage systems, climatic conditions, and soil productivity.

■ Category 4: Changes in or addition of structures

This category includes those BMPs that involve physical changes to the farm's land base. By their very nature, these are long-term changes and need to be analyzed in that context. There may be both direct and indirect costs associated with these BMPs. For example, the planting of grass buffer strips involves the cost of the seed, planting, and long term maintenance. If these strips are planted on ground that was previously cropped, the foregone crop revenue is also a "cost" of grass filter strips and needs to be considered.

Partial budgeting analysis should include this lost income from ground taken out of production. Again, for those changes that are expected to have long lifetimes, the principles of discounting and compounding need to be incorporated and the costs of these BMPs should be considered on an annual basis. Any yield increase or loss will need to be taken into account. Cost-share programs are often available for structural practices. Check with your local USDA Natural Resources Conservation Service office to determine cost-share availability for practices you are considering.

Information on Best Management Practices

BMPs for nutrient management have been developed by CSU Cooperative Extension with help from Colorado producers. Some of these practices and the economic considerations associated with their adoption are listed on the following page. More information on BMPs for irrigation, fertilizer, manure, and pesticide management is available through the CSU Cooperative Extension Resource Center at (970) 491-6198. This fact sheet and the BMPs are also available online at *www.ag.state.co.us/pl_industry.html.*

Available BMP Booklets:

1. An Overview *(Bulletin #XCM-171)*
2. Nitrogen Fertilizer *(Bulletin #XCM-172)*
3. Irrigation Management *(Bulletin #XCM-173)*
4. Manure Utilization *(Bulletin #XCM-174)*
5. Phosphorus Fertilization *(Bulletin #XCM-175)*
6. Pest Management *(Bulletin #XCM-176)*
7. Pesticide Use in Field Crops *(Bulletin #XCM-177)*
8. Pesticide and Fertilizer Storage and Handling *(Bulletin #XCM-178)*
9. Wellhead Protection *(Bulletin #XCM-179)*

Economic Considerations of Best Management Practices for Nutrient Management	Additional Costs				Potential Returns*
	Management	Labor	Land	Capital	
Test soil annually		✓			+
Set realistic yield expectations	✓				+
Analyze & credit irrigation water nitrate	✓				+
Test subsoil for residual nitrate & credit	✓	✓			+
Analyze and credit manure, compost, and biosolids	✓				+
Develop a nutrient management plan	✓				+, 0
Split N applications		✓			+, 0
Avoid fall fertilizer applications	✓				0
Utilize nitrification inhibitors				✓	-
Apply P fertilizer in sub-surface bands	✓				+, 0
Calibrate manure and fertilizer application equipment		✓			+, 0
Incorporate manure after spreading		✓			+
Establish buffer zones around water supplies	✓		✓	✓	-
Install vegetative filter strips		✓	✓	✓	-
Implement no-till or conservation tillage systems	✓				+, 0, -
Strip crop erosive fields	✓	✓			0
Manage irrigation to minimize leaching and runoff	✓	✓			0
Mix, load, and store fertilizers 100 ft. from any water supply	✓				0
Avoid N fertilizer applications through ditch water unless tailwater recovery is used	✓		✓		0, -

* Returns will vary by site, crop, management, and year.

+ = potential positive return

0 = no additional return expected

- = additional costs with no additional returns expected

Partial Budget Form

BENEFITS:

1. Additional Income: $ ________
   List the items of increased or additional income from the BMP plan

2. Reduced Expenses: $ ________
   List the expenses that will be avoided by implementing BMPs

3. Benefits Subtotal (1 + 2) $ ________

COSTS:

4. Reduced Income $ ________
   List the lost income that will not be received from the BMP plan

5. Additional Expenses $ ________
   List the additional items of expense from the BMP plan that are not required with the base plan. Cost-share or incentive programs may reduce some of these expenses

6. Costs Subtotal (4 + 5) $ ________

7. DIFFERENCE (Benefits - Costs) $ ________

A positive difference indicates that the net income from the BMP plan exceeds the net income of the base plan by the amount shown. A negative difference indicates that the net income from the BMP plan is less than the net income of the base plan by the amount shown. Net returns in the partial budget analysis should not be confused with a full economic analysis. A negative difference does not necessarily mean the operation is not profitable, but rather the BMP plan is less profitable than the base plan.

In using the partial budgeting approach, it is not necessary to have entries in each of the partial budgeting categories. For example, some BMPs may only affect expenses, not gross income levels. Producers should not expect that all BMPs will have a positive effect on net returns, especially short-term returns. Economic considerations are among the many criteria in the decision to adopt any particular BMP. Thus, some BMPs that reduce income may be implemented if producers decide that other factors are "worth the cost."

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AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

July 1997
Fact Sheet #14

Economic Considerations of Pest Management BMPs

Concern about pesticides in drinking water has resulted in a search for pest management approaches that protect water quality. A number of practices (known as Best Management Practices or BMPs) have been identified which can help keep pesticides on the desired target.

Due to the economic risks inherent in agriculture, producers need incentives to change proven ways of doing business. These incentives may include increased profits, decreased costs, cost-share funding, enhanced environmental quality, or even improved public perception. Producers should evaluate the potential environmental benefits versus the costs and returns of BMPs as they determine which practices are most appropriate for their operation. Not all practices are equal in their environmental or economic benefit. This publication is intended to help producers think through some of the economic considerations associated with adopting BMPs.

The adoption of BMPs may require changes from existing management and cultural practices. Economic analysis of these changes involves calculation of the costs and benefits of the new system versus the old. Consideration of BMPs can be a complicated decision; there may not be a single factor by which to judge the appropriateness of any particular BMP. The economic and financial considerations of BMPs are important parts of the decision process.

The complexity of the economic analysis depends on the particular practice and situation being analyzed. The basic partial budgeting framework can be adapted for any of the BMPs. The calculation of particular costs and returns will be specific to the BMP under consideration and the particular farming situation where it is to be applied. In all cases, only those costs and returns that will be impacted by the change will be relevant to the partial budget decision.

Categories of BMPs

For purposes of economic analysis, BMPs may be divided into four categories. While the basic economic principles of calculating additional costs

BMP Categories

Best Management Practices for pest management may be divided into four categories, depending on which types of changes are involved.

1. Changes in pesticide usage or changes in pest management
2. Changes in crop mix/rotations
3. Changes in tillage practices
4. Changes in or additions of structures

and returns hold for each of the BMP categories, the application of these principles can be quite different. It could be as basic as calculating the cost and returns associated with changing crop variety, or as complicated as calculating the costs and benefits associated with investing in secondary containment structures. Secondary containment structures have a considerable lifetime and involve the economics associated with investment analysis. Economic analysis for each of these categories will be discussed.

■ Category 1: Changes in pesticide usage or changes in pest management

The economic assessment of these types of changes is relatively straightforward. The expected benefits for most of these BMPs will be realized fairly quickly, most often in the first production year. Thus, benefits from this type of BMP will be easy for the farm operator to calculate.

Likewise, the costs of implementing BMPs in this category will also occur in the first production year. The economic analysis involves comparing the added costs with the expected benefits in a straightforward application of the partial budgeting process.

Example: Field Scouting For Pests

Field scouting to assess pest and crop development is essential to any pest management program. Pest types and infestation levels can be identified before economic thresholds (levels of pest infestation at which it pays to take remedial action) are exceeded. While guidelines have been established for the primary crops and insects, actual economic thresholds vary by pest, crop, crop value, and control costs.

Crop consulting services are an excellent way for farmers to monitor pest levels and determine treatment actions on a field specific basis. Typical costs for such services (pest scouting and irrigation scheduling) in Colorado are $8 to $10 per acre. These costs can be recovered by increasing yields by 4.0 bushels of corn per acre ($2.50 per bushel) or 0.13 tons of alfalfa per acre ($75.00 per ton). ***Pest scouting may allow for fewer pesticide applications while obtaining the same level of pest control; thus, saving the producer money.***

Example Partial Budget for BMP: Pest Scouting

BENEFITS:

1. Additional Income	$ -		
2. Reduced Expenses	$ 15.50/A	(- 1 pesticide application)	
3. Benefits Subtotal (1 + 2)			$ 15.50

COSTS:

4. Reduced Income	$ -		
5. Additional Expenses	$ 8.00/A	(Pest Scouting)	
6. Costs Subtotal (4 + 5)			$ 8.00
DIFFERENCE: (Benefits - Costs)			$ 7.50/A

■ Category 2: Changes in crop mix/rotations

Crop rotation is one of the most effective pest management tools available to producers. Changes in the mix of crops grown on the farm or the rotation of crops grown will involve a more detailed economic analysis. If new crops are to be grown on the farm, a detailed enterprise budget that allows for the determination of net income from each crop will be required. Enterprise budgeting, while not difficult, can be tedious. CSU Cooperative Extension has procedures available to assist producers with enterprise budgeting. The farm manager will need to know very specific information about the production process and practices required for new crops. The results of the enterprise budgeting activity would then be used in the partial budgeting format to determine the economic impact of the BMP under consideration.

Changes in crop rotations may also involve a two-step economic analysis. The first step would determine the impact on net income of changing rotations. Because rotations occur over time, the analysis needs to make the appropriate adjustments in costs and returns for different years so that they may be compared at the same point in time. The adjusting of time differences is usually referred to as compounding or discounting.

An important consideration in this process is the selection of the appropriate interest rate. The appropriate rate will be a "real" rate of interest rather than a "nominal" rate.

Nominal Interest Rate - Inflation Rate = Real Interest Rate

The nominal rate is typically considered to be the rate that lenders charge borrowers. A real interest rate of approximately five percent is often used in these calculations. These results would then be used in the partial budgeting analysis to determine the economic impact of BMPs.

■ Category 3: Changes in tillage practices

The economic assessment of BMPs in this category will involve the analysis of changes in equipment for most producers. Both economic and financial considerations need to be included in this analysis. The economic analysis will include the consideration of the investment requirements if a change in machinery will be necessary. The financial analysis will include an evaluation of the cash flow impacts of changes in the machinery complement. Farm managers will want to weigh both of these analyses in their decision regarding the adoption of BMPs in this category. In many cases, changes in tillage practices will also result in changes in inputs such as nutrients and pesticides.

Machinery investment analysis involves the use of compounding and discounting principles in a manner similar to crop rotation decisions. The major difference is that with machinery investment decisions, there are often subsequent replacement decisions that must be considered. With rotations, once in place they may not change. The costs associated with the new machinery complement will be a major portion of the partial budget analysis for these BMPs. Farm managers can still use the partial budget framework for this analysis, but must carefully consider the benefits and the timing of those benefits.

It is essential to examine all inputs that may change when analyzing alternative tillage systems. Input changes may relate to purchased inputs within an enterprise, the addition or deletion of an entire enterprise, or a change in a machinery complement that will impact all crop enterprises on the farm.

Example: Band Herbicide Application

Band application (versus broadcast application) of herbicides requires less total herbicide per crop row, and typically one to two additional tillage operations to achieve optimum weed control. For example, a 15-inch band on 30-inch rows would decrease the herbicide application by half the amount used on a broadcast basis. If one additional cultivation pass costs $6.00/acre and the herbicide costs $12.00/acre on a broadcast basis ($6.00/acre banded), the band application would be "break-even". More expensive herbicides would result in a cost saving. The herbicide savings must offset additional tillage costs and additional weeds must not reduce crop yields for this BMP to be cost effective.

Example Partial Budget for BMP: Band herbicide application			
BENEFITS:			
1. Additional Income	$ -		
2. Reduced Expenses	$ 6.00/A	(1/2 rate of herbicide)	
3. Benefits Subtotal (1 + 2)			$ 6.00
COSTS:			
4. Reduced Income	$ -		
5. Additional Expenses	$ 6.00/A	(1 additional cultivation)	
6. Costs Subtotal (4 + 5)			$ - 6.00
DIFFERENCE: (Benefits - Costs)			$ 0 (Breakeven)

■ Category 4: Changes in or addition of structures

This category includes those BMPs that involve physical changes to the farm's land base. By their very nature, these are long-term changes and need to be analyzed in that context. There may be both direct and indirect costs associated with these BMPs. For example, the planting of grass buffer strips involves the cost of the seed, planting, and maintaining them. If these strips are planted on ground that was previously cropped, the foregone crop revenue is also a "cost" of grass filter strips and needs to be considered.

The partial budgeting analysis includes this foregone income. Again, for those changes that are expected to have long lifetimes, the principles of discounting and compounding need to be incorporated and the costs of these BMPs should be considered on an annual basis. Any yield increase or loss will need to be taken into account. Cost-share programs are often available for many structural practices. Check with your local USDA Natural Resources Conservation Service office to determine cost-share availability for practices you are considering.

Information on Best Management Practices

BMPs for pest management have been developed by CSU Cooperative Extension with help from Colorado producers. Some of these practices and the economic considerations associated with their adoption are listed on the following page. More information on BMPs for irrigation, fertilizer, manure, and pesticide management is available through the CSU Cooperative Extension Resource Center at (970) 491-6198. This fact sheet and the BMPs are also available online at *www.ag.state.co.us/pl_industry.html.*

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5. Phosphorus Fertilization *(Bulletin #XCM-175)*
6. Pest Management *(Bulletin #XCM-176)*
7. Pesticide Use in Field Crops *(Bulletin #XCM-177)*
8. Pesticide and Fertilizer Storage and Handling *(Bulletin #XCM-178)*
9. Wellhead Protection *(Bulletin #XCM-179)*

Economic Considerations of Best Management Practices for Pest and Pesticide Management	Additional Costs				Potential Returns*
	Management	Labor	Land	Capital	
PEST MANAGEMENT					
Integrated Pest Management (IPM)	✓	✓			+
Pest scouting		✓			+, 0, -
Crop rotation	✓			✓	0
Maintain pest and pesticide records	✓				0
Protect beneficial insects	✓				0
Control volunteer crops and pest over wintering sites		✓			+
Use cultural, biological, mechanical control methods	✓	✓			+
Incorporate economic thresholds into pest management decisions	✓				+
Use clean planting materials and pest resistant varieties				✓	+
PESTICIDE MANAGEMENT					
Read and follow all label instructions	✓				0
Select chemicals least likely to impact water or non-target species	✓				0
Mix, load, and store pesticides away from water supplies	✓				0
Rotate chemicals with different modes of action	✓				+
Band/spot pesticide application		✓			+
Avoid runoff and leaching during chemigation	✓				0
Establish pesticide application setbacks from water sources			✓		-
Purchase and mix only the amount of pesticide needed	✓				+
Do not dispose of pesticides or empty containers on the farm	✓				0
Construct secondary containment and mixing pads			✓	✓	-

* Returns will be site, crop, pest, and climate specific

+ = potential positive return

0 = no additional return expected

\- = additional costs with no additional returns expected

Partial Budget Form

BENEFITS:

1. Additional Income: $ __________
   List the items of increased or additional income from the BMP plan

2. Reduced Expenses: $ __________
   List the expenses that will be avoided by implementing the BMPs

3. Benefits Subtotal (1 + 2) $ __________

COSTS:

4. Reduced Income: $ __________
   List the lost income that will not be received from the BMP plan

5. Additional Expenses: $ __________
   List the additional items of expense from the BMP plan that are not required with the base plan. Cost-share or incentive programs may reduce some of these expenses.

6. Cost Subtotal (4 + 5) $ __________

7. DIFFERENCE (Benefits - Costs) $ __________

A positive difference indicates that the net income from the BMP plan exceeds the net income of the base plan by the amount shown. A negative difference indicates that the net income from the BMP plan is less than the net income of the base plan by the amount shown. Net returns in the partial budget analysis should not be confused with a full economic analysis. A negative difference does not necessarily mean the operation is not profitable, but rather the BMP plan is less profitable than the base plan.

In using the partial budgeting approach, it is not necessary to have entries in each of the partial budgeting categories. For example, some BMPs may only affect expenses, not gross income levels. Producers should not expect that all BMPs will have a positive effect on net returns, especially short-term returns. Economic considerations are among the many criteria in the decision to adopt any particular BMP. Thus, some BMPs that reduce income may be implemented if producers decide that other factors are "worth the cost."

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APPENDIX II

1997 Annual Report
Colorado State University Cooperative Extension

Summary of Accomplishments:

- Conducted educational programs throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed include commercial applicators, chemical dealers, weed districts, crop consultants, crop and livestock producers, agency personnel, and urban chemical users.

- Conducted training related to the Colorado Best Management Practice Manual. Distributed booklets to Colorado citizens covering nutrient, pesticide, irrigation, manure, and water well management.

- Developed and published two factsheets on economic aspects of BMPs entitled (Appendix I):
  Economic Considerations of Pest Management BMPs
  Economic Considerations of Nutrient Management BMPs

- Conducted a statewide survey of irrigated crop producers to determine status of BMP adoption by farmers. This survey was sent to approximately 3300 producers with irrigated acreage statewide. The information from the 41% of respondents was tabulated and studied to identify progress in the SB 90-126 program and areas needing more effort. (Appendix I)

- Worked on the Certified Crop Advisors Program in Colorado; including rewriting the state performance objectives and the state exam and representing Colorado at the National Advisory Board.

- Developed a CSU Extension Water Quality Website to disseminate BMP information via the internet.

- Developed a focused program to work on education and demonstration projects with farmers in the South Platte River Basin, a high priority watershed for SB 90-126 efforts. This work included farmer demonstrations to show the benefits of crediting N received through irrigation water and working on nutrient management under manured conditions.

- Began a program to monitor nutrient runoff from high altitude golf courses.

- Cooperated on a field project to evaluate nutrient management on fields receiving swine effluent applications.

- Worked with four local groups in Colorado to develop and disseminate localized BMP guidelines for groundwater protection. The local group in the San Luis Valley published their findings in two booklets entitled: "Best Management Practices for Potato Pest Management in the San Luis Valley" and "Best Management Practices for Small Grain Pest

Management in the San Luis Valley. The local group in the Montrose area headed by the Shavano Soil Conservation District developed and published practices appropriate for the West Slope in a booklet entitled: "Best Management Practices for the Lower Gunnison Basin". A newly established local BMP group in the lower South Platte River Basin began developing practices appropriate for that region.

- Distributed a series of four factsheets to educate Colorado homeowners on BMPs for urban pesticide and fertilizer use. These factsheets are entitled:
  - Homeowner's Guide to Protecting Water Quality and the Environment
  - Homeowner's Guide to Pesticide Use Around the Home and Garden.
  - Homeowner's Guide: Alternative Pest Management for the Lawn and Garden.
  - Homeowner's Guide to Fertilizing Your Lawn and Garden.

- Published a booklet of BMPs specifically for irrigated barley production in Colorado. (Appendix I)

- Published a pocket-sized record keeping book for private pesticide applicators to help them keep track of chemical use and learn about BMPs. (Appendix I)

- Cooperated with county Extension agents on nutrient management demonstrations on farmer fields and conducted manure management field days in eastern Colorado to discuss proper nitrogen, manure, and water management practices.

- Produced newsletter articles, press releases, fact sheets, technical papers, radio and other mass media articles on groundwater protection in Colorado.

- Distributed a 20 minute instructional video entitled "Best Management Practices for Colorado Agriculture".

- Worked to coordinate efforts of the Agricultural Chemicals and Groundwater Protection program with other state and federal programs in Colorado.

- Assisted the Colorado Department of Agriculture in the implementation of the Bulk Storage Regulations and the development of the generic State Management Plan. Contracted with a private consultant to prepare a protocol for developing a Colorado groundwater sensitivity map.

BMP Development

Colorado State University Cooperative Extension is working with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, land owners, and commercial agricultural chemical applicators. The chemical user because of the site-specific nature of groundwater protection must ultimately determine the BMPs adopted for use at the local level. The local perspective is also needed to evaluate the feasibility and economic impact of these practices. The SB 90-126 Advisory Committee has recommended that a significant level of input be received at the local level prior to adoption of recommended BMPs.

Colorado State University Cooperative Extension has compiled a broad set of BMPs encompassing nutrient, pest, and water management which will be used as a template for local committees. These documents were published in a notebook form in 1995 that will be updated as needed and expanded to include additional guidelines.

Cooperative Extension has piloted the local BMP development process in the San Luis Valley and in the front range area of the South Platte Basin. The local working committees consist of a small group of producers, consultants, and chemical applicators. The San Luis Valley group has produced a set of BMPs appropriate for their area which are being publicized and will be implemented by cooperating farmers in field scale demonstrations. The South Platte group is working towards consensus in a very complex farming region. Both of these groups have produced BMPs for nutrient and irrigation management - the most serious problem in their respective areas. They are now working on pest and pesticide management BMPs for specific crops. A local BMP group was formed in 1995 in the Montrose/Delta area. The Shavano SCD worked with local Extension agents and producers to develop a set of practices appropriate for the West Slope entitled "Best Management Practices for the Lower Gunnison Basin". During 1996, a fourth local BMP work group was initiated in the lower South Platte Basin.

Field Demonstrations

Colorado State University Cooperative Extension has worked with the USDA Agricultural Research Service and farmers on field research and educational plots to demonstrate improved nitrogen, manure, and irrigation management techniques. New production tools are being evaluated and demonstrated to farmers which may improve producer profitability and help protect groundwater.

Field trials are held on farm fields in Colorado to demonstrate BMPs. Educational field days are held at these sites to acquaint other producers and interested parties with the need for groundwater protection.

A new technology known as in-season nitrate testing was demonstrated to farmers on strip trials on their farms. This tool may help farmers improve N recommendation accuracy and minimize the use of "insurance" N fertilizer. By complementing preplant soil testing with in-season testing, it may be possible to improve N fertilizer requirement prediction accuracy, resulting in reduced leaching of nitrate to groundwater. Quick soil test kits for nitrate have been developed that allow "field testing," thereby alleviating the problem of slow turn-around time in commercial soil testing laboratories. The development of these quick test kits has made the in-season nitrate test a viable soil testing procedure for assessing the N fertility status of crops at any growth stage. It is expected that this will result in the joint use of preplant deep soil nitrate testing and in-season testing which will increase the accuracy of N fertilizer recommendations. The total application of N fertilizer can be decreased without negatively affecting crop yields as farmers adopt this improved technology.

Other production tools being evaluated and demonstrated to farmers include the portable chlorophyll meter to access N status of growing plants and surge irrigation valves to help decrease irrigation water runoff and leaching. Additionally, research is being conducted on the usefulness of the NLEAP computer model in selecting and evaluating BMPs for nitrogen leaching.

APPENDIX III

COLORADO DEPARTMENT OF HEALTH
Water Quality Control Division
Ag Chemicals Program

Executive Summary

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment (CDPHE) has responsibility under the Agricultural Chemicals and Ground Water Protection Program (SB 90-126) to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. This data assists the Commissioner of Agriculture in determining whether agricultural operations are impacting ground water quality. In 1997, the program began a regional groundwater quality baseline study for the Colorado High Plains region.

The Colorado High Plains, Ogallala aquifer is the largest aquifer in the state and is a sole source water supply for the 12,000 square miles it underlies. The Ogallala aquifer is recharged solely by precipitation and withdrawals exceed recharge. Therefore, the aquifer is essentially a nonrenewable resource. The High Plains is one of Colorado's major agricultural regions and the economy of the region is based upon irrigated agriculture.

One hundred twenty four samples have been collected to date with a goal of 150 samples. All sample points to date are existing wells that are privately owned and permitted as domestic wells. Nitrate analysis showed that 6% of all the wells exceeded the nitrate drinking water standard of 10 mg/L. Pesticide data revealed three pesticides, Atrazine, Bromacil, and Prometon present in the well samples. The breakdown product of Atrazine, Deethyl Atrazine was also present. One well exceeded the water quality standard for Atrazine. In cooperation with a major manufacturer of Atrazine, Novartis Crop Protection Company, all samples collected in Weld County this year were analyzed by Novartis's laboratory for all the metabolites (break down products) of Atrazine.

In addition to monitoring ground water for the presence of agricultural chemicals, the Ag Chemicals Program is required to determine the likelihood that an agricultural chemical will enter the ground water. This type of determination has been described as a vulnerability analysis. The Program has contracted with Dr. Maurice Hall of Radford University to develop a statewide vulnerability analysis for Colorado. A pilot project covering the northeastern portion of the state has been completed and the results were evaluated by CDPHE, CDA, CSU, and USEPA and approved for expansion throughout the state. The state wide project will be completed in June 1998. The finished mapping project will provide a standard method to determine vulnerability statewide. This effort will become a key element of the State Management Plan for pesticides implemented under the Federal Insecticide, Fungicide, and Rodenticide Act.

Bradford Austin CDPHE

Introduction

The Water Quality Control Division (WQCD) of the Colorado Department of Public Health and Environment (CDPHE) has responsibility under the Agricultural Chemicals and Ground Water Protection Program (SB 90-126) to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. The Agricultural Chemicals Program has been established to provide current, scientifically valid, ground water quality data to the Commissioner of Agriculture. Prior to passage of SB 90-126, a lack of data had prevented an accurate assessment of impacts to groundwater quality from agricultural operations. This program will assist the Commissioner of Agriculture in determining to what extent agricultural operations are impacting ground water quality. The program also assists the Commissioner in identifying those aquifers that are vulnerable to contamination. The philosophy adopted is to protect ground water and the environment from impairment or degradation due to the improper use of agricultural chemicals, while allowing for their proper and correct use.

This report has been prepared to provide a summary of the work completed in 1997. The monitoring program involves the collection and laboratory analysis of ground water samples. This monitoring program was planned to meet the objectives necessary for a preliminary determination of the existence of agricultural chemicals in the ground water in a safe, cost effective, and timely manner.

The ground water quality sampling program is intended to fulfill the following objectives:

1. Determine if agricultural chemicals are present in the ground water.
2. Provide data to assist the Commissioner of Agriculture in the identification of potential agricultural management areas.

The factors considered in selecting an area for monitoring are:

1. Agricultural chemicals are used in the area.
2. The ground water in the area is shallow in depth or vulnerable.
3. The majority of the agricultural chemical use is on irrigated land.
4. The soil types are conducive to leaching.
5. The alluvial and /or shallow bedrock aquifers are utilized for domestic water supplies.

Before an area is selected for monitoring, CDPHE will contact interested parties to inform them of the sampling program and SB 90-126, and how we envision its implementation. CDPHE will coordinate closely with federal agencies, county extension agents, conservancy districts, and local health officials in the project area.

Bradford Austin CDPHE

Ground Water Monitoring Program

The 1997 monitoring program began a regional groundwater quality baseline study for the Colorado High Plains region. The Colorado High Plains, Ogallala aquifer is the largest aquifer in the state and is a sole source water supply for the 12,000 square miles it underlies. The Ogallala aquifer is recharged solely by precipitation and withdrawals exceed recharge. Therefore, the aquifer is essentially a nonrenewable resource. The High Plains is one of Colorado's major agricultural regions and the economy of the region is based upon irrigated agriculture.

One hundred twenty four samples have been collected to date with a goal of 150 samples. All sample points to date are existing wells that are privately owned and permitted as domestic wells. The samples were analyzed for nitrate and 45 pesticides. Preliminary analysis of the nitrate and pesticide data indicates that ground water in the majority of the area sampled has been impacted by current agricultural practice but the levels of contamination are manageable. The major inorganic contaminant of concern in this area is nitrate. Nitrogen analysis indicated that no wells tested for a level of nitrate / nitrite as nitrogen below the laboratory detection limit of 0.5 mg/L (parts per million). Ninety four percent of the wells tested in the range of 0.5 to 9.9 mg/L, indicating nitrogen present but below the drinking water standard of 10 mg/L. Six percent of all the wells exceeded the nitrate drinking water standard of 10 mg/L. The majority of these seven wells fell in the range of 13 to 15 mg/L with a high of 33 mg/L. The drinking water standard is used as a benchmark for nitrate levels in all wells regardless of use. Pesticide data revealed three pesticides, Atrazine, Bromacil, and Prometon present in the well samples. The breakdown product of Atrazine, Deethyl Atrazine was also present. The pesticide levels ranged from the laboratory detection limit of 0.1 ug/L (part per billion) to 1.4 ug/L. Seven wells tested positive for Atrazine, five for Deethyl Atrazine, and two each for Bromacil and Prometon. One well exceeded the water quality standard for Atrazine at 4.2 ug/L. This well is not currently being used as a drinking water supply.

Nineteen ninety seven was the third year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. From June through August, 1997, 78 wells located in Weld County were sampled. Two types of existing wells were used, 21 monitoring wells operated by the Central Conservancy District and 57 irrigation wells sampled in 1989, 1990, 1991, 1994, 1995, and 1996. All wells were analyzed for nitrate / nitrite as nitrogen. The 21 monitoring wells were analyzed for the complete suite of 45 pesticides. The pesticide analysis for the irrigation wells was a immuno assay screen for the triazine herbicides. Nitrogen analysis indicated that 71% of the monitoring wells and 74% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels ranged from a low of 1.9 mg/L nitrate as nitrogen to a high of 46.4 mg/L. In the irrigation wells, nitrate levels ranged from below our detection level of 0.5 mg/L nitrate as nitrogen to a high of 43.5 mg/L. Pesticide data revealed four pesticides, Atrazine, Metolachlor, Metalaxyl, and Prometone present in the monitoring well samples. The breakdown product of Atrazine, Deethyl Atrazine was also detected. Atrazine was present in 33% of the wells, Deethyl Atrazine in 52% of the wells, Metolachlor in 24% and

Prometone in 52%. Metalaxyl was detected in only one well. The level of Metolachlor reached 6.6 ug/L (ppb) in one well. Detection levels for the other pesticides averaged around one ppb.

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, and Prometone. The results are calibrated in units of Atrazine equivalent but may be actually composed of one or more of the components. In 1997, triazine herbicides were detected in 95% of the irrigation wells. Levels ranged from 0.05 ug/L to 1.30 ug/L (ppb).

In cooperation with a major manufacturer of Atrazine, Novartis Crop Protection Company, all samples collected in Weld County this year were analyzed by Novartis's laboratory for all the metabolites (break down products) of Atrazine. Recent research has suggested that the ratios of these break down products to the parent may be an indicator of the amount of time the contaminate has been in the environment. If this proves to be true we will have the data on file for this special type of analysis.

The monitoring program included sample collection, laboratory analysis, and data analysis and storage. This survey, in combination with concurrent work, (see below) should establish a current baseline for agricultural chemicals in ground water in this area. Upon completion of the sampling and a full analysis, which should include integration with previous and current studies by other agencies, the resulting sampling program will provide the basis for determining a groundwater quality baseline for this region.

The monitoring wells in Weld County were sampled in cooperation with the Central Colorado Water Conservancy District in June 1997 by Brad Austin of CDPHE. John Colbert, of CDPHE, sampled the irrigation wells in Weld County in July and August 1997. All other sampling was performed by Brad Austin, July through December, 1997. Field sampling procedures followed the protocol developed by the ground water Quality Monitoring working group of the Colorado nonpoint task force.

The Colorado Department of Agriculture, Standards Laboratory performed all laboratory analysis. Well samples were analyzed for nitrate / nitrite as nitrogen, and selected pesticides. A list of the pesticides analyzed for is presented in Table 1. Temperature, conductivity, total dissolved solids, pH, and dissolved oxygen were measured in the field.

The results from this sampling program have been entered into the CDPHE Groundwater Quality Data System maintained at CDPHE. A detailed report describing the area sampled, the protocol for sampling and analysis, and the results of the analysis will be provided to the Commissioner of Agriculture upon completion of the survey.

Local Ground Water Monitoring Program

Recent development pressures, in once rural outlying areas, has heightened public awareness of the potential for impacts to water quality. Local concern for ground water quality in the High Plains has been a prominent issue recently. The Program has responded to these concerns by offering technical assistance to local ground water management districts interested in evaluating water quality in their area. This past year in cooperation with our regional baseline study we assisted nine local districts in a supplemental sampling program that would complement and enhance our work in the High Plains. The local districts collected an additional one hundred seventy five samples in coordination with our work. This data in combination with ours will enhance the overall coverage and completeness of the baseline water quality determination.

TABLE - 1

Colorado Department Agriculture
Standards Laboratory

Pesticide Methods and Detection Levels

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	MDL (ug/L)
Harness	Acetachlor	Herb	acetoalinide	525.1	0.1
Lasso	Alachlor	Herb	OrganoCL	525.1	0.1
AAtrex	Atrazine	Herb	Triazine	525.1	0.1
	Deethyl At			525.1	0.2
	Deisopropyl At			525.1	0.2
Balan	Benfluralin	Herb	OrganoFL	525.1	0.2
Hyvar	Bromacil	Herb	uracil	525.1	0.4
Captane	Captan	Fungi	carboximide	525.1	1.4
Lorsban	Chlorpyrifos	Insect	OrganoPH	525.1	0.1
Bladex	Cyanazine	Herb	Triazine	525.1	0.2
Dacthal	DCPA	Herb	phthalic-acid	525.1	0.1
Diazinon	Diazinon	Insect	OrganoPH	525.1	0.2
Casoron	Dichlobenil	Herb	nitrile	525.1	0.1
Cygon	Dimethoate	Insect	OrganoPH	525.1	0.5
	p,p-DDT	Insect	OrganoCL	525.1	0.4
	Endrin	Insect	OrganoCL	525.1	0.3
	Heptachlor	Insect	OrganoCL	525.1	0.6
	Heptachlor epoxide	Insect	OrganoCL	525.1	0.8
Velpar	Hexazinone	Herb	Triazine	525.1	0.1
Gamma-mean	Lindane	Insect	OrganoCL	525.1	0.1
Malathion	Malathion	Insect	OrganoPH	525.1	0.1
Ridomil	Metalaxyl	Fungi	acylalanine	525.1	0.2
Marlate	Methoxychlor	Insect	OrganoCL	525.1	0.9
Dual	Metolachlor	Herb	acetamide	525.1	0.1
Sencor	Metribuzin	Herb	Triazine	525.1	0.5
Prowl	Pendimethalin	Herb	dinitroaniline	525.1	1.2
Prometon	Prometone	Herb	Triazine	525.1	0.1
Princep	Simazine	Herb	Triazine	525.1	0.2
Treflan	Trifluralin	Herb	OrganoFL	525.1	0.3

TABLE - 1 (continued)

Colorado Department Agriculture
Standards Laboratory

Pesticide Methods and Detection Levels

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	MDL (ug/L)
Weed B Gone	2,4-D	Herb	PhenoxyAcid	515.2	0.2
Banvel	Dicamba	Herb	Benzoic Acid	515.2	0.1
Kilprop	MCPP	Herb	PhenoxyAcid	515.2	2.0
Agritox	MCPA	Herb	PhenoxyAcid	515.2	2.0
Tordon	Picloram	Herb	PicolinicAcid	515.2	0.35
Temik	Aldicarb	Insect	Carbamate	531.1	1.0
	Aldicarb sulfone		Carbamate	531.1	1.0
	Aldicarb sulfoxide		Carbamate	531.1	1.0
Sevin	Carbaryl	Insect	Carbamate	531.1	1.0
Furadan	Carbofuran	Insect	Carbamate	531.1	1.0
	3-Hydroxycarbofuran		Carbamate	531.1	1.0
	Methiocarb	Insect	Carbamate	531.1	1.0
Lannate	Methomyl	Insect	Carbamate	531.1	1.0
	1-Naphthol		Carbamate	531.1	1.0
DPX	Oxamyl	Insect	Carbamate	531.1	1.0
Baygon	Propoxur	Insect	Carbamate	531.1	1.0

Inorganic Nutrient Methods and Detection Levels

Analyte	MDL (mg/L)
Nitrate / Nitrite as Nitrogen	0.5

Aquifer Vulnerability Study Summary

In addition to monitoring ground water for the presence of agricultural chemicals, the Ag Chemicals Program is required to determine the likelihood that an agricultural chemical will enter the ground water. This determination is based upon the chemical properties of the chemical in question, the behavior of a particular chemical in the soil types of the region under study, the depth to ground water, the farming practices in use, and other factors. This type of determination has been described as a vulnerability analysis.

In the process of writing the generic State Management Plan for Pesticides (SMP), the staff at CDPHE, CDA, and CSU has studied various types of vulnerability analysis. The goal has been to satisfy the requirements of the SMP and SB 90-126, while remaining within the confines of existing staffing, organization and budget. In early 1996, a project was contracted to conduct a limited test of a aquifer sensitivity method in the northeastern section of the state. The results of this pilot project have been evaluated by CDPHE, CDA, CSU, and USEPA and approved for use throughout the state. The Program has expanded this effort statewide in 1997 to produce a vulnerability analysis for Colorado. The scheduled completion date is June 1998. The finished mapping project will provide a standard method to determine aquifer sensitivity and agricultural chemical vulnerability statewide. Results will be evaluated and incorporated into a standard method to map those areas of the state were ground water is vulnerable to contamination from agricultural chemicals. The monitoring program can then target resources to those areas where attention is most needed. This effort will become a key element of the State Management Plan for pesticides implemented under the Federal Insecticide, Fungicide, and Rodenticide Act

Update on collecting existing Ground Water Quality Data

In the FY-98 Memorandum of Understanding, the Ag Chemicals Program agreed to pursue collecting, evaluating, and entering into a database all existing ground water quality data available. Ground water quality data from various regions of the state has been entered as it becomes available. Recently this includes, CDPHE data collected as part of Super Fund preliminary assessment studies by the Haz. Mat. Division, and recently published U. S. Geological Survey data. As the data from these studies is received, it is entered into a database specifically designed for this purpose. In addition, collection and entry of historical data from the U. S. Geological Survey and U. S. EPA is an ongoing process.

The U. S. Geological Survey (USGS) is now wrapping up monitoring in the South Platte and the San Luis Valley areas under the National Water Quality Assessment (NAWQA) program. The Upper Colorado Basin NAWQA is now underway with sampling planned for Federal FY97 and FY98. As this data becomes available it will be incorporated into the final analysis for water quality in these areas. Several water conservancy districts are also actively engaged in collecting ground water quality data. Unfortunately, this data is not always readily available due to concerns about privacy and future use of the data. The program hopes that as the monitoring effort continues and the agricultural community grows comfortable with our goals and intent, this valuable source of data will become available and enhance our understanding of the overall ground water quality of the state.

Other Activity

A long range sampling plan has been developed for the monitoring program. The plan covers three major types of ground water monitoring. The first type of monitoring is the initial screening surveys to be conducted on all major aquifers subject to contamination from agricultural chemicals. The screening surveys for the South Platte River alluvial aquifer, San Luis Valley unconfined aquifer, Arkansas River alluvial aquifer (Appendix I), and the Front Range Urban Corridor are complete. The second type of monitoring is a follow-up sampling program to resample, for confirmation, all wells in which any contaminant was detected at a level of concern. Surrounding wells may also be sampled, if available, to determine if the contamination is widespread or only a localized problem. Follow-up sampling was conducted in the South Platte in 1993 and in the Lower Arkansas in 1995. The third type of monitoring is the specialized sampling needed for evaluation of Best Management Practices or Agricultural Management Areas when established. This long term monitoring, utilizing special wells such as dedicated monitoring wells, was started in 1995 in the Brighton to Greeley reach of the South Platte. In 1997, we continued this long term monitoring project and began the initial statistical analysis of the data that has been gathered to date.

Recent development pressures, in once rural outlying areas, has heightened public awareness of the potential for impacts to water quality. The Program has responded to these concerns by offering technical assistance to water conservancy districts, ground water management districts, and other local entities interested in evaluating water quality in their area. Presentations of how the program works, past and present water quality projects, and plans for future projects with request for local input are made at every opportunity. In 1997, presentations were made at ten major meetings and several small local groups throughout the state. We consider this type of outreach an important part of the customer service component of the program.

Before an area is selected for monitoring, CDPHE will contact interested parties to inform them of the sampling program and SB 90-126, and how we envision its implementation. CDPHE will coordinate closely with federal agencies, county extension agents, conservancy districts, and local health officials in the project area.

APPENDIX IV

1997 Annual Report
Colorado Department of Agriculture

Rules and Regulations for Agricultural Chemical Bulk Storage Facilities and Mixing and Loading Areas

Section 25-8-205.5 (3)(b) of the Agricultural Chemicals and Groundwater Protection Act requires the Commissioner of Agriculture to develop regulations where pesticides and fertilizers are stored or handled in quantities that exceed the established thresholds. These regulations were adopted in July 1994 and became effective September 30, 1994. The law mandated at least a three year phase-in period for the regulations. As a result of comments prior to and at the public hearings, a graduated phase-in schedule was adopted. Compliance is required by:

- **September 30, 1997** for liquid pesticide secondary containment and mixing and loading pads.
- **September 30, 1997** for liquid fertilizer tanks greater than 100,000 gallons, one of the three prescribed methods of leak detection must be utilized unless secondary containment is in place.
- **September 30, 1999** for liquid fertilizer secondary containment and mixing and loading pads.
- **September 30, 1999** for dry fertilizer storage and mixing and loading pads.
- **September 30, 2004** for secondary containment for fertilizer storage tanks with a capacity greater than 100,000 gallons.

Efforts to provide information on the requirements of the regulations and the time line for compliance were initiated at that time. During 1997, numerous presentations were made to groups throughout the state. The presentations were given to organizations and associations which have a substantial number of their members subject to the regulations. In addition, numerous facilities were visited to provide information and answer specific questions. This educational process aids individuals in determining first, whether or not compliance with the regulations is required and second, what specifically must be accomplished to meet the requirements.

Also during 1997 an inspection form was developed. Following the September 30 deadline, approximately 20 inspections were performed on pesticide facilities requiring compliance with the regulations. All facilities inspected were in general compliance with the regulations. Some minor modifications were needed at some sites. A database of inspections sites continues to be developed to track inspections. Inspections of pesticide facilities and fertilizer facilities with storage tanks greater than 100,000 gallons will be ongoing during 1998. In addition, educational efforts will continue at all fertilizer facilities needing to be in compliance by late 1999.

One requirement of the regulations is that the facility design be signed and sealed by an engineer registered in the state of Colorado; or the design be from a source approved by the commissioner and available for public use. The Colorado Department of Agriculture (CDA) in conjunction with Dr. Lloyd Walker, extension agricultural engineer with Colorado State University Cooperative Extension, produced a set of plans that meet the second criteria. The document is entitled, Agricultural Chemical Bulk Storage and Mix/Load Facility Plans for Small to Medium-Sized Facilities. The plans are available from Colorado State University or CDA free of charge.

Copies of the complete regulations and a summary sheet that contains a check list to allow individuals to determine if the regulations apply to their operation are also available from CSU or CDA or via the internet at www.ag.state.co.us/DPI/programs/groundwater.html.

State Management Plans for Pesticides

In October of 1991, the EPA released their Pesticides and Ground-Water Strategy. The document describes the policies, management programs, and regulatory approaches that the EPA will use to protect the nation's groundwater resources from risk of contamination by pesticides. It emphasizes prevention over remedial treatment. The centerpiece of the Strategy is the development and implementation of State Management Plans (SMPs) for pesticides that pose a significant risk to groundwater resources.

The EPA will require an SMP for a specific pesticide if: (1) the Agency concludes from the evidence of a chemical's contamination potential that the pesticide "may cause unreasonable adverse effects to human health or the environment in the absence of effective local management measures; and (2) the Agency determines that, although labeling and restricted use classification measures are insufficient to ensure adequate protection of groundwater resources, national cancellation would not be necessary if the State assumes the management of the pesticide in sensitive areas to effectively address the contamination risk. If the EPA invokes the SMP approach for a pesticide, its legal sale and use would be restricted to States with an EPA-approved pesticide SMP.

EPA published the proposed rule for state management plans for pesticides on June 26, 1996. As stated in last year's report, comments on the proposed rule were submitted under the signature of the Commissioner of Agriculture, Director of Colorado State University Cooperative Extension and the Executive Director of the Colorado Department of Public Health and the Environment. These comments were printed in the 1996 report. To date, EPA has not published the final rule. It is uncertain when the document will be completed and what will be included based on the comments submitted.

In 1996, a complete draft of the generic state management plan was finished and provided to EPA for their informal review. If Colorado can complete and receive concurrence from EPA on a generic plan, it should be much easier for a pesticide specific plan to be approved once the proposed rule is finalized. EPA's comments on the draft plan were extensive. The three agencies charged with the agricultural chemicals and groundwater protection program had significant disagreements with the comments from EPA. Because of this, it was determined we would wait and see if the final rule provided any relief to the issues in disagreement.

In September, EPA hosted a meeting of the Region VIII states. The purpose of this meeting was to discuss issues common to pesticide managers and EPA across the region. Significant time was devoted to discussion of the generic SMP approval process. There is considerable frustration among the states with the difficulty of the process in obtaining concurrence on generic plans. Some issues were resolved and it was agreed Colorado would submit another draft of their generic plan. This draft was submitted in January 1998.

As discussed in last year's report, one of the more significant issues involves EPA's demand for a sensitivity analysis/vulnerability assessment map of the state in a Geographic Information System (GIS) format by which to determine where to focus education and monitoring activities. Funding has been unavailable to perform this analysis for even a portion of the state. In addition, significant amounts of data that is required for this analysis is not in electronic format to utilize with GIS. In late 1995, a small EPA grant was obtained to perform a sensitivity analysis pilot project for the northeastern part of the state. This work was completed in 1996 and provided to EPA. EPA reacted favorably to the project and has provided funding for a sensitivity analysis to be completed on the rest of the state. The work has begun and should be completed by mid-1998.

Pesticide use data at the county level is another requirement of the SMP. In addition, with the passage of the Food Quality Protection Act by Congress, accurate pesticide use information has become more critical. To try and provide this data, CDA along with CSU Cooperative Extension contracted with the Colorado Agricultural Statistics Service to perform a statewide pesticide use survey. All commercial pesticide applicators will be surveyed during the winter of 1997/98. In addition, farmers who responded to a pre-survey that they apply some portion of their own pesticides will be surveyed. Results of the survey should be available in late 1998 or early 1999. The majority of the funding for the survey is being provided by an EPA grant.

Waste Pesticide Disposal

In 1995, CSU Cooperative Extension operated a pilot waste pesticide collection program in Adams, Larimer, Boulder and Weld Counties. The purpose of this type of program is to provide pesticide users an opportunity to dispose of banned, canceled or unwanted pesticides in an economical and environmentally sound manner. Part of the funding for the program was provided by an EPA Nonpoint Source 319 grant. The program was a success. Approximately 17,000 pounds of waste pesticides from 67 participants were collected and safely disposed.

Based on the success of this pilot program, CDA was asked to continue a program that could collect and dispose of waste pesticides in other areas of the state. However, CDA currently has no statutory authority or funding to operate such a program. In light of this, two alternatives were discussed as a way for a waste pesticide collection program to continue. The first was for CDA to seek statutory authority and funding from the Legislature to operate a state-run program. The second was to determine if a private program, operated by a hazardous waste handling company, was possible.

The EPA and the Colorado Department of Public Health and Environment made the possibility of continuing a waste pesticide disposal program significantly easier by the passage of the Universal Waste Rule (UWR) in late 1995. The UWR was developed to encourage disposal of products identified as universal wastes by relaxing the regulations in the Resource

Conservation and Recovery Act (RCRA) and therefore making it easier to properly dispose of these products. Waste pesticides were defined in the rule as a universal waste.

CDA spoke to hazardous waste contractors to determine if they would be interested in attempting to collect and dispose of waste pesticides as a private program. One company, MSE Environmental Inc., stated they would be interested. Discussions were initiated with the company and it appeared it would be possible for MSE to operate a private program at a reasonable cost to the participants. The collection and disposal costs for participants would be between $2.25 and $2.75 a pound.

Based on this information, it was determined that the private program option would be pursued since the possibility of getting legislation passed was slim. Furthermore, the time required for legislation to be passed would considerably delay the operation of a program.

After numerous issues were addressed, MSE targeted two areas of the state to initiate the program, the San Luis Valley and the six counties in northeastern Colorado. Registration for participants was set to begin in early 1997, with a scheduled collection of pesticides set for mid-March 1997. This program was very successful. Over 10,500 pounds of waste pesticides were collected from 33 participants. The cost to participants was $2.65 per pound.

Based on the success of this program, MSE conducted a statewide collection program in November 1997. Over 23,000 pounds of waste pesticides were collected from 75 participants. Again the cost was $2.65 per pound.

There is considerable interest in continuing this type of program. It is anticipated another statewide collection program will be operated in late 1998 or early 1999.

APPENDIX V

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION ACT ADVISORY COMMITTEE 1997

Water Quality Control Commission

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Mr. Steven D. Geist
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