SPECIAL REPORT 143

MINERAL LAND CLASSIFICATION

OF THE GREATER LOS ANGELES AREA

Part VII

Classification of Sand and Gravel Resource Areas,

San Bernardino Production-Consumption Region

By

Russell V. Miller

Under the Direction of James F. Davis, Rudolph G. Strand, and David J. Beeby

1984

CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY
1416 Ninth Street, Room 1341
Sacramento, California 95814

STATE OF CALIFORNIA
GEORGE DEUKMEJIAN
GOVERNOR

THE RESOURCES AGENCY
GORDON K. VAN VLECK
SECRETARY FOR RESOURCES

DEPARTMENT OF CONSERVATION
DON L. BLUBAUGH
DIRECTOR

DIVISION OF MINES AND GEOLOGY
JAMES F. DAVIS
STATE GEOLOGIST

PREFACE

The Los Angeles metropolitan area, with a population of nearly 10 million people, is the largest urbanized area in California. This region includes the southern part of Los Angeles County and parts of San Bernardino, Riverside, and Orange counties. Although substantial parts of the Los Angeles area have been developed, widespread urbanization is still occurring at a rapid rate.

In any metropolitan or rural region undergoing urban development, it is of considerable importance that adequate supplies of mineral commodities be readily available. Minerals used in construction, particularly sand, gravel, or stone used in concrete, should be available from the region in sufficient quantities to assure reasonable costs. For many years, the Los Angeles area has been fortunate in this respect: adequate quantities of low-cost aggregate materials, chiefly sand and gravel, have been available locally. However, as more and more land in a region becomes urbanized, nearby sand and gravel deposits suitable as sources of low-cost aggregate tend either to be depleted by mining or lost to competing land uses.

The principal objective of this project is to classify land in the Los Angeles area into Mineral Resource Zones (MRZs) based on guidelines adopted by the California State Mining and Geology Board. This classification project will assist the Board in the event the Board contemplates designation of lands containing regionally significant aggregate resources pursuant to the Surface Mining and Reclamation Act of 1975.

Classification information is presented in six parts, one for each of the production-consumption regions that have been identified in the greater Los Angeles metropolitan area. An introductory section describing the background, purpose, and scope of the overall project and one section on the classification of each of the six production-consumption regions are being published as they are completed as parts of California Division of Mines and Geology Special Report 143. Each of the six parts classifying production-consumption regions will include maps showing the locations of significant sand and gravel deposits and an explanatory text with tables and charts that present data on population, production, aggregate consumption, future requirements, and estimates of aggregate resources.

Part I, the introductory section, and Part II, which explains the classification of sand and gravel resource areas in the San Fernando Valley Production-Consumption Region, were published in a single volume. Part I is also being published as a separate volume. The present volume, which focuses on the classification of sand and gravel resource areas in the San Bernandino Production-Consumption Region, is Part VII of Special Report 143.

The reader may wish to refer to "Aggregates in the Greater Los Angeles Area," California Division of Mines and Geology Special Report 139, which describes and evaluates the significance, uses, prices, marketing, transportation, supply, and other factors that relate to the aggregate industry of the greater Los Angeles metropolitan area.

CONTENTS

ILLUSTRATIONS

TABLES

PLATES

EXECUTIVE SUMMARY

The San Bernardino Production-Consumption (P-C) Region, as defined in this report, covers 1,098 square miles and includes the large urbanizing portions of southwestern San Bernardino County and northwestern Riverside County. Although substantial portions of this area have been developed, urbanization is still occurring at a rapid pace.

In any urban development, it is important that land-use decisions be made with full recognition of the natural resources of the area. Mineral resources, including aggregate, are limited within a given region. The object of this report is to convey information concerning the aggregate resources of the San Bernardino P-C Region and the expected needs of the region for such resources in the next 50 years. For many years, the San Bernardino area has been fortunate to have adequate quantities of relatively low-cost aggregate materials locally available. However, as more areas become urbanized, suitable sand and gravel deposits are being lost through urban development and are being diminished yearly by mining.

This report presents a classification of the land in the San Bernardino P-C Region by Mineral Resource Zones (MRZs) based on guidelines adopted by the California State Mining and Geology Board. This classification project will assist the Board in the event the Board contemplates designation of lands containing regionally significant aggregate resources pursuant to the Surface Mining and Reclamation Act of 1975.

The California Division of Mines and Geology has classified the 855 square miles of urbanizing lands within the San Bernardino P-C Region according to the presence or absence of significant sand, gravel, or stone deposits that are suitable as sources of Portland cement concrete (PCC) grade aggregate. If a deposit contained more than $5 million worth (in 1978 dollars) of suitable material and could be extracted and marketed profitably under present technologic conditions, or those which could be estimated to exist in the foreseeable future, the deposit was classified MRZ-2.

The land classification within the San Bernardino P-C Region is presented in the form of Mineral Resource Zones on 26 U.S. Geological Survey topographic quadrangle maps that accompany this report (Plates 7.1 - 7.26). Mineral Resource Zones were established on the basis of a sand, gravel, and stone resource appraisal which included a study of pertinent geologic reports and maps, field investigations of outcrops and active and inactive pits, and an analysis of water-well logs and drill records. Nine major areas were determined to contain significant aggregate deposits and were classified MRZ-2. Cumulatively, the MRZ-2 areas cover 116 square miles (14% of the total classified area). Several of these areas were subdivided by urbanization into many smaller areas that have been identified separately on Plates 7.27 - 7.38. In addition, there were large areas that contained aggregate resources, but their significance could not be evaluated from available data; these areas were classified MRZ-3.

In order to organize the volume calculations of the aggregate resources, the State Geologist has developed the concept of "sectors" to identify those MRZ-2 areas that have not been urbanized. The geometrical configuration and the geologic continuity of the deposit in each sector is fairly uniform, so tonnage of the aggregate present can be calculated with some reliability. Thus, for example, sector boundaries are established between that part of a natural deposit formed on a fan, and that part within the confines of an adjacent modern stream channel and its floodplain. The sector concept is used for the convenience of arraying resource information, and is intended to convey accurate information regarding the locations and approximate tonnage of resources found in nonurbanized areas.

In the San Bernardino P-C Region, nine major MRZ-2 areas, divided into 127 smaller areas, with existing land uses that are compatible with mining, qualify as sectors. Together they cover 64 square miles (7% of the total classified area) and contain a total of 10.4 billion tons of aggregate. The sectors are described in this report, and are shown on Plates 7.27 - 7.38. The identification of resource sectors has been done to inform lead agencies and others of aggregate resources that could be made available for mining by virtue of the present, generally undeveloped status of the land. The sectorization of any specific area is not an advocacy of mining in that area.

Reserves are aggregate materials that a sand and gravel company owns or controls, and for which it has a valid mining permit; resources are the total amount of available aggregate within an area, including any reserves. The estimated aggregate resources within the nine sectors amount to 10.5 billion tons; of this, 430 million tons are identified as reserves available for mining at the end of 1981. These reserves cover only 10 square miles, which is 1% of the total classified area. Over 99% of these resources lie in the San Bernardino Valley and San Gorgonio Pass areas in the northern and eastern parts of the region in alluvial fan and river deposits. The remaining, less than 1%, lies in two alluvial deposits in the far southwestern part of the region near Lake Elsinore.

The total projected aggregate consumption to the year 2032 is estimated to be 476 million tons. Unless additional resources are permitted for mining or alternative resources are utilized, existing reserves will be depleted in 41 years.

To make the aggregate demand projection, production records and population figures were correlated for the past 22 years (1960-1981) to obtain an average per capita rate of consumption. The derived rate of 8.4 tons per person per year was used along with population projections to make the estimate of total P-C Region consumption for the next 50 years. Should unforeseen events occur, such as massive urban renewal, disaster reconstruction, or major recession, the aggregate demand could change considerably. The presence of the active San Andreas and San Jacinto fault systems within the San Bernardino P-C Region increases the chance for a damaging earthquake and the need for subsequent extensive reconstruction.

Possible alternative sources of aggregate, in addition to those deposits classified MRZ-2, are present within the San Bernardino P-C Region and in adjacent areas. Included in this group are Holocene alluvial deposits, older Tertiary sedimentary deposits, and areas underlain by crystalline rock that are all now classified MRZ-3. Too little is known about the physical and chemical qualities of these possible sources to permit even crude resource estimates.

If additional aggregate was needed in the San Bernardino P-C Region, the most readily available source would be the producers in the neighboring P-C regions of Orange County - Temescal Valley and Claremont- Upland. However, both of those adjacent areas are projected to have a shortfall of aggregate reserves before the San Bernardino P-C Region.

As with many forecasts of economic activity, the forecasts in this report should not be viewed as offering unqualified predictions of how the future will unfold. The forecasts of this report are based on assumptions of the accuracy of the basic data, and the continuation of the development trends of the past two decades into the five decades ahead.

Conclusions

Assuming the correctness of our forecasts for the consumption of aggregate in the San Bernardino and adjacent P-C regions, the following conclusions were reached:

- The anticipated consumption of aggregate resources in the P-C region to the year 2032 is forecast to be 476 million tons.

- Unless additional resources are permitted for mining, or alternative sources are utilized, total existing reserves would be depleted in 41 years. The existing 430 million tons of reserves amounts to 90 percent of the anticipated consumption during the next 50 years.

- A total of 1.35 billion tons of aggregate resources has been identified within the adjacent Claremont-Upland P-C Region. Of this, 50 million tons, or a 15-year supply, have been identified as reserves.

- A total of 1.46 billion tons of aggregate resources has been identified in the adjacent Orange County - Temescal Valley P-C Region. Of this, 260 million tons, or an 18-year supply, has been identified as reserves.

- Both the Claremont-Upland and Orange County - Temescal Valley P-C regions could turn to the San Bernardino P-C Region as a future supply of aggregate, leading to an earlier depletion of its reserves.

- If as a result of any permit decisions or other land-use actions there is a preemption of land now calculated to have reserves present to be used for mining, the available reserves and the duration over which they can be used to satisfy the future needs will be commensurately reduced.

CLASSIFICATION OF SAND AND GRAVEL RESOURCES AREAS, SAN BERNARDINO PRODUCTION - CONSUMPTION REGION

INTRODUCTION

The California Division of Mines and Geology has classified urbanizing lands within the San Bernardino Production-Consumption (P-C) Region according to the presence or absence of significant sand and gravel deposits that are suitable as sources of Portland cement concrete aggregate. Figure 7.1 shows the general location of San Bernardino P-C Region in southern California. The land classification is presented in the form of Mineral Resource Zones (MRZ)--as described in Part I of this report--on 26 U.S. Geological Survey topographic quadrangle maps that accompany this report (Plates 7.1 - 7.26). Nine resource sectors containing a total of 10.5 billion tons of aggregate resources have been identified within these MRZ-2 areas. The sectors are described in detail in this report, and are shown on 12 additional topographic maps (Plates 7.27 - 7.38). Figure 7.2 correlates the 26 U.S. Geological Survey quadrangles, the mineral classification maps, and the aggregate resources sector maps, of the San Bernardino P-C Region. Table 7.1 lists the lead agencies located in the San Bernardino P-C Region.

Based on population records and projections, and aggregate production records, the San Bernardino P-C Region will need 476 million tons of aggregate during the next 50 years. Of this projected demand, about 430 million tons (90 percent) were available for mining at the end of 1981.

Several alternative sources of aggregate for this P-C region are discussed. Similar studies have been completed for the Claremont-Upland (adjacent on the west) and Orange County - Temescal Valley P-C regions (adjacent on the southwest) as Parts III and VI of this report. Pertinent data from those two reports are included herein for comparison.

To assist the reader, the following "road map" through this report will be helpful. The classification process, which is described more fully in Special Report 143, Part I (Anderson and others, 1979), is separated into seven interrelated steps. Steps 1 and 2 in the following list are not described in this report, but are restated herein from Part I for completeness. Steps 3 through 7 form the bulk of this report (Part VII) and are described sequentially. Resource information is integrated in Table 7.2 (page 29).

The classification process can be briefly summarized in the following steps:

1. Determination of Production-Consumption (P-C) region boundaries: In this step, active aggregate operations are identified (Production) and the market area they serve is determined (Consumption).

2. Determination of modified OPR boundaries within the P-C region: Only those portions of the P-C region that are urbanized or urbanizing (based on determination by the State Office of Planning and Research, as modified by local lead agencies) are classified for their aggregate content. Other areas may be classified with the approval of the State Mining and Geology Board (SMGB). This step determines which areas are to be classified.

3. Establishment of Mineral Resource Zones (MRZ): This step includes a geologic appraisal of aggregate deposits for all land within the modified OPR boundaries.

4. Determination of Sectors: Only those portions of land classified MRZ-2 (in Step 3) that have current land uses considered to be compatible with mining are considered to be available as future aggregate resources for the P-C region. This step utilizes intensive field checking to determine present land uses. See Appendix for sector criteria.)

5. Calculation of resource volumes within Sectors: In this step, careful analysis of site-specific conditions is utilized to calculate total volumes of aggregate reserves and non-permitted resources within each sector.

6. Forecasting: In this step, anticipated aggregate demand in the P-C Region for the next 50 years is estimated. This is done by correlating historic population and aggregate production data for the past 20 years to calculate an annual per capita consumption rate. This figure is used with projected populations figures for the area to determine anticipated aggregate demand for the next 50 years. Results of this analysis are compared with total volumes of aggregate reserves in the P-C Region.

7. Alternative resources: A variety of potential alternative aggregate resources are described in this final step of the classification process.

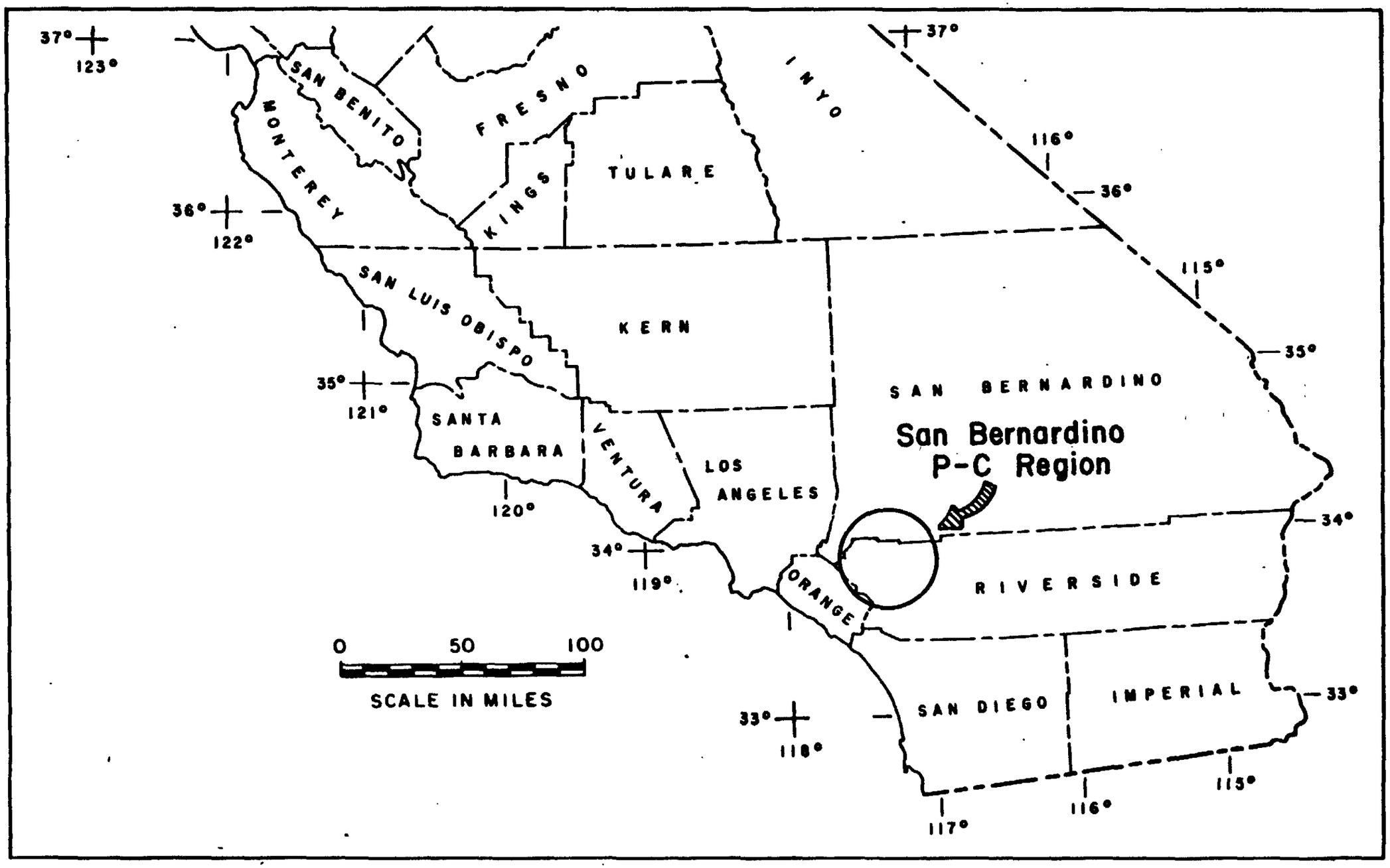


Figure 7.1 - General location of the San Bernardino P-C Region in southern California. See Figures 7.2 and 7.3 for detailed location.

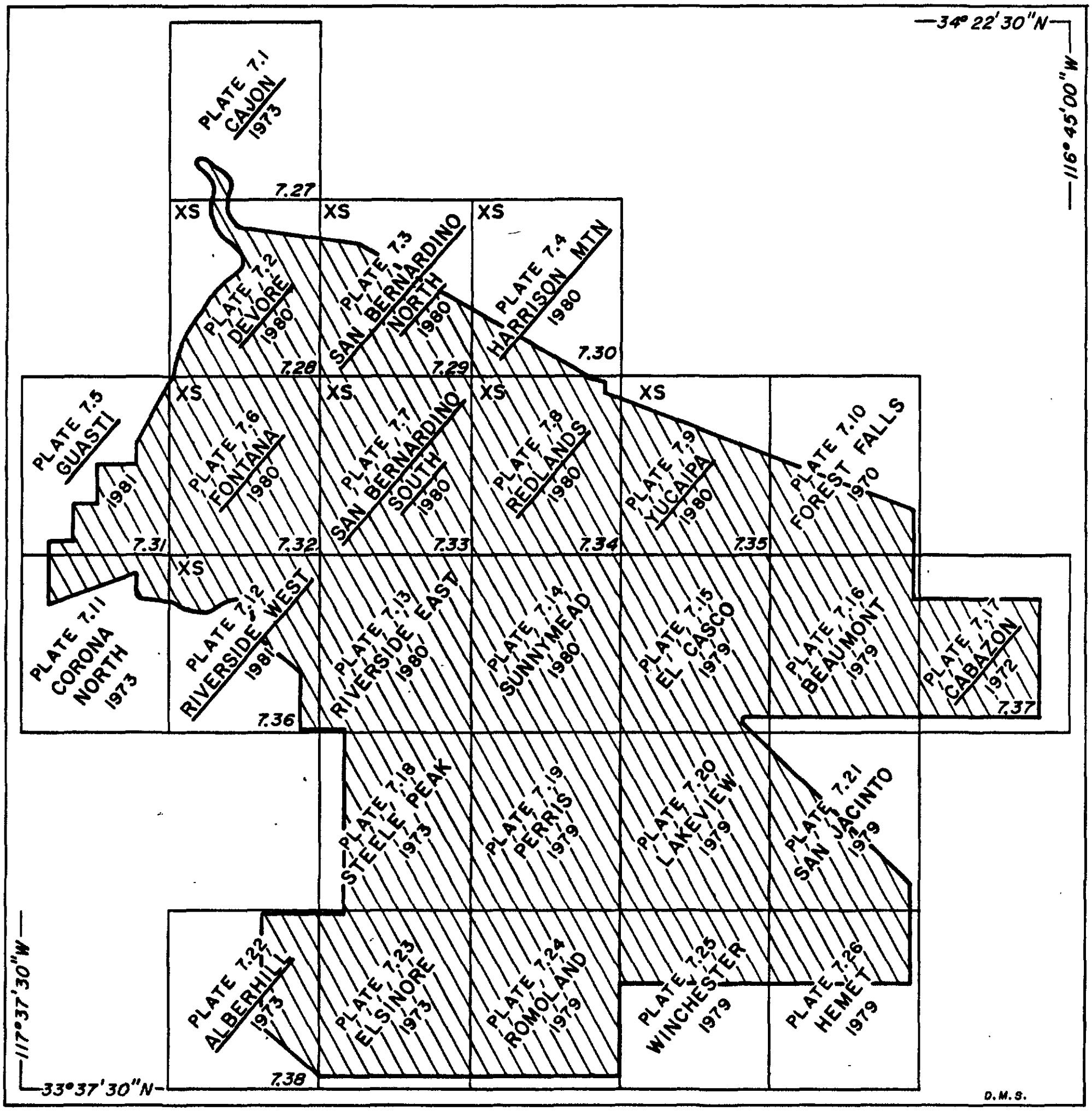


Figure 7.2 - Index map of U.S. Geological Survey 7.5-minute quadrangles covering the San Bernardino P-C Region. The Mineral Land Classification Maps are indicated by the plate numbers above the quadrangle names (Plates 7.1 - 7.26); the Aggregate Resource Sector Maps are indicated by the underlined quadrangle names and the italic numbers in the lower right-hand corners of the quadrangles (Plates 7.27 - 7.38); and the quadrangles containing geologic cross sections are indicated by an "XS" in the upper left-hand corner; see Figure 7.4 for detailed locations.

SAN BERNARDINO COUNTY

* △ Bloomington	Guasti	△ Ontario
Byrn Mawr	△ Highland	△ Rancho Cucamonga
△ Colton	Loma Linda	* △ San Bernardino
* △ Fontana	△ Mentone	Yucaipa
△ Grand Terrace	△ Muscoy	△ Redlands
		△ Rialto

RIVERSIDE COUNTY

Alberhill	Hemet	Quail Valley
Arnold Heights	Highgrove	* △ Riverside
△ Banning	Lake Elsinore	Romoland
Beaumont	Lakeview	△ Rubidoux
* △ Cabazon	△ Mira Loma	San Jacinto
Calimesa	Moreno	Sun City
Canyon Lake	Nuevo	Sunnymead
Edgemont	△ Pedley	Winchester
Gilman Hot Springs	Perris	Valle Vista
Glen Avon		

Table 7.1 List of lead agencies (county and incorporated by city governments) located within the San Bernardino P-C region. Cities that have active aggregate operations within their jurisdictional boundaries are denoted by asterisks. Cities that have land within their jurisdiction classified MRZ-2 are denoted by△.

ESTABLISHMENT OF THE P-C REGION AND MINERAL RESOURCE ZONES

Mineral Resource Zones within the San Bernardino P-C Region are classified on the basis of an aggregate resource appraisal which includes: an analysis of geologic reports and maps; field investigations; an examination of active sand and gravel mining operations; analyses of drill-hole data; interpretation of aerial photographs; and evaluation of private company data.

The Mineral Resource Zones depicted on Plates 7.1 through 7.26 were classified based on the suitability of the deposits for use as Portland cement concrete (PCC) aggregate. Lower quality aggregate resources, acceptable for use as asphaltic concrete aggregate, construction sub-base, railroad ballast, etc., have not been zoned independently on the plates, but were evaluated only where they occur in conjunction with PCC-quality aggregate.

Areas Classified MRZ-1

Areas which have been zoned MRZ-1 include both Holocene alluvial areas, consisting predominantly of silts and clays, and older schistose metamorphic rocks. These are areas where adequate information indicates that no significant aggregate deposits are present or where it is judged that little likelihood exists for their presence ("Guidelines for Classification and Designation of Mineral Lands," Appendix A-3, Part I).

Most of the alluvial areas are located in river floodplains where fine sediments have accumulated. Identification of these areas was largely dependent on well-log information and geologic interpretation.

Areas Classified MRZ-2

Figure 7.3 shows the general localities in the San Bernardino P-C Region that are classified MRZ-2. These are areas where adequate information indicates that significant mineral deposits are present (deposits that are marketable under present technologic and economic conditions or which can be estimated to exist in the foreseeable future, and that contain in excess of $5 million worth of aggregate material in 1978-equivalent dollars) or where it is judged that a high likelihood for their presence exists ("Guidelines for Classification and Designation of Mineral Lands," Appendix A-3 in SR 143, Part I, p. 32). Also, for a deposit of sand and gravel to be categorized as significant, the geologic factors that resulted in the formation of the deposit must be understood clearly enough so that reasonable interpretations can be made from surface exposure of the material and from drill-hole data.

The geologic setting of the sand and gravel resources in the San Bernardino P-C Region is an area of alluvial fans and river courses in the San Bernardino Valley and San Gorgonio Pass and to a limited extent in the Elsinore Lake area. Deposits within the San Bernardino P-C Region that are classified MRZ-2 occur within Lytle Creek alluvial fan, Lytle Creek wash, Cajon Creek wash, Santa Ana River, Day Creek fan deposit, San Gorgonio River, and Rice Canyon and McVickers Canyon alluvial deposits. Geologic cross sections of the San Bernardino Valley area are presented on Plates 7.40 - 7.44. Figure 7.4 shows the locations of the cross sections.

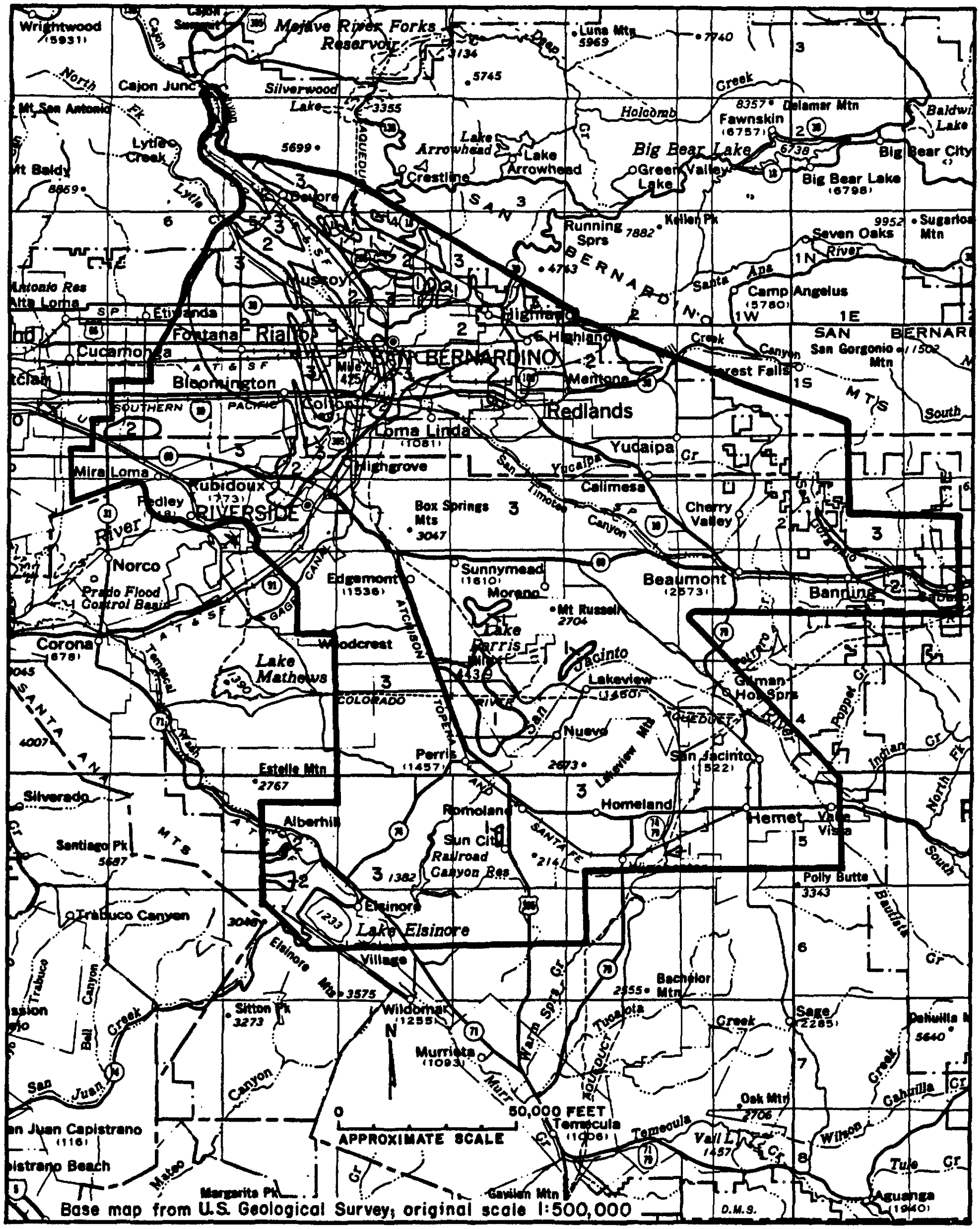


Figure 7.3 - Map showing generalized classification of aggregate resources of the San Bernardino P-C Region.

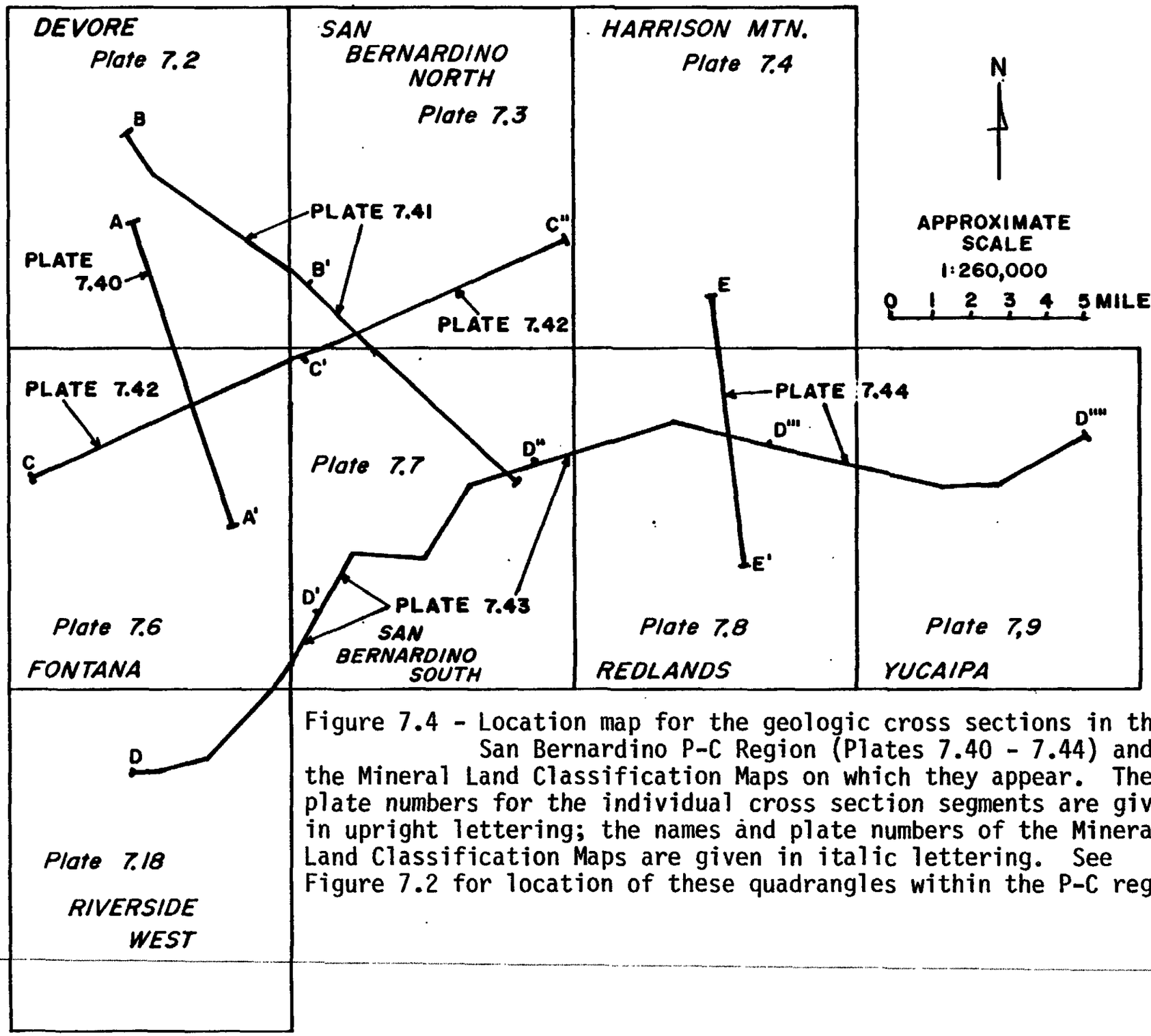


Figure 7.4 - Location map for the geologic cross sections in the San Bernardino P-C Region (Plates 7.40 - 7.44) and the Mineral Land Classification Maps on which they appear. The plate numbers for the individual cross section segments are given in upright lettering; the names and plate numbers of the Mineral Land Classification Maps are given in italic lettering. See Figure 7.2 for location of these quadrangles within the P-C region.

LYTLE CREEK ALLUVIAL FAN

The large alluvial fan formed at the mouth of Lytle Creek Canyon, and extending south to the Jurupa Hills has a surface area of about 50 square miles, of which 32 square miles are classified MRZ-2. The fan is crossed on its east flank by the Lytle Creek wash, the present course of Lytle Creek. The fan has been deposited over many thousands of years by the outflow of Lytle Creek, which has carried sediments from the San Gabriel Mountains on the north to be laid down over the broad San Bernardino Valley. The material deposited in the fan consists of poorly sorted sand, gravel, clay, and boulders. The coarser clasts most commonly are composed of gneissic granite and granodiorite. Only the distal areas of the fan are known to contain significant deposits of suitable aggregate material. Sparse well-log data in the proximal or headward parts of the fan indicate that those areas are underlain by lenses of finer sediments (see cross section A-A', Plate 7.40).

The Lytle Creek fan is underlain at depth by older alluvial deposits which contain large amounts of weathered material, making them generally unsuitable as sources of Portland cement concrete aggregates. In places this older alluvium is exposed at the surface of the present fan. The depth of the buried surface of this older material is shown on Plate 7.39.

At present, three producers excavate aggregate material from the Lytle Creek fan: Fontana Paving in the city of Fontana, and Owl Rock and Holliday Trucking, both near the Santa Ana River (Figures 7.5 and 7.7b and c). This fan area has produced an average of over one-half million tons of aggregate per year over the past ten years.

LYTLE CREEK WASH

Lytle Creek wash, which contains 19 square miles of ground classified as MRZ-2, emanates from Lytle Canyon on the south margin of the San Gabriel Mountains and traverses the Lytle Creek fan. The wash merges with Cajon Creek wash about 4 miles from the mouth of Lytle Canyon and continues to the Santa Ana River, 8 miles to the south.

The material is similar to that of Lytle Creek fan with the clast types predominantly being metamorphic and granitic.

Lytle Creek wash is underlain by older alluvial material at depths shown on Plate 7.39 and cross section B-B', Plate 7.41. This older material contains large amounts of clay and weathered material and is generally suspected to be unsuitable for use as Portland cement concrete aggregate.

Three producers of aggregate mine material from the Lytle Creek wash: Owl Rock near the crossing of Interstate 15, Conrock immediately south near Rialto, and Fourth Street Rock Crusher in the city of San Bernardino (Figures 7.6 and 7.7a). Aggregate material has been mined in the area of the Conrock property since 1922.

The annual production for the Lytle Creek wash has averaged about 2 milion tons over the last ten years.

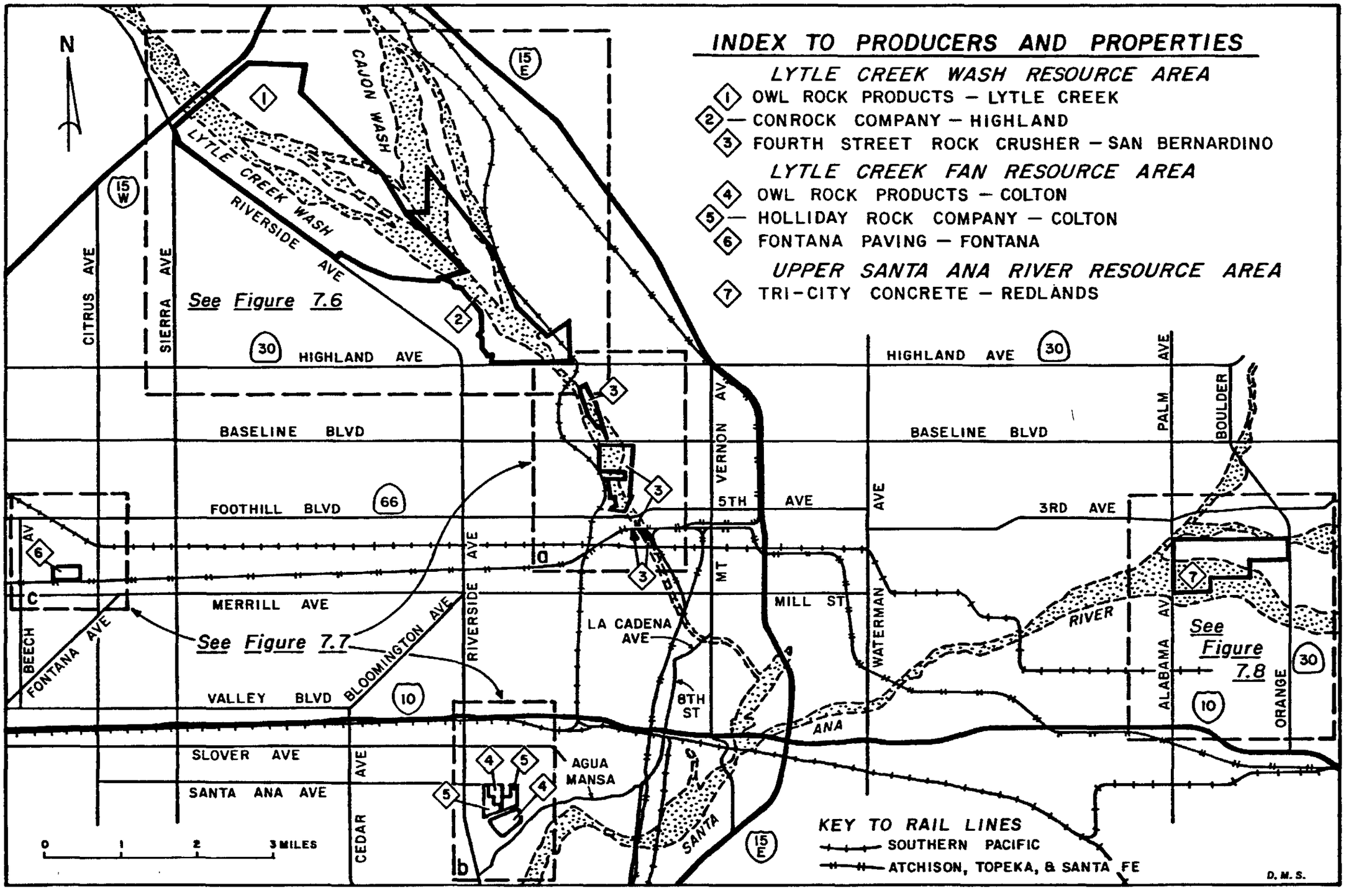


Figure 7.5 - Lytle Creek Wash - Lytle Creek Fan - Upper Santa Ana River Resource Area: Sketch map showing land owned or leased by aggregate companies.

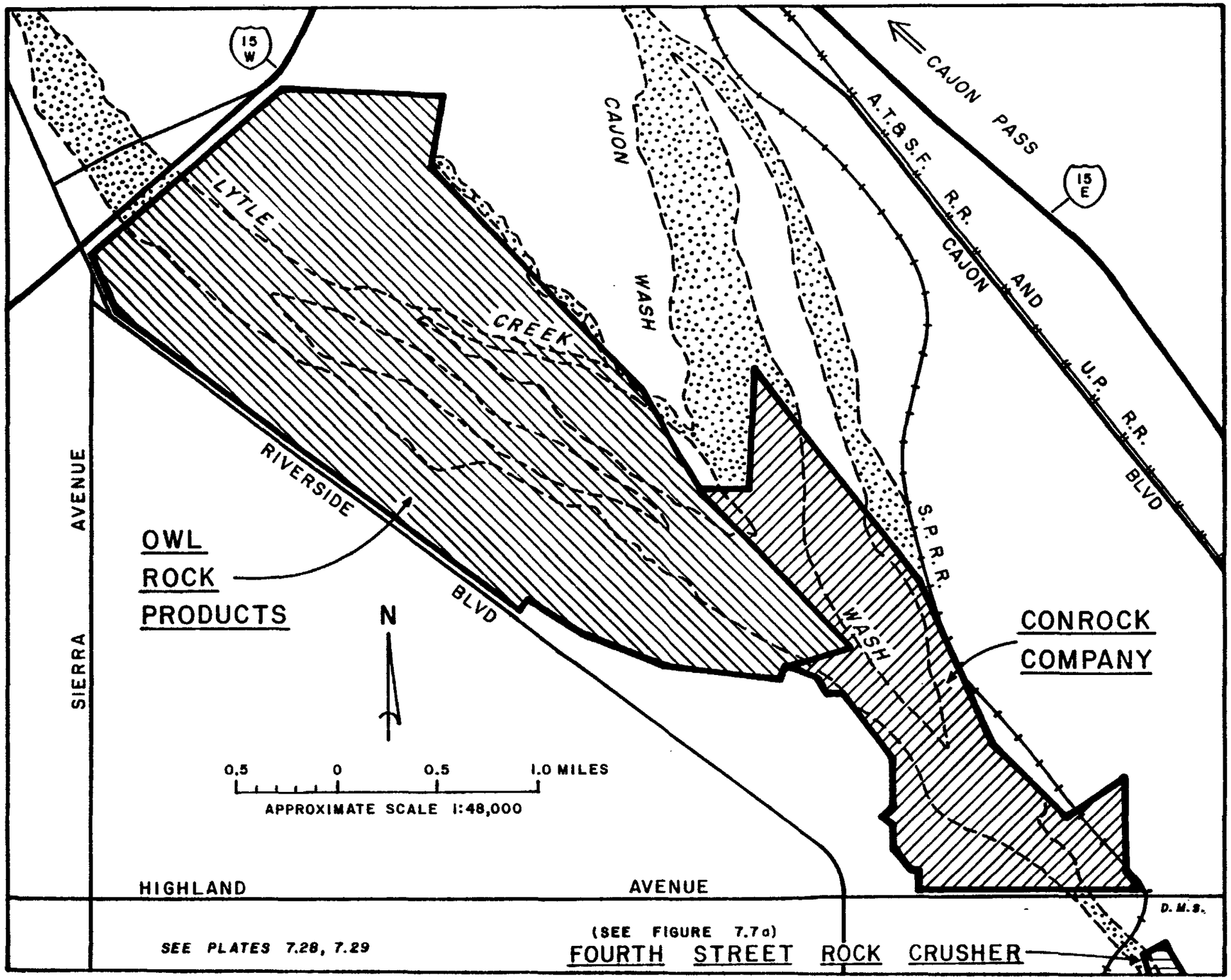


Figure 7.6 - Lytle Creek Wash Resource Area: Sketch map of the northern part showing land owned or leased by aggregate companies.

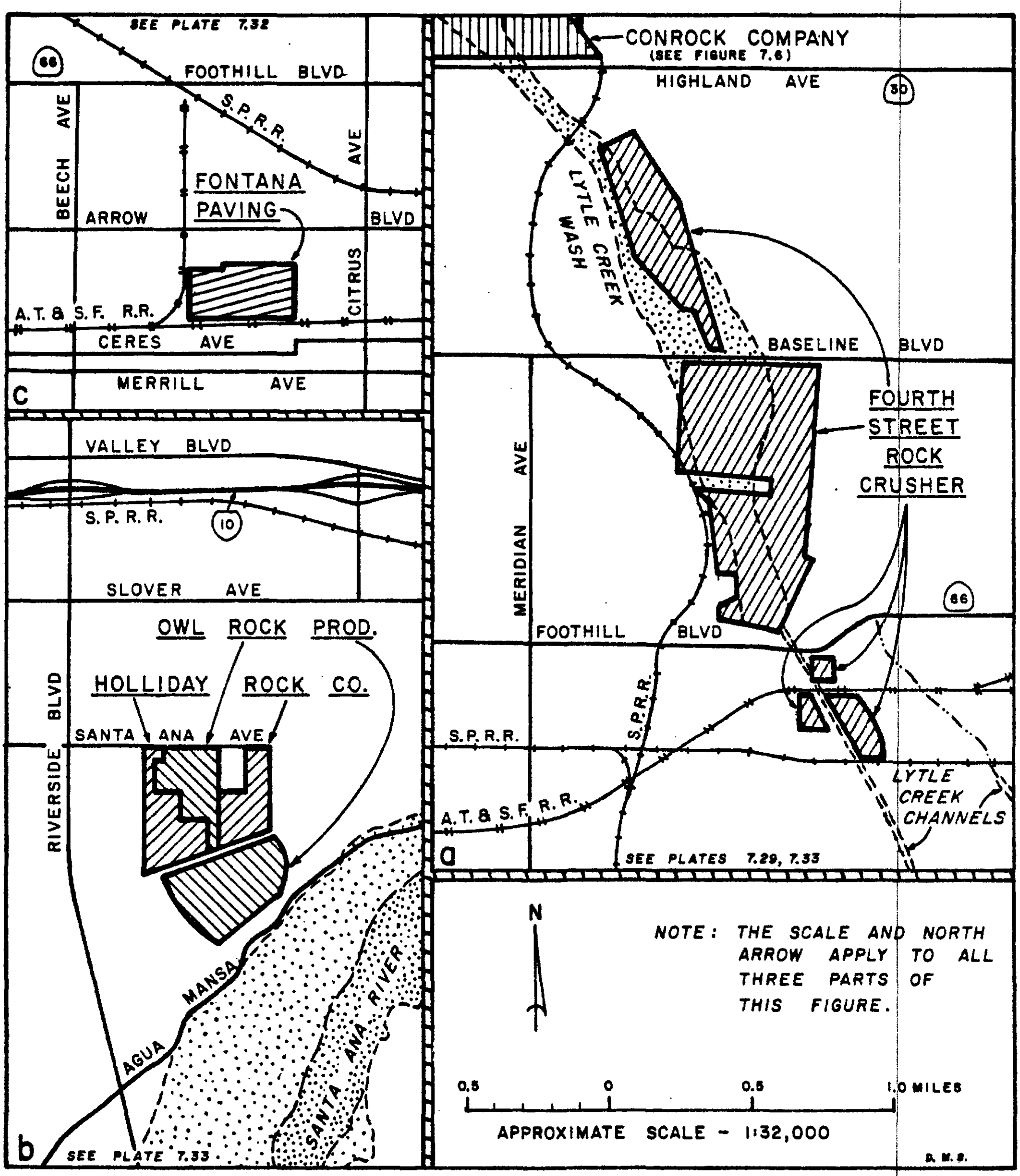


Figure 7.7 - Lytle Creek Wash(a) - Lytle Creek Fan(b & c) Resource Areas: Sketch map of southern and western parts respectively, showing land owned or leased by aggregate companies.

CAJON CREEK WASH

That part of the Cajon Creek wash that lies within the P-C region contains 11 square miles of ground classified as MRZ-2 and extends upstream from its confluence with the Lytle Creek wash about 8 miles. Most of Cajon Creek, however, is outside of the San Bernardino P-C Region and is mentioned in the section on alterative resources.

The alluvial material in Cajon Creek wash is made up of sand, gravel, and silt. The Conrock Company presently mines the deposit near the juncture with Lytle Creek.

SANTA ANA WASH AND RIVER

Along the southwestern edge of the San Bernardino Mountains the Santa Ana River debouches from its narrow canyon onto a widening floodplain in the eastern arm of the San Bernardino Valley. Joined by the effluence of Mill Creek, the Santa Ana River flows across a broad wash for about 6 miles before entering the constriction of the Santa Ana River channel. The river courses through another 18 miles before reaching the boundary of the P-C region at a point near the city of Riverside. Santa Ana wash contains almost 34 square miles of land classified MRZ-2. The river channel contains an additional 10 square miles of land classified MRZ-2.

The deposits of alluvium underlying the Santa Ana River are topped by an upper layer of younger deposits suitable for use as Portland cement concrete aggregate. This layer, made up of deposits of boulders, gravel, sand, and occassionally clay, overlies an older weathered alluvium which is probably unsuitable for use as PCC aggregate. The thickness of the overlying younger alluvium varies from about 15 feet to 390 feet (see cross section, Plates 7.43 and 7.44). This large variation in thickness is due in part to tectonic movement of the area, forming downwarps in some areas that are then infilled, and upwarps in other areas, such as near the San Jacinto fault, that tend to thin the deposit.

The younger alluvial wash material overlying the upper Santa Ana Valley is composed chiefly of quartz monzonite-granodiorite clasts with lesser amounts of gneissic granite, granite, aplite, and quartz diorite. The deposit is poorly sorted and consists of about 40% gravel with an average maximum size of about 10 inches. There is some variation in sand-gravel ratio with depth and, as shown on the cross section, the material in the upstream part of the wash is bouldery.

The alluvial material in the Santa Ana River, downstream of the wash, is better sorted and finer, predominantly sand, and is composed of generally the same rock types. The influx of alluvial material from Lytle Creek may increase the percentage of metamorphic clasts in the deposit downstream of that point.

Tri City Concrete near Redlands is presently the only active producer of aggregate along the Santa Ana River (Figure 7.8). The General Portland Cement Company owns land in this area but is not mining aggregate at present.

DAY CREEK FAN

The Day Creek fan deposit, which contains almost 3 square miles of land classified MRZ-2, lies in the Chino Basin near the west end of the Jurupa Mountains. The source of the alluvial material in this deposit is primarily to the north from the Day Creek wash and is perhaps partly derived from the Lytle Creek fan to the northeast.

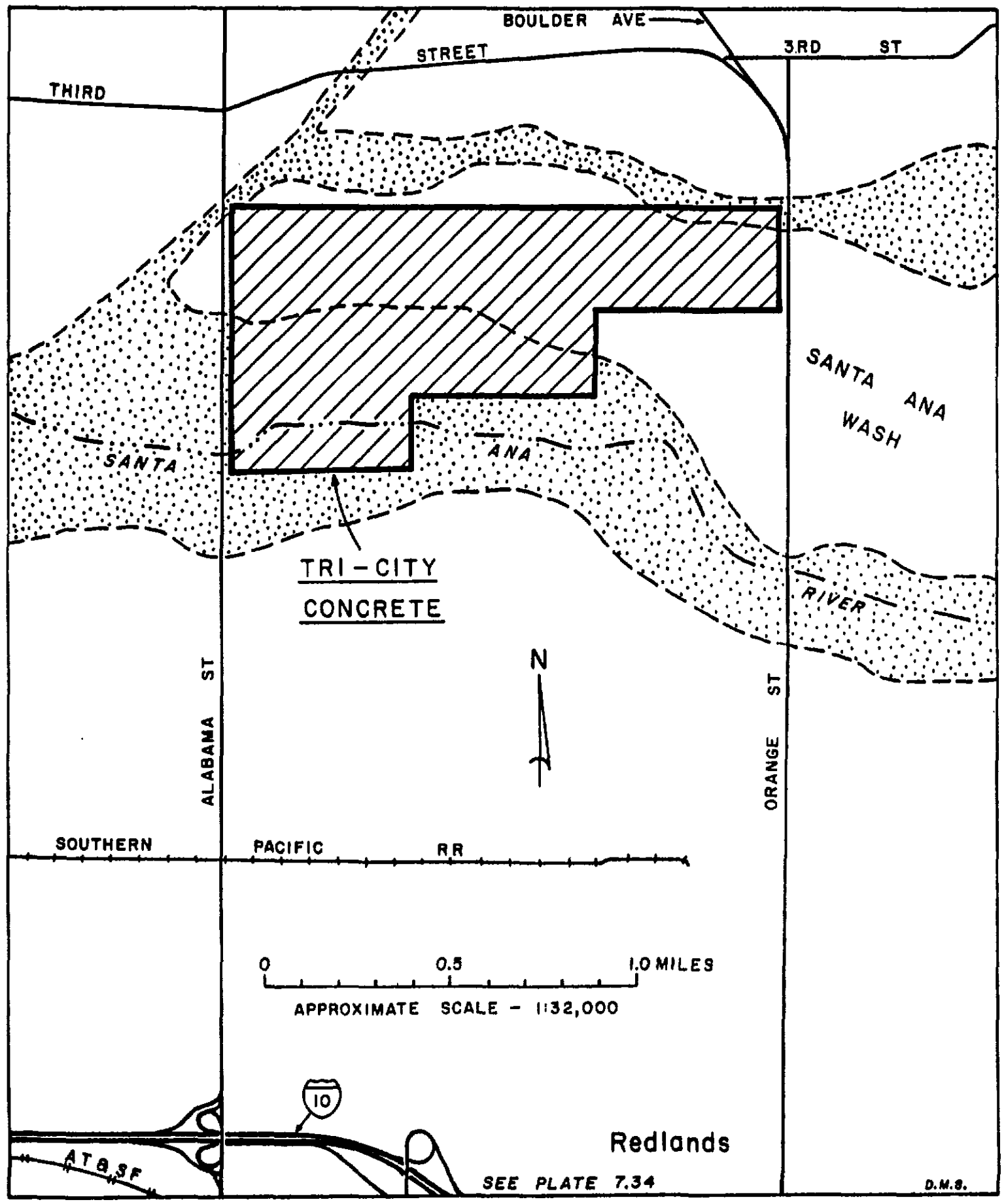


Figure 7.8 - Upper Santa Ana River Resource Area: Sketch map of the eastern part showing land owned or leased by aggregate company.

The coarser parts of the deposit consist of about 50% sand and 50% gravel with a maximum clast size of about 8 inches. There is a silt overburden up to 20 feet thick and silt layers at a depth of about 50 feet. The coarse clasts are predominantly mica schist and granitic rock types.

Triangle Rock Products, Inc. of Mira Loma operated an aggregate pit here until 1969 that produced concrete sand and gravel and plaster sand.

SAN GORGONIO RIVER

The San Gorgonio River flows south and southeastward out of the San Bernardino Mountains and into San Gorgonio Pass where it turns more eastward along the north edge of the San Jacinto Mountains. The alluvial deposit underlying the river covers almost 7 square miles of land classified MRZ-2, and consists of about 65 percent gravel with boulders up to 2 feet in diameter. The coarse clasts are predominantly metamorphic rocks with minor amounts of granitic rocks.

At present two aggregate producers mine sand and gravel from the San Gorgonio River. Beckham Bros. operates from a pit near the mouth of Banning Canyon, northeast of the town of Banning, and Beaumont Concrete excavates aggregate material about 3 miles farther downstream near the town of Cabazon (Figure 7.9a). Indications, from the two producers, are that the minable quality aggregate is about 100 feet thick in the river floodplain in the San Gorgonio Pass area. Lack of well-log data in Banning Canyon precludes an estimate of thickness upstream from the producing area.

RICE AND McVICKERS CANYONS AND FANS

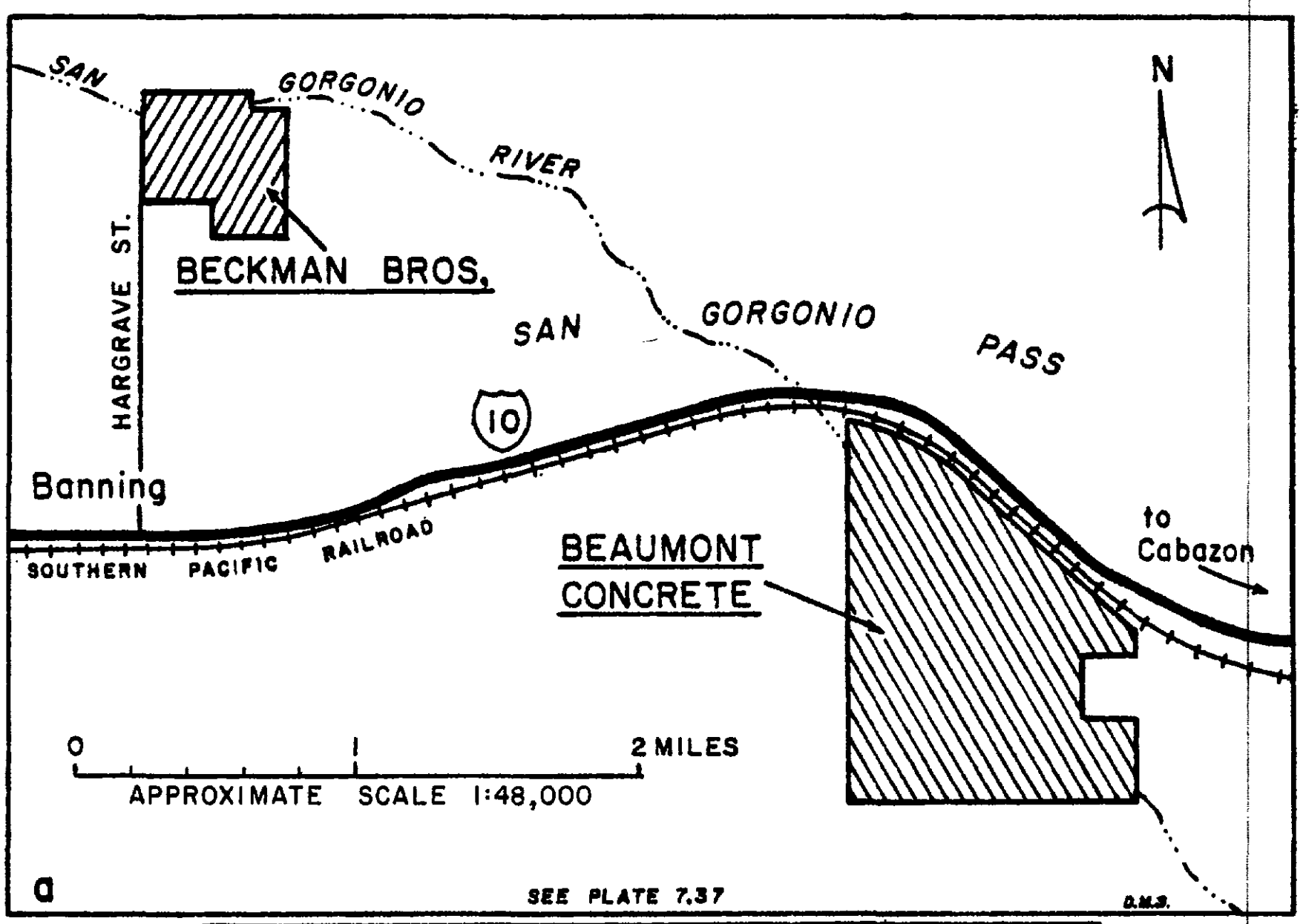
Rice and McVickers canyons are incised on the east flank of the Santa Ana Mountains a few miles northwest of Lake Elsinore. Rice Canyon drains an area underlain primarily by granodioritic rocks. Runoff has deposited significant amounts of alluvial material derived from those rocks in the lower part of the canyon and in a narrow fan extending northward from the canyon mouth in Temescal Valley. About 10 percent of the deposit consists of gravel, 70 percent consists of sand, and the remaining 20 percent is silt and clay.

McVickers Canyon drains bedrock areas underlain partly by granitic rocks and partly by metamorphic rocks. Granitic and phyllitic rock types compose the coarse fraction of the alluvial deposits in the lower part of the canyon and the fan near the mouth. About 75 percent of the deposit is made up of coarse fragments with the remainder mostly sand and minor silt and clay.

Both of these deposits, amounting to 1 square mile of land classified MRZ-2, are mined by the Elsinore Ready Mix Company, which began operations here in 1958 (Figure 7.9b).

Areas Classified MRZ-3

Figure 7.2 shows the general localities of the 725 square miles of MRZ-3 areas within the San Bernardino P-C Region. These areas incorporate land containing aggregate mineral deposits, the significance of which cannot be evaluated from available data (see Appendix A-3 in SR 143, Part I, p. 32). MRZ-3 areas in the San Bernardino P-C Region include valley, hilly, and mountainous terrain. MRZ-3 areas located in valley or basin regions are generally underlain by alluvial deposits of Quaternary age. These deposits



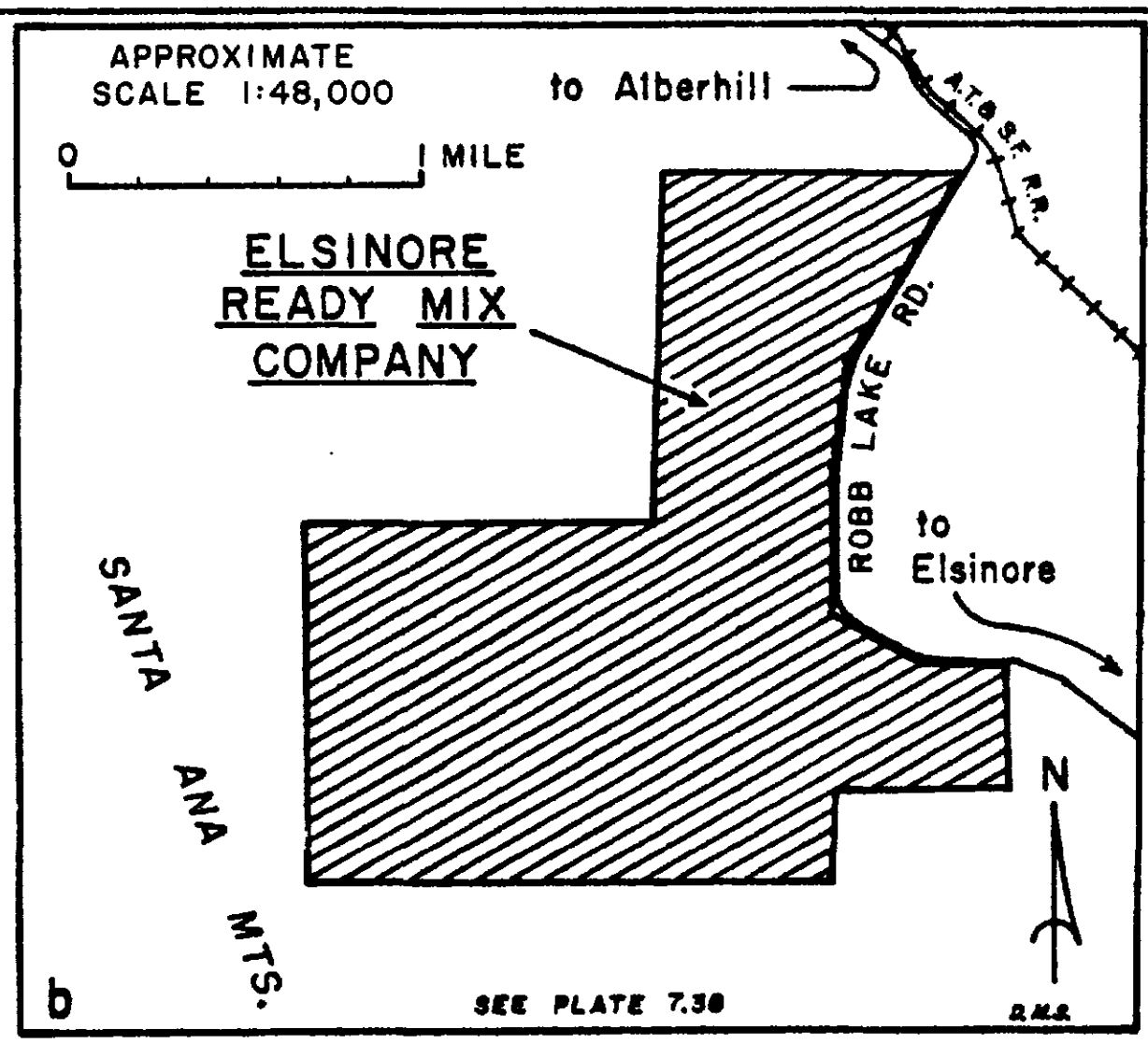


Figure 7.9 - San Gorgonio River (a) and Rice and McVickers Canyons (b) Resource Areas: Sketch maps showing land owned or leased by aggregate companies.

contain sand and gravel resources about which little is known because of inadequate subsurface data. MRZ-3 areas located in hilly or mountainous terrain are generally underlain by sedimentary deposits of Tertiary age, crystalline basement rock, or Paleozoic or Mesozoic metamorphic rocks. Very little data of the type needed to evaluate the suitability of these rocks for use in Portland cement concrete is available. Consequently, these areas were classified as MRZ-3.

Those MRZ-3 areas that are most promising as potential sources of PCC aggregate material are discussed in the "Alternative Sources of Aggregate" section.

GAVILAN HILLS

This area is defined as the low, bedrock hills bordering Perris Valley on the west, stretching from the Box Springs Mountains near Riverside, south to the Lake Elsinore area. The predominant rock types underlying the Gavilan Hills are quartz diorite and tonalite of the Southern California Batholith and older metasedimentary rocks of the Bedford Canyon Formation. Both of these rock types possibly are suitable for use as crushed aggregate in unweathered condition; however, the Gavilan Hills are an old erosion surface and in most areas are deeply weathered. Detailed mapping of the weathered zones and testing of the fresh rock types would be necessary to determine the potential of these rocks as a crushed rock resource.

Other rock types with small areas of exposure have also been classified MRZ-3 in the Gavilan Hills area, such as the San Marcos Gabbro, which may be suitable as a source of crushed PCC aggregate in some areas, and a Pliocene non-marine sedimentary unit along Cajalco Road, which is a candidate for further testing to assess its suitability as an aggregate source.

MORENO - PERRIS - SAN JACINTO VALLEYS

These valley areas are mostly underlain by alluvium of Quaternary age classified MRZ-3. Crystalline and metasedimentary bedrock is exposed in low hills throughout these valley areas such as the Bernasconi Hills near Lakeview and Double Butte near Homeland. These bedrock units are also classified MRZ-3 as they are potential sources of crushed aggregate. The extent of surface weathering, and the aggregate test characteristics of individual units would have to be investigated in order to further classify any of the rock exposed in these hills.

THE BADLANDS

The northeastern edge of the San Jacinto Valley is bounded by a front of hills named The Badlands. These hills are made up primarily of a Pleistocene non-marine sedimentary unit called the San Timoteo Formation. This formation contains a high percentage of poorly-indurated conglomerate and residual clays. Determination of the local concentrations of conglomerate would be necessary to further classify this unit.

JURUPA MOUNTAINS AND PEDLEY HILLS

The Jurupa Mountains and Pedley Hills lie west of the downtown area of the city of Riverside and north of the Santa Ana River. Both highlands are, for the most part, made

up of granitic and recrystallized metamorphosed sedimentary rocks. The granitic rocks here are the northernmost exposures of rocks of the Southern California Batholith; the metasedimentary rocks form irregular partitions between the granitic intrusions, and are composed of quartz-biotite gneiss, quartzite, biotite-quartz schist, marble, various calcareous-siliceous rocks, and amphibolite schists.

The crystalline rocks in the Jurupa Mountains have been quarried for many years for use as rip rap, roofing granules, and other minor uses. Weathering in these rocks has not penetrated beyond a few feet and the fresh rock is easily exposed. The Jurupa Mountains and Pedley Hills may contain significant deposits suitable for use in PCC-grade aggregate.

SAN GABRIEL AND SAN BERNARDINO MOUNTAINS

Parts of the foothills of the San Gabriel Mountains and San Bernardino Mountains that have been included in the urbanizing area of the P-C region have been classified MRZ-3. These areas include the southeasternmost tip of the San Gabriel Mountains near the mouth of Lytle Creek Canyon, the southwestern margin of the San Bernardino Mountains bordering the eastern San Bernardino Valley, and the Crafton Hills near Yucaipa. The bedrock underlying these areas consists of Tertiary sediments, Mesozoic granitic rocks, and pre-Cretaceous metamorphic rocks.

The coarser parts of the Pliocene sandstone unit along the San Bernardino Mountain front may be a source of suitable aggregate. The remaining bedrock formations may be suitable for use as crushed aggregate. Further testing of these units will be necessary to assess their potential.

EVALUATION OF AGGREGATE RESOURCES IN THE SAN BERNARDINO P-C REGION

An analysis of aggregate supply in the San Bernardino P-C Region is presented in this section of the report. The analysis was conducted on the basis of a quantitative evaluation of the aggregate resources contained in urbanizing portions and immediately adjacent areas of the San Bernardino P-C Region. A similar evaluation has already been completed for the adjacent Orange County - Temescal Valley P-C Region (Miller and Corbaley, 1981). Evaluation of the neighboring Claremont-Upland P-C Region's aggregate resources is being done concurrently with this study. Evaluation of these adjacent P-C regions is necessary in order to determine the effects that these regions might have on the availability of aggregate in the San Bernardino P-C Region. These evaluations are presented in the "Alternative Sources of Aggregate."

Almost 116 square miles of land in the San Bernardino P-C Region has been classified MRZ-2 (Figure 7.3). This represents about 14% of the total area classified. Many of the sand and gravel deposits contained within these MRZ-2 areas lie beneath already urbanized land. Some of the remaining unoccupied land is broken up into isolated properties by subdivisions, freeways, and other threads of urban expansion. Many of these isolated, unoccupied properties are too small to be considered for sand and gravel extraction.

Terminology used to reflect the confidence level of resources has been adopted from U.S. Geological Survey Bulletin 1450-A (Appendix C in SR 143, Part I, Anderson and others, 1979). For this study, permitted resources (reserves) fall under the category of indicated reserves. Non-permitted resources meet the criteria set forth for either indicated or inferred resources.

A mineral commodity is recoverable only if local regulations permit mining activity. Therefore, sand and gravel resources herein placed in the category of reserves are limited to resources that underlie land where mining is permitted by lead agencies having jurisdiction over such land. The term resources includes both reserves and non-permitted resources (usable materials which could be mined, but for which no use-permit allowing extraction has been granted, or for which mining has not been definitely established to be feasible based on current technological or economic conditions).

Mining Constraints

The quantity of reserves is highly dependent on both regulatory and economic constraints. For non-permitted resources, future regulatory and economic constraints may differ from those of the present, thereby drastically reducing or enlarging the quantity available.

REGULATORY CONSTRAINTS

The major regulatory restrictions that affect the total sand and gravel reserve deal with slope angles, depth of extraction, and setback distances from adjacent objects or borders. These regulatory constraints are largely imposed by the city or county that has jurisdiction over the mining property.

The present sand and gravel operations in the San Bernardino P-C Region are within the jurisdictional boundaries of either San Bernardino County or Riverside County. Both counties impose restrictions on aggregate mining on a site-specific basis with no general code. In the case of the operations in the channel of Lytle Creek, the San Bernardino County Flood Control Department has imposed constraints to preserve flood control facilities and to ensure that runoff water is not ponded.

ECONOMIC AND QUALITY CONSTRAINTS

In classifying sand and gravel deposits as significant and in calculating the available resources within those deposits, the following conditions involving economic factors were satisfied:

1. Material meets the mineability and threshold criteria given in the "Guidelines for Classification of Mineral Lands" (Appendix A-3 in SR 143, Part I, Anderson and others, 1979).

2. The deposit consists of sound durable material substantially free of chemically reactive substances that would preclude its use as a construction material.

3. Combined clay and silt fraction does not exceed 25 % by volume.

4. Technology limits extraction to a maximum of 100 feet below the water table.

5. Setbacks will be 100 feet from all developed areas when calculating resources outside of present aggregate producer property (setback required by use permits may differ on producer property).

Resource Sectors

THE CONCEPT OF SECTORS

To organize the volume calculations of the aggregate resources, and to inform the public about the resources within specific land-use areas, the State Geologist has utilized the concept of "sectors" to identify those MRZ-2 areas that meet the Board's guidelines as eligible to be considered for designation as having regional or statewide significance. Each sector shown on Plates 7.27 through 7.38 is a part of the nonurbanized MRZ-2 land wherein the geometrical configuration and material content of the deposit are fairly uniform, so that tonnages of the aggregate resource present can be estimated with some reliability. Some sectors that have been subdivided by highways and other intervening developments have been given sub-sector numbers for ease in identifying individual areas. Where sector boundaries are adjacent to urbanized land, a 100-foot setback (which is consistent with local use-permit conditions) was subtracted during resource calculations. The sector concept is used for the convenience of arraying the resource information. The sector criteria are given in the Appendix.

Much of the resource calculation that follows is based on an evaluation of over 1000 drill-hole records of variable reliability collected over a time span extending back to the early part of this century. The drill-hole records describe the types of earth material (clay, silt, sand, gravel, and bedrock types) encountered at various depths. The quality of drill-hole descriptions range from poor to good, but only drill-hole records that contain descriptions judged to be acceptable for analysis were used in the present study.

All sand and gravel deposits suitable for use as PCC aggregate in the nonurbanized part of the San Bernardino P-C Region have been divided into 9 sectors for the purpose of making resource calculations. Sectors A-F are all alluvial areas generally within the Lytle Creek Fan - Upper Santa Ana River production district (Figure 1.2 in SR 143, Part I, Anderson and others, 1979). Sector G covers the San Gorgonio River deposit, and Sectors H and I cover the Rice Canyon and McVickers Canyon deposits near Elsinore.

SECTOR A - LYTLE CREEK FAN

Sector A covers the nonurbanized portions of the Lytle Creek fan that are classified as MRZ-2, exclusive of the Lytle Creek wash, which is the most recent course of Lytle Creek, which drains across the eastern margin of the fan. The portion of the fan classified MRZ-2 extends from a few miles south of the mouth of Lytle Creek Canyon to the Santa Ana River to the southeast. The nonurbanized part of this totals nearly 11.7 square miles.

Well-log evaluation indicates that the depth of sand and gravel deposits believed to be of suitable quality for use in Portland cement concrete ranges from 24 feet in the southeastern areas of the fan, adjacent to exposures of older alluvium, to 140 feet in the central part of the fan (see cross sections A-A' and C-C," Plates 7.40 and 7.42). Plate 7.39 shows the thickness of the suitable Holocene material in the fan area.

The quantities of aggregate reserves and resources were calculated for the Lytle Creek fan based upon the following assumptions.

1. The material is assumed to have a 10% waste factor based on operation of the Fontana Paving plant.

2. In-place density of the resource is assumed to be .065 short tons per cubic foot (15.4 ft^3 per ton) (from Special Report 139, Evans and others, 1977).

3. Pit-wall slopes will be calculated at a 1:1 gradient for non-permitted resources and will conform to use-permit requirements in the calculation of reserves.

There are 1.8 billion tons of resources in Sector A; of this about 8 million tons are reserves.

SECTOR B - LYTLE CREEK WASH

Sector B includes the present course of Lytle Creek from about 5 miles upstream of the mouth of Lytle Creek Canyon to the Santa Ana River, an area of about 10.7 square miles. As indicated on the cross section on Plate 7.41, the depth of suitable quality aggregate material is about 90 feet thick in the northern or upstream part of the wash and thins to about 50 feet in the southern portion.

The following assumptions were made for calculating the resources for Sector B.

1. The material is assumed to have a waste factor of from 2-10% based on the operation of the three plants in this area.

2. The in-place density of the resource is assumed to be .063 short tons of sand and gravel per cubic foot (14.9 ft^3/ton) (from Special Report 139, Evans and others, 1977).

3. The pit-slope walls will be calculated at a 1:1 gradient for non-permitted resources and will conform to use-permit requirements in the calculation of reserves.

Based on the above assumptions, approximately 970 million tons of resources are believed to lie beneath Sector B. Of this, about 120 million tons are reserves.

SECTOR C - CAJON WASH

Sector C, Cajon wash, extends from the confluence of Cajon wash and Lytle wash to about 8 miles upstream. Sector C covers about 7.4 square miles. Although little subsurface data is available for Cajon Wash, the thickness of the upper younger alluvial material, as projected from drill-hole data, is about 140 feet in the central part of the active stream channel and thins to about 80 feet in the area of Shandin Hills in the southeastern part of the sector.

The following assumptions were made for the purpose of determining the resources in Sector C.

1. The material is assumed to have an average waste of 8% based on the plant operation of the Conrock Company in the Cajon wash.

2. The in-place density of the resource is assumed to be .063 short tons per cubic foot (14.9 ft^3/ton) (from Special Report 139, Evans and others, 1977).

3. The pit-walls slopes will be calculated at a 1:1 gradient for non-permitted resources and will conform to use-permit requirements in the calculation of reserves.

Based on the above assumptions, over 1.1 billion tons of resources are be calculated to underlie Sector C. The reserves total for Sector C are proprietary, but are included in the total reserves for all sectors in Table 7.2.

SECTOR D - DAY CREEK FAN, MIRA LOMA AREA

Well-log data and information from Bulletin 180-C (Goldman, 1968) were used to outline Sector D on the southern or distal part of the Day Creek Fan near Mira Loma. There are about 1.5 square miles within Sector D.

Information, from the now-inactive Triangle Rock Products, Inc. sand and gravel pit, here indicates that the thickness of suitable material averages about 35 feet (Goldman, 1968). Overburden here averages about 15 feet. The following assumptions were used in calculating resources for Sector D.

1. The material is assumed to have an average waste factor of 10% (Goldman, 1968).

2. The in-place density of the resource is assumed, based on comparison with other similar deposits, to be .063 short tons per cubic foot (14.9 ft^3/ton).

3. The pit-wall slopes will be calculated at a 1:1 gradient.

Based on these assumptions, approximately 70 million tons of aggregate resource are believed to underlie Sector D. There are no reserves in this sector.

SECTORS E AND F - SANTA ANA RIVER AND SANTA ANA WASH

The dividing line between Sectors E and F is placed near Interstate Highway 395 as it crosses the Santa Ana River. Upstream of this point the Santa Ana River together with the effluent from Mill Creek and several smaller tributaries forms a broad wash, Sector F, of which about 19.6 square miles is nonurbanized. Downstream of Interstate Highway 395

RESOURCES (million short tons)			
SECTOR	PERMITTED (RESERVES) RESOURCES (Indicated Category)	NON-PERMITTED RESOURCES (Indicated and Inferred Category)	TOTAL RESOURCES
A	10	1,810	1,820
B	120	970	1,090
C	*	1,120	1,120+
D	none	70	70
E	none	570	570
F	*	4,660	4,660+
G	*	800	800+
H	*	5	5+
I	*	20	20+
TOTAL	430	10,020	10,450

TABLE 7.2 Aggregate resources of the San Bernardino P-C region
(all numbers in million short tons)

* Cannot be shown due to confidentiality of producer data

NOTE: All figures over 50 million rounded to nearest 10 million;
Figures less than 50 million rounded to nearest 5 million tons.

the Santa Ana River is confined to a narrower floodplain averaging about one mile wide. The nonurbanized portion of the downstream area, Sector E, encompasses about 5.5 square miles.

The thickness of sand and gravel suitable for use as PCC aggregate in Secter E is generally a uniform 90 feet except in the area near the Santa Ana wash. In this area the surface of the underlying sediments has been deformed by movement along the San Jacinto fault, creating a shallowing of the overlying Holocene alluvium to a minimum thickness of about 30 feet. In Sector F, the Santa Ana wash, the Holocene sediments fill a basin or depression in the underlying older alluvium and attain a thickness of as much as 385 feet. Due to the water table and clay layers, much of these younger sediments are not economical to mine for sand and gravel. Drill-hole log data indicate that the thickest section of suitable alluvial material here is about 250 feet, in the central part of the wash. The proposed construction of a flood control dam (Mentone Dam) within Sector F puts a question on the future availability of much of the resource in this area.

The following assumptions were made in determining the resources for Sectors E and F.

1. The material is assumed from the Tri-City Concrete Company plant operation, to have an average waste factor of 5%.

2. The in-place density of the resource is assumed to be .063 short tons per cubic foot (14.9 ft^3/ton) (Special Report 139, Evans and others, 1977).

3. The pit-wall slopes will be calculated at a 1:1 gradient for non-permitted resources and will conform to use-permit requirements in the calculation of reserves.

Based on the above assumptions, it is calculated that 570 million tons of resources underlie Sector E and over 4.6 billion tons of resource underlie Sector F. The reserve figure for Sector F is proprietary and is included in the total reserves for all sectors in Table 7.2. There are no reserves in Sector E.

SECTOR G - SAN GORGONIO RIVER

Sector G covers 6.5 square miles and encompasses the nonurbanized part of the floodplain of the San Gorgonio River from the mouth of Banning Canyon southeast to the community of Cabazon. Examination of sand and gravel pits in the area indicates that the thickness of suitable alluvial material in this area is about 100 feet. No drill-hole log data is available for this sector.

Based on personal communications with operators of Beckham Bros. and Beaumont Concrete companyies, both operating in the San Gorgonio River area, the following assumptions were made for determining the resource in Sector G.

1. The material is assumed to have no waste.

2. The in-place density of the resource is estimated from similar deposits to be .063 short tons per cubic foot (14.9 ft^3/ton).

3. The pit-wall slopes will be calculated at a gradient of 1:1.

Based on the above assumptions, well over 800 million tons of resources are believed to lie beneath Sector G. The reserves for this sector are proprietary, but are included in the total reserves for all sectors in Table 7.2.

SECTORS H AND I - RICE AND McVICKER CANYONS AND FANS

Sector H covers 0.3 square mile and encompasses the alluvial channel and narrow fan of Rice Canyon. Personal communications with Elsinore Ready Mix Company operators indicate that the average thickness of this deposit is about 20 feet.

Sector I covers about 0.7 square mile and encompasses the alluvial channel of McVickers Canyon and the proximal part of the alluvial fan that has formed at the mouth of the canyon. Elsinore Ready Mix personnel indicated that the thickness of the aggregate material in the canyon averages about 50 feet and in the fan about 100 feet.

The following assumptions were made for the purpose of calculating resources in Sectors H and I.

1. The material is assumed, based on the operation of the Elsinore Ready Mix Company plant, to have an average waste factor of 12%.

2. The in-place density of the resource is assumed to be .055 short tons per cubic foot (13 ft^3/ton) (Special Report 139, Evans and others, 1977).

3. The pit-wall slopes will be calculated at a 1:1 gradient.

Based on the above assumptions, over 5 million tons of resources are believed to lie beneath Sector H and well over 20 million tons lie beneath Sector I. The reserves for these sectors are proprietary, but are included in the total reserves for all sectors in Table 7.2.

ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE

The total projected consumption of aggregate in the San Bernardino P-C Region for the next 50 years (to 2032) is estimated to be 476 million tons (Table 7.3). This estimate is based on past consumption rate patterns as described in SR 143, Part I, "Description of the Mineral Land Classification Project of the Greater Los Angeles Area."

Aggregate Production Records

Aggregate production records were compiled for the years 1960 through 1980 for the San Bernardino P-C Region. Records for the greater Los Angeles Basin for the years prior to 1960 are, in most cases, incomplete. Aggregate production data was obtained from the United States Bureau of Mines (USBM) statistics. These records are compiled from responses to voluntary questionnaires that are sent annually to all known mining operators. Each producer is requested to divulge the production from each of his producing properties for the preceding year. It is important to note that the degree of accuracy of these statistics depends entirely on the producer's response. The DMG staff did not seek to verify production data or get production data from companies that did not respond to the U.S Bureau of Mines inquiry.

Population Records

Population data for the San Bernardino and adjacent P-C regions were compiled for the years 1960-1980 (Figures 7.10 - 7.12). The historical population data for this period was obtained from statistical bulletins that have been published by San Bernardino and Riverside counties on a quarterly or an annual basis.

Population projections to the year 2020 were made for the P-C region using area projections furnished by county governments, the State Department of Finance (1977), and the Southern California Association of Governments (1978). Population projections for the 12-year period between 2020 and 2032 were extrapolated by DMG staff from the previously mentioned data for the preceding 40 years. Population projections to the year 2032 are presented as Figure 7.13.

Per Capita Consumption Rates and Population Densities

Per capita consumption rates of aggregate have varied through time and are different in each P-C region (Figure 7.14). Several factors, such as changes in urban growth with time, relative degrees of urban maturity, and proximity to major construction projects (for example, freeways), account for some of the variations and differences.

Historical per capita consumption rates from the years 1960 through 1980 for the San Bernardino and its adjacent P-C regions are shown on Figure 7.14. The San Bernardino P-C Region had an average rate of about 8.4 tons of aggregate per person per year between 1960 and 1980 (Figure 7.14). This per capita consumption rate was projected to the year 2032 to estimate a total aggregate demand for the next 50 years. The per capita consumption rate for the Orange County - Temescal Valley P-C Region is 5.9 tons per year and is taken from Special Report 143, Part III (Miller and Corbaley, 1980). The per capita rate for the Claremont-Upland P-C Region is 7.17 tons per person per year and was derived in a similar manner.

The population density of the San Bernardino P-C Region is lower than the densities of the more mature urban areas (full "urban maturity" is the point in the development of an area at which construction materials are used primarily to maintain what has already been developed rather than to supply further development) in the Orange County - Temescal Valley and other Los Angeles basin P-C regions (Figure 7.15). The Orange County - Temescal Valley P-C Region's per capita consumption rate of 5.9 tons is lower than the San Bernardino P-C Region rate of 8.4 tons. The Claremont-Upland P-C Region rate of 8.75 tons per person per year is similar to that of San Bernardino and reflects the similar degrees of "urban maturity" of these regions. Other than the high density population centers such as the downtown areas of the cities of San Bernardino and Riverside, the region has large areas available for growth. The San Bernardino P-C Region's per capita consumption is thus projected to retain its high growth pattern and not to change significantly in the next 50 years. However, events such as massive urban renewal or disaster reconstruction following a major earthquake, for example, would result in a sharp increase in per capita consumption of aggregate during the period of active reconstruction. The amount of aggregate needed in addition to the projected consumption would depend on the extent and duration of reconstruction. Per capita consumption would probably then gradually return to a maintenance level equivalent to that which existed before reconstruction began.

PROJECTED AGGREGATE CONSUMPTION FOR SAN BERNARDINO P-C Region

Years	Average Population (millions)	5-year Per-Capita Consumption (tons)	Aggregate Consumption (million tons)
1982-1986	.83	42	35
1987-1991	.92	42	39
1992-1996	.99	42	42
1997-2001	1.05	42	44
2002-2006	1.11	42	47
2007-2011	1.17	42	49
2012-2016	1.22	42	51
2017-2021	1.28	42	54
2022-2026	1.34	42	56
2027-2031	1.40	42	59
TOTAL			476

PROJECTED AGGREGATE CONSUMPTION

OF ADJACENT P-C REGIONS

(million short tons)

Claremont-Upland (1982-2031):	245
Orange Co.-Temescal Valley (1980-2030):	844

Table 7.3 Projected aggregate consumption (in million short tons) for San Bernardino and adjacent P-C Regions.

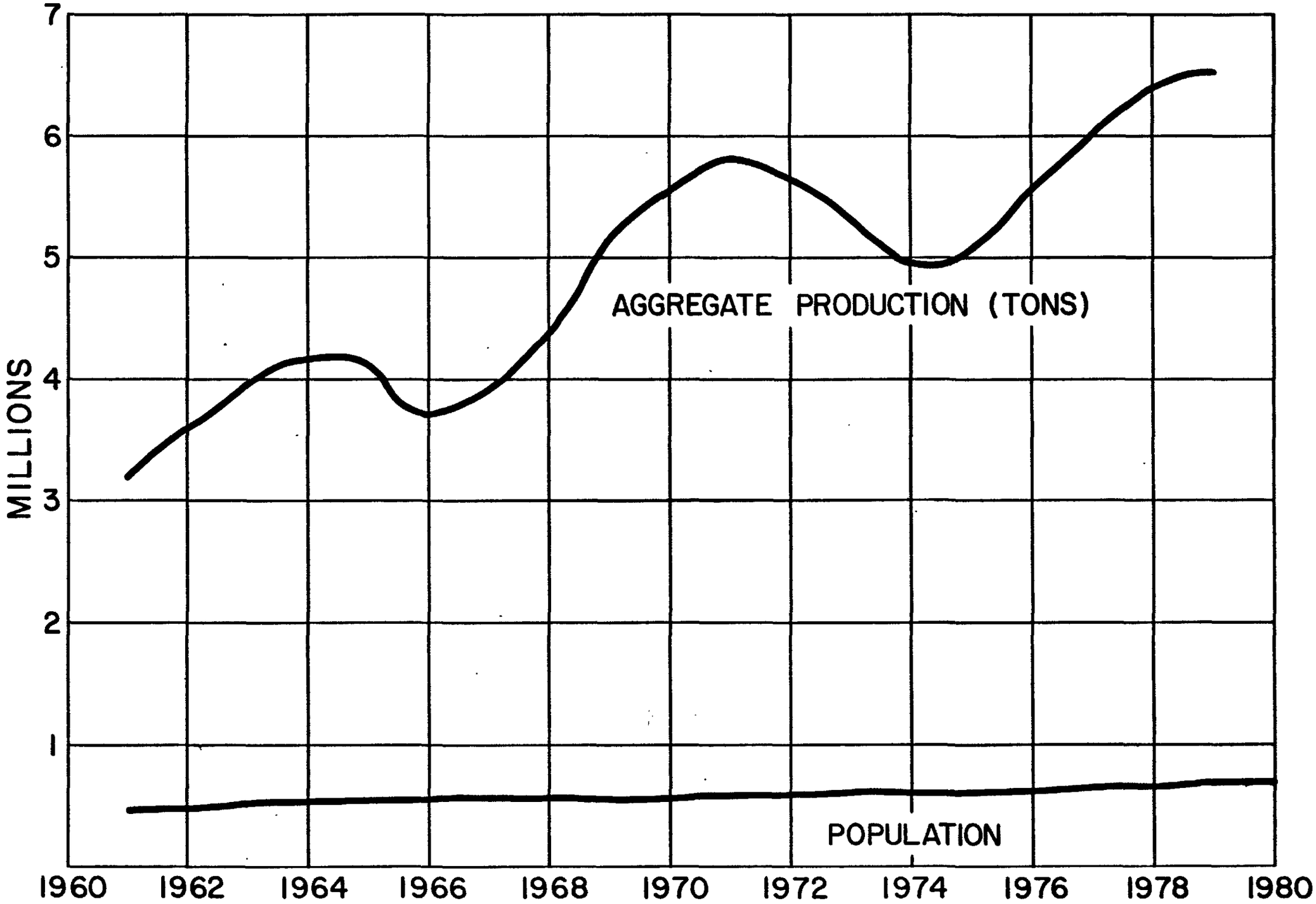


Figure 7.10 - San Bernardino P-C Region: Population and aggregate production records for years 1960-1980.

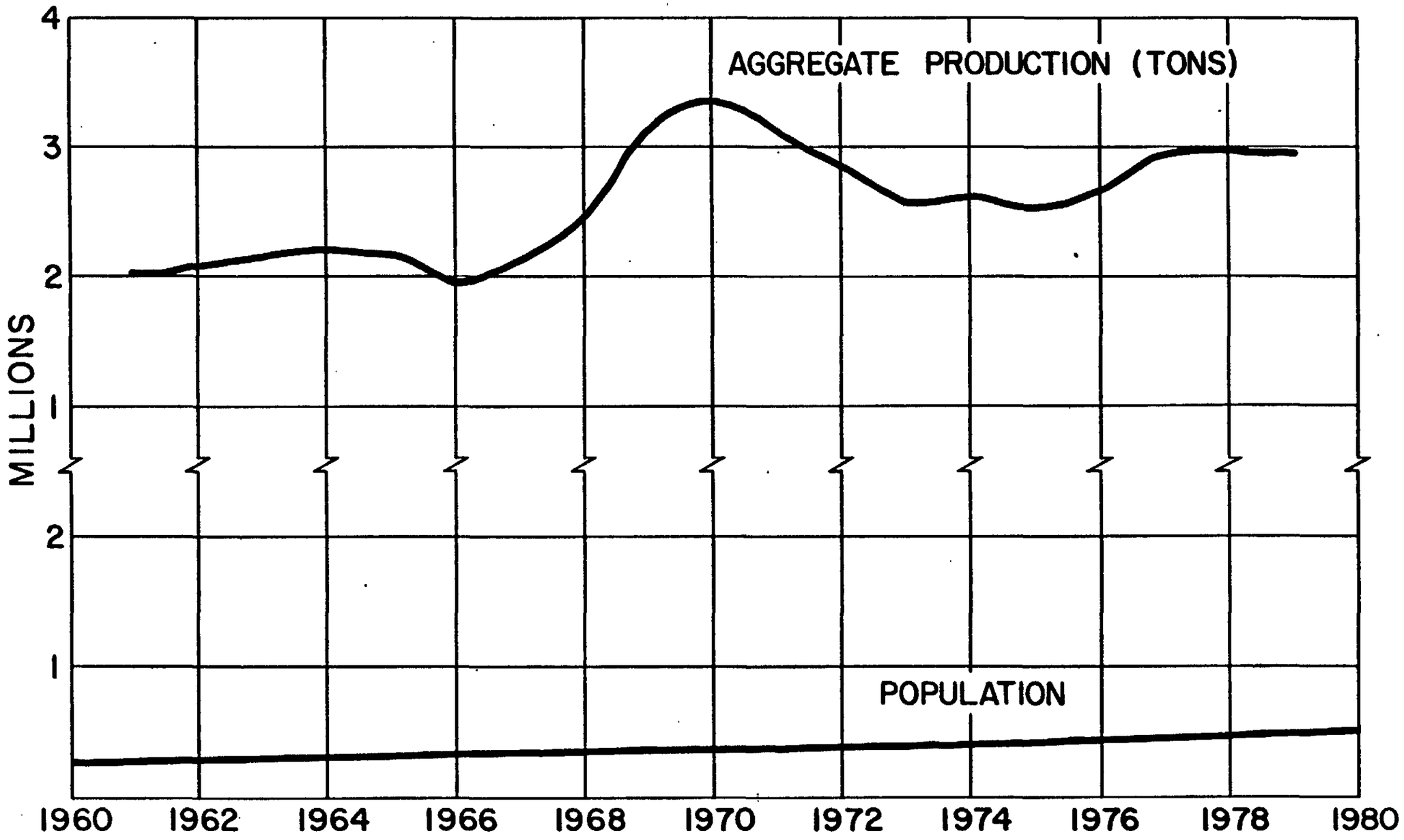


Figure 7.11 - Claremont - Upland P-C Region: Population and aggregate production records for years 1960-1980.

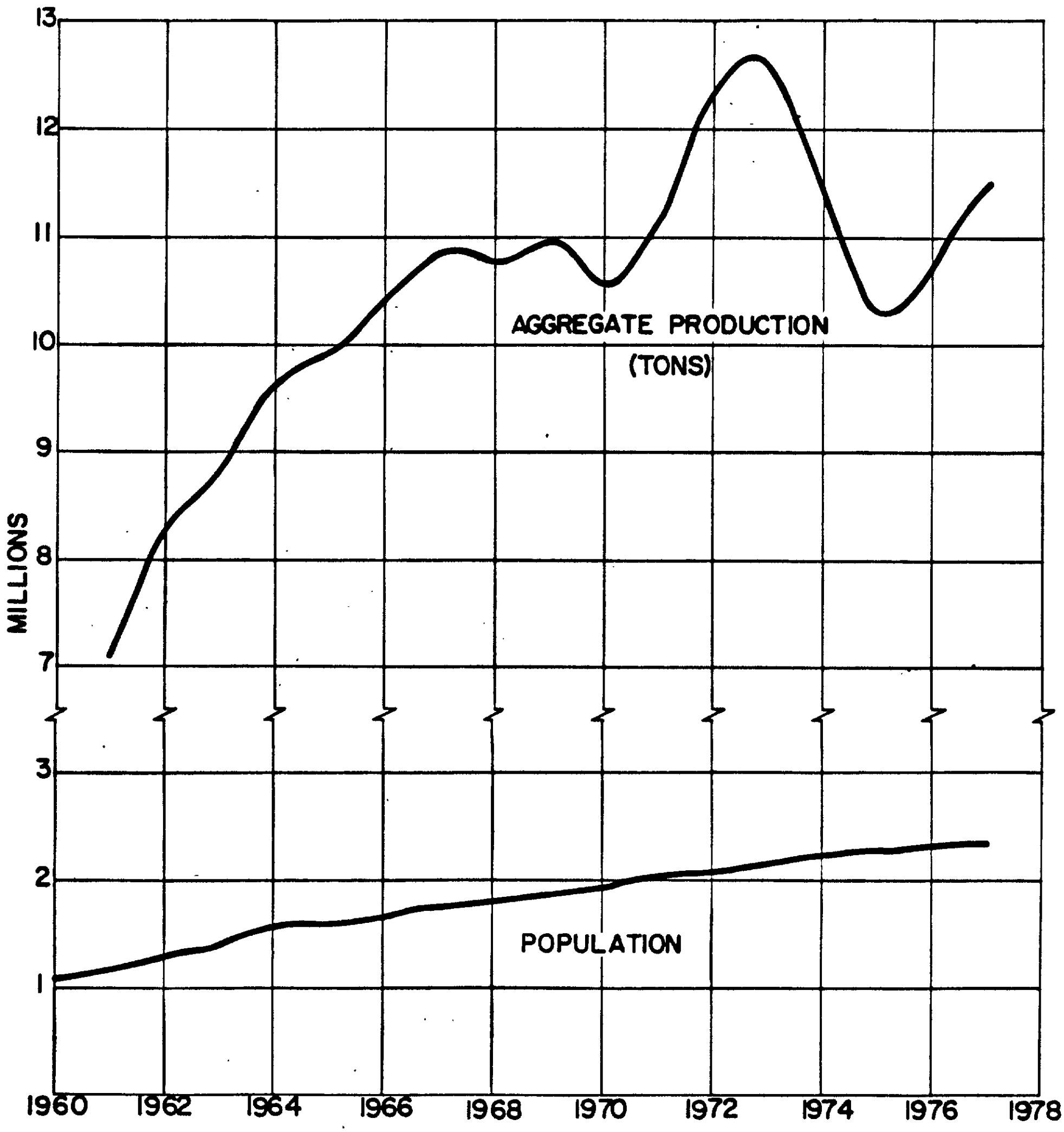


Figure 7.12 - Orange County - Temescal Valley P-C Region: Population and aggregate production records for years 1960-1977.

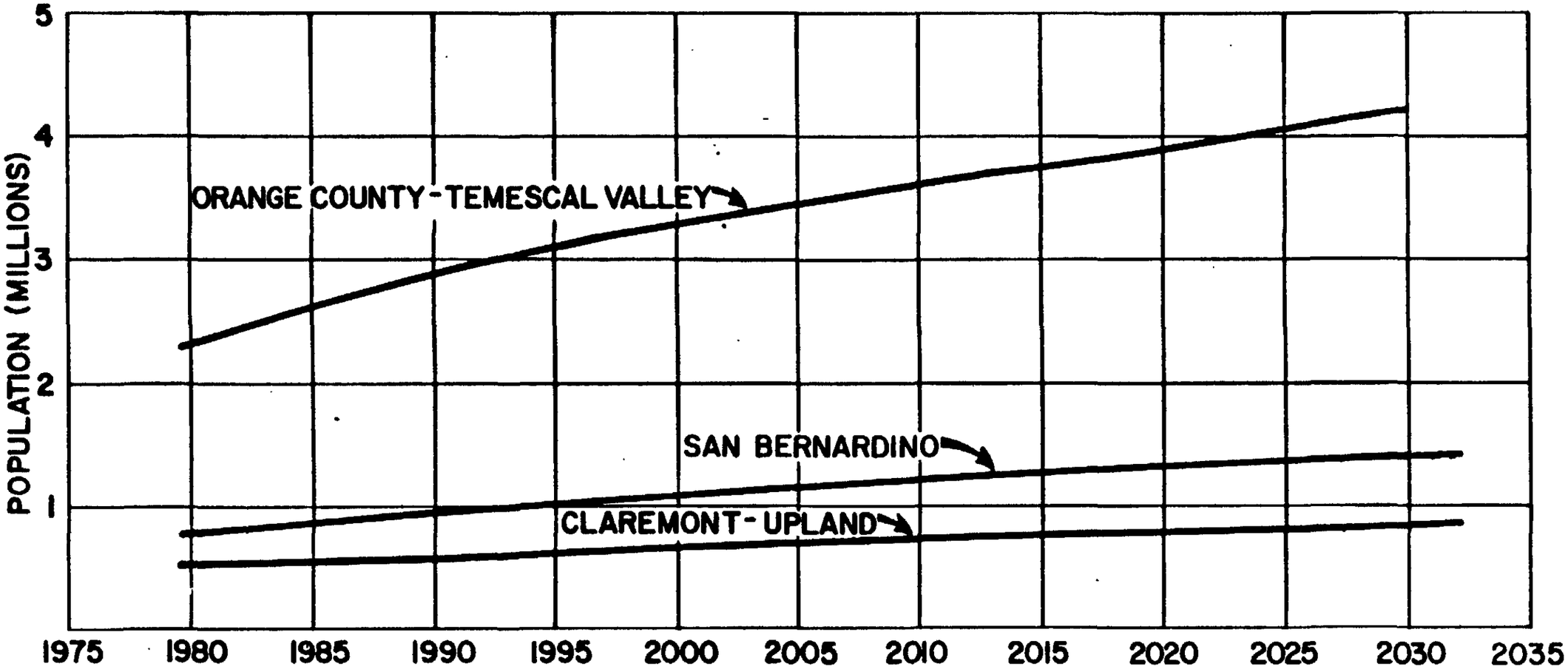


Figure 7.13 - Projected populations (50 years from the date of study) of the San Bernardino, Claremont - Upland, and Orange County - Temescal Valley P-C Regions to the year 2032.

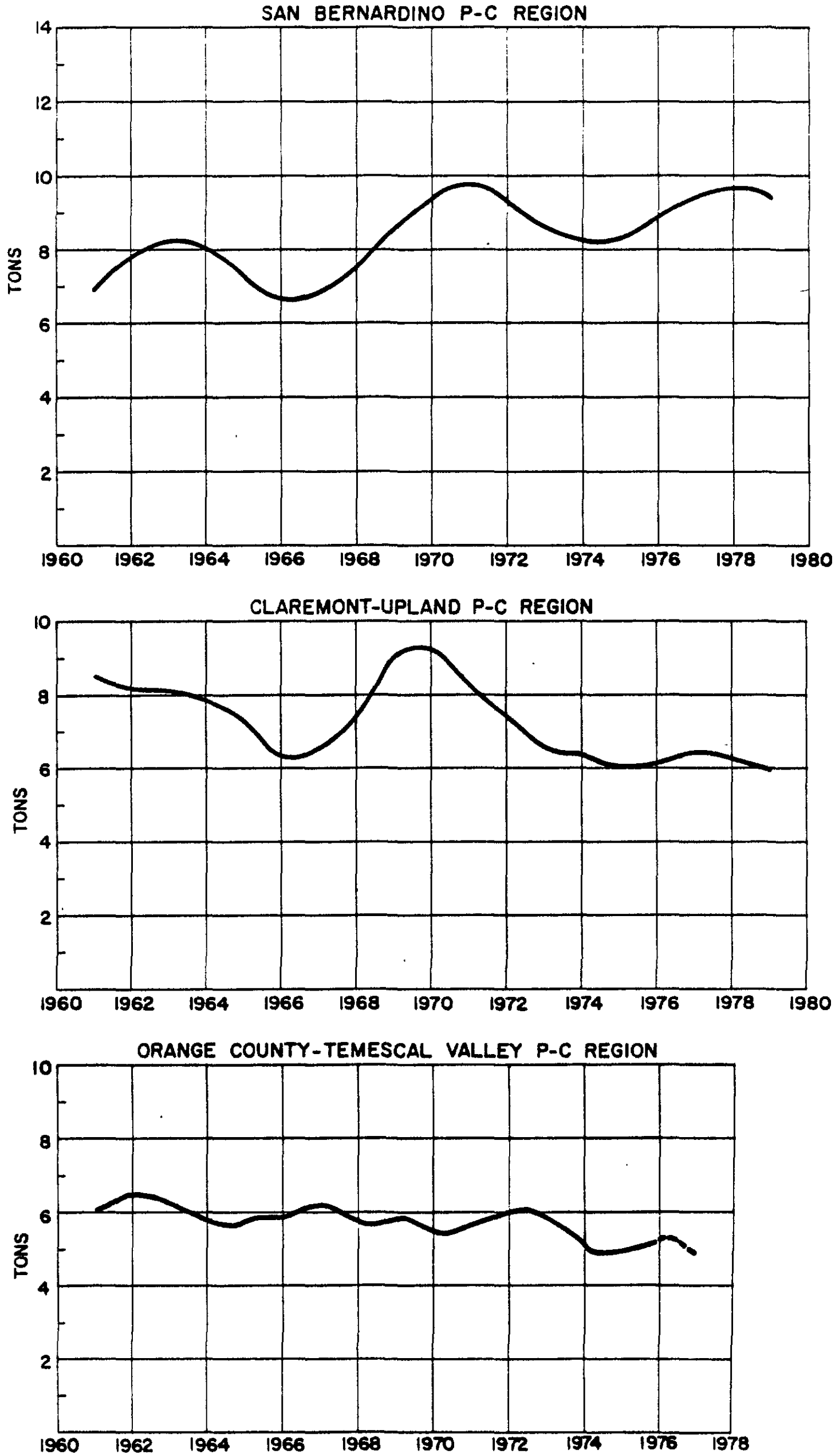


Figure 7.14 - Annual per capita consumption of aggregate in the San Bernardino, Claremont - Upland, and Orange County - Temescal Valley P-C Regions for years 1961-1977.

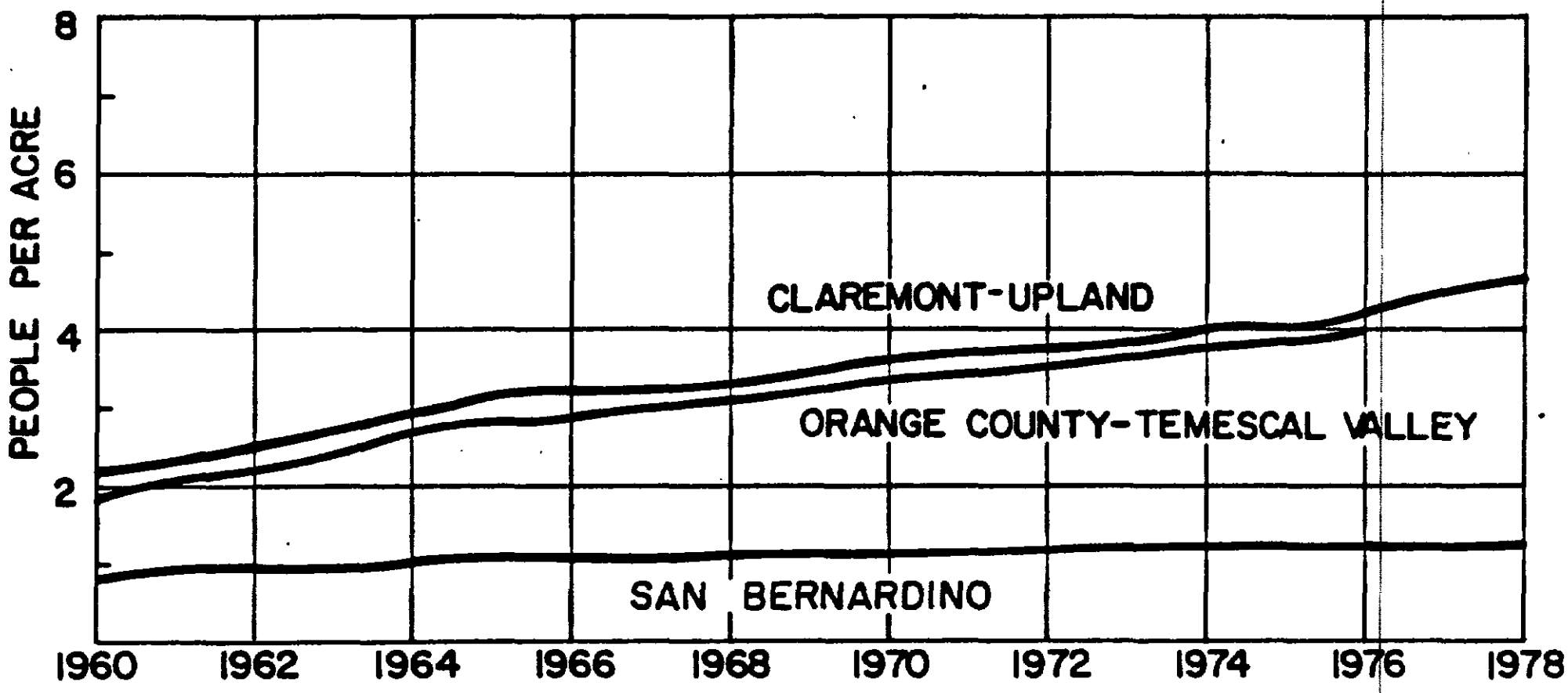


Figure 7.15 - Comparison of population densities for San Bernardino, Claremont - Upland, and Orange County - Temescal Valley P-C Regions for years 1960-1978.

ALTERNATIVE SOURCES OF AGGREGATE

Potential alternatives to those sources of aggregate described in Sectors A through I (Plates 7.27 - 7.38) occur in areas within and near the San Bernardino P-C Region. These sources include resources in adjacent P-C regions, other Holocene alluvial deposits, older Tertiary sedimentary deposits, and areas underlain by crystalline rock.

Except for the resources in adjacent P-C regions, too little is known about the physical and chemical properties (see "Overview of Aggregate" section in SR 143, Part I, Anderson and others, 1979) of the alternative sources of aggregate to permit resource estimates to be made. However, a general discussion about the potential resources, their occurrence, and factors controlling their utilization is presented in this section.

Sand and Gravel Resources of Adjacent P-C Regions

RESOURCE ESTIMATES

The total resource estimate for the adjacent Orange County - Temescal Valley P-C is 1500 million tons (Miller and Corbaley, 1981). The total resource calculation of 1400 million tons for the Claremont-Upland P-C Region is from a preliminary report. The reserve estimates are current to January 1979 in the Orange County - Temescal Valley P-C Region (260 million tons) and to January 1981 in the Claremont-Upland P-C Region (60 million tons).

The estimated resources of the two adjacent P-C regions are summarized in Table 7.4.

ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE IN ADJACENT P-C REGIONS

Estimated 50-year aggregate needs for adjacent P-C regions are presented on Table 7.3 (page 35). Comparison of Tables 7.3 and 7.4 shows that the projected 50-year total consumption of aggregate for both the adjacent P-C regions is less than their respective total resource estimates; however, the reserves in either the Orange County - Temescal Valley P-C Region or the Claremont-Upland P-C Region are not sufficient to supply their respective 50-year projected needs. This could mean a total shortfall of over 800 million tons for these P-C regions. It should be noted that, if non-permitted resources within these two P-C regions are not utilized to fill the shortfall, they will have to be filled from other areas. In such an event, it is likely that a major source of supply would be aggregate reserves of the San Bernardino P-C Region.

Crushed Rock Sources as Alternative Sources of Aggregate

Metamorphic and granitic rocks are exposed over large areas within and near the San Bernardino P-C Region. These areas are potential sources of crushed rock for use as aggregate material. The prospective resource areas that are located within the San Bernardino P-C Region are classified MRZ-3. However, large tracts of prospective crushed rock resource occur in the unclassified areas of the San Gabriel and San Bernardino Mountains north and east of the region.

PRODUCTION-CONSUMPTION REGION	INFERRED RESERVES (Million Tons)	INFERRED RESOURCES (Million Tons)	TOTAL (Million Tons)
CLAREMONT-UPLAND	60	1300	1400*
ORANGE COUNTY-TEMESCAL VALLEY	260	1200	1500*
CATEGORY TOTAL	320	2500	
TOTAL RESERVES-RESOURCES, Claremont-Upland Orange County-Temescal Valley:			2900*

TABLE 7.4 Aggregate resources of the Claremont-Upland and Orange County-Temescal Valley P-C regions.

* Figures rounded to nearest 100 million.

One of the more promising areas for potential crushed rock is the Jurupa Mountains northwest of Riverside. Granitic rock has been quarried extensively here for many decades for riprap and other uses; none, however, has been used as crushed rock for aggregate. Additional testing for suitability and marketability is necessary to further assess the resources here.

Teritary Sedimentary Rocks as Alternative Sources of Aggregate

Tertiary sedimentary units that may have potential for aggregate use include the San Timoteo and Potrero formations exposed in the Badlands adjacent to the San Jacinto Valley, the Potato Sandstone along the margin of the San Bernardino Mountains, and an alluvial unit filling an old Tertiary channelway on the Gavilan Plateau northwest of Perris.

Of these, the Tertiary sediments of the Badlands may be the most promising because of the larger potential tonnages and because alluvium eroded from this area has been mined for use as aggregate in the canyon west of Jackrabbit Trail. Detailed mapping of the Badlands area to locate suitable conglomerate deposits would be necessary to determine the significance of these units.

Holocene Alluvial Deposits as Alternative Sources of Aggregate

There are several areas underlain by Holocene alluvium in and near the P-C region that are potential sources of aggregate. Those areas that are within the P-C region have all been classified MRZ-3 due to lack of data necessary to determine their quality or extent.

A portion of the proximal part of the Lytle Creek fan has not been classified MRZ-2 as is the majority of the remaining area of the fan. The few drill holes within this lobe-shaped area near the mouth of Lytle Creek Canyon show a higher concentration of fine-grained deposits in the subsurface than is present elsewhere in the fan. This differs from conventional geologic interpretation of fan deposits in which the more distal parts of the fan are expected to contain the concentrations of finer sediments and the proximal part the coarser. Until more subsurface data is acquired in this area a detailed explanation cannot be made. However, parts of the proximal area of the fan probably contain suitable aggregate deposits of significance.

Drill-hole data from San Timoteo wash and its major tributary Oak Glen Creek indicate that coarse alluvial material is present in their channels in locally significant amounts. However, no production has taken place within these deposits, and test data concerning the suitability of the material for use as PCC aggregate is lacking.

Along the northeastern margin of the San Jacinto Valley is a series of small alluvial fans and their upstream alluvial deposits which form an irregular belt from several hundred yards to about a mile wide. These fans have been built of sediments eroded from the Badlands to the northeast. Some of this material has been mined for various types of aggregate, and the deposit in the canyon west of Jackrabbit Trail has been used in part for PCC aggregate. At present most of the material in this canyon has been excavated and the remaining small tonnages of aggregate suitable for use in PCC in the upstream end of the channel is below threshold value. Subsurface information is too sparse at present in this line of mountain-front fans to locate other areas of probable suitability.

The MRZ-2 area outlining the San Gorgonio River alluvial deposits is bordered by other alluvial deposits in the San Gorgonio Pass which are derived from generally the same source-rock types in the San Bernardino Mountains to the north. Although differences in sorting during transport may cause some changes in size content, there should be other deposits in the MRZ-3 areas in San Gorgonio Pass that are suitable for use as PCC aggregate.

Three major river channels which may contain significant deposits of aggregate lie adjacent to the San Bernardino P-C Region. These are the Lytle Creek channel and the Cajon Creek channel, both north of San Bernardino, and the Banning River channel north of Banning. Lack of sursurface data in all three areas prevents an estimate of the aggregate quantities present.

SUMMARY OF DESIGNATION FACTORS

Table 7.5 shows the nine aggregate resource sectors listed from top to bottom in order of their importance to the San Bernardino P-C Region over the next 50 years as determined by the amount of aggregate resources contained within each sector.

The most important sectors within the San Bernardino P-C Region are Sectors B, F, and G. They contain nearly 90% of the reserves and over 60% of the non-permitted resources in the region. The total resources contained within these sectors add up to over 6800 million tons, which is many times over enough to supply the San Bernardino P-C Region's 50-year demand of 480 million tons. The actual tonnage of aggregate material that will be extracted from Sectors B, F, and G depends on future land uses and permitted depths of mining.

Sectors A and C are important in terms of resource tonnage of contained aggregate material. These two sectors have a small percentage of the total reserves of the P-C region, but they contain over 2900 million tons of non-permitted resources (30% of the total within the San Bernardino P-C Region).

Sectors H and I contain less than 1% of the total resources for the San Bernardino P-C Region, but the reserves here are an important source of aggregate because this sector is the only one in the southern part of the region.

Sector E has approximately 7% of the total non-permitted resources for the region and contains no active producers. The material here is predominantly sand.

Sector D contains less than 1% of the total non-permitted resources and no reserves.

CONCLUSIONS

An estimated 10,000 million tons of aggregate resources exist in the San Bernardino P-C Region. However, current reserves available within the San Bernardino P-C Region are not quite adequate for supplying construction aggregate for the population for the next 50-year period. Based on a projected population increase for the region (Table 7.3) and the projected per capita consumption for each 5-year period, approximately 480 million tons of aggregate will be required to satisfy demand to the year 2032. Only 430 million tons of aggregate reserves remain within the San Bernardino P-C Region (Table 7.2), an amount which is projected to be depleted in approximately 41 years. Any loss of current reserves due to land-use decisions to use land for other purposes will foreshorten the time farther. The 50-million-ton deficit can be supplied by (1) extending the operating life of existing operations where there are resources available which are not permitted for mining; (2) opening new operations to develop the large quantities of non-permitted resources available in the region; and/or (3) importing material from adjacent areas.

A glance at Tables 7.3 and 7.4 shows that neither of the adjacent P-C regions has an adequate supply of reserves to meet their respective total projected needs to the year 2032. In fact, these data indicate that they will exhaust their reserves long before the San Bernardino P-C Region. Consequently, if the adjacent two P-C regions do not utilize other available resources, it is likely that they will need to import material from the San Bernardino P-C Region, in which case the calculated 41-year supply of reserves for this region will be depleted sooner.

SECTOR	PERCENT OF THE TOTAL P-C REGION RESERVES WITHIN THE SECTORS	PRECENT OF THE TOTAL P-C REGION NON-PERMITTED RESOURCES WITHIN THE SECTOR	ACTIVE MINING WITHIN SECTOR	REMARKS
B,F,G,	89	62	YES	Construction of proposed Flood control dam in Sector F would significantly reduce resources.
A,C	*	30	YES	Parts of these sectors are rapidly urbanizing.
H,I	*	1	YES	Important source of aggregate for southern part of region.
E	NONE	7	NO	Predominantly sand.
D	NONE	1	NO	

* Cannot be shown due to confidentiality of producer data

TABLE 7.5 Summary of Relative Importance of the Resource Sectors in the San Bernardino P-C Region

ACKNOWLEDGMENTS

The Division of Mines and Geology gratefully acknowledges the full cooperation of the local government agencies, organizations, and aggregate producers called upon for information during the course of this study. Special thanks are extended to the Southern California Rock Producers Association; the planning departments of San Bernardino and Riverside counties and the city of Fontana; the Southern California Association of Governments; and the California Department of Water Resources.

REFERENCES - PART VII

Allen, C.R., 1954, The San Andreas fault zone in San Gorgonio Pass, California: California Institute of Technology, Unpublished Ph.D. thesis, map scale 1:31,680.

Anderson, T.P., Loyd, R.C., Clark, W.B., Miller, R.V., Corbaley, R., Kohler, S., and Bushnell, M.M., 1979, Mineral land classification of the greater Los Angeles area; Part I, Description of the mineral land classification of the greater Los Angeles area: California Division of Mines and Geology Special Report 143, Part I, 51 p.

California Department of Finance, 1977, Population projections for California counties 1975-2020 with age/sex detail to 2000, series E-150, 34 p.

California Department of Water Resources, 1970, Meeting water demands in the Chino-Riverside area, Appendix A: Water supply: Bulletin No. 104-3.

California Department of Water Resources, 1970, Meeting water demands in the Bunker Hill - San Timoteo area: Bulletin No. 104-5.

California Department of Transportation, 1975, Standard specifications, 620 p.

Cox, B.F., and Morton, D.M., 1978, Generalized map of surficial materials in northwestern Riverside and southwestern San Bernardino counties, California: U.S. Geological Survey Open-File Report 78-978, map scale 1:125,000.

Dutcher, L.C., and Garrett, A.A., 1963, Geologic and hydrologic features of the San Bernardino area, California: U.S. Geological Survey Water-Supply Paper 1419, 114 p., map scale 1:31,680, cross sections.

Eckis, Rollin, 1928, Alluvial fans of the Cucamonga district, southern California: Journal of Geology, v. 36, no. 3, p. 224-247.

Evans, J.R., Anderson, T.P., Manson, M.W., Maud, R.W., Clark, W.B., and Fife, D.L., 1977, Aggregates in the greater Los Angeles area, California: California Division of Mines and Geology Special Report 139.

Fife, D.L., Rodgers, D.A., Chase, G.W., Chapman, R.H., Sprotte, E.C., and Morton, D.M., 1976, Geologic hazards in southwestern San Bernardino County, California: California Division of Mines and Geology Special Report 113.

Goldman, H.B., 1968, Sand and gravel in California, an inventory of deposits, Part C - Southern California: California Division of Mines and Geology Bulletin 180-C, 56 p.

Gray, C.H., Jr., 1954, Geology of the Corona-Elsinore-Murrieta area, Riverside County, in Geology of southern California: California Division of Mines and Geology Bulletin 170, Map Sheet 21.

Kohler, S.L., Loyd, R.C., and Anderson, T.P., 1981, Mineral land classification of the greater Los Angeles area, Part IV: Classification of sand and gravel resource areas, San Gabriel Valley Production-Consumption Region: California Division of Mines and Geology, in press.

Larsen, E.S., 1951, Crystalline rocks of the Corona, Elsinore, and San Luis Rey quadrangles, southern California: California Division of Mines Bulletin 159, p. 7-50, map scale 1:125,000.

Larsen, N.R., 1962, Geology of the Lamb Canyon area, Beaumont, California: Claremont College, Unpublished M.A. thesis, 93 p.

Mackevett, E.M., 1951, Geology of the Jurupa Mountains, San Bernardino and Riverside counties, California: California Division of Mines Special Report 5, 14 p., map scale 1:15,840.

Mendenhall, W.C., 1905, Hydrology of San Bernardino Valley, California: U.S. Geological Survey Water-Supply and Irrigation Paper No. 142, 124 p.

Miller, R.V. and Corbaley, R., 1980, Mineral land classification of the greater Los Angeles area, Part III, Orange County - Temescal Valley Production-Consumption Region: California Division of Mines and Geology Special Report 143, Part III.

Morton, D.M., 1966, Petrology of the Lakeview Mountains pluton and adjacent area, Riverside County, California: University of California, Los Angeles, Unpublished Ph.D. thesis, 163 p.

Morton, D.M., 1972, Geology of the Lakeview-Perris quadrangles, Riverside County, California: California Division of Mines and Geology Map Sheet 19, scale 1:24,000.

Riverside County Planning Commission, 1960-1969, Quarterly cummulative population estimates.

Riverside County Department of Development, 1970, Census summary by tract and city, from U.S. Bureau of Census Information.

Riverside County Planning Department, 1971-1980, Population and dwelling units, in Planning News.

Rogers, T.H., 1965, Geologic map of California, Santa Ana sheet: California Division of Mines and Geology, scale 1:250,000.

Rogers, T.H., 1967, Geologic map of California, San Bernardino sheet: California Division of Mines and Geology, scale 1:250,000.

San Bernardino County Planning Commission, 1960-1969, Population and Housing Quarterly Bulletin, v. 1, nos. 1, 5, 9, 13, 17, 21, 25, 29, and 33.

San Bernardino County Planning Department, 1976, 1978, and 1980, Population-Housing Bullletin, v. 2, nos. 8, 9, and 10.

Schwarcz, H.P., 1960, Geology of the Winchester-Hemet area, Riverside County, California: California Institute of Technology, Unpublished Ph.D. thesis, 277 p.

Southern California Association of Governments, 1978, Draft SCAG-78, Growth Forecast policy, in Development Guide, 72 p.

Weber, F.H., Jr., 1977, Seismic hazards related to geologic factors, Elsinore and Chino fault zones, northwestern Riverside County, California: California Division of Mines and Geology Open-File Report 77-4 LA, map scale 1:24,000.

APPENDIX

Interim Criteria for Sectorization of MRZ-2 Areas for Aggregate

The purpose of sectorizing MRZ-2 areas is to provide a semi-quantified estimate of construction aggregate resources which are likely to be available to satisfy society's needs during the next 50 years. This estimate, when compared to DMG projected needs for the next half century, provides the context for communities to plan for future resource availability in their land-use policies. The determination of sectors is intended for the use of the State Mining and Geology Board in identifying areas which are candidates for designation under SMARA. The development of sectors provides a perception of future mineral resource availability in the face of future needs and also portrays where these available minerals are generally located. This information is distributed by the Board to all affected lead agencies to provide them with the data necessary to plan for future resource availability in their land-use policies.

Areas within MRZ-2 classifications are sectorized if they have current land uses which are similar to those in areas which have been feasible mineral extraction in the past. Areas within MRZ-2 classifications which have generally not been available for surface mining in the past for specified social or economic reasons are not sectorized. Since such areas are unlikely to be used for surface mining during the foreseeable future, their inclusion in estimates of future resource availability would be misleading.

The estimation of future mineral resource availability in sectors is not a precise analysis, but rather is the best general estimate which can be made with the data presently available. Areas within and without sectors, can be used for mining or other land uses at the discretion of the local governments which are charged with responsibility for making land-use decisions. Establishment of sectors in no way infringes on this authority. Rather, it provides a perception of future mineral resource availabilities in the face of future needs and also portrays where these available minerals are generally located.

The following criteria will be used by DMG in identifying mineral resource areas which are available for future use. These criteria, in conjunction with the geologic and geometric characteristics of specific mineral deposits will be used in sectorizing MRZ-2 areas. Use of these criteria will assure that sectors contain geologically homogeneous mineral deposits that, based upon current land use, will be available for future use.

These land-use criteria are interim and will be used on a trial basis by DMG to evaluate their usefulness. DMG will provide the SMGB with formal recommendations concerning these criteria early in fiscal year 1983-84.

The following specific land uses are considered to be generally incompatible with mining and will thus be excluded from sectors. Mineral resource areas containing land uses not specifically listed will be considered for sectorization. The criteria are to be applied only to lands classified as MRZ-2.

There are two general categories of exclusion: I) Economic Exclusion, and II) Social Exclusion. These exclusions will be applied to land uses that exist at the time the classification report is being prepared. The exclusion will not be applied to proposed or planned land uses.

I. Economic Exclusion

Specific excluded land uses are:

1. Residential areas
2. Commercial areas with land improvements (buildings)
3. Industrial areas (buildings and adjacent needed storage and parking facilities)
4. Major public or private engineering projects, including:
   a. canals
   b. freeways
   c. bridges
   d. airports and associated developments such as parking lots
   e. dams
   f. railroads
   g. major pipelines
   h. major power transmission lines

II. Social Exclusion

Specific excluded land uses are:

1. Cemeteries
2. Geologic Scientific Zones
3. Public parks, developed historical sites and structures, and public recreation areas of all types
4. Public or private schools, institutions, hospitals, and prisons, including adjacent grounds and related structures
5. Military bases and reservations