MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE SAN FRANCISCO–MONTEREY BAY AREA

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CALIFORNIA DEPARTMENT OF CONSERVATION
DIVISION OF MINES AND GEOLOGY

SPECIAL REPORT 146

Part II

Classification of
Aggregate Resource Areas

**SOUTH SAN FRANCISCO BAY
PRODUCTION–CONSUMPTION REGION**

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South San Francisco Bay Production-Consumption Region

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CALIFORNIA DEPARTMENT OF CONSERVATION

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FOREWORD

Special Report 146, "Mineral Land Classification of the San Francisco-Monterey Bay Area," is the first analysis of mineral resources in the San Francisco-Monterey Bay area to be developed by the Division of Mines and Geology under authority of the Surface Mining and Reclamation Act of 1975 (SMARA). This classification is provided to the State Mining and Geology Board for transmittal to the local governments which regulate land use in this region, and for consideration of areas, if any, to be designated as regionally significant. SMARA was enacted by the State Legislature to assure mineral resource conservation and adequate mined land reclamation.

The Mining and Geology Board adopted Guidelines in June 1978 to be employed by the Division in its mineral resource classification. This report was prepared in conformance with those directives. The undertaking is of great importance in economic geology, because it deals with very specific mineral resource conservation issues in areas of intensive competing land use.

James F. Davis
State Geologist

PREFACE

Data presented in this report is accurate as of January 1983, at which time a preprint version of the report was circulated to lead agencies and made available to the public. Changes in reserves resulting from either the premature closure of mines active in 1983, or the permitting of new mines since that time, may have impacted forecasted depletion dates for the three production-consumption regions studied. However, the material presented and the fundamental conclusions of the report remain valid and useful.

David J. Beeby
Urban SMARA Program Manager

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EXECUTIVE SUMMARY (PART II)

The San Francisco-Monterey Bay area, with its population of over six million people, is the largest urbanized area in northern California. This region includes twelve counties that border on San Francisco or Monterey bays. Although substantial portions of the region have been developed, urbanization is still occurring at a rapid rate.

In any urban development it is important that land-use decisions are 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 region and the expected needs of the region for such resources in the coming decades. For many years, the San Francisco-Monterey Bay area has been fortunate because adequate quantities of low-cost aggregate materials have been available locally. However, as more and more areas become urbanized, suitable sand, gravel, and stone deposits are being lost through urban development and are being diminished yearly by mining.

The principal objective of this project is to classify land in the San Francisco-Monterey Bay 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 designating lands that contain valuable mineral resources, as mandated by the Surface Mining and Reclamation Act of 1975. The objective of the classification and designation process is to insure, through appropriate lead agency policies and procedures, that mineral deposits of statewide or regional significance are considered for availability when needed.

The Division of Mines and Geology has classified urbanizing lands within the South San Francisco Bay Production-Consumption (P-C) Region according to the presence or absence of significant sand, gravel, or stone deposits that are suitable as sources of aggregate. If a deposit contained more than $5 million worth of material suitable for at least sub-base aggregate, the deposit was classified MRZ-2.

In the San Francisco-Monterey Bay area, classification was done with regard to the suitability of the underlying material for use as asphaltic concrete aggregate, road base, or subbase material, in addition to its use as Portland cement concrete (P.C.C.) aggregate. This classification project stands in contrast to the various P-C region studies underway in southern California, where only P.C.C.-grade deposits were classified. This approach is appropriate in the San Francisco-Monterey Bay area for two reasons:

1. In the Los Angeles Basin almost all aggregate production is from deposits which meet P.C.C. specifications. The Bay area, in contrast, is not blessed with such large amounts of high quality sand and gravel, and about half the production comes from deposits which are not of P.C.C. quality. To accommodate this difference, all deposits in the Bay area containing suitable material for aggregate commodities higher than fill quality have been classified. Each deposit has been identified on the basis of sales records or test data as to its highest use.

2. The Los Angeles Basin aggregate production is dominated by alluvial sand and gravel deposits with very little crushed stone production. The Bay area is much more dependent on crushed rock quarries (many of which do not meet P.C.C. specifications) to satisfy its aggregate demands. Therefore, crushed stone deposits have been segregated from sand and gravel deposits in the San Francisco reports.

The land classification within the South San Francisco Bay P-C Region is presented in the form of Mineral Resource Zones on 46 U.S. Geological Survey topographic quadrangle maps that accompany this report (Plates 2.6 - 2.51). Mineral resource zones were established on the basis of a sand, gravel, and stone resource appraisal which included the following actions: a study of pertinent geologic reports and maps; field investigations and sampling at outcrops and active and inactive pits and quarries; and an analysis of water-well logs and drill records. Sixty-three areas were determined to contain significant aggregate deposits and were classified MRZ-2. In addition, there were 107 areas that contained mineral 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 utilized the concept of 'sectors' to identify those MRZ-2 areas that have not been urbanized. The geometrical configuration of the deposit in each sector is fairly uniform, so that tonnage of the mineral resource present can be calculated with some reliability. Thus, for example, sector boundaries would be 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 flood plain. 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 South San Francisco Bay P-C Region, 42 MRZ-2 areas with existing land uses that are compatible with mining qualify as sectors; they contain a total of 6.3 billion tons of resources. The sectors are described in detail in this report, and are shown on Plates 2.52 - 2.75. Some sectors encompass unimproved portions of dedicated parklands. It is recognized that dedicated parklands have special status as opposed to other current uses of sectorized land, consequently the resources within parks have been sectorized separately and the quantifications of those resources are presented separately in the tables. The quantification of resources within park sectors is expressed to a lower degree of accuracy rather than to the higher level of accuracy reflected in the resources calculations for other sectors.

The South San Francisco Bay P-C Region is dependant upon aggregate from both crushed stone and alluvial deposits. Because these two commodities are not entirely interchangeable, resource and reserve totals for each type have been identified separately.

Reserves are aggregate materials that a company owns or controls, and for which it has a valid mining permit; *resources* are the total amount of available aggregate within the sector, including any reserves. The estimated resources within the 16 sand and gravel sectors amount to 1.1 billion tons, of which 259 million tons are classified as reserves available for mining at the end of 1980. The estimated crushed stone resources within the remaining 26 sectors amount to 5.2 billion tons, of which 293 million tons are classified as reserves available for mining at the end of 1980.

The total projected aggregate consumption through the year 2030 is estimated to be 1.5 billion tons, of which at least 39 percent (580 million tons) must be of P.C.C. quality. Of the projected total demand, 552 million tons (35 percent) were available for mining at the end of 1980. Unless additional resources are permitted for mining or alternative resources are utilized, existing reserves will be depleted in 12 years (1999). To make the projections, production records and population figures were correlated for the past 28 years (1953-1980) to obtain an average per capita rate. The derived rate of 6.0 tons per year was used along with population projections to make the estimate of total consumption.

The average annual per capita consumption rate for the South San Francisco Bay P-C Region may decrease, at a more or less steady rate, as the area becomes more urbanized until a steady state (urban maturity) is reached. Should unforeseen events occur, such as massive urban renewal, disaster reconstruction, or major recession, the per capita consumption rate could change significantly. The presence of several major active fault systems within the South San Francisco Bay P-C Region increases the chance for a damaging earthquake and the need for subsequent extensive reconstruction afterwards.

Alternative sources of aggregate, in addition to those deposits classified MRZ-2 and MRZ-3, occur in areas within the South San Francisco Bay P-C Region, and in adjacent P-C regions. Some potential deposits lie outside the OPR urbanizing boundaries, but still within the P-C region boundaries. Included within the group of potential resources are the extensions of several deposits classified MRZ-2 or MRZ-3. In addition, sand and fine gravel occur in bars on the floor of San Francisco Bay, between the Golden Gate Bar and the confluence of the Sacramento and San Joaquin rivers. Except for the aggregate resources in adjacent P-C regions and marine sand deposits, too little is known about the physical and chemical qualities of most of the alternative sources to permit even crude resource estimates.

If additional aggregate is needed in the South San Francisco Bay P-C Region on a short-term basis, the most readily available material is located in the neighboring regions - North San Francisco Bay, Monterey Bay, and Sacramento-Fairfield P-C regions. On a short-term basis the active quarries in these P-C regions can send large amounts of aggregate into the South San Francisco Bay P-C Region, but the delivered price per ton would be greatly increased by higher transportation costs and by any supply-demand conflicts. The long-term (50 year) resource picture is more uncertain. The North San Francisco Bay P-C Region is projected to have a deficit of P.C.C.-grade aggregate, while the Monterey Bay P-C Region appears to have a surplus of material. Projected aggregate needs and available supplies in the Sacramento-Fairfield P-C Region are currently being studied.

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 upon assumptions concerning the accuracy of the basic data, and the continuation of the development trends of the past three decades into the five decades ahead.

Assuming, however, the correctness of our forecasts for the consumption of aggregate, the following conclusions were reached:

- The anticipated consumption of aggregate resources in the P-C region to the year 2030 is forecast to be 1.5 billion tons, of which approximately 39 percent or 580 million tons must be of P.C.C. quality.

- Unless additional resources are permitted for mining, or alternative resources are utilized, total existing reserves (both P.C.C. and non-P.C.C. aggregate) would be depleted by the year 1999, only 12 years from the publication of this report. About 552 million tons of permitted aggregate reserves exist in the P-C region. About 49 percent of the permitted reserves are sand and gravel, and 51 percent are crushed stone. In total, the 552 million tons amount to 37 percent of the anticipated consumption during the next 50 years.

- Of the 552 million tons of permitted reserves, about 313 million tons are suitable for use as P.C.C. aggregate. This amounts to 54 percent of the anticipated P.C.C. aggregate consumption during the next 50 years.

- The expected longevity of the existing reserves is based upon the assumption that mining of these reserves will continue to be permitted until the reserves are depleted.

- P.C.C. reserves, because of their higher quality specifications will be the most difficult to replace as existing permitted deposits are depleted.

- Of the 15 stratigraphic/lithologic units suitable for aggregate in the P-C region, only 7 are known to be suitable for P.C.C. aggregate.

- A total of 6.3 billion tons of aggregate resources (including reserves) have been identified within the South San Francisco Bay P-C Region. One and one-tenth billion tons of sand and gravel and 5.2 billion tons of crushed stone compose the 6.3 billion tons of resources. Of this total, 2 billion tons are on parklands.

- If all of the reserves suitable for P.C.C. aggregate are utilized for only that purpose, P.C.C.-grade reserves would be depleted in about 20 years (2007). However, we can expect that some of the production from these reserves will be used for non-P.C.C. applications, consequently, the expected exhaustion of these reserves will occur considerably earlier.

- Seven sectors containing about 489 million tons of P.C.C. sand and gravel do not have permitted mining or established reserves.

- Of 34 aggregate production sites in the South San Francisco Bay P-C Region, 12 contain sand and gravel resources and 22 contain crushed stone resources.

SPECIAL REPORT 146

MINERAL LAND CLASSIFICATION: AGGREGATE MATERIALS IN THE SAN FRANCISCO - MONTEREY BAY REGION

Part II

Classification Of Aggregate Resource Areas South San Francisco Bay Production-Consumption Region

INTRODUCTION

The Division of Mines and Geology has classified urbanizing lands within the South San Francisco Bay Production-Consumption (P-C) Region according to the presence or absence of significant sand, gravel, or stone deposits that are suitable as sources of aggregate. The land classification is presented in the form of Mineral Resource Zones (MRZ) - as described in Part I of this report - on 46 U.S. Geological Survey topographic quadrangles that accompany this report (Plates 2.6-2.51). Sixty-three areas are classified MRZ-2 (they contain significant aggregate deposits). Forty-two resource sectors containing a total of 6.3 billion tons of resources have been identified within the MRZ-2 areas. The sectors are described in detail in this report, and are shown on 24 additional topographic quadrangles.

Based on population records and projections and aggregate production records, the South San Francisco Bay P-C Region will need 1.5 billion tons of aggregate during the next 50 years. Of this projected demand, 552 million tons (37 percent) were available for mining at the end of 1980.

Several alternative sources of aggregate for this P-C region are discussed. Similar studies have been completed for the North San Francisco Bay and Monterey Bay P-C regions (Parts III and IV) and pertinent data 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 146, Part I, occurs in seven separate but interrelated steps. Steps One and Two in the following list are described in Part I, but are restated merely for completeness. Steps Three through Seven form the bulk of this report (Part II) and are described sequentially. Resource information is integrated in Table 2.12 and described on a sector-by-sector basis on pages 12 through 38.

The classification process can be briefly summarized as occurring in the 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 should be classified.
3. *Establishment of Mineral Resource Zones (MRZ):* This step includes a geologic appraisal for aggregate deposits of 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 resources for the P-C region. This step utilizes intensive field checking to make that determination.
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 resources within each sector.
6. *Forecasting:* In this step, anticipated aggregate demand in the P-C Region for the next 50 years is determined. This is done by correlating historic population and aggregate production data for the past 28 years to calculate an annual per capita consumption rate. This figure is used with projected population figures in the area to determine anticipated aggregate demand. Results of this analysis are compared with total volumes of permitted aggregated reserves in the P-C Region.
7. *Alternative Resources:* A variety of potential alternative aggregate resources are evaluated in this final step of the classification process.

ESTABLISHMENT OF MINERAL RESOURCE ZONES

Mineral resource zones within the South San Francisco Bay P-C Region were established on the basis of a sand, gravel, and stone resource appraisal which included the following actions: a study of pertinent geologic reports and maps; field investigations and sampling at outcrops and active and inactive pits and quarries; analysis of water-well logs and drill records. Sixty-three areas were classified MRZ-2 (see below for a description of MRZ terminology). In addition, there were 107 areas that contained mineral resources, but did not possess all the qualifications for classification as MRZ-2; these areas were classified MRZ-3.

Due to the large amount of area classified in this report - portions of 46 quadrangles - the field and office work extended over a 7-year period. Field work was done during the following months: Alameda County - September 1978, January 1979, March 1979; Contra Costa County - January 1979, March 1979; San Francisco County - May 1979; San Mateo County - May 1979; Santa Clara County - March 1979, April 1979, and May 1979. Selected areas within these counties were revisited in August 1982, May 1983, and September 1984.

Plates 2.6-2.75 are 1:48,000 scale copies of U.S. Geological Survey topographic quadrangles that cover the urbanizing portions of the South San Francisco Bay P-C Region. Refer to Plate 1.1 (in Part I) or Table 2.1 for an index to quadrangle classified in the P-C region. A list of possible lead agencies and other affected agencies within the P-C region is presented in Table 2.2.

Areas Classified MRZ-1

Areas classified MRZ-1 are "areas where adequate information indicates that no significant mineral deposits are present, or where it is judged that little likelihood exists for their presence" (see Part I, Appendix A-3, page 25). The areas in the South San Francisco Bay P-C Region that have been classified MRZ-1 are underlain by Quaternary alluvial material judged to contain too much clay and silt for use as aggregate. The data used in evaluating these areas included available water-well logs and the best-available geologic and soil maps.

Areas Classified MRZ-2

Sixty-three areas within the South San Francisco Bay P-C Region are classified MRZ-2 (Plates 2.1-2.4, and 2.6-2.51). These are "areas where adequate information indicates that significant deposits are present, or where it is judged that a high likelihood for their presence exists" (see Part I, Appendix A-3, p. 25).

The guidelines set forth two requirements to be used to determine if land should be classified MRZ-2:

1. The deposit must be composed of material that is suitable as a marketable commodity.

2. The deposit must meet threshold value. The projected value (gross selling price) of the deposit, based on the value of the first marketable product must be at least $5 million (1978 dollars).

Although not specified in the guidelines, the following criteria were applied to each deposit to test its suitability for inclusion in a MRZ-2 zone:

A. The presence of an operating quarry within the deposit is considered proof that Condition 1 has been met.

B. An average value of $2.00 per ton (all aggregate types) and a conversion factor of 2,500 tons per acre-foot of material (0.065 tons per cubic foot with 10 per cent waste) requires a minimum amount of 1,000 acre-feet of material within the deposit, exclusive of overburden and fill material, to meet suggested threshold value.

C. A deposit of aggregate material must have an overburden-to-ore ratio of less than 1 to 1 in order for mining to be economic at the present time.

Specific criteria are discussed in the section "Estimated Aggregate Resources of the South San Francisco Bay P-C Region."

In the San Francisco-Monterey Bay area, classification was done with regard to the suitability of the underlying material for use as asphaltic concrete aggregate, road base, or subbase material, in addition to its use as Portland cement concrete (P.C.C.) aggregate. If a deposit contained more than $5 million worth of material suitable for at least subbase aggregate, the deposit was classified MRZ-2. This classification project stands in contrast to the various P-C region studies underway in southern California, where only the P.C.C.-grade deposits were classified. This different approach is appropriate in the San Francisco-Monterey Bay area for two reasons:

1. In the Los Angeles Basin, almost all aggregate production is from deposits which meet P.C.C. specifications. The Bay area, in contrast, is not blessed with such large amounts of high quality sand and gravel, and about half the production comes from deposits which are not of P.C.C. quality. To accommodate this difference, all deposits in the Bay area containing suitable material for aggregate commodities higher than fill quality have been classified. Each deposit has been identified on the basis of sales records or test data as to its highest use.

2. The Los Angeles Basin aggregate production is dominated by alluvial sand and gravel deposits with very little crushed stone production. The Bay area is much more dependent on crushed stone quarries (many of which do not meet P.C.C. specifications) to satisfy its aggregate demands. Therefore, crushed stone deposits have been segregated from sand and gravel deposits in the San Francisco reports.

The following areas within the South San Francisco Bay P-C region have been classified MRZ-2 because they contain sand and gravel resources that meet the criteria outlined above: in Alameda County, much of the Livermore-Amador Valley, Alameda Creek (Sunol Valley and Niles Cone areas), and the plateau area immediately south of Mission San Jose; in Contra Costa County, a low hill near Antioch, and hills 3 miles west of Byron; in western Santa Clara County two areas near Cupertino that are underlain by conglomerate. By far, the bulk of the sand and gravel deposits within the classified areas occurs beneath urbanized land. Such areas are considered unavailable as sources for aggregate because present land uses are incompatible with mining (see "Calculation of Available Aggregate Resources" in Part I, p. 9).

The following areas within the South San Francisco Bay P-C Region have been classified MRZ-2 because they contain stone

Table 2.1 List of U.S. Geological Survey 7.5 minute quadrangles classified in the South San Francisco Bay P-C Region. Plates 2.6 - 2.51 show the classification in these quadrangles.

ALAMEDA COUNTY	PLATE	CONTRA COSTA COUNTY	PLATE
Altamont	2.6	Antioch North	2.25
Briones Valley	2.7	Antioch South	2.26
Byron Hot Springs	2.8	Benicia	2.27
Dublin	2.9	Brentwood	2.28
Hayward	2.10	Briones Valley	2.7
Hunters Point	2.11	Clayton	2.29
La Costa Valley	2.12	Diablo	2.30
Las Trampas Ridge	2.13	Dublin	2.9
Livermore	2.14	Honker Bay	2.31
Milpitas	2.15	Jersey Island	2.32
Mountain View	2.16	Las Trampas Ridge	2.13
Newark	2.17	Mare Island	2.33
Niles	2.18	Oakland East	2.19
Oakland East	2.19	Port Chicago	2.34
Oakland West	2.20	Richmond	2.22
Redwood Point	2.21	San Quentin	2.35
Richmond	2.22	Walnut Creek	2.36
San Leandro	2.23		
Tassajara	2.24		

SAN FRANCISCO - SAN MATEO COUNTIES	PLATE	SANTA CLARA COUNTY	PLATE
Half Moon Bay	2.37	Calaveras Reservoir	2.45
Hunters Point	2.11	Castle Rock Ridge	2.46
Mindego Hill	2.38	Cupertino	2.47
Montara Mountain	2.39	Los Gatos	2.48
Palo Alto	2.40	Milpitas	2.15
Redwood Point	2.21	Mindego Hill	2.38
San Francisco North	2.41	Mountain View	2.16
San Francisco South	2.42	Palo Alto	2.40
San Mateo	2.43	San Jose East	2.49
Woodside	2.44	San Jose West	2.50
		Santa Teresa Hills	2.51

resources that meet the criteria outlined above: two areas near Clayton (Contra Costa County) that are underlain by Jurassic diabase and basalt or Franciscan Complex sandstone and greenstone; several areas in the Berkeley Hills (Alameda County) that are underlain by rocks of the Briones Formation, Franciscan Complex, Leona Rhyolite, or volcanic rocks of the Moraga Formation. In western Santa Clara County, a series of northwest-trending masses of rock of the Franciscan Complex have been classified MRZ-2. Rocks of the Briones Formation in eastern Santa Clara County have also been classified MRZ-2. Cretaceous quartz diorite near Half Moon Bay, and rocks of the Franciscan Complex located near Belmont, Daly City, Pacifica, San Carlos, and at San Bruno Mountain (in San Mateo County), and in San Francisco, also have been classified MRZ-2. Some of these areas are unavailable for mining, because they occur in areas presently urbanized or committed to uses that preclude the extraction of aggregate.

As explained in Part I under the heading "Concept of Sectors," the State Geologist has identified as resource sectors those MRZ-2 areas with existing land uses that are compatible with mining (Part I, p. 9 and Appendix A-5, p. 41). In the South San Francisco Bay P-C Region, 42 areas qualify as sectors; they contain sand and gravel, or stone suitable for aggregate. Tables 2.3, 2.4, 2.5, and 2.6 list the geologic units and formations underlying the resource sectors, and show which sectors contain material that may be suitable for Portland cement concrete aggregate. Detailed descriptions of the individual sectors are included below in the section "Estimated Aggregate Resources of the South San Francisco Bay P-C Region." The identification of resource sectors has been done to inform lead agencies and oth-

Table 2.2 List of lead agencies (counties and incorporated city governments) and other affected agencies (special districts, State and U.S. Government agencies) located within the South San Francisco Bay P-C Region. Agencies with active aggregate operations within their jurisdictional boundaries are denoted by asterisks (*). Agencies that have land classified MRZ-2 within their jurisdiction are denoted by plus signs (+).

ALAMEDA COUNTY

*+ Alameda County	+ Hayward	San Leandro
* Alameda	+ Livermore	Union City
+ Albany	+ Newark	+ East Bay Regional Park District
+ Berkeley	*+ Oakland	U.S. Navy
Dublin	+ Piedmont	U.S. Army
Emeryville	*+ Pleasanton	+ State of California
*+ Fremont	* Bay Conservation and Development Commission	

CONTRA COSTA COUNTY

*+ Contra Costa County	Lafayette	San Pablo
Antioch	Martinez	Walnut Creek
Brentwood	Pinole	+ East Bay Regional Park District
Clayton	Pittsburg	U.S. Navy
+ Concord	Pleasant Hill	+ State of California
+ El Cerrito	*+ Richmond	* Bay Conservation & Development Commission

SAN FRANCISCO - SAN MATEO COUNTIES

*+ San Mateo County	Half Moon Bay	San Carlos
Atherton	Hillsborough	San Mateo
Belmont	Menlo Park	South San Francisco
+ Brisbane	Millbrae	Woodside
Burlingame	*+ Pacifica	U.S. Department of Defense
*+ Colma	Portola Valley	State of California
Daly City	Redwood City	+ City & County of San Francisco
Foster City	San Bruno	* Bay Conservation & Development Commission

NORTHERN SANTA CLARA COUNTY

*+ Santa Clara County	Los Altos	Saratoga
Campbell	+ Los Altos Hills	Sunnyvale
+ Cupertino	Monte Sereno	U.S. Navy
Los Gatos	+ Palo Alto	State of California
Milpitas	*+ San Jose	* Bay Conservation & Development Commission

ers of resources that could be made available for mining by virtue of the present, generally undeveloped status of the land. It is recognized that dedicated parklands have special status as opposed to other current uses of sectorized land, consequently the resources within parks have been sectorized separately and the quantifications of those resources are presented separately in the tables. The quantification of resources within park sectors are expressed to a lower degree of accuracy rather than to the higher level of accuracy reflected in the resource calculations for other sectors. The sectorization of any area is not an advocacy of mining in that area.

Areas Classified MRZ-3

One hundred seven (107) areas in the South San Francisco Bay P-C Region have been classified MRZ-3 (Plates 2.1-2.4, and 2.6-2.51). Areas classified MRZ-3 contain mineral deposits, but their significance cannot be evaluated from available data (see

Table 2.3 Geologic units underlying resource sectors within Alameda County. Those deposits chosen as sectors are identified by the letters A-MM. Present or potential sources of Portland cement concrete aggregate are identified with an asterisk (*). Geologic units shown without an asterisk are potential sources of non-P.C.C. aggregate.

QUADRANGLE	GEOLOGIC UNIT					
	Quaternary Alluvium *	Irvington Gravels *	Leona Rhyolite	Briones Formation sandstone	Franciscan Complex undifferentiated rock	Franciscan Complex greenstone *
Altamont	C					
Hayward			O			N,O
La Costa Valley	E					D
Livermore	A,B,C, JJ					
Mountain View	J					
Milpitas	J,K			I		
Newark	F,J,L, KK				M,MM	
Niles	E,F,J, K,KK	G		H,LL		
Oakland East			P			

Table 2.4 Geologic units underlying resource sectors within Contra Costa County. Those deposits chosen as sectors are identified by the letters Q-GG. Present or potential sources of Portland cement concrete aggregate are identified with an asterisk (*). Geologic units shown without an asterisk are potential sources of non-P.C.C. aggregate.

QUADRANGLE	GEOLOGIC UNIT					
	Domengine Formation sandstone	Wolfskill Formation sandstone	Moraga Formation basalt and andesite	Franciscan Complex greenstone *	Franciscan Complex sandstone *	Jurassic diabase and basalt
Antioch South		Q				
Brentwood	GG					
Byron	GG					
Clayton				R		S
Oakland East			T,U,V			
Richmond					W	
San Quentin					W.	

Table 2.5 Geologic units underlying resource sectors within San Francisco and San Mateo counties. Those deposits chosen as sectors are identified by the letters X-NN. Present or potential sources of Portland cement concrete aggregate are identified with an asterisk (*). Geologic units shown without an asterisk are potential sources of non-P.C.C. aggregate.

QUADRANGLE	GEOLOGIC UNIT		
	Franciscan Complex greenstone and Calera Limestone *	Franciscan Complex sandstone *	Montara Quartz Diorite
Half Moon Bay			HH
Montara Mountain	Y		HH
San Francisco South		X,NN	

Table 2.6 Geologic units underlying resource sectors within Santa Clara County. Those deposits chosen as sectors are identified by the letters I-PP. Present or potential sources of Portland cement concrete aggregate are identified with an asterisk (*). Geologic units shown without an asterisk are potential sources of non-P.C.C. aggregate.

QUADRANGLE	GEOLOGIC UNIT					
	Santa Clara Formation conglomerate *	Franciscan Complex greenstone *	Franciscan Complex sandstone	Franciscan Complex serpentine	Calera Limestone *	Briones Formation sandstone
Cupertino	AA,DD, PP	Z,BB, CC			BB	
Los Gatos			II			
Mindego Hill		Z,OO				
San Jose East				EE		
Santa Teresa Hills			FF			
Milpitas						I
Calaveras Reservoir						I

Part I, Appendix A-3, p. 25). Geologic units and formations underlying areas classified MRZ-3 are given in Tables 2.7-2.10. A summary of MRZ-3 areas, by county and by quadrangle, is presented in Appendix B of this report (p. 65).

MRZ-3 areas located in valleys are generally underlain by Quaternary alluvial deposits containing sand and gravel, but resource calculations cannot be made due to inadequate subsurface data (either the well-log data is unavailable or the available data is inconclusive). An area will be classified MRZ-3 if, based upon well-log data, sand and gravel are present that do not meet the criteria for MRZ-2 listed above. MRZ-3 areas in hilly or mountainous terrain are generally underlain by Tertiary sedimentary or volcanic rocks, or by Mesozoic sedimentary, volcanic, or metamorphic basement rocks. Many of these areas are classified as such due to the lack of outcrops or accessible areas for field examination.

Areas Classified MRZ-4

Areas where available information is inadequate for assignment to any other MRZ category are classified MRZ-4 (Part I, Appendix A-3, p. 25) In the South San Francisco Bay P-C Region, all MRZ-4 areas are located in hilly or mountainous terrain underlain by Tertiary-age sedimentary or volcanic rocks, or Jurassic-Cretaceous sedimentary, igneous, or metamorphic rocks. The areas often are poorly mapped, have poor accessibility, and may be underlain by rock units that have never been quarried for aggregate.

EVALUATION OF AGGREGATE RESOURCES IN THE SOUTH SAN FRANCISCO BAY P-C REGION

Data Base

In order for any appraisal of a resource to have credibility, the basis for that appraisal must be described. If the data base is weak, the resource appraisal must indicate this fact; conversely, if it is strong, this should also be noted. Terminology used to reflect the confidence level of the data base for this project have been adapted from the U.S. Geological Survey Circular 831 (Appendix A of this report - p. 57). For this project, *reserves* represent tested material determined to be acceptable for commercial use, that exists within properties owned or leased by an aggregate producing company, and for which permission allowing mining and processing has been granted by the proper authorities. *Resources* include *reserves* as well as all similar potentially usable aggregate materials which may be mined in the future, but for which no permit allowing mining has been granted, or for which marketability has not been established.

Factors Considered in Calculation of Resources

The resource estimates given here are limited to those resources present in nonurbanized portions of the areas designated by the Office of Planning and Research (OPR) as subject to urbanization within the near future (1990) as modified for this study by available information from county or city planning departments (Plates 2.6-2.51).

Forty-two areas were chosen as resource sectors during the course of this study. The sectors are identified on 24 sector maps (Plates 2.52-2.75), which are 1:48,000 scale reductions of the U.S. Geological Survey quadrangles in which the sectors are located. The sectors are identified by the letters A through PP on the sector maps, in Table 2.11, and in the sector descriptions below. Reserves and resources within the sectors are shown in Table 2.12.

Parameters used in determining locations and volumes of resources within the 42 sectors included the following items:

1. The most detailed geologic and topographic maps available were used for classification. Published and unpublished reports were used to locate and identify active and inactive quarries within the P-C regions.

2. An operating quarry was considered sufficient evidence that commercial-quality aggregate was present in the deposit.

3. All areas classified MRZ-2 and MRZ-3 were field-checked, and found to contain material similar to that occurring in active quarries. Material suitable only for fill was not classified MRZ-2.

4. The lateral and vertical distribution of the resource was determined on the basis of geologic projections from sample sites at quarries and outcrops, and on the basis of an understanding of the geological processes responsible for the formation of the deposit. The resource evaluation of the sand and gravel deposits are based in part on analyses of several thousand water-well logs. The logs describe the types of earth materials (clay, silt, sand, gravel) and bedrock encountered at various depths, as interpreted by the well driller (who may have had little or no training in earth sciences). The quality of the descriptions range from bad to very good. Many water-well logs were unsuitable because of the incomplete descriptions of the earth materials encountered in the well. In some instances the location of the well was vague. Only well logs that contain acceptable descriptions and locations were used in this study.

5. Resource estimates for those deposits chosen as sectors are based on measurements of volumes made from base maps enlarged to scales of 1:6,000 or 1:12,000. Tonnage conversion factors are based on density tests of samples from the sectors or from quarries with material similar to the sector material.

Included within the boundaries of many sectors are active commercial aggregate operations. Reserve and resource calculations were done in 1977 for each significant quarry or sand pit in the five counties, as part of a study of the aggregate industry in the San Francisco-Monterey Bay region (Chesterman and Manson). These calculations were revised to 1980, the year of the most recent available production statistics, to accommodate resource depletion and other factors. County totals of commercial reserves and resources in the 3 P-C regions are included in Tables 2.12, 2.19, and 2.20 for comparison with the resources available in the sectors.

Parameters used by Chesterman and Manson in making their calculations, largely of demonstrated reserves (see Appendix

Table 2.7 Geologic units underlying areas classified MRZ-3 within Alameda County.

QUADRANGLE	GEOLOGIC UNIT												
	Quaternary Alluvium	Irvington Gravels	Livermore Gravels	Santa Clara Formation	Leona Rhyolite	Moraga Formation basalt	Briones Formation sandstone	Cierbo Formation sandstone	Niles Canyon Formation sandstone	Oakland Conglomerate	Franciscan Complex greenstone	Franciscan Complex sandstone	Jurassic intrusive rock (gabbro)
Altamont	X		X										
Briones Valley						X							
Dublin	X		X				X						
Hayward					X		X			X	X		X
La Costa Valley	X		X				X	X					
Livermore	X		X				X						
Milpitas	X			X									
Newark	X												
Niles	X	X	X				X		X	X			
Oakland East					X	X						X	
San Leandro					X								X

Table 2.8 Geologic units underlying areas classified MRZ-3 within Contra Costa County.

QUADRANGLE	GEOLOGIC UNIT											
	Quaternary Alluvium	Quaternary dune sand	Wolfskill (Tehama) Formation	Orinda (Tassajara) Formation	Moraga Formation basalt	Neroly Formation sandstone	Cierbo Formation sandstone	Briones Formation sandstone	San Pablo Formation (of Lawson) sandstone	San Ramon Formation sandstone	Domengine sandstone	Great Valley Sequence
Antioch North		X										
Antioch South		X	X								X	
Benicia						X	X	X				
Brentwood		X	X								X	
Briones Valley								X				
Clayton	X		X			X	X					
Diablo				X		X	X	X				
Dublin				X			X	X				
Honker Bay			X			X	X					
Jersey Island		X										
Las Trampas Ridge								X	X			
Mare Island						X	X	X				
Oakland East					X							
Port Chicago			X				X					X
Richmond								X				
Walnut Creek							X		X	X		

Table 2.9 Geologic units underlying areas classified MRZ-3 within San Francisco and San Mateo counties.

QUADRANGLE	GEOLOGIC UNIT											
	Quaternary Alluvium and Terraces	Quaternary dune sand	Santa Clara Formation	Merced Formation	Lompico Sandstone	Franciscan Complex greenstone	Franciscan Complex graywacke	Franciscan Complex "sheared rocks"	Calera Limestone	Franciscan Complex chert	Cretaceous quartz diorite	Serpentinite
Half Moon Bay	X				X						X	
Mindego Hill			X									
Montara Mtn.	X			X		X	X	X	X	X	X	X
Palo Alto			X			X	X			X		
San Francisco North		X										
San Francisco South		X		X		X	X			X		X
San Mateo				X		X	X	X		X		
Woodside			X			X	X	X				

Table 2.10 Geologic units underlying areas classified MRZ-3 within northern Santa Clara County.

QUADRANGLE	GEOLOGIC UNIT						
	Quaternary Alluvium	Santa Clara Formation	Briones Formation sandstone	Page Mill basalt	Oakland Conglomerate	Franciscan Complex graywacke	Franciscan Complex greenstone
Calaveras Reservoir	X	X	X		X		
Castle Rock Ridge		X				X	X
Cupertino	X	X				X	X
Los Gatos	X	X				X	X
Milpitas		X					
Mindego Hill		X				X	X
Mountain View		X					
Palo Alto		X		X		X	X
San Jose East	X		X		X		
San Jose West	X	X					
Santa Teresa Hills	X					X	

Table 2.11 Resource sectors in the South San Francisco Bay P-C Region.

SECTOR	QUADRANGLE	CLASSIFICATION	REFERENCE IN TEXT
A	Livermore Quadrangle	MRZ-2(a)	p. 12
B	Livermore Quadrangle	MRZ-2(a)	p. 17
C	Altamont Quadrangle	MRZ-2(a)	p. 18
	Livermore Quadrangle	MRZ-2(a)	
D	La Costa Valley Quadrangle	MRZ-2(b)	p. 22
E	La Costa Valley Quadrangle	MRZ-2(a)	p. 19
	Niles Quadrangle	MRZ-2(d)	
F	Newark Quadrangle	MRZ-2(a)	p. 19
	Niles Quadrangle	MRZ-2(a)	
G	Niles Quadrangle	MRZ-2(b)	p. 20
H	Niles Quadrangle	MRZ-2(c)	p. 24
I	Milpitas Quadrangle	MRZ-2(b)	p. 24
	Calaveras Reservoir Quadrangle	MRZ-2(a)	
J	Milpitas Quadrangle	MRZ-2(a)	p. 20
	Mountain View Quadrangle	MRZ-2(a)	
	Newark Quadrangle	MRZ-2(a)	
	Niles Quadrangle	MRZ-2(a)	
K	Milpitas Quadrangle	MRZ-2(a)	p. 20
	Niles Quadrangle	MRZ-2(a)	
L	Newark Quadrangle	MRZ-2(a)	p. 20
M	Newark Quadrangle	MRZ-2(b)	p. 25
N	Hayward Quadrangle	MRZ-2(a)	p. 26
O	Hayward Quadrangle	MRZ-2(b)	p. 26
P	Oakland East Quadrangle	MRZ-2(a)	p. 26
Q	Antioch South Quadrangle	MRZ-2(a)	p. 21
R	Clayton Quadrangle	MRZ-2(c)	p. 27
S	Clayton Quadrangle	MRZ-2(b)	p. 27
T	Oakland East Quadrangle	MRZ-2(c)	p. 28
U	Oakland East Quadrangle	MRZ-2(d)	p. 28
V	Oakland East Quadrangle	MRZ-2(e)	p. 29
W	Richmond Quadrangle	MRZ-2(e)	p. 30
	San Quentin Quadrangle	MRZ-2(a)	
X	San Francisco South Quadrangle	MRZ-2(a)	p. 31
Y	Montara Mountain Quadrangle	MRZ-2(a)	p. 31
Z	Cupertino Quadrangle	MRZ-2(a)	p. 32
	Mindego Hill Quadrangle	MRZ-2(a)	

Table 2.11 Resource sectors in the South San Francisco Bay P-C Region (continued).

SECTOR	QUADRANGLE	CLASSIFICATION	REFERENCE IN TEXT
AA	Cupertino Quadrangle	MRZ-2(b)	p. 21
BB	Cupertino Quadrangle	MRZ-2(d)	p. 32
CC	Cupertino Quadrangle	MRZ-2(e)	p. 32
DD	Cupertino Quadrangle	MRZ-2(c)	p. 22
EE	San Jose East Quadrangle	MRZ-2(a)	p. 33
FF	Santa Teresa Hills Quadrangle	MRZ-2(a)	p. 33
GG	Brentwood Quadrangle Bryon Hot Springs Quadrangle	MRZ-2(a) MRZ-2(a)	p. 34
HH	Half Moon Bay Quadrangle Montara Mountain Quadrangle	MRZ-2(a) MRZ-2(c)	p. 34
II	Los Gatos Quadrangle	MRZ-2(a)	p. 34
JJ	Livermore Quadrangle	MRZ-2(a)	p. 34
KK	Newark Quadrangle Niles Quadrangle	MRZ-2(a) MRZ-2(a)	p. 35
LL	Niles Quadrangle	MRZ-2(c)	p. 35
MM	Newark Quadrangle	MRZ-2(b)	p. 36
NN	San Francisco South Quadrangle	MRZ-2(a)	p. 37
OO	Mindego Hill Quadrangle	MRZ-2(b)	p. 37
PP	Cupertino Quadrangle	MRZ-2(b)	p. 38

A), are site specific and reflect all conditions listed in the mine's use permit. These parameters may include some or all of the following items:

1. Setbacks of excavation areas from property lines range from zero to 105 feet. Minimum setbacks usually occur when the excavation area is adjacent to other producers. Maximum setbacks are delineated along public roads.

2. Pit-wall slopes are usually required to have a horizontal-to-vertical ratio of less than or equal to 1:1, 1.5:1, or 2:1. Quarry walls usually are required to be benched at specific vertical intervals and may have sloped connecting walls. When benching is required, the width of the bench, if specified, often is approximately equal to one-half the vertical interval. This design results in an approximate slope of 63 degrees. Occasionally, benches are forbidden and a smooth wall with a 2:1 or 3:1 slope is specified in the use permit.

3. Maximum pit depth or minimum quarry floor elevation is indicated in many use permits. Depths of excavation range from 40 to 120 feet below ground surface. At present in the Livermore-Amador Valley area (Sector A), the aggregate producers may not excavate below the "second aquiclude."

4. Densities of the in-place material vary considerably between individual deposits and from one rock type to another. Where aggregate is composed of sediments derived from the Franciscan Complex [as in the Livermore and Sunol Valleys, Alameda Creek, and Mission San Jose (Irvington Gravels) areas] a factor of 14.50 cubic feet per ton (0.069 tons per cubic foot) is used in reserve calculations. This factor is derived from data supplied by producers in the Livermore-Amador Valley. The specific gravities of rock samples from individual quarries range from 2.13 to 2.70, yielding individual conversion factors from 0.06 to 0.08 tons per cubic foot.

5. Waste factors vary from plant to plant, and considerable variations within a deposit often are shown by detailed sampling. Most sand and gravel plants have waste factors that range from 5 to 15 percent of gross tonnage. The rock quarries usually have no waste because the low grade material is sold for fill or topsoil.

ESTIMATED AGGREGATE RESOURCES OF THE SOUTH SAN FRANCISCO BAY P-C REGION

The available aggregate resources within the urbanizing portions of the South San Francisco Bay P-C Region are summarized by county and by sector in Table 2.12. The table identifies the sectors and lists the amounts of available aggregate within the sectors. In addition, Table 2.12 lists the amount of sand and gravel or stone reserves controlled by commercial aggregate companies within the five counties of this P-C region. In Table 2.12, *reserves* are aggregate materials that a company owns or controls, and for which it has a valid mining permit; *resources* are the total amount of available aggregate within the sector. Unless noted otherwise, all resources are of the inferred category as described in Appendix A of this report (p. 57).

The estimated resources within the 16 sand and gravel sectors amount to 1,122 million tons, of which approximately 259 million tons qualify as reserves available for mining at the end of 1980. The sand and gravel sectors are distributed as follows: Alameda County has 1,014 million tons of Quaternary alluvium and Irvington Gravels; Contra Costa County has more than 5 million tons of Wolfskill Formation sand and Domengine Formation sand; Santa Clara County has more than 75 million tons of conglomerate of the Santa Clara Formation. Unapportioned holdings (proprietary data) amount to 28 million tons.

The estimated resources within the 26 crushed stone sectors amount to 5,199 million tons, of which approximately 293 million tons qualify as reserves available for mining at the end of 1980. Stone resources within the P-C region are distributed as follows: Alameda County contains 1,893 million tons of Briones Formation sandstone, Franciscan Complex sandstone, greenstone, chert, and shale, Jurassic diabase and serpentinite, and Leona Rhyolite; Contra Costa County has more than 1,012 million tons of Franciscan Complex sandstone, Moraga Formation basalt, and Jurassic diabase; northern Santa Clara County contains more than 361 million tons of Calera Limestone, Franciscan Complex greenstone, sandstone, and serpentinite, and 125 million tons of Briones Formation sandstone; San Francisco and San Mateo counties have approximately 1.6 billion tons of Cretaceous quartz diorite and Franciscan Complex sandstone, greenstone, and Calera Limestone. Unapportioned holdings (proprietary data) amount to 173 million tons.

The estimated P.C.C.-grade aggregate resources (from both crushed stone and sand and gravel deposits) within all sectors amount to 2,100 million tons, of which approximately 313 million tons qualify as reserves available for mining at the end of 1980. P.C.C. aggregate for the P-C region is obtained from three sources: the Livermore Valley-Sunol Valley-Niles Cone Production District; limestone quarries of Kaiser Cement Corporation and Quarry Products, Inc.; sand and crushed granite imported from the Monterey Bay P-C Region. Sand and gravel obtained from the production district supplies the bulk of the demand for P.C.C. aggregate in the South San Francisco Bay P-C Region. The deposits within the production district consist of stream channel and floodplain material, and form several aquifers in the valleys named above. Reserves of limestone at the Rockaway Beach Quarry of Quarry Products,Inc., are small and may soon be depleted. Crushed limestone from the Permanente Quarry of Kaiser Cement Corporation is a by-product of their Portland cement operations. The company would prefer to use as much limestone as possible for cement instead of for the lower priced aggregate, so the deposit cannot be considered a guaranteed source of P.C.C. aggregate.

Table 2.13 lists all resource sectors containing proven P.C.C.-grade aggregate, their resources, and any reserves where active mines exist within their boundaries.

Sand and Gravel Resources

In the South San Francisco Bay P-C Region, sand and gravel production, and sand and gravel resource sectors are restricted to three counties: Alameda, Contra Costa, and Santa Clara. The principal sand and gravel production occurs in two areas - the Livermore-Amador Valley and Sunol Valley - both in Alameda County. Relatively minor production occurs at Fremont, near Byron, and at Cupertino, and sand is dredged from marine deposits in the San Francisco Bay and the Carquinez Strait.

Sectors A, B, and C are in the Livermore-Amador Valley Production District (Figure 2.1), which consists of gently-dipping alluvial gravel deposits (aquifers) that are separated by relatively impermeable clay beds (aquicludes) of varying thickness. The upper or first aquiclude caps Amador Valley and nearly the entire western portion of Livermore Valley. The soil zone and upper aquiclude have a combined thickness of up to 70 feet. The upper aquifer, which contains most of the minable sand and gravel in the deposit, lies directly beneath the upper aquiclude but is exposed at the surface in the southern part of the Livermore Valley. The upper aquifer consists of a permeable mixture of sand, gravel, and some silt, and ranges in thickness from about 25 feet near Pleasanton to over 100 feet near the active producers in Sector A (Figure 2.2). Beneath the aquifer lies the second aquiclude, which is similar to the upper aquiclude.

SECTOR A: QUATERNARY ALLUVIUM - LIVERMORE-AMADOR VALLEY

Plate 2.14 Livermore Quadrangle MRZ-2(a) Sector Plate 2.52*

Sector A consists of three parts: A-1, A-2, and A-3. The first two parts are owned in fee or are leased by three active sand and gravel producers: Kaiser Sand and Gravel, Lone Star Industries, and Rhodes-Jamieson, Ltd. Sector A-3 is north of Pleasanton and northeast of the San Ramon Valley branch of the Southern Pacific Railroad. This area (Figure 2.2) is underlain by a thick accumulation of sand and gravel (the upper aquifer) contained in part between the first and second aquicludes. Although recoverable sand and gravel in some spots extends to depths or more than 150 feet below the surface, commercial mining is restricted by conditions in use permits to the upper aquifer.

Available material remaining at the end of 1980 in the approximately 3700 acres owned or controlled by the three companies (Sectors A-1 and A-2) is estimated to be 370 million tons. Of this total, 242 million tons are classified as reserves by virtue of existing mining permits. This figure is arrived at through use of proprietary data provided by the operators which cannot be discussed here.

Sector A-3 contains the unurbanized remainder of a deposit not controlled by aggregate companies, but which is an extention of the aquifer mined in Sectors A-1 and A-2. Hansen and Vantine (1966, Plate 6) indicate that the area is underlain by 40 to 60 feet of aquifer within the first 100 feet of depth. Available well log data shows that overburden is 20 to 45 feet thick.

*Resource sectors have not been labeled as such on the 46 quadrangles (Plates 2.6 through 2.51) that accompany this report. Instead, they are individually identified under each heading in the text, in Tables 2.11 and 2.12, and on individual sector maps (Plates 2.52 through 2.75). For example, Sector A-1 is within the area identified by the symbol MRZ-2(a) on Plate 2.14 and within the area designated 'Sector A-1' on Plate 2.52. Many of the resource sectors do not occupy the entire area classified MRZ-2 due to some restrictions caused by urbanization.

Table 2.12 Reserves and resources within sectors in the South San Francisco Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector.

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons)		CRUSHED STONE AMOUNT (millions of tons)	
		Reserves	Resources	Reserves	Resources
Alameda	A	242	383		
	B		88		
	C		99		
	D				1,041
	E	*	142		
	F	*	*		
	G	*	*		
	H				112
	I				299
	J		32		
	K		63		
	L		188		
	M			*	23
	N			*	*
	O			*	*
	P			*	*
Alameda Subtotal		259#	995+	20+#	1,495#
Parklands	JJ		7		
	KK		12		
	LL				316
	MM				82
Parklands Subtotal			19		398
ALAMEDA COUNTY TOTAL		259#	1,014+	20+#	1,893#
Contra Costa	Q	*	5		
	R			*	*
	S			*	683
	T				121
	U				94
	V				29
	W			*	85+
	GG	*	*		
CONTRA COSTA COUNTY TOTAL		*	5+	54#	1,012+

* Proprietary data
\# Includes combined proprietary data

(continued on next page)

Table 2.12 Reserves and resources within sectors in the South San Francisco Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector (continued).

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons) Reserves	SAND AND GRAVEL AMOUNT (millions of tons) Resources	CRUSHED STONE AMOUNT (millions of tons) Reserves	CRUSHED STONE AMOUNT (millions of tons) Resources
San Francisco	X			*	*
&	Y			*	35
San Mateo	HH			*	*
San Francisco & San Mateo Subtotal				*	35+
Parklands	NN			*	1,600
Parklands Subtotal				*	1,600
SAN FRANCISCO & SAN MATEO COUNTIES TOTAL		0	0	*	1,635+
	I			27	125
Northern	Z			*	37
Santa Clara	AA		37		
	BB			*	*
	CC			*	186
	DD	*	*		
	EE			*	97+
	FF			*	*
	II			*	*
Northern Santa Clara Subtotal		*	37+	167#	445+
Parklands	OO				41
	PP		38		
Parklands Subtotal			38		41
NORTHERN SANTA CLARA COUNTY TOTAL		*	75+	167#	486+
P-C Region Total		259+#	1,122#	293#	5,199#

* Proprietary data
\# Includes combined proprietary data

TOTAL RESERVES IN SOUTH SAN FRANCISCO BAY P-C REGION = 552 MILLION TONS
TOTAL RESOURCES IN SOUTH SAN FRANCISCO BAY P-C REGION = 6.3 BILLION TONS

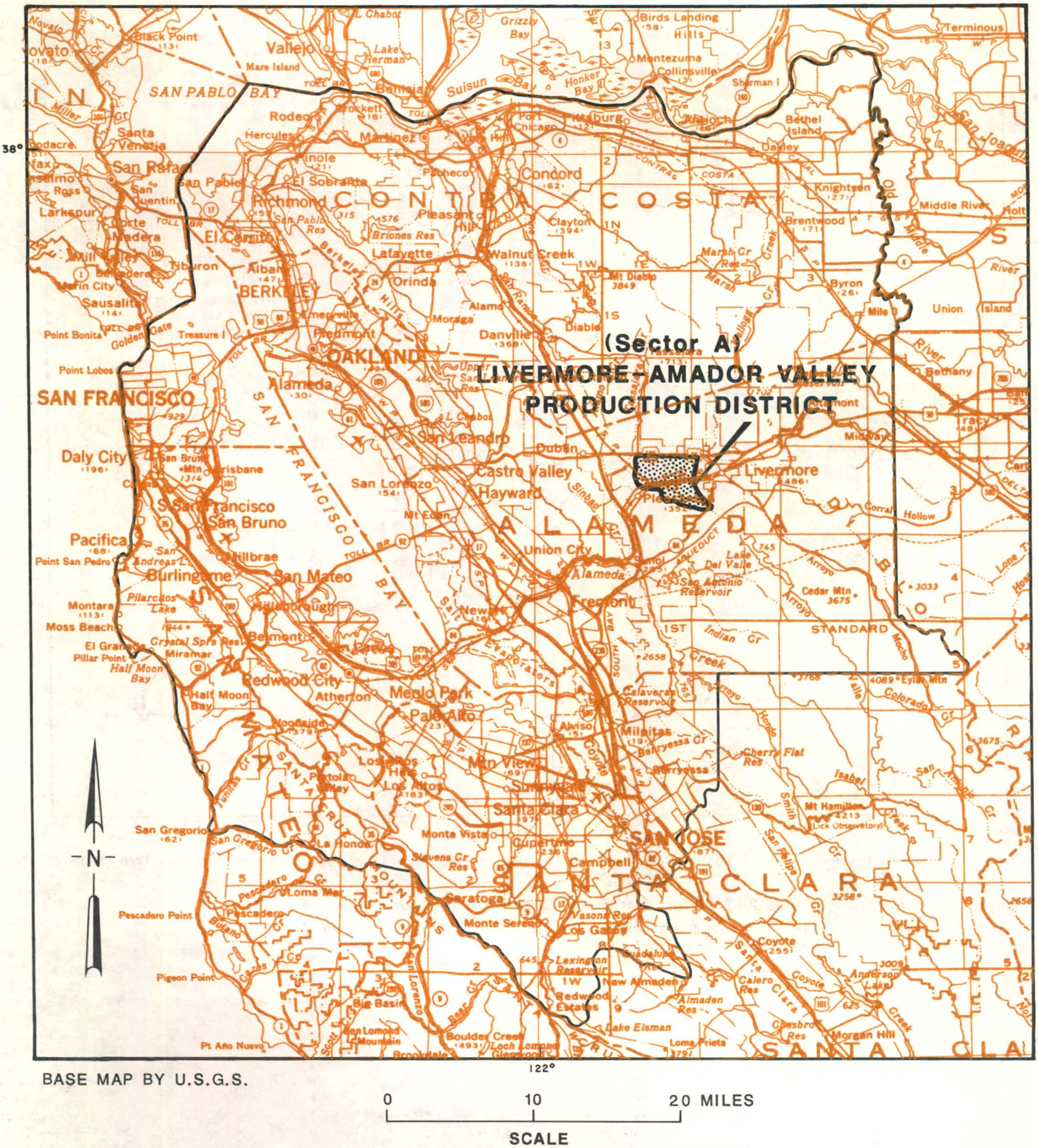

Figure 2.1 Map of the South San Francisco Bay P-C Region showing location of the Livermore-Amador Valley Production District (Sector A).

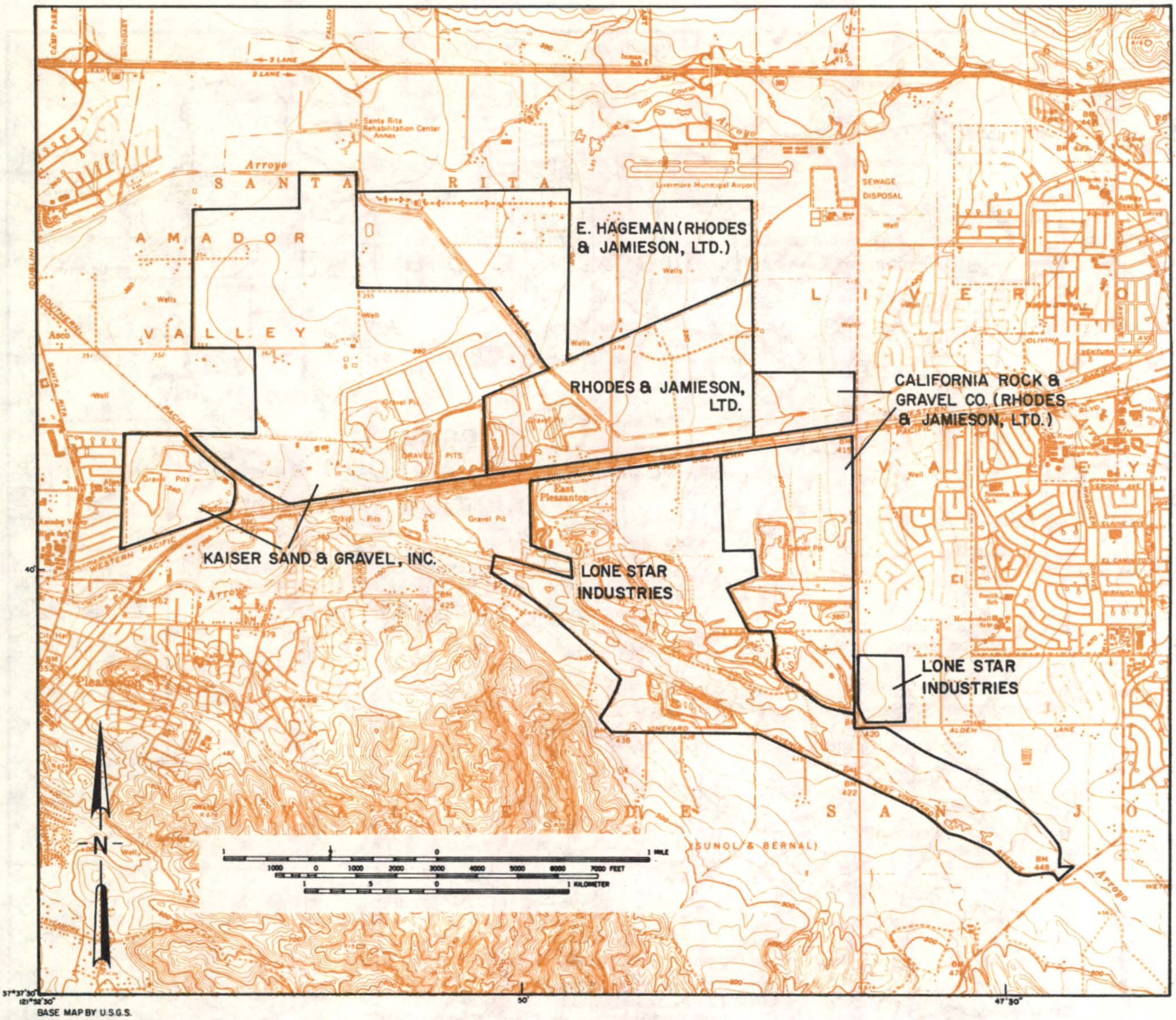

Figure 2.2 Map of the Livermore-Amador Valley Production District showing land owned or leased by aggregate companies as of July 1976 (Sector A).

Table 2.13 Sectors that contain proven P.C.C.-grade aggregate, their resources, and any reserves that may exist within their boundaries.

SECTOR	MATERIAL	RESOURCES (Million tons)	RESERVES
A	S&G	383	242
B	S&G	88	-
C	S&G	99	-
D	Stone	1,041	-
E	S&G	142	*
F	S&G	*	*
G	S&G	*	*
J	S&G	32	-
K	S&G	63	-
L	S&G	188	-
BB	Stone	*	*
GG	S&G	*	*
JJ	S&G	7	-
KK	S&G	12	-
		Total 2,055+	313

*Proprietary data

Sand and gravel resources are given in the table below. They were calculated by successively adding the volumes of horizontal prisms, beginning below the overburden (at the top of the first aquifer) downward to the base of the deposit. This technique was used in all subsequent alluvial deposits. Factors used (which include both factual data and assumptions in this and all subsequent sector tonnage calculations) in calculating resources included the following items:

1. Resource material is Quaternary sand and gravel within Amador Valley.
2. The sand and gravel present in the aquifer is suitable for P.C.C. aggregate.
3. Waste is 10 percent of the total material.
4. The ratio of overburden to aggregate is no greater than 1 to 1, and overburden is no thicker than 50 feet. It is assumed that overburden has been stripped prior to the calculation of resources. Resource totals, therefore, do not include overburden.
5. Wall slopes above the aquifer were not considered.
6. Depth to water in Sector A is probably at least 70 feet.
7. A conversion factor of 14.50 cubic feet of material per ton is used. This factor is based on detailed calculations made in 1977 during a previous aggregate study (Chesterman and Manson), and will be used for other alluvial deposits composed of sediments derived from rocks of the Franciscan Complex.
8. Base map for resource calculations is the Livermore 7.5 minute quadrangle (1980).

RESOURCES - SECTOR A-3

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
Top	83.47						
		—	83.47	X	(50)(43,560)(.90) / 14.50	=	11,280,000
-50 feet	83.47						
		—	53.31	X	(10)(43,560)(.90) / 14.50	=	1,440,000
-60 feet	23.14						
					TOTAL SECTOR A-3	=	12,720,000

TOTAL RESOURCES - SECTOR A = 383 MILLION TONS (ALL PCC GRADE)

TOTAL RESERVES - SECTOR A = 242 MILLION TONS

SECTOR B - QUATERNARY ALLUVIUM - LIVERMORE VALLEY

Plate 2.14 Livermore Quadrangle MRZ-2(a) Sector Plate 2.52

Sector B consists of 6 parcels of unurbanized land underlain by stream channel alluvium and gravelly alluvial fan material situated along Arroyo del Valle at the southwest corner of Livermore. According to Hansen and Vantine (1966, p. 17), the alluvium in the Livermore quadrangle is revealed in well-logs to be composed of overlapping, interfingering lenses, stringers, and sheets of gravel, sand, silt, and clay. Individual layers are not extensive enough to be traced between wells because they change their physical nature over short distances and are no longer recognizable. There is a maximum of 80 feet of aquifer material (sand and gravel) within the first 100 feet below the surface. During the course of the classification process, over 100 well-logs from the Livermore and Amador valleys were examined, and the conclusions drawn by Hansen and Vantine were substantiated. The gravel beds in Sector B have been the source of aggregate for at least two commercial operations (both presently inactive). Both of these pits were field-checked, as well as several other areas within the sector, and the sand and gravel appear to be identical to the material being mined in Sector A.

Resources of sand and gravel within Sector B are given in the tables below. Factors used in calculating the amount of resources included the following items:

1. Resource material is Quaternary sand and gravel within the upper aquifer in the Livermore Valley.
2. Sand and gravel present in the aquifer is suitable for P.C.C. aggregate.
3. Waste is 10 percent of the total material.
4. The ratio of overburden to ore is no more than 1:1, and overburden is no thicker than 30 feet. It is assumed that overburden has been stripped prior to the calculation of resources. Resource totals, therefore, do not include overburden.
5. Wall slopes above the aquifer were not considered.
6. Depth to ground water in Sector B is not known.
7. A conversion factor of 14.50 cubic feet of material per ton is used (see Sector A, item #7).
8. Base map for resource calculations is a 4:1 enlargement of the Livermore 7.5 minute quadrangle (1980).

RESOURCES - SECTOR B

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR B-1							
Top	106.20						
		—	106.20	X	(30)(43,560)(.90) / 14.50	=	8,610,000
-30 feet	106.20						
		—	89.33	X	(10)(43,560)(.90) / 14.50	=	2,420,000
-40 feet	72.54						
		—	60.95	X	"	=	1,650,000
-50 feet	49.36						
		—	36.76	X	"	=	990,000
-60 feet	24.16						
		—	14.69	X	"	=	400,000
-70 feet	5.22						
					TOTAL SECTOR B-1	=	14,070,000
SECTOR B-2							
Top	122.93						
		—	122.93	X	(30)(43,560)(.90) / 14.50	=	9,970,000
-30 feet	122.93						
		—	109.68	X	(10)(43,560)(.90) / 14.50	=	2,970,000
-40 feet	96.42						
		—	80.87	X	"	=	2,190,000
-50 feet	65.32						
		—	50.08	X	"	=	1,350,000
-60 feet	34.84						
		—	21.12	X	"	=	570,000
-70 feet	7.40						
					TOTAL SECTOR B-2	=	17,050,000

RESOURCES – SECTOR B (continued)

AQUIFER INTERVAL	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR B-3						
Top	152.15					
		— 152.15	x	(40)(43,560)(.90) / 14.50	=	16,450,000
-40 feet	152.15					
		— 149.94	x	(10)(43,560)(.90) / 14.50	=	4,050,000
-50 feet	147.73					
		— 141.85	x	"	=	3,840,000
-60 feet	135.96					
		— 119.69	x	"	=	3,240,000
-70 feet	103.42					
		— 74.07	x	"	=	2,000,000
-80 feet	44.71					
				TOTAL SECTOR B-3	=	29,580,000
SECTOR B-4						
Top	37.02					
		— 37.02	x	(30)(43,560)(.90) / 14.50	=	3,000,000
-30 feet	37.02					
		— 28.30	x	(10)(43,560)(.90) / 14.50	=	770,000
-40 feet	19.57					
		— 11.74	x	"	=	320,000
-50 feet	3.90					
		— 1.98	x	(8)(43,560)(.90) / 14.50	=	40,000
-58 feet	.06					
				TOTAL SECTOR B-4	=	4,130,000
SECTOR B-5						
Top	18.19					
		— 18.19	x	(30)(43,560)(.90) / 14.50	=	1,480,000
-30 feet	18.19					
		— 14.32	x	(10)(43,560)(.90) / 14.50	=	390,000
-40 feet	10.45					
		— 5.63	x	"	=	150,000
-50 feet	.80					
				TOTAL SECTOR B-5	=	2,020,000
SECTOR B-6						
Top	151.86					
		— 151.86	x	(30)(43,560)(.90) / 14.50	=	12,320,000
-30 feet	151.86					
		— 136.05	x	(10)(43,560)(.90) / 14.50	=	3,680,000
-40 feet	120.24					
		— 101.59	x	"	=	2,750,000
-50 feet	82.93					
		— 65.66	x	"	=	1,780,000
-60 feet	48.38					
		— 32.05	x	"	=	870,000
-70 feet	15.73					
		— 9.70	x	"	=	260,000
-80 feet	3.67					
				TOTAL SECTOR B-6	=	21,660,000

TOTAL RESOURCES - SECTOR B =
88 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR B =
0 TONS

SECTOR C - QUATERNARY ALLUVIUM - LIVERMORE VALLEY

Plate 2.6 Altamont Quadrangle MRZ-2(a) Sector Plate 2.53
Plate 2.14 Livermore Quadrangle MRZ-2(a) Sector Plate 2.52

Sector C consists of several unurbanized portions of the alluvial fan deposit that underlies the city of Livermore. The material was transported along Arroyo Mocho and deposited by floodwaters in interfingering lenses, stringers, and sheets of gravel, sand, silt, and clay (see Hansen and Vantine, 1966, p. 17). According to data contained in Hansen and Vantine, there is a maximum of 80 feet of aquifer material (sand and gravel) in the first 100 feet below the surface.

Resources of sand and gravel are given in the table below. Factors used in calculating resources in Sector C included the following items:

1. Resource material consists of Quaternary sand and gravel in the Livermore Valley.
2. The sand and gravel present in the aquifer is suitable for P.C.C. aggregate.
3. Waste is 10 percent of the total material.
4. The ratio of overburden to ore is less than 1 to 1, and overburden is no more than 30 feet thick. It is assumed that overburden has been stripped prior to the calculation of resources. Resource totals, therefore, do not include overburden.
5. Wall slopes above the aquifer were not considered.
6. Depth to water in Sector C is not known.
7. A conversion factor of 14.50 cubic feet of material per ton is used (see Sector A, item # 7).
8. Base map for resource calculations is a 4:1 enlargement of the Altamont and Livermore 7.5 minute quadrangles (1968 and 1980, respectively).

RESOURCES – SECTOR C

AQUIFER INTERVAL	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR C-1						
Top	145.95					
		— 145.95	x	(60)(43,560)(.90) / 14.50	=	23,680,000
-60 feet	145.95					
		— 137.14	x	(10)(43,560)(.90) / 14.50	=	3,710,000
-70 feet	128.33					
		— 97.23	x	"	=	2,630,000
-80 feet	66.12					
				TOTAL SECTOR C-1	=	30,020,000
SECTOR C-2						
Top	186.01					
		— 186.01	x	(20)(43,560)(.90) / 14.50	=	10,060,000
-20 feet	186.01					
		— 172.90	x	(10)(43,560)(.90) / 14.50	=	4,670,000
-30 feet	159.78					
		— 148.33	x	"	=	4,010,000
-40 feet	136.88					
		— 119.81	x	"	=	3,240,000
-50 feet	102.73					
		— 81.50	x	"	=	2,200,000
-60 feet	60.26					
		— 55.59	x	"	=	1,500,000
-70 feet	50.91					
		— 35.13	x	"	=	950,000
-80 feet	19.34					
				TOTAL SECTOR C-2	=	26,630,000
SECTOR C-3						
Top	53.72					
		— 53.72	x	(55)(43,560)(.90) / 14.50	=	7,990,000
-55 feet	53.72					
		— 46.09	x	(5)(43,560)(.90) / 14.50	=	620,000
-60 feet	38.45					
		— 22.76	x	(10)(43,560)(.90) / 14.50	=	620,000
-70 feet	7.06					
				TOTAL SECTOR C-3		9,230,000
SECTOR C-4						
Top	10.85					
		— 10.85	x	(50)(43,560)(.90) / 14.50	=	1,470,000
-50 feet	10.85					
		— 6.23	x	(10)(43,560)(.90) / 14.50	=	170,000
-60 feet	1.61					
				TOTAL SECTOR C-4	=	1,640,000

RESOURCES – SECTOR C (continued)

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR C-5							
Top	150.37						
		—	150.37	x	(30)(43,560)(.90) / 14.50	=	12,200,000
-30 feet	150.37						
		—	136.25	x	(10)(43,560)(.90) / 14.50	=	3,684,000
-40 feet	122.13						
		—	103.74	x	"	=	2,800,000
-50 feet	85.34						
		—	54.01	x	"	=	1,460,000
-60 feet	22.67						
					TOTAL SECTOR C-5	=	20,140,000
SECTOR C-6							
Top	81.78						
		—	81.78	x	(50)(43,560)(.90) / 14.50	=	11,060,000
-50 feet	81.78						
					TOTAL SECTOR C-6	=	11,060,000

TOTAL RESOURCES - SECTOR C =
99 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR C =
0 TONS

SECTOR E - QUATERNARY ALLUVIUM - ALAMEDA CREEK

Plate 2.12	La Costa Valley Quad.	MRZ-2(a)	Sector Plate 2.54
Plate 2.18	Niles Quadrangle	MRZ-2(d)	Sector Plate 2.55

Sector E consists of a large portion of the floodplain of Alameda Creek within Sunol Valley. Two producers - Santa Clara Sand and Gravel Company and Mission Valley Rock Company - are active in this sector. Reserve figures for this sector are proprietary. This area is underlain largely by sand and gravel, with discontinous layers of clay. The aggregate is derived from rocks of the Franciscan Complex. Soil is very thin (approximately 1 foot thick) along the eastern margin of the deposit, and is approximately 4 feet thick, with 20 feet of weathered alluvium, along the northwest edge. The few water-well logs available suggest that the sand and gravel thickens from 50 feet on the western edge of the valley (in the Niles quadrangle) to over 450 feet near the Calaveras fault along the northeast edge of the valley (in the La Costa Valley quadrangle).

Resources in Sector E are given in the table below. Factors used in calculating the resources included the following items:

1. Resource material in Sector E is Quaternary sand and gravel.
2. The entire area classified MRZ-2 contains sand and gravel suitable for P.C.C. aggregate.
3. Waste is 10 percent of the total material.
4. Overburden varies in thickness from about 25 feet at the western edge of the valley to 1 foot at the eastern edge. The overburden is considered as waste and is not included in the calculations.
5. Wall slopes have a ratio of 2:1 (horizontal to vertical).
6. Thickness of sand and gravel is assumed to vary from 25 to 100 feet, although 450 feet of sand and gravel are reported in a well-log from the east side of the deposit.
7. The water table is about 40 feet below the surface, and can be lowered at least 60 feet more by pumping.
8. A conversion factor of 14.50 cubic feet of material per ton is used (see Sector A, item # 7).
9. Depth of mining in 1979 varied from a maximum of 100 feet at Mission Valley Rock Company to 40 feet at Santa Clara Sand and Gravel Company.
10. Base maps used in resource calculations were 4:1 enlargements of the La Costa Valley 7.5 minute quadrangle (1968) and the Niles 7.5 minute quadrangle (1980).

RESOURCES – SECTOR E

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR E-1							
Top	237.03						
		—	198.67	x	(100)(43,560)(.90) / 14.50	=	53,710,000
-100 feet	160.30						
					TOTAL SECTOR E-1	=	53,710,000
SECTOR E-2a							
Top	135.16						
		—	116.45	x	(100)(43,560)(.90) / 14.50	=	31,480,000
-100 feet	97.74						
					TOTAL SECTOR E-2a	=	31,480,000
SECTOR E-2b							
-40 feet	121.84						
		—	121.84	x	(60)(43,560)(.90) / 14.50	=	19,770,000
-100 feet	121.84						
					TOTAL SECTOR E-2b	=	19,770,000
SECTOR E-3							
Top	106.12						
		—	92.95	x	(75)(43,560)(.90) / 14.50	=	18,850,000
-75 feet	79.78						
					TOTAL SECTOR E-3	=	18,850,000
SECTOR E-4							
Top	121.61						
		—	111.74	x	(50)(43,560)(.90) / 14.50	=	15,110,000
-50 feet	101.87						
					TOTAL SECTOR E-4	=	15,110,000
SECTOR E-5							
Top	59.23						
		—	50.85	x	(25)(43,560)(.90) / 14.50	=	3,440,000
-25 feet	42.47						
					TOTAL SECTOR E-5	=	3,440,000

TOTAL RESOURCES - SECTOR E =
142 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR E =
(PROPRIETARY DATA)

SECTOR F - QUATERNARY ALLUVIUM - ALAMEDA CREEK

Plate 2.17	Newark Quadrangle	MRZ-2(a)	Sector Plate 2.56
Plate 2.18	Niles Quadrangle	MRZ-2(a)	Sector Plate 2.55

This sector consists of the 26-acre property owned by Quarry Products, Inc. located on the Niles Cone, a large delta formed by Alameda Creek at the mouth of Niles Canyon. Numerous gravel pits have been operated along Alameda Creek since 1912 (Huequin and Castello, 1920, p. 38). Pit material is light brown to tan, cobbly pebble conglomerate. Maximum cobble size is about 6".The coarse material is composed of well-rounded disks and rollers. Approximately 75 percent of the gravel is Jurassic-age Franciscan Complex greywacke and red chert, with minor quartz and reworked sedimentary clasts from assorted Cretaceous and Tertiary units in the hills east of Niles and south of the Livermore and Amador valleys. Material from this deposit is suitable for use as P.C.C. aggregate.

Reserve data within Sector F are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR F =
(PROPRIETARY DATA, ALL PCC GRADE)
TOTAL RESERVES - SECTOR F =
(PROPRIETARY DATA)

SECTOR G - IRVINGTON GRAVELS - MISSION SAN JOSE

Plate 2.18 Niles Quadrangle MRZ-2(b) Sector Plate 2.55

This 700 acre plateau south and west of Mission San Jose is underlain by stream-deposited sands and pebble gravels collectively called the Irvington Gravels. Most of the material in the Pleistocene-age deposit is derived from rocks of the Franciscan Complex with minor reworked sedimentary material. One active and three inactive quarries are located on the west side of the deposit. A screening and washing plant for P.C.C. aggregate was previously operated at the Henry Sands Quarry (active). The deposit is bounded on the north, west, and south by Mission Creek, the Hayward fault and Canada de Aliso Creek. Available water-well logs indicate that large amounts of silt and clay exist along the margins of the deposit. Data from the three well-logs show that gravels occur from 190 feet to over 300 feet beneath the bed of Mission Creek. Exposures of gravel are visible in the deposit in a ravine east of the Henry Sands quarry. Overburden consists of soil, silt, and clay, which are exposed along the western edge of the deposit. Few exposures were available to determine the thickness of the overburden.

Most of this deposit has been urbanized, with the resultant loss of resources. Practically all that remains available is the property owned by Henry Sands, who has an active permit for quarry operations. Reserve data within Sector G are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR G =
(PROPRIETARY DATA, ALL PCC GRADE)
TOTAL RESERVES - SECTOR G =
(PROPRIETARY DATA)

SECTORS J,K,L - QUATERNARY ALLUVIUM - ALAMEDA CREEK

Plate 2.15	Milpitas Quadrangle	MRZ-2(a)	Sector Plate 2.57
Plate 2.16	Mountain View Quad.	MRZ-2(a)	Sector Plate 2.58
Plate 2.17	Newark Quadrangle	MRZ-2(a)	Sector Plate 2.56
Plate 2.18	Niles Quadrangle	MRZ-2(a)	Sector Plate 2.55

These three sectors are portions of the same deposit: the Niles Cone, a large subaerial delta formed by Alameda Creek at the mouth of Niles Canyon. The material is derived predominantly from rocks of the Franciscan Complex, with minor reworked sedimentary and volcanic material. Numerous gravel pits (for example, Sector F, p. 19, and Sector KK, p. 35) have been operated near these sectors since 1912 (Hueguin and Castello, 1920, p. 38). The deposit has been traced below the ground surface by Ford and Hansen (1967), and Ford, et al (1975), using water-well logs. Within the areas encompassing the resource sectors, the aquifers are between 30 and 140 feet in combined thickness, with less than 40 feet of overburden.

Resources for the three sectors are given in the tables below. Factors used in calculating the available resources included the following items:

1. Resource material is Quaternary sand and gravel lying within aquifers in the Niles Cone.
2. All aquifer material within the sectors consists of sand and gravel suitable for P.C.C. aggregate.
3. Waste is equal to 10 percent of the total material.
4. Overburden thickness is no greater than 40 feet. It is assumed that overburden has been stripped prior to the calculation of resources. Resource totals, therefore, do not include overburden.
5. Thickness of sand and gravel varies from 30 feet to more than 100 feet.
6. Wall slopes above the aquifer were not considered.
7. Depth to water table is assumed to be 55-60 feet.
8. A conversion factor of 14.50 cubic feet of material per ton was used in resource calculations (see Sector A, item #7)
9. Base maps for resource calculations were 4:1 enlargements of the Milpitas, Mountain View, Newark and Niles 7.5 minute quadrangles (1980, 1973, 1980 and 1980, respectively).

RESOURCES – SECTOR J

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
Top	293.56	—	293.56	X	$\frac{(40)(43,560)(.90)}{14.50}$	=	31,750,000
-40 feet	293.56						
					TOTAL SECTOR J	=	31,750,000

TOTAL RESOURCES - SECTOR J =
32 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR J =
0 TONS

RESOURCES – SECTOR K

AQUIFER INTERVAL	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR K-1							
Top	248.62	—	248.62	X	$\frac{(40)(43,560)(.90)}{14.50}$	=	26,890,000
-40 feet	248.62	—	210.52	X	$\frac{(20)(43,560)(.90)}{14.50}$	=	11,380,000
-60 feet	172.41						
					TOTAL SECTOR K-1	=	38,270,000

RESOURCES – SECTOR K (continued)

AQUIFER INTERVAL	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR K-2						
Top	155.82					
		— 155.82	x	(40)(43,560)(.90) / 14.50	=	16,850,000
-40 feet	155.82					
		— 150.77	x	(20)(43,560)(.90) / 14.50	=	8,150,000
-60 feet	145.72					
				TOTAL SECTOR K-2	=	25,000,000

TOTAL RESOURCES - SECTOR K =
63 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR K =
0 TONS

RESOURCES – SECTOR L

AQUIFER INTERVAL	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR L-1						
Top	207.87					
		— 207.87	x	(40)(43,560)(.90) / 14.50	=	22,480,000
-40 feet	207.87					
		— 124.00	x	(20)(43,560)(.90) / 14.50	=	6,710,000
-60 feet	40.12					
				TOTAL SECTOR L-1	=	29,190,000
SECTOR L-2						
Top	122.36					
		— 122.36	x	(55)(43,560)(.90) / 14.50	=	18,200,000
-55 feet	122.36					
		— 120.10	x	(5)(43,560)(.90) / 14.50	=	1,620,000
-60 feet	117.83					
		— 83.02	x	(20)(43,560)(.90) / 14.50	=	4,490,000
-80 feet	48.21					
				TOTAL SECTOR L-2	=	24,310,000
SECTOR L-3						
Top	680.84					
		— 680.84	x	(40)(43,560)(.90) / 14.50	=	76,630,000
-40 feet	680.84					
		— 548.35	x	(20)(43,560)(.90) / 14.50	=	29,650,000
-60 feet	415.86					
		— 352.27	x	"	=	19,050,000
-80 feet	288.68					
		— 174.13	x	"	=	9,420,000
-100 feet	59.57					
				TOTAL SECTOR L-3		134,750,000

TOTAL RESOURCES - SECTOR L =
188 MILLION TONS (ALL PCC GRADE)
TOTAL RESERVES - SECTOR L =
0 TONS

SECTOR Q - WOLFSKILL FORMATION - SMITH DEPOSIT

Plate 2.26 Antioch South Quad. MRZ-2(a) Sector Plate 2.61

Resource Sector Q encompasses a 56 acre sand deposit included as a part of the Wolfskill Formation (Brabb, et al, 1971). A portion of this deposit is currently being operated as the H. Smith Sand Quarry. The material is sold for fill sand, but appears suitable for higher uses. Reserve data is proprietary and is included with other company-controlled data in Table 2.12.

Resources of sand are given in the table below. Factors used in calculating resources in Sector Q included the following items:

1. The material is Wolfskill Formation sand.

2. The sand appears suitable for asphaltic concrete sand.

3. There is no waste or overburden.

4. Base elevation of the quarry is 160 feet.

5. The quarry site would be flat with no side walls.

6. No ground water would be encountered.

7. A conversion factor of 18.90 cubic feet of material per ton is used. This figure is approximately the density of dry sand.

8. The base map used in calculating resources is the 1973 edition of the Antioch South 7.5 minute quadrangle.

RESOURCES – SECTOR Q

CONTOUR ELEVATION	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
260	2.00					
		— 12.50	x	(60)(43,560) / 18.90	=	1,730,000
200	23.00					
		— 39.50	x	(40)(43,560) / 18.90	=	3,640,000
160	56.00					
				TOTAL SECTOR Q	=	5,370,000

TOTAL RESOURCES - SECTOR Q =
5 MILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR Q =
(PROPRIETARY DATA)

SECTOR AA - SANTA CLARA FORMATION - STEVENS CREEK DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(b) Sector Plate 2.68

Resource Sector AA is the area adjacent to Stevens Creek County Park that is underlain by conglomerate of the Santa Clara Formation. The unit in the vicinity of Sector AA has been folded into a syncline, the axis of which crosses the sector in a northwesterly direction. The strata of conglomerate are up to 30 feet thick, and have a maximum dip of approximately 30 degrees to the northeast. The conglomerate is bluish-gray when fresh, and weathers to a tan color. It is composed of pebbles and cobbles derived from the Franciscan Complex, and has a soft matrix of sand or silt.

Conglomerate has been quarried from several pits in the vicinity of Stevens Creek Reservoir. One inactive quarry is located in Sector AA. The active Stevens Creek Quarry (Sector DD) is located one-half mile west of this sector. Stevens Creek and Stevens Creek Canyon Road separate Sector AA from a northwest extension of the deposit. The northwest deposit is classified MRZ-3 due to the presence of weathered material suitable only for fill, and a lack of visible outcrops due to the heavy brush cover.

Resources in Sector AA are given in the table below. Factors used in calculating resources included the following items:

1. All of the material within Sector AA is conglomerate of the Santa Clara Formation.

2. The unweathered conglomerate is suitable for asphaltic concrete and perhaps P.C.C. aggregate.

3. Overburden and waste factors are lumped together and are considered to amount to 10 percent of the total, due to the lack of test data for the deposit.

4. Wall slopes are approximately 2:1 (horizontal to vertical)

5. Minimum elevation for the quarry floor is 400 feet.

6. Ground water is not expected to be encountered in the quarry.

7. A conversion factor is 14.50 cubic feet of material per ton was used, due to the similarity of this material to the material found in the Livermore-Amador Valley.

8. Base map for this resource sector is a 4:1 enlargement of the Cupertino 7.5 minute quadrangle (1973).

RESOURCES – SECTOR AA

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
920	2.18						
		—	3.30	X	(40)(43,560)(.90) / 14.50	=	360,000
880	4.42						
		—	6.34	X	"	=	690,000
840	8.26						
		—	12.94	X	"	=	1,400,000
800	17.62						
		—	24.88	X	"	=	2,690,000
760	32.14						
		—	37.34	X	"	=	4,040,000
720	42.53						
		—	47.09	X	"	=	5,090,000
680	51.65						
		—	54.06	X	"	=	5,850,000
640	56.47						
		—	57.39	X	"	=	6,210,000
600	58.31						
		—	36.19	X	"	=	3,910,000
560	14.06						
		—	14.75	X	"	=	1,600,000
520	15.44						
		—	15.56	X	"	=	1,680,000
480	15.67						
		—	14.98	X	"	=	1,620,000
440	14.29						
		—	12.97	X	"	=	1,400,000
400	11.65						
					TOTAL SECTOR AA	=	36,540,000

TOTAL RESOURCES - SECTOR AA =
37 MILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR AA =
0 TONS

SECTOR DD - SANTA CLARA FORMATION - STEVENS CREEK QUARRY DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(c) Sector Plate 2.68

Sector DD consists of a portion of the area underlain by a northwest-trending, east-dipping belt of conglomerate of the Santa Clara Formation. Most of the area is owned by the active Stevens Creek Quarry, Inc. When this area was field checked in 1979 only fill material was being sold, but in past years a crushing and screening plant produced aggregate suitable for asphaltic concrete. Due to lack of outcrops and the heavy brush cover, the MRZ-2 area could not be extended very far beyond the quarry property boundaries.

Reserve data within Sector DD are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR DD =
(PROPRIETARY DATA ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR DD =
(PROPRIETARY DATA)

Crushed Stone Resources

In the South San Francisco Bay P-C Region, crushed stone production and resources are found in four of the five counties. As shown in the following sector discussions, there is a large amount of stone suitable for aggregate in the P-C region, compared to sand and gravel resources. There are no large production districts for stone, but numerous small groups and scattered isolated producers.

SECTOR D - FRANCISCAN COMPLEX GREENSTONE - APPERSON RIDGE

Plate 2.12 La Costa Valley Quad. MRZ-2(b) Sector Plate 2.54

Resource Sector D consists of Apperson Ridge, a conspicuous northwest-trending ridge underlain by greenstone (metamorphosed basalt) of the Franciscan Complex. A thin, rocky soil covers the greenstone, and supports a sparce growth of grass. The greenstone is exposed in many outcrops and at a small test quarry. Where exposed, the material appears to be similar - a dense, hard rock which is suitable for P.C.C. aggregate (as demonstrated by test results from samples obtained at the quarry site). Layers of tuff, which are found interbedded with greenstone at several quarries in Santa Clara County and which are suitable only for fill material, were not found in this deposit but may be present. A drilling program would be needed to determine if tuff exists here.

Crushed stone resources in Sector D are given in the table below. They were calculated by successively adding the volumes of horizontal prisms, beginning below the overburden and weathered material (at the top of the deposit) downward to the base of the deposit. This technique was used in all subsequent stone deposits. Factors used in calculating resources included the following items:

1. All material in Sector D is greenstone of the Franciscan Complex; no tuff is present within the deposit.

2. The unweathered greenstone is suitable for P.C.C. aggregate. Weathered greenstone is probably suitable for road base material.

3. There is no waste material in this deposit. Since low quality material commonly forms a very small percentage of the total deposit, and is sold for fill or topsoil, stone quarries usually have no allowance for waste in the resource calculations.

4. Thickness of overburden is negligible.

5. Wall slopes are no steeper than 2:1 (horizontal to vertical). Benches are drawn in at elevation 1400 feet in Sector D-1, elevations 1200 feet and 1400 feet in Sector D-2, and elevations 1200 feet, 1400 feet, and 1600 feet in Sector D-3.

6. Minimum quarry floor elevation is 1200 feet for Sector D-1, and 1000 feet for Sectors D-2 and D-3.

7. Ground water probably would not affect quarry operations.

8. A conversion factor of 10.68 cubic feet of material per ton

was used. This factor is based on density tests performed on greenstone samples from Sector D.

9. Base map used for calculations is a 4:1 enlargement of the 1968 edition of the La Costa Valley 7.5 minute quadrangle.

RESOURCES – SECTOR D

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	x	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR D-1							
1840	2.18						
		—	5.62	x	(40)(43,560) / 10.68	=	920,000
1800	9.07						
		—	12.31	x	"	=	2,010,000
1760	15.55						
		—	18.39	x	"	=	3,000,000
1720	21.24						
		—	24.71	x	"	=	4,030,000
1680	28.18						
		—	31.88	x	"	=	5,200,000
1640	35.58						
		—	39.03	x	"	=	6,370,000
1600	42.47						
		—	46.09	x	"	=	7,520,000
1560	49.70						
		—	53.03	x	"	=	8,650,000
1520	56.36						
		—	59.75	x	"	=	9,750,000
1480	63.13						
		—	67.64	x	"	=	11,040,000
1440	72.14						
		—	77.11	x	"	=	12,580,000
1400	82.07						
Bench							
1400	60.20						
		—	63.85	x	"	=	10,420,000
1360	67.49						
		—	71.86	x	"	=	11,720,000
1320	76.22						
		—	81.55	x	"	=	13,300,000
1280	86.89						
		—	91.97	x	"	=	15,000,000
1240	97.05						
		—	102.27	x	"	=	16,680,000
1200	107.50						
					TOTAL SECTOR D-1	=	138,190,000
SECTOR D-2							
1920	17.56						
		—	23.42	x	(40)(43,560) / 10.68	=	3,820,000
1880	29.27						
		—	34.06	x	"	=	5,560,000
1840	38.85						
		—	43.93	x	"	=	7,170,000
1800	49.01						
		—	53.43	x	"	=	8,720,000
1760	57.85						
		—	62.27	x	"	=	10,160,000
1720	66.69						
		—	70.76	x	"	=	11,540,000
1680	74.84						
		—	78.94	x	"	=	12,880,000
1640	83.05						
		—	86.35	x	"	=	14,090,000
1600	89.65						
		—	93.75	x	"	=	15,290,000
1560	97.85						
		—	101.73	x	"	=	16,600,000
1520	105.60						
		—	108.41	x	"	=	17,690,000
1480	111.23						
		—	114.01	x	"	=	18,600,000
1440	116.79						
		—	117.71	x	"	=	19,200,000
1400	118.63						
Bench							
1400	103.36						
		—	98.69	x	"	=	16,100,000
1360	94.01						
		—	90.16	x	"	=	14,710,000
1320	86.32						
		—	83.05	x	"	=	13,550,000
1280	79.78						
		—	76.99	x	"	=	12,560,000
1240	74.21						
		—	70.97	x	"	=	11,580,000
1200	67.72						
Bench							

RESOURCES – SECTOR D (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	x	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1200	111.34						
		—	105.57	x	(40)(43,560) / 10.68	=	17,220,000
1160	99.81						
		—	94.41	x	"	=	15,400,000
1120	89.02						
		—	84.14	x	"	=	13,730,000
1080	79.26						
		—	74.67	x	"	=	12,180,000
1040	70.08						
		—	65.28	x	"	=	10,650,000
1000	60.49						
					TOTAL SECTOR D-2	=	299,000,000
SECTOR D-3							
2200	20.09						
		—	23.93	x	(40)(43,560) / 10.68	=	3,900,000
2160	27.78						
		—	32.83	x	"	=	5,360,000
2120	37.88						
		—	43.39	x	"	=	7,080,000
2080	48.90						
		—	54.29	x	"	=	8,860,000
2040	59.69						
		—	65.46	x	"	=	10,680,000
2000	71.22						
		—	80.06	x	"	=	13,060,000
1960	88.90						
		—	100.18	x	"	=	16,340,000
1920	111.46						
		—	124.97	x	"	=	20,390,000
1880	138.49						
		—	147.56	x	"	=	24,070,000
1840	156.62						
		—	165.12	x	"	=	26,940,000
1800	176.61						
		—	180.47	x	"	=	29,440,000
1760	187.33						
		—	190.83	x	"	=	31,130,000
1720	194.33						
		—	196.40	x	"	=	32,040,000
1680	198.46						
		—	200.01	x	"	=	32,630,000
1640	201.56						
		—	201.65	x	"	=	32,900,000
1600	201.73						
Bench							
1600	171.44						
		—	171.09	x	"	=	27,910,000
1560	170.74						
		—	170.94	x	"	=	27,890,000
1520	171.14						
		—	169.88	x	"	=	27,720,000
1480	168.62						
		—	167.13	x	"	=	27,270,000
1440	165.63						
		—	162.91	x	"	=	26,580,000
1400	160.19						
Bench							
1400	153.69						
		—	147.84	x	"	=	24,120,000
1360	141.99						
		—	138.60	x	"	=	22,610,000
1320	135.22						
		—	130.83	x	"	=	21,340,000
1280	126.44						
		—	121.64	x	"	=	19,850,000
1240	116.85						
		—	112.95	x	"	=	18,430,000
1200	109.05						
Bench							
1200	105.89						
		—	101.25	x	"	=	16,500,000
1160	96.42						
		—	90.94	x	"	=	14,840,000
1120	85.46						
		—	80.44	x	"	=	13,120,000
1080	75.41						
		—	69.62	x	"	=	11,360,000
1040	63.82						
		—	58.43	x	"	=	9,530,000
1000	53.03						
					TOTAL SECTOR D-3	=	603,890,000

TOTAL RESOURCES - SECTOR D = 1,041 MILLION TONS (ALL PCC GRADE)

TOTAL RESERVES - SECTOR D = 0 TONS

SECTOR H - BRIONES FORMATION SANDSTONE - NILES DEPOSIT

Plate 2.18 Niles Quadrangle MRZ-2(c) Sector Plate 2.55

Sector H is situated at the northern end of a deposit of Briones Formation sandstone located within the Niles District of the City of Fremont. The sandstone is fine-grained and well-indurated; minor amounts of shale are interbedded with the sandstone. The strata have been folded into an anticline which is partially overlain by the Claremont Shale. This deposit was mined for subbase and fill at the Bellini Quarry (located at the southern end of the deposit) and at the inactive Serpa Quarry in Milpitas (Santa Clara County).

Resources in Sector H are given in the table below. Factors used in calculating the resources included the following items:

1. Resource material is Briones Formation sandstone.
2. The sandstone is suitable for roadbase and perhaps asphaltic concrete aggregate.
3. There is no waste, and overburden can be sold for fill.
4. Wall slopes have a 2:1 ratio (horizontal to vertical).
5. Minimum quarry floor elevation would be 320 feet.
6. Ground water is not expected to hinder quarry operations.
7. A conversion factor of 13.70 cubic feet of material per ton is used. This factor is based on the result of density tests performed on samples of Briones Formation sandstone from the Serpa Quarry.
8. Base map for resource calculations was a 4:1 enlargement of the Niles 7.5 minute quadrangle (1980).

RESOURCES – SECTOR H

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1000	.31						
		—	.56	x	(40)(43,560) / 13.70	=	70,000
960	.81						
		—	6.51	x	"	=	830,000
920	12.21						
		—	20.38	x	"	=	2,590,000
880	28.55						
		—	39.36	x	"	=	5,010,000
840	50.16						
		—	53.58	x	"	=	6,810,000
800	56.99						
		—	64.76	x	"	=	8,240,000
760	72.53						
		—	69.41	x	"	=	8,830,000
720	66.29						
		—	65.09	x	"	=	8,280,000
680	63.88						
		—	63.23	x	"	=	8,040,000
640	62.58						
		—	60.63	x	"	=	7,710,000
600	58.68						
		—	58.44	x	"	=	7,430,000
560	58.20						
		—	62.44	x	"	=	7,940,000
520	66.68						
		—	69.16	x	"	=	8,800,000
480	71.63						
		—	70.08	x	"	=	8,910,000
440	68.52						
		—	65.84	x	"	=	8,370,000
400	63.16						
		—	60.28	x	"	=	7,670,000
360	57.39						

RESOURCES – SECTOR H (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
360	57.39						
		—	54.64	X	(40)(43,560) / 13.70	=	6,950,000
320	51.88						
					TOTAL SECTOR H	=	112,480,000

TOTAL RESOURCES - SECTOR H =
112 MILLION TONS (ALL ROADBASE GRADE)

TOTAL RESERVES -SECTOR H =
0 TONS

SECTOR I - BRIONES FORMATION SANDSTONE - SCOTT CREEK DEPOSIT

Plate 2.15 Milpitas Quadrangle MRZ-2(b) Sector Plate 2.57
Plate 2.45 Calaveras Reservoir Quad. MRZ-2(a) Sector Plate 2.75

Resource Sector I includes outcrops of Briones Formation sandstone within the Milpitas and Calaveras Reservoir quadrangles. The sandstone is fine-grained and well indurated; minor amounts of shale are interbedded with the sandstone. The unit extends southward along the edge of the Santa Clara Valley and dips to the west at a 35 to 60 degree angle. Four companies are presently mining in the sector; the Curtner Quarry in Sector I-1, the Raisch Quarry in Sector I-2, the Swenson Quarry in Sector I-3, and the Winterbaur Quarry in Sector I-4. The southern portion of Sector I extends outside the urbanizing portion of Santa Clara County.

Resources in Sector I are given in the table below. Factors used in calculating the resources included the following items:

1. Resource material is Briones Formation sandstone.
2. The sandstone is suitable for roadbase and perhaps asphaltic concrete aggregate.
3. There is no waste and overburden can be sold for fill.
4. Wall slopes have a 2:1 ratio (horizontal to vertical).
5. Base elevation of the quarry floor varies from 400 feet to 660 feet.
6. Ground water is not expected to hinder quarry operations.
7. A conversion factor of 13.70 cubic feet of material per ton is used. This figure is based on density tests performed on sample of Briones Formation sandstone from the Raisch Quarry.
8. Base map for resource calculations was the Calaveras Reservoir 7.5-minute quadrangle (1980) and a 4:1 enlargement of the Milpitas 7.5-minute quadrangle (1980).

RESOURCES – SECTOR I

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR I-1							
1300	.92						
		—	1.61	X	(20)(43,560) / 13.70	=	100,000
1280	2.30						
		—	2.27	X	"	=	140,000
1260	3.04						

RESOURCES – SECTOR I (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1260	3.04						
		—	3.88	X	(20)(43,560) / 13.70	=	250,000
1240	4.71						
		—	6.32	X	"	=	400,000
1220	7.92						
		—	11.25	X	"	=	720,000
1200	14.58						
		—	17.37	X	"	=	1,100,000
1180	20.15						
		—	21.70	X	"	=	1,380,000
1160	23.24						
		—	24.45	X	"	=	1,550,000
1140	25.65						
		—	26.54	X	"	=	1,690,000
1120	27.43						
		—	28.61	X	"	=	1,820,000
1100	29.79						
		—	31.17	X	"	=	1,980,000
1080	32.54						
		—	34.29	X	"	=	2,180,000
1060	36.04						
		—	38.14	X	"	=	2,430,000
1040	40.23						
		—	42.36	X	"	=	2,690,000
1020	44.48						
		—	47.44	X	"	=	3,020,000
1000	50.39						
		—	52.89	X	"	=	3,360,000
980	55.38						
		—	59.00	X	"	=	3,750,000
960	62.62						
		—	66.49	X	"	=	4,230,000
940	70.36						
		—	74.35	X	"	=	4,730,000
920	78.34						
		—	82.07	X	"	=	5,220,000
900	85.80						
		—	89.68	X	"	=	5,700,000
880	93.55						
		—	97.40	X	"	=	6,190,000
860	101.24						
		—	105.55	X	"	=	6,710,000
840	109.85						
		—	115.10	X	"	=	7,320,000
820	120.35						
		—	125.32	X	"	=	7,970,000
800	130.28						
		—	135.93	X	"	=	8,640,000
780	141.58						
		—	150.51	X	"	=	9,570,000
760	159.43						
		—	168.70	X	"	=	10,730,000
740	177.97						
		—	185.89	X	"	=	11,820,000
720	193.81						
		—	201.10	X	"	=	12,790,000
700	208.39						
		—	225.26	X	"	=	14,320,000
680	242.13						
		—	265.55	X	"	=	16,890,000
660	288.97						
		—	270.95	X	"	=	17,230,000
640	252.92						
		—	238.49	X	"	=	15,170,000
620	224.06						
		—	225.32	X	"	=	14,330,000
600	226.58						
		—	211.95	X	"	=	13,480,000
580	197.31						
		—	198.66	X	"	=	12,630,000
560	200.01						
		—	201.02	X	"	=	12,780,000
540	202.02						
		—	200.56	X	"	=	12,750,000
520	199.09						
		—	193.90	X	"	=	12,330,000
500	188.70						
		—	137.74	X	"	=	8,760,000
480	86.78						
		—	86.26	X	"	=	5,490,000
460	85.74						
		—	76.76	X	"	=	4,880,000
440	67.78						
		—	65.23	X	"	=	4,150,000
420	62.67						
		—	59.23	X	"	=	3,770,000
400	55.79						
					TOTAL SECTOR I-1	=	299,200,000
SECTOR I-2							
720	0						
		—	1.32	X	(40)(43,560) / 13.70	=	170,000
680	2.64						
		—	7.93	X	"	=	1,000,000
640	13.22						
		—	15.87	X	"	=	2,010,000
600	18.51						

RESOURCES – SECTOR I (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
		—	21.16	X	(40)(43,560) / 13.70	=	2,680,000
560	23.80						
		—	26.45	X	"	=	3,350,000
520	29.09						
		—	25.78	X	"	=	3,270,000
480	22.48						
		—	17.85	X	"	=	2,260,000
440	13.22						
			TOTAL SECTOR I-2			=	14,740,000
SECTOR I-3							
680	0						
		—	12.56	X	"	=	1,600,000
640	25.12						
		—	38.36	X	"	=	4,880,000
600	51.57						
		—	61.49	X	"	=	7,820,000
560	71.40						
		—	74.71	X	"	=	9,500,000
520	78.02						
		—	77.35	X	"	=	9,840,000
480	76.69						
		—	74.71	X	"	=	9,500,000
440	72.73						
		—	66.78	X	"	=	8,490,000
400	60.83						
			TOTAL SECTOR I-3				51,630,000
SECTOR I-4							
800	0						
		—	3.97	X	"	=	500,000
760	7.93						
		—	23.80	X	"	=	3,030,000
720	39.67						
		—	44.96	X	"	=	5,720,000
680	50.25						
		—	52.23	X	"	=	6,640,000
640	54.21						
		—	56.20	X	"	=	7,150,000
600	58.18						
		—	58.18	X	"	=	7,400,000
560	58.18						
		—	59.50	X	"	=	7,570,000
520	60.83						
		—	58.84	X	"	=	7,480,000
480	56.86						
		—	54.88	X	"	=	6,980,000
440	52.89						
		—	50.25	X	"	=	6,390,000
400	47.60						
					TOTAL SECTOR I-4	=	58,860,000

TOTAL RESOURCES - SECTOR I =
424 MILLION TONS (ALL ROADBASE GRADE)
TOTAL RESERVES - SECTOR I =
27 MILLION TONS

SECTOR M - FRANCISCAN COMPLEX - COYOTE HILLS DEPOSIT

Plate 2.17 Newark Quadrangle MRZ-2(b) Sector Plate 2.56

Sector M contains a portion of the Coyote Hills west of Newark in Alameda County. This deposit of Franciscan Complex chert, graywacke, basalt, diabase, and Jurassic serpentinite contains one active quarry (Dumbarton Quarry Associates) and several inactive quarries. Reserve data for the active quarry is proprietary data and cannot be discussed here, but is included with proprietary data from other producers in Table 2.12. The deposit is divided into three parcels - North Hill, Central Hill, and South Hill. Sector M is limited to the southern half of Central Hill. North Hill and the northern half of Central Hill are included in the Coyote Hills Regional Park, and are discussed as Sector MM, p. 36. South Hill is included in the San Francisco

Bay National Wildlife Refuge, and is also included in Sector MM.

Resource calculations are given in the table below. Factors used in calculating resources in Sector M included the following items:

1. The deposit consists of graywacke, chert, basalt, and diabase of the Franciscan Complex, and Jurassic serpentinite.
2. Some of the material can be used for asphaltic concrete aggregate; the remainder can be used for road base, subbase material, or fill.
3. There is no waste and overburden can be sold for fill.
4. Base elevation of the quarry floor would be 20 feet. Pit walls will have a 2:1 slope ratio (horizontal to vertical). There would be a berm left at elevation 40 feet.
5. Ground water would not affect quarry operations.
6. A conversion factor of 11.54 cubic feet of material per ton was used. This factor is based on file data in a property report done during an earlier study by Chesterman and Manson.
7. Base map used for resource calculations is a 2:1 enlargement of the 1973 edition of the Newark 7.5 minute quadrangle.

RESOURCES - SECTOR M

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
260	2.76						
		--	3.10	X	$\frac{(20)(43,560)}{11.54}$	=	230,000
240	3.44						
		--	5.28	X	"	=	400,000
220	7.12						
		--	9.19	X	"	=	690,000
200	11.25						
		--	13.43	X	"	=	1,010,000
180	15.61						
		--	18.60	X	"	=	1,400,000
160	21.58						
		--	23.88	X	"	=	1,800,000
140	26.17						
		--	29.16	X	"	=	2,200,000
120	32.14						
		--	34.67	X	"	=	2,620,000
100	37.19						
		--	38.80	X	"	=	2,930,000
80	40.40						
		--	42.01	X	"	=	3,170,000
60	43.62						
		--	44.20	X	"	=	3,340,000
40	44.77						
Berm							
40	39.26						
		--	40.06	X	"	=	3,020,000
20	40.86						
					TOTAL SECTOR M	=	22,810,000

TOTAL RESOURCES - SECTOR M =
23 MILLION TONS (MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR M =
(PROPRIETARY DATA)

SECTOR N - FRANCISCAN COMPLEX GREENSTONE - LA VISTA DEPOSIT

Plate 2.10 Hayward Quadrangle MRZ-2(a) Sector Plate 2.59

Sector N includes the active La Vista Quarry of East Bay Excavating Company. The sector is located near the southeastern end of a series of greenstone deposits that occur in a more-or-less continuous band stretching northwestward across the quadrangle. The San Leandro Rock Company (Sector O) is situated at the northwest end of the group of deposits. The Hayward fault passes through the center of the La Vista Quarry; it forms the contact between the greenstone on the west and sedimentary rocks of the Knoxville Formation on the east. A small body of Leona Rhyolite existed in the quarry area, but apparently was mined out before the quarry was visited in September, 1978. East of the Hayward fault the Franciscan greenstone underlies the Knoxville Formation. At this location the Knoxville Formation consists of soft, badly fractured shale and sandstone, and is suitable only for fill.

Reserve data within Sector N are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR N =
(PROPRIETARY DATA, MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR N =
(PROPRIETARY DATA)

SECTOR O - FRANCISCAN COMPLEX GREENSTONE AND LEONA RHYOLITE - SAN LEANDRO DEPOSIT

Plate 2.10 Hayward Quadrangle MRZ-2(b) Sector Plate 2.59

Sector O is limited to the property owned by the San Leandro Rock Company, at the northern end of the greenstone and rhyolite deposits described in Sector N above. The sector is bounded by Lake Chabot Road on the north and east sides, and the Hayward fault along the western edge. The greenstone and rhyolite are suitable for asphaltic concrete aggregate, road base, and fill.

Reserve data within Sector O are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR O =
(PROPRIETARY DATA, MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR O =
(PROPRIETARY DATA)

SECTOR P - LEONA RHYOLITE - GALLAGHER & BURKE QUARRY DEPOSIT

Plate 2.19 Oakland East Quadrangle MRZ-2(a) Sector Plate 2.60

Sector P is a portion of an immense deposit of Leona Rhyolite that is situated between Oak Knoll Naval Hospital and Peralta Creek in the Berkeley Hills. The Leona Heights Quarry was operated for several years around the turn of the century; currently it is the site of Merritt College. The Alma and Leona pyrite mines were active for approximately forty years during the first part of this century. The pyrite (iron sulphide) was used to manufacture sulfuric acid (Aubury, 1906, p. 311-315, and Davis, 1950, p. 305 - 307). Gallagher & Burke, Inc. have an active quarry near the southern end of the deposit. The rhyolite is suitable for asphaltic concrete aggregate and road base material. Although most of Sector P is mapped as containing Leona Rhyolite, small outcrops of Cretaceous-age sedimentary rocks within the sector indicate that the deposit is not uniform throughout. The sedimentary rocks appear to be too soft for use as anything other than fill.

Reserve data within Sector P are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR P =
(PROPRIETARY DATA, MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR P =
(PROPRIETARY DATA)

SECTOR R - FRANCISCAN COMPLEX GREENSTONE - MOUNT DIABLO DEPOSIT

Plate 2.29 Clayton Quadrangle MRZ-2(c) Sector Plate 2.62

Sector R includes the quarry of Mount Diablo Rock and Asphalt Company, located southeast of Clayton in Contra Costa County, on the northern slope of Mount Diablo. Resources consist of greenstone and chert fragments and blocks up to 6 feet in diameter, which form an old landslide or talus deposit. The deposit has a maximum width of approximately 2,600 feet and extends upslope for approximately 3,200 feet. Depth of the landslide debris is not known. The coarse material can be used for asphaltic concrete aggregate and road base material.

Reserve data within Sector R are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR R =
(PROPRIETARY DATA, MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR R =
(PROPRIETARY DATA)

SECTOR S - JURASSIC DIABASE - MOUNT ZION DEPOSIT

Plate 2.29 Clayton Quadrangle MRZ-2(b) Sector Plate 2.62

Mount Zion is located northwest of Mount Diablo and east of Walnut Creek. Sector S encompasses Mount Zion (Sector S-1) and a smaller adjacent hill (Sector S-2). Two sites, on the east and west sides of Mount Zion, are currently being quarried for asphaltic concrete aggregate, base material and rip-rap by Lone Star Industries and Kaiser Sand and Gravel, respectively. Reserve data for the two quarries are proprietary and cannot be discussed here, but are combined with data from other producers and shown in Table 2.12. The material consists of fractured and faulted massive greenish-gray diabase and pillow basalt of Jurassic age. The diabase is younger than the rocks of the Franciscan Complex that underlie Mount Diablo. Several old adits and prospect holes are located on the south and east slopes of Mount Zion, which was a center of a "copper boom" in the 1860's. Some copper and insignificant amounts of gold and silver have been reported from this area (Davis and Goldman, 1958, p. 521).

Resources in Sector S are given in the tables below. Factors used in calculating resources included the following items:

1. The material being quarried consists of Jurassic diabase and pillow basalt.

2. The diabase and basalt are suitable for asphaltic concrete aggregate and perhaps P.C.C. aggregate if no sulphide minerals are present locally.

3. There is no waste and overburden can be sold for fill.

4. Wall slopes have a ratio of 2:1 (horizontal to vertical).

5. Minimum quarry elevation in Sector S-1 is 600 feet; minimum elevation in Sector S-2 is 800 feet. Benches are located at elevations of 800 feet and 1000 feet in Sector S-1.

6. Ground water is not expected to hamper quarry operations.

7. A conversion factor of 11.30 cubic feet of material per ton was used in calculating resources. This factor is based on density tests performed on samples from the Lone Star Quarry on the east side of Mount Zion.

8. Base map for resource calculations is a 4:1 enlargement of the 1973 edition of the Clayton 7.5 minute quadrangle. No allowance has been made for material already quarried by Kaiser Sand and Gravel and Lone Star Industries, since their total production amounts to a very small percentage of the resources in the sector.

RESOURCES – SECTOR S

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR S-1							
1600	1.03						
		—	2.50	X	(40)(43,560) / 11.30	=	390,000
1560	3.96						
		—	8.01	X	"	=	1,240,000
1520	12.05						
		—	15.99	X	"	=	2,470,000
1480	19.92						
		—	25.46	X	"	=	3,930,000
1440	30.99						
		—	35.52	X	"	=	5,480,000
1400	40.05						
		—	50.62	X	"	=	7,810,000
1360	61.18						
		—	69.85	X	"	=	10,770,000
1320	78.51						
		—	87.93	X	"	=	13,560,000
1280	97.34						
		—	105.35	X	"	=	16,240,000
1240	113.35						
		—	121.33	X	"	=	18,710,000
1200	129.30						
		—	136.05	X	"	=	20,980,000
1160	142.79						
		—	149.48	X	"	=	23,050,000
1120	156.16						
		—	162.91	X	"	=	25,120,000
1080	169.65						
		—	176.65	X	"	=	27,240,000
1040	183.65						
		—	191.14	X	"	=	29,470,000
1000	198.63						
Bench							
1000	182.22						
		—	189.25	X	"	=	29,180,000
960	196.28						
		—	202.48	X	"	=	31,220,000
920	208.67						
		—	217.37	X	"	=	33,520,000
880	226.06						
		—	234.04	X	"	=	36,090,000
840	242.02						
		—	249.14	X	"	=	38,420,000
800	256.25						
Bench							
800	235.07						
		—	248.85	X	"	=	38,370,000
760	262.62						
		—	273.24	X	"	=	42,130,000
720	283.86						
		—	293.73	X	"	=	45,290,000
680	303.60						
		—	302.74	X	"	=	46,680,000
640	301.88						
		—	303.34	X	"	=	46,770,000
600	304.80						
					TOTAL SECTOR S-1	=	594,130,000

RESOURCES – SECTOR S (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR S-2							
1240	1.89	—	7.92	X	(40)(43,560) / 11.30	=	1,220,000
1200	13.95						
		—	18.28	X	"	=	2,820,000
1160	22.61						
		—	27.66	X	"	=	4,270,000
1120	32.71						
		—	37.25	X	"	=	5,740,000
1080	41.78						
		—	46.23	X	"	=	7,130,000
1040	50.68						
		—	54.99	X	"	=	8,480,000
1000	59.29						
		—	62.76	X	"	=	9,680,000
960	66.23						
		—	69.53	X	"	=	10,720,000
920	72.83						
		—	76.79	X	"	=	11,840,000
880	80.75						
		—	83.71	X	"	=	12,910,000
840	86.66						
		—	92.03	X	"	=	14,190,000
800	97.39						
					TOTAL SECTOR S-2	=	88,900,000

TOTAL RESOURCES - SECTOR S =
683 MILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR S =
(PROPRIETARY DATA)

SECTOR T - MORAGA FORMATION BASALT - SOUTH GUDDE RIDGE

Plate 2.19 Oakland East Quadrangle MRZ-2(c) Sector Plate 2.60

Resource Sector T contains basalt and andesite of the Moraga Formation. The volcanic rocks cover the ridgetop along the southeast half of Gudde Ridge within the city limits of Moraga. The northeast-dipping lava flows are underlain by sediments of the Orinda Formation. The basalt is dark gray when fresh and weathers to a reddish color. Crushed stone from the Moraga Formation has been a major source of roadbase and fill material in the local area. This deposit was quarried for base material and ballast by the Oakland, Antioch, and Eastern Railroad (predecessor to the Sacramento Northern Railroad), but at present there are no active quarries. Although not observed in the field, volcanic tuff and sedimentary rocks may exist within the deposit in significant amounts; this material would be suited only for fill.

Resources in Sector T are given in the table below. Factors used in calculating resources included the following items:

1. Sector T contains basalt and andesite of the Moraga Formation. It is assumed that tha lava flows are uniform in composition (no tuff or sedimentary rocks exist above the projected contact).

2. The basalt is suitable for asphaltic concrete aggregate and roadbase.

3. There is no waste and overburden can be sold for fill.

4. Wall slopes would have a 2:1 ratio (horizontal to vertical).

5. Minimum quarry elevation would be 700 feet.

6. Ground water would not pose a problem to quarry operations.

7. A conversion factor of 11.45 cubic feet of material per ton was used in calculating resources. This factor is based on density tests performed on basalt samples from Sector T.

8. Base map for resource calculations is a 4:1 enlargement of the 1973 edition of the Oakland East 7.5 minute quadrangle.

RESOURCES – SECTOR T

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1060	2.35						
		—	3.79	X	(20)(43,560) / 11.45	=	290,000
1040	5.22						
		—	7.84	X	"	=	600,000
1020	10.45						
		—	14.67	X	"	=	1,120,000
1000	18.88						
		—	22.87	X	"	=	1,740,000
980	26.86						
		—	31.77	X	"	=	2,420,000
960	36.67						
		—	42.04	X	"	=	3,200,000
940	47.41						
		—	53.01	X	"	=	4,030,000
920	58.60						
		—	65.46	X	"	=	4,980,000
900	72.31						
		—	78.74	X	"	=	5,990,000
880	85.17						
		—	91.77	X	"	=	6,980,000
860	98.37						
		—	104.94	X	"	=	7,980,000
840	111.51						
		—	118.20	X	"	=	8,990,000
820	124.88						
		—	131.77	X	"	=	10,030,000
800	138.66						
		—	144.23	X	"	=	10,970,000
780	149.79						
		—	155.50	X	"	=	11,830,000
760	161.21						
		—	167.15	X	"	=	12,720,000
740	173.09						
		—	175.22	X	"	=	13,330,000
720	177.34						
		—	177.00	X	"	=	13,470,000
700	176.65						
					TOTAL SECTOR T	=	120,670,000

TOTAL RESOURCES - SECTOR T =
121 MILLION TONS (MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR T =
0 TONS

SECTOR U - MORAGA FORMATION BASALT - NORTH GUDDE RIDGE

Plate 2.19 Oakland East Quadrangle MRZ-2(d) Sector Plate 2.60

Resource Sector U is situated on the northwest half of Gudde Ridge and contains basalt and andesite of the Moraga Formation. The basalt is dark gray when fresh, and weathers to a reddish color. As mentioned above in the description of Sector T, the volcanic rocks of the Moraga Formation have been used for ballast, road base and fill. Extensive quarrying has occurred in this sector, evidently in connection with the construction of Highway 24 and BART (Bay Area Rapid Transit), but there are no presently active quarries. Although not observed in the field, volcanic tuff and sedimentary rocks may exist within the deposit.

Resources in Sector U are given in the table below. Factors used in calculating resources included the following items:

1. Sector U contains basalt and andesite of the Moraga Formation. It is assumed that the lava flows are uniform in composition (no tuff or sedimentary rocks exist above the projected contact).

2. The basalt and andesite are suitable for asphaltic concrete aggregate and road base.

3. There is no waste and overburden can be sold for fill.

4. Wall slopes have a ratio of 2:1 (horizontal to vertical).

5. Minimum quarry elevation is 1060 feet.

6. Ground water is not expected to present problems for quarry operations.

7. A conversion factor of 11.45 cubic feet of material per ton was used in calculating resources. This factor is based on density tests performed on similar material from Sector T.

8. Base map for resource calculations is a 4:1 enlargement of the 1973 edition of the Oakland East 7.5 minute quadrangle. No allowance is made for material mined since the map was released, since it is small in comparison to the total resource, and would reveal proprietary data.

RESOURCES – SECTOR U

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1600	.46						
		—	.95	x	(20)(43,560) / 11.45	=	70,000
1580	1.44						
		—	1.84	x	"	=	140,000
1560	2.24						
		—	2.82	x	"	=	210,000
1540	3.39						
		—	4.22	x	"	=	320,000
1520	5.05						
		—	6.83	x	"	=	520,000
1500	8.61						
		—	9.90	x	"	=	750,000
1480	11.19						
		—	12.69	x	"	=	970,000
1460	14.18						
		—	16.48	x	"	=	1,250,000
1440	18.77						
		—	21.58	x	"	=	1,640,000
1420	24.39						
		—	27.35	x	"	=	2,080,000
1400	30.30						
		—	34.98	x	"	=	2,660,000
1380	39.66						
		—	44.08	x	"	=	3,350,000
1360	48.50						
		—	53.18	x	"	=	4,050,000
1340	57.85						
		—	61.78	x	"	=	4,700,000
1320	65.71						
		—	68.47	x	"	=	5,210,000
1300	71.22						
		—	75.02	x	"	=	5,710,000
1280	78.82						
		—	78.47	x	"	=	5,970,000
1260	78.11						
		—	78.89	x	"	=	6,000,000
1240	79.66						
		—	79.29	x	"	=	6,030,000
1220	78.91						
		—	79.12	x	"	=	6,020,000
1200	79.32						
		—	79.26	x	"	=	6,030,000
1180	79.20						
		—	78.86	x	"	=	6,000,000
1160	78.51						
		—	77.48	x	"	=	5,900,000
1140	76.45						
		—	74.67	x	"	=	5,680,000
1120	72.89						
		—	69.42	x	"	=	5,280,000
1100	65.94						
		—	55.90	x	"	=	4,250,000
1080	45.86						
		—	38.60	x	"	=	2,940,000
1060	31.34						
					TOTAL SECTOR U	=	93,730,000

TOTAL RESOURCES - SECTOR U =
94 MILLION TONS (MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR U =
0 TONS

SECTOR V - MORAGA FORMATION BASALT - ORINDA DEPOSIT

Plate 2.19 Oakland East Quadrangle MRZ-2(e) Sector Plate 2.60

Sector V encompasses a deposit of Moraga Formation basalt and andesite located on the hill south of Orinda and east of Highway 24. This deposit has been quarried in the past, probably in connection with the construction of Highway 24 and BART, but at the present time there are no active quarries. The basalt and andesite are suitable for ballast, asphaltic concrete aggregate, and road base material. Although not observed in the field, volcanic tuff and sedimentary rocks may exist within the deposit, and would be suitable only for fill.

Resources in Sector V are given in the table below. Factors used in calculating resources included the following items:

1. Sector V contains Moraga Formation basalt and andesite. It is assumed that the lava flows are uniform in composition (no tuff or sedimentary rocks exist above the projected contact).

2. The basalt and andesite are suitable for asphaltic concrete aggregate and road base material.

3. There is no waste and overburden can be sold for fill.

4. Wall slopes would have a ratio of 2:1 (horizontal to vertical).

5. Minimum quarry elevation would be 780 feet.

6. Ground water would not pose a problem to quarry operations.

7. A conversion factor of 11.45 cubic feet of material per ton was used in calculating resources. This factor is based on density tests performed on similar material in Sector T.

8. Base map for resource calculations is the 1973 edition of the Oakland East 7.5 minute quadrangle. No allowance is made for material mined since the map was released, since it is small in comparison to the total resource, and would reveal proprietary data.

RESOURCES – SECTOR V

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1200	.34						
		—	.95	x	(20)(43,560) / 11.45	=	70,000
1180	1.55						
		—	2.27	x	"	=	170,000
1160	2.98						
		—	3.56	x	"	=	270,000
1140	4.13						
		—	4.97	x	"	=	380,000
1120	5.80						
		—	6.95	x	"	=	530,000
1100	8.09						
		—	9.21	x	"	=	700,000
1080	10.33						
		—	11.60	x	"	=	880,000
1060	12.86						
		—	14.44	x	"	=	1,100,000
1040	16.01						
		—	17.97	x	"	=	1,370,000
1020	19.92						
		—	22.62	x	"	=	1,720,000
1000	25.31						
		—	27.15	x	"	=	2,070,000
980	28.98						
		—	31.05	x	"	=	2,360,000
960	33.12						

RESOURCES – SECTOR V (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
		—	34.50	X	(20)(43,560)/11.45	=	2,630,000
940	35.87						
		—	36.76	X	"	=	2,800,000
920	37.65						
		—	36.62	X	"	=	2,790,000
900	35.58						
		—	33.81	X	"	=	2,570,000
880	32.03						
		—	28.87	X	"	=	2,200,000
860	25.71						
		—	23.48	X	"	=	1,790,000
840	21.24						
		—	19.15	X	"	=	1,460,000
820	17.05						
		—	13.49	X	"	=	1,030,000
800	9.93						
		—	5.71	X	"	=	430,000
780	1.49						
					TOTAL SECTOR V	=	29,320,000

TOTAL RESOURCES - SECTOR V =
29 MILLION TONS (MIXED NON-PCC GRADES)

TOTAL RESERVES - SECTOR V =
0 TONS

SECTOR W - FRANCISCAN COMPLEX SANDSTONE - RICHMOND DEPOSIT

Plate 2.22	Richmond Quadrangle	MRZ-2(e)	Sector Plate 2.63
Plate 2.35	San Quentin Quadrangle	MRZ-2(a)	Sector Plate 2.64

Sector W consists of 3 portions (Sectors W-1, W-2, and W-3) of the 500-foot high ridge at the western end of the City of Richmond. This ridge contains sandstone and shale of the Franciscan Complex, and has four existing quarries on it, three of which are inactive. The active quarry is the Point Molate Quarry of Quarry Products, Inc. (Sector W-2). Reserve figures for this sector are proprietary but are included with other company-controlled data in Table 2.12. Franciscan sandstone from this quarry is suitable for asphaltic concrete aggregate and perhaps P.C.C. aggregate.

Resources of Sector W are given in the tables below. Factors used in calculating resources included the following items:

1. The ridge forming Sectors W-1, W-2, and W-3 is underlain by sandstone and interbedded shale of the Franciscan Complex.

2. The sandstone is suitable for asphaltic concrete aggregate and perhaps P.C.C. aggregate.

3. There is no waste since the shale may be suitable for processing into lightweight aggregate (Burnett, 1965, p. 13).

4. Quarry floor elevation would be the 20 foot contour.

5. Wall slopes would have a 2:1 ratio (horizontal to vertical).

6. Ground water would not pose a problem to quarry operations.

7. A conversion factor of 11.64 cubic feet of material per ton was used in calculating resources. This factor is based on density tests performed on typical samples of Franciscan sandstone.

8. Base maps for resource calculations are 4:1 enlargements of the 1973 edition of the Richmond 7.5 minute quadrangle and the 1968 edition of the San Quentin 7.5 minute quadrangle.

Sector W-2 - Quarry Products, Inc., - Point Molate Quarry

Sector W-2 encompasses the property leased by Quarry Products, Inc. Reserve data within Sector W-2 are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

Sector W-3 - Point Richmond Deposit

This sector is bisected by an underground gas line owned by Pacific Gas and Electric Company. The resource calculations are based on the assumption that P.G. & E would prefer to leave the gas line in place. The resource calculations are divided into two tables; one for the east side, and one for the west side. An inactive quarry leased by Quarry Products, Inc. is located near the eastern end of this sector.

RESOURCES – SECTOR W

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR W-1 - Point San Pablo Deposit							
320	.69						
		—	1.44	X	(20)(43,560)/11.64	=	110,000
300	2.18						
		—	3.24	X	"	=	240,000
280	4.30						
		—	5.71	X	"	=	430,000
260	7.12						
		—	8.96	X	"	=	670,000
240	10.79						
		—	12.17	X	"	=	910,000
220	13.55						
		—	16.22	X	"	=	1,210,000
200	18.88						
		—	20.78	X	"	=	1,560,000
180	22.67						
		—	25.05	X	"	=	1,870,000
160	27.43						
		—	30.02	X	"	=	2,250,000
140	32.60						
		—	35.30	X	"	=	2,640,000
120	37.99						
		—	41.30	X	"	=	3,090,000
100	44.60						
		—	48.99	X	"	=	3,670,000
80	53.38						
		—	57.37	X	"	=	4,290,000
60	61.35						
		—	65.60	X	"	=	4,910,000
40	69.85						
		—	75.25	X	"	=	5,630,000
20	80.64						
					TOTAL SECTOR W-1	=	33,480,000
SECTOR W-3 - East side Of Sector W-3							
300	2.98						
		—	3.96	X	(20)(43,560)/11.64	=	300,000
280	4.94						
		—	5.86	X	"	=	440,000
260	6.77						
		—	7.86	X	"	=	590,000
240	8.95						
		—	9.96	X	"	=	750,000
220	10.96						
		—	12.08	X	"	=	900,000
200	13.20						
		—	15.04	X	"	=	1,130,000
180	16.87						
		—	18.54	X	"	=	1,390,000
160	20.20						
		—	21.61	X	"	=	1,620,000
140	23.01						
		—	23.65	X	"	=	1,770,000
120	24.28						
		—	24.83	X	"	=	1,860,000
100	25.37						

RESOURCES – SECTOR W (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
100	25.37						
		—	27.58	X	(20)(43,560) / 11.64	=	2,060,000
80	29.79						
		—	30.25	X	"	=	2,260,000
60	30.71						
		—	31.43	X	"	=	2,350,000
40	32.14						
		—	32.80	X	"	=	2,450,000
20	33.46						
			TOTAL SECTOR W-3 (east side)			=	19,870,000
SECTOR W - West side Of Sector W-3							
300	2.35						
		—	5.02	X	(20)(43,560) / 11.64	=	380,000
280	7.69						
		—	9.13	X	"	=	680,000
260	10.56						
		—	12.08	X	"	=	900,000
240	13.60						
		—	15.41	X	"	=	1,150,000
220	17.22						
		—	19.12	X	"	=	1,430,000
200	21.01						
		—	23.11	X	"	=	1,730,000
180	25.20						
		—	26.78	X	"	=	2,000,000
160	28.35						
		—	30.82	X	"	=	2,310,000
140	33.29						
		—	35.16	X	"	=	2,630,000
120	37.02						
		—	39.12	X	"	=	2,930,000
100	41.21						
		—	44.00	X	"	=	3,290,000
80	46.78						
		—	49.79	X	"	=	3,730,000
60	52.80						
		—	53.72	X	"	=	4,020,000
40	54.64						
		—	54.27	X	"	=	4,060,000
20	53.89						
			TOTAL SECTOR W-3 (west side)			=	31,240,000
			TOTAL SECTOR W-3			=	51,110,000

TOTAL RESOURCES - SECTOR W =
GREATER THAN 85 MILLION TONS
(ALL ASPHALTIC AGGREGATE GRADE)

TOTAL RESERVES - SECTOR W =
(PROPRIETARY DATA)

SECTOR X - FRANCISCAN COMPLEX SANDSTONE - SAN BRUNO MOUNTAIN

Plate 2.42 San Francisco South Quad. MRZ-2(a) Sector Plate 2.65

This immense deposit of sandstone lies immediately south of the City of San Francisco. There is one active quarry (Quarry Products, Inc.'s Guadalupe Quarry), one active fill-sand pit (Colma Sand Pit), and several inactive quarries located around the mountain. Sandstone has been quarried from San Bruno Mountain for P.C.C. aggregate and asphaltic concrete aggregate since the turn of the century (Aubury, 1906, p. 323).

Sector X is limited to the property owned by Quarry Products, Inc. Reserve data within Sector X are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR X =
(PROPRIETARY DATA, ALL ASPHALTIC AGGREGATE GRADE)

TOTAL RESERVES - SECTOR X =
(PROPRIETARY DATA)

SECTOR Y - FRANCISCAN COMPLEX GREENSTONE AND CALERA LIMESTONE - ROCKAWAY BEACH

Plate 2.39 Montara Mountain Quad. MRZ-2(a) Sector Plate 2.66

Sector Y consists of a west-trending ridge on the north side of Calera Valley in Pacifica (San Mateo County). The deposit contains greenstone of the Franciscan Complex and associated Calera Limestone. The limestone and greenstone are currently quarried for P.C.C. aggregate and asphaltic concrete aggregate at the Rockaway Beach Quarry of Quarry Products, Inc. Reserve data for this quarry is proprietary and cannot be discussed here but is included with other company-controlled data in Table 2.12. An inactive quarry lies north of the Rockaway Beach quarry.

Resources for Sector Y are given in the table below. Factors used in calculating resources included the following items:

1. The deposit consists of Franciscan Complex greenstone and Calera Limestone.
2. The material, when fresh, is suitable for P.C.C. aggregate and asphaltic concrete aggregate.
3. There is no waste.
4. All material above the 100-feet elevation would be quarried for aggregate.
5. Ground water is not expected to pose any problems to quarry operations.
6. A conversion factor of 11.40 cubic feet material per ton was used. This factor is based on results of density tests performed upon samples from the Quarry Products, Inc. quarry in this sector.
7. Base map for resource calculations is a 2:1 enlargement of the 1968 edition of the Montara Mountain 7.5 minute quadrangle. Allowance was not made for aggregate mined since the map was released since it is small in comparison to the total resource, and would reveal proprietary data.

RESOURCES – SECTOR Y

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
300	3.03						
		—	5.96	X	(25)(43,560) / 11.40	=	570,000
275	8.88						
		—	13.29	X	"	=	1,270,000
250	17.70						
		—	23.07	X	"	=	2,200,000
225	28.44						
		—	34.06	X	"	=	3,250,000
200	39.67						
		—	46.84	X	"	=	4,470,000
175	54.00						
		—	61.58	X	"	=	5,880,000
150	69.15						
		—	78.86	X	"	=	7,550,000
125	88.57						
		—	98.83	X	"	=	9,440,000
100	109.09						
					TOTAL SECTOR Y	=	34,630,000

TOTAL RESOURCES - SECTOR Y =
35 MILLION TONS (MIXED AGGREGATE GRADES)

TOTAL RESERVES - SECTOR Y =
(PROPRIETARY DATA)

SECTOR Z - FRANCISCAN COMPLEX GREENSTONE - NEARY QUARRY DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(a) Sector Plate 2.68
Plate 2.38 Mindego Hill Quadrangle MRZ-2(a) Sector Plate 2.67

Sector Z is located in the foothills on the west side of the Santa Clara Valley and is underlain by greenstone and metatuff of the Franciscan Complex. Patton Brothers, Inc. produces road base and fill material from this deposit at the Neary Quarry. Reserve data within Sector Z are proprietary and cannot be discussed here but is included with other company-controlled data in Table 2.12. The greenstone (altered basalt) is greenish-gray to dark gray in color and badly shattered by several northeast-trending faults that traverse the deposit. Several zones of green metatuff are contained in the deposit.

Resources in Sector Z are given in the table below. Factors used in calculating resources included the following items:

1. All resource material within Sector Z is assumed to be Franciscan Complex greenstone.
2. The greenstone is suitable for road base material and probably for asphaltic concrete aggregate.
3. There is no waste.
4. Quarry wall slopes would have a ratio of 2:1 (horizontal to vertical).
5. Minimum quarry elevation would be 600 feet.
6. Ground water table elevation is approximately 350 feet at the Neary Quarry, so water would not pose a problem to mining.
7. A conversion factor of 10.68 cubic feet of material per ton was used in calculating resources. This factor is based on results of density tests performed on samples from Sector D (Apperson Ridge).
8. Base maps for resource calculations are 4:1 enlargements of the Cupertino and Mindego Hill 7.5 minute quadrangle (1973 and 1968, respectively).

RESOURCES – SECTOR Z

CONTOUR ELEVATION	AREA (acres)	AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
880	2.87					
		11.25	x	(40)(43,560) / 10.68	=	1,840,000
840	19.63					
		23.76	x	"	=	3,880,000
800	27.89					
		30.62	x	"	=	5,000,000
760	33.35					
		35.27	x	"	=	5,750,000
720	37.19					
		38.68	x	"	=	6,310,000
680	40.17					
		41.35	x	"	=	6,750,000
640	42.53					
		44.31	x	"	=	7,230,000
600	46.09					
				TOTAL SECTOR Z	=	36,760,000

TOTAL RESOURCES - SECTOR Z =
37 MILLION TONS (ALL ROADBASE GRADE)
TOTAL RESERVES - SECTOR Z =
(PROPRIETARY DATA)

SECTOR BB - CALERA LIMESTONE AND FRANCISCAN COMPLEX GREENSTONE - PERMANENTE DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(d) Sector Plate 2.68

Sector BB contains a large body of Calera Limestone with smaller bodies of greenstone of the Franciscan Complex. Most of the sector is owned or controlled by the Kaiser Cement Corporation, and the limestone is used in production of Portland cement. Limestone unsuitable for cement is crushed and sold for P.C.C. aggregate. Some of the greenstone is sold for road base material, although it appears suitable for asphaltic concrete aggregate. The weathered material and soil can be sold for fill. Although aggregate is a by-product of the cement operation, sufficient low-grade limestone is present to warrant an MRZ-2 classification. Reserve data within Sector BB are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR BB =
(PROPRIETARY DATA, ALL PCC GRADE)
TOTAL RESERVES - SECTOR BB =
(PROPRIETARY DATA)

SECTOR CC - FRANCISCAN COMPLEX GREENSTONE - STEVENS CREEK QUARRY DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(e) Sector Plate 2.68

Sector CC lies near the southern end of a large body of greenstone that extends northwesterly across the quadrangle. The greenish-black greenstone (altered basalt) of the Franciscan Complex, where exposed at several quarries, shows pillow structure suggestive of submarine lava flows. No volcanic tuff, which is suitable only for fill, was found within the sector. Two active and at least three inactive quarries are found in the sector. Stevens Creek Quarry, Inc. is located at the southern end of Sector CC. A power-line easement passes diagonally across property owned by Stevens Creek Quarry, Inc.. Reserve data is proprietary and is included with other company-controlled reserves in Table 2.12.

Resources in Sector CC are given in the tables below. Factors used in calculating resources included the following items:

1. The material in Sector CC is greenstone of the Franciscan Complex.
2. The greenstone is suitable for asphaltic concrete aggregate and probably P.C.C. aggregate.
3. There is no waste.
4. Wall slopes would have a ratio of 2:1 (horizontal to vertical).
5. Minimum quarry elevation would be 800 feet. There would be a bench at elevation 1000.
6. Ground water should not pose a problem to mining.
7. A conversion factor of 11.05 cubic feet of material per ton was used in calculating resources. This factor is based on results of density tests performed on greenstone samples from Sector CC.

8. Base map for resource calculations is a 4:1 enlargement of the 1973 edition of the Cupertino 7.5 minute quadrangle. No allowance is made for material mined since the map was released, since it is small in comparison to the total resource, and would reveal proprietary data.

RESOURCES – SECTOR CC

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
1600	.63						
		—	2.10	X	(40)(43,560) / 11.05	=	330,000
1560	3.56						
		—	7.81	X	"	=	1,230,000
1520	12.05						
		—	18.05	X	"	=	2,850,000
1480	24.05						
		—	29.25	X	"	=	4,610,000
1440	34.44						
		—	40.24	X	"	=	6,350,000
1400	46.03						
		—	50.77	X	"	=	8,010,000
1360	55.50						
		—	61.36	X	"	=	9,680,000
1320	67.21						
		—	72.43	X	"	=	11,420,000
1280	77.65						
		—	84.08	X	"	=	13,260,000
1240	90.51						
		—	95.88	X	"	=	15,120,000
1200	101.24						
		—	101.07	X	"	=	15,940,000
1160	100.89						
		—	100.69	X	"	=	15,880,000
1120	100.49						
		—	98.17	X	"	=	15,480,000
1080	95.85						
		—	92.03	X	"	=	14,510,000
1040	88.21						
		—	83.68	X	"	=	13,190,000
1000	79.14						
Bench							
1000	75.82						
		—	70.63	X	"	=	11,140,000
960	65.43						
		—	59.20	X	"	=	9,330,000
920	52.97						
		—	47.92	X	"	=	7,560,000
880	42.87						
		—	37.42	X	"	=	5,900,000
840	31.97						
		—	26.58	X	"	=	4,190,000
800	21.18						
					TOTAL SECTOR CC	=	185,980,000

TOTAL RESOURCES - SECTOR CC =
186 MILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)

TOTAL RESERVES - SECTOR CC =
(PROPRIETARY DATA)

SECTOR EE - FRANCISCAN COMPLEX MELANGE AND SERPENTINITE - HILLSDALE DEPOSIT

Plate 2.49 San Jose East Quadrangle MRZ-2(a) Sector Plate 2.69

Sector EE consists of portions of the central and south hills (Sectors EE-1 and EE-2) of the three Hillsdale Hills in south San Jose. The sector is underlain by melange of the Franciscan Complex and associated serpentinite and silica-carbonate rock, and each of the two hills contains an active quarry (A. J. Raisch Paving Company in Sector EE-1, and Hillsdale Rock Company in Sector EE-2). Reserve data within Sector EE-2 are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12. Sandstone within the melange is suitable for asphaltic concrete aggregate and the serpentinite is suitable for fill and perhaps subbase material.

Resources in Sector EE-1 are given in the table below. Factors used in calculating resources included the following items:

1. Resource material within Sector EE-1 consists of Franciscan Complex melange and associated serpentinite.
2. Sandstone within the melange is suitable for asphaltic concrete aggregate, while the sheared matrix of the melange and the serpentinite and silica carbonate rock are suitable for road base, subbase, or fill material.
3. There is no waste.
4. Base level for the quarries would be at an elevation of 160 feet.
5. Quarry wall slopes would have a ratio of 2:1 (horizontal to vertical).
6. Ground water would not be expected to pose a problem to mining.
7. A conversion factor of 13.50 cubic feet of material per ton was used in calculating resources. This factor is based on results of density tests performed on samples from Sector EE.
8. Base map for resource calculations is a 4:1 enlargement of the 1973 edition of the San Jose East 7.5 minute quadrangle. An allowance was made for material that has been mined from Sector EE-1 since the map was released.

RESOURCES – SECTOR EE

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 10,000 tons)
SECTOR EE-1							
400	6.08						
		—	18.22	X	(20)(43,560) / 13.50	=	1,180,000
380	30.36						
		—	44.40	X	"	=	2,870,000
360	58.43						
		—	70.60	X	"	=	4,560,000
340	82.76						
		—	92.40	X	"	=	5,960,000
320	102.04						
		—	110.19	X	"	=	7,110,000
300	118.34						
		—	127.01	X	"	=	8,200,000
280	135.68						
		—	143.51	X	"	=	9,260,000
260	151.34						
		—	157.74	X	"	=	10,180,000
240	164.14						
		—	169.02	X	"	=	10,910,000
220	173.90						
		—	178.75	X	"	=	11,540,000
200	183.60						
		—	188.51	X	"	=	12,170,000
180	193.41						
		—	197.63	X	"	=	12,750,000
160	201.85						
					TOTAL SECTOR EE-1	=	96,690,000

TOTAL RESOURCES - SECTOR EE =
MORE THAN 97 MILLION TONS, (MIXED NON-PCC GRADE)

TOTAL RESERVES - SECTOR EE =
(PROPRIETARY DATA)

SECTOR FF - FRANCISCAN COMPLEX SANDSTONE - SANTA TERESA HILLS

Plate 2.51 Santa Teresa Hills Quad. MRZ-2(a) Sector Plate 2.70

Sector FF is located at the north end of the Santa Teresa Hills at the north end of Almaden Valley, and is the site of the active Piazza Quarry. Resource material in Sector FF consists of sandstone and interbedded shale of the Franciscan Complex. The sandstone is suitable for asphaltic concrete aggregate, while the shale and weathered sandstone are suitable for fill and perhaps subbase material.

Resources at Sector FF are limited, as urbanization has encroached on all sides of the quarry. The rock being mined is sold for riprap by Granite Construction Company. Reserve data within Sector FF are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR FF =
(PROPRIETARY DATA, MIXED NON-PCC GRADES)
TOTAL RESERVES - SECTOR FF =
(PROPRIETARY DATA)

Resource Sectors Outside of the Urbanizing Areas

In the South San Francisco Bay P-C Region there are three significant quarries that lie outside of the OPR urbanizing areas. Since their production has been included in reserve projections for the P-C region, and these quarries meet threshold value, they have been included as sectors and are described below.

SECTOR GG - DOMENGINE SANDSTONE - RIDGEMOOR QUARRY DEPOSIT

Plate 2.28	Brentwood Quadrangle	MRZ-2(a)	Sector Plate 2.71
Plate 2.8	Byron Hot Springs Quad.	MRZ-2(a)	Sector Plate 2.72

This sector is located 3.5 miles south of Brentwood and 3 miles northwest of Byron, on the east side of Mt. Diablo. The property is underlain by sandstone of the Domengine Formation (Eocene), whose beds strike northwest and dip northeast in the sector. The sandstone is poorly consolidated, finegrained, and massive, with beds up to several tens of feet thick. Ridgemoor Development Company has operated the quarry since 1974. Products from the quarry are P.C.C.-grade sand, asphaltic concrete sand, and fill.

Reserve data within Sector GG are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR GG =
(PROPRIETARY DATA, ALL PCC GRADE)
TOTAL RESERVES - SECTOR GG =
(PROPRIETARY DATA)

SECTOR HH - MONTARA QUARTZ DIORITE - PILLARCITOS QUARRY DEPOSIT

Plate 2.37	Half Moon Bay Quad.	MRZ-2(a)	Sector Plate 2.73
Plate 2.39	Montara Mountain Quad.	MRZ-2(c)	Sector Plate 2.66

Sector HH is located in Nuff Creek drainage, approximately 2.5 miles northeast of Half Moon Bay and about one mile north of San Mateo-Half Moon Bay Road (State Highway 92). The quarry is operated by Lone Star Industries. The area is underlain by rocks that range from granite to quartz diorite. The rock is fractured, deeply weathered in the upper part of the quarry although relatively fresh at depth, and is locally massive. Products of this operation are sand (granite fines), base, subbase, and fill.

Reserve data within Sector HH are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR HH =
(PROPRIETARY DATA, ALL ROADBASE GRADE)
TOTAL RESERVES - SECTOR HH =
(PROPRIETARY DATA)

SECTOR II - FRANCISCAN COMPLEX SANDSTONE - LEXINGTON QUARRY DEPOSIT

Plate 2.48	Los Gatos Quadrangle	MRZ-2(a)	Sector Plate 2.74

This sector is located near Limekiln Canyon, about one mile south of Los Gatos via Highway 17, near Lexington Reservoir. The quarry lies within a large northwest-trending deposit of sandstone and siltstone of the Franciscan Complex. The quarry was first worked in 1962, and is now operated by Hillsdale Rock Company. Although the sandstone may be suitable for asphaltic concrete aggregate, the rock products obtained from this quarry are mainly road base, quarry fines, and fill.

Reserve data within Sector II are proprietary and cannot be discussed here. The amount of reserves in this sector are included with those of other company-controlled deposits in Table 2.12.

TOTAL RESOURCES - SECTOR II =
(PROPRIETARY DATA, ALL ROADBASE GRADE)
TOTAL RESERVES - SECTOR II =
(PROPRIETARY DATA)

Resource Sectors Within Parks

It is recognized that dedicated parklands have special status as opposed to other current uses of sectorized land, consequently the resources within parks have been sectorized separately below, and the quantification of those resources are presented separately in the tables. The quantification of resources within park sectors are expressed to a lower degree of accuracy rather than to the higher level of accuracy reflected in the previous sections.

SECTOR JJ - QUATERNARY ALLUVIUM - ROBERTSON PARK

Plate 2.14	Livermore Quadrangle	MRZ-2(a)	Sector Plate 2.52

Sector JJ consists of the undeveloped areas of Robertson Park, in southwestern Livermore. The sector contains two parts: JJ-1 and JJ-2. Both sectors lie immediately south of College Avenue along Arroyo Mocho Creek, and are separated by Arroyo Road. This sector is underlain by alluvial sand and gravel typical of the Livermore - Amador Valley as described above in Sectors A and B.

Resources of sand and gravel within Sector JJ are given in the tables below. Factors used in calculating the amount of resources included the following items:

1. Resource material is Quaternary sand and gravel within the upper aquifer in the Livermore Valley.

2. Sand and gravel present in the aquifer is suitable for P.C.C. aggregate.

3. Waste is 10 percent of the total material.

4. The thickness of sand and gravel is 30 feet, and there is no overburden.

5. Wall slopes would have a ratio of 2:1 (horizontal to vertical).

6. Depth to ground water in Sector JJ is not known.

7. A conversion factor of 14.50 cubic feet of material per ton is used (see Sector A, item #7).

8. Base map for resource calculations is the Livermore 7.5 minute quadrangle (1980).

RESOURCES - SECTOR JJ

DEPTH BELOW SURFACE	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS		TONNAGE = (To nearest 100,000 tons)
SECTOR JJ-1							
Surface	44.08	--	44.08	X	(5)(43,560)(.90) / 14.50	=	600,000
-5 feet	44.08	--	32.10	X	(25)(43,560)(.90) / 14.50	=	2,200,000
-30 feet	20.11						
					TOTAL SECTOR JJ-1	=	2,800,000
SECTOR JJ-2							
Surface	64.74	--	64.74	X	(5)(43,560)(.90) / 14.50	=	900,000
-5 feet	64.74	--	49.31	X	(25)(43,560)(.90) / 14.50	=	3,300,000
-30 feet	33.88						
					TOTAL SECTOR JJ-2	=	4,200,000

TOTAL RESOURCES - SECTOR JJ =
7 MILLION TONS (ALL PCC GRADE)

TOTAL RESERVES - SECTOR JJ =
0 TONS

SECTOR KK - QUATERNARY ALLUVIUM - ALAMEDA CREEK QUARRIES REGIONAL PARK

Plate 2.17	Newark Quadrangle	MRZ-2(a)	Sector Plate 2.56
Plate 2.18	Niles Quadrangle	MRZ-2(a)	Sector Plate 2.55

Sector KK is located west of Mission Boulevard (Highway 238) and north of Peralta Avenue (Highway 84) in the City of Fremont, and is part of Alameda Creek Quarries Regional Park. This sector is situated adjacent to Sector F on the Niles Cone, a large delta at the mouth of Niles Canyon on Alameda Creek, and includes several former gravel pits. The sector is divided into two parts, KK-1 and KK-2, and includes both undisturbed material and the levees that separate the former gravel pits. See Sector F, p. 19, for a description of the material.

Resources of sand and gravel within Sector KK are given in the tables below. Factors used in calculating the amount of resources included the following items:

1. Resource material is Quaternary sand and gravel lying within aquifers in the Niles Cone.

2. All sand and gravel within the sector is suitable for P.C.C. aggregate.

3. Waste is equal to 10 percent of the total material.

4. The thickness of sand and gravel is 40 feet, and there is 30 feet of overburden.

5. Wall slopes were not considered in Sector KK-1 (the former gravel pit area) but have a ratio of 2:1 (horizontal to vertical) in Sector KK-2.

6. Sector KK-2 is divided into two pits; the larger pit is Pit A, and the smaller pit is Pit B.

7. Depth to ground water in Sector KK is approximately 30 feet.

8. A conversion factor of 14.50 cubic feet of material per ton is used (see Sector A, item #7).

9. Base maps for resource calculations are the Newark and Niles 7.5 minute quadrangles (1980).

RESOURCES - SECTOR KK

DEPTH BELOW SURFACE	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS		TONNAGE = (To nearest 100,000 tons)
SECTOR KK-1							
-30 feet	93.66	--	93.66	X	(40)(43,560)(.90) / 14.50	=	10,100,000
-70 feet	93.66						
					TOTAL SECTOR KK-1	=	10,100,000
SECTOR KK-2							
Pit A							
-30 feet	14.60	--	11.16	X	(40)(43,560)(.90) / 14.50	=	1,200,000
-70 feet	7.71						
					TOTAL	=	1,200,000
Pit B							
-30 feet	6.89	--	4.83	X	(40)(43,560)(.90) / 14.50	=	500,000
-70 feet	2.76						
					TOTAL	=	500,000
					TOTAL SECTOR KK-2	=	1,700,000

TOTAL RESOURCES - SECTOR KK =
12 MILLION TONS (ALL PCC GRADE)

TOTAL RESERVES - SECTOR KK =
0 TONS

SECTOR LL - BRIONES FORMATION SANDSTONE - MISSION PEAK REGIONAL PARK

Plate 2.18	Niles Quadrangle	MRZ-2(c)	Sector Plate 2.55

This sector contains the portion of Mission Peak Regional Park within the OPR zone, in the Mission San Jose District of the City of Fremont, and lies between Sectors H and I. All three sectors are underlain by the same material - Briones Formation sandstone - and are portions of the same large deposit. Sector LL consists of two parts, LL-1 and LL-2.

Resources in Sector LL are given in the table below. Factors used in calculating the resources included the following items:

1. Resource material is Briones Formation sandstone.

2. The sandstone is suitable for roadbase and perhaps asphaltic concrete aggregate.

3. There is no waste and overburden can be sold for fill.

4. Wall slopes have a 2:1 ratio (horizontal to vertical).

5. Base elevation of the quarry would be 800 feet in Sector LL-1, and 400 feet in Sector LL-2.

6. Ground water is not expected to hinder quarry operations.

7. A conversion factor of 13.70 cubic feet of material per ton is used in resource calculations. This figure is based on density tests performed on sample of Briones Formation sandstone from the inactive Serpa Quarry in Milpitas (Santa Clara County).

8. Base map for resource calculations was the Niles 7.5 minute quadrangle (1980).

RESOURCES - SECTOR LL

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
SECTOR LL - 1							
1200	32.14						
		—	102.39	X	(200)(43,560) / 13.70	=	65,100,000
1000	172.64						
		—	163.46	X	"	=	103,900,000
800	154.27						
					TOTAL SECTOR LL -1	=	169,000,000
SECTOR LL - 2							
1000	11.02						
		—	32.60	X	(200)(43,560) / 13.70	=	20,700,000
800	54.18						
		—	83.11	X	"	=	52,800,000
600	112.03						
		—	114.79	X	"	=	73,000,000
400	117.54						
					TOTAL SECTOR LL - 2	=	146,600,000

TOTAL RESOURCES - SECTOR LL =
316 MILLION TONS (ALL ROADBASE GRADE)

TOTAL RESERVES - SECTOR LL =
0 TONS

SECTOR MM - FRANCISCAN COMPLEX - COYOTE HILLS REGIONAL PARK

Plate 2.17 Newark Quadrangle MRZ-2(b) Sector Plate 2.56

Sector MM consists of the northern part of the Coyote Hills located in the western part of Newark. The sector contains three parts: MM-1 (North Hill), MM-2 (the northern half of Central Hill) and MM-3 (South Hill). Material in this sector is the same as within Sector M at the south end of the Coyote Hills: Franciscan Complex chert, graywacke, basalt, diabase, and serpentinite.

Resource calculations for Sector MM are given in the tables below. Factors used in calculating the amount of resources included the following items:

1. Resource material is graywacke, chert, basalt, and diabase of the Franciscan Complex, and Jurassic serpentinite.

2. Some of the material can be used for asphaltic concrete aggregate; the remainder can be used for road base or subbase.

3. There is no waste, and overburden can be sold for fill.

4. The deposit would be quarried down to an elevation of 20 feet. Quarry walls would have a 2:1 slope ratio (horizontal to vertical).

5. Ground water would not present any problems in mining.

6. A conversion factor of 11.54 cubic feet of material per ton was used. This factor is based on file data in a property report for Sector M, which was done during an earlier study by Chesterman and Manson (In press).

7. Base map used for resource calculations is a 2:1 enlargement of the 1973 edition of the Newark 7.5 minute quadrangle.

RESOURCES - SECTOR MM

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
SECTOR MM-1 (North Hill)							
200	17.91						
		—	28.13	X	(40)(43,560) / 11.54	=	4,200,000
160	38.34						
		—	70.72	X	(60)(43,560) / 11.54	=	16,000,000
100	103.09						
		—	162.91	X	(80)(43,560) / 11.54	=	49,200,000
20	222.73						
					TOTAL SECTOR MM-1	=	69,400,000
SECTOR MM-2 (Central Hill)							
220	.21						
		—	.49	X	(20)(43,560) / 11.54	=	- - -
200	.76						
		—	1.24	X	"	=	100,000
180	1.72						
		—	2.17	X	"	=	200,000
160	2.62						
		—	3.14	X	"	=	200,000
140	3.65						
		—	5.75	X	"	=	400,000
120	7.85						
		—	10.57	X	"	=	800,000
100	13.29						
		—	16.01	X	"	=	1,200,000
80	18.73						
		—	21.08	X	"	=	1,600,000
60	23.42						
		—	26.18	X	"	=	2,000,000
40	28.93						
		—	31.68	X	"	=	2,400,000
20	34.43						
					TOTAL SECTOR MM-2	=	8,900,000
SECTOR MM-3 (South Hill)							
140	.46						
		—	1.38	X	(20)(43,560) / 11.54	=	100,000
120	2.30						
		—	3.91	X	"	=	300,000
100	5.51						
		—	6.66	X	"	=	500,000
80	7.81						
		—	9.07	X	"	=	700,000
60	10.33						
		—	11.25	X	"	=	800,000
40	12.17						
		—	13.78	X	"	=	1,000,000
20	15.38						
					TOTAL SECTOR MM-3	=	3,400,000

TOTAL RESOURCES - SECTOR MM =
82 MILLION TONS (MIXED NON-PCC GRADES)

TOTAL RESERVES - SECTOR MM =
0 TONS

SECTOR NN - FRANCISCAN COMPLEX SANDSTONE - SAN BRUNO MOUNTAIN STATE AND COUNTY PARK

Plate 2.42 San Francisco South Quad. MRZ-2(a) Sector Plate 2.65

Sector NN contains most of an immense deposit of sandstone, which lies immediately south of the City of San Francisco. There is one active quarry mining this deposit in the adjacent Sector X (Quarry Products, Inc.'s Guadalupe Quarry),one active fill-sand pit (Colma Sand Pit), and several inactive quarries located around the mountain. Reserve data is proprietary and cannot be presented here but is included with other company-controlled data in Table 2.12. Sandstone has been quarried from San Bruno Mountain for P.C.C. aggregate and asphaltic concrete aggregate since the turn of the century (Aubury, 1906, p. 323).

Sector NN is devided into five parcels: NN-1, NN-2, NN-3, NN-4, and NN-5. Resource calculations for the sector are given in the tables below. Factors used in calculating the resources included the following items:

1. Resource material is sandstone and shale of the Franciscan Complex.
2. The sandstone is suitable for asphaltic concrete aggregate, and perhaps P.C.C. aggregate.
3. There is no waste, since the shale may be suitable for processing into lightweight aggregate (Burnett, 1965, p. 13).
4. Wall slopes have a ratio of 2:1 (horizontal to vertical).
5. Base elevations of the quarries in the five parcels is as follows: NN-1, 400 feet; NN-2, 400 feet; NN-3, 500 feet; NN-4, 300 feet; NN-5, 200 feet.
6. A conversion factor of 12.10 cubic feet of material per ton was used in calculating resources. This factor is based on samples from Sector X.
7. Base map for resource calculations is the San Francisco South 7.5 minute quadrangle (1968).
8. Because Sector X must be mined before Sector NN-4 can be mined, resource totals calculated for Sector NN-4 include all of the resources in Sector X. No allowance was made for material mined since the map was released, since it is insignificant in comparison to the amount of the total resource.

RESOURCES - SECTOR NN

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
SECTOR NN-1							
800	15.61						
		—	71.63	X	(100)(43,560) / 12.10	=	25,800,000
700	127.64						
		—	155.65	X	"	=	56,000,000
600	183.66						
		—	164.38	X	"	=	59,200,000
500	145.09						
		—	121.68	X	"	=	43,800,000
400	98.26						
					TOTAL SECTOR NN-1	=	185,000,000

RESOURCES - SECTOR NN (continued)

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
SECTOR NN-2							
1100	18.37						
		—	42.70	X	(100)(43,560) / 12.10	=	15,400,000
1000	67.03						
		—	95.96	X	"	=	34,500,000
900	124.89						
		—	153.82	X	"	=	55,400,000
800	182.74						
		—	220.85	X	"	=	79,500,000
700	258.95						
		—	271.35	X	"	=	97,700,000
600	283.75						
		—	271.81	X	"	=	97,900,000
500	259.87						
		—	238.29	X	"	=	85,800,000
400	216.71						
					TOTAL SECTOR NN - 2	=	466,200,000
SECTOR NN-3							
1000	2.76						
		—	8.26	X	(100)(43,560) / 12.10	=	3,000,000
900	13.77						
		—	17.91	X	"	=	6,400,000
800	22.04						
		—	28.01	X	"	=	10,100,000
700	33.98						
		—	42.70	X	"	=	15,400,000
600	51.42						
		—	73.46	X	"	=	26,400,000
500	95.50						
					TOTAL SECTOR NN - 3	=	61,300,000
SECTOR NN-4							
1100	16.53						
		—	32.14	X	(100)(43,560) / 12.10	=	11,600,000
1000	47.75						
		—	72.55	X	"	=	26,100,000
900	97.34						
		—	149.68	X	"	=	53,900,000
800	202.02						
		—	230.03	X	"	=	82,800,000
700	258.04						
		—	289.72	X	"	=	104,300,000
600	321.40						
		—	357.67	X	"	=	128,800,000
500	393.94						
		—	429.30	X	"	=	154,500,000
400	464.65						
		—	488.53	X	"	=	175,900,000
300	512.40						
					TOTAL SECTOR NN - 4	=	737,900,000
SECTOR NN-5							
1000	4.59						
		—	12.40	X	(100)(43,560) / 12.10	=	4,500,000
900	20.20						
		—	29.85	X	"	=	10,700,000
800	39.49						
		—	48.67	X	"	=	17,500,000
700	57.85						
		—	68.41	X	"	=	24,600,000
600	78.97						
		—	81.27	X	"	=	29,300,000
500	85.56						
		—	85.40	X	"	=	30,700,000
400	87.24						
		—	88.62	X	"	=	31,900,000
300	89.99						
		—	89.99	X	"	=	32,400,000
200	89.99						
					TOTAL SECTOR NN - 5	=	181,600,000

TOTAL RESOURCES - SECTOR NN =
1.6 BILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR NN =
(PROPRIETARY DATA)

SECTOR OO - FRANCISCAN COMPLEX GREENSTONE - FOOTHILLS PARK

Plate 2.38 Mindego Hill Quadrangle MRZ-2(b) Sector Plate 2.67

Sector OO consists of the extreme western portion of the City of Palo Alto's Foothills Park, and is underlain by Franciscan Complex greenstone and metatuff, similar to material that was quarried for aggregate at the nearby Page Mill Quarry (presently inactive). Several inactive quarries are located within this body of greenstone, which extends at least 10 miles to the southeast. The unweathered greenstone is suitable for roadbase material, and perhaps for asphaltic concrete aggregate and P.C.C. aggregate. Weathered greenstone and the metatuff are suitable only for fill material. The greenstone appears to extend east and southeast of the old Page Mill Quarry site.

Resources in Sector OO are given in the table below. Factors used in calculating resources included the following items:

1. The material within Sector OO is assumed to be greenstone of the Franciscan Complex.
2. Greenstone is suitable for road base material and perhaps for asphaltic concrete aggregate and P.C.C. aggregate.
3. There is no waste.
4. Wall slopes would have a ratio of 2:1 (horizontal to vertical).
5. Minimum quarry elevation would be 600 feet.
6. Ground water is not expected to pose a problem to mining.
7. A conversion factor of 10.68 cubic feet of material per ton was used in calculating resources. This factor is derived from the results of density tests performed on greenstone samples from Sector D, and assumes that the material is uniform throughout the sector (the ratio of metatuff to greenstone is not known).
8. Base map for calculating resources is the Mindego Hill 7.5 minute quadrangle (1968).

RESOURCES – SECTOR OO

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
920	.92						
		—	1.38	X	(40)(43,560) / 10.68	=	200,000
880	1.84						
		—	11.94	X	"	=	1,900,000
840	22.04						
		—	26.63	X	"	=	4,300,000
800	31.22						
		—	32.60	X	"	=	5,300,000
760	33.98						
		—	37.65	X	"	=	6,100,000
720	41.32						
		—	44.54	X	"	=	7,300,000
680	47.75						
		—	47.75	X	"	=	7,800,000
640	47.75						
		—	47.29	X	"	=	7,700,000
600	46.83						
					TOTAL SECTOR OO	=	40,600,000

TOTAL RESOURCES - SECTOR OO =
41 MILLION TONS (ALL ROADBASE GRADE)
TOTAL RESERVES - SECTOR OO =
0 TONS

SECTOR PP - SANTA CLARA FORMATION - STEVENS CREEK COUNTY PARK DEPOSIT

Plate 2.47 Cupertino Quadrangle MRZ-2(b) Sector Plate 2.68

Resource Sector PP is the portion of Stevens Creek County Park that is underlain by conglomerate of the Santa Clara Formation, and is adjacent to Sector AA (see p. 21). See the discussion of Sector AA above for a description of the resource material and the deposit.

Resources in Sector PP are given in the table below. Factors used in calculating resources included the following items:

1. All of the material within Sector PP is conglomerate of the Santa Clara Formation.
2. The unweathered conglomerate is suitable for asphaltic concrete and perhaps P.C.C. aggregate.
3. Overburden and waste factors are lumped together and are considered to amount to 10 percent of the total, due to the lack of test data for the deposit.
4. Wall slopes would be approximately 2:1 (horizontal to vertical).
5. Minimum elevation for the quarry floor would be 400 feet.
6. It is assumed that the resources in Sector AA have been mined prior to excavation in Sector PP.
7. Ground water is not expected to be encountered in the quarry.
8. A conversion factor is 14.50 cubic feet of material per ton was used, due to the similarity of this material to the material found in the Livermore-Amador Valley.
9. Base map for this resource sector is a 4:1 enlargement of the Cupertino 7.5 minute quadrangle (1973).

RESOURCES – SECTOR PP

CONTOUR ELEVATION	AREA (acres)		AVERAGE AREA (acres)	X	CONVERSION FACTORS	=	TONNAGE (To nearest 100,000 tons)
800	1.55						
		—	3.13	X	(40)(43,560)(.90) / 14.50	=	300,000
760	4.71						
		—	8.01	X	"	=	900,000
720	11.31						
		—	18.23	X	"	=	2,000,000
680	25.14						
		—	30.57	X	"	=	3,300,000
640	35.99						
		—	41.70	X	"	=	4,500,000
600	47.41						
		—	52.35	X	"	=	5,700,000
560	57.28						
		—	55.65	X	"	=	6,000,000
520	54.01						
		—	51.23	X	"	=	5,600,000
480	48.44						
		—	45.69	X	"	=	5,000,000
440	42.93						
		—	39.63	X	"	=	4,300,000
400	36.33						
					TOTAL SECTOR PP	=	37,600,000

TOTAL RESOURCES - SECTOR PP =
38 BILLION TONS (ALL ASPHALTIC AGGREGATE GRADE)
TOTAL RESERVES - SECTOR PP =
0 TONS

ESTIMATED 50-YEAR CONSUMPTION OF AGGREGATE

The total projected aggregate consumption through the year 2030 in the South San Francisco Bay P-C Region is estimated to be 1,490 million tons. This figure was obtained by correlating production records and population data to compute a per capita consumption rate, then using this consumption rate and population projections to make the 50-year estimate. Comparison of the permitted reserves total and the estimated consumption shows that permitted reserves amount to only 37 percent of the future consumption. Based upon the per capita use rate, all existing aggregate reserves will be depleted by the year 1999, unless additional resources are permitted for mining or are imported.

Since Portland cement concrete (P.C.C.) is a widely used construction material in our society, it is necessary that suitable aggregate be available in sufficient quantities. According to production statistics for the period 1953-1980, an average of 39 per cent of the total aggregate consumed annually in the South San Francisco Bay P-C Region was used in Portland cement concrete or concrete products (Table 2.13). Of this concrete aggregate, sand and gravel comprises 87 percent while the remainder is crushed stone.

The total projected P.C.C.-grade aggregate consumption through the year 2030 in the South San Francisco Bay P-C Region is estimated to be 580 million tons. This is based on an average annual per-capita consumption rate for P.C.C.-grade aggregate of 2.3 tons per person per year (39% of total per capita consumption). As shown in Table 2.13, 313 million tons of permitted reserves in the region meet P.C.C. aggregate specifications, which amounts to only 54 percent of the anticipated consumption.

If all reserves suitable for use as P.C.C. aggregate are utilized for that purpose, P.C.C.-grade reserves will be depleted in 20 years (2007). However, typical marketing practice in the aggregate industry shows that some of the P.C.C. production will be used for non-P.C.C. applications. It is probable that this practice will continue, and that P.C.C. reserves could be depleted in a shorter time period. P.C.C. reserves, because of their high quality requirements, will be the most difficult to replace as existing permitted deposits are depleted.

It is important to realize that new P.C.C. as well as non-P.C.C. resources will need to come into production to meet the 50-year aggregate demands in this P-C Region.

Population Records

Population records were compiled and correlated with aggregate consumption records for the period 1953-1980 for the South San Francisco Bay P-C Region (Figures 2.3 and 2.4, Table 2.15). Records of population and aggregate consumption for this period were compiled for two adjacent regions: North San Francisco Bay and Monterey Bay P-C regions (Figures 2.5 - 2.9). Population records for the three P-C regions were compiled from publications of the California Department of Finance (no date, 1969, 1977a, 1977b, 1980a, 1980b, 1981, 1982a, 1982b). Population projections for the years 1980-2020 were made using projec-

Table 2.14 Percentage of total aggregate consumption used for Portland cement concrete (PCC) aggregate in the South San Francisco Bay P-C Region during the period 1953-1980.

YEAR	P.C.C. AGGREGATE CONSUMED (Tons)	TOTAL AGGREGATE CONSUMED (Tons)	PERCENT OF TOTAL AGGREGATE CONSUMPTION USED AS P.C.C. AGGREGATE
1953	4,750,000	10,684,000	44.5
1954	4,604,000	10,066,000	45.7
1955	6,369,000	13,343,000	47.7
1956	7,421,000	19,296,000	38.5
1957	6,507,000	14,363,000	45.3
1958	6,871,000	15,519,000	44.3
1959	7,047,000	16,066,000	43.9
1960	6,004,000	15,575,000	38.5
1961	6,599,000	16,659,000	39.6
1962	6,508,000	17,800,000	36.6
1963	7,984,000	22,250,000	35.9
1964	8,350,000	24,099,000	34.6
1965	8,603,000	25,603,000	33.6
1966	8,590,000	23,389,000	36.7
1967	6,504,000	24,645,000	26.4
1968	9,932,000	26,914,000	36.9
1969	11,735,000	30,517,000	38.5
1970	10,088,000	24,683,000	40.9
1971	12,251,000	29,615,000	41.4
1972	8,719,000	23,140,000	37.7
1973	9,536,000	24,751,000	38.5
1974	10,941,000	25,611,000	42.7
1975	7,328,000	17,684,000	41.4
1976	7,996,000	19,016,000	42.1
1977	8,490,000	19,892,000	42.7
1978	6,913,000	25,223,000	27.4
1979	8,376,000	30,428,000	27.5
1980	Not Available	21,539,000	

Average Percentage of total aggregate consumption used as P.C.C. aggregate = 38.9 %

Percentage calculations may not replicate precisely due to rounding.

P.C.C. = Portland cement concrete.

tions from the State Department of Finance (1977b, 1980a, 1981).

Population projections for the 10 year period from 2020 to 2030 were extrapolated by DMG staff from the data mentioned above. Population projections for the South San Francisco Bay P-C Region to the year 2030 are given on Table 2.16. Population projections for all three P-C regions to the year 2030 are presented in Figure 2.10.

Per Capita Consumption Rates

The South San Francisco Bay P-C Region had an average per capita consumption rate of 6.0 tons per year during the period 1953-1980 (Table 2.15). Due to the erratic nature of the annual aggregate production (see Figure 2.3), a three-year moving average of the annual production was used with the annual population data to compute the per capita rates for the South San Francisco Bay P-C Region. The average per capita rate was combined with the population projections for the South San Francisco Bay P-C Region in order to estimate aggregate consumption for the period 1981-2030 (Table 2.17). Similar techniques were used to compute per capita rates for the North San Francisco Bay and Monterey Bay P-C regions, and these per capita rates are discussed below in the section "Aggregate Resources of Adjacent P-C Regions - Estimated Consumption of Aggregate."

Factors Affecting Per Capita Consumption Rates

Per capita consumption of aggregate has varied with time and is different in each P-C region. Several factors, such as changes in urban growth rates with time, relative degrees of urban maturity, and major construction projects (for example, freeways), may account for the variations and differences. Another factor may be possible incompleteness or inaccuracy of the production records compiled by the U.S. Bureau of Mines or of the population data compiled by the California Department of Finance. In addition, very high interest rates, such as existed in California during the period 1980-1982, tend to lower the amount of new construction in an area.

The average annual per capita consumption rate for the South San Francisco Bay P-C Region may decrease, at a more or less steady rate, as the area becomes more urbanized until a steady state (urban maturity*) is reached. Should unforeseen events occur, such as massive urban renewal, disaster reconstruction, or major recession, the per capita consumption rate could change significantly. The presence of several major active fault systems within the South San Francisco Bay P-C Region increases the chance for a damaging earthquake and the need for subsequent extensive reconstruction afterwards (*see* Davis, and others, 1982).

* 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.

Table 2.15 Population, aggregate consumption, and per capita consumption of aggregate in the South San Francisco Bay P-C Region during the period 1953-1980.

YEAR	POPULATION	AGGREGATE CONSUMPTION (Rounded to nearest 1000 Tons)	CONSUMPTION 3-YEAR AVERAGE (Tons)	ANNUAL PER CAPITA CONSUMPTION (Tons)
1953	2,588,500	10,684,000		
1954	2,649,100	10,066,000	11,364,000	4.3
1955	2,694,000	13,343,000	14,234,000	5.3
1956	2,779,000	19,296,000	15,667,000	5.6
1957	2,857,800	14,363,000	16,392,000	5.7
1958	2,952,500	15,519,000	15,316,000	5.2
1959	3,035,900	16,066,000	15,720,000	5.2
1960	3,112,100	15,575,000	16,099,000	5.2
1961	3,204,200	16,659,000	16,677,000	5.2
1962	3,286,800	17,800,000	18,902,000	5.8
1963	3,379,200	22,250,000	21,382,000	6.3
1964	3,425,800	24,099,000	23,983,000	7.0
1965	3,526,700	25,603,000	24,363,000	6.9
1966	3,598,100	23,389,000	24,545,000	6.8
1967	3,680,200	24,645,000	24,982,000	6.8
1968	3,740,700	26,914,000	27,358,000	7.3
1969	3,785,800	30,517,000	27,371,000	7.2
1970	3,855,200	24,683,000	28,271,000	7.3
1971	3,903,100	29,615,000	25,812,000	6.6
1972	3,933,200	23,140,000	25,835,000	6.6
1973	3,960,200	24,751,000	24,500,000	6.2
1974	3,984,600	25,611,000	22,681,000	5.7
1975	4,022,400	17,684,000	20,769,000	5.2
1976	4,057,500	19,016,000	18,863,000	4.6
1977	4,088,600	19,892,000	21,376,000	5.2
1978	4,122,300	25,223,000	25,181,000	6.1
1979	4,165,200	30,428,000	25,730,000	6.2
1980	4,190,200	21,539,000		

Average annual per capita aggregate consumption 1954-1979 = 6.0 tons.

Percentage calculations may not replicate precisely due to rounding.

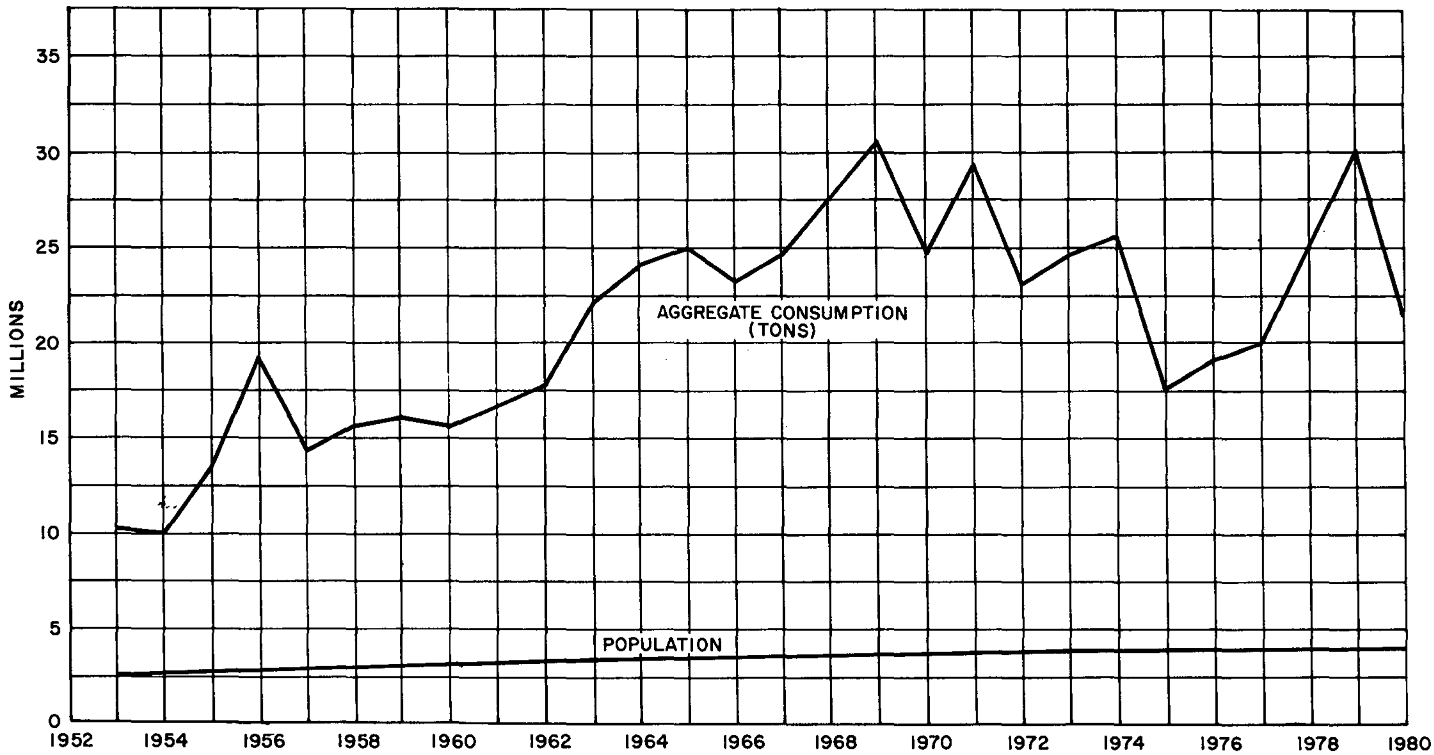

Figure 2.3 South San Francisco Bay P-C Region: population and aggregate consumption records for years 1953-80.

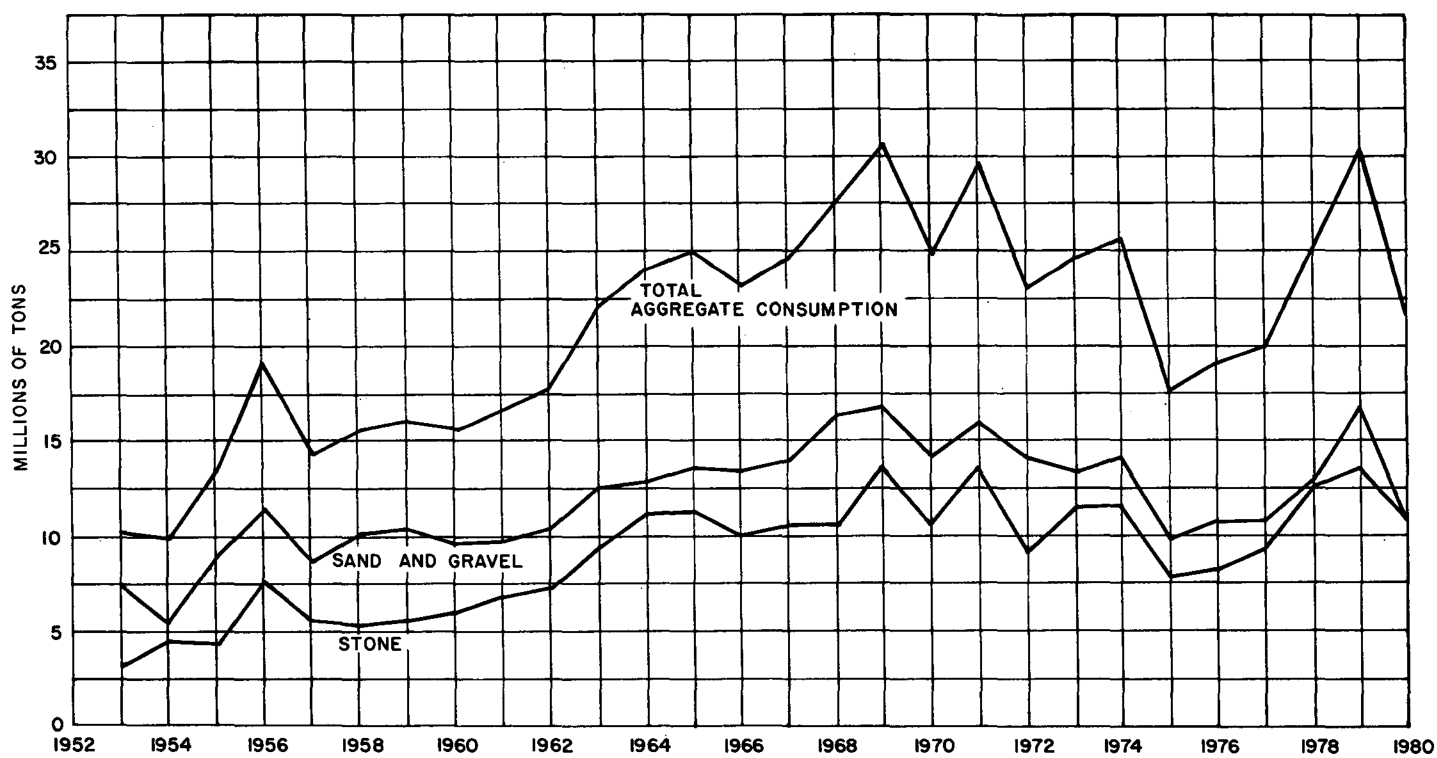

Figure 2.4 South San Francisco Bay P-C Region: sand and gravel, stone, and total aggregate consumption records for years 1953-80.

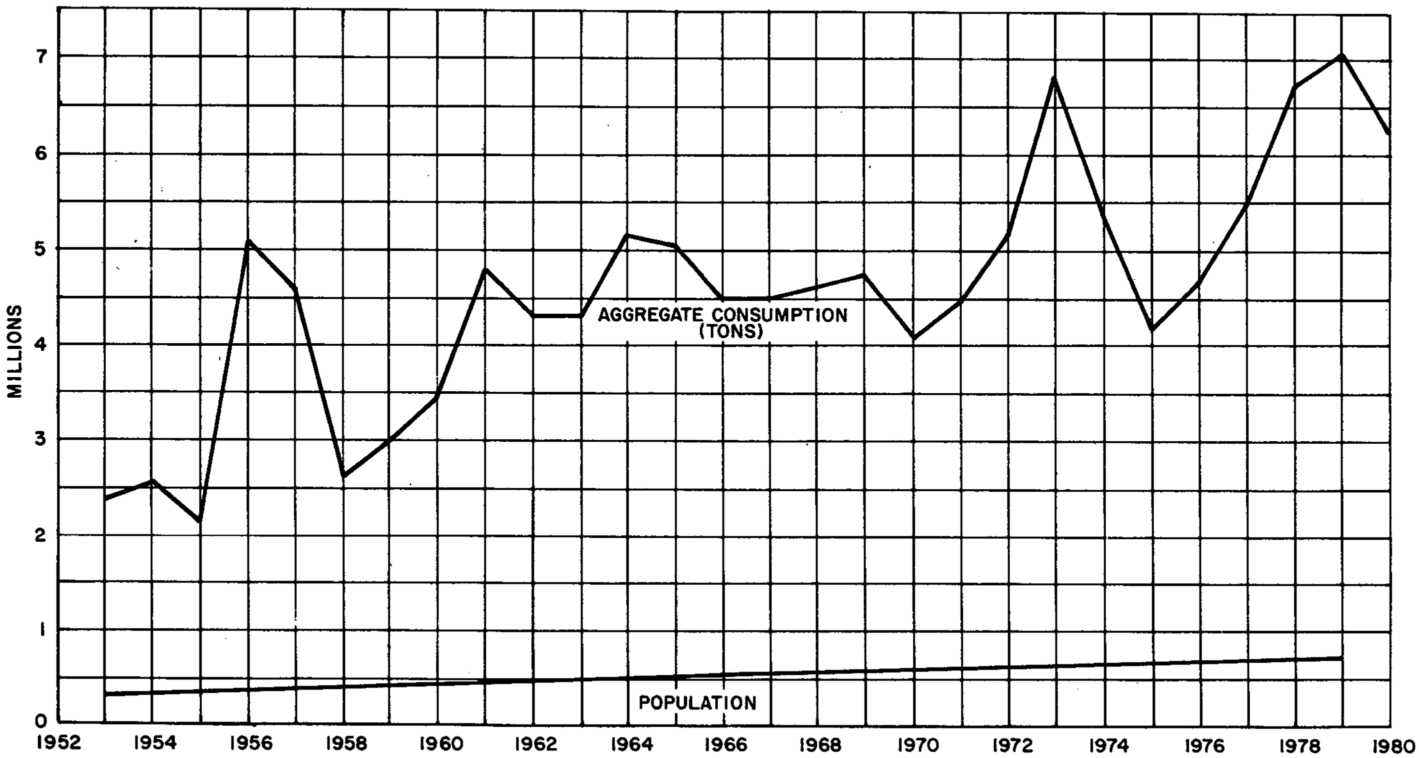

Figure 2.5 North San Francisco Bay P-C Region: population and aggregate consumption records for years 1953-80.

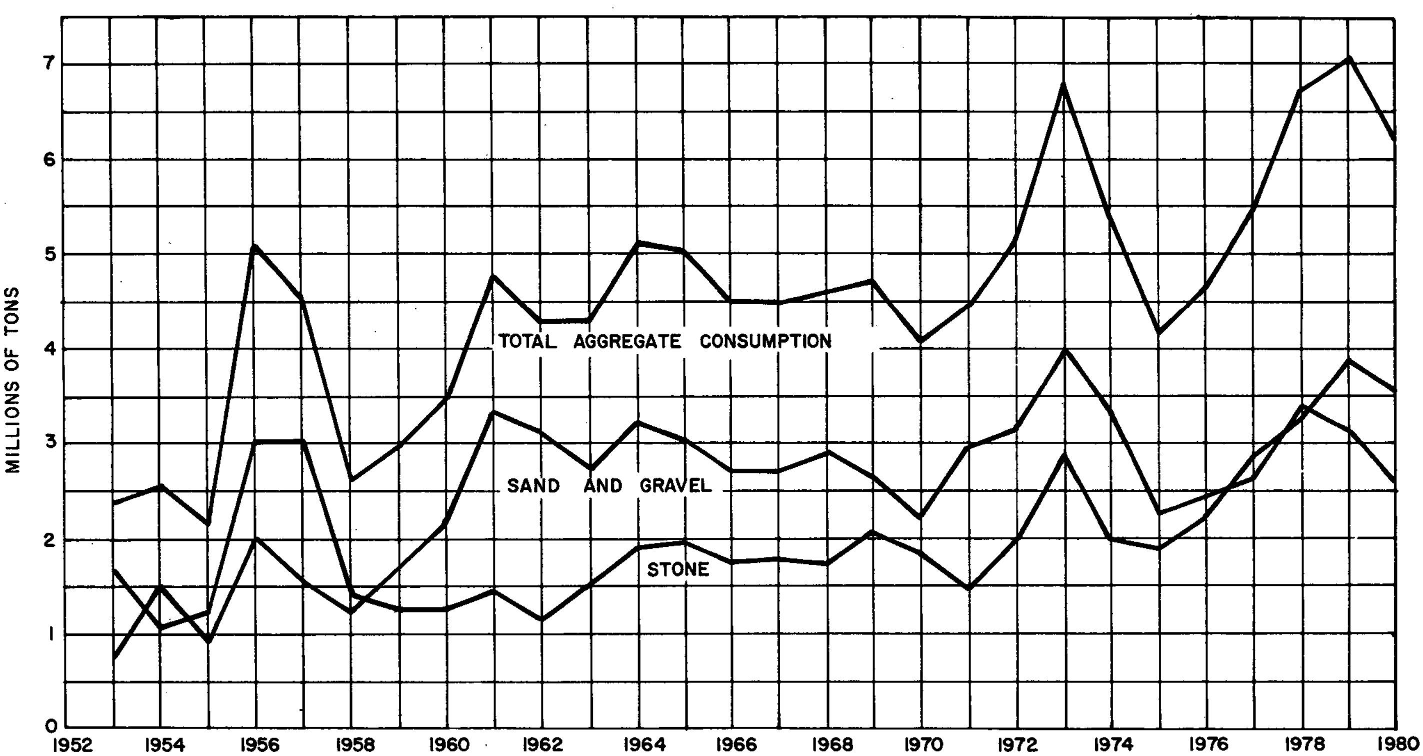

Figure 2.6 North San Francisco Bay P-C Region: sand and gravel, stone, and total aggregate consumption records for years 1953-80.

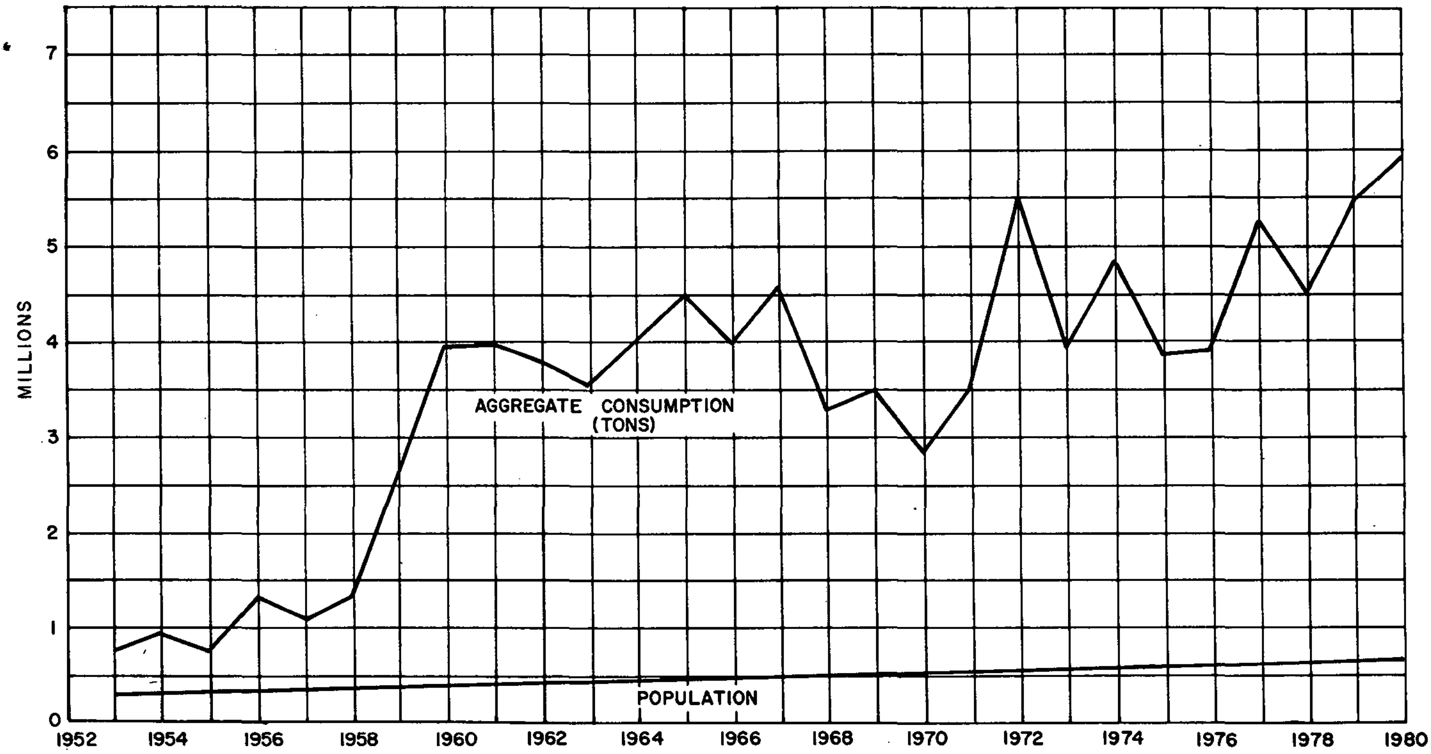

Figure 2.7 Monterey Bay P-C Region: population and aggregate consumption records for years 1953-80.

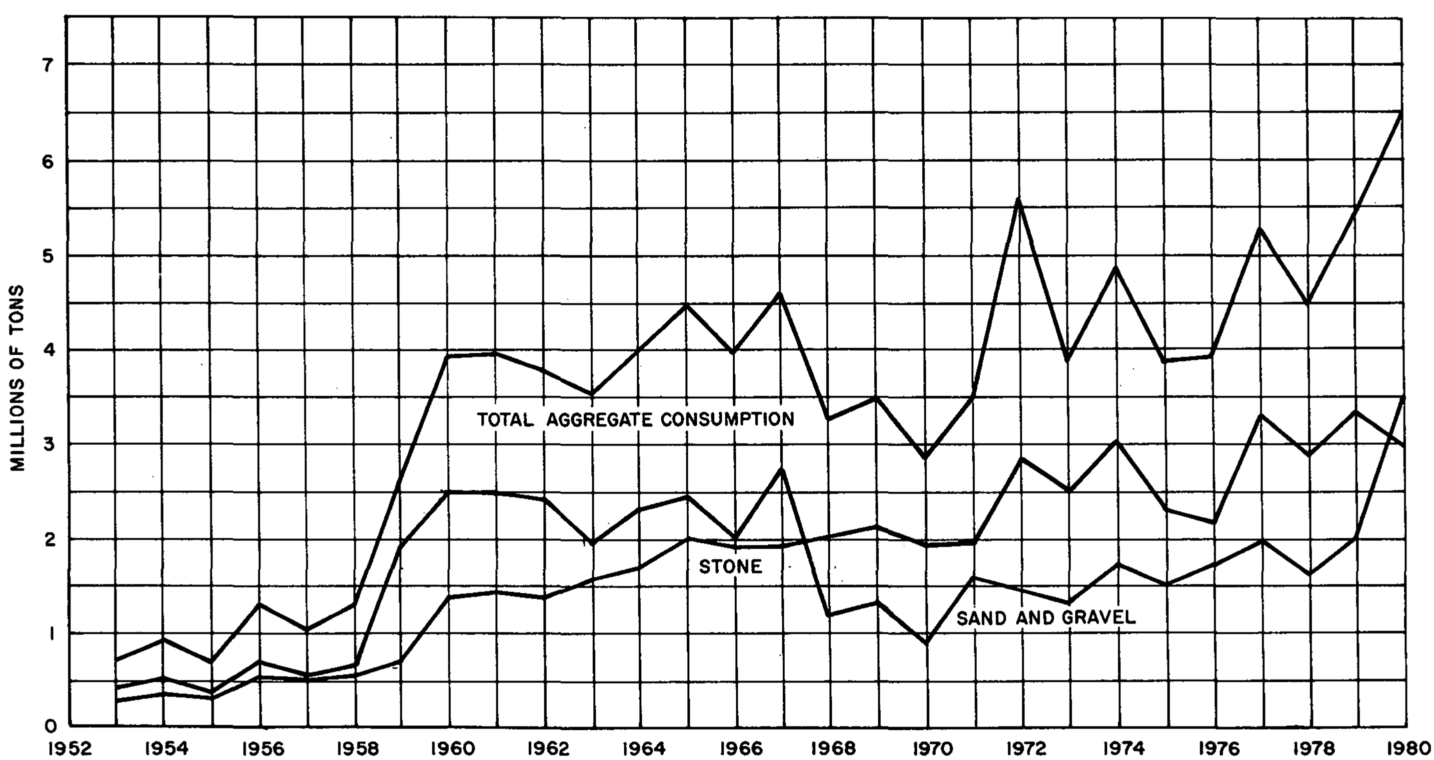

Figure 2.8 Monterey Bay P-C Region: sand and gravel, stone, and total aggregate consumption records for years 1953-80.

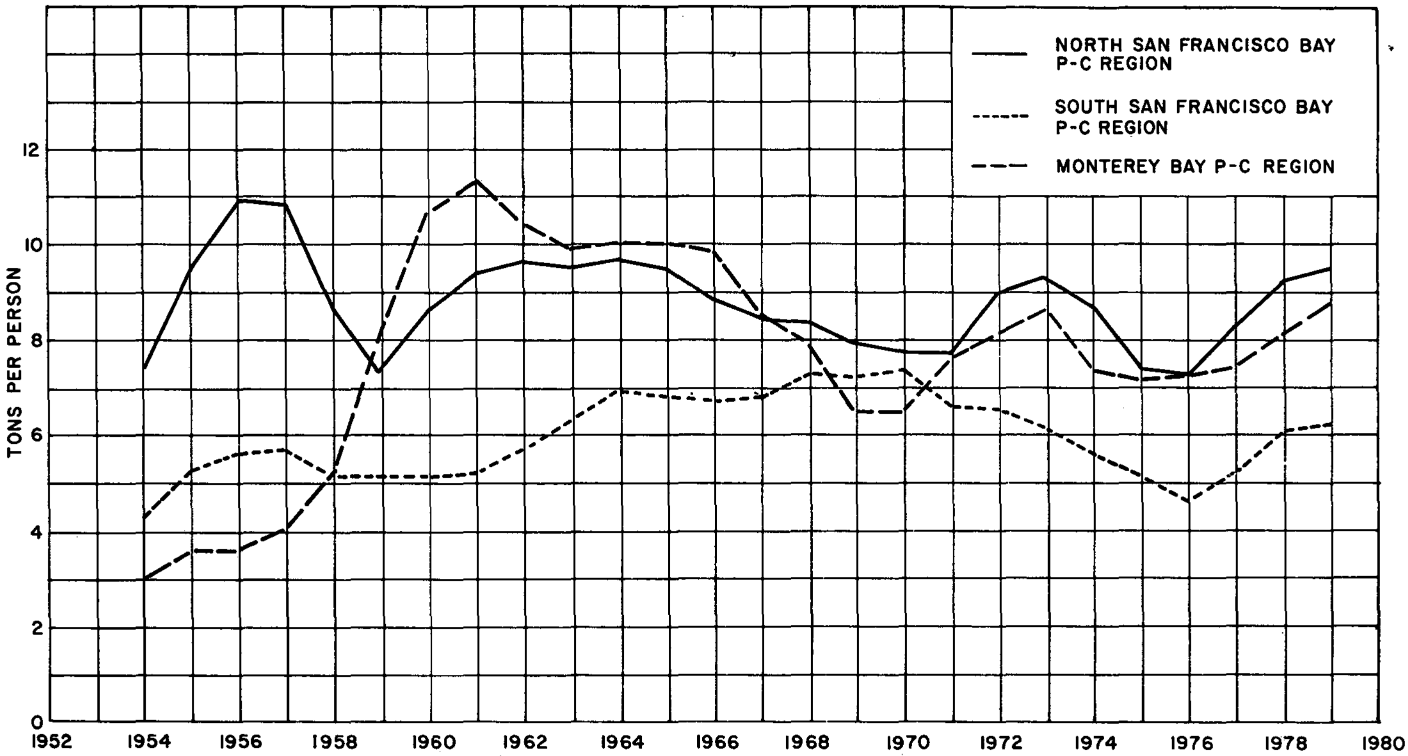

Figure 2.9 Annual per capita consumption of aggregate in the South San Francisco Bay, North San Francisco Bay, and Monterey Bay P-C regions for years 1954-1979.

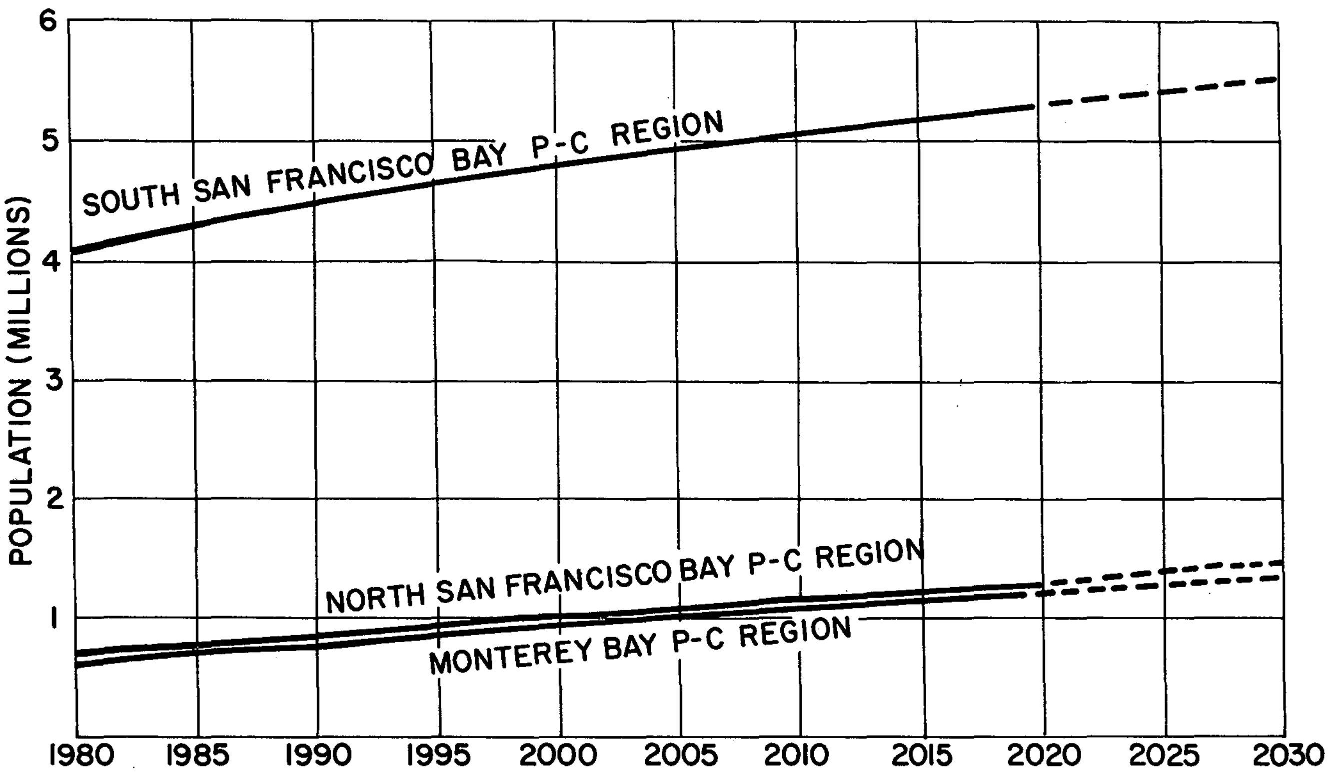

Figure 2.10 Projected populations of the South San Francisco Bay, North San Francisco Bay, and Monterey Bay P-C regions to the year 2030.

Table 2.16 Population projections for Alameda, Contra Costa, San Francisco, San Mateo, and northern Santa Clara counties, 1980 - 2030.

YEAR	ALAMEDA	CONTRA COSTA	SAN FRANCISCO	SAN MATEO	NORTHERN SANTA CLARA*	TOTAL
1980	1,105,400	660,900	678,000	588,900	1,157,000	4,190,200
1985	1,125,200	732,400	667,500	609,900	1,247,300	4,382,300
1990	1,152,900	799,800	660,200	630,800	1,337,000	4,580,700
1995	1,183,800	845,400	661,100	646,000	1,423,000	4,759,300
2000	1,208,800	881,300	662,500	651,500	1,493,300	4,897,400
2005	1,229,800	911,900	667,500	652,000	1,555,600	5,016,800
2010	1,249,100	943,100	676,000	651,800	1,617,700	5,137,700
2015	1,266,600	976,100	685,400	651,700	1,682,500	5,262,300
2020	1,280,200	1,007,100	694,100	649,700	1,745,700	5,376,800
2025	1,293,800	1,038,100	702,800	647,700	1,761,200	5,443,600
2030	1,307,400	1,069,100	711,500	645,700	1,776,700	5,510,400

*Northern Santa Clara County is assumed to constitute 89% of Santa Clara County's total projected population.

Source: California Department of Finance (1977b, 1981a).

Population projected by DMG from data in California Department of Finance (Ibid) for years 1995 through 2030, inclusive.

Table 2.17 Projected aggregate consumption for the South San Francisco Bay P-C Region, 1981 - 2030.*+

(Rounded to Nearest 100,000 Tons)

Period	6.0 Tons (Average) Per Capita
1981-1985	128,200,000
1986-1990	134,100,000
1991-1995	139,700,000
1996-2000	144,400,000
2001-2005	148,300,000
2006-2010	151,900,000
2011-2015	155,600,000
2016-2020	159,100,000
2021-2025	162,600,000
2026-2030	166,000,000
50-Year Total	1,489,800,000

*Aggregate consumption (tons) =
Population (5-year average) x 5 year per capita consumption

+Projections based on data in Tables 2.15 and 2.16.

ALTERNATIVE SOURCES OF AGGREGATE

Introduction

Alternative sources of aggregate, in addition to those deposits classified MRZ-2 and MRZ-3, occur in areas within the South San Francisco Bay P-C Region, and in adjacent P-C regions. Some potential resources lie outside the OPR urbanizing boundaries, but still within the P-C region boundaries. Included within the group of potential resources are the extensions of several deposits classified MRZ-2 or MRZ-3. In addition, sand and fine gravel occur in bars on the floor of San Francisco Bay, between the Golden Gate Bar and the confluence of the Sacramento and San Joaquin rivers. Except for the aggregate resources in adjacent P-C regions and marine sand deposits, too little is known about the physical and chemical qualities of most of the alternative sources to permit even crude resource estimates. A general discussion about the potential resources and their occurrences is included in this section.

Additional Sand And Gravel Resources - South San Francisco Bay P-C Region

Several additional sources of sand and gravel occur within the South San Francisco Bay P-C Region. One such potential source in Alameda County is the geologic unit known as the Livermore Gravels. This formation has a stratigraphic thickness of 4,000 feet, covers an estimated 75 square miles of area, and underlies the hills on the east and west sides of Sunol Valley (Hall, 1958; Huey, 1948). The Livermore Gravels exposed in the vicinity of Vallecitos Valley contain sand, gravel, and partially cemented conglomerate. Near Mission San Jose, a lithologically similar formation, the Irvington Gravels, has been mined for Portland cement concrete aggregate, and is classified MRZ-2 and MRZ-3 in this report. Detailed mapping and sampling of the Livermore Gravels would be needed to delineate areas with suitable material in commercial quantities.

Another potential source in the South San Francisco Bay P-C Region (also just outside the OPR urbanizing boundaries) is the Santa Clara Formation. This formation has a stratigraphic thickness of more than 2,000 feet, and consists of conglomerate and interbedded sandstone, siltstone, and clay (Dibblee, 1966). The Santa Clara Formation extends along the lower foothills on both sides (east and west) of Santa Clara Valley. Little information is available about the quantity and quality of the sand and gravel in the Santa Clara Formation on the east side of Santa Clara Valley, since it has not been quarried there. The Santa Clara Formation on the west side of Santa Clara Valley extends in a northwest direction from near Los Gatos to Palo Alto. Sand and gravel have been recovered from the conglomerate at several sites near Monte Vista and Stevens Creek Reservoir. The Santa Clara Formation in this area has been classified MRZ-2 and MRZ-3. However, the Santa Clara Formation extends for some distance beyond the OPR urbanizing boundary where it has not been classified. One active quarry (Stevens Creek Quarry) lies inside the OPR boundary. The conglomerate occurs in discontinuous lenses or beds throughout the formation and, therefore, detailed mapping and sampling will be required to find suitable material.

DEEP SAND AND GRAVEL DEPOSITS WITHIN THE LIVERMORE VALLEY-SUNOL VALLEY-NILES CONE PRODUCTION DISTRICT

One of the most geologically promising alternative sources of high quality (P.C.C.-grade) sand and gravel occurs in the Livermore Valley - Sunol Valley - Niles Cone Production District, below the current maximum permitted mining depth of existing gravel pits. The few deep water-well records available show locally continuous deposits of sand and gravel to depths of more than 700 feet in the Livermore Valley, more than 400 feet in Sunol Valley, and more than 500 feet in the Niles Cone. The present level of available data is adequate only to classify these lower aquifers as MRZ-3 without additional drilling and testing.

Before these deep deposits could be considered as resources, the thickness and continuity of interbedded aquicludes would require study, and the quality of the lower sand and gravel would need to be tested. However, since all materials in the several aquifers were derived from the same source rocks, and all of the deposits in the district are of approximately the same age, it is likely that rock quality would be high throughout the deposits.

Pit depths down to 100 feet below the local water table are feasible with today's mining technology. Utilization of these deep alternative resources would require care to preserve present ground water quality, but would maximize recovery of valuable mineral resources in the P-C region.

Additional Crushed Stone Resources - South San Francisco Bay P-C Region

The Mindego Hill Basalt, which underlies parts of Mindego Hill and Langley Hill in San Mateo County, is currently being quarried for aggregate. Expanded operations could supply material needed when other nearby quarries cease operations. Cretaceous granodiorite forms the bulk of Montara Mountain, which overlooks Half Moon Bay. Although much of the exposed material is weathered, the western slope of the mountain may be suitable for quarrying, and operations there could provide substantial quantities of crushed stone. Large deposits of Franciscan Complex graywacke and greenstone occur in the mountains south of Los Gatos and east of San Jose, in Santa Clara County. Both areas are accessible by highways.

Portions of the Niles Canyon Formation (Cretaceous) in the vicinity of Niles and Sunol (Alameda County) contain very hard sandstones. Sandstone of the Briones Formation has been quarried at a number of sites between San Jose and Antioch. However, because of the variation in hardness and silt content between sites, detailed field mapping and testing will be necessary to delineate areas where suitable material exists.

The Calera Limestone, which is associated with rocks of the Franciscan Complex, occurs as a discontinuous zone of limestone bodies extending southeasterly from Calera Valley (Pacifica) in San Mateo County, through western Santa Clara County to New Almaden. Individual masses of limestone are as much as a mile in length and range from 40 feet to 2,500 feet in width. The largest known body of limestone occurs at Permanente in Santa Clara County, where the Kaiser Cement Company operates a large quarry to obtain limestone for the Permanente cement plant. Limestone unsuitable for the manufacture of cement is crushed and used for Portland cement concrete aggregate. A large tonnage of rock suitable for aggregate is still available at the Permanente Quarry. Several inactive quarries are located in the Calera Limestone between Pacifica and New Almaden, and limestone suitable for aggregate may be present. According to

Kupferman (1980, p. 112) development of the individual deposits would probably be limited to aggregate quarries "due to the limited extent of each mass and the dispersion of chert interbeds throughout the limestone."

Marine Sand and Gravel Deposits of the San Francisco Bay Area

Sand and some gravel have been dredged from San Francisco Bay for many years. According to Goldman (1969, p. 22), sand occurs in or immediately adjacent to existing current channels at a number of places between the confluence of the Sacramento and San Joaquin rivers and the western edge of the Golden Gate Bar. The largest area of sand is on the bay floor, between Point San Quentin and the City of San Francisco, but deep water precludes dredging from much of this area. The largest potential source of sand outside of the Golden Gate is on the semicircular Golden Gate Bar. The general distribution of sand and gravel is shown on Figure 2.11. Other sand deposits that lie beneath a cover of younger bay mud have been dredged as sources of fill. The bulk of this sand is on the east side of San Francisco Bay between Point Richmond and Bay Farm Island. This sand lens is cut in several places by mud-filled channels and may extend southward beyond Bay Farm Island (Ibid, p. 33). In general, the areas from which sand is being excavated are operated under lease from the State Lands Commission, and are the shoal areas: Point Knox Shoal, southwest of Angel Island; Presidio and Alcatraz shoals, west and southwest of Alcatraz; Southampton Shoal, southwest of Point Richmond; and San Bruno Shoal, east of San Bruno. In 1971 and 1972, E.E. Welday and J.W. Williams of the California Division of Mines and Geology made a geologic reconnaissance of the marine mineral resources of the San Francisco Bay region. Over 400 samples were collected, and samples that appeared to be of economic importance were analyzed. Welday (1975, p. 23) estimates that nearly one-half billion cubic yards of sand (predominantly medium-grained but with a significant coarse-grained fraction) is accessible to currently operating dredges. If dredging is possible at depths to 100 feet, this tonnage could be increased at least 50 percent. The most valuable deposit is the Point Knox Shoal, as it contains abundant coarse material. This deposit is currently being dredged for P.C.C. sand. An estimate of the offshore sand resources of the San Francisco Bay area is presented in Table 2.18.

AGGREGATE RESOURCES OF ADJACENT P-C REGIONS

If additional aggregate is needed in the South San Francisco Bay P-C Region on a short-term basis, the most readily available material is located in the neighboring regions - North San Francisco Bay, Monterey Bay, and Sacramento-Fairfield P-C regions. On a short-term basis the active quarries in these three P-C regions can send large amounts of aggregate into the South San Francisco Bay P-C Region, but the delivered price per ton would be greatly increased by inflated transportation costs and by any supply-demand conflicts (see Tables 1.2, 1.3, and 1.4 in Part I of this report). The long-term (50 year) resource picture is more uncertain. As described in greater detail below, the North San Francisco Bay P-C Region is projected to have a deficit of aggregate or P.C.C.-grade aggregate, while the Monterey Bay P-C Region appears to have a surplus of material. Projected aggregate needs and available supplies in the Sacramento-Fairfield P-C Region are currently under study.

Resource Estimates

Resource estimates given in this report (Part II) for P-C regions near or adjacent to the South San Francisco Bay P-C Region represent data taken from Parts III and IV of this study. The North San Francisco Bay P-C Region has approximately 2.4 billion tons of aggregate in its resource sectors (908 million tons of sand and gravel, and 1,449 million tons of stone). At the end of 1980, commercial deposits within the P-C region contained 108 million tons of sand and gravel reserves and 432 million tons of crushed stone reserves, for a total of 540 million tons. The Monterey Bay P-C Region has approximately 3.1 billion tons of aggregate within its resource sectors (more than 715 million tons of sand and gravel and more than 2,366 million tons of stone). At the end of 1980, commercially controlled deposits within the P-C region contained 195 million tons of sand and gravel reserves and 591 million tons of stone reserves, for a total of 786 million tons. Tables 2.19 and 2.20 list the resource sectors, available tonnages, and commercial reserves for the North San Francisco Bay and Monterey Bay P-C regions.

Estimated Consumption of Aggregate

Estimated 50-year aggregate consumption for nearby P-C regions is presented in Table 2.21. At the projected level of consumption (8.8 tons per person annually; 478 million tons over 50 years), the North San Francisco Bay P-C Regions's reserves will be depleted in 49 years (2036). Thus, if the South San Francisco Bay P-C Region relies on these neighboring reserves, the projected North San Francisco Bay P-C Region P.C.C.-grade aggregate shortfall will occur much sooner. In contrast, the Monterey Bay P-C Region is projected to have a surplus of aggregate available for its 50-year needs. Based on an average annual per capita consumption of 7.7 tons, approximately 374 million tons will be needed during the next 50 years, and 786 million tons were available at the end of 1980. Sand and crushed stone are currently imported into the South San Francisco Bay P-C Region from the Monterey Bay P-C Region. This arrangement will undoubtedly continue under present economic conditions.

Potential Aggregate Resources Outside of OPR Boundaries

Several geologic units, which have not been classified as part of this overall study because they are located outside the OPR zones in the Monterey Bay or North San Francisco Bay P-C regions, may become sources of aggregate in the future. These units contain stone or sand or gravel; they appear to be suitable for aggregate, based on written descriptions in geological reports and limited field examinations.

SAND AND GRAVEL

The San Benito Gravels are a group of Plio-Pleistocene continental deposits located south of Hollister (in San Benito County, Monterey Bay P-C Region). Although the gravels are not known to have been quarried, outcrops along Paicines Creek contain gravel that appears suitable. The following data are taken from Griffen (1967). The unit covers an area of approximately 150 square miles, and has a stratigraphic thickness of at least 2,000 feet. The main body forms a northwest-trending belt two to five miles wide. The portion of the San Benito Gravels that appears suitable for aggregate is the "white sands" section,

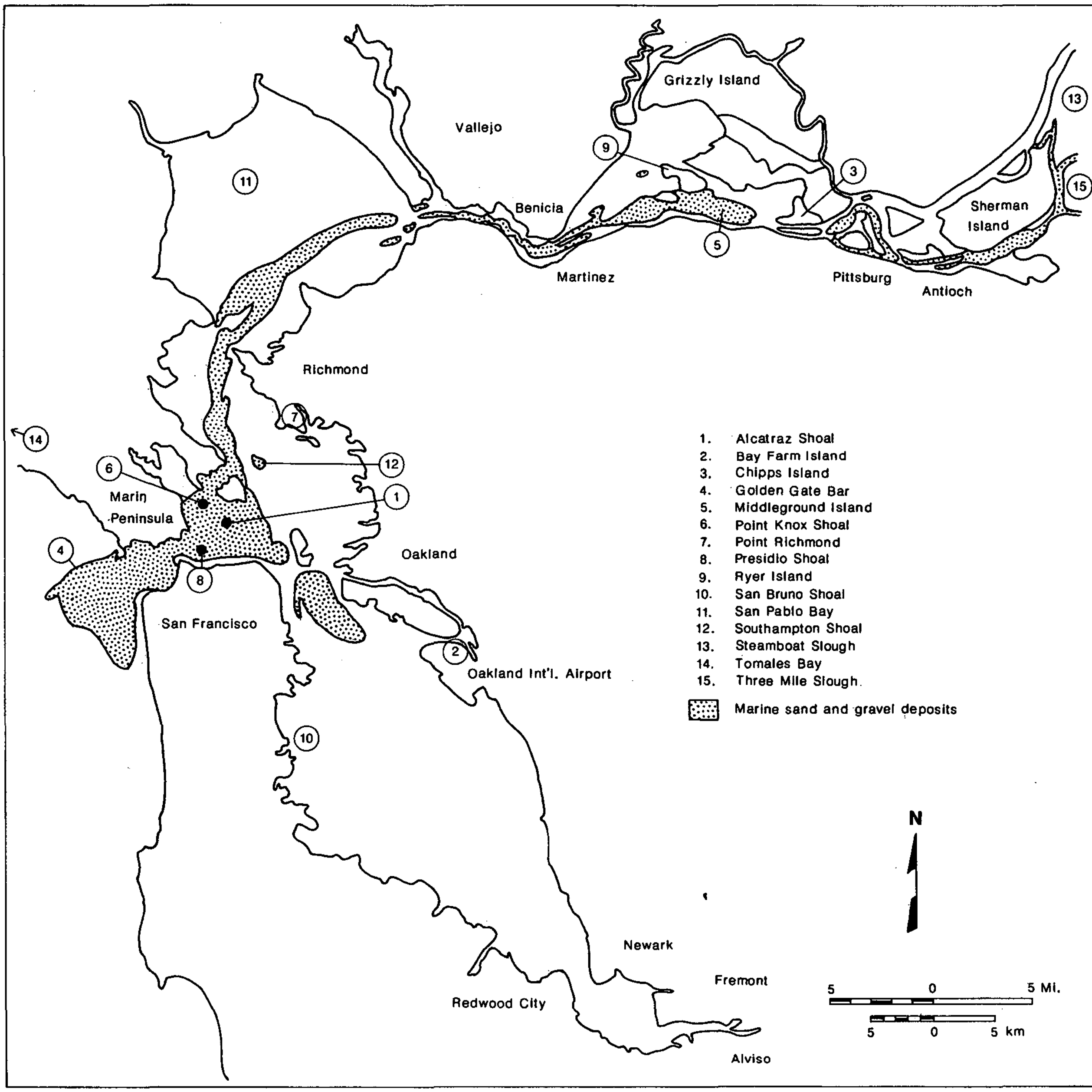

Figure 2.11 Marine sand and gravel deposits in San Francisco Bay and Sacramento River—Delta (after E.E. Welday, 1975). Known aggregate deposits are shown by dot pattern.

which extends southeast from Tres Pinos to within a mile of Elkhorn Ranch, and is largely confined to the hills between Tres Pinos Creek and the San Benito River. The "white sands" section of the gravels covers over 20 square miles and has a maximum stratigraphic thickness of at least 800 feet. Gravel forms 20 to 25 percent of the "white sands" section, silt and clay form about 5 percent, and the remaining 70 to 75 percent is sand. A basal section at Tres Pinos contains approximately 30 feet of massive silt. Detailed mapping and sampling will be needed to locate suitable sites for quarry operations.

CRUSHED STONE

In the North San Francisco Bay P-C Region, basalt, andesite, and rhyolite of the Sonoma Volcanics, graywacke and greenstone of the Franciscan Complex, and Cretaceous conglomerate appear suitable for aggregate. Several deposits have been quarried for aggregate, building stone, or paving blocks. A reconnaissance study of potential stone sites was undertaken in 1979 by R. Erickson and three assistants for the Sonoma County Planning Department. Numerous deposits of sandstone, greenstone, and basalt were identified in the resultant report (Erickson and others, unpublished). Some of these deposits may be quarried in the future. Detailed geologic mapping and sampling will be needed to identify those deposits that contain sufficient material for economic operations.

An enormous body of granite forms the northern portion of the Gabilan Range along the Monterey-San Benito County boundary (Monterey Bay P-C Region). The granite covers an area of approximately 12 townships (approximately 400 square

Table 2.18 Marine sand resources of the San Francisco Bay area. Data from Welday (1975, p. 24). Numbers in parentheses are the equivalent tonnage at 1.5 tons per cubic yard.

LOCATION	VOLUME Million Cubic Yards (Million Tons)	TOTAL Million Cubic Yards (Million Tons)
Vicinity of Rio Vista to Antioch		
Steamboat Slough, Sacramento River	15 (22.5)	
Threemile Slough to Antioch	40 (60)	55 (82.5)
Antioch to Benicia		
Antioch to Chipps Island	40 (60)	
Chipps Island to Ryer Island	40 (60)	
Ryer Island to Benicia	50 (75)	130 (195)
Benicia to Angel Island		
Channel of San Pablo Bay and San Pablo Strait	20 (30)	
Channel Vicinity of Southampton	20 (30)	40 (60)
Angel Island to the Golden Gate		
Point Knox Shoal	25 (max. depth 75 ft.) (37.5)	
Presidio Shoal	30 (45)	55 (82.5)
San Francisco Bar (Inner)	165 (max. depth 75 ft.) (247.5) (350 @ max. depth 100 ft.) (525)	165 (247.5)
Tomales Bay	35 (52.5)	35 (52.5)
	Total	480 (720)

Table 2.19 Reserves and resources within sectors in the North San Francisco Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector.

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons)		CRUSHED STONE AMOUNT (millions of tons)	
		Reserves	Resources	Reserves	Resources
Marin	D		29		
	I			*	*
	J				8
	L			*	*
	M			*	*
Marin Subtotal			29	*	8+

* Proprietary data

\# Includes combined proprietary data

(continued on next page)

Table 2.19 Reserves and resources within sectors in the North San Francisco Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector. (continued)

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons)		CRUSHED STONE AMOUNT (millions of tons)	
		Reserves	Resources	Reserves	Resources
MARIN (continued)					
Parklands	V				31
Parklands Subtotal				31	
MARIN COUNTY TOTAL			29	*	39+
Western Solano	G			*	413
SOLANO COUNTY TOTAL				*	413
Napa	H			*	641
NAPA COUNTY TOTAL				*	641
Sonoma	A	*	449		
	B	*	405		
	C	*	25		
	E			*	*
	F			*	*
	K			*	151
	N			*	*
	O			*	*
	P			*	*
	Q			*	*
	R			*	*
	S			*	*
	T	*	*	*	*
	U	*	*		
	W			*	*
	X			*	*
	Y			*	*
SONOMA COUNTY TOTAL		108#	879+	180#	330#
P-C REGION TOTAL		108#	908+	432#	1,449#

TOTAL RESERVES IN NORTH SAN FRANCISCO BAY P-C REGION = 540 MILLION TONS
TOTAL RESOURCES IN NORTH SAN FRANCISCO BAY P-C REGION = 2.4 BILLION TONS

* Proprietary data

Includes combined proprietary data

Table 2.20 Reserves and resources within sectors in the Monterey Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector.

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons)		CRUSHED STONE AMOUNT (millions of tons)	
		Reserves	Resources	Reserves	Resources
Monterey	G			*	*
	H	*	43+		
	I		208		
	J			*	31
	K		3		
	N	*	*		
	O	*	*		
	P	*	*		
Monterey Subtotal		*	254+	*	31+
Parklands	S		20		
	T		4		
Parklands Subtotal			24		
MONTEREY COUNTY TOTAL		*	278+	*	31+
San Benito	E	*	226		
	F			*	395
SAN BENITO COUNTY TOTAL		*	226	*	395
Santa Cruz	A			*	1,004
	B	*	*		
	C	*	*		
	L			*	*
	M	*	*		
Santa Cruz Subtotal		*	*	*	1,004+
Parklands	Q				381
	R				555
Parklands Subtotal					936
SANTA CRUZ COUNTY TOTAL		*	*	*	1,940+

* Proprietary data

\# Includes combined proprietary data

Table 2.20 Reserves and resources within sectors in the Monterey Bay P-C Region. The reserves (calculated through 1980) are material that commercial aggregate companies control, and for which the companies have valid mining permits. Resources include the reserves and any other material within the sector. (continued)

COUNTY	SECTOR	SAND AND GRAVEL AMOUNT (millions of tons) Reserves	Resources	CRUSHED STONE AMOUNT (millions of tons) Reserves	Resources
Southern Santa Clara	D	*	25		
	U	*	21		
SANTA CLARA COUNTY TOTAL		*	46		
P-C REGION TOTAL		195#	715#	591#	2,366+

TOTAL RESERVES IN MONTEREY BAY P-C REGION = 786 MILLION TONS
TOTAL RESOURCES IN MONTEREY BAY P-C REGION = 3.1 BILLION TONS

* Proprietary data
# Includes combined proprietary data

Table 2.21 Projected aggregate consumption to the year 2030 for the South San Francisco Bay, North San Francisco Bay, and Monterey Bay P-C regions.

	SOUTH SAN FRANCISCO BAY P-C REGION		NORTH SAN FRANCISCO BAY P-C REGION		MONTEREY BAY P-C REGION	
	5 yr per capita consumption = 30.0 tons/person		5 yr per capita consumption = 44.0 tons/person		5 yr per capita consumption = 38.5 tons/person	
YEARS	Average Population (millions)	Aggregate Consumption (million tons)	Average Population (millions)	Aggregate Consumption (million tons)	Average Population (millions)	Aggregate Consumption (million tons)
1981-1985	4.38	128.2	.792	33.2	.704	26.1
1986-1990	4.58	134.1	.860	36.4	.760	28.2
1991-1995	4.76	139.7	.940	39.4	.830	30.6
1996-2000	4.90	144.4	1.015	43.1	.848	33.3
2001-2005	5.02	148.3	1.087	46.3	.967	35.9
2006-2010	5.14	151.9	1.161	49.5	1.039	38.6
2011-2015	5.26	155.6	1.234	52.8	1.110	41.4
2016-2020	5.38	159.1	1.303	55.9	1.177	44.1
2021-2025	5.50	162.6	1.373	59.0	1.243	46.6
2026-2030	5.61	166.0	1.442	62.0	1.310	49.2
Total		1,489.8		478.0		374.0

* Aggregate consumption = Population (5-year average) x 5 year per capita consumption.

miles). The Southern Pacific Railroad traverses the Salinas Valley, which lies on the west side of the Gabilan Range. Large amounts of aggregate could be supplied by rail from this granite to nearby P-C regions. Similar material also is available in the Santa Lucia Range (Monterey County), but access is difficult. In Santa Cruz County, a large granite pluton near Felton and a smaller body north of Soquel are quarried for aggregate. Cretaceous sandstone deposits along the east side of the Santa Clara Valley in the Monterey Bay P-C Region may contain suitable material, but have not been tested (Rogers and Williams, 1974, Plate 1).

CONCLUSIONS

Within the South San Francisco Bay P-C Region, 42 sectors have been identified that contain a total of 6.3 billion tons of aggregate resources (1.1 billion tons of sand and gravel resources and 5.2 billion tons of crushed stone resources). This resource total includes material suitable for Portland cement concrete and material suitable only for asphaltic concrete, road base, or subbase.

Based upon available production data and population projections, the South San Francisco Bay P-C Region will need 1.5 billion tons of aggregate during the next 50 years. Of this projected demand, 39 percent (approximately 580 million tons) must be suitable for Portland cement concrete. At the end of 1980, approximately 552 million tons of aggregate reserves existed within the P-C region, of which 313 million tons were suitable for use as P.C.C. aggregate. Total aggregate reserves amount to about 37 percent of the projected demand, and P.C.C.-grade reserves amount to 54 percent of the projected P.C.C. aggregate demand. Unless new resources are permitted for mining, or alternative resources are utilized, existing reserves will be depleted by the year 1999, only 12 years from the publication of this report, and P.C.C.-grade material will have been utilized where lower quality aggregate would have been adequate. If a major earthquake were to occur within the P-C region and extensive reconstruction was necessary, the depletion date could arrive in less than the projected 12 years.

Alternatives

The South San Francisco Bay P-C Region has five alternatives to cope with the projected deficiency of both total aggregate and P.C.C.-grade aggregate. Other alternatives are essentially combinations of the five discussed here.

1. Permit expansion of existing gravel pits and quarries if additional resources exist within sectors containing active operations.
2. Permit mining in previously unmined sectors.
3. Encourage exploration and where feasible, development of deposits within areas classifed MRZ-3 or deposits outside of the OPR areas.
4. Rely upon imports of aggregate from outside of the P-C region.
5. Encourage the use of recycled aggregate materials.

PERMIT EXPANSION OF EXISTING GRAVEL PITS AND QUARRIES

Over one-fourth of the sectors in the P-C Region contain both permitted reserves and non-permitted resources. Permitted reserves are often much less than the total resources within a sector. The amount of deep sand and gravel resources within the Livermore Valley-Sunol Valley-Niles Cone Production District, for example, could quite possibly be as great or greater than the calculated amount of resources within the upper aquifers. Mining of these deep resources would require care to preserve present groundwater quality but would maximize recovery of the valuable P.C.C.-grade resources within the P-C Region.

PERMIT MINING IN PREVIOUSLY UNMINED SECTORS

Permitting mining within the previously unmined sectors would make available more than a billion tons of aggregate, including P.C.C.-grade aggregate. Because of the large volume of resources within these sectors, systematic long-range planning and development for the entire P-C Region would be possible.

ENCOURAGE EXPLORATION AND DEVELOPMENT OF MRZ-3 DEPOSITS

Several deposits classified as MRZ-3 within the South San Francisco Bay P-C Region are good potential sources of aggregate. Other deposits lie outside of the OPR zone and were not classified (marine sand and gravel deposits) but may contain suitable material. In any of these deposits, a detailed exploration and testing program would be necessary to determine quality and extent of the aggregate deposit. The extraction of aggregate from MRZ-3 areas could provide an alternative to mining in designated areas that are deemed by lead agencies to be more suitable for purposes other than mining.

RELY UPON IMPORTS OF AGGREGATE FROM OUTSIDE OF THE P-C REGION

This approach, in the long run, would probably be the most expensive to the people living in the South San Francisco Bay P-C Region. When the reserves within this P-C Region are depleted, consumers would have to rely on outside imports. Supply-and-demand economics dictate that the price of scarce commodities will probably rise. Aggregate should be no exception. Transportation costs would increase as haulage distances increase, and these higher costs would be borne directly or indirectly by all consumers within the P-C Region.

Adverse environmental impacts would accompany this alternative. These include increased air emissions and fuel consumption by haul vehicles, and increased wear to local highways and rail lines.

While reliance on outside imports could alleviate any short-term deficit in the South San Francisco Bay P-C Region, adjacent P-C regions cannot provide an unlimited supply of aggregate over the long term. Only the Monterey Bay P-C Region contains reserves in excess of its own 50-year needs, but this excess is insufficient to balance the shortfall in the South Bay. A long-term solution other than the import alternative is clearly needed.

ENCOURAGE THE USE OF RECYCLED AGGREGATE MATERIALS

At present, some recycling of aggregate products does occur.

Asphaltic concrete and Portland cement concrete are crushed and used for road base, subbase, and fill. Specifications for P.C.C. aggregate, however, do not allow the use of recycled aggregate materials. Recycling of aggregate should obviously be encouraged to lessen demands on limited natural resources. However, the low output of recycled aggregate cannot be expected to make a significant impact on the almost one-billion ton deficit in the foreseeable future. Other alternatives will be necessary.

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APPENDIX A

Principles of the Mineral Resources Classification System of the U.S. Bureau of Mines and the U.S. Geological Survey (From U.S. Geological Survey Circular 831)

Principles of a Resource/Reserve Classification For Minerals

By the U.S. Bureau of Mines and
the U.S. Geological Survey

GEOLOGICAL SURVEY CIRCULAR 831

A revision of the classification system published as U.S. Geological Survey Bulletin 1450-A

1980

Principles of a Resource/Reserve Classification for Minerals

By the U.S. BUREAU OF MINES and the U.S. GEOLOGICAL SURVEY

INTRODUCTION

Through the years, geologists, mining engineers, and others operating in the minerals field have used various terms to describe and classify mineral resources, which as defined herein include energy materials. Some of these terms have gained wide use and acceptance, although they are not always used with precisely the same meaning.

Staff members of the U.S. Bureau of Mines and the U.S. Geological Survey collect information about the quantity and quality of all mineral resources, but from different perspectives and with different purposes. In 1976, a team of staff members from both agencies developed a common classification and nomenclature, which was published as U.S. Geological Survey Bulletin 1450-A—"Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey." Experience with this resource classification system showed that some changes were necessary in order to make it more workable in practice and more useful in long-term planning. Therefore, representatives of the U.S. Geological Survey and the U.S. Bureau of Mines collaborated to revise Bulletin 1450-A.

Long-term public and commercial planning must be based on the probability of discovering new deposits, on developing economic extraction processes for currently unworkable deposits, and on knowing which resources are immediately available. Thus, resources must be continuously reassessed in the light of new geologic knowledge, of progress in science and technology, and of shifts in economic and political conditions. To best serve these planning needs, known resources should be classified from two standpoints: (1) purely geologic or physical/chemical characteristics—such as grade, quality, tonnage, thickness, and depth—of the material in place: and (2) profitability analyses based on costs of extracting and marketing the material in a given economy at a given time. The former constitutes important objective scientific information of the resource and a relatively unchanging foundation upon which the latter more variable economic delineation can be based.

The revised classification system, designed generally for all mineral materials, is shown graphically in figures 1 and 2 (see page 5); its components and their usage are described in the text. The classification of mineral and energy resources is necessarily arbitrary, because definitional criteria do not always coincide with natural boundaries. The system can be used to report the status of mineral and energy-fuel resources for the Nation or for specific areas.

RESOURCE/RESERVE DEFINITIONS

A dictionary definition of resource, "something in reserve or ready if needed," has been adapted for mineral and energy resources to comprise all materials, including those only surmised to exist, that have present or anticipated future value.

Resource.—A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth's crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

Original Resource.—The amount of a resource before production.

Identified Resources.—Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. *Identified resources* include economic, marginally economic, and subeconomic components. To reflect varying degrees of geologic

(**Identified Resources** – Continued)
certainty, these economic divisions can be subdivided into *measured, indicated,* and *inferred.*[1]

Demonstrated. – A term for the sum of *measured* plus *indicated.*

Measured. – Quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and(or) quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurement are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

Indicated. – Quantity and grade and(or) quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

Inferred. – Estimates are based on an assumed continuity beyond measured and(or) indicated resources, for which there is geologic evidence. *Inferred resources* may or may not be supported by samples or measurements.

Reserve Base. – That part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth. The *reserve base* is the in-place demonstrated (measured plus indicated) resource from which reserves are estimated. It may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics. The *reserve base* includes those resources that are currently economic (*reserves*), marginally economic (*marginal reserves*), and some of those that are currently subeconomic (*subeconomic resources*). The term "geologic reserve" has been applied by others generally to the *reserve-base* category, but it also may include the *inferred-reserve-base* category; it is not a part of this classification system.

[1]The terms "proved," "probable," and "possible", which are commonly used by industry in economic evaluations of ore or mineral fuels in specific deposits or districts, have been loosely interchanged with the terms *measured, indicated,* and *inferred.* The former terms are not a part of this classification system.

Inferred Reserve Base. – The in-place part of an identified resource from which inferred reserves are estimated. Quantitative estimates are based largely on knowledge of the geologic character of a deposit and for which there may be no samples or measurements. The estimates are based on an assumed continuity beyond the reserve base, for which there is geologic evidence.

Reserves. – That part of the reserve base which could be economically extracted or produced at the time of determination. The term *reserves* need not signify that extraction facilities are in place and operative. *Reserves* include only recoverable materials; thus, terms such as "extractable reserves" and "recoverable reserves" are redundant and are not a part of this classification system.

Marginal Reserves. – That part of the reserve base which, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technologic factors.

Economic. – This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

Subeconomic Resources. – The part of identified resources that does not meet the economic criteria of reserves and marginal reserves.

Undiscovered Resources. – Resources, the existence of which are only postulated, comprising deposits that are separate from identified resources. *Undiscovered resources* may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or subeconomic. To reflect varying degrees of geologic certainty,

(**Undiscovered Resources**—Continued)
undiscovered resources may be divided into two parts:

Hypothetical Resources.—Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about their quality, grade, and quantity, they will be reclassified as identified resources.

Speculative Resources.—Undiscovered resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade, and quality, they will be reclassified as identified resources.

Restricted Resources/Reserves.—That part of any resource/reserve category that is restricted from extraction by laws or regulations. For example, *restricted reserves* meet all the requirements of reserves except that they are restricted from extraction by laws or regulations.

GUIDELINES FOR CLASSIFICATION OF MINERAL RESOURCES

1. All naturally occurring metals, nonmetals, and fossil fuels in sufficient concentration can be classified in one or more of the categories.

2. Where the term *reserves* is used alone, without a modifying adjective such as indicated, marginal, or inferred, it is to be considered synonymous with the demonstrated-economic category, as shown in figure 1.

3. Definitions of resource categories can be modified for a particular commodity in order to conform with accepted usage involving special geological and engineering characteristics. Such modified definitions for particular commodities will be given in forthcoming government publications.

4. Quantities, qualities, and grades may be expressed in different terms and units to suit different purposes, but usage must be clearly stated and defined.

5. The geographic area to which any resource/reserve estimate refers must be defined.

6. All estimates must show a date and author.

7. The *reserve base* is an encompassing resource category delineated by physical and chemical criteria. A major purpose for its recognition and appraisal is to aid in long-range public and commercial planning. For most mineral commodities, different grades and tonnages, or other appropriate resource parameters, can be specified for any given deposit or area, or for the Nation, depending on the specific objectives of the estimators; therefore, the position of the lower boundary of the reserve base, which extends into the subeconomic category, is variable, depending on those objectives. The intention is to define a quantity of in-place material, any part of which may become economic, depending on the extraction plans and economic assumptions finally used. When those criteria are determined, the initial reserve-base estimate will be divided into three component parts: reserves, marginal reserves, and a remnant of subeconomic resources. For the purpose of Federal commodity assessment, criteria for the reserve base will be established for each commodity.

8. *Undiscovered resources* may be divided in accordance with the definitions of *hypothetical* and *speculative resources,* or they may be divided in terms of relative probability of occurrence.

9. *Inferred reserves* and the *inferred reserve base* are postulated extensions of reserves and of the reserve base. They are identified resources quantified with a relatively low degree of certainty. Postulated quantities of resources not based on reserve/reserve-base extensions, but rather on geologic inference alone, should be classified as undiscovered.

10. Locally, limited quantities of materials may be produced, even though economic analysis has indicated that the deposit would be too thin, too low grade, or too deep to be classified as a reserve. This situation might arise when the production facilities are already established or when favorable local circumstances make it possible to produce material that elsewhere could not be extracted profitably. Where such production is taking place, the quantity of in-place material shall be included in the reserve base, and the quantity that is potentially producible shall be included as a reserve. The profitable production of such materials locally, however, should not be used as a rationale in other

areas for classifying as reserves, those materials that are similar in thickness, quality, and depth.

11. Resources classified as reserves must be considered economically producible at the time of classification. Conversely, material not currently producible at a profit cannot be classified as reserves. There are situations, however, in which mining plans are being made, lands are being acquired, or mines and plants are being constructed to produce materials that do not meet economic criteria for reserve classification under current costs and prices, but would do so under reasonable future expectations. For some other materials, economic producibility is uncertain only for lack of detailed engineering assessment. The marginal-reserves category applies to both situations. When economic production appears certain for all or some of a marginal reserve, it will be reclassified as reserves.

12. Materials that are too low grade or for other reasons are not considered potentially economic, in the same sense as the defined resource, may be recognized and their magnitude estimated, but they are not classified as resources. A separate category, labeled *other occurrences,* is included in figures 1 and 2.

13. In figure 1, the boundary between *subeconomic* and *other occurrences* is limited by the concept of *current or potential feasibility of economic production,* which is required by the definition of a resource. The boundary is obviously uncertain, but limits may be specified in terms of grade, quality, thickness, depth, percent extractable, or other economic-feasibility variables.

14. Varieties of mineral or energy commodities, such as bituminous coal as distinct from lignite, may be separately quantified when they have different characteristics or uses.

15. The amount of past cumulative production is not, by definition, a part of the resource. Nevertheless, a knowledge of what has been produced is important to an understanding of current resources, in terms of both the amount of past production and the amount of residual or remaining in-place resource. A separate space for cumulative production is shown in figure 1. Residual material left in the ground during current or future extraction should be recorded in the resource category appropriate to its economic-recovery potential.

16. In classifying reserves and resources, it is necessary to recognize that some minerals derive their economic viability from their coproduct or byproduct relationships with other minerals. Such relationships must be clearly explained in footnotes or in an accompanying text.

17. Considerations other than economic and geologic, including legal, regulatory, environmental, and political, may restrict or prohibit the use of all or part of a deposit. Reserve and resource quantities known to be restricted should be recorded in the appropriate classification category; the quantity restricted and the reason for the restriction should be noted.

18. The classification system includes more divisions than will commonly be reported or for which data are available. Where appropriate, divisions may be aggregated or omitted.

19. The data upon which resource estimates are based and the methods by which they are derived are to be documented and preserved.

RESOURCES OF (commodity name)

[A part of reserves or any resource category may be restricted from extraction by laws or regulations (see text)]

AREA: (mine, district, field, State, etc.) UNITS: (tons, barrels, ounces, etc.)

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserves		Inferred Reserves		
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUB-ECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		

Other Occurrences	Includes nonconventional and low-grade materials

Author: Date:

FIGURE 1.—Major elements of mineral-resource classification, excluding *reserve base* and *inferred reserve base.*

RESOURCES OF (commodity name)

[A part of reserves or any resource category may be restricted from extraction by laws or regulations (see text)]

AREA: (mine, district, field, State, etc.) UNITS: (tons, barrels, ounces, etc.)

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range (or)	
	Measured	Indicated		Hypothetical	Speculative
ECONOMIC	Reserve		Inferred		
MARGINALLY ECONOMIC	Base		Reserve Base		
SUB-ECONOMIC					

Other Occurrences	Includes nonconventional and low-grade materials

Author: Date:

FIGURE 2.—*Reserve base* and *inferred reserve base* classification categories.

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APPENDIX B

Summary Of The Classification Of MRZ-3 Areas, Construction Materials Only

AREAS CLASSIFIED MRZ-3

A. ALAMEDA COUNTY:

Plate 2.6 Altamont Quadrangle

MRZ-3

(a) Quaternary alluvium (gravel facies) - Positions of boundary lines between MRZ-2 and MRZ-3 are based on the existence of detailed data in well-logs.

(b) Livermore Gravels - Data regarding quality and quantity of material on the eastern edge of several low rolling hills near the western edge of the quadrangle is not available.

Plate 2.7 Briones Valley Quadrangle

MRZ-3

(a) Moraga Formation basalt - small patches within OPR zone that may not meet threshold value. If the material within Charles Lee Tilden Regional Park is added, then the threshold value probably would be exceeded.

Plate 2.9 Dublin Quadrangle

MRZ-3

(a) Livermore Gravels and Quaternary stream channel gravels - This material is similar to that being mined at Mission San Jose and Livermore. There are no active quarries, and the deposit may not reach threshold value.

(b) Briones Formation sandstone - Extensively quarried for crushed stone, but not within this quadrangle. Subsurface data is lacking in the quadrangle. Some deposits may not reach threshold value.

(c) Quaternary alluvium in Amador Valley and western Livermore Valley - DWR data indicates the possible existence of 40-60 feet of gravel, with overburden over 40 feet in thickness and with the amount of interbedded clay and silt over 25 percent. Inadequate well-log data to eliminate possibility of local deposits of commercial sand and gravel.

Plate 2.10 Hayward Quadrangle

MRZ-3

(a) Leona Rhyolite - These areas are classified MRZ-3 due to lack of outcrops, inaccessability, or apparent lack of sufficient material to reach threshold value.

(b) Jurassic gabbro intruded into rocks of Franciscan Complex - These areas are classified as MRZ-3 due to serpentinization and fracturing of material, which renders it unsuitable for aggregate. Detailed mapping and drilling is needed to locate good material.

(c) Oakland Conglomerate - No quarries within this quadrangle, and lack of subsurface data for classification.

(d) Franciscan Complex greenstone - This material is covered by excessive amounts of overburden, and may not meet threshold value.

(e) Briones Formation sandstone - There may be insufficient material within the urbanizing zone to attain threshold value.

Plate 2.12 La Costa Valley Quadrangle

MRZ-3

(a) Briones Formation sandstone - Sandstone is similar to that being quarried for crushed stone elsewhere. The deposit has not been previously quarried but may be suitable for aggregate.

(b) Livermore Gravels - Material at this deposit appears to be similar to the Irvington Gravels, which have been extensively quarried for sand and gravel near Mission San Jose.

(c) Cierbo Formation sandstone - Sandstone of the Cierbo Formation has been crushed and used for aggregate at several localities in Contra Costa County. Similar material may exist at this deposit.

(d) Quaternary alluvium - Floodplain of San Antonio Creek. Local accumulations of sand and gravel suitable for aggregate may exist within this area. Well-log data is not available and there are no known quarries within the area.

Plate 2.14 Livermore Quadrangle

MRZ-3

(a) Quaternary alluvium - 30-50 feet of gravel covered by 35-50 feet of overburden.
(b) Quaternary alluvium (gravel facies) along eastern and western edges of Arroyo del Valle - less than 30 feet of gravel.
(c) Briones Formation - Sandstone of the Briones Formation has been quarried for aggregate near Milpitas. Similar material may exist at this locality, but subsurface data is lacking.
(d) Livermore Gravels - The Livermore Gravels have not been quarried for sand and gravel, but significant deposits may be present.

Plate 2.15 Milpitas Quadrangle

MRZ-3

(a) Quaternary alluvium in the Niles Cone - Sand and gravel deposit with more than 40 feet of overburden.
(b) Santa Clara Formation - No quarry activity in this quadrangle, but gravel beds near Cupertino have been extensively mined for aggregate. Subsurface data is lacking.

Plate 2.17 Newark Quadrangle

MRZ-3

(a) Quaternary alluvium in the Niles Cone - This material has an overburden-to-ore ratio of less than 1:1 (non-economic at present).

Plate 2.18 Niles Quadrangle

MRZ-3

(a) Quaternary alluvium in the Niles Cone - There are 40 feet or more of sand and gravel with an overburden-to-ore ratio of less than 1:1 (non-economic at present).
(b) Irvington Gravels and Quaternary landslide debris - This area may be underlain by Irvington Gravels, but there are no quarries or outcrops to confirm the presence of Irvington Gravels.
(c) Oakland Conglomerate -There does not appear to be enough material to meet suggested threshold value.
(d) Niles Canyon Formation sandstone - This unit was quarried for dimension stone only, not aggregate. A sampling program is needed to determine the extent of suitable material within the deposit.
(e) Briones Formation sandstone with limestone - This unit has been quarried elsewhere but not in this quadrangle. Subsurface data is lacking.
(f) Livermore Gravels - This unit has not been quarried, but may be of commercial-grade locally.

Plate 2.19 Oakland East Quadrangle

MRZ-3

(a) Leona Rhyolite - These are small deposits that individually lack sufficient material to meet suggested threshold value.
(b) Franciscan Complex sandstone - There may be insufficient material to meet suggested threshold value, or no quarry activity to indicate quality of material.
(c) Leona Rhyolite - Small deposit contains old quarry, but appears to have insufficient material remaining to meet suggested threshold value.
(d) Moraga Formation basalt - This is a small deposit, with insufficient material to meet suggested threshold value, if quarried within urbanizing boundary.

Plate 2.23 San Leandro Quadrangle

MRZ-3

(a) Leona Rhyolite - These outcrops are part of a discontinuous belt along the ridgeline. No quarry activity within this quadrangle. The deposits are probably too small to meet threshold value.
(b) Basic intrusive rock - There are several bodies of serpentinized gabbro, but no known quarry activity. Rock quality or overburden thickness are impossible to determine with existing data.

B. CONTRA COSTA COUNTY

Plate 2.25 Antioch North Quadrangle

MRZ-3

(a) Quaternary dune sand deposits - Believed to be similar to those deposits along the San Joaquin River, the area is classified MRZ-3 because of the lack of underground data.

Plate 2.26 Antioch South Quadrangle

MRZ-3

(a) Wolfskill Formation - Locally, this unit may contain resources of aggregate. Insufficient data is available to justify a MRZ-2 classification.

(b) Quaternary dune sand deposits - Meager well-log data indicates that it is doubtful that a site occurs within the area where sufficient sand could be commercially recovered to meet suggested threshold value.

(c) Wolfskill Formation - These areas include a 100 acre quarry which was operated from the 1950s until the early 1970s. Material seen during a field examination was suitable only for fill. The area is given an MRZ-3 classification because better material may occur within the area.

(d) Wolfskill Formation - This area includes an inactive quarry that is now a sanitary land fill. A field examination of the rock remaining at the site shows that the rock is suitable only for fill. However, because rock suitable for aggregate may occur elsewhere within the area, the area is classified MRZ-3.

(e) Domengine Sandstone - This formation consists of sandstone with interbedded mudstone, siltstone, and conglomerate. Sand has been recovered from at least two inactive quarries in the area and is being mined at a nearby site. However, because of the local variation in quality of rock, the area is classified MRZ-3.

Plate 2.27 Benicia Quadrangle

MRZ-3

(a) Briones Formation sandstone - There are no active quarries within the area but rock appears to be similar to that quarried in Alameda County.

(b) Neroly Formation sandstone and Cierbo Formation sandstone - Rock from both of these formations has been quarried for use as aggregate from nearby sites, but because of the apparent variation in quality, the area is classified MRZ-3.

Plate 2.28 Brentwood Quadrangle

MRZ-3

(a) Wolfskill Formation - This unit has been quarried for aggregate at several sites, but because of local variation in the quality of rock, the area is classified MRZ-3.

(b) Quaternary dune sand deposits - These deposits are classified MRZ-3 because of the apparent variation in thickness and lack of available well-log data. All known commercial sand operations in the area are the first stage of a land leveling program needed to convert the dune areas from vineyard and fruit farming to truck farming.

(c) Domengine Sandstone - This formation is being quarried for sand at a nearby site. However, because of the local variation in the quality of rock, the area is classified MRZ-3.

Plate 2.7 Briones Valley Quadrangle

MRZ-3

(b) Briones Formation sandstone - These deposits appear to be similar to Briones Formation sandstone being mined and crushed for aggregate at several localities in Alameda County. The Hambre Sandstone is reported to occur as a narrow northwest trending belt near the center of this unit.

Plate 2.29 Clayton Quadrangle

MRZ-3

(a) Quaternary alluvium along Mount Diablo Creek - Well-log data is inconclusive as to whether or not commercial - size accumulations of sand and gravel exist.

(b) Wolfskill Formation - Although the Wolfskill Formation has been quarried at several localities nearby, the material appears to be suitable only for fill. Because of the uncertainty of the quality of the material in this area, the area is classified MRZ-3.

(c) Neroly and Cierbo Formations - Both of these sandstone units have been mined nearby. The areas are classified MRZ-3 because of the apparent lack of sufficient material to meet threshold values.
(d) Quaternary alluvium in Clayton Valley - This area is classified MRZ-3 because of uncertainty about the quality of the alluvium.
(e) Franciscan Complex greenstone - Greenstone and chert similar to that being mined nearby may occur in this area. No data on extent or quality is available.

Plate 2.30 Diablo Quadrangle
MRZ-3
(a) Neroly Formation - This area includes the site of the former Souza and Lawrence Quarry. Because the material examined at the site appears to be suitable only for fill, the area is classified MRZ-3.
(b) Briones and Cierbo Formations - Both of these sandstone formations have been quarried in the past, but insufficient material lies within the OPR urbanizing zone to meet suggested threshold value.
(c) Orinda or Tassajara Formation - There are two inactive quarries nearby, but material appears to be suitable only for fill.

Plate 2.9 Dublin Quadrangle
MRZ-3
(d) Briones and Cierbo Formation sandstone - Both formations have been mined for aggregate at nearby sites, but due to a lack of previous quarry activity in this area and lack of sufficient material within the OPR urbanizing zone to meet suggested threshold value, the area is classified MRZ-3.
(e) Orinda or Tassajara Formation - Two inactive quarry sites are reported within this area, but field examination of the area indicates that only fill was recovered at the quarries.

Plate 2.31 Honker Bay Quadrangle
MRZ-3
(a) Wolfskill or Tehama Formation - This unit consists of silty clay, sand, gravel, and interbedded volcaniclastic rocks. Sand and gravel is being mined elsewhere (Solano County) from the Tehama Formation. The only quarry within this area is producing bank-run fill. Because of the possibility that local accumulations of sand and gravel may occur within the area, the area is classified MRZ-3.
(b) Neroly Formation sandstone and Cierbo Formation sandstone - Rock from both of these formations has been quarried for use as aggregate from several inactive sites within the area. But because of the apparent variation in quality, the area is classified MRZ-3.

Plate 2.32 Jersey Island Quadrangle
MRZ-3
(a) Quaternary dune sand deposits - These deposits appear to be similar to those being mined a few miles away. Available well-log data indicates that the deposits have a maximum thickness of 30 feet. In order to meet suggested threshold value needed for an MRZ-2 classification, large areas would have to be quarried. Such areas probably do not exist; therefore, the area is classified MRZ-3.

Plate 2.13 Las Trampas Ridge Quadrangle
MRZ-3
(a) Sandstone of the San Pablo Formation of Lawson (1914) - Sandstone suitable for subbase and fill may occur in this area. An inactive quarry is located a few miles to the north, in rock that appears to be similar to material found here. The sandstone found at this site may be suitable for subbase.
(b) Sandstone of the San Pablo Formation of Lawson (1914), and Briones Formation of Ham (1952) - The inactive Mulloy Quarry is located partially within this area. The area is classified MRZ-3 because, based upon a field examination, some doubt exists that the rock is suitable for aggregate other than fill.

Plate 2.33 Mare Island Quadrangle
MRZ-3
(a) Briones Formation sandstone, with minor shale and siltstone - This unit has been quarried for aggregate a few miles to the south. Because the Briones Formation has not been quarried for aggregate in the Mare Island Quadrangle and its suitability for aggregate is unknown, the area is classified MRZ-3.

(b) Neroly Formation and Cierbo Formation sandstones - These deposits have not been quarried but may be suitable for road base material. However, no data is available regarding the suitability of the rock for aggregate.

Plate 2.19 Oakland East Quadrangle

MRZ-3

(d) Basalt and andesite of the Moraga Formation - This deposit has not been previously mined, and information is not available regarding the suitability of the rock for aggregate. The area is classified MRZ-3 because the rock appears to be similar to that mined elsewhere.

(e) Basalt and andesite of the Moraga Formation - This is an extension of a body of basalt and andesite already classified MRZ-2. This narrow belt of rock may not contain enough material to meet suggested threshold value.

Plate 2.34 Port Chicago Quadrangle

MRZ-3

(a) Great Valley Sequence - This unit has been quarried at two sites within the Port Chicago Quadrangle. Based upon a field examination, the material appears to be too soft and weathered for any use except for fill. However, suitable material may be found in the deposits.

(b) Wolfskill Formation - This area includes several inactive quarries but the material appears to be suitable only for fill. Because of the uncertainty of the quality of the material in this area, the area is classified MRZ-3.

(c) Cierbo Formation sandstone - Rock from this formation has been quarried nearby for use as aggregate. However, data regarding quality of rock from this area is not available.

Plate 2.22 Richmond Quadrangle

MRZ-3

(a) Briones Formation sandstone - This unit has been quarried for aggregate a few miles to the south in Alameda County. The area is classified MRZ-3 because its suitability for aggregate is unknown.

Plate 2.36 Walnut Creek Quadrangle

MRZ-3

(a) San Ramon Formation - This is a hard, fine - grained sandstone which may be suitable for aggregate. The sandstone has never been quarried, and no data is available regarding the suitability of the rock for aggregate.

(b) Cierbo Formation of Saul (1973), and San Pablo Formation of Lawson (1914) - Sandstones from both formations are reported to be suitable for aggregate. The area is classified MRZ-3 because of inaccessibility and the lack of good exposures.

(c) San Pablo Formation of Lawson (1914) - This area includes an inactive quarry in hard sandstone. Based upon a cursory examination of the area, it appears that at least part of the rock in the area may be suitable for aggregate. The area is classified MRZ-3 because of the lack of test data.

C. SAN FRANCISCO AND SAN MATEO COUNTIES:

Plate 2.37 Half Moon Bay Quadrangle

MRZ-3

(a) Quaternary marine terrace, alluvial fan, and valley alluvium deposits along the coast - No active operations at present time to indicate the quality of the material.

(b) Cretaceous quartz diorite - Accessible outcrops are weathered; there are no active operations within the OPR zone at this time. Data regarding rock quality and overburden thickness are lacking.

(c) Lompico Sandstone (Miocene) - No active operation at present; the material is probably suitable only for fill.

Plate 2.38 Mindego Hill Quadrangle

MRZ-3

(d) Santa Clara Formation - This is a small deposit that may not contain sufficient material to meet suggested threshold value. In addition, there has been no quarry activity within this body, so there is no data concerning the quality of the material.

Plate 2.39 Montara Mountain Quadrangle

MRZ-3

(a) Franciscan Complex greenstone and Calera Limestone member - These deposits are similar to the deposit at Rockaway Beach, but may lack sufficient material to reach suggested threshold value, or have no previous quarry activity, so there is no data concerning the quality of the material.

(b) Cretaceous quartz diorite - This is the same material that has been quarried at El Granada and Half Moon Bay. The deposits may lack sufficient material to reach suggested threshold value, or they lack exposures that would indicate the quality of the material.

(c) Franciscan Complex greenstone, with minor deposits of limestone, chert, and serpentinite - This unit is presently quarried at several points along the Peninsula. These deposits probably will not attain suggested threshold value.

(d) Merced Formation sand and sandstone - This unit is mined for fill at Colma, and has been mined near Millbrae. Although test data is lacking, the material may be suitable for aggregate other than fill.

(e) Franciscan Complex "sheared rocks" with minor greenstone and serpentinite - Several quarries along the Peninsula have produced aggregate from this unit, but detailed mapping and sampling are needed to locate sufficient coarse material within the clay matrix.

(f) Quaternary marine terrace - This zone includes marine terraces, beach sands, and valley alluvium along the coast between Half Moon Bay and Montara. No aggregate has been produced from these deposits, although asphaltic concrete sand was mined from beach sand deposits approximately one mile south of the quadrangle boundary.

Plate 2.40 Palo Alto Quadrangle

MRZ-3

(a) Santa Clara Formation - There is no data on location or extent of the conglomerate member of the formation. The conglomerate member is the source of sand and gravel being quarried a few miles to the south.

(b) Page Mill Basalt - This material was formerly quarried in the quadrangle. Subsurface data necessary to confirm distribution and quality of the unit are lacking.

(c) Franciscan Complex graywacke - This material has been quarried elsewhere for aggregate. Suitability of material at this locality is not known.

(d) Franciscan Complex greenstone and chert - Part of this deposit is being quarried nearby, but data regarding the rock quality and overburden thickness are not available for this portion.

Plate 2.41 San Francisco North Quadrangle

MRZ-3

(a) Quaternary dune sand - Similar material has been mined for aggregate in the past in other quadrangles. Test data to confirm the quality of the sand in this location are lacking, so the deposit is classified MRZ-3.

Plate 2.42 San Francisco South Quadrangle

MRZ-3

(a) Dune sand - This material has been mined for aggregate in the past. Lack of subsurface data precludes the classification of this deposit as MRZ-2.

(b) Merced Formation sandstone - This material has been used for fill at the San Francisco International Airport. Although test data is lacking, the material may be suitable for aggregate other than fill.

(c) Franciscan Complex graywacke, greenstone, or other members of the Franciscan Complex - Inactive quarries exist at these deposits, but remaining volumes of acceptable material cannot be calculated without data on waste and rock suitability. Threshold values may not be present.

(d) Franciscan Complex greenstone, with minor deposits of limestone, chert, and serpentinite - This unit is presently quarried at several points along the Peninsula. These deposits probably will not attain suggested threshold value.

Plate 2.43 San Mateo Quadrangle

MRZ-3

(a) Franciscan Complex chert, graywacke, and greenstone - At least three quarries have been operated in this deposit (which extends into the Woodside Quadrangle), but data on rock quality, distribution, or overburden thickness are lacking.

(b) Franciscan Complex "sheared rocks" (melange) - This deposit has two inactive quarries, but is classified MRZ-3 due to a lack of data on rock quality, distribution, or overburden thickness. The clayey matrix may contain enough large "knockers" to meet threshold value.
(c) Franciscan Complex greenstone and chert at Coyote Point - This site contains a small, inactive quarry, and suitable material remains in place. However, there does not appear to be sufficient material to attain threshold value.
(d) Merced Formation sandstone - This material has been used as fill at the San Francisco International Airport. Although test data is lacking, the material may be suitable for aggregate other than fill.

Plate 2.44 Woodside Quadrangle

MRZ-3
(a) Santa Clara Formation sand and gravel - A lack of both quarry activity and subsurface data within this quadrangle neccessitates the classification of these deposits as MRZ-3.
(b) Franciscan Complex greenstone - The larger of these deposits has two inactive quarries, but the deposits are classified as MRZ-3 due to lack of data regarding the rock quality and overburden thickness.
(c) Franciscan Complex graywacke, with minor siltstone and limestone - This deposit, which extends into the San Mateo Quadrangle, has been mined in the past, but contains no presently active quarries. A lack of data on rock quality, distribution, or overburden thickness makes it necessary to classify the deposit as MRZ-3.
(d) Franciscan Complex "sheared rocks" (melange) - There may not be sufficient material in this deposit to attain threshold value.

D. SANTA CLARA COUNTY:

Plate 2.45 Calaveras Reservoir Quadrangle

MRZ-3
(a) There are possible sand and gravel resources in the fan at the mouth of Penitencia Creek, but the available data is inconclusive and comes from only one well-log.
(b) Briones Formation sandstone - The deposit does not appear to meet suggested threshold value.
(c) Oakland Conglomerate - This unit has not been quarried previously, but may be suitable for aggregate.
(d) Santa Clara Formation - There is only one inactive quarry in the Santa Clara Formation on the east side of Santa Clara Valley, and there is no subsurface data available for the deposit.

Plate 2.46 Castle Rock Ridge Quadrangle

MRZ-3
(a) Franciscan Complex sandstone and greenstone - This deposit has not been mined, but is too small to meet suggested threshold value.
(b) Santa Clara Formation - There is no data on the presence within the deposit of conglomerate suitable for aggregate.

Plate 2.47 Cupertino Quadrangle

MRZ-3
(a) Santa Clara Formation - This classification includes areas occupied by several inactive quarries. There is insufficient data available regarding areal extent and quality of conglomerate, and thickness or overburden.
(b) Franciscan Complex greenstone - This area adjoins the presently active Neary Quarry, but a lack of information on rock quality and overburden thickness precludes the classification of this deposit as MRZ-2.
(c) Franciscan Complex sandstone - There is insufficient material to attain suggested threshold value. This deposit is an extension of the MRZ-3(c) area in the Mindego Hill Quadrangle.
(d) Franciscan Complex greenstone - This deposit north of the Permanente plant of Kaiser Cement Company does not have sufficient outcrops nor are data on rock quality and overburden thickness available to warrant a classification of MRZ-2. Volcanic tuff may be present within the greenstone, as in the nearby Neary and Page Mill quarries.
(e) Franciscan Complex greenstone - This deposit is an extension of Sector CC. However, a lack of exposures and data on rock quality and overburden thickness precludes the classification of this deposit as MRZ-2.

(f) Quaternary fan deposit of Stevens Creek - This deposit is delineated on the basis of water-well logs in the files of DMG. However, three well-logs at the mouth of Stevens Creek Canyon show the existence of a large body of silt and clay, and detailed drilling and sampling will be necessary to resolve the problem.

Plate 2.48 Los Gatos Quadrangle

MRZ-3

(a) Santa Clara Formation - There are no active quarries in these areas, but conglomerate suitable for aggregate may occur within one or more of the areas given this classification.

(b) Streambed and terrace deposits of Los Gatos and Guadalupe creeks - Once extensively mined, these deposits are now urbanized or used for ground water percolation ponds. Resources of sand and gravel may still be present along parts of Los Gatos Creek channel and terraces, but subsurface data is lacking.

(c) Franciscan Complex greenstone, graywacke, and shale - Part of the area is urbanized, but suitable rock may exist at unurbanized sites. No data as to extent or quality is available.

Plate 2.15 Milpitas Quadrangle

MRZ-3

(b) Santa Clara Formation - Some gravel is found within the unit on the west side of Santa Clara Valley, but no information is available regarding the presence or distribution of gravel in these deposits.

Plate 2.38 Mindego Hill Quadrangle

MRZ-3

(a) Franciscan Complex greenstone - this area has insufficient exposures to provide data necessary for a higher classification.

(b) Santa Clara Formation - This region may contain sand and gravel resources, but subsurface data is lacking.

(c) Franciscan Complex sandstone - This material was formerly mined at the nearby Adobe Creek Quarry, but there is insufficient material to attain suggested threshold value.

Plate 2.16 Mountain View Quadrangle

MRZ-3

(a) Santa Clara Formation - There are no known quarries in the area and no data on the quality of material in this quadrangle. The area is now completely urbanized.

Plate 2.40 Palo Alto Quadrangle

MRZ-3

(a) Santa Clara Formation - There is no data on location or extent of the conglomerate member of the formation. The conglomerate member is the source of sand and gravel being quarried a few miles to the south.

(b) Page Mill Basalt - This material was formerly quarried in the quadrangle. Subsurface data necessary to confirm distribution and quality of the unit are lacking.

(c) Franciscan Complex graywacke - This material has been quarried elsewhere for aggregate. Suitability of material at this locality is not known.

(d) Franciscan Complex greenstone and chert - Part of this deposit is being quarried nearby, but data regarding the rock quality and overburden thickness are not available for this portion.

Plate 2.49 San Jose East Quadrangle

MRZ-3

(a) Guadalupe Creek sand and gravel - Deposit appears to be depleted, but resources may exist at depth.

(b) Briones Formation sandstone - This material is similar to that being mined to the north, but insufficient data is available to justify classification as MRZ-2.

(c) Coyote Creek sand and gravel - This deposit has been mined in the past, and some material may still be present, but subsurface data is lacking.

(d) Oakland Conglomerate - This unit has been mined for aggregate, but no data is available on the suitability of the material at this site. In addition, there is insufficient material present to meet suggested threshold value.

(e) Buried stream channel deposits - These deposits have been delineated by the Department of Water Resources from well-logs. There is no data available on the suitability of material for aggregate.

Plate 2.50 San Jose West Quadrangle

MRZ-3

(a) Santa Clara Formation - Insufficient data available regarding location of conglomerate member of the formation. Material suitable for sand and gravel is found only in the conglomerate member of the formation.

(b) Guadalupe Creek streambed - The southern end of the area has been quarried. Only limited resources remain, which appear to have less than threshold value.

(c) Los Gatos Creek streambed and floodplain - This area was actively mined in the past. Limited sand and gravel resources may still remain, but subsurface data is lacking.

(d) Quaternary fan deposit of Los Gatos Creek - This deposit is delineated on the basis of limited water-well logs in the files of DMG. Detailed drilling and sampling will be needed to verify the existence of the deposit.

Plate 2.51 Santa Teresa Hills Quadrangle

MRZ-3

(a) Franciscan Complex sandstone and interbedded shale - Similar rock is found at the Piazza Quarry, but there is insufficient material to meet suggested threshold value.

(b) Quaternary alluvial fan material - This material was deposited by Coyote Creek as it meandered over the Santa Clara Valley floor. Data regarding sand and gravel content, thickness of deposit, and thickness of overburden are not available.

(c) Alamitos Creek sand and gravel - This zone includes an area mined in the past. Sufficient sand and gravel may be left to meet threshold value, but adequate data is lacking for classification as MRZ-2.

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