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SAND AND GRAVEL

BEAR CREEK AND ROGUE RIVER VALLEYS

Jackson County, Oregon

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By

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DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
1069 State Office Building
Portland, Oregon 97201
In Cooperation with
Jackson County Board of Commissioners
and
Jackson County Planning Commission
Jackson County Courthouse
Medford, Oregon

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PLANNING COMMISSION

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MEDFORD, OREGON

January 9, 1970

FOREWORD

Rogue River, Applegate River, and Bear Creek provide an important natural and economic resource to the people of Jackson County. Although we depend on these waters for many purposes -- domestic and industrial use, irrigation, fish and wildlife habitat, recreation, and construction materials -- their future preservation is being endangered by increasing pressures of development within the flood plains and by mining activity in the stream channels.

In response to growing demands on our river and stream resources, the Jackson County Board of Commissioners in 1968 initiated, in consultation with numerous local, state, and federal agencies, an intensive resource conservation investigation in and along Rogue and Applegate Rivers, and Bear Creek. To our knowledge, no other county in the State of Oregon has ever embarked on a comprehensive rivers conservation program with the breadth and scope of this effort.

Sand and Gravel is the first in a series of technical reports being produced under the rivers planning program. It presents information about sand and gravel reserves along the Rogue River and Bear Creek, and measures present and likely demands upon these resources over the next thirty-year period. The investigation involves the present and to some extent the past, but its principal concern is for the future.

This report by the State of Oregon Department of Geology and Mineral Industries, together with investigations that will follow, provides a foundation from which public plans for the future development and management of our major waterways can be made.

Gary A. Scott
Director of Planning

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INTRODUCTION

This report was prepared at the request of the Jackson County Board of Commissioners and Jackson County Planning Commission to provide information on the sand and gravel resources of the Bear Creek and Rogue River Valleys. A report on the Applegate River Valley will be finished by next fall.

Sand and gravel are vital to the construction of foundations, buildings, bridges, highways, streets, driveways, sidewalks, and many other concrete structures that enter into the development of an urban region. For the past 10 years, sand and gravel have been consumed in Jackson County at the rate of 10.2 tons per person annually. In 1970 the county's consumption will be more than one million tons.

The county officials are desirous of assuring for the people of Jackson County a continuing supply of sand and gravel, to be provided in a manner that will be compatible with the surrounding land uses and that will eventually improve the land.

The Bear Creek and Rogue River Valleys are the areas of Jackson County that are experiencing the greatest population expansion and are therefore the places where local deposits of sand and gravel are most needed as aggregate for future construction. Thus it becomes mandatory that the reserves of such vital ingredients be outlined and that other pertinent facts about these resources be made available for use in planning for the future. This report outlines the extent of the sand and gravel deposits, provides information on their quantity and quality, and makes estimates of future requirements for these resources.

A survey of the Rogue River and Bear Creek Valleys revealed that there are significant but limited amounts of sand and gravel on the flood plains and terraces of the two streams. In addition, it was determined that the Agate Desert area north of Medford, although not a part of the Rogue River and Bear Creek Valleys, has large reserves of sand and gravel.

Quarry rock as an alternate source of aggregate was not considered in this study, although basalt and andesite lavas and granitic rocks are quarried in Jackson County for construction projects in mountainous areas where gravel is lacking. Bear Creek and Rogue River gravels are not transported to these construction sites because of excessive distance; for the same reason, quarry rock is not used in the valleys. The use of crushed quarry rock will probably continue to have only local application for some time to come and will not affect the life of the gravel reserves in the valley areas. After the gravel deposits are depleted, in 20 to 30 years, quarry rock could become an important aggregate resource.

Methods of study

The gravel resources along the Rogue River and Bear Creek were studied in detail in the field, but no drilling or subsurface investigations of any kind were conducted. Visual inspection of outcrops of gravel and bedrock was made from boat and automobile traverses during a two-week period in July and August 1969. Additional mapping and delineation of the gravel beds was accomplished from a light aircraft, and photographs taken during aerial traverses were used in mapping.

In addition to field work, extensive use was made of published literature and geologic maps of the area. Large-scale topographic maps of the Rogue River supplied by the U.S. Geological Survey were used in constructing geologic cross sections which helped determine the thickness and extent of the gravels. Data on rock quality were obtained from engineering laboratories of federal, state, and county agencies and from the local gravel industry.

Future sand and gravel requirements for Jackson County were based on an estimate of the population expected by 1985 and projected beyond that date. Population forecasts, together with the calculated per capita use of aggregate in the county, provided the basis for predicting future sand and gravel needs.

Previous work

Published maps and reports describing the major geologic features were used in providing the geologic framework for this report. These reports include: (1) "Geologic map of the Butte Falls quadrangle" by W.D.Wilkinson, published by the State of Oregon Department of Geology and Mineral Industries in 1941; (2) "Geologic map of the Grants Pass quadrangle" by Francis G. Wells of the U.S. Geological Survey, published in cooperation with the State of Oregon Department of Geology and Mineral Industries; and (3) two geologic maps of the Medford quadrangle. The first of these, a preliminary map and text by Francis G. Wells, was printed in 1939 by the State of Oregon Department of Geology and Mineral Industries in cooperation with the U.S. Geological Survey, and the second, more detailed, map, also by Wells, was published by the U.S. Geological Survey in 1956 as GQ-89. These maps are all on a scale of 1:96,000. In 1961 Wells and Dallas L. Peck compiled a map of Oregon west of the 121st meridian on a scale of 1:500,000 which was also employed in this investigation.

The maps contained in the Jackson County interim flood report by the U.S. Army Corps of Engineers were used as a base for field mapping of the gravel deposits. A report prepared by William Power and Earle Rother in 1969, entitled "Interim Soil Survey Report, Jackson area, Oregon," was utilized as an aid in identifying gravel deposits and obtaining some of the geographical data.

Acknowledgments

We are grateful to the many individuals; federal, state, and county agencies; and the sand and gravel companies for supplying much of the detailed information used in this report.

The Jackson County Board of Commissioners participated with the State of Oregon Department of Geology and Mineral Industries in providing financial assistance which made this study possible. Mr. Gary Scott and members of his planning staff cooperated fully and provided personnel and data used during the study. Mr. Curtis Weaver of the County Planning Department provided a boat and guide service for traversing the Rogue River from Shady Cove to about 2 miles below Bybee Bridge. Mr. Kerry Lay furnished information on the county population growth pattern which was used in determining future sand and gravel requirements.

Mr. Robert Carstensen, County Engineer, provided valuable data regarding the gravel produced by the county since 1960.

The sand and gravel companies of the area were most cooperative in providing resource and economic data, without which this report would have been incomplete. Mr. Arthur Heizenrader, managing director of the Oregon Concrete Aggregate Producers Association (OCAPA), was instrumental in informing his members of our needs. Special thanks are due members of the local gravel firms, specifically Mr. Rodney Miller, general manager of M.C. Lininger & Sons, and Messrs. Richard Hensley and Robert Stuart, officers of Concrete Steel Corporation.

We are grateful for the assistance of Mr. Jerry Gray, U.S. Bureau of Mines, Mr. Fred Yarbrough and Mr. Edgar Johnson of the Oregon Highway Department, Mr. M. D. Brands, Flood Control Section, U.S. Army Corps of Engineers, Mr. William Bartholomew of the Office of the State Engineer, Mr. Stanley Kapustka and Mr. David Harris of the U.S. Geological Survey, and Mr. William Power and Mr. Earle Rother of the U.S. Soil Conservation Service. We wish to thank Mr. C. R. Barkhurst for his excellent recommendations and Mr. Ned Langford and Mr. Ray Lamberg for their helpful suggestions regarding the study.

A number of the persons mentioned above read the manuscript, and we are most grateful to them for their help in improving the report. In addition, we wish to express our appreciation to members of the State of Oregon Department of Geology and Mineral Industries for preparing the maps and text for publication, and to Virginia Walther, Jackson County Printing Section, for producing the final bound volume.

Location and extent of area

The area covered by this report includes the channels, floodplains, and terraces of the Rogue River and its tributary, Bear Creek, and also the high bench area known as the Agate Desert north of Medford (figure 1).

The reach of the Rogue River considered here extends from the proposed Lost Creek dam site downstream to the Josephine County line, a distance of about 32 miles. Its flood plain covers about 14 square miles and is about $1\frac{1}{2}$ miles wide at its broadest portion above Gold Ray Dam. The valley becomes a narrow, V-shaped canyon at either end.

The Bear Creek flood plain, which extends from Emigrant Dam northwestward to the Rogue River, is about 25 miles long. It is about a quarter of a mile wide at its southern end and broadens to a width of $3\frac{1}{2}$ miles north of Medford, occupying an area of about 50 square miles.

The Agate Desert is a triangular-shaped, high gravel plain lying between the Rogue River and Bear Creek in the vicinity of White City, as shown on figure 2. Its elevation above the present stream levels is about 100 feet, and it has an area of approximately 25 square miles.

Distribution of the gravel deposits is shown on the accompanying geologic maps.

Climate and vegetation

The climate in the Rogue and Bear Creek Valley areas is mild, with the mean annual temperature ranging from 52°F. to 54°F., and a frost-free period of from 160 to 180 days. The annual rainfall varies from 17 to 35 inches, and snowfall usually lasts from one to several days. The higher mountains to the west rise to an elevation of about 6000 feet above sea level and are generally snow-capped in the winter; Mount Ashland supports a winter skiing resort. The elevation of the valley floor is about 1200 feet above sea level.

The natural vegetation varies, depending upon the soil types, degree of slope, and the water-retention qualities of the ground. The broad, higher terraces support annual grasses and forbs, wedge leaf ceanothus, and white oak; granitic soils have open stands of pine, fir, madrone, various shrubs, and drought-tolerant forbs and grasses. Hilly areas underlain by sandstone west of Bear Creek support stands of white oak, madrone, manzanita, Idaho fescue, blue bunch wheatgrass, and annual weeds. On the gravelly terraces and fans, star thistles flourish. Steep hillsides underlain by colluvium and talus have abundant poison oak.

POPULATION GROWTHS AND GRAVEL NEEDS

Population studies and growth trends

An unpublished report prepared in 1969 by the Jackson County Technical Advisory Committee indicates that the population of Jackson County is increasing at a greater rate in the Ashland-Medford area and Bear Creek area north of Medford than in any other parts of the county. The reasons given for this are: the attraction by the major cities, availability of homes and homesites, jobs, sewer,and water, and fire and police protection. The population of Bear Creek Valley is now about 82 percent of the county, and in 1985 is predicted to be 85 percent. Between 1965 and 1985 the population of the entire county is expected to increase by 72 percent (figure 3).

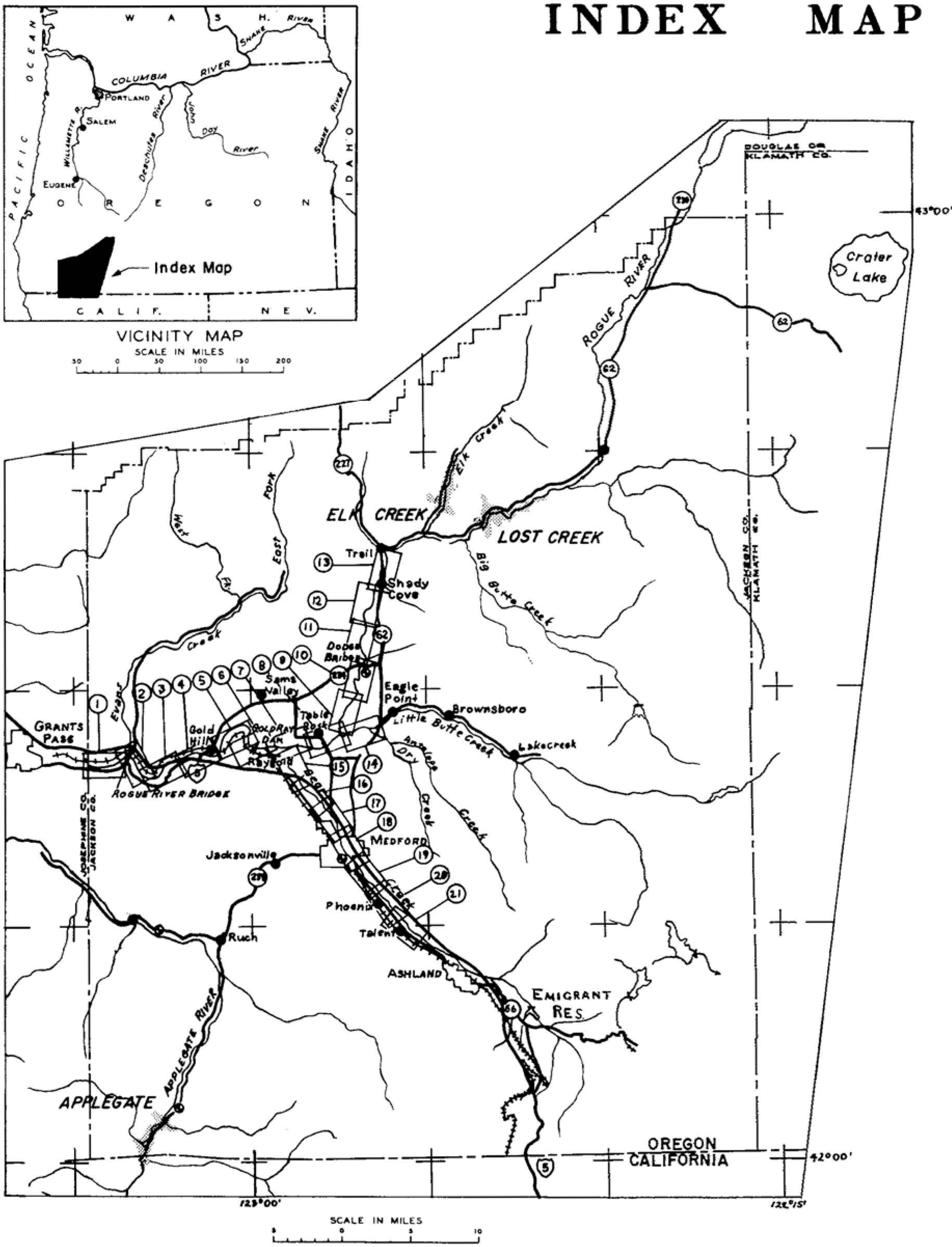


Figure 1. Index map to the geologic map sheets of the Bear Creek and Rogue River area.

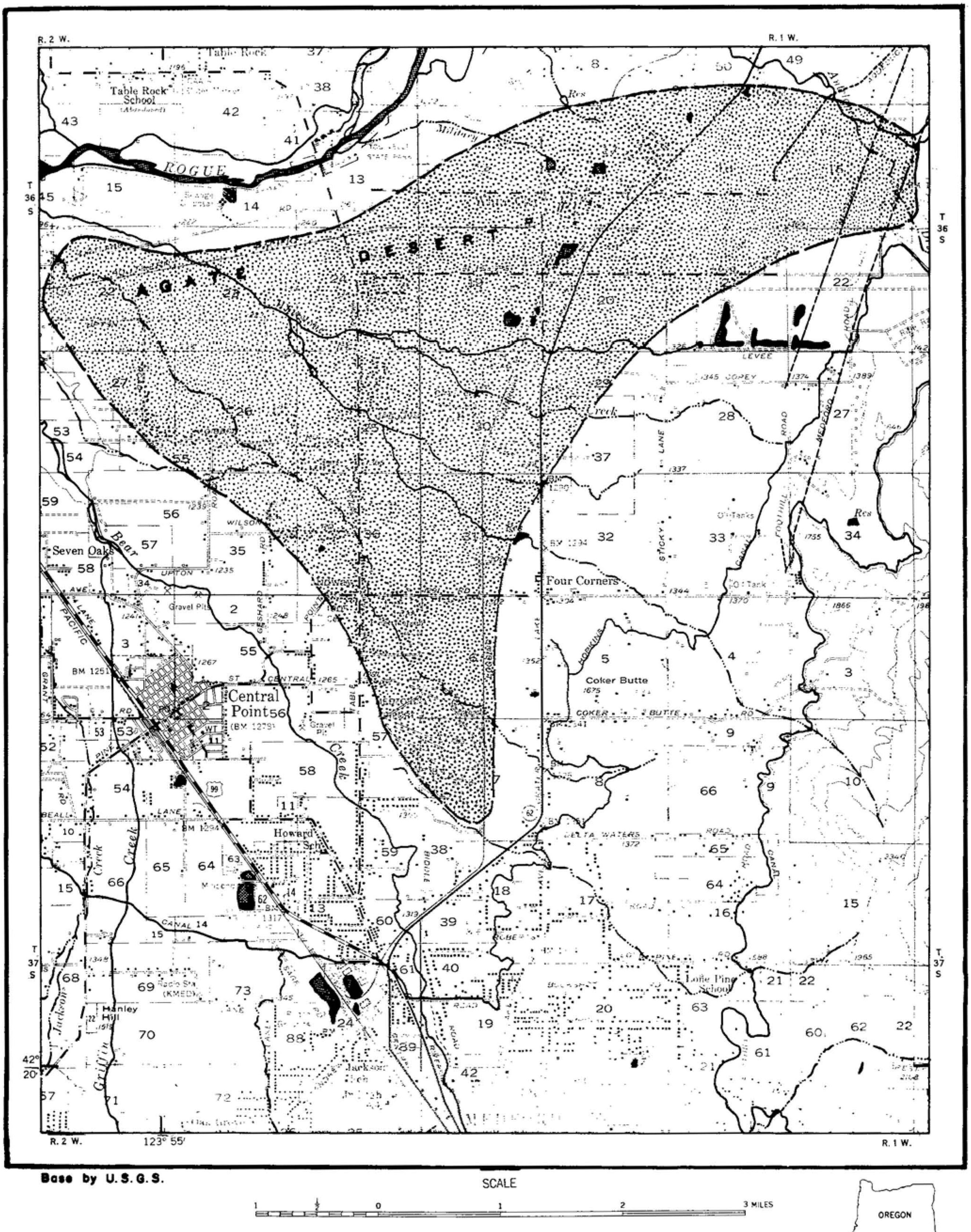


Figure 2. Agate Desert gravel area.

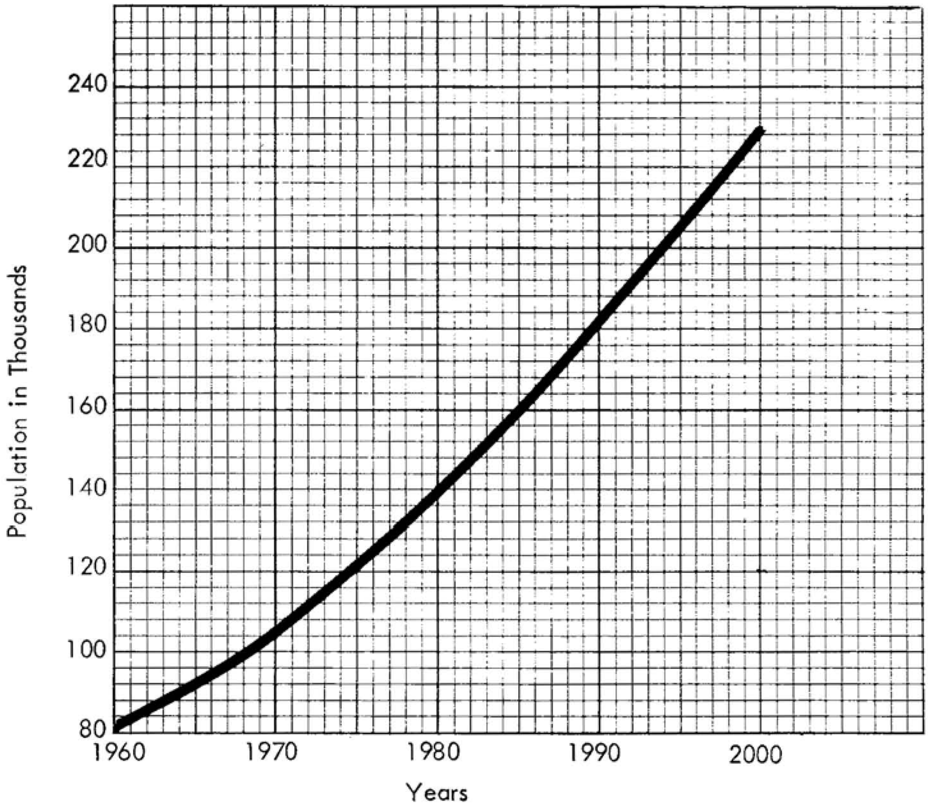


Figure 3. Population projections for Jackson County.

Low-cost housing and industrial development is likely to concentrate north of Medford in the Central Point, White City, and Eagle Point areas. Some of the reasons for this are: the nearly level topography above the normal river flood plain, the good foundation characteristics of the gravelly soils, the availability of ground water for domestic and industrial supply, and the conveniently located construction materials.

Relationship of population to gravel needs

Earlier studies (Schlicker, 1961, 1969) indicate that sand and gravel requirements in Oregon range from 8 to as much as 15 tons per capita annually. Large state and federal projects such as dams, freeways, and bridges can temporarily more than double the normal requirements for sand and gravel for certain years during the construction periods and cause wide fluctuations in the annual consumption (figure 4).

The per-capita usage of sand and gravel in Jackson County has been calculated from the average population versus the average consumption, including the amount of aggregate used in freeway construction, from the years 1960 to 1969. This shows the average annual per-capita consumption to be 10.2 tons for that 9-year period. Since additional construction projects, such as several large dams, more freeway lanes, and airport expansion, are anticipated for Jackson County, and all of these activities would require large amounts of sand and gravel, it appears that the per-capita consumption of 10.2 tons will not decrease in the future.

Population Data

Year	Jackson County	Bear Creek Valley
1965*	92,100	74,601
1970**	104,800	85,936
1975**	121,700	101,011
1980**	139,900	117,516
1985**	159,200	135,320

* MacConnell (1966)
** (Forecasts by the Technical Advisory Committee, 1969 - see Bibliography)

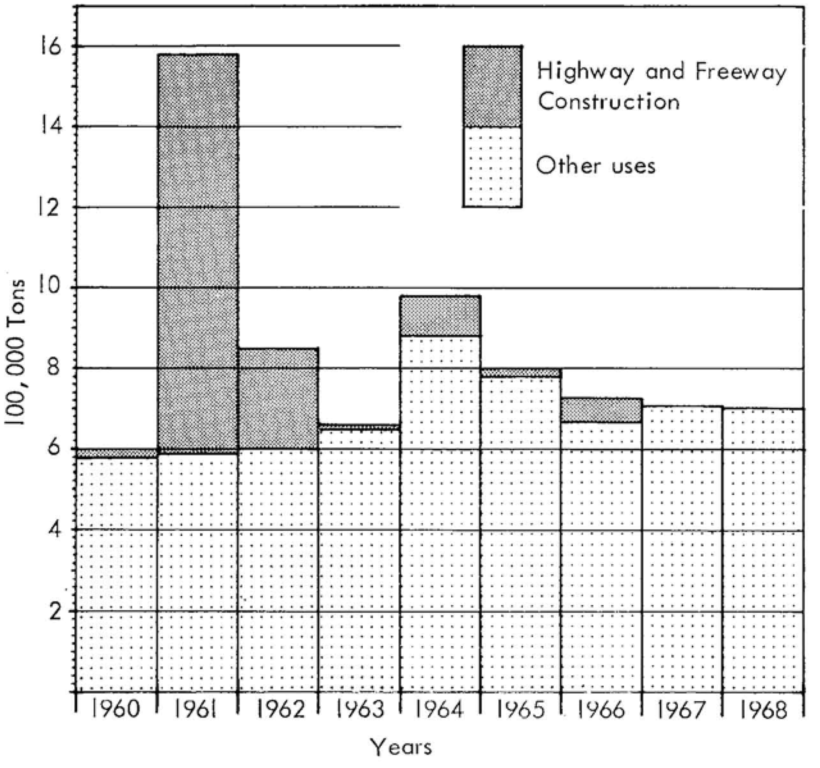


Figure 4. Total sand and gravel production, 1960-68.

URBAN DEVELOPMENT VERSUS GRAVEL RESERVES

Sand and gravel deposits, regardless of their apparently large extent, are not inexhaustible resources and therefore must be given early consideration by planners. As an urban region grows and makes use of its local sand and gravel deposits, it locks up more than an equal amount of reserves under housing, freeways, industrial plants, and other land uses. This forces the gravel industry to move farther from the markets, resulting in a greater cost to the consumer. A report published by the Central Lane Planning Council in Eugene, Oregon (1968, p. 16) states:

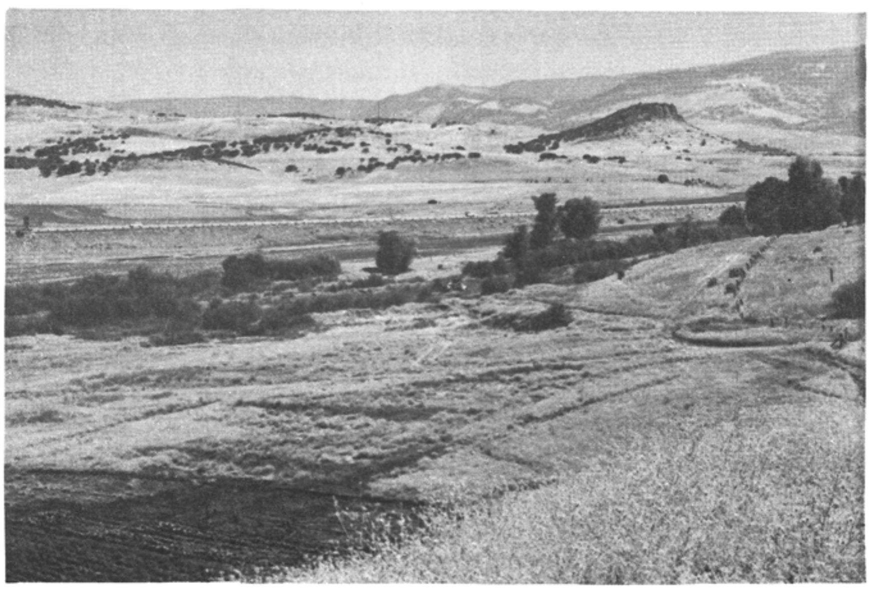
"Sand and gravel is a bulky, low-cost product that cannot be transported great distances without substantial cost increase. For this reason, sand and gravel is seldom transported more than 30 miles from the processing plant. Many operators feel that 15 miles is a more reasonable maximum hauling distance.

"Local trucking costs, for instance, average 12 cents per ton per mile. At that rate, the price of a ton of sand will increase from about $1.30 at the plant to approximately $2.50 after a 10-mile haul."

These costs seem to be in agreement with those in Jackson County.

Since sand and gravel operations must be located close to the market, there is often a conflict between industrial and urban land use. The generally antagonistic attitude of a community toward nearby sand and gravel plants unfortunately does not reflect the importance of this mineral resource in development of the community. It cannot be said that most sand and gravel operations have moved in on the city, but, rather, the other way around. As large numbers of people leave the metropolitan centers for suburban areas, urban development gradually encroaches upon already established mining operations. The residents in the area or those along the truck-haul routes soon consider the operation a hazard or a nuisance, and pressure is brought to bear on local authorities to limit the industry,

Water-filled gravel pit adjacent to Bear Creek north of Medford. Note competing uses for land -- freeway, nursery, farmland, and orchards.



Narrow southern part of Bear Creek near Talent.

sometimes forcing closure. In other instances all of the gravel reserves adjacent to the plant are covered up by buildings and the plant is forced to move or shut down because of lack of materials.

Some of the reasons residents object to having a gravel operation for a neighbor include unsightliness, decrease of property values, heavy truck traffic, dust, and noise. The removal of the gravel leaves a steep-walled pit which lowers the value of adjacent property; it becomes a dangerous place for children in the community; and water can accumulate and stand as a stagnant pond where mosquitoes breed. There also have been problems of lowered water table, causing nearby wells to go dry or to become contaminated.

There are ways, however, in which sand and gravel operations can be made compatible with the communities. The producers can improve the appearance of their land adjacent to bordering streets and highways by building a dike or berm and planting shrubs or trees which hide the pit from public view; they can keep their buildings painted; they can locate haul roads in the least objectionable places; use water to hold down the dust; and take advantage of natural topography and distance to lessen the noise. The ideal situation, of course, is one where the gravel operation and the residential community are separated by sufficient distance that the conflicts do not arise.

Encroachment by housing onto land underlain by gravel deposits and the need to reserve areas for future mineral production must be considered by the officials and residents of the community. Plans to re-use the mined-out land for county parks, lake-side homesites, or industrial purposes should be included in the long-range planning by local governments.

The problems of finding places for solid waste disposal are becoming critical. Gravel-pit operations and sanitary land fills are highly compatible and can sometimes be operated simultaneously. Certain procedures must be prescribed to prevent contamination of the ground water by sealing the ground if necessary. The overburden can be used for cover, and when the gravel has been removed and the area filled properly the land can be used for parks and recreation, housing, or industrial purposes. The land, whether owned by the county or the gravel operator, will have greater value than before.

GEOLOGY OF THE ROGUE RIVER AND BEAR CREEK VALLEYS

Topography

The Rogue River flows through a narrow canyon cut into resistant lava flows from the Lost Creek Dam site near McLeod to Indian Creek, a distance of 5 miles. Downstream from Indian Creek, however, the valley widens progressively as far as Gold Ray Dam near the mouth of Bear Creek. This 13-mile segment of the valley has developed in sandstones and shales. From Gold Ray Dam to the Josephine County line the valley is extremely narrow and is incised into resistant metavolcanic and metasedimentary rocks.

Bear Creek follows the northwesterly strike of eastward-dipping shales and sandstones and has eroded a wide valley in these rocks. The valley is flanked on the west by steep ridges of the Klamath Mountains composed of granitic and metamorphic rocks and on the east by less mountainous sedimentary and volcanic terrain in the southern Cascade Range.

According to Wells (1956), the Rogue River became the master stream of the area in late Miocene time and both Bear Creek and Rogue River developed wide valleys which were later incised about 800 feet and widened somewhat. During periods of alluviation in Pleistocene time, both valleys were filled with gravel to depths of more than 70 feet. Agate Desert in the vicinity of White City is a high gravel fan that was probably deposited at that time as a combined floodplain of the Rogue River, Bear Creek, and smaller local streams. With a lowering of base level, the Rogue and Bear Creek eroded out much of the filling, leaving it as terraces along the edges of the valleys. Both streams have lowered their base levels to bedrock. An exception is the channel of Bear Creek north of Medford, which is mostly Pleistocene gravel.

Bedrock strata exposed in the Rogue River downstream from Shady Cove.

Sandstone bedrock exposed in Bear Creek south of Medford.

Stratigraphic Summary

The study area is underlain by rocks ranging in age from Triassic (200 million years old) to Holocene (present time). The rock sequence, from oldest to youngest, includes the following units: Triassic Applegate Group, consisting of highly altered volcanic and sedimentary rocks; Jurassic or Cretaceous diorite intrusions; Cretaceous marine sandstones of the Hornbrook Formation; Eocene non-marine sedimentary rocks; Oligocene to Miocene fragmental volcanic rocks; pre-Mazama basalt flows; and several stages of Pleistocene and Holocene gravel deposits.

All of the rocks older than the gravels are grouped as bedrock units. These older consolidated materials have been the source of the sand and gravels deposited in the valleys of the Rogue and its tributaries. The bedrock units are discussed briefly below and the gravels are then treated in more detail. The distribution of the bedrock and gravel units is shown on the accompanying geologic maps.

Bedrock Units

Applegate Group (Ms, Mv)

The Applegate Group includes a thick series of metavolcanic rocks and lesser amounts of metasedimentary rocks of Triassic age. These rocks occur along the Rogue River between Grants Pass and Gold Ray Dam and are extensive in the mountains west of Bear Creek Valley south to a point about half way between Talent and Ashland.

Metasedimentary rocks (Ms): These altered sedimentary rocks are mainly dense, black, fine-grained argillites with interbedded layers of sandstone and grit composed of particles of quartz, chert, and volcanic rocks. Strata of chert and quartzite grading laterally into argillite and limestone are also present as lenses about 100 feet thick and a few hundred feet to a mile long. The metasedimentary rocks have steep dips and strike northeastward across the Rogue River. They crop out from Gold Hill downstream for about 1½ miles, at the town of Rogue River for a quarter of a mile, and at a few other places along the Rogue (Wells, 1940, 1956).

Metavolcanic rocks (Mv): The metavolcanic rocks are pale green to greenish gray, with textures ranging from fine to coarse grained. These rocks were originally porphyritic basalt, andesite, pillow basalt, flow breccia, agglomerate, and probably some fine-grained, thin-bedded tuff (Wells, 1940). Intrusive bodies too small to be mapped have been included in this unit.

Coarse-grained intrusive rocks (Di)

Coarse-grained intrusive rocks of Late Jurassic or Early Cretaceous age are scattered throughout the mountains west of Bear Creek and along the lower Rogue River. They range from diorite to granite in composition. Large bodies of granodiorite or quartz diorite occur in upper Evans Creek, along the Rogue River west of Gold Ray Dam, and west of Central Point. Most of the intrusive bodies are 1 to 10 square miles in area, but one larger mass, known as the Ashland stock, extends from 3 miles northwest of Ashland southward into California and covers about 110 square miles.

The granitic rocks are generally deeply weathered, as much as 30 feet in places, to a granular soil or highly friable rock. This material is frequently used for road base or embankments. In places erosion has removed the friable material exposing fresh rock.

Hornbrook Formation (Kh)

The Hornbrook Formation is composed of marine sedimentary rock of Late Cretaceous age. It occurs in narrow, intermittent outcrops along the west edge of Bear Creek Valley from the Jacksonville area south to the community of Mistletoe. It is also exposed in the bed of Bear Creek for about a mile between Talent and Ashland. The formation is composed of well-bedded, hard, fine-grained, greenish-gray arkosic sandstone with local lenses of coarse conglomerate and sandy shale. The cementing material is calcium carbonate, which makes up about 10 percent of the rock (Wells, 1956).

The Hornbrook Formation is 600 feet thick in the Bear Creek area, but much of its original extent and thickness has been greatly reduced by erosion.

Nonmarine sedimentary rocks (Ten)

Nonmarine sedimentary rock of Eocene age is the dominant bedrock formation in Bear Creek Valley. This unit forms a band from 3 to 5 miles wide in the foothills along the eastern margin of Bear Creek Valley from 5 miles south of Klamath Junction to the Agate Desert north of Medford, where it is covered by the younger gravels. It also crops out in scattered patches at Phoenix south of Medford and in the bed of the Rogue River from Dodge Bridge to Gold Ray Dam. It underlies the basalt capping of Upper and Lower Table Rocks and is exposed in the area of Sams Valley. The unit is about 8000 feet thick and is composed primarily of sandstone, with minor shale and conglomerate lenses (Wells, 1956). It ranges from massive to thin or well bedded. The shales are occasionally carbonaceous and a few thin coal beds are present. The unit weathers along blocky joints to rounded spheroids and forms resistant bluffs. It rests on the Upper Cretaceous Hornbrook Formation.

Fragmental volcanic rocks (Tmop)

Fragmental volcanic rocks and flows of Oligocene and Miocene age were named the Little Butte Volcanic Series by Wells, 1956. They occur primarily east and north of Dodge Bridge in the Rogue River Valley in the vicinity of Trail and in the valley of Little Butte Creek, after which they are named. They are extensive in the hills 5 miles east from Bear Creek Valley and in Little Butte Creek Valley they are as much as 3000 feet thick. The lower sequence is composed of flows, flow breccias, and agglomerates. The upper part, about 1100 feet thick, is fine-grained siliceous tuff. These rocks supply much of the stream gravels in the Rogue River and its tributaries above Dodge Bridge.

Pre-Mazama basalt (Tpm)

The pre-Mazama basalt caps Upper and Lower Table Rock just north of the Rogue River at the confluence of Bear Creek. It represents erosional remnants of a much larger lava flow of Pliocene age. The basalt forming the two mesas is about 125 feet thick and is grayish black, containing phenocrysts of feldspar, augite, and olivine, the last altered to a red mineral called iddingsite. The flow is cut from top to bottom by vertical joints and horizontally by short, irregular transecting joints (Wells, 1956).

Fine-grained intrusives (not shown on map)

Diorite, gabbro, and basalt have intruded older rocks in the Rogue River Valley. East of Bear Creek, diorite and gabbro sills, stocks, and dikes commonly stand out as knobs. Small basalt dikes have cut the tuffs on the north side of the South Fork of Little Butte Creek.

Gravel Units

The sand and gravel deposits have been separated into four units based on the type of deposit, age, and topographic position. The accompanying diagrammatic sketch (figure 5) shows the probable relationships of these units to each other. They are discussed below in chronological sequence from oldest to youngest in the following order: Bench Gravel, Terrace Gravel, Floodplain Gravel, and Channel and Bar Gravel.

Bench Gravel

Bench Gravel occupies an area of about 25 square miles north and northeast of Medford. The unit underlies several nearly flat terraces extending from the Medford airport northward and including the Agate Desert. It is bounded on the west and north by the floodplains of Bear Creek and Rogue River, and on the east by Eocene bedrock exposed in the foothills (figure 2).

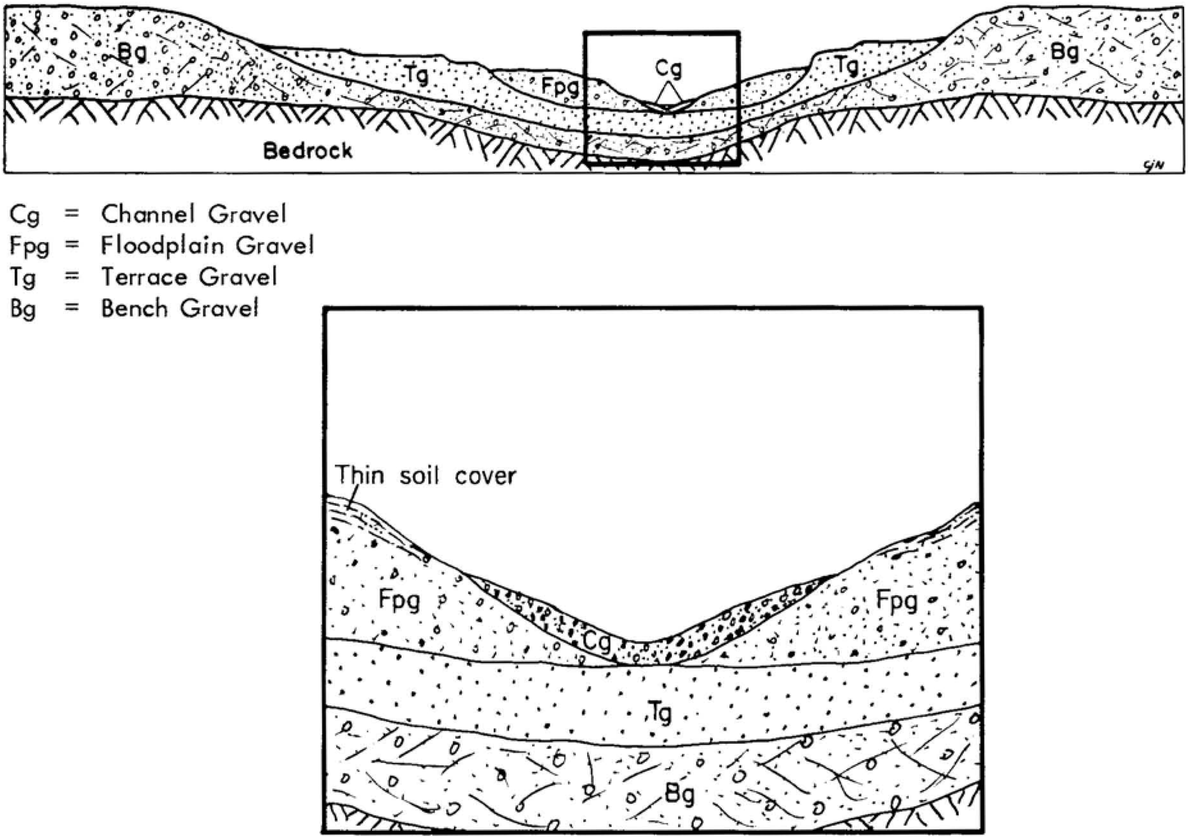


Figure 5. Cross section showing relationship of the various gravel units.

The Bench Gravel was deposited during several stages of alluviation in Pleistocene time. It is composed of poorly sorted, cross-bedded deposits of subrounded boulders, cobbles, pebbles, and sand; layers of cemented clayey gravel occur at several levels. The maximum thickness is 70 feet (Wells, 1956), and there is a soil capping ranging in thickness from a few inches to 20 feet. In the vicinity of White City, a 6-foot layer of rust-brown gravels deposited by an early stage of the Rogue River covers the Bench Gravel.

Logs of water wells in the White City area indicate that about 15 square miles are underlain by an average of 40 feet of Bench Gravel.

Terrace Gravel

Gravel of this unit occurs in terraces adjacent to the modern floodplains. These terraces flood only during extremely high water, such as that of 1964-65. The Terrace Gravel unit is as much as 40 feet thick. It is commonly cross bedded with steep foreset beds, and contains lenses of sand, silt, and clay. Pebble sizes range from a quarter of an inch to about 4 inches, and there are occasional large cobbles. The gravel unit is partially weathered and in places weakly cemented by iron oxide. An overburden of sand, silt, and clay covers the Terrace Gravel unit to a thickness which ranges from 5 to 12 feet.

Along the Rogue River the Terrace Gravel is composed primarily of unweathered to slightly weathered basalt, andesite, and rhyolite. Along Bear Creek north of Medford the unit contains considerable quartzite and granite in addition to basalt. The granitic rock pebbles and cobbles are sometimes deeply weathered, but the basalt is fresh to only slightly weathered.

In the area north of Medford the Terrace Gravel unit is especially extensive east of the Bear Creek floodplain. The unit is bounded on the east by a sharp terrace which forms the boundary with the Bench Gravel unit. The Terrace Gravel underlies the younger Bear Creek floodplain (Floodplain Gravel unit) at shallow depth in the bed of Bear Creek.

Floodplain Gravel

The modern floodplains of the Rogue River and Bear Creek contain gravels in low terraces at several levels. These deposits are generally covered by vegetation unless cleared for farming. In most places, 1 to 5 feet of sand or sandy silt overlie the gravel.

Floodplain Gravel adjacent to the stream channel can be either eroding to form a steep gravel bank or building up at the deposit's edge to form a point bar in the stream channel.

In Bear Creek Valley, the Floodplain Gravel is thin, ranging from 5 to 8 feet in most places, and rarely to as much as 12 feet. South of Medford this gravel unit rests on sandstone bedrock, but to the north it lies on older, cross-bedded gravels which are probably equivalent to either the Terrace or the Bench Gravel. In the Bear Creek floodplain area north of Medford, the combined floodplain and underlying Bench and Terrace Gravels make up the deposits known locally as "Bear Creek gravel."

Channel and Bar Gravel

The most recently deposited gravel unit is represented by the gravel in the bed and bars of the Rogue River. This type of gravel is transitory in nature and is in the process of being eroded, transported from one place, and redeposited in another. Erosion and deposition of such gravel is responsible for the frequent changes in the course of the stream channel. Older Floodplain Gravels were originally deposited as bar gravels; in fact, the older gravel beds grow larger by accretion along point bars.

Significant deposits of channel and bar gravels can occur only where the stream valley widens and the gradient decreases. Channel and Bar Gravel in Bear Creek is insignificant at the present time, although deposits of this type in the past are responsible for the Floodplain Gravel available today.

Channel and Bar Gravel in the Rogue River occurs in the proposed Lost Creek Dam reservoir area (figure 6). It occurs at scattered localities downstream from Shady Cove to Gold Ray Dam, with many stretches of the River having only Eocene bedrock exposed in the channel.

Gravels in the channel and bars consist of unweathered pebbles and cobbles of basalt, andesite, and rhyolite with a small percentage of sand. The bars are generally less than 10 feet thick, but a few are as much as 15 feet thick.

Channel and Bar Gravel is not normally recommended for extraction for the following reasons:

1. The deposits are small in aerial extent and only a few feet thick. Quantities are, therefore, minor.
2. For uses other than concrete, for example, fill or embankment or road-base material, lower grade gravel is suitable.
3. Removal of channel and bar gravel causes rapid channel changes which can be damaging to property along the river and can cause erosion of the older gravel deposits.
4. Floodplain Gravel is generally locally available and can be extracted with less adverse an effect on the riverbed and stream ecology than can extraction of Channel and Bar Gravel.
5. After the proposed Lost Creek Dam is built, much of the river's source for gravel will be trapped behind the reservoir, and the downstream river bars and channel gravels will not be replaced.

In certain cases, however, a large bar or island of gravel which would restrict or divert the stream during high water might be removed or modified to advantage. In such cases, a hydrologic study should be made to ascertain the need for such stream-bed modification. In addition, diking, filtration, vegetation stripping, and antipollution practices should be performed in accordance with the recommendations of the State Fish Commission, State Game Commission, Environmental Quality Control Division of the State Board of Health, the U.S. Army Corps of Engineers, and other departments and agencies as stipulated by law.

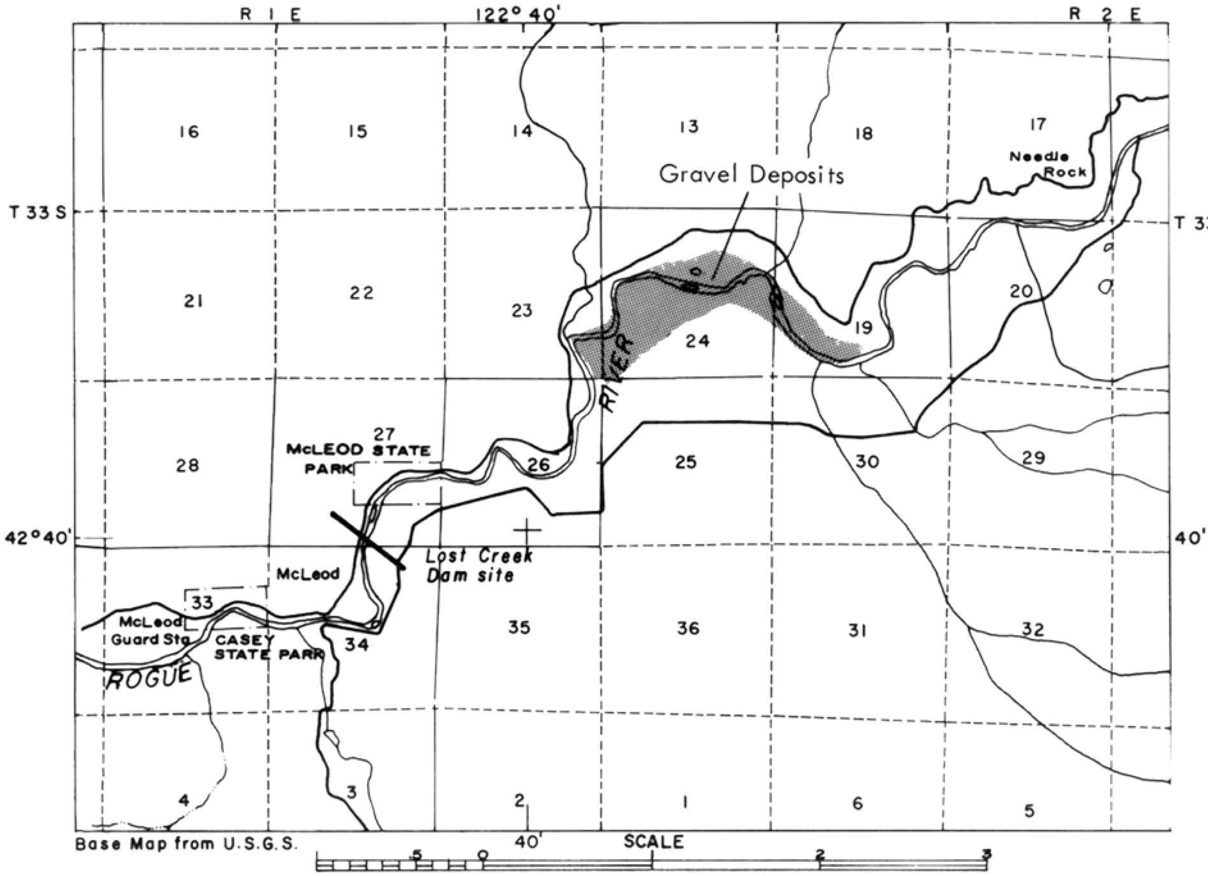
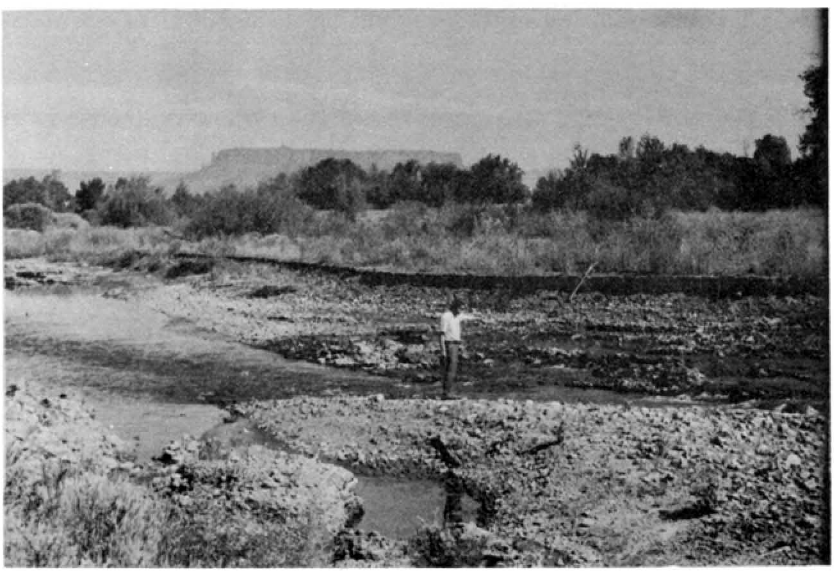


Figure 6. Gravel deposits in the reservoir area of Lost Creek Dam site.



Thin Bear Creek Floodplain Gravel with underlying Terrace Gravel unit exposed in stream channel.

Gravel pit in Rogue River floodplain.

Rogue River Floodplain Gravel undergoing erosion by river.

Summary of Gravel Reserves

The following is a summary of the total gravel reserves in the study area at the present time. It should be noted that computations of gravel reserves are based on estimated quantities only, with allowances made for waste, landscaping, and river-bank protection, and for material already removed. The amount of sand and gravel which will actually be available in the future for Jackson County will depend on how the land is used. Land planning and appropriate zoning will be necessary to protect these gravel reserves for future consumption.

Total (recoverable) gravel reserves	
Rogue River Floodplain Gravel	10,000,000 tons
"Bear Creek gravel"	14,000,000 tons (350 acres)
Terrace Gravel	20,000,000 tons (450 acres)
Bench Gravel	20,000,000 tons (350 acres)

The Rogue River gravel deposits include gravel units (exclusive of the stream bed) from the mouth of Bear Creek to Dodge Bridge. Gravel beds upstream are either too small or too far from the markets to be considered favorably.

Gravels available from Bear Creek are almost entirely restricted to the area north of Medford. They include the older Terrace Gravel units which underlie the younger Floodplain Gravel; both must be extracted simultaneously to be economical. Much of the area underlain by these gravels is occupied by agricultural and orchard lands.

The area underlain by Terrace Gravel is flat and lies above the flood elevation. At present it is occupied by streets, highways, a railroad, the Medford airport, and residential and industrial sites. If a significant quantity of this gravel is to be utilized, existing undeveloped areas will have to be excluded from urban encroachment.

Present information from scattered, deep water wells indicates that the Agate Desert area is underlain extensively by the Bench Gravel unit. Certain portions of this gravel will soon have to be set aside for future production, because the area is rapidly being developed for other industrial purposes.

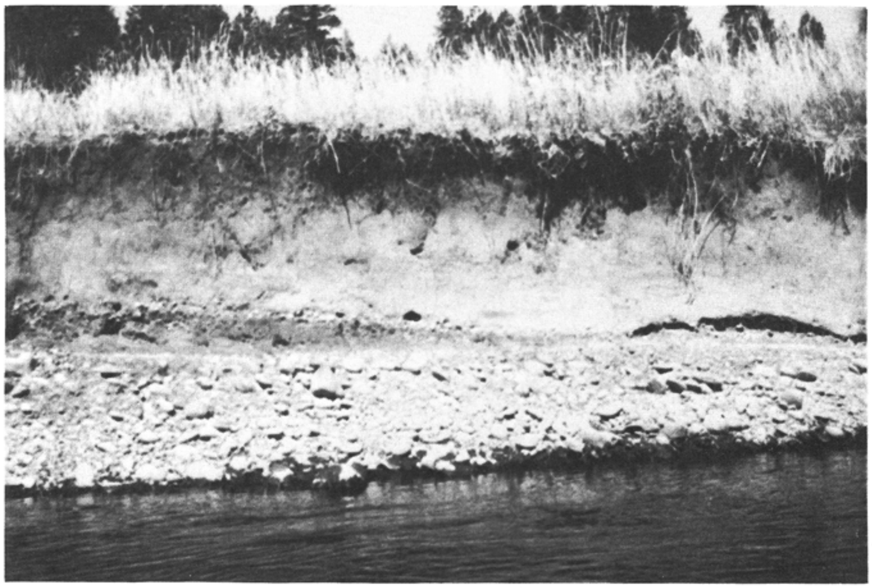
The quantity and quality of gravel available in these four source areas are discussed below in more detail.

Rogue River gravels

Channel, Bar, and narrow Floodplain Gravels occur along the Rogue River between Savage Rapids Dam near the Josephine County line and the mouth of Bear Creek. In this area there is an estimated 6 million tons of gravel; however, nearly all of it is covered by freeway, residential, and other land uses, making significant gravel recovery here unlikely.

Most of the gravel reserves in the Rogue near enough to be marketed in Medford occur from the mouth of Bear Creek upstream to Dodge Bridge. This gravel is on the wide floodplain and can be removed without disturbing the stream channel. From Reese Creek to Shady Cove the deposits are small and appear to average less than half a million tons at each locality for a total of about 2.8 million tons. This material will probably be limited to local use because of haul distances. In the proposed Lost Creek Reservoir area, an indicated 6 million tons of gravel could be extracted; however, its distance from the market appears to make its use unlikely other than locally. The maximum amount of gravel that the Rogue River could be expected to supply to the Medford area is estimated to be about 10 million tons.

The Rogue River gravels are of good quality and are suitable for use in portland cement concrete. The gravel is unweathered, contains little silt, and is uncemented. The results of laboratory tests on Rogue River gravels from four localities are given in the appendix.



Sandy silt overlying Rogue River Floodplain Gravel.

Terrace Gravel unit exposed in Bear Creek north of Medford.

Bear Creek gravels

The name "Bear Creek gravel" as used in this report refers to gravel deposited on the floodplain of Bear Creek and the Terrace Gravel unit which underlies the floodplain north of Medford. Gravel deposited by Bear Creek is about 6 to 8 feet thick and has 1 to 2 feet of soil overburden. The underlying older gravel unit is 20 to 30 feet thick.

Until recent years gravel producers had used only the upper gravel deposited by Bear Creek. This practice resulted in the disturbance of large areas of ground from which relatively minor amounts of material were produced.

In the area north of Medford, estimates indicate that the Bear Creek floodplain contains about 14 million tons of available gravel. From observations of existing gravel pits, a recovery of about 40,000 tons of material can be expected per acre of ground. The recovery of 14 million tons of aggregate will require at least 350 acres of land in addition to plant and stockpile sites. If Bear Creek were the only source of gravel being utilized, the available supply would probably be entirely gone in about 10 years.

South of Medford, the recoverable gravels are much thinner, generally only 6 to 10 feet, and are underlain in the bed of the creek by shale and sandstone bedrock. Present information indicates that about 1.8 million tons of gravel is still recoverable; but it is anticipated that this material will probably be used to a very limited extent if at all.

The quality of Bear Creek gravel ranges from fair to poor, depending upon the methods used in processing it. The strength of concrete produced from this material can be varied to meet the desired specifications by modifying the mix.

Laboratory tests of the gravel have been obtained from two gravel pits north of Medford and two localities south of the city. The test results appear in the appendix.

Terrace Gravel unit

The Terrace Gravel unit is especially extensive in the area north of Medford. The unit is bounded on the east by a sharp, higher terrace composed of Bench Gravel. On the west, the Terrace Gravel is bounded by the younger Bear Creek Floodplain Gravel unit and also underlies it.

As previously described, the Terrace Gravel is cross bedded, with steep foreset beds, and contains lenses of sand, silt, and clay. The gravels are partially weathered and in places weakly cemented with iron oxide deposits. Special preparation is often required to remove the clay and silt particles when clean aggregate is required. Laboratory test data from one locality is given in the appendix.

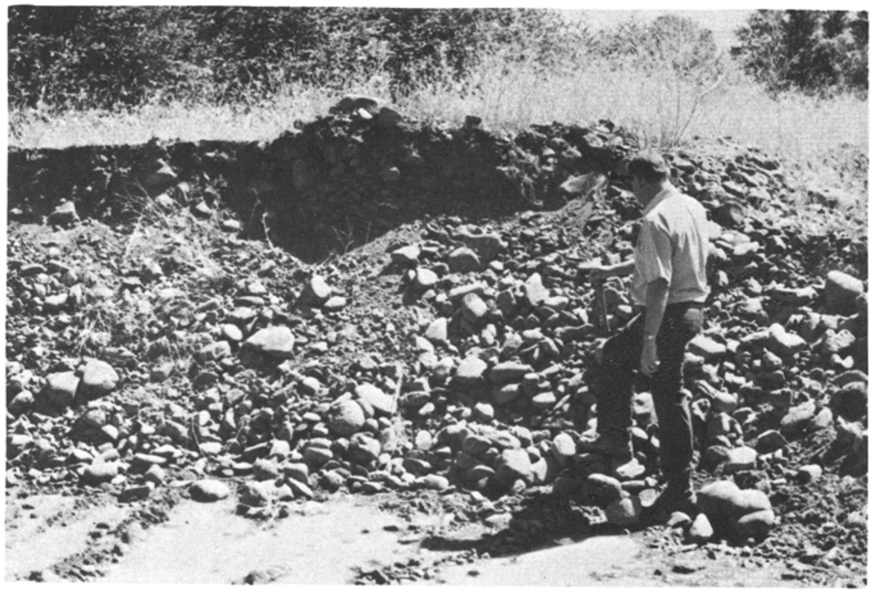
Present available information indicates that soil overburden on the gravel ranges from 5 to 12 feet in thickness. Subsurface investigations by drilling will be required to determine the actual thickness of overburden, together with the thickness and quality of the gravel.

The Terrace Gravel unit has large reserves of gravel, but its position above the floodplain and the flat configuration of its surface have resulted in its having been developed extensively for agriculture, housing, industry, and transportation facilities, thereby severely limiting the amount of land available for gravel. Preliminary information indicates that there are about 20 million tons of recoverable Terrace Gravel north of Medford, and that this tonnage would require about 450 acres of land to produce this amount.

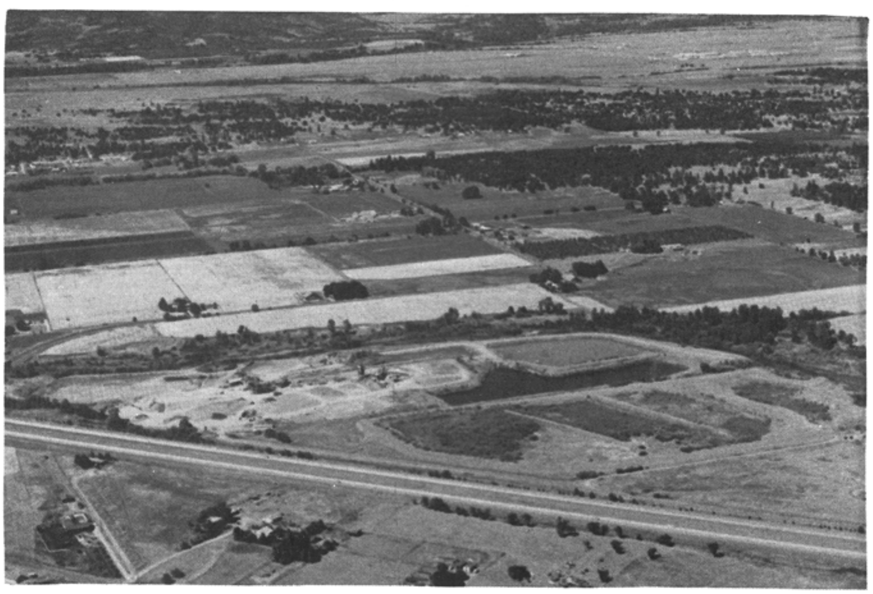
Bench Gravel unit

On the basis of available information, the largest gravel reserve for the region is in the area of Bench Gravel in the Agate Desert north and northeast of Medford. Although much of the Agate Desert land is presently used for other purposes, there are areas that could be delegated for gravel extraction. These areas may not be available in the future, however, if action to preserve them is not taken soon.

Logs from deep water wells indicate that the Bench Gravel extends to an average depth of 40 feet. It is composed of boulders, cobbles, and pebbles, and in places is cemented with iron and clay.



Bear Creek Floodplain Gravel.



Gravel pit operation adjacent to freeway north of Medford.

In the northern part of the area the top 6 feet is a layer of rust-brown gravel. The soil overburden ranges from a few inches to 20 feet in thickness, but usually is less than 10 feet.

The area underlain by recoverable Bench Gravel is estimated to contain about 20 million tons of sand and gravel. This tonnage will require 350 acres of land. In calculating the volume of this gravel, about 25 percent should be considered waste; however, in certain cases the waste material may be marketable as fill.

Laboratory information on Bench Gravel at only one site is given in the appendix; however, field studies indicate that the material is comparable in quality to the Terrace Gravel. Experience has shown that special equipment for washing, screening, and scrubbing is necessary in order to produce satisfactory concrete aggregate.

Estimated Gravel Requirements for the Future

As shown in an earlier section of this report (Population Growth and Gravel Needs), calculations based on population indicate that the per-capita consumption of sand and gravel in Jackson County is about 10.2 tons per year. These annual requirements can be predicted for future years by multiplying the per-capita figure by the projected population (figure 7). A cumulative production curve based on the predicted annual production has been calculated to show the total amount of sand and gravel resources that will be consumed by a certain date (figure 8). This graph also shows the probable available reserves from each gravel unit and the life of these deposits.

Between 1960 and 1969, Bear Creek yielded 68 percent of the sand and gravel used in the area, while the Rogue River contributed the remaining 32 percent. Present information indicates that, if only Bear Creek gravel and Rogue River gravel are used to supply aggregate for the area, these reserves will be depleted by about 1982 (figure 8). Therefore, it is abundantly clear that Terrace Gravel and Bench Gravel will also have to be utilized in order to extend the life of sand and gravel

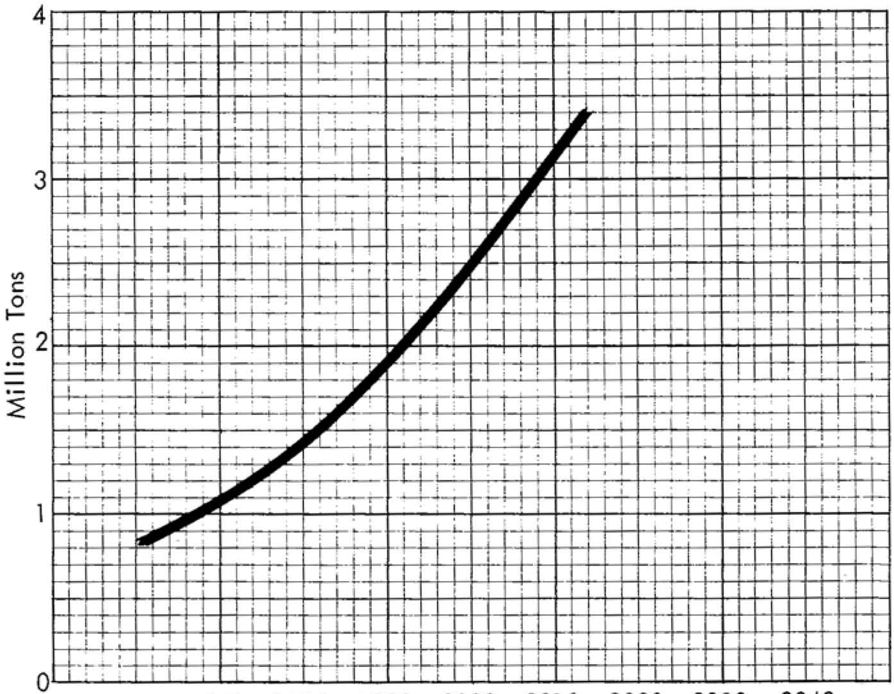
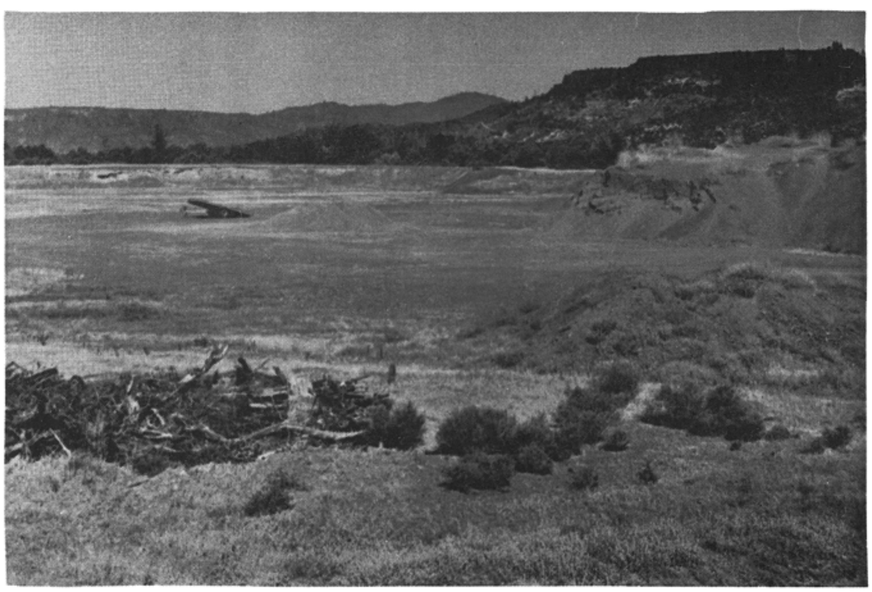


Figure 7. Projected annual sand and gravel production curve.

Gravel pit in Bench Gravel unit southeast of White City.



Gravel pit in Bench Gravel unit one mile north of White City.

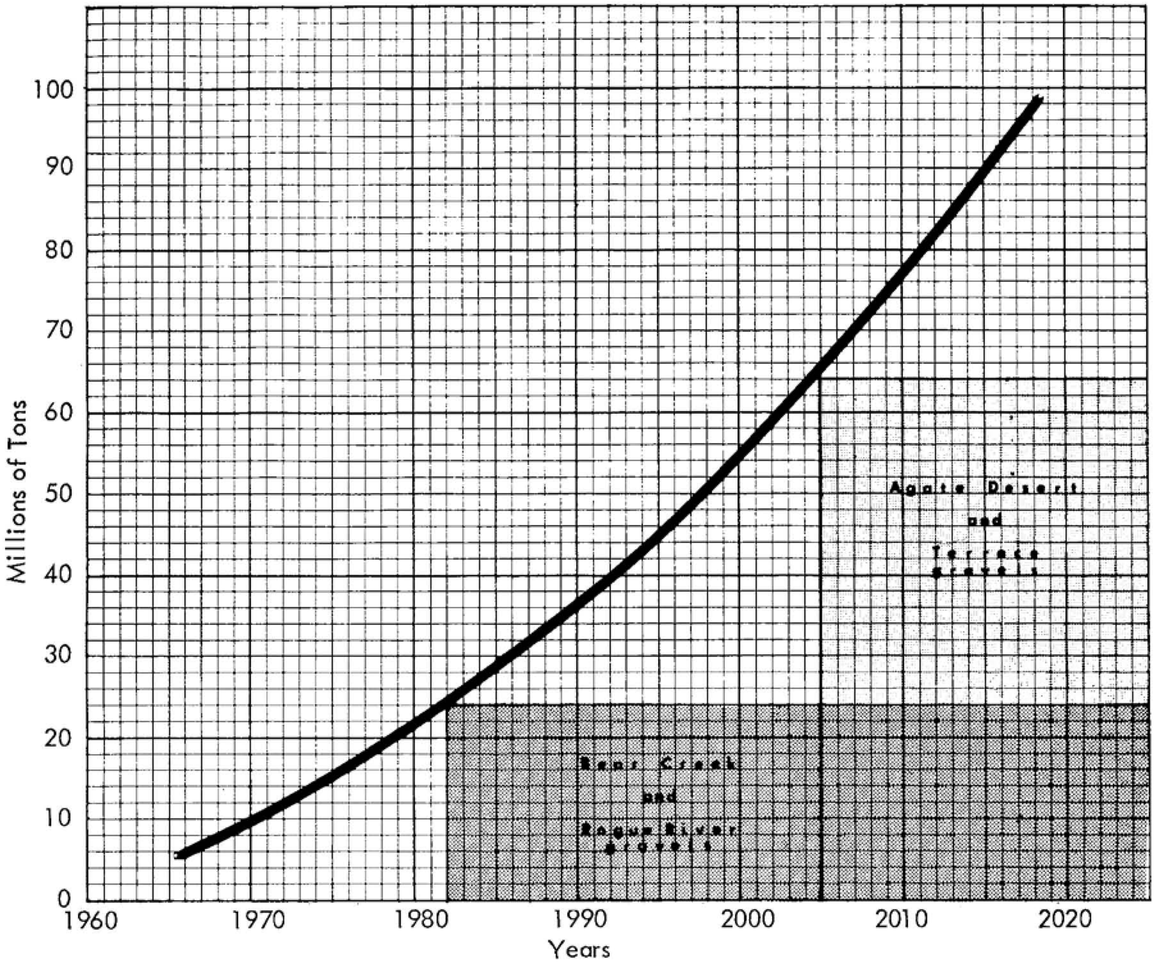


Figure 8. Cumulative sand and gravel production curve showing predicted life of the gravel reserves.

production in the Medford area. As shown in figure 8, the use of these gravels can prolong the availability of sand and gravel in the area until the year 2005. By that time, 64 million tons of sand and gravel will have been consumed.

Summary and Conclusions

Rogue River Channel and Floodplain Gravels require only washing and screening and crushing of the oversize material to produce concrete aggregate. Unfortunately, the tonnage of Rogue gravel is too small to fill the growing needs of the area, so the industry must rely on the lower quality Bear Creek, Terrace, and Agate Desert gravels. These gravels contain silt and clay lenses and the individual grains have surface coatings that must be removed by special scrubbing, but, when properly treated, the gravels produce satisfactory concrete aggregate.

The Rogue River can supply about 10 million tons of aggregate from its floodplain, from the mouth of Bear Creek upstream to Dodge Bridge. Elsewhere the recovery of Rogue gravel is limited by existing land uses, the small size of the deposits, or excessive distance from markets.

Bear Creek gravel occurs in the floodplain area north of Medford and includes the upper Bear Creek-deposited gravel and the underlying "bedrock" gravel. Assuming that 350 acres of land can be made available for gravel production, about 14 million tons can be extracted.

Terrace Gravel occurs mainly between the floodplain of Bear Creek and the edge of the Agate

Desert. Most of this land is already allocated for purposes other than gravel extraction. Well logs indicate that approximately 45,000 tons of aggregate can be produced from one acre of ground. Therefore, 450 acres of land will be needed to produce the 20 million tons required for the future.

The Agate Desert area is extensively underlain by sand and gravel. Preliminary estimates indicate that about 60,000 tons can be produced from one acre of ground. The 20 million tons of gravel needed from this area by the year 2005 will require 350 acres of land.

It has been the experience in other rapidly developing regions that extensive gravel deposits have been lost to over-building and other conflicting land uses. Possibly as much as 75 percent of the presently available sand and gravel resources in the Bear Creek Valley and the Agate Desert will be lost unless action is taken very soon.

The life of the gravel resources of the Bear Creek and Rogue River Valleys, together with the Agate Desert area, if properly directed can be prolonged until about the year 2005 A.D. Planners will have to decide on the size and location of parcels of land to be set aside in order to assure adequate gravel for the future.

BIBLIOGRAPHY

Central Lane Planning Council, 1968, Sand and gravel: Eugene, Oregon, Central Lane Planning Council.

Gray, Jerry J., 1960-1968, Mineral industry of Oregon: Albany, Oregon, U.S. Bur. Mines.

Jackson County Technical Advisory Committee, 1969, Bear Creek Transportation Study, Jackson County, unpub.

Kom, T.N., Kelber, L., and Reid, D., 1966, Regional park and recreation plan, Bear Creek Urban Region, Jackson County, Oregon: Univ. Oregon Bur. Municipal Research and Service.

MacConnell, Earl H., 1966, Population estimates for counties and incorporated cities: Portland State Univ. Center for Population Research and Census.

Metropolitan Planning Commission, 1964, Sand and gravel resources of the Portland metropolitan area: Portland, Ore., Metropolitan Planning Commission.

Peck, Dallas L., and others, 1964, Geology of the central and northern parts of the Western Cascade Range in Oregon: U.S. Geol. Survey Prof. Paper 449 (in coop. with Oregon Dept. Geology and Mineral Industries).

Power, W. E., and Rother, E.W., 1969, Interim Soil Survey Report, Jackson area, Oregon: U.S. Dept. Agriculture Soil Cons. Service (in coop. with Oregon Agric. Exp. Sta.).

Schlicker, Herbert G., 1961, Gravel resources in relation to urban development in the Salem area: Oregon Dept. Geology and Mineral Industries and Mid Willamette Valley Council of Governments, Salem, Oregon.

__________, 1969, Sand and gravel in Oregon: in Mineral and water resources of Oregon: Oregon Dept. Geology and Mineral Industries Bull. 64, p. 233-236.

Schlicker, Herbert G., and Deacon, R. J., 1967, Engineering geology of the Tualatin Valley region, Oregon: Oregon Dept. Geology and Mineral Industries Bull. 60.

Wells, Francis G., 1939, Preliminary geologic map of the Medford quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries geol. map.

__________, 1940, Preliminary geologic map of the Grants Pass quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries geol. map.

__________, 1956, Geologic map of the Medford quadrangle, Oregon-California: U.S. Geol. Survey Geol. Quad. Map GQ-89.

Wells, F. G., and Peck, D. L., 1961, Geologic map of Oregon west of the 121st meridian: U. S. Geol. Survey Map I-325 (in coop. with Oregon Dept. Geology and Mineral Industries).

Wilkinson, W. D., and others, 1941, Reconnaissance geology of the Butte Falls quadrangle, Oregon: Oregon Dept. Geology and Mineral Industries geol. map.

U.S. Army, Corps of Engineers, 1965, Jackson County, Oregon floodplain information interim report: Portland, Ore., U.S. Army Engineer District.

APPENDIX

LABORATORY TESTS

BENCH GRAVEL

Bench Gravel Site
(SE¼ sec. 1, T. 37 S., R. 2 W.)

% Retained on sieve	% Single sieve	% Accu-mulated
4	0	0
3	4.4	4.4
2	5.4	9.8
1½	9.6	19.4
1	20.7	40.1
3/4	7.3	47.4
½	9.5	56.9
¼	10.8	67.7
10	17.1	80.8
40	12.9	93.7
80	3.7	97.4
200	1.3	98.7
Pass 200	1.3	100.0

Abrasion	29.0
Specific gravity	2.69
Na_2SO_4	20.1
Plasticity	18
Liquid limit	44

TERRACE GRAVEL

Game Commission property in Butte Creek
(SE cor. sec. 36, T. 35 S., R. 1 W.)

% Retained on sieve	% Single sieve	% Accu-mulated
3	0	0
2	13	13
1½	5	18
1	15	33
3/4	7	40
½	9	49
¼	12	61
4	5	66
10	13	79
40	14	93
80	4	97
200	2	99
Pass 200	1.2	1.2
Pass 200 wet	0	6.6

Abrasion	18.6
Specific gravity	2.74
Plasticity - fines	19
Liquid limit - fines	59
Sand equivalent	16
Degradation	22.8
Height	2.3

Explanation

Abrasion according to A.A.S.H.O. T-96
Resistance to abrasion of coarse aggregate by use of Los Angeles Machine.
Specific gravity - absolute measured on solids.
Oregon Degradation Test, Oregon State Highway Department.

Glasscock property - Talent

% Retained on sieve	% Single sieve	% Accumulated
2½	0	0
2	5.3	5.3
1½	20.7	26.0
1	41.4	67.4
3/4	13.7	81.1
½	9.2	90.3
¼	5.3	95.6
10	2.2	97.8
40	.9	98.7
Pass 40	1.3	100.0

Abrasion 28.1
Specific gravity . . 2.73
Plasticity 0
Liquid limit 23

Bell Pit - near Central Point

% Retained on sieve	% Single sieve	% Accumulated
1½	0	0
1	15	15
3/4	11	26
½	11	37
¼	26	63
4	9	72
10	10	82
40	11	93
80	4	97
200	1	98
P- 200	1.8	99.8
P- 200 wet	2.9	- -

Abrasion . . . . .
Specific gravity . . 2.81
Plasticity. 0
Liquid limit 20

Emigrant Creek
(SW¼SW¼ sec. 17, T. 39 S., R. 2 E.)

% Retained on sieve	% Single sieve	% Accumulated
5	0	0
4	12.1	12.1
3	8.0	20.1
2½	8.8	28.9
2	11.8	40.7
1½	4.6	45.3
1	8.2	53.5
3/4	4.6	58.1
½	6.0	64.1
¼	11.6	75.7
10	12.3	88.0
40	7.0	95.0
80	2.4	97.4
200	1.5	98.9
Pass 200	1.1	100.0

Abrasion 23.6
Specific gravity . 2.76
Plasticity. . . . 16
Liquid limit . . . 39

Degraded material .
Plasticity . . 0
Liquid limit . . 21

Bear Creek - North of Medford

Abrasion 22.4
Specific gravity . . 2.78
Na_2SO_4 . . . . . 2.2

Elk Creek Reservoir Site
(SE¼ sec. 23, T. 35 S., R. 1 E.)

Sieve analysis

% Retained on sieve	% Single sieve	% Accumulated
6	0	0
5	6.4	6.4
4	17.8	24.2
3	32.9	57.1
2½	12.4	69.5
2	8.5	78.0
1½	5.4	83.4
1	2.0	85.4
½	.2	85.6
½	.1	85.1
¼	.1	85.8
10	.2	86.0
40	1.3	87.3
Pass	12.7	100.0

Abrasion	27.2
Specific gravity .	2.98
Na_2SO_4	.7
Liquid limit - fines	33
Degraded material	
Plasticity . . .	0
Liquid limit . .	22

Kendall Bar
(W½ sec. 16, T. 36 S., R. 2 W.)

Sieve analysis

% Retained on sieve	% Single sieve	% Accumulated
3	0	0
2	8.3	8.3
1½	8.0	16.3
1	11.8	28.1
3/4	9.9	38.0
½	11.5	49.5
3/8	6.2	55.7
¼	6.8	62.5
Pass	37.5	100.0

Abrasion	16.3
Specific gravity	2.74
Air degradation	20.17
Height	1.2 in.

Dennis Bar
(NE¼ sec. 28, T. 34 S., R. 1 W.)

% Retained on sieve	% Single sieve	% Accumulated
5	0	0
4	7	7
3	6	13
2	12	25
1½	8	33
1	12	45
3/4	5	50
½	6	56
3/8	4	60
¼	3	63
4	2	65
10	6	71
40	21	92
80	6	98
200	1	99
Pass 200	.5	99.5
Pass 200 wet	.9	99.9

Abrasion	18.5
Specific gravity	2.76
Plasticity	0
Liquid limit	19
Oregon air degradation, pass 20	21.0
Height	0.7 in.

County Pit - Military Road Bridge

Abrasion	18.1
Specific gravity . . .	2.75
Plasticity - natural fines .	0
Liquid limit	20
Degraded material	
Plasticity index . .	0
Liquid limit	26

GEOLOGIC TIME CHART

AGE DIVISIONS: ERA	PERIOD	EPOCH	DOMINANT LIFE: ANIMAL	DOMINANT LIFE: PLANT	TIME: DURATION IN MILLIONS OF YEARS: ERA	PERIOD	EPOCH	BEGINNING MILLIONS OF YEARS AGO *
CENOZOIC	QUATER-NARY	HOLOCENE	MAN		63.011	1.011	0.011	0.011
		PLEISTOCENE					1	1
	TERTIARY	PLIOCENE				62	12	13
		MIOCENE	MAMMALS	FLOWERING TREES AND SHRUBS			12	25
		OLIGOCENE	BONY FISH BIRDS				11	36
		EOCENE	SHELL FISH ARTHROPODS				22	58
		PALEOCENE**					5	63
MESOZOIC	CRETACEOUS				167	72		135
	JURASSIC		REPTILES	CONIFERS CYCADS GINKGOS FERNS		46		181
	TRIASSIC					49		230
PALEOZOIC	PERMIAN			SCALE TREES	370	50		280
	PENNSYLVANIAN (CARBON-IFEROUS)		AMPHIBIANS INSECTS	CORDAITES TREE FERNS		40		320
	MISSISSIPPIAN (CARBON-IFEROUS)			CALAMITES		25		345
	DEVONIAN		SHARKS	PRIMITIVE SCALE TREES AND TREE FERNS		60		405
	SILURIAN**		LUNGFISH	PSILOPHYTES		20		425
	ORDOVICIAN**		CORALS BRACHIOPODS			75		500
	CAMBRIAN**		ECHINODERMS TRILOBITES	FUNGI ALGAE		100		600
PRE-CAMBRIAN	GRENVILLE OROGENY **		BEGINNING OF PRIMITIVE PLANT AND ANIMAL LIFE		4000			1000
	OLDEST KNOWN ROCKS IN NORTH AMERICA**							3200
	OLDEST KNOWN ROCKS (MURMANSK AREA)**							3400
	PROBABLE AGE OF THE EARTH							4600

*ADAPTED FROM KULP, 1961

**ROCKS OF THIS AGE NOT KNOWN TO EXIST IN OREGON

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES


JOSEPHINE CO.
JACKSON CO.
ROGUE RIVER
Mv
Mv
Mv
Mv
Mv
Mv
Mv
Mv
Mv
Tg
Tg
Tg
Tg
Cg
Abn
Ms
Savage
103
104
105
106
99
ROGUE
RIVER
Sheet 1

GRAVEL UNITS

Holocene	Cg	Channel and Bar Gravel. Occurs in the Rogue River. No overburden; very clean; nonweathered; thickness 1 to 15 feet.
Holocene	Fpg	Floodplain Gravel. Occurs in terraces of modern flood plain at several levels. Overburden about 1 to 5 feet of sand and sandy silt. Thickness generally 5 to 15 feet.
Holocene	Tg	Terrace Gravel. Occurs in terrace adjacent to the modern flood plain of the Rogue River and Bear Creek. Its upper boundary roughly coincides with the height of the 1964-65 "100-year" flood. Sand, silt, and clay overburden. Thickness as much as 40 feet (Wells, 1956).
Pleistocene	Bg	Bench Gravel. Occurs in uppermost gravel terrace and in Agate Desert area. Terraces at several levels, but generally at 1250 to 1300 feet elevation. Not subject to flooding. Consists of cross-bedded, poorly sorted, subrounded boulders and pebbles and dark-gray sand. Weakly cemented. Overlain in most areas by a sandy silt layer containing some gravel.

BEDROCK UNITS

Plio.?	Tpm	Pre-Mazama basalt flows capping Upper and Lower Table Rock.
Olig.-Mio.	Tmop	Fragmental volcanic rocks. Includes tuff, lithic tuff, tuff breccia, and local conglomerate.
Eocene	Ten	Nonmarine sedimentary rocks. Includes thick-bedded, massive, fine-to-medium sandstone, conglomerate with thin siltstone interbeds, shale, and some coaly layers.
Cretaceous	Kh	Hornbrook Formation. Well-bedded, fine, greenish-gray feldspathic marine sandstone, locally gold bearing; local conglomerate and sandy shale.
	Di	Diorite intrusions of Upper Jurassic or Lower Cretaceous age.
Triassic		Applegate Group:
Triassic	Ms	Metasedimentary rocks. Altered tuffaceous sediments, argillite, quartzite, chert, and limestone.
Triassic	Mv	Metavolcanic rocks. Altered lava flows, flow breccia, and pyroclastics with some intrusive rocks.

Area of sand and gravel

Approximate limits of 1861 flood

23 — River miles from 1923 U.S.G.S. Survey

500 0 1000 2000 feet

Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

Base photograph from U.S. Army Corps of Engineers, February 1965.

Ms
Creek
Mv
Ward
Bg
Mv
Rogue River
Evans
Creek
Tg
Cg
Mv
ROGUE
RIVER
SOUTHERN
PACIFIC
Tg
Cg
Tg
Tg
Mv
Mv
Ms
Sheffiein
Gulch
Mv
Tg
Mv
Mv


Mv
Mv
Mv
Tg
Tg
Tg
Cg
112
234
RIVER
ROGUE
SOUTHERN
PACIFIC
Gold Hill
Mv
Tg
Cg
Tg
111
Fpg
99
Mv
Mv
Tg
Cg
Cg
110
Fpg
Cg
Cg
Tg
Mv
MILLERS
GULCH
Mv

Sheet 3


Mv
Tg
Rock Point
113
Mv
ROGUE
Mv
Cg
Tg
Sardine Creek
Mv
114
SOUTHERN
PACIFIC
Ms
Mv
NUGGET BUTTE
Ms
NORTH
99
Mv
Tg
Cg
Tg
Cg
RIVER
Mv
Gold Hill
Mv
115
Mv
Ms
Tg
Tg
Mv
Mv
Cg
Cg
Mv
Mv
Mv
Mv
Kane Creek
Sheet 4


Ms
Mv
Sams Creek
Mv
Tg
119
118
ROGUE
RIVER
Ms
Mv
Cg
Di
Tg
Cg
Tg
SOUTHERN
PACIFIC
Ms
117
Mv
Mv
Tg
Mv
Di
Mv
120
Mv
Mv
Gold Hill
116
Mv
GOLD HILL
Cg
Cg
Tg
Mv


Ten
Cg
Cg
Tg
Mv
NORTH
Ten
Ten
Mv
121
Di
ROGUE
PACIFIC
Fpg
Kelly
Slough
123
Fpg
Cg?
Di
122
RIVER
Cg?
Di
Fpg
Fpg
Di
Fpg
Bear
Creek
Tg
Tg
Bg
Mv
Di
Sheet 6

Lower Table Rock
Ten
Ten
Tpm
Bg
Bg
Tg
Creek
Solider
Fpg
Fpg
ROGUE
RIVER
Cg
Cg
Cg
Cg
Cg
Cg
Cg
Cg
Cg
Fpg
Fpg
Fpg
Fpg
Tg
Tg
Tg
Tg
Tg
Tg
Tg
Bg
Bg
Bg
Bg
Fpg
Bear
Creek
Whetstone
Creek
End of Survey
KIRTLAND
ROAD
SOUTHERN
PACIFIC
NORTH
123
124
125
126


Ten
Ten
Bg
Cg
MODOC ROAD
Bg
Ten
Fpg
Fpg
Bg
Ten
TABLE ROCK ROAD
Table Rock
g
Ten
Little Butte Creek
Ten
Tg
RIVER
Fpg
Fpg
Cg
Tg
Fpg
Bg
Cg
ROGUE
Cg
Cg
Fpg
Bg
Bg
White City


MODOC ROAD
ROAD
NORTH
ROGUE RIVER
AGATE ROAD
Bg
Tg
Ten
Cg
Fpg
Tmop
132
Sheet 9


Bg
Bg
Bg
Mv
SAMS VALLEY ROAD
NORTH
Tmop
Mv
Very thin
Bg / Toup
-Tg
Ten
Ten
Fpg
Fpg
Bg
Dodge Bridge
ROGUE
RIVER
Ten
Ten
Fpg
Cg
Cg
Cg
Cg
Fpg
Fpg
Fpg
Ten
Cg
Tmop
Fpg
Fpg
Tmop
Bg
AGATE ROAD
Tmop
Bg - Very
Thin over
bedrock
Fpg
Bg
Hog Creek
Tmop / Mv

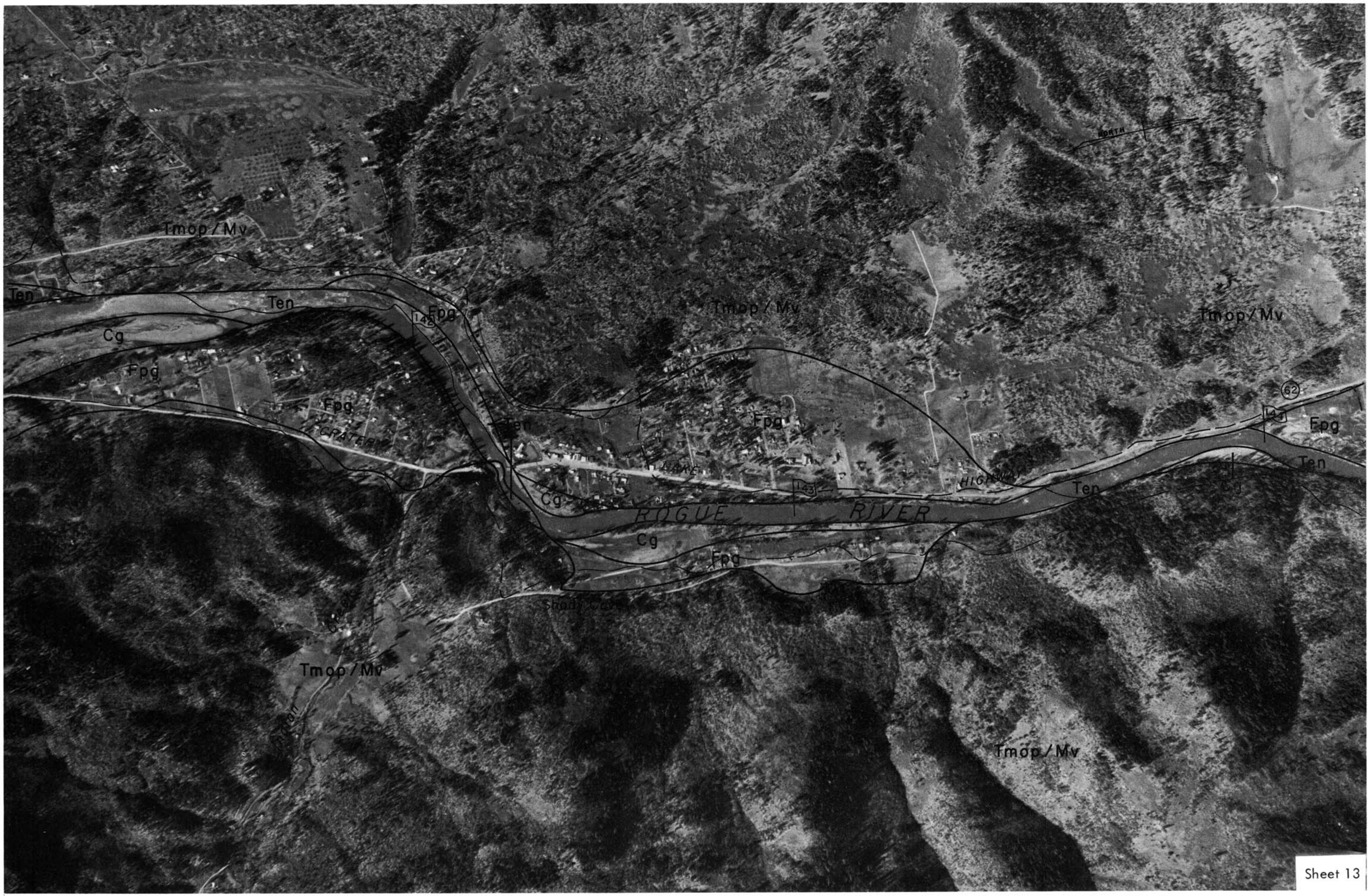
Sheet 10


NORTH
Dry Creek
Tmop
Tmop
Ten
57
Fpg
Ten
RIVER
Cg
Tmop
Cg
Fpg
58
Cg
Bg
Very thin gravel
over bedrock
Fpg
ROGUE
Fpg
Fpg
Cg
Cg
Ten
Fpg
Cg
Fpg
Tmop
56
Cg
Cg
Thin Tg over Tmop bedrock.
Cg
Ten
Fpg
Cg
Fpg
Reese
Creek
Tmop
CRATER LAKE HIGHWAY
62

Sheet 11


Tmop
Ten
Cg
ROGUE
Fpg
Tmop
Fpg
Fpg
Ten
Cg
Cg
Tmop
Fpg
Cg
Cg
Mv
Ten
Ten?
Ten
RIVER
Cg
Cg
Cg
Fpg
Thin Bg/Tmop
Fpg
Tmop
Lange
Tmop
Creek
HIGHWAY
LAKE
CRATER
Long

Sheet 12


Tmop / Mv
Ten
Ten
Fpg
142
Cg
Fpg
Fpg
CRATER
Ten
Tmop / Mv
Tmop / Mv
62
Fpg
Fpg
Ten
Ten
Cg
ROGUE RIVER
Cg
Fpg
Tmop / Mv
Tmop / Mv

Cg
Fpg
Bg
ROGUE RIVER
Ten
Tg
ROAD
Butte
Creek
NORTH
Little
Cg
Ten
Ten
End of 1861 Survey
Cg
Fpg
Bg
62
Antelope
Creek
HIGHWAY
End of Survey
AGATE
LAKE
CRATER
VETERANS HOSPITAL

Sheet 14

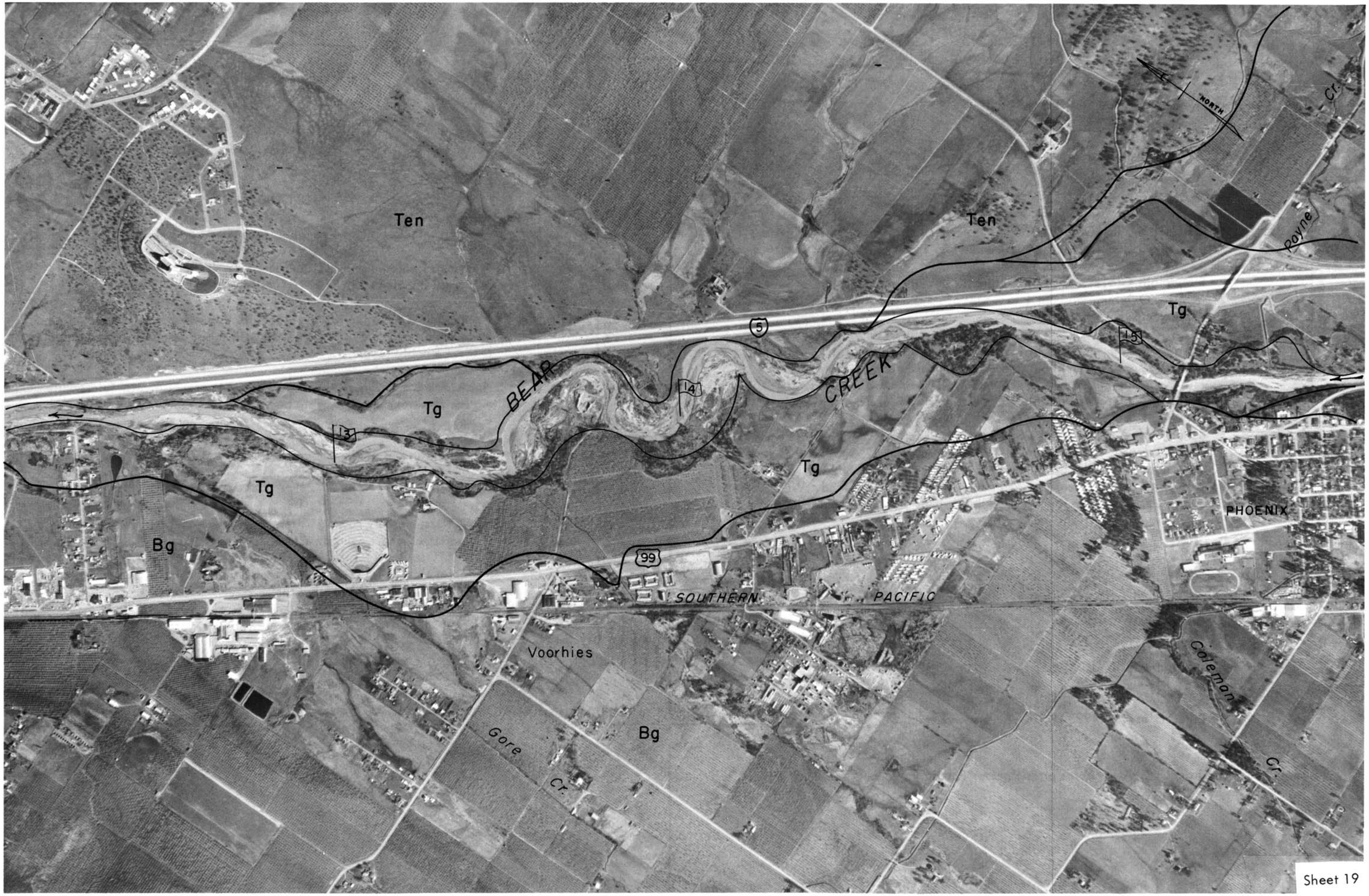
KIRTLAND
ROAD
NORTH
Bg
End of 1861 Survey
Tg
BEAR
CREEK
Tg
Tg
Tg
xx
Tg or Bg
Bg
Tg
Tg
Seven
Oaks
Tg
Willow
Bg
99
5
S. P.
SOUTHERN
PACIFIC
Tg
Mv
Creek
Bg

MEDFORD AIRPORT
Midway
TABLE ROCK ROAD
NORTH
Bg
Tg
Tg
BEAR CREEK
Tg
5
Tg
Bg
Bg
Tg
Bg
Seven Oaks
Griffin Cr
CENTRAL POINT
99
SOUTHERN PACIFIC
4
5
6
7

Sheet 16


Bg
LOGGING
ROAD
62
NORTH
Bg
Bg
Tg
MEDFORD
AIRPORT
TABLE
ROCK
ROAD
BEAR
CREEK
5
8
7
9
10
Tg
Tg
Tg ?
Tg
Tg
Tg
CANAL
Bg
MEDFORD
Bg
Bg
99
HOPKINS

Ten
MEDFORD
NORTH
Ten
Larson
Cr.
Ten
Bg
CREEK
12
Ten
Mv
Tg
BEAR
11
10
5
Bg
99
SOUTHERN
PACIFIC
Sheet 18



Ten
Ten
NORTH
Payne Cr.
5
Tg
15
BEAR
CREEK
14
Tg
13
Tg
Tg
Tg
PHOENIX
Bg
99
SOUTHERN PACIFIC
Voorhies
Coleman Cr.
Gore Cr.
Bg


Ten
Payne Cr.
Older Stream Valley Miocene
Ten
CANAL
Kenutchen Cr.
Ten
CREEK
Tg
5
BEAR
Tg
6
Tg
Mv
Tg
Tg
Bg
CANAL
99
Ten
Bg
PHOENIX
Anderson Cr.
Bg
TALENT
PACIFIC
SOUTHERN
Sheet 20


NORTH
Ten
Ten
5
Meyer Cr.
20
ASHLAND 3 Mi.
CREEK
BEAR
Mv
18
19
Bg
Ms
Tg
Bg
99
Kh
PACIFIC
Wagner
Ms
SOUTHERN
TALENT
LATERAL
Cr.
Bg
TALENT

Sheet 21

GRAVEL UNITS

Holocene

- **Cg** — Channel and Bar Gravel. Occurs in the Rogue River. No overburden; very clean; nonweathered; thickness 1 to 15 feet.
- **Fpg** — Floodplain Gravel. Occurs in terraces of modern flood plain at several levels. Overburden about 1 to 5 feet of sand and sandy silt. Thickness generally 5 to 15 feet.
- **Tg** — Terrace Gravel. Occurs in terrace adjacent to the modern flood plain of the Rogue River and Bear Creek. Its upper boundary roughly coincides with the height of the 1964-65 "100-year" flood. Sand, silt, and clay overburden. Thickness as much as 40 feet (Wells, 1956).

Pleistocene

- **Bg** — Bench Gravel. Occurs in uppermost gravel terrace and in Agate Desert area. Terraces at several levels, but generally at 1250 to 1300 feet elevation. Not subject to flooding. Consists of cross-bedded, poorly sorted, subrounded boulders and pebbles and dark-gray sand. Weakly cemented. Overlain in most areas by a sandy silt layer containing some gravel.

BEDROCK UNITS

Olig.-Mio. Plio.?

- **Tpm** — Pre-Mazama basalt flows capping Upper and Lower Table Rock.
- **Tmop** — Fragmental volcanic rocks. Includes tuff, lithic tuff, tuff breccia, and local conglomerate.

Eocene

- **Ten** — Nonmarine sedimentary rocks. Includes thick-bedded, massive, fine-to-medium sandstone, conglomerate with thin siltstone interbeds, shale, and some coaly layers.

Cretaceous

- **Kh** — Hornbrook Formation. Well-bedded, fine, greenish-gray feldspathic marine sandstone, locally gold bearing; local conglomerate and sandy shale.

- **Di** — Diorite intrusions of Upper Jurassic or Lower Cretaceous age.

Triassic

Applegate Group:

- **Ms** — Metasedimentary rocks. Altered tuffaceous sediments, argillite, quartzite, chert, and limestone.
- **Mv** — Metavolcanic rocks. Altered lava flows, flow breccia, and pyroclastics with some intrusive rocks.

Area of sand and gravel

Approximate limits of 1861 flood

23 — River miles from 1923 U.S.G.S. Survey

500 0 1000 2000 feet

Map prepared by
STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

Base photograph from U.S. Army Corps of Engineers, February 1965.


JOSEPHINE CO.
JACKSON CO.
ROGUE RIVER
Mv
Tg
106
Mv
Cg
Tg
Abn
106
99
Mv
Mv
103
RIVER
ROGUE
104
Mv
Tg
Tg
Mv
Mv
Mv
Ms
Savage

Sheet 1


Ms
Mv
Bg
Mv
Rogue River
Mv
SOUTHERN PACIFIC
Tg
Tg
Cg
RIVER
ROGUE
Evans Creek
Tg
Cg
Tg
Mv
99
Mv
Ms
Shefflein Gulch
Tg
Mv


Mv
Mv
Mv
Tg
Tg
Tg
Cg
Gold Hill
RIVER
ROGUE
SOUTHERN
PACIFIC
Cg
Tg
Tg
Fpg
Tg
Cg
Cg
Fpg
Cg
Cg
Mv
Mv
Mv
Tg
Mv
MILLERS
GULCH
Mv
Sheet 3


Mv
Tg
Rock Point
113
Mv
ROGUE
Cg
Mv
Tg
Sardine Creek
Mv
114
SOUTHERN PACIFIC
Ms
Mv
NUGGET BUTTE
NORTH
Ms
99
Mv
Tg
Cg
Cg
Tg
Cg
RIVER
Mv
Gold Hill
Mv
115
Ms
Tg
Tg
Mv
Mv
Mv
Cg
Cg
Mv
Mv
Mv
Kane Creek

Sheet 4


Sams Creek
Mv
Mv
Ms
Mv
Tg
119
116
Ms
ROGUE
RIVER
Mv
Cg
Di
Tg
PACIFIC
Cg
Tg
SOUTHERN
Ms
Mv
117
Mv
Mv
Tg
Di
Mv
120
Mv
Mv
GOLD HILL
Gold Hill
Cg
Cg
116
Mv
Tg
Mv


Ten
Cg
Cg
Tg
Mv
Ten
Ten
Mv
121
Di
ROGUE
SOUTHERN PACIFIC
Di
122
Fpg
Kelly
Slough
125
Fpg
Cg?
RIVER
Cg?
Di
Fpg
Fpg
Fpg
Di
Bear
Creek
Tg
Tg
Bg
Mv
Di
NORTH
Sheet 6


Lower
Table Rock
Ten
Ten
Tpm
Bg
Bg
Tg
Soldier Creek
NORTH
Fpg
123
ROGUE RIVER
Cg
Cg
Cg
Cg
Cg
Cg
Cg
Cg
Cg
125
124
126
Fpg
Fpg
Fpg
Fpg
Tg
Tg
Tg
Bg
Fpg
Tg
Bear Creek
Whetstone Creek
End of Survey
KIRTLAND ROAD
Tg
Bg
Tg
Bg
Bg
Tg
Fpg
SOUTHERN PACIFIC

Sheet 7


Ten
Ten
Bg
Cg
MODOC
ROAD
Bg
Fpg
Ten
129
Fpg
Ten
Bg
TABLE
ROCK
Table Rock
ROAD
g
Tg
Ten
Little
Butte
Creek
Ten
RIVER
Fpg
Fpg
26
Cg
Fpg
Tg
Cg
27
Cg
ROGUE
Bg
Cg
Fpg
Bg
Bg
White City

Sheet 8


NORTH
MODOC ROAD
ROAD
ROGUE RIVER
AGATE ROAD
Bg
Ten
Cg
Fpg
Tg
Tmop
Sheet 9

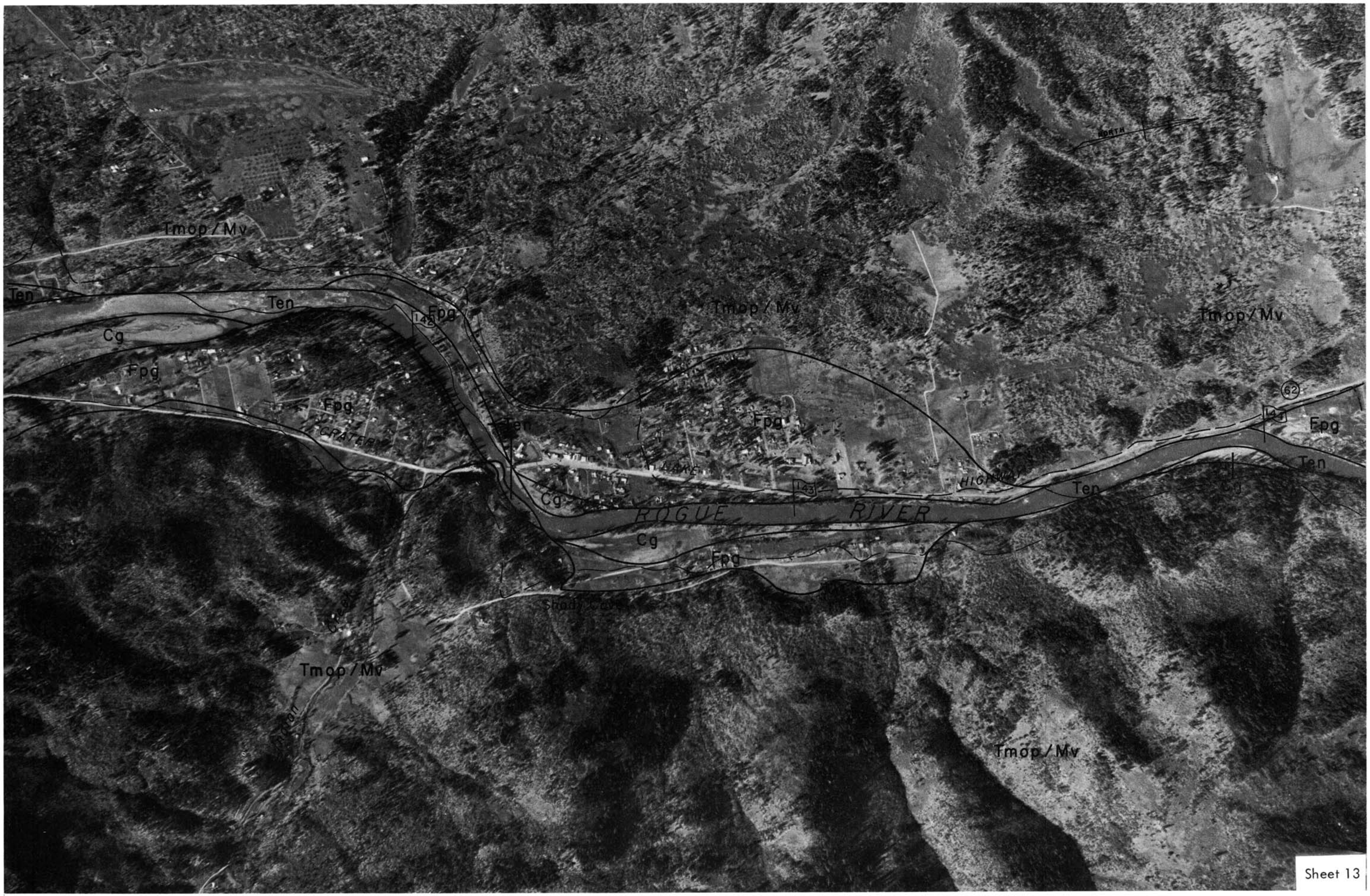

SAMS VALLEY ROAD
NORTH
Tmop
Mv
Bg
Bg
Bg
Tg
Very thin
Bg / Toup
Ten
Fpg
Bg
Mv
Ten
Fpg
Dodge Bridge
Ten
Fpg
ROGUE
Ten
Cg
Fpg
RIVER
Cg
Cg
Cg
Fpg
Fpg
Ten
Cg
Tmop
Fpg
Fpg
Tmop
Bg
AGATE
ROAD
Tmop
Bg - Very
Thin over
bedrock
Fpg
Bg
Hog
Creek
Tmop / Mv
234

Sheet 10


NORTH
Dry Creek
Tmop
Tmop
Ten
Fpg
Ten
RIVER
Cg
Tmop
Cg
Fpg
Cg
Bg
Very thin gravel over bedrock
Fpg
ROGUE
Fpg
Fpg
Cg
Cg
Ten
Fpg
Cg
Fpg
Tmop
Cg
Cg
Thin Tg over Tmop bedrock.
Cg
Ten
Fpg
Cg
Fpg
Reese Creek
Tmop
CRATER LAKE HIGHWAY
62

Sheet 11


Tmop
Ten
Cg
ROGUE
Fpg
Tmop
Fpg
Fpg
Ten
Cg
Cg
Fpg
Cg
Cg
Tmop
Mv
Ten
Ten ?
Ten
RIVER
Cg
Cg
Cg
Fpg
Thin Bg/Tmop
Fpg
Tmop
Tmop
Creek
HIGHWAY
LAKE
CRATER
Sheet 12


Tmop / Mv
Ten
Ten
Cg
Fpg
Fpg
Fpg
Tmop / Mv
Tmop / Mv
Fpg
Ten
Cg
ROGUE
RIVER
Cg
Fpg
Ten
Ten
Fpg
Tmop / Mv
Tmop / Mv
62
HIGHWAY
CRATER
NORTH


Cg
Fpg
Bg
ROGUE RIVER
Ten
Tg
ROAD
Butte
Creek
Little
Cg
Ten
Ten
End of 1861 Survey
Cg
Fpg
Bg
AGATE
Antelope
Creek
HIGHWAY
End of Survey
LAKE
CRATER
VETERANS HOSPITAL
NORTH

Sheet 14

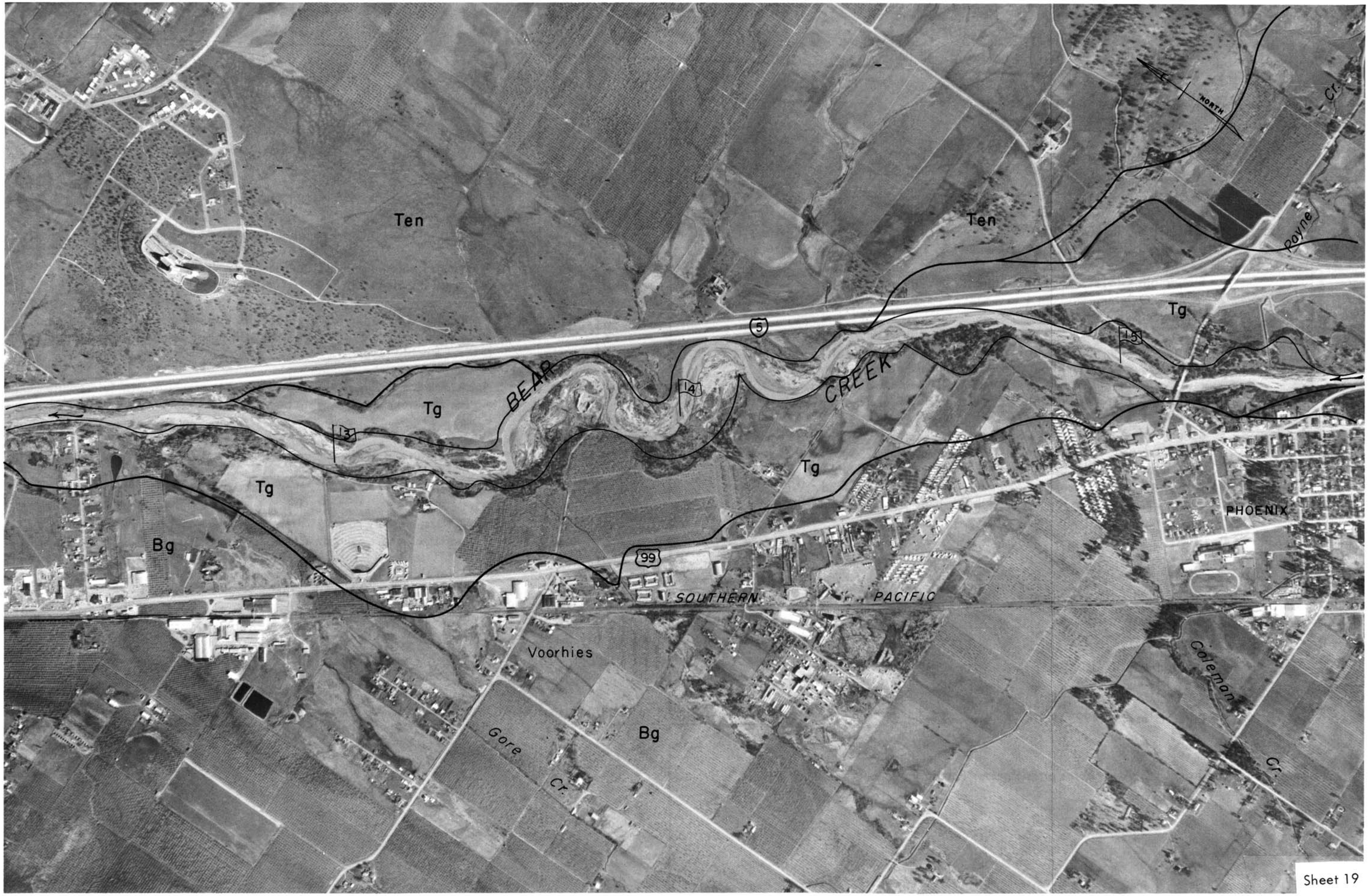

KIRTLAND
ROAD
NORTH
Bg
End of 1861 Survey
Tg
BEAR
CREEK
Tg or Bg
Bg
Tg
Seven Oaks
Willow
Creek
99
5
SOUTHERN
PACIFIC
S. P.
Mv
1
2
3
4


MEDFORD AIRPORT
Midway
TABLE ROCK ROAD
NORTH
Bg
Tg
BEAR CREEK
5
6
7
4
Tg
5
Tg
Bg
Bg
Tg
Bg
Seven Oaks
Griffin Cr
CENTRAL POINT
99
SOUTHERN PACIFIC

Sheet 16

LOGGING
ROAD
Bg
62
NORTH
Bg
Bg
Tg
MEDFORD
AIRPORT
TABLE
ROCK
ROAD
BEAR
8
5
Tg
Tg
7
Tg ?
Tg
CREEK
9
Tg
10
Tg
CANAL
Bg
MEDFORD
Bg
Bg
99
HOPKINS

Ten
MEDFORD
NORTH
Ten
Cr
Larson
Ten
Bg
CREEK
BEAR
Ten
Mv
Tg
Bg
12
11
10
5
99
SOUTHERN
PACIFIC



Ten
Ten
NORTH
Payne Cr.
Tg
5
15
BEAR
CREEK
14
Tg
13
Tg
Tg
Bg
PHOENIX
99
SOUTHERN PACIFIC
Voorhies
Coleman Cr.
Gore Cr.
Bg
Sheet 19


Ten
Payne Cr.
Older Stream Valley Miocene
Ten
Kenutchen Cr.
Ten
CANAL
CREEK
Tg
5
BEAR
Tg
6
Tg
Tg
Mv
Tg
Bg
CANAL
99
Ten
Bg
PHOENIX
Anderson Cr.
Bg
TALENT
PACIFIC
SOUTHERN
Sheet 20


NORTH
Ten
Ten
5
Meyer Cr.
20
ASHLAND 3 Mi.
BEAR CREEK
Mv
19
18
Bg
Ms
Tg
Bg
99
Kh
PACIFIC
Ms
Wagner
SOUTHERN
TALENT
LATERAL
Cr.
Bg
TALENT
Sheet 21