

CHAPTER 87

COASTAL SAND MINING IN NORTHERN CALIFORNIA, U.S.A.

by

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ABSTRACT

The commercial mining of sand at coastal locations along California has been a continuing activity at some sites, sporadic at others and altogether discontinued at still other sites. This mining activity includes all methods of sand mining (dragline, self-propelled bottom-dump scrapers, diesel shovels, etc.) and may be classified by littoral zone location as (1) mining from a beach fore-shore or backshore area wetted by the normal tidal range, (2) mining within a river mouth or other estuary upstream from the ocean but still within the tidal zone, and (3) mining from bluff or dune areas not wetted by the normal range of tides but still within the littoral system. Processing of the sand thus mined takes place when the material is transported from the mining site, usually by end dump trucks or belt conveyor to either a fixed or a portable plant.

Commercial uses of the sand thus mined fall into two general categories, (1) construction and (2) special purposes. Construction usage includes aggregate for concrete, asphalt, mortar, plaster and stucco, base material in road construction, and fill and structural backfill. Specialty uses include sand blasting and filtration material, foundry and engine sands, and raw material for manufacture of glass and ceramics.

Within the area studied (see Figure 1) the Monterey Bay area has the highest concentration of mining activity. To the north, the area around Fort Bragg yields significant quantities to the commercial miner. Most of the remaining coastal sand mining activity is concentrated in the San Francisco area.

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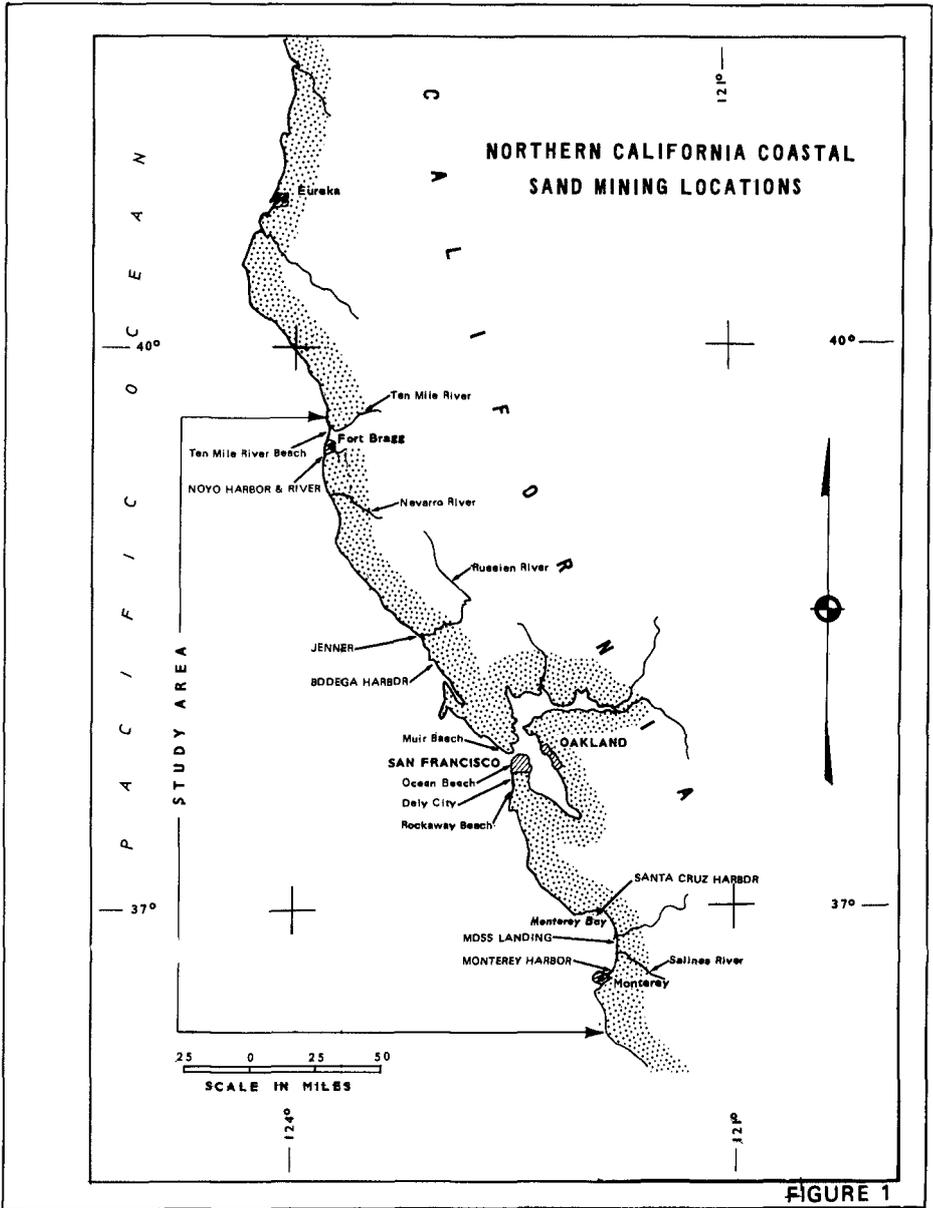


FIGURE 1

Total sand (and gravel) production in California is increasing at a rate that is rapid even when compared with the production increases of other minerals in the state. Although that portion of total sand production occurring in the shore zone is extremely small compared to the vast quantity of sand comprising the present littoral system, the mining of sand does reach significant magnitudes in specific physiographic reaches along the coast. This is important inasmuch as sandy beaches represent a major recreational asset to certain coastal areas of the world.

INTRODUCTION

The study area for this paper extends from the Monterey Bay Area on the south to the vicinity of Fort Bragg on the north, or a total distance of about 230 nautical miles. San Francisco and San Francisco Bay are located about midway between Monterey and Fort Bragg (see Figure 1). Although the investigation of particular sites is limited to this portion of the California coastline, the paragraphs discussing the California sand and gravel industry in general apply statewide. Raised numbers in parentheses throughout the text refer the reader to the list of references at the conclusion of this paper for source material. Additional references of interest are listed following these under the heading "General References."

THE SAND AND GRAVEL INDUSTRY IN CALIFORNIA⁽¹⁾⁽²⁾

The economic and population growth of California has been paralleled by that of one of its leading non-metallic commodities - sand and gravel. This fact is clearly illustrated on Figure 2 which shows total sand and gravel production in the State of California for the years 1920 through 1964. California's total production in 1920 was almost 5 million tons and by 1964 this had risen to over 100 million tons. To further illustrate this growth, by 1969 total production had risen to 125 million tons, by 1970, 140 million tons and last year, 1971, 145 million tons. Since 1942 California has led the nation in the production of sand and gravel, with only petroleum products and cement outdistancing sand and gravel in total production within the state. About two percent of California's total output of sand and gravel is produced from beach and dune deposits.

USES OF SAND AND GRAVEL⁽¹⁾⁽³⁾⁽⁴⁾

About nine-tenths of the state's output is used as aggregate in mixtures of either Portland Cement or asphaltic compounds for use in construction or road building. The remaining one-tenth is specialty sand, mostly used in glass making, sandblasting, filters and foundry processes. This breakdown of sand and gravel into use categories applies to sand alone as well. Commercial uses

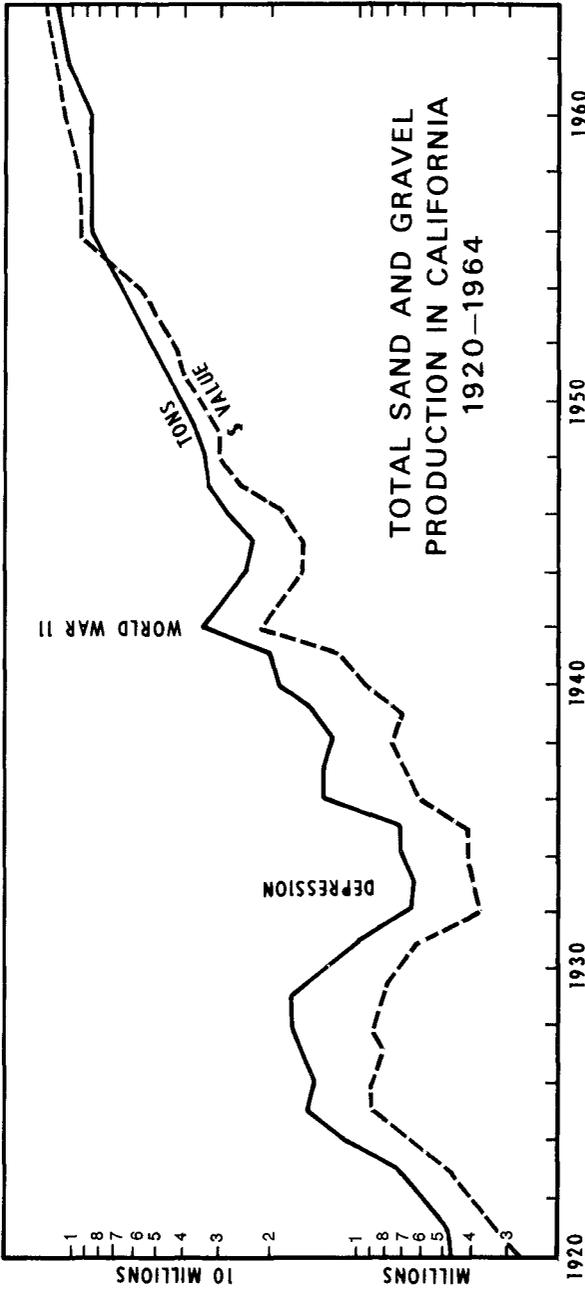


FIGURE 2

of sand fall into two general categories, (1) construction and (2) special purposes. A further breakdown as to specific uses under each general category may be helpful. The "construction" use category includes:

- a. Aggregate for portland cement, concrete, asphalt concrete, mortar, plaster and stucco.
- b. Base materials in road construction.
- c. Fill and structural backfill.

Included under "specialty purposes" we find:

Glass Making	Specialty Aggregate
Foundry and Engine Sand	(granules for roofing,
Paint Filler	landscaping or aquariums)
Enamels	Sandblasting
Pottery and Ceramics	Filtration
Abrasives	

SOURCES OF SAND AND GRAVEL⁽¹⁾⁽⁴⁾⁽⁵⁾⁽⁶⁾

Sand for commercial purposes is commonly found in three different types of source materials: Quaternary^{1/} beach and dune deposits, Quaternary stream deposits in channels, floodplains, terraces and alluvial fans and older formations. Much of the sand and practically all of the gravel used in construction comes from Quaternary stream deposits. Specialty sands and granules, on the other hand, are obtained almost entirely from **Quaternary beach and dune** deposits. The latter deposits are also important sources of construction sand. A small amount of road construction material has been obtained from older formations of sand and gravel.

HISTORY OF SAND MINING

Sand mining activity along the coast can be traced backward in time to about 1865 when California's first State Geologist, J.S. Whitney,⁽⁷⁾ reported that large quantities of white sand suitable for glass manufacture existed in the Monterey Bay-Carmel Bay area at Cypress Point and Pescadero Beach. The first reported use of sand from coastal sources such as these began in Monterey

^{1/} The last one million years, in terms of geologic time, are referred to as the Quaternary Period.

at least as early as 1867 when it was mined for use by the San Francisco glass industry to make lighthouse glass and wine bottles. J.R. Browne⁽⁸⁾ reported that two of the glassworks employed 150 men and boys and annually produced \$250,000 worth of glassware, using the deposits "near the harbor of Monterey" as the chief source of sand.

PRESENT ACTIVITY

Present sand mining activity on the reach of coast from Monterey to Fort Bragg is still concentrated in the Monterey Bay area with the remaining activity essentially limited to the Fort Bragg and San Francisco areas.

SPECIALTY SANDS⁽¹⁾

Keeping in mind the specific uses for specialty sands, in 1964, California produced 1,482,000 tons of specialty sands, or about 1.5 percent of the state's total sand and gravel production for that year. The value of the 1964 production of specialty sand was over \$6,000,000. The following tabulation presents the use breakdown for the 1964 production:

Glass Making	65%
Sandblasting	13
Grinding and Polishing	6
Engine Sand	4
Other Uses	<u>12</u>
	100%

As stated previously, the specialty sands used in California consist largely of material from Quaternary beach and dune deposits and early Tertiary sandstones. Most specialty sands are obtained from the purest available sand deposits that can be economically worked. A high content of quartz makes the sand physically durable and chemically inert, and also provides silica as an ingredient of glass and soluble silicates.

Recent beach and dune sands along the Pacific Ocean, in general, contain a lower percentage of quartz and a higher percentage of feldspar, dark mineral grains, and rock fragments than the Tertiary sandstones that are mined for high silica specialty sands. Beach sands, therefore, are used for minor applications that do not require high purity silica sand. Most beach sand deposits are measurable in millions of tons, have little or no overburden and can be mined inexpensively. Most of the beach and dune sand that is mined in California for specialty uses is obtained from two areas in Monterey County; one immediately southwest of Pacific Grove and the other along the shore of Monterey Bay. The deposits southwest of Pacific Grove are unlike any others in California because of their very

white color and general lack of clay, iron-bearing minerals and rock fragments (Figure 3). The east shore of Monterey Bay is formed almost entirely of sand dunes which have an appreciably higher content of iron than the Pacific Grove sand (Figure 4).



FIGURE 3. Remaining dune deposits Southwest of Pacific Grove

Most of the beach and dune sands in Northern California contain large proportions of dark mineral grains and dark rock fragments, and have been much less extensively used as specialty sands than those from Monterey Bay and southward. In 1963, for example, all of the specialty sand recovered from California beaches was obtained from 7 operations, 5 in the Monterey Bay area and 2 in Southern California.



FIGURE 4. East shore of Monterey Bay

METHODS OF EXTRACTION⁽⁴⁾⁽⁵⁾⁽⁶⁾

How is the sand extracted in coastal mining operations? Most of the operators on Monterey Bay, for example, dredge the sand from the surf zone using a dragline bucket (Figure 5). Some dune sand is also mined in this manner. Other equipment used includes clamshells, diesel or electric shovels, frontend loaders (Figure 6) and bulldozers. Processing of the sand thus mined takes place when the material is transported from the mining site to either a fixed or portable plant. Modes of transportation used include end dump trucks, tractor scrapers, self propelled bottom dump scrapers and conveyor belts (Figure 7). This paper will not attempt a discussion of plant facilities, however, an excellent and detailed discussion of those in the Monterey Bay area is contained in Earl W. Harts 1966 report entitled, "Mines and Mineral Resources of Monterey County."⁽⁴⁾



FIGURE 5. Dragline bucket in surf zone.



FIGURE 6. Removal of sand using front-end loader and dump truck.



FIGURE 7. Transportation of sand from mining site to plant via conveyor belt.

DISCUSSION OF SPECIFIC SITES

The remainder of this paper will be devoted to a discussion of specific operating sites along the coast, beginning on the north near Fort Bragg and proceeding downcoast to the Monterey Bay area. Table 1 gives the distances between these sites in nautical miles. A listing of discontinued operations follows the "MONTEREY PENINSULA" discussion under the heading, "INACTIVE SITES."

TABLE 1

Distances Between Mining Operations Discussed

<u>Site</u>	<u>Miles</u>
Ten Mile River	0-5.0
Ten Mile River Beach	4.0-9.0
Fort Bragg	75.0
Mouth of Russian River	60.0
Golden Gate	5.0
Ocean Beach	6.0
Daly City	80.0
Mouth of Salinas River	12.0
Monterey	4.0-8.0
Monterey Peninsula	

In discussing quantities in the Monterey Bay area it has been necessary to do so in broad terms, i.e., no breakdown is available for each operator. This is, of course, due to the proprietary nature of this information. Another real problem in discussing total quantities for any given reach of coast is that of sand mining done extra-legally. (State and Federal permits are required for any mining activity seaward of the mean high tide line.) These operations go on undetected and the quantities, of course, are never reported. To further compound the problem of how to accurately estimate total quantities, much of the legal sand mining activity occurs above the mean high tide line and may or may not be reported since it's beyond the purview of the regulatory agencies.

FORT BRAGG AREA

Ten Mile River

A Fort Bragg gravel company mines the Ten Mile River streambed deposit which extends for about five miles upstream from a point one mile east of the Highway 1

Bridge. The material is excavated with a dragline to a depth of five feet and then hauled by trucks to the plant about one mile away. Reported capacity of the plant is 300-500 cubic yards per day. Products are essentially concrete sand and gravel and bituminous sand and gravel.

Ten Mile River Beach⁽⁹⁾

From the mouth of the Ten Mile River, approximately nine miles above Noyo Harbor, to Laguna Point, approximately 4.3 miles above Noyo Harbor, the coast is low and contains an extensive beach, locally known as Ten Mile River Beach. Portions of this beach have been intermittently mined for sand by the same Fort Bragg gravel company since about 1961.

At Mean Higher High Water, the beach is about 100 feet wide. The beach consists of a dark sand with a median-grain size at mean sea level of between 0.52 and 0.90 millimeters (mm). The backshore grain size varies considerably from 2.0 mm to 0.52 mm. Ten Mile River Beach is backed by prominent sand dunes. These dunes extend inland approximately 0.8 mile, and are traveling to the south-east under the influence of the predominant northwest wind at an average rate of about two feet per year and at a maximum rate of four feet per year (Figure 8).



FIGURE 8. Inland advance of Ten Mile River Beach dunes.

The State of California is in the process of acquiring Ten Mile River Beach for inclusion in the State Park system. Once included, commercial sand mining on the beach would be prohibited. However, until the transaction is finalized there is nothing to prevent the continuing removal of beach sand. During a period of about one month in the spring of this year, the company mined about 5,000-7,000 cubic yards from two separate beach sites (Figure 9).



FIGURE 9. Upper beach mining site - Ten Mile River Beach

Jenner (Mouth of the Russian River)

The area near the mouth of the Russian River is presently an untapped source of aggregate material (Figure 10). Reliable estimates place the sand and gravel deposit in this area at 60,000,000 tons. A San Francisco based construction and mining company negotiated a lease contract in 1966 with the California State Lands Commission. This gave the company the exclusive right to remove sand and gravel from the bed of the Russian River in an area within 4-1/2 miles of the river mouth. In payment for this privilege, the State could either accept cash royalties or parcels of real property for use as part of a State park. The mining company was unable to extract sand and gravel subsequent to execution of

the contract due to their inability to maintain a channel opening at the river mouth. The company had planned to use ocean going barges to transport the material to their San Francisco Bay processing plant. Then in 1970, strong objections to the proposed operation were raised on environmental grounds and in September 1970 the county of Sonoma turned down the company's permit application.



FIGURE 10. Mouth of the Russian River.

SAN FRANCISCO AREA

San Francisco County - Ocean Beach⁽¹⁰⁾⁽¹¹⁾

In 1953, the city of San Francisco first took bids from private contractors for the mining of sand from Ocean Beach. Between June 1959 and June 1967 a total of 176,000 cubic yards of sand was removed from the section between Sloat Boulevard and the Cliff House. The city dictates how much sand will be removed, and from where. The contractor removes it, and gives the city whatever it needs, for asphalt mix, backfills and sandboxes. The contractor may sell whatever is left, paying the city a specified figure (forty-six cents per cubic yard in 1964, ninety-six cents in 1967).

Because of this operation, an argument has raged for years between local beach buffs who insist the city is ruining the beach for the sake of the "almighty dollar" and the city whose officials defend the sand removal as necessary to prevent closure of the Great Highway by blowing sand. Short periods of closure have been necessitated in the past due to blowing sand and sand on the roadway.

The last collection of money by the city of San Francisco for the selling of sand took place on 14 July 1967. At that time the contractor was instructed to cease his operation, however, he was still conducting unauthorized sand removal activities through October of that year. Shortly thereafter, however, the commercial operation was brought to a final halt.

Subsequent to cessation of the commercial operation in 1967, the city and county of San Francisco has continued periodically to remove sand from the dune and beach areas, presumably to lessen the impact of blowing sand (Figure 11). However, no quantities are available from 1967 to the present.



FIGURE 11. Sand removal from Ocean Beach area - San Francisco

Daly City

According to newspaper accounts in late 1971, (12)(13) the mining of sand from the ocean front near Mussel Rock (Daly City-Pacifica boundary) by a San Francisco scavenger company had, at that time, been going on for about six years (Figure 12). This sand removal was halted in 1971 when the company was notified that they were conducting the operation without the required Federal (Corps of Engineers) or State (State Lands Commission) permits.



FIGURE 12. Scavenger Company sand mining operation -
Daly City

This sand removal beginning in 1965 was necessitated, according to the company, to permit the laying of a foundation for a seawall along a 1,900-foot stretch of beach from Mussel Rock north. The necessity for the seawall was, in turn, attributed to wave action which had, at that time, uncovered an abandoned dump. Refuse from this dump had begun to float to sea and adjacent beaches were being polluted resulting in a cease and desist order from the State Water Quality Control Board pertaining to the dumping site. Construction of the seawall was necessary to satisfy the Board.

According to a company spokesman, only about 2,500 cubic yards of sand were exported over a 10-month period. This material was sold for forty cents a cubic yard. Others estimate this quantity to be much higher and the mining activity to have extended over a longer (6-year) period of time.

MONTEREY BAY AREA⁽⁴⁾

Mouth of Salinas River⁽¹⁴⁾

It has been reported that the Monterey County Flood Control District has been removing sand from the river mouth periodically over a period of about ten years. This is done to provide better flow characteristics thereby reducing flood hazards in the lower reaches of the river. The sand removed by the county is placed alongside the mouth and some of this is probably removed by private interests for varied uses. Although much of the area is owned by a private concrete aggregate company, it is not believed that the company uses any of this material for commercial purposes.

Along Monterey Bay (General)

Sand is obtained from well established plants operating from about two miles south of the Salinas River mouth to the city of Monterey (Figure 13). The mouth of the Salinas River is shown near the lower right-hand corner of Figure 13. Due to the fact that these beaches are either advancing or retreating, sand producers here have some difficulty in locating draglines and equipment.

Total production along Monterey Bay since inception of this industry has been estimated at about 9,000,000 tons.

Lone Star Industries-Lapis Deposit

This site, two miles north of Marina and about two miles downcoast from the mouth of the Salinas River is the northernmost operation in the Monterey area and has been operating since 1906. Since 1929 it has been operated by Pacific Cement and Aggregates, now Lone Star Industries. Processing equipment is now used to produce sand for concrete aggregate and mortar and sand for sand-blasting and other specialty uses.

The modern beach sand has not been used much since 1959. The operator is now using an older beach deposit about one-quarter mile inland from the shoreline. The coarser sand is excavated using a suction dredge floating in a circular pit about 400 feet in diameter. The material is pumped to the plant where it is sorted hydraulically, classified and dried. Sand is shipped from the plant by truck and rail, dry or wet, bulk or sacked.



FIGURE 13. Monterey Peninsula and East shore of Monterey Bay.

Seaside Sand and Gravel Company

This plant is located about one mile northwest of Marina, just north of the Monterey Sand Company's Marina plant and about one mile downcoast from the Lone Star Industries-Lapis Deposit (Figure 14). Since 1957 coarse sand has been taken



FIGURE 14. Seaside Sand and Gravel Company.

from the breaker zone using a dragline scraper. The dunes are not high in this reach of shoreline. The sand is moved to a nearby surge pile and conveyed to washing and screening equipment. Principal products are blasting sand, plaster sand, concrete sand and roofing granules. Sand is shipped in bags or bulk.

Monterey Sand Company-Marina Deposit

This beach sand deposit was developed in approximately 1944 and is located about one mile north of Marina and less than one mile downcoast from the Seaside Sand and Gravel Company operation. The material taken from beach is coarse and well sorted. It is mined from surf zone using a typical dragline scraper. It is then taken from the surge pile, washed and classified. Blasting and plastering sands are the principal products, but the plant also produces engine and filter sand and roofing granules (Figure 15).



FIGURE 15. Monterey Sand Company - Marina Facility.

Lone Star Industries-Prattco Deposit

This deposit is located further downcoast in Sand City but still about five miles upcoast from Monterey. Beach sand mining has occurred at this site since 1921. The present operator, formerly Pacific Cement and Aggregates, produces sand for concrete, blasting and stucco. Dragline scrapers remove sand from both the surf zone and the extensive dune deposits (Figures 16 and 17). The sand is

stockpiled, psrtially sorted and blended. Medium grained sand is taken from the dunes and coarser sand from the beach. Dredging from the beach is often discontinued during the summer when the sand becomes too fine. On the whole, however, more beach sand than dune sand is excavated. The equipment is located on the dunes about thirty feet above sea level.



FIGURE 16. Lone Star Industries-Prattco Deposit,
surf zone mining.



FIGURE 17. Lone Star Industries-Prattco Deposit,
dune mining.

Granite Construction Company Deposit

Located in Sand City, this plant has produced fine aggregate for concrete and asphalt since the late 1940's. Coarse beach sand is taken from the surf zone with a dragline scraper, and medium grained sand is taken by dragline scraper from the dunes. Material over 4-mesh size is removed and the dune and beach sands are blended, stored and trucked unwashed to the concrete and asphalt batch plants one-quarter mile to the east.

Monterey Sand Company-Sand City Deposit

Located in Sand City, this is the last operation before coming to the city of Monterey. This deposit has been worked since before 1931. The present company has been operating here since 1946. Coarse beach sand is taken from the surf zone using a dragline scraper (Figure 18). Dune sand is also taken. From the surge pile the sand is moved by conveyor to the washing-classifying section. It is hydraulically sorted, blended and stored for bulk shipment by truck. The principal products are concrete fine aggregate, plaster sand and blasting sand. The company owns a drying-screening plant two-thirds of a mile to the south.



FIGURE 18. Monterey Sand Company - Sand City Facility.

MONTEREY PENINSULA⁽⁴⁾General

Along the scenic Monterey Peninsula coastline (Figure 13) between Monterey and Carmel, beach deposits are scant, but extensive dunes once stretched up to one-half mile inland and over 200 feet above sea level in height in some areas. The white sand found in these dunes has been used for glass manufacture and specialty construction purposes. It is a medium-grained sand consisting almost entirely of equal parts of quartz and feldspar. These dunes have been mined extensively since about 1903 and the original sand resource is now largely depleted. Figure 19 shows an area that was once covered by extensive dunes. At present two companies have mining operations and/or processing plants on the peninsula coast.



FIGURE 19. Area formerly covered by extensive dunes.

Owens-Illinois Moss Beach Deposit

The first of these is Owens-Illinois whose Moss Beach deposit is located at the southern part of Moss Beach along the Seventeen Mile Drive. The property is owned by Del Monte Properties Company and leased to Owens-Illinois. Dunes up to forty feet in height formerly covered this area reaching about one-half mile inland. Dune sand has been bulldozed to a surge pile and moved on a half-mile long conveyor belt (Figure 20) to the processing plant. Since 1903 this operation has depleted nearly all of the dune resource at this site. The sand from this deposit is classified and extensively washed and cleaned at the processing plant. This process provides the company with the feldspathic raw material for the production of flint and colored glass. A small amount of the sand has been used for other specialty purposes.



FIGURE 20. Surge pile and conveyor belt -
Owens-Illinois Moss Beach Deposit.

Del Monte Properties

The other peninsula operator, Del Monte Properties, is presently limited to the processing of sand trucked in from inland deposits. The company had been operating dune deposits at Moss Beach and Fan Shell Beach, but these resources are nearly depleted.

INACTIVE SITES

Based on a reconnaissance of the study area in 1961, the following coastal sand mining sites were reported as active at that time. In the case of Muir Beach, a field estimate of the total quantity mined was made:

<u>Site</u>	<u>County</u>	<u>Total Quantity Mined (Cubic Yards)</u>
Navarro River	Mendocino	Unknown
Muir Beach	Marin	5,000
Rockaway Beach	San Mateo	Unknown

SUMMARY

In conclusion then, what are the problems facing the sand miner, and conversely, what is mining's effect on the sand resource? One of the miner's problems has just been covered. In areas where mining activity has been going on since the beginning of this century, the sand resource has been noticeably depleted. This is especially true along the Monterey Peninsula where replenishment by wind and wave action is less than the excavation rate. Near population centers, another problem emerges, that of recreational and residential development, such as the golf course shown on Figure 21, further limiting utilization of the remaining beach and dune deposits.

Finally, then, and to repeat an earlier statement, although only about two percent of California's total output of sand and gravel is produced from beach and dune deposits and although this is quite small when compared to the vast quantities of sand comprising the present littoral system, the mining of sand does reach significant magnitudes in specific physiographic reaches along the coast. This is important inasmuch as sandy beaches represent a major recreational asset to certain coastal areas of the world.



FIGURE 21. Golf course, Monterey Peninsula.

ACKNOWLEDGMENT

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