THE Cross SECTION

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Loan Funds Available For Water Conservation Equipment

Now, during the winter lull between harvest and planting, is the time to consider making improvements in the efficiency of your irrigation application and distribution systems. The High Plains Water District now has a second fund of $1 million available for loan, at an interest rate of 6.75 percent, to qualified farmers who wish to purchase agricultural water conservation equipment.

On December 5, the Water District received its second loan from the Texas Water Development Board through the pilot Agricultural Water Conservation Loan program. The money must be loaned to qualified irrigators within 120 days, or the District must return any unused funds to the TWDB.

Because the loan funds are available for a limited amount of time, Ag Loan Program Coordinator Becca Williams urges interested parties to apply for a loan as soon as possible.

She explains, "Applications are processed on a first-come, first-served basis. We encourage people to take advantage of this program while they can, because the pilot program ends next September."

The District had approved three loans totalling $76,326 from the new funds as of December 9. The loans, two from Hockley County and one from Parmer County, will be used to help purchase center pivot sprinkler systems.

The District approved loans for more than $445,000 to 21 farmers from the first $1 million fund, which was available from May 29 through September 29. The loans will be used to help purchase more than $620,000 worth of agricultural water conservation equipment, mainly center pivot sprinkler systems and surge valves. It is expected that these farmers will save more than 1,980 acre-feet of water each year through improved irrigation efficiencies.

Farmers who irrigate land which lies within the boundaries of the Water District's service area are eligible to apply for a loan. Qualified applicants may take out a loan to purchase water conservation equipment such as center pivot sprinkler systems, surge systems, furrow dikers, soil moisture monitoring equipment, computer software used in irrigation scheduling, laser land-leveling equipment and other equipment eligible under the Water District's loan guidelines.

Use of the conservation equipment can help a farmer save ground water by improving the application and distribution efficiency of his irrigation system. For instance, the average system efficiency, a combination of the application and distribution efficiencies, of a typical furrow irrigation system is 60 percent. The average system efficiency of a partial drop-line center pivot system is 82 percent. A surge system can improve the efficiency of furrow irrigation to about 80 percent, and a Low Energy Precision Application (LEPA) sprinkler system modification can improve sprinkler irrigation efficiency to as high as 98 percent.

The equipment can save the farmer money as well. By increasing his irrigation efficiency, the farmer uses less water because more of the water pumped reaches the crop and is not lost to evaporation, says Ken Carver, Assistant Manager of the High Plains Water District. This reduces pumping costs. In addition, higher crop yields usually result from more efficient irrigation.

The District operates the loan program under provisions of House Bill 2, approved by Texas voters in November 1985. A one-time fee of 2.5 percent of the loan amount is charged to cover administrative costs. Interest fees charged by the District on loans to individual borrowers are the same as the interest fees the Water District pays to the TWDB. The current interest rate is 6.75 percent.

For more information, program guidelines or an application form, contact Becca Williams at the High Plains Water District's Lubbock office. —*BS*

IT'S TAX TIME — IRS Engineers from Dallas review the cost-in-water guidelines and the decline data developed by the Water District for use in supplying landowners with the information they will need to claim a water depletion deduction on their federal income tax returns. Pictured from left to right are IRS Engineer Stonewall "Brink" Brinkman, Water District Geologist Don McReynolds, Farm and Ranch Appraiser B.L. Jones, III and IRS Engineer Lorinda Busby.

District Directors' Election

Vote January 17

Registered voters residing in Water District Directors' Precinct Three, consisting of portions of Bailey, Castro and Parmer Counties, and District Directors' Precinct Four, consisting of parts of Armstrong, Deaf Smith, Potter and Randall Counties, may wish to cast their votes on January 17 to elect a member of the Board of Directors who will represent their interests in Water District activities for 1987.

All registered voters who live within these Directors' Precincts in the Water District's service area are eligible to vote for a Director to represent them on the Board. Webb Gober of Farwell currently represents Precinct Three. Precinct Four is currently represented by Jim Conkwright of Hereford. Both Gober and Conkwright are running for re-election.

In order to comply with the provisions of House Bill 332 of the Texas Legislature, which changed the terms of office for Water District Directors, Board Members elected January 17 will serve a one-year term. An election in 1988 for the same Directors' Precincts will place the election dates in presidential election years. After the 1988 voting, elected Board members for these precincts will serve four-year terms.

Polling places will be open from 7 a.m. to 7 p.m. Polling places and presiding judges are as follows:

DIRECTORS' PRECINCT FOUR:

Voting Precinct 1 for that part of *Potter County* lying within the bounds of the Water District: School House, Bushland, TX 79012; Presiding judge, Charles Henderson.

Voting Precinct 2 for that part of *Deaf Smith County* lying within the bounds of the Water District: Deaf Smith County Courthouse, Hereford, TX 79045; Presiding judge, Virginia Holmes.

Voting Precinct 3 for that part of *Randall County* lying within the bounds of the Water District: Consumers Fuel Association, West First Avenue, Canyon, TX 79015; Presiding judge, C.R. Grone.

Voting Precinct 4 for that part of *Armstrong County* lying within the bounds of the Water District: Wayside Community Center, Wayside, TX 79094; Presiding judge, Estelle Rogers.

continued on page 4 ... VOTE

Safety Precautions Prevent Aquifer Contamination

Chemigation Systems Gaining Popularity

Today, many producers are using their irrigation systems to apply agricultural chemicals to their fields through a process commonly known as chemigation. The process involves injecting an agricultural chemical into an irrigation pipeline so that the chemical mixes with the irrigation water. The water/chemical solution is then distributed over the field through the irrigation system.

Chemigation is an effective and economical method of applying agricultural chemicals such as pesticides, fertilizers, herbicides and fungicides. Chemigation can be used in both soil treatments and plant applications with any irrigation system, although continuously moving lateral sprinkler irrigation systems and center pivots are the most common. A chemigation system is normally composed of an irrigation pump, a chemigation pump, a chemical tank and a backflow prevention system to prevent contamination of the water supply.

According to E. Dale Threadgill, Professor and Head of the Agricultural Engineering Department at the University of Georgia, chemigation use has increased rapidly over the last few years, with an estimated 12.8 million acres chemigated in the United States in 1985.

Chemigation Advantages

Chemigation offers several advantages. It can provide excellent uniformity of application, because the application efficiency of sprinkler systems is considerably higher than the application efficiency of airplanes. Also, chemicals distributed through a chemigation system can be applied whenever the plant needs them, because application is not dependent upon the weather or upon the availability of a pilot, as with aerial application. Further, compounds which require water for incorporation are applied with water and thus are activated immediately. Use of chemigation also reduces soil compaction and mechanical damage to crops, because it reduces the number of tractor trips through the field.

Economics

Chemigation may also be economically advantageous. Dr. Bill Lyle, Professor and Irrigation Researcher with the Texas Agricultural Experiment Station in Lubbock, is working with a Multifunction Irrigation System (MFIS) to study irrigation and chemigation. "Through use of our MFIS system and the in-canopy application that we are able to get through this system, we have found that we can drastically cut the amount of chemical that is used. We are getting results in greenbug control on grain sorghum with 1/16 of the recommended rates," states Lyle. "With chemigation, in specific management cases, it may be possible to reduce the amount of chemical applied and still get good results."

According to a 1985 analysis by Threadgill, multiple chemigation applications within one year are very cost effective. However, a single chemigation application in a year is probably cost effective only for those chemicals which require water for incorporation.

Costs for chemigation range from 34 to 60 percent of conventional chemical application costs, according to Threadgill. The costs generally decrease as the number of chemigations increase. As a general rule, chemigation will normally cost no more than aerial or tractor applications, and in most cases, will cost one-third to one-half of the cost of applying chemicals by airplane or tractor, Threadgill reports.

Chemigation Safety

While chemigation can be an economical farm management tool, proper care should be taken with its use. Chemigation must be managed correctly to maintain human and animal safety and prevent contamination of the environment by toxic chemicals.

Ground-water contamination is one of the most obvious dangers associated with chemigation. The potential for accidental contamination of the ground-water supply could occur if the water/chemical mixture were to backflow into the well. An unexpected shut down of the irrigation pump due to electrical or mechanical failure, combined with continued operation of the chemical injection system after the irrigation pump has shut down, could allow the water/chemical mixture to flow back into the well, thus contaminating the aquifer.

The risks of ground-water contamination can be substantially reduced with the use of a backflow prevention system. Some states, like Kansas and Georgia, require a backflow prevention system by law. "There are commercially available packages that give you all the required equipment," says Lyle.

"Use check valves on your irrigation pipeline that prevent movement of water back into the well when the well stops pumping. The check valve automatically closes if the irrigation pump shuts off. Thus water cannot flow back through the line into the well. Along with the check valve there is a required suction breaker, which is actually an air vent, that opens preventing a vacuum from being created by falling water when the pump shuts off. This prevents chemicals from being sucked past the closed safety valve," Lyle explains. Both the check valve and vacuum relief valve should be located on the irrigation pipeline between the irrigation pump and the injection line.

Lyle notes that if a chemical did backflow into the ground water, the chemical will either be absorbed into a clay soil particle or stay in the water solution.

"If a chemical backflows into a well, the likelihood of it moving from that location is fairly remote. Water that drains back into the well will not move very far in a short period of time, meaning a few hours to a few days. Hopefully, the chemical solution can be pumped back out soon. If absorbed on a clay soil particle in the aquifer, it won't move either, but will remain tied up at that location."

A chemical in solution will stay in the vicinity of the well because for a short time after pumping stops, ground-water flow caused by pumping runs toward the well, even as water levels immediately around the well begin to recover. This tends to trap any back-siphoned chemicals within the well or in the immediate vicinity of the well. Thus, if pumping restarts soon after the shutdown, the chemicals can be pumped out of the aquifer, minimizing the potential for ground-water contamination.

"We don't want the chemicals down in the aquifer, but if the well can be restarted fairly soon, 99 percent of the chemical can be retrieved out of the well," says Lyle.

An automatic low pressure drain further insures that chemicals will not flow back into the water supply should the irrigation pump shut off. Placed on the bottom side of the irrigation pipeline between the check valve and the irrigation pump and always before the point of chemical injection, the drain catches any chemical mixture that might leak through the check valve and channels it away from the water supply.

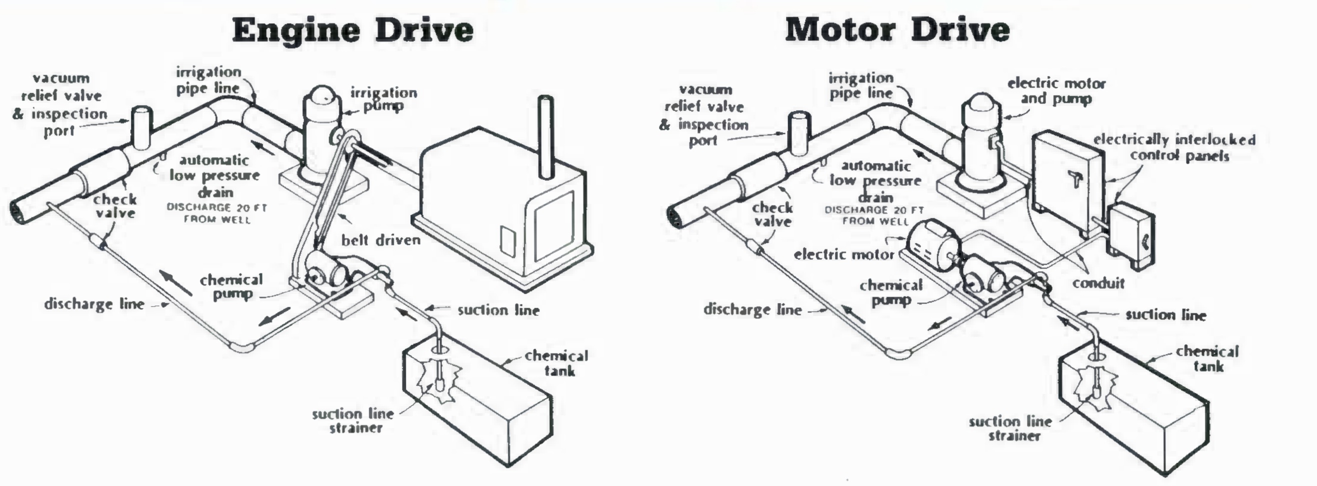
Lyle explains, "The minute the pump stops and removes the positive pressure of the water, the water that trickles by runs out the drain."

Another check valve may be installed on the chemical injection line to stop the flow of water from the irrigation system into the chemical supply tank and to prevent gravity flow from the chemical supply tank into the irrigation pipeline after an unexpected shutdown. If the injection pump stopped unexpectedly and irrigation water flowed into the chemical supply tank, the tank could overflow, causing a spill around the irrigation well.

"You also need a device that will stop the injection pump when the irrigation pump stops. If the irrigation pump stops, you don't want chemicals running into the main system," Lyle says.

One way to make sure both pumps shut down is to interlock the

Chemigation Safety Devices And Arrangement



These two arrangements of a chemigation system, engine driven (left) and motor driven (right), include the minimum safety equipment and show the positioning of the equipment in a backflow prevention system. The diagrams were designed by P.E. Fischbach, D.E. Eisenhauer and D.R. Hay and are reprinted courtesy of the University of Nebraska-Lincoln, Agricultural Engineering Department, Cooperative Extension Service and Institute of Agriculture and Natural Resources.

irrigation pump and chemical injection pump so that if the irrigation pump stops for any reason, the injection pump will shut down also. This will prevent the chemical from being injected into the pipeline when the water is no longer flowing.

For internal combustion pump engines, the injection pump can be belted to the drive shaft of an accessory pulley of the irrigation engine. Or the injection pump may be operated from the irrigation engine electrical system or from the power source of the sprinkler system drive.

If the irrigation pump is electrically powered, a separate small electric motor is usually needed to power the injection pump. In this case, the electric controls of the pumps can be interlocked so that both motors will shut down if the irrigation pump stops.

Additionally, a pressure sensing device can be located at a center pivot to shut off the pivot and the injection pump when a pressure change is caused by a shutdown of the irrigation pump.

Other safety equipment includes an inspection port located between the pump discharge and the mainline check valve. Often the vacuum relief valve can serve as the inspection port. The inspection port allows a visual check to see if the check valve leaks.

Also, a chemical suction line strainer can be placed on the chemical suction line to prevent clogging or fouling of the injection pump, check valve or other equipment.

Chemigation Calibration

As a further safety tip, Lyle advises, "Be careful in applying the amount of chemical required and substantiate the amount you are actually applying to the field. This means you need a calibration tube. I think everyone should use a calibration tube to check their injection rate. Even after the initial calibrations, chemigators should come back and check the injection rate."

Calibration of chemigation equipment is very important for maintaining personal and environmental safety and running an economical operation. Inaccurate calibrations can cause differences in delivery which, over an extended period of time, can produce unsatisfactory crop results or potential pollution when high applications are made. In a study by Nebraska agricultural engineers, 60 percent of the applicators surveyed missed their estimated application rate by more than 10 percent. Nearly one-third of the applicators over-applied or under-applied by more than 10 percent, with an average error of 30 percent. Losses due to poor chemical application are estimated to be $1 billion nationwide, according to John F. Witkowski, Extension Entomologist at the University of Nebraska Northeast Research and Extension Center.

Additional Safety Tips

Lyle advises, "Be sure everyone involved with your operation is aware you are applying chemicals through the system."

Additional safety tips include maintaining all hoses, clamps and fittings in good repair and checking them often. All components that will come in contact with the chemicals should be constructed of chemically resistant material and have adequate pressure ratings.

After chemigation is completed, the entire system sould be flushed with clean water from the irrigation pump for at least 10 minutes to clear the system of any residual chemicals. If the irrigation system was shut down unexpectedly, flush the system as soon as possible for at least 30 minutes.

Chemigators should also consider the type of chemical they are applying. For instance, fertilizers generally are not as toxic to humans and animals as insecticides and fungicides. Also, the chemicals are usually very concentrated in the tank, but diluted in the irrigation system.

As with irrigation alone, chemigation should be managed to prevent drift and runoff. Also, applying chemigation on fields with a permanent or periodic surface water area, such as a playa basin, should be avoided. Pollutants in these places may adversely affect livestock, wildlife, non-target plants or groundwater quality. In some cases, the chemigator may even be held liable for damages, if the chemicals he applies affect land other than his own or the aquifer, and a complaint is made.

Chemigation Legal Considerations

Carelessness or misuse of chemigation may result in legal consequences. Common law liabilities and damages brought against farmers and ranchers for groundwater contamination include trespass, negligence, nuisance and strict liability, according to Michael T. Olexa, Project Director, Joint University of Florida/National Agricultural Pesticide Impact Program, Agricultural Law Program, and Food Resource Economics Department, and Paul W. Bergman, National Agricultural Pesticide Impact Assessment Program, U.S. Department of Agriculture, Extension Service.

Olexa and Bergman recommend that chemigators always follow the label instructions of the chemical. As far as the courts are concerned, they say, the label and any other literature accompanying the product is the law. The installation of safety equipment can reduce liability and, in view of high legal costs, is a sound investment.

Many states have passed laws regulating chemigation which usually require safety equipment. For instance, Kansas passed a law requiring registration and the installation of safety equipment among other provisions.

According to Dr. Pat Morrison, Extension Entomologist at the TAES in Lubbock, no specific law governs chemigation in Texas. However, the operation of chemigation systems and human and environmental safety requirements do fall under the regulations of agencies such as the Texas Department of Agriculture, the Texas Water Commission, the Texas Department of Health, the Texas Water Development Board and the High Plains Underground Water Conservation District No. 1.

Currently in Texas, chemigation may be practiced with any chemical unless the label specifically prohibits it. However, the Environmental Protection Agency is considering regulations which will require labels on agricultural chemical products to state specifically whether the chemical may be used with chemigation. In this case, if the label does not mention chemigation, then the product may not be used in chemigation. These rules have been circulated among the states for comment, but have not appeared in the Federal Register for public comment and review.

Lyle anticipates a growing future for chemigation. "I think a lot of people are using it to some extent. We feel like there will be some tremendous advances in the next few years in chemigation. Research stemming from MFIS will result in some very effective chemigation systems. We have a tremendous tool with which we can help the farmer."

—BS

'87 Water Legislation

Legislation proposing various comprehensive plans for the development, financing, control and/or management of the water resources of the State of Texas has been at the forefront of several of the more recent sessions of the Texas Legislature. With the passage of House Bill 2, the compromise water package that was presented and passed during the 69th Legislative Session in 1985, one might think that there would be no major legislative proposals concerning water that would need to be considered during the 70th Session of the Texas Legislature, which begins in January 1987.

However, a check with Morris Wilkes, Administrative Aide to Senator John T. Montford of Lubbock, reveals that there are important legislative issues concerning water that will come to the attention of the legislature during the up-coming session.

Water Districts and River Authorities Oversight

"Today, prior to the beginning of the legislative session, the major water issue that I see will be the oversight of water districts, river authorities and of related subdivisions in the state," states Wilkes. "The suggestions and recommendations of the Water Districts and River Authorities Study Committee and the legislative proposals based on these suggestions and recommendations will form the major water-related legislation during the coming session."

The Water Districts and River Authorities Study Committee was created by the 69th Legislature under S.B. 249 to study water districts and river authorities to determine if their powers and duties are appropriate for management of the state's water resources and to determine if the state's role relative to the creation and operation of these authorities should be changed.

"The report from the committee to the 70th Legislature proposes that the committee be continued in some form or fashion to review water policy within the state," notes Wilkes.

Basically, the report contains a total of seven recommendations from the committee. The recommendations are based on written and oral testimony that was provided by members of the public, representatives of districts and river authorities, staff from the Texas Water Commission and the Texas Water Development Board and others during 11 public hearings that were held across the state from December 1985 to November 1986.

The seven recommendations contained in the report are as follows:

- Recognizing that water conservation programs are a critical part of a water resource management program, the Committee recommends that appropriate regulation be developed to provide for improved water use, re-use and reduced consumption of water as an objective of water resource management throughout the state.
- Recognizing that the current method of implementing water resource projects at the lowest practicable level of government is desirable in Texas and is recognized in the Constitution and laws of the state, the committee recommends that local entities should continue to be responsible for planning, implementing and operating water resource projects.
- Recognizing the need to assure that the state's water resources are appropriately utilized in the future, the committee recommends that all districts and authorities be subject to uniform rules and regulations by the state which take into consideration regional resources and uses and that appropriate legislation be defined to clarify state authority for this purpose.

continued on page 4 ... LEGISLATION

LEGISLATION ...
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- Recognizing that there are gaps and overlaps within the existing institutional framework of water entities which inhibit effective water resource management in certain areas, and recognizing that these problems may increase in number in the future, the committee recommends that regional coordinating mechanisms be established under the appropriate state agency to facilitate water resource planning and coordination of programs and projects by local entities in regions of the state where water resource needs are not being addressed.
- Recognizing that ground water is an essential component in any comprehensive water resource management plan, the committee recommends that the state seek authority to impose minimum criteria for regulation of groundwater production on local groundwater management entities and to create management entities where necessary.
- Recognizing that the issue of water resource management in the state is in transition and that the institutional relationships among water entities in the state need to be re-directed at this time to ensure appropriate management of these resources, the committee sees the need for continuing oversight of the water resource management process in the state and recommends that an appropriate oversight body be created by the legislature for this purpose.
- Recognizing that all public agencies must be accountable to the people of Texas, the Committee recommends that the legislature require all districts and authorities to adopt policies which would set standards of conduct for their employees, officials, and directors and which would require clearer and more thorough financial reporting.

Under each of the basic recommendations of the committee, there are specific actions proposed which will address the recommendations. A few of the specific actions include:

- The adoption of uniform regulations by the Texas Water Commission and the Texas Water Development Board that require applicants for water rights permits from the Commission and applicants for financial assistance from the Board to formulate and submit to the respective agencies conservation plans and to adopt and implement reasonable conservation measures.
- The development of a state policy which encourages conservation of water in agricultural uses including metering at the point water is diverted from its source.
- The appointment of regional advisory committees to examine the problems in those regions of the state where appropriate.
- The promulgation of minimum criteria and enforcement standards for water conservation, production and water quality and to make all underground water conservation districts subject to these minimum standards.
- The creation of a special oversight committee to provide oversight of all public interests and entities involved in water resource planning, development, management, utilization and regulation at the local, regional and state levels.

State Control of Ground Water

Wilkes also sees a continuing push in the legislature for the state to control ground water in areas where no local or regional ground-water control agency is established by the people of the area.

The push for ground-water control, according to Wilkes, will primarily be based on the need to protect the water resources of the state from pollution. Secondly, proponents of state control will use conservation as justification for the state to control ground water.

Those people and organizations that have historically supported strict control of ground water are likely to push for strict ground-water control legislation during the next session, as Wilkes sees it. "Others will support leaving things as they are." Wilkes also sees that there is a lot of support in the middle ground area, between leaving things as they are and moving toward limited state control.

Other Possible Items of Interest

Other than these two major items, Wilkes sees that the legislature may have some items in House Bill 2 which will need correction and clarification. These items will primarily involve technical corrections in the legislation.

"Primarily though, we will see a continued interest in the oversight of the different water agencies and a push by some for state control," emphasizes Wilkes.

Although the passage of House Bill 2 and approval of its provisions by state voters moved the state forward in terms of financing, development and management of the water resources of the state, it appears that there may be important additional water legislation that will bear close scrutiny during the up-coming session of the Texas Legislature beginning in January. A complete copy of the Water Districts and River Authorities Study Committee "Report to the 70th Texas Legislature" may be obtained from the Water Districts and River Authorities Study Committee, Box 13087, Capitol Station, Austin, Texas 78711, or telephone 512-463-7863. —*KR*

VOTE ...
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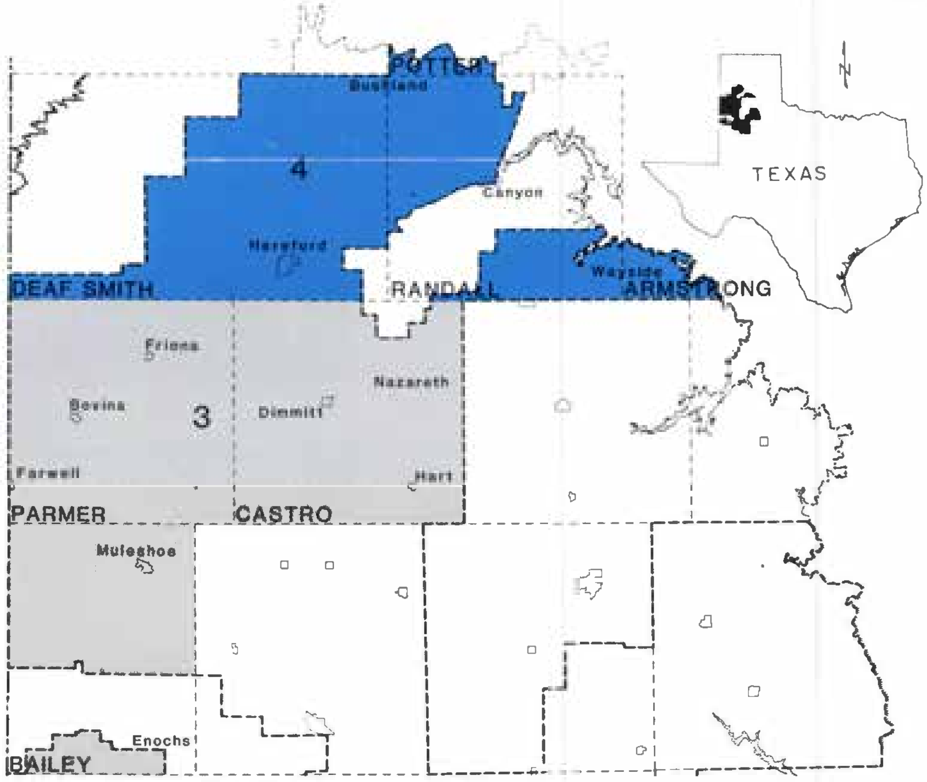
DIRECTORS' PRECINCT THREE:

Voting Precinct 5 for that part of *Parmer County* lying within the bounds of the Water District: County Courthouse, Farwell, TX 79325, Presiding judge, Mrs. Carolla Smith.

Voting Precinct 6 for that part of *Castro County* lying within the bounds of the Water District: City Hall Alderman's Room, Dimmitt, TX 79027; Presiding judge, Oleta Walser.

Voting Precinct 7 for that part of *Bailey County* lying within the bounds of the Water District: Bailey County Courthouse, Muleshow, TX 79347, Presiding judge, Margrethe Taylor.

The election will be conducted and returns made to the Secretary of the Board of Directors of the High Plains Underground Water Conservation District No. 1 for canvassing in accordance with the Election Code of the State of Texas. —*BS*



Water District Directors' Precincts Three and Four

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A.W. "Webb" Gober

James C. Conkwright

Board Members Reelected

When the polls closed on election night, Saturday, January 17, and the votes were counted, results revealed that Webb Gober of Farwell and Jim Conkwright of Hereford had been reelected to the Board of Directors of the High Plains Underground Water Conservation District No. 1. Gober, who begins his seventh term in office, will represent the interests of the residents of Director's Precinct Three, consisting of the portions of Bailey, Castro and Parmer Counties which lie within the boundaries of the Water District's service area. Conkwright was reelected to his fourth term in office by the voters of Director's Precinct Four, comprised of the portions of Armstrong, Deaf Smith, Potter and Randall Counties which lie within the boundaries of the Water District's service area. —*KR*

Pre-Plant Soil Moisture Best In Five Years

The results of the High Plains Water District's Pre-Plant Soil Moisture Survey show that soil moisture conditions are better than they have been in the past five years. Above average rainfall received over most of the Water District's service area in late 1986 is credited for the good soil moisture conditions.

Generally Speaking

Mike Risinger, USDA-Soil Conservation Service Soil Scientist, directs the program. Risinger explains, "In general, most soils are at or near field capacity in the upper two feet of the five-foot soil profile, but commonly the soils are at 65 to 80 percent of field capacity in the lower part of the profile." Fifty percent of field capacity approximates the permanent wilting point for crops grown in the District's service area.

"The lower depths will require one-half to 1.5 inches of water per foot of soil to reach field capacity prior to planting," continues Risinger.

Moisture Conditions Mapped

The map on page 2 shows the amount of plant available water that is currently stored in the top five feet of the soil profile, as it was found by Water District field monitoring crews, who measured soil moisture conditions from late November to mid-January.

The map on page 3 illustrates the amount of water that needs to be added to the five-foot crop root zone to bring the soil profile to field capacity prior to planting.

> "In General, Most Soils Are At Or Near Field Capacity In The Upper Two Feet Of The Five-Foot Profile . . ."

Moisture deficits generally range from one to six inches across the District's service area. The upper two feet are generally in excellent soil moisture condition. In fact, there are a few sites that have a water content above field capacity, where moisture will move into the lower root zone areas in time.

Soil Water-Holding Capacities

The variations in soil moisture conditions are partially due to differences in each soil's capacity to hold water. Other factors such as individual farm management practices and the type of crops grown in an area also affect the amount of deficit recorded.

On the average, soils in the Water District's service area hold a total of 7.8 to 9.8 inches of plant available water in the five-foot root zone soil profile.

continued on page 2 ... PRE-PLANT

Soil Nitrogen/Phosphorus Levels Inadequate For Economically Acceptable Crop Yields

During the spring and summer of 1986, a soil sampling study was conducted to determine if low soil fertility levels were limiting the yield and water-use efficiency of field crops grown in the area served by the High Plains Water District. The results of this study showed that on more than half of the fields sampled, nitrogen and/or phosphorus levels were inadequate to support what most farmers would consider minimum acceptable yields for any of the major crops grown in this area.

Assuming that the study results are representative of the area as a whole, the study basically showed that on those farms with low fertility levels, where additional nitrogen and/or phosphorus was not applied, the producers were locked into less than acceptable crop yields regardless of weather conditions or water supplies.

Details of the Study

For this study, soil samples were taken from each foot of the soil profile to a depth of four feet on 212 farms and to three feet on 15 farms located throughout the Water District's service area. A total of 853 soil samples were collected.

The soil samples were analyzed for plant nutrient availability, including: nitrate nitrogen, phosphorus, potassium, calcium, magnesium, zinc, iron, manganese, copper and sodium. Soil pH and salinity were also measured.

The analyses revealed that of all the nutrients measured, only nitrogen and phosphorus levels were commonly low enough to limit the production and water-use efficiency of field crops grown in this area.

Basic Nitrogen Requirements

In order to produce an economically acceptable yield, it requires about 90 pounds of available nitrogen per acre to produce 80

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PRE-PLANT ...

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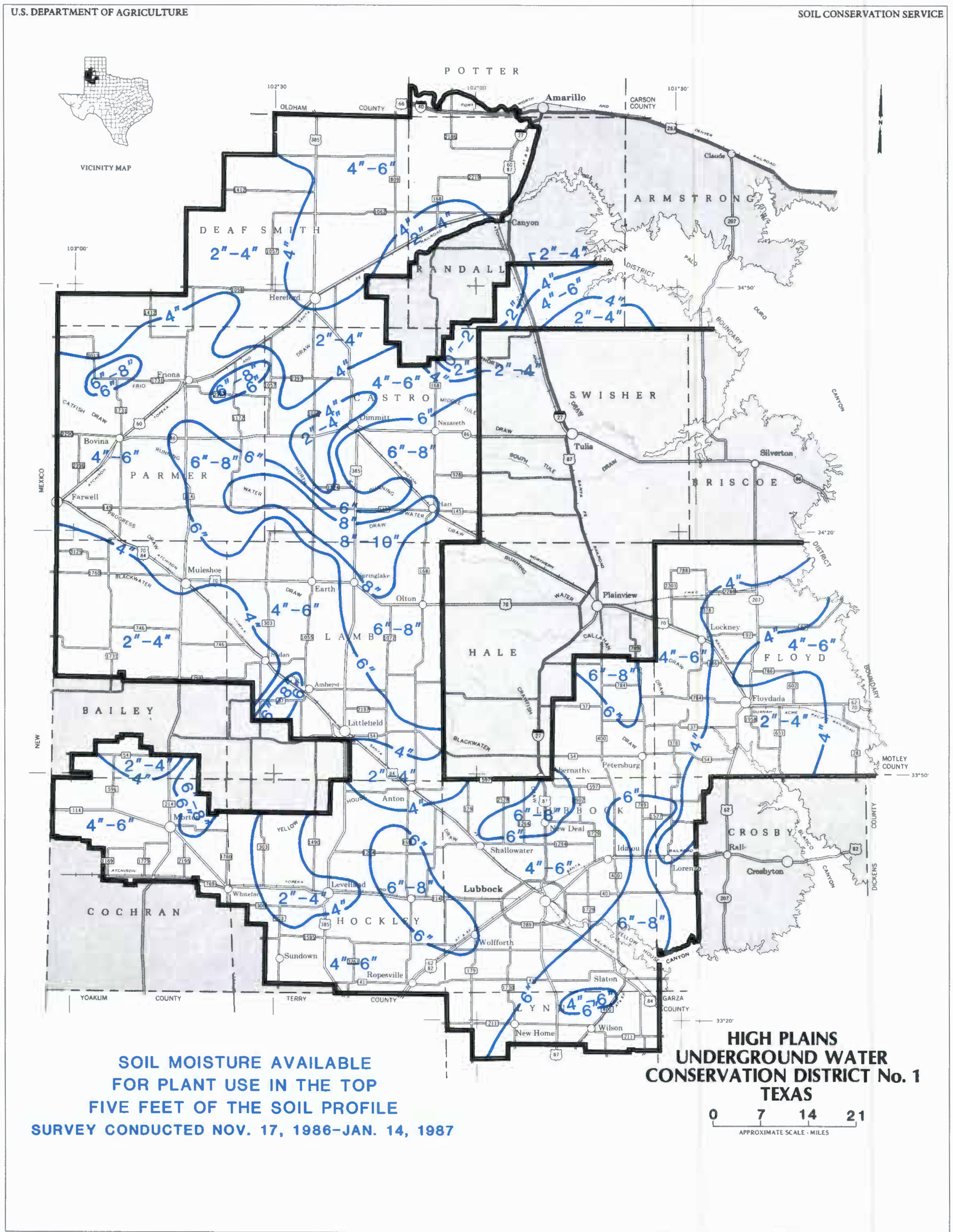
Rainfall Runoff

"Much of the rainfall we received occurred from August to November when the soil conditions were least suitable for taking advantage of the precipitation," notes Risinger. "This is evident as you look at the playa basins full of water across the area.

"During this rainy period, surface layers were wet, with cracks and larger pores closed by the swelling of the clay fraction in the surface of clayey soils and in the upper subsoil of sandier soils. In both cases, soils remained wet from one rain to the next and these adverse water intake conditions remained present during the August to November period. In addition, most row cropped fields had been compacted by plowing and/or harvesting operations, which further reduced water intake rates.

"In the wheat growing areas, where early-planted, rapidly-growing wheat was present, deficits were also found in the surface layers during the soil moisture survey," notes Risinger. Irrigators in these areas should be able to take advantage of the runoff water collected in the playas for early season irrigations.



Individual Monitoring Recommended

Individual producers should check their own soil moisture conditions to determine their pre-plant irrigation needs, if any. One way individuals may monitor their soil moisture conditions is through the feel and appearance method of soil moisture monitoring. The Water District has a Water Management Note available entitled "Monitoring Soil Moisture by Feel and Appearance" that is free of charge. This Water Management Note provides step-by-step procedures that producers can follow to determine their soil moisture conditions. It takes a little work, but considering the cost of applying pre-plant irrigations, it could prove to be a very worthwhile exercise.

Farmers should also check for hardpans in their fields. If present, hard pans should be destroyed to make the most of any rainfall received between now and planting season. Significant hardpans may be found in those fields where harvesting equipment was run under wet conditions.

Fertility Management

With the favorable moisture conditions, it might be a good time to consider deep placement of phosphorus in a band and applying from 30 to 50 percent of the nitrogen fertilizer that will be needed during the growing season. The good soil moisture conditions should provide an optimum climate for getting the 1987 growing season off to a good start, provided that adequate nutrients are present in the soil to meet the crop's early season needs. Then, if good moisture conditions prevail during the growing season, additional nitrogen can be added as necessary.

A soil sample analysis will show producers the current status of their soils in terms of plant nutrient availability. Most analyses are accompanied with recommendations on the amount of fertilizer which needs to be applied to meet yield goals set by the producer.

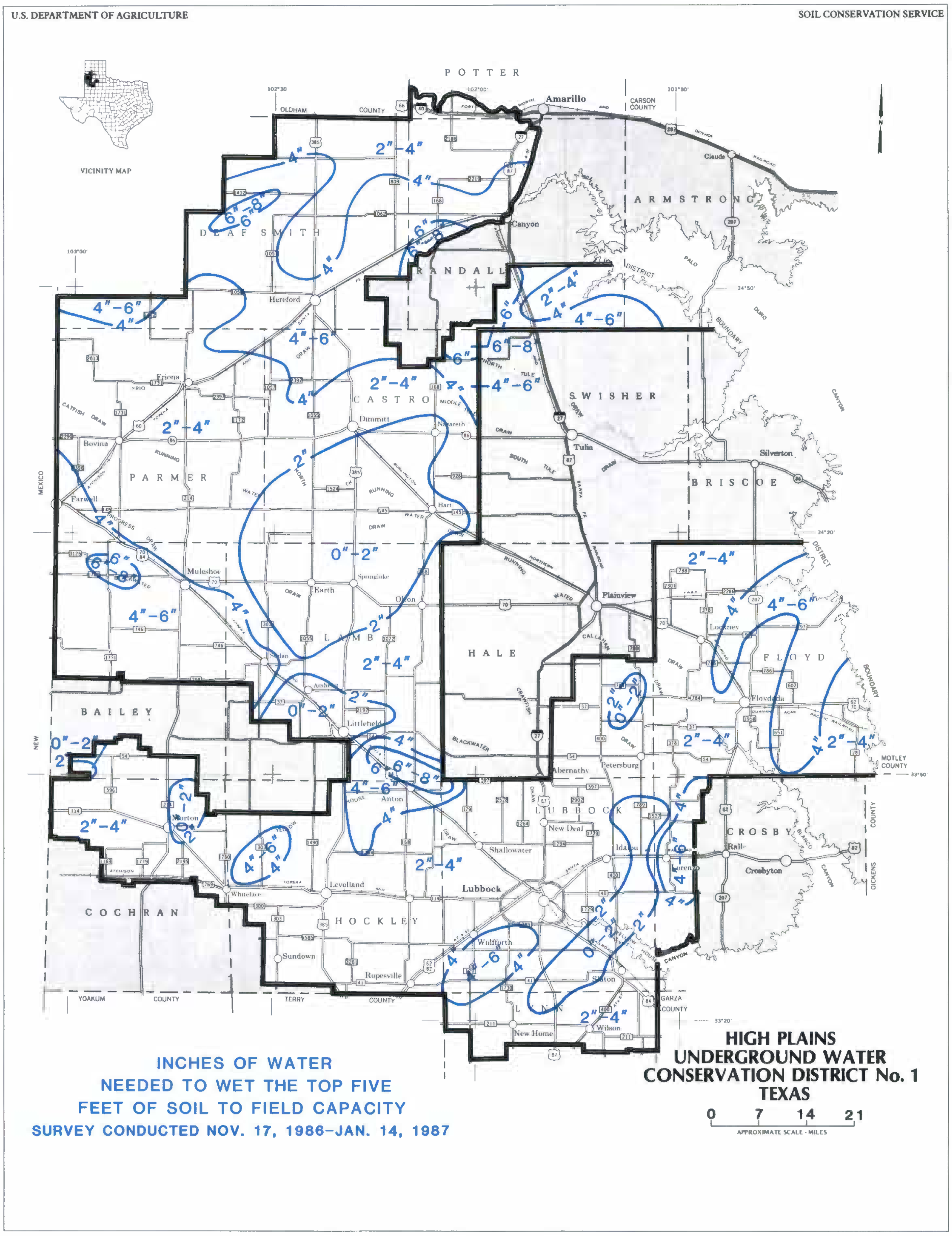
The Bottom Line

The bottom line, so to speak, is that there are approximately 3.5 million irrigated acres in the Water District's service area, and historical pre-plant irrigations have ranged from 4 to 12 inches per acre. By adding only the water needed as illustrated on the soil moisture deficit map, the historical pre-plant water use could be reduced by one-fourth to one-half. In dollars and cents, that amounts to a potential annual savings in fuel cost alone of more than $15 million.

Additionally, it is estimated that if irrigators applied only the amount of moisture needed to bring the soil profile to field capacity, 437.5 thousand acre-feet of water could be saved for future use.

The soil moisture survey is conducted by the High Plains Water District in cooperation with the USDA-Soil Conservation Service. The maps are published to provide producers with a guide to the soil moisture conditions over the entire area. With this information, producers should be able to make more informed irrigation decisions, which may help avoid either over or under irrigating in the spring. It can also give an indication of the potential for dryland production.

Soil moisture sites are selected to represent the farm management and cropping patterns typical of the site area and are monitored in cooperation with local landowners. —*KR*



CROP YIELDS ...

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bushels of corn, about 40 pounds per acre to produce 300 pounds of lint cotton, about 40 pounds per acre to produce 1500 pounds of grain sorghum and about 50 pounds per acre to produce 20 bushels of wheat.

Of the 434 soil samples taken from the top two feet of the soil profile, 300 (or 69 percent) were rated "low or very low" in nitrate nitrogen. The average available nitrate nitrogen content in this group of soil samples was 4.77 parts per million or 19.08 pounds per acre.

This measurement indicates that the average available nitrogen content in the top two feet of the soil would be about 38 pounds per acre. Thirty-eight pounds of available nitrogen per acre is less than adequate to support economically acceptable yields for any of the major crops grown in this area.

Basic Phosphorus Requirements

The quantity of available phosphorus needed to produce economically acceptable yields is about 70 pounds per acre to produce 80 bushels of corn, about 30 pounds per acre to produce 300 pounds of lint cotton, about 35 pounds per acre to produce 1500 pounds of grain sorghum and about 35 pounds per acre to produce 30 bushels of wheat.

Of the 434 soil samples taken from the top two feet of the soil profile, 227 (or 52 percent) were rated "very low" in phosphorus. The average available phosphorus content of this group of samples was 2.77 parts per million or 11.08 pounds per acre.

This measurement indicates that the average available phosphorus content in the top two feet of the soil profile would be a little more than 22 pounds per acre, which is also inadequate to support economically acceptable yields for any of the major crops grown in this area.

Both nitrogen and phosphorus play vital roles in the development, growth, water-use efficiency and yield potential of field crops.

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Annual Precipitation Measurements And Averages 1976-1986

AMARILLO PRECIPITATION—National Weather Service

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1976	*	.10	.79	1.65	1.36	2.94	1.77	1.78	4.28	1.14	.43	*	16.24
1977	.64	.53	.24	2.74	4.01	2.06	3.14	4.94	.03	.26	.32	.27	19.18
1978	.63	.80	.21	.55	5.76	6.50	1.82	1.61	2.42	.97	.47	.27	22.01
1979	.92	.28	1.46	1.29	3.94	3.19	2.03	5.08	.52	1.28	.40	.07	20.46
1980	.85	.55	1.38	.82	2.88	1.30	.65	1.80	1.55	.42	.84	.35	13.39
1981	.11	.23	1.87	.90	2.11	1.04	2.73	5.22	3.47	1.79	1.50	.03	21.00
1982	.15	.39	.52	.43	1.96	4.75	6.23	.55	1.37	.71	.75	.79	18.60
1983	1.78	1.19	.98	.83	2.85	1.76	.74	.28	.37	3.23	.33	.64	14.98
1984	.56	.37	.98	1.18	.04	6.76	.83	2.28	.95	3.19	1.09	1.00	19.23
1985	.99	.77	1.49	2.79	.86	3.08	2.07	1.67	4.96	3.07	.39	.26	22.40
1986	.00	1.02	.60	.30	3.28	3.70	3.52	7.04	1.45	1.94	1.82	.66	25.33
Average (1976-1986)	.60	.57	.96	1.23	2.64	3.37	2.32	2.93	1.94	1.64	.76	.39	19.35

*Trace

LUBBOCK PRECIPITATION—National Weather Service

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1976	*	.03	.24	1.76	1.19	2.46	7.20	1.99	3.28	1.39	.56	.01	20.11
1977	.24	.38	.82	2.90	2.46	2.28	1.13	4.31	.49	1.11	.02	.01	16.15
1978	.59	1.39	.23	.21	3.20	1.93	.15	.34	3.29	1.06	1.11	.17	13.67
1979	.33	.85	2.95	1.17	4.00	3.69	1.84	3.81	.21	.59	.09	1.29	20.82
1980	.54	.38	.19	1.13	3.46	1.78	.20	1.64	3.55	.19	2.29	.51	15.86
1981	.32	.67	1.19	2.05	1.25	.79	3.35	5.41	1.78	5.34	.64	.20	22.99
1982	.05	.39	.44	2.53	4.54	4.99	2.08	1.08	1.29	.48	1.18	1.95	21.00
1983	2.75	.32	.55	.77	1.23	1.79	.41	.32	.39	10.80	.54	.36	20.23
1984	.03	.17	.23	.23	.45	4.32	.53	3.72	.15	1.74	1.87	1.18	14.62
1985	.38	.27	1.19	.48	2.97	4.51	3.94	.63	4.73	3.60	.27	.18	23.15
1986	.00	.94	.39	.72	1.82	4.92	1.41	3.60	6.90	2.89	1.73	1.29	26.61
Average (1976-1986)	.48	.53	.77	1.27	2.42	3.04	2.02	2.44	2.37	2.65	.94	.65	19.58

*Trace

FERTILITY ...

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Plants and Soil Nitrogen

Nitrogen is necessary to plants for the formation of the proteins that form the protoplasm of all living cells. Nitrogen is also required by plants in the production of chlorophyll, nucleic acids, and enzymes. It is usually the nutrient which most limits plant growth in High Plains soils.

Plants and Soil Phosphorus

Phosphorus is essential for many plant processes including photosynthesis, respiration, energy storage and transfer, and cell division. Phosphorus stimulates early growth and root formation in plants, while insuring early maturity and promoting seed production.

In cotton, for example, most of the phosphorus uptake occurs from emergence to peak flowering. Following the high phosphorus uptake during the early vegetative period, the need for phosphorus declines as the plant ages. The plant needs very little phosphorus during the latter stages of boll development when oil deposition in the seed and cellulose deposition in the fiber occur.

Overcoming Nutrient Deficiencies

Of the two limiting nutrients, nitrogen and phosphorus, identified by this study, a soil nitrogen deficiency appears easier to overcome, because nitrogen moves with water in the soil. When present, nitrogen is readily available to the plant at any depth where roots and water are present.

Phosphorus deficiencies and applications, on the other hand, require special attention, since phosphorus does not move with water in the soil. Research indicates that phosphorus moves downward in the soil at a rate of only two-tenths of one inch per year under natural conditions. Phosphorus easily ties up on soil particles or in combination with other chemical constituents and remains where it is placed unless additional tillage operations are used to relocate it in the soil profile.

Thus, not only is the availability of these soil nutrients important to crop production, but their location within the soil profile can influence plant responses as well.

Fertilizer Placement

The most common method of fertilizer application today is to broadcast the fertilizer over the entire soil surface, then disc or plow it into the upper plow layer. This practice can result in a reduction in utilization of the fertilizer by the plant.

Phosphorus Placement Crucial

Since phosphous does not move downward in the soil, broadcasting phosphorus on the soil surface and disking it in places the phosphorus in the top few inches of the soil. Soil moisture in this zone changes from very wet to very dry several times during the growing season. Under dry conditions, plant roots either die or become dormant and cannot extract water or nutrients. Also, by mixing phosphorus uniformly in the plow layer, the phosphorus is exposed to a much greater soil volume, which increases the amount tied up by soil-chemical reactions.

During the growing season, crop roots actually contact only a small portion of the soil in the top foot. In order for the plant to absorb the phosphorus it needs, its roots must make contact with the layer of water around the soil particles that contain phosphorus. Because of these conditions, it is common for 20 percent or less of the broadcast-applied phosphorus to be used by the crop in the year it is applied.

Phosphorus may be used more efficiently if it is placed deeper in the soil. Plowing or banding the phosphorus deeper in the soil places it in a zone less likely to become too dry for plants to extract water containing phosphorus. Banding also decreases the amount of soil-nutrient contact and thus the amount of phosphorus tied up by soil-chemical reactions. In addition, banding places the fertilizer below the zone where root-pruning herbicides are usually applied, which makes more of the applied phosphorus available to the plant.

Banding nitrogen and phosphorus together causes a symbiotic effect which increases plant-root proliferation and increases utilization of both nutrients. Zoning placement — applying fertilizer bands on the surface and deep plowing them under — is another effective method of placing phosphorus where it is the most beneficial.

How Plants Utilize Soil Nutrients

In a theoretical crop-root growth pattern, the plant extracts 40 percent of the water it uses from the top foot of the soil profile. Thirty percent is taken from the second foot, 20 percent is taken from the third foot, and 10 percent is taken from the fourth foot. The accompanying table compares the theoretical extraction pattern for cotton to the actual extraction pattern determined in 1975, an average precipitation year, and in 1976, a wet year.

GENERALIZED WATER UPTAKE PATTERN FOR COTTON

PERCENT OF TOTAL WATER EXTRACTED

ROOT ZONE DEPTH	Theoretical	Cotton 1975	Cotton 1976
1st 25%	40	38	62
2nd 25%	30	32	20
3rd 25%	20	18	14
4th 24%	10	12	4

The moisture extraction pattern becomes important in growing conditions where dryland or limited irrigation production systems are used. In these types of systems, the top foot of the soil profile is exposed to repeated wetting and drying cycles. Since plants can extract nutrients from the soil only in the presence of plant-available water, soil nutrients cannot be obtained from the top foot of the soil profile during the dry cycles. Thus, plants have to depend on the lower root zone soil profile to supply part of the water and nutrients needed.

If either water or the proper nutrients are not available in these lower zones during critical growth stages when the surface soil is dry, then reduced yields can be expected. If nutrients are available and uniformly distributed in the soil in amounts equal to or in excess of the plant's requirements, they will be extracted from the soil profile by the plant at about the same percentages as water.

As an example of the nutrient extraction pattern, assume that a cotton crop requires 90 pounds of nitrogen and 50 pounds of phosphorus per acre for a yield of 500 pounds of lint cotton per acre. In this case, 36 pounds of nitrogen would be extracted from the first foot, 27 pounds from the second foot, 18 pounds from the third foot, and 9 pounds from the fourth foot. The phosphorus would be extracted at 20 pounds from the top foot, 15 pounds from the second foot, 10 pounds from the third foot, and 5 pounds from the fourth foot. The amounts of water and nutrients actually extracted from the soil by a plant are affected by factors such as soil type, soil water content, atmospheric conditions, precipitation events, irrigation, and the distribution and adequacy of nutrients present in the soil profile.

Under fully irrigated conditions, nutrient placement is less critical. With full irrigation, where good moisture is maintained throughout the growing season, plants can continue to draw much of the moisture and plant nutrients needed for growth from the top foot of the soil.

Soil fertility levels also affect a crop's water-use efficiency, which is a measurement of the plant's ability to convert the water it extracts from the soil into dry matter. A study currently being evaluated on the water-use efficiency of field crops grown under various fertility treatments shows that proper fertility can increase water-use efficiency by as much as 30 percent. The study compares crops grown in soils deficient in nitrogen and phosphorus with crops grown in soils having adequate nitrogen and phosphorus.

Don't Make Fertility Assumptions

The results of this 1986 survey should alert farmers in the Water District's service area to the fact that they cannot assume that their soils contain adequate plant nutrients to support economically acceptable crop yields.

Based on the study findings, it is recommended that farmers collect soil samples from each field on every farm and have the soil samples analyzed. This is the only way to obtain a competent recommendation as to the kind and amount of fertilizer, if any, that should be applied to provide adequate soil nutrients to support the desired yield for the type of crop produced. *—KR*

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Producers Share Insights And Experiences

Fertility Programs Increase/Sustain Crop Yields

Recent studies by the High Plains Water District and the Texas Agricultural Experiment Station in Lubbock and observations by area farmers show that soil fertility management is extremely important in producing maximum economic crop yields. Research currently indicates that an interrelationship exists between water use and soil fertility levels that affects plant growth, the fruiting processes and early maturity.

Fertility and Crop Rotations

Monty Henson, a farmer for 18 years who operates about 3,000 acres near Brownfield, watched his crop yields decline over the years like many other area farmers. Then he started a crop rotation program. Combining the crop rotation program with a full-level fertility program has resulted in good yields for Henson.

"I'm a firm believer in a real good fertility program, but I think a combination of crop rotation with a good soil fertility program has a super additive effect," says Henson. "I'd like to stress that crop rotation is definitely not a substitute for your fertilizer. I strictly think they work together in good combination."

Henson recommends a pre-plant fertilizer application. On land that is irrigated, he fertilizes for maximum yields, applying 90-100 pounds per acre of nitrogen and 50-60 pounds per acre of phosphorus. He chisels in the phosphorus and applies additional nitrogen four to six weeks after emergence. Fertilizer for his irrigated land costs about $45 per acre.

On dryland, where he anticipates lower yields, he puts down 40-45 pounds per acre of phosphorus and 60 pounds per acre of nitrogen in a pre-plant application. Fertilizer costs on dryland run about $30 per acre. "We've even gone to fertilizing our set-aside land since we included cattle in our farm operation. We've found that fertilizing pasture for the livestock is cost effective," says Henson.

He also applies a pre-plant irrigation of about 2.5 inches. He applies five irrigations of about 1.5 inches each throughout the growing season — a total of about 12 inches of irrigation water.

Don't Guess - Soil Test

Henson also recommends soil testing as part of a soil fertility program. "I believe that soil testing is very important. When you run a soil test, you should not only test for your macro-nutrients, but for micro-nutrients as well. Unless you've got a good balanced fertilizer program, you may be putting out one nutrient when your limiting factor is another. Also, if you've got limited capital with which to fertilize, I would try to shoot for a very balanced fertilizer program in whatever blend is used. This seems to work better for me than anything."

He continues, "I think if you irrigate, you should balance your fertilizer program with your water capabilities. I anticipate lower yields where I've got limited water, and I can more or less go full out for high yields where I've got good water. Where I've got good irrigation water, I can put on somewhere between 12 and 15 inches of water a year."

A good fertility program usually results in quicker maturity and earlier fruiting in cotton, Henson says. He adds that it has been his experience that the quicker he can get his cotton planted, get a good healthy stand and get it going, the fewer problems he has as compared to cotton planted later, especially if it is not fertilized properly.

He adds, "I really believe in chiselling in pre-plant fertilizer. I believe it is one of the most important changes I've made in my farming operation."

To Henson, management practices that increase yields, such as fertility programs, are the way to survive in today's tight agricultural economy. "The farmer has to cut every corner and cost he can in order to survive. But it's hard to do this without decreasing yields. About the only way that I see that we can stay in business is to lower the cost per unit of production. The only way to do this is to increase our per acre yields.

"For instance, if you raised a cotton crop and the crop yielded 500 pounds per acre and it cost you $250 an acre to produce that bale of cotton, it cost you 50 cents a pound to produce the cotton. But if you can boost your yield up to 750 pounds and it cost you $275 an acre to produce the cotton, you've reduced

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Phosphorus Deep Placement Accomplished

A recent survey of 227 farms in the High Plains Water District's service area revealed that phosphorus is low or very low in the top two feet of the soil profile on 52 percent of the farms sampled. Additionally, phosphorus moves downward in the soil at a rate of only about two-tenths of one inch per year. Therefore, if the producer is to obtain maximum benefits from phosphorus applications, the phosphorus needs to be banded deep in the soil profile.

Max Lee, owner of Max Lee's Crop Spraying in Slaton, Texas, has come up with a way to achieve deep placement of phosphorus in a band.

Lee put together a "back-swept chisel" rig for about $20 per row that has been used successfully on two local farms. Lee explains that he tried several different rigs before he settled on the back-swept chisel.

First, Lee added six inches to the shank of a standard front-swept chisel to get the depth he needed. Then, "we tried fluted coulters mounted on the front of our tool bar with the front-swept chisels behind the coulters," says Lee. The reason for using the coulters was to keep the stalks from building up on the chisel, explains Lee.

After experimenting with this arrangement in the field, Lee decided that he didn't need the coulters. "They just wouldn't go deep enough to help that much." Besides, adds Lee, adding the coulters would run the equipment costs up to about $150 to $200 per row.

Lee then experimented with a back-swept chisel, again with a six-inch extension added to the shank. Thus far, after two field runs with the

continued on page 4 ... PHOSPHORUS

IT'S NOT AS DIFFICULT AS IT SEEMS — Max Lee wanted to prove to himself that it wouldn't be difficult to band phosphorus deep in the soil profile. So, in experiments to develop the right tool, he added six inches to the shank of a back-swept chisel. Thus far he has applied bands of phosphorus 13 inches deep in two plots of flat-tilled ground.

FERTILITY ...

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your cost of production by 15 cents a pound.

"I believe we can raise our yields through very timely management — a properly balanced fertility program, water management and crop rotation."

Developing a Game Plan

Henson describes other ways he keeps his operation profitable. "At the start of every year I sit down and develop a game plan with realistic goals in mind. I consider management, fertility and water management, and realistic yield goals. Once I've committed myself to a game plan, I'm going to have to stick with it from day one."

He notes that all farmers need to do a better job of educating their bankers. Henson suggests that when producers go see their bankers to obtain their 1987 operational loans, the bankers may suggest that the producer cut his budgets. Henson says, in doing so, producers may cut their production potential; and when producers look at their land preparation and fertilizer costs, that's often where the budget cutting starts.

"It might be better that we have a good long talk with our banker and try to get him to approach farming with a more positive attitude." Henson suggests that farmers should try to convince their bankers that they need to lower the cost of each unit of production by increasing yields, rather than trying to minimize a loss.

The Proof is in the Yield

The yields Henson obtains on his farms seem to bear out his ideas. "I think that fertilizer is really cost effective," he says. He notes that he pre-plant fertilized two rows and skipped two rows in deep sand one year. He planted the fertilized rows to cotton, but lost the cotton to hail. He replanted the field solid in grain sorghum. The two rows of grain sorghum without fertilizer on them weren't worth harvesting, he says.

Other fertilized land has shown consistently good results as well. A dryland farm Henson operates has produced 400 pounds per acre of cotton five out of the last six years. On some irrigated land, Henson has been able to maintain an average of a bale and a half for the last three years. Henson rented another farm with a proven yield of 325 pounds of cotton per acre. After fertilizing, he improved the yield to 745 pounds per acre and probably increased the net returns per acre by $200, he says. He notes that he only paid $40 per acre for fertilizer.

Water's No Substitute for Fertilizer

Another farmer, Kelly Thomas of Woodrow, also obtains increased yields from a soil fertility program.

"I noticed a drop in yields from virtually the early sixties." He also says that at that time the more water he put on cotton the more yield it would make.

For a while Thomas concentrated on adding water and rotating crops. "In 1983 I planted cotton behind grain sorghum. The cotton looked good until about the first of July and then began to turn yellow and just quit growing. We poured the water to it where we do have water (most of my land is dryland), but the best we could do was three-quarters of a bale per acre. That was very disappointing to me. At that time, I decided I was going to get involved in a fertilizer program of some sort." Thomas says he noticed the good crops that some of his neighbors who had a good fertility program had been producing. The most notable thing, according to Thomas, was that they had good yields while his yields just kept tapering off.

Once he started a fertility program, Thomas noticed immediate results. In 1983, his 1,240 acres of cotton to which no fertilizer had been applied yielded 375 pounds per acre. But in 1984, he fertilized 1,030 acres of cotton at a cost of $25 per acre. That raised his yield to 515 pounds per acre. In 1985, his cotton yield increased a little more to 532 pounds per acre. Thomas' net return, using an average of 55 cents per pound on cotton, increased about $50 an acre in 1984 and returned more than $60 per acre in 1985.

"I was quite impressed with that because about 70 percent of my land is dryland," comments Thomas.

The remaining 30 percent of Thomas' land is what he calls semi-irrigated. He only has enough water for a pre-plant irrigation and a summer irrigation if conditions are good. He applies fertilizer in January or February prior to cutting stalks and winter plowing. He has used several methods to plow in the fertilizer.

"This year because of the good moisture we're just lightly chiselling it and applying Treflan at the same time," notes Thomas. "I broadcast and use a single application pre-plant. My reason for this is just because of the shortage of time that we have in the month of June for a split application. I certainly see the merit of chiselling part of your fertilizer in pre-plant and coming back later with a second application. But because of the problems we have in June trying to get a crop to grow, we've opted for a single fertilizer application."

Thomas uses a dry fertilizer to hold down costs. The way Thomas figures it, he can apply his fertilizer and save about $4.50 an acre in application costs.

Thomas followed the recommendations of a soil test in 1984 when he first went into the program. The yield goal was 625 pounds of cotton per acre on irrigated land and 500 pounds per acre on dryland. The recommendation suggested about 220 pounds per acre of a dry fertilizer combination of 28 pounds of nitrogen, 14 pounds of phosphorus and 7 pounds of potassium. He also added one-half pound of manganese and one pound of zinc per acre to this mixture. His fertilizer cost was about $21.50 per acre.

> "I Think If You Irrigate, You Should Balance Your Fertilizer Program With Your Water Capabilities."
>
> Monty Henson

Thomas notes that fertilizer helps maturity. "To me the number one problem that we have in increasing our yields on the South Plains is maturity. I know that fertilizer does help maturity, and anything that we can do to help that situation is worthwhile to me."

"The worst thing is to do nothing," Thomas states.

Thomas farms about 2,200 acres, consisting mostly of cotton with some grain sorghum around the Slide-Woodrow area in Lubbock County. He has been farming since 1965.

Bids Hold Fertility Costs Down

Greg Methvin, who farms 1,200 acres on his own and also works land with his father, has always included a fertility program in his farming operation.

"I picked up on what my dad was doing. It was working for him and it's worked real well for me too," says Methvin.

Farming since 1979, Methvin utilizes dry fertilizer in his cotton and grain sorghum farming operation.

"We try to farm for maximum production. That's just the approach we take. We'll vary the amounts of fertilizer we'll use depending on the amount of available irrigation water, and on dryland we'll use lesser amounts of fertilizer."

Methvin adds that in the past few years he has been taking bids for his fertilizer. "It's been working out well for us. We like to take bids, and it's saved us quite a bit of money.

Methvin believes that proper land preparation prior to planting is very important in his farming operation. He explains, "We flat break the land or chisel it or deep plow it every year." Next on his agenda is his fertility program. "We have been using dry fertilizer ever since we started.

"Before we fertilize, we take soil samples. We hadn't taken soil samples until the last few years." Methvin says that the analysis of the soil samples with the fertilizer recommendations gives him a reason to feel a little bit better about the money he's spending on fertilizer. He adds that the analysis provides him with information on what kind and how much fertilizer he needs to apply for his yield goals. He targets the fertilizer application for a 500 pound per acre cotton yield, provided he has adequate irrigation water available to support the crop. He adjusts the fertilizer rate down if he does not have enough irrigation water to get over a field quickly.

Methvin continues, "The last few years the fertilizer blend we've been using is 32 pounds of nitrogen, 23 pounds of phosphorus and no potassium per 100 pounds of fertilizer. Where we have the water and can get over the field in a couple of weeks or a few days longer than that, we'll put down 150 pounds of dry fertilizer. Where we're under a little bit more limited water or dryland, we've been going with a 100 pound per acre fertilizer rate."

On his irrigated land Methvin side dresses 60 units of anhydrous ammonia in the furrow in June and July before the crop starts blooming and fruiting.

"We've fertilized every year," Methvin says. A block he farms south of Levelland under limited irrigation has about 650 gallons of water per minute available to irrigate 400 acres. "That's pretty thin, but when we can get some help from the rain, it's benefited us quite a bit." In 1984, Methvin notes that the 400 acres made about a bale and a quarter to the acre. As a comparison, in 1985, which was a pretty dry year, he says the same field made nearly a bale to the acre. "In 1986, we had quite a bit of rain as everybody knows, and that field made about 750 pounds of cotton to the acre."

Carry-Over Effects

In addition, residual fertilizer buildup has helped Methvin. "I feel we're benefiting some from carry-over. We haven't ever quit fertilizing; and, therefore I believe that we benefit a little bit more since we've had a consistent program."

He explains, "My dad has a place that he's been farming for 20 years. He's got a lot of water that he can put down — five inches every 12 hours — and he gets over the field in 18

continued on page 4 ... CROP YIELDS

Fertilizers Affect Cotton Water-Use Efficiencies

"It is commonly assumed that if a field crop such as cotton did not have the proper amount of nutrients it needed for growth, the plant would just sit there and do nothing," says Dr. Charles Wendt, Professor of Soil Physics at the Texas Agricultural Experiment Station in Lubbock. However, results from a 1986 container-grown cotton study conducted at the Experiment Station show that this is not the case.

"A nutrient deficient plant may visually just sit there and do nothing, but it is continually drawing moisture from the soil profile in an attempt to obtain the nutrients it needs for growth. Since water is used with little or no growth, water-use efficiency is drastically reduced."

Due to rainy weather the study was not initiated until July, notes Wendt. "However, the differences in water-use efficiency that we observed due to the various fertility treatments were dramatic."

Container-Grown Cotton Studies

During the 1986 cotton season, Wendt and Dr. Arthur Onken, a Professor of Soil Chemistry also with the Texas Agricultural Experiment Station, conducted experiments on container-grown cotton to determine the influence of water levels and fertilizer treatments on the water-use efficiency of cotton.

The studies were conducted under a rain-out shelter to control moisture. The cotton was planted in plastic containers filled with a soil that was deficient in both nitrogen and phosphorus.

The experiments involved two water treatments and four fertility treatments for a total of eight treatment combinations.

The water treatments were replacement of 100 percent of the evaporative demand and replacement of 50 percent of the evaporative demand.

The fertility treatments consisted of a control to which nothing was added, a treatment of nitrogen at 160 pounds per acre, a treatment of phosphorus at 160 pounds per acre, and a treatment of nitrogen plus phosphorus at 160 pounds per acre each. (It is normal research practice to use higher fertilizer rates in container studies than normally would be used in field production due to restricted soil volumes.)

Every two weeks, approximately 64 plants were harvested and tissue analyses made to determine nitrogen and phosphorus levels in the plants.

Treatment Responses

The researchers observed no response to the application of nitrogen alone. In fact, there was probably a slight depression of growth in the plant in response to the application of nitrogen alone.

Significantly less water was required to produce dry matter in the phosphorus and phosphorus plus nitrogen treatments, and under these treatments the plants produced more fruit.

The accompanying graphics illustrate dry matter and water data obtained during the study.

The most efficient use of water and the highest yield was observed in the nitrogen plus phosphorus high-water (NPH) treatment. Good water-use efficiencies were also observed under the nitrogen plus phosphorus low-water (NPL) treatment and under the phosphorus high-water (PH) treatment.

Primarily, the study points out the need to have a balanced fertility program to get the most efficient use of water.

In analyzing the data, Wendt observes, "It appears that you have to have phosphorus to achieve nitrogen uptake. You also have to have water for nutrient uptake. We still need to find out just how to balance our fertility against our water supplies," states Wendt.

Other observed responses include:

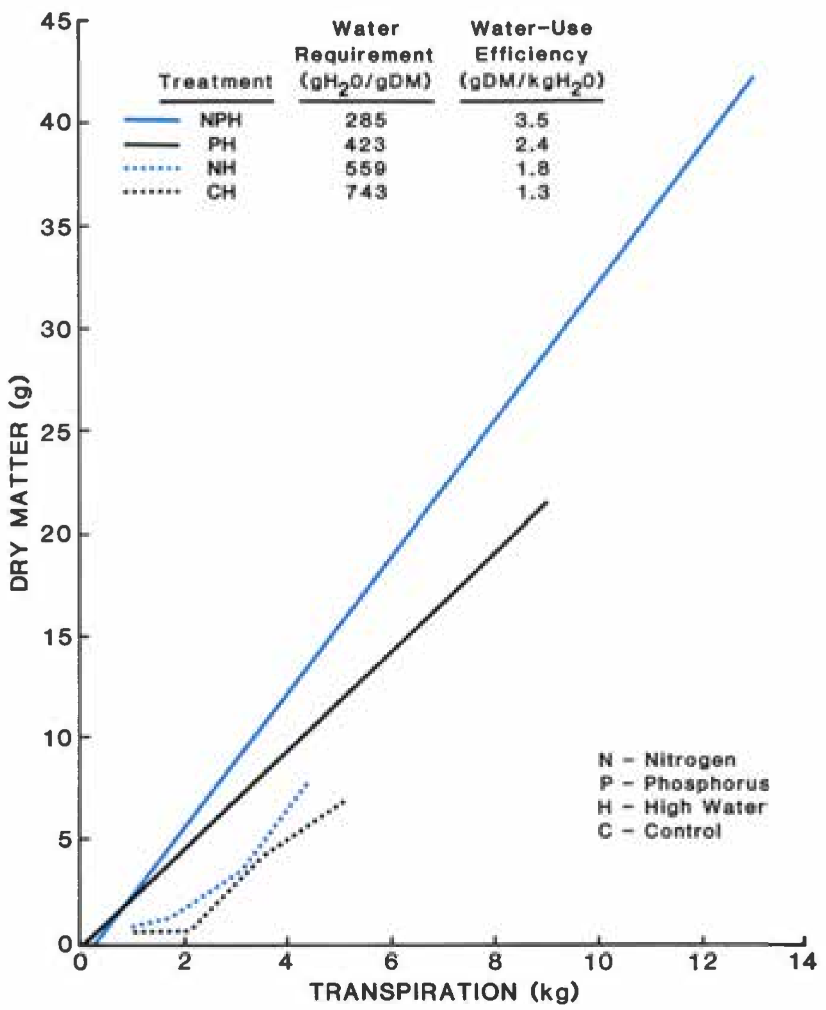
- Both water level and fertility affected water-use efficiency.
- The control low-water treatment (CL) showed a fairly good water-use efficiency, but did not produce much dry matter. In general, the water requirement increased as the fertility level decreased.
- The researchers did get fruit production where phosphorus either alone or in combination with nitrogen was applied. However, they did not get fruit production where phosphorus was not applied.
- The researchers observed that the top, root, and total plant weights were significantly higher in the high than in the low moisture levels.

Summary

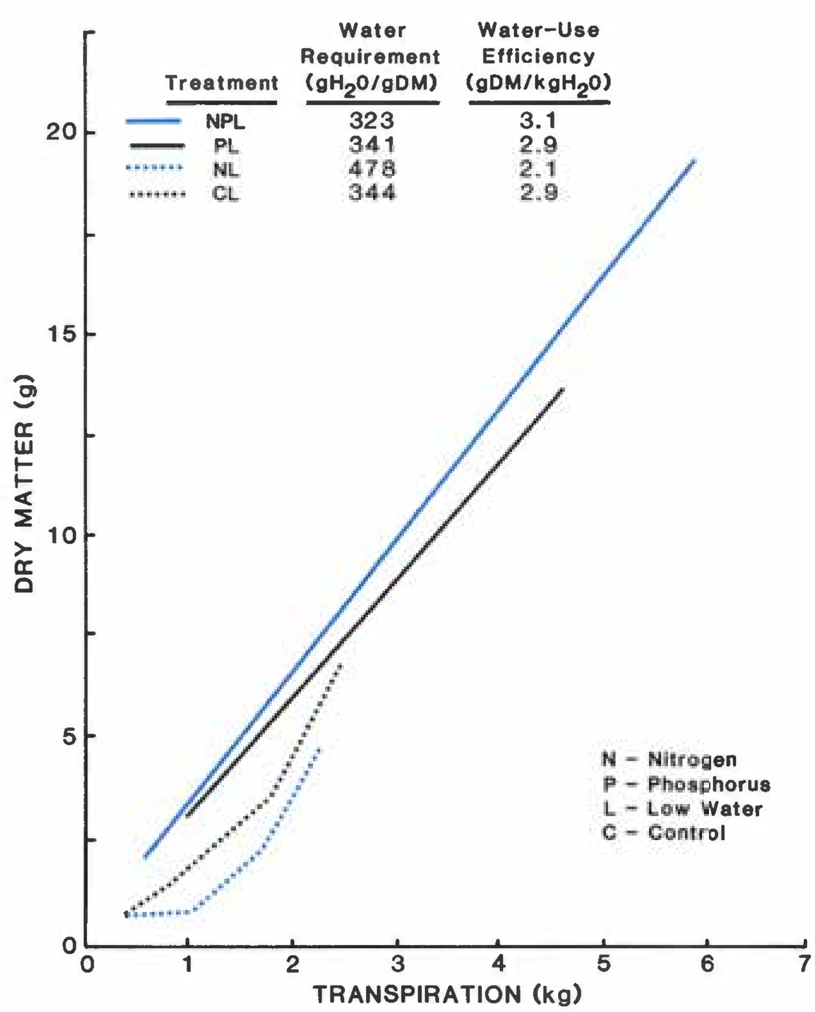
Wendt reports that the fertility data from the 1986 container-grown cotton studies show that fertilizers can have an impact on water-use efficiency. Additionally, he notes that nitrogen alone had no effect on growth and water-use efficiency. The addition of phosphorus and nitrogen plus phosphorus significantly increased the weight of the plant parts and fruit and decreased the amount of water required to produce dry matter while increasing the production of fruiting parts.

—KR

Cotton Response To Fertilizer/High Water Treatments



Cotton Response to Fertilizer/Low Water Treatments



CROP YIELDS ...

continued from page 2

days. He's made as much as 900 pounds to the acre, and his current yield is 750 pounds per acre. He's got a real good yield on that place.

"That's why we have never changed our program. I just feel that if a guy wants to go out and shoot for maximum production, he can't do it without fertilizer," states Methvin.

Old-Fashion Fertilizer Basics

Paul Kitchens, who farms near Slaton in the Posey community, fertilizes the old-fashioned way. He uses manure from a nearby feedlot to fertilize his 3,350 acres of mostly cotton and grain sorghum. Kitchens has been farming since 1961 and has used manure as fertilizer off and on for about 17 years.

"I'm talking about manure fertilizer," says Kitchens, "I'm real fortunate to be pretty close to a big feedlot. This has really helped my operation a lot."

Like the other farmers, Kitchens observes the best results when he plows in his fertilizer. He notes, "I like to deep break the manure in about 10 or 12 inches deep. The best results I've had are putting the manure on milo stubble and then rotating it with cotton. In a dry year the manure can be a disadvantage. If it's hot and you just have marginal moisture to get the crop up, with manure you might not get the crop up. I think the manure works better if you turn it under."

Kitchens applies the manure fertilizer with a cotton yield goal of 750 pounds per acre on dryland. "If the weather cooperates, we can maintain that yield," he says. "We had some cotton in 1984 that made two bales per acre. In 1985, the weather was about the same, but the cotton made only 1.5 bales per acre."

Kitchens applies manure in the winter about every three years. He usually side dresses nitrogen every second or third year because the manure loses nitrogen after the first or second year, he says.

Comparison Proves Fertility Success

The results from the manure application seem to be pretty good. Kitchens compared two blocks of land. One 31-acre block, which had no fertilizer applied for several years, yielded 1,162.5 pounds per acre of grain sorghum. Kitchens applied seven tons per acre of manure to another 70-acre block of land. This acreage yielded 1,965.14 pounds per acre of grain sorghum, a yield increase of 803 pounds per acre over the unfertilized block.

In other examples, Kitchens deep broke 10 tons of manure fertilizer in at 10 to 12 inches deep along with applying Treflan on 89.9 acres. The block yielded 4,585 pounds per acre of grain sorghum. On a 99.5-acre field where seven tons of manure fertilizer was applied in 1983 without Treflan, the carry-over effects of the manure helped hold his yield up to 4,300 pounds per acre of grain sorghum in 1986.

Although his results are shown with grain sorghum, Kitchens says cotton will respond to fertilizer from manure as well. "I feel like you can gain at least a quarter to half a bale more cotton using barnyard manure," he says.

Applying seven tons of manure per acre on dryland at $2.50 per ton, Kitchens figures his fertilizer costs to be about $21.70 per acre after including transportation costs of 12 cents per ton per mile. On irrigated land he applies 10 tons of manure per acre.

Not only is the manure a relatively inexpensive form of fertilizer, but it contains most of the necessary soil nutrients as well. Kitchens runs tests on manure to see how much nitrogen is in it.

He explains, "I analyzed some manure. We had some that was fresh out of the pens and some that had been piled up for about a year. There was very little difference in it. The fresh manure had more moisture in it, but by the time you take the moisture out, it was just about the same as dry in nutrients. The nitrogen was about 2.8 percent and phosphate about three percent. It has a lot of good trace elements in it."

Kitchens, Henson, Thomas and Methvin described their ideas on soil fertility management to participants at the Soil Fertility Conference, February 19, at the Texas A&M University Agricultural Research and Extension Center in Lubbock. Eddie Teeter, a Lockney farmer, also told about his experiences with a soil fertility/water management program, which was described in the December 1986 issue of *The Cross Section*. The conference was sponsored by the High Plains Water District in cooperation with the Soil Conservation Service, the Texas Agricultural Extension Service, the Texas Agricultural Experiment Station and the College of Agricultural Sciences at Texas Tech University.

—BS

Phosphorus ...

continued from page 1

rig, Lee has had good luck in getting the phosphorus down deep. "With the back-swept chisel we don't have the trash build up on the chisel."

Working with George Cunningham, Lee placed a band of phosphorus at a depth of about 13 inches on flat-tilled ground with the back-swept chisel rig. Lee explains that when the soil is bedded up and planted, the phosphorus will be about 17 to 18 inches below the seed bed.

"We started out chiseling about four inches to the side of last year's seed bed. At four inches, it balled up too much. Next, we moved over to about six inches from the center of the bed." Moving that far over has worked pretty well.

"This year we've got perfect soil moisture conditions for putting phosphorus deep with the rig we developed." Lee notes that if the soils were drier, he probably couldn't get anything down that deep; and if he did, the equipment probably would not hold together.

In another field application of the back-swept chisel rig, Lee worked with Bill Johnston. For this trial, Lee added a refinement to the deep placement rig. He added a second hole higher up on the fertilizer line to apply phosphorus at two depths simultaneously. The upper hole will emit the phosphorus six to seven inches deep, and the bottom hole will emit phosphorus 14 to 16 inches deep. Time will tell just how important this refinement will be in terms of crop yields.

Lee says he has a lot of customers that are interested in working on their fertility programs this year, particularly with phosphorus deep placement. At this point, Lee is advising his patrons to take their fertilizer dollars and do a good job of fertilizing a few acres, instead of trying to spread a limited amount of fertilizer out over their entire field. This way, he tells his patrons, they will really see if the extra money spent on fertility will pay for itself.

Lee says that his patrons will get more benefit out of the deep placement of phosphorus than they will from broadcasting phosphorus on the surface and disking it in. With the two-in-and-one-out planting pattern that is commonly used in his area, Lee reasons that his customers will be getting one-third more fertilizer on the rows they are planting than if they broadcast their fertilizer across the field.

Lee notes, "I've been working with the fertilizer business since 1968, and we're still doing it like we always have — broadcasting phosphorus and turning it under a maximum depth of four inches." As a result of the recent work done concerning soil fertility, Lee says it's time for a change; and he wants to see just how he can accomplish deep placement of phosphorus with limited effort and input expense.

—KR

THE Cross SECTION

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District Marks Another First

Staff Documents First Ever Net Rise In Water Levels

The High Plains Water District has recorded another first in its 36-year history by documenting an average net rise in the water levels in observation wells penetrating the Ogallala Formation throughout the District's 5.2 million acre service area. The net rise of more than one-half foot indicates a reverse in the trend of water-level changes from a decline in water levels to stabilization of the aquifer.

"The most important thing about a zero net change, such as that recorded last year, or a net rise, such as what we have this year, in the measured water levels is that the amount of water in the aquifer is not changing significantly. The aquifer is stabilizing," states Don McReynolds, Director of the Geohydrologic Division at the Water District. "If we're not using the water now, it means more water will be available for future use."

Although the District-wide average shows a net rise, the actual measured depth to water and the resultant averages vary from county to county.

Trends Vary From County to County

Twelve of the 15 counties served by the Water District show an average annual rise in water levels from January 1986 to January 1987. Rises range from a slight rise of 0.03 of a foot in Lamb County to an impressive rise of 3.27 feet in that portion of Lynn County lying within the District's service area.

Of the 15 counties within the District, four show average annual water-level rises for the 10-year period 1977 to 1987, and six show average annual rises for the five-year period 1982 to 1987.

Only three counties in the District's service area, Castro, Deaf Smith and Parmer counties, show an average net decline in water levels from 1986 to 1987. The declines are all less than one-half foot, ranging from 0.16 of a foot in Castro County to 0.38 of a foot in Parmer County. However, even these small declines hold good news in that generally the rate of decline is reduced from previous years.

District-Wide Declines Significantly Reduced

The average change in water levels in the Ogallala aquifer throughout the District's service area for the five-year period 1982 to 1987 shows a total decline of one foot. This equals an average annual decline of 0.20 of a foot.

The 10-year average change in water levels from 1977 to 1987 for all the wells measured shows a total water-level decline of 7.40 feet, which equals an average annual decline of 0.74 of a foot.

Recharge and Ag Economy Among Contributing Factors

McReynolds attributes the rise in measured water levels to a number of factors including the large amounts of precipitation which fell over parts of the Water District's service area in late fall of 1986 and to the agricultural economy including high fuel costs, which contributed to reduced pumpage.

In addition, more efficient irrigation management and equipment such as center pivot sprinkler systems, furrow dikes and surge valves have also helped reduce the amount of water pumped from the aquifer.

"As long as the agricultural economy remains in its present condition, it is likely that this trend of decreasing declines will continue," predicts McReynolds.

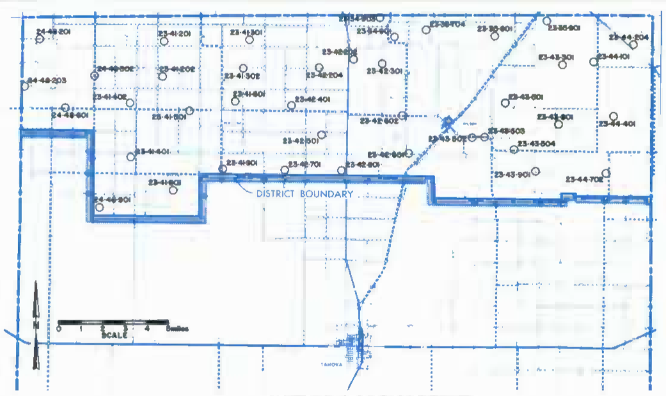
Water Levels Measured Annually

Staff at the Water District annually measure and record the depth to water in the Ogallala

continued on page 8 ... NET RISE

Average Changes In Depths to Water In Observation Wells — 1987

	Number of Observation Wells Maintained	Average Annual Change-1977 to 1987	Average Annual Change-1982 to 1987	AverageAnnual Change-1986 to 1987
Armstrong	9	−0.41	−0.11	+1.09
Bailey	74	−0.87	−0.42	+0.14
Castro	89	−1.84	−1.23	−0.16
Cochran	52	+0.25	+0.52	+0.96
Crosby	23	−0.53	+1.03	+1.50
Deaf Smith	83	−1.10	−0.76	−0.22
Floyd	98	−1.06	−0.53	+0.19
Hale	27	−0.53	+0.12	+2.18
Hockley	88	+0.17	+0.59	+1.16
Lamb	99	−1.82	−1.06	+0.03
Lubbock	116	+0.06	+0.87	+1.28
Lynn	40	+0.62	+1.73	+3.27
Parmer	97	−2.00	−1.29	−0.38
Potter	6	−0.78	−0.36	+0.36
Randall	50	−0.17	−0.20	+0.29



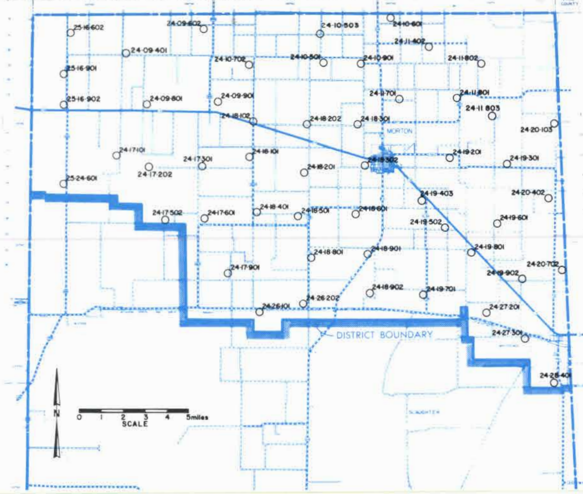
LYNN COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
23-34-901	143.28	147.72	141.89	140.88	+ 2.40	+ 6.84	+ 1.01
23-34-903	151.47	156.82	153.34	151.85	− 0.38	+ 4.97	+ 1.49
23-35-704	132.21	138.13	135.65	133.43	− 1.22	+ 4.70	+ 2.22
23-35-801	87.72	87.78	87.50	87.09	+ 0.63	+ 0.69	+ 0.41
23-35-901	90.02	91.98	91.06	90.67	− 0.65	+ 1.31	+ 0.39
23-41-201	103.62	108.35	101.80	98.02	+ 5.60	+ 10.33	+ 3.78
23-41-202	0.0	0.0	112.50	108.96	0.0	0.0	+ 3.54
23-41-301	0.0	135.90	131.80	130.84	0.0	+ 5.06	+ 0.96
23-41-302	0.0	0.0	109.32	108.38	0.0	0.0	+ 0.94
23-41-401	90.44	95.55	90.10	87.93	+ 2.51	+ 7.62	+ 2.17
23-41-402	0.0	107.67	99.62	96.50	0.0	+ 11.17	+ 3.12
23-41-501	69.31	74.45	65.56	62.59	+ 6.72	+ 11.86	+ 2.97
23-41-601	0.0	105.96	103.02	102.34	0.0	+ 3.62	+ 0.68

LYNN COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
23-41-801	0.0	76.33	66.75	60.87	0.0	+ 15.46	+ 5.88
23-41-901	126.97	126.09	119.70	117.59	+ 9.38	+ 8.50	+ 2.11
23-42-202	124.39	124.44	121.17	120.46	+ 3.93	+ 3.98	+ 0.71
23-42-204	0.0	120.89	117.65	117.04	0.0	+ 3.85	+ 0.61
23-42-301	109.49	110.45	106.32	105.33	+ 4.16	+ 5.12	+ 0.99
23-42-401	113.61	114.91	107.43	107.05	+ 6.56	+ 7.86	+ 0.38
23-42-501	100.08	102.45	96.38	90.63	+ 9.45	+ 11.82	+ 5.75
23-42-601	40.46	44.23	41.20	35.01	+ 5.45	+ 9.22	+ 6.19
23-42-602	87.52	89.67	88.29	86.02	+ 1.50	+ 3.65	+ 2.27
23-42-701	99.01	97.65	85.96	83.38	+ 15.63	+ 14.27	+ 2.58
23-42-801	63.77	68.95	60.14	58.12	+ 5.65	+ 10.83	+ 2.02
23-43-301	28.19	33.25	26.08	11.78	+ 16.41	+ 21.47	+ 14.30
23-43-501	71.71	72.38	68.04	66.60	+ 5.11	+ 5.78	+ 1.44
23-43-502	77.47	79.22	75.68	73.97	+ 3.50	+ 5.25	+ 1.71
23-43-503	84.87	85.86	82.57	81.25	+ 3.62	+ 4.61	+ 1.32
23-43-504	75.27	75.80	70.94	69.64	+ 5.63	+ 6.16	+ 1.30
23-43-601	0.0	41.60	36.70	29.03	0.0	+ 12.57	+ 7.67
23-43-901	57.03	56.90	51.67	48.15	+ 8.88	+ 8.75	+ 3.52
23-44-101	61.08	65.75	55.18	43.45	+ 17.63	+ 22.30	+ 11.73
23-44-204	0.0	0.0	135.59	129.37	0.0	0.0	+ 6.22
23-44-401	40.94	41.88	39.17	34.35	+ 6.59	+ 7.53	+ 4.82
23-44-702	25.14	26.81	23.90	19.71	+ 5.43	+ 7.10	+ 4.19
24-48-201	0.0	101.32	96.51	93.58	0.0	+ 7.74	+ 2.93
24-48-203	0.0	94.96	86.54	84.23	0.0	+ 10.73	+ 2.31
24-48-302	108.39	111.00	100.52	92.79	+ 15.60	+ 18.21	+ 7.73
24-48-601	86.79	89.52	82.38	78.29	+ 8.50	+ 11.23	+ 4.09
24-48-901	0.0	0.0	115.22	113.06	0.0	0.0	+ 2.16

NOTE: 0.0 Denotes data not available



COCHRAN COUNTY

Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
24-09-401	92.37	94.56	96.62	96.72	– 4.35	– 2.16	– 0.10
24-09-602	127.08	129.42	128.74	127.83	– 0.75	+ 1.59	+ 0.91
24-09-801	123.94	123.86	124.02	123.85	+ 0.09	+ 0.01	+ 0.17
24-09-901	107.02	109.70	108.05	106.12	+ 0.90	+ 3.58	+ 1.93
24-10-501	94.36	94.57	92.71	92.42	+ 1.94	+ 2.15	+ 0.29
24-10-503	0.0	106.26	103.92	103.67	0.0	+ 2.59	+ 0.25
24-10-601	92.56	94.44	91.75	90.76	+ 1.80	+ 3.68	+ 0.99
24-10-702	112.82	112.12	112.21	111.76	+ 1.06	+ 0.36	+ 0.45
24-10-901	93.29	93.51	0.0	0.0	0.0	0.0	0.0
24-11-402	0.0	126.79	125.72	124.92	0.0	+ 1.87	+ 0.80
24-11-701	126.66	126.55	125.90	125.04	+ 1.62	+ 1.51	+ 0.86
24-11-801	107.97	109.39	0.0	0.0	0.0	0.0	0.0
24-11-802	115.82	114.54	114.07	112.64	+ 3.18	+ 1.90	+ 1.43
24-11-803	0.0	0.0	130.25	128.69	0.0	0.0	+ 1.56
24-17-101	0.0	135.44	132.98	132.17	0.0	+ 3.27	+ 0.81
24-17-202	0.0	142.20	139.88	138.10	0.0	+ 4.10	+ 1.78
24-17-301	148.31	148.45	143.87	142.85	+ 5.46	+ 5.60	+ 1.02

COCHRAN COUNTY

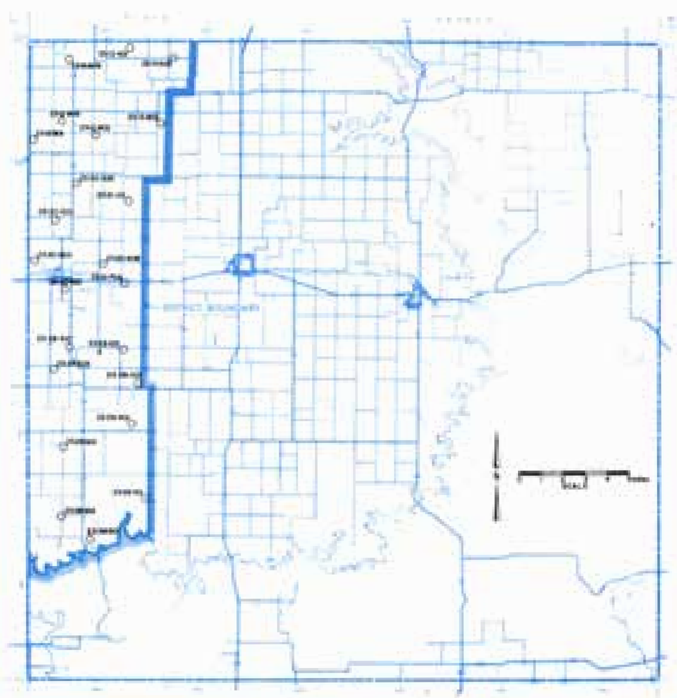
Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
24-17-502	159.71	158.38	152.80	151.52	+ 8.19	+ 6.86	+ 1.28
24-17-601	153.69	152.90	150.00	149.14	+ 4.55	+ 3.76	+ 0.86
24-17-901	168.44	168.00	164.28	163.01	+ 5.43	+ 4.99	+ 1.27
24-18-101	148.12	146.43	144.09	144.97	+ 3.15	+ 1.46	– 0.88
24-18-102	157.40	156.00	154.63	151.03	+ 6.37	+ 4.97	+ 3.60
24-18-201	178.65	179.20	176.09	175.34	+ 3.31	+ 3.86	+ 0.75
24-18-202	138.05	138.00	136.73	136.12	+ 1.93	+ 1.88	+ 0.61
24-18-301	134.58	136.94	136.44	135.22	– 0.64	+ 1.72	+ 1.22
24-18-302	165.60	165.98	0.0	0.0	0.0	0.0	0.0
24-18-401	155.05	155.88	152.57	151.19	+ 3.86	+ 4.69	+ 1.38
24-18-501	198.58	198.94	197.60	196.28	+ 2.30	+ 2.66	+ 1.32
24-18-601	178.27	178.00	174.77	173.28	+ 4.99	+ 4.72	+ 1.49
24-18-801	194.61	194.80	191.40	189.62	+ 4.99	+ 5.18	+ 1.78
24-18-901	114.46	115.20	113.00	111.12	+ 3.34	+ 4.08	+ 1.88
24-18-902	0.0	140.61	138.80	138.95	0.0	+ 1.66	– 0.15
24-19-201	148.57	148.82	151.01	149.49	– 0.92	– 0.67	+ 1.52
24-19-301	173.11	167.76	166.16	164.18	+ 8.93	+ 3.58	+ 1.98
24-19-403	0.0	0.0	153.18	0.0	0.0	0.0	0.0
24-19-502	176.42	174.83	171.87	170.87	+ 5.55	+ 3.96	+ 1.00
24-19-601	157.62	159.80	160.35	159.09	– 1.47	+ 0.71	+ 1.26
24-19-701	154.79	151.78	149.53	149.05	+ 5.74	+ 2.73	+ 0.48
24-19-801	171.44	169.89	167.18	166.05	+ 5.39	+ 3.84	+ 1.13
24-19-902	130.27	130.55	130.82	130.04	+ 0.23	+ 0.51	+ 0.78
24-20-103	151.62	145.58	145.65	143.40	+ 8.22	+ 2.18	+ 2.25
24-20-402	150.40	0.0	158.55	158.51	– 8.11	0.0	+ 0.04
24-20-702	153.84	154.55	156.05	155.05	– 1.21	– 0.50	+ 1.00
24-26-101	0.0	151.14	148.70	149.67	0.0	+ 1.47	– 0.97
24-26-202	164.64	160.78	158.55	157.18	+ 7.46	+ 3.60	+ 1.37
24-27-201	183.06	182.82	179.61	180.22	+ 2.84	+ 2.60	– 0.61
24-27-301	180.81	181.50	180.42	180.11	+ 0.70	+ 1.39	+ 0.31
24-28-401	187.41	189.42	189.53	188.31	– 0.90	+ 1.11	+ 1.22
25-16-602	78.11	80.47	78.35	76.42	+ 1.69	+ 4.05	+ 1.93
25-16-901	93.33	94.03	92.40	91.13	+ 2.20	+ 2.90	+ 1.27
25-16-902	0.0	109.53	109.20	108.83	0.0	+ 0.70	+ 0.37
25-24-601	0.0	142.62	139.82	139.66	0.0	+ 2.96	+ 0.16

NOTE: 0.0 Denotes data not available

CROSBY COUNTY

Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
23-12-606	183.61	197.58	201.80	202.70	– 19.09	– 5.12	– 0.90
23-12-801	203.17	210.50	209.06	208.75	– 5.58	+ 1.75	+ 0.31
23-12-902	223.86	243.59	233.19	234.40	– 10.54	+ 9.19	– 1.21
23-12-905	208.99	219.38	218.65	217.88	– 8.89	+ 1.50	+ 0.77
23-13-401	199.09	212.54	216.77	216.65	– 17.56	– 4.11	+ 0.12
23-13-502	218.37	229.98	232.24	232.81	– 14.44	– 2.83	– 0.57
23-13-803	214.97	248.36	247.50	247.30	– 32.33	+ 1.06	+ 0.20
23-20-201	0.0	192.91	191.10	190.13	0.0	+ 2.78	+ 0.97
23-20-305	0.0	225.81	219.27	218.84	0.0	+ 6.97	+ 0.43
23-20-503	207.03	0.0	213.71	208.90	– 1.87	0.0	+ 4.81
23-20-608	0.0	0.0	222.36	220.49	0.0	0.0	+ 1.87
23-20-901	207.01	215.01	208.20	205.95	+ 1.06	+ 9.06	+ 2.25
23-21-101	0.0	254.06	236.67	236.85	0.0	+ 17.21	– 0.18
23-21-706	208.05	212.68	209.56	208.40	– 0.35	+ 4.28	+ 1.16
23-28-202	133.29	139.81	129.25	127.60	+ 5.69	+ 12.21	+ 1.65
23-28-310	0.0	178.98	175.48	174.20	0.0	+ 4.78	+ 1.28
23-28-601	144.10	0.0	125.20	117.25	+ 26.85	0.0	+ 7.95
23-28-901	0.0	101.49	92.70	90.21	0.0	+ 11.28	+ 2.49
23-29-102	0.0	187.30	180.95	176.80	0.0	+ 10.50	+ 4.15
23-29-103	0.0	207.14	200.34	196.90	0.0	+ 10.24	+ 3.44
23-29-401	208.30	0.0	203.30	200.70	+ 7.60	0.0	+ 2.60
23-29-701	0.0	0.0	113.10	112.90	0.0	0.0	+ 0.20
23-36-301	0.0	152.84	151.41	150.70	0.0	+ 2.14	+ 0.71

NOTE: 0.0 Denotes data not available



23-25-304	37.28	33.65	30.04	28.47	+ 8.81	+ 5.18	+ 1.57
23-25-401	146.12	148.10	143.84	142.23	+ 3.89	+ 5.87	+ 1.61
23-25-704	130.52	132.83	127.26	126.28	+ 4.24	+ 6.55	+ 0.98
23-25-801	0.0	113.80	110.17	109.51	0.0	+ 4.29	+ 0.66
23-25-904	0.0	77.30	66.68	63.02	0.0	+ 14.28	+ 3.66
23-26-101	59.84	55.78	51.06	50.21	+ 9.63	+ 5.57	+ 0.85
23-26-301	93.30	93.59	88.85	87.66	+ 5.64	+ 5.93	+ 1.19
23-26-603	11.33	13.14	12.67	0.0	0.0	0.0	0.0
23-26-604	51.42	50.31	48.69	47.06	+ 4.36	+ 3.25	+ 1.63
23-26-802	0.0	73.10	65.39	62.10	0.0	+ 11.00	+ 3.29
23-27-102	0.0	84.57	79.37	78.25	0.0	+ 6.32	+ 1.12
23-27-201	92.12	94.54	89.79	88.52	+ 3.60	+ 6.02	+ 1.27
23-27-204	91.82	93.33	90.04	88.60	+ 3.22	+ 4.73	+ 1.44
23-27-207	97.02	104.44	95.66	91.14	+ 5.88	+ 13.30	+ 4.52
23-27-302	79.54	82.34	76.90	71.14	+ 8.40	+ 11.20	+ 5.76
23-27-402	73.29	73.00	71.94	70.45	+ 2.84	+ 2.55	+ 1.49
23-27-601	86.29	85.75	82.14	78.57	+ 7.72	+ 7.18	+ 3.57
23-27-603	0.0	87.43	83.20	79.94	0.0	+ 7.49	+ 3.26
23-27-701	0.0	0.0	63.36	54.91	0.0	0.0	+ 8.45
23-27-801	0.0	128.55	123.71	122.59	0.0	+ 5.96	+ 1.12
23-28-203	0.0	171.89	154.25	152.17	0.0	+ 19.72	+ 2.08
23-28-501	0.0	89.11	86.32	84.02	0.0	+ 5.09	+ 2.30
23-28-701	57.50	59.83	54.13	43.50	+ 14.00	+ 16.33	+ 10.63
23-33-201	129.99	130.25	128.41	127.73	+ 2.26	+ 2.52	+ 0.68
23-33-301	0.0	106.36	101.00	96.40	0.0	+ 9.96	+ 4.60
23-33-401	105.50	106.76	104.38	103.71	+ 1.79	+ 3.05	+ 0.67
23-33-501	110.09	112.00	110.16	109.95	+ 0.14	+ 2.05	+ 0.21
23-33-601	104.75	107.09	104.30	103.21	+ 1.54	+ 3.88	+ 1.09
23-33-801	99.06	99.89	97.10	96.07	+ 2.99	+ 3.82	+ 1.03
23-33-901	119.66	121.39	117.18	116.22	+ 3.44	+ 5.17	+ 0.96
23-34-101	113.15	116.11	110.61	109.57	+ 3.58	+ 6.54	+ 1.04
23-34-202	0.0	100.58	92.76	88.05	0.0	+ 12.53	+ 4.71
23-34-402	116.28	117.85	114.87	114.70	+ 1.58	+ 3.15	+ 0.17
23-34-502	138.96	143.00	139.59	138.84	+ 0.12	+ 4.16	+ 0.75
23-34-503	120.85	124.40	119.22	117.89	+ 2.96	+ 6.51	+ 1.33
23-34-601	127.39	130.18	127.38	127.53	– 0.14	+ 2.65	– 0.15
23-34-801	147.56	149.42	146.60	145.14	+ 2.42	+ 4.28	+ 1.46
23-34-805	142.44	144.89	141.31	140.21	+ 2.23	+ 4.68	+ 1.10
23-34-902	135.81	139.52	136.82	136.78	– 0.97	+ 2.74	+ 0.04
23-35-101	80.64	81.70	76.45	74.80	+ 5.84	+ 6.90	+ 1.65
23-35-301	112.32	111.78	109.50	107.39	+ 4.93	+ 4.39	+ 2.11
23-35-502	97.88	99.40	95.94	95.79	+ 2.09	+ 3.61	+ 0.15
23-35-503	125.90	131.69	126.99	126.41	– 0.51	+ 5.28	+ 0.58
23-35-701	130.23	134.28	131.25	130.95	– 0.72	+ 3.33	+ 0.30
23-35-703	135.12	139.52	132.64	132.43	+ 2.69	+ 7.09	+ 0.21
23-35-706	127.75	133.21	130.54	128.94	– 1.19	+ 4.27	+ 1.60
23-35-707	0.0	134.32	131.71	130.83	0.0	+ 3.49	+ 0.88
23-35-802	116.31	120.30	118.61	115.22	+ 1.09	+ 5.08	+ 3.39
23-35-902	147.27	147.13	144.54	143.69	+ 3.58	+ 3.44	+ 0.85
23-35-903	146.88	154.97	147.68	144.71	+ 2.17	+ 10.26	+ 2.97
23-36-201	0.0	77.88	75.36	71.84	0.0	+ 6.04	+ 3.52
23-36-401	103.52	103.73	101.81	101.73	+ 1.79	+ 2.00	+ 0.08
23-36-701	118.69	118.88	119.10	118.13	+ 0.56	+ 0.75	+ 0.97
23-36-702	211.40	222.40	208.69	207.15	+ 4.25	+ 15.25	+ 1.54
23-36-703	204.08	208.75	197.62	197.56	+ 6.52	+ 11.19	+ 0.06
24-16-601	129.14	136.76	134.93	134.19	– 5.05	+ 2.57	+ 0.74
24-16-901	171.50	170.32	169.90	169.29	+ 2.21	+ 1.03	+ 0.61
24-24-201	67.85	70.60	69.28	67.12	+ 0.73	+ 3.48	+ 2.16
24-24-301	136.56	137.02	134.95	133.09	+ 3.47	+ 3.93	+ 1.86
24-24-602	84.75	87.80	84.64	82.13	+ 2.62	+ 5.67	+ 2.51
24-24-901	0.0	172.69	165.60	167.19	0.0	+ 5.50	– 1.59
24-24-902	119.60	126.15	123.50	119.45	+ 0.15	+ 6.70	+ 4.05
24-32-201	0.0	103.92	103.03	102.39	0.0	+ 1.53	+ 0.64
24-32-303	0.0	119.80	119.35	119.22	0.0	+ 0.58	+ 0.13
24-32-304	143.62	146.80	146.03	144.59	– 0.97	+ 2.21	+ 1.44
24-32-305	0.0	0.0	126.01	125.06	0.0	0.0	+ 0.95
24-32-502	0.0	0.0	119.15	117.68	0.0	0.0	+ 1.47
24-32-601	133.19	135.34	134.18	134.57	– 1.38	+ 0.77	– 0.39
24-40-201	138.30	136.20	133.07	132.76	+ 5.54	+ 3.44	+ 0.31
24-40-301	146.95	148.60	145.24	144.75	+ 2.20	+ 3.85	+ 0.49
24-40-601	125.48	128.43	125.63	125.82	– 0.34	+ 2.61	– 0.19
24-40-603	0.0	89.30	86.15	86.49	0.0	+ 2.81	– 0.34
24-40-901	68.18	71.85	67.23	64.09	+ 4.09	+ 7.76	+ 3.14

NOTE: 0.0 Denotes data not available

Well Number	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
10-26-603	0.0	0.0	338.44	341.40	0.0	0.0	– 2.96
10-26-702	228.74	240.38	243.20	244.83	– 16.09	– 4.45	– 1.63
10-26-802	239.66	255.89	262.80	264.67	– 25.01	– 8.78	– 1.87
10-27-102	288.60	302.90	314.91	316.66	– 28.06	– 13.76	– 1.75
10-27-103	0.0	389.66	403.24	406.05	0.0	– 16.39	– 2.81
10-27-301	327.49	341.72	351.92	354.53	– 27.04	– 12.81	– 2.61
10-27-501	362.58	386.80	403.03	404.88	– 42.30	– 18.08	– 1.85
10-27-601	0.0	364.29	376.88	378.18	0.0	– 13.89	– 1.30
10-27-702	0.0	300.98	308.32	308.75	0.0	– 7.77	– 0.43
10-27-901	270.82	291.94	296.50	297.03	– 26.21	– 5.09	– 0.53
10-28-102	0.0	335.11	347.10	348.90	0.0	– 13.79	– 1.80
10-28-202	300.96	318.03	328.40	329.22	– 28.26	– 11.19	– 0.82
10-28-501	318.43	348.32	360.39	362.85	– 44.42	– 14.53	– 2.46
10-28-703	0.0	278.38	289.71	291.16	0.0	– 12.78	– 1.45
10-28-801	0.0	306.55	318.46	319.70	0.0	– 13.15	– 1.24
10-33-103	0.0	0.0	324.19	327.12	0.0	0.0	– 2.93
10-33-310	0.0	275.37	286.39	282.06	0.0	– 6.69	+ 4.33
10-33-501	286.22	306.26	0.0	0.0	0.0	0.0	0.0
10-33-502	0.0	336.13	344.84	345.84	0.0	– 9.71	– 1.00
10-33-603	0.0	0.0	327.33	328.35	0.0	0.0	– 1.02
10-33-801	0.0	266.12	279.62	281.49	0.0	– 15.37	– 1.87
10-33-802	221.36	241.32	253.20	254.87	– 33.51	– 13.55	– 1.67
10-33-902	220.81	236.29	247.01	248.82	– 28.01	– 12.53	– 1.81
10-34-102	230.96	246.58	255.75	257.41	– 26.45	– 10.83	– 1.66
10-34-202	0.0	287.66	293.16	293.52	0.0	– 5.86	– 0.36
10-34-302	226.96	245.56	252.04	253.64	– 26.68	– 8.08	– 1.60
10-34-403	0.0	304.64	313.43	314.01	0.0	– 9.37	– 0.58
10-34-404	296.34	315.48	323.48	324.35	– 28.01	– 8.87	– 0.87
10-34-602	0.0	285.57	293.44	0.0	0.0	0.0	0.0
10-34-801	228.09	244.23	254.64	255.70	– 27.61	– 11.47	– 1.06
10-34-802	254.84	272.59	279.88	281.60	– 26.76	– 9.01	– 1.72
10-35-304	225.73	241.44	249.03	249.55	– 23.82	– 8.11	– 0.52
10-35-401	263.22	278.77	286.56	290.53	– 27.31	– 11.76	– 3.97
10-35-501	251.56	268.81	271.55	272.13	– 20.57	– 3.32	– 0.58
10-35-603	0.0	221.18	234.45	235.58	0.0	– 14.40	– 1.13
10-35-702	238.11	259.56	263.93	266.79	– 28.68	– 7.23	– 2.86
10-35-802	0.0	265.61	0.0	278.38	0.0	– 12.77	0.0
10-35-901	264.31	284.36	289.04	293.03	– 28.72	– 8.67	– 3.99
10-35-902	259.35	280.96	288.24	290.06	– 30.71	– 9.10	– 1.82
10-36-102	223.91	241.22	246.18	247.10	– 23.19	– 5.88	– 0.92
10-36-401	0.0	193.58	207.71	206.45	0.0	– 12.87	+ 1.26
10-36-602	0.0	0.0	247.80	247.64	0.0	0.0	+ 0.16
10-36-702	0.0	228.99	240.67	242.43	0.0	– 13.44	– 1.76
10-36-801	204.90	224.65	236.40	236.20	– 31.30	– 11.55	+ 0.20
10-41-209	206.46	221.23	239.24	231.70	– 25.24	– 10.47	+ 7.54
10-41-301	194.42	211.83	220.90	220.48	– 26.06	– 8.65	+ 0.42
10-41-403	0.0	196.66	203.40	204.47	0.0	– 7.81	– 1.07
10-42-104	0.0	0.0	210.52	212.50	0.0	0.0	– 1.98
10-42-202	216.20	232.99	240.33	241.79	– 25.59	– 8.80	– 1.46
10-42-302	0.0	199.32	208.16	212.03	0.0	– 12.71	– 3.87
10-42-506	0.0	188.69	198.34	198.90	0.0	– 10.21	– 0.56
10-43-203	0.0	229.89	236.73	239.25	0.0	– 9.36	– 2.52
10-44-102	201.94	224.98	234.64	235.18	– 33.24	– 10.20	– 0.54
10-44-202	214.84	237.27	243.75	244.80	– 29.96	– 7.53	– 1.05
10-44-203	0.0	233.63	247.02	247.68	0.0	– 14.05	– 0.66

NOTE: 0.0 Denotes data not available

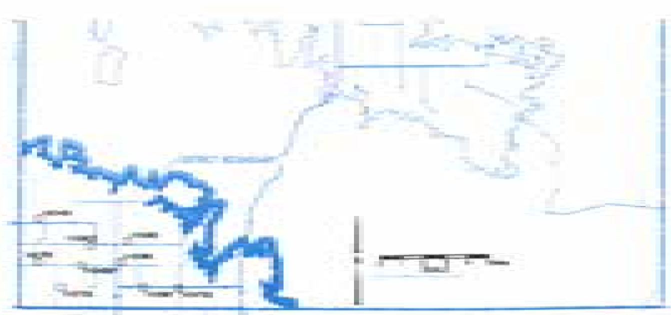
ARMSTRONG COUNTY

Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
11-12-401	124.64	128.38	130.47	130.73	– 6.09	– 2.35	– 0.26
11-12-601	115.94	119.77	120.65	120.35	– 4.41	– 0.58	+ 0.30
11-12-701	143.45	147.48	148.80	148.43	– 4.98	– 0.95	+ 0.37
11-12-702	153.96	156.62	156.83	155.38	– 1.42	+ 1.24	+ 1.45
11-12-801	148.37	150.39	151.96	150.97	– 2.60	– 0.58	+ 0.99
11-12-802	159.52	161.49	162.75	161.34	– 1.82	+ 0.15	+ 1.41
11-12-803	137.61	144.43	146.39	145.65	– 8.04	– 1.22	+ 0.74
11-12-901	130.99	134.41	135.85	134.34	– 3.35	+ 0.07	+ 1.51
11-13-702	0.0	0.0	123.28	119.97	0.0	0.0	+ 3.31

NOTE: 0.0 Denotes data not available

Well Number	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
10-54-701	0.0	96.13	109.77	111.99	0.0	– 15.86	– 2.22
10-54-801	78.12	90.32	108.90	110.66	– 32.54	– 20.34	– 1.76
10-55-203	188.17	208.50	218.66	218.58	– 30.41	– 10.08	+ 0.08
10-55-301	213.01	236.32	239.10	238.44	– 25.43	– 2.12	+ 0.66
10-55-404	188.03	203.99	208.94	0.0	0.0	0.0	0.0
10-55-701	95.96	110.40	118.53	118.48	– 22.52	– 8.08	+ 0.05
10-55-802	101.52	117.64	133.02	130.58	– 29.06	– 12.94	+ 2.44
10-55-902	164.98	187.38	199.94	198.54	– 33.56	– 11.16	+ 1.40
10-55-904	159.58	178.33	185.17	185.78	– 26.20	– 7.45	– 0.61
10-56-102	219.23	235.73	244.33	246.13	– 26.90	– 10.40	– 1.80
10-56-403	203.67	229.00	240.40	239.06	– 35.39	– 10.06	+ 1.34
10-56-404	220.89	240.00	252.61	252.30	– 31.41	– 12.30	+ 0.31
10-60-103	142.54	143.30	141.18	140.88	+ 1.66	+ 2.42	+ 0.30
10-60-304	86.04	105.40	109.44	111.00	– 24.96	– 5.60	– 1.56
10-60-401	125.45	123.90	121.93	120.12	+ 5.33	+ 3.78	+ 1.81
10-60-604	0.0	97.24	95.28	93.68	0.0	+ 3.56	+ 1.60
10-60-904	136.76	135.81	133.28	132.22	+ 4.54	+ 3.59	+ 1.06
10-61-101	88.80	105.91	117.11	117.84	– 29.04	– 11.93	– 0.73
10-61-105	0.0	0.0	98.94	94.91	0.0	0.0	+ 4.03
10-61-201	64.62	75.60	82.97	83.89	– 19.27	– 8.29	– 0.92
10-61-501	148.35	160.92	167.14	168.39	– 20.04	– 7.47	– 1.25
10-61-602	101.01	121.70	133.35	133.62	– 32.61	– 11.92	– 0.27
10-61-701	136.19	149.24	150.49	150.35	– 14.16	– 1.11	+ 0.14
10-62-101	61.37	74.41	84.74	0.0	0.0	0.0	0.0
10-62-207	0.0	129.46	136.15	136.37	0.0	– 6.91	– 0.22
10-62-304	0.0	0.0	0.0	106.90	0.0	0.0	0.0
10-62-603	0.0	111.88	116.23	116.71	0.0	– 4.83	– 0.48
10-62-701	135.94	146.20	153.84	155.09	– 19.15	– 8.89	– 1.25
10-63-102	0.0	0.0	0.0	106.01	0.0	0.0	0.0
10-63-202	0.0	0.0	125.28	124.35	0.0	0.0	+ 0.93
10-63-306	0.0	0.0	158.04	161.37	0.0	0.0	– 3.33
10-63-404	0.0	131.41	137.64	138.07	0.0	– 6.66	– 0.43
10-63-601	123.39	141.44	147.65	147.92	– 24.53	– 6.48	– 0.27
10-63-702	144.85	151.78	154.36	154.90	– 10.05	– 3.12	– 0.54
10-63-801	0.0	132.39	131.00	131.85	0.0	+ 0.54	– 0.85
10-64-103	0.0	163.55	172.24	171.77	0.0	– 8.22	+ 0.47
10-64-701	128.62	142.14	0.0	151.85	– 23.23	– 9.71	0.0
24-04-301	51.59	59.85	61.02	58.50	– 6.91	+ 1.35	+ 2.52
24-05-102	0.0	53.94	54.21	53.74	0.0	+ 0.20	+ 0.47
24-05-303	0.0	142.87	149.31	149.85	0.0	– 6.98	– 0.54
24-05-601	80.49	73.50	71.02	69.41	+ 11.08	+ 4.09	+ 1.61
24-06-101	0.0	139.91	143.71	144.18	0.0	– 4.27	– 0.47
24-06-203	0.0	0.0	147.47	149.97	0.0	0.0	– 2.50
24-06-402	88.28	87.72	86.82	85.75	+ 2.53	+ 1.97	+ 1.07
24-06-507	0.0	84.34	83.66	81.64	0.0	+ 2.70	+ 2.02
24-06-604	137.23	148.22	151.25	149.10	– 11.87	– 0.88	+ 2.15
24-06-902	99.83	104.88	104.25	102.63	– 2.80	+ 2.25	+ 1.62
24-07-101	0.0	141.71	144.69	145.39	0.0	– 3.68	– 0.70
24-07-202	157.66	0.0	0.0	0.0	0.0	0.0	0.0
24-07-301	0.0	141.72	142.42	141.22	0.0	+ 0.50	+ 1.20
24-07-602	0.0	0.0	148.52	147.45	0.0	0.0	+ 1.07
24-07-701	144.05	147.02	147.29	147.30	– 3.25	– 0.28	– 0.01
24-07-901	120.39	126.72	129.26	129.96	– 9.57	– 3.24	– 0.70
24-08-402	0.0	157.15	158.88	158.52	0.0	– 1.37	+ 0.36
24-08-701	137.87	143.79	146.42	146.32	– 8.45	– 2.53	+ 0.10
24-14-301	0.0	57.66	59.75	56.70	0.0	+ 0.96	+ 3.05
24-15-201	121.37	121.52	120.88	120.49	+ 0.88	+ 1.03	+ 0.39
24-15-506	80.73	82.79	81.65	80.33	+ 0.40	+ 2.46	+ 1.32
24-15-609	136.73	139.58	137.50	136.70	+ 0.03	+ 2.88	+ 0.80
24-16-101	0.0	166.54	167.24	166.82	0.0	– 0.28	+ 0.42

NOTE: 0.0 Denotes data not available



Well Number	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
11-61-801	232.31	244.97	253.70	252.51	– 20.20	– 7.54	+ 1.19
11-61-901	216.48	240.34	246.70	246.11	– 29.63	– 5.77	+ 0.59
11-62-201	144.90	145.39	143.79	143.29	+ 1.61	+ 2.10	+ 0.50
11-62-301	0.0	155.61	155.80	155.30	0.0	+ 0.31	+ 0.50
11-62-401	62.50	62.21	61.50	60.65	+ 1.85	+ 1.56	+ 0.85
11-62-601	151.01	150.77	150.98	149.55	+ 1.46	+ 1.22	+ 1.43
11-62-602	156.46	155.69	156.47	155.30	+ 1.16	+ 0.39	+ 1.17
11-62-701	130.11	133.18	135.08	135.01	– 4.90	– 1.83	+ 0.07
11-62-702	104.87	108.35	108.21	108.88	– 4.01	– 0.53	– 0.67
11-62-801	115.26	116.15	109.54	107.14	+ 8.12	+ 9.01	+ 2.40
11-63-401	0.0	156.86	157.59	157.27	0.0	– 0.41	+ 0.32
11-63-501	236.07	237.24	239.39	237.47	– 1.40	– 0.23	+ 1.92
11-63-801	212.69	212.18	212.70	214.67	– 1.98	– 2.49	– 1.97
11-63-901	0.0	247.96	251.48	249.01	0.0	– 1.05	+ 2.47
11-64-101	237.41	247.48	249.79	249.97	– 12.56	– 2.49	– 0.18
11-64-403	0.0	0.0	252.50	252.24	0.0	0.0	+ 0.26
11-64-803	0.0	0.0	266.93	267.64	0.0	0.0	– 0.71
23-04-301	0.0	201.13	211.61	209.71	0.0	– 8.58	+ 1.90
23-04-504	0.0	0.0	216.21	215.65	0.0	0.0	+ 0.56
23-04-602	202.70	218.55	222.55	222.52	– 19.82	– 3.97	+ 0.03
23-04-603	203.29	0.0	221.74	221.78	– 18.49	0.0	– 0.04
23-04-802	198.57	207.64	213.75	213.85	– 15.28	– 6.21	– 0.10
23-05-202	214.92	234.53	240.79	243.55	– 28.63	– 9.02	– 2.76
23-05-301	0.0	0.0	247.80	249.32	0.0	0.0	– 1.52
23-05-502	0.0	239.69	246.40	245.67	0.0	– 5.98	+ 0.73
23-05-602	0.0	265.47	264.59	262.38	0.0	+ 3.09	+ 2.21
23-05-603	0.0	263.05	266.48	265.45	0.0	– 2.40	+ 1.03
23-05-701	0.0	221.85	225.98	225.63	0.0	– 3.78	+ 0.35
23-05-802	225.59	238.84	242.55	242.81	– 17.22	– 3.97	– 0.26
23-06-302	191.63	194.18	194.50	194.08	– 2.45	+ 0.10	+ 0.42
23-06-502	255.69	263.52	266.28	262.40	– 6.71	+ 1.12	+ 3.88
23-06-503	0.0	285.28	286.14	285.75	0.0	– 0.47	+ 0.39
23-06-601	0.0	279.91	278.82	285.50	0.0	– 5.59	– 6.68
23-06-704	0.0	261.82	265.58	261.93	0.0	– 0.11	+ 3.65
23-07-103	260.10	266.03	261.02	0.0	0.0	0.0	0.0
23-07-202	0.0	0.0	287.66	287.60	0.0	0.0	+ 0.06
23-07-401	293.27	294.56	296.28	295.46	– 2.19	– 0.90	+ 0.82
23-07-501	294.27	297.55	296.35	295.79	– 1.52	+ 1.76	+ 0.56
23-07-503	0.0	0.0	0.0	292.51	0.0	0.0	0.0
23-07-601	298.61	302.71	302.32	302.25	– 3.64	+ 0.46	+ 0.07
23-07-702	0.0	209.82	213.55	213.78	0.0	– 3.96	– 0.23
23-07-801	0.0	0.0	289.11	292.60	0.0	0.0	– 3.49
23-07-901	0.0	283.41	285.34	284.73	0.0	– 1.32	+ 0.61
23-08-201	270.04	274.55	276.55	276.87	– 6.83	– 2.32	– 0.32
23-08-401	289.18	291.84	293.44	292.63	– 3.45	– 0.79	+ 0.81
23-08-502	276.76	278.48	278.37	277.98	– 1.22	+ 0.50	+ 0.39
23-08-701	284.82	288.15	289.64	288.77	– 3.95	– 0.62	+ 0.87
23-12-301	0.0	216.38	220.29	219.80	0.0	– 3.42	+ 0.49
23-13-101	200.90	209.67	215.03	214.70	– 13.80	– 5.03	+ 0.33
23-13-302	239.60	255.70	0.0	255.15	– 15.55	+ 0.55	0.0
23-13-303	0.0	240.03	240.60	240.10	0.0	– 0.07	+ 0.50
23-14-101	259.70	265.16	264.50	264.02	– 4.32	+ 1.14	+ 0.48
23-14-301	244.68	0.0	253.81	253.58	– 8.90	0.0	+ 0.23
23-15-203	0.0	0.0	303.19	301.96	0.0	0.0	+ 1.23
23-15-302	303.50	309.64	307.36	307.20	– 3.70	+ 2.44	+ 0.16
23-16-101	311.40	319.35	319.63	319.27	– 7.87	+ 0.08	+ 0.36
23-16-201	0.0	306.65	307.31	0.0	0.0	0.0	0.0

NOTE: 0.0 Denotes data not available

THE Cross SECTION

THE CROSS SECTION (USPS 564-920)

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10-49-202	0.0	0.0	75.39	75.32	0.0	0.0	+0.07
10-49-303	55.41	74.25	85.02	86.67	-31.26	-12.42	-1.65
10-49-501	0.0	58.00	57.10	61.20	0.0	-3.20	-4.10
10-49-602	64.82	0.0	91.12	93.95	-29.13	0.0	-2.83
10-49-603	0.0	65.50	69.11	69.57	0.0	-4.07	-0.46
10-49-801	79.42	81.30	85.25	83.94	-4.52	-2.64	+1.31
10-49-803	0.0	0.0	105.79	104.35	0.0	0.0	+1.44
10-50-104	0.0	110.68	123.90	124.29	0.0	-13.61	-0.39
10-50-505	91.19	107.91	112.62	0.0	0.0	0.0	0.0
10-50-602	0.0	80.65	82.01	81.54	0.0	-0.89	+0.47
10-50-702	97.68	111.47	0.0	0.0	0.0	0.0	0.0
10-50-801	72.88	70.72	68.81	65.78	+7.10	+4.94	+3.03
10-50-901	0.0	72.94	76.50	77.34	0.0	-4.40	-0.84
10-51-101	88.35	100.81	0.0	103.99	-15.64	-3.18	0.0
10-51-105	78.87	89.56	91.34	91.21	-12.34	-1.65	+0.13
10-51-311	0.0	102.20	104.59	104.51	0.0	-2.31	+0.08
10-51-403	59.28	69.41	75.06	73.65	-14.37	-4.24	+1.41
10-51-406	0.0	67.85	72.00	70.92	0.0	-3.07	+1.08
10-51-501	61.86	80.75	89.12	85.62	-23.76	-4.87	+3.50
10-51-507	0.0	78.22	85.60	86.32	0.0	-8.10	-0.72
10-51-602	73.19	92.05	98.64	98.40	-25.21	-6.35	+0.24
10-51-609	0.0	0.0	113.66	113.42	0.0	0.0	+0.24
10-51-703	98.64	101.72	104.13	102.79	-4.15	-1.07	+1.34
10-51-704	0.0	0.0	84.92	85.62	0.0	0.0	-0.70
10-51-808	0.0	0.0	100.67	100.42	0.0	0.0	+0.25
10-51-908	0.0	110.41	114.60	115.19	0.0	-4.78	-0.59
10-51-909	0.0	0.0	124.17	122.25	0.0	0.0	+1.92
10-51-910	0.0	0.0	119.51	118.47	0.0	0.0	+1.04
10-51-911	0.0	0.0	128.00	127.60	0.0	0.0	+0.40
10-52-408	84.16	0.0	105.36	103.97	-19.81	0.0	+1.39
10-57-103	81.01	82.03	83.10	81.90	-0.89	+0.13	+1.20
10-57-401	111.17	111.18	112.00	111.72	-0.55	-0.54	+0.28
10-57-501	38.77	35.89	42.38	41.64	-2.87	-5.75	+0.74
10-58-201	0.0	30.81	28.61	27.29	0.0	+3.52	+1.32
10-58-502	71.34	0.0	66.88	63.91	+7.43	0.0	+2.97
10-58-601	0.0	74.83	74.39	72.94	0.0	+1.89	+1.45
10-58-701	49.07	46.15	46.67	43.61	+5.46	+2.54	+3.06
10-58-801	26.77	24.79	25.52	0.0	0.0	0.0	0.0
10-59-106	112.68	112.93	113.96	113.19	-0.51	-0.26	+0.77
10-59-107	0.0	100.44	101.51	101.00	0.0	-0.56	+0.51
10-59-302	111.37	113.08	113.74	112.19	-0.82	+0.89	+1.55
10-59-401	115.88	117.32	117.21	116.82	-0.94	+0.50	+0.39
10-59-501	97.68	95.89	95.36	94.83	+2.85	+1.06	+0.53
10-59-601	134.99	133.59	131.19	129.24	+5.75	+4.35	+1.95
24-02-701	52.88	49.99	48.14	47.11	+5.77	+2.88	+1.03
24-09-101	0.0	168.71	164.23	162.73	0.0	+5.98	+1.50
24-09-302	0.0	86.45	86.40	85.97	0.0	+0.48	+0.43
24-10-201	114.91	115.21	111.56	110.68	+4.23	+4.53	+0.88
24-10-303	141.78	131.92	116.34	110.98	+30.80	+20.94	+5.36
24-11-201	103.71	101.97	93.92	91.97	+11.74	+10.00	+1.95
24-11-202	0.0	84.95	84.90	84.22	0.0	+0.73	+0.68

NOTE: 0.0 Denotes data not available

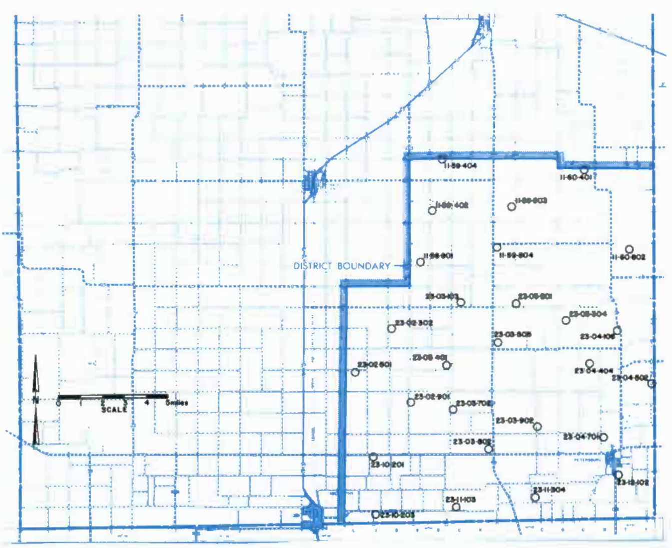
10-31-201	185.58	193.26	201.19	196.65	-11.07	-3.39	+4.54
10-31-301	186.04	193.32	0.0	188.29	-2.25	+5.03	0.0
10-31-501	219.84	225.51	228.76	228.63	-8.79	-3.12	+0.13
10-31-601	173.64	185.83	191.64	192.73	-19.09	-6.90	-1.09
10-31-701	263.08	267.49	263.11	263.18	-0.10	+4.31	-0.07
10-31-803	0.0	259.94	271.65	272.55	0.0	-12.61	-0.90
10-32-201	176.08	177.88	178.26	177.98	-1.90	-0.10	+0.28
10-32-301	0.0	184.55	176.89	175.30	0.0	+9.25	+1.59
10-32-501	140.99	0.0	145.20	145.63	-4.64	0.0	-0.43
10-32-601	0.0	0.0	0.0	133.81	0.0	0.0	0.0
10-32-703	251.31	266.02	269.53	269.79	-18.48	-3.77	-0.26
10-32-801	216.96	217.56	218.60	217.64	-0.68	-0.08	+0.96
10-36-301	0.0	222.20	230.13	230.49	0.0	-8.29	-0.36
10-37-301	0.0	206.10	215.12	217.19	0.0	-11.09	-2.07
10-37-403	0.0	0.0	206.67	207.91	0.0	0.0	-1.24
10-37-501	0.0	193.51	204.43	205.85	0.0	-12.34	-1.42
10-37-601	167.28	188.90	195.93	197.78	-30.50	-8.88	-1.85
10-37-801	0.0	183.89	193.80	195.38	0.0	-11.49	-1.58
10-37-901	164.06	182.97	193.58	195.09	-31.03	-12.12	-1.51
10-38-101	185.47	206.97	217.67	214.39	-28.92	-7.42	+3.28
10-38-201	0.0	196.56	208.50	208.71	0.0	-12.15	-0.21
10-38-401	180.51	202.01	209.57	209.19	-28.68	-7.18	+0.38
10-38-603	169.00	190.92	201.20	199.22	-30.22	-8.30	+1.98
10-38-802	172.46	194.08	203.59	202.89	-30.43	-8.81	+0.70
10-39-101	216.09	238.40	244.19	246.29	-30.20	-7.89	-2.10
10-39-201	0.0	0.0	268.49	269.69	0.0	0.0	-1.20
10-39-302	244.18	266.00	0.0	281.72	-37.54	-15.72	0.0
10-39-402	0.0	0.0	219.30	220.03	0.0	0.0	-0.73
10-39-501	195.65	212.29	220.00	219.72	-24.07	-7.43	+0.28
10-39-702	159.94	178.34	187.86	188.98	-29.04	-10.64	-1.12
10-39-801	176.58	193.23	201.77	202.02	-25.44	-8.79	-0.25
10-39-901	0.0	187.72	197.36	198.71	0.0	-10.99	-1.35
10-40-301	0.0	171.38	173.46	173.91	0.0	-2.53	-0.45
10-40-402	0.0	221.99	231.08	232.27	0.0	-10.28	-1.19
10-40-502	228.20	248.09	260.92	261.62	-33.42	-13.53	-0.70
10-40-601	0.0	237.60	244.60	245.78	0.0	-8.18	-1.18
10-40-803	201.05	223.44	235.08	235.21	-34.16	-11.77	-0.13
10-44-601	0.0	188.40	203.45	204.31	0.0	-15.91	-0.86
10-45-102	180.17	196.19	206.45	208.57	-28.40	-12.38	-2.12
10-45-301	186.85	204.92	0.0	216.44	-29.59	-11.52	0.0
10-46-101	164.32	182.10	0.0	193.16	-28.84	-11.06	0.0
10-46-302	156.08	174.67	184.54	186.25	-30.17	-11.58	-1.71
10-46-303	0.0	0.0	191.77	193.97	0.0	0.0	-2.20
10-46-405	187.68	204.20	0.0	0.0	0.0	0.0	0.0
10-47-101	151.06	168.80	181.58	183.55	-32.49	-14.75	-1.97
10-47-201	187.60	204.99	214.77	214.52	-26.92	-9.53	+0.25
10-47-302	172.19	191.31	201.55	201.85	-29.66	-10.54	-0.30
10-48-103	0.0	0.0	198.04	199.32	0.0	0.0	-1.28
10-48-302	0.0	187.49	198.02	199.39	0.0	-11.90	-1.37
10-48-303	0.0	206.55	215.60	215.49	0.0	-8.94	+0.11
10-48-603	168.36	194.62	202.42	202.96	-34.60	-8.34	-0.54

NOTE: 0.0 Denotes data not available

24-23-302	117.08	117.51	119.50	120.14	-3.06	-2.63	-0.64
24-23-304	0.0	127.79	126.63	126.00	0.0	+1.79	+0.63
24-23-501	107.90	110.29	106.74	106.39	+1.51	+3.90	+0.35
24-23-701	107.67	109.17	109.50	108.85	-1.18	+0.32	+0.65
24-24-402	157.52	159.38	156.82	153.56	+3.96	+5.82	+3.26
24-24-701	125.22	125.12	124.18	0.0	0.0	0.0	0.0
24-28-103	145.45	142.88	139.01	135.77	+9.68	+7.11	+3.24
24-28-203	0.0	142.82	145.21	147.29	0.0	-4.47	-2.08
24-28-303	0.0	0.0	123.10	122.56	0.0	0.0	+0.54
24-28-501	153.45	155.42	155.36	153.64	-0.19	+1.78	+1.72
24-28-601	0.0	143.70	137.85	137.28	0.0	+6.42	+0.57
24-28-901	168.74	172.00	169.08	166.95	+1.79	+5.05	+2.13
24-29-308	150.62	154.06	154.81	152.86	-2.24	+1.20	+1.95
24-29-312	0.0	139.72	140.03	139.12	0.0	+0.60	+0.91
24-29-401	141.66	142.03	141.35	140.03	+1.63	+2.00	+1.32
24-29-603	0.0	135.60	134.17	133.60	0.0	+2.00	+0.57
24-29-901	196.35	191.63	186.68	184.97	+11.38	+6.66	+1.71
24-30-102	139.71	140.05	136.06	133.77	+5.94	+6.28	+2.29
24-30-304	109.17	110.89	108.80	108.25	+0.92	+2.64	+0.55
24-30-409	0.0	0.0	108.58	106.38	0.0	0.0	+2.20
24-30-502	0.0	136.42	132.98	128.80	0.0	+7.62	+4.18
24-30-801	177.77	181.47	179.18	178.42	-0.65	+3.05	+0.76
24-30-901	159.72	159.52	156.56	155.67	+4.05	+3.85	+0.89
24-31-101	0.0	71.24	70.55	69.14	0.0	+2.10	+1.41
24-31-203	0.0	0.0	104.16	0.0	0.0	0.0	0.0
24-31-401	136.19	134.10	127.42	125.25	+10.94	+8.85	+2.17
24-31-501	77.61	80.24	76.00	74.02	+3.59	+6.22	+1.98
24-31-601	117.64	116.43	112.52	110.80	+6.84	+5.63	+1.72
24-31-801	148.23	150.69	148.41	147.83	+0.40	+2.86	+0.58
24-31-902	0.0	126.65	123.40	121.84	0.0	+4.81	+1.56
24-32-401	106.04	104.32	99.05	98.08	+7.96	+6.24	+0.97
24-32-702	0.0	0.0	127.44	126.61	0.0	0.0	+0.83
24-36-302	0.0	173.49	174.60	173.39	0.0	+0.10	+1.21
24-36-601	148.64	149.86	148.06	147.66	+0.98	+2.20	+0.40
24-37-101	153.83	161.23	158.03	157.55	-3.72	+3.68	+0.48
24-37-204	154.04	155.91	155.41	153.69	+0.35	+2.22	+1.72
24-37-308	147.66	149.49	148.99	148.45	-0.79	+1.04	+0.54
24-37-502	0.0	0.0	143.34	142.75	0.0	0.0	+0.59
24-38-201	175.87	177.00	177.75	176.04	-0.17	+0.96	+1.71
24-38-403	164.84	168.86	165.69	165.35	-0.51	+3.51	+0.34
24-38-501	0.0	0.0	161.79	160.65	0.0	0.0	+1.14
24-38-602	0.0	124.79	121.43	118.80	0.0	+5.99	+2.63
24-38-801	164.40	163.05	159.69	157.44	+6.96	+5.61	+2.25
24-39-101	157.17	155.62	150.69	149.82	+7.35	+5.80	+0.87
24-39-302	150.24	150.49	148.60	147.86	+2.38	+2.63	+0.74
24-39-501	134.42	134.91	133.10	132.50	+1.92	+2.41	+0.60
24-39-701	117.36	112.48	106.14	103.51	+13.85	+8.97	+2.63
24-39-901	95.89	97.11	94.00	93.10	+2.79	+4.01	+0.90
24-40-401	143.60	147.42	145.10	144.49	-0.89	+2.93	+0.61
24-40-403	149.94	151.10	149.40	148.22	+1.72	+2.88	+1.18
24-40-702	0.0	114.10	111.41	111.69	0.0	+2.41	-0.28

NOTE: 0.0 Denotes data not available

HALE COUNTY

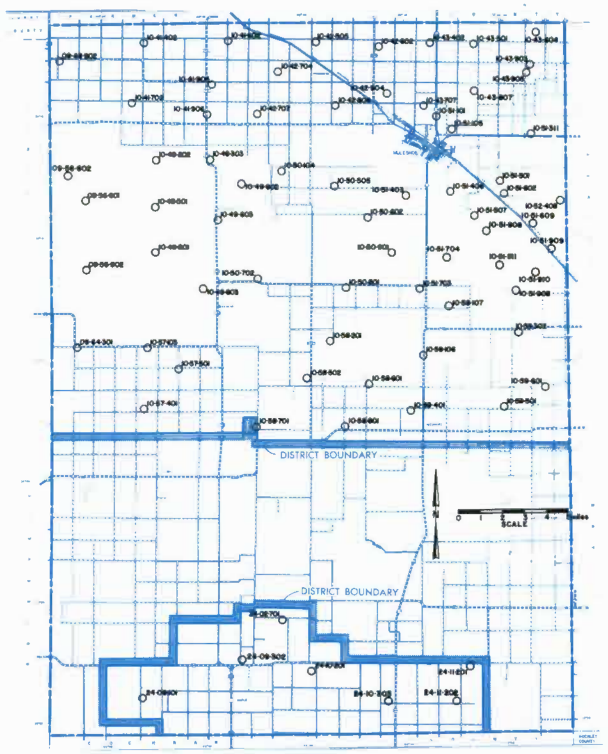


Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
11-58-901	0.0	102.74	99.15	96.44	0.0	+6.30	+2.71
11-59-402	86.48	96.01	79.88	74.57	+11.91	+21.44	+5.31
11-59-404	0.0	188.29	196.40	196.44	0.0	-8.15	-0.04
11-59-503	86.60	87.51	80.80	78.71	+7.89	+8.80	+2.09
11-59-804	0.0	0.0	105.03	94.56	0.0	0.0	+10.47
11-60-401	94.45	96.50	101.07	101.18	-6.73	-4.68	-0.11
11-60-802	0.0	184.77	179.49	178.24	0.0	+6.53	+1.25
23-02-302	109.91	113.26	113.64	112.93	-3.02	+0.33	+0.71
23-02-501	189.02	203.68	209.31	207.75	-18.73	-4.07	+1.56
23-02-901	0.0	190.35	193.67	192.47	0.0	-2.12	+1.20
23-03-103	114.87	119.09	114.99	111.89	+2.98	+7.20	+3.10
23-03-201	0.0	137.61	133.14	132.14	0.0	+5.47	+1.00
23-03-304	0.0	134.63	133.30	132.17	0.0	+2.46	+1.13
23-03-401	0.0	106.76	108.30	107.53	0.0	-0.77	+0.77

Well Number	Depth to Water Below Land Surface In Feet				Total Change In Water Levels In Feet		
	1977	1982	1986	1987	1977 to 1987	1982 to 1987	1986 to 1987
23-03-505	0.0	0.0	123.74	115.73	0.0	0.0	+8.01
23-03-702	0.0	183.59	194.70	188.53	0.0	-4.94	+6.17
23-03-802	186.01	198.86	206.88	206.81	-20.80	-7.95	+0.07
23-03-902	0.0	184.65	188.80	188.97	0.0	-4.32	-0.17
23-04-106	0.0	207.37	209.01	208.60	0.0	-1.23	+0.41
23-04-404	0.0	0.0	135.90	133.49	0.0	0.0	+2.41
23-04-502	203.82	213.09	218.10	217.57	-13.75	-4.48	+0.53
23-04-701	157.08	161.71	161.84	162.15	-5.07	-0.44	-0.31
23-10-201	164.18	167.54	169.69	163.11	+1.07	+4.43	+6.58
23-10-203	0.0	167.89	169.36	168.52	0.0	-0.63	+0.84
23-11-103	0.0	215.98	217.65	216.62	0.0	-0.64	+1.03
23-11-304	187.67	203.09	209.85	0.0	0.0	0.0	0.0
23-12-102	192.10	202.09	206.40	206.43	-14.33	-4.34	-0.03

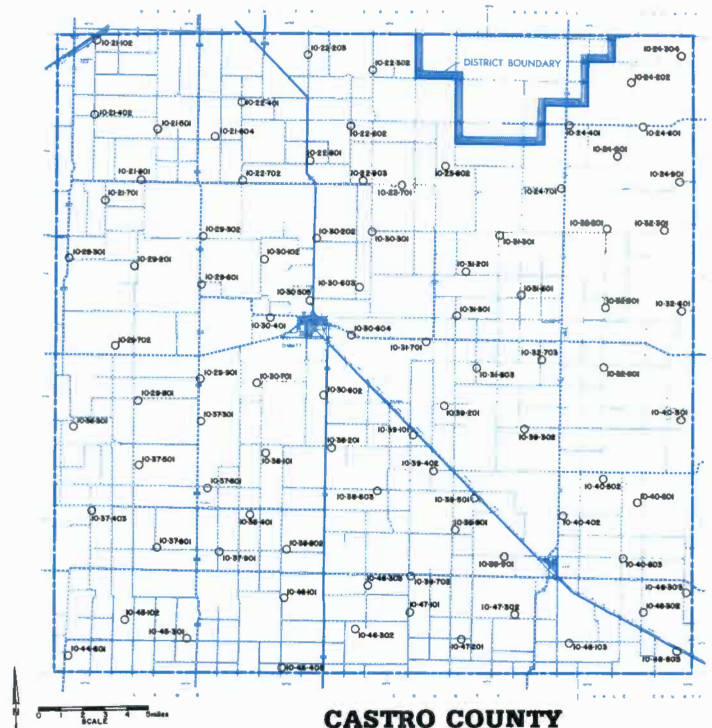
NOTE: 0.0 Denotes data notavailable

Water-Level Observation Well Measurements Tabulated



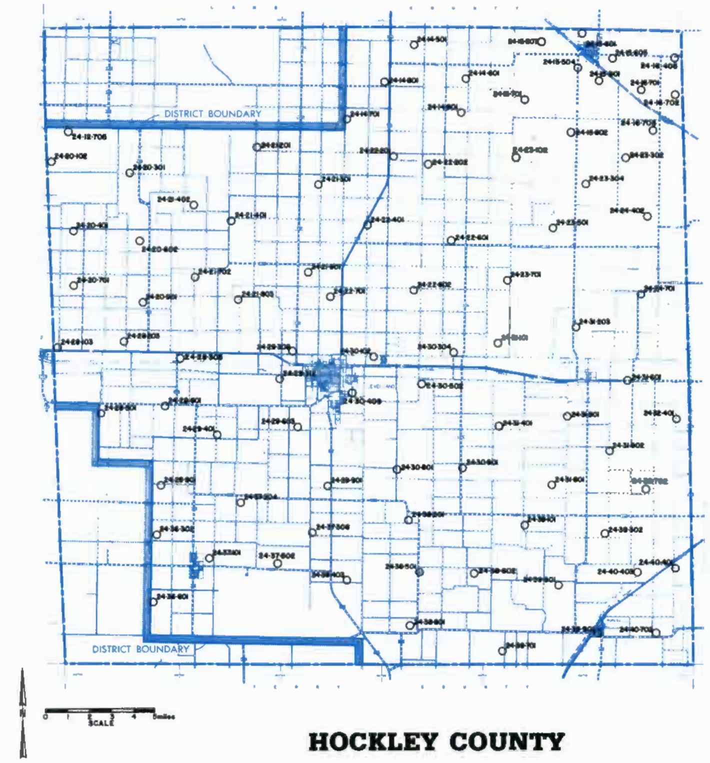
BAILEY COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
09-48-902	151.51	161.91	168.09	170.21	- 18.70	- 8.30	- 2.12
09-56-601	0.0	0.0	44.04	49.30	0.0	0.0	- 5.26
09-56-602	0.0	0.0	64.60	65.95	0.0	0.0	- 1.35
09-56-902	42.41	44.71	46.98	47.53	- 5.12	- 2.82	- 0.55
09-64-301	65.15	75.13	67.00	65.35	- 0.20	+ 9.78	+ 1.65
10-41-402	163.88	174.22	177.64	178.02	- 14.14	- 3.80	- 0.38
10-41-602	0.0	0.0	170.73	171.77	0.0	0.0	- 1.04
10-41-702	107.55	119.04	123.80	125.19	- 17.64	- 6.15	- 1.39
10-41-905	121.21	133.10	134.87	135.39	- 14.18	- 2.29	- 0.52
10-41-906	94.65	107.59	111.84	113.67	- 19.02	- 6.08	- 1.83
10-42-505	134.39	152.85	161.45	162.14	- 27.75	- 9.29	- 0.69
10-42-602	0.0	145.70	152.15	153.22	0.0	- 7.52	- 1.07
10-42-704	125.59	137.25	139.86	140.78	- 15.19	- 3.53	- 0.92
10-42-707	102.53	112.38	113.11	113.10	- 10.57	- 0.72	+ 0.01
10-42-808	94.92	104.34	105.97	107.70	- 12.78	- 3.36	- 1.73
10-42-904	0.0	0.0	115.87	116.65	0.0	0.0	- 0.78
10-43-402	135.81	151.90	158.31	160.99	- 25.18	- 9.09	- 2.68
10-43-501	0.0	143.68	154.15	155.89	0.0	- 12.21	- 1.74
10-43-604	0.0	168.61	177.34	178.97	0.0	- 10.36	- 1.63
10-43-707	100.07	116.45	117.77	117.39	- 17.32	- 0.94	+ 0.38
10-43-807	0.0	112.03	117.34	118.12	0.0	- 6.09	- 0.78
10-43-903	117.76	136.28	140.87	141.38	- 23.62	- 5.10	- 0.51
10-43-905	104.86	121.13	126.69	127.50	- 22.64	- 6.37	- 0.81



CASTRO COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
10-21-102	0.0	238.17	236.25	236.97	0.0	+ 1.20	- 0.72
10-21-402	178.13	195.99	207.80	208.52	- 30.39	- 12.53	- 0.72
10-21-501	166.49	182.64	187.65	188.82	- 22.33	- 6.18	- 1.17
10-21-604	149.80	0.0	167.71	166.62	- 16.82	0.0	+ 1.09
10-21-701	231.50	242.76	244.13	242.29	- 10.79	+ 0.47	+ 1.84
10-21-801	217.24	233.49	243.00	241.77	- 24.53	- 8.28	+ 1.23
10-22-203	174.36	184.34	193.24	191.18	- 16.82	- 6.84	+ 2.06
10-22-302	107.55	107.70	107.48	106.10	+ 1.45	+ 1.60	+ 1.38
10-22-401	160.89	173.72	0.0	0.0	0.0	0.0	0.0
10-22-602	81.50	84.08	86.09	85.60	- 4.10	- 1.52	+ 0.49
10-22-702	179.48	190.34	195.56	197.51	- 18.03	- 7.17	- 1.95
10-22-801	166.83	178.24	184.00	184.01	- 17.18	- 5.77	- 0.01
10-22-903	149.78	156.27	153.82	153.38	- 3.60	+ 2.89	+ 0.44
10-23-701	119.17	114.14	113.35	112.39	+ 6.78	+ 1.75	+ 0.96
10-23-802	0.0	0.0	140.20	140.68	0.0	0.0	- 0.48
10-24-202	176.75	176.99	177.83	177.96	- 1.21	- 0.97	- 0.13
10-24-304	0.0	164.89	165.61	165.58	0.0	- 0.69	+ 0.03
10-24-401	192.48	191.80	191.05	191.04	+ 1.44	+ 0.76	+ 0.01
10-24-601	162.97	162.02	161.94	161.35	+ 1.62	+ 0.67	+ 0.59
10-24-701	191.39	190.06	188.64	188.26	+ 3.13	+ 1.80	+ 0.38
10-24-801	189.77	187.30	185.45	185.09	+ 4.68	+ 2.21	+ 0.36
10-24-901	0.0	200.49	199.20	196.88	0.0	+ 3.61	+ 2.32
10-28-301	291.61	304.40	311.23	311.41	- 19.80	- 7.01	- 0.18
10-29-201	0.0	263.39	281.27	0.0	0.0	0.0	0.0
10-29-302	287.78	298.13	301.35	302.58	- 14.80	- 4.45	- 1.23
10-29-601	271.16	283.15	287.47	0.0	0.0	0.0	0.0
10-29-702	298.38	321.10	334.20	334.73	- 36.35	- 13.63	- 0.53
10-29-801	226.17	247.26	258.92	260.42	- 34.25	- 13.16	- 1.50
10-29-901	246.14	257.49	266.32	266.04	- 19.90	- 8.55	+ 0.28
10-30-102	263.18	274.02	277.06	277.95	- 14.77	- 3.93	- 0.89
10-30-202	245.18	261.99	261.33	259.25	- 14.07	+ 2.74	+ 2.08
10-30-301	0.0	170.92	174.66	172.67	0.0	- 1.75	+ 1.99
10-30-401	274.44	287.80	292.79	292.71	- 18.27	- 4.91	+ 0.08
10-30-505	237.62	244.03	247.52	247.58	- 9.96	- 3.55	- 0.06
10-30-603	213.42	219.12	219.77	218.55	- 5.13	+ 0.57	+ 1.22
10-30-604	264.25	275.78	278.64	277.94	- 13.69	- 2.16	+ 0.70
10-30-701	0.0	246.76	255.59	255.76	0.0	- 9.00	- 0.17
10-30-802	218.50	242.22	253.68	254.67	- 36.17	- 12.45	- 0.99



HOCKLEY COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
24-12-705	0.0	141.65	141.19	140.51	0.0	+ 1.14	+ 0.68
24-14-501	104.24	103.15	99.06	97.38	+ 6.86	+ 5.77	+ 1.68
24-14-601	0.0	133.53	128.49	127.56	0.0	+ 5.97	+ 0.93
24-14-701	0.0	44.60	43.03	39.52	0.0	+ 5.08	+ 3.51
24-14-801	49.84	52.52	46.08	45.25	+ 4.59	+ 7.27	+ 0.83
24-14-901	99.39	100.49	99.88	99.73	- 0.34	+ 0.76	+ 0.15
24-15-504	69.29	72.16	70.28	69.27	+ 0.02	+ 2.89	+ 1.01
24-15-507	81.37	88.02	82.93	81.37	0.00	+ 6.65	+ 1.56
24-15-601	109.59	113.78	113.22	112.78	- 3.19	+ 1.00	+ 0.44
24-15-605	101.28	102.82	103.15	102.55	- 1.27	+ 0.27	+ 0.60
24-15-701	0.0	103.16	100.71	99.28	0.0	+ 3.88	+ 1.43
24-15-802	184.53	183.80	177.73	176.36	+ 8.17	+ 7.44	+ 1.37
24-15-901	48.96	52.98	53.61	50.77	- 1.81	+ 2.21	+ 2.84
24-16-405	133.25	134.43	134.25	133.28	- 0.03	+ 1.15	+ 0.97
24-16-701	68.08	73.85	75.68	74.77	- 6.69	- 0.92	+ 0.91
24-16-702	100.94	102.77	102.31	99.81	+ 1.13	+ 2.96	+ 2.50
24-16-705	0.0	95.40	92.61	92.02	0.0	+ 3.38	+ 0.59
24-20-102	152.25	150.33	150.79	150.71	+ 1.54	- 0.38	+ 0.08
24-20-301	138.72	139.45	140.29	138.91	- 0.19	+ 0.54	+ 1.38
24-20-401	122.51	128.94	133.60	133.28	- 10.77	- 4.34	+ 0.32
24-20-602	154.08	156.64	158.90	158.57	- 4.49	- 1.93	+ 0.33
24-20-701	148.40	150.24	151.73	151.72	- 3.32	- 1.48	+ 0.01
24-20-901	150.84	153.84	155.20	154.17	- 3.33	- 0.33	+ 1.03
24-21-201	44.46	46.56	46.14	43.65	+ 0.81	+ 2.91	+ 2.49
24-21-301	94.65	94.52	94.32	93.86	+ 0.79	+ 0.66	+ 0.46
24-21-401	157.00	156.16	156.27	155.83	+ 1.17	+ 0.33	+ 0.44
24-21-402	0.0	141.93	140.37	139.18	0.0	+ 2.75	+ 1.19
24-21-702	0.0	151.23	150.70	149.38	0.0	+ 1.85	+ 1.32
24-21-803	169.38	169.49	170.15	168.04	+ 1.34	+ 1.45	+ 2.11
24-21-901	166.21	169.06	170.57	169.70	- 3.49	- 0.64	+ 0.87
24-22-201	72.04	73.96	72.13	71.06	+ 0.98	+ 2.90	+ 1.07
24-22-202	84.96	85.25	84.36	83.86	+ 1.10	+ 1.39	+ 0.50
24-22-401	85.75	85.64	84.17	84.39	+ 1.36	+ 1.25	- 0.22
24-22-601	103.10	101.00	100.04	98.83	+ 4.27	+ 2.17	+ 1.21
24-22-701	178.67	178.86	177.08	175.45	+ 3.22	+ 3.41	+ 1.63
24-22-802	123.47	125.61	116.10	114.44	+ 9.03	+ 11.17	+ 1.66
24-23-102	0.0	113.68	112.87	112.34	0.0	+ 1.34	+ 0.53

PARMER COUNTY

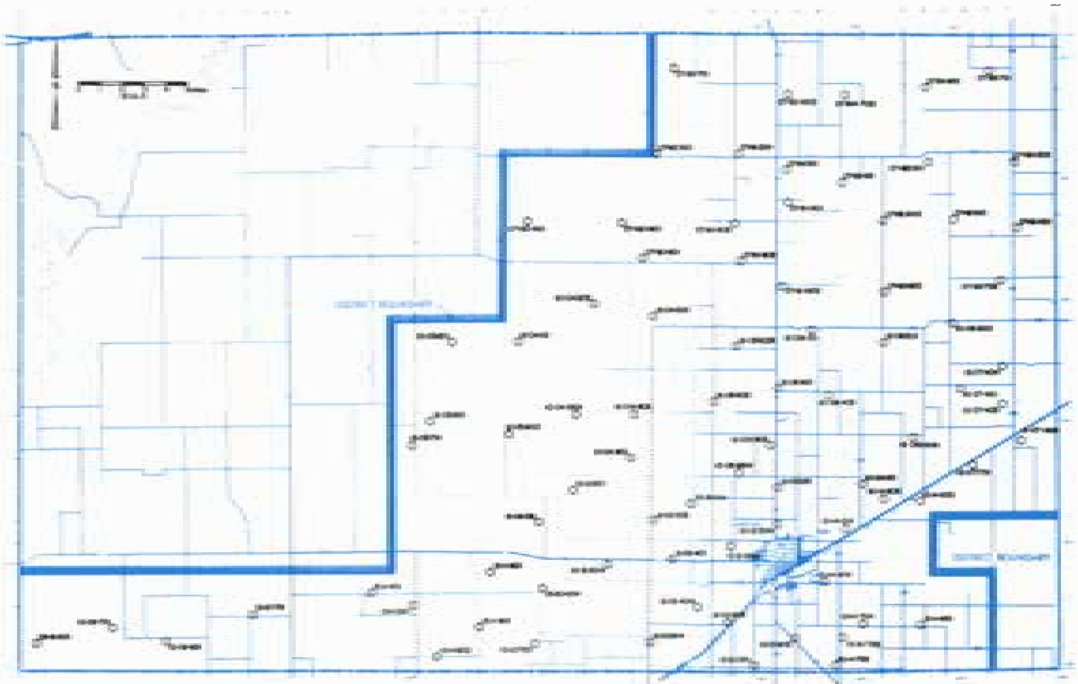
Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
09-24-302	0.0	289.96	291.85	288.05	0.0	+ 1.91	+ 3.80
09-24-601	0.0	336.87	340.39	335.12	0.0	+ 1.75	+ 5.27
09-24-901	0.0	291.33	293.08	293.30	0.0	– 1.97	– 0.22
09-32-303	0.0	344.40	337.88	334.74	0.0	+ 9.66	+ 3.14
09-32-501	0.0	354.42	359.43	358.35	0.0	– 3.93	+ 1.08
09-32-601	311.56	320.94	326.24	324.35	– 12.79	– 3.41	+ 1.89
09-40-301	310.89	321.86	318.15	320.79	– 9.90	+ 1.07	– 2.64
09-40-801	0.0	257.18	269.78	269.99	0.0	– 12.81	– 0.21
09-40-901	277.17	295.75	309.97	308.48	– 31.31	– 12.73	+ 1.49
09-40-903	253.27	267.57	276.84	276.51	– 23.24	– 8.94	+ 0.33
09-48-301	232.49	246.89	0.0	253.87	– 21.38	– 6.98	0.0
10-17-301	194.08	0.0	0.0	0.0	0.0	0.0	0.0
10-17-401	283.08	284.66	282.49	281.94	+ 1.14	+ 2.72	+ 0.55
10-17-501	269.34	263.93	262.71	260.60	+ 8.74	+ 3.33	+ 2.11
10-17-602	0.0	189.10	192.57	191.51	0.0	– 2.41	+ 1.06
10-17-804	0.0	220.02	220.12	217.17	0.0	+ 2.85	+ 2.95
10-18-204	0.0	314.68	311.45	307.71	0.0	+ 6.97	+ 3.74
10-18-302	0.0	248.37	247.69	247.35	0.0	+ 1.02	+ 0.34
10-18-503	0.0	264.24	266.70	262.72	0.0	+ 1.52	+ 3.98
10-18-602	308.69	308.82	305.64	304.95	+ 3.74	+ 3.87	+ 0.69
10-18-701	258.66	257.75	252.36	251.49	+ 7.17	+ 6.26	+ 0.87
10-18-901	271.68	276.00	269.68	268.62	+ 3.06	+ 7.38	+ 1.06
10-19-101	288.60	292.68	293.54	293.36	– 4.76	– 0.68	+ 0.18
10-19-202	0.0	310.92	314.69	315.09	0.0	– 4.26	– 0.40
10-19-301	281.14	281.19	278.70	278.74	+ 2.40	+ 2.45	– 0.04
10-19-404	0.0	235.70	241.85	242.52	0.0	– 6.82	– 0.67
10-19-602	255.95	274.00	279.03	280.75	– 24.80	– 6.75	– 1.72
10-19-802	0.0	230.14	232.20	234.07	0.0	– 3.93	– 1.87
10-20-201	0.0	190.23	191.95	192.27	0.0	– 2.04	– 0.32
10-20-402	250.42	258.10	258.96	260.74	– 10.32	– 2.64	– 1.78
10-20-901	0.0	197.84	203.80	204.87	0.0	– 7.03	– 1.07
10-25-102	294.33	288.67	284.55	282.97	+ 11.36	+ 5.70	+ 1.58
10-25-301	301.14	304.87	303.80	303.69	– 2.55	+ 1.18	+ 0.11
10-25-402	0.0	264.35	265.45	265.44	0.0	– 1.09	+ 0.01
10-25-502	175.21	178.55	0.0	179.87	– 4.66	– 1.32	0.0
10-25-701	285.28	299.77	298.10	297.63	– 12.35	+ 2.14	+ 0.47
10-25-801	0.0	252.78	255.60	256.30	0.0	– 3.52	– 0.70
10-26-102	0.0	0.0	297.75	295.20	0.0	0.0	+ 2.55
10-26-201	0.0	285.50	292.01	290.77	0.0	– 5.27	+ 1.24
10-26-301	342.94	364.58	372.99	374.67	– 31.73	– 10.09	– 1.68
10-26-402	0.0	324.84	326.15	324.11	0.0	+ 0.73	+ 2.04
10-26-502	0.0	341.69	353.26	356.15	0.0	– 14.46	– 2.89

LAMB COUNTY

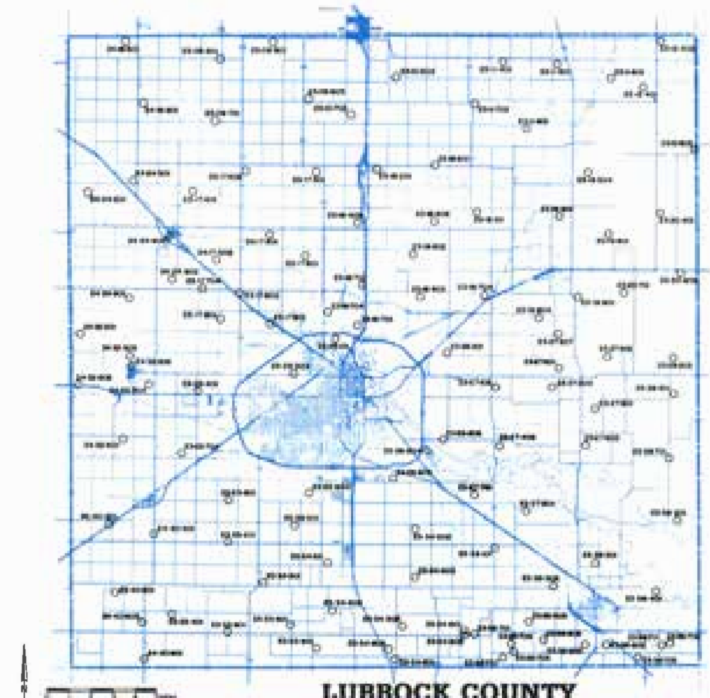
Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
10-44-401	152.57	180.58	187.48	188.34	– 35.77	– 7.76	– 0.86
10-44-501	160.91	176.72	184.21	186.50	– 25.59	– 9.78	– 2.29
10-44-703	116.15	131.00	140.02	141.75	– 25.60	– 10.75	– 1.73
10-44-711	98.01	107.80	112.50	112.65	– 14.64	– 4.85	– 0.15
10-44-802	96.38	108.94	115.48	116.19	– 19.81	– 7.25	– 0.71
10-45-402	156.71	176.37	192.87	189.75	– 33.04	– 13.38	+ 3.12
10-45-702	108.70	123.24	127.82	128.30	– 19.60	– 5.06	– 0.48
10-45-801	172.98	189.87	197.52	195.99	– 23.01	– 6.12	+ 1.53
10-45-903	0.0	0.0	193.08	192.75	0.0	0.0	+ 0.33
10-46-601	192.55	213.80	221.87	222.95	– 30.40	– 9.15	– 1.08
10-46-703	186.73	202.02	207.74	207.50	– 20.77	– 5.48	+ 0.24
10-47-401	170.06	184.74	198.84	0.0	0.0	0.0	0.0
10-47-501	167.14	183.49	194.75	194.40	– 27.26	– 10.91	+ 0.35
10-47-802	0.0	215.60	223.95	225.61	0.0	– 10.01	– 1.66
10-48-403	184.37	202.20	212.05	211.40	– 27.03	– 9.20	+ 0.65
10-52-209	0.0	101.50	105.85	109.00	0.0	– 7.50	– 3.15
10-52-308	0.0	103.54	104.56	104.56	0.0	– 1.02	0.00
10-52-406	0.0	0.0	114.05	113.90	0.0	0.0	+ 0.15
10-52-508	0.0	0.0	77.33	77.58	0.0	0.0	– 0.25
10-52-509	0.0	0.0	85.90	85.64	0.0	0.0	+ 0.26
10-52-601	38.50	44.86	49.58	51.06	– 12.56	– 6.20	– 1.48
10-52-715	0.0	0.0	133.99	133.12	0.0	0.0	+ 0.87
10-52-719	0.0	0.0	122.55	124.99	0.0	0.0	– 2.44
10-52-804	0.0	0.0	119.39	119.04	0.0	0.0	+ 0.35
10-52-811	0.0	0.0	89.74	88.63	0.0	0.0	+ 1.11
10-52-813	0.0	0.0	85.57	85.29	0.0	0.0	+ 0.28
10-52-902	55.62	59.62	63.32	64.30	– 8.68	– 4.68	– 0.98
10-52-905	0.0	0.0	99.02	99.73	0.0	0.0	– 0.71
10-53-101	78.25	91.73	95.81	98.69	– 20.44	– 6.96	– 2.88
10-53-206	0.0	141.47	146.25	146.32	0.0	– 4.85	– 0.07
10-53-307	118.30	134.59	139.93	139.47	– 21.17	– 4.88	+ 0.46
10-53-404	0.0	67.55	72.89	0.0	0.0	0.0	0.0
10-53-602	62.98	76.90	85.16	85.68	– 22.70	– 8.78	– 0.52
10-53-608	0.0	96.70	101.53	102.78	0.0	– 6.08	– 1.25
10-53-803	0.0	66.80	77.19	75.98	0.0	– 9.18	+ 1.21
10-54-205	128.07	144.07	150.07	150.73	– 22.66	– 6.66	– 0.66
10-54-301	183.50	205.12	212.44	211.19	– 27.69	– 6.07	+ 1.25
10-54-404	0.0	116.00	124.37	124.28	0.0	– 8.28	+ 0.09
10-54-502	120.57	135.10	140.57	140.31	– 19.74	– 5.21	+ 0.26

FLOYD COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
11-44-903	0.0	0.0	185.93	188.12	0.0	0.0	– 2.19
11-45-408	0.0	204.29	212.99	213.74	0.0	– 9.45	– 0.75
11-45-802	178.06	188.58	0.0	195.30	– 17.24	– 6.72	0.0
11-45-806	168.47	173.92	175.66	175.65	– 7.18	– 1.73	+ 0.01
11-45-902	186.18	186.46	188.67	190.15	– 3.97	– 3.69	– 1.48
11-46-605	0.0	0.0	215.24	215.55	0.0	0.0	– 0.31
11-46-701	212.81	220.01	224.48	223.95	– 11.14	– 3.94	+ 0.53
11-46-802	0.0	259.84	262.05	260.85	0.0	– 1.01	+ 1.20
11-47-703	231.80	235.33	238.50	239.45	– 7.65	– 4.12	– 0.95
11-52-305	177.22	186.64	191.85	192.05	– 14.83	– 5.41	– 0.20
11-52-609	0.0	204.65	213.90	214.40	0.0	– 9.75	– 0.50
11-52-901	196.09	213.75	224.03	225.50	– 29.41	– 11.75	– 1.47
11-52-908	192.80	219.91	229.47	229.90	– 37.10	– 9.99	– 0.43
11-53-102	193.09	198.44	199.89	198.86	– 5.77	– 0.42	+ 1.03
11-53-205	155.00	158.72	160.56	161.00	– 6.00	– 2.28	– 0.44
11-53-302	0.0	199.99	203.44	203.80	0.0	– 3.81	– 0.36
11-53-501	212.00	219.98	222.36	222.34	– 10.34	– 2.36	+ 0.02
11-53-702	181.10	193.49	202.20	201.45	– 20.35	– 7.96	+ 0.75
11-53-705	206.52	229.99	236.57	236.60	– 30.08	– 6.61	– 0.03
11-53-802	0.0	152.67	152.63	152.76	0.0	– 0.09	– 0.13
11-53-903	162.70	162.08	160.98	162.06	+ 0.64	+ 0.02	– 1.08
11-54-101	211.73	216.72	220.13	218.85	– 7.12	– 2.13	+ 1.28
11-54-30[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	– [illegible]	– [illegible]	+ [illegible]
11-54-303	0.0	248.79	253.10	253.64	0.0	– 4.85	– 0.54
11-54-401	183.36	183.29	184.08	0.0	0.0	0.0	0.0
11-54-601	0.0	247.05	246.31	246.42	0.0	+ 0.63	– 0.11
11-54-802	0.0	0.0	175.57	175.44	0.0	0.0	+ 0.13
11-54-901	223.94	223.74	222.87	225.50	– 1.56	– 1.76	– 2.63
11-55-501	0.0	280.31	278.71	280.04	0.0	+ 0.27	– 1.33
11-55-801	0.0	243.27	245.64	244.90	0.0	– 1.63	+ 0.74
11-55-901	290.36	289.94	289.60	289.94	+ 0.42	0.00	– 0.34
11-60-302	198.29	227.15	233.58	234.06	– 35.77	– 6.91	– 0.48
11-60-502	199.57	223.16	230.79	229.15	– 29.58	– 5.99	+ 1.64
11-60-605	217.50	230.49	235.72	234.51	– 17.01	– 4.02	+ 1.21
11-60-801	0.0	149.91	155.89	154.20	0.0	– 4.29	+ 1.69
11-60-902	206.89	221.60	233.45	232.70	– 25.81	– 11.10	+ 0.75
11-61-110	0.0	0.0	234.19	233.94	0.0	0.0	+ 0.25
11-61-204	210.85	223.51	228.90	226.76	– 15.91	– 3.25	+ 2.14
11-61-406	232.70	243.44	248.35	248.42	– 15.72	– 4.98	– 0.07
11-61-407	234.94	243.81	249.64	248.23	– 13.29	– 4.42	+ 1.41
11-61-603	87.82	90.87	90.75	90.80	– 2.98	+ 0.07	– 0.05



DEAF SMITH COUNTY



LUBBOCK COUNTY

Deaf Smith County

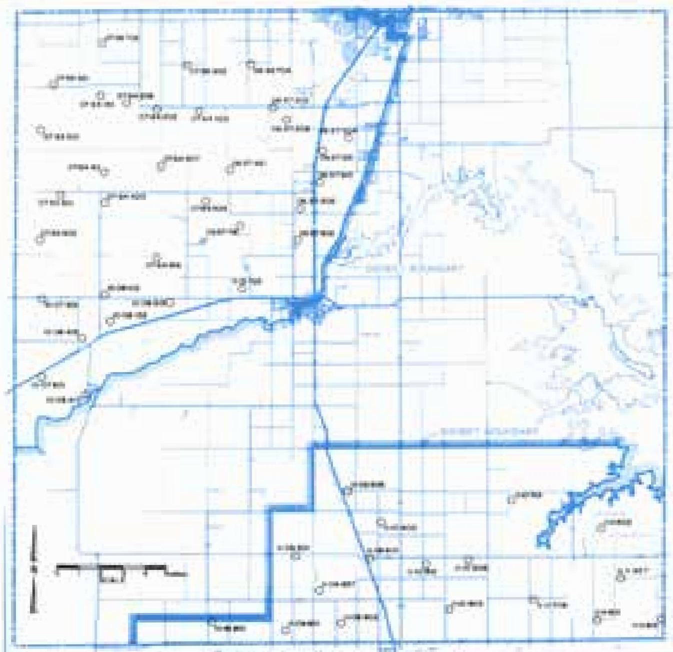
Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
07-53-701	235.42	236.75	236.59	236.73	− 1.31	+ 0.02	− 0.14
07-53-902	226.33	234.60	237.11	237.28	− 10.95	− 2.68	− 0.17
07-54-702	0.0	0.0	170.20	170.43	0.0	0.0	− 0.23
07-54-901	0.0	183.59	189.38	190.34	0.0	− 6.75	− 0.96
07-55-701	226.56	234.13	237.59	236.67	− 10.11	− 2.54	+ 0.92
07-60-301	282.80	292.20	300.49	298.68	− 15.88	− 6.48	+ 1.81
07-60-401	299.64	306.76	307.59	307.68	− 8.04	− 0.92	− 0.09
07-60-601	250.36	260.20	266.07	266.60	− 16.24	− 6.40	− 0.53
07-60-901	0.0	0.0	245.59	247.02	0.0	0.0	− 1.43
07-61-224	0.0	258.14	262.57	263.20	0.0	− 5.06	− 0.63
07-61-301	218.26	226.40	229.49	230.33	− 12.07	− 3.93	− 0.84
07-61-502	211.80	224.74	228.91	230.47	− 18.67	− 5.73	− 1.56
07-61-601	206.05	217.28	221.55	222.62	− 16.57	− 5.34	− 1.07
07-61-802	0.0	0.0	218.97	220.88	0.0	0.0	− 1.91
07-61-902	0.0	0.0	209.19	212.08	0.0	0.0	− 2.89
07-62-101	224.13	230.83	233.28	232.49	− 8.36	− 1.66	+ 0.79
07-62-301	187.23	188.55	192.25	192.24	− 5.01	− 3.69	+ 0.01
07-62-502	0.0	0.0	208.72	209.10	0.0	0.0	− 0.38
07-62-601	199.43	206.17	207.69	207.83	− 8.40	− 1.66	− 0.14
07-62-823	0.0	181.48	0.0	191.07	0.0	− 9.59	0.0
07-63-202	0.0	192.17	195.01	195.32	0.0	− 3.15	− 0.31
07-63-501	134.38	145.60	0.0	156.27	− 21.89	− 10.67	0.0
07-63-702	161.45	173.13	177.45	177.97	− 16.52	− 4.84	− 0.52
09-16-901	120.89	125.68	129.39	130.63	− 9.74	− 4.95	− 1.24
10-03-201	288.81	297.95	301.44	300.50	− 11.69	− 2.55	+ 0.94
10-03-501	0.0	257.91	258.57	258.23	0.0	− 0.32	+ 0.34
10-03-701	0.0	224.68	225.47	0.0	0.0	0.0	0.0
10-03-902	0.0	272.60	271.14	269.77	0.0	+ 2.83	+ 1.37
10-04-101	334.25	341.40	327.96	327.28	+ 6.97	+ 14.12	+ 0.68
10-04-202	294.09	303.70	307.17	307.19	− 13.10	− 3.49	− 0.02
10-04-301	0.0	307.31	310.41	310.94	0.0	− 3.63	− 0.53
10-04-504	0.0	0.0	281.59	281.48	0.0	0.0	+ 0.11
10-04-603	0.0	266.40	268.34	268.68	0.0	− 2.28	− 0.34
10-04-901	213.27	213.10	216.45	215.23	− 1.96	− 2.13	+ 1.22
10-05-225	0.0	227.98	242.32	241.58	0.0	− 13.60	+ 0.74
10-05-502	201.52	217.85	217.28	217.73	− 16.21	+ 0.12	− 0.45
10-05-601	158.79	172.02	180.37	181.46	− 22.67	− 9.44	− 1.09
10-05-804	0.0	170.28	180.35	184.01	0.0	− 13.73	− 3.66
10-05-905	0.0	0.0	202.10	204.72	0.0	0.0	− 2.62
10-06-101	0.0	172.85	183.69	184.50	0.0	− 11.65	− 0.81
10-06-201	168.07	175.21	178.59	179.47	− 11.40	− 4.26	− 0.88
10-06-302	167.14	178.22	189.94	190.83	− 23.69	− 12.61	− 0.89

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
10-06-403	181.13	191.61	197.98	197.81	− 16.68	− 6.20	+ 0.17
10-06-801	79.89	80.75	82.11	82.13	− 2.24	− 1.38	− 0.02
10-06-909	153.11	156.78	160.24	160.25	− 7.14	− 3.47	− 0.01
10-07-401	179.78	189.44	194.44	194.57	− 14.79	− 5.13	− 0.13
10-07-403	156.43	161.10	167.25	169.54	− 13.11	− 8.44	− 2.29
10-07-404	163.86	171.60	184.33	185.75	− 21.89	− 14.15	− 1.42
10-07-701	0.0	114.76	110.14	109.65	0.0	+ 5.11	+ 0.49
10-07-805	0.0	0.0	138.90	137.60	0.0	0.0	+ 1.30
10-09-601	0.0	0.0	58.46	57.51	0.0	0.0	+ 0.95
10-09-701	135.45	0.0	137.43	137.68	− 2.23	0.0	− 0.25
10-09-801	53.96	53.94	56.58	53.85	+ 0.11	+ 0.09	+ 2.73
10-10-701	162.34	161.57	162.25	161.41	+ 0.93	+ 0.16	+ 0.84
10-11-401	191.83	195.24	193.88	194.40	− 2.57	+ 0.84	− 0.52
10-11-501	195.60	199.35	201.33	200.90	− 5.30	− 1.55	+ 0.43
10-11-601	0.0	161.54	161.41	161.32	0.0	+ 0.22	+ 0.09
10-11-802	0.0	233.98	237.29	236.89	0.0	− 2.91	+ 0.40
10-11-901	189.36	197.96	200.68	200.88	− 11.52	− 2.92	− 0.20
10-12-102	161.64	0.0	173.03	173.60	− 11.96	0.0	− 0.57
10-12-201	70.37	72.50	72.55	72.82	− 2.45	− 0.32	− 0.27
10-12-302	187.39	197.78	206.27	206.96	− 19.57	− 9.18	− 0.69
10-12-404	0.0	223.05	223.24	222.10	0.0	+ 0.95	+ 1.14
10-12-504	224.34	228.08	230.09	228.15	− 3.81	− 0.07	+ 1.94
10-12-703	0.0	0.0	192.94	196.66	0.0	0.0	− 3.72
10-12-904	172.71	187.47	194.27	195.19	− 22.48	− 7.72	− 0.92
10-13-104	0.0	0.0	235.78	235.48	0.0	0.0	+ 0.30
10-13-230	0.0	0.0	244.36	244.35	0.0	0.0	+ 0.01
10-13-304	177.09	185.62	187.73	0.0	0.0	0.0	0.0
10-13-305	171.95	181.55	189.14	190.11	− 18.16	− 8.56	− 0.97
10-13-401	176.98	200.08	211.93	213.20	− 36.22	− 13.12	− 1.27
10-13-404	0.0	174.22	185.95	187.24	0.0	− 13.02	− 1.29
10-13-806	0.0	0.0	190.06	189.78	0.0	0.0	+ 0.28
10-13-903	186.76	202.20	208.15	209.19	− 22.43	− 6.99	− 1.04
10-14-104	81.74	79.27	78.28	77.93	+ 3.81	+ 1.34	+ 0.35
10-14-205	0.0	112.78	108.79	105.54	0.0	+ 7.24	+ 3.25
10-14-303	79.97	73.37	73.33	71.34	+ 8.63	+ 2.03	+ 1.99
10-14-404	149.02	161.24	162.21	160.80	− 11.78	+ 0.44	+ 1.41
10-14-702	188.04	196.27	199.39	199.54	− 11.50	− 3.27	− 0.15
10-14-704	0.0	158.50	161.11	161.59	0.0	− 3.09	− 0.48
10-14-705	0.0	0.0	191.70	192.61	0.0	0.0	− 0.91
10-14-901	112.59	111.44	111.25	111.35	+ 1.24	+ 0.09	− 0.10
10-21-201	210.55	0.0	231.54	232.53	− 21.98	0.0	− 0.99

NOTE: 0.0 Denotes data not available

Lubbock County

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
23-09-501	167.98	169.73	168.82	167.62	+ 0.36	+ 2.11	+ 1.20
23-09-601	145.19	145.61	145.87	145.21	− 0.02	+ 0.40	+ 0.66
23-09-701	166.53	169.87	169.53	167.98	− 1.45	+ 1.89	+ 1.55
23-09-903	0.0	173.53	169.57	168.12	0.0	+ 5.41	+ 1.45
23-10-502	195.80	205.80	207.81	207.00	− 11.20	− 1.20	+ 0.81
23-10-703	0.0	174.73	171.42	169.97	0.0	+ 4.76	+ 1.45
23-11-401	209.34	217.25	217.57	217.28	− 7.94	− 0.03	+ 0.29
23-11-501	0.0	195.18	196.71	196.15	0.0	− 0.97	+ 0.56
23-11-601	171.73	173.65	175.03	175.21	− 3.48	− 1.56	− 0.18
23-11-702	192.30	200.93	204.20	203.04	− 10.74	− 2.11	+ 1.16
23-11-801	205.69	213.64	214.44	214.75	− 9.06	− 1.11	− 0.31
23-12-401	178.06	184.56	186.78	187.42	− 9.36	− 2.86	− 0.64
23-12-402	195.48	210.55	213.28	213.65	− 18.17	− 3.10	− 0.37
23-12-803	0.0	200.13	197.10	197.08	0.0	+ 3.05	+ 0.02
23-17-104	0.0	137.10	137.66	137.45	0.0	− 0.35	+ 0.21
23-17-202	160.21	166.32	163.60	162.70	− 2.49	+ 3.62	+ 0.90
23-17-301	0.0	169.83	166.65	165.92	0.0	+ 3.91	+ 0.73
23-17-406	0.0	79.55	80.41	79.78	0.0	− 0.23	+ 0.63
23-17-501	129.42	132.72	132.46	132.48	− 3.06	+ 0.24	− 0.02
23-17-601	0.0	119.25	120.31	119.68	0.0	− 0.43	+ 0.63
23-17-704	76.52	79.13	76.64	76.95	− 0.43	+ 2.18	− 0.31
23-17-801	88.99	89.34	86.13	86.56	+ 2.43	+ 2.78	− 0.43
23-17-802	76.97	80.64	83.77	84.26	− 7.29	− 3.62	− 0.49
23-17-901	70.79	71.37	64.07	61.42	+ 9.37	+ 9.95	+ 2.65
23-18-201	164.59	170.10	168.35	168.53	− 3.94	+ 1.57	− 0.18
23-18-301	194.72	203.60	201.99	202.49	− 7.77	+ 1.11	− 0.50
23-18-409	0.0	154.26	150.90	150.07	0.0	+ 4.19	+ 0.83
23-18-502	135.57	139.62	135.18	135.04	+ 0.53	+ 4.58	+ 0.14
23-18-602	0.0	155.20	151.19	151.38	0.0	+ 3.82	− 0.19
23-18-701	86.49	89.64	89.27	88.55	− 2.06	+ 1.09	+ 0.72
23-18-703	80.45	79.96	77.22	76.59	+ 3.86	+ 3.37	+ 0.63
23-18-704	80.82	82.74	80.13	79.71	+ 1.11	+ 3.03	+ 0.42
23-18-802	0.0	100.88	97.48	97.32	0.0	+ 3.56	+ 0.16
23-19-101	186.66	194.23	192.32	192.09	− 5.43	+ 2.14	+ 0.23
23-19-304	210.45	216.39	213.55	213.44	− 2.99	+ 2.95	+ 0.11
23-19-501	203.24	210.31	207.38	206.50	− 3.26	+ 3.81	+ 0.88
23-19-601	0.0	212.49	208.89	207.90	0.0	+ 4.59	+ 0.99
23-19-704	102.62	105.62	100.24	99.55	+ 3.07	+ 6.07	+ 0.69
23-19-804	107.95	119.50	113.95	109.49	− 1.54	+ 10.01	+ 4.46
23-19-901	163.34	169.72	168.50	166.04	− 2.70	+ 3.68	+ 2.46
23-20-401	196.46	203.24	201.64	200.88	− 4.42	+ 2.36	+ 0.76
23-20-701	187.89	193.72	189.30	188.01	− 0.12	+ 5.71	+ 1.29
23-20-802	207.10	216.78	213.60	213.78	− 6.68	+ 3.00	− 0.18



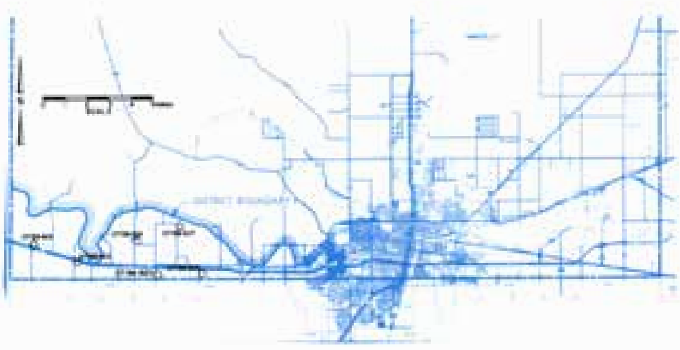
RANDALL COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
06-49-704	0.0	0.0	214.18	214.59	0.0	0.0	– 0.41
06-57-202	0.0	198.02	201.78	202.37	0.0	– 4.35	– 0.59
06-57-208	0.0	197.80	200.35	199.45	0.0	– 1.65	+ 0.90
06-57-304	0.0	161.98	161.03	160.48	0.0	+ 1.50	+ 0.55
06-57-315	0.0	152.55	153.11	153.42	0.0	– 0.87	– 0.31
06-57-421	0.0	189.53	188.28	189.25	0.0	+ 0.28	– 0.97
06-57-505	0.0	185.71	187.60	184.82	0.0	+ 0.89	+ 2.78
06-57-601	184.06	189.32	189.30	186.71	– 2.65	+ 2.61	+ 2.59
06-57-716	0.0	166.85	169.15	169.64	0.0	– 2.79	– 0.49
06-57-802	159.41	158.64	158.07	156.79	+ 2.62	+ 1.85	+ 1.28
07-55-921	0.0	224.78	229.10	230.99	0.0	– 6.21	– 1.89
07-56-702	246.88	246.77	252.17	251.86	– 4.98	– 5.09	+ 0.31
07-56-902	210.22	215.39	215.64	215.67	– 5.45	– 0.28	– 0.03

RANDALL COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
07-63-301	231.48	234.59	232.67	232.93	– 1.45	+ 1.66	– 0.26
07-63-601	171.70	182.44	190.65	190.58	– 18.88	– 8.14	+ 0.07
07-63-902	155.63	158.14	164.44	165.67	– 10.04	– 7.53	– 1.23
07-64-135	0.0	0.0	223.33	222.22	0.0	0.0	+ 1.11
07-64-202	0.0	184.24	187.30	186.23	0.0	– 1.99	+ 1.07
07-64-209	0.0	178.84	179.92	180.49	0.0	– 1.65	– 0.57
07-64-323	0.0	157.94	160.50	161.30	0.0	– 3.36	– 0.80
07-64-411	0.0	0.0	119.65	119.67	0.0	0.0	– 0.02
07-64-422	0.0	0.0	108.83	108.08	0.0	0.0	+ 0.75
07-64-507	170.65	164.46	160.48	160.37	+ 10.28	+ 4.09	+ 0.11
07-64-624	0.0	170.78	171.20	172.18	0.0	– 1.40	– 0.98
07-64-816	0.0	137.16	140.66	138.61	0.0	– 1.45	+ 2.05
10-07-301	135.16	136.61	139.66	138.98	– 3.82	– 2.37	+ 0.68
10-07-601	103.19	102.89	104.78	104.23	– 1.04	– 1.34	+ 0.55
10-08-102	143.25	147.08	148.52	148.64	– 5.39	– 1.56	– 0.12
10-08-132	0.0	174.39	177.98	175.79	0.0	– 1.40	+ 2.19
10-08-213	0.0	130.85	131.92	131.38	0.0	– 0.53	+ 0.54
10-08-415	0.0	113.21	114.81	114.79	0.0	– 1.58	+ 0.02
10-08-417	0.0	0.0	96.89	97.08	0.0	0.0	– 0.19
10-16-901	181.94	183.92	184.90	185.09	– 3.15	– 1.17	– 0.19
11-01-103	0.0	83.03	84.70	83.53	0.0	– 0.50	+ 1.17
11-09-306	0.0	161.81	162.58	162.77	0.0	– 0.96	– 0.19
11-09-501	185.54	186.59	186.58	186.19	– 0.65	+ 0.40	+ 0.39
11-09-601	200.15	198.43	196.99	196.35	+ 3.80	+ 2.08	+ 0.64
11-09-801	196.59	196.23	194.51	195.08	+ 1.51	+ 1.15	– 0.57
11-09-837	0.0	178.67	178.19	178.35	0.0	+ 0.32	– 0.16
11-09-902	209.08	205.29	200.17	199.46	+ 9.62	+ 5.83	+ 0.71
11-10-301	128.04	128.98	129.20	128.88	– 0.84	+ 0.10	+ 0.32
11-10-402	176.10	175.48	175.27	174.57	+ 1.53	+ 0.91	+ 0.70
11-10-506	0.0	140.66	142.86	143.47	0.0	– 2.81	– 0.61
11-10-512	0.0	179.76	181.27	181.71	0.0	– 1.95	– 0.44
11-10-802	183.76	179.93	179.19	178.86	+ 4.90	+ 1.07	+ 0.33
11-11-502	169.54	167.82	166.90	166.49	+ 3.05	+ 1.33	+ 0.41
11-11-709	0.0	0.0	185.70	184.71	0.0	0.0	+ 0.99
11-11-801	127.79	133.75	137.21	137.15	– 9.36	– 3.40	+ 0.06
11-11-901	128.50	133.08	135.70	135.05	– 6.55	– 1.97	+ 0.65
11-11-927	0.0	146.21	149.05	147.70	0.0	– 1.49	+ 1.35

NOTE: 0.0 Denotes data not available



POTTER COUNTY

Well Number	Depth to Water Below Land Surface In Feet 1977	1982	1986	1987	Total Change In Water Levels In Feet 1977 to 1987	1982 to 1987	1986 to 1987
07-55-601	0.0	256.32	255.52	255.30	0.0	+ 1.02	+ 0.22
07-56-307	0.0	224.64	224.78	225.22	0.0	– 0.58	– 0.44
07-56-401	232.37	238.19	243.60	242.70	– 10.33	– 4.51	+ 0.90
07-56-501	222.78	228.82	230.38	230.75	– 7.97	– 1.93	– 0.37
07-56-520	0.0	238.19	242.34	243.09	0.0	– 4.90	– 0.75
07-56-601	216.39	221.63	224.06	221.46	– 5.07	+ 0.17	+ 2.60

NOTE: 0.0 Denotes data not available

NET RISE continued from page 1

aquifer within its service area through a network of about 950 water-level observation wells scattered throughout the District's service area. The wells are privately-owned and are spaced at a density of approximately one per nine square miles.

This month's issue of *The Cross Section* features water-level data for each county or portion of a county lying within the District's service area. The data includes a summary table (on page 1) showing the number of observation wells maintained and the one, five and 10-year average annual changes in water levels for each county.

Also, a map of each county showing the location of each well measured and the assigned well number is included. Tabulations by county showing the depth to water in feet for each well measured for the years 1977, 1982, 1986 and 1987, and the total change in water levels for 10, five and one-year periods is also included. A plus denotes a gain in water levels and a minus denotes a loss. —*BS*

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HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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Water Bills Sponsored

Legislators Seek More Control of Ground Water Resources in the State

A large number of bills dealing with water have been filed for consideration in the 70th Texas legislative session in Austin. Some of these bills call for state control of Texas water resources, principally by broadening the rule-making powers of the Texas Water Commission.

Presented here is a synopsis of some of these bills, accompanied by comments by A. Wayne Wyatt, Manager of the High Plains Underground Water Conservation District No. 1. Copies of these bills may be obtained from the Texas Legislative Service by writing P.O. Box 100, Austin, Texas 78767 or calling (512) 476-7596.

Senator John Montford

MONTFORD AND EVANS SPONSOR BILLS RECOMMENDED BY COMMITTEE

Six bills sponsored by Senator John Montford of Lubbock in the Senate and Representative Charles Evans of Hurst in the House of Representatives are based on recommendations made after public hearings of the Water District and River Authority Study Committee. This committee was authorized by the 69th Texas Legislature. The Montford/Evans-sponsored bills pertaining to management of ground water in Texas would give the Texas Water Commission (TWC) the power to designate critical ground water areas, set minimum standards and rules for water management entities, make rules concerning water resource management and set up provisions for state management of critical ground water areas or for the creation of underground water districts. Other bills are meant to broaden provisions in existing law to apply to river authorities.

S.B. 670/H.B. 2283

Senate Bill 670, sponsored by Senator Montford, and House Bill 2283, sponsored by Representative Evans, relate to the creation and operation of the Texas Water Resources Management Oversight Committee.

The Texas Water Resources Management Oversight Committee would have jurisdiction and investigative authority over water managing entities in the state. The committee would have the power to inspect water management operations, including requiring audits, inspections, engineering reports, evaluation reports and financial information relating to water resource management. The committee would report its findings and recommendations to the legislature. Fees paid by the water entities being reviewed would pay for administrative costs.

The seven members of the oversight committee would be appointed for two-year terms by the governor and lieutenant governor. Membership on the committee would consist of a state senator, a state representative, a representative of a river authority or water district, two persons from the general public with no connection or financial interest in any water district or river authority, one person with a working knowledge of water issues in Texas and one person with a working knowledge of environmental issues. House Bill 1583, introduced by Representative Tom Craddick of Midland, is similar to Senate Bill 670.

Wayne — This bill would remove the river authorities from the sunset review by the legislature. However, it adds water districts to its list for review by the oversight committee.

Water district directors and county committeemen are elected by popular vote under the general election laws of the state. We believe the voters can best make the decision as to whether or not the district is performing its duties. If the voters are displeased, they can replace the board of directors and county committeemen under the Election Code of the state. We therefore recommend that this proposed legislation not be passed as written.

S.B. 671/H.B. 2284

Senate Bill 671, sponsored by Senator Montford, and House Bill 2284 sponsored by Representative Evans, relate to the policies and audits of certain water districts and authorities.

The bill would require the governing board of a river authority to adopt a specified set of policies and ethics.

Wayne — This water district already performs those functions outlined in this bill which may apply to our operation as required by Chapter 52 of the Water Code. We therefore have no comments on this bill.

State capitol building in Austin

S.B. 672/H.B. 2285

Senate Bill 672, sponsored by Senator Montford, and House Bill 2285, sponsored by Representative Evans, relate to the continuing supervision of certain water districts and authorities by the Texas Water Commission.

This bill broadens the powers of the Texas Water Commission, which supervises districts and authorities

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Redeker Departs District

After almost 12 years, Kathy Redeker has left the Water District to join Sierra Tejas Properties, a public relations, media production and promotion company in Midland, as vice president and office manager.

Starting at the Water District as receptionist in May 1975, Kathy served as executive secretary to the manager for five years before becoming Information and Education Division Director in 1984. Kathy won several awards as the Information and Education Director, including a public media award from Region 1 of the Texas Soil and Water Conservation Districts of Texas in 1986, a communications award from the Lubbock County Soil and Water Conservation District in 1985 and an Outstanding Young Woman of America Award in 1984.

Kathy will be missed at the Water District, and we wish her the best in her new endeavors.

Kathy Redeker

WATER BILLS

continued from page 1

managing water resources, to include river authorities. The bill deletes a provision in existing law which made this bill inapplicable to river authorities encompassing 10 or more counties and which were not subject to the continuing right of supervision on June 10, 1969. Representative Craddick introduced House Bill 1582, which is identical to House Bill 2285.

Wayne — We do not believe the provisions of this bill will change any law relating to underground water conservation districts, and we therefore offer no comment.

A. Wayne Wyatt

H.B. 2173

House Bill 2173, sponsored by Representative Cliff Johnson of Palestine, relates to the continuing right of supervision of certain districts and authorities by the Texas Water Commission. This proposed legislation is identical to House Bill 2285 and Senate Bill 672, except for an additional section. Section 6 requires that the TWC assure that any action taken by a water district or authority is consistent with the needs of the river basins where the action takes place or any adjacent river basins affected by the action.

Wayne — The section added to the end of this bill conveys very broad authority to the TWC to totally regulate the ground water resources of the state through the inclusion of all river basins. Since each square mile of the state is located within a river basin, all underground water conservation districts are located in a river basin and would be affected by this proposed legislation. We have therefore recommended that this provision be deleted from the proposed legislation.

S.B. 673/H.B. 2286

Senate Bill 673, sponsored by Senator Montford, and House Bill 2286, sponsored by Representative Evans, relate to the authority of the Texas Water Commission to adopt certain rules.

The TWC would be authorized to make rules to promote the conservation of water, regionalization and the protection of the environment. Rules may apply to the issuance of permits, the use of water held under existing water rights and any other activity regulated under these chapters.

Wayne — The language of Section 26.0111 of this proposed legislation is so broad that the TWC could adopt any rule it chose to conserve and protect the water resources of the state. The definition of water in Chapter 26 includes ground water. Therefore, it appears that under this proposed legislation the TWC could regulate the use of ground water to any degree it chose. The TWC could even prohibit the use of agricultural chemicals, including fertilizers, under the guise of protecting the environment and water resources!

In essence, the TWC would have unlimited power to adopt rules. Neither public hearings nor the gathering of any evidence would be required before the TWC made rules. We believe that this is very dangerous.

We strongly recommend that this bill not be allowed to become law.

S.B. 674/H.B. 2287

Senate Bill 674, sponsored by Senator Montford, and House Bill 2287, sponsored by Representative Evans, relate to minimum standards for underground water regulation.

The Texas Water Commission would be authorized to develop and adopt minimum standards for underground water regulation to be implemented by entities which manage underground water in terms of water well spacing and production, conservation of underground water and prevention of waste of underground water, including those entities created under Chapter 51 and 52 of the Water Code. Any district affected by this amendment would have to adopt standards or amend its rules to meet the minimum requirements set by the TWC. If a district did not meet or enforce the standards set by the TWC, the TWC would have the power to direct the district to do so; or the TWC could assume jurisdiction of the water management in the district. The TWC could adopt new rules that the district would be authorized to adopt.

Representative Lena Guerrero of Austin has introduced House Bill 2228 which also addresses minimum standards. The same provisions are also included in House Bill 1451 introduced by Representative Terral Smith of Austin and in Senate Bill 967 introduced by Senator H. Tati Santiesteban of El Paso.

Wayne — We believe that minimum standards for nonfunctioning water districts are necessary. However, we object to minimum standards for districts with a proven history of performance.

An underground water conservation district is established under the Texas Water Code as a political subdivision with officials elected by the residents within its boundaries, and is directly responsible to those

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Ken Carver .... Asst. Manager
Don McReynolds .... Geologist
Cindy Gestes .... Geologist
Keith Whitworth .... Draftsman
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Obbie Goolsby .... Engineer Technician
Dan Seale .... Engineer Technician
Dennis Sensenbrenner .... Geologist
Jerry Funck .... Agricultural Engineer
Richard Howard .... Draftsman
Johnita Franklin .... Bookkeeper
Bobbie Bramblett .... Receptionist-Secretary
Rosie Risinger .... Executive Secretary
Beth Snell .... Assistant, Information/Education

residents. Conditions are unique to each district. To give any agency authority to develop and adopt rules for a functioning district directly contradicts the concept of the underground water district as a political entity and reduces it to the level of clerical staff carrying out the dictates of an administrative agency. We therefore oppose the setting of minimum standards for any district which has already adopted rules and is enforcing those rules.

We have made numerous suggestions to the authors of these bills and to the Natural Resources Committees in both the House and the Senate as to changes which we feel need to be made to make this provision workable and acceptable.

S.B. 675/H.B. 2288

Senate Bill 675, sponsored by Senator Montford, and House Bill 2288, sponsored by Representative Evans, relate to the jurisdiction over underground water in critical areas and addition of territory to and adoption and collection of fees by underground water conservation districts.

This bill makes provisions to place designated critical ground water areas under water management supervision, either through the creation of a local underground water district by local voters or

Representative Charles Evans

through management by the Texas Water Commission if the local voters do not choose to create a district. The TWC would be empowered to exercise authority over the ground water in the area and issue rules and regulations for management, including the charging of fees to pay for the area's management and supervision.

Twelve months after the TWC assumed jurisdiction over a critical ground water area, a majority consisting of at least 50 voters in the area could petition the TWC to appoint directors to call another election to approve the creation of a district.

The bill would also amend the procedure to be followed to decide if a critical ground water area would be added to an existing water district adjacent to the area in question. If the board of directors of the existing water district vote to accept the additional territory, they would issue an order for election in the critical area. If the new territory were added to the district, the board would be required to provide for reasonable representation of the new territory on the board.

Another section of this bill would authorize a district to establish and collect fees for its administration and operation.

Wayne — There is a very strong effort in Austin to place all the ground water in the state under full state control. We therefore appreciate legislation which gives the local people an opportunity to create and manage their own underground water resources through an underground water conservation district. We also appreciate the need for control and management of the ground water resources in critical areas should the local people not choose to create their own district. We cannot offer a better solution than to place the critical area under the jurisdiction of the state if the local people do not choose to create a district or join an existing district.

We feel that some minor changes are needed in this bill and have offered our suggestions to the authors and the Natural Resources Committees.

S.B. 761

Senate Bill 761, sponsored by Senator Montford, is also sponsored as House Bill 1447 by Representative Terral Smith.

This bill clarifies whether the Texas Water Commission or the Texas Water Development Board assumed certain duties formerly performed by the Texas Department of Water Resources in regard to designation of critical areas and the creation of underground water conservation districts in critical areas.

Wayne — We have reviewed this bill and can offer no suggestions for

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WATER BILLS

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improvement. We agree that this legislation is needed to clarify H.J.R. 6, as passed by the 69th Legislature in 1985.

BILL INTRODUCED TO EXTEND PILOT LOAN PROGRAM

S.B. 410

Senate Bill 410, also sponsored by Senator Montford, relates to agricultural water grant and loan programs approved by Texas voters in November 1985.

Through the Pilot Loan Program, the Texas Water Development Board may loan money to underground water conservation districts and soil and water conservation districts, who then can loan money to individual borrowers for purchase of agricultural water conservation equipment.

This bill would extend the Pilot Program from two years to four years, making loan funds available through this program until September 1989. The bill would also add irrigation districts to the authorized lenders.

Another provision of the bill allows grants under the program for agricultural water conservation equipment to be used on dryland and rangeland. The bill also allows loan funds to be used for physical conversion by an irrigation district to an approved system for the district's irrigation water delivery system, in addition to other equipment and services available for loan funds.

Wayne — We appreciate Senator Montford's introduction of this legislation which would extend the Pilot Loan Program for low interest loans for agricultural water conservation equipment through 1989. We believe that the additional time is needed to evaluate the loan program. We therefore fully support this proposed legislation.

> "We ... appreciate legislation which gives the local people an opportunity to ... manage their own underground water resources ..."
>
> A. Wayne Wyatt

NATURAL RESOURCES COMMITTEES

House of Representatives
Chairman: Terral Smith
Vice Chairman: Jack Harris
CBO: Cliff Johnson
Seniority Appointments:
Sam Russell, Jerry Yost
Speaker Appointments:
Bill Hammond, Steve Holzheauser, Dan Shelley, Mike Toomey

Senate
Chairman: Tati Santiesteban
Vice Chairman: John Montford
Members: Kenneth Armbrister, J.E. (Buster) Brown, Ted Lyon, Bill Sarpalius, Bill Sims, Frank Tejeda, Hector Uribe, John Whitmire, Judith Zaffirini

MOST COMPREHENSIVE BILL

H.B. 1451/S.B.967

The bill sponsored as House Bill 1451 by Representative Terral Smith and as Senate Bill 967 by Senator Santiesteban relates to minimum standards for underground water regulation by the creation, operation and financing of underground water districts.

These bills include provisions similar to those in Senate Bills 674 and 675 sponsored by Senator Montford, House Bills 2228 and 2229 sponsored by Representative Guerrero and House Bills 2287 and 2288 sponsored by Representative Evans.

Wayne — These are by far the most comprehensive of the bills pertaining to ground water. We have offered numerous suggestions for changes and deletions to the bills' authors and to the Natural Resources Committees in both the House and the Senate. With appropriate changes we may support the passage of one or more of these bills.

POSSIBLE GROUND WATER CONTAMINANTS

H.B. 2232/S.B. 1033

House Bill 2232 is one of seven bills sponsored by Representative Guerrero. The companion bill in the Senate is Senate Bill 1033 sponsored by Senator Santiesteban. These bills relate to the protection of ground water in Texas.

The intent is to protect and maintain dependable supplies of high quality ground water through regulatory and other programs of state agencies with responsibilities related to ground water. The Act states that it is the goal of the state to assure that there will be no degradation of the existing quality of ground water sources and requires that state regulations and programs related to ground water be directed toward that goal.

The Act identifies 53 organic substances which could potentially contaminate ground water and the agencies with responsibilities related to the protection of ground water.

Representative Terral Smith

The bill would require these agencies to prohibit activities reasonably suspected of causing ground water contamination by organic substances if any of the substances are detected at any level in an aquifer.

Wayne — We realize the need to protect the ground water aquifers of the state. However, we feel that this legislation exceeds present need.

This proposed legislation has the potential to limit agricultural production in Texas to a very minimum level. The goal as set forth in Section 26.401 (b) that there be "no degradation of the existing quality of ground water sources..." is unrealistic. Nature's processes prior to the existence of man resulted in degradation of the quality of ground water, and these processes continue today.

This bill would require the TWC to establish enforcement standards for use of organic substances that might be introduced into ground water as contaminants as a result of man-made pollution sources. Most of the 53 organic substances listed are used in agri-business. The use of agricultural chemicals has resulted in the highest level of agricultural production the world has ever known. Most of these chemicals are used in very small quantities and have a very short half-life, meaning that either they decompose or they are tied up with the minerals in the soil in a short period of time. Also, the United States Environmental Protection Agency has spent millions of dollars in an attempt to determine the maximum safe level of these substances in drinking water and has yet to determine their safe limits and continues to pursue this effort. It appears unnecessary for the state of Texas to duplicate this pursuit. Let the EPA continue their efforts. At such time as they determine safe levels for these organic substances, we can address the subject in state legislation.

The equipment currently available to detect organic substances can detect their presence in parts per billion — perhaps even in parts per trillion. An increase from one part per billion to two parts per billion of an organic substance would represent a 100 percent increase, thus indicating contamination. Without determining safe limits for these organic substances, the state agency with regulatory jurisdiction might take whatever action it deemed necessary to prevent further contamination, even though the level of the organic substance in the water might be harmless.

If we are not careful, we may set such high standards for protection of ground water aquifers that we would limit the use of agricultural chemicals to such a degree that we would starve to death while drinking pure water!

We oppose this proposed legislation.

REGULATED GROUND WATER BASINS

H.B. 1898

House Bill 1898, sponsored by Representative Guerrero, relates to the declaration of regulated ground water basins and the adjudication of ground water rights.

This bill would make it a state policy to encourage coordinated management of surface and ground water resources. To this end, if it appeared to the Texas Water Commission that the ground water and surface water of an area were hydrologically connected and that excessive use of ground water in the area threatened surface water rights, the TWC could declare an area a regulated ground water basin.

The TWC could then adjudicate the ground water rights of the area. A water rights claim would be valid only to the extent of maximum application of the water to beneficial use without waste during three calendar years preceding notice of the adjudication, although a municipality would be able to claim additional rights based on anticipated needs.

Senator Tati Santiesteban

Wayne — The key words in this bill are "whenever it appears to the Commission that ground water and surface water are hydrologically connected . . ." No proof is required. It would be entirely at the whim of the TWC to make this judgment.

Numerous springs flow from the Ogallala aquifer along the edge of the High Plains escarpment. Therefore, all the water in the Ogallala Formation could be subject to adjudication if the proposed legislation is passed! I do not know of a ground water aquifer in the state of Texas that does not have one or more springs. This proposed legislation could result in all the ground water in the state becoming subject to adjudication.

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One provision in essence says "use it or lose it!" A claim to a ground water right would be recognized as valid only to the extend of maximum actual application of water put to beneficial use without waste during the three calendar years preceding a notice of adjudication. This is in direct opposition to all efforts to promote conservation. This provision would not only eliminate any incentive for conservation, but actually require the owner to use water whether he needed it or not to protect his claim!

A claim for ground water rights under adjudication would require the date wells were drilled and the amounts of water used in each of three prior calendar years based upon actual metered measurement or other reasonable methods of estimating flow approved by the TWC. A $450 meter necessary for each of the 75,000 irrigation wells in the High Plains of Texas to provide actual metered measurement would cost the landowners and/or operators $33,750,000!

In our opinion, this proposed legislation could cause irreparable damage, as well as cost the taxpayers and/or landowners/operators millions of dollars, while providing very limited benefit to a few users of spring water in the state. We have very strongly opposed passage of this legislation.

Watch for upcoming field demonstration days

H.B. 2227

House Bill 2227, sponsored by Representative Guerrero, relates to creation and operation of the Texas Groundwater Protection Committee.

The Texas Water Commission would be the lead agency to manage the activities of the Texas Groundwater Protection Committee. The committee members would consist of the chief executives of the Texas Water Commission, the Texas Water Development Board, the Texas Railroad Commission, the Texas Department of Health and the Texas Department of Agriculture. The committee would coordinate ground water protection activities of certain agencies; develop and update a comprehensive ground water protection strategy for Texas to provide guidelines for the prevention of contamination and the conservation of ground water and also to integrate ground water protection activities of the agencies represented on the committee; study programs for or recommend to the legislature programs for any area of ground water protection not already regulated; and file with the governor, lieutenant governor and speaker of the house a report of its activities and any recommendations for legislation.

Wayne — We are very concerned that this bill would create another layer of bureaucracy which would serve no useful purpose. Each agency named already has directives from the legislature as to its responsibility in the area of ground water protection.

If a further review of the ground water protection program is needed, then we would suggest that a joint House-Senate committee, comprised of members of the respective Natural Resources Committees, perform this function.

MINIMUM STANDARDS

H.B. 2228

House Bill 2228, sponsored by Representative Guerrero, relates to minimum standards for underground water regulation.

Wayne — This bill is similar to the other bills regarding minimum standards for the regulation of underground water.

CREATION OF GROUND WATER DISTRICTS

H.B. 2229

House Bill 2229, sponsored by Representative Guerrero, relates to the creation and powers of and imposition of fees by underground water conservation districts.

Wayne — This bill is essentially a duplication of House Bill 1451 sponsored by Representative Terral Smith, Chairman of the Natural Resources Committee in the House of Representatives. We recommended several changes to make this bill the best possible water legislation dealing with the creation, operation and financing of underground water conservation districts.

Representative Lena Guerrero

PROPOSED REGULATIONS FOR UNDERGROUND STORAGE TANKS

H.B. 2230

House Bill 2230, sponsored by Representative Guerrero, relates to the regulation of underground tanks used to store certain substances.

It would be state policy to maintain and protect the quality of ground water from substances stored in underground tanks which may pollute the ground water. The Texas Water Commission would be the lead agency for administering the Act and would adopt rules and cooperate and contract with cities and towns and state and federal agencies, departments and other political subdivisions.

Wayne — This proposed legislation appears to be unnecessary, because the United States Congress has recently addressed this issue in Section 9002 of the Resource Conservation and Recovery Act, as amended. The TWC has been delegated the authority to enforce this act and is currently engaged in this effort.

REGULATION OF WATER WELLS

H.B. 2231

House Bill 2231, sponsored by Representative Guerrero, relates to the regulation of water wells.

This bill would require the Texas Water Commission to inspect water wells completed after January 1, 1988, to determine if their construction meets TWC standards. In addition, the TWC would charge a one-time fee of not more than $100 on each water well in the state to cover administration costs of the water well regulation program.

Other provisions would include the creation of a water well fund in the State Treasury for inspection and enforcement costs and the distribution at the time of inspection of educational materials encouraging the testing for contaminants in water wells used for drinking water. The TWC would be required to demand corrective action from the owner of a water well which did not meet commission standards for well location, completion, capping or plugging.

Wayne — This bill provides absolute state control of ground water in Texas. We are absolutely against state control of ground water!

This bill is also a duplication of current law (Texas Water Well Drillers' Act) and would result in an unnecessary expense to anyone who will ever have a well drilled in this state. There is no need to inspect every new well drilled. The Texas Water Well Drillers' Act requires that proper completion of wells include the cementing of the top 10 feet of the well and a cement pump base extending a minimum of two feet in all directions from the well. This act also provides for heavy fines and/or the loss of license for failure to comply with this law.

We oppose this legislation.

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Texas Beef Production Remains State's Largest Ag Industry

MANAGER'S NOTE:

Most people are surprised to learn that 40 percent of the total cash value of agricultural commodities produced in the High Plains is derived from beef production and that a large portion of the water produced from the Ogallala aquifer is used directly or indirectly to support the beef cattle industry. A beef animal will drink from 10 to 30 gallons of water per day, depending on its size and the climatic conditions of the day. Cattle eat locally-grown corn, wheat, milo, alfalfa, cotton seed, silage and other crops which have been grown under irrigation. The beef cattle industry is predicted to grow even larger in the High Plains when the conservation compliance provision of the 1985 Food Security Act takes effect in 1990. We are very proud of our beef cattle industry. In this issue we highlight the beef feedlot operation. One story details their economic importance to the area. The other article explains the research being conducted by Texas Tech University to make sure our feedlots have the technology to continue to be leading producers of fed beef in a highly competitive market.

A hundred years ago, giant cattle ranches spread across Texas. Then, the legendary roundup and trail drives moved cattle to the railroads, where they were shipped to out-of-state markets. Today, one of Texas' earliest industries remains one of its biggest and most influential. Beef production is the number one agricultural industry in the state's $74 billion agricultural economy.

According to 1985 Texas Department of Agriculture figures, the state boasts 148,000 cattle operations. This includes about 150 large commercial feedlots with a capacity of 5,000 head or more. These feedlots produce about 40 percent of the total cash value of agricultural commodities in Texas. Other beef operations such as farms and ranches selling beef generate an additional 18.4 percent. Eighty-two of these large feedlots are located in the Texas High Plains. Texas feedlots market about five million fed cattle annually, which is about 20 percent of the total fed cattle in the nation. About 80 percent of the state's fed cattle are produced in the High Plains of Texas.

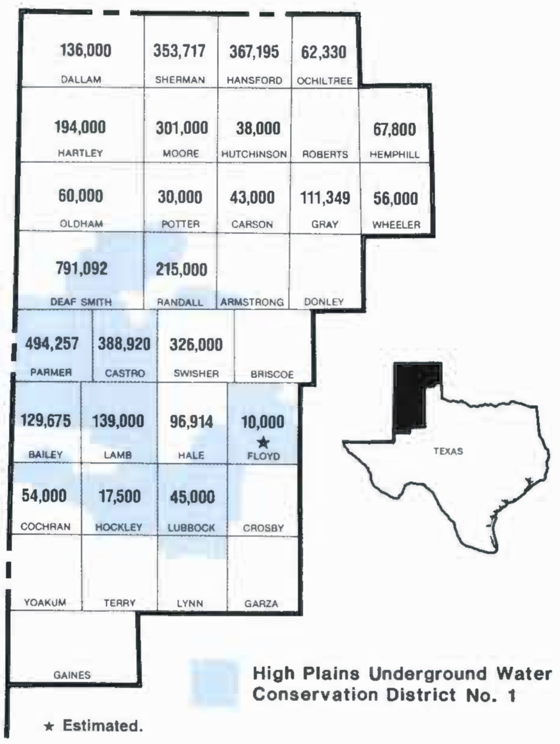
Texas contains more feedlots processing more cattle than any other state, and the economic impact of this industry is sizeable. On a state level, cattle feeding generates about $3 billion annually in direct cash sales. Most of this money circulates through the local economy an average of two or three times in a "multiplier effect," generating revenues totalling $8 billion. Through the multiplier effect, beef dollars eventually affect almost every sector of the local economy by passing through businesses which provide goods and services to the cattle industry and to individuals and companies which supply these businesses.

The beef producing business particularly affects the High Plains of Texas, since most of the feedlots are clustered in this area. In 1986, more than 4.5 million cattle were fed in 82 Panhandle feedyards. At current

continued on page 3 ... CATTLE

1987 Fed Cattle Survey

In Southwestern Public Service Area (Texas Only)
Where 4,527,749 Cattle Were Fed in 1986.



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Tech Research Feedlot "Modern"

"The development of irrigation and the increase of grain production enabled the cattle industry in the High Plains of Texas to grow," says Dr. Rodney L. Preston, Director of the Burnett Center for Beef Cattle Research and Instruction. The Center is locally known as the Texas Tech feedlot.

In a $3 billion a year industry, every animal in a feedyard represents hundreds of dollars of investment and potential profit. The more efficiently a feedlot can fatten its cattle, the more profit it will make. Thus, feeding these hungry animals effectively for rapid weight gain, while satisfying the current consumer demand for leaner meat, has turned into a science.

Through the recently completed feed mill and feedlot, the Texas Tech Center is researching ways to improve the economic efficiency of cattle feeding. The experimental

continued on page 3 ... TTU

New Information/Education Director

McCain Joins District Staff

Carmon E. McCain joins the High Plains Underground Water Conservation District No. 1 as the new Information and Education Director after seven years with the composing department of the *Lubbock Avalanche-Journal.*

A native of Midland, Carmon graduated from both Midland High School and Midland College and later from Texas Tech University with a bachelor's degree in journalism and public relations.

"Working nights for the A-J provided me with additional insight to the mechanics of producing a publication," says Carmon. "Deadline pressure is almost second nature."

Writing for a publication is nothing new, either. Carmon served as newsletter editor for Lions Clubs International District 2-T2 for two years and edited his home club newsletter as

continued on page 3 ... McCAIN

Carmon McCain

Rigs Enable Phosphorus Deep Placement

Lockney Farmers Develop Liquid Fertilizer and Tillage Operation

Research at the Texas Agricultural Experiment Station in Lubbock during the past year has demonstrated the importance of phosphorus and its effect on water use in field crops.

Because of limited movement of phosphorus in the soil, a great deal of interest has developed in equipment and technology to apply phosphorus at a depth where the plant can best utilize it.

The optimum application method seems to consist of banding the phosphorus into the soil just below the plow layer, rather than broadcasting the phosphorus and then disking it in. Banding below the plow layer provides two advantages. First, the phosphorus is concentrated so that a higher percentage of the nutrient will be in an area where there is a large concentration of plant roots. Second, the loss of moisture to evaporation below the plow layer is small and therefore phosphorus is available to the plant for a longer period of time.

Two Lockney farmers have developed a way to band liquid fertilizer in combination with other tillage operations. By attaching a pump and plastic tubing to their plow rigs, Ricky Kellison, who operates Comprehensive Agri Services in Lockney, and Ronnie Aston, a cotton farmer in Floyd County near Lockney, can band fertilizer during almost any phase of their farming operation.

On Kellison's rig, a pump is attached to the plow. The pump injects the fertilizer into a hose which carries the liquid to a central manifold located on the middle of the tool bar. From there, the liquid is dispersed into tubes which are attached to each plow. The tube carries the fertilizer to the plow tip and ejects it at whatever soil depth the plow is set.

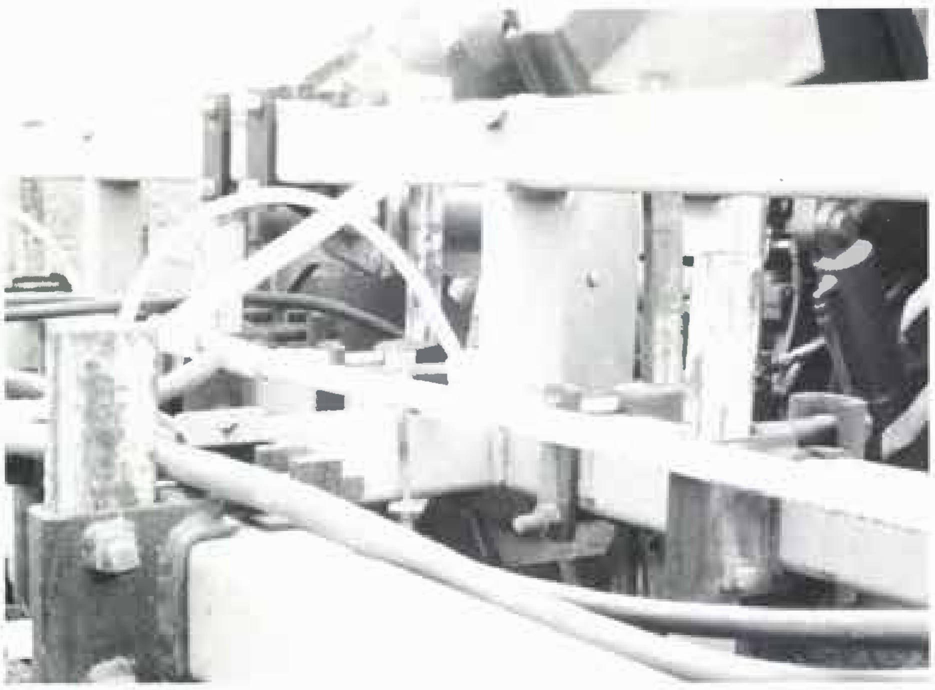
Aston uses the same concept and equipment, except that Aston uses plastic PVC pipe running the length of the tool bar instead of a central manifold. A hose connects the pump with the pipe and individual tubes attached at intervals on the pipe conduct the fertilizer to the plow tip where the fertilizer is ejected into the soil. Aston banded his phosphorus a minimum of 8-10 inches deep during listing using this method.

Both systems disperse fertilizer with a pump operating on a positive displacement ground wheel. With this ground wheel, each man can calibrate his system so that the pump puts out fertilizer only when the wheel touches the ground. The amount of fertilizer applied is automatically adjusted according to the speed of the wheel. The calibration involves the size of the tire, the size of the sprocket driver and the ratio between the tire size, the teeth on the drive sprocket and the teeth on the driven sprocket. The tank containing the liquid fertilizer rides on the tractor.

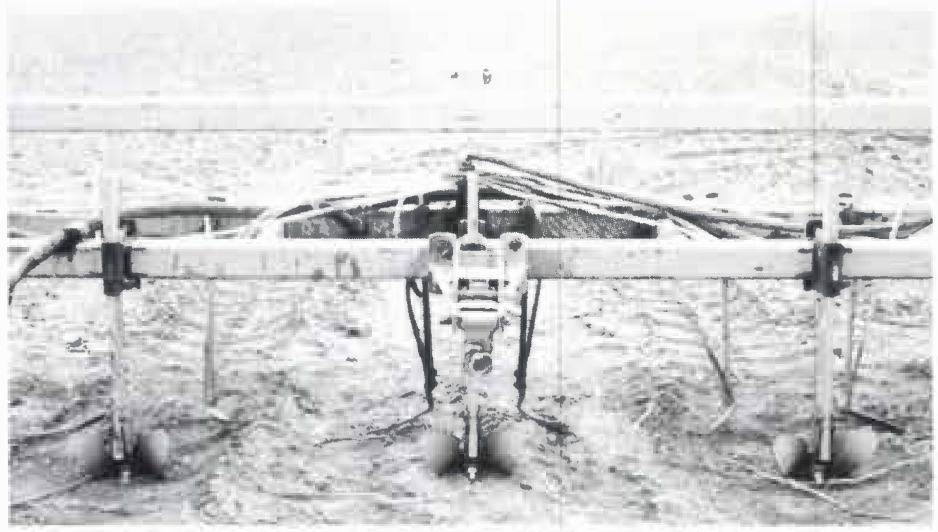
A fertilizer application unit of this sort offers several benefits, including saving time, fuel and money, says Kellison. It allows the farmer to perform two operations in one trip. "I'm not making an extra trip to put out fertilizer. I'm going to save three trips across my land because I'm going to fertilize at times when I'll be out there anyway," states Aston.

By aiming for a versatile rig that fits easily into their management practices, Kellison and Aston also cut down on the investment cost. "One thousand dollars could pay for this rig if a rebuilt pump is used," notes Aston.

The system allows the farmer flexibility in fertilizer management in terms of how often he applies fertilizer, when he applies fertilizer and the soil depth at which he places fertilizer. Aston comments, "Some people don't fertilize until late June to see what the hail does. This rig does leave me some versatility with nitrogen. If I get hailed out, I won't apply more nitrogen."



Ronnie Aston's fertilizer rig has PVC pipe running the length of the tool bar. Plastic tubing supplies fertilizer from the pipe to the chisel tips. Aston says the rig construction was inexpensive.



Ricky Kellison's rig uses beet knives to side-dress fertilizer 6-10 inches deep on both sides of the rows.

Surface Reservoir Conservation Totals Up

The Texas Water Development Board recently reported that surface reservoir conservation storage in Texas has surpassed 30 million acre feet for the first time in history. This is 94 percent of the conservation capacity of all the surface reservoirs in the state.

It is interesting to note that the Ogallala aquifer in the High Plains of Texas contains about 420 million acre feet of water. This amount is 14 times greater than all the surface reservoir conservation storage in the state.

If the 420 million acre feet of water in storage in the Ogallala were placed in a reservoir with the same surface area covered by the Ogallala Formation in the High Plains of Texas, the average depth of water in the surface reservoir would be about 18 feet and would cover 23 million acres.

THE Cross SECTION

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TTU High-Tech Feedlot Researches Cattle Feeding Efficiency

continued from page 1

feedlot incorporates the latest techniques in cattle feeding and researches various combinations of feed rations.

The basic facility consists of a feed mill, which processes feed grains for cattle and other livestock operations, a three-level, computer-operated mixing plant and 122 cattle pens. Preston states, "This feedlot is state of the art. There isn't another cattle research facility like it."

FEEDLOT

The feedlot includes 114 pens capable of holding eight animals each. In these pens, cattle are fed daily through an automated belt-feeder system. These pens stand on a partially-slotted concrete surface for easy waste removal. Eight conventional dirt pens can hold 32 animals each and are used for teaching purposes. The feedlot also includes a cattle working area with sorting pens, several chutes and an office with a sample preparation laboratory. In addition, the facility features electronic scales for weighing cattle and an IBM computer which stores and computes cattle weights and feed data. Currently, the feedlot holds about 950 cattle with seven animals in each pen.

MIXING PLANT

The mixing plant handles formulation of the various ration combinations used in the feedlot. Different combinations of feed grains, roughages, micro-ingredients and liquid ingredients, along with the total feed weight, are fed into the computer to produce the rations.

The computer system can feed up to 200 rations at any time. But with four to five pens assigned to each experiment, researchers have never used more than 25 different rations at once. Preston is working with 12 to 14 rations in his current experiments.

"It is a very scientific method of feeding," he says. "The computer will put any amount of any ingredient we want in a ration. This enables us to produce any kind of experimental ration that we need for research purposes."

MIXING FEED RATIONS

The whole mixing process is like following a recipe. The ration recipe is fed into the computer, which directs the measuring, mixing and transportation of feed into each pen. Each ingredient is carefully measured before it is mixed, and rations are prepared for one pen at a time.

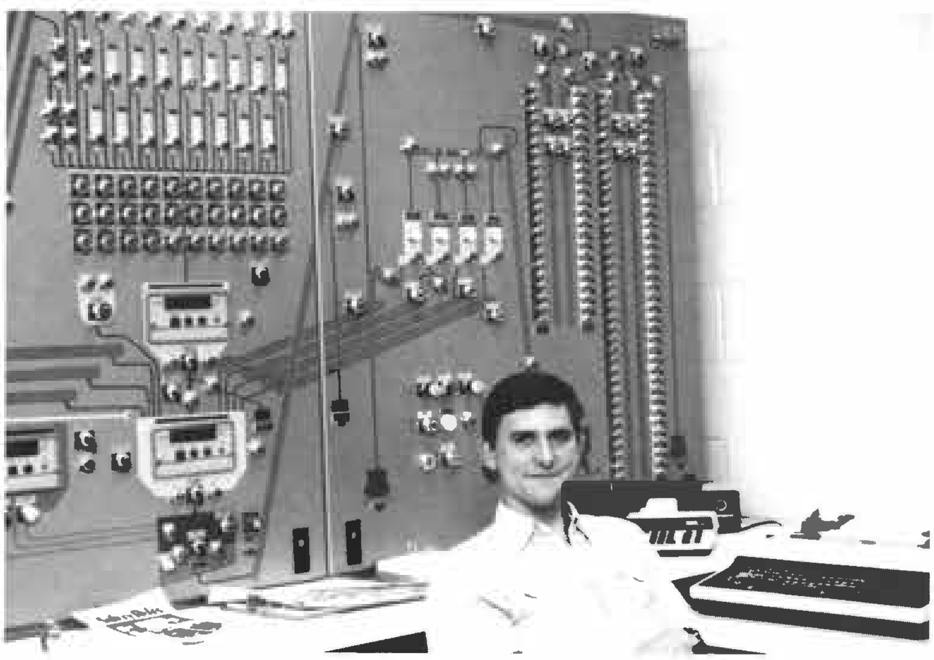
During on-going experiments, daily observation of the feed troughs determines when the amount of feed needs to be increased or decreased. The new feed weight is entered into the computer, which recalculates the amount of each ingredient going into the ration prior to mixing.

The measuring process begins on the top floor of the mixing plant where 24 canisters are arranged in a circle. The canisters contain micro-ingredients such as vitamins, minerals and antibiotics. Preston compares them to a spice rack.

According to ration specifications, each required micro-ingredient feeds down to a scale and is weighed to the nearest two-hundredths of a pound.

On the next floor, the three major ingredients, corn, grain sorghum and wheat, as well as roughages, are fed onto a larger scale which is accurate to the nearest tenth of a pound. Roughages used include cottonseed hulls, silage and alfalfa.

After the ingredients are measured, they drop into a mixer located on the ground floor. Here, the liquid ingredients, water, molasses and fats, are weighed and added to the mixture.



Texas Tech graduate student Glen Ross sits before the computer which directs the ration formulation and feeding processes at the Texas Tech University experimental feedlot. The boxes, bars and lines show a schematic representation of the mixing plant and feedlot.

FEEDING

After the ration is mixed, it drops onto a conveyor belt which carries it out of the mixing plant and across a road to the cattle pens. "Then it is distributed via the belts to one of 114 pens," explains Preston. A plow and brush distribute the feed evenly in the trough at the individual pen.

The system takes about three minutes to feed each individual pen,

continued on page 4 ... TTU

Cattle: "Big Business in Texas"

continued from page 1

market prices of $72.50 per hundred weight, a 1,000-pound steer is worth $725. Thus, the 4.5 million cattle in Panhandle feedlots will have a potential value of about $3.26 billion when they reach slaughter weight.

The larger Texas feedlots spent about $2.2 billion in 1985 for goods and services. Most of this money went to purchase feeder cattle and feed grain, promoting ranching and grain crop operations in the area.

Feedlots also provide a ready market for local farmers and grain elevators. Feedyards spent $378 million in 1985 to purchase feed grains. Cattle feed requirements are about 20 pounds per head per day, so feedyards reduce transportation costs by purchasing grain locally. In addition, feedyards often offer feed and special silage contracts to local farmers. According to Bill Nelson, Executive Vice President of the Texas Wheat Producers Association, the demand for wheat at feedyards often adds 25 to 50 cents per bushel to the price of wheat at harvest time.

In addition to providing a steady market for cattlemen and farmers, the feedlot itself provides employment. On the average, the industry employs 1.4 employees for every 1,000 head of feeder cattle. More than 7,300 people are hired to buy, sell and take care of fed cattle. The feedlot payroll totals more than $131 million, and most of the money stays in the local economy. The Texas cattle feeding industry creates about 106,000 jobs and generates more than $1.4 billion in personal income annually.

Feedlots attract packing plants, and these operations also provide local employment, generate revenue and require goods and services for operation. Texas slaughter houses generated $1.15 billion in 1985 from primary meat sales, which were mostly supplied with cattle from state feedyards. Texas feedyards sold 90 percent of their fed cattle to state packing plants. Twelve packing plants capable of slaughtering more than five million cattle are located in the Panhandle.

Feedlots circulate money in other areas and influence non-agricultural businesses.

For example, feedlots generate $13.2 million annually for the trucking industry, with an average of six truckloads of grain delivered to feedlots each day. The typical cattle-feeding operation will borrow 75 percent of the capital needed to run the operation from credit agencies, stimulating hefty interest fees paid to the bank or credit institution. Feedlots paid $35.3 million in taxes in 1985 and made property payments totalling $97 million. Beef by-product sales totalled $164 million in 1985.

The nation eats Texas beef. Restaurants paid an estimated $104 million for Texas beef to satisfy their customers. Texas packing plants sold 60 percent of their beef to out-of-state clients. Texas beef sold out of state in 1985 bought $1.55 billion into the state economy.

Texas leads the United States in many areas of cattle production, including numbers of cattle and calves, cattle operations, farms and ranches, fed cattle marketed and cash receipts for cattle and calves. The cowboy lives on, managing cattle that are now a billion-dollar industry.

McCain New Staff Member

continued from page 1

well. He was also a general assignments reporter for the Texas Tech *University Daily*.

He is active in civic affairs. Carmon is a member of the Hub Lions Club and is currently serving a two-year term on the Board of Directors of the Texas Lions Camp for Crippled Children at Kerrville. He explains, "I find it satisfying to be affiliated with the Texas Lions Camp. It gives approximately 1,400 handicapped and diabetic children a chance to experience camping for two weeks each summer and learn to be accepted by their peers."

Carmon and his wife, Karen, have a daughter — Kimberly Shannon — born May 13, 1987. Karen is employed as a secretary for Sonja O. Lee, DVM.

Carmon says, "The Water District has a very important message to tell not only the farming community, but each of us who utilizes our precious resource — water. This organization provides an excellent opportunity to work with a diverse group of individuals. I look forward to promoting the water conservation messages of the District."

Salt Pond Creates Electricity

EDITOR'S NOTE: In future issues of *The Cross Section,* we plan to expand our reporting to include various land and water management alternatives that might provide economic opportunities for residents on the Texas High Plains.

The following story examines the potential use of saltwater to provide electricity. (This story was written by former *Cross Section* Editor Kathy Redeker and contains excerpts taken from an article originally appearing in *U.S. Water News.*)

For years, oil and gas producers in the High Plains of Texas have searched for economical ways to dispose of the salt water that is a by-product of oil and gas production. Now, it seems that some people in El Paso may have the perfect solution.

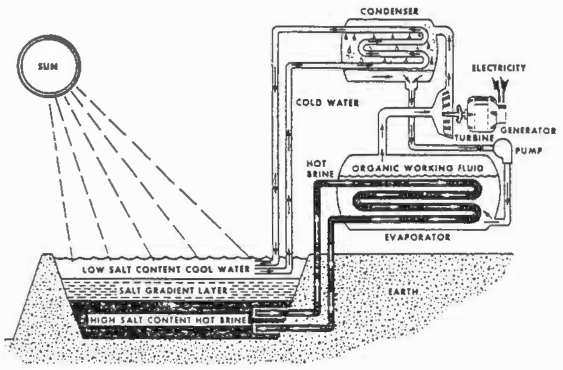
In a cooperative project involving the U.S. Bureau of Reclamation, El Paso Electric Company, Bruce Foods Corporation and the University of Texas at El Paso, the nation's first solar pond power system is in operation at a test site near El Paso. The system will ultimately produce both fresh water and electricity from salty water.

The small-scale project, consisting of a 0.8-acre pond, is being used to convert saline water into fresh water and electrical power. The first phase of the project, power generation, began last fall; and the second phase, the water desalting system, will become operational this year. So far, the solar pond has been effective in generating up to 100 kilowatts of electricity. That is enough to supply 10 homes.

Saline water, heavy with dissolved minerals and salts, often kills crops and corrodes plumbing; but in a solar pond this water is put to beneficial use. The sun's heat warms the salt water at the bottom of the pond, while layers of cooler fresh water at the surface serve as an insulation to prevent heat from escaping into the atmosphere. The hot salt water is used to boil Freon, turning it into a gas that propels a turbine, which in turn, spins an electrical generator. At the same time, the layer of fresh water is constantly removed as it is distilled by the sun's heat.

The pond is located at the Bruce Foods canning plant on the outskirts of El Paso. Power from the solar pond is being used to provide process heat for the canning operations, and company officials estimate the solar energy will save the plant $20,000 in electric bills a year.

The saltwater that is a by-product of oil and gas production has typically been considered a nuisance more than anything else. However, based on the work being done in El Paso, this salt water may be a potentially untapped resource that could be used by municipalities or private industry in the Texas High Plains for power generation and fresh water production.



The first solar pond successfully implemented in the United States provides both fresh water and electricity to Bruce Foods in El Paso.

Critical Ground Water Areas Named

The first two areas scheduled for study as potential critical ground water areas have been designated by the Texas Water Commission and the Texas Water Development Board.

One area includes portions of Travis, Williamson, Milam, Bell and Burnet counties. The other study area covers all of Blanco, Kendall and Bandera counties as well as parts of Travis, Hays, Comal, Medina, Kerr, Gillespie and Burnet counties.

The studies will examine the occurrence and availability of ground and surface water. Also, conservation practices and the protection of ground water will be noted. Projected water supplies, population increase, and water quality during the next 20 years for these areas will be examined. These potential critical ground water areas will be researched by a joint team representing the Texas Water Commission and the Texas Water Development Board.

The regions proposed for the study exclude areas lying within existing underground water conservation districts.

TTU Feedlot Research Noted

continued from page 3

while the whole feeding process takes about six hours.

RESEARCH

Although the feedlot has only been in operation a year and a half, some results have already been noted.

For instance, bloodmeal, a packing plant by-product normally used in poultry and swine feeds, appears to be beneficial to newly shipped-in feeder cattle as a source of protein. Preston notes, "We've been getting fantastic gains with the bloodmeal."

Corn gluten meal, a by-product of a Dimmitt corn sugar plant, also helps alleviate the stress of shipping.

The Tech feedlot is located at the Northeast Lubbock County Field Laboratories, 15 miles north of Lubbock and six miles east of New Deal.

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Loan funds Still available For equipment

Loan funds continue to be available from the High Plains Underground Water Conservation District No. 1 for the purchase of agricultural water conservation equipment.

The Agricultural Water Conservation Equipment Pilot Loan Program was to expire August 31, 1987, but legislation sponsored by Senator John Montford of Lubbock in the 70th Legislative Session extends the program until August 31, 1989.

A part of the water package approved by Texas voters in November 1985, the Pilot loan program has been in effect since May 1986 when the Water District obtained the first funds. The Water District borrows funds from the Texas Water Development Board to lend to qualified irrigators to help promote water conservation measures. Irrigators may obtain loans for the purchase of agricultural water conservation equipment such as center pivot sprinkler systems, surge irrigation systems, low pressure drip irrigation systems, soil moisture monitoring equipment and underground pipeline. Irrigators may borrow up to 75 percent of the purchase price of permanently installed equipment and 50 percent of the cost for contractor services, installation and non-recoverable items.

The funds are loaned at 6.75 percent interest, and a one-time service fee of 2.5 percent of the loan amount is charged to cover administrative costs. Loans are processed on a first-come, first served basis.

For Water District loan guidelines and applications, contact Becca Williams at the High Plains Water District office at 2930 Avenue Q, Lubbock, Texas 79405, (806) 762-0181.

Solons flood session with ground water bills

STATE HOUSE—The State capitol building in Austin (above) was the site of numerous discussions concerning the protection and management of ground water during the recent 70th Texas legislative session. Nearly 50 water-related bills were introduced by lawmakers during this time.

By Beth Snell

Of the issues addressed during the 70th Texas legislative session in Austin, the protection and management of the ground water resources in the state emerged as a principal topic of discussion by the Legislature. Almost 50 bills concerning ground water, some of them controversial, were introduced during the session. However, a majority of the ground water related bills did not pass the legislature, leaving Texas' current ground water management laws relatively unchanged.

In the May issue of *The Cross Section,* we described several proposed water bills. When the legislative session closed at midnight June 1, only two of the highlighted bills — Senate Bill 410 and House Bill 1582 — had passed the House of Representatives and Senate. These bills were later signed into law by Governor Bill Clements.

SB 410 — Pilot Ag Loan Program

Senate Bill 410, sponsored by Senator John Montford of Lubbock, became effective May 26. The measure extends the Agricultural Water Conservation Equipment Pilot Loan Program until September 1989, for further evaluation of the program.

Through the pilot loan program, funds are made available to individual borrowers for the purchase of agricultural water conservation equipment through underground water conservation districts as well as soil and water conservation districts. The districts borrow the money from the Texas Water Development Board.

Another provision of the bill makes irrigation districts authorized lenders. Pilot program grants may also be used on dryland farms and rangeland. In addition, the bill expands the program's equipment and services to include physical conversion by an irrigation district to an approved irrigation water delivery system.

HB 1582 — Policies and Audits

House Bill 1582, sponsored by Representative Tom Craddick of Midland, concerns the policies and

See FEW BILLS Page Three

Risinger given USDA award

William M. "Mike" Risinger received the U.S. Department of Agriculture's Superior Service Award from Secretary of Agriculture Richard E. Lyng during recent ceremonies in Washington, D.C.

The Agriculture Secretary noted that President Abraham Lincoln established the USDA in 1862 as a government agency, or "People's Department," to dispense service to the American people.

"Over the past 125 years, that concept of service has been demonstrated daily on America's farms, in our rural communities and in urban centers all across this nation", Lyng said. "I know from personal experience that these individuals represent the finest among the entire Federal work force."

Risinger, a soil scientist with the USDA's Soil Conservation Service (SCS), was cited for superior technical assistance which benefitted farmers by conserving soil, water and energy resources in the High Plains of Texas.

Since 1981, he has helped the High Plains Underground Water District No. 1 as well as the SCS provide soil moisture monitoring information to farmers throughout a 15 county area. This monitoring project has helped area farmers save several thousand acre-feet of water annually.

"I never expected to be recognized at this level," Risinger said. "This is what you expect to happen to someone else."

Risinger began his conservation career in 1967 as a student trainee in Pampa. He later graduated from Texas Tech in 1969 with a bachelor of science degree in agronomy. In 1973, he received a master's degree in soil science.

Mike Risinger

Australian recycles tires, bottles to save surface water

EDITOR'S NOTE: The old set of tires in the barn and the non-returnable plastic bottles on the shelf could prevent water evaporation losses. Crazy? The following story, reprinted from *U.S. Water News*, shows how these normal throw-away items are finding new lives in the fight to halt evaporation water losses. This technique may have application in prolonging recharge in the larger playa areas on the Southern High Plains of Texas and New Mexico over the Ogallala formation. Other uses may include small lakes, farm ponds and stock tanks throughout the state.

SYDNEY, Australia — In the land "down under" where up to 90 percent of the available surface water dries up each year, an inventor has taken some old tires and empty bottles to put a lid on the evaporative loss of water.

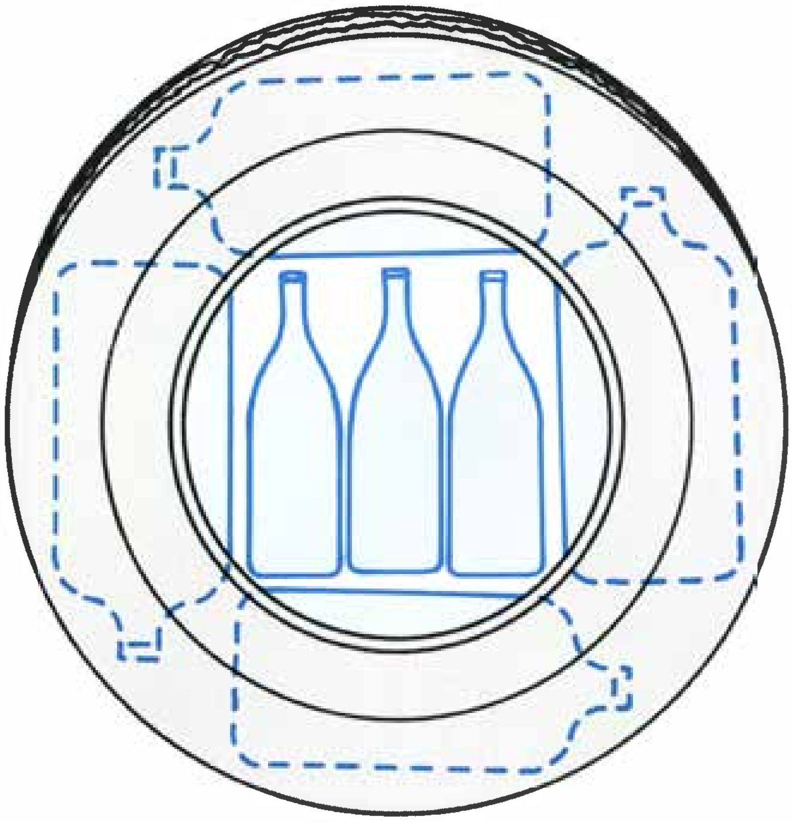
After seeing dead and dying livestock around a dried up waterhole during a recent Australian drought, Cornelius Doyle came up with what he calls his "Dambooster" idea. Doyle's invention is to simply link tire-bottle units together to cover much of the surface area of a water reservoir to reduce the amount of water exposed to the sun. After being cleaned and sorted, the glass and plastic bottles are stuffed inside a car or motorcycle tire to give it buoyancy, and a cover disc of marine plywood, aluminum, or Masonite is attached.

After being assembled, the tire-bottle units are simply shoved out onto the reservoir until most of the surface area is covered. The quantity of available tires is no problem in Australia, because over 12 million are dumped each year, posing a significant pollution problem. The tires are not worth recycling, said Doyle, because 90 percent of them contain no rubber.

"I first developed the idea of the 'Dambooster' during a disastrous drought that lasted four years, ending in 1982," said Doyle. "As far as I know, there is nowhere else in the world using a similar system." He pointed out that Australia's Commonwealth Scientific and Industrial Research Organization has tried various methods, including floating ping-pong balls, to cut evaporation loss. All the methods have failed.

To test the Dambooster concept, Doyle compared evaporation loss of two small water tanks. One tank had a tire "lid." while the other was left open to the atmosphere. After six months, the water level of the tire-lidded lake fell by just over an inch, while the open tank completely evaporated and had to be refilled four times. "The water in the tire-lidded tank was still palatable even after 18 months," he said.

Evaporation has been cited as a major cause of water loss on the continent of Australia each year. In 1983, one of the nation's senators was quoted as saying, "fifty percent of the water that falls on Australia each year runs into the sea and is wasted. Of the rest, about 90 percent evaporates. Of the remainder, one percent is consumed in domestic, industrial and municipal use and seven percent in irrigating crops and watering stock."



HPUWD Graphic/Keith Whitworth

DAMBOOSTER IDEA—Australian inventor Cornelius Doyle inserts plastic and glass bottles into a discarded tire, as illustrated, then shoves the entire unit onto the surface of a pond. These "dambooster" units help combat water loss through evaporation.

THE Cross SECTION

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NOTICE: Information regarding times and places of the monthly County Committee meetings can be secured from the respective County Secretaries.

Applications for well permits can be secured at the address shown below the respective County Secretary's name.

New tax reforms slash conservation deductions

Soil and water conservation expenditure provisions have been changed due to the Tax Reform Act of 1986, and those involved in agri-business are advised to consult with their personal tax adviser regarding the new law's full effect.

The old federal tax code provided for taxpayer deduction of soil and water conservation practices which would otherwise have to be capitalized.

Among these deductions, as determined by the Soil Conservation Service (SCS), were grading, terracing and contour furrowing as well as the construction of drainage ditches, irrigation ditches, dams, ponds and windbreaks.

However, the 1986 Tax Reform Act revised the tax law to limit such deductions to those consistent with a conservation plan approved by the SCS or a plan of a comparable state conservation agency.

The SCS defines an approved plan as one meeting the requirements of the National Conservation Planning Manual and the Field Office Technical Guide. The plan must also have the signature of the district conservationist. This provision applies to expenditures incurred after December 31, 1986.

Expenditures for draining or filling wetlands must be capitalized and added to the cost of the land. Also, installation and operation of center pivot irrigation equipment must be capitalized and deducted through depreciation.

Special land clearing deductions have been deleted by the new tax reform law. After 1986, only expenses for routine brush clearing and other ordinary property maintenance activities will be deductible.

The cost of acquiring and applying fertilizer, lime and other soil conditioners is still deductible in the year paid — even when the effectiveness of the conditioner applied will last longer than one year.

Taxpayers will have the burden of proof for expenditures. They must maintain expense records as well as a copy of the conservation plan they are working under.

Field Demonstration Days

The rainfall simulator is among 1987 field day exhibits.

Farm water management field day demonstrations are currently under way in the 15-county service area of the High Plains Underground Water District No. 1. Please plan now to attend the field day activities in your respective county!

Date	County
July 7th	Hale
July 8th	Lynn
July 9th	Castro
July 10th	Crosby
July 14th	Potter & Randall
July 15th	Lamb
July 16th	Bailey
July 17th	Deaf Smith
July 23rd	Lubbock
August 4th	Armstrong
August 11th	Hockley

Few ground water bills pass despite large number introduced

Continued from Page One

audits of certain water districts and river authorities.

Specifically, the bill requires the board of directors of a river authority or water district to adopt a code of ethics for district officers, directors and employees. A policy for expenditures, district investments and management information, including a cost control budget, audit committee and uniform reporting requirements must also be adopted. In addition, each district or authority must file its annual audit with the state auditor's office unless that office performs the audit.

ADDITIONAL BILLS

A few other bills of interest to those in agri-business were also passed. Among them are the following:

SB 779 — Underground Storage Tanks

Senate Bill 779, sponsored by Senator Tati Santiesteban of El Paso, regulates certain underground storage tanks holding potential ground water contaminants. The provisions include the imposition of fees, authorization of late payment charges and establishment of an underground storage tank fund to cover administrative and inspection costs, as well as corrective action costs incurred from leakage.

The Act also empowers the Texas Water Commission to adopt regulation requirements, storage tank performance standards, leak detection system standards, requirements for substance release contingency plans and tank closure requirements. In addition, the TWC has the power to take corrective action and issue emergency orders, whenever deemed necessary. Underground storage tanks exempt from the Act include farm or residential motor fuel storage tanks with a 1,100 gallon capacity or less; surface impoundments, pits, ponds or lagoons; and tanks used for exploration, development or production of oil, gas, or geothermal resources. This Act takes effect September 1.

HB 1328 — Application Fees

Through House Bill 1328, introduced by Representative Cliff Johnson of Palestine, the Texas Water Commission may charge an application fee of up to $700 for petitioners wishing to create a water district, a resolution for a water district conversion or the addition of sewage/drainage powers. Also, anyone who files a bond issue application with the TWC may be charged a fee not exceeding $500.

HB 1347 — Water Well Drillers Act

The Water Well Drillers Act has been expanded and clarified through House Bill 1347, sponsored by Representative Jack Harris of Pearland. The bill's provisions mandate a license for any type of driller service, in addition to current license requirements for water well or injection well drilling.

Also, well drillers will be required to notify the Texas Water Commission and the landowner when harmful water is encountered during drilling. This measure helps ensure that the well will be plugged, repaired or completed to avoid injury or pollution. Licensed drillers must also notify landowners or well owners when an abandoned or deteriorated well is discovered. The bill states that the owners of abandoned or deteriorated wells must cap or plug them within six months. Under this law, a well is considered "abandoned" if it has not been used in six months. A deteriorated well will likely cause water pollution. This bill takes effect September 1, 1987.

HB 1875 — On-Site Sewage Systems

House Bill 1875, sponsored by Representative Mike Millsap of Fort Worth, requires persons to hold a valid Texas Department of Health permit before construction and/or operation of an on-site sewage disposal system can commence.

The bill also authorizes the Department to establish reasonable fees to cover the permitting costs.

The majority of the bill's provisions will take effect September 1, 1987. This bill grandfathers sewage facilities existing prior to the effective date providing there has not been any significant increase in the system's use or the system received approval for construction from a legally authorized licensing authority prior to the effective date.

HB 1896 — Agricultural Chemicals

House Bill 1896, sponsored by Representative Nancy H. McDonald of El Paso, requires certain agricultural employers to provide agricultural laborers with information concerning hazardous chemicals to which they may be exposed.

Researchers pleased with artificial recharge data

By Carmon McCain

Researchers at Texas Tech University's Water Resources Center are "very happy" with data received from their recent artificial recharge experiments.

The playa recharge installation, located in a playa basin near Shallowater, is designed to evaluate the potential for using native soil components and geotextile filter materials to remove the silt and sand, sediments and biological life from the playa water before it is injected into the Ogallala aquifer.

This marks the second year research has been conducted using three different filtering systems at the playa site. A 12-inch layer of soil was excavated from the playa lake basin to create the **pan system.** Forty trenches were dug in the pan and were partially filled with gravel. Perforated plastic pipe and gravel were placed in the trench. Sand, gravel and natural playa materials were used to backfill the site.

The HiTek system is made up of 19 partially gravel-filled trenches containing filters. PVC pipe connects the filter to the recharge well. The system is covered with sand and playa basin top soil.

The A.D.S. system consists of a geotextile filter placed in a 16-inch deep trench and covered with gravel, sand and playa basin soil. (**Ed. Note** — Each of these systems were described in detail in the July 1986 issue of *The Cross Section.*)

The playa basin began receiving rainfall during the last week of May, according to Dr. Lloyd Urban, TTU Water Resources Center Director. "Last year's experiences taught us that after a heavy rain, the lake water will contain a number of fine particles in suspension. It takes one to three days for these materials to settle out," Urban said.

"Fine-tuning" of the recharge system began on June 1, and actual continuous playa recharge began on June 4.

Initial flow rates for the three systems are similar to those recorded in 1986, Urban said.

"We are seeing a combined flow of about 200 gallons per minute. The A.D.S. and HiTek systems are initially showing 100 to 110 gallons per minute," he said. However, a faulty flow meter denied the researchers figures for the pan system. "It appears we will have an initial 150 to 160 gallons per minute flow into the well with this system," he added.

Urban noted that the flow rates are declining as expected with a typical infiltration operation.

"During the first two weeks, it appears that the rate of recharge averaged about 200 gallons per minute," he said.

At press time, the system was filtering nearly one acre-foot of recharge water daily. Urban said 16 acre-feet of water had been recharged since the injection operation began June 1.

"This is very encouraging. The flow rates are high and are what we expected based on the 1986 data. We have also found that our recharge well is accepting water at a greater rate than in 1986," he said.

The increased water acceptance rate is due to end-of-season well maintenance. Urban said chlorination and pumping redeveloped the well acceptance capacity.

"Water quality has also been tested, and we have seen a higher quality in our recharge water than we had in 1986. Samples tested show low nitrates, sulfides and chlorides," Urban said.

Urban terms the project results "very satisfying." He is pleased to see the actual results of the research.

"Recently, we had a cloudy week, and there was very little run-off coming into the lake. Yet, you could actually see the water level dropping day by day. It was real neat to see almost an acre-foot of water leave the lake each day and go through the artificial recharge process," he said.

HITEK DRAIN FIELDS—In this 1986 file photo, some of the 19 V-shaped ditches are shown with HiTek filters in place. These filter drain lines are connected with PVC pipe to a central water line entering the recharge well. Tech researchers state the initial flow rate for the combined filtration systems is 200 gallons per minute.

Playas: Good irrigation source

Irrigators should ready their pumps and lines to take advantage of recent rainfall runoff which has increased the volume of water in the numerous playa basins dotting the High Plains Underground Water Conservation District No. 1 service area.

The prepared irrigator can take advantage of rainfall runoff which collects in playa basins about three times a year. Generally, the catchments during a rainfall event are not large. Therefore, if the runoff is not utilized in a short period of time, it will be lost due to evaporation, evapotranspiration or deep percolation.

Irrigators can save pumping costs and reduce demand on the Ogallala aquifer through the use of playa basin water.

The amount of fuel needed for powering a lake pump is usually about 50 percent less than that needed for pumping ground water. Also, the initial investment in setting up a lake pump system can usually be recovered in one year through fuel savings and increased yields, provided the basin catches an ample supply of water. In the thin sections of the aquifer where well yields are low, a higher volume of water can be pumped with lake pumps than from the wells, allowing more acres to be watered in a shorter period of time.

Playa water pumping reduces the dependency for water from the Ogallala aquifer and preserves ground water for future use.

Playa basin water is beneficial to crops as well. Most major crops grown on the Texas South Plains are very sensitive to temperature variations. Water pumped from playa basins averages about 80°F from June through September while water pumped from the aquifer is a cooler 63°F. The cooler water temperature can lower soil temperatures and retard plant growth.

Other playa basin water irrigation benefits include weed control and elimination of mosquito breeding areas.

Through the use of water collected in these natural reservoirs, producers can take advantage of a cost-effective, efficient means to decrease their dependency on ground water.

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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Directors review 10-year management plan

MANAGER'S NOTE: The High Plains Underground Water Conservation District No. 1 Board of Directors adopted a 10-year management plan in 1980 to be used to guide the manager in directing the long-term activities of the District. The Management Plan is presented below, with status reports in italic type. Each year, the Directors review the progress or status of each of the activities outlined in the plan. In their annual deliberations, they consider the current needs of the area and may add new projects and de-emphasize or accelerate work on certain projects.

The five Board members are dedicated to making sure the Water District serves the needs of the area in matters pertaining to the conservation and preservation of ground water resources. They welcome your comments and suggestions on how the Water District can better serve the area. **A. Wayne Wyatt**

Please direct your comments to:
Mr. James P. Mitchell
Chairman, Board of Directors
High Plains Underground Water
Conservation District No.1
2930 Avenue Q • Lubbock, Texas 79405

High Plains Underground Water Conservation District No. 1
Management Plan — 1980-1990

1. **Continuing enforcement of the rules of the Water District, including requiring spacing of wells, protecting the aquifer from pollution, and prohibiting the waste of water.**
2. **Inventorying ground water resources and publishing maps illustrating the quantity and areal distribution of this resource.**
   Detailed hydrologic atlases were published in 1981 for each county served by the District and are currently being updated to illustrate the ground water conditions as of January 1985. These atlases contain a short text and a set of maps illustrating the elevation of the land surface, the elevation of the water table for 1985, the elevation of the base of the aquifer and the aquifer's saturated thickness for 1985. Copies of these atlases are available through the county and district offices.
3. **Promoting on-farm water conservation with on-farm irrigation efficiency testing.**
   A. *A fleet of mobile field water conservation laboratories were constructed and equipped to conduct irrigation application efficiency tests. These mobile labs have been used throughout the District's service area.*
   B. *A cooperative agreement was made with the USDA-Soil Conservation Service to use the mobile labs and equipment to conduct irrigation application and distribution efficiency tests for any irrigator requesting this service.*

See PLAN Page Three

Revised Atlases Available

Newly-revised hydrological atlases for the southern counties of the High Plains Underground Water Conservation District No. 1 service area are now available to the public.

County atlases now ready for distribution include Cochran, Crosby, Hale, Hockley, Lubbock and Lynn.

"The original hydrological atlases were printed in 1981. For the revised atlases, updated data such as water-table elevation maps and saturated thickness maps depicting ground water conditions for 1985 were added. We feel this has enhanced the estimation of the ground water availability in these counties," said Don McReynolds, Geohydrologic Division Director.

McReynolds noted the remaining nine atlases are under revision, and their availability will be announced in future issues of *The Cross Section.*

Atlases may be obtained by visiting the District office or calling (806) 762-0181.

Wind strip-cropping helps new cotton survive

By Carmon McCain

Blowing topsoil and drying heat are two of the many obstacles young cotton plants must overcome on their way to maturity. However, a cultivation technique being used by a Lubbock County farmer may give his immature plants a better chance of survival.

Richard Bednarz, who farms near Slaton, is using wind strip-cropping for the first time this year, and he is already pleased with the results.

"The wind blowing from the south in the summer can really hurt young cotton. It looks like the plants will do better this year with a calm place to grow in," he said.

COTTON PROTECTION—Strips of haygrazer help protect young cotton plants until they can hold their own against the damaging West Texas wind. This cultivation technique is being used at the Richard Bednarz farm near Slaton.

Bednarz has planted a haygrazer wind strip-crop using a pattern of 26 rows of cotton alternating with six rows of sorghum. The tall haygrazer crop provides needed protection for the smaller, fragile cotton until it can hold its own against the wind.

Also, he noted that the two rows of cotton plants nearest to the haygrazer appear to be taller than the remaining rows. "I was driving along and noticed the definite rise out there. I don't know if those plants will yield more, but it will be interesting to see what happens," he said.

"My main reason for using this technique is that we do not have any extra employees to operate sand-fighting equipment during the early part of the growing season. With the wind-strips, the wind can be blowing, and the young cotton is protected. This gives us a chance to operate the sand-fighting equipment where it is needed the most instead of having to try to stop the sand blowing on every acre we farm in a few short hours," he said.

Also, he said he is using the wind strip-crop as conservation reserve acres. "The government has so

See WIND STRIP Page Two

Irrigators urged to watch for farm safety hazards

As irrigators increase their activity in the field, they should always keep alert to potentially hazardous situations. A little extra care can increase irrigation water management safety.

Aluminum irrigation pipe coming in contact with highline wires is the most commonly reported irrigation related farm accident. Many irrigators and children have been either seriously injured or killed when they tried to free a small animal from a section of irrigation pipe and accidentally touched the pipe to overhead wires.

The drive shaft on an irrigation pump turns at 1,750 revolutions per minute. Serious accidents can occur when clothing or other objects become snagged in the U-joints on either end of the shaft. In a split second, clothing can wind around the spinning shaft and pull in a leg or an arm causing serious injury. A guard or shield over the shaft can help eliminate this hazard.

All electrical equipment should be checked to see that it is properly grounded prior to operation. A reading taken on an inexpensive electrical tester, available at any hardware store, will indicate electrical current passing through the equipment. This will serve as a warning not to touch the equipment. Also, any loose or exposed wires on equipment must be repaired before use. Irrigators should seek professional electrical help to avoid shock hazards if any electrical current is detected. If you do not have an electrical tester, cut your risk by touching the electric-powered equipment with the **back** of your hand. If there is a current, you may be able to pull away. If you touch it with the **palm** of your hand, the electricity would force your muscles to pull and cause you to grip the equipment. Also, never touch electrically powered equipment while standing in mud or water.

Center pivot wires should be examined regularly. Shorted out wires can electrify the entire pivot, causing unwary irrigators to come into contact with 440 volts of electricity. Also, if center pivot and electric pump panel boxes are not properly grounded, they may be "hot" even though turned off. Panel boxes should be examined frequently for signs of wire wear or cattle damage, if livestock have been near the equipment since its last use.

Please take a little time this growing season to check and repair your potentially hazardous irrigation equipment. Caution your family and employees to be careful, as the life they save may be their own.

Wind strip protects cotton

Continued from Page One

much land set aside anyway. Some people leave the ACR land idle or plant black-eyed peas on it. We are going to have to plant something out there due to the government's soil erosion classifications — so I might as well use it like this," he said.

Bednarz said the planting went smoothly, and he can only foresee two potential problems with this type of cultivation: debris in cotton at harvest and bollworms.

"The worst problem I think I will have with this is getting the straw out of the cotton lint. Otherwise, it will cause the cotton to receive a poor grade. Also, I'm not sure if the sorghum planted between rows will attract bollworms. The experts say the insect likes corn, but they are unsure about the sorghum. I guess I'll have to wait to see what happens in the next two months," he said.

Already planning to incorporate wind strip-cropping into next year's production, Bednarz said he intends to move the crops over eight to nine rows. "The residue and stubble left behind by previous crops really helps. It looks like the best cotton I'll have this year is following grain sorghum," he said.

Bednarz serves as a member of the Lubbock County Committee for the High Plains Underground Water Conservation District No. 1.

EDITOR'S NOTE: For additional information on wind strip-cropping, please see the October 1986 issue of *The Cross Section.*

Field Demonstration Days

Farm water management field day demonstrations are currently under way in the 15-county service area of the High Plains Underground Water District No. 1. Please plan now to attend the field day activities in your respective county!

Date	County
August 4th	Armstrong
August 11th	Hockley

Call the District Office at (806) 762-0181 for detailed location information.

THE Cross SECTION

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NOTICE: Information regarding times and places of the monthly County Committee meetings can be secured from the respective County Secretaries.

Applications for well permits can be secured at the address shown below the respective County Secretary's name.

Plan cites District activities for decade

Continued From Page One

C. An extensive training program was conducted to teach the Water District and the SCS staffs to conduct irrigation application evaluations.
D. Written reports on the results of efficiency evaluations are provided to landowners/operators. Suggestions are offered for modifying equipment and/or practices to improve efficiency.
E. On-farm irrigation field days are conducted annually in each county served by the Water District to demonstrate to irrigators the latest techniques and equipment available to obtain maximum water use efficiency. The SCS, Texas Agricultural Extension Service and local soil and water conservation districts assist in conducting the field days.

4. Developing a public school education program to promote better understanding of ground water and the need for water conservation.
A. A supplementary textbook on water and water conservation in the Southern High Plains of Texas was written and distributed to the 65 public school systems in the Water District's service area. A revision of this textbook is currently in progress.
B. Teacher's guides were written to be used with the textbook and distributed to public school systems.
C. Films on water and water conservation are evaluated. Those considered worthwhile are purchased and distributed to the public schools through the Education Service Centers in Amarillo and Lubbock.
D. Additional water and water conservation educational materials have been purchased and distributed to the public school systems for use at the appropriate grade levels.
E. Water resources education packets have been developed for use in vocational agriculture classes and made available throughout the District.

5. Utilizing existing water education information materials and developing new educational tools for distribution to the general public.
A. The newsletter, **The Cross Section,** has been published and distributed since 1954. It contains current water information and is distributed free to approximately 6,000 local, regional, state, national and international readers.
B. A series of seven "Water Management Notes" has been written and distributed throughout the area. Each management note addresses a specific water conservation technique or tool.
C. Timely news releases on a wide range of water conservation topics are provided to the local media.
D. Fair booths with a water conservation theme are displayed at regional fairs each year.
E. Slide presentations addressing water topics are used for programs at civic and social clubs in the area.

6. Conducting research and demonstrations.
A. Research has been funded to develop a method for removing suspended solids from rainfall runoff water collected in playa basins for recharge into the Ogallala Formation.
B. It has been determined that there is 1.3 billion acre-feet of capillary water in storage in the High Plains of Texas. Research and field demonstrations have been conducted to develop and test methods of releasing this water to make it available for capture through wells.

7. Developing a program to assist local towns and cities in evaluating their current water supplies and, if needed, assisting them in locating the additional supplies needed to satisfy long-term needs.
A. Sixteen local towns and cities have requested and received water assessment studies.
B. Irrigation application and distribution efficiency tests have been conducted for local towns and cities in city-maintained parks and cemeteries in an effort to assist them in improving their water use efficiency.

8. Maintaining a program to provide a reasonable estimate of the net depletion of the Ogallala aquifer. This is accomplished by annual measurements of the depth to water below land surface in a network of approximately 950 privately owned observation wells.
A. The depth-to water measurements made in each well is published annually to provide District residents current water level conditions in the area where their farm is located.
B. The volume of water in storage in the aquifer in each county is calculated and compared to quantities available in previous years to provide an incentive for water saving in the following year.

9. Determining the baseline quality of the water in the aquifer and subsequently determining if any changes in the quality of the water in the aquifer have occurred.
A. Water samples have been collected for chemical analysis from a network of approximately 1,000 privately owned wells located throughout the Water District to determine the baseline water quality.
B. This same group of wells is re-sampled on a three to five year interval for comparison to earlier analyses to determine if any significant changes has occurred in the water quality.
C. If a significant change occurs, the source of the pollution is determined and appropriate action is taken to correct the problem.

10. Monitoring soil chemistry to detect salinity and nitrate buildup.
A. Soil samples are collected from the top foot of the soil profile to detect any salinity buildup in the topsoil as a result of reduced irrigation rates. To date, no salinity buildup has been detected.
B. Soil samples are collected from the second, third and fourth feet of the soil profile to test for nitrate accumulation as a result of overfertilization. Only in a few isolated fields has this been observed; and in those cases, the irrigator has reduced his nitrogen application rates to eliminate the possibility of nitrates moving below the root zone profile to pollute the ground water.

11. Promoting water conservation by the urban population.
A. Research is supported on equipment used to irrigate lawns and gardens to determine which commercially available sprinklers are the most efficient. This information is distributed to the public.
B. Timely tips for urban water conservation are provided to the news media for publication.

12. Setting in place any program or activity that provides an opportunity for improvement in water use efficiency or promotion of conservation.
A. A regional pre-plant soil moisture survey has been developed and is conducted each year. County and regional maps are provided to local news media for publication prior to the pre-plant irrigation season to show the irrigator how much water is currently in storage in his root zone profile and how much water he needs from either precipitation or irrigation to bring his soil to field capacity prior to planting.
B. Use of soil moisture monitoring equipment during the growing season is promoted through a cooperator program and through making equipment available for purchase.
C. Regional soil fertility inventories are conducted. Adequate soil fertility is necessary for maximum water use efficiency by field crops. The results of these surveys are published by the local news media.
D. New technology and equipment with promise of improving water use efficiency or conserving water are evaluated. This equipment, such as surge time control valves, is then demonstrated to the public.

13. Promoting a cooperative effort by all public agencies to promote water conservation with a minimum of duplications.
A. The SCS cooperates with the Water District in conducting irrigation efficiency evaluations using the mobile field laboratories provided by the Water District. Additionally, the SCS cooperates in conducting soil moisture surveys, fertility surveys and the growing season soil moisture monitoring effort.
B. The Water Resources Center at Texas Tech University has assisted the Water District in the investigation of the release of capillary water from the wet sand of the Ogallala Formation (Secondary Recovery). The Water District has, in turn, assisted and partially funded research directed by the Tech Water Resources Center to artificially recharge the Ogallala Formation from rainfall runoff water collected in playa basins.

See MANAGEMENT Page Four

DIRECTORS REVIEW PLAN—District ground water conservation efforts during the last six years are currently under Board review. Directors are (clockwise from top left) A.W. "Webb" Gober, Secretary-Treasurer; Gilbert Fawver, Precinct Five; Jim Conkwright, Precinct Four; Mack Hicks, Vice-President and James P. Mitchell, President.

Winter wheat soil fertility check urged before planting

By Beth Snell

Most winter wheat in the Texas High Plains is currently grown for cattle grazing and forage, as opposed to grain production. Producers may wish to consider the impact of this usage on soil fertility as they plan their wheat management program.

"You need to soil test," says Robert Devin, Randall County Extension Agent. "During the last few years we've had above average grazing of the dryland wheat crop in our county. Last spring, nitrogen deficiencies began showing up in the wheat crop. In areas with serious deficiencies, you may see some benefit from a fall application of nitrogen."

Dr. Michael Hickey, Area Specialist in Soil Chemistry and Fertility at the Texas Agricultural Extension Service in Lubbock, makes fertilizer application rate recommendations based on soil tests. The soil test data is used in addition to the yield goal of the farmer. High yields require more nutrients and water. One without the other usually leads to disappointment by the operator.

Hickey also recommends that farmers always maintain a perception of the past history of production from each area of the field. Soil tests can offer a guide on fertility needs, but conditions may not be uniform across the entire field, he adds.

Soil testing kits with instructions are available from local county extension agents. Soil samples will be analyzed for nitrogen, phosphorus and potassium levels by the Texas Agricultural Experiment Station in Lubbock for $6.

One factor affecting fertility is soil moisture.

Devin recommends basing a management plan on available soil moisture. "Any fertilizer needs to work hand-in-hand with the available soil moisture," he says.

If adequate moisture is available, fertility may be is the limiting resource if the crop is not growing and developing as expected, Devin warns.

A good management plan will maximize water use efficiency, which for winter wheat would be the pounds of beef or the bushels of grain produced per unit of water, says Hickey.

He continues, "To maximize water use efficiency, a good fertilizer program must be in place. It has been shown that good soil fertility will increase plant water use efficiency. Anything that will improve the yield will generally improve the water use efficiency," Hickey says.

Hickey explains the importance of good soil fertility in a dryland wheat and cattle operation.

As a general rule, dryland wheat with a cattle stocking rate of 150 pounds per acre will remove 18-30 pounds per acre of nitrogen. On an irrigated pasture, a higher stocking rate of two head of cattle per acre will remove up to 180 pounds per acre of nitrogen, he says.

"In the case of beef production, we're actually marketing protein. The higher the amount of protein in the plant, the higher the rate of gain on the animal. Protein is a function of nitrogen availability. The more nitrogen available to the plant, the more protein the wheat will contain," Hickey says.

Most producers aim for a cattle gain rate of 60 pounds per acre on dryland wheat and up to 360 pounds per acre on irrigated wheat, says Hickey.

"We had a good response this year to nitrogen applications, primarily from the forage standpoint," he adds.

Researchers from the Texas Agricultural Research and Extension Center compared two dryland wheat plots in Fisher County. Sixty pounds of nitrogen per acre was applied to one plot, while no nitrogen was added to the other. The plot with added nitrogen showed a four-fold increase in forage production and produced 19 bushels of wheat per acre, as compared to 10 bushels of wheat per acre produced on the plot with no nitrogen added.

Hickey offers other tips for preparing a wheat management program. "Decide how government programs will affect you, and then plan how to grow the crop and what type management strategy you will use."

He said such strategies include selecting wheat varieties. For example, certain wheat varieties will produce forage at different times during the growing season. By mixing different varieties in the field, rather than growing a uniform crop, maximum forage could be provided throughout the growing season.

Hickey also recommends some flexibility in the wheat management plan to allow for alterations due to environmental conditions, beef prices, wheat prices and other factors.

Management plan outlines ground water conservation activities

Continued From Page Three

C. *With the Texas Tech College of Agricultural Sciences, soil fertility studies are funded.*

D. *With Texas A&M University System and the Texas Agricultural Experiment Station, work on plant growth regulator research, evapotranspiration retardants and fertility studies to improve water use efficiency by field crops is being done.*

E. *With Texas A&M University System and the Texas Agricultural Extension Service, the District staff conducts Field Days, with demonstrations and evaluations of irrigation equipment.*

14. Providing services to landowners/operators/residents of the Water District.

A. *On an annual basis, cost-in-water, saturated thickness and change in water level data are provided to landowners in the Water District service area to support their cost-in-water income tax depletion claim.*

B. *Rural homeowners with private water supply wells are assisted through the collection of water samples for bacteriological analysis. When problems are found, the owner is instructed in proper treatment or corrective action necessary to make the water safe for consumption.*

C. *Landowners/operators are provided geohydrologic information for their farm upon request — such as the depth-to-water below land surface, depth to base of formation and saturated thickness. Additionally, historical data regarding changes in depth to water and quality of the ground water in the area of their farms is provided.*

15. Monitoring U.S. Department of Energy proposed plans and activities related to development of a possible repository located in Deaf Smith County for high-level nuclear waste and the potential effects of this activity on the Ogallala and Triassic Dockum Group aquifers.

A. *A District shaft rule was adopted which requires the DOE to obtain a permit prior to beginning construction of any shaft through the Ogallala Formation and to specify plans for these activities prior to beginning work.*

B. *A Resident Inspector (District Employee or Agent) will be on-site to monitor the activities of the DOE during any testing or construction activity.*

C. *A staff geologist has devoted full-time effort to reviewing DOE documents to identify potential problems and to notify the DOE of the District's concerns. Also, this geologist is compiling baseline data reports on soil salinity, surface water quality, ground water quality, natural radiation and other geohydrological conditions in the site area. Should this site be used, these reports will be invaluable to prove contamination or pollution.*

16. Administering the Agricultural Water Conservation Equipment Pilot Loan Program.

A. *Guidelines were adopted by the Board of Directors for making loans to owners/ operators.*

B. *Loans have been requested and granted to the Water District by the Texas Water Development Board for lending to owners/operators within the Water District service area.*

C. *Loans have been made to about 25 applicants for the purchase of agricultural water conservation equipment, such as low pressure center pivot sprinkler systems or surge valves.*

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER
CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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Open hole caution urged

Imagine a child happily walking home on a fall afternoon. He has just left the bus stop and has decided to cut across his neighbor's open field. Near the center of the field, he steps on a piece of plywood, and the board splinters under his weight. Seconds later, the boy is falling feet first down an abandoned irrigation well shaft.

In the High Plains of Texas, more than 75,000 large capacity irrigation wells have been drilled since large scale irrigation began in the late 1930s. Many of these wells have been abandoned or are not currently in use. Those wells not equipped with a pump or which have not been properly plugged or capped represent a serious safety hazard for animals, children and even adults. They also provide a direct conduit for possible contamination to the Ogallala aquifer. Locating and getting these wells plugged or capped is one of the many responsibilities of the High Plains Underground Water Conservation District No. 1.

Obbie Goolsby, Engineer-Technician in charge of the District's open hole program, dedicates much of his time and effort to the program. Obbie warns that "some unused wells are simply open and may be hidden among weeds. Anyone walking across a field could accidentally fall in and be trapped."

Luckily, there have only been two such accidents reported during the Water District's 36-year history. In 1986, a six-year old stepped off a school bus and fell into a snow-covered well hole. Five years earlier, a four-year old fell 260 feet into a well that his uncle was in the process of filling. These children were fortunate. They were rescued without injury.

"People need to know how dangerous these open holes are," says Goolsby. "If a child fell in a hole only a few feet deep and the dirt caved in on top of him, he could suffocate. Open holes are a death trap."

Although open shafts can be hard to see, Goolsby points out some common signs of an unused well site. "Older wells were often drilled on a high point; and in many cases, a lone tree was planted next to the well site. The area around most producing wells is kept clean, but a weedy area that the farmer avoids plowing can signal an abandoned well site," he says.

State law and Water District rules require wells to be covered at all times. According to Water District rules, an open or uncovered well is defined as "any artificial excavation drilled or dug for the purpose of

See OPEN Page Three

HAZARD — Dangerous open holes, as shown in this file photo, may be found dotting the South Plains. Producers should check all abandoned well sites on their property to make sure the well is properly capped.

Schillings Recognized by Awards program

Mr. and Mrs. Ronald C. Schilling of Slaton have been recognized as one of nine winning High Plains families in the National Soil and Water Conservation Awards program.

The program, created in 1983 by the Du Pont Company and the National Endowment for Soil and Water Conservation, honors those farmers/ranchers who are initiating innovative, cost-effective soil and water conservation techniques.

The Schillings utilize several soil and water conservation management techniques at their 480-acre farm. Precipitation management includes furrow dikes, terraces, contour farming and reduced tillage. Any precipitation which runs off Schilling's farm is collected in a modified playa basin, where much of the water percolates back to the aquifer or is pumped from the playa basin for irrigation. Conservation practices associated with irrigation include several miles of underground pipe to transport water from the wells to the field.

See AWARD Page Three

Ground water shows little quality change...

No significant change has occurred in the quality of the ground water in the Ogallala Formation during the past 10 to 20 years,

• See Related Story Page Two

according to Dr. Tommy Knowles, Ground Water Activities Director for the Texas Water Development Board. The Board recently prepared a statistical evaluation of changes in the quality of the ground water in the High Plains (Ogallala) aquifer through time. Analyses of more than 600 water samples collected at three to five-year intervals from a network of 226 wells were used in the evaluation. Results of the analyses showed an average increase in the mean total dissolved solids content of 33 milligrams per liter, when comparing the samples taken prior to 1977 with those collected since that date. The samples collected after 1977 averaged 459 milligrams per liter. This amount is less than one-half the maximum safe level of 1,000 milligrams per liter of dissolved solids recommended for drinking water by the Texas Department of Health.

The Texas Water Development Board (TWDB), in cooperation with three underground water conservation districts (High Plains, Pan handle and North Plains), maintains a ground water quality monitoring network consisting of more than 1,000 privately-owned water wells in the 35,000 square-mile area covered by the Ogallala Formation in 46 Texas High Plains counties. In the service areas of the three water districts, the districts maintain the program, collect and pay for approximately 50 percent of the water sample analyses. In areas not served by a water district, the TWDB maintains a program with a monitoring well density equal to about one-half of that maintained by the districts. The Texas Water Development Board stores all the analyses results and provides computer-processed reports to the water districts and other interested parties upon request.

For further information on water quality in Texas aquifers, contact Dr. Tommy Knowles at P.O. Box 13231, Capitol Station, Austin, Texas 78711-3231.

...while observation wells show rise in levels

Two recently-completed studies by the Texas Water Development Board show water levels in observation wells on the Texas High Plains have been rising since the early 1980s.

• See Map Page Three

The Texas Water Development Board, along with the High Plains Underground Water Conservation District No. 1, the North Plains Ground Water Conservation District and the Panhandle Underground Water Conservation District, annually measure the water level in more than 3,000 wells the High Plains.

Historically, intense irrigation on the High Plains had caused a consistent decline in the Ogallala aquifer's water levels as heavy pumpage exceeded the amount of

See AREA Page Three

Tech Water Resources Center readying activities

The Water Resources Center at Texas Tech University, under the direction of Dr. Lloyd Urban, is gearing up to expand its activities and services to the region and the state.

Since its conception in 1965, the purpose of the Center has been to encourage, conduct and coordinate water resources research and related activities at Texas Tech. Research priorities are to increase the supply of available water, reduce the demands by increasing the efficiency of water use and prevent the pollution of existing water supplies.

Most problems and opportunities encountered at the Center require numerous disciplines to properly address. Therefore, Urban is currently compiling a list of research associates from each school within the University who have expressed an interest in assisting with water related research conducted by the Center.

An 11-member Advisory Board was recently named by Urban. The board members were selected to represent municipal, industrial and agricultural interest in the region, as well as major water interest groups and academic interests of the University.

The Board met recently to discuss how the Center might better serve the region. Dr. Jim Parker, Board Member and Director of the Textile Research Center, suggested that the Water Resources Center might provide the leadership to obtain economical solutions for the safe disposal of liquid waste created by the processing of animal skins for leather. He pointed out that the High Plains of Texas is the major livestock feeding and meat producing area in the state, yet most of the animal skins are shipped out of state for leather processing. Additionally, most of the manufactured leather products are manufactured outside of this area. Parker concluded that, in his opinion, the Texas High Plains is missing a tremendous regional opportunity.

Advisory Board Member Clayton Yeager, President of Parkhill, Smith and Cooper, an engineering consulting firm, suggested that the Water Resources Center work to improve understanding that most towns and cities have adequate supplies of good quality water to support any type of industry wishing to locate in the area. He suggested that the Water Resources Center coordinate the development of a report to document the potential for growth of the region's towns and cities relative to their water resources reserves.

Jim Bertram, City of Lubbock Assistant City Manager and Advisory Board Member, suggested that professors directing graduate students in their masters and doctoral theses at Tech expand their contacts off campus to identify current opportunities and problems for the students to address in their research. He suggested that the Water Resources Center could disseminate to the proper departments suggestions from the public, municipal, industrial, and agricultural sectors on special water related problems or opportunities that need to be addressed.

Urban encourages your suggestions, comments and help in his directing the Water Resources Center at Texas Tech to become a viable force in solving the area's water resources problems, while pursuing new opportunities to expand the economic opportunity of the region and state. He can be reached at (806) 742-3597, or visit the Water Resources Center, located in the Civil and Agricultural Engineering building on the Tech campus.

Area water samples examined

High Plains Underground Water Conservation District No. 1 staff members collected 187 water samples for routine chemical analysis during July and August. The analyses from this group of water samples will be compared to analyses of water samples collected from the same wells at an earlier date to determine if any significant change in the ground water quality has occurred as a result of man's activities.

The Water District maintains a network of 950 privately-owned wells in which annual depth-to-water levels are measured to determine changes in the quantity of ground water in storage. Water samples are collected for chemical analysis from this same network of wells at three to five year intervals to determine if any changes are occurring in the ground water quality. Each well in the 950-well network was visited during the sampling effort. As time permits, wells not pumping at the time of the first visit will be revisited and samples collected if they are found pumping.

The information collected from the recent sampling effort should be available for public use in about a month. The results of historic samples are available for public use or inspection at the Water District office during normal business hours. In order to make this data more useful and available, individual county reports are being prepared for public distribution. These reports will contain a county road map showing the location of each well in the water quality monitoring program. Each well is assigned a unique number for identification. This number will be plotted next to the well symbol. The report will also contain tables giving the amount of each chemical found in the water. The tables will depict amounts of each chemical in milligrams per liter for the historic and current water samples. These reports should be available to the public around January 1, 1988.

THE Cross SECTION

THE CROSS SECTION (USPS 564-920)

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CARMON McCAIN, Editor
DIRECTOR, INFORMATION/EDUCATION

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District Office at Lubbock

NOTICE: Information regarding times and places of the monthly County Committee meetings can be secured from the respective County Secretaries.

Applications for well permits can be secured at the address shown below the respective County Secretary's name.

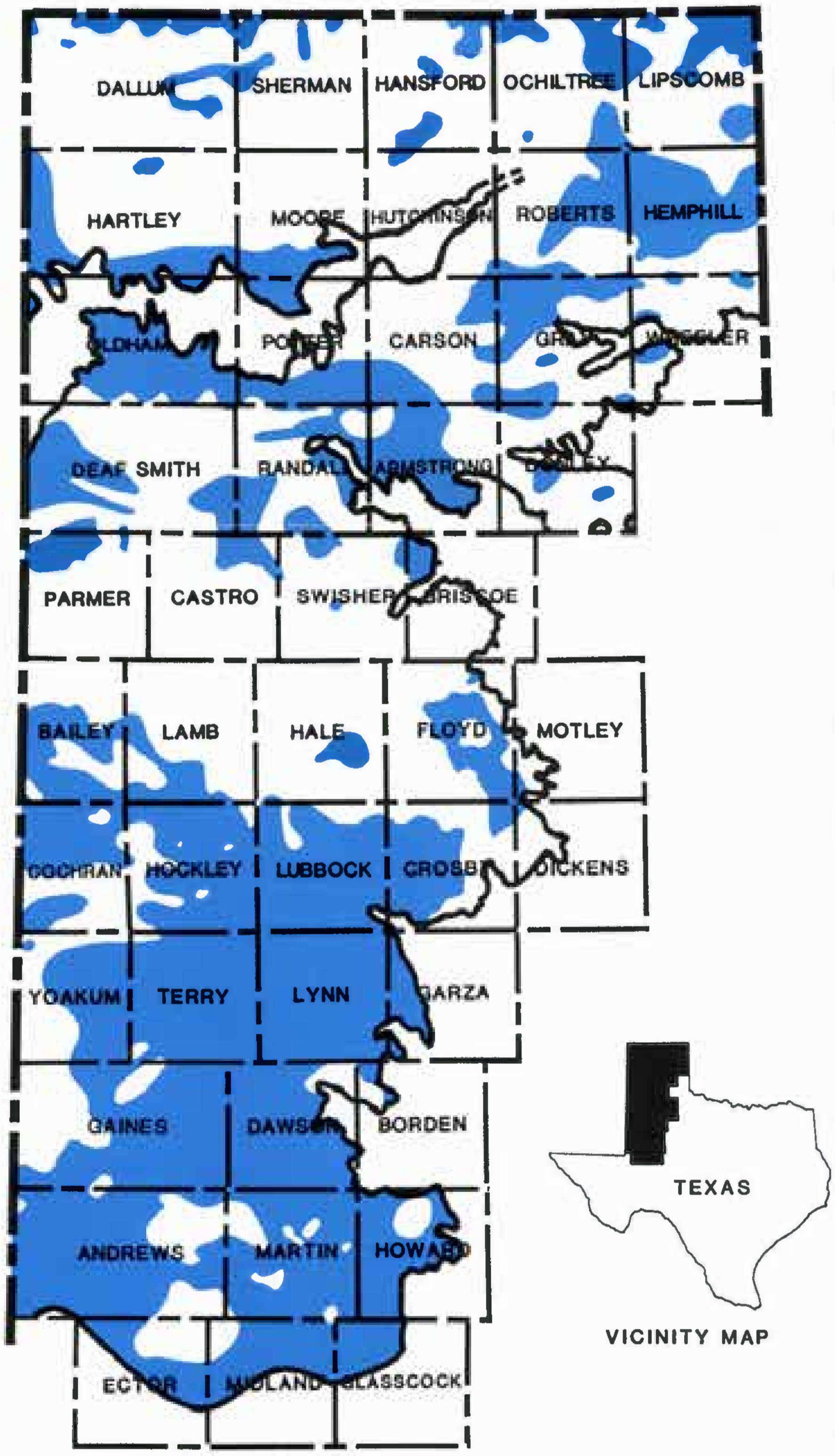
Area water levels increase

Continued From Page One

water being recharged. In the late 1970s, a reversal of this trend was seen in several counties — especially those south of Lubbock. During the early 1980s, the area of water-level rises expanded.

A five-year comparison of water levels between 1980 and 1985 shows that at least a portion of every county in the Texas High Plains has experienced an overall water-level rise. At the end of 1986, the High Plains Underground Water Conservation District No. 1 recorded the first net average water-level rise within its 15-county service area.

Although the 1985 and 1986 above-normal precipitation is partially responsible for accelerated recharge into the aquifer, a number of other factors have added to the water-level rise. A depressed agricultural economy and high fuel costs have reduced irrigation pumpage substantially. Even more important, improved irrigation management and more efficient equipment have lessened the quantity of water pumped for raising crops.



AREAS OF WATER LEVEL RISES BETWEEN 1980 AND 1985

Open holes "death traps"

Continued From Page One

producing water from the underground reservoir, not capped or covered as required by these rules, which is as much as 10 feet deep and not less than 10 inches, nor more than six feet in diameter."

These wells must be covered with a solid cap capable of supporting a minimum of 400 pounds. The cap should extend at least three feet into the well casing. Also, the cover should extend out far enough from the hole on all sides to assure that the hole will remain covered if the cap is shifted to the side.

Producers should check all well sites on their property to make sure they remain properly covered, especially after heavy rains.

Cave-ins around the casing can occur even at the site of a well that has been properly capped. Cave-ins are more common around an unused site. The only permanent solution is to cut off the casing below ground, cap the casing, plug the hole with cement to near the surface and fill the remainder of the hole with dirt.

Producers often do not think of their well as an "open hole" when the pump has been pulled for repairs. However, the same danger exists when the well is temporarily uncovered. In fact, curiosity about the activity may make a temporarily uncovered well an increased hazard. When the pump is pulled for repairs, a cap should be installed until the pump is returned to the hole.

The Water District maintains an active program to locate and properly close open holes. All wells abandoned when a replacement well is drilled are field checked to make sure they are properly closed. District staff in the field check suspect locations for open holes among their other duties. If you know of an open hole which needs to be capped or would like additional information, contact the High Plains Underground Water Conservation District No.1, 2930 Avenue Q, Lubbock, Texas 79405 or call (806) 762-0181.

Report out-of-district sites

Responsibility for seeing that abandoned wells or open holes are plugged or capped outside the boundaries of an underground water conservation district rests with the Texas Water Commission.

The Texas Water Commission has two regional offices located in the Texas High Plains. The local office is located at 5124 C 69th Street, Lubbock, TX. 79413 or may be reached by calling (806) 794-4435. The Amarillo office is located at 3918 Canyon Drive, Amarillo, TX. 79110, (806) 353-9251.

Reports of open holes may also be sent to the Texas Water Commission's state office, P.O. Box 13087, Capitol Station, Austin, TX. 78711-3087. Larry R. Soward is the Executive Director and may be reached at (817) 463-7791.

Award recognizes Schillings

Continued From Page One

Schilling is a member of the St. Joseph Catholic Church finance committee and a Director of the Slaton Co-op Gin. He was the Slaton Chamber of Commerce's Farmer of the Year in 1970, and he served eight years as a Lubbock County Committeeman of the High Plains Underground Water Conservation District No. 1.

"We are very pleased Ronald and his wife have been recognized for their soil and water conservation efforts," said Ken Carver, Assistant Manager of the High Plains Underground Water Conservation District No. 1. "Ronald has used a number of water conservation measures on his farm. By his example, others can see excellent soil and water conservation techniques in practice," Carver said.

The national winners were selected by committees of public and private agricultural organizations in each state. A group of 10 national finalists will be selected, and they will receive an expense-paid trip to a special Washington D.C. awards ceremony in October. Three national winners will be selected from these finalists, and they will receive $1,000 and recognition at the national awards ceremony to be held in Washington in December.

HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1
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VISIT OUR WATER CONSERVATION EXHIBITS AT

THE TRI-STATE FAIR
SEPTEMBER 21-26, 1987
AMARILLO, TX.

THE PANHANDLE-SOUTH PLAINS FAIR
SEPTEMBER 26-OCTOBER 3, 1987
LUBBOCK, TX.

Precipitation enhancement may aid area's future water needs

MANAGER'S NOTE: The Colorado River Municipal Water District, headquartered in Big Spring, Texas, has been conducting a weather modification program for approximately 16 years in all or part of 14 counties in the Permian Basin area.

Counties or parts of counties included in the project are Lynn, Garza, Kent, Dawson, Borden, Scurry, Fisher, Martin, Howard, Mitchell, Nolan, Glasscock, Sterling and Coke.

One method used to evaluate the benefits of the weather modification program is to compare cotton yields. Cotton yields over the 1971-1985 cloud seeding period averaged 47 percent higher than normal for seeded counties: 44 percent higher for downwind counties and six percent higher for upwind counties. During the 16-year seeding period, average rainfall from May through September for seeded stations was 14.18 inches. Average rainfall for the same time period at unseeded stations was 12.84 inches.

There have been some weather modification efforts in the High Plains of Texas to suppress hail. The theory, as we understand it, is to seed a cloud heavily during its early development to cause it to rain out quickly before it develops enough to produce hail.

Many dryland farmers who depend solely on precipitation for their water supply opposed this effort because they believed it would decrease the amount of rainfall in the area. Others believe that Man should not attempt to modify the weather, based on their religious beliefs. Weather modification for hail suppression is managed much differently than weather modification for precipitation enhancement.

The success demonstrated by the Colorado River Municipal Water District's precipitation enhancement program is certainly worthy of our attention.

We hope that in the future, more time and attention will be devoted to learning about the weather and precipitation enhancement. We may need to consider precipitation enhancement as one of our alternatives to supplying area water needs in the future.

In an effort to show why it rains and how cloud seeding works, we have borrowed from several sources to compile the following article.

— **A. Wayne Wyatt**

Although little of it is visible as clouds at any given time, millions of tons of water are always present in the atmosphere over the earth in the form of vapor, ice particles and liquid droplets.

Cumulus clouds form when bubbles of buoyant air rise from heated land surfaces or are lifted by low-pressure disturbances. Some of these cumuli form and fade quickly or produce only light and scattered showers.

As the air is lifted to higher, colder elevations, the water vapor present in the air condenses around microscopic particles called cloud condensation nuclei (CCN). Just as water vapor is always present in the air, so too are the particles of dust, smoke, salt, soil and other materials upon which condensation begins. Similar particles which create ice at colder temperatures are called ice-forming nuclei (IFN). Cloud droplets freeze on contact with the IFN, or ice crystals form directly from water vapor. A cloud is made of billions of cloud droplets, ice crystals, or both.

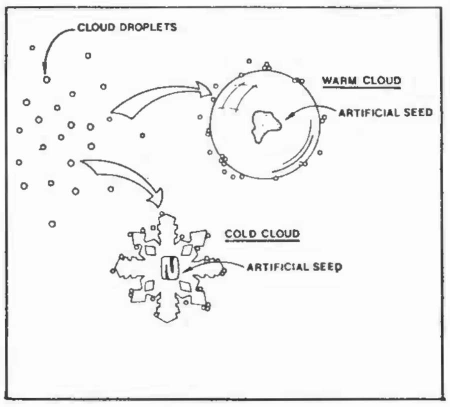
The formation of a cloud depends upon enough water vapor in the air; some means of cooling (a cloud updraft or cool weather front); and enough aerosol particles to serve as nuclei upon which condensation can begin. When and how much it rains depends on the vertical and horizontal dimensions of the clouds, the duration of cloud life, the sizes and concentrations of cloud droplets and/or ice particles and the strength of the cloud updraft.

Precipitation forms by two basic processes: *coalescence,* which occurs in "warm" clouds with temperatures of 32 degrees Fahrenheit or higher, and *ice phase,* which occurs in clouds colder than 32 degrees. Coalescence is the merging by collision of a million or more cloud drops, a process made more efficient if there are enough large nuclei available to collect some drops large enough and heavy enough to fall.

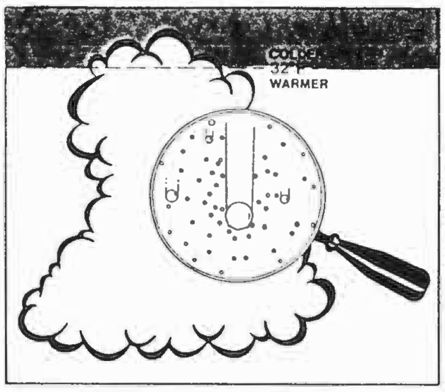
The sizes, types and concentrations of nuclei available in the atmosphere make a critical difference in forming clouds and producing rain. Since oversize nuclei are abundant as salt crystals over oceanic regions, rain can form and fall well within the lifetime of the clouds. This is not the case, however, over inland regions such as the High Plains, where smaller, more abundant nuclei create only medium-sized clouds which usually dissipate before the coalescence can initiate rain. Providing large artificial "seeds" such as urea particles can accelerate the warm rain process. Similarly, silver iodide or dry ice seeding can create the additional ice crystals critical in producing rain from a cold cloud.

Silver iodide and dry ice are effective seeding agents when the cloud temperature is 32 degrees Fahrenheit or colder, and introduction of such materials into a supercooled cloud causes the liquid drops to freeze. With millions of repetitions of this freezing action, a great amount of heat is produced. The heat of fusion makes the cloud more buoyant, thrusting it higher, helping it to grow larger and enabling it to produce more rain for a longer period than it would have without seeding. The ice crystals formed in the cloud grow by merging with frozen or super-cooled droplets until they are heavy enough to fall, melting into raindrops on their fall to earth.

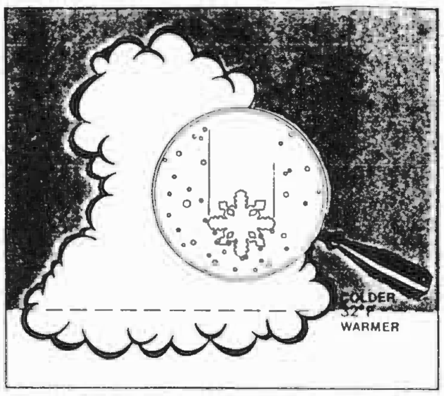
Among the means developed for the delivery of cloud seeding materials are ground generators located upwind of the target area and aircraft flying above cloud tops, below cloud bases or passing through the clouds. When promising cumuli form, all other climatological conditions appear favorable, and radar confirms that there is no severe weather, cloud seeding is implemented.



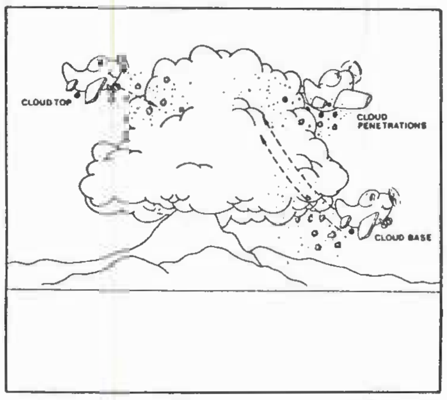
Weather modification scientists know that precipitation efficiency can be increased by seeding promising cumuli with artificial nuclei such as silver iodide, dry ice, urea or water vapor.



Rain is formed by coalescence in warm clouds with temperatures of 32 degrees Fahrenheit or higher. A raindrop is the result of the merging by collision of a million or more tiny cloud drops until the drop is heavy enough to fall to the ground.



The ice phase process occurs in clouds or regions of a cloud where the temperature is colder than 32 degrees Fahrenheit. Ice crystals grow by merging with frozen or supercooled droplets, then melt into rain on their trip to earth.



Specially instrumented aircraft are used to dispense an ideal number of CCN or IFN into a promising cumulus formation at cloud top or cloud base or by penetration.

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Laws spur interest in new districts

MANAGER'S NOTE: Several bills were introduced during the past two regular legislative sessions which, if passed, would have provided for state control of underground water in areas of Texas without organized, functioning underground water conservation districts. We expect the same type of legislation to be introduced during the next regular legislative session, which meets in 1989.

The threat to private ownership of the ground water by this legislative activity has stimulated interest in the creation of underground water conservation districts in some areas of the state.

The following guidelines are provided for those who wish to consider creation of a district. — **A. Wayne Wyatt**

CREATION OF UNDERGROUND WATER CONSERVATION DISTRICTS

Chapters 51 and 52 of the Texas Water Code, as amended by the 69th Legislative Session, 1985, set up the mechanism for the creation of underground water conservation districts to "provide for the conservation, preservation, protection, recharging and prevention of waste of the underground water reservoirs, or their subdivisions, and to control subsidence caused by water withdrawal."

All or part of one or more counties, cities, districts or other political subdivisions may be included in the underground water district boundaries.

A petition signed by a majority of the persons holding title to land in a proposed district starts the process of creating a water conservation district. If more than 50 persons hold title to land within a proposed district, 50 signers are sufficient. The petition is filed with the Texas Water Commission, which then orders a public hearing. If the commission finds that a district is feasible and practical, would be a benefit to land in the district and would be a public benefit, temporary directors are appointed and an election is ordered for the confirmation of the district and election of directors by the people within the proposed district.

See LEGISLATIVE Page Two

District urges annual coliform inspection

WATER SAMPLES — These water samples are shown prior to testing by High Plains Underground Water Conservation District staff. Rural residents may have their domestic water wells tested for contaminants upon request.

By Carmon McCain

Bird droppings, burrowing rodents, trapped animals and septic tank scum carried by ground water are only a few of the ways in which rural water wells can become contaminated. Rural residents need to inspect their well sites frequently for signs of animal entry, and water quality samples should be collected on an annual basis.

"Generally, the most common contamination problem I've encountered occurs when an animal or animal waste enters the well," says Dan Seale, Engineer Technician with the High Plains Underground Water Conservation District No. 1 Field Support Section.

Seale says he has observed many situations in which the septic system and the well are properly installed, yet rodent holes allowed contaminants to enter the well.

"I checked a well in a garage and found nothing about its outward appearance to suggest a contamination source. Yet, the owner specifically complained that the water was muddy whenever it rained. After closer examination, I found places where the rainfall runoff from an adjacent cow lot was entering the well through rodent holes," Seale says.

He recalled another situation in which the well owner had noticed a number of holes around his well site and was determined to flush out whatever was making them. "Unfortunately, the owner wasn't aware that he was flushing all the rodent waste into the well, too!" Seale says.

FECAL COLIFORM SAMPLING

The Water District samples domestic well water for contamination upon request of rural residents in the 15-county service area. The water sample test will detect fecal coliform from the intestines of a warm-blooded animal. This is the most common source of well contamination problems.

Water samples are placed on a media pad in a petri dish and allowed to incubate 24 hours at 104° F.

"When a test comes back positive," Seale says, "the first priority is

See CONTAMINATED Page Three

Drinking water criteria noted

MANAGER'S NOTE: National safe drinking water standards have been evolving for many years. The most recent revisions occurred this year. These standards attempt to set maximum safe levels in water for a number of elements. Regulation of the quality of drinking water continues to be a "hot" issue with some federal legislators.

The following is a listing of standards for safe drinking water, including sources of the elements and the possible dangers presented by each. — **A. Wayne Wyatt**

The primary standards for safe drinking water include safe limits for eight trace elements. Although most of these elements occur naturally in ground water, excessive amounts may cause serious illness, or in extreme cases, death.

Arsenic is sometimes found in ground water, or in surface water as an industrial pollutant or runoff. The safe limit for this element is .05 milligrams per liter. Ingestion of arsenic may cause symptoms such as fatigue, and a sufficient quantity will result in death.

Barium may also be found naturally in ground water or as a pollutant. It can have toxic effects on the heart, blood vessels, nerves and kidneys. One milligram per liter is the accepted safe limit.

Cadmium is primarily found in surface water polluted with byproducts from industries such as electroplating. Its safe limit is 0.010 milligrams per liter. Cadmium can cause anemia, retarded growth and increased hypertension.

Chromium may be found in ground water naturally or in surface water as an industrial pollutant from a plating industry. Small doses may cause skin irritations with external contact, and larger doses can be toxic. Internal exposure can cause liver damage. Its safe limit is 0.05 milligrams per liter.

Fluoride can be dissolved from small quantities of rock and soil. Some towns and cities add it to their drinking water supplies for its benefits in strengthening teeth. Excessive fluoride may mottle developing children's teeth, with the effects ranging from a slight discoloration to a dark brown stain and even malformation of the teeth. Fluoride safe limits are determined by the average temperature of the area.

Lead is prevalent in surface water near industrial waste-polluted sites. Symptoms of lead poisoning range from gastrointestinal disturbances to inflammation of the brain and the

See SAFE Page Four

Legislative activity spurs interest to create new districts

Continued From Page One

ADDITION OF LAND TO AN EXISTING UNDERGROUND WATER CONSERVATION DISTRICT

To begin the process for adding land to an existing district, a petition must be signed by a majority of persons holding title to the land within the proposed addition; or, if more than 50 persons hold title to land within the proposed addition, 50 signatures are sufficient. This petition is filed with the governing board of the existing district. The board then holds a public hearing within the proposed area to determine if the addition would be beneficial to the present district and/or that the proposed area would benefit by joining the district. If the board finds the addition feasible, they call an election to allow voters within the proposed addition and existing district to decide upon the annexation. A majority vote both within the proposed addition and within the existing district is required to confirm the addition of the land.

CREATION OF DISTRICTS IN CRITICAL AREAS

The Texas Water Commission may designate certain areas of the state as "critical areas," based on studies of available ground water within the area. A "critical area" is defined as an area which is experiencing or is expected to experience critical underground water problems, such as water shortages, land subsidence, underground water contamination, salt water intrusion and underground water waste.

If the commission declares an area to be a "critical area," they may call an election for the creation of a district; or they may recommend that the area be added to an existing underground water conservation district.

Contact Larry Soward, Executive Director of the Texas Water Commission, at P.O. Box 13087, Capitol Station, Austin, Texas 78711, or (512) 463-7791, for more information.

Amendment consideration set

Voters will be asked to consider several Texas Constitutional amendments during a special election November 3, 1987.

One of these proposed amendments, Proposition #23, deals with water development, and we are printing it in *The Cross Section* for your information.

Senate Joint Resolution 54 proposes a constitutional amendment authorizing the Texas Water Development Board to issue an additional $400 million in water development bonds. Of the authorized $400 million, $200 million would be designated for conservation and development of water resources, $150 million would be designated for water quality enhancement and $50 million would be designated for flood control. The amendment also authorizes the legislature to provide for review and approval of the issuance of the bond proceeds.

The proposed amendment will appear on the ballot as follows:

Proposition #23

"The Constitutional amendment to authorize the issuance of an additional $400 million of Texas Water Development Bonds for water supply, water quality and flood control purposes."

FOR ( ) AGAINST ( ) NO POSITION ( )

DELEGATION VISITS DISTRICT — These Senegal officials recently visited the High Plains Underground Water Conservation District office to study water conservation practices. Drought and water quality are major concerns to people living in this West African country. Questions raised by the group ranged from the use of artificial recharge to the role of chlorination in water purification.

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NOTICE: Information regarding times and places of the monthly County Committee meetings can be secured from the respective County Secretaries.

Applications for well permits can be secured at the address shown below the respective County Secretary's name.

Contaminated domestic wells "a serious health hazard"

Continued From Page One

to notify the people to stop drinking the contaminated water and switch to bottled water. Next, we try to identify the source of the contamination and recommend how to solve the problem. After this, we recommend the entire system from the well to the faucet be chlorinated," Seale says.

Chlorination is extremely important, emphasizes Seale. Chlorine should be added to the well water and pumped through the system. Beginning at the far point in the water distribution system, each faucet should be opened and run until chlorine can be smelled. The faucet should then be closed and the next one opened until all faucets have been flushed. The system should then be closed for 24 hours to allow the chlorine to work, Seale says.

If the contamination source has been eliminated, the chlorination will normally clean up most wells and allow safe water use. If the source of contamination still exists, the well may become contaminated again, Seale stresses.

He says a well which tested positive for fecal coliform is resampled after the chlorine has been flushed from the system. Six months later, a second check ensures the contamination source has been eliminated.

WELL SITES

Many well sites provide direct access for contaminants to enter the well and subsequently, the aquifer itself.

One case that Seale remembers involved an older well hidden inside a well house. Abandoned, it had not been properly sealed and this oversight allowed rodents and other animals easy access to the well for nesting purposes.

"This abandoned well was adjacent to a newer well. When I entered the old well house, I saw an open hole with indications that water and animals had been going down into the well. After closing the old well's open shaft and heavy chlorination, the new well cleared up. The family's chronic gastrointestinal problems were remedied as well," Seale says.

Producers should never store any herbicides, pesticides and fertilizers in the well house.

"The best advice I can give is to tell people not to put anything in their well house that they don't want ending up in their water supply. Keep the well house clean and don't stack things in there which will give rats an ideal nesting place," Seale says.

Bacteriological water testing may be scheduled by contacting Dan Seale at the High Plains Underground Water Conservation District office, 2930 Avenue Q, Lubbock, Texas 79405 or by calling (806) 762-0181.

SEPTIC TANKS

Septic tanks naturally break down human wastes. The waste leaves the home and is collected in a sealed underground container or tank. Inside the tank, the heavier solids sink to the bottom while lighter materials remain at the top. The liquids are called **scum,** and the solids are called **sludge.** People relying on this type of waste disposal system should note the distance between any septic system and their domestic water supply. If the well is located less than 150 feet from the septic tank or drain lines, they should have their well water checked annually for bacterial organisms.

Bacteria decomposes the waste material into sludge. The liquids leave the container through a system of buried perforated pipe. The pipe distributes the liquid into a large area of land, or **drainfield,** for absorption into the soil, evaporation or plant use.

However, if the drainfield becomes saturated, the liquids can pool on the ground above it. This liquid, or effluent, usually produces a foul odor and contains bacteria and viruses. Effluent surfacing above the ground is hazardous.

INSTALLING A SEPTIC SYSTEM

Homeowners should consider several factors prior to installing a septic system. The most important is the location of the domestic water supply well. The septic tank and drain lines should be located at least 150 feet from the water supply well. The soil type, the amount of wastewater produced and the winter evaporation rate are important considerations in deciding the size of the holding tank and the length of drain line needed. These items need to be discussed with your local contractor before installing the system.

If the system is improperly installed or maintained, a definite health hazard exists. This health hazard may cause minor discomfort; or in some cases, result in death.

"In many cases, there are no telltale symptoms, such as odor or taste, to indicate well contamination," says A. Wayne Wyatt, Manager of the High Plains Water District. "If rural families have repeated, flu-like virus symptoms, or if guests in the house complain of cramping or diarrhea, this can signal a contaminated water supply," he says.

Proper septic tank maintenance is important during the life of the system. Homeowners should avoid dumping large amounts of solid waste, such as left-over food, coffee grounds and other materials, into their septic system tank. Care should be taken to prevent solvents and chemicals from entering the septic system. These may kill the bacteria in the septic tank which are necessary for waste breakdown. Also, the system should be professionally cleaned every two to three years.

CESSPOOLS

Cesspools are simply holes in the ground where waste is collected. Unlike septic systems with feeder lines, cesspool waste is concentrated in one area. In many contamination cases, cesspools provide an on-going source of waste entering the well.

Cesspools should be replaced with a certified, inspected septic system. "Your health is worth much more than the cost of a new septic system. Cesspools are a probable cause of most rural domestic well contamination problems, and in wet years like this one, they're even worse," says Wyatt.

"An above average recharge rate and in some areas, rises in the water table to near land surface, have resulted in the problem becoming very serious for some rural residents."

In order to regulate the installation, alteration, repair or extension of on-site sewage disposal systems, the 70th Texas Legislative Session passed **House Bill 1875.** As of September 1, 1987, this law requires the acquisition of a valid Texas Department of Health permit before construction, alteration, repair or extension of an on-site sewage disposal system can commence. This includes those sewage systems intended for private family dwelling use. The bill exempts systems installed prior to September 1, 1987, providing there has been no significant increase in the system's use. Also, any system which received construction approval from a legally authorized licensing authority prior to the effective date is exempt under this Act.

Local government entities have until September 1988 to adopt a resolution or order regulating sewage disposal systems under this Act. If they fail to do so, the Texas Department of Health will enforce the system regulations.

CONTAMINATED OR NOT? — Dan Seale, Engineer Technician in the High Plains Underground Water Conservation District No. 1 Field Support Section, conducts a fecal coliform test. The bacteria from the intestines of warm-blooded animals are a common source of water well contamination on the High Plains.

Safe drinking water standards, elements noted

Continued From Page One

spinal cord. The acceptable limit for lead is 0.05 milligrams per liter.

Mercury concentrations are caused by industrial and agricultural pollution. Mercury poisoning attacks the central nervous system. The safe limit is 0.002 milligrams per liter.

Nitrate is produced by decaying organic matter, sewage, fertilizers and nitrates in the soil. The safe limit is 45 milligrams per liter.

Secondary standards for safe drinking water include acceptable limits for chloride, copper, dissolved solids, iron, manganese, soil hydrogen ion concentration (pH), sulfates, and zinc. The color, taste and odor of the water are also included in the secondary standards.

Chloride may de dissolved from the rocks and soils. It is found in large amounts in oilfield brine, industrial brine and sea water. Water will have a salty taste when chloride is combined with sodium. It may also increase the water's corrosiveness. Accepted limits are 250 milligrams per liter.

Copper in water is usually caused by contamination from mining operations. Jaundice and anemia may result from copper poisoning. Corrosiveness, staining and bad taste may also result. The safe limit is one milligram per liter.

Total dissolved solids is the total quantity of organic and inorganic matter dissolved in water. This matter includes minerals dissolved from the rocks and soil. These solids greatly influence water quality, especially in terms of the taste and color. The safe limit of total dissolved solids is 500 milligrams per liter.

The **hydrogen ion concentration,** or **pH,** is lowered by acids. PH is raised with carbonates, bicarbonates, phosphates, silicates and borates. The pH is a measure of the acid qualities of the water. A reading of 7.0 is neutral. Above 7.0 is alkaline, while below 7.0 is acidic.

Iron also may be dissolved from the rocks and soil. Other sources include lead pipes, pumps and other equipment where low pH water is present. When exposed to air, iron in ground water will oxidize and leave a reddish-brown stain. Its safe limit is 0.3 milligrams per liter.

Manganese is dissolved from shale, sandstone or other river basin materials. It may be found in surface water in swampy areas. Manganese can give water a grayish appearance and cause stains on plumbing fixtures and laundry. Acceptable limits are 0.05 milligrams per liter.

Sulfates are dissolved from rocks and soils containing gypsum, iron sulfides and other sulfur compounds. Sulfates in water with calcium form scale on boilers. Sulfates can have a laxative effect or, in large amounts, can give water a bad taste. Acceptable limits are 250 milligrams per liter.

Zinc may be a natural occurrence in water, but it usually indicates pollution. It can cause a chalky appearance and bad taste in water. Its safe limits are five milligrams per liter.

The **water color** results from decaying vegetation, organic material and iron compounds in solution. The water color may be visually objectionable, and it may indicate organic pollution. Fifteen color units is the acceptable limit.

Water taste and **odor** are caused by decaying organic material, hydrogen sulfide gas, iron, algae, and petroleum compounds. If water smells or tastes bad, it can indicate contamination.

Other factors to consider when examining water quality include alkalinity, the amounts of calcium, magnesium, carbonates, bicarbonates, sodium, and total hardness.

Water alkalinity indicates the presence of bicarbonates, carbonates and hydroxides. Alkalinity totals are helpful in determining water softening levels and corrosion control.

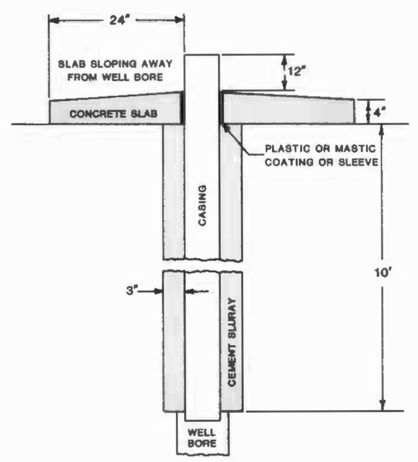
Calcium and **magnesium** are formed from carbonated rock such as limestone and dolomite. They are responsible for most of the hardness and scale-forming properties of water.

Carbonates and **bicarbonates** are also formed from carbonated rock. They produce alkalinity and form scale.

Sodium may be dissolved out of rocks and soil. Moderate amounts have little effect on water usefulness, but may cause problems for people on low sodium diets.

The total hardness of water is caused by the presence of calcium and magnesium. Hard water decreases soap lathering and creates scale in boilers, water heaters and pipes.

Proper water well completion specifications set by H.B. 1347



PROPER WELL CONSTRUCTION — This graphic shows the proper construction of a well borehole according to standards adopted with the passing of House Bill 1347 during the 1985 Texas Legislative session.

State-wide standards for the completion of domestic, industrial, injection and irrigation wells were adopted with the passing of House Bill 1347 during the 1985 Texas Legislative session.

This rule requires wells to be completed with the following specifications in addition to any local or city ordinances.

* The annular, or ring-shaped space between the borehole and the casing shall be cement-filled at least 10 feet below the land surface or well head. In areas with a shallow, unconfined ground water aquifer, the cement is not necessary below the static water level. In confined aquifers with an artesian head, the cement is not required beyond the top water-bearing strata.

* In wells where plastic casings are used, a concrete slab or block must be placed around the well at the ground surface. This slab must meet three requirements: 1) It must extend two feet from the well in all directions and must be a minimum of four inches thick; 2) a plastic covering or sleeve must be in place to keep the slab from bonding to the casing; 3) the top of the casing shall extend a minimum of one foot above the slab.

* If a steel casing is used, it shall extend a minimum of one foot above the ground surface. A concrete slab or block is required to cover the cement except when pitless adapters are used. These adapters may only be used if they can be welded to the casing, or if the annular space between the borehole and the casing is filled with cement no less than 15 feet below the adapter connection.

* All wells, especially those with a gravel packing, will be completed so that water supplies with different chemical qualities will not mix together and cause aquifer or zone quality loss.

* Well casings must be completed or capped to keep contaminants from entering the well.

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Child rescued from open well

SCOTT SHAW/THE ODESSA AMERICAN

RESCUERS ASSIST CHILD — Midland toddler Jessica McClure emerges from a rescue shaft adjacent to the abandoned water well in which she had been trapped almost 58 hours.

During the past five years, High Plains Underground Water Conservation District No. 1 Engineer Technician Obbie Goolsby has investigated more than 1,100 open hole sites across the District's service area. These potential death traps have been properly closed, mostly due to his efforts. Still, Goolsby says he lives with the constant fear of people becoming trapped in open wells.

Last month, the world shared Goolsby's fear with the news that 18-month-old Jessica McClure of Midland had fallen into a eight-inch open hole and was trapped 22 feet below.

After 58 hours, the toddler was rescued by paramedics and volunteer rescue workers who had drilled through almost impenetrable rock to reach her. At press time, Jessica's condition was improving, and doctors were continuing to monitor the circulation in her right foot, which had become pinned during the fall. If the circulation doesn't improve, amputation of the foot may be required.

As Midlanders celebrated the child's release, an 11-year-old boy drowned after falling into an open well in central Missouri. Christopher Brown of Gilliam, Missouri, fell into a well near a new business under construction. The well, which was about 15 feet deep, was three-quarters full of water. Workers had to pump water from the well before a rescue could be attempted.

These situations could have been avoided through proper attention to open unused wells.

The High Plains Underground Water Conservation District No. 1 strongly urges any homeowner or producer who may have a well on their property to make sure it is properly covered.

Open well holes are a danger to humans and animals alike. Also, they can provide a direct route for contaminants to enter the Ogallala Aquifer, our source of domestic, municipal, industrial and irrigation water.

Both state law and High Plains Water District rules require all wells to be properly covered at all times, even if the pump is only temporarily removed for repair. The cover must be a solid cap, capable of supporting

See OPEN Page Four

Expanding clays present water well yield problems

By A. Wayne Wyatt

Changes in water well drilling and well completion techniques in recent years have resulted in a decline in specific capacities of most new wells drilled in the area.

Specific capacity is the gallons per minute per foot of drawdown of water a well will yield.

Specific capacities of 10 to 15 gallons per minute were common for wells drilled in the 1950s and 1960s. Recently completed wells report yields of 3 to 10 gallons per minute per foot, with an average of about six gallons per minute per foot.

Dollars and Cents

The significance of the decline in the specific capacity can be illustrated by an example of a situation where the well yield is limited by the total feet of saturated thickness of the formation. As an example, if a well were drilled at a location where the saturated thickness of the Ogallala Formation was 100 feet and the specific capacity was ten gallons per minute per foot, the maximum yield of the well would be 1,000 gallons per minute. If the specific capacity were only five gallons per minute per foot, the maximum yield would be 500 gallons per minute. If a landowner needed 800 gallons per minute, it would be necessary for him to drill and equip two wells with a specific capacity of five gallons per minute. However, one well would satisfy his needs if it would yield ten gallons per minute per foot.

There are significant additional costs associated with producing water from a greater depth. For example, if a well owner wanted to produce 400 gallons per minute from the well, the pumping level would be 40 feet below the static water level for a specific capacity of 10 gallons per minute per foot and 80 feet below the static water level for a specific capacity of 5 gallons per minute per foot.

The cost for fuel to lift the water the additional 40 feet would be $4.40 per acre-foot using natural gas ($0.11 per acre-foot/foot-lift) and $8.00 per acre-foot with electricity ($0.20 per acre-foot/foot-lift). If the farmer operated the well 2,000 hours (83.3 days) per year, he would pump about 147 acre-feet of water. The added cost for the additional lift of 40 feet would be $646.80 with natural gas or $1,176 using electricity.

Early Well Completion Techniques

Water well drilling and completion techniques used during the 1950s and 1960s generally included the

See NEW Page Two

Ag loan funds still available

By Beth Snell

The High Plains Underground Water Conservation District No. 1 has obtained a third loan of $1 million from the Texas Water Development Board (TWDB). These funds are available to qualified borrowers for the purchase of agricultural water conservation equipment. The interest rate for this loan is 6.48 percent.

Through the Agricultural Water Conservation Equipment Pilot Loan Program, the Water District borrows funds from the TWDB to lend to qualified applicants to encourage the purchase of water conservation irrigation equipment. The pilot program was to expire in August 1987, but the 70th Texas Legislature extended the program until 1989 to allow further evaluation of the program.

More than $500,000 has been lent by the High Plains Water District since June 1986. Most of these funds were used for the purchase of center pivot irrigation systems.

Loan funds may also be used to purchase other agricultural water conservation equipment such as surge irrigation systems, low pressure drip irrigation systems, soil

See EQUIPMENT Page Four

New well completion techniques may cause yield declines

Continued From Page One

drilling of a large diameter hole — 18 inches to 20 inches — with a rotary rig to the base of the formation. Generally no drilling mud was added, as there seemed to be ample clay in the formation to form a mud pack on the wall of the well to keep it open until the casing was set.

Normally 16-inch used steel gas lines were installed as casing. A cutting torch was used to cut perforations in the casing to allow the water to enter the well from the formation. The perforations were cut in the casing before it was placed in the well. The length of perforated casing was approximately equal to the saturated thickness of the formation, which is measured from the depth at which water is first encountered to the base of the formation. There were usually four to six rows of perforations cut in the casing from one quarter inch to as much as one inch in width and one to two feet in length. In some instances, the perforations were even wider.

Generally no rock or gravel was placed between the casing and the wall. If rock or gravel was added, it was usually larger in diameter than the perforations, ranging from one half to one inch in diameter. After the casing was set, the wells were bailed, which usually resulted in the removal of a great deal of sand and mud. A test pump was then installed, and more mud and sand were produced from the well. The well was pumped until it "cleared up" or pumped little sand. In many cases, the mud pits filled with sand, as well as the farmer's irrigation ditches and the borrow ditches along the county roads. The production of large quantities of sand indicated that the mud pack on the well wall was removed in the area of the perforations.

In some wells large cavities were created in the area opposite the perforations as a result of the removal of the sand from the formation. Landowners and operators soon tired of wells that pumped sand and demanded that the local water well drillers improve their drilling and completion techniques to provide them a "sand-free" well.

A Change in Techniques

A serious attempt was made to stop the sand movement from the formation into the well. The problem seemed to be that the casing perforations were too large, and a serious attempt was made to reduce the width of the perforations. Slits were cut in the casing and were described to be the width of a cutting torch. Most were from one-eighth inch to one-fourth inch in width, depending on the skill of the person operating the cutting torch. The diameter of the gravel used in the gravel pack could be smaller without passing through the perforations. Many wells were drilled using this technique. Use of smaller gravel, in combination with the thinner perforations, resulted in wells producing little or no sand with the water, but also made it more difficult to clean the mud from the wall of the well. A partial mud pack on the wall of the well reduced the flow of the water into the well, thus reducing the specific capacity of the well. This did not seem to be a serious problem at the time, as the thickness of the aquifer was still adequate in most of the area to yield large quantities of water and the energy cost to produce the water from a greater depth did not seem to be too high a price to pay for a sand-free well.

Cutting a clean slit in the casing the width of a cutting torch was rather difficult. Therefore, a High Plains driller, Dub Jones of Dumas, developed a saw to cut perforations. The width of the slits were one-sixteenth inch to one-eighth inch and approximately four inches in length. Eight to twelve rows were cut per foot of casing. These smaller perforations allowed the use of smaller gravel.

The principal problem with developing a sand-free well to produce an acceptable yield appeared to be the removal of the mud pack from the wall of the well through narrow perforations or well screen openings with a gravel pack consisting of a layer of very small uniform-sized, rounded gravel approximately two inches thick between the casing and the wall of the well.

In an effort to overcome this problem, high speed bailers, as much as 14 inches in diameter and 30 feet in length, were used to develop the well. These high speed bailers are capable of removing several hundred gallons of water a minute from the well. The bailers create a vacuum inside the casing as the bailer is pulled up at high speed. (At the elevation of the High Plains, the maximum force that could be created by the vacuum would equal 14.4 pounds per square inch.) The vacuum creates a pulling force inside the casing. This suction, in combination with the gravitational force created by the water weight in the formation outside the well bore, helps to overcome the resistance. This causes the water to wash a part of the mud pack through the gravel pack into the casing to be removed. The weight of one hundred feet of water equals 43.3 pounds of pressure per square inch at the bottom of the well, 21.7 pounds of pressure per square inch at 50 feet below the water level and 10.9 pounds of pressure per square inch at 25 feet below the water level. Following the introduction of the high speed bailer, it was possible to remove more of the mud from the well face. Most wells pumped little or no sand, but the specific capacities remained below the desired levels.

An assortment of acids and detergents have been used to break up the mud pack on the wall of the well. The degree of success has not been good. Some well yields have been helped; others have not.

X-Ray Diffraction Studies

The difficulties experienced in the mud pack removal from the well wall lead us to believe that the problem may be more complicated than first believed. Therefore, Water District personnel collected approximately 100 formation samples from mud pits of wells drilled in the District's service area.

An X-ray diffraction analysis of these samples was made under contract with the Water District by Dr. Nicip Güven, Department of Geosciences at Texas Tech University. This study identified the major minerals in the Ogallala Formation to help find a way to remove the clays from the well wall.

Dr. Güven's analyses found quartz, calcite, feldspars and clay minerals in the samples.

Quartz

Quartz was present in all samples. The quartz content ranged from 28 percent to 92 percent. The quartz concentration gives the total of all forms of quartz in the samples: monocrystalline quartz, polycrystalline quartz, quartz overgrowths and chert. These various forms are not distinguishable by X-ray diffraction.

Feldspars

At least two types of feldspars are present in the samples, high sodium plagioclases and potassium feldspar. Generally the total feldspar content of the samples is below 10 percent, although some samples contain as high as 20 percent feldspars.

Clay Fractions

Smectite, a swelling clay, appears to be the dominant clay mineral in all the samples, making up as high as 80 percent of the clay size formation. Kaolinite, illite and randomly interstratified illite-smectite mixed-layers were also present in substantial quantities in the samples. Quartz, feldspars and calcite were also detected in the -4 micron fractions.

Dr. Güven's survey of the mineralogical composition of the Ogallala Formation shows some rather significant features of the aquifer, which must be kept in mind in the drilling, production and stimulating operations.

1. The presence of large quantities of calcite should be considered an important factor of the ground water geochemistry.
2. Smectites and illite/smectite mixed-layers are the swelling type clay minerals with high cation exchange capacities. They play a significant part as an ion-exchanger in the geochemistry of the aquifer. They are also known to cause "damage" to the porosity and permeability of the reservoirs because of their swelling properties and their easy migration during the flow in the aquifer. In short, the Ogallala Aquifer contains significant amounts of "water-sensitive" clays.

Dr. Güven offers some recommendations which may help in future development of methodology of well drilling:

1. In the light of the mineralogical data, past drilling practices should be examined to determine if any formation damage has been caused. In future drilling operations, muds must be used to minimize such damage.
2. It may be worthwhile to consider aquifer stimulation since the swelling and migration of the clays and possible cementation by calcite can slowly (with time) reduce the permeability of the aquifer, especially in wells showing a gradual drop in their water yields. In any case the stimulation should be designed to minimize the adverse effects of these minerals.
3. The mineralogical data in this report should be compared with the geological features of the aquifer, specifically with Ogallala depositional facies and

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THE Cross SECTION

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Dense mud pack often reduces water flow from formation

Continued From Page Two

sediment dispersal systems in the Southern High Plains, in order to find out the reasons for mineralogical variations between the wells in this report.

4. No vertical differentiation of the mineralogy in the Ogallala Aquifer can be done at the present since the cores need to be systematically collected at various depths. It is desirable to do such a study in the future for a few selected wells.

Putting It Into Perspective

As the drill bit encounters the clay beds in the drilling of a well, the clays are torn apart and picked up in the fresh water drilling fluid being circulated in the well. The formation being drilled will take water in at a rate equal to or greater than it will give water up until the pores between the sand grains are sealed by the clay. The clay particles are much smaller than sand particles.

Therefore, a large portion of the clay particles broken up in the drilling operation can move through the pore spaces between the sand grains away from the well before a mud pack on the well wall is formed. As clay particles move away from the well, they absorb water, which results in swelling. At some point in enlargement, they can no longer move through the pores between the sand grains and are trapped.

The number of clay particles making up the mud pack on the well wall continues to increase, making the mud pack more dense and harder to remove. The weight of the gravel added between the wall of the well and the casing packs the clay still more and holds the mud pack in place. Imagine the forces needed to tear this mud pack apart, move it through a two inch layer of gravel, then through openings equal to less than ten percent of the total surface area of the casing to be bailed or pumped from the well!

The water weight outside of the mud pack, which translates into pounds of pressure per square inch of force against the mud pack as the fluid is removed from inside the casing, is the only natural force available to tear the mud pack apart. If the mud pack is removed or partially removed, the water can move from the formation into the well.

The clay particles which moved out into the formation during the drilling process compound the problem of obtaining an adequate yield. Gravity causes the water to move into the well through the pores between the sand grains, but the enlarged clay particles which moved out into the formation serve as dams or blocks to prevent water from moving through the pores back into the well.

In the old days when wells were developed to produce a cavity, large quantities of sand were removed from the well. Along with the removal of sand, a large portion of the clay particle blockage was probably also removed. The well drilling techniques presently used attempt to prevent the well from producing sand, which leaves the clay particles in place, thus contributing to the decline in the specific capacities of wells.

R. Paul Coneway, P.E., a long-term water well drilling contractor from Hereford, Texas, (Water Industries) offered the following comments on this study and my observations.

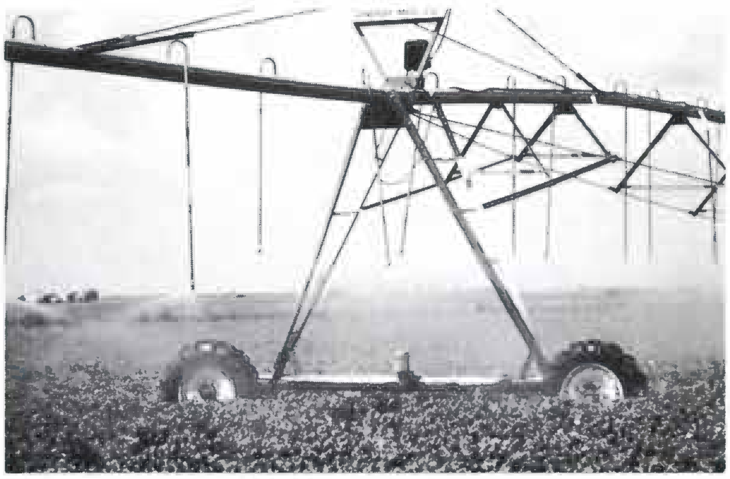
Your comments on early drilling techniques in the 1950s and 1960s brought back many memories to me. When I started in this business 40 years ago, one simply drilled a 19 inch hole, with little or no mud (usually lime), torch perforated the casing, allowing for approximately 30 feet of drawdown, set the casing, and installed a pump. Development was, as you say, to pump sand until it cleared up (and sometimes they didn't), collect your money and move to the next location.

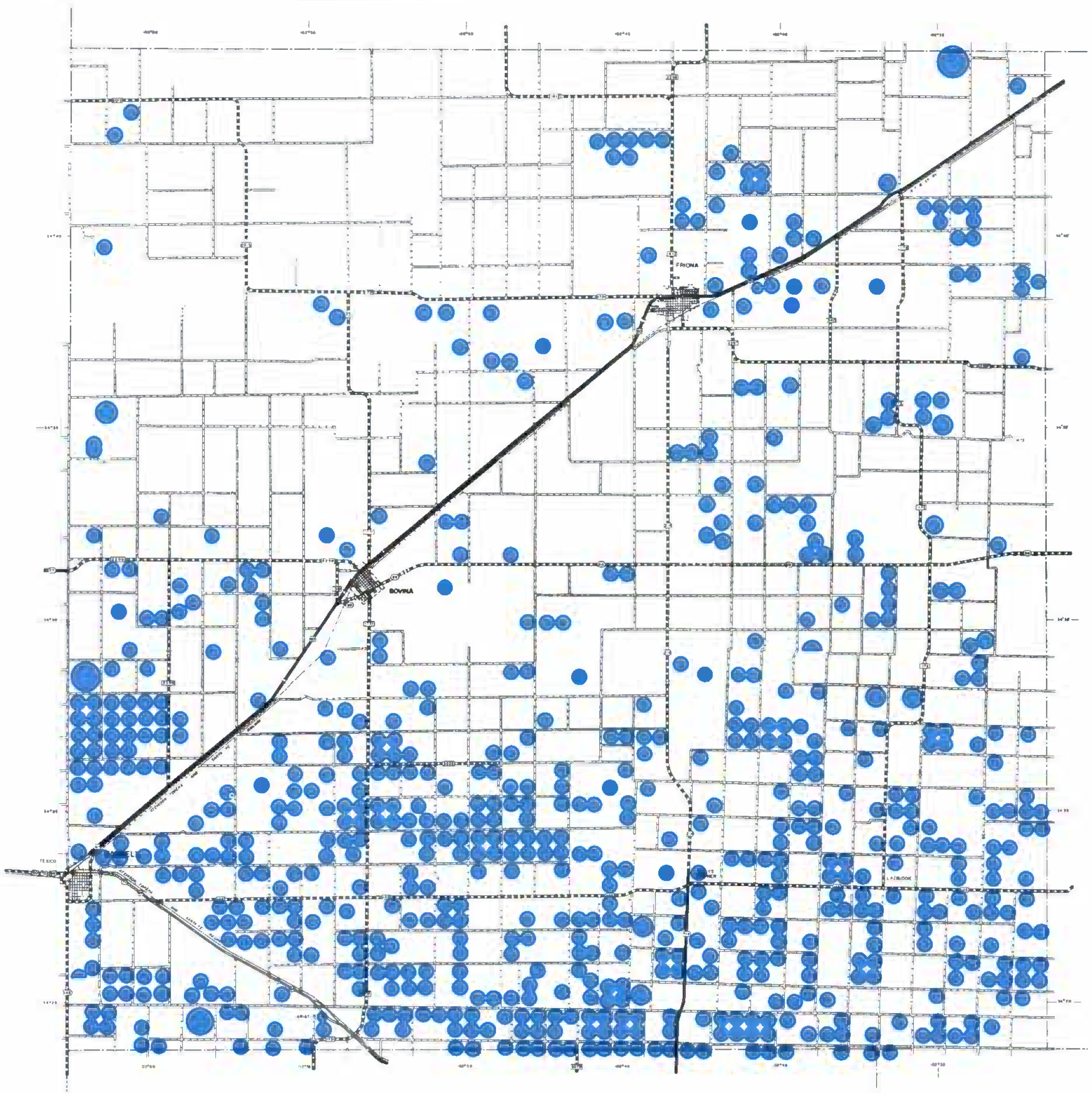
It is probably true that a cavity was developed until the slope of the sand in the formation stabilized itself and a "natural gravel pack" developed when the smaller grain size sand particles were removed, leaving the larger grain size in the formation behind. This development also removed some of the clay particles you refer to.

Your statement about landowners demanding improved methods to produce "sand-free" wells is very true. Unfortunately, methods were developed through trial and error, with no scientific aids or approaches to the problem such as are available now. Some of them were to a certain degree available then. However, economics played an important part. We all knew from literature and books available the subjects of sieve analysis, grain size, screen slot size, and gravel gradation, but it was impossible to get the necessary money for such a well from your customers. They reasoned, why pay extra expense when what was being tried seemed to be successful to make

See BETTER Page Four

Center pivot irrigation systems as seen from the air and in the field.





689 CENTER PIVOTS MAPPED — With the help of aerial photographs, Engineer Technicians Obbie Goolsby and Arnold Husky counted and plotted the locations of center pivot irrigation systems in Parmer County. The 689 systems, given an average cost of $30,000 each, represent a $20 million dollar investment by Parmer County farmers. More than 90 percent of the center pivot systems are equipped with droplines which have an average water application efficiency of 80 to 90 percent. Most center pivots were installed on previously furrow irrigated land where water efficiency rates were about 60 percent. Congratulations are extended to the Parmer County landowners and operators for making this tremendous water conservation and energy expenditure.

Better well construction may produce higher water yields

Continued From Page Three

a "sand-free" well. There was no thought of well efficiency or such subjects as specific capacity, coefficient of storage, transmissivity, etc.

Concerns materialized when people began to realize that the Ogallala was not an inexhaustible tub of water.

Clay stabilization through additives to the drilling fluid can be successfully done through a good mud program. Baroid has done extensive research and laboratory and field testing on this very problem as it affects oil and gas well drilling. We have learned that mud techniques developed for the "oil patch" can successfully be used in the "water patch." Baroid was one of the first to recognize this, and they are eager and willing to share their knowledge with mud rotary water well contractors. (See page 51, September 1987 Water Well Journal.) Their product, Dextrid, a polymer, in connection with salts, such as sodium chloride, potassium chloride, diamond phosphate and calcium chloride, have been found the most effective in shale stabilization in terms of both cost and overall performance. In mud rotary drilling, a fairly soft filter, or wall cake, ideally should be two-thirty seconds of an inch maximum thickness. Then it is effective in hole stability and easily removed during development.

Regarding openings in the casing and/or well screen, a 16-inch rod base stainless steel screen has an open area of 6 percent per linear foot of total area up to 28 percent, from the minimum slot opening (0.010 inch) to the maximum slot opening (0.250 inch). Compare these numbers to percent open area in mill slot or louver type openings and you can see why it is easier to develop a new well (remove the clay particles and open the sand pores) with a rod base screen than other types of perforation. You simply have more open area to work through.

We have found that clear water jetting the screen areas, followed by high speed bailing and swabbing, is most effective in removing wall cake and developing the aquifer. The Ogallala, being composed of some few gravels, sand, sandy clay, clay and shale sections, is not a high specific capacity formation such as some in other areas where we have had specific capacities in the range of 70-80 gallons per minute/per foot drawdown.

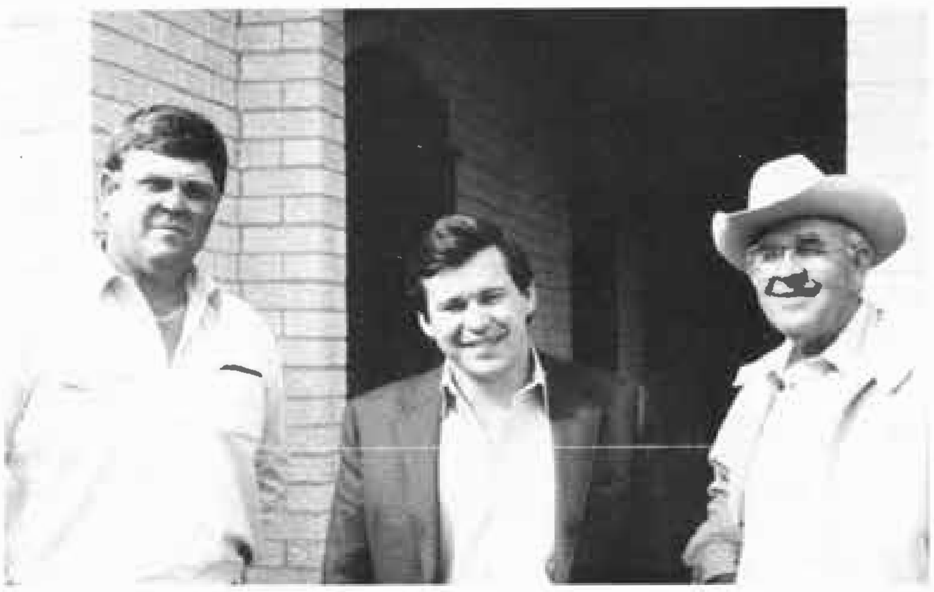
I agree with you in that we should give more thought to well construction on the High Plains now; in fact, we should have started 30-40 years ago. Again, it was a question of economics that we didn't.

A program of good formation sampling, electric logging interpretation, sand sieve analysis to determine gravel pack gradation and screen slot opening, combined with a good mud program diligently followed while drilling, and an effective development method, can effect the desired results of optimum well efficiency and thus optimum specific capacity.

In discussion of the problem with the local farmers, I found agreement that they were not willing to pay extras for an "engineered well" when energy was cheap and water was plentiful; but things have changed. Today, they are not willing to pay for anything less than the highest performance wells that the driller is capable of delivering. They are willing to pay more for water well drilling and completion, provided that the well performs at the highest possible level the formation is capable of delivering. The farmers have reservations in agreeing to pay a higher charge without some assurance or guarantee that they are going to get value for their money.

One farmer stated that he would not give a dime for another hole in the ground, but would be willing to pay a water well driller a good profit for a high performance well. We suggest that the water well drillers develop a new pricing schedule based on completed well performance. If the driller puts more into the well, then he should be paid more money. However, by the same token, if the farmer pays more money for the well, he should get more water in gallons per minute/per foot of drawdown for his new well than he is currently getting from his old well.

Perhaps for example, the price scale could have a minimum charge for a well with a specific capacity equal to his old well, with a price increase for each gallon per minute/per foot of drawdown above the old well yields.



COMMISSIONER VISITS — Newly-appointed Texas Water Commissioner Buck J. Wynne (center) recently visited the High Plains Underground Water Conservation District office to learn about the District's operation. Accompanying Wynne are (from left), John Baker, Texas Farm Bureau Vice-President and S.M. True, Texas Farm Bureau President.

Equipment loans still available

Continued From Page One

moisture monitoring equipment and underground pipe.

Producers may borrow up to 75 percent of the purchase cost of permanently installed equipment and 50 percent of the cost for contractor services, installation and non-recoverable items. A one-time service fee of 2.5 percent of the loan amount is charged to cover administrative costs. Loans are processed on a first-come, first served basis.

For loan guidelines and applications, contact Becca Williams at the High Plains Water District office at 2930 Avenue Q, Lubbock, Texas 79405, or call (806) 762-0181.

Open well capping urged

Continued From Page One

a minimum of 400 pounds. The cap should extend at least three feet into the well casing. Also, the cover should extend out far enough from the hole on all sides to assure that the hole will remain covered if the cap is shifted to the side.

The Water District encourages the reporting of open holes. Please call (806) 762-0181 or come by the District office, 2930 Avenue Q, Lubbock, TX.

THE CROSS SECTION (USPS 564-920)
HIGH PLAINS UNDERGROUND WATER
CONSERVATION DISTRICT NO. 1
2930 AVENUE Q
LUBBOCK, TEXAS 79405

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Soil moisture monitoring under way

Staff from the High Plains Underground Water Conservation District No. 1 and the USDA Soil Conservation Service have begun their annual measurement of soil moisture conditions. The field teams began their survey on November 23 and should be completed by Christmas.

Approximately 220 permanent soil moisture sites throughout the Water District service area are being measured. Six new sites in Crosby County and 13 additional sites in Floyd County have been added this year.

Neutron moisture meters, the most accurate soil moisture measuring device available, are being used by the teams to obtain data. Measurements are made by inserting a neutron probe into a previously installed access tube. Readings are then taken at six-inch intervals in a five-foot soil profile. These soil moisture monitoring sites are representative of typical dryland or irrigated farming practices, and selection is based on soil type, aquifer saturated thickness and crop type grown.

Soil moisture data gathered will be used to construct soil moisture availability and deficit maps. These maps will show producers approximate plant-available water amounts in the soil profile, water distribution in the soil profile and the water amount needed to fill the soil profile to field capacity.

Completed 1988 soil moisture maps will be available in early February. The Water District provides individual soil moisture readings to those landowners and operators with soil moisture monitoring sites on their land.

At these same sites, samples will be collected to determine soil fertility levels. Also, soil density measurements will be made to determine if hard pans have developed as a result of last year's farming operation.

With increased fertilization

Producers note positive crop results

EXTRA SOIL FERTILITY BENEFITS CROP — Dan Smith of Lockney yielded two and a half bales of cotton per acre from this field. Smith is among many area producers who have increased their nitrogen and phosphorus applications in an attempt to halt low cotton yields.

EDITOR'S NOTE: Since 1965, annual High Plains cotton crop yields have been consistently declining. Texas Tech University Agricultural Economist Don E. Ethridge has examined crop yields from five major Southwestern cotton producing regions. Of these, the Texas High Plains is the only one experiencing negative yield trends. Ethridge's research suggests that decreasing fertilizer use might be a major cause of declining annual cotton crop yields.

Last year, the High Plains Underground Water Conservation District No. 1, in conjunction with the USDA Soil Conservation Service (SCS) surveyed general soil fertility levels in the 15-county Water District service area. The study, led by SCS Soil Scientist Mike Risinger, indicated nitrogen and phosphorus levels so low as to limit crop yields in a majority of fields tested.

Both the Water District and SCS emphasized the need for soil testing and proper fertilization through news releases, articles, and meetings with producers.

As a result, many producers conducted soil tests and worked to improve their soil fertility. The extra cost and effort seem to be paying off as experts are forecasting a high-yielding, excellent quality 1987 cotton crop — **CEM.**

Area producers have begun to increase their nitrogen and phosphorus applications in an attempt to halt consistently low cotton yields. As the 1987 cotton crop harvest begins, many farmers and fertilizer dealers say they have noted positive results due to the increased fertilizer treatments.

Producers Note Higher Yields

Lockney

Proper fertilization, correct irrigation timing and early insect control are priorities in Dan Smith's cotton management program. With a two and a half bales per acre yield, it appears to have paid off for the Lockney farmer.

This is Smith's second year in a fertilization and water management program developed by Comprehensive Agri Services of Lockney. Texas Tech University Crop Physiologist Dr. Dan Krieg serves as a program consultant. (See "Water Management/Fertility Program Linked To Improved Cotton Yields," **The Cross Section,** December 1986.) The program aims at keeping water, nitrogen, phosphorus and heat units in balance in order to enhance production.

See AREA Page Three

Annual District election nears

Registered voters residing in either Directors' Precinct Three or Four are encouraged to cast their ballots during the High Plains Underground Water Conservation District No. 1 election, Saturday, January 16, 1988.

A board member will be elected to serve a four-year term from each of these precincts. Also, two committeemen from each county in Directors' Precincts Three and Four will be elected for four-year terms. District by-laws limit county committeemen to a maximum of two consecutive terms.

Water District Directors' Precinct Three

Directors' Precinct Three consists of Parmer County and those portions of Bailey and Castro counties which lie within the Water District's service area. A.W. "Webb" Gober of Farwell presently serves as Precinct Three Director.

Bailey County Committeeman positions are currently held by Tommy Haley of Muleshoe and D.J. Cox of Enochs. Haley, who is eligible for a second term in office, represents the portion of Bailey County Commissioners' Precinct One within the Water District's boundaries. Cox, representing Bailey County Commissioners' Precinct Three, has served two terms and is not eligible for re-election.

In Castro County, Committeeman positions in Commissioners' Precincts Three and Four are open for election. George Elder of Dimmitt currently holds the Precinct Three County Committeeman position and Floyd Schulte of Dimmitt is the current Precinct Four Committeeman. Both men have served two terms in office and thus are not eligible for re-election.

Parmer County Committeemen for Precincts One and Two are also to be elected. Jerry London of Friona is the current Precinct One Committeeman, and Billy Lynn Marshall of Bovina presently represents Commissioners' Precinct Two. Both men are eligible for a second term.

Water District Directors' Precinct Four

The parts of Armstrong, Randall, Deaf Smith and Potter counties within Water District boundaries

See NORTHERN Page Two

Northern precincts to select directors, committeemen

Continued From Page One

comprise Directors' Precinct Four, which is currently represented by James C. Conkwright of Hereford.

Joe Edd Burnett and James Stockett, both of Wayside, currently hold the two at-large County Committeeman positions up for election in Armstrong County. Burnett is eligible for a second term in office. However, Stockett has already served two terms and is ineligible for re-election.

In Deaf Smith County, the at-large County Committeeman position currently held by W.L. Davis, Jr. of Hereford is to be filled. Davis is ineligible to run again, since he is currently serving his second term. R.D. Hicks of Hereford is currently serving his first term as the Deaf Smith Precinct Four County Committeeman and is eligible to seek re-election.

The two at-large Potter County Committeeman positions to be filled are currently held by Sam W. Line of Bushland and Mark Menke of Amarillo. Both men have served two terms and may not seek re-election.

At-large Randall County Committeeman positions on the ballot are currently held by Tom Payne of Canyon and Roger B. Gist III of Happy. Payne is eligible to run again, while Gist may not be re-elected to the position as he is currently serving his second term in office.

Board members oversee all Water District activities, including legal, financial and business matters. They set long-range goals and direct the Water District's staff through the Water District's manager. The Texas Water Code requires quarterly board meetings; however, the Board usually meets monthly to consider Water District business.

County Committeemen meet regularly to make recommendations regarding water well permits and agricultural water conservation equipment loan applications. Committeemen help keep Directors advised on their county's water related needs. Also, they serve as a local contact person for water conservation problems or opportunities.

Candidates for a Water District Board of Directors or County Committee position must be at least 18 years old, a Texas resident and a resident of the Precinct for which they are seeking office for at least six months. Qualified candidates may obtain an application to have their name placed on the ballot from any Water District office. Completed applications must be notarized and returned to the Water District office by December 23.

Absentee ballots may be cast from December 28 through January 12 during normal business hours. Absentee polling places are as follows:

Precinct Three

Bailey County—Bailey County Courthouse, County Clerk's Office, 300 S. First Street. Muleshoe, TX 79347; Barbara McCamish, Clerk

Castro County—High Plains Water District Office, 120 Jones, Dimmitt, TX 79027; Dolores Baldridge, Clerk

Parmer County—High Plains Water District Office, 323 North Street, Bovina, TX 79009; Pat Kunselman, Clerk

Precinct Four

Armstrong County—Tulia Wheat Growers, Wayside, TX 79094; Chris Wright, Clerk

Deaf Smith County—High Plains Water District Office, 110 E. Third Street, Hereford, TX 79045; Gloria Escamilla, Clerk

Potter County—Bushland Grain Co-op, Bushland, TX 79012; Bruce Blake, Clerk

Randall County—Richardson Farm Supply, Hereford Highway, Canyon, TX 79015; Robert Tucek, Clerk.

Questions related to the election should be addressed to Election Coordinator Becca Williams at the District's Lubbock office, 2930 Avenue Q, Lubbock, TX 79405, (806) 762-0181.

District seeks court injunctions for tailwater waste violations

Temporary injunctions were issued in September to two landowners for irrigation tailwater waste in the High Plains Underground Water Conservation District No. 1 service area. Permanent injunctions by the Court have been requested by the District.

"Tailwater waste is not only costly in terms of water and energy, but it is against the law," says Ken Carver, High Plains Water District Assistant Manager.

Tailwater waste is defined as "Willfully or negligently causing, suffering, or permitting underground water produced for irrigation or agricultural purposes to escape into any river, creek, or other natural watercourse, depression, or lake, reservoir, or into any sewer, street, highway, road, road ditch, or upon the land of any other person than the owner of such well, or upon public land."

Since its inception in 1951, the Water District has been charged with eliminating tailwater waste. The District is usually notified of tailwater waste through complaints or by infield observation by District personnel. These sites are investigated to determine the tailwater origination. Photographs are taken for documentation.

"We then send the owner or operator a letter advising him that he is in violation of District rules, as well as state law, by letting water run off his property and that he must correct the problem," Carver says. "We generally meet with him on his property to discuss possible solutions. In instances where no major changes have to be made, we expect immediate action. Any further waste is documented by on-site investigation and photographs in preparation for a court hearing.

"If major changes need to be made in the farming operation, such as the installation of a tailwater return system, a center pivot sprinkler system or land levelling, then we ask him to submit a written plan with a specific time for completion. If the farmer does not keep his agreement, we seek legal action.

"In any case where it becomes apparent that the operator is not correcting the problem and we have sufficient documentation of continuing waste, we file for an injunction with no further notice to the farmer. We do not want anyone to lose a crop, but the waste must be stopped.

"Once an injunction is granted, any further tailwater offenses become Contempt of Court. In extreme cases, waste violators can face fines of up to $500 per violation and/or jail terms of up to six months. The violator may also be liable in several areas. There is public and private property loss, including crop loss if his waste water damages his neighbor's crop. Also, there may personal injury involved if an accident occurs as a result of tailwater flooding a roadway," he says.

Carver added, "The District considers a court injunction a last resort, but we do seek one if necessary."

November article paragraph missing

In the November **Cross Section,** a paragraph was omitted from District Manager A. Wayne Wyatt's article on water well drilling techniques and resulting specific yields. The missing paragraph, printed below, describes one of the major minerals detected by X-ray diffraction studies. We sincerely regret this error **— CEM.**

Calcite

Calcite was detected in all samples, ranging from trace amounts up to 72 percent. Quartz and calcite correlate negatively in the samples analyzed.

Merry Christmas

FROM THE BOARD OF DIRECTORS AND STAFF OF THE HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1

THE Cross SECTION

THE CROSS SECTION (USPS 564-920)

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2930 Avenue Q, Lubbock, Texas 79405
Telephone (806) 762-0181

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Area producers boost crop yields with improved soil fertility

Continued From Page One

"In the past with irrigated cotton, I produced between 500 and 700 pounds per acre. This year, we yielded two and a half bales per acre. I have never produced a crop quite like this," Smith says.

He tested the upper two feet of the soil profile to determine the amount of fertilizer needed before planting.

"We applied 200 pounds of 28-0-0 nitrogen before planting. Then, we side-dressed additional nitrogen after June 15, hoping to avoid any hailstorms. We don't want to put a lot of fertilizer down and then have the crop hailed out," he says.

The weather proved its unpredictability when a mid-July hailstorm did minor damage to Smith's crop.

The cotton on his father's farm sustained heavier damage. "The plants lost their leaves, but retained their blooms. It looks like the storm damaged the crop enough to delay maturity a month to six weeks. However, if we hadn't had such a good water and fertilizer management program to help the crop come back, I probably would have plowed this particular field under," he says.

Even with maximum fertility, Smith notes that producers must still watch for plant water stress if they wish to achieve high yields.

"I was taught to stress the cotton in August and cause it to root down. The producers can't continue to do this and expect high yields. If the plant doesn't get the water and fertilizer that it needs at the right time, then the development is delayed. With our short season, the plants can't catch up and yields will be down," he says.

Woodrow

Woodrow farmer Doug Wuensche says he would choose fertilization over irrigation, if faced with the choice. "I believe a man ought to go with the highest amount of fertilizer he can afford," says Wuensche.

Wuensche gave his soil an application of 10-34-0 and stubble mulched before the beds were listed. "We set it down about six to eight inches below the furrow. Also, we used some 20-10-5, plus zinc and manganese," he says. Cow manure was also added to the soil.

He expects his dryland cotton to produce more than two bales per acre. "We put our cotton in soil wet to capacity, then we had the June rains and a couple of rains in July. If we had had one more rain, there's no telling what we would have produced," he says.

"When we had those June rains, we decided to get in the field and give that yellow cotton a shot," he says. Wuensche side-dressed with 100 to 175 pounds of nitrogen.

In contrast, Wuensche says there is a noticeable difference between the cotton on his farm and that of his father. "I've used cow manure in the past at my dad's farm. There really wasn't any type of fertilization program to speak of, and you might see three small bolls per stalk. Most cotton plants produce about two good-sized bolls per stalk, and there will be about six plants per foot. With this year's fertilization, I can see a double-yield on my farm. It looks like the cotton is averaging five to six bolls per plant." he notes.

"We set a 650 pound-per-acre goal this season, and with this type of fertilization, it looks like we'll surpass it," he adds.

Levelland

The current yield average for one piece of land farmed by Levelland producer Greg Methvin and his father is 750 pounds per acre. The farm has produced as much as 900 pounds per acre, and this gives Methvin a reason to praise his father's soil fertilization practices.

"If a guy wants maximum production, I just don't feel he can do it without fertilizer," he says.

Methvin recently told the **Texas Farmer-Stockman** that he has never missed fertilizing, and his yields have held up. "On a block south of Levelland where I have to spread 150 gallons of water per minute pretty thin over 400 acres, I harvested a bale and a quarter per acre in 1984 and a bale per acre in 1985. In 1986, there was some adverse weather, but we still produced 750 pounds of cotton per acre."

Soil-testing before fertilization helps him set the pound-per-acre yield goal and determine the amount of fertilizer to be applied.

Methvin says he farms for maximum production by taking the data from the soil fertility testing and varying the amount of fertilizer, based on water availability.

"We use a dry mix of 32-23-0 and apply it at a rate of 150 pounds per acre where irrigation capacity is good. Where water is limited or where the crop is farmed dryland, we apply 100 pounds per acre. Where good irrigation is available, I side-dress 50 units of anhydrous ammonia in the middle of furrows on 40-inch, solid-planted cotton in June and July," Methvin says.

He also feels that they are benefitting from carry-over. "We haven't ever quit fertilizing, and I believe we benefit a little bit more since we've had a consistent program," he says.

Dealers Note Positive Results

Brownfield

Brownfield area producers have gone "full force" with their individual fertilization programs, according to Billy Wood, retail fertilizer sales assistant manager for Goodpasture, Inc. Wood says he expects his retail outlet's fertilizer sales to be five times the amount of last year's totals.

"Lower dry fertilizer prices, ideal soil moisture conditions, and available money have caused our producers to put a lot more fertilizer out this year than in previous years," he says.

"Farmers have always known fertilization will pay off for them. But, in years past, they cut corners and didn't put out the amounts needed for a good net return. If they needed 200 pounds of a blend, they might skimp and apply 125 pounds instead. This year, they followed the recommendations, and you can see the difference," he says.

Wood cited one specific field which is expected to have a minimum of 300 pounds per acre yield increase as a result of increased fertilization. "With $30 an acre fertilizer cost and 300 pounds per acre at the current market prices, the farmer can make $120 net return on his fertilizer investment," he says.

He added that for many farmers, this year's fertilizer push seemed to be a "do or die" effort in an attempt to make a successful crop.

"For a lot of these people, it seemed like they had to fertilize or they wouldn't be in business tomorrow. They did the fertilization right and went full force with it. That, along with the early ideal weather conditions, will really make a difference this year," he said.

Slaton

Jerry Kitten, manager of Kitten-Moseley Fertilizer and Supply Inc. in Slaton, has also noted that past fertilizer purchasing trends have reversed.

"In the recent past, people quit using fertilizer. Then, articles came out stating that it was necessary, and now they're buying it again," he says. While sales figures are not available yet, Kitten says he believes twice as many people are using fertilizer as were last year.

Muleshoe

David Seymour, Riverside Terra salesman in Muleshoe, says there has been a gradual upswing in the amount of fertilizer applied in his area during the past few years.

"Each year, we see a little increase and that's good. The more fertilizer the farmer puts down, the better crop yields will be," Seymour says.

Levelland

Jim Davis, co-owner of Ag Products, Inc. in Levelland says his fertilizer sales have been slightly depressed over the past three years. This year, his fertilizer sales showed some increase.

"It's just a matter of economics," Davis says. "Some people got into the fertilization program simply because they were able to get better financing from the ag lenders."

Davis added that fertilization is an easy program to cut when production costs increase and financing dwindles. "In the past, we'd see the farmers put down 60 to 70 units of nitrogen, 40 to 60 units of phosphorus and maybe some potash, sulphur and zinc. When financing decreased, producers would drop the zinc, sulphur and even the nitrogen and phosphorus to cut costs," he says.

Soil Fertility Research Under Way

While fertilizer dealers expect an above-average cotton crop this season, on-going research is exploring the effects nitrogen and phosphorus will have on future crop yields and water use efficiency.

Texas Agricultural Extension Service

Dr. Michael Hickey, Area Specialist in Soil Chemistry and Fertility at the Texas Agricultural Extension Service in Lubbock, feels that soil fertility is one of the most controllable factors affecting plant growth and that it is important for adequate nutrient amounts to be provided for plant use.

See CONTINUING Page Four

COTTON HARVESTING UNDERWAY — Producers have entered the fields to harvest a record-setting 1987 cotton crop. Increased fertilization and ideal weather conditions could push area production to just over 2.7 million bales. This marks the largest crop since 1981 and the fourth largest ever, according to Plains Cotton Growers, Inc. officials.

Continuing research explores soil fertility, water interaction

Continued From Page Three

Hickey is currently studying the effectiveness of phosphorus, in conjunction with nitrogen, in boosting yields and water use efficiency in cotton and grain sorghum. The effects of phosphorus placement on crop yields and water use are also being examined.

Approximately 10 research sites were selected for use this year by the Texas Agricultural Extension Service (TAEX), County Extension Agents and Water District personnel. Various treatments of nitrogen and phosphorus were applied in a minimum of 4 rows (40 inches) down the field length.

Plots were evaluated by TAEX personnel during the growing season for overall crop status, earliness, and boll retention or set. Water District personnel also placed two neutron probe access tubes in each treatment and have monitored the crop's water status regularly. After machine harvesting, yields will be calculated by weighing the cotton in a modified "boll buggy." Data will then be evaluated and reports will be developed.

Texas Tech Research Farm

At the Texas Tech University Research Farm, Dr. Howard Taylor and Dr. Norman Hopper are hoping to determine the effects of four different phosphorus application rates and methods on tissue concentration, fiber yields and cotton root during the growing season.

Phosphorus was applied as 0-46-0 in the following methods. 1) It was applied to the soil surface without disking, 2) applied to the soil surface and then disked about 4 inches deep, 3) applied 2 inches to the side and 2 inches below the seed at planting time and 4) applied at least 12 inches deep by chiselling immediately beneath the row. Phosphorus amounts ranged from zero to three times the amount recommended by TAEX soil test results.

All water measurements were done at three levels. One measurement was taken at the sprinkler line, one at the midpoint between the sprinkler line and the no-irrigation line, and one with no irrigation.

Texas Agricultural Experiment Station

Dr. Charles Wendt and Dr. Arthur Onken of the Texas Agricultural Experiment Station are continuing their container studies to determine the soil water-soil fertility interactions on cotton water use efficiency.

In 1985, a preliminary study revealed that the highest water use efficiency was obtained when both nitrogen and phosphorus were added to the soil. The current study seeks to determine the influence of different water, nitrogen and phosphorus levels on water use efficiency. Also, they hope to discover if differences in water and nutrient use efficiency exist among cotton varieties.

Tech study will highlight wind strip-cropping symposium

MANAGER'S NOTE: The Food and Fiber Act of 1985 requires conservation compliance by growers in order to be eligible for participation in federally funded programs. Controlling wind erosion on sandy soils is required. Permanent wind strip-cropping may provide a method for area growers to economically comply with the Act.

— A.W.W.

The results of a three-year Texas Tech University study on the agronomic and economic impacts of High Plains wind strip-cropping will be featured at a symposium, Tuesday, January 12, 1988, at the Holiday Inn Civic Center, 801 Avenue Q, in Lubbock.

WIND STRIP-CROPPING SYMPOSIUM FOCUS — The economic and agronomic impacts of High Plains wind strip-cropping will be discussed at a symposium to be held January 12, 1988 in Lubbock. This aerial photo, taken by the Soil Conservation Service, shows wind strip-cropping rows in place to help protect soil and young plants from wind damage.

The three-year Tech study, funded by the SCS, examined various aspects of perennial wind strip-cropping, with cotton grown between weeping lovegrass terraces. In strip-cropping, the taller plants protect the shorter plants from blowing wind and sand, reducing wind damage and soil erosion. The wind strips do not lower net profits, and insect problems appear to be controllable, according to the study.

Registration for the symposium begins at 8 a.m., and the meeting will follow at 9:30 a.m. The symposium is open to the public and is free of charge. Morning refreshments and a noon luncheon will be provided.

A welcoming address by Dr. Sam Curl, Dean of the Texas Tech College of Agricultural Sciences will begin the morning session. Tech Research Scientist Dr. Richard Zartman will discuss the agronomic effects of perennial wind strip-cropping. The economic impacts of wind strip-cropping will be discussed by Dr. Bob Davis. Insect control will be addressed by Dr. Sherman Phillips. Ute Becton, Lubbock County Soil and Water Conservation District Director, will moderate the morning session.

Wilson Scaling, Chief of the USDA Soil Conservation Service (SCS), will be the noon speaker. Jim Stewart of KFYO Radio will emcee.

Starting at 1 p.m., Ronald Thuett of Post, Sunny Lupton of Shallowater and Coy Franks of Matador will discuss their first-hand experiences with both annual and perennial wind strip-cropping. Texas State Conservationist Coy Garrett will relate wind strip-cropping to conservation provisions required by the 1985 Food Security Act, also known as the 1985 Farm Bill.

More detailed wind strip-cropping information will be given during an afternoon panel discussion consisting of Zartman, Davis, Phillips, Scaling and Garrett. Wayne Wyatt, Manager of the High Plains Underground Water Conservation District No. 1, will serve as moderator.

The symposium is co-sponsored by Texas Tech University, the SCS, the Lubbock County Soil and Water Conservation District and the High Plains Underground Water Conservation District No. 1.

THE CROSS SECTION (USPS 564-920)
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