LAND USE IN THE SAN CARLOS-SAFFORD-DUNCAN NONPOINT-SOURCE MANAGEMENT ZONE

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INTRODUCTION

As part of a continuing study of nonpoint-source pollution in Arizona, this report delineates different uses of land in the San Carlos-Safford-Duncan Nonpoint-Source Management Zone (Figure 1) and the potential affects on water quality of those uses. Land use information is of value to water-quality management agencies in directing resources toward protection and maintenance of water quality. Land use identification may help in predicting potential nonpoint sources of pollutants.

Categories of land use in this study are Agriculture, Developed (e.g residential or industrial), Mining, and Grazing. These uses are the most commonly suspected as potential sources of water quality problems in the Management Zone.

METHODS

Agricultural and developed (residential/commercial) land use was determined using air-photos, soil survey reports, and field checks. Air-photo coverage for the San Simon-Bowie area at a scale of 1:6000 (1989) was obtained from the Cochise County Highway and Floodplain Department. A strip of photos along Interstate 10 was made available by the Arizona Department of Transportation (1970, scale 1:20,000). Air-photos of the Safford Valley were obtained from the U.S. Department of Agriculture Farm Service Agency (1996, scale 1:7900) and from the Graham County Planning and Zoning Department (1984, scale 1:5000).

These recent photos were compared against older photos from the 1970s, such as in soil survey reports (DeWall and others, 1981; Vogt and others, 1980) to determine areas where land use has noticeably changed. Land use in the Duncan Valley was determined from photos in DeWall and Others (1981) , with field verification.

Air photos were not available for the San Carlos Indian Reservation. Land use patterns there are shown on Plate 3, taken from U.S. Geological Survey Land Use and Land Cover Map L-41 (U.S. Geological Survey, 1979).

LAND USE IN THE MANAGEMENT ZONE

Agriculture

Agriculture accounts for approximately 67,000 acres in the Management Zone (Plates 1, 2, 3). In Graham County, approximately 37,000 acres are under tillage, while in Greenlee county, 4866 acres are being farmed. About 25,000 acres of land are used for agriculture in the Bowie- San Simon area of Cochise County.

Agricultural use is defined here as land which currently is, or has been at one time, tilled and irrigated. Major crops include cotton, alfalfa, fruit, nuts, chilis and beans. Some land formerly used for farming has been abandoned, or has been fallow for many years. Areas where the farmed land has apparently been abandoned or is inactive are distinguished from active farm land on Plates 1 and 2. Whether or not any of this abandoned land, or new land, will be put to agricultural use in the future is unknown.

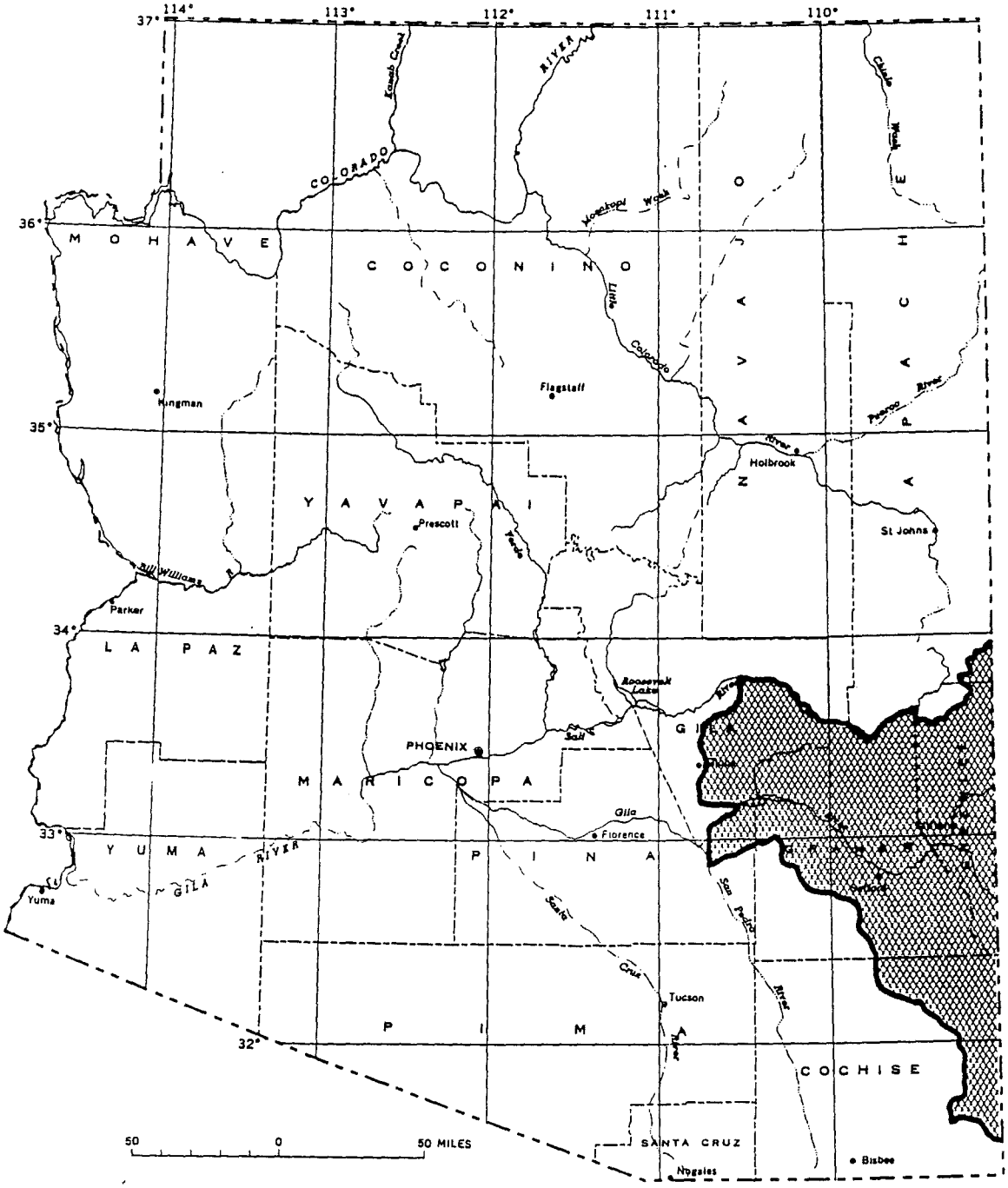

Figure 1. Location of San Carlos-Safford-Duncan Nonpoint-Source Management Zone.

Areas delineated as 'agriculture' are those larger than about ten acres. Not shown on the maps are houses or shops associated with farms, nor small, family "backyard" farms, such as where a family has a large garden and a horse or two for personal use. Boundaries of agriculture along the Gila River are generalized in places because of repeated changes caused by major floods.

Mining

Mining land use is shown on Plates 1 and 2. The Morenci Mine (Plate1), the largest copper mine in North America, stands out as the largest mining area in the Management Zone. Although not developed yet, several large copper deposits north of Safford are expected to begin producing in the coming decades and are indicated on Plate 1 (Safford district and Sanchez deposit). Other currently or recently active mine areas include the Ash Peak mine, scattered quarries in the Bowie zeolite deposit (Plate 2), and sand and gravel operations.

Some areas, such as near Portal and Paradise, on the eastern edge of the Chiricahua Mountains, are former mining districts that are now being developed into rural residential areas. Both the abandoned mines and the new residences are too scattered to show at the scale of the maps. Mining ceased in the area by the 1950s (Keith, 1973).

Developed land (residential, commercial, industrial)

Land use defined as developed in this report is based on the categories of the U.S. Geological Survey Land Use and Land Cover Classification System (e.g., Mitchell and others, 1977, Gilliom and Thelin, 1997). Developed or 'built-up' land includes residential, commercial, and industrial uses, as well as suburban and mixed uses commonly found around urban centers. These developed lands are shown on Plates 1 and 2. Individual houses and shops associated with farms are not shown, and are included in the agricultural land use designation.

The Graham County 1996 population of 31,150 is expected to increase by 2.46% per year from 1997 to 2007 Safford, the largest town in the Management Zone, has grown from 7359 people in 1990 to 9095 in 1996 (all figures from Arizona Department of Economic Security).

Many areas in the Management Zone are rural, with scattered, very low-density development. For example, the southernmost San Simon Valley, east of Portal, is rapidly being divided into "ranchettes". In this type of development, the land remains largely undisturbed desert, with perhaps one house per ten or twenty acres . No attempt was made to delineate this type of scattered, low-density development in rural areas.

Grazing

Grazing occurs on much of the land within the Management Zone. Virtually all State and BLM land is currently grazed, as is most private land outside of urban areas. National Forest land is not grazed, except for one small allotment that extends into the Chiricahua Mountains west of Portal, according to State Land Department maps. Because grazing takes place on essentially all land not under other land use, it is not distinguished on the maps.

LAND USE AND WATER QUALITY

Agriculture

According to the 1995 U.S. Environmental Protection Agency Water Quality Inventory, agriculture is the leading source of impairment of water quality in the Nation's rivers and wetlands. The extent to which agriculture is contributing to water quality problems in Management Zone is uncertain. Water quality may be degraded by the following:

- Pesticide, herbicide, and fungicide use
- Fertilizer use (especially nitrogen and phosphorus)
- Build-up of salts by evaporation of irrigation water.
- Use of high-TDS well water.
- Leaching of naturally-occurring soluble minerals in the soil
- Erosion of bare soil

After talking with a major farm supply distributor and several farmers in Safford, it is apparent that very little nitrate, phosphate, or sulfate fertilizer is used in the Management Zone, mainly due to cost. Rather, the most common fertilizer is anhydrous ammonia, which is usually added directly to the irrigation water during flood irrigation of crops.

Irrigation water comes mostly from the Gila River or from shallow wells that draw water indirectly from the river through infiltration. This river and shallow well water is generally of good quality (Hem, 1950). Deep well water in the region is higher in TDS, but is used only when ample supplies of river water are not available. Water from deep wells is an occasional source of some TDS in the Gila.

Mining

Mining activities can provide a potential source of TDS to surface and groundwater. The nature and magnitude of potential water quality impacts associated with mining are controlled by a number of factors (Frisch-Gleason, 1995), including:

- type and size of mine
- type and volume of waste
- hydrology, geology, topography, and climate of mine site
- exposure to air and water
- distribution of sulfide minerals

In southeast Arizona, most mineralized zones and virtually all large ore bodies contain abundant sulfide minerals. These sulfides weather naturally by oxidation to form sulfate or sulfuric acid, and metals contained in the minerals may be released. Acid mine drainage is generally considered to be the major environmental impact of mining. In Arizona, however, this potential problem is not as severe as in other parts of the country, for several reasons. First, the climate is arid, so abundant water, the main ingredient in acid mine drainage, is not available. Second, the abundance of carbonates in and around mining areas allows for prevention or rapid neutralization of any potential acid generation (see references on acid mine drainage neutralization in Frisch-Gleason, 1995). Carbonates are present in the following forms:

- limestone and dolomite bedrock
- limestone and dolomite clasts in alluvial basin fill
- ubiquitous soil caliche (pedogenic carbonate)
- secondary calcite formed by weathering of rocks
- lacustrine and evaporitic limestones and marls in basin fill

Developed land

As the population in the Management Zone increases, the Gila River is likely to be affected in a number of ways. More people means more municipal wastewater, which is high in TDS, such as nitrates, and sometimes contains heavy metals and other undesirable constituents. Personal use of pesticides, herbicides, fertilizers in yards, and cleaning and other toxic chemicals in the home presents the same kinds of potential impact to water quality as agriculture. In fact, backyard chemicals, such as fertilizer and pesticides, are often applied at a much higher dosage than used by farmers. Chemical use may also high at golf courses and parks.

The acreage of houses, driveways, roads and parking lots will increase with population, leading to increased runoff, and potentially larger floods. Floods can affect land use by destroying land once used for farming or houses. Runoff from roads and parking lots may carry with it oil, gas, brake fluid, and radiator fluid dripped from cars and trucks. Production of garbage, which ends up in landfills, will also increase with population.

Grazing

Grazing by livestock can impact water quality, primarily by increasing soil erosion and sedimentation. The importance of rangeland as a source of nonpoint pollution increases as more vegetative cover is removed. Hoof impacts can knock down streambanks and churn soil, increasing erosion and sedimentation. Manure generated by livestock may also contribute nutrients, especially nitrate and phosphate, as well as pathogens to watersheds

The impact of cattle grazing on water quality in the Gila River is decreasing due to a lessening of sediment runoff from grazed watersheds. This reduction of sediment transport has been accomplished through a combination of factors (Molitor, 1997):

- Construction of 19 detention dams.
- Decrease in the number of cattle per acre
- Rotation of grazed areas to allow recovery of vegetation.
- Fencing off of streams and riparian areas.
- Dispersion of watering sites

TRENDS OF LAND USE CHANGE

Agriculture

Use of land for agriculture in southeast Arizona may decrease in the future because of the following:

- Some residential development will increase at the expense of agricultural land.

- Increased land values will make farmers more likely to sell land for residential development.
- Higher taxes and increased costs (labor, equipment, energy) may reduce profitability of farming.
- Increased population will put more demands on the water supply available for farming.
- Demands of downstream water users (e.g. Indian Reservations, towns and farms in central Arizona) may decrease the amount of water available to farmers in the Management Zone.
- Some agricultural land may be lost due to salt buildup in the soil.
- Environmental regulations may prevent some farmers from achieving economical yields due to restriction of fertilizer and pesticide use.
- Agricultural land is occasionally lost to severe floods

Developed Land

Residential growth is certain to be one of the most important changes in land use in the Safford and Duncan Valleys. Census figures show a steady increase in the population of Graham, Greenlee, and Cochise Counties since 1960. Graham County, for example, has grown from 14,045 people in 1960 to 26,554 in 1990. The Graham County 1996 population of 31,150 is expected to increase by 2.46% per year from 1997 to 2007. Safford, the largest town in the Management Zone, has grown from 7359 people in 1990 to 9095 in 1996 (all figures from Arizona Department of Economic Security).

Areas where high-density residential development is likely to take place first are around the outskirts of existing towns, where infrastructure is already in place. Lower density development is likely to continue south of Safford and Thatcher, east of Portal, and in the Duncan Valley. Residential development is limited to private land, and areas prone to development can be predicted by looking at land status maps that show private vs. public land (private land makes up 7% of Graham County, and 6% of Greenlee County). In areas such as Artesia, and south of Thatcher, development will take place on desert land that in many places is already relatively disturbed. In the center of the Safford and Duncan Valleys, growth will be at the expense of agricultural land.

Mining

The total acreage of land used for mining may increase in the future as new ore deposits are brought into production and new sand and gravel quarries are opened. Increasing residential development will mean an increase in demand for materials like sand and gravel for roads and building block, and copper for electrical wiring in cars and new homes.

Mining operations at Morenci have steadily increased in size since the 1800s, and new ore deposits adjacent to the existing open pit mine are expected to be put into production in coming decades. New open pit operations are planned in the Safford District and Sanchez deposit, and these represent the largest potential land-use change as far as mining.

In some areas, land once used for mining is rapidly being converted to rural residential use. In the Portal area of the Chiricahua Mountains, for example, patented mining claims are being sold to individuals who are building houses on the land. Even though the area is heavily mineralized, there is little possibility of any new mining taking place there.

Grazing

Currently, most State, BLM, and non-residential private land is used for grazing. As more land is developed for residential or mining use, less land will be available for grazing, although the amount of land to potentially be developed is a small fraction of that currently being grazed. Calls for changes in grazing policies have made the future of grazing uncertain, especially on state land. Even with reforms, grazing is likely to continue to some degree on most of the land where grazing occurs now.

REFERENCES

DeWall, A.A., Hutchinson, S.D., and Westberg, W.J., 1981, Soil survey of Gila-Duncan area, Arizona - Parts of Graham and Greenlee Counties: U.S. Department of Agriculture Soil Conservation Service and U.S. Department of Interior Bureau of Land Management Report, 177 p., 76 sheets, scale 1:24,000.

Frisch-Gleason, R., 1995, Controlling and remediating surface and groundwater pollution from inactive and abandoned mines: A survey of management practices: Arizona Geological Survey Open-File Report 95-13, 79 p.

Gilliom, R.J., and Thelin, G.P., 1997, Classification and mapping of agricultural land for National Water Quality Assessment: U.S. Geological Survey Circular 1131, 70 p.

Hem, J.D., 1950, Quality of water of the Gila River Basin above Coolidge Dam: U.S. Geological Survey Water-Supply Paper 1104, 230 p.

Keith, Stanton B., 1973, Index of mining properties in Cochise County, Arizona: Arizona Bureau of Mines Bulletin 187, 98 p.

Mitchell, W.B., Guptill, S.C., Anderson, K.E., Fegeas, R.G, and Hallam, C.A., 1977, GIRAS: A geographic information retrieval and analysis for handling land use and land cover data: U.S. Geological Survey Professional Paper 1059, 16 p.

Molitor, D., 1997, Suspended Sediment Monitoring Project, San Simon watershed, southeast Arizona: U.S. Bureau of Land Management Report, 69 p., 1 sheet, scale 1:155,000.

U.S. Geological Survey, 1979, Land use and land cover, 1972-1974, Mesa, Arizona: U.S. Geological Survey Land Use Series Map L-41, scale 1:250,000.

Vogt, K.D., Barmore, R.L, and Humphrey, L.H., 1980, Soil survey of San Simon area, Arizona - Parts of Cochise, Graham, and Greenlee Counties: U.S. Department of Agriculture Soil Conservation Service Report, 150 p., 41 sheets, scale 1:24,000.