MAUI INLAND SAND RESOURCE QUANTIFICATION STUDY

MAUI, HAWAII

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Prepared for:

COUNTY OF MAUI
DEPARTMENT OF PUBLIC WORKS &
ENVIRONMENTAL MANAGEMENT

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1. PURPOSE

This study was commissioned by the County of Maui, Department of Public Works and Environmental Management, for the purpose of better understanding the extent of the inland sand supply that is available for excavation on the island of Maui. Sand is an essential component of Hawaii's two main industries – tourism through its beaches, and construction with its concrete and fill requirements. As the amount of sand available for excavation is limited by the physical extent of inland sand dunes, burial complexes, and existing and proposed land use, the Department is seeking a quantification of the available supply of inland sand in order to better manage this resource.

2. MAUI INLAND DUNE SAND - DESCRIPTION

The "Soil Survey of the Islands of Kauai, Oahu, Maui, Molokai, and Lanai, State of Hawaii", 1972, published by the United States Department of Agriculture, Soil Conservation Service, describes two types of soil in the central valley of Maui which consists of calcareous sand. Calcareous sand is composed mainly of calcium carbonate derived from shells or the skeletal remains of marine organisms.

One type found often along narrow strips of beaches, is called Jaucas sand, 0 to 15 percent slopes. It is described as single grained sand, pale brown to very pale brown in color, and more than 60 inches deep. The water erosion hazard is slight, but wind erosion is a severe hazard where vegetation has been removed. It is generally found in elevations from sea level to 100 feet.

The other type is called Puuone sand, 7 to 30 percent slopes. This soil is very similar to the Jaucas sand as both are derived from coral and seashells. However this type of sand is found at elevations from 50 feet to 350 feet which is higher in elevation than the Jaucas sand locations. The Puuone sand is the type that comprises most of the Central Maui inland dunes.

These sand deposits were built up over thousands of years when the central valley was covered by the ocean and also through conveyance by the winds. The sand granules in the inland dunes are finer in gradation than generally found in the sand on most beaches. This is due to the wind blown nature of these deposits, since the lighter particles are the ones that are most likely to be picked up and carried by the winds.

Most of the sand deposits are generally sitting on hard pan composed of clay or they may be on a rocky substrata. In most cases, the surface of the dunes has a thin layer of organic material consisting of decomposed vegetation that has grown over the years. Once the organic material is removed, the sand under the surface is generally fairly clean.

Companies that use the sand as a component for concrete screen the sand to remove larger particles such as sand stones, and roots. Sand which is unsuitable for concrete because of high organic content is used for backfill material and is generally not screened

3. MAUI INLAND DUNE SAND - LOCATION

The inland sand deposits start downwind of the mouth of Waihee Stream, parallels along the Waiehu coastline, and fans out towards Maalaea generally between Kahekili Highway and Honoapiilani Highway on the west side, and Kuihelani Highway on the east. Waiko Road demarcates the generally southerly boundary of the dunes, though there is a sand layer under the more or less level lands towards Maalaea. (See Location Maps, Figures 1, 2, and 3).

In general, the largest sand deposits are visible along Waihee and Waiehu, and in Wailuku. These larger dunes may exceed one hundred feet (100') in depth. The Waihee dune runs along lands that are owned by the Maui Coastal Land Trust, along the Waiehu Golf Course, and into the Leisure Estates Subdivision. The Waiehu Heights Subdivision also sits on top of a substantial sand dune.

The largest dune in Wailuku runs immediately south of Lower Main Street and east of Waiale Drive. The area is appropriately called "Sand Hills". There is another very large dune in the area upon which Mahalani Street and the Maui Memorial Medical Center are located.

The dunes located south of the Mahalani Street dune in the area of Maui Lani are generally lower in height when compared to the larger dunes to the north. The sand deposits from Maui Lani to the south towards Maalaea do, however, cover a large area.

4. HISTORY OF SAND USAGE

Sand was a very easily attainable commodity on Maui prior and immediately after World War II. There were many large, undeveloped parcels at that time containing a great supply of sand.

An August, 1954 report by Doak Cox (Reference No. 2), entitled "The Spreckelsville Beach Problem", states that the use of sand for road resurfacing and concrete, averaged about 8,500 cy, or 10,600 tons per year for the five years prior to his report. Mr. Cox also estimated that 3,500 cy, or 4,400 tons per annum was utilized in lime manufacture.

For a number of years before and after the writing of Mr. Cox's report, Hawaiian Commercial and Sugar Co. operated a lime kiln in Paia which utilized the sand from off the beach. The company also hauled the sand from off the site for principally cane haul road resurfacing, but also for the manufacture of concrete. The lime kiln shut down approximately 30 years ago.

Prior to WWII, Portland cement concrete was not very commonly used in construction in Maui. However during the early 1940's, the Navy Seabees started a quarry and set up a rock crushing plant at Camp 10, Puunene, which was located above the Haleakala Highway and Hana Highway junction. The Seabees also setup concrete batching and asphalt paving plants which were used to provide materials to construct the Puunene military airport, bunkers, and camps to house the thousands of military men that were based on Maui during the war.

After the war, a private company called Concrete Industries, Inc. (CII) bought the equipment and went into business at the same location. The concrete business was relatively slow back then, with an average volume not exceeding 2,000 cubic yards per month. Each cubic yard of concrete used about 0.3 tons of sand. Thus, the volume of sand usage in concrete during the period from 1950 to 1970 probably averaged less than 8,000 tons per year.

After 1970, the pace of development started to increase along with the demand for concrete. In 1972, the Kaahumanu Shopping Center was constructed, as well as the first condominium in Kihei (the Mana Kai). Wailea Resort also started construction of its first golf course, and the first hotels in Wailea were built soon after.

At about the same time, the allure of Maui was being discovered by visitors from the mainland USA and Canada, and many of those who came to visit Maui, decided to purchase condominium units. The idea of condominium ownership started becoming very popular. Between 1972 through 1982, many condominium projects were built along the Kihei coast, as well as from Lahaina to Napili in West Maui. In addition, the Wailea and Kaanapali Resorts had a number of hotels constructed in that period of time.

Government also had to keep up with infrastructure, and the County built its 9 story office building in Wailuku in 1972. A new wastewater treatment plant was built in Kahului in the early 70's as well as construction of wastewater plants in Lahaina and in Kihei a little later.

The ramp up of construction in the 70's required a much greater amount of concrete and its components including sand. There were two concrete supply companies in the market during that decade. These were Ameron HC&D, which had purchased CII, and Maui Concrete and Aggregates (MCA). The latter was subsequently taken over by Hawaiian Cement. Between the two companies, average concrete production during that decade was probably in the neighborhood of 160,000 cubic yards, which required 48,000 tons of sand.

5. THE SAND ALTERNATIVE

In the 1970's and early 1980's, the concrete companies in Honolulu were using a product called Mansand (short for manufactured sand) to provide the fines in their concrete. Mansand was being used because the natural sand supply on Oahu was very limited in availability. Mansand was produced by crushing basaltic rock to meet the requirements of the applicable aggregate and concrete specifications.

However Mansand due to the type of base material used and also due to the crushing process, produced concrete that was not fluid or very workable. In addition, more cement had to be used in the mixes to attain similar compressive strengths when compared with the Maui mix designs.

Portland cement is a fine powder made by heating and mixing various minerals. When mixed with water, the cement becomes the binding agent in concrete. Portland cement is shipped into Honolulu from various out of state sources, and is stored and distributed by Hawaiian Cement. .It is the most expensive ingredient in concrete. The cement is shipped from Honolulu to Maui so the cost of cement on Maui is higher than it is in Honolulu.

However in the early 1980's, the Honolulu concrete batching plants had to use significantly more cement than the Maui plants used for similar mixes. Thus the cost of concrete at the plants was more in Honolulu than on Maui despite cement being cheaper in Honolulu. During that period of time, the Honolulu plants were using Mansand, and the Maui plants were utilizing Maui inland sand in their concrete mixes.

The differences between the concrete produced on Maui and that on Oahu was looked at closer by the test labs. A sample of Maui inland dune sand was sent to Honolulu by Ameron to be tested in concrete made with the basaltic rock that was mined there. It was found that similar savings in cement usage was attainable in the concrete mixes on Oahu if natural sand could also be used.

A closer analysis of Mansand and Maui inland sand revealed the reason for the improved quality of concrete with the Maui sand. The Mansand individual particles were very angular, more cubicle than round in shape. Natural sand particles are very smooth and act like little ball bearings in the concrete mixes which increases the fluidity of concrete so that it may be easily finished, and which will also allow the concrete to flow much easier into wall forms.

It was found that the trucking and barging costs of bringing sand from Maui to Honolulu were largely offset by the savings in cement. In addition, the quality of concrete was vastly improved and the increased workability greatly aided the contractors in the construction of their projects.

Another alternative to natural sand which may have been explored would have been the use of crushed recycled glass. Recycled glass is currently required for some government projects in asphalt concrete pavements, or in trench backfill. This has never been fully looked into because the available quantities of recycled glass are much smaller than the required amounts of the fines used in the concrete market. In addition there may be the same quality problems found in crushing basaltic rock, in that angular edges of fine aggregate produces a non-fluid, and hard to finish concrete mix.

6. EXPORTING OF SAND TO OAHU

Around 1985 the Leisure Estates Subdivision was constructed in Waiehu. It was located just south of the Waiehu Golf Course, and it was built upon a large sand dune. Though the project was not designed to maximize the amount of sand that would be removed during construction, a considerable quantity of sand was excavated due to the cutting of the roadways, and the shaping and leveling of the individual lots. The excess sand was trucked and stockpiled on an adjoining property to the north on which the Waiehu Kou Subdivision was later built upon. Ameron made a decision to purchase the sand to barge it to Honolulu. The first barge load of sand to Honolulu was in 1985 and it has continued since. At current rates of export,

approximately one barge load of sand each week leaves from Maui to Honolulu.

The use of sand or an alternative equivalent in concrete in Honolulu will probably need to continue even if sand will not be available for export from Maui in the future. The contractors and other users of concrete on Oahu will demand that the quality of concrete be maintained as it has been for the last 20 years. Other possible sources of sand outside of the State are starting to be looked at, as well as the use of new technologies, to replace sand in order to maintain consistent concrete quality and production.

The demand and production of concrete in Honolulu is in the order of about four times that of Maui. In Honolulu however, the companies try to economize on the amount of sand in their concrete to keep the cost as low as possible, while still producing a quality mix. They traditionally use a little less sand than the Maui companies use in their concrete. Thus, the export of concrete quality sand to Honolulu is not an exact correlation to the ratio of concrete demand on both islands.

Significant quantities of sand have been excavated in several sites in the Waihee area and Central Maui. These include the sand from Leisure Estates, the mauka side of the Waiehu Heights Subdivision, several properties along Piihana Road, an area adjacent to Waiale Road, and in parts of Maui Lani.

7. OTHER USES OF SAND

The discussion thus far, has dealt with the quality sand that is used by the concrete companies in their mixes. The sand used in concrete can be categorized as grade "A" in quality as it has to be relatively clean, and meet a certain minimum standard set by the concrete companies' testing labs.

However, sand is also used for other purposes in construction. It is used quite commonly as backfill material in utility trenches. While select onsite or offsite materials such as select granular materials, can be used in most cases for trench cushion and backfill, contractors most often prefer sand since it can be very quickly placed and water tamped to attain the proper compaction. Thus, even though it might cost more to truck the product into the project site, sand is the preferred backfill material for most contractors. However, the trench backfill sand does not need to be of the same quality used by the concrete companies. The sand could have some silt in it, and still be utilized for the purpose intended. This grade "B" sand is not exported to Honolulu.

Some projects in the 1970's and 1980's may have also used sand for general fill requirements in raising the elevation of a site. The Kaonoulu Subdivision in Kihei that was constructed around 1988, used many thousands of yards of inland dune sand to fill that site.

Clean sand has been too valuable over the last 15 years to be used for general fill purposes. It is cheaper to find organic soil and rock borrow sites, or to purchase crusher run from the quarries than to use sand for fill.

Maui inland grade "A" dune sand has also been used for beach replenishment or nourishment purposes. The quantities used for beach replenishment have been relatively small thus far compared to that used by the construction industry.

The Kana`i A Nalu condominium in Ma`alaea and the Sugar Cove condominium in Spreckelsville were two projects in recent years which trucked in and placed sand upon their adjacent beaches. It has been estimated by Zoe Norcross-Nu`u, Coastal Processes Extension Agent, of the University of Hawaii Sea Grant College Program, that a total of 43,000 cubic yards of inland sand have been used for beach replenishment projects to date.

For purposes of this report, the sand inventories described further in this report are clean grade "A" sand suitable for concrete or for placement on a beach, and does not include grade "B" sand.

8. CONVERSION FACTORS AND COMPARISONS

To make it easier for the lay person to understand the following sections of this report, the following conversion factors and quantity comparisons are included for reference:

1 cubic yard of sand in volume can be contained in a box that is 3 feet wide on each side by 3 feet high.

1 cubic yard of sand weighs approximately 1.25 tons.

1 acre equals 43,560 square feet.

A football field between the goal lines is equivalent to 1.1 acres.

1 acre of sand that is one foot deep equals 43,560 cubic feet or 1,600 cubic yards.

1 acre of sand one foot deep is also equivalent to 2,000 tons.

Kaanapali Beach had approximately 566,000 cubic yards, or 700,000 tons of sand in 1997 based upon research by Eversole and Fletcher of the University of Hawaii (Reference No. 3).

A typical barge load of sand is equivalent to 4,000 tons.

A standard tandem dump truck holds 15 cubic yards or 19 tons of sand.

A semi-trailer end dump holds 24 cubic yards or 30 tons of sand.

A 4,000 ton barge load is equivalent to 133 semi-trailer end dump loads.

9. CURRENT USAGE

The two main producers of concrete on Maui and also in Honolulu are Ameron Hawaii and Hawaiian Cement. They have an interesting relationship in that Ameron is a customer of Hawaiian Cement for the purchase of Portland cement, however they are competitors in the concrete and aggregates market. Their market share has historically been about even on Maui, but Ameron normally has had a greater market share of the concrete business on Oahu.

Hawaiian Cement is currently using about 44,000 tons of sand per annum on Maui, and exporting about 144,000 tons per annum to Honolulu. Ameron currently is using sand at the rate of about 30,000 tons annum on Maui, and exporting about 100,000 tons per annum to Honolulu.

Between the two companies a total of approximately 244,000 tons of sand per annum is currently being barged to Honolulu for use in ready mix concrete, while an additional 74,000 tons are used locally on Maui.

Usage within past ten year periods would have the following approximate totals, based upon concrete production:

HISTORICAL CONCRETE SAND USAGE (tons)

	Used on Maui	To Honolulu	TOTAL
1956 to 1965	100,000	0	100,000
1966 to 1975	170,000	0	170,000

1976 to 1985	400,000	50,000	450,000
1986 to 1995	700,000	1,800,000	2,500,000
1996 to 2005	800,000	2,200,000	3,000,000

PROJECTED CONCRETE SAND USAGE FROM 2006 (tons)

Per annum	74,000*	244,000**	318,000
10 Year Period	740,000	2,400,000	3,200,000

* Maui Use: Ameron 30,000 tons, Hawaiian Cement 44,000 tons.
** Oahu Use: Ameron 100,000 tons, Hawaiian Cement 144,000 tons.

The 10 year projections are based upon current consumption levels of concrete sand requirements only.

10. AVAILABLE INVENTORY

Most of the inland sand dune areas are no longer available for excavation. Some sites such as the properties along Piihana Road have been depleted of their inventory. The northern Waihee dune is protected from excavation or of any other type of disturbance to the land. It is owned by the Maui Coastal Land Trust and the land will be kept in perpetuity as a natural preserve.

Most of the other large dunes have been developed upon with residential housing projects. These include the Leisure Estates Subdivision, Waiehu Heights Subdivision, the dune above Lower Main Street, and the Sand Hills Subdivision. The Mahalani Street dune has also been extensively built upon with Maui Memorial Medical Center at the top, along with other medical facilities, as well as other governmental and non-profit agencies.

For the last 15 years, there have been sand excavation activities at various parcels in Maui Lani. Ameron is currently working on a Maui Lani site located at TMK (2) 3-8-007:131. This site will probably be the last area that Maui Lani Partners will allow sand to be excavated and removed offsite. Maui Lani feels that all of the other currently undeveloped areas that it owns will need to retain the excess material in order to fill and balance the low areas.

If this is the case, the last remaining available site with significant reserves is the 435 acre parcel that is owned by A&B in lower Waikapu located at (TMK (2) 3-8-007:101) aka as Lot 12-A. (See Location Map, Figure 1).

This site is bordered by Kuihelani Highway to its east, smaller individual parcels that are adjacent to Waiko Road along its southern boundary, and the old Waikapu landfill along a portion of its western boundary. Its northern property line borders several large parcels that are owned by Maui Lani Partners.

Hawaiian Cement is currently working in the western portion of this parcel. This area contains smaller dunes that are five feet to 30 feet in depth. However a good portion of that area has already had its sand removed or it did not contain much recoverable sand on it to begin with.

At this time, 22 acres of the dunes have been restricted from further excavation to protect burial sites. More than 50 individual burial sites have been located in the area. The burials consist of native Hawaiian skeletal remains (iwi). Most of the burials are protected by a minimum buffer zone of 50 feet. (There are two previously identified burial sites that have 100 foot buffers).

On the island of Maui, there is a high probability of iwi being buried in the sand dunes. Hawaiian Cement has been working diligently with the Department of Land and Natural Resources, State Historic Preservation Division, and the Island of Maui and Lanai Burial Council on the treatment of identified burials.

Hawaiian Cement has an archaeologist on site that monitors all ground disturbance and excavation activities. The archaeological monitoring plan that was submitted for this work was reviewed and approved by the State Historic Preservation Division and imposed as a condition of the grading permit.

They currently have an agreement with the land owner, A&B Properties, to excavate upon 188.8 acres, but it may possibly be increased by another 46 acres, for a total of 235 acres. (See Location Map, Figure 1).

Sand dunes on the site are clearly discernable by sight observations and through shade files derived from an aerial photo. However, these dunes are not as high or as deep as those located to the north of the site in the Maui Lani properties.

<u>HAWAIIAN CEMENT INVENTORY ON LOT 12-A, ON 234.5 ACRES</u>

Assumptions:

* 32 acres have already had its sand removed. Of the 32 acres, half of the area was within and half outside of the main dune on the site.

* 20% of the remaining area has little recoverable inventory.

* The major dune on the site covers an area of 44 acres with an average recoverable depth of 6 feet.

* Approximately 22 acres of the dune cannot be disturbed due to archaeological preservation restrictions.

* The remaining area outside of the dune will have an average recoverable depth of sand of 4 feet.

One acre sand per foot of depth: 43,560 x 1 /27 x 1.25 = 2017 tons

Sand Dune	44 x 6 x 2017	= 532,000 tons
Less Restricted Area	(22/44 x 532,000)	= - 266,000 tons
Quantity of Sand Within Dune		= 266,000 tons
Area Outside of Dune	(0.8*(235 – 44) x 4 x 2017	= 1,234,000 tons
Total Sand Prior to Excavation		1,500,000 tons
Less Sand Excavated To Date	(16/22)*532,000 + (16/152.8)*1,234,000 =	516,000 tons
Remaining Sand Inventory		984,000 tons

Hawaiian Cement uses about 3,600 tons per month on Maui, and barges 12,000 tons to Honolulu. Thus, they use a total of 15,600 tons per month, or 188,000 tons per year. Thus the remaining sand inventory would compute to a 5.3 year supply at the current usage rate.

In summary, the computed inventory of 984,000 tons would amount to a 5 year supply for Hawaiian Cement's Maui and Honolulu use. As the factors affecting usage and inventory may vary widely from the assumptions made, the available life may vary from that estimate.

AMERON HAWAII INVENTORY

MAUI RESERVES

Ameron has stockpiled a 5 year supply at their Puunene plant or about 120,000 tons of sand at current sand usage rates for Maui ready mix concrete use. They have recently started to reduce the amount of sand in their mixes to make the inventory last longer. To build this inventory, Ameron had entered into an agreement with Maui Lani

Partners to excavate the sand from their southwestern most parcel which is located just north of the old Waikapu landfill.

This site contains reserves that are much deeper than the Hawaiian Cement sand excavation site. In addition, it does not have the large concentration of burials that Hawaiian Cement has on its site. The parcel that Ameron is on has had two sites identified which contained a total of four individual burials.

The sand from this site was excavated, trucked, and stockpiled at Ameron's Camp 10, Puunene, baseyard, to create this 5 year inventory.

HONOLULU RESERVES
Ameron will also be removing sand from the same parcel for storage and barging to Honolulu. The storage requirement is necessary since Maui Lani has stipulated that the available sand on the site be removed within the next one year period; thus they will be storing the sand on a vacant area that is owned by A&B Properties, which is located adjacent to the Maui Lani parcel.

They will be able to remove and store about 600,000 tons of sand which is equivalent to a six year supply for their company's use in the Honolulu ready mix concrete market.

OTHER POTENTIAL RESERVES
In addition, Ameron has entered into an agreement with A&B to remove the sand from the eastern half of the same large parcel that Hawaiian Cement is currently excavating the sand from. This 200 acre area is fairly flat without any significant sand dunes. A portion of the site was also cleared and leveled in the past. (See Location Map, Figure 1).

AMERON HAWAII INVENTORY ON LOT 12-A, ON 200.0 ACRES
Assumptions:

* 40% of the site does not contain recoverable sand.

* The recoverable sand on the remainder of the site will be 4 feet deep.

One acre sand per foot of depth: 43,560 x 1/27 x 1.25 = 2017 tons

Available Sand on Lot 12-A 0.60 x 200 x 4 x 2017 = 970,000 tons

Total Ameron sand usage per annum 130,000 tons per year

Time of Use of Sand on Lot 12-A 970,000 / 130,000 = 7.5 years

However, there may be several factors that will preclude the use of sand from this portion of Lot 12-A. First of all, Ameron will have an available 6 year inventory of sand from the Maui Lani site that they are currently working upon; thus, they will have a reasonable supply of sand to take care of their needs for the immediate future.

However, A&B may not be able to wait an extended period of time for Ameron to remove the sand. They have other plans for the property which will limit the time available for removal of the sand.

Also, since the land in the area is fairly flat and the grade is at the approximate elevation of Kuihelani Highway, any material excavated will have to be replaced by another type of fill to keep the surface of the property at the existing grade. In addition, the top one or two feet of material will need to be grubbed off and will be unusable for concrete sand purposes. There will also be the cost of archaeological monitoring for any work on this property.

Thus the cost of removal of this relatively shallow layer of sand will be very high. Recovery of the sand for long term storage will probably not justify the cost of grubbing, archaeological monitoring, import of fill, and restoration of the surface.

For all intents and purposes, Ameron's stockpile of sand stored at their Puunene plant site, along with the remaining quantity left at their Maui Lani sand excavation site will be their last available sand resources. This inventory will take care of their needs for the next five to six years.

11. EXTERNAL FACTORS

There are other factors that will affect the use of sand in concrete. Some of these are apparent such as the strength of the construction industry, and the costs involved in excavating and hauling of sand. Other factors may not be so apparent.

One potentially looming impact on the use of sand in Honolulu is a potential restriction by the State Department of Transportation on the sand barge from berthing in Honolulu Harbor. The DOT is currently looking at creating space for the Super Ferry in Honolulu Harbor. As available harbor space is restricted, other uses are being consolidated or will be transferred to Kalaeloa Harbor on the west side of Oahu. The berthing and unloading of the sand barge may be required to be performed out of Kalaeloa within a year or two.

If this happens, the cost of concrete sand to the batch plants on Oahu will greatly increase. Not only will there will additional barging costs due to the greater distance for the tugboats, but the cost of trucking from the product from Kalaeloa Harbor back to Honolulu and to other plants such as in Kailua will be greatly increased.

While most of these expenses will probably be passed on to the consumers, it will not help the concrete producers to compete for future projects against other construction materials such as steel, wood, and asphalt. Increasing their prices may have a longer term negative effect on their unit sales in the future.

Another development which could affect the use of sand is a new technology which possibly could reduce or eliminate the use of natural concrete sand in the future. This is a liquid additive which will impart a negative charge on the finer particles within a concrete mix allowing the mix to be more fluid and workable. Research is currently being conducted to see if this may be a possible solution to eliminate the use of natural sand in concrete in the coming years.

12. SAND FOR BEACH REPLENISHMENT

The "Beach Management plan for Maui", December, 1997, (Reference No. 8), defines beach replenishment, aka nourishment, as "a technique used to restore an eroding or lost beach or to create a new sandy shoreline, involves the placement of sand fill with or without supporting structures along the shoreline to widen the beach". It further goes on to state that it is "the only management tool which serves the dual purpose of protecting coastal lands and preserving beach resources".

The quantities of sand required for beach replenishment so far have been relatively small compared to the quantities required for use by the concrete industry. As previously stated, it has been estimated that 43,000 tons of inland sand has been used for beach replenishment purposes, as compared to 3,000,000 tons for use in concrete.

However, the demand and need for beach replenishment will most probably increase in the near future. The tedious and costly permitting process for beach replenishment projects has been recently streamlined. Zoe Norcross Nu'u of the University of Hawaii Sea Grant Program, also provided the following information on the change in permitting procedures and its effect on future projects:

"Prior to 2005, the permit process for beach replenishment was lengthy and complicated to a point where only the most dedicated applicants were able to see it through. This was compounded by the fact that one of the state agencies involved in the permit process was not supportive of beach replenishment due to their concern about potential negative environmental impacts. The two projects that were successful in obtaining permits were Sugar Cove in Spreckelsville and Kanai A Nalu in Maalaea. With the development of the new streamlined beach replenishment permit application process in 2005 that has combined all the necessary state and federal permits into a single application, it is expected that the number of applicants for beach replenishment will increase. The average rate of shoreline retreat for the island of Maui is 1 foot/year, so erosion issues are becoming increasingly apparent and severe. Currently the only means of shore protection on sandy shorelines that is encouraged by state, county and federal agencies is beach replenishment, and beach replenishment is increasingly being used as a condition of other development permits.

"The new streamlined permit allows for projects of less than 10,000 cubic yards to take place provided that no negative impacts are anticipated. There are two categories, one for projects of less than 500 cubic yards (Category I) and one for projects of up to 10,000 cubic yards (Category II) under which applicants may apply. While it is difficult to predict how much sand will be needed for a given project and how frequently the sand placement will need to take place, it should be noted that in the vast majority of cases, beach replenishment needs to be repeated every year or every few years. Thus, most groups that undertake beach replenishment understand that they are making a long-term commitment to regular sand placement. As such, as new projects come online, the total volume of sand required annually for beach replenishment will most likely increase."

Ms. Norcross-Nu`u projects that in the near future there may be an annual demand of 10,000 cubic yards, or 12,500 tons of sand for beach replenishment. This need will also increase over time.

So where will the sand for beach replenishment come from once the concrete companies stop using Maui inland dune sand in their products? One option is to look for construction projects that may have a surplus of material from which the contractor or property owner may be willing to sell. However the timing of material availability will have to be right in order for this scenario to be feasible.

Another option is to deal with the owner of a property to excavate the sand from it. There are individual properties along Lower Main Street,

Piihana, Maui Lani, and Waikapu which contain sand. These are properties with quantities of sand which are too small to interest the concrete companies but which may be sufficient for the needs of an individual beach project.

The negative aspect of this option is that besides the obvious expenses of purchasing and trucking the sand for placement on a beach, the buyer will have to be willing to coordinate and to pay the expenses of testing the sand, to provide for an archaeological survey and monitoring, to obtain a grading permit, and to restore the site. The unit costs could become prohibitive for an individual beach replenishment project.

The large scale operation of the concrete companies ironically helps to reduce the cost of beach replenishment projects. The cost of opening, operating, testing, monitoring, and restoring a site is amortized over a large quantity which reduces the unit cost of the product for sale to beach replenishment projects. Once the companies close down their sand removal operations, the cost of sand on the island will probably greatly increase as there will not be a company with an ongoing sand processing operation that one could call upon.

A third possible option would be to work with the concrete companies while they are still excavating Maui inland sand, and have them designate a stockpiled supply of sand for beach restoration purposes only. There will probably be a need to provide funding to cover the expenses of purchasing, trucking, and storage for a period of time until the sand could be sold for various beach replenishment projects. However as previously mentioned sand for beach replenishment will be much cheaper to purchase when the companies are processing sand, rather than later when they are no longer in the sand business.

A fourth option is to utilize surplus sand from governmental projects for future use in beach projects. The surplus sand could come from the dredging of harbors, and from parks construction or other governmental construction projects. The sand could be stored at a secure site and designated for the sole purpose of beach replenishment.

A fifth option would be to consider allowing removal of sand from designated County owned properties which contain sand dunes. These properties are typically County park related facilities such as the Kahului Community Center Park, Keopuolani Park, and the Waiehu Golf Course.

Individual projects will need to purchase the sand from the County at a market rate. Even so, this would be attractive because the sand source would be established, and the purchaser will not need to absorb the other expenses involved with grading a new area. The profits from the sale of this sand could be earmarked for use in other coastal environmental projects.

There is also a sixth option which would require more research and would potentially involve an extensive permitting process before it could be implemented on any beach. This would be to mine offshore sand deposits for placement upon adjacent beaches. The "Beach Management Plan for Maui" states that offshore sources include shallow water sand fields, medium depth sand channels, and deeper water sand banks. It goes on to say that "Maui should build its capacity to tap offshore sand resources. Potential offshore borrow sites should be identified, mapped and sampled".

To date, offshore dredging of sand deposits has not been utilized on Maui. There are no dredges based on the island that could be utilized for this purpose. Ms. Norcross-Nu`u states that, "limited surveys have been done to explore the quality of offshore sand for beach replenishment. Much of the sand offshore is fine and silty and not suitable for beach replenishment. More research is necessary to locate deposits suitable in quality and volume for beach replenishment."

The State Department of Land and Natural Resources has a proposed project to restore a portion of Waikiki Beach by taking sand from the waters off the beach with the use of a suction hose. This would be the first project of its kind in Hawaii and could be considered at this time to be more of an experimental study than the start of a new trend.

13. GENERAL CONCLUSION

Much of the great Maui inland sand resources that were available 30 years ago are no longer available, due to development on, or preservation of the larger dunes. The last remaining areas in which substantial quantities of sand can be removed are currently being worked upon by the concrete companies.

Clean sand is required not only for concrete but for beach replenishment purposes. The total amount of sand used for beach replenishment in recent years has been about 43,000 tons. The quantities of sand required for this purpose is small compared to that

required for concrete. Over the last ten years, 3,000,000 tons of sand has been used in concrete.

The smaller quantities required for a single beach replenishment project of say 4,000 tons, can probably be excavated from smaller sites which the concrete companies will not even consider because of their much greater needs. Possible alternative solutions could also include the use of sand from harbor dredging as well as allowing sand to be removed from governmental lands.

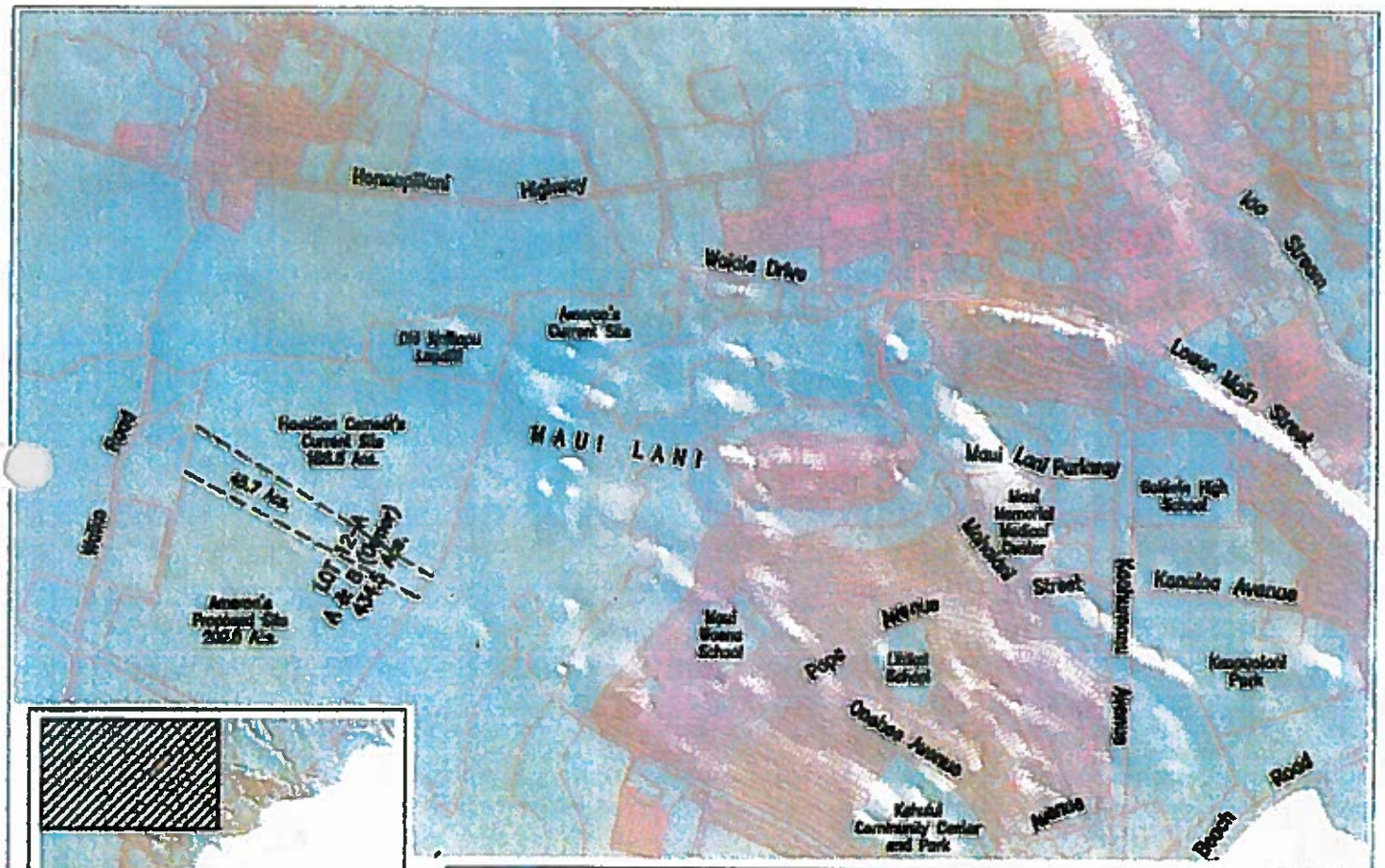
There is also a possibility that dredging offshore sand deposits may be another alternative solution for beach replenishment. However more research on offshore resources will need to take place in order to locate suitable deposits of quality sand.

As described within, the available concrete sand resources on Maui have been identified and are limited to the areas that are currently being worked upon. There may be other properties in the future from which sand may become available, but they will not have the quantities required to have the concrete companies excavate and make it worth their while.

The two concrete companies on Maui which depend upon sand as a critical ingredient in their product realize that the remaining supply is limited. Both companies have available inventories that may last for another five or six years based upon current usage rates. As the remaining inland sand inventory gets lower, the companies have started and will be making further efforts to reduce the use of inland sand. Ameron, for example, is adjusting their concrete mixes to use less sand per cubic yard without significantly affecting their strength and workability.

Both companies are also looking at alternative solutions including importing from sand sources outside of the state, and possibly the use of new technologies which could reduce or eliminate the need for sand in concrete. They both realize that the remaining life of easily available sand is getting short, and that they need to plan for the end of this supply.

MAP EXHIBITS



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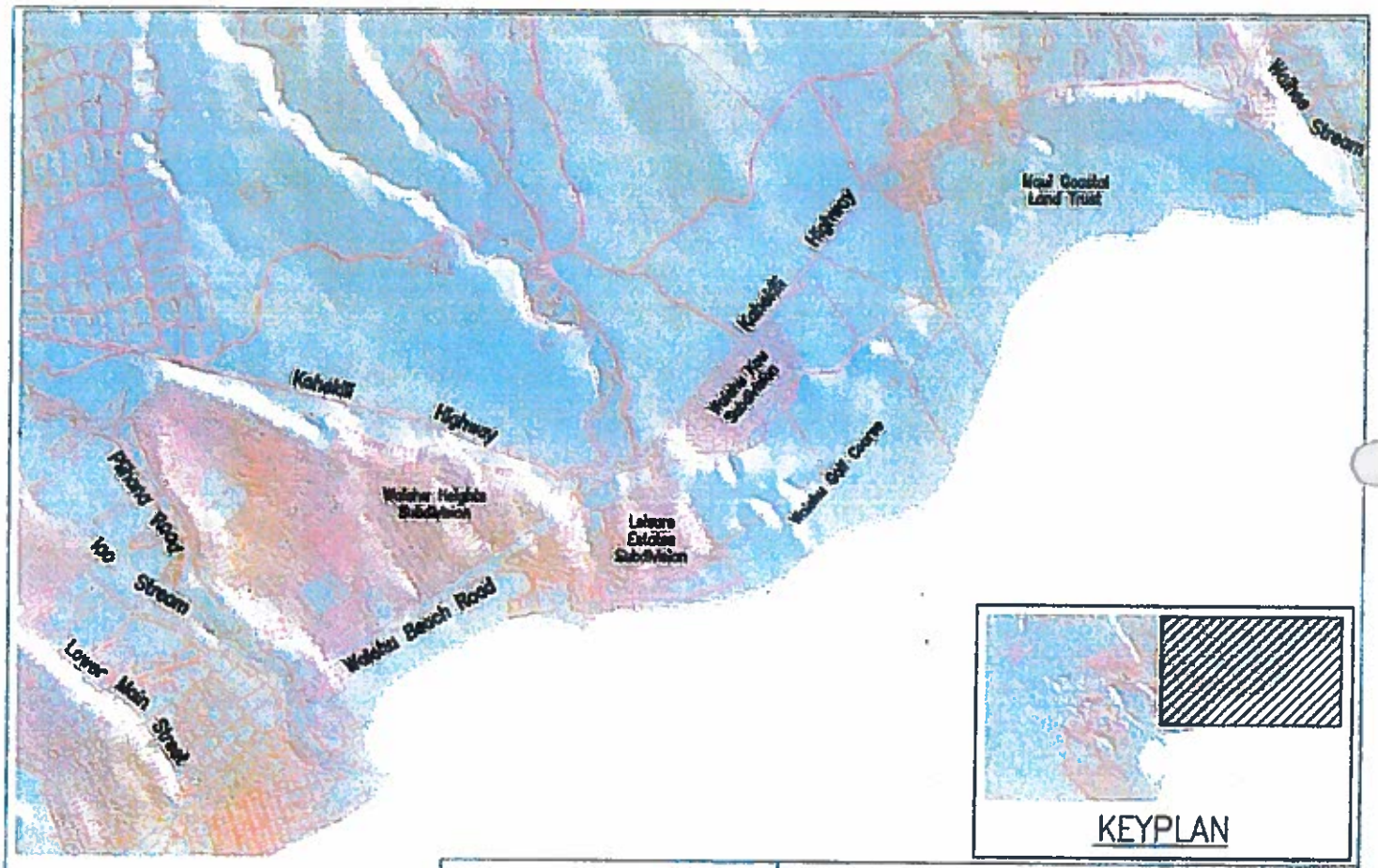
MAUI INLAND SAND RESOURCE QUALIFICATION STUDY
LOCATION MAP

SCALE: NOT TO SCALE | DATE: 01/13/06

FIGURE 1



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MAUI INLAND SAND RESOURCE QUALIFICATION STUDY
LOCATION MAP

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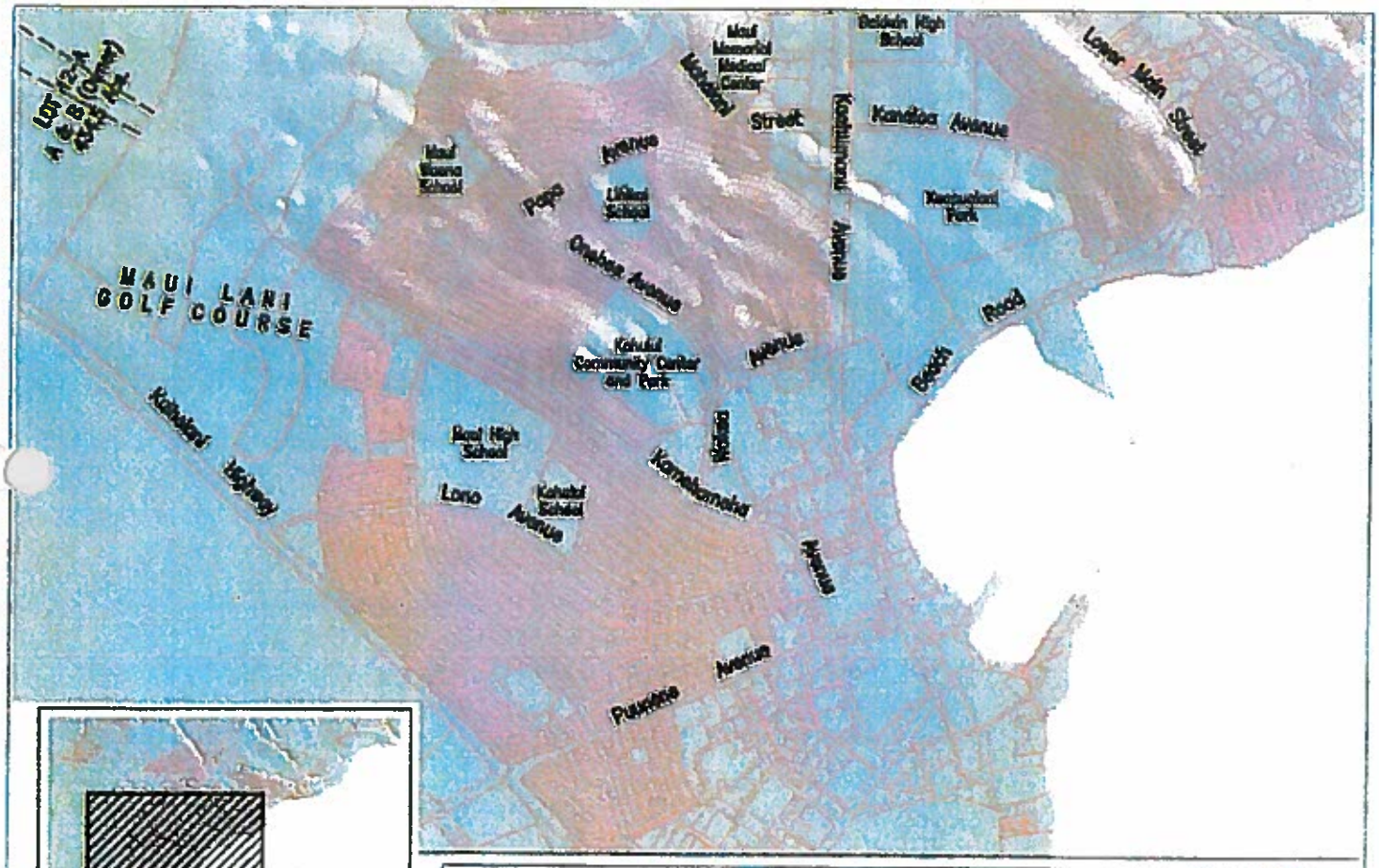
FIGURE 2



KEYPLAN

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MAUI INLAND SAND RESOURCE QUALIFICATION STUDY
LOCATION MAP

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FIGURE 3

PHOTO EXHIBITS

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MAUI INLAND SAND RESOURCE QUALIFICATION STUDY

SAND DUNES OVERLOOKING
A & B's LOT 12-A NEAR MAUI LANI

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FIGURE
P-1

DUNE AT WAIEHU GOLF COURSE

DUNE ADJACENT TO MAIN STREET

SSFM International, Inc. 501 Sumner Street, Suite 620 Honolulu, Hawaii 96817	MAUI INLAND SAND RESOURCE QUALIFICATION STUDY		FIGURE P-2
	SCALE: NOT TO SCALE	DATE: 01/17/06	

PROTECTED WAIHEE DUNE
OWNED BY THE COASTAL LAND TRUST

WAIEHU HEIGHTS SUBDIVISION

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AMERON SAND EXCAVATION SITE AT MAUI LANI

HAWAIIAN CEMENT SAND EXCAVATION SITE
ON A & B's LOT 12-A

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		SCALE: NOT TO SCALE DATE: 01/17/06	

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J. A&B Properties, Inc. (Mercer Vicens).

K. State of Hawaii, Office of State Planning.

L. State of Hawaii, Department of Transportation, Harbors Division.