ANNUAL REPORT
FOR 2001

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

www.ag.state.co.us/DPI/GroundWater/home.html

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Executive Summary

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

In the annual report for 2000, several goals for 2001 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 2002 between the Colorado Department of Agriculture and: 1) Colorado State University Cooperative Extension, and 2) the Colorado Department of Public Health and Environment. The program objectives for 2002 are stated on pages five through six.

Colorado Department of Agriculture

Storage Regulations

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. Pesticide and fertilizer facility inspections continued in 2001.

Pesticide Management Plan

EPA is developing a program that would require states to produce management plans for pesticides thought to be significant hazards to groundwater. 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. EPA concurred on Colorado's Generic Pesticide Management Plan (PMP) in March of 2000. This generic plan will be used as a model to produce the pesticide specific plans.

Waste Pesticide Disposal

MSE Environmental Inc., the private contractor, conducted another "Chemsweep" program in April, 2001.

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 once during 2001.

Colorado State University

Education and Communication

Communication is a vital component of the program. Information is provided to individuals and organizations using agricultural chemicals as well as the general public through: written fact sheets; publications; newsletters; over the web (http://www.colostate.edu/Depts/SoilCrop/extension/WQ/); and through radio shows, mass media, press releases, and presentations at meetings throughout the state.

Ongoing BMP Development and Education

Colorado State University Cooperative Extension (CSUCE) has worked with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, landowners, and commercial agricultural chemical applicators. Because of the site-specific nature of groundwater protection, the chemical user 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.

Demonstration Sites and Field Days

The groundwater program at CSUCE works with crop producers, their advisors, fertilizer dealers, USDA NRCS, commodity groups, and local county Extension faculty, to demonstrate and evaluate new and existing production tools that may improve producer profitability and help protect groundwater.

Colorado Department of Public Health and Environment

In 2001, the program completed the seventh year of a long term monitoring effort initiated in the South Platte alluvial aquifer from Brighton to Greeley. From June through August 2001, 84 wells in the long-term network were sampled. Nitrogen analysis indicated that 67% of the monitoring wells, 50% of the domestic wells, and 71% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. Pesticide data revealed six pesticides, Acetochlor, Atrazine, 2,4-D, Dicamba, Hexazinone, and Metolachlor, present in the monitoring well samples. The pesticide Atrazine was detected at 5.47 ug/L in one well, a level that exceeds the applicable standard of 3.0 ug/L. Pesticide results for the domestic well portion of the network revealed five pesticides, Atrazine, Chlorpyrifos, Hexazinone, Malathion, and Metolachlor present in the well samples.

South Platte River Alluvial Aquifer Regional Monitroing

The 2001 monitoring program also included a regional groundwater quality study for the South Platte River alluvial aquifer in Weld, Morgan, Logan, and Sedgwick Counties (Figure 2). The sampling area includes the South Platte River valley from Fort Lupton in southern Weld County, to Ovid in Sedgwick County.

San Luis Valley Joint Monitoring Project with the USGS

In February and April of 2001, the program made two public presentations of our joint monitoring project with the U.S. Geological Survey completed in 2000. This survey sampled 33 dedicated monitoring wells in the San Luis Valley. The wells were originally installed in 1993 by the USGS NAWQA program as part of the Rio Grande Basin regional water quality study. The purpose of the sampling project was to acquire a high quality data set to use in an aquifer vulnerability modeling project with the USGS for 2001-2002.

Aquifer Vulnerability Study Summary

In addition to monitoring groundwater for the presence of agricultural chemicals, the SB 90-126 Program is required to determine the likelihood that an agricultural chemical will enter the groundwater. In the process of writing the generic Pesticide Management Plan (PMP), the staff at CDPHE, CDA, and CSU has studied various types of vulnerability analysis. In 1999, the legislature approved additional funding for a project to develop a method to determine aquifer vulnerability to both pesticides and nitrate statewide. Upon completion of the project, the program will be able to determine groundwater vulnerability to agricultural chemicals statewide.

Objectives for 2002 Determined

The following objectives for 2002 have been established:

- Continue production of a report on water quality status in Colorado based on data collected in previous years;
- Continue the 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, pesticide, and water management to farmers;
- Coordinate with other agencies and non-governmental organizations to deal with water quality issues throughout the state;
- Continue BMP education work in vulnerable groundwater areas of Colorado;
- Continue the distribution of BMP materials on the economic considerations of BMP adoption for nutrient and pest management;
- Continue to develop and update educational resource materials for groundwater education;
- Publish, distribute, and display on the web, 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 performing inspections of facilities requiring compliance with containment regulations;
- Continue to provide information on and enforcement of the containment rules and regulations;
- Continue collection and analysis of groundwater samples for pesticides and nitrates on a regional scale;

- Continue the long term monitoring program in Weld County by collecting and analyzing groundwater samples for pesticides and nitrates;
- Evaluate and validate the sensitivity analysis and vulnerability models developed for Colorado groundwater;
- Analyze data and publish results of BMP survey;
- 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;
- Update the rules and regulations for bulk storage and mixing and loading facilities;
- Cooperate with the USGS to conduct groundwater monitoring studies in Custer county;
- Cooperate with the USGS on phase 2 of the South Platte NAWQA;
- Collaborate with the USGS on groundwater monitoring in the Northern High Plains NAWQA;
- Begin work on the monitoring well installation project;
- Complete BMP guide for corn production in Colorado;
- Revise phosphorus BMP bulletin;
- Prepare bulletin on pesticide fate and transport;
- Participate in USDA PDP program; and
- Consolidate CDPHE monitoring program with CDA.

APPENDICES

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APPENDIX I

2001 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.

Regulation of pesticide secondary containment/storage facilities and mixing and loading pads, and for liquid fertilizer tanks greater than 100,000 gallons (one of three prescribed methods of leak detection must be utilized unless secondary containment is in place) began on September 30, 1997. Regulation of fertilizer secondary containment/storage facilities and mixing and loading pads began on September 30, 1999. Compliance is required by:

- **September 30, 2004** for secondary containment for fertilizer storage tanks with a capacity greater than 100,000 gallons.

During 2001, facilities were visited to provide information and answer specific questions regarding the rules and regulations for bulk storage and mixing/loading facilities. 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.

Pesticide and fertilizer facility inspections continued in 2001. A total of 31 pesticide secondary containment structures and 46 mixing/loading pads were inspected. A total of 23 fertilizer secondary containment structures and 23 mixing/loading pads were also inspected. No leak detection inspections were conducted for facilities storing fertilizer in tanks larger than 100,000 gallons. Fourteen Cease and Desist Orders and one Violation Notice were issued during 2001; modifications were needed at some sites. In addition, 121 follow-up inspection orders were issued for problems at facilities that were not serious enough at this time to warrant a Cease and Desist Order or Violation notice. Inspection of pesticide and fertilizer facilities will be ongoing during 2002.

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. The Colorado Department of Agriculture is currently working in conjunction with CSU on developing a set of generic plans for steel containment facilities to compliment the previously mentioned publication which focuses only on concrete. These plans are near completion and should be available for use in 2002.

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

Pesticide Registration and Groundwater Protection

The program continues to review products for registration in Colorado which have groundwater label advisories. As in previous years, Balance herbicide was registered for use in Colorado for 2001 after extensive review. A decision regarding re-registration is expected to be made in early 2002.

Pesticide Management Plan

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 Pesticide Management Plans (PMPs) for pesticides that pose a significant risk to groundwater resources.

The EPA will require a PMP 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 PMP approach for a pesticide, its legal sale and use would be restricted to States with an EPA-approved PMP.

EPA published the proposed rule for Pesticide Management Plans on June 26, 1996. As stated in previous year's reports, 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 Pesticide 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. A redrafted, general Pesticide Management Plan based on EPA's comments on previous versions was submitted in January 1998. Comments on this version were received from EPA in April 1998, and Colorado then submitted a document final in August 1998 for formal review and concurrence. Two subsequent documents were submitted to EPA based on comments received, the last being in January of 2000. EPA concurred on Colorado's Generic Pesticide Management Plan (PMP) in March of 2000.

One of the more significant issues regarding the PMP 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. 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 provided funding for a statewide sensitivity analysis, which was completed in 1998. This information has been published in an 8 page fact sheet titled Relative Sensitivity of Colorado Groundwater to Pesticide Impact. This publication assesses aquifer sensitivity based on 4 primary factors: conductivity of exposed aquifers; depth to water table; permeability of materials overlaying aquifers; and availability of recharge for the transport of contaminants. These factors were selected because they incorporate the best data currently available for the entire state and incorporate important aspects of Colorado's unique climate and geology.

In 1999, the SB 90-126 program was given spending authority to begin an aquifer vulnerability project to compliment and improve the existing aquifer sensitivity map. Work on one project was completed June 30, 2001 with the Colorado School of Mines. Another related project in conjunction with the United States Geological Survey (USGS) began in the fall of 2000 and is scheduled for completion in October, 2002.

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 lbs. 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 $2.65 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 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 lbs. 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 lbs. of waste pesticides were collected from 75 participants. Again the cost was $2.65 per pound. Subsequent programs are as follows:

Year	Pesticides Collected (lbs.)	Number of Participants
1998	0	0
1999	19,792	47
2000	0	0
2001	13,486	34

APPENDIX II

2001 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.

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

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

- Cooperated with the Colorado Corn Growers Association (CCGA) to develop and demonstrate BMPs appropriate for corn production for the third year of their EPA 319 program (Appendix IV).

- In conjunction with CCGA, provided 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, using the pre-sidedress soil nitrate test (PSNT), comparing soil testing laboratory recommendations, and using atmometers to schedule irrigations.

- Cooperated with county Extension agents on nitrogen and irrigation management demonstrations on farmer fields and a golf course throughout Colorado. These demonstrations focused primarily on using atmometers for irrigation scheduling and the PSNT for predicting the need for in-season nitrogen applications to corn (Appendix IV).

- Conducted a state wide Irrigated Crop Production Survey to assess the current level of BMP adoption by Colorado producers.

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

- Advised a graduate student, Zac Ceplecha, in the Department of Soil and Crop Sciences to develop a nitrate vulnerability map for Colorado and a field specific vulnerability assessment tool. Thesis title: Sensitivity and Vulnerability Assessment of Colorado Groundwater to Nitrate Contamination.

- Collaborated with Colorado School of Mines and the USGS to develop and refine groundwater vulnerability matricies and map for assessing pesticide contamination potential.

- Maintained a CSU Extension Water Quality Website to disseminate BMP information via the Internet.

- Cooperated with other CSU faculty and NRCS personnel on a research project to evaluate phosphorus (P) runoff from irrigated fields and used these results to develop a phosphorus risk index to predict potential P losses.

- Cooperated with CSU faculty at the Mountain Meadow Research Station on a research project to compare phosphorus (P) runoff from meadows fertilized under different application timings.

- Revised and 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 & Garden
  Homeowner's Guide to Fertilizing Your Lawn and Garden

- Distributed over 1000 revised Pesticide Record books for Private Applicators (Appendix IV).

- Distributed a booklet of BMPs specifically for greenhouse growers in Colorado entitled: "Pollution Prevention for Colorado Greenhouses."

- 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.

Ongoing BMP Development and Education

Colorado State University Cooperative Extension (CSUCE) has worked with the Colorado Department of Agriculture to develop Best Management Practices for Colorado farmers, landowners, and commercial agricultural chemical applicators. Because of the site-specific nature of groundwater protection, the chemical user 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 that has been used as a template for local committees. These documents were published in a notebook form in 1995 that are updated as needed and expanded to include additional guidelines.

Cooperative Extension 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. Both of these groups have produced BMPs for nutrient and irrigation management - the most serious problem in their respective areas. The San Luis Valley group also produced a guide 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. They published their findings in a bulletin entitled "Best Management Practices for the Lower South Platte River Basin." Although most of these work groups have not been active since finishing their local BMP publications, these guides continue to be distributed at the local and state level. The S. Platte BMP workgroup in the Front Range area continues to be active and meets once a year to review current groundwater quality data and discuss research, education, and regulatory issues affecting groundwater in their area.

Evaluation of BMP Adoption

A mailed crop production survey was conducted during the last week of November, 2001 to measure the progress of our educational efforts related to SB 90-126. This survey (Appendix IV) was mailed to 3,260 irrigating crop producers. To date, 1,298 (40%) producers have responded. The primary objective of this survey was to learn the adoption rate of nutrient, pesticide, and irrigation BMPs among Colorado producers. Results will be used to focus the groundwater program on the geographical and topical areas that need higher adoption rates to protect water quality. Because we conducted a similar survey in 1997, we can use the 2001 survey to measure progress in our educational efforts since that time. The results of this survey will be published in a technical report and fact sheets. We will encourage other CSU faculty and CE agents, NRCS staff, water and soil conservation districts, and others to use the survey information to focus groundwater protection resources in deficient areas.

A new technology known as presidedress soil nitrate testing (PSNT) was highlighted for demonstration. This tool may help corn farmers improve nitrogen recommendation accuracy and minimize the use of "insurance" fertilizer. Demonstration plots in the South Platte River Basin in 2000 showed farmers how to use this method to reduce unnecessary nitrogen applications.

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. Other production tools being evaluated and demonstrated to farmers include the portable chlorophyll meter to access N status of growing plants, atmometers (ETgages), PAM (polyacrylamide, an irrigation water treatment for soil erosion prevention), ETgages for simple and effective irrigation scheduling, atrazine alternatives, and surge irrigation valves to help decrease irrigation water runoff and leaching.

Education and Communication

Communication is a vital component of the program. Numerous methods are used to provide information to individuals and organizations using agricultural chemicals as well as the general public. We continue to provide written Factsheets and publications with information on the program and distribute at meetings, conferences, and trade shows. Also, a display board is being utilized at conferences and trade shows to provide information on the program. Information on groundwater protection is continually being presented to the public through radio shows, mass media, press releases, and presentations at meetings throughout the state. Presentations on 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 2001, presentations were made at several major meetings and small local groups throughout the state. We consider this type of outreach an important part of the customer service component of the program.

This past year we worked on improving the quantity and quality of information available over the internet. Several locations including the CSU Cooperative Extension web site (http://www.ext.colostate.edu), the CSU Cooperative Extension Water Quality web site (http://www.colostate.edu/Depts/SoilCrop/extension/WQ/), and the Agricultural Chemicals and Groundwater Protection Program web site (http://www.ag.state.co.us/dpi/GroundWater/home.html), provide information on BMPs.

APPENDIX III

Colorado Department of Public Health and Environment
2001 Annual Report

Summary of Accomplishments:

- Completed a groundwater monitoring project in the South Platte Valley. Thirty-seven dedicated monitoring wells, located within the South Platte River alluvial aquifer system from Fort Lupton downstream to Ovid Colorado, were sampled for a broad range of analytes. This data set will be used as the input to a GIS based modeling process to determine the vulnerability of the area to agricultural chemical contamination.

- Continued the long term monitoring project in the Weld County portion of the South Platte River Basin, a high priority watershed for SB 90-126 efforts. This year the sampling program sampled eighteen (18) monitoring wells and fifty-two (52) irrigation wells.

- Completed a regional groundwater quality assessment of Mesa County, Colorado.

- Cooperated in a joint project with the U.S. Geological Survey, NAWQA program for the High Plains in an assessment of pesticides in the vadose zone overlying the Ogallala Aquifer.

- Responded to citizen's request to sample wells in the San Luis Valley regarding a possible cluster of cancer cases.

- Assisted in the planning, design, and funding of a project between CDPHE, the State Engineers Office, and local Groundwater Management Districts to begin a long-term groundwater quality monitoring project in the High Plains of Colorado.

- Completed the joint project with the Colorado School of Mines to develop groundwater vulnerability matrices for assessing the potential for pesticide contamination.

- Participated in and provided contract oversight for the U. S. Geological Survey to develop a GIS based statistical approach to groundwater vulnerability for pesticide contamination.

- Collaborated with Colorado State University researchers on the development of a statewide aquifer sensitivity map and vulnerability model for nitrate.

- Collaborated with the Department of Agriculture Standards Laboratory to revise and refine the laboratory analysis used on all groundwater samples.

- Assisted the Colorado Department of Agriculture in the development of the generic Pesticide Management Plan and the implementation of the Bulk Storage Regulations.

- Appeared before the Colorado Water Quality Control Commission to address groundwater quality issues.

- Worked on the Certified Crop Advisors Program in Colorado. Assisted with certification testing.

- Severed on the Board of Examiners of water well construction and pump installation contractors.

- Began a project to automate data retrieval and report production utilizing the Access database for all the program's groundwater data storage and retrieval needs.

- Addressed groups throughout Colorado on SB 90-126 and issues related to agricultural chemicals and groundwater quality. Groups addressed include chemical dealers, groundwater management districts, crop and livestock producers, and agency personnel.

- Cooperated with the Colorado Corn Growers Association in their BMP's for corn production project.

- Distributed fact sheets and reports on Colorado groundwater quality to interested parties and fielded question by phone and e-mail to Colorado citizens.

- Cooperated with county Extension agents on disseminating information about Colorado groundwater quality.

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

- Cooperated and provided assistance to the South Platte BMP workgroup.

- Assisted the Water Quality Control Division in reviewing and evaluating suitability of monitoring plans for housed commercial swine feeding operations.

- Evaluated the pesticide survey data to extract information needed to improve laboratory analysis.

- Participated on the Divisions agriculture team to ensure program goals are integrated into other agriculturally oriented programs.

Weld County Long Term Monitoring

In 2001, the program completed the seventh year of a long term monitoring effort in the South Platte alluvial aquifer from Brighton to Greeley. The long-term monitoring network was established in 1995 and is a combination of three types of wells designed to sample a complete cross-section of the aquifer (Figure 1). The network well types are: a) Twenty (20) dedicated monitoring wells operated by the Central Colorado Water Conservancy District; b) Sixty (60) irrigation wells that were previously sampled in 1989, 1990, 1991, 1994; and c) Eighteen (18) domestic wells first sampled in 1992. The monitoring and irrigation wells are sampled each year, the domestic wells every three years.

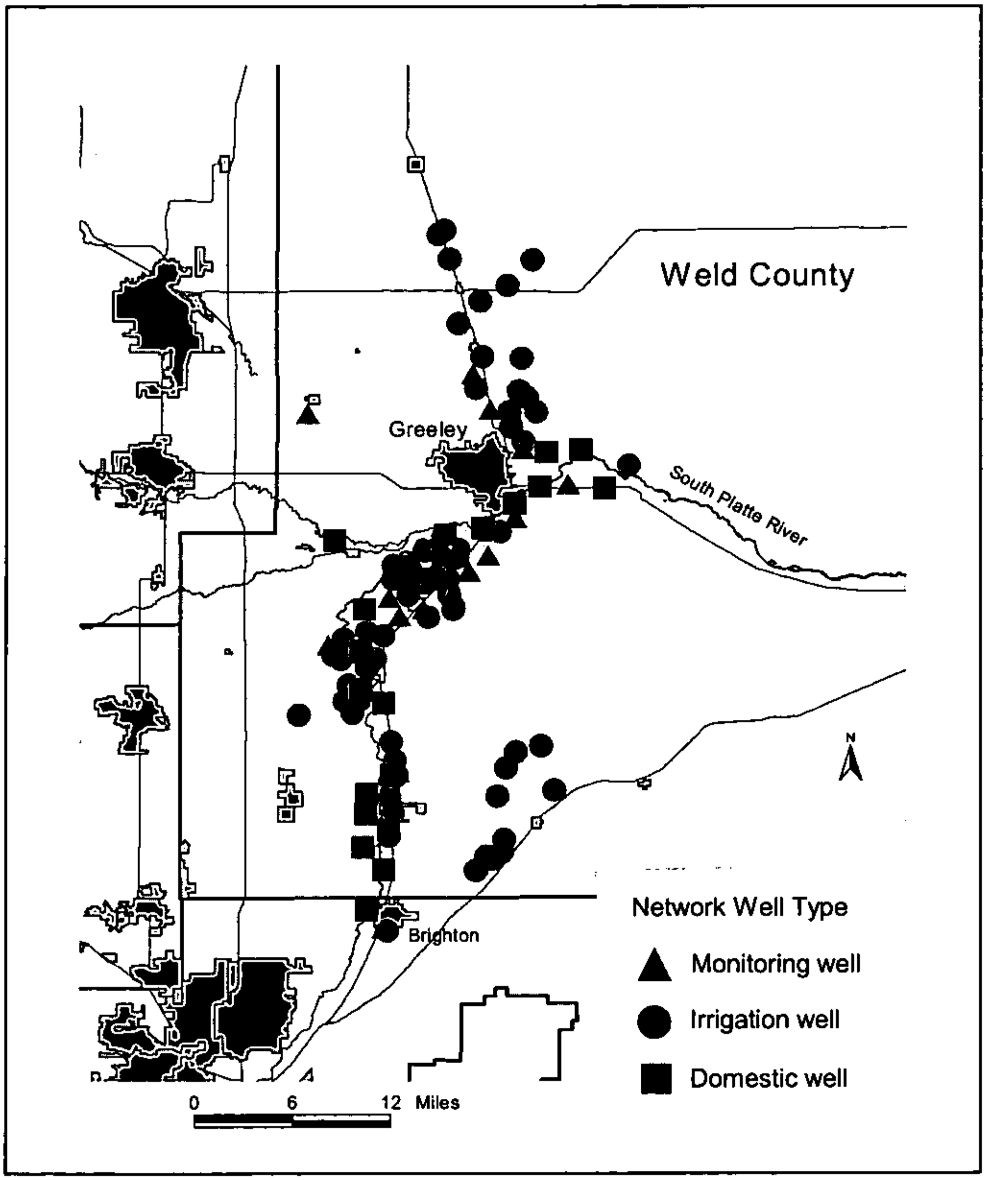


FIGURE 1 - Location and type of well comprising the Weld County, Colorado long term monitoring network.

From June through August 2001, 84 wells in the long-term network were sampled. All wells were analyzed for nitrate-nitrite as nitrogen. The 18 monitoring wells and 14 domestic wells were analyzed for the complete suite of 47 pesticides listed in Table 4. The pesticide analysis for the 52 irrigation wells was an immuno assay screen for the triazine herbicides.

Nitrogen analysis indicated that 67% of the monitoring wells, 50% of the domestic wells, and 71% of the irrigation wells exceeded the nitrate drinking water standard of 10 mg/L. In the monitoring wells, nitrate levels varied over a broader range, with the highest median value. The monitoring wells sample the upper most zone (10 feet) of the aquifer. The irrigation wells recorded a narrower range in nitrate levels and a significantly lower median value. The domestic wells recorded the lowest median. The differences are expected due to the different zones of the aquifer sampled by each well set, as the domestics typically pull their water from the bottom 20 feet or so of the aquifer while the irrigation wells sample the entire saturated zone. Table 1, below; list the summary statistics for all three sets of wells.

TABLE 1 - Summary statistics for the Weld County nitrate monitoring results, 2001.

Weld County Nitrate Monitoring			
	Monitoring wells	Domestic wells	Irrigation wells
Mean	23.2	12.4	17.1
Median	27.7	9.1	16.8
Standard Deviation	16.03	9.91	9.75
Minimum	3.1	1.4	< 0.01
Maximum	59.5	33.9	33.7
# wells sampled	18	14	52
Note: all values are Nitrate as N (mg/L), except # wells			

Pesticide data revealed six pesticides, Acetochlor, Atrazine, 2,4-D, Dicamba, Hexazinone, and Metolachlor present in the Weld County monitoring well samples. The breakdown product of Atrazine, Deethyl Atrazine, was also detected. Atrazine was present in 44% and Deethyl Atrazine in 28% of the wells. Metolachlor was detected in 56% of the wells, Dicamba in 17% and Hexazinone in 11%. Acetochlor and 2,4-D were each detected in one well. Detection levels for all pesticides averaged less than 1.0 ug/L (ppb). The pesticide Atrazine was detected at 5.47 ug/L in one well, a level that exceeds the applicable standard of 3.0 ug/L.

Pesticide results for the domestic well portion of the network revealed five pesticides, Atrazine, Chlorpyrifos, Hexazinone, Malathion, and Metolachlor present in the well samples. The breakdown product of Atrazine, Deethyl Atrazine was also detected. Atrazine was present in 29% and Deethyl Atrazine in 50% of the wells. Chlorpyrifos, Hexazinone, Malathion, and Metolachlor were each detected in one well. Detection levels for all pesticides averaged near 0.5 ug/L (ppb).

The triazine herbicide screen used on the irrigation wells detects any pesticide in this family, which includes Atrazine, Simazine, Cyanazine, Deethyl Atrazine, Deisopropyl 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 2001, triazine herbicides were detected in 71% of the irrigation wells. Levels ranged from 0.07 ug/L to 0.58 ug/L (ppb).

Brad Austin of CDPHE sampled the monitoring wells in Weld County permitted by the Central Colorado Water Conservancy District in June 2001. John Colbert, of CDPHE, sampled the domestic and irrigation wells in Weld County, July through September 2001. Field sampling procedures followed the protocol developed by the groundwater quality monitoring working group of the Colorado nonpoint task force.

South Platte River Alluvial Aquifer Regional Monitoring

The 2001 monitoring program included a regional groundwater quality study for the South Platte River alluvial aquifer which included, Weld, Morgan, Logan, and Sedgwick Counties of Colorado (Figure 2). The sampling area includes the South Platte River valley from Fort Lupton in southern Weld County, to Ovid in Sedgwick County. The area is approximately 180 miles in length and occupies about 850 square miles. This area was previously sampled in 1992 utilizing 92 privately owned domestic wells. The 2001 sampling project used a network of dedicated monitoring wells to collect the groundwater samples. The monitoring well network was assembled for this project by combining three sets of existing monitoring wells controlled by three agencies. The upper reach of the alluvial aquifer in Weld County was sampled using the twenty monitoring wells permitted by the Central Colorado Water Conservancy District (CCWCD). These are the same monitoring wells utilized every year in the Weld County long term monitoring effort. The lower reach of the aquifer, from Fort Morgan to Ovid, was sampled using a monitoring well network established by the Lower South Platte Water Conservancy District (LSPWCD). The area between these networks is filled in by four monitoring wells permitted by the Colorado Department of Public Health and Environment (CDPHE).

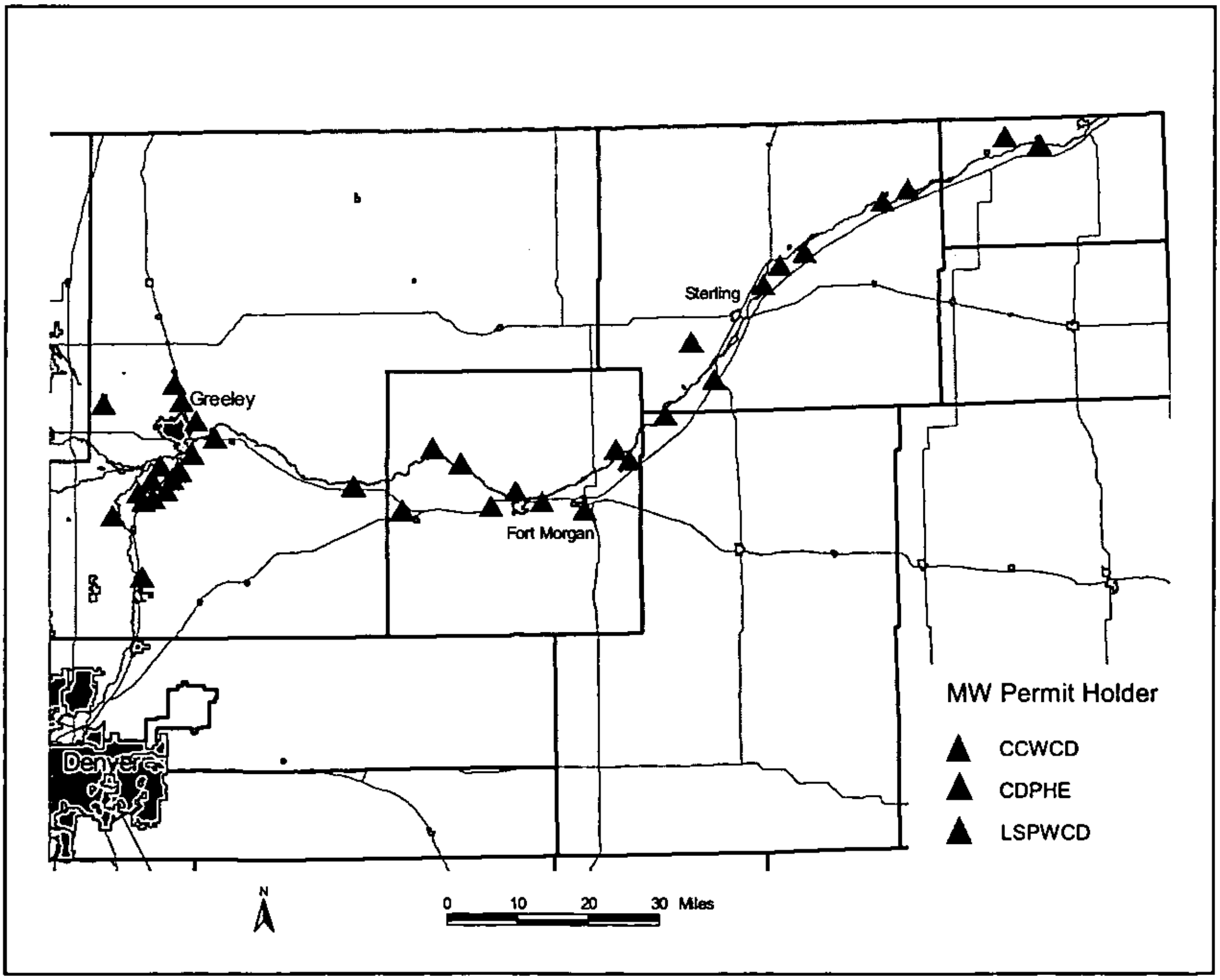


FIGURE 2 - Location of monitoring wells sampled in the South Platte River alluvial aquifer, regional groundwater quality study, and controlling agency.

The alluvium in the South Platte River valley was deposited in a channel eroded into the underlying bedrock and consists mainly of heterogeneous mixtures of clay, sand, and gravel, or lenses of these materials. The thickness of the alluvium ranges from less than a foot to more than 290 feet in some areas. The alluvium contains the major available supply of groundwater in the area covered by this study. Throughout the South Platte River valley and its tributary valleys, these deposits form an almost continuous unconfined aquifer that is in hydraulic connection with the South Platte River. In the South Platte River valley, surface water and groundwater are two components of one hydraulic system. Precipitation, applied irrigation water, and leakage from canals and reservoirs recharge the valley-fill aquifer. The application of surface water for irrigation results in water percolating into the alluvium beneath the fields to recharge the aquifer. Recharge to the aquifer from irrigated land is from 45 to 50 percent of the applied irrigation water and precipitation. Groundwater return flows that augment the flow of the river are the direct result of recharge from applied irrigation water. As a result of consumptive losses, due to evaporation and evapotranspiration, recharged groundwater is higher in dissolved solids than the applied irrigation water. This creates a general increase in dissolved solids concentration in a down-gradient and down-valley direction within the alluvial aquifer.

Brad Austin, Rob Wawrzynski (CDA), and Reagan Waskom (CSUCE), were the field personnel for the South Platte sampling in July through August 2001. Field sampling procedures followed the protocol developed by the groundwater quality monitoring working group of the Colorado non-point task force. Well samples were analyzed for basic water quality and dissolved metals at the Colorado State University water testing laboratory. The Colorado Department of Agriculture Standards Laboratory performed the laboratory analysis for nitrate, and pesticides. The complete analysis performed on all samples, along with laboratory methods and reporting limits for each analyte, is presented in Table 4. Temperature and conductivity were measured in the field as part of the well purging process.

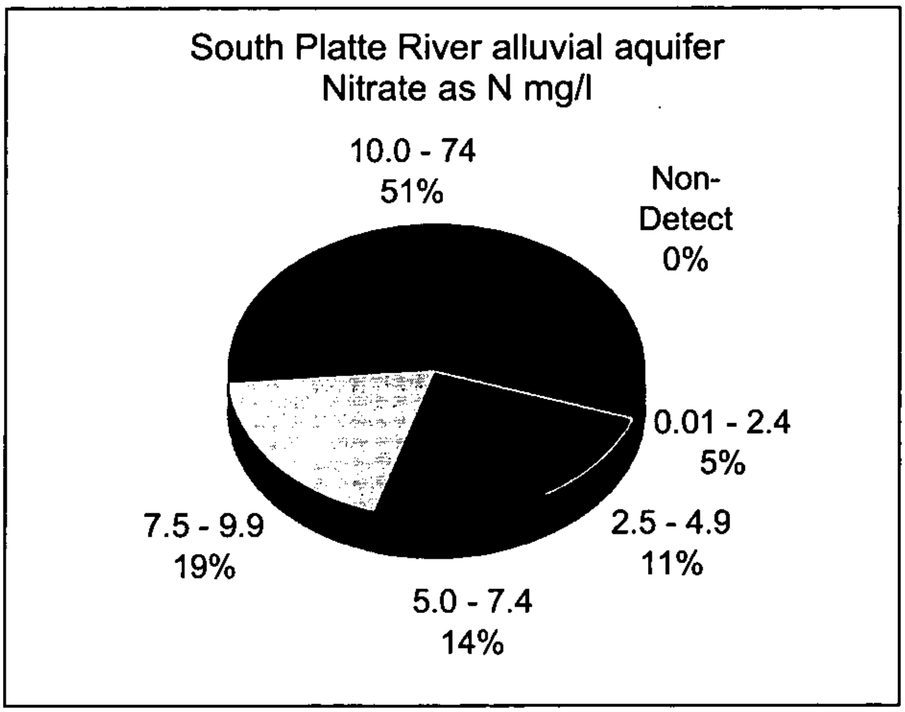


FIGURE 3 - Breakdown of nitrate levels for 37 monitoring wells sampled in the South Platte valley, Colorado, by CDPHE in 2001.

In the 2001 survey, 19 wells (51%) exceeded the nitrate drinking water standard of 10 mg/L, with test results ranging from 2.2 mg/l to a high of 74 mg/L (Figure 3). Nitrate levels show no geographic regional trend as does dissolved solids, but tend to be most problematic in

Weld and Morgan Counties (Figure 4). This distribution appears to be most associated with those areas were both commercial fertilizer and manure are used together. Most manure use is concentrated in Weld and Morgan Counties due to the proximity to commercial feedlots located there and the high cost of hauling.

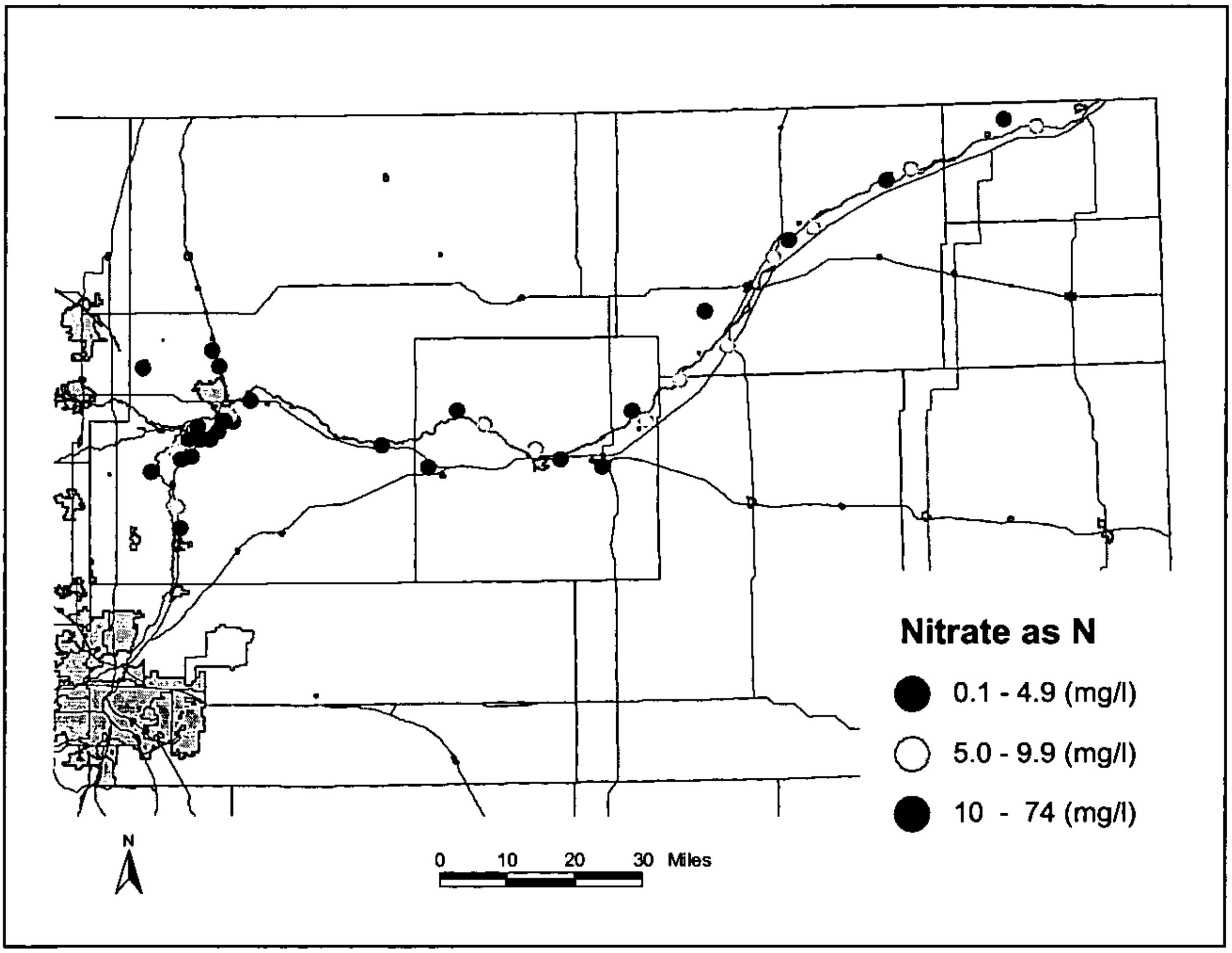


FIGURE 4 - Sample locations and nitrate levels. Map showing the location and corresponding nitrate level in monitoring wells sampled in South Platte River alluvial aquifer.

Several of the monitoring wells sampled in this survey were utilized by the USGS NAWQA program when they surveyed the South Platte Basin in 1994. Although two sampling events separated by seven years is not suitable for looking at trends in water quality, it might be interesting to compare the results from the two studies. In Figure 5, the nitrate as nitrogen values are compared from these two studies. Table 2, list the summary statistics from each study.

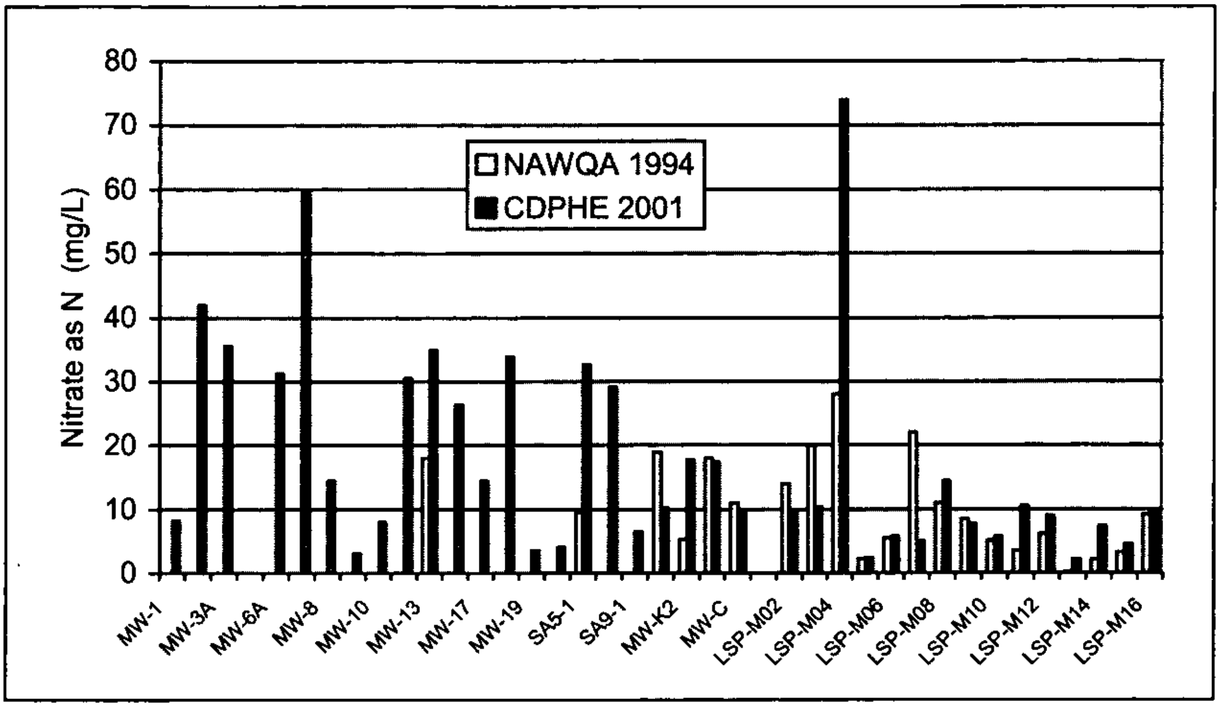


FIGURE 5 - Comparison of nitrate levels from 1994 USGS NAWQA sampling to the 2001 CDPHE sampling, for the 37 monitoring wells in the South Platte alluvial aquifer.

TABLE 2 - Comparison of summary statistics for the 1994, 2001 monitoring results.

South Platte monitoring wells		
	1994 NAWQA	2001 CDPHE
Mean	12.4	16.0
Median	9.4	9.8
Minimum	0.2	2.2
Maximum	52	74
# wells nitrate increased		14
# wells nitrate decreased		7
Note: all values are Nitrate as N (mg/L), except # wells		

The pesticide analysis performed on the samples collected in 2001 was more extensive than that performed in the initial sampling of this aquifer in 1992, analyzing for 47 compounds. The 2001 survey also had lower detection limits on the majority of the pesticide compounds. For some compounds the detection limits have decreased an order of magnitude from the earlier survey.

The pesticide data revealed 23 of the 37 wells (62%) testing positive for one or more of the eight pesticides detected in this study. Atrazine and its breakdown product, Deethyl Atrazine (DEA), accounted for the majority of detections (Table 3). Metolachlor was the next most commonly detected pesticide. Eight of the 37 wells had more than one pesticide present.

TABLE 3 - Results of Pesticide Analysis, South Platte Alluvial aquifer, 2001.

Pesticide	Detections	Range	DL	MCL
Acetochlor	1	0.15	0.1	
Atrazine	15	0.06 - 5.5	0.06	3
Deethyl Atrazine	13	0.13 - 1.2	0.07	
Dicamba	3	0.14 - 6.0	0.05	
Metalaxyl	1	2.2	0.1	
Metolachlor	11	0.05 - 13.1	0.03	
Prometon	1	1.1	0.08	100
Velpar	2	0.15 - 2.8	0.03	90
2,4-D	1	0.30	0.03	70

- Amounts are given in micrograms per liter (ug/L), a unit of measurement for pesticide concentrations in water that is equivalent to parts per billion.
- Detections - The number of wells testing positive for that pesticide.
- Range - The range of concentration values for that pesticide in those wells.
- DL - Minimum concentration that can be detected by the laboratory.
- MCL - the maximum amount allowed in drinking water, if no MCL has been established the number given is the lifetime drinking water health advisory.

Atrazine herbicide is widely used on corn and pasture lands throughout the region. Metolachlor herbicide is also used on corn as well as some vegetable crops. The Atrazine detections are scattered throughout the basin owing to its widespread use (Figure 6). The Metolachlor detections are for the most part confined to Weld County reflecting its more prevalent use there.

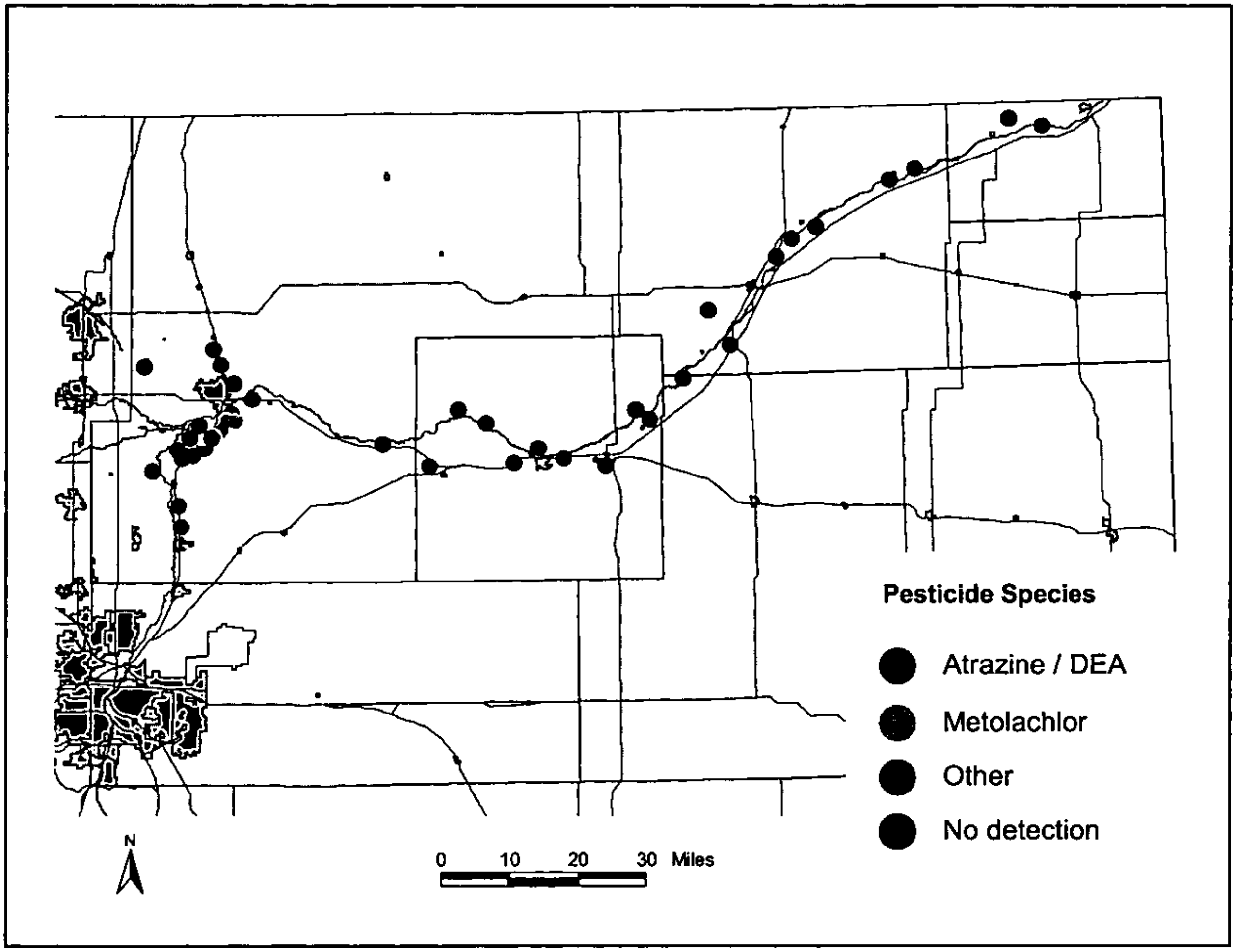


FIGURE 6 - Location of pesticide detections. Map showing the location and type of pesticide detected in monitoring wells sampled in South Platte River alluvial aquifer.

San Luis Valley special study

In February and April of 2001, the program made two public presentations of our joint monitoring project with the U.S. Geological Survey completed in 2000. This survey sampled thirty-three dedicated monitoring wells in the San Luis Valley. The wells were originally installed in 1993 by the USGS NAWQA program as part of the Rio Grande Basin regional water quality study. The purpose of the sampling project was to acquire a high quality data set to use in an aquifer vulnerability modeling project with the USGS for 2001-2002.

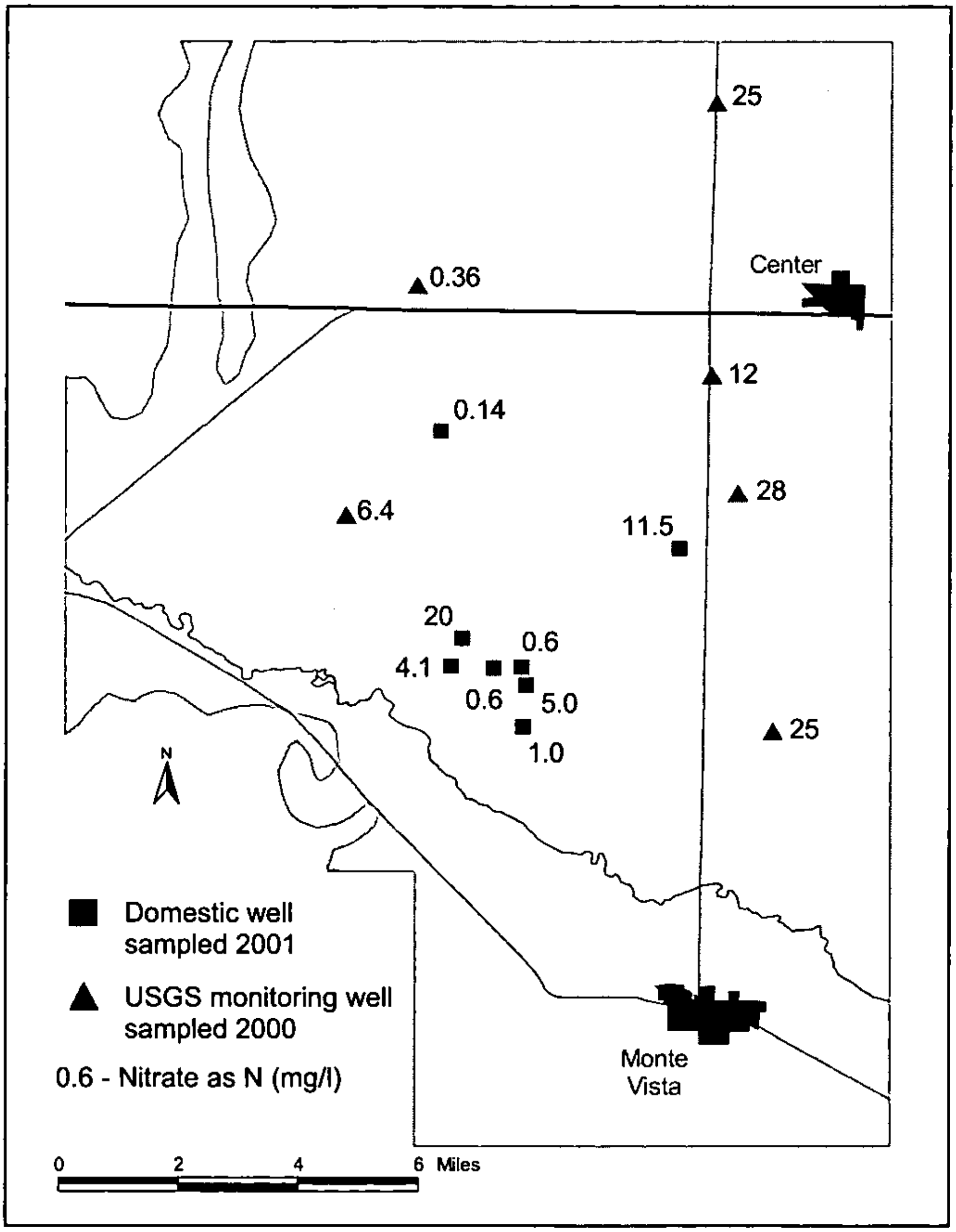


FIGURE 7 - Location of wells sampled San Luis Valley. Map showing the location and corresponding nitrate level in wells sampled in San Luis Valley special study.

Brad Austin and Reagan Waskom received a letter from a resident of the valley concerned about a cluster of cancer cases in the area of the valley were they lived. In response to the concerns expressed in this letter, the program planned a special study. The epidemiology section of the Colorado Department of Health was also notified about the case and invited to participate in the investigation. A sampling program was planned for the fall of 2001 to collect samples from six domestic wells surrounding the area of concern (Figure 7). The sampling plan also included the two monitoring wells from the previous year that were not sampled due to field problems. All samples were to be analyzed for the full suite of analysis. This would include the basic water quality analysis and dissolved metals analysis performed at the CSU laboratory in addition to nitrate / nitrite and all pesticides at the Colorado Department of Agriculture laboratory (Table 4).

The results of this study showed the well water of the affected residents is of very good quality. No basic water quality or dissolved metal analysis result exceeded a recommended level. Only one of the six domestic wells sampled in the area of concern exceeded the nitrate drinking water standard of 10 mg/l (Figure 7, 20 mg/l). Due to the isolated nature of this exceedence a localized problem is suspected in this case, i.e. poor well construction or nearby point source of nitrogen contamination. One other well to the northeast of the immediate study area was sampled for other reasons. This well also exceeded the nitrate standard (Figure 7, 11.5 mg/l). This result was expected due to its location just west of the historic nitrate hot spot near Center, Colorado as shown in Figure 7, USGS well results 2000. The sampling included two USGS monitoring wells that were skipped in 2000. One well was sampled and reported 0.14 mg/l Nitrate as N, the other was dry, as it had been in the previous year. The pesticide analysis for all wells sampled was negative.

There are of course many contaminates that can find their way into groundwater, and have an adverse effect on human health. This program, which focuses on agricultural chemicals, can't test for every possible contaminate present. But it is felt that, considering the area in question is predominately agricultural, the analysis that was performed was the most appropriate, if not complete.

Aquifer Vulnerability Project Update

In addition to monitoring groundwater for the presence of agricultural chemicals, the Ag Chemicals Program is required to determine the likelihood that an agricultural chemical will enter the groundwater. 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 groundwater, 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 Pesticide Management Plan (PMP), the staff at CDPHE, CDA, and CSU have studied various types of vulnerability analysis. The goal has been to satisfy the requirements of the PMP 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 an aquifer sensitivity method in the northeastern section of the state. The results of this pilot project were evaluated by CDPHE, CDA, CSU, and USEPA, and approved for use throughout the state. The Program expanded this effort statewide in 1997 to produce an aquifer sensitivity map for Colorado. The project was completed in June 1998. The final map product provides a standard method to determine aquifer sensitivity to pesticides statewide for the program.

In 1999, the legislature approved additional funding to expand this effort to the next phase. Over the next four years, the program will attempt to add vulnerability factors to the pesticide model, develop a nitrate sensitivity map, and produce a field scale decision matrix for fertilizer applications. This project aims to develop a method to determine aquifer vulnerability to both pesticides and nitrate statewide. A nitrate sensitivity map will be created in a similar fashion to the method developed for pesticides. Those unique factors that influence nitrate movement to groundwater will be incorporated as new GIS layers for the map. The project will then develop a vulnerability matrix for both pesticides and nitrate. These vulnerability matrices must account for the local factors that influence pesticide and nitrate movement. Irrigation practice, soil properties, pesticide properties, nitrogen leaching chemistry, and pesticide and nitrogen application methods are some but not all of the factors to be investigated.

An additional project has been developed with the USGS to investigate the applicability of a statistical model to predict areas more susceptible to contamination from agricultural chemicals. This type of model was used in Idaho with some success. The program feels the benefit of this type of approach is to eliminate the subjective inputs that plague the other models. The downside of this approach is that it's wholly dependent on the statistical distribution of the monitoring data utilized.

Upon completion of all the projects, the program will be better able to determine groundwater vulnerability to agricultural chemicals statewide. Results will be evaluated and incorporated into a standard method to delineate those areas of the state were groundwater is vulnerable to contamination from agricultural chemicals. The monitoring program can then target resources to those areas where attention is most needed.

Table 4 - Laboratory Methods and Detection Levels

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

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 Atrazine		Triazine	525.1	0.2
	Deisopropyl Atrazine		Triazine	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
Dazzel	Diazinon	Insect	OrganoPH	525.1	0.2
Barrier	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
Primatol	Prometon	Herb	triazine	525.1	0.1
Princep	Simazine	Herb	triazine	525.1	0.2
Treflan	Trifluralin	Herb	OrganoFL	525.1	0.3
Weed B Gone	2,4-D	Herb	PhenoxyAcid	515.2	0.03
Stinger	Clopyralid	Herb	PicolinicAcid	515.2	0.07
Banvel	Dicamba	Herb	BenzoicAcid	515.2	0.05
Kilprop	MCPP	Herb	PhenoxyAcid	515.2	0.06
Agritox	MCPA	Herb	PhenoxyAcid	515.2	0.02
Tordon	Picloram	Herb	PicolinicAcid	515.2	0.17
Turflon	Triclopyr	Herb	PicolinicAcid	515.2	0.01

Table 4, continued - Laboratory Methods and Detection Levels

Colorado Department of Agriculture Standards Laboratory

PESTICIDE ANALYSIS

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	MDL (ug/L)
Temik	Aldicarb	Insect	Carbamate	531.1	1.0
	Aldicarb sulfone		Carbamate	531.1	2.0
	Aldicarb sulfoxide		Carbamate	531.1	2.0
Sevin	Carbaryl	Insect	Carbamate	531.1	2.0
Furadan	Carbofuran	Insect	Carbamate	531.1	1.5
	3-Hydroxycarbofuran		Carbamate	531.1	2.0
	Methiocarb	Insect	Carbamate	531.1	4.0
Lannate	Methomyl	Insect	Carbamate	531.1	1.0
	1-Naphthol		Carbamate	531.1	1.0
DPX	Oxamyl	Insect	Carbamate	531.1	2.0
Baygon	Propoxur	Insect	Carbamate	531.1	1.0

INORGANIC ANALYSIS	EPA Method	MDL (mg/L)
Nitrate/Nitrite as N	300	0.1

Table 4, continued - Laboratory Methods and Detection Levels

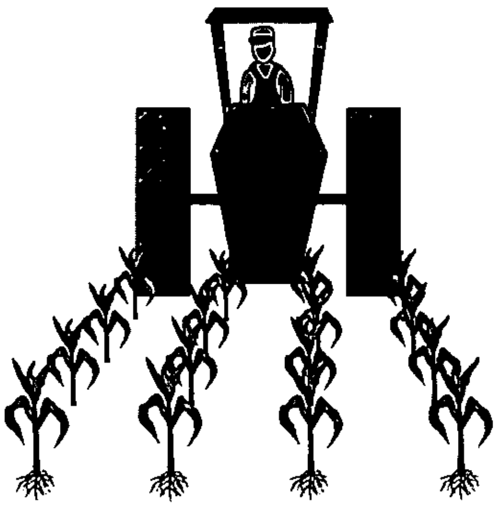
Colorado State University Soils Laboratory

MINERALS AND DISSOLVED METALS ANALYSIS

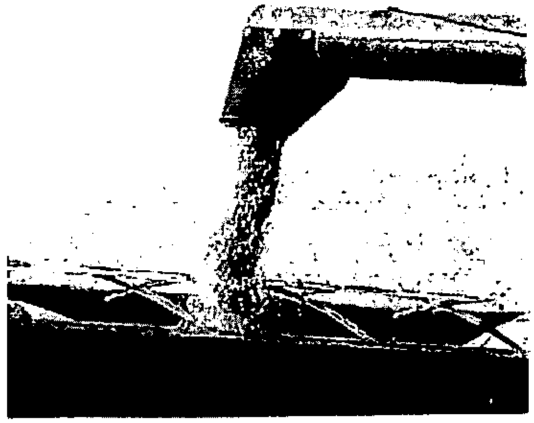
Basic Water Quality Parameters (mg/L)	Method	Reporting Limit
Boron	EPA 200.0	0.01
Bicarbonate	APHA 2320B	0.1
Calcium	EPA 200.0	0.1
Carbonate	APHA 2320B	0.1
Chloride	EPA 300.0	0.1
Magnesium	EPA 200.0	0.1
Nitrate	EPA 300.0	0.1
pH	EPA 150.1	0.1 pH unit
Sodium	EPA 200.0	0.1
Specific conductance (TDS)	EPA 120.1	1.0 uS/cm
Sulfate	EPA 300.0	0.1
Potassium	EPA 200.0	0.1
Alkalinity, total	Titration	1.0
Solids, Total Dissolved	Gravimetric	10.0
Hardness, total as $CaCO_3$	Calculation	1.0
Dissolved Metals		
Aluminum	EPA 200.0	0.1
Barium	EPA 200.0	0.01
Cadmium	EPA 200.0	0.01
Chromium	EPA 200.0	0.01
Copper	EPA 200.0	0.01
Iron	EPA 200.0	0.01
Manganese	EPA 200.0	0.01
Nickel	EPA 200.0	0.01
Molybdenum	EPA 200.0	0.01
Phosphorous, total	EPA 200.0	0.1
Zinc	EPA 200.0	0.01

APPENDIX IV

Survey of Irrigated Crop Production in Colorado



Colorado State University Cooperative Extension
Colorado Department of Agriculture



Use Nitrogen Credits to Reduce Fertilizer Costs: Colorado Corn / CSU Demonstration Site Results

Cooperator: James Ewing

- Beef feedlot manure supplies approximately 10 and 3 lbs N per acre for each ton applied during the first and second years respectively following application.
- One inch of irrigation water supplies 0.23 lb. N per acre for each ppm of NO3-N in the water.
- Call Troy Bauder (970) 491-4923 with CSU or Ginger Davidson with Colorado Corn (970) 351-8201 for more information.
- Our sincere thanks to James Ewing and Mike Hubbard for their help with this demonstration!

Background Information

Irrigation water and manure crediting are important best management practices (BMP) for maximum economic yield. Irrigation water containing nitrate supplies considerable amounts of nitrogen (N) because it is applied during the growing season and is immediately available for crop uptake. Livestock manure is rich in plant available nutrients, especially nitrogen and phosphorus, which should be credited toward the fertilizer requirements of a crop. In most situations, fields with past manure applications and irrigated with high nitrate water will not require additional nitrogen fertilizer.

This site demonstrated how adjusting fertilizer rates to account for these nitrogen sources can save input costs while maintaining yields. We applied nitrogen fertilizer rates of 30, 100 and 170 lbs. N/ acre (30 lbs. preplant, the rest sidedress) to six-row strips. These rates approximate fertilizer recommendations with and without manure and water nitrogen credits. The manure credit was for the second year after application. We based all rates upon a 200-bu yield goal and preplant soil analysis results.

Results: Average* corn grain yield and economic comparisons for 2000 crop.

Nitrogen Credit Used	Nitrogen Credit	Fertilizer Nitrogen Rate	Fertilizer Cost	BMP Cost***	Grain Yield	$ Return on Practice**
	-- lb / acre	lb / acre --	-- $ / acre --	-- $ / acre --	-- bu / acre --	-- $ / acre --
Water + 2nd year manure	140	30	7.20	5.50	182	43.30
Water only	60	100	24.00	4.50	181	16.30
None	0	170	40.80	2.00	178	-42.80
Average					180	

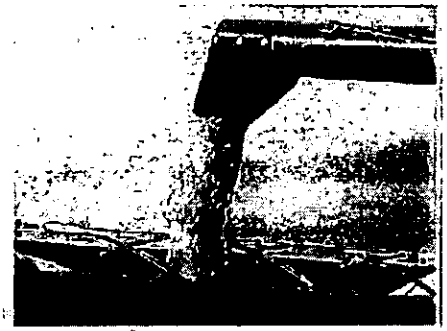
*Results provided are an average of two replications of each treatment, except 0 rate which only had one rep.
**Return was computed using a $2.00 / bu corn price and a $0.24 / lb. N cost.
Return on Practice = (yield difference between practice and BMP N rate x $2.00) - N cost difference - BMP cost.
***Cost based upon 40 acre field, includes expenses for labor and laboratory tests. Contact authors for further explanation.

What Did We Learn?

Although the growing conditions at this site did not allow us to meet the 200 bushel yield goal, reducing the N fertilizer rate to account for irrigation water and/or manure nitrogen sources did not affect grain yield at this site. Therefore, the highest economic return resulted from crediting manure (second year after application) and water N sources. These results support using all appropriate nitrogen credits for maximum economic yield. Similar results were found at this site in 1999.

Field Background information:

Soil type:	Julesburg sandy loam
Planting date:	April 20, 2000
Hybrid and population:	Pioneer 34G81; 28,750 emerged plants/acre
Manure rate and timing:	Approximately 20 tons applied Fall 1998, incorporated Spring 1999
Preplant soil NO_3-N:	0 - 1' = 31 ppm; 0 - 4' = 12 ppm
Presidedress soil NO_3-N:	0 - 1' = 23 ppm (critical level is 15 ppm)
Irrigation water NO_3-N:	28 ppm
Previous crop:	Corn
Sidedress fertilizer:	UAN 32%, applied May 12 (2 - leaf growth stage)



Alternative Herbicides
Colorado Corn / CSU Demonstration Site Results

Cooperator: Wes Moser and Sons

- This site demonstrates atrazine herbicide alternatives using GMO technology.
- Herbicide tolerant corn can have environmental benefits including lower groundwater contamination risk.
- For further information contact: Duane Toenges with CCGA at (970) 351-8201 or Troy Bauder with CSU at (970) 491-4923.
- Our sincere thanks to Ron Ditson with Wes Moser and Sons for his help and cooperation on this project.

Background Information

Atrazine is a compound frequently found in the groundwater (alluvial aquifer) of the South Platte Valley. Although these detections are usually below the U.S. EPA drinking water standard (3.0 parts per billion), the public often perceives any pesticide detection as a threat to safe drinking water. Therefore, weed control programs with no or reduced rates of atrazine are preferable in this area.

At this site we demonstrated an atrazine alternative using a variety of corn that is herbicide tolerant and produced with GMO (genetically modified organism) technology. The variety being used is Pioneer 33G28, a Liberty Link® corn. Liberty is a contact, broad spectrum herbicide containing the active ingredient glufosinate-ammonium and is similar to Roundup® (glyphosate). It has no soil activity and a much lower ground water contamination risk than atrazine. Weed control and yield were compared to a conventional weed control program (Dual + Atrazine).

Results:

Table 1. Silage yield and dry matter comparisons between the two herbicide programs.

Herbicide	Dry Matter	Adjusted Yield (30% DM)*	Organic Dry Yield
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]

*Yields are an average of two applications.

Table 1. Weed control visual observations between the two herbicide programs.

Herbicide	Date and Growth Stage — June-14, (V6)	June-27, (V8)	June-30	July-7, (V10)
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

*Dominant weeds prior to application: lambsquarter (to 8"), pigweed, foxtail, sandbur, and wild proso millet.
Weed pressure was heavy in Liberty plots prior to application.

What Did We Learn?

Weed control was acceptable under both herbicide programs. Although the "conventional" program provided better residual control later in the season, the Liberty can be combined with other products to achieve this result. Yields were slightly, but not significantly lower in the alternative program. This and other herbicide tolerant programs may fit well into areas with groundwater sensitive to contamination from atrazine or other herbicides with groundwater problems.

Note: ***No** product endorsement by CCGA or CSUCE is intended or implied. Cooperator preference and compatibility determined products used.*

Field Background information:

Soil type:	Valent and Vona loamy sand
Planting date:	May 10, 2000
Hybrid and population:	Pioneer 33G28; 35,000 planted seeds/acre
Conventional Herbicide:	Dual + Atrazine applied pre-emergence + 6 oz Clarity (Dicamba) post
Liberty Rate:	28 oz Liberty (glufosinate) + 3 lb ammonium sulfate/acre + 6 oz Clarity post
Previous crop:	Potatoes

Irrigating Corn Under Tight Nitrogen Budgets

By: Troy Bauder, CSU Cooperative Extension

Higher nitrogen (N) fertilizer prices have caused many producers to use lower N rates this year. Growing corn with less N requires careful water management to maintain yields. Nitrate-nitrogen is highly soluble and moves readily downward with soil water. Applying more irrigation water than can be stored in the crop root zone will increase N losses through nitrate leaching. Adjusting irrigation management to increase efficiency and uniformity will result in more N available for crop uptake throughout the growing season.

Corn producers should reevaluate their irrigation management when growing crops under a tighter N budget. Decide when to irrigate based upon an estimate of crop and soil water status, as labor and water delivery permits. If currently irrigating on a fixed-day schedule, consider whether increasing the length of time between irrigations is feasible, especially when corn is not in a sensitive growth stage (tassel to soft dough). Early (prior to 12-leaf) and late (after soft dough) in the growing season, you can let the soil moisture decline to a lower level (up to 30 percent of available moisture) without compromising yield. If N is limiting, slight moisture stress during this time may have less yield impact than over-irrigating and losing N to leaching.

Two pieces of information that can help time irrigation include soil water-holding capacity (Table 1) and crop water use or evapotranspiration (ET). The plant available water columns of Table 1 provide a range of the total usable soil water for various soil types. The portion of this water that you can deplete prior to irrigating changes as the crop grows as shown by the next five columns. You can roughly estimate the time between irrigations by dividing the allowable depletion by the daily ET rate. For example, assume a recently irrigated (to field capacity) field with a sandy loam soil was tasseling, and the ET rate was 0.35 inches per day. The next irrigation would need to be completed before five days (1.8 / 0.35) and replace at least 1.4 inches of water. Periodic soil probing is recommended to check this scheduling method.

Table 1. Soil water-holding capacity of typical Colorado soils. The allowable depletions provided represent crop water use (when starting at field capacity) between irrigations without water stress for corn.

Soil Texture	Plant Available Water		Approximate soil water allowable depletion in rootzone at selected growth stages*				
	Low	High	V6	V12	Tassel	Silk	Hard Dough
	inches / foot		inches water / rootzone				
Loamy sand	0.8	1.2	0.6	1.6	1.4	1.5	2.3
Sandy loam	1.2	1.5	0.9	2.2	1.8	2.0	3.1
Fine sandy loam	1.5	2.0	1.1	2.8	2.4	2.6	4.0
Sandy clay loam	1.6	2.1	1.2	3.0	2.5	2.8	4.2
Loam	1.7	2.5	1.4	3.4	2.8	3.1	4.8
Silty loam	2.0	2.5	1.5	3.6	3.0	3.4	5.1
Silty clay loam	1.8	2.0	1.2	3.0	2.6	2.8	4.3
Clay loam	1.6	2.4	1.3	3.2	2.7	3.0	4.6

*Allowable depletion based upon average rooting depth at each growing stage. Assuming noncompacted rooting zone.

ET information is available on the Web sites provided below or by calling toll free (888) 662-6426 along the S. Platte. One source of site-specific ET information for scheduling is an atmometer (ETgage). This tool is simple to use, low maintenance, provides a visual estimate of crop water use, and is relatively inexpensive. Alternatively, consider using an irrigation scheduling service offered by crop consultants as a cost-effective method of scheduling irrigations to maximize return from N fertilizer inputs.

An atmometer (ETgage) is one cost-effective tool to schedule irrigations.

Late season firing or yellowing of the lower three to four corn leaves is likely under tight soil N supplies, but does not always indicate a yield limiting N deficiency. During grain fill the corn plant is rapidly moving N from older vegetative tissue into the grain. The severity of leaf yellowing also will vary between hybrids. Although N applications through fertigation may keep the canopy green to the end of the season, an economical yield response may not occur. Light green leaves in the middle or upper part of the plant are a better indicator of yield limiting N deficiency.

ET information online:
http://ulysses.atmos.colostate.edu/~coag/Et.html or
http://www.ncwcd.org/

For more information on atmometers and irrigation management see the following Web sites:
http://www.colostate.edu/Depts/SoilCrop/extension/Newsletters/news.html
http://deal.unl.edu/waterquality/firsttime.html
http://www.ext.colostate.edu/pubs/crops/pubcrop.html

Attention All Agricultural Extension Faculty - Extension Opportunity for 2001 Cropping Year

Presidedress Soil Nitrate Test (PSNT) for Corn

We would like to cooperate with interested county faculty (agriculture, natural resource, agronomy, etc) statewide to promote the presidedress soil nitrate test (PSNT) to Colorado corn producers. With corn prices low and fertilizer costs high, this is a good opportunity for county faculty to help growers adopt a higher level of nitrogen management for increased profitability and water quality protection. The PSNT meets both of these objectives.

- Nitrogen (N) fertilizer prices have almost doubled from last year.
- Corn is a crop with a high N requirement.
- The majority of N uptake by corn occurs in mid-summer (Fig 1). N application just prior to this time can help producers stretch tight and expensive N supplies.
- The PSNT offers growers a tool to assess soil nitrate status in early summer and make a more informed decision on the need for additional N.
- The Water Quality Extension program in the Department of Soil and Crop Sciences is offering an opportunity to extend this tool to growers in 2001.

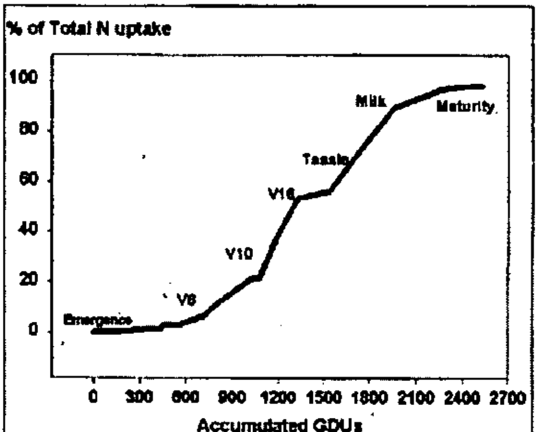


Fig. 1 – Corn N uptake begins slowly and then rapidly accelerates after V10.

Background Information

Current N fertilizer recommendations in Colorado are based on soil samples taken in the fall or in the early spring. However, most N uptake by corn occurs in midsummer from the 8-leaf stage to pollination (Figure 1). Mineralization of N from manure or other organic matter, and nitrate leaching, can significantly change soil N status before this time. The pre-sidedress nitrate test (PSNT) measures these potential changes. By complementing preplant soil testing with PSNT, growers can better predict yield response from N fertilizer, saving unnecessary fertilizer costs.

The PSNT is based on nitrate concentration in the top 12 inches of soil when corn is 6 to 12 inches tall (V6 growth stage). Under typical Colorado conditions, CSU researchers found the critical PSNT level is 13 to 15-ppm nitrate-N (NO_3-N) in the top foot of soil at this growth stage. If the PSNT level is lower than 13 ppm NO_3-N, sidedress N should be applied. If the PSNT level is higher than 15 ppm NO_3-N, the probability of a yield response to additional N is low (see Table 1). Although the PSNT was originally calibrated for non-manured fields in

Colorado, the 13-15 ppm NO_3-N should also be sufficient for fields with recent manure applications or legume crops. The test is most useful for predicting whether or not soil N is sufficient - not for making an N rate prediction. Growers and crop consultants must assess yield potential as well as soil nitrate levels to determine how much additional N is needed if the PSNT is below 15 ppm.

Table 1. The yield response of corn to sidedress N application of 60 lbs/acre when PSNT was above or below the critical NO_3-N concentration at V6

(Sampling Depth: 0 - 12")	Observations	Yield response from sidedress N	Prediction accuracy
	#	# of Sites	%
Below critical level	35	19	54**
Above critical level	21	0	100
Total	56		71

Based on equal sampling intensity from both furrow and shoulder positions
**19 sites did not respond to additional N, yield levels ranged from 120 to 210 bu/acre

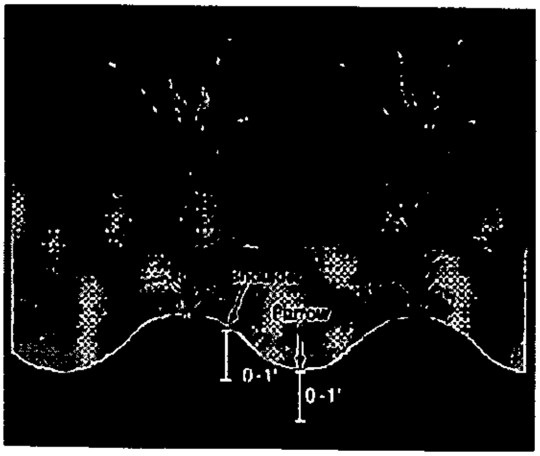


Fig. 2 – PSNT sampling positions. Collect equal numbers of samples from both row and shoulder.

Proper soil sampling may be the most critical step in the PSNT procedure. To sample a field, take a minimum of 15 to 20 random soil core samples from a uniform soil area or 40-acre field. On surface irrigated fields, we recommend collecting equal numbers of soil samples from the furrow and shoulder of the bed (see Fig. 2) and sampling depth of 12 inches. Get the soil sample to a testing lab right away and tell the lab you are evaluating the sample for PSNT and need your results quickly. Using the PSNT will give growers more confidence to evaluate their sidedress decision, saving both fertilizer and sleep..

Extension Program

We are offering:

- Technical assistance in setting up field demonstrations (size and complexity of field demonstrations will be determined by county faculty and cooperating producers)
- Financial assistance for travel, field supplies, soil sampling and other expenses up to $500 (must be spent by June 30, 2001)
- Our time and travel to help setup demonstrations and promote practice

For more information contact: Troy Bauder, Extension Specialist, (970) 491-4923
Please contact us by **April 23, 2001** to reserve your spot in this program.
tbaud@lamar.colostate.edu
or
Reagan Waskom
(970) 491-2947

Attention All Agriculture Extension Faculty - Extension Opportunity for 2001 Cropping Year

Using ETgages (Atmometers) for Irrigation Scheduling

We would like to cooperate with interested county faculty (agriculture, natural resource, agronomy, etc) statewide to promote irrigation scheduling with ETgages to Colorado producers. Higher energy costs for pumping and increased fertilizer costs present us with an opportunity to help growers adopt a higher level of irrigation and nitrogen management for increased profitability and water quality protection. Irrigation scheduling with atmometers can meet both of these objectives.

♦ Nitrogen (N) fertilizer prices have almost doubled from last year and energy prices for pumping are also expected to be high this year.

♦ Irrigation scheduling may reduce the number of irrigations required and thus energy cost.

♦ ETgages are one of many tools available to help producers schedule irrigations, and have several advantages over other methods:

- ✓ Simple to use
- ✓ Low maintenance
- ✓ Provide visual estimate of crop water use
- ✓ Relatively inexpensive

♦ ETgages can complement other scheduling methods including soil moisture monitoring and computer programs such as Cropflex.

♦ The Water Quality Extension program in the Department of Soil and Crop Sciences is offering an opportunity to promote this tool in 2001. We have been working with farmers in the upper S. Platte and have found ETgages to be a good tool to increase their interest in irrigation scheduling. Also, installing the gage in an area with frequent traffic attracts the curiosity of other growers. They are a good tool to demonstrate scheduling with a small investment in time and an easy learning curve.

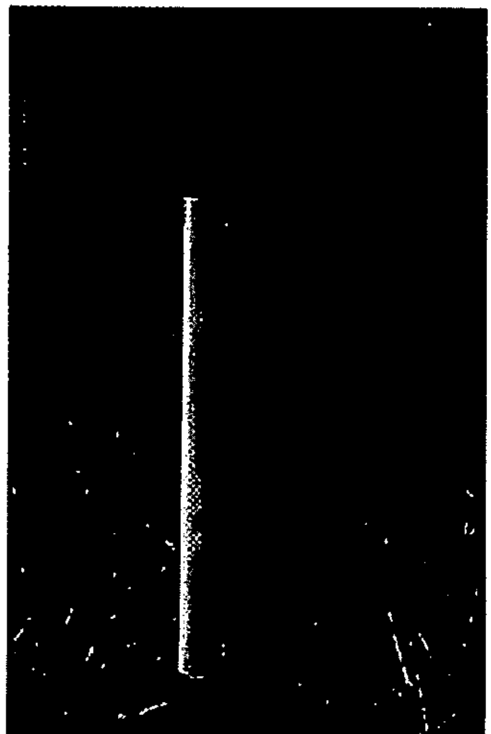


Fig. 1 – ETgage mounted for field use. Atmometers are typically mounted on a wooden post near irrigated fields.

Background Information

Irrigation scheduling based upon crop ET (evapotranspiration) is often perceived as too difficult or too time consuming for many producers and crop advisers. However, Atmometers are a tool that reduces the work and the complexity associated with sound ET-based scheduling. The primary purpose of these instruments is to provide actual crop ET at any field location they are installed. This information is visually displayed on a site tube mounted in front of a ruler on the instrument (Figure 1). Reading the site tube is as easy as reading a rain gauge. Therefore, the user can quantitatively gauge how crop water use varies with ever-changing weather conditions in Colorado.

Essentially, an atmometer acts as mini-weather station that, when properly installed, will provide reference ET (ET_r) at a reasonable cost and with little effort. A Colorado supplier sells a modified atmometer (ETgage®) for about $200. They are easy to install and require little maintenance. Studies conducted by CSU and the USDA in Fort Collins show that an atmometer will provide ET_r values that closely match ET_r calculated from weather station data (Figure 2). This ability to provide reliable ET makes atmometers especially useful for areas that do not have nearby weather stations that provide this information over the phone, DTN, Internet, or for people that do not have access to this information. A consultant or grower can install an atmometer in these areas to help schedule irrigations for many fields within a several mile radius. Also ET data from an atmometer may be more convenient and site specific than these other sources.

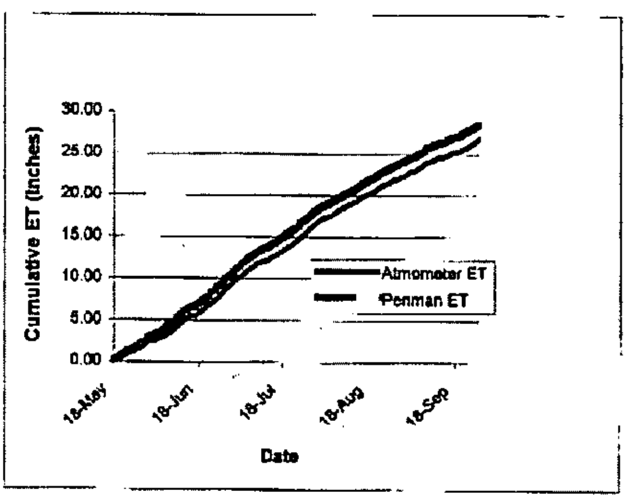


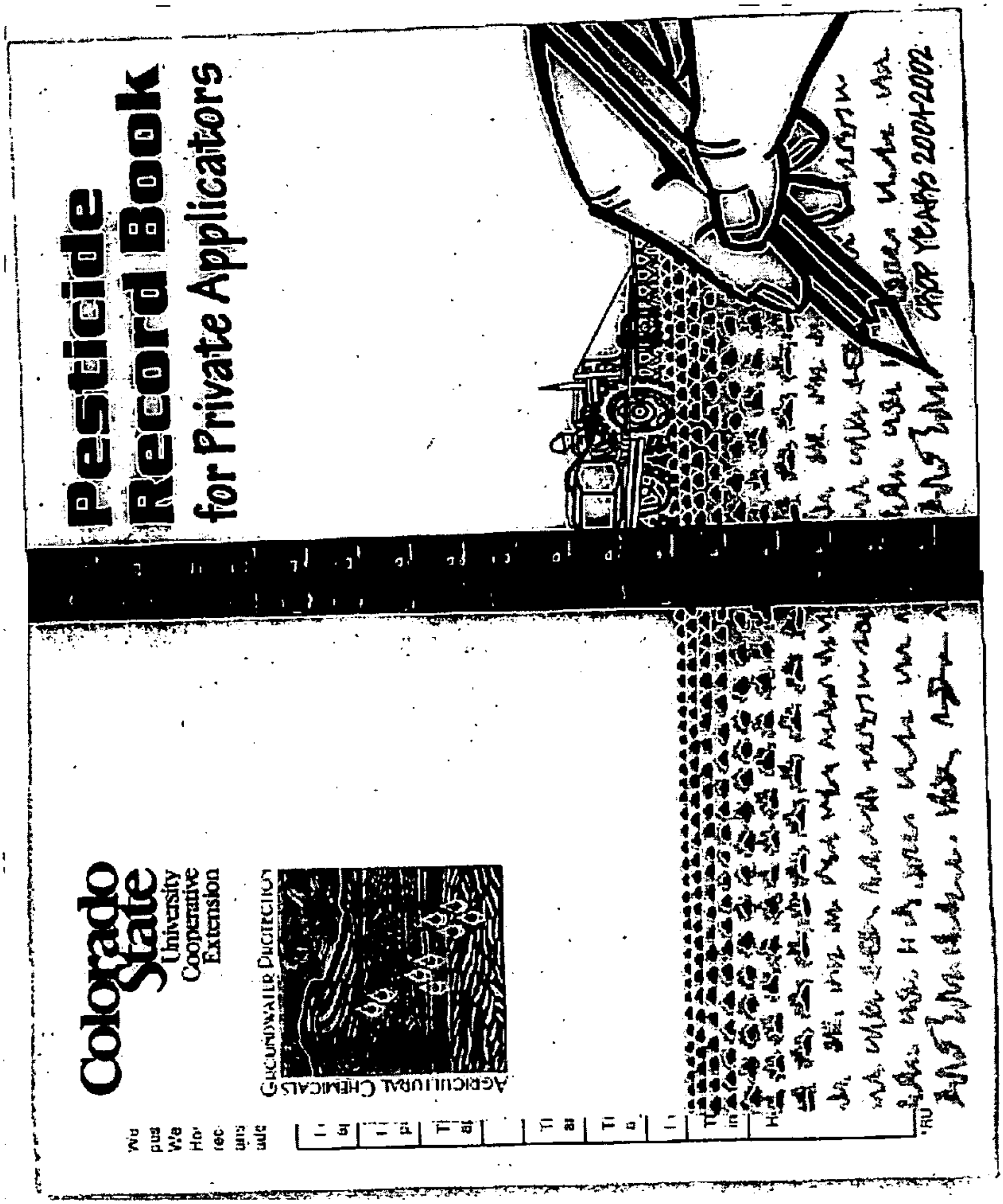
Fig. 2 – Comparison of atmometer ET to Penman ET calculated from weather station.
Source: Dr. Walter Bausch, USDA, ARS.

Extension Program

We are offering:

- Supplies: ETgage, mounting post, distilled water, brochure box for literature.
- Extension materials and literature to explain and promote use of irrigation scheduling.
- Technical assistance in setting up equipment and selecting installation location.
- Financial assistance for travel, field supplies, soil sampling and other expenses up to $200 (must be spent by June 30, 2001)
- Our time and travel to help setup demonstrations and promote practice

For More Information contact: Troy Bauder, Extension Specialist, (970) 491-4923
tbaud@lamar.colostate.edu
or
Reagan Waskom, (970) 491-2947
Please contact us by **May 5, 2001** to express your interest in this program.


Pesticide Record Book
for Private Applicators
CROP YEARS 2001-2002
Colorado State
University
Cooperative
Extension
AGRICULTURAL CHEMICALS
GROUNDWATER PROTECTION

APPENDIX V

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION ACT ADVISORY COMMITTEE

Water Quality Control Commission

Mr. Rob Sakata
662 Rose Dr.
Brighton, CO 80601
(303) 659-8675
rtsakata@aol.com
Original Appointment: 1991

General Public

Ms. Barbara Fillmore
18150 North Elbert Road
Elbert, CO 80106
(H) (303) 648-9972
(W) (303) 648-9897
Original Appointment: 1997

Mr. John Stout
8782 Troon Village Pl.
Lone Tree, CO 80124
(303) 708-1841
jstout@mines.edu
Original Appointment: 1998

Joyce Wallace
Colorado Corn Growers
127 22nd St.
Greeley, CO 80632
(970) 351-8201
Fax: (970) 351-8203
Jwallace@coloradocorn.com

Commercial Applicators

Mr. Steven D. Geist
Swingle Tree Co.
8585 East Warren Avenue
Denver, CO 80231
(303) 337-6200
sgeist@swigletree.com
Original Appointment: 1994

Mr. Mark McCuistion
McCuistion Aerial Applicators
P.O. Box 232
Rocky Ford, CO 81039
(719) 254-7999
Original Appointment: 1999

(Revised 3/11/02)

Green Industry

Mr. Eugene Pielin
GMK Horticulture
2768 Crestview Ct.
Loveland, CO 80538
(970) 669-0248
GMKHort@aol.com
Original Appointment: 1999

Mr. John Wolff
Grand Lake Golf Course
P.O. Box 590
Grand Lake, CO 80447
(970) 627-3429
Original Appointment: 1998

Ag Chemical Suppliers

Mr. Anthony Duran
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Original Appointment: 1998

Mr. Wayne Gustafson
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Mr. Lanny Denham
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Mr. Mike Mitchell
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Original Appointment: 1995

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cmsmith@rural-com.com
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Mr. Leon Zimbelman, Jr.
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Original Appointment: 1993