
Appendix A

Glossary

- Acequia - community irrigation ditch or association
- Acidic - having a pH value of less than 7; acidic liquids are corrosive and sour
- Acre-Foot of Water - the amount of water needed to cover one acre of land with one foot of water, about 325,851 gallons
- Adaptation - modification of an organism or its parts that makes it more fit for existence under the conditions of its environment
- Adjudication - a formal court proceeding which results in the determination of the validity and extent of a water right
- Aggregate - a clustered mass of soil particles varied in shape and ranging in size from microscopic to a small crumb and considered the basic structural unit of soil
- Alkaline - having a pH value of more than 7; acidic liquids are caustic and bitter; sometimes called basic
- Amendment - material added to soils to improve soil structure and fertility
- Annual - a plant which completes its life cycle from seed in one year
- Appropriation - a taking of either surface or groundwater and applying it to beneficial use
- Arthropod - any of the phylum Anthropoda of invertebrate animals (insects, arachnids, and crustaceans) that have jointed body and limbs
- Bark - the tough exterior covering of a woody root or stem
- Berm - a mound or wall of earth used in landscaping to direct or contain water
- Biennial - lasting or living for two years
- Biodegradable - able to be decomposed by natural biological processes, such as by being digested by bacteria or fungi
- Biodiversity - the number of different varieties of life forms in a given area, or an index derived from this number
- Bosque - "forest" in Spanish; in New Mexico the term has been adapted to mean the cottonwood forests surrounding river areas
- Bunch Grass - grasses that come up from a single root and propagate through seeds; can be used as a turf grass or an ornamental grass
- Caliche - a crust of calcium carbonate that forms on the stony soil of arid regions
- Carbon Dioxide - colorless, odorless gas made of carbon and oxygen (CO²); exhaled by animals and humans, utilized by plants in photosynthesis
- Catchment - any area from which water can be collected, such as roofs and paved areas
- Cation - a positively charged ion
- Cation Exchange - the trading of ions between positively and negatively charged ions
- Cistern - an artificial reservoir for storing water
- Clay - low-porosity soil with little, if any, sand or silt and with particle sizes less than 0.002 millimeter
- Clipart - artwork (typically illustrations or photos) that can be used in a publication or advertisement, for which no royalties must be paid. Clipart is now commonly available on CD-ROMs.

Appendix A

Glossary

- Community - assemblage of populations of species living together and interacting with each other within a certain area
- Companion Planting - using plants together that complement each other in similar needs (soil, water and sunlight)
- Compost - a breakdown of organic matter by aerobic bacteria that produces a humus-like product that can be used as a fertilizer or soil conditioner
- Compound Leaf - part of a plant with more than one leaflet growing from each stem
- Conservancy District - a political subdivision of the State of New Mexico with the power to implement and oversee a conservation program for the purchase and retirement of surface and groundwater rights, for metering water diversions, and to establish other programs such as: providing and maintaining flood protection, river control, drainage, water storage for supplementing irrigation needs, constructing and maintaining distribution systems for irrigation, and other improvements for public health, safety, convenience, and welfare
- Continuous Data - marked by uninterrupted extension in space, time or sequence; temperature would be continuous data, if the set of all values, when pictured on the number line, consists of intervals
- Creeping Grass - grasses whose roots grow in the form of runners on top of, or below, the soil; they propagate through growth nodes on these roots and are usually used as a turf grass
- Critical - extremely important; absolutely necessary
- Deadline - the time by which something must be finished or submitted
- Deciduous - leaves that fall off or shed seasonally
- Decompose - the process of breaking down into constituent parts or elements
- Depth - vertical measurement of soil, water, mulch, etc.
- Desert - one of the two types of climate, characterized by very low average annual precipitation (less than 25 centimeters, or 10 inches, a year) and sparse, mostly low vegetation; the driest of the climates
- Detritus - a direct product of disintegration or wearing away, as in rock
- Dicot - a plant, such as grass, with a pair of embryonic seed leaves that appears at germination
- Discrete Data - a separate entity, individual
- Draft - the preliminary form of any writing or design, subject to later revisions
- Drip Emitter - drip irrigation system component that is used to deliver water to plants one drop at a time
- Drip Irrigation - method of irrigation in which small pipes and emitters deliver water to plant roots
- Drought - a prolonged period of dryness or below-normal rainfall
- Elevation - the height to which something is elevated in relation to sea level
- Emitter - drip irrigation system component that is used to deliver water to plants

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- End Cap - drip irrigation system component used to terminate a section of pipe
- Euphorbia - a large genus of plants that have a milky juice
- Evaporation - the process of changing from a liquid to a vapor
- Evapotranspiration - the combined loss of water from the soil due to evaporation and plant transpiration
- Evolution - the process by which a population of a species changes its characteristics (genetic makeup) over time in response to changes in environmental conditions
- Exotic - unusual or non-native plant
- Extraction - removal
- Fertilizer - a substance that makes the land or soil capable of producing more vegetation or crops
- Flood Irrigation - way of watering an area in which water diverted from a ditch or gated pipe is allowed to spread across a field contained by raised borders
- Flow Rate - the speed at which a volume of water moves
- Formatting - the general physical appearance of a page in a book, magazine, newspaper or newsletter, including the arrangement of text and illustrations on a page, type size and style, column width, etc.
- Fresh Water - water containing an insignificant amount of salts, such as inland rivers and lakes
- Fully Appropriated - when all available water has been reserved for existing water rights
- Furrow Irrigation - method of irrigation in which multiple streams of water diverted from a ditch or gated pipe are directed into furrows or corrugations and the water is allowed to run the length of the field
- Germinate - to begin to grow; growth of a plant from a seed
- Gravel - loose, rounded fragment of rock
- Groundcover - a planting of low plants that covers the ground; used in place of turf
- Growth Node - a knob-like marking on a plant stem or root from which a leaf, bud or stem will grow
- Habitat - place or type of place where an organism or community of organisms naturally or normally thrives
- Hardscape - an non-permeable surface in a landscape; includes sidewalks, patios, and porches
- Heat Sink - retention of heat in an area due to material absorbing heat from the sun and releasing it slowly
- Herb - a plant or plant part valued for its medicinal, savory or aromatic qualities
- Herbaceous - a plant that has a non-woody stem and which dies back at the end of the growing season
- Humus - a complex mixture of partially decomposed material found in the topsoil layer; helps retain water and water-soluble nutrients so they can be taken up by plant roots

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Glossary

- Infiltrate - to permeate soil by penetrating its pores or interstices
- Interest Group - a group of people with similar traits, such as farmers, consumers, or developers who have a vested concern in a particular issue
- Interstate Compact - an agreement made between two or more states, which is approved by Congress and the President, on the division of waters in rivers and streams that flow from one state into another
- Introduced - presented for the first time; plants are introduced into areas where they are not natives; they originated somewhere else
- Invasive - spreading at the expense of other plants growing in the area
- Leach - the process by which components found in upper layers are dissolved and carried to lower layers, usually by water
- Limiting Factor - factor such as temperature, light, water, or a chemical that limits the existence, growth, abundance, or distribution of an organism
- Macro Organism - an organism (living being) that can be seen with the naked eye
- Meadow Grass - grass used as a lawn but not likely to stand up to regular foot traffic of multiple uses; mainly used for visual effect
- Microorganisms - an organism (living being) that is too small to see with the naked eye
- Micro-sprayer - a low-volume emission device that operates at a lower flow rate than a conventional spray head; used to water an entire hydrozone rather than individual plant root zones
- Micro-tubing - drip irrigation system component; plastic tubing of a small diameter (1/8" - 1/4") used to connect main irrigation line to plants
- Monocot - a plant, such as grass, with a single embryonic seed leaf that appears at germination
- Morphology - the form and structure of an organism or part of an organism; the study of form and structure
- Morphotype - an infrasubspecific group of bacterial strains distinguishable from other strains of the same species on the basis of morphologic characters
- Mulch - a protective covering spread or left on the ground to reduce evaporation, maintain even soil temperature, minimize erosion, control weeds or enrich the soil
- Multi-faceted - many faces or surfaces; a mirror has one face, a prism is multi-faceted
- Native - plant that occurs naturally in a locale or region
- Neutral - not acidic or alkaline; a solution containing an equal number of hydrogen ions (H⁺) and hydroxide ions (OH⁻); has a pH of 7
- Niche - all the factors (physical, chemical and biological) that a species needs to survive in an ecosystem
- North Exposure - facing the north; exposed to cooler mornings as the sun comes up and shaded in the afternoon

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Nutrient - compounds, minerals, or elements needed by living organisms to carry on their functions

Organic - of, relating to, or arising from living organisms

Organism - a living being

Organic Matter - matter that is of, pertaining to, or derived from living organisms

Pedologist - soil scientist

Perennial - a plant that lives longer than 2 years from time of seeding

Permeable - passable, allowing fluid to penetrate or pass through

Petal - one of the modified leaves of a corolla of a flower

pH - a measure of the concentration of hydrogen ions (H) in a solution; the pH scale ranges from 0 to 14, where 7 is neutral; values less than 7 are acidic, and values greater than 7 are alkaline or basic

Phloem - the food-conducting tissue of vascular plants

Pistil - the female part of a flower consisting of stigma, style, and ovary

Plugs - (also called sprigs) a small core or segment removed from a larger object, in this case a turf grass; the plugs are used instead of sod to allow more flexibility in placement and to reduce cost

Porous - possessing or full of pores; permeable to liquids

Porosity - a description of the total volume of rock or soil not occupied by solid matter; number of pores and the average distance between pores in a given sample

Propagate - to reproduce; in the case of plants, through seeds or growth nodes

Reflectivity - the amount of light and heat that bounces off surfaces

Respiration - the sum total of the process of oxygen being conveyed to the cells and tissues of living organisms and the process by which the products of CO₂ and H₂O are given off

Rhizomes - a horizontal underground stem which can send out both shoots and roots

Root - a part of the body of a plant which typically grows downward into the soil, fixing the plant and absorbing nutrients and moisture

Runners - roots that grow either above or below the ground; grass runners will grow new grass 'leaves' at each growth node

Runoff - water (originating as precipitation) that flows across the surface rather than soaking in; eventually enters a body of water; may pick up and carry a variety of pollutants

Saline - salt

Salt Water - water associated with the seas and distinguished by high salinity

Sand - small rock or mineral fragments having diameters ranging from 0.05 to 1 millimeter

Saturation - being filled to capacity; having absorbed all that can be taken up; water-holding capacity

Shoot - a growing stem

Silt - small mineral soil particles with diameters ranging from 0.002 to 0.05 millimeter

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- Single Leaf - only one leaflet grows from each bud or stem
- Site Plan - layout of planting beds, irrigation system, structures, and other features
- Soil - complex mixture of inorganic materials, decaying organic matter, water, air, and living organisms (mostly clay, silt, and sand)
- Soil Heaving - the expansion and contraction of the soil due to changes in temperature
- Soil Horizons - horizontal layers that make up a particular type of soil
- Soil Type - classification of soil based upon the amounts of sand, silt, and clay
- South Exposure - facing the south; exposed to shaded mornings and hot afternoon sun
- Species - all organisms of the same kind; a group of plants or animals potentially capable of breeding with other members of its group but normally not with organisms outside its group
- Sprayer - drip irrigation system component that is used to deliver water to plant using a spray, includes adjustable sprayers that allow the user to focus the spray in a particular direction or range, micro-sprayers with a short-to-medium range spray (1 to 6 feet), and sprinklers with a large range spray
- Sprinkler- irrigation component used to shoot a fine spray of water over a large radius (up to 20 or 30 feet); often used on lawns and playing fields
- Stakeholders - people who have a vested interest in a project or issue; for example, the stakeholders for a business that wants a xeriscape landscape on its property would include the owners, the employees, the customers, the neighborhood, and other businesses in the area
- Staking - providing support for plants
- Stamen - the male part of the flower consisting of an anther and filament
- Stem - the main trunk of a plant
- Stolons - a ground-lying or trailing stem that produces roots at the nodes
- Stomata - opening at the epidermis, especially on the underside of leaves through which gases and water vapor pass
- Swamp - wet land dominated by shrubs and trees
- T-Connection - drip irrigation system component that is used to split one irrigation line into two irrigation lines; is shaped like a 'T'
- Temperate - having a moderate climate; not too hot or too cold
- Timer - irrigation system component that is used to time the delivery of water, such as run times, start times
- Topographic Map - a map showing the changes in elevation of naturally occurring features, such as mountains and river valleys
- Transpiration - transfer of water from exposed parts of plants through leaf pores to the atmosphere
- Variety - a group of individuals within a species that differs in certain characteristics from other groups of the species
- Vegetation - plant life

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Water - a clear, colorless, odorless and tasteless liquid, H²O, that is essential for all plant and animal life

Water Conservation - wise use and careful management of water, so as to obtain the maximum possible social benefits from it for present and future generations; methods include preservation, balanced multiple use, reducing unnecessary waste, recycling, reuse, and decreased use

Water Holding Capacity - the saturation level of a given soil

Water Infiltration - the movement of surface water into rock or soil through cracks or pore spaces

Water Right - a legal right to divert water to a specific beneficial use; water rights are granted in New Mexico by the Office of the State Engineer

Weathering - process in which bedrock is gradually broken down into small bits and pieces that make up most of the soil's inorganic material as a result of physical and chemical processes

Wilting Point - the amount of moisture present in the soil when plants first become permanently wilted

Xeriscape - a type of landscaping that emphasizes the use of low-water-use plants and efficient irrigation systems

Xylem - the supporting and water-conducting tissue of vascular plants, consisting primarily of woody tissue

Zone - a subdivision of a biogeographic region that supports similar flora and fauna

Glossary definitions came from various sources including: *Webster's Ninth New Collegiate Dictionary*, *The Water Sourcebook*, *New Mexico Water Rights (WRRI)*, and <http://biotech.icmb.utexas.edu/search/dict-search.html>

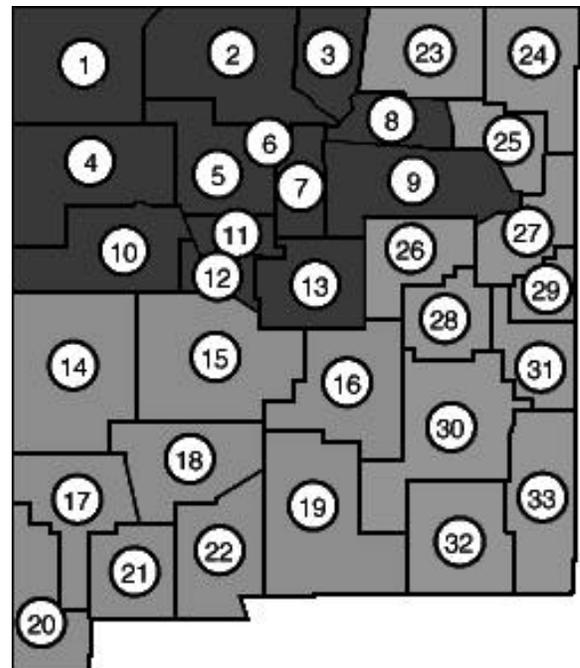
Appendix B

Cooperative Extension Service Directory New Mexico State University <http://www.cahe.nmsu.edu/county/>

Extension offices exist at both the local and state levels. In addition to the county offices listed below, you may want to contact the district directors, Extension Indian Reservation Programs, regional and state subject matter departments, or state offices. For even more help, search the Expertise Guide, the Agricultural Experiment Station, or the overall College Staff Directory. The links to these websites can be found at <http://www.cahe.nmsu.edu/county/>.

All area codes are 505 unless otherwise stated.

1. San Juan (Aztec): 334-9496
2. Rio Arriba (Española, Los Ojos): 753-3405, 588-7423
3. Taos (Taos): 758-3982
4. McKinley (Gallup): 863-3432
5. Sandoval (Bernalillo): 864-2582
6. Los Alamos (Los Alamos): 662-2656
7. Santa Fe (Santa Fe): 471-4711
8. Mora (Mora): 387-2856
9. San Miguel (Las Vegas): 454-1497
10. Cibola (Grants): 287-9266
11. Bernalillo (Albuquerque): 243-1386
12. Valencia (Los Lunas): 865-9561
13. Torrance (Estancia): 384-2416
14. Catron (Reserve): 533-6430
15. Socorro (Socorro): 835-0610
16. Lincoln (Carrizozo): 648-2311 or 648-2312
17. Grants (Silver City): 388-1559
18. Sierra (Truth or Consequences): 894-2375
18. Otero (Alamogordo): 437-0231
19. Hidalgo (Lordsburg): 542-9291
20. Luna (Deming): 546-8806
21. Doña Ana (Las Cruces): 525-6649
22. Colfax (Raton): 445-8071
23. Union (Clayton): 374-9361
24. Harding (Mosquero): 673-2341
25. Guadalupe (Santa Rosa): 472-3652
26. Quay (Tucumcari): 461-0562
27. De Baca (Fort Sumner): 355-2381
28. Curry (Clovis): 763-6505
29. Chaves (Roswell): 622-3210 / 3211
30. Roosevelt (Portales): 356-4417
31. Eddy (Carlsbad): 887-6595
32. Lea (Lovington): 396-2819



Appendix B

Reservations

- Jicarilla Apache Reservation (Dulce): 759-3530
- Tri-State Navajo Nation (Shiprock): 368-4191
- Tri-State Navajo Nation (St. Michael's, AZ): (602) 871-6605 / 7406

State Offices

- Extension 4-H and Youth Development: 646-3026
- Accountability and Evaluation: 646-5975
- Extension Animal Resources: 646-3326 / 3325
- Extension Home Economics: 646-6720
- Extension Plant Sciences: 646-5280
- Rural Economic Development: 646-3215
- Rural Economic Development Through Tourism: 646-3742
- Rural Agricultural Improvement & Public Affairs Program: 852-4241
- Extension Computer Systems: 646-3305
- Agricultural Communications: 646-1173
- Extension Directors: 646-3015

Appendix C

Charts, Graphs, and Tables

Inches of Average Monthly Rainfall for New Mexico Towns

*INCHES OF AVERAGE MONTHLY RAINFALL FOR NM TOWNS													
**NM Towns	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Abiquiu Dam	0.38	0.26	0.51	0.55	0.83	0.71	1.59	2.01	1.13	0.88	0.53	0.34	9.71
Alamogordo	0.73	0.52	0.46	0.32	0.50	0.83	2.13	2.13	1.68	1.05	0.54	0.81	11.68
Albuquerque	0.39	0.40	0.48	0.50	0.61	0.65	1.31	1.52	1.02	0.81	0.48	0.49	8.66
Animas	0.70	0.54	0.49	0.19	0.17	0.45	2.20	2.36	1.46	0.99	0.57	1.03	11.15
Belen	0.28	0.40	0.40	0.26	0.31	0.63	1.40	1.32	0.90	0.98	0.20	0.39	7.45
Bernalillo	0.43	0.49	0.56	0.43	0.58	0.55	1.47	1.50	0.83	0.95	0.44	0.47	8.68
Carlsbad	0.43	0.44	0.30	0.53	1.24	1.53	1.73	1.96	2.34	1.24	0.49	0.51	12.72
Clayton	0.27	0.40	0.65	1.21	2.39	1.91	2.64	2.31	1.68	1.09	0.50	0.38	15.44
Clines Corners	1.05	0.82	0.99	1.00	1.60	1.61	2.72	3.16	2.24	1.49	1.04	1.00	18.71
Clovis	0.43	0.43	0.59	1.04	2.10	2.60	2.62	2.96	2.16	1.61	0.56	0.60	17.71
Corrales	0.43	0.39	0.67	0.65	0.68	0.82	1.63	1.95	1.18	0.85	0.91	0.64	10.80
Crownpoint	0.52	0.51	0.49	0.50	0.36	0.67	2.06	1.89	0.85	0.85	0.46	0.61	9.75
Cuba	0.89	0.69	0.88	0.68	0.80	0.80	2.07	2.28	1.38	1.11	0.80	0.72	13.09
Deming	0.48	0.54	0.34	0.20	0.16	0.37	2.07	1.90	1.22	0.79	0.52	0.89	9.50
Española	0.47	0.43	0.59	0.58	0.89	0.75	1.50	1.94	1.00	0.90	0.57	0.50	10.12
Estancia	0.54	0.53	0.64	0.55	1.01	0.97	2.19	2.38	1.51	1.13	0.64	0.80	12.87
Farmington	0.58	0.50	0.55	0.51	0.36	0.46	0.80	1.07	0.83	1.11	0.49	0.62	7.89
Fort Sumner	0.39	0.40	0.44	0.59	1.16	1.47	2.42	2.81	1.80	1.37	0.55	0.49	13.90
Gallup	0.89	0.73	0.89	0.53	0.64	0.47	1.54	1.93	1.13	1.00	0.99	0.74	11.50
Grants	0.51	0.43	0.52	0.45	0.57	0.57	1.71	2.10	1.35	1.10	0.56	0.66	10.52
Hobbs	0.48	0.45	0.46	0.80	2.09	1.83	2.16	2.42	2.66	1.58	0.57	0.58	16.06
Jemez Springs	1.08	0.88	1.02	0.89	1.07	1.07	2.61	3.12	1.58	1.50	1.06	0.94	16.83
Las Cruces	0.52	0.33	0.23	0.21	0.33	0.66	1.46	2.27	1.31	0.82	0.46	0.76	9.17
Los Alamos	0.91	0.79	1.10	0.94	1.31	1.38	3.14	3.78	1.82	1.42	0.98	0.98	18.53
Los Lunas	0.35	0.42	0.46	0.44	0.49	0.57	1.23	1.76	1.21	1.06	0.46	0.53	8.98
Pecos	0.66	0.65	0.86	0.73	1.14	1.29	3.00	3.48	1.86	1.09	0.80	0.63	16.21
Raton	0.37	0.39	0.71	0.91	2.51	2.25	2.87	3.34	1.88	0.92	0.49	0.41	17.07
Roswell	0.42	0.46	0.29	0.60	1.33	1.63	2.01	2.48	2.16	1.06	0.51	0.59	13.52
Ruidoso	1.17	1.20	1.21	0.63	0.94	1.94	4.05	4.03	2.65	1.54	0.85	1.63	21.85
Sandia Park	3.10	1.24	1.44	0.93	1.14	1.12	3.00	3.00	1.83	1.40	1.31	1.20	20.44
Santa Fe	0.65	0.74	0.79	0.94	1.33	1.05	2.35	2.17	1.52	1.11	0.62	0.71	13.99
Shiprock	0.51	0.43	0.46	0.40	0.52	0.32	0.63	0.98	0.67	0.86	0.57	0.59	6.93
Silver City	1.25	0.85	0.84	0.55	0.21	0.58	2.78	2.48	1.91	1.21	0.49	1.07	14.17
Socorro	0.39	0.39	0.33	0.37	0.59	0.62	2.59	1.77	1.46	0.97	0.37	0.56	10.40
Taos	0.71	0.63	0.83	0.77	1.17	0.89	1.62	1.98	1.25	1.03	0.84	0.68	12.40
Tijeras	0.63	0.97	1.06	0.90	0.78	0.88	2.45	2.42	1.57	1.46	0.80	1.18	15.10
T or C	0.47	0.37	0.33	0.21	0.42	0.81	1.72	2.11	1.37	0.96	0.54	0.96	10.26
Tucumcari	0.26	0.47	0.39	0.87	1.49	1.78	3.30	2.40	1.46	0.94	0.50	0.27	14.11
Vaughn	0.44	0.44	0.35	0.51	0.92	1.60	1.99	2.56	1.41	0.87	0.41	0.38	11.87

Table from City of Albuquerque *Rainwater Harvesting Supply from the Sky*

*Data Obtained from the Western Regional Climate Center and the National Oceanic and Atmosphere Agency

** The average rainfall for more specific locations may vary from the averages shown here. In Albuquerque, for example, average rainfall ranges from 8.51 inches a year at the airport to 14.00 inches a year near the Sandia foothills.

Appendix C

Charts, Graphs, and Tables

Average Evapotranspiration Rates for Selected Areas in New Mexico

* AVERAGE EVAPOTRANSPIRATION FOR SELECTED AREAS IN NM													
Areas	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
Northwestern Plateau (Gallup)	0	0.33	0.86	1.87	3.37	4.95	6.15	5.37	3.56	1.91	0.60	0	28.9
Northern Mtns. (Santa Fe)	0	0.30	0.68	1.56	2.82	4.26	5.05	4.51	3.02	1.63	0.52	0	24.3
Eastern Plains (Clovis)	0.35	0.55	1.27	2.53	4.31	6.23	7.00	6.30	4.26	2.42	0.91	0.45	36.5
Western Mtns. (Grants)	0.26	0.41	0.98	1.87	3.23	4.85	5.67	4.94	3.41	1.92	0.71	0.35	28.6
Central Valley (Albuquerque)	0.38	0.64	1.44	2.76	4.58	6.37	7.17	6.43	4.42	2.52	0.93	0.46	38.1
Central Highlands (Mountainair)	0.26	0.41	0.98	1.94	3.33	4.85	5.48	4.81	3.39	1.91	0.71	0.35	28.4
Southeastern Plains (Carlsbad)	0.52	0.78	1.68	3.10	4.95	6.79	7.33	6.66	4.69	2.84	1.17	0.66	41.1
Southern Desert (Las Cruces)	0.56	0.83	1.78	3.11	4.94	6.91	7.66	6.80	4.88	2.97	1.24	0.68	42.3

Table from City of Albuquerque *Rainwater Harvesting Supply from the Sky*

* Data Obtained from the Toro Company, "Rainfall-Evapotranspiration Data," Form #490-1358

In the News

Reprinted with permission from The Associated Press

May 13, 2001

America's Next Crisis: Going Dry

Story by Mort Rosenblum
Photographs by Damian Dovarganes
of the Associated Press

Palm Springs, Calif.- The desert around here, so dry that imported Arizona cactus needs watering, has sprouted a man-made ski lake, 100 lush golf courses, outdoor air conditioning and gardens fit for the tropics.

A quarter million residents use an average of 375 gallons of water a day at home, twice the national norm. That costs a household only half as much as cable TV.

Beyond the Salton Sea to the south, 400 Imperial Valley farmers receive as much Colorado River water as Arizona and Nevada combined. Their main crop is alfalfa, a thirsty, low-profit feed for dairy cows and horses.

There, rain is a curse. It wilts the lettuce and unbalances the water district's cash flow by cutting demand for irrigation.

This is just a start. The Colorado is piped to the fastest growing cities in the United States: Los Angeles, San Diego, Las Vegas, Nev., Phoenix, Tucson. What little is left irrigates Mexico's richest farm region.

To water specialists, the overtapped Colorado River basin is symbolic of a calamity facing much of the world. Fresh water reserves are disappearing fast.

These experts see the California power crisis as the harbinger of much worse to come.

"No one thought that a state richer than most countries could fail to deliver reliable supplies of electricity," warned Richard Brusca, a University of Arizona environmental scientist. "Well, guess what's next?"

People can survive power cuts and even live without oil, he adds. Water is another matter entirely.

Like China lifeline Yellow River and other waterways on six continents, the Colorado often runs dry before reaching its mouth. Across America and the world, ancient underground lakes are squandered by over-pumping.

Pesticides, fertilizers and solvents poison some aquifers far below the surface. Others take on salt water when levels drop too low.

The planet has no more fresh water than it did millenia ago. But with today's rocketing growth in arid zones, conflicting needs of farms, cities, industry, recreation and wetlands promise bitter water wars.

"We foresee serious problems," said Bruce Smith, the U.S. Defense Department official who supervises 300 projects in 100 countries designed to help provide water and reduce political tensions. "This is getting very bad."

He said the Pentagon and the State Department now give high priority to preventing private conflict over water in the Middle East, Asia and Africa. Yet water managers across America say the public and political leaders who can effect change seem to ignore the danger.

"Planners always say that we can worry about water supplies in the future," said Tom Turney, the New Mexico state engineer. "That doesn't work anymore. The future is now."

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America's Next Crisis: Going Dry (continued)

Trouble spots

The Rio Grande is as overcommitted as the Colorado. Albuquerque, whose underground reserves were until recently vastly overestimated, could dry up by 2050.

Ciudad Juarez, across the border from El Paso, has soared beyond a million inhabitants, typical of northern Mexico's growth. It could run out as early as five years from now.

"When you open the doors and see inside, it terrifies you," said Aletta Belin, a Santa Fe, N.M., environmental lawyer. "You think, 'Isn't someone supposed to be watching all this?'"

Linda Vida, of the Water Resources Center at University of California-Berkeley, sees the same phenomenon across the American West and beyond.

"Nobody is looking out," she said, "The stakeholders want what they want. No political leader is willing to go out on a limb and make some people very unhappy. No one wants to deal with tying growth to resources. They just squeeze out more." As a result, she said, a drought that otherwise might be managed with water reserves could hit California far harder than the energy crisis.

Making gains

Interviews with scores of specialists lead to a gloomy picture, but some also see points of light.

"People are beginning to ask the right questions," said Peter Gleick of the Pacific Institute for Development in Berkeley. Technology is helping. Now, he noted, it takes one-tenth the water to make a ton of steel.

The Metropolitan Water District's conser-

vation programs have reduced consumption, stabilizing water in Los Angeles despite population growth. "Met" is filling new reservoirs, above and below ground, to add reserve capacity.

Orange County Water District has a revolutionary project to triple-filter waste water and recharge the substantial Santa Ana aquifer. This also helps to block encroaching sea water.

"We're showing California and the world that you can effectively recycle water," said William Mills, head of the district.

Still, as a seasoned engineer and manager, Mills sees the conflicts ahead. Old-style fights involved rifles and dynamited aqueducts, but now stakeholders head for the courts.

"We're going to see lawsuits everywhere over the next 10 years," he said. "The water wars are going to start all over again."

Who's in charge here?

Each state has its own complex policy based on the days when farmers and ranchers held sway. Municipalities and water districts set their own rules. There is no federal water master.

Arizona is regarded as forward-looking in water matters. But its Water Resources Department in Phoenix, which sits behind a lush green lawn, faces frightening projections. The state population grew by 40 percent in a decade.

Two decades doubled Arizona's population to 5.13 million, pushing new homes onto waterless wasteland. Golf courses and parking lots climb dramatic hillsides, replacing unique Sonoran desert.

In Phoenix, where urban canals still flood home gardens, daily water use is 250 gallons

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per person. Wealthy suburbs are awash in lagoon-fringed subdivisions with “water” and “lake” in their names.

In Tucson, with more restrictions, the average use is 175 gallons. Yet saguaro stands and mountain foothills are plowed up for more resorts.

Tom Levy, general manager of the Coachella Water District and president of the California Water Contractors Association, sighs ruefully when asked about long-range planning.

“We water guys can never confront the hard issues,” he said. “We find a temporary fix and hope we’re retired before we have to answer for it. Then if our kids are attorneys, they can make a living sorting it out.”

Dennis Underwood, former head of the U.S. Bureau of Reclamation and now assistant director of the Met in Los Angeles, lamented, “When it comes to planning, we’re still looking at the end of our noses.”

No isolated problem

Although attention mostly focuses on the U.S. Southwest, rivers as unlikely as the Ipswich near Boston have been pumped dry.

William Alley, director of groundwater research at the U.S. Geological Survey, sees shortages looming in much of the United States. Even areas with plentiful supplies are taking no chances.

The Great Lakes have one-fifth of the world’s fresh surface water, he said, but recently a Korean tanker was refused permission to fill up there for ballast.

Along the Atlantic coast, seawater seeps into aquifers from Cape Cod to the tip of Florida.

The huge High Plains (Ogallala) Aquifer has been tapped so heavily that parts of

Kansas and other Midwest areas may have to switch to rain-fed agriculture, Alley said.

In many places, land subsides.

Overpumping in California’s San Joaquin Valley has caused one section of farmland to drop 29 feet. Tucson, Albuquerque and Las Vegas are slowly sinking.

Severe drought in the Northwest, where reservoirs have been drawn down to supply power for California, threatens a calamitous summer. Already, salmon are in danger, unable to spawn because of low water.

In the Southeast, drought has further depleted aquifers, letting in seawater. Desperate Florida authorities seek federal clearance to replenish underground water with untreated runoff.

Worse seen ahead

Scientists expect problems to worsen if global warming upsets rainfall patterns. Dams and diversions may aggravate crisis. As deltas and wetlands dry, ecosystems suffer.

“It took nature millions of years to fine-tune these systems, and we come along and think we can improve them,” Brusca of the University of Arizona observed. “We may be in for some ugly surprises.”

Most experts believe people won’t save water until it costs what it is actually worth. Water is now essentially free. Most consumers pay only the cost of treatment and delivery. In some places, it is even illegal to meter water.

But putting a value on water is touchy.

Las Vegas authorities, for instance, insist their lavish use of water draws big spenders. Casinos among blazing lights and lagoons bring in far more than wheat and alfalfa.

Sandra Postel, author of two books on

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global water issues, worries about monetizing water. If the wealthy can buy up scarce water, what about the poor?

"How do we decide who wins and who loses?" Postel reflected. "Is this just a market issue?"

Palm Springs and nearby towns bloom on a desert moonscape against a backdrop of starkly beautiful mountains. Less than three inches of rain fall each year.

At the Palm Desert Marriott resort, boats ferry diners from the lobby to a restaurant across a 23-acre artificial lake. Inside its brochure boasts, "It took over 50 million gallons of water to fill the indoor lakes and waterfalls."

Elsewhere, cooled mist above café terrace tables air-conditions the outdoors. Badly aimed sprinklers water paved streets. Nearly every home has a swimming pool, its water evaporating in the heat.

"People today are selfish, thoughtless and don't seem to care about anyone's future," fumes Pat Finlay, a retired actress and self-described "water nazi" who badgers her Palm Desert neighbors to save every drop.

Levy, the district's manager, scheduled two public meetings to push conservation. Despite newspaper ads and 80,000 mailed notices, only 40 people showed up.

Levy must supply scarce water not only to grape, citrus, and date farmers but also to resort operators whose lush paradises enrich the local economy.

Controversy erupted when developers of Shadow Lake, near Indio, bought land and planned to pump groundwater to fill a 43-acre ski lake, 12 feet deep, and sell 48 sites for shore-side homes.

Levy twice asked California's State Water Resources Control Board to step in, citing the state constitution's stipulation that water

use must be "reasonable and beneficial."

When the board declined to consider his request, Levy said, he had no choice but to provide Colorado water in order to protect the aquifer.

Kevin Loder, sales manager of Shadow Lake, acknowledges that his project might look like a waste of water. But he insists the opposite is true.

When completed, the opulent gated community will be worth \$70 million, he said, contributing \$1 million a year in taxes. The same water used for agriculture would add up to a fraction of net value.

"It all depends on the price you put on a bucket of water," Loder said. "The beauty of this is that we paid only \$3,400 to fill the lake because we used agricultural water." He estimates the total at 100 million gallons.

He added: "We have a right to dig wells. Anyway, if we didn't use the water it would just be sitting in Lake Havasu." California draws its Colorado River water from Havasu, a man-made reservoir on the border with Arizona.

Raising objections

Others disagree vehemently. Mexico has twice as much farmland as the Imperial Valley but only half the water. Shrimp industries and fisheries are imperiled when Colorado water does not reach the Gulf of California.

The Los Angeles metropolitan area and San Diego are eager for more of the Colorado. Both have negotiated with the Imperial Valley district for water saved by more efficient - and costly - irrigation.

In all, California gets one-quarter of 17.5 million acre feet divided annually among seven Western states and Mexico. It has also

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been consuming an extra 900,000 acre feet unused by others.

An acre foot, or 325,000 gallons, would cover a football field in a foot of water.

After negotiation last year, then Interior Secretary Bruce Babbitt signed a 15-year plan that would return California to its quota despite rocketing new demands.

Imperial Valley Irrigation District has raised \$23 million to defend historical rights to its 3.1 million acre feet. At the IID, a framed 1901 masthead of the Imperial Press declares: "Water is King, and Here Is Its Kingdom."

Plans gone awry

But reality is complicated. In 1993, the Bass brothers of Texas bought 46,000 acres in hopes of selling the water rights to San Diego. When IID directors opposed that, they sold the land to U.S. Filter Corp.

Then U.S. Filter was acquired by Vivendi, the giant French water and entertainment conglomerate. Now the valley's largest landholders are stockholders in France.

The valley's 100 different crops earn \$1 billion a year, but the majority of water goes to break-even hay, including sudan grass hay exported cheaply to Japan as cattle feed.

Some farmers say the only way to long-term survival is to fallow mediocre land, sell surplus water rights, and use the remaining land more wisely. They see alfalfa as a holdover from the past.

"I'm convinced we can eventually grow 10 times the food on a quarter of the land," said Alex Jack, whose high-tech investments include soil sensors linked by radio to his laptop computer.

But others maintain that Imperial Valley

farmers who pioneered the land should not be deprived of the fruits they earned. If they go, they argue, who will produce food?

"I honestly think city people believe every supermarket has three cows and a wheat field in the back room to provide their food," farmer Toni Holtz said, with a bitter laugh.

Jesse Silva, IID manager, is open to new water transfers but sees limits to how much water farmers can save.

"The way we're going, it's pretty scary," he said.

Long-term challenges

In Palm Desert, Levy predicts that large-scale desalination will be essential within 50 years. Even if technology cuts the cost, he said, agriculture will still face severe changes.

Desalination now costs about \$800 an acre foot, Levy noted, but farmers can lose money with water at \$15 an acre foot.

That adds in the issue of food security. What American farmers do not grow must be bought in world markets. But water shortages already cut deeply into other countries' production.

Experts agree that big-picture solutions in America and beyond must be as much political as technical.

Victor Baker, head of the University of Arizona hydrology department, believes engineers could solve most of the world's water problems if scientists and politicians alike would think differently.

"Politicians don't understand the science, or they manipulate it to their own purposes," he concluded. "Scientists, who don't understand politics, always think they'll be heard. The trick is to make politicians more realistic and scientists more understanding."

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Los Angeles Times

“The unfolding tragedy is the culmination of a century of unsustainable federal policies designed to satisfy demands for cropland, fishing, population growth and wildlife protection.”...

Dreams Dry Up in Klamath Basin

Public policy allowed too many water-reliant interests to come into being. Drought triggers a collapse that could be repeated elsewhere.

By DEBORAH SCHOCH
Times Environmental Writer

July 23, 2001

KLAMATH FALLS, Ore. — Gone is the familiar hiss of water through irrigating wheel lines, the hum of tractors and combines and the raucous honking of ducks. Even the whine of mosquitoes is eerily missing.

The barley should be hip-high in the field that Gene Haskins tilled like his father and grandfather before him. But his stunted crop barely reaches his knees in dried-up soil. Haskins filed for bankruptcy in April, as have dozens of local farmers, victims of a vicious drought and a century of ill-conceived public policy.

Along dusty roads in lip-splitting dry heat, signs of desperation are everywhere. Sheep grazing on bare ground run toward the road when a car stops, baaing furiously and wrap-

ping their mouths around the strands of barbed-wire fence.

The farmers blame their plight on the Endangered Species Act, a law widely condemned for valuing wildlife more than people. But the cruel truth is that the farm economy and the environment are crashing in tandem.

Birds are dying as ponds dry up in wildlife refuges. The Klamath River Basin’s six refuges are part of the largest wintering grounds for bald eagles in the Lower 48 states. The two refuges in the worst shape have depended on irrigation water ever since a network of marshes and lakes was drained to provide more water for agriculture.

The unfolding tragedy is the culmination of a century of unsustainable federal policies designed to satisfy demands for cropland, fishing, population growth and wildlife protection.

Experts warn that what is happening here may be a precursor of potential catastrophe looming in other Western communities accustomed to cheap and abundant federal water and plentiful wildlife.

“This has been coming for a long time. They overbooked the plane. There’s only so much water, and they’ve given it too many times,” said writer William Kittredge, a former rancher who grew up near Klamath Falls and whose books deal with water and other resources in the West. “The defining fact about the West is aridity.”

Established in 1907, the Klamath irrigation project was one of the first of its kind. In

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Dreams Dry Up in Klamath Basin (continued)

1947, a Life magazine cover story featured a beaming young World War II veteran and his bride who had won a lottery entitling them to a homestead on the rich soils of Tulelake, Calif., at the southern end of the Klamath irrigation project. It was a dream come true.

The dream dried up this spring, after the Klamath River Basin was seized by a historic drought. For the first time in 94 years, the federal water did not flow, starving 1,200 farms along the Oregon-California border. The U.S. Bureau of Reclamation in April announced a 90% reduction in irrigation water—leaving 19 of 21 water districts and two federal wildlife refuges with no water at all.

Federal officials blamed the water shut-off on the drought and a legal obligation to give first priority for water to imperiled fish—two species of suckers and the coho salmon—in the Klamath River and in Upper Klamath Lake. “We’ve been providing water to this community for 94 years, and we’re really frustrated this year,” said bureau spokesman Jeffrey S. McCracken.

Farmers erupted, protesting that the government valued fish over people. Hundreds of protest signs appeared almost overnight in bare fields and frontyards: “Loggers, Ranchers, Farmers, What’s Next?,” “Federally Created Disaster Area,” “No Water, No Barley, No Beer.”

Farmers and their supporters set up camp at the south end of Upper Klamath Lake, next to the now-shut head gates that seal off lake water from the irrigation canal leading to the water-deprived farms. Beyond a chain-link fence, federal law enforcement officers stand

guard at the gates. Four times, protesters have forced open the gates and built a makeshift pipeline that sluices water toward ruined fields.

‘That’s Our Water,’ Says One Protester

Tensions mounted last week when the protesters moved a large yellow excavator and a bulldozer onto the site and marked the earth with orange lines, as if they were about to carve their own canal from the lake toward their farms.

“The gist of the whole thing is that’s our water,” said Jon Hall, 49, motioning at the lake. “They’ve taken a fish and put it over you and me.”

But others blame a system long overtaxed with too many obligations to farmers, fishermen, Native American tribes, migrating waterfowl and endangered wildlife.

“Federal policy on development and federal policy on environment—it’s a collision,” said Reed Marbut, intergovernmental coordinator at the Oregon Water Resources Department.

“This is one where it seems humans want it all,” said David Yparraguirre, waterfowl coordinator at the California Department of Fish and Game. “We want to keep the agricultural base. We want the wildlife, with the fish. We want it all.”

The basin’s promise of secure water opened a new frontier to hundreds of families early in the 20th century. Farmer Marshall Staunton’s stockbroker grandfather, a World War I veter-

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an, obtained homestead land here just before losing everything else in the 1929 stock market crash. The land offered him and his family security in depressed times. Other families settled in the basin after the two world wars, intent on peacetime economic success.

“The government encouraged everyone to come out here, develop the land, feed the nation,” said Jim Carlton, 33, of Merrill, Ore.

What the basin offered them was cheap water and cheap electric power to pump it. The Reclamation Act of 1902 made possible the massive Klamath project, which not only channeled water to arid land—the typical Western technique—but drained as much as 80% of the basin’s bountiful lakes and marshes to create even more farmland on rich peat lake-bottom soil.

Ensuring a productive landscape required re-engineering the valley’s natural hydrology, using a complex system of dams, dikes, channels, pipelines and even a 6,600-foot tunnel. Today, a basin map shows an elaborate grid of thin red lines—the once-dependable lifelines for basin farmers. It feeds more than 200,000 acres of irrigated lands, once flush with crops of grains, alfalfa, potatoes, sugar beets, horseradish and sweet-scented mint.

Every spring, water revived the valley.

“We call it painting the valley green,” said Staunton, the oldest of three brothers still farming the land. The winter landscape would be gray and brown, a cold wind blowing. “Then, boom, here come the plants.”

Not this year. The valley is a patchwork of green and brown, a map of haves and have-nots. Some lucky farmers have wells and green fields. Some are wealthy enough to buy water. Some fields are deceptively green, planted with soil-saving cover crops. Others, close up, are really huge weed patches, worrying farmers with the specter of autumn winds whipping weed seeds up and down the valley.

The Klamath Basin tragedy has been portrayed as bottom-feeding fish violating hard-working people’s rights. To a point, the Endangered Species Act did trump the laws protecting basin water users.

“The ESA set the stage, and the drought set the table,” said Marbut of the Oregon Water Resources Department.

The U.S. Fish and Wildlife Service placed the Lost River sucker and the short-nosed sucker on the endangered species list in 1988. The National Marine Fisheries Service followed in 1997 by listing the coho salmon. Such listing means that the fish cannot be harassed, harmed or killed.

Environmentalists say the disappearing fish signaled the collapse of the entire Klamath River ecosystem.

In a controversial April opinion that helped trigger the water crisis, Fish and Wildlife biologists wrote: “Nearly all basin streams and rivers have been degraded, some seriously, by the loss of riparian vegetation, geomorphic changes, introduction of return flows from agricultural drainage ditches and water pumped from drained wetlands. . . . Most water bodies in the basin fail to meet water quality criteria.”

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Dreams Dry Up in Klamath Basin (continued)

Yurok Tribe Members Depend Heavily on Fish

Some claim this crisis could have been predicted years ago, if the signs had been heeded. Coho salmon runs grew markedly thin in the Lower Klamath River, historically one of the most important salmon rivers on the Pacific Coast.

“Man has manipulated the habitat, and now we’re paying the price of that manipulation,” said Troy Fletcher, the executive director of the Yurok tribe.

The Yurok reservation flanks the lower 44 miles of the Klamath, and tribe members heavily depend on its fish for food and commerce.

“This isn’t a fish-versus-people issue, as it’s been framed,” Fletcher said. “There are people behind the fish, real people on which this has real impact.”

Inevitably, critics come back to the Endangered Species Act. “The real problem here is that the ESA doesn’t allow a compromise,” said David Haddock, staff attorney for the Sacramento-based Pacific Legal Foundation, a conservative firm representing the Klamath and Tulelake irrigation districts, which are mulling a suit against the federal government.

“If the ESA weren’t so rigid,” Haddock said, “we could try for a compromise.”

Some officials suspect a long-term solution could be a habitat conservation plan—a system of compromise created by a 1982 Endangered Species Act amendment. But

such a plan would take years to complete.

The Klamath crisis looms as the biggest challenge to date for Interior Secretary Gale A. Norton, who oversees three agencies with conflicting interests in the water wars—the Fish and Wildlife Service, the Bureau of Reclamation and the Bureau of Indian Affairs. A Norton aide attended mediation sessions in Eugene, Ore., last week, but officials were tight-lipped about the outcome.

As the drought takes its toll on wallets and spirits, family nurse-practitioner Michael Sheets says he has been prescribing antidepressants to one of every three patients he sees. Retired from the U.S. Public Health Service, Sheets has spent his career working in poor rural areas, but he has seen nothing like this year in the Klamath Basin. He breaks down as he describes the pain he witnesses every day.

“I’ve got people puking blood, because of bleeding ulcers, because they’re so angry,” he said. “They don’t want drugs. They don’t want government handouts. They want to work.”

Some farmers, like Gene Haskins and his parents, are ready to sell their land. Others, like Staunton, want to see a plan crafted to allow farming to continue in this troubled valley, perhaps slightly reduced with a redesigned irrigation system and improved water quality.

“Agriculture’s headed for a horrible outcome unless we resolve this,” Staunton said. As for the farmers who settled this valley: “We have to approach the Klamath like we did San Francisco after the earthquake. We didn’t

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blame people for building on an earthquake fault.”

Haskins said, his voice suddenly becoming animated. “It’s got kernels in it, and it’s starting to get some meat on it.”

The Silence Is Haunting

On Wednesday, Haskins applied for assistance to go to truck-driving school.

Then, he moves on to another field that lies fallow. The silence is haunting, he says. Normally, you’d hear tractors, irrigators, people driving around.

He insists he is ready to sell out, but he still wanders through his fields, looking for signs of life, finding faint hope in a frail green shaft of barley.

“The farmers around here, I imagine they’re awful bored. Sitting around at home. Wondering.”

“There’s going to be something out here,”

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In the News

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City Studies Impact of Growth Limits

Report says controls in city might simply push growth into surrounding areas

By Tom Sharpe
The New Mexican

May 15, 2002

If the city of Santa Fe adopts growth controls in response to water shortages, it could simply accelerate growth in the surrounding area.

That's one of the conclusions in a new study commissioned by the city to help councilors decide whether to adopt a "water budget" and other restrictions on new development.

Most of the Santa Fe area's population growth already is taking place outside city limits, notes the report, issued this week by the University of New Mexico's Bureau of Business and Economic Research. Meanwhile, most of the job growth is taking place inside the city.

An analysis of what happened in other communities where various types of growth limits were adopted- including Boulder, Colo.; San Luis Obispo, Calif., and Thousand Oaks, Calif.,- found that, "The regional impact of limits can result in increased commuting, automobile congestion and leapfrog development."

The city of Santa Fe already is growing more slowly than the surrounding area. In the last decade, the city's population

increased by 11 percent. The number of people living in the urban area just outside the city, however, grew by 62 percent and the surrounding region-unincorporated areas of the county from Cerrillos on the south to Chupadero on the north-by 68 percent.

The report, titled *The Economic Impact of a Growth Rate Ordinance in the City of Santa Fe*, examines the possible impact on Santa Fe under four alternative scenarios through 2010.

The first scenario assumes no water shortage.

The second assumes a serious water shortage develops in 2004 and the city declares a 12-month moratorium on building in 2005.

The third assumes the city adopts a water budget that sets "moderate" annual limits on new hook-ups to the city water system.

The fourth assumes a "tight" water budget.

Tony Sylvester, one of the study's authors, said Tuesday that none of the scenarios would affect the city's economy as much as its population growth, though that could change in the long term if many people relocate to rural parts of the country.

"Santa Fe is an employment center," he said. "All the retail, all the stores, at this point, at least, they're not building them outside the city too much."

"That might not be true if there's a whole lot of population outside the city. One of the things our case study in Boulder shows us is that, at first, Boulder was the employment center and the retail center and getting all the taxes.

But you start putting some limits on there, people start moving out and then people say 'I don't want to drive all the way

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down there for my gallon of milk,' and then pops up a 7-Eleven or something.”

Well-designed growth controls, he said, “can minimize the impact and make sure that the positive benefits of growth are still there without the negative ones.”

As for housing costs, Sylvester said that regional economic trends might have a greater impact than growth controls.

“When California (job) marked declined, housing prices didn’t get impacted too much,” he said.

“But, boy, when things are taking off, I don’t care if (development) is limited or not, housing prices go up.”

With the exception of the most recent five-year period, the study says, Santa Fe’s non-agricultural employment has typically increased at faster rates than both the state and the nation.

Reed Liming of the city Planning and Land Use Department is expected to discuss the study during the city Public Utilities Committee meeting in City Hall Council Chambers at 5:15 p.m. Thursday.

Growth Study

Under a section titled “Lessons From Other Communities,” the study says:

- Growth limits do not always limit growth. While several cities have experienced slower rates of growth after implementing limits, the decline is likely due to a combination of factors including declining regional growth and alternative areas for development.
- Growth limits might push growth into sur-

rounding areas. The limits, regulatory requirements and uncertainty combine to make development outside the controlled area more attractive. The regional impact can result in increased commuting, automobile congestion and leapfrog development.

- Market demand and not land constraints has been recognized as a primary determinant in housing prices. While limits can increase housing prices, the impact is shaped by a variety of factors, including the structure of local housing markets, the patterns of land ownership, availability of land in surrounding areas, and an inventory of land zoned at different intensities. Additionally, the shift to larger, more profitable housing and quality of life improvements can put upward pressure on housing prices.
- The design of growth controls shapes the impacts. Growth management measures that limit the amount of available land can have disproportionate impacts on rental housing, and low-income and minority households.
- Indirect growth controls—down-zoning residential densities, reducing floor area ratios, more stringent development requirements, delays in processing of building permits—can restrict growth and impact housing prices and availability.

Source:

The Economic Impact of a Growth Rate Ordinance in the City of Santa Fe

In the News

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New Mexican

State Land Office Plans to Get Rid of Grass Lawn

By Tom Sharpe
The New Mexican

May 18, 2002

State Land Commissioner Ray Powell Jr. plans to replace the green grass in front of the State Land Office with native Southwestern vegetation this summer.

"We're working to devise a plan that will make it not only very attractive, but conserve that water that has become very precious in the drought," Powell said this week.

Powell said the State Land Office has observed city restrictions that limit outdoor irrigation to one day a week, causing the Kentucky bluegrass on the front lawn "to turn brown very, very quickly and we're not even in the hot part of the summer yet."

If all outdoor irrigation is banned and the mountain showers don't start soon, he said, the lawn will die.

"One of the most frustrating things for anyone is when they try to nurture something and suddenly the water isn't available," he said. "It's heartbreaking letting it go."

A State Land Office employee called *The New Mexican* this week to complain about the plan to tear out the Kentucky bluegrass and suggested irrigating with city effluent instead.

But Powell said he was not aware of complaints or the suggestion of using effluent.

"For some people, change is traumatic," he said.

Powell said there are no plans to remove existing trees on the property. Xeriscaping will be done in stages, beginning with lawn facing Old Santa Fe Trail where sculptures are displayed.

Eventually, the xeriscaping might be extended to the north side of the building, which slopes to the Santa Fe River, he said. He said he will hire "world known" xeriscaping expert Judith Phillips of Belen to design the new plantings.

He said he plans to host a public meeting this summer in Morgan Hall at the State Land Office to tell people about the design and educate them on how they can save irrigation on their own yards. No time has been set yet.

Powell said he hopes eventually to surround the State Land Office with native vegetation that provides examples of what grows naturally in New Mexico with little or no irrigation.

Powell was appointed as land commissioner in May 1993, elected in 1994 and re-elected in 1998. He will leave office at the end of this year.

Powell sought the Democratic nomination for governor, but bowed out, leaving the race to Bill Richardson.

"When you live in one of the most arid places on the entire planet, you really have to keep an eye out on how you use water," Powell said.

In the News

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Albuquerque Journal

Barren Lands

Range that has turned to dust has New Mexico ranchers cutting their herds and hoping for the best

Story by Leslie Linthicum
Albuquerque Journal

May 26, 2002

CIRCLE DOT RANCH - Out on the rolling ranch land where grass usually is richly green and 3 inches tall by now, the landscape is the color of a bowl of beans.

The dirt is brown. The grass is brown. Even the broom snake weed, a sturdy intruder that turns chartreuse with even the promise of moisture, is brown, crackly and dead.

It's been a long, hot spring for anyone trying to keep cattle alive in New Mexico.

Bill Sauble is a 53-year-old Colfax County native who helps run the family ranch on about 80 square miles east of the town of Maxwell. Bumping his pickup across one of his toasty pastures, he ponders one of the many ironies of raising cows amidst a drought: It takes a lot more work to make a lot less money.

The ranch counts on 15 inches of rain each year to grow its native grasses-blue, hairy and sideoats grammas and Western wheat grass. Last year, the total was less than 9 inches. So far this year Sauble has measured less than an inch.

There is nothing left for the Circle Dot's 800 Angus-Gelbvieh cross cattle to eat on the range. So Sauble, his son, sister and other relatives load trailers full of protein pellets every

day and haul them out to the cows.

Once or twice a day they check on the water in their stock tanks. And they constantly inventory the herd for weak cattle that might need help or be next on the auction block.

Sauble, like many New Mexico ranchers, already has cut the size of his herd sharply.

Two hundred of a thousand Circle Dot cows have gone to the auction in the past couple months and more will be culled and sold in the coming weeks.

How many?

"We'll know within the next 30 days," Sauble said. "One inch of rain or better will green this up and get us some growth."

Ranchers Cut Herds, Hope for Best

A survey of range conditions across New Mexico by the U.S. Department of Agriculture on May 16 showed 43 percent of ranch land was in very poor condition and 43 percent was in poor condition. Thirteen percent was in fair condition and 1 percent was in good condition.

Traveling around rural New Mexico, it is hard to imagine where that 1 percent of good rangeland might be.

"It looks like the dead of winter," said Colfax County agriculture agent Sandra Barraza. "It's not green at all."

In Tarrant County west of Albuquerque it's the same story.

"You'd think it was February," agriculture agent Bill Nesh said.

A lack of rain and snow for several seasons in a row is to blame.

There was not enough moisture last year to make the grass grow. That stunted grass sat through a dry winter and now has none to little of the spring rain it needs to turn green and begin to grow again.

In the News

Barren Lands (continued)

Simply put, the brown stubble in pastures is the dried out remains of grass that hasn't grown well in two years.

Some grass has died altogether.

In New Mexico, where 1.6 million cows and calves live-nearly a cow for every person-poor range conditions mean real economic hurt.

Raising cattle on broad stretches of grassland that is watered by rain is always a gamble. And even in wet years cattle need some extra help in the form of nutrition pellets or hay to get them through winter.

This spring, across the state, the feeding never stopped.

Some ranchers have pulled their cattle into their least-grazed pastures and are dropping a couple of pounds of food pellets for each animal-at a minimum of \$180 a ton-every day. Meanwhile, cattle prices have dropped steadily in the past few weeks.

If feeding a cow and a calf costs 40 cents per day and the price that pair can fetch at auction drops \$5 a day, the costs of holding on begin to mount.

Each time a rancher ships some cattle to auction, his costs go down and some cash comes in.

The culling starts with cows that have not bred. Then the older cattle go. Next are calves that are not thriving.

After that, discretion takes over. "Do I like the way she looks? Or do I just not like her?" Sauble said. "Did she kick me last year?"

Sauble could easily cut half his herd by the summer, he said. Many other ranchers have already cut that deeply.

It will take a lot more than this drought to force cattle ranchers to liquidate their herds, although it might send some of them to town looking for jobs to help weather the drought.

Ron Lamb, agriculture agent in Grant

County, one of the driest parts of the state, said selling off completely when prices are low means having to restock next year when prices are higher and most ranchers will try to limp through the drought with help from bankers before they will sell off.

"It's a cause for concern," Lamb said, "but they'll get through it. They have done it before."

Dry Stock Bonds

Beyond the costs of feed, is the necessity of water.

A cow drinks about 15 gallons a day. Without the snows and rains that feed creeks and washes, stock ponds have gone dry and ranchers must rely on windmill-powered wells to provide water for their cows.

Ranchers who have the least sources of water are the ones who will have to cut their herds most dramatically.

The Saubles started building a vast secondary water system on their ranch in the 1970s, running dozens of miles of pipe and spreading stock tanks over tens of thousands of acres.

Just about every creek and wash on the Circle Dot is dry this spring, but ground water wells pumped by wind, sun and generators are keeping stock tanks brimming.

"This," said Sauble, "is what's keeping us going."

Across the Navajo Nation, the lack of water is threatening thousands of sheep, horses and cattle.

Range conditions are so poor and water is so scarce that the tribal government has urged livestock owners to liquidate their herds before drought kills them.

The problem is windmill-driven wells that are not producing because they tap into

In the News

Barren Lands (continued)

shallow wells fed by snow pack and rain. Snow pack in the Navajo Reservation's mountain range, the Chuskas, was 17 percent of normal last year. Rainfall has not come since October.

Hundreds of animals have already died from dehydration and without water no amount of supplemental feeding will save the others, according to Alex DiNatale, a hydrologist with the Navajo Nation Department of Water Resources.

The tribe's Game and Fish rangers have begun shooting dying cattle they find roaming and are considering citing cattle owners for cruelty, DiNatale said.

"They're just getting skinnier and withering away, he said. "Any animal that's on the reservation will probably die."

It will take a wet winter to replenish springs and wells on the Navajo Reservation and across New Mexico.

And it will take a lot of rain-4 to 6 inches above what is normal for the rest of the year-to make range conditions desirable again. The forecast for summer rains this year is no worse or better than normal.

'Nothing but dust'

Larry Perkins grabs a shovel from his pickup and digs it into the ground on a patch of his ranch southeast of Tukumcari.

He digs down 6 or 8 inches, raises a shovel full of red dirt and dumps it into the wind.

"Nothing but dust," said Perkins.

Blue gramma grass relies on moisture in the top 4 inches of soil. It will take some rain soon to save the grass plants that lift easily out of the ground now, their roots short and withered.

Perkins has already cut his herd in half. He's running 150 cattle instead of the 330 his ranch will carry.

And he is in better shape than a lot of his neighbors because the ranch his family has owned for four generations also has irrigated farmland.

Even though his irrigation allotment this year is one-sixth what it normally is because of poor water flows in the river that feeds into Conchas Lake, Perkins still can grow some pasture grass. It means he can keep his cows off his damaged ranch land and keep them fed until the rains come.

When will that be?

Perkins, 47, has dusty rain gauges that have had nothing to measure in months. Cactus on his property are refusing to bloom.

"I don't think I've seen it this bad, this dry, this long," said Perkins. "Our conditions now are as poor as I've ever seen."

As Perkins speaks, clouds begin to gather on the horizon, turning gray, then purple, then black.

Other storms have threatened and refused to deliver. Others have swept through the county but not delivered a drop to Perkins' place.

An optimist, like anyone who bets his livelihood on rain in New Mexico, Perkins has planted a field of sorghum silage just in case the skies decide to open.

He looked at the threatening sky and said, "We just need one of those."

Eventually the clouds break and the rain comes down like a prodigal prize.

It is a gully washer, a real frogchoker of a deluge that causes bar ditches to run and windshield wipers to jog double time.

The fringes of the rain storm dampen the soil at Perkins' ranch but the core of the storm misses his ranch by miles. A 50-mph wind the next day blows any new moisture out of the soil.

"What can you do?" said Perkins. "Put us on your prayer list if you've got one."

In the News

Reprinted with permission from the
Albuquerque Tribune

Golf Courses Tee Up Ways to Reduce Use of Water

By Shea Andersen

June 5, 2002

As drought tightens its dusty grip on Albuquerque, the city's golf courses have had to find new ways to save water.

Golf courses are cutting back on the number of acres they irrigate, deploying expensive computerized watering systems and, in some cases, moving toward using recycled water to green up the fairways.

Golf in the desert has never been a simple proposition.

"Anyone who goes out and plays can see what's happening," says Mo Olguin, the Albuquerque publisher of *Golf New Mexico*, a magazine and Web site devoted to the sport. "They're all feeling the effects of the drought."

The city of Albuquerque owns and operates four courses that are open to the public. Together they amount to about 493 very thirsty acres, says John King, manager of the city's Golf Division.

"The shortcomings in our irrigation system become more noticeable" in a drought, King says. "We've just got to be really cognizant of our water management practices."

Two of the city's courses, Ladera and Los Altos, are watered with well water. The remaining two, Arroyo del Oso and Puerto del Sol, use city water supplies.

Since 1995, King says, the Golf Division has spent more than \$1.2 million to upgrade

irrigation equipment. That's out of a \$4 million annual budget that is fed largely by green fees.

The upgrades included removing thousands of sprinkler heads that threw water in a full circle and replacing them with heads that throw water toward the fairways.

And the courses have gone to a central computerized irrigation system that feeds weather information to golf course managers, allowing them to water based on such vagaries as evapotranspiration rates.

King says that since 1995 the city courses have cut their water use by about 20 percent. He estimates the city courses use about 1,650 acre-feet of water a year.

King says the 493 acres of golf course property are limited to 40 inches of water per acre per year. That translates to about 19,720 inches of water used per year.

The University of New Mexico is also looking for ways to keep the fairways fairly green. UNM's Director of Golf George Trujeque says the primary tactic so far is to reduce the acreage watered.

UNM has two courses that, together, make up about 300 irrigated acres. He says that of the 220 acres included in the 18-hole South, or Championship, Golf Course, the university is choosing to water 200 acres.

"Everybody's trying to but back on grass," Trujeque says. "We try to be as lean as possible."

That means letting grass get to the point of browning out before watering it and using new computer-driven watering systems.

"There's been some tremendous strides made in the irrigation business in the last 15 to 20 years," says John Mondragon, owner of Mountain West Golfscapes Inc. His Peralta company helped build the Santa Ana, Isleta and Paa-Ko Ridge golf courses. Most new

In the News

Golf Courses Tee Up Ways to Reduce Use of Water (continued)

irrigation systems are controlled by computers that are linked to miniature weather stations, he says.

Another water-saving technology catching the attention of golf course superintendents is the use of gray, or recycled, water for irrigation. King says the city's Arroyo del Oso course plans to go to a gray water system next year.

Water from a variety of industrial users would be recaptured and piped to the holding ponds near the golf course. The golf course would then pump the water out onto the fairways. Cost estimates for the plan were unavailable.

At UNM's Championship Course, Trujeque isn't convinced of the worth of that

idea. He estimates that to retrofit the university's courses to use gray water would be overly expensive.

Just to build the treatment plant to remove pollutants and salts in the water would cost about \$1 million, he says.

"Hindsight is worth a lot. If they could have anticipated this problem 30 years ago when these courses were built, they could have done that," he says.

Instead, he says, he's focusing on getting new and improved sprinkler heads, which aren't cheap. To buy and install the sprinklers costs about \$700 per head, he says.

"We're chipping away at it every winter, when we're not trimming grass," he says.

In the News

Reprinted with permission from the
Albuquerque Journal

Drought Leaves Outdoor Business Reeling

*Outfitters and tour
guides shift tactics in
the face of dry weather*

By Will Webber
Journal and Staff Writer

June 4, 2002

When rain begins falling and the forests reopen, outdoor and recreation business owners around northern New Mexico will look back at the drought conditions of 2002 and say it could have been worse.

But not much.

Hit hard by the recent closures of the Santa Fe and Carson national forests, outfitters and tour guides across the region are changing their business philosophies in the spring season's homestretch.

Retailers point to among other things a sluggish economy, and unseasonably dry and balmy winter and the outbreak of forest fires in recent weeks.

"It's hard enough to keep sales up without the media telling the world that New Mexico's on fire," said Jarrett Sasser, owner of The High Desert Angler fly shop in Santa Fe. "We rely a lot on tourism, and when they're not coming, it's hard." As a business, you just have to change your thinking to keep people rolling in."

Added Grayson Hartley of Santa Fe's Bike 'N Sport bicycle shop, "You can be cre-

ative and you can have a good time; you just have to pick and choose what areas you want to explore. It's easy to see all the closures and decide not to go out, but if you really want to go, you can."

The drought has been hardest on rafting businesses.

With the Rio Chama off limits thanks to the closure of the Santa Fe National Forest, rafting companies have had to concentrate almost exclusively on the Rio Grande this season. But water flow through the gorge section is approximately one-eighth of capacity.

"Obviously, we're looking at all available options in New Mexico," said David Brown, president of America Outdoors, a national organization which represents outfitters in 40 states. "Financially, there's nothing that we know of that's available."

He said he contacted the Federal Emergency Management Agency, for example, to see whether the agency offers loans or compensation for businesses affected. But, he said, "there's nothing there."

Brown said his organization is lobbying to reopen the Rio Chama on a limited basis for local rafting outfits. But relief may need time, he said.

"We're trying to help businesses survive," he said. "Of all the states, New Mexico and probably Arizona (are) the worst. Colorado, particularly the southern part, is significantly affected. The rest of the country is doing much better."

The rafting companies' plight is shared by the recreational fishing business.

"We agree with the idea to close the forests, but it doesn't make things easier on us," Sasser said. "I'll be the first to tell you that I'd hate to have some idiot come along and start a fire and ruin everything forever."

In the News

Drought Leaves Outdoor Business Reeling (continued)

But still, we're trying to run a business here. Eighty-five percent of what we do (is in the Pecos Wilderness) and that's an area we can't access."

Shops in Pecos are also in dire straits.

"I'll tell you, this is like February except it's so hot," said George Adelo, owner of Adelo's Town and Country Store in Pecos. "We're a seasonal business, and we absolutely depend on the recreational use of forest areas for our livelihood. This past Memorial Day Weekend, I've never seen such a sad time. (The closures) flat-lined our business."

Likewise for Terrero's General Store and Riding Stables. Offering horse tours to the Pecos Wilderness, its lifeblood has been cut off.

"It's just killed our business," said co-owner Sherry Ley. "I think to be fair we all have to understand that we can't police people when it's like this, and we certainly can't watch them all the time."

Most outdoor outfitters agree this is among the toughest seasons in recent memory. But, they say, there are options.

"People in Santa Fe are not going outside, so they don't need as much equipment,"

said Kent Little of Sangre de Cristo Mountain Works in Santa Fe. "But we've seen customers change their focus. They're putting aside larger purchases for smaller ones, so I wouldn't say our business is absolutely falling apart."

Elsewhere, bicycle shops seem to have found a happy medium. While sales for mountain bikes have decreased slightly, sales for the higher-priced road bikes have risen.

"We're not doing too badly," said Stephen Newhall of Rob and Charlie's in Santa Fe. "We don't do as much high-end clientele as other shops, so it's not devastating if we don't move a lot of bikes."

The key for some businesses is owning their own swath of land within the national forests. At least two fly-fishing outfitters still take clients to their property along the Pecos River, for example.

"I bought mine a long time ago, and that's how I stay alive," said Al Johnson of AA Taos Ski Valley Wilderness Adventure Trail Rides and Cowboy Camp. "It's hard on everyone, but sometimes having your own land is how it works."

Installing a Garden at School: Where to Find the Information

Greening School Grounds, Creating Habitats for Learning

Grant, Tim and Littlejohn, Gail. 2001. *Greening School Grounds, Creating Habitats for Learning*. Gabriola Island, BC: New Society Publishers.

Greening School Grounds, Creating Habitats for Learning is from the publishers of Green Teacher Magazine. It is a guide to help teachers “through all phases of a school grounds project, from developing a rationale that will win the support of principals and administrators, through redesigning the grounds, to tapping the rich potential of the schoolyard as a place for hands-on, multidisciplinary learning.” Also includes a great resource section.

To Order:

- Website: <http://www.greenteacher.com/>
- Email: greentea@web.net
- Phone: (416) 960-1244
- Fax: (416) 925-3474
- Mail:

In Canada:

Green Teacher
95 Robert Street
Toronto, Ontario M5S 2K5

In the U.S.:

Green Teacher
P.O. Box 452
Niagara Falls, NY 14304-0452

Plants for Play: A Plant Selection Guide for Children’s Outdoor Environments

Moore, Robin C. 1993. *Plants for Play: A Plant Selection Guide for Children’s Outdoor Environments*. Berkley: MIG Communications.

Robin C. Moore is a Professor of Landscape and Architecture at North Carolina State University, Raleigh, and former President of the International Association for the Child’s Right to Play (IPA). He has more than twenty-five years experience designing children’s environments. His book includes what plants to plant for what purpose, (shade, climbing, play materials, etc.) and also a very handy section on what not to plant (toxic!).

<http://www.kidsgardening.com/> – is sponsored by the National Gardening Association. Their commitment is to support educators and parents who garden with kids, whether as family projects or as educational tools. They are committed to providing horticultural expertise, quality resources, meaningful networking opportunities, and ideas for sparking inquisitiveness and exploration.

Installing a Garden at School: Where to Find the Information

National Wildlife Federation – Schoolyard Habitats

NWF's Schoolyard Habitats program provides resources, training, and curriculum support to schools (K-12), day care centers, nature centers and community groups.

Turning school grounds into a National Wildlife Federation certified Schoolyard Habitats provides outdoor learning opportunities that are:

- interdisciplinary
- standards-based
- hands-on
- inexpensive

In fact, a Schoolyard Habitats site will not only provide inspiration for learning among students, teachers and the community, but will become an important part of your local ecosystem providing essential habitat for wildlife.

<http://www.nwf.org/schoolyardhabitats/>

Schoolyard Habitats Program
11100 Wildlife Center Drive
Reston, VA 20190-5362
1-800-822-9919

Digging Deeper: Integrating Youth Gardens Into Schools & Communities

Joseph Kiefer, Martin Kemple, Melanie Manaugh, and Robin Wimbiscus . 1998, Publisher: Foods Works, ISBN: 188443004X

Excerpt from the book:

There are countless reasons for young people to start a garden in their school, community, or home: to feel the power of growing their own food with their own hands; to witness the simple glory of a plant maturing from seed to flower; to work in harmony with the forces of nature as our forebears have done for centuries; to learn firsthand a wide range of basic academic skills and concepts in science, math, language arts, and social studies; to experience the satisfaction of working cooperatively with others to make the world more beautiful. This practical, step-by-step guide for creating successful youth gardens offers all these plus one more reason for children to grow gardens where they live.

Gardening provides an ideal context for youngsters, and the wider community, to reawaken their relationship to the natural world, a world that has been so transformed by human expansion in the 20th century alone. Starting with growing foods and flowers in their own neighborhoods, children can use the activities, project ideas, and resources in Digging Deeper to become catalysts for teaching their community a blend of life-enhancing methods for living sustainably in their own local ecosystem.... It is designed to help adults lead children in practical learning activities around food growing, nutrition education, ecological restoration, and community service learning.

Appendix F

How to Order Free Materials

Water conservation education materials can be ordered from:

Water Use and Conservation Bureau
New Mexico Office of the State Engineer
P.O. Box 25102
Santa Fe, NM 87504-5102
1-800-WATER-NM
www.ose.state.nm.us

Or in Albuquerque:
Water Conservation Office
City of Albuquerque
P. O. Box 1293
Albuquerque, NM 87103
(505) 768-3655

Appendix G

Resources

Albuquerque's Environmental Story was written by Joan & Hy Rosner and published by The Friends of Albuquerque's Environmental Story, Inc. It provides a very complete story of the interaction between man and the environment in the growth of Albuquerque. Ideas and suggestions for teachers are included at the end of each chapter. The complete curriculum is on-line at <http://www.cabq.gov/aes/index.html>.

Complete How to Guide to Xeriscaping, The published by the City of Albuquerque includes a list of recommended plants for central New Mexico. See Appendix F for ordering information.

Desert Blooms: A SunScape Guide to Plants for a Water-Scarce Region is a searchable plant guide on a CD Rom. It includes detailed information with great pictures for plants that should and should not be used in the landscape. The plant list is for the El Paso, Texas region, so check for temperature ranges before choosing a plant. It can be found online at <http://www.uc.usbr.gov:2525/dblooms>

Dig In! Hands-On Soil Investigations authored and published by the National Science Teachers Association takes soil down to the very youngest students. The curriculum is for kindergarten through fourth grade and provides wonderful drawings and stories to entertain and educate. Available from a variety of sources, 0-87355-189-3.

Field Guide to the Grasses, Sedges and Rushes of the United States by Knobel Edward includes dichotomous-like key for easy identification, good illustrations and common names as well as scientific names. It is inexpensive and available from a variety of sources, ISBN 048623505X.

Greening School Grounds: Creating Habitats for Learning published by Green Teacher is a guide for teachers on how to implement a school ground project. It covers everything from convincing the administration, securing resources, implementing, suggested activities, and preventing vandalism. This is a must for any teacher starting at the beginning and implementing a school garden project, ISBN 0865714363

Growing Classroom: Garden-Based Science, The by Roeberta Jaffe and Gary Appel provides an elementary perspective on soils. Their chapter called The Living Earth/Soil includes sixteen activities on soil.

They range from fun songs to how to work the soil using tools. Highly recommended curriculum for younger groups that is available from a variety of sources, ISBN 0-201-21539.

Healing Herbs of the Upper Rio Grande: Traditional Medicine of the Southwest by L. S. M. Curtin was first published in 1947 to preserve traditional information on the plants and their lore from Native Americans of northern New Mexico. Available from a variety of sources, ISBN 1889921017.

Lean & Green, A Simple Guide to Water-wise Lawn Care is published by the City of Albuquerque and is free to the public. It contains a short list of xeric grasses for New Mexico. See Appendix F for ordering information.

Let it Rot, The Gardener's Guide to Composting by Stu Campbell from Pownal: Storey Books. It contains advice for starting and maintaining a composting system, building bins, and using compost. It is available from a variety of sources, ISBN 1580170234.

Life in a Bucket of Soil was written by Alvin and Virginia Silverstein and published by Dover Publications. It includes good general information about the arthropods and invertebrates that live in soil. It is available from a variety of sources, ISBN 0-486-41057-9.

Low-Volume Irrigation Design and Installation Guide by the City of Albuquerque's is an easy how-to guide for installation and maintenance of drip irrigation systems. It is available in Albuquerque through the City of Albuquerque or statewide through the New Mexico Office of the State Engineer; see Appendix F for ordering information.

Manual of the Grasses of the United States, 2nd ed., is a two-volume set published by Dover Publication. It is a reprint of A.S. Hitchcock's 1950 Manual of the Grasses and includes descriptions, illustrations, distribution and, introductions of exotics. It is available from a variety of sources, ISBN 0486227170.

Appendix G

Resources

Mulch Book: A Complete Guide for Gardeners, The is written by Stu Campbell and published by Storey Books. This is a wonderful guide to everything imaginable about mulch. It includes benefits, drawbacks, tips for vegetables and fruits, and an astounding list of the different types of mulches. It is available from a variety of sources, ISBN 0-88266-659-2.

New Mexico Gardener's Guide is Judith Phillips' most recent publication on xeriscaping and xeric plants. It is available from a variety of sources, ISBN 1888608552.

New Mexico Water Rights, WRRRI Miscellaneous Report No. 15 provides a good introduction to the history of water rights in New Mexico. It is not overly technical and is within the capabilities of most high school students. It is available through New Mexico State University, Water Resource Research Institute for a minimal cost. Contact them at 505-646-1813 for more information.

Rainwater Harvesting, Supply from the Sky by the City of Albuquerque is a detailed booklet on how to start a rainwater harvesting project. It includes information on passive systems such as berming and active systems with cisterns. It does not include information on potable water supply. It is available in Albuquerque through the City of Albuquerque or statewide through the New Mexico Office of the State Engineer; see Appendix F for ordering information.

Water: A Never Ending Story teacher guide and video is collection of hands-on, interdisciplinary activities organized into a complete curriculum on water. It is designed to help students cultivate a water conservation attitude. The curriculum is on a middle school level and includes sections on watersheds, water treatment and distribution and non-point source pollution. Activities include science, math, art, and language arts. Available through the New Mexico Office of the State Engineer; see Appendix F for ordering instructions.

Worms Eat My Garbage was written by Mary Appelhof and published by Flower Press. Now in its second edition, it is a wonderful resource book for worm composting in the classroom. This book is extremely complete, everything from what and how much to feed the worms, to how to use the resulting compost. It is available from a variety of sources, ISBN 0-942256-10-7.

Worms Eat My Garbage: Classroom Activities for a Better Environment, also written by Mary Appelhof and published by Flower Press. Designed to complement her first book, this activity guide integrates earthworm activities into the classroom. Order directly from the author at <http://wormwoman.com>. ISBN 0-942256-05-0.

Xeriscape Gardening, Water Conservation for the American Landscape by Connie Ellefson, Tom Stephens, and Doug Welsh is an excellent all-around book on the principles of xeriscaping, ISBN 0026141256.

Appendix H

Grants

(as of February 2003)

Captain Planet Foundation

<http://www.captainplanetfdn.org/>
(on-line proposals only)

The mission of the Captain Planet Foundation is to fund and support hands-on environmental projects for children and youths. Their objective is to encourage innovative programs that empower children and youth around the world to work individually and collectively to solve environmental problems in their neighborhoods and communities. Through environmental education, they believe that children can achieve a better understanding and appreciation for the world in which they live.

All applicant organizations or sponsoring agencies must be exempt from federal taxation under the Internal Revenue Code Section 501, in order to be eligible for funding (this includes most schools and non-profit organizations).

ALL PROJECTS MUST:

- Promote understanding of environmental issues
- Focus on hands-on involvement
- Involve children and young adults 6-18
- Promote interaction and cooperation within the group
- Help young people develop planning and problem solving skills
- Include adult supervision
- Commit to follow-up communication with the Foundation (specific requirements are explained once the grant has been awarded)

The Captain Planet Foundation reserves the right to earmark funding for specific budgetary items, and decline funding for budgetary items which are not consistent with grant

guidelines. Generally, the range of grants awarded by the Foundation is \$250 - \$2,500.

EPA Environmental Education Grant Program

<http://www.epa.gov/enviroed/grants.html>

EPA Headquarters

U.S. Environmental Protection Agency
Public Affairs
1200 Pennsylvania Avenue, N.W. (1704A)
Washington, DC 20460
Phone: (202) 564-0443

Region 6 - AR, LA, NM, OK, TX

U.S. EPA, Region 6
1445 Ross Avenue (6XA)
Dallas, TX 75202

The grant program sponsored by EPA's Office of Environmental Education supports environmental education projects that enhance the public's awareness, knowledge, and skills to make informed decisions that affect environmental quality. Since 1992, EPA has received between \$2 and \$3 million in grant funding per year and has awarded about 1,700 grants.

Grants of \$25,000 or less are awarded in EPA's ten regional offices, and grants of more than \$25,000 are awarded at EPA Headquarters in Washington, D.C.

Each year EPA's Office of Environmental Education releases a Solicitation Notice in the Federal Register that provides instructions for obtaining a grant.

Appendix H

Grants

(as of February 2003)

National Gardening Association Grant Programs

<http://www.kidsgardening.com/grants.asp>

National Gardening Association supports programs across the country that actively engage kids in the garden. To be eligible for the following grants, your school or organization must plan to garden with at least 15 kids between the ages of 3 and 18.

Youth Garden Grant

Schools and community organizations with child-centered outdoor garden programs receive seeds, tools, garden products, and educational resources generously donated by companies in the lawn and garden industry. Selection criteria include leadership; need; sustainability; community support; innovation; and educational, environmental and/or social programming. Applications are available on the website and from their headquarters beginning in February of each year.

Kids Growing with Dutch Bulbs

This grant, sponsored by the Mailorder Gardening Association and administered by the National Gardening Association, awards 500 schools with a package of 200 premium Dutch flowering bulbs. Selection criteria include student involvement, curriculum integration, and administrative support.

Healthy Sprouts Awards

The National Gardening Association and Gardener's Supply Company have partnered to support schools and community organizations that use gardens to teach about nutrition and explore the issue of hunger in the United States. Each of twenty-five programs receives an award package of seeds, tools,

garden products, and educational resources for growing a vegetable garden. Five of these programs also receive \$500 cash and a \$200 gift certificate to the Gardener's Supply Company catalog. The selection of winners is based on the demonstrated relationship between the garden and nutrition education and hunger awareness. At least 10% of the food produced from the program should be donated.

National Wildlife Federation Wild Seed Fund Grant

<http://www.nwf.org/schoolyardhabitats/>
Schoolyard Habitats Program
11100 Wildlife Center Drive
Reston, VA 20190-5362
1-800-822-9919

The Wild Seeds Fund Grant program provides assistance to schools and organizations to help get their Schoolyard Habitats projects off the ground. Each year the Schoolyard Habitats program awards fifty \$250 mini-grants to schools starting a Schoolyard Habitats project. It provides materials and training for educators and school communities. They look for projects that include a high degree of student involvement in the implementation and use of a Schoolyard Habitat.

Appendix H

Grants

(as of February 2003)

Newman's Own Grants

http://www.newmansown.com/5b1_grants.html

Paul L. Newman - c/o Newman's Own
246 Post Road East
Westport, CT 06880

Paul Newman donates all profits, after taxes, from the sale of his products for educational and charitable purposes.

Grants are awarded annually to a wide range of organizations. Eligible categories include: children and youth, health, education, elderly, environment, the arts, handicapped, literacy, substance abuse education, programs for the needy including housing and food. Individual donations and scholarships are not eligible.

Eligible charities must be U.S. organizations with an IRS 501-c-3 designation. Schools, hospitals and other public institutions are also eligible.

PG&E National Energy Group Environmental Education Grants Program

<http://www.neg.pge.com/grantProgram.html>
grants@neg.pge.com

or write to:

PG&E National Energy Group
Environmental Education Grant Program
7600 Wisconsin Avenue
Bethesda, MD 20814

In 1998, PG&E Corporation established the Environmental Education Grant Program. Administered by PG&E National Energy Group in partnership with PG&E Corporation Foundation, it encourages and supports educators and conservation groups with innovative ideas for educating young people about our environment.

Grants awarded will help sponsor programs that promote a greater understanding of challenges facing our environment with an emphasis on solutions improving local environmental quality. Grants awarded are up to \$10,000.

The grant program began in New England and expanded nationally in 2001. It is open to all schools and non-profit organizations that are engaged in education, earth sciences, conservation and environmental projects. Dedication to environmental stewardship is one of the guiding principles. They encourage and participate in many cooperative environmental projects aimed at land conservation, pollution prevention, sustainable development and public education.

Appendix H

Grants (as of February 2003)

The Lorrie Otto Seeds for Education Fund

<http://www.for-wild.org/seedmony.htm>

The Lorrie Otto Seeds for Education Fund of the Milwaukee Foundation gives small monetary grants to schools, nature centers, or other educational organizations whose efforts best reflect the message of creating natural landscapes using native plants and appreciating humankind's proper place in the web of life. Established by Wild Ones in 1996, the fund honors their "philosophical compass", Lorrie Otto. They award grants for child-centered projects that create native plant landscapes or develop outdoor classrooms.

Eligible Applicants: Schools, nature centers and other non-profit places of learning, including houses of worship, with a site available for this stewardship project may apply.

Eligible Costs: Funds will be provided only for the purchase of native plants and seed. A project budget should show how monies are to be spent.

Appendix J

Supplemental Xeriscape Web Sites

Acequias

<http://www.seo.state.nm.us/water-info/acequias.html> - history of acequias and example by-laws

Design

<http://dmoz.org/Home/Gardens/Landscaping/Design/> - Open Directory Project includes a listing of landscape design sites

<http://www.lesslawn.com/> - practical steps to shrink the lawn

http://www.bae.ncsu.edu/programs/extension/publicat/wqwm/ag508_2.html - how to plan and design a wise-water-use landscape, from the North Carolina Cooperative Extension Service

<http://www.udel.edu/LongwoodGrad/symp97.htm> - using hardscape elements of wood and stone to create a unified garden

Grasses

http://www.santarosagardens.com/html/ornamental_grasses.html - ornamental grasses including grass selection, when to plant, maintenance and growth habits from Santa Rosa Gardens, Florida

<http://www.cache.nmsu.edu/ces/yard> - Southwest Yard & Garden, a weekly column written by a New Mexico State University Extension horticulture specialist, answers questions about how to care for your garden and landscape, includes current columns and searchable database of old columns

Irrigation

<http://watershare.mp.usbr.gov/waterlearn/agriwater/index.htm> - animated examples of the three basic types of irrigation from the U.S. Bureau of Reclamation

<http://www.cadvision.com/rolld/indexdrip.htm> - uses advance calculations to determine watering needs

<http://www.dripworksusa.com/> - online catalogue of drip irrigation and micro-irrigation supplies for home owners, landscapers, greenhouse watering and farmers

<http://jessstryker.com/> - landscape design tutorials with detailed information and great schematics

Kids

<http://extension-horticulture.tamu.edu/county/smith/kids.html> - gardening resources for kids

<http://www.kidsgardening.com/> - support for educators and parents who garden with kids, sponsored by the National Gardening Association

Maintenance

<http://www.co.broward.fl.us/bri00300.htm> - comprehensive site with easy-to-understand explanations of how to prune plants

<http://www.marchbiological.com/> - using integrated pest management, natural controls of insects

Appendix J

Supplemental Xeriscape Web Sites

<http://www.fertilizer.org/ifa/> - a glossary of fertilizer terms in English, Spanish, German and Dutch.

http://cahe.nmsu.edu/pubs/_a/a-128.html - column Fertilizer Guide for New Mexico written by a New Mexico State University county extension agronomist.

Mulch and Composting

http://srd.yahoo.com/goo/mulch/6/*http://forums.gardenweb.com/forums/soil/ - forum for questions

http://srd.yahoo.com/goo/mulch/10/*http://landscaping.about.com/cs/mulchmaterials/ - links to mulch, stone and landscape fabric pages

Plants

<http://weather.nmsu.edu/AbqPlantList/index.htm> - searchable database for low-water-use plants for the Southwest

<http://www.hort.usu.edu/natives/index.html> - searchable database with pictures of drought-tolerant plants for the Intermountain West

<http://aggie-horticulture.tamu.edu/plantanswers/publications/westtexas/wtexas.html> - extensive plant list for El Paso County, Texas

<http://www.naturesongs.com/vvplants/> - lists of common native plants of Verde Valley, and Sedona, Arizona

<http://www.blm.gov/education/weed/weed.html> - Bureau of Land Management site on noxious weeds, with classroom activities

http://horizon.nmsu.edu/ddl/wqnaturalhist_k.html - National Museum of Natural History activity where participants become curators and research plants and cultures for the museum

<http://www.treenm.com> - a non-profit dedicated to planting trees on public lands and providing environmental education to New Mexico

<http://www.plantadviser.com> - plant lists, interactive plant locator and links for the southwestern deserts

<http://www.uc.usbr.gov:2525/dblooms> - Desert Blooms: A Sunscape Guide to Plants for a Water-Scarce Region, includes searchable plant list

Plant Hunters

<http://www.ars.usda.gov/is/kids/plants/story4/hunters.htm> - general article about plant hunting and the history of plant hunting, written in a kid-friendly manner

<http://www.gla.ac.uk/publications/avenue/30/legacy2.html> - brief histories of William Hooker and David Douglas, plant hunters from the University of Glasgow, Scotland

http://www.channel4.com/plus/diary_garden/3modern.html - provides a brief history of the plant hunters of exotic species

Rainwater Collection

<http://www.twdb.state.tx.us/publications/reports/RainHarv.pdf> - complete guide to rainwater harvesting developed by the Texas Water Development Board

Appendix J

Supplemental Xeriscape Web Sites

<http://twri.tamu.edu/twripubs/WtrSavrs/v3n2/article-1.html> - explanation of harvesting rainwater and several stories about its use

<http://www.rainwatercollection.com/homepage.html> - friendly site with easily understood account of the problems, process and products of rainwater collection

Soil

http://www.warrenswcd.com/soil_percolation.htm - soil percolation lab suitable for middle school students; complete with worksheets

<http://www.meritbadge.com/bsa/mb/106.htm> - Boy Scout soil and water conservation merit badge with a list of links to find the answers to some of the posed problems

<http://www.fmnh.org/ua/netsoil.htm> - four experiments on soil: compaction, percolation, mudshake, and texture test, in English and Spanish

<http://www.calpoly.edu/~ss/career.html> - list of possible careers for a soil scientist

http://www.statlab.iastate.edu/survey/SQI/soil_biology.htm - a complete primer on soils including classroom activities from USDA's Natural Resource Conservation Services

Water Supply

<http://www.nm.nrcs.usda.gov/drought/drought.htm> - New Mexico Drought Map, indicates current drought status in an easy to use colored map

<http://www.nm.nrcs.usda.gov/snow/Default.htm> - New Mexico Snow Survey & Water Supply Forecasting Program includes actual snow pack and precipitation data along with water supply forecast, both text and maps

<http://www.ec.gc.ca/water/> - Teacher's Corner from Environment Canada, includes downloadable curriculum Let's Not Take Water For Granted: A Resource Guide

Water Use Data

<http://www.ga.usgs.gov/edu/tables/dlps.html> - United States Geological Services site for public-supply water use in the United States, 1990 a state-by-state comparison

<http://www.cia.gov/cia/publications/globaltrends2015/754033.gif> - availability of world water, great visual, includes water availability predictions for the year 2015

<http://water.usgs.gov/watuse/> - extremely detailed data on water use in the United States by various categories, includes maps

Weather

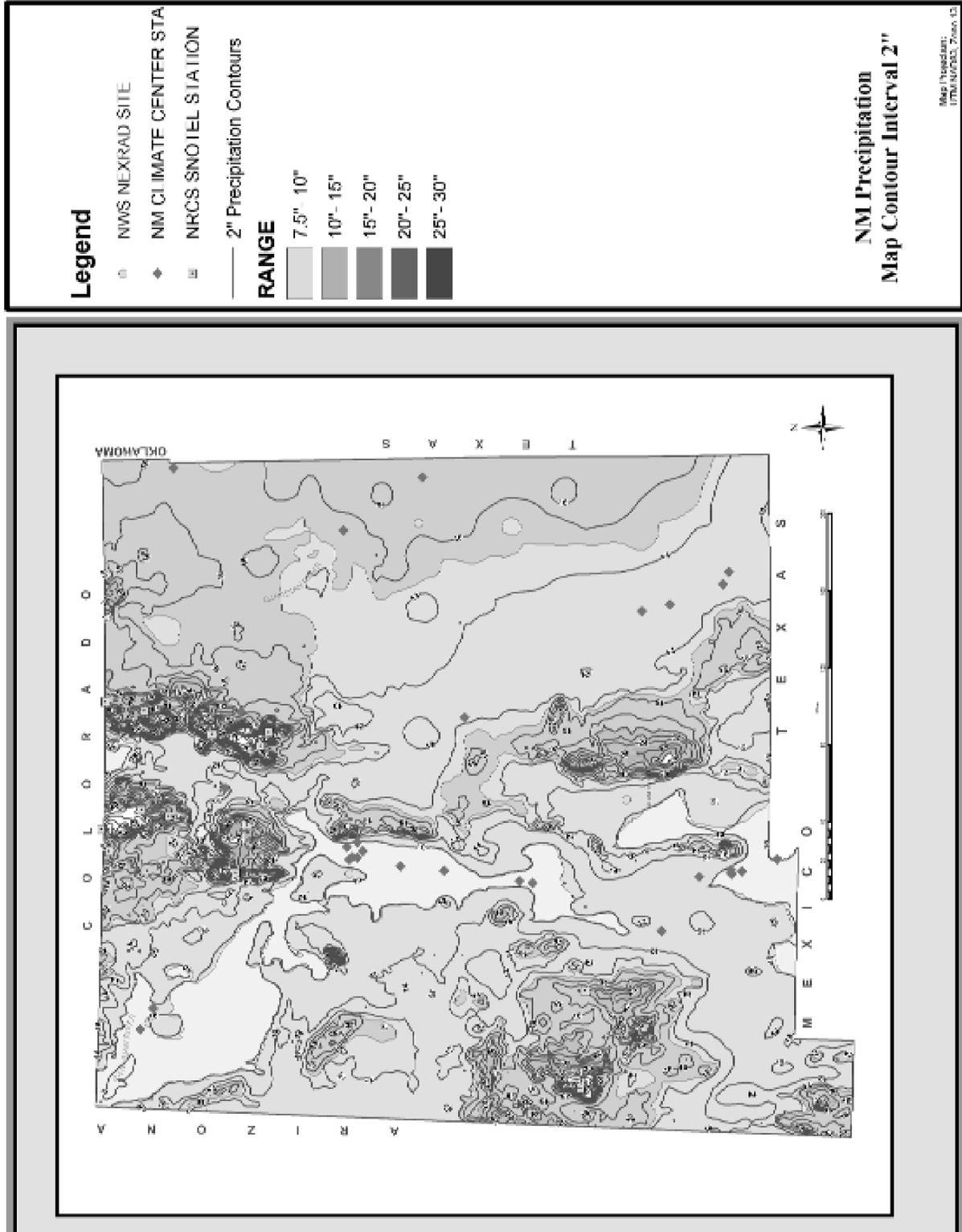
<http://www.srh.noaa.gov/abq/> - current weather

<http://www.srh.noaa.gov/abq/climate.htm> - past weather data

<http://weather.nmsu.edu/nmcccooperator/index.htm> - state weather data

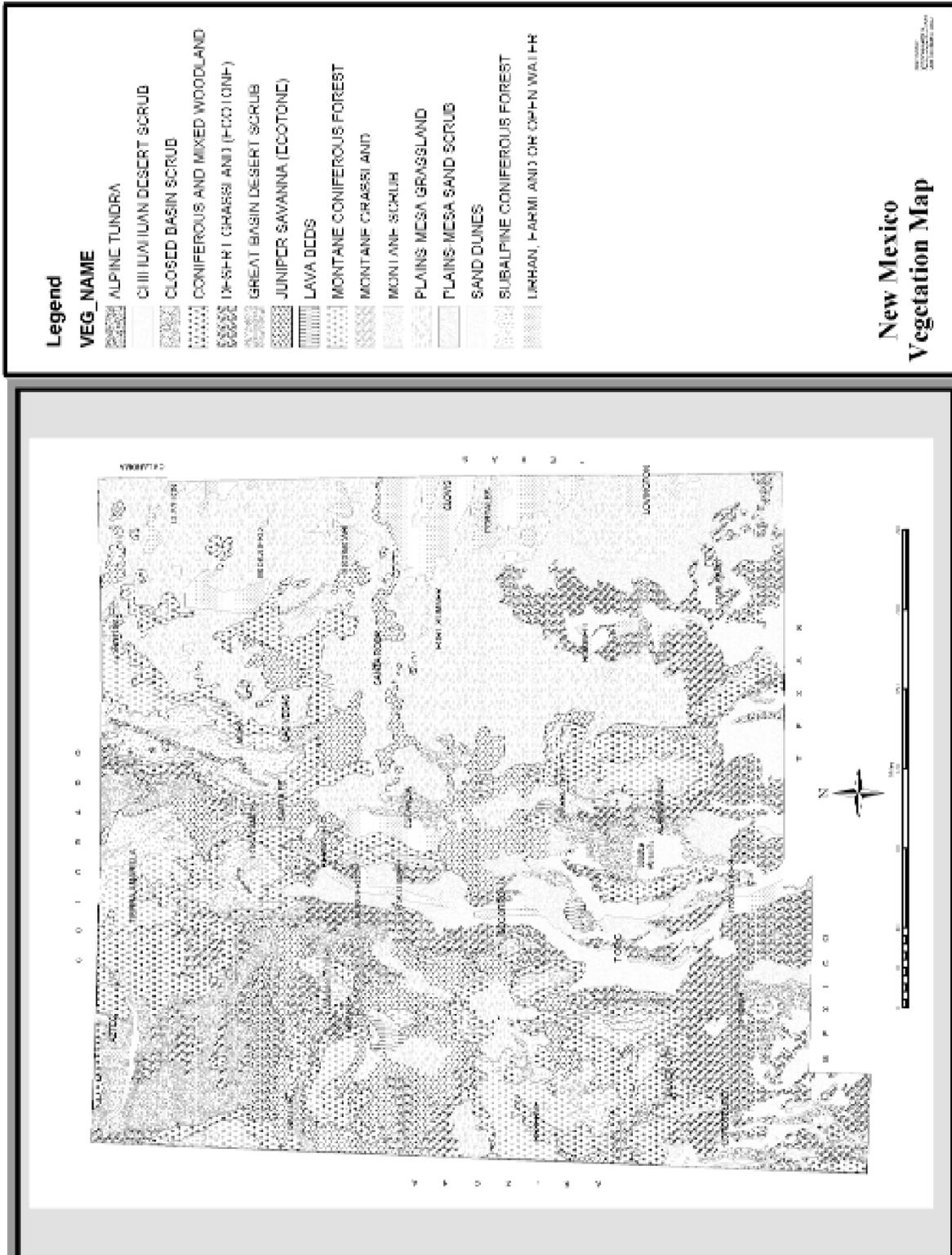
Appendix 9

New Mexico Precipitation Map



Appendix 9

New Mexico Vegetation Map



Xeriscape Gardens to Visit

The following list is provided courtesy of the Xeriscape Council of New Mexico. The gardens looked acceptable as of Spring, 2000. For more information about the Xeriscape Council of New Mexico, please visit their web site at www.xeriscapenm.com.

Built Landscapes: Albuquerque

New Mexico Museum of Natural History and Science

(1801 Mountain Rd. NW)

The plantings at the northwest corner of the property are typical of the region of the upper Chihuahuan Desert between Albuquerque and Las Cruces, showcasing feathery Velvet Mesquite, Creosote Bush, Ocotillo, Desert Broom, Turpentine Bush, and Sotol.

The Albuquerque Museum

(2000 Mountain Rd. NW)

Interesting pockets of paving and plazas are softened with upland plants such as Autumn Sage and Chamisa and riparian plants including California Sycamore and Yerba de Mansa.

Terra American Bistro

(1119 Alameda Ave. NW)

This recent recipient of an Associated General Contractor's award for remodeling features a simple entrance planting of Honey Mesquite, Big Sage, Lady Banks' Rose on the metal trellis work and the bold Giant Hesperaloe, before you get to the cuisine inside.

The Pavilions at San Mateo

(northwest of the San Mateo exit off I-40)

An attractively landscaped commercial space that uses a network of curb cuts to

harvest rainwater runoff into appropriately dense plantings including Emory Oak, Regal Mist Grass, Turpentine Bush, Rosemary and Desert Prickly Pear cactus.

Rio Grande Title

(6400 Indian School Rd. NE, within the area around the eastern parking lot)

A simple planting to buffer parked vehicles and allow for visibility at the intersection, using Mexican Blue Oak, along with Beargrass, Turpentine Bush and Trailing Rosemary.

Los Altos Christian Church

(11900 Haines Ave. NE, entrance to new sanctuary from parking lot and west slope along Paisano NE)

The east-facing entry in the newest building is an oasis with berms and a low rock wall, surrounded with Chinese Pistache, Chocolate Flower, various Thymes, Rosemary, and a Turf-Type Tall Fescue lawn. The west slope features an erosion control planting using sweeps of soil-binding Apache Plume, Sotol, and Turpentine Bush under Escarpment Live Oak, along with larger rock to minimize soil movement.

Eubank medians, between Academy and the split with Juan Tabo NE

A simple, non-irrigated planting with year-round appeal that features a naturalistic grouping of Ocotillo, various Yucca, Apache Plume, Fourwing Saltbush, and Chamisa.

High Desert

(east of Tramway Blvd. NE on Academy NE or Spain NE)

This residential development contains some nice revegetation work, retained desert grassland, and common area plantings including

Xeriscape Gardens to Visit

Netleaf Hackberry, Beargrass, Desert Marigold, Cholla, Red Yucca, including some desert-adapted ornamental grasses.

Demonstration Landscapes: Albuquerque

Rio Grande Botanic Gardens (2601 Central Ave. NW, 505-764-6200)

The entire area surrounding the Conservatory and the Spanish-Moorish Garden contain extensive collections and some nice groupings of plants from the Chihuahuan, Mojave and Great Basin Deserts, along with adapted plants from the Mediterranean and other dry lands.

Lovelace Medical Center (5400 Gibson Blvd. SE, within pathways and parking areas)

There are numerous plantings such as Vitex Tree, Penstemon, and other perennials.

Albuquerque Police Dept. Xeriscape Garden (Osuna Rd. NE and Wyoming Blvd. NE)

This committee-designed landscape demonstrates a variety of plants adapted or native to the Albuquerque metro area, including many grasses and wildflowers, turf types, shrubs such as Scotch Broom and Cotoneaster, and trees such as Palm Yucca and Redbud.

Wyoming Library and Rose Garden (8205 Apache NE)

More than just roses: contains plantings in and out of the rose family (such as Southern Live Oak, Chisos Rosewood, Fernbush, etc), walkways, and neat shade structures.

Demonstration Landscapes: New Mexico

Santa Fe Greenhouses (2902 Rufina St., Santa Fe, NM, 800-925-9387)

The garden here displays some of the many plants offered for sale in the nursery that are suitable for Santa Fe and far beyond, wherever sunshine is common and rain is not.

Demonstration Landscapes: Outside of New Mexico

Water Conservation Garden (12122 Cuyamaca College Drive West, El Cajon, CA)

A unique new garden that introduces guests to water saving gardening techniques as they walk through the Seven Principles of Xeriscape.

Arizona - Sonoran Desert Museum (2021 N Kinney Rd. Tucson, AZ 85743, 520-883-1380)

A renowned zoo, natural history museum and botanical garden, all in one place. Explore desert paths and encounter Gila monsters, hummingbirds, boojums, and much more amidst the beautiful Tucson Mountains.

Tohono Chul Park (7366 N. Paseo del Norte Tucson, AZ 85704 USA (520)742-6455)

Tohono Chul Park is a 49-acre desert preserve located in the midst of an ever-growing urban area in northwest Tucson. Tohono Chul Park's mission is to enrich people's lives by providing them the opportunity to

Xeriscape Gardens to Visit

find peace and inspiration in a place of beauty, to experience the wonders of the Sonoran Desert, and to gain knowledge of the natural and cultural heritage of this region.

Chihuahuan Desert Gardens, UTEP Centennial Museum

(the corner of University and Wiggins,
University of Texas El Paso, El Paso TX,
915-747-5565)

A new and extensive series of gardens that showcase plants, native stone walls, and other materials of North America's largest desert, the Chihuahuan Desert of the U.S. and Mexico.

Denver Botanic Gardens

(1005 York St., Denver CO,
303-331-4000)

The extensive plant collections and theme gardens from around the world include an extensive Xeriscape Garden, a collection of oaks adapted to semiarid conditions, the Watersmart Garden, the Plains Garden, and the famous Alpine Rock Garden.

Denver Water Department

(1600 W. 12th Ave., Denver, CO,
303-628-6000)

Many different plants are displayed from the Rocky Mountains, Great Plains, and other semiarid regions in the areas surrounding the offices of the Denver Water Department.

Desert Demonstration Gardens

(3701 W. Alta Dr., Las Vegas, NV,
702-258-3205)

See over 1000 plant species of plants in many theme gardens, which dispel the many myths about desert landscaping in the Mojave Desert region.

Colorado Springs Utilities Xeriscape Demonstration Garden

(2855 Mesa Rd., Colorado Springs, CO,
719-448-4555)

The plantings and garden are intended to enlighten the public with plants and landscape methods to conserve water attractively for the Pikes Peak area.

New Mexico Office of the State Engineer

Agency Overview

The Office of the State Engineer (OSE) and the Interstate Stream Commission (ISC) are separate but companion state agencies.

The Office of the Territorial Irrigation Engineer, created in 1905, became the Office of the Territorial Engineer in 1907 with jurisdiction over the surface waters of the state. The OSE is responsible for water rights administration, conducting hydrographic surveys for water rights adjudication, performing water resource investigations, inspecting dams for safety, rehabilitating diversion dams and ditches, reviewing subdivision water supply proposals received from New Mexico counties, and issuing water well-driller licenses.

When the Legislature created the ISC in 1935, it gave the Commission broad powers to investigate, protect, conserve and develop the stream systems of the state. The Commission administers interstate stream compacts; funds water research, conservation and development projects, and regional planning projects; oversees interstate litigation; cooperates in the financial assistance for the construction of irrigation works; and administers the state's regional water planning program.

Together, the OSE and the ISC are responsible for the administration, investigation, planning, development, conservation, and protection of New Mexico's water resources. The two agencies describe their joint mission in the agency's strategic plan to "actively manage the state's water resources through the lawful allocation, development, and administration of the state's water for beneficial use

within the state for the benefit of the people of the State of New Mexico."

The State Engineer performs a key function in relation to both agencies. He is a member of the ISC and serves as its secretary and executive officer. He also directs the activities of the staff of the OSE. The State Engineer is appointed by the Governor and confirmed by the Senate.

Water Rights Administration

The water-rights administration responsibilities of the OSE are based on three principles found in Article XVI of the 1912 New Mexico Constitution:

- The unappropriated water of every natural stream, perennial or torrential, within the state of New Mexico, belongs to the public and is subject to appropriation for beneficial use in accordance with the laws of the state.
- Beneficial use shall be the basis, the measure, and the limit of the right to the use of water.
- Priority of appropriation shall give the better right.

Following these fundamental principles, the State Engineer is responsible for the supervision, measurement, appropriation, and distribution of the state's water. He performs these duties according to the licenses issued by him and his predecessors and the adjudications of the courts.

New Mexico law establishes the administrative procedures for appropriating both surface and ground water. In order to appropriate either, a person must obtain a permit

New Mexico Office of the State Engineer

from the State Engineer, except that no permit is required to appropriate ground water outside declared groundwater basins. An appropriator may change the place or purpose of water use, or change the point of diversion, with the State Engineer's approval.

Before granting a permit for a new appropriation, the State Engineer must determine that there is unappropriated water available for beneficial use by the applicant. For either a new appropriation or a change in the place or purpose of use of an existing water right, he must also find that granting the application will not impair existing rights, that the intended use is not contrary to water conservation within the state, and that it is not detrimental to the public welfare of the state.

The law requires that notice of a water-right application be published in a newspaper of general circulation to give anyone an opportunity to protest the application if they feel their rights may be impaired if the application is granted, or if they feel the application does not meet the other criteria of state law. In the event of a protest or if the applicant does not agree with the State Engineer's decision, the law provides for a hearing before the State Engineer, and finally for an appeal to the District Court.

State law also gives the State Engineer the authority to declare a certain geographical area a groundwater basin. After a basin is declared, any person wishing to appropriate ground water for beneficial use within that basin must first apply for a permit, which will be considered under the same criteria as an application to appropriate surface water.

Adjudications

An adjudication of a water right determines the ownership and extent of the right and gives it legal recognition. It is similar to a quiet title suit to establish the ownership of land. It may be initiated by the state, the federal government, or an interested person. The adjudication process includes:

- A technical phase in which a hydrographic survey is performed to locate, quantify and date water uses and to determine the ownership of water rights in a particular stream system.
- A legal phase in which a lawsuit is filed and court orders are entered which state the nature, extent and priority of each owner's water right.

A water-right adjudication takes place in a Federal or New Mexico District Court. The State Engineer does not adjudicate water rights. The OSE does, however, assist the court in an adjudication suit by:

- Conducting a hydrographic survey to identify all water users and the history of their water use.
- Issuing offers of judgment to each water-right claimant on the stream system.
- Representing the interests of the state and the State Engineer in court.

In addition, the OSE has recently initiated alternative dispute resolution processes to resolve issues pertaining to water-right adjudication in a less costly and more timely and satisfactory manner. Agreements reached through alternative dispute resolution would be reviewed and approved by the court and incorporated into the adjudication decree.

New Mexico Office of the State Engineer

Once an adjudication decree is entered, the State Engineer administers the water rights in accordance with the decision of the court.

Public Information

The OSE collects and interprets various hydrologic and other water resources data which it publishes or otherwise makes available to the public through its library. Much of the information is gathered in cooperation with other agencies, principally the U.S. Geological Survey and the U.S. Bureau of Reclamation.

Water Conservation Program

The OSE and ISC maintain a Water Conservation Program which provides information on water conservation to the general public, technical assistance to water users on water conservation, and assists in the development of the water conservation policies implemented in the administration of water rights.

Other Duties

In addition to managing the use of water in New Mexico, the OSE is responsible for the inspection of non-federal dams, the review of subdivision plans, regulation of well drillers, and providing assistance to local governments in the case of a flood. From 1909 to 1921, the Office of the Territorial Engineer was also responsible for road construction, but these duties were assigned to the State Highway Department when it was formed.

Organizational Structure

The OSE is composed of five divisions, as set out in the organizational chart included herein.

Administrative Services Division. Includes three bureaus: The Management Services Bureau provides budget planning, financial management, and purchasing services; the Human Resources Bureau provides a comprehensive, coordinated human resource management support system; and the Information Management Systems Bureau is responsible for development of the agency's computer and communication systems.

Legal Services Divisions. Includes two bureaus: The Adjudication Bureau prosecutes adjudications on behalf of the state, represents the Water Rights Division in administrative hearings and provides legal representation to the ISC on interstate matters; the Hydrographic Survey Bureau conducts the hydrographic surveys needed for water right adjudication.

Water Rights Division. Administers the state's surface and groundwater rights. The Division has district offices in Albuquerque, Roswell, Deming, and Las Cruces, as well as two sub-offices in Aztec and Cimarron.

In addition to the five divisions, two programs within the office report directly to the State Engineer.

An independent Hearing Unit is responsible for hearing protests of water-rights applications, assisted by hearing examiners under contract with the OSE.

Appendix L

New Mexico Office of the State Engineer

The Special Assistant on Indian Water Resources was established in 1995, and is responsible for promoting a spirit of cooperation, coordination, communication and good will on water issues between tribal and state governments.

Technical Division. Includes three bureaus: the Design and Construction Bureau which administers the dam safety program, prepares flood damage reports and oversees irrigation ditch construction and rehabilitation grants; the Hydrology Bureau, which

conducts specialized hydrological investigations; and the Water Use and Conservation Bureau, which inventories surface and groundwater use, manages the agency's Water Conservation Program; and reviews subdivision water supply proposals received from New Mexico counties.

Interstate Stream Commission Staff. Supports the activities of the Commission to protect, conserve and develop the waters of the state.

Appendix M

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Appendix M

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Appendix N

Metric Conversions

To determine the metric equivalent of a standard (U.S.) measurement, use the conversion chart below.

INTO METRIC			OUT OF METRIC		
If you know	Multiply by	To Get	If you know	Multiply by	To Get
Length			Length		
inches	2.54	centimeters	millimeters	0.04	inches
foot	30	centimeters	centimeters	0.4	inches
yards	0.91	meters	meters	3.3	feet
miles	1.6	kilometers	kilometers	0.62	miles
Area			Area		
sq. inches	6.5	sq. centimeters	sq. centimeters	0.16	sq. inches
sq. feet	0.09	sq. meters	sq. meters	1.2	sq. yards
sq. yards	0.8	sq. meters	sq. kilometers	0.4	sq. miles
sq. miles	2.6	sq. kilometers	hectares	2.47	acres
acres	0.4	hectares			
Mass (Weight)			Mass (Weight)		
ounces	28	grams	grams	0.035	ounces
pounds	0.45	kilograms	kilograms	2.2	pounds
short ton	0.9	metric ton	metric tons	1.1	short tons
Volume			Volume		
teaspoons	5	milliliters	milliliters	0.03	fluid ounces
tablespoons	15	milliliters	liters	2.1	pints
fluid ounces	30	milliliters	liters	1.06	quarts
cups	0.24	liters	liters	0.26	gallons
pints	0.47	liters	cubic meters	35	cubic feet
quarts	0.95	liters	cubic meters	1.3	cubic yards
gallons	3.8	liters			
cubic feet	0.03	cubic meters			
cubic yards	0.76	cubic meters			
Temperature			Temperature		
Fahrenheit	Subtract 32, then multiply by 5/9ths	Celsius	Celsius	Multiply by 9/5ths, then add 32	Fahrenheit