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DEPARTMENT OF THE INTERIOR
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LAND RESOURCE INFORMATION NEEDS OF COUNTY GOVERNMENT: A CASE STUDY IN LARIMER COUNTY, COLORADO

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The study was carried out in association with the Program on Environment and Behavior, Institute of Behavioral Science, University of Colorado, Boulder.

ABSTRACT

A preliminary assessment of the needs for land resource information by the government of Larimer County, Colorado, was compared with the earth and soil science information programs of the U.S. Geological Survey and the U.S. Soil Conservation Service. Information on geology, soils, topography, hydrology, and land use from the two Federal agencies was evaluated by five departments of County government. For each type of information, County officials provided data on its uses in land use management and other governmental functions.

Larimer County is part of the rapidly changing metropolitan region along Colorado's Front Range. The study was undertaken as part of both Federal Agencies' recent efforts to make their information programs more useful to local governments which are coping with rapid growth. In addition to determining what earth and soil science information is required by county government, the study sought to find out why the information is needed, how it has been obtained in the past, how adequate is the available information, what are the anticipated future needs, and what if any changes should be recommended for improved intergovernmental relationships regarding earth and soil science information programs.

Many of the information products supplied by the Federal agencies, including soil surveys, surficial geologic maps, hydrologic data, topographic maps, and aerial photo-based products, were directly applicable to County government needs, and found widespread applications to subdivision approvals, hazardous waste disposal, engineering design for roads and bridges, flood and landslide hazard mitigation, and as supporting data for the County Comprehensive Plan. However, certain County needs for detailed data are not being met by either Federal agency. Examples include large-scale (1:24,000 or larger) surficial geologic maps, detailed ground-water data including information on alpine aquifers, detailed surface-water data, and detailed land use maps. Also lacking is a coordinated mapping scale and presentation format, whereby County officials can directly overlay and compare information on topography, geology, soils, and land use.

Further cooperative efforts are recommended to reduce information gaps in the future. Such efforts might determine, for example, whether changes in Federal agency procedures and planning could result in more effective data production and distribution, with coordination among participants in Federal, State, and local governments, the academic community, and private consulting firms. High-priority topics for a cooperative follow-on effort include: (1) continuing interagency liaison and coordination; (2) improved bibliographies and indexes to available information; (3) improved interpretation of earth and soil science information; (4) coordinated map folios for geology, soils, topography, slope, and land use maps; and (5) cooperative land use data program. The Larimer County Commissioners voted unanimously on July 12, 1982, to endorse this report's recommendation and to seek continued cooperation with the U.S. Geological Survey and Soil Conservation Service.

LAND RESOURCE INFORMATION NEEDS OF COUNTY GOVERNMENT:

A CASE STUDY IN LARIMER COUNTY, COLORADO

I. INTRODUCTION

One consequence of rapid population growth is an increased need for basic information by local governments. This report examines a part of that need--the land and water resource information required by county governments to provide for orderly management and other necessary services that accompany growth and development.

Larimer County, Colorado, in the northern part of the rapidly-growing metropolitan region along Colorado's Front Range, was the subject of a cooperative case study by County government, the U.S. Geological Survey (USGS), and the U.S. Soil Conservation Service (SCS). The two Federal agencies have long provided earth and soil science information[1]--including maps, scientific reports, and other data necessary to describe earth materials and processes. County governments have routinely used the USGS and SCS information. However, in recent years local governments have been facing changing requirements for such information. This case study was undertaken to document how those changes have affected Larimer County, specifically (1) to assess the County's needs for earth and soil science information, (2) to determine what, if any, changes in existing information programs might better meet County needs, and (3) to determine whether further interagency cooperation is called for to improve information exchange and use in the future.[2]

Field-office representatives of the USGS and the SCS began informal conversations with officials of Larimer County, to explore the possibility of assessing the County's information needs in a pilot study. These conversations resulted in a formal Memorandum of Understanding (Appendix A), which was ratified by the Larimer County Commissioners and the regional program administrators of the two Federal agencies. The study was carried out with a three-member team, one from each agency, meeting informally as time permitted over a period of several months. There was no exchange of funds; the agency expenditures were represented entirely by the loan of their personal and associated administrative support for the study.

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[1]The term "earth and soil science information" is used in this report synonymously with "land resource information," to refer to those maps, scientific reports, remote sensing data, and other data that are necessary to describe the topographic, geologic, hydrologic, soil, and land use distributions and processes, particularly in land use management applications.

[2]County government's information needs are cited in this report whether or not providing such information is within the responsibilities of USGS or SCS.

In the study's early stages there were meetings with other scientists and officials of all three cooperating agencies, so that all participants could become generally acquainted with the County's information needs as related to the two Federal agencies' programs in earth and soil science. After establishing the areas of overlapping interest, the two Federal agencies presented to Larimer County officials a collection of all information products thought relevant to the County's needs (Appendix B). Five selected County departments reviewed this information. Separate interviews were conducted with representatives of those departments, to form the basis for this report.

II. BACKGROUND

A "New Clientele" for Earth and Soil Science Information

The USGS has long been the standard source of topographic maps, which are of wide use among the general public. The soil surveys of the SCS are being used primarily in the agricultural sector. The more scientifically and technically oriented reports on geology, hydrology, and soil science have been directed primarily toward other scientists in government, universities, and industry.

Applications to Land Use Decisionmaking

In recent years both USGS and SCS have experienced increased demand for their products and services from a relatively new user community. This new user community or "new clientele" is responsible for planning and managing land use at local governmental levels, where most land use decisions are made. It falls to local government to provide public services required by population growth, and to approve locations for housing, industry, recreation, and critical facilities such as dams and power plants.

Local communities that have ignored environmental and economic impacts of earlier land use decisions have often been saddled with increased costs later. Inappropriate land use decisions, for example, could result in flood damage, downstream pollution, and degradation of vital watershed. Much of the earth and soil science information traditionally prepared by USGS and SCS is potentially useful to local governments in the land management process. Thus, local government officials have attempted to extract as much information as possible from these basic information sources; they have frequently turned to other sources, when information prepared by USGS and SCS has not filled their needs.

Past Information Dissemination by SCS and USGS

The SCS, in cooperation with the extension services of the Department of Agriculture, State agencies, and the local Soil Conservation Districts, has developed strong, grass-roots connections with its information users. It has maintained those connections through State and county organizations that reach to the farmer as ultimate consumer. The USGS, on the other hand, does not maintain such direct connections at local government levels,

relying instead upon State officials and a State-level USGS Water Resources Division official for liaison with local government and the general public. In collaborating with SCS on this study, USGS officials hoped to learn from SCS experiences at local levels, and perhaps take advantage of information channels already in use.

Recent USGS Experiences in Information Transfer

Echoing the lessons learned by SCS, recent USGS experience with the information needs of its "new clientele" underscores the need for special efforts apart from the original scientific objectives, if the information is to be properly used in land management. Robinson and Spieker (1978) called the attention of land managers to earth science information in urbanized and urbanizing areas. Non-traditional presentation formats included the use of different kinds of illustrative material, specially prepared and simplified maps, and a style of writing that stresses communication to a broader audience.

In other efforts, major new collections of earth science information products were specifically prepared for the new clientele of users. Kockelman (1976) documented the uses of many of these new information products in eight California counties, as part of the San Francisco Bay Region Environment and Resources Planning Study, a cooperative effort of several years' duration involving USGS, the Department of Housing and Urban Development (HUD), and local governments in the San Francisco Bay region. He found the major types of planning applications in Bay Area county government to be: geologic hazard studies, seismic safety and public safety plan elements, general reference, and the preparation and review of environmental impact reports and statements. Transferability of those results to areas outside the study region was found to be dependent on the following factors: (1) presence of similar geologic and hydrologic environments, (2) availability of similar data and interpretations, (3) existence of similar plan and plan-implementation legislation, (4) community interest or priority in addressing earth science-related problems, and (5) potential users' familiarity with the information products in their actual application. (Kockelman, 1976, p. 150.) Among Kockelman's recommendations for county government applications were: (1) monitor emerging critical issues, for example, through a users' advisory committee; (2) monitor new State and Federal laws to better anticipate county information needs; (3) provide engineering interpretations and land use capability ratings, to make the earth science information more readily usable; (4) give priority in areas impacted by development; (5) provide the information and maps at the larger scale and greater detail commonly needed by counties; (6) provide for early release of earth science information according to a formal distribution pattern; and (7) provide educational advisory and review services. (Kockelman, 1976, p. 152-157.)

Downing (1978) traced specially produced USGS information products for the Colorado Front Range Urban Corridor to potential users at local government levels. A portion of Larimer County was included in the study area. For sources of geologic and hydrologic information, he found a preference for maps at a scale of 1:24,000. In contrast, smaller-scale

maps were of less use in local government. Among recommendations from Downing's study were improved coordination between suppliers and users of earth science information, and increased use of staff geologists in local government.

In a study written to interpret geologic hazard information for non-geologist users in Allegheny County, Pennsylvania, Briggs, Pomeroy, and Davies (1975) provided examples of hazardous actions and how to avoid them, such as overloading of slopes, improper cutting into a slope, and altering water movement conditions. A special section, "What the Buyer, Builder, or Homeowner Should Look For," was included, with specific signs of potential difficulties that could result from landslide hazards.

In a summary of several recent experiences that USGS has had with the applications of its products to land use planning and decisionmaking in urban areas, Bates (1979) recognized the following pertinent problems being faced increasingly by local government: (1) water supply and water quality, (2) solid and liquid waste disposal, (3) loss of prime agricultural land, (4) pollution of air and water, (5) mining of construction materials and/or mineral resources in urbanizing areas, (6) more use of the subsurface environment, and (7) multiple land and water uses where conflicting purposes dictate shared responsibilities of various interest groups. Bates further noted the varying levels of appreciation of the potential earth and soil science information applications in local government. He cited a need for assistance from soil scientists, geologists, hydrologists, and other specialists to help define and meet the specific information needs of local government. He recommends the establishment and maintenance of close, mutually beneficial working relationships among the cooperating groups--the scientists, the land use planners and decisionmakers, and the citizens they serve.

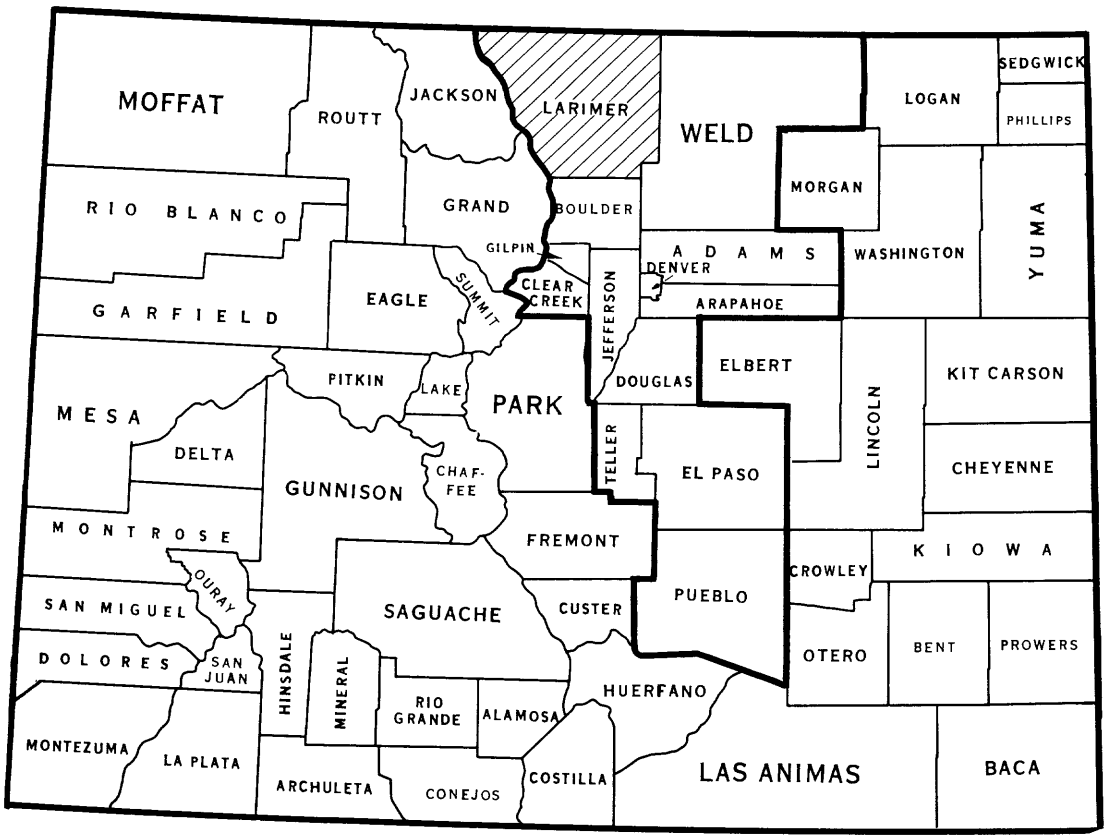
Larimer County: The Setting

Larimer County has varied characteristics that make a favorable site for this study. With its mountains, foothills, and plains environments, the County has a diversity of natural conditions, land use types, and resource management problems. It has also been the site of rapid urban growth. Because of these factors it was thought that this study might serve as a prototype for similar efforts in other counties, in a wider attempt to make Federal agency practices more applicable to the problems facing county governments in the future.

Larimer County is in the middle of the northernmost tier of Colorado counties. It is also at the northwestern extremity of the 13-county region defined as the area of major impact by the Governor's Colorado Front Range Project (fig. 1). This project was a 2-year public and private-sector cooperative effort, initiated by Governor Richard D. Lamm in November, 1979, to address the pressures and opportunities of the expected population increase of 1.25 million in the 13 Front Range counties during the period 1980-2000 (Colorado Front Range Project, 1981).

Figure 1

Larimer County and other Colorado Front Range Counties



0 100 mi.

0 100 km.

A distinct north-south physiographic boundary separates Larimer County's 2,614 square miles (6,770 square kilometers) into a western three-fourths of mountains and foothills and an eastern one-fourth of plains (fig. 2). Elevations range from over 13,500 feet (4,115 meters) in Rocky Mountain National Park, to about 4,800 feet (1,463 meters) in the eastern plains. The western boundary of Larimer County partly follows the Continental Divide at the crest of the Front Range of the Southern Rocky Mountains. The scenic higher mountains are underlain by igneous and metamorphic rocks, sculptured by streams and glaciers. The foothills and plains on the Colorado Piedmont Section of the Great Plains are underlain principally by flat-lying sedimentary rocks, upturned nearest the mountains. The Piedmont contains alluvial gravel and sand deposits in river bottoms and on nearly flat river terraces representing past geomorphic events. In the northern Piedmont area, gravel-capped pediments are interspersed with the gently rolling topography of dissected uplands. In the southeastern part of the County, two major rivers, the Cache la Poudre and the Big Thompson, flow eastward on broad floodplains.

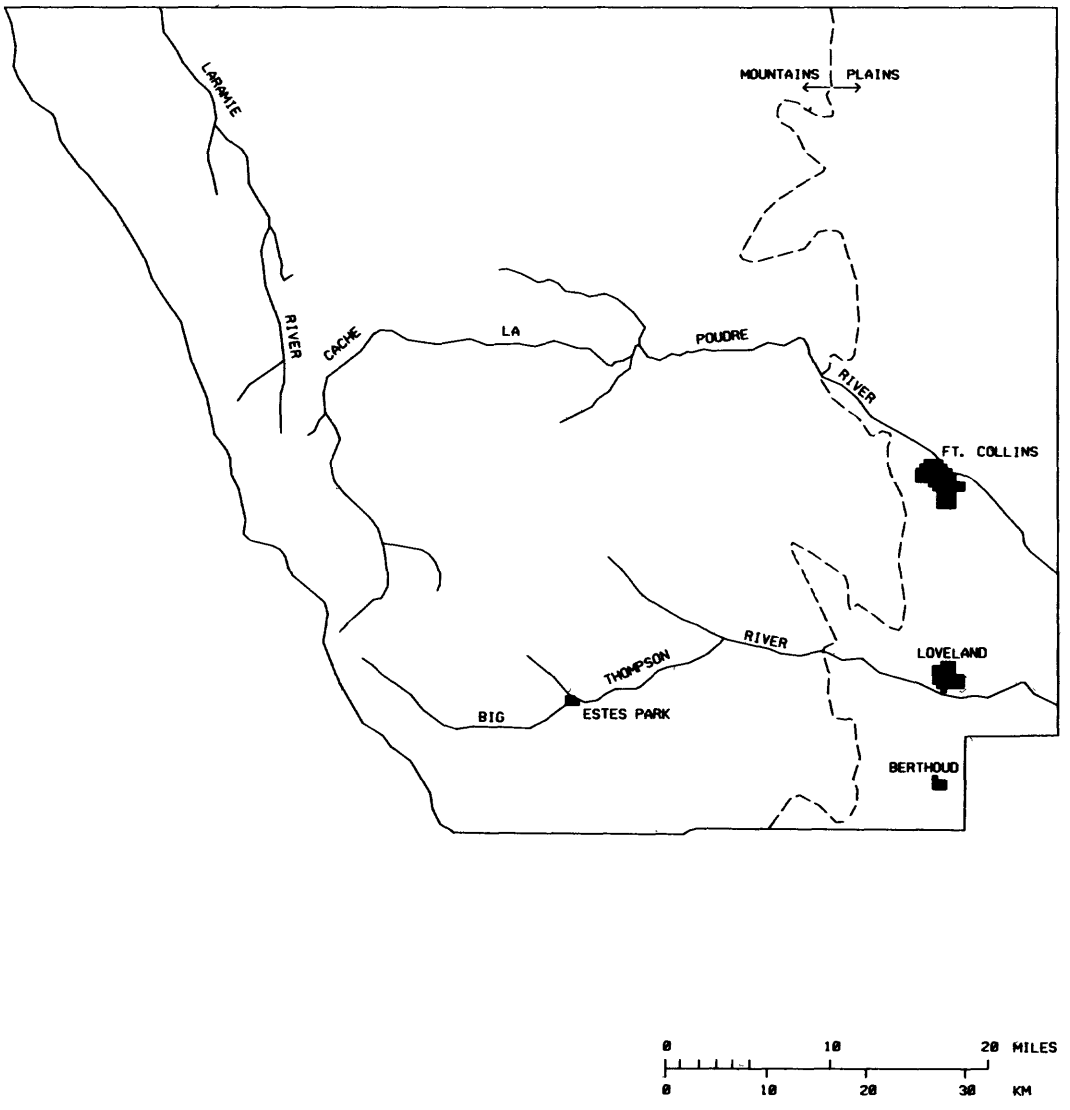
Larimer County's combination of plains and mountains has been an asset as well as the source of natural hazards that have intensified with the increased population. A disastrous flood on the Big Thompson River on the night of July 31, 1976, caused 139 deaths and more than $35 million in damages (USGS, 1979). In its aftermath, public officials all along the Front Range were alerted to the devastating potential of flash floods in this environment and the need for improved preparedness.

Climate on the plains of Larimer County is semi-arid and temperate, with July mean temperatures of 70.8° F., January mean temperatures of 26.8° F., and a generally somewhat milder climate than places of comparable latitude farther east on the Colorado High Plains, owing to the warming effect of downslope winds. The cooler and wetter mountain areas receive heavy winter snowfall, although some mountain valleys, such as the Big Thompson at Estes Park, have surprisingly mild winters. Growing season ranges from about 150 days in the extreme eastern part of the County to about 60 days in the cultivated portions of the mountains. Average annual precipitation in the cultivated areas ranges from 12 to 20 inches. Soil types correlate roughly with the physiographic divisions of the County. The mountains and foothills regions are characterized by cold and cool soils, developed on the generally steep slopes, suitable primarily for rangeland, with some areas of grain production. The soils on the eastern plains are the dry, warm soils, potentially rich for a variety of agricultural products, if sufficiently watered.

Larimer County has diversified agriculture, and is one of the leading Colorado counties in agricultural production. The bulk of the cultivated land lies on the Piedmont in the southeastern portion of the County. Agricultural land is mainly irrigated, although some dry cropland is found on upland surfaces beyond the reach of irrigation. In dry-land farming, crops are planted every 2 years. The land is left fallow in alternate years. Principal crops in Larimer County are corn for grain and silage, wheat, hay, barley, dry beans, sugar beets, and oats.

Figure 2

Larimer County Index Map



Fort Collins and Loveland, the largest cities in Larimer County, are situated in the narrow belt along the eastern plains, where most of the County's population is concentrated. Estes Park, at the gateway to Rocky Mountain National Park, though much smaller, is the center of a sizeable temporary population during the tourist seasons. The Fort Collins Standard Metropolitan Statistical Area (SMSA), defined by the Bureau of the Census as consisting of Larimer County, was the fourth fastest-growing SMSA in the United States in the decade 1970-1980. During that time the County grew 66 percent in population, from just under 89,000 to over 149,000 (table 1).

Larimer County thus typifies recent growth centers in the Sunbelt and Mountain West. Larimer County has had consistently higher growth rates than the national average, exceeding or equalling the average in seven out of the past eight decades; in the past two decades, the County's rate of growth has been five to six times the national rate, and more than twice that of Colorado (table 2). Population projections to the year 2000 call for the addition of at least another 100,000 people (table 3).

Population growth has been accompanied by changes in land use. Land use data are not as easily obtained as population data, although some indirect indications of land use changes may be obtained. For example, the U.S. Department of Agriculture reports that the acreage in farms decreased from about 770,000 acres in 1954 to about 580,000 acres in 1969. The loss of prime farmland has been recognized as a major trend (U.S. Department of Agriculture, 1980). Other indicators may be obtained from platted subdivision records, records of city annexations, records of agricultural production, and water use data. The County Planning Department monitors building permits and assessment records for the urbanized southeast part of the County, excluding incorporated areas. There is, however, no comprehensive updated land use monitoring for the entire County. More precise information on the rate of change of land use in Larimer County would be useful.

Principal industrial and economic sectors in Larimer County are education, light manufacturing, housing, trade, agriculture, tourism, and other services. Larimer County is the location of Colorado State University, electronics firms, a photographic manufacturing plant, and other large industrial employers.

Half of the land in Larimer County is in public ownership, of which 47 percent is in Federal government ownership and 3 percent in State ownership. The principal Federal land management agencies and the areas under their jurisdictions are the Forest Service, 951 square miles (2,462 square kilometers) in the Roosevelt National Forest; and the National Park Service, 226 square miles (586 square kilometers) in Rocky Mountain National Park.

U.S. Geological Survey: Earth Science Information

The U.S. Geological Survey was created as a scientific Bureau within the Department of the Interior on March 3, 1879, consolidating into one Federal Bureau the four territorial surveys of the West, which at that time

Table 1

Ten Fastest-Growing Standard Metropolitan Statistical Areas (SMSA's), 1970-1980

SMSA	Rank	% Increase 1970-1980
Fort Myers-Cape Coral, Florida	1	94.2
Las Vegas, Nevada	2	69.1
Sarasota, Florida	3	67.5
FORT COLLINS, COLORADO	4	66.0
Fort Lauderdale-Hollywood, Florida	5	62.2
Bryan-College Station, Texas	6	61.2
Reno, Nevada	7	60.1
West Palm Beach-Boca Raton, Florida	8	58.2
Provo-Orem, Utah	9	57.7
Phoenix, Arizona	10	55.6

Source: U.S. Bureau of the Census, Press Release, March 19, 1981

Table 2

Percent Population Increase,
United States, Colorado, and Larimer County

Time Period	United States	CO	Larimer County
1900-1910	21	48	108
1910-1920	15	5	10
1920-1930	16	23	19
1930-1940	7	8	7
1940-1950	14	18	23
1950-1960	19	32	22
1960-1970	13	26	69
1970-1980	11	30	66
1900-1980	198	433	1126

Source: Bureau of the Census

Table 3

Larimer County Population Projections,
1980-2000

Year	LWCOG Projection, 1977	Projected Growth Rate, Prior Decade	Projection Adjusted For 1980 Pop.
1980	159,825	---	149,205*
1990	215,930	35%	201,427
2000	281,000	30%	261,855

*Actual

Source: Larimer-Weld Regional Council of Governments, cited in Larimer County Land Use Plan, March 1978, p. 48; adjusted with 1980 census data, same projected growth rates.

were the primary sources of geologic and geographic information about this then little-known part of the country. The Organic Act charged the new agency with the responsibility for "classification of the public land, and examination of the geologic structure, mineral resources, and products of the National Domain."

The USGS mission today is to collect, analyze, and publish information about the Nation's energy, mineral, land, and water resources; to conduct research to determine the geologic structure of the United States, and to develop an understanding of Earth processes and history.

The following categories of USGS information are available in varying degrees of detail and coverage for Larimer County or portions thereof:

1. Topographic Maps: Maps at various scales showing three-dimensional representations of the land surface and associated water bodies; primarily maps having shaded relief representations; county format maps at 1:50,000 scale funded cooperatively with the Colorado Department of Local Affairs.

2. Aerial and Satellite Photographs, Photomaps, and Remote-Sensing Data: Includes all aerial photographs obtained in support of USGS mapping programs, all NASA high-altitude aerial photographs and Landsat images, some other aerial photographs and other remote-sensing data such as thermal infrared, radar, and passive microwave; quadrangle-centered aerial photographs and orthophotoquads funded cooperatively with the Colorado Department of Local Affairs; and indexes to photographs obtained by other agencies.

3. Land Use and Other Planimetric Maps: Includes the recent maps portraying land use and land cover at scales of 1:250,000 and 1:100,000, other planimetric maps of a wide variety exemplified by the collection in the National Atlas of the United States.

4. Geodetic Data: Horizontal and vertical control for the basic topographic mapping program.

5. Geologic Maps and Reports: Geologic and geophysical maps at various scales and assessments of geologic structures, rocks, mineral resources, and processes that affect their origins and distributions; including recent analyses of suitability for development, based on subsurface materials and susceptibility to geologic hazards.

6. Water Resource-Related Reports, Maps, and Data: Records of surface and ground-water measurements, drainage basin maps, and a wide variety of interpretive reports, including resource estimates and flood and drought hazard assessments.

7. Bibliographies and Indexes: Regularly and irregularly published bibliographies, indexes, and abstracts of the output of the Geological Survey.

8. Brochures, News Releases, and Educational Material: Pamphlets and other items intended for popular dissemination and explanation of Geological Survey programs, activities, and results.

Published maps and reports of the Geological Survey can be obtained by mail or by over-the-counter sale at the Regional Distribution Centers. The nearest Distribution Center to Larimer County, Colorado, is the following:

Branch of Distribution
U.S. Geological Survey
Box 25046, Federal Center
Denver, Colorado 80225

In addition to standard outlets for published materials, the USGS maintains a variety of more specialized information outlets as indicated by the following list:

U.S. Geological Survey Information Office: Press releases and general information for the news media.

Public Inquiries Offices: General information on Survey activities and products.

Geologic Inquiries Group: Answers specific inquiries on all aspects of geology.

Water Information Group: Answers specific questions about USGS water programs.

National Cartographic Information Center: A national information service for U.S. cartographic data.

National Water Data Exchange (NAWDEX): A computerized data system for sources of water data.

National Water Data Storage and Retrieval System (WATSTORE): Provides access to all types of water data.

EROS Data Center: Distributes remote-sensing data obtained from satellites and aerial photography.

National Earthquake Information Service: Computes and publishes locations of epicenters for earthquakes worldwide and provides other information pertaining to current earthquakes.

Details of the above and other information outlets have been summarized in the publication, "A Guide to Obtaining Information from the USGS," 1981, Geological Survey Circular 777 (Clarke, Hodgson, and North, 1981).

Soil Conservation Service: Soil Science Information

The Soil Conservation Service (SCS) began during the Dust Bowl period in the mid-1930's, and the establishment of the Soil Conservation Districts in Colorado developed in the late 1930's.

The SCS is the technical soil and water conservation agency of the U.S. Department of Agriculture. It provides technical leadership and assistance in programs to develop, protect, and improve soil, water, and wildlife resources to assure an efficient agriculture and a healthy and attractive environment. The agency also gives technical assistance in establishing outdoor recreation on non-Federal lands.

The programs that the SCS works with in accomplishing its objectives are:

1. Conservation Operation: Provides technical assistance to help landowners improve irrigation systems and conserve irrigation water, build ponds for livestock and wildlife, reduce erosion and pollution on farms, ranches, and in the cities (subdivisions, shopping centers, airports, etc.); advises on proper use to improve the land, such as terraces on wheat fields, and other related conservation practices.

2. Great Plains Conservation Program (GPCP): Provides technical and financial assistance for the portions of the Great Plains that have intermittent drought, so the farmers and ranchers are better equipped to combat the drought; assistance includes land use adjustments and soil and water conservation practices; includes Eastern Colorado and portions of Larimer County.

3. Soil Surveys: Provide information about the characteristics and slopes of soils. Soil survey information can be used to help in agriculture by determining classes of land so the landowners can decide how to manage their soils and water for the highest economic return and the most beneficial long-range use. Other information is used to help determine the most suitable location for home and industrial sites, roads, airports, and other installations. Larimer County has a published soil survey on private lands (U.S. Department of Agriculture, 1980). Copies of the soil maps and interpretations of the soils are also available at the Fort Collins SCS office.

4. Snow Survey: Forecasts the supply of water from mountain snow. The SCS conducts snow surveys from which potential water yield is measured for municipal uses, power, and irrigation. Larimer County has eight sites that are measured for flow in the Cache la Poudre drainage. SCS releases water forecasts to the public once a month, January through May.

5. Watershed Protection: Protects agricultural resources, improves water supplies, develops wildlife, and reduces flood damage through the Watershed Protection and Flood Prevention Act (Public Law 566). Larimer County has two ongoing projects: (1) the Boxelder Creek Watershed, north of Fort Collins, in which four dams and a stabilizing structure have been constructed and one large dam is to be constructed soon; and (2) the Handy Ditch Watershed Supplement, south of Loveland, including various irrigation structures installed and planned. The Home Supply and Louden Ditch have completed watershed projects.

6. River Basin Studies: Provide information for water planning. One example is a study on the Cache la Poudre River from Wellington to the County boundary.

7. Resource Conservation Act of 1977 (RCA): Requires a total assessment or appraisal of America's basic natural resources, to help protect and improve them. Then, a comprehensive 5-year program is planned to guide conservation efforts and evaluate the effectiveness of ongoing conservation programs in cooperation with public participation and other government agencies.

The Soil Conservation Service works with, or through, the Soil Conservation Districts (SCD). These Districts are organized by rural landowners with common conservation problems, in accordance with State law. The SCD's are examples of local democracy in action. Local district leaders enlist the voluntary commitment of thousands of land owners.

Each district is run by five supervisors. Three are elected landowners and two, who need not be landowners, are appointed by the Colorado State Soil Conservation Board.

Districts receive some financial support from the State Legislature, and Larimer County pays a District Clerk. Larimer County has two SCD's:

1. Fort Collins SCD, which generally encompasses the land north of a line between Loveland and Fort Collins to the Wyoming State Line. Some land along Colorado Highway 14 in Weld County is included. Excluding Forest Service and National Park lands, the Fort Collins SCD has approximately 1,190,233 acres and 720 cooperators; and

2. The Big Thompson SCD, which generally encompasses the land south of Fort Collins SCD, but also includes land in Weld County around the Johnstown area. The Big Thompson SCD has approximately 500,985 acres and 1,134 cooperators.

The Soil Conservation Service is the only agency that works directly with private landowners in preparing conservation plans; it gives technical assistance such as surveys, designs, and checkouts of conservation practices. It differs from the Extension Service in that SCS is a Federal agency, while the Extension Service is part of State government, in cooperation with the U.S. Department of Agriculture (USDA), and serves as the education arm of USDA.

III. FINDINGS: LARIMER COUNTY GOVERNMENT AND ITS INFORMATION NEEDS

Detailed interviews were held with five County departments: Assessor, Engineer, Health, Planning, and Sheriff. Respondents were asked for information on their respective department functions, needs for earth and soil science information, pertinent laws and regulations (which often specify directly or indirectly where earth and soil science data are needed), comments on the suitability of the USGS and SCS information products submitted for review, and general suggestions and comments. The interviews took place in the offices of each County department and were accompanied by brief tours, explanations of departmental operations, and introductions to staff members.

Some State laws apply to all County departments of a given type. In Colorado, counties are considered to be an extension of State government, having legally only those powers given them by State statutes. Statutory authority for county government is contained in Chapter 30 of the Colorado Revised Statutes, 1973, as amended. Counties have, by law, the following elective officers:

County Commissioners (3)
Sheriff
County Clerk
Coroner
Treasurer
Assessor
Surveyor

In addition to the elective officials, counties have boards and commissions to assist in the decisionmaking process, including the Planning Commission and the Board of Health, each of which is provided for by State statute. The legal authority under which these boards generally operate is the police power, which utilizes governmental authority to promote the health, safety, and welfare of the citizens.

Assessor

The primary purpose of the County Assessor is to ascertain the valuation for assessment of all real personal property in his jurisdiction, for the purpose of ad valorem taxation. In the context of the present study, attention is focused on the Assessor's role in establishing the valuation of land.

To perform this valuation function the Assessor's Office must maintain large amounts of information, including maps and files containing information on the location, use, current markets, prior valuations, and other factors bearing upon the current assessment.

Pertinent Laws and Regulations

A wide variety of potential methods for establishing value is available to and in common use by assessors. With some exceptions, including

agricultural land, Colorado statutes require that valuation shall be based on the following factors:

1. Location and desirability
2. Functional use
3. Current replacement cost (new, less depreciation)
4. Comparison with other properties of known or recognized value
5. Market value in the ordinary course of trade
6. Earning or productive capacity
7. Appraisal value for loan purposes on comparable properties.

Actual value of agricultural land, less improvements, is determined by its productive capacity during a reasonable time period, capitalized at a rate established by the Legislature. To be assessed as agricultural, lands must have been classified as such for the ten years preceding assessment, and must have been used during the two years preceding assessment for the purpose primarily of obtaining a profit through crops, livestock, poultry, fur-bearing animals, bees, or dairying, and must continue to have agricultural use.

A major new requirement was placed on county assessors by the provisions of Colorado House Bill 1089 in 1976. House Bill 1089 stated that "each assessor shall prepare and maintain full, accurate, and complete maps showing the parcels of land in his county. The maps shall include a master County Index Map, together with applicable township, section, and quarter-section maps, depending on density. Guidelines shall be established by the Administrator to produce uniformity throughout the State. The guidelines shall include the definition of a parcel, the development of a parcel-numbering system, map size, map scale, and suggestions for minimum information to be plotted."

Among the guidelines established for the administration of this law were that one of the following map scales would be used:

Township Map	1:14,400	(1 inch = 1,200 feet)
Section Map	1:2,400	(1 inch = 200 feet)
Quarter-Section Map	1:1,200	(1 inch = 100 feet)
High-Density Map	1:600	(1 inch = 50 feet)

Larimer County decided on map scales of 1:14,400; 1:2,400; and 1:200; and further required that the new maps be keyed to the State Plane Coordinate System, and be prepared for computer processing of the land-parcel data.

Needs for Earth and Soil Science Information

In order to carry out the Assessor's responsibilities for determination of value of property, it is necessary for the Office to have precise infor-

mation on the location of land parcels. This includes legal descriptions and survey records, as well as appropriate maps to show relationships of parcels to one another and to other geographic features necessary or useful for establishing location, principal use, and other necessary factors for land valuation.

In addition to the mapping needs, the Office requires some information on the potential for mineral extraction existing throughout the County. This requirement derives from the need to know in advance, if possible, the kinds of development that result in the creation of new land parcels associated with mineral resource exploitation. For example, a recent proposal to develop a silica sand operation in Larimer County necessitated the Assessor's Office having fundamental geological information to assist in property valuation.

a. Topographic Maps: The Assessor's Office presently uses information contained on USGS 7½-minute quadrangle maps, and other maps provided by the City of Fort Collins and private engineering consultants, primarily for a planimetric base on which to map land parcels.

b. Aerial Photographs and Photomaps: The Assessor's Department requires aerial photographs for updating their land parcel files, and for compiling the new County maps at three different scales. Low-altitude aerial photographs are needed, as high-altitude aerial photography and satellite coverage are not sufficiently detailed. The County presently has and uses USGS aerial photographic coverage of Larimer County, plus industry-supplied low-altitude coverage.

c. Geodetic Data: The County Assessor's Office requires second-order, second-class geodetic control for the new mapping program. Prior to the mapping program undertaken as a result of House Bill 1089, the location of recent subdivisions and other new developments had not been determined with sufficient accuracy. Such location became critical when, for example, the planning for pipelines, new utility connections, and new roads was hindered by a lack of appropriate survey control.

d. Geologic Maps and Reports: The Assessor's Office staff makes use of all pertinent geologic information which helps identify potential use and valuation of the land. For example, locations of potential metallic and non-metallic mineral deposits are useful to the Assessor's Office.

e. Soils Maps and Reports: The Assessor's Office requires soils capability information so that appropriate valuations for irrigated farmland, dry farmland, and grazing land can be assigned. Soils information must be combined with information on the availability of water, to arrive at the actual valuation.

f. Land Use and Land Cover Maps: The Assessor's Office needs land use maps to assist in property valuation, not only for an individual land parcel but for determining uses and values of surrounding properties.

Evaluation of Available Information

a. Topographic Maps: USGS topographic maps are adequate for some uses, for example, the location of large land ownership units with respect to other geographic features. County officials also make use of the grid systems, since their more-detailed mapping uses the State Plane Coordinate System as a basis for a computerized mapping system.

The USGS maps, on the other hand, are marginally suitable or unsuitable for use where the larger map scales are required, where there is a lack of suitable control in densely built-up areas, or where there is a lack of detail for locating land parcels. The preceding statement applies for both present and anticipated future uses.

At a special meeting at the USGS Rocky Mountain Mapping Center in Denver, requested by the Larimer County officials responsible for the mapping program, USGS mapping specialists demonstrated photogrammetric procedures used in map compilation, and discussed other aspects of USGS mapping programs of interest to Larimer County. USGS provided some enlargements to 1:14,400 from a 1:24,000 base as an experiment to determine applicability at the smallest (township) scale County requirement. These enlargements proved usable at that scale, and thus proved applicable to one of the County's mapping needs.

The Assessor's Office uses the County Topographic Maps, four sheets, scale 1:50,000, which were produced by a program cooperatively funded by USGS and the Colorado Department of Local Affairs. These maps are highly regarded and used in many County offices in addition to the Assessor's Office. They are useful to locate some land parcels and larger subdivisions. They are useful for dealing with the general public for reference and index to larger map coverage. It would be useful if section lines were more prominently indicated. Assessor's Office staff spent 80 hours drawing in the section lines so that they could be more readily seen. In general, the portrayal of Larimer County in its entirety in an area small enough to fit on an office wall is a strong point of the 1:50,000 scale county map series. For all USGS topographic maps, the Assessor's Office was aware of:

1. Preliminary one-color blue-line manuscripts
2. Final one-color blue-line manuscripts
3. Custom-file composite reproducibles
4. Indexes and schedules

The officials were also aware of the State Cartographer's geo-indexing system, having visited his office during the trip to Denver as arranged by members of this project's study team.

b. Aerial Photographs and Photomaps: The high-altitude aerial photographs are not sufficiently detailed for the County Assessor's use. The orthophoto materials at a scale of 1:24,000 were marginally useful.

Index information on large-scale photographs was found useful. The Assessor's Office staff would like to have advance information on schedules for large-scale aerial photography. Perhaps a more direct contact with those who schedule aerial photography in USGS and elsewhere would be desirable. Since the County has to obtain photography of a large scale at relatively frequent intervals, for different parts of the County, it would be helpful for them to know in advance whether planned Federal or State programs might provide all or part of such coverage. The highest priority for early 1980's aerial photography is the rapidly developing portion of the County.

c. Geodetic Data: The geodetic data in the archives of the Federal agencies were not of sufficient density to create a horizontal control network in the highly developed areas for mapping at the larger scales. County officials were aware, from the example in nearby Jefferson County, that local government can enter into a cooperative agreement with the National Geodetic Survey (NGS) to densify the national geodetic network within the local jurisdiction. Because of time constraints, however, the County officials contracted with a private firm to create adequate geodetic control.

d. Geologic Maps and Reports: USGS geological reports dealing with Larimer County were all found to be useful by the Assessor's Office. The information was adequate for the portions of the County covered, but did not supply all of the County needs, since coverage for all geologic topics was not available at the necessary levels of detail for all portions of the County. The 1:24,000 geologic quadrangle maps, if available, would be very helpful. Mineral resource maps showing the location of deposits at a scale of 1:24,000 would also be helpful. However, the information on the USGS-supplied, smaller-scale, maps was helpful for general background use.

e. Soils Maps and Reports: The recently published Soil Survey of Larimer County provides general information of use to the Assessor's Office. However, an already-established system, based on a previous input of information, serves as the basis of the Office's day-by-day procedures for assigning agricultural land valuations.

This procedure derives from the "capability classes" of agricultural and grazing lands (table 4). Within each major capability class, a further quality indicator, rated A through F, with A being the best and F the worst, is assigned. The third element of this classification scheme is the availability of water, simplified to location north of the Cache la Poudre River, where water is less available, and south of the river, where it is more available. A table is prepared and periodically updated, containing the assessed value (dollars per acre), which is 30 percent of the actual market value, for land parcels already classified according to the above soil and water categories (table 5).

f. Land Use and Land Cover Maps: The Assessor's Office obtains land use information primarily from the parcel files and secondarily from the maps prepared by the County Planning Department. The USGS land use information, even enlarged to a scale of 1:100,000 lacks sufficient detail to be used for parcel location, as required by the Assessor's Office.

g. Other Information: The information products presented by USGS and SCS were very numerous (Appendix B). The Assessor's Office suggested that it would be very helpful in evaluating that large amount of material if they had more comprehensive indices and summaries of the information, so that they could determine which products were more pertinent to their needs. They suggested, for example, an overview map with reference to the different areas of the County to which different reports applied. The Assessor's Office staff found the indexes and bibliographies that were supplied to be useful (e.g., Index to Geological Maps and Reports, as prepared by the Geologic Division; other USGS bibliographies). A suggestion was made that local university reports might also be included, to increase the value to the user.

Engineer

The County Engineer is an official hired by the Commissioners with the traditional function of designing and maintaining county roads. Increasingly there has been a tendency for the position to develop into a public works director in the more-populated counties. The function is thus evolving into one of administrative authority over activities such as drainage and flood control, in addition to the road system. In Larimer County the Engineering Department surveys and designs all County roads and bridges, reviews all road and drainage subdivision maps, and surveys and writes land descriptions in response to any County requirement; for example, descriptions of rights-of-way, and legal descriptions of other land parcels where the County has an interest.

Needs for Earth and Soil Science Information

In fulfilling its mission, the Engineering Department needs a variety of maps of Larimer County. The Department requires general location maps at smaller scales, as well as more-detailed maps that show existing roads

Table 4

Soil Capability Classes

Class I	Few limitations that restrict use
Class II	Moderate limitations that reduce the choice of plants or that require moderate conservation practices
Class III	Severe limitations that reduce the choice of plants, require special conservation practices, or both
Class IV	Very severe limitations that reduce the choice of plants, require very careful management, or both
Class V	Not likely to erode, but have other limitations, impractical to remove, that limit use largely to pasture, range, woodland, or wildlife habitat
Class VI	Severe limitations, generally unsuited to cultivation, use limited largely to pasture, range, woodland, or wildlife habitat
Class VII	Very severe limitations, unsuited to cultivation, use restricted largely to pasture, range, woodland, or wildlife habitat
Class VIII	Limitations preclude use for commercial plants and restrict use to recreation, wildlife habitat, water supply, or esthetic purposes.

Source: U.S. Department of Agriculture, 1980, p. 63

Table 5

Assessed Value for Agricultural and Grazing Land, in Dollars per acre[1]

Irrigated Farm Land

II AS	102.08	II AN	85.36
II BS	83.60	II BN	69.52
III AS	78.32	III AN	60.72
III BS	65.12	III BN	49.28
IV AS	50.16	IV AN	33.44
IV BS	30.80		

Dry Farm Land

III A	III B	IV A	IV B
19.36	14.96	11.44	7.92

Irrigated Meadow--Irrigated Pasture

V A	V B	V C	V D	V E	V F
36.96	22.00	7.92	17.60	10.56	8.45

Grazing Land

VI A	VI B	VII A	VII B	VII C	VIII
3.50	3.22	2.76	2.30	1.93	1.38

[1] II through VII: Soil capability classes.
A through F: Decreasing quality within class.
N = North of Cache la Poudre River (inadequate water availability).
S = South of " " " (adequate water availability).

Source: Larimer County Assessor's Office, 1979

and bridges, with sufficient detail for planning new roads and bridges. The Engineer also requires information on the engineering properties of surface materials, in selecting sites for roads and bridges. In addition, he requires information pertaining to drainage, one of the principal concerns in road design. Information on past floods and their extent, including expected heights at road crossings, is useful.

a. Topographic Maps: The Department uses topographic maps in planning and siting new roads and bridges, and for plotting locations of new subdivisions. Topographic maps are also used for general locational references, for relating Engineering Department work to that of other County departments.

b. Aerial Photographs and Photomaps: The County Engineer makes some use of existing aerial photo coverage of Larimer County, in association with topographic maps for detailed location of areas of recent growth.

c. Geologic Maps and Reports: Information on surface and subsurface geology is of some importance at present, and will be of increasing importance in the future, as the County Engineer becomes more involved in the decisions on subdivision proposals for areas with potential foundation problems. Geologic maps and reports are also needed to evaluate foundation sites for bridge construction and maintenance, and to aid in locating sand, gravel and aggregate sources.

d. Soils Maps and Reports: The Engineering Department uses soils survey data for planning roads, bridges, and subdivisions. The soils maps, plotted on an aerial-photographic base, are matched with the associated information on engineering properties and classifications, physical and chemical properties of soils, building site development applications, and construction materials.

e. Water Data and Reports: Water data are used for the planning and building of bridges. For example, high-flow records for streams are of use in determining the height to which bridges should be built, with the longer the measurement, the better.

Evaluation of Available Information

a. Topographic Maps: The Engineering Department presently uses USGS 7½-minute quadrangle maps and finds them adequate for many applications. In addition, they have a requirement for larger-scale maps than those supplied by USGS. To fulfill that need, USGS quadrangle maps were enlarged to a scale of 1" = 400' (5 times enlargement). When used in that fashion, the Department finds the 7½-minute quadrangle maps satisfactory.

The Department has also used the 1:50,000-scale County topographic maps, and finds them very useful for general location. One Department need not fulfilled by available maps was for depiction of section corners in mountainous areas. In addition, the Engineering Department would like to have the information on survey ground control points, displayed on the map. The Department has made use of advance blue-line prints of topographic maps. It became aware of the State Cartographer's geodata information system as a result of the contacts brought about by this project.

b. Aerial Photographs and Photomaps: The Engineering Department obtains aerial photos primarily from files of the County Planning Department. This source is considered adequate for the needs of the County Engineer.

c. Geologic Maps and Reports: All the pertinent USGS geologic information is used, along with geological studies done by consultants. The information is adequate where available, but for large areas of the County the geologic information does not exist, or is not in sufficient detail for the requirements of the County Engineer. In the future, more-detailed information on local geology will be required, as development goes into "marginal" sites, where construction is more difficult, for example, steeper slopes and potential slide areas.

d. Soils Maps and Reports: The present source of soils maps and reports for the County Engineer's Office is the SCS Soil Survey for Larimer County. The soil survey data are generally adequate for planning and obtaining an overview of the potential problems, but inadequate for the more-detailed site surveys that need larger-scale maps and borings.

e. Water Data and Reports: At present, water data are obtained from USGS records and other data prepared in the County Planning Department. More-detailed data, for example as needed in estimating high flow levels at bridge crossings, would be helpful.

f. Other Information: The County Engineer's Office was on the mailing list for products of the USGS Front Range Urban Corridor Project. Upon completion of that project, the Engineer realized that a regular list of available USGS reports and maps would be useful in alerting the Department to the availability of relevant information. Therefore, the Engineer's Office was designated to receive the monthly "New Publications of the Geological Survey."

Health Department

The Health Department, operating under the authority of the Board of Health, has authority to regulate activities which may affect the general health. Environmental health concerns may include, for example, air pollution, noise, odors, and sanitation conditions. Health laws generally

are retroactive; thus established facilities may be required to be brought to a standard of health. Of particular concern in health matters is the regulation of sanitary waste-disposal activities, including on-site disposal systems. The proper functioning of such systems is quite sensitive to soil and ground-water conditions.

Of the two major divisions within the Health Department, only the Environmental Health Division has concerns for earth and soil science information. This Division has responsibility for water quality, air quality, and food inspection. The other division of the Health Department has responsibility for nursing and illness prevention. It is estimated that 40 percent of the effort of the Environmental Health Division is devoted to matters that concern the use of earth and soil science information.

Needs for Earth and Soil Science Information

Because of the dispersal of contaminants through surface and ground water, the Health Department needs information on soil and drainage conditions near sites of waste disposal. The Department also needs ground-water information where the water table is less than 7 feet from the surface. Recently the Department has had increased concern over properties of soils and near-surface geological formations governing horizontal and vertical migration of methane gas from old landfills.

The use of existing earth and soil science information and maps is primarily in the first step of the development approval process. In this step the developer submits a request for approval of a proposed development, along with a sketch map. Health Department staff evaluates the development site to see if there are any major environmental health concerns that would preclude development, or that would call for additional information. At this first step in the review process, the staff must rely on whatever maps and other pertinent information are available. The second and third steps in the approval process, preparation of preliminary and final plans, usually require more-detailed site information than that available in existing USGS and SCS information products.

a. Topographic Maps: The Health Department requires topographic maps for general location of properties and for relating topography to geological conditions, soils, and drainage.

b. Aerial Photographs and Photomaps: The Department requires aerial photographs for detailed examination of surface conditions, as required for the approval process for new developments. The aerial photos assist in identifying conditions or facilities that may cause health problems in the vicinity of a proposed new development.

c. Geologic Maps and Reports: The Health Department uses geologic maps and information to alert Department officials concerning local conditions where hazards might occur; for example, faults, unstable flat areas, or badly eroded areas with vegetation disrupted. The Department needs maps that show surficial conditions governing movement of leachate from waste-disposal areas. Map coverage is required in the floodplain and foothill areas, which are presently of prime concern for development. The granite terrains in the mountains are of secondary concern with regard to surficial geologic information, with the exception of high priority for information on waste-disposal conditions in some mountain valleys. The Health Department is also interested in information on ground stability and the likelihood of landsliding or other geologic hazards.

d. Soils Maps and Reports: The Health Department uses soils maps to examine development sites prior to approval for each new subdivision. Such examination alerts the Department to soil conditions that may be unsuitable for development, and that may require more-detailed information than is available in present soils maps. In addition to soils information, ground-water information is needed if the water table is within 7 feet of the surface.

e. Water Data and Reports: The Health Department needs baseline data and current water-quality data to evaluate suitability of certain kinds of industrial siting problems. For example, a recently completed industrial facility which could put out an effluent into surface water necessitated the Health Department to obtain baseline data 2-3 years before the plant moved in, and then to monitor water quality afterward.

f. Land Use and Land Cover Maps: The Health Department requires land use information for the first step of the subdivision evaluation process. Such information is helpful, for example, in determining the impact on surrounding areas of a proposed industrial site. The Department staff must look for such impacts as air pollution, migration of contaminants through the ground and surface water, noise and noxious activities in surrounding areas, and impact on surrounding land uses.

Evaluation of Available Information

a. Topographic Maps: The USGS 7½-minute topographic maps are adequate for the Health Department's present needs. Though they use the 1:24,000-scale series primarily, they have occasional uses for the smaller-scale maps. The 1:50,000-scale county maps are used for planning the activities of the Department, and for general location of proposed sites. The Department officials would prefer to have township and range markers in lines that are more visible than presently used. The staff adds heavier lines to the maps so that they can more easily see the location grid. Also, the reference coordinates in the margins of the map are inconveniently placed and hard to read. They would prefer to have such lines in red.

b. Aerial Photographs and Photomaps: The Health Department obtains the aerial photographs it needs from local engineering firms, and the coverage is updated frequently. This source of information is adequate for present needs. The Department anticipates, however, that it will need more detail than is present in the 1" to 400' scale mapping now required, within the next decade.

c. Geologic Maps and Reports: Presently available geologic information, from whatever source, is not adequate for the increasingly detailed needs for surficial geologic information. The Health Department will seek more-detailed geologic information in the coming years.

d. Soils Maps and Reports: The Department presently obtains soils data from the SCS Soil Survey for Larimer County. That information has been very adequate for the first stage of the development approval process, which relies on existing information. The presently available information, however, is not adequate for the second and third steps, namely, presentation of preliminary and final plans for development. These latter steps require more-detailed information that must be obtained from engineering studies on-site. Soils data obtained from the SCS soil survey are not carried deep enough to cover present information needs with regard to methane migration problems. For such applications, 40-foot-deep test drillings in old landfills are required. Such information, if not available on existing maps, would be required from the developer whose engineers would conduct borehold tests on-site. At present there is no readily available source of information adequate for the methane-migration problem, and the Health Department must depend upon obtaining new information as needed.

e. Water Data and Reports: The County Health Department presently obtains its own water samples. Department officials have not thoroughly evaluated presently available USGS surface-water information in terms of its potential for fulfilling County Health Department needs. It appears that much of the USGS water-quality data might be useful to the County.

f. Land Use and Land Cover Maps: The Health Department obtains land use information from any source available, primarily the existing land use maps prepared by the County Planning Department. USGS small-scale land use maps are of interest in a general sense, but are not adequate for the evaluation process. In the future, more-detailed information than that available on the 1:100,000 and 1:250,000 USGS maps is needed.

Planning Department

The Larimer County Planning Department has responsibility for planning future land use and for determining whether any given proposal for land use change fits within the overall plan. In addition, the Board of County Commissioners has authority to consider the development of land, and thus the creation of small tracts from large tracts. Colorado law defines the creation of any new tract of land of less than 35 acres a subdivision, and thus subject to regulatory authority.

The Larimer County Planning Department consists of four sub-departments as follows: Inspection Services, having the responsibility for approval of new building permits; Development Processing, having a day-to-day planning function in processing and reviewing applications for subdivisions and rezoning requests; Comprehensive Planning, responsible for long-range planning and for development of the Comprehensive Plan for Larimer County; and Administrative Support.

Pertinent Laws and Regulations

According to Colorado law, the county is legally responsible to the State and Federal government for developing and using guidelines for making proper land use decisions.

In 1974 the Colorado Legislature clarified the powers of local governments to plan for and govern the use of land within their respective jurisdictions through the use of tools such as the land use plan. House Bill 1034 amended the Colorado Revised Statutes, 1973, to include the following powers of local government:

1. Regulating development and activities in hazardous areas;

2. Protecting lands from activities which would cause immediate or foreseeable material danger to significant wildlife habitat and from activities which would endanger a wildlife species;

3. Preserving areas of historical and archeological importance;

4. Regulating the establishment of roads on public lands administered by the Federal Government;

5. Regulating the location of activities and developments which may result in significant changes in population density;

6. Providing for phased development of services and facilities;

7. Regulating the use of land on the basis of its impact on the community or surrounding areas; and

8. Otherwise planning for and regulating the use of land so as to provide planned and orderly use of land and protection of the environment in a manner consistent with Constitutional rights.

Many Federal statutes also govern aspects of the planning activities of county government. Examples of some of these are the following:

1. Federal Housing Act of 1954 as amended, especially Section 701 dealing with the requirements for a comprehensive plan;

2. Solid-Waste Disposal Act of 1975, as amended;

3. Air Quality Act of 1967, as amended;

4. Intergovernmental Cooperation Act of 1968, and its provisions for the "A-95" review process to assure coordinated application of Federal laws and policy;

5. National Environmental Policy Act of 1969;

6. Federal Water Pollution Control Act of 1972, especially Section 208 requiring provisions for control of area-wide sources of water pollution.

Needs for Earth and Soil Science Information

The Planning Department is a major focus for the procurement and use of earth and soil science information among the agencies of county government. Not only does it acquire and develop such information for use in the Comprehensive Plan, it also provides such information as a service to other county agencies and to the general public. The staff estimates that about 10 percent of their effort is directly applied to the analysis and use of earth and soil science information. The remainder is concerned with a wide variety of other types of environmental, socioeconomic, and demographic information as input to the planning process.

With the exception of geodetic data, the Planning Department has needs for the entire range of earth and soil science information types presented by USGS and SCS in this project. These data products find their way into practical use through two main routes: first, as basic data used in the development of the Larimer County Comprehensive Plan, and second, as information to back up current operational decisions concerning subdivision applications and other proposals for land use change within the County's jurisdiction.

a. Topographic Maps: The County Planning Department uses USGS 1:24,000-scale topographic maps as a mapping base for compiling information for the Land Use Plan, one of the elements of the Comprehensive Plan. After compilation, these maps are then reduced to a scale of 1:63,360, to allow easy comparison of data on a County-wide basis. The USGS 1:24,000-scale quadrangle series maps are considered essential primary source materials for many uses in Larimer County planning operations. The 1:50,000-scale County maps are finding increasing use in the Planning Department, for example as working maps for plotting areas of current activity.

b. Aerial Photographs and Photomaps: The Planning Department uses aerial photographs and photomaps as map bases for their 1" = 400'-scale, township-level maps. The photomaps are used as references

for subdivision applications wherever available and at a sufficient scale to determine site impacts. Air photos and photomaps are also distributed to other agencies and the public.

c. Geologic Maps and Reports: Geologic maps and reports enter the planning data base at several points. They are used for assessment of mineral resources, infiltration and surficial conditions, and impact of geologic hazards such as landslides, land subsidence, floods, and earthquakes. The preferred data set for these compilations is the 1:24,000-scale geologic quadrangle map series.

d. Soils Maps and Reports: Soils maps are used in both the long-range planning and current planning activities. They are used for evaluation of agricultural lands and of potential hazards to residential and other proposed developments.

e. Water Data and Reports: Water data and reports are used to help solve local drainage and flood-plain management problems. Such information is also utilized, after interpretation by the State Engineer's Office, to determine availability of water for development purposes.

f. Land Use and Cover Maps: Land use and cover maps are used in the comprehensive planning process, to estimate areas of potential development pressures, based on patterns of existing development.

g. Other Information: The Planning Department also uses bibliographic references and other sources of information on published or unpublished studies. The Department has produced an annotated bibliography of principal references, and maintains a small reference library for staff use.

Much information is now needed in digital format, for example information on the hydrologic characteristics of river basins to be used in assessing the effects of recent basin changes on downstream flooding. For a recent basin assessment the Department staff prepared the data for computer processing. Also, recent needs have been identified for a type of geographic information system which would permit more rapid access to existing data and more analytical capability to compare and evaluate several different types of environmental information.

Evaluation of Available Information

a. Topographic Maps: The USGS topographic maps at 1:24,000 scale are the principal sources of terrain information, and the principal base maps upon which to plot other information. The Planning Department has depended heavily on these maps. The 1:50,000-scale topographic maps (County Map Series) are of too small a scale for direct compilation of planning data, though they are popular as wall maps and for recording the locations of study areas. The Department has received some requests for these maps. Smaller-scale topographic maps were not useful.

b. Aerial Photographs and Photomaps: Larimer County uses its own local sources for aerial photography. The USGS indexes to aerial photographs and space imagery are of interest only where referring to photography at scales of 1:24,000 or larger. Indexes pertaining only to the County, and incorporating the County's existing photographs, would be of use to the Planning Department. The orthophotoquad sheets of recent vintage contain useful information for the Department, and might be used to update in-house quadrangle base maps. These orthophotoquads resulted from a trilateral agreement among SCS, USGS, and the Colorado Department of Local Affairs.

c. Geologic Maps and Reports: Most geologic maps at scales smaller than 1:24,000 were of little use to the Planning Department except as general background information. The USGS geologic quadrangle maps at 1:24,000 would be satisfactory for many uses, but unfortunately only four such maps are published for areas within Larimer County.

Different staff members within the Department preferred different levels of interpretation in the geologic maps. For example, one staff member who had a good background in soils and hydrology preferred the basic bedrock and/or surficial geology maps containing the full detail of the original information presented by the geologist. On the other hand, a staff member speaking for the interests of the "generalist" planner preferred an interpreted or simplified presentation. A nonmetallic mineral resources map at a scale of 1:100,000, which was produced as part of the USGS Front Range Urban Corridor project, provided explanations of mineral uses that were helpful to the planners, though the scale of the map was too small to help in development review or general planning.

Specialized geologic hazard maps, of the type USGS has prepared at 1:24,000 for demonstration projects elsewhere, are in greater demand since the Big Thompson Flood of 1976. Larimer County has contracted with a geological consulting firm to produce several such maps (Empire Laboratories, Inc., 1978).

Most reports on the geology of mineral deposits are "too technical" for Planning Department use. Reports containing general reviews of mineral resource development issues, including review of mining laws, were useful.

d. Soils Maps and Reports: The SCS Soil Survey maps and report are standard sources in the Planning Department for soils information, for the evaluation of urbanizing areas as well as the remaining agricultural areas. These materials are rated fully adequate for Department needs. A complaint of County staff at the beginning of this study, however, was that the delay in publication of these materials was impeding their full use, both in the Department and outside. Only one heavily used set of maps was available in the

County offices. Feedback of this information through the Soil Conservation Service member of the study team influenced the Department of Agriculture's priority for publication, with the result that the completed Soil Survey for Larimer County is now published.

e. Water Data and Reports: Water-resources reports, including the summary report for Colorado, ground-water reconnaissance reports of mountain sites, and basic ground-water data reports, were all found to be useful by the Department. The USGS surface-water data are useful inputs to the detailed hydrologic studies that the Department must carry out for bridge design, other flood planning, and assessing adequacy of water supply. Many routine development permit requests involve hydrologic considerations that depend on detailed information, and often information more detailed than that supplied by USGS is needed. Considering all the water-data needs of the Department, USGS information was rated as only partially or marginally adequate. For example, there is need for more-detailed information on alpine aquifers and other ground-water situations in mountain areas, to accommodate an increasing number of development initiatives in those areas.

f. Land Use and Cover Maps: The County staff attempts to develop its own land use information from aerial photographs and other sources. The most recent usable land use map in the Department's possession is a hand-colored map of only the southeastern portion of the County, at a scale of 1:24,000, dated 1976. The USGS land use maps at 1:250,000 and 1:100,000 do not satisfy the need, although the USGS 1:250,000 map (also enlarged to 1:100,000) was the only graphic land use information available for the mountainous areas of the County.

Staff members had hoped to make use of a newly computerized land parcel file developed by the Assessor's Office, but the necessary computer programs were either too expensive or not flexible enough to supply the information in the form needed by Planning. The USGS classification system is not as detailed as that used by the County, but some uses would be possible if USGS maps were made at 1:24,000 and at Level III or IV detail (Anderson and others, 1976). Adequate land use information, of sufficient detail and currency, remains an unfulfilled requirement of the Planning Department.

g. Other Information: The available indexes and other sources of earth and soil science information for Larimer County only partially satisfy the requirements of the Planning staff. Until the data presentations by USGS and SCS at the beginning of this study, Larimer County had no comprehensive listings of the information available from either Federal agency, although the SCS products were better known, owing to the SCS county representatives and their continuing associations with county staff. Consequently, the need for better indexing, abstracting, and interpretation

for planning applications, of available data from the Federal agencies, was expressed by members of the Planning Department. They found the two published specialized USGS bibliographies quite useful, though somewhat out of date (Chronic and Chronic, 1974; Eister, 1976). For the "generalist" county planner, however, such bibliographies would be more useful if the entries were annotated or evaluated to indicate appropriateness for planning use. The same comment applied to the chronological catalogs of USGS publications, 1879 to present.

A map of "outstanding natural and historic landmarks," issued as part of the USGS Front Range Urban Corridor project, was found "very good" and "fascinating" by the Planning staff. It would be more useful for them if presented at a larger scale, and intended for use at local levels rather than regionally. The USGS Professional Paper 950, "Nature to be Commanded...", was rated as "very good" for its format, presentation, and lucid explanations of uses of earth science information in planning.

Sheriff

The Sheriff has responsibility for law enforcement and other aspects of public safety, such as mountain rescue and disaster warning and management.

Needs for Earth and Soil Science Information

The Information products that are of interest to the Sheriff's Department are topographic maps and aerial photographs. The Office keeps a collection of USGS topographic maps to be used in emergency situations such as mountain rescue and forest firefighting. To a lesser extent, the maps are used for location purposes in law-enforcement activities. Aerial photographs are used for more-accurately determining locations in the mountainous portions of Larimer County. They are useful, for example, in determining landmarks to assist in locating a lost person.

Evaluation of Available Information

The USGS 1:24,000-scale topographic maps are adequate for most needs of the Sheriff's Department staff. Though they maintain a file of the 1:24,000 maps, they also display on their office wall a copy of the 1:50,000-scale Larimer County Map. They make use of the UTM grid system and the range and township system for radio communication of locations. They would like to see the UTM grid more clearly depicted on the topographic maps.

Though the Sheriff's Department makes use primarily of black-and-white aerial photography, it feels that color aerial photographs or color photomaps would have an additional value in determining locations in mountainous terrain. Department officials would also like to have aerial photographs taken more frequently in the canyon areas near the cities.

IV. SUMMARY AND RECOMMENDATIONS

The study team found a diversity and complexity, both in the land resource information available for Larimer County and in the needs of County government for applying such information in its operational functions. In this final section of the project report, the information obtained from the interviews with County government officials is synthesized with other information obtained from various written materials supplied by the County Planning Department, The City of Fort Collins, the Larimer-Weld Regional Council of Governments, and the local newspaper. The summary material is organized according to the five tasks set out in the original Memorandum of Understanding (Appendix A).

Information Needs and Driving Forces

Task 1: Assess the specific needs of local government for hydrologic, earth, and soil science information, and the driving forces behind such needs, such as laws and regulations, limited resources, natural hazards, and citizen pressure.

Information Needs

This task occupied the major portion of the study team effort. In order to assess the County's needs for hydrologic, earth, and soil science information, the study team first assembled examples of information products from USGS and SCS, along with bibliographies of other products. These information products turned out to be so numerous that they were further sorted into sub-categories in accordance with a preliminary understanding of the information needs of the each of the County agencies interviewed. Using the examples of the assembled information products, representatives of the following five County agencies were interviewed: Assessor, Engineer, Health Department, Planning Department, and Sheriff.

In general, it was found that the County uses earth and soil science information in both daily operations and in long-range planning. In daily operations, the need for an analysis and decision is so urgent that there usually is no time for detailed consideration of a new application of earth and soil science information. For example, the Assessor's Office gets daily requests for new assessments or evaluation of property recently subdivided; the Health Department is required to make a recommendation on the location of a proposed new landfill; the Planning Department is asked for technical review of a proposed new residential subdivision. These are examples of day-by-day County operations which ought to have input from earth and soil science information. Long-range planning uses of earth and soil science information are primarily those activities undertaken in support of the Larimer County Comprehensive Plan.

Of the seven major categories of earth and soil science information products considered in this study, all were needed and used by County government (table 6). Information-supplying organizations include those at Federal, State, and local governmental levels, and private industry. Adequacy of the specific products presented by USGS and SCS ranged from

Table 6

Summary of Use of Earth and Soil Science Information Products by Larimer County Government Departments

	Earth and Soil Science Information Products						
	A. Topographic Maps	B. Air Photos and Photomaps	C. Geodetic Data	D. Geologic Maps and Reports	E. Soils Maps and Reports	F. Water Data and Reports	G. Land Use and Cover Maps
1. Information Needed & Used	X	X	X	X	X	X	X
2. Present Sources of Information	GS*	PC GS* LC	PC	GS PC CGS	SCS PC	GS SCS LC	LC GS**
3. Adequacy of USGS/ SCS Information for present Needs	1	2	3	2	1	2	3

Explanation

GS = U.S. Geological Survey
SCS = U.S. Soil Conservation Service
CGS = Colorado Geological Survey
LC = Larimer County Government
PC = Private consultant or industry

X = Information needed and used, whether or not supplied by USGS and SCS

1 = Adequate
2 = Partially or marginally adequate
3 = Not adequate

*in cooperation with Colorado Department of Local Affairs

**Topographic maps only

"adequate" for USGS topographic maps and the SCS Soil Survey; to "marginally adequate" for aerial photo products, geologic information, and water resources data; to "not adequate" for geodetic data and land use and cover maps. Details for the specific information categories follow.

Topographic Maps: The USGS 7½-minute quadrangle maps are used widely throughout County government, both as a direct source of land information and as a plotting base for a variety of other information. The topographic maps constitute the only data base presented by the two Federal agencies that has complete coverage for the entire County at the same scale, and which is suitable for basic applications in all County agencies surveyed. Though the County now has some larger-scale planimetric maps for plotting locations of new developments, the need still exists for the basic 1:24,000-scale topographic quadrangle maps. The USGS/Colorado Department of Local Affairs County Map Series (scale 1:50,000) is becoming increasingly popular for a variety of uses in County government. County officials report that they expect such information to be adequate for needs in the near future, as well. A number of users reported that they would like to have clear designation of section lines on the topographic maps. Other thematic material, such as land use information in the mountainous portion of the County, was extracted directly from topographic map bases and field-checked. These needs for separate thematic information suggest that, in the future, County users may be able to benefit from topographic map component themes presented in digital form. The County's extraction of land use and land cover data from topographic maps, while not an ideal method, represents the County's lack of any other more-suitable land use base data.

Aerial Photographs and Photomaps: Larimer County's new mapping program, under the direction of the Assessor's Office, uses aerial photographs at a contact (negative) scale of 1:12,000. Such photographs are obtained by contracting with private industry. For the less-detailed requirements of the Planning Department, smaller-scale aerial photographs, obtained once each year, would suffice. USGS experience indicates that good-quality aerial photographs at contact scales ranging from 1:80,000 to 1:120,000 might be suitable for mapping land use at a scale of 1:24,000. Considerable cost savings would result from the use of smaller-scale aerial photography; a 9 x 9-inch aerial photograph at 1:120,000 scale covers 291 square miles, an area 100 times that covered by a photograph at 1:12,000 scale. In the future, it seems that the County will require aerial photographs at different scales for different purposes; some requirements might be met by photographs obtained by other agencies. Better knowledge by County officials of the availability or scheduling of such photography might also result in cost-saving through sharing of data. Photomaps and/or images made from satellite data at scales from 1:50,000 to 1:250,000 seem to have only marginal use at present within County government.

Geodetic Data: The County had a requirement for detailed geodetic data at the time the mapping program under the direction of the Assessor's Office was initiated. The USGS and National Geodetic Survey control data were not sufficiently detailed for County needs, and therefore the County contracted with private industry to provide the needed data for mapping control.

Geologic Maps and Reports: Geologic maps and reports have widespread use in a number of County government departments. These departments need, for example, information on potential recoverable minerals, to establish land valuation; surficial geologic information, to assess land suitability for various uses; surficial information, to evaluate dispersion of hazardous wastes; and geologic information, to assess the potential for loss from landslides, land subsidence, swelling clay, earthquakes, and other geologic hazards. USGS geologic quadrangle maps, at a scale of 1:24,000, are satisfactory sources of much of the needed information. However, only four out of a total of fifty-seven Larimer County quadrangles had been published at the time of this study. Colorado Geological Survey has provided surficial geologic maps for the purpose of establishing locations of sand and gravel deposits and other mineral deposits that have significant economic or strategic value. For the detailed geologic information requirements of the Larimer County Comprehensive Plan, maps prepared by private consulting firms at a scale of 1:24,000 have been used. These maps draw upon whatever sources of geologic information are available, and in some cases require new fieldwork for filling in details.

Soils Maps and Reports: Soils maps are used by County departments to help establish value of agricultural lands; to provide land suitability status for engineering, construction, and other non-agricultural uses of the land; and for input to the County Comprehensive Plan. The Soil Survey for all non-public lands of Larimer County was published during the period of the present study. Information from the Soil Conservation Service has been the primary source of soils information for Larimer County. Where more detail is required, for example in individual site assessments for roads or engineering purposes, private contractors have been used as a source of soils information. In many cases, boreholes are needed to verify soil conditions to comply with County requirements for information.

Water Data and Reports: The County depends upon a variety of sources for water data. The Assessor's Office uses water availability information in assigning valuation to certain land parcels. The County Engineer needs data on expected flood heights for bridges and other design requirements. The Planning Department uses a variety of water-data sources for assessing potential water supply, assessing the impact of recent development on downstream flow, and for developing plans for mitigating flood hazards. The Health Department has had increasing needs for detailed water-quality data to assess the effects of hazardous substances in the ground and surface waters.

The County receives stream-gauging data, water-quality data, and other standard data from USGS sources. The County also receives snow-survey data provided during the winter months by SCS. It appears that neither of these standard Federal agency sources is sufficient for the needs of the County for water data. Several other sources are sought, including the County's own data-collection program. The information is particularly lacking in the mountain areas, for example in estimating infiltration from septic systems. Also, the aquifers in the granitic and metamorphic terrain of the mountains are more irregular in distribution and reservoir behavior, and require more-detailed studies than are generally available at present.

It seems that there is a need for additional information by County government on water quantity and quality, both for present and future uses. It may be that some of the needed information could be provided by improved communication among data-producing sources, water-data information systems, and the various agencies of County government. In other cases, new data sources will be required.

Land Use and Land Cover Maps: Several County functions make use of land use and land cover maps as a source of information on the geographic distribution of factors that affect land value, impacts of a proposed change on other areas, and correspondence of proposed land use changes to the County Comprehensive Plan. Information on land use and land cover is available for Larimer County from both USGS and SCS. However, the maps are generally at too small a scale for the uses required by the County government. Therefore, other sources have been sought. The USGS topographic map series has been a source of information on land use and land cover in the mountains. However, because of the variation in dates of photographic source material for those maps, all such designations had to be field-checked by County personnel.

For the area of largest population and most developmental activity, the southeastern portion of the County, the County Planning Department has compiled a land use map at a scale of 1:24,000. They have not, however, been able to keep the map updated to the extent that they would like, because of staff limitations and a wide variety of other, more-urgent tasks that must be performed. Apparently the computerized land use data file compiled by the Larimer-Weld Regional Council of Governments does not satisfy Larimer County government requirements (Larimer-Weld Regional Council of Governments, 1977). Because of inadequate available information, land use and land cover data constitute a topic for further investigation to better meet the future needs of Larimer County.

Driving Forces

The driving forces behind the needs for earth and soil science information in County government include legislative and regulatory mandates and certain other, less easily defined forces growing from the desire of citizens and public servants alike to make the County's development as environmentally sound as possible.

Federal and State Laws: Several Federal laws were identified as being important in information requirements at the level of county government (page 29). The Reagan Administration's change in emphasis will certainly reduce the importance of these Federal laws as driving forces for local government information requirements, as has already happened with the phasing-out of the HUD "701" programs and the EPA "208" programs.

The State of Colorado has enacted a number of laws in recent years which directly or indirectly have affected local government information requirements. House Bill 1089, stating the assessors' mapping requirements, has already been mentioned (page 16), as has House Bill 1034,

known as the "local government land use control enabling act" of 1974 (page 28). The Colorado Geological Survey calls House Bill 1034 "perhaps the broadest statement of local government's authority to control development in geologically-hazardous areas" (Shelton and Prouty, 1979, p. 72). In the same document, Shelton and Prouty summarize four additional laws affecting local government's information requirements (ibid.):

> "Senate Bill 35 (1972)....requires that all proposed developments of land in unincorporated areas dividing property into two or more parcels shall be accompanied by reports on the geologic characteristics significantly affecting the proposed land use....(and) on proposed subdivisions... (Senate Bill 35) also requires: (1) reports concerning streams, lakes, topography, and vegetation; (2) evaluations of potential radiation hazards; (3) maps and tables concerning the suitability of types of soil in a proposed subdivision; (4) adequate evidence that a water supply that is sufficient in terms of quality, quantity, and dependability will be available to insure an adequate supply of water for the type of subdivision proposed; and (5) evidence of adequate sewage-disposal conditions.
>
> "House Bill 1529 (1973).....commonly known as the sand and gravel bill,....(provides local officials powers to regulate development that would preclude extraction of minerals having)...significant economic or strategic value to the area, state, or nation...(House Bill 1529) also requires local governments to adopt a master plan for the extraction of commercial mineral deposits.
>
> "House Bill 1041 (1974)....(encourages local governments to designate areas and activities of "state interest", including) geologic hazards such as avalanches, landslides, rockfalls, mudflows, debris fans, unstable or potentially unstable slopes, seismic effects, radioactivity, ground subsidence, and expansive soil and rocks. The law requires the Colorado Geological Survey to assist local governments in identifying, designating, and adopting guidelines for the administration of such areas of state interest. The law states that, in geologic hazard areas, all development shall be engineered and administered in such a manner as will minimize significant hazard to public health and safety, or to property, due to geologic hazards. Similarly, mineral resource areas...shall be protected and administered in such a manner as to permit the extraction and exploration of minerals therefrom, unless extraction and exploration would cause significant danger to public health and safety.
>
> "House Bill 1574 (1974) requires that all geologic reports prepared for governmental review must be prepared by a professional geologist. A professional geologist is defined as an individual with at least 30 semester hours of geologic education and 5 years of experience."

A detailed volume of guidelines for the use of local government has been prepared by the Colorado Geological Survey (Rogers and others, 1974). In addition, workshops and conferences have been held in various parts of

the State to publicize and further explain the implications of House Bill 1041, insofar as it pertains to geologic hazards and mineral resource areas. An example of these is a series of conferences, convened by the Governor, to bring together geological experts and representatives of local governments who administer the programs (e.g. Shelton, 1977).

The County Comprehensive Plan: At the level of Larimer County government, many of the above laws are translated into specific guidelines and operational procedures, which are reflected in the preceding section of this report. In addition, a primary driving force for obtaining land resource information (as well as many other kinds of information) is the Larimer County Comprehensive Plan. Its goals and objectives can best be conveyed by the following excerpt from the document setting forth those goals at the beginning of the Plan's development (Larimer County, November 1974, p. 1):

> "The lack of effective guidelines or plans for future development generally leads to the following patterns: small towns become medium cities; rural areas become suburbs; farms become shopping centers, and cities become part of a sprawling megalopolis. Without an effective land use policy plan, there is no reason to expect that the same pattern won't be repeated in Larimer County. If positive steps are not taken now, the choice of what type of environment we want to live in will be lost under the increasing pressures for development from every corner of the County.
>
> "At the same time, continued urban growth seems desirable to many of our residents, especially when such growth helps to provide increases in income, employment, and the tax base.
>
> "Some may think that the only solution to this dilemma is to stop all growth. Others may think the only solution is to drop all governmental controls of land use. However, based upon available information and a great deal of open, public discussion, we think that a more logical, rational approach is not only available, but also more popular. We do not believe that stopping all growth would be a viable or even a legal remedy; growth is vitally necessary to the economy and well-being of Larimer County. At the same time, we recognize the need to strongly regulate and control growth in a manner that will preserve the various existing life styles and amenities presently offered in Larimer County.
>
> "To this end, Larimer County has begun to develop a comprehensive land use plan."

At the outset, goals and objectives of the Comprehensive Plan were stated in broad terms, under the following headings:

A. URBAN DEVELOPMENT AND HOUSING
   1. Urban Development
   2. Housing

B. SUPPORT SYSTEMS
   1. Transportation
   2. Domestic Water and Sanitation
   3. Power, Communication, and Natural Gas
   4. Emergency Protection
   5. Education

C. RESOURCES AND ENVIRONMENT
   1. Natural Resources
      a. General
      b. Agricultural Land
      c. Development in Rural Areas
      d. Water Resources
   2. The Environment
      a. Environmental Constraints
      b. Environmental Concerns
      c. Open Space

D. SOCIO-CULTURAL AND ECONOMIC CONDITIONS

Under almost every heading there are implications for earth and soil science information requirements; although also for biological, engineering, socioeconomic, aesthetic, and other kinds of information needed to meet the County's goals. Just one example, goals and objectives for "urban development," is cited (ibid, p. 3):

"GOAL: All new development should be located in areas suitable for such development in terms of the environment, economic feasibility of providing daily necessities, availability and efficiency of support systems, aesthetics, community identity, natural resources, public health, safety and welfare, the character of existing development in the area, and the overall plan for the area.

OBJECTIVE: Proposals for new urban development must be reviewed for their potential short-term and long-term impact upon the future of Larimer County and its residents.

OBJECTIVE: New urban development outside of and not contiguous to municipalities should be restricted to modes which are suitable for urban development as defined in the goal statements of this plan.

GOAL: New Development should pay its own way.

OBJECTIVE: Provide mechanisms whereby new urban development pays for the additional costs associated with those services demanded by the new development. These services may include but are not limited to police and fire protection, school site acquisition, school construction, increased road

maintenance, road construction or expansion, emergency service, the extension of utility lines, and the increased demand or need for open space and other services provided by local government."

The details of the plan implementation are spelled out in later documents, particularly the one describing the land use element (Larimer County, 1978). The documents describing and supporting the Larimer County Comprehensive Plan provide to the non-planner a vivid demonstration of the interdisciplinary nature of the use of scientific information in the land use planning and management processes.

Citizen Pressure: It was recognized in the Memorandum of Understanding that citizen pressures might be driving forces which would indirectly or directly result in the demand for more earth and soil science information. Such pressures are probably felt most strongly by the County Commissioners, who are elected officials. Though it was beyond the scope of the study team's efforts to document such pressures, it was possible to obtain an indication of land resource and environmental issues that are important to the general public. This was done by monitoring all daily and Sunday issues of the principal local newspaper, the Fort Collins Coloradoan, for a period of 4 months.

The items selected were those covering natural resources, environmental management, natural hazards, and land use issues including, for example, growth management, wilderness, agriculture, transportation, historic preservation, recreation, and a variety of issues concerning land use planning. A news item was classified according to whether it referred to a "local" issue involving Larimer County, or a "State" issue in Colorado outside of Larimer County. The results of the survey are summarized in table 7.

During the course of the newspaper monitoring period, a major local election was held in the City of Fort Collins. One of the principal issues was a growth-management plan, in which new housing permits for single-family dwellings would be limited to 750 in any given year. The Fort Collins growth-management proposal was connected in news items with a similar plan that had recently been voted into law in Boulder, 45 miles to the south. The Boulder law, known as the "Danish Plan" after Councilman Paul Danish, its author, was enacted with a considerable amount of publicity associating the plan with issues of responsible land use planning, unfavorable and costly environmental consequences of unlimited growth, costs of sprawl, and other issues which translate into an increased need for scientific information in the administration of such a law. Such publicity reached Larimer County, and for this reason the election coverage was classified as a land use issue. Candidates took positions for or against the law. The Fort Collins growth-management scheme was defeated by a margin to 2 to 1.

Among the resource and environmental issues summarized in table 7, land use issues are clearly in the lead, whether or not the large amount of coverage generated by the local election is included. Also it is seen that these issues are primarily local rather than State issues, as are resource

Table 7

Coverage of Environmental and Resource Management Issues in the Fort Collins Coloradoan[1]

Resource Supply and Management Issues	News Coverage in Thousands of Square Centimeters		
	Local[2]	State	Total
Solar Energy	1.5	---	1.5
Other Energy Resources	2.4	1.6	4.0
Water Resources	9.7	4.0	13.7
Recycling	0.3	---	0.3
Total Resource Supply:	13.9	5.6	19.5
Hazards			
Water/Land Pollution	1.6	0.8	2.4
Air Pollution	0.8	1.6	2.4
Radiation	0.2	2.7	2.9
Earthquake	---	0.1	0.1
Landslide	---	0.5	0.5
Miscellaneous	0.7	---	0.7
Total Hazards:	3.3	5.7	9.0
Land Use Issues			
Transportation	7.8	0.1	7.9
Local Election[3]	23.5	---	23.5
General Land Use Issues[4]	46.2	2.7	48.9
Total Land Use:	77.5	2.8	80.3
TOTAL ALL ISSUES:	94.7	14.1	108.8

[1] February 23 - June 17, 1979 (1 page = 1.8 thousand cm^2)

[2] Fort Collins and Larimer County

[3] Primarily land use concerns

[4] Planning and management, growth control, recreation, wilderness, agriculture, zoning, etc.

supply and management issues. On the other hand, the issue of natural hazards received more coverage from sources outside Larimer County than within.

It would be interesting to further trace the content of these news items to implications for the providers and users of land resource information. An item of "land use" interest does not translate directly into a need for land use information. In many cases one of the other topics--water resources, pollution, transportation--was presented in such a way that the relationship to a land use decision was clear. Therefore, even more than indicated by table 7, the issue of land use is a central and "integrating" one for local government. Many different specialized types of earth and soil science information, as well as other information, can be useful inputs to the land use decisionmaking process. Data and maps on land use can be used to monitor the results of the overall process, and the extent to which the Comprehensive Plan is being followed. Although data-producing agencies have made attempts to "integrate" data categories from different disciplines, for the most part the integration task falls to the Planning Department staff, and later to the County Commissioners.

Modifications of Existing Information

Task 2: Determine what modifications of existing information might be made to meet user needs in a more effective manner, and make recommendations to this effect.

County staff members recommended five categories of modifications that might be made on existing information products: publish available unpublished information, produce coordinated map folios, increase detail and currency of land use information, improve bibliographies and indexes, and provide more interpretation for non-specialist planners to accompany geologic and soils maps and associated earth and soil science information.

Publication of the Larimer County Soil Survey

For some time prior to the beginning of this study, the Larimer County Soil Survey had been completed but unpublished. Single copies of the maps had to be consulted either in the offices of the County Planning Department or the Soil Conservation Service. The study provided a forum for communicating back to the Department of Agriculture that the Survey would be of much greater value if published and made widely available throughout the County. As a result, the publication schedules were advanced, and the completed Soil Survey was published and presented to the Larimer County Commissioners.

Folios of Topographic, Soils, and Geology Maps

Commenting on the wide variety of map scales and coverages in the materials presented for evaluations, County officials suggested that they could benefit from having a new and coordinated set of maps combining earth and soil science information. Some sort of map folio format was envisioned,

in which topographic, geologic, soils, and land use maps would be produced at a scale of 1:24,000 following standard cartographic procedures. The folios could consist of loose-leaf sheets, with the initial package of maps consisting of the 12 highest-priority quadrangles covering the most rapidly developing section in southeast Larimer County (fig. 3). This priority area also coincides with the urban core area as defined by the Larimer-Weld Regional Council of Governments in its "208" water quality planning study (fig. 4). Benefits might accrue to Larimer County if all interested parties are included in map planning.

Detailed and Current Land Use Information

The County needs more detailed and current land use and land cover information than presently provided by any agency. Both USGS and SCS have relevant source materials (aerial photographs, thematic data from topographic maps, agricultural information), as does County government (prior maps, assessment records, building permit files, aerial photographs), but for whatever reason, these various source materials have not been put together into a readily usable land use information system to support the County planning and decisionmaking process. It seems likely that a more workable system than that now in operation might result from a coordinated effort on the problem, by appropriate, technically qualified people from concerned agencies.

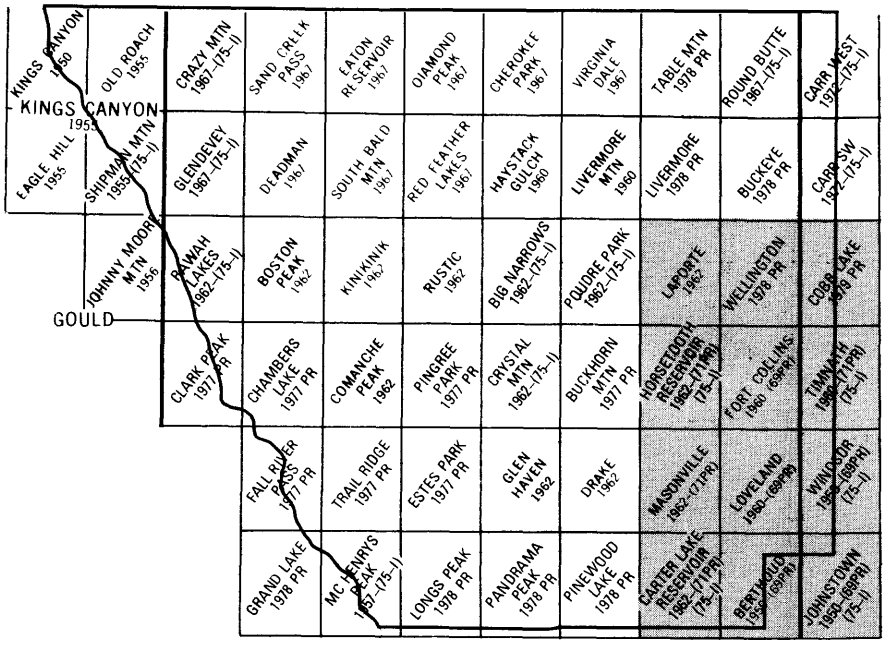
The County's land use classification system is based upon the Standard Land Use Coding Manual, which carries residential, commercial, and industrial classes to considerable detail. The USGS system, on the other hand, is based on remote sensing and is incapable of reaching the detail possible in the other system, but is more economical when applied to large areas. A common ground for carrying on further discussions might be the kinds of computerized information systems that are coming into wider use and that will probably be an essential part of the County's operations in the near future. Both USGS and Larimer County have had experience in working with such systems, and both might benefit from further discussions of Larimer County's land use information problems.

Improved Bibliographic Information

The diversity of information types, sources, and publication formats led to recommendations that bibliographic and indexing services be improved. All USGS bibliographies and reference materials to information sources within USGS were praised by the County government reviewers, but such materials do not go far enough. One suggestion was to include in bibliographic references a small index map, showing the specific locations within Larimer County referred to in the map or report. No such general reference aid is in widespread use. The Larimer County Planning Department has prepared a modest bibliography of references important to the Department's operations, containing such a map indexing system along with a brief annotation in terms meaningful to the planners (Smith, 1974). A specimen page from that bibliography is shown in fig. 5.

Figure 3

Index to Larimer County 7½-minute quadrangles



12 quadrangles of highest priority for consolidated earth and soil science map coverage

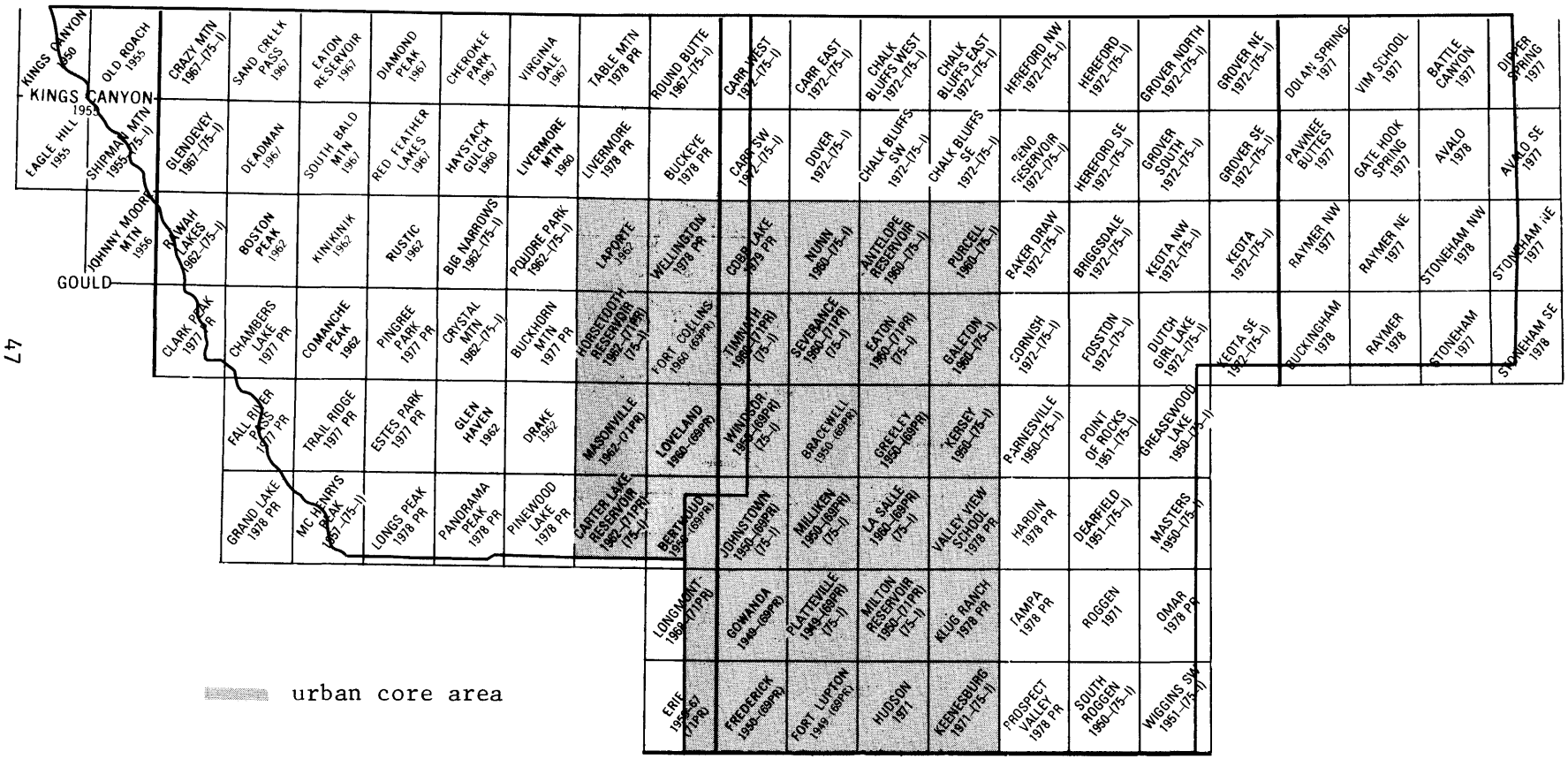


Figure 4

Larimer-Weld Regional Council of Governments, Urban Core Area, Quadrangle Index

Source: Larimer-Weld Regional Council of Governments, 1977

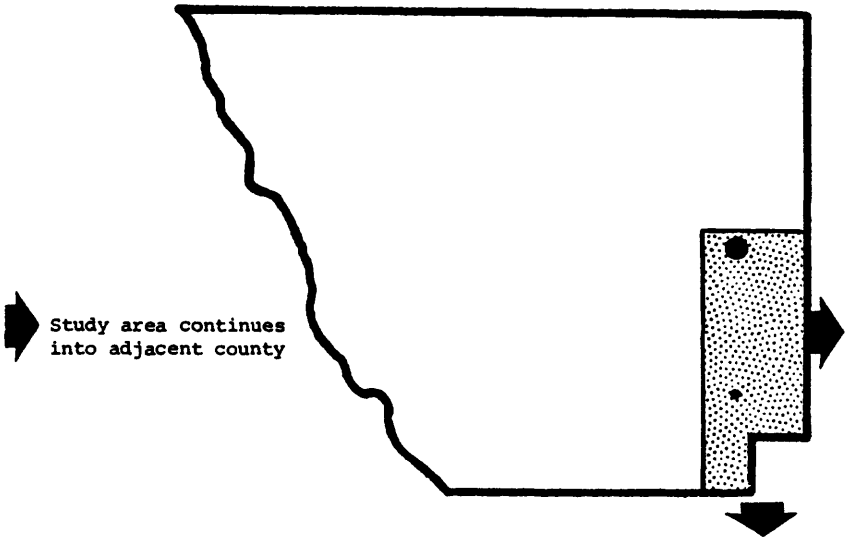
Figure 5

Specimen Page from Larimer County Research Bibliography

Ficke, John F. and T.W. Danielson. Front Range Urban Corridor - Environmental Geologic and Hydrologic Studies - Lakes in Boulder, Fort Collins, and Greeley Area. 1973.
This map indicates the physical, chemical and biological characteristics of approximately 280 lakes in the Boulder - Fort Collins - Greeley Area. The map covers portions of Larimer - Weld and Boulder Counties of the northern 1/3 of the Front Range Urban Corridor. The report presents information assembled for the purpose of providing aid in planning the use of lakes in this area of rapid growth. The report includes lake size and water quality data. An index of lakes and their location is provided.

SCALE: 1:100,000

Mapped area shown below.



Source: Smith, 1974

Map Interpretation for Non-Specialist Planners

A recurrent lesson learned from this and other studies of earth science information transfer is the need for a "translation" or "interpretation" function between the map or research reports produced by the earth and soil science professionals and the non-scientist decisionmakers who apply the information at local government levels. Larimer County planners recommended that such "interpreted" maps be made available so that a map user could readily identify each geographic area according to its suitability for various land uses. Geologists often call such maps "derivative" maps. An example of a scheme for translating geological map information is given in Appendix C, taken from the legend of one of the 1:24,000-scale maps already available to the County (Empire Laboratories, Inc., 1978). However, the maps presently available are not consistent in their level of interpretation, nor do they cover all the areas of the County where such information is needed.

Further Interagency Cooperation

Task 3: Consider developing capabilities of the two Federal agencies in areas related to land use planning and decisionmaking (such as land use and land cover mapping, map digitization, computer compositing) and make recommendations for the use of appropriate tools in a cooperative program among Larimer County, the SCS, and the USGS to increase the effectiveness of planning and decisionmaking at local government levels.

Further interagency cooperation to increase the effectiveness of County planning and land use decisionmaking might take two different forms: making the liaison and coordination functions operational, and sharing in the research and development of map-making and data-handling technology. Both of these concepts might beneficially be tested in a follow-on demonstration, using Larimer County as a test case.

Continuing Liaison and Coordination

Because of the major areas of overlapping concerns, it is recommended that continuing and permanent liaison and coordination arrangements be maintained among SCS, USGS, and county governments to facilitate application of shared information resources to the improvement of land use decisionmaking. The Soil Conservation Service already has such arrangements, which were built into its way of doing business from the beginning. This recommendation, then, applies primarily to the USGS, which could improve the relevance of its information programs at the county level by further utilizing the existing SCS channels, and others.

This recommendation does not necessarily mean continuing indefinitely the kind of study team that was brought together for the present study. The USGS will certainly not have such a study for 3,000 counties. Rather, a process that utilizes and strengthens existing communication channels is to be preferred. For example, USGS presently coordinates with several State of Colorado officers, including the State Geologist, State Cartographer,

and the State Water Engineer. A small additional function could be built into such coordination to specifically address the needs of county government for resource information in support of land use decisionmaking, as identified in this study and elsewhere. Channels for communication of information needs and other concerns of county government could be provided. Other state officials might be added as appropriate. Perhaps the notion of a "citizens' advisory committee," which Kockelman found useful in the San Francisco Bay Study, could be adapted to the needs of counties in Colorado and elsewhere (page 3 above). This recommendation is more in the nature of procedural changes than adding new programs; conceivably the job could be done by slight shifts in assignments of the agencies' existing staffs, provided that responsibility for maintaining communication is fixed.

Mapping and Data-Handling Technology

A number of data-gathering, data-handling, and map-making technologies are available which have the potential for time and cost saving in the handling of earth and soil science information at county government level. Examples are multispectral remote sensing; raster scanning and a host of other map digitizing techniques; digital cartography; digital ground-water modeling; and integrated geographic information systems that incorporate data capture, analysis, communication, and display. Some of these technologies are in place and functioning in some county, state, and Federal government operations. But the array of potential technological improvements has not been thoroughly evaluated for applications in Larimer County, or probably in any other county.

Many program managers prefer to have a "total system," involving one or more of the above technologies, under their control. However, at present not many program managers at local, state, or Federal government levels can afford the necessary investment. Therefore, it is likely that long-range benefits will accrue to those managers who learn to cooperate and share portions of the needed systems in a creative way. Such cooperation can be beneficial, both across the Federal-State-local hierarchy and among departments within county government.

County needs place two opposing types of requirements on the land resource information-handling system. First, the system must handle increasing quantities of information as the county grows; and second, the speed of data-handling must be increased to meet the deadlines of the development review process. County technical staff is overloaded with the short-deadline tasks, and has little time left for paying attention to longer-range needs. But these longer-range needs are likely to be similar to those of other counties. Furthermore, there is a rapid turnover in technical planning staff in county government, and thus it is difficult to maintain continuity in program expertise. The above-mentioned parameters are among those which would govern the assessment of appropriate technology. A cooperative technology review program among the three cooperating agencies of this study, augmented by the appropriate State agencies, would be a useful component of a follow-on study. It is quite possible that assistance could be provided by other organizations such as Colorado Counties, Inc., and National Association of Counties.

Needs for New Information

Task 4: Determine what new hydrologic, earth, and soil science information, if any, may be needed to help resolve land use problems in Larimer County.

As discussed in the preceding two sections, many of Larimer County's information needs could be met by expanding the coverage or detail of information products similar to those already produced by the two Federal agencies. In this section several products, new or significantly different from those now being produced, are listed.

One of Larimer County's needs for new information is being met by the new mapping program under development in the Assessor's Office (pages 16, 17, and 36). Three sets of large-scale maps, required by the Assessor's Office through the provisions of House Bill 1089, 1976, are being prepared. The scales of these maps are 1:1,200; 1:2,400; and 1:14,400. Production of such maps was beyond the missions of either USGS or SCS, although USGS mapping specialists demonstrated how enlargements of film positive separates of the standard 1:24,000 map series could be used in preparation of the 1:14,400 maps.

Detailed surficial geologic maps, interpreted to indicate several categories of land use suitability, would be useful to the generalist planners, as discussed in the preceding section. Such maps could assist in developing more rapid procedures for evaluation of subdivision or zoning applications, in conformance with the Comprehensive Plan.

New information is needed on subsurface geology and soils, and groundwater hydrology in the mountains, where bedrock consists of igneous and metamorphic rocks. In most cases, existing surficial geologic information in those areas is not sufficient for evaluation of proposed septic fields, aquifers, and for other purposes.

Another category of information that would be useful to planners is more detailed information on water use. A USGS/State Engineer program to provide such information has been reduced because of funding cutbacks.

Water use information helps make more accurate estimates of the sufficiency of water supplies for growing populations.

Another kind of information needed, particularly by the County Health Department, concerns the permeability of the near-surface formations in the vicinity of existing and abandoned landfills. Horizontal migration of methane gas which accumulates in the vicinity of solid-waste deposits is a serious concern, having caused explosions and even deaths in the Denver metropolitan area. Very detailed subsurface information is needed to detect, chart, and remove such methane accumulations. Poisonous leachates, also from old landfills or hazardous waste dumps, can infiltrate surface- or ground-water supplies. Detailed permeability information, presently nonexistent or inadequate, is also needed to alleviate this hazard.

Recommendations for a Follow-On Program

Task 5: Prepare a report setting forth the findings resulting from the above tasks. If a cooperative program is deemed worthwhile, the study team should also formulate a design which would serve as a proposal in seeking the necessary support for such an effort.

This report completes the requirement of Task 5, setting forth the findings of the study team. The recommendation of the study team, transmitted via this report to the Larimer County Commissioners, and to administrators of SCS and USGS, is that a further cooperative effort be undertaken to improve the availability and effectiveness of earth and soil science information in Larimer County.

There are several reasons for recommending a follow-on effort at this time. Larimer County has for several decades been the site of rapid population growth, which is likely to continue until past the year 2000 at rates exceeding the national average. There is good likelihood that under such circumstances an improved program of earth and soil science information transfer could result in substantial benefits for the County, measured in terms of a greater satisfaction in Larimer County as a place to live and work, better health and safety of its citizens, and monetary savings to County government and citizens resulting from more economically-sound land use decisions.

Another reason for recommending a follow-on study is that the County Planning Department has recently undertaken a major new initiative to upgrade planning operations, in response to rapid population growth and other related trends (Larimer County Planning Department, 1982). Several aspects of the new effort involve or imply improving systematic access to a variety of information sources, including earth and soil science information. For example, an expandable "data dictionary" to be prepared by the Comprehensive Planning Section would provide a uniform format and central index of known data, available both for in-house use and by the public. This new effort increases the likelihood of beneficial results from further specific cooperation with USGS and SCS.

Also, further cooperative effort at this time would be useful in assessing the impacts of recent cutbacks in Federal programs that have been sources of information in the past for county governments. A follow-on study, building upon the base of cooperation already achieved, could provide indications useful at all levels of government, as to the effects of shifts in many responsibilities from Federal to State and local government.

A first step in a follow-on cooperative effort was a request from Larimer County to USGS and SCS, following the unanimous endorsement by the Board of County Commissioners on July 12, 1982. Designated representatives of the three bodies could jointly prepare the outlines of a proposal, specifying the effort's scope, content, and possible means of support. Based upon the results of this study, the highest-priority components of a follow-on study would include the following items:

1. Continuing Interagency Liaison and Coordination: Methods for continuing and making permanent a liaison and technical communication arrangement among County government, SCS, and USGS, including appropriate State government offices.

2. Improved Bibliographies and Indexes: Special reference aids to available USGS and SCS information, keyed to County needs and geographic location within the County.

3. Improved Interpretation of Earth and Soil Science Information: Additional derivative or "translated" maps in which the scientific information elements are interpreted in terms of general suitability for various land uses, or for assessments of natural resources and hazards.

4. Coordinated Map Folios for Geology, Soils, Topography, Slope, and Land Use Maps: Presentation of basic map data at 1:24,000 scale, with priority given to quadrangles representing rapid-growth areas.

5. Cooperative Land Use Data Program: Multi-agency attack on the County's urgent need for land use maps at 1:24,000 scale, quantified as to area covered, and updated annually.

* * * * * *

From the viewpoint of Larimer County, a follow-on effort to the present study has the potential of reaping future benefits from improved information about the land and water resource base. In mid-1982 the County Planning Department initiated a 2-year work program to upgrade its land resource data base and to make it more usable for public decisionmaking. From the viewpoints of USGS and SCS, a follow-on effort could aid in planning future information programs, so as to increase their usefulness to local governments.

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Larimer County, Colorado, 1978, Larimer County Land Use Plan: An element of the Comprehensive Plan: Larimer County Planning Department, Fort Collins, Colorado. 152 p.

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Larimer-Weld Regional Council of Governments, 1977, Larimer-Weld region land use alternatives: Analysis of 20-year growth demands and impacts: Prepared for U.S. Environmental Protection Agency, Region VIII, Denver, Colorado. 208 Areawide water quality management plan. 295 p.

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Shelton, David C., editor, 1977, Proceedings, Governor's Third Conference on Environmental Geology, Aspen, Colorado, September 25-26, 1975: Special Publication 8, Geologic factors in land-use planning, House Bill 1041. Colorado Geological Survey, Denver, Colorado. 111 p.

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U.S. Geological Survey, 1979, Storm and flood of July 31-August 1, 1976, in the Big Thompson River and Cache la Poudre River basins, Larimer and Weld Counties, Colorado: USGS Professional Paper 1115. U.S. Government Printing Office, Washington. 152 p.

page 57 follows

MEMORANDUM OF UNDERSTANDING

Subject: Agreement of Larimer County, Colorado; the Soil Conservation Service, U.S. Department of Agriculture; and the Geological Survey, U.S. Department of the Interior for the conduct of a cooperative project entitled: "A Study to explore the desirability and feasibility of undertaking a Larimer County, Colorado-SCS-USGS program to maximize effective use of earth and soil science for planning and decisionmaking at local government levels."

This Memorandum of Understanding hereby approves the assignment of up to two man months of effort, together with supporting funds for travel, clerical services, and essential supplies, from each of the three cooperating agencies for the purpose of conducting the subject study described in the attached document.

Chairman, Board of Commissioners, Larimer County, Colorado

LIA Office, Geological Survey
U.S. Department of the Interior

State Conservationist,
Soil Conservation Service
U.S. Department of Agriculture

Attachment

Date: January 1, 1979

A STUDY
to explore the desirability and feasibility of undertaking
A LARIMER COUNTY, COLORADO-SCS-USGS PROGRAM
to maximize the effective use of Earth and Soil Science
for Land Use Planning

Introduction

The topographic maps of the U.S. Geological Survey (USGS) and the soil survey maps and reports of the Soil Conservation Service (SCS) have long been the standard information sources used by planners and decision-makers confronted with the need for preparing land use plans. With the escalation in recent years of both energy problems and environmental concerns, the need has arisen for more and better land use planning, particularly in areas of urbanization. That need has increased the pressure on planners to extract as much information as possible from these basic information sources and to supplement it with any other available earth and soil science data supplied by these and other agencies.

These same needs and pressures, greatly amplified by the rapidly increasing number of planners throughout the country that must face them, make it incumbent on federal agencies to be constantly alert to the changing requirements of this new user community, and to explore continously any meaningful new ways in which their information can be prepared, packaged, and transferred in the best interest of the recipients.

Larimer County, Colorado, provides a particularly appropriate site for such a study for a number of reasons, among them:

- As a part of the Colorado Front Range urban corridor and the site of Fort Collins, Colorado, the County is experiencing

strong urbanizing and other developmental pressures.

- o There is great diversity in the County of soils, rock types, physiography, hydrology, climate, and other natural features having a direct bearing on land planning and use.
- o The eastern part of the County borders on one of the most productive agricultural areas in the nation; whereas the mountains in the western part are subject to heavy pressures for recreation, forestry, and tourism.
- o Problems of natural hazards (landslides, floods, shrink-swell clays) and resource needs (sand and gravel, irrigation water) make it particularly important that earth and soil science be properly taken into account in the County decisionmaking process.

Purpose

The purpose of this study is to assess and provide a report on the desirability of instituting a Larimer County, Colorado - SCS-USGS program to supply and bring about the effective use of hydrologic data and earth and soil science information for planning and decisionmaking at local government levels.

Scope

The study team will investigate: (1) the current and anticipated needs for hydrologic, earth, and soil science information for land use and other local government decisionmaking purposes in Larimer County, Colorado and (2) the experience, problems, and benefits to the County in attempting to use available information of this nature to meet the needs.

The team will also give consideration to: (a) the current capabilities of the SCS and USGS to provide information and data to meet the needs of the County; and (b) how resources might be used in a continuing program involving Larimer County, the SCS, and the USGS.

Members of the study team will keep other agencies and interested groups advised of their activities and will actively seek, from appropriate representatives of such groups, advice and counsel pertinent to their task. It is appreciated that numerous other agencies and institutions--operating at federal, state, and local levels--play essential roles in providing information and making other contributions to the land use planning processes of Larimer County. The narrow focus adopted for this "pilot" study has been chosen with no intent to minimize the importance of other critical components of the total planning and decisionmaking system, but rather to simplify the initial task by emphasizing that part of the system which falls within the areas of responsibility of the USGS and SCS.

Feasibility Study Tasks

The study team will:

- o assess the specific needs of local government for hydrologic, earth, and soil science information, and the driving forces behind such needs, such as laws and regulations, limited resources, natural hazards, and citizen pressure;
- o determine what modifications of existing information might be made to meet user needs in a more effective manner, and make recommendations to this effect;

- o consider developing capabilities of the two federal agencies in areas related to land use planning and decisionmaking (such as land use and land cover mapping, map digitization, computer compositing) and make recommendations for the use of appropriate tools in a cooperative program among Larimer County, the SCS, and the USGS to increase the effectiveness of planning and decisionmaking at local government levels;
- o determine what new hydrologic, earth, and soil science information, if any, may be needed to help resolve land use problems in Larimer County;
- o prepare a report setting forth the findings resulting from the above tasks. If a cooperative program is deemed worthwhile, the study team should also formulate a design which would serve as a proposal in seeking the necessary support for such an effort.

Feasibility Study Organization and Management

The study team will consist of one representative of each of the three cooperating entities: Larimer County, the Soil Conservation Service of the U.S. Department of Agriculture, and the Geological Survey of the U.S. Department of the Interior. For a one year period from January 1, 1979, to December 31, 1979, each agency will contribute up to two man months to the team effort involved in accomplishing the above tasks. Funds for necessary travel, clerical, and other costs incurred by each representative in performance of the tasks will be provided by that representative's organization.

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LIST OF USGS AND SCS PRODUCTS SUBMITTED TO LARIMER COUNTY FOR REVIEW

USGS:

National Mapping Division and EROS Program

I. Maps

- A. Advance Topographic Quadrangles Index (1:24,000)
- B. Orthophotoquads (1:24,000)
- C. Photoquads (1:24,000)
- D. Land Use, Land Cover, and Associated Maps (1:250,000) Order Form & Index
- E. Published 7½-minute Topographic Quadrangles Index
- F. County Map Series (1:50,000)*
- G. Colorado State Index for Photoquads
- H. 1° x ½° Quad Format (1:100,000) Index Planimetric, Surface Management, & Mineral Management Editions Published
- I. Maps of County on file in the Library of Congress--identified by interactive inquiry of the NCIC Cartographic Catalog Data Base--Printout
- J. Topographic Maps (1:250,000) Index
- K. Other Map Products
  1. Colorado State Base Map (1:500,000)
  2. Map Feature Separates on Stable Base Film for all 7½- and 15-minute topographic quads
  3. Satellite Image Mosaic Maps (various scales from 1:500,000 to 1:10,000,000)

II. Aerial Photography and Space Imagery

- A. Aerial Photography—Printout enclosed from interactive inquiry of NCIC "Aerial Photography Summary Record System" Data Base. This itemizes Black & White, Color, and Color IR available from many agencies including USGS, ASCS, Mark Hurd, U.S. Army, NASA, NARS, USFS
- B. Aerial Photography--Printout enclosed from search of EROS Data Base for NASA Black & White, Color, and Color IR
- C. Space Imagery--Dry silver copies of microfiche giving listings of Landsat MSS and RBV scenes in the EROS Data Base from 1972 to present
- D. Dry silver prints of USGS photo indexes and location diagrams (made from microfiche) of USGS aerial photography
- E. Computer Listing Key

*Produced in cooperation with the Colorado Department of Local Affairs

III. Geodetic Control

A. Geodetic Control Diagram, Greeley Quadrangle (1:250,000); shows both USGS and NGS horizontal and vertical control

B. Specimen Horizontal Control List--USGS

C. Specimen Vertical Control List--USGS

IV. Digital Data

A. Digital Terrain Tape information pamphlet and ordering instructions

B. Digital Terrain Tape Index

V. Land Use and Land Cover and Associated Maps

A. At compilation scale of 1:125,000:

Greeley W½, Greeley E½, Craig E½

Paper ozalids, one each:

Land Use and Land Cover only
Land Use and Land Cover with a screened base as background
Base only

Clear film, .004", one each:

Base only

B. At open-file scale of 1:250,000:

Greeley, Craig

Paper ozalids, one each:

Land Use and Land Cover
Political Units
Hydrologic Units
County Census Subdivisions
Base

Clear Film, .007", one each:

Land Use and Land Cover

Geologic Division

I. Maps

A. Geologic Quadrangle Maps

Number	Author & Date	Subject	Scale
GQ-829	Braddock, W.A., et al., 1970	Drake Quadrangle, Larimer County	1:24,000
GQ-832	Braddock, W.A., et al., 1970	Masonville Quadrangle, Larimer County	1:24,000
GQ-1323	Abbot, J.T., 1976	Big Narrows Quadrangle, Larimer County	1:24,000

B. Geophysical Investigations Maps

GP-836	Zeitz, Isidore, and Kirby, J.R., Jr., 1972	Aeromagnetic Map of Colorado	1:500,000
GP-895	Behrendt, J.C., and Bajwa, L.Y., 1974	Bouger Gravity Map of Colorado	1:500,000
GP-896	Behrendt, J.C., and Bajwa, L.Y., 1974 (1975)	Bouger Gravity and Generalized Elevation Maps of Colorado	1:1,000,000

C. Miscellaneous Investigations Series Maps

I-175	McKee, E.D., et al., 1956	Paleotectonic Maps, Jurassic System	1:5,000,000
I-300	McKee, E.D., et al., 1959	Paleotectonic Maps, Triassic System	1:5,000,000
I-439	Scott, G.R., and Cobban, W.A., 1965	Geologic and Biostratigraphic Map of Pierre Shale between Jarre Creek & Loveland, CO	1:48,000
I-450	McKee, E.D., et al., 1965	Paleotectonic Maps, Permian System	Not listed
I-687	Hershey, L.A., and Schneider, P.A., Jr., 1972	Geologic Map, Lower Cache la Poudre	1:62,500

Miscellaneous Investigations Series Maps (Continued)

Number	Author & Date	Subject	Scale
I-855-A	Ficke, J.F., and Danielson, T.W., 1973 (1974)	Lakes in Boulder-Ft. Collins-Greeley, FRUC	1:100,000
I-855-B	Driscoll, L.B., 1974	Land-Use Classification in Boulder-Ft. Collins-Greeley, FRUC	1:100,000
I-855-C	Hampton, E.R., et al., 1974	Availability of Hydrologic Data, Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-855-D	Colson, R.B., and Fitch, H.R., 1974	Potential Sources of Gravel & Crushed-Rock Aggregate, Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-855-E	McCain, J.F., and Hotchkiss, W.R., 1975	Flood-Prone Areas, Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-855-F	Petrie, B.N., 1975	Outstanding Natural & Historic Landmarks, Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-855-G	Colton, R.B., 1978	Geologic Map of Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-855-H	Crosby, Eleanor J., 1978	Landforms in the Boulder-Ft. Collins-Greeley Area, FRUC	1:100,000
I-964	Colton, R.B., et al., 1976	Preliminary Map of Landslide Deposits in CO	1:500,000
I-965	Crosby, Eleanor J., 1978	Nonmetallic Mineral Resources (Except Fuels) in Bedrock, FRUC	1:100,000
I-972	Tweto, Ogden, 1976	Geologic Map of Craig 1^{o} by 2^{o} Quad., NW CO	1:250,000
I-1039	USGS & Colorado GS, 1977	Energy Resources Map of Colorado	1:500,000

D. Miscellaneous Field Studies Maps

Number	Author & Date	Subject	Scale
MF-130	Osterwald, F.W., & Bean, B.A., 1958	Preliminary Tectonic Map, Distribution of Uranium Deposits--Northern CO & NE Utah	Not Listed
MF-666	Tweto, Ogden, 1975	Preliminary Geologic Map, Craig 1^{o} by 2^{o} Quadrangle, NW Colorado	1:250,000
MF-704	Colton, R.B., et al., 1975	Prelimary Map, Landslide Deposits, Greeley 1^{o} by 2^{o} Quadrangle, Colorado	1:250,000
MF-788	Tweto, Ogden, 1976 (1977)	Preliminary Geologic Map of Colorado	1:500,000
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MF-996	Schmidt, P.W., 1978	Reconnaissance Map, Relative Amounts of Soil and Bedrock, Buckhorn Mtn. Quadrangle, Larimer County, CO	1:24,000
MF-997	Schmidt., P.W., 1978	Reconnaissance Map, Relative Amounts of Soil & Bedrock, Mountainous Part of Horsetooth Res. Quadrangle, Larimer County, CO	1:24,000
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131-H	Reeside, J.B., Jr., 1923	The fauna of the so-called Dakota formation of northern central Colorado and its equivalent in southeastern Wyoming
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223	Lakes, Arthur, 1904	Colorado, in Adams, G.I., and others, Gypsum deposits in the U.S.

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730-A	Lee, W.T., 1923	Peneplains of the Front Range and Rocky Mtn. National Park
751-A	Lee, W.T., 1925	Continuity of some oil-bearing sands of Colorado and Wyoming
796-B	Mather, K.F., et al., 1928	Geology and oil and gas prospects of northeastern Colorado
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1114	Eckel, E.B., 1961	Minerals of Colorado--a 100-year record
1241-D	Norton, J.J., 1966	Ternary diagrams of the quartz-feldspar content of pegmatites in Colorado
1306	Chronic, Felicie, and Chronic, John, 1974	Bibliography and index of geology and hydrology, Front Range Urban Corridor, Colorado
1422-D	Tweto, Ogden, 1977	Nomenclature of Precambrian rocks in Colorado

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Thurston, W.R., 1951	Exploration of the Big Boulder prospect, Larimer County, Colo.

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74-178	Soule, J.M., 1974	Gravel resources, urbanization, and future land use, Front Range Urban Corridor, Colo., with a section on calculation of gravel reserves, by H.R. Fitch
75-129	Gill, J.R., et al., 1975	Unedited stratigraphic sections of the Pierre Shale near Round Butte & Buckeye in Larimer County, northern Colorado
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77-776	Shurr, G.W., 1977	The Pierre Shale, northern Great Plains; a potential isolation medium for radioactive waste
78-532	Braddock, W.A., and Cole, J.C., 1978	Preliminary geologic map of the Greeley 1^{o} by 2^{o} quadrangle, Colorado and Wyoming
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Water Resources Division

I. List of 22 current surface water stations, with period of record

II. List of 10 current water quality stations

III. Professional Papers

Professional Paper 1115

Storm and flood of July 31-August 1, 1976, in the Big Thompson River and Cache la Poudre River basins, Larimer and Weld Counties, Colorado.

Part A--Meteorology and hydrology in the Big Thompson River and Cache la Poudre River basins, by J.F. McCain, L.R. Hoxit, R.A. Maddox, C.F. Chappell, and Fernando Caracena.

Part B--Geologic and geomorphic effects in the Big Thompson Canyon area, Larimer County, by R.R. Shroba, P.W. Schmidt, E.J. Crosby, and W.R. Hansen, with a section on damages caused by geologic processes during flood-producing storms, by J.M. Soule.

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NAWDEX: Key to Finding Water Data

Public Inquiries Office of the U.S. Geological Survey

Land Information and Analysis Office--An Information Bridge

Topographic Maps

The EROS Data Center

SCS:

I. SCS Maps and Reports

A. General Soils Map, scale 1:126,720

B. Detailed Soil Survey Maps, scale approx. 8" = 1 mi. in plains; smaller scale in mountains

C. Snow Survey Data for Water Supply Outlook--Mailing List

D. Watershed Data
1. Boxelder Work Plan
2. Home Supply/Handy Supplement Work Plan

E. Soil Conservation Districts Map
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2. Big Thompson Soil Conservation District

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N. Important Farmlands of Larimer County, Colo., scale 1:100,000, 1979

O. Soil Survey of Larimer County Area, Colorado, 1980

P. Soil and Water Resources Conservation Act, Colorado Comments, 1982 (Pamphlet)

Q. Report, "An appraisal of outdoor recreation potentials, Larimer-Morgan-Weld Counties, Colorado," August 1970.

II. Published Maps from the State Land Use Commission, scale 1:500,000

A. Sediment Yield

B. Land Use

C. Snow Depth

D. Soil Shrink-Swell Potential

TRANSLATION OF GEOLOGIC INFORMATION FOR LARIMER COUNTY LAND USE PLANNING APPLICATIONS[1]

Geologic Hazard Legend for Maps (Scale 1:24,000)

* Landslide Area
* Unstable Slope Area
* Potential Soil Failure Area
* Potential Rock Failure Area
* Rockfall Area
* Debris Fan Areas
* High Water Table Area

Potentially Active Fault

Flash-Flood Channel

Physiographic Flood Plain

Table 1: Geologic Hazards in Relation to Land Use

Table 1 is a matrix matching each asterisked category in "Geologic Hazard Legend" (above) with the following land use types:

Heavy commercial, industrial, and residential complexes

Residential and light commercial structures
- High density
- Low density

Light-duty agricultural buildings

Roads

Utilities

Open-space recreational complexes (not including structures)

[1]Source: Empire Laboratories, Inc., 1978

Each of the matrix squares of Table 1 contains the following three ratings for a proposed land use located in the given geologic hazard category:

1. Brief textual discussion

2. Numerical rating for "magnitude of expected problems," using the following scale:

   7 and 6: Extensive problems, high risk

   5 and 4: Significant problems, moderate risk

   3 and 2: Minor problems, low risk

   1 and 0: Few, if any, problems; minimal risk.

3. Letter rating for "factors which may affect the magnitude and distribution of expected problems:"

   A. Slope failure potential and severity are directly related to percent of slope.

   B. Oversteepness or cutting of slopes may significantly increase the magnitude of expected problems.

   C. Loading of upper slope areas may significantly increase the magnitude of expected problems.

   D. Artificial or natural increases in ground moisture may adversely affect slope stability.

   E. Hazard occurrence and relative activity may be dependent upon climatic variations.

   F. Removal of vegetation may increase hazard potential and severity.

   G. Earth stresses induced by vibration, i.e. earthquakes, man-made vibrations, may increase slope failure potential and severity.

Note: A detailed site investigation is necessary in all cases.