# Chapter 10

## ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES

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#### IN TRODUCTION

Construction, improvement and maintenance of beaches through the artificial deposition of sand on the shore is rapidly gaining prominance in the field of shore protection engineering. The trend toward this type of shore improvement has resulted from our changing economy, modes of transportation and recreational habits. As our mode of transportation improved and people had more time for recreation, beach resorts developed and grew to proportions typified by Atlantic City, N. J. Numerous factors control the growth of a resort of this size but undoubtedly all will agree that it is the beach which is the resorts' primary asset. This fact was recognized very early in resort development and every effort was made to preserve the beaches from the ravages of the sea. Unfortunately the science of shore protection lagged behind resort development and beaches soon became covered with a maze of structures which discouraged rather than encouraged their use. At this point something had to be done to restore the beaches to their original attractiveness. The obvious means for this improvement was to eliminate all structures as far as possible and to replace the beach material which had been removed. Was it possible that such plans could succeed? Careful study convinced a number of engineers that beach restoration employing artificial nourishment had possibilities and in some instances might be the most economical as well as best method of improvement. More importantly, there has developed a growing recognition of the fact that preventing erosion by means of protective structures is a dangerous practice, in the sense that in many cases such protection is secured at the expense of producing an ever expanding problem area. Artificial nourishment, on the other hand, benefits not only the shore upon which it is placed but adjoining shores as well. The economic merit of this type of treatment has often been difficult to evaluate because of uncertainties in prospective maintenance cost and in determination of the extent of shore which would be benefited. It is needless to say here that although the method has been employed without a complete understanding of all the factors controlling an ideal installation the results have been gratifying.

It is the purpose of this paper; first, to outline the criteria pertinent to the design of artificially nourished beaches and explain how each is derived and used; second, to present a brief history of five areas where the four types of artificial nourishment have been tried; namely the offshore dumping method, the stockpiling method, the continuous supply method, and the direct placement method; and third, to present a tabular record of a great number of artificially nourished and constructed beaches including factors relating to their placement and economic life.

## DESIGN CRITERIA

At the present time although the design of artificially nourished and constructed beaches has not been firmly established on a scientific basis, advances have been made in the field of wave motion and the effect waves have on the shore which have established it on better than a rule of thumb basis. In the following paragraphs criteria for the design of artificially nourished and constructed beaches will be enumerated and their derivation and use will be explained.

The first task in approaching a design problem of this nature is to determine quantitatively the deficiency in material supply in the problem area. This is the rate of loss of beach material and is the rate at which the material supply must be increased to balance the transport capacity of littoral forces so that no net loss will occur. If there is no natural supply available, as may be the case on shores down drift from a major littoral barrier, the deficiency in supply will be equal to the full rate of littoral drift. If the problem area is part of a continuous and unobstructed sandy beach, it is likely that the deficiency will be relatively small compared with the drift rate. Comparison of surveys over a long period of time is the only accurate means of determining the rate of nourishment required to maintain stability of the shore. Since surveys in suitable detail for volumetric measurement are rarely available at problem areas, approximations computed from changes in the shore position determined by air photos or any other suitable records is often necessary. For such approximations a rule of thumb equation wherein one square foot of surface area equals one cubic yard of beach material appears to provide acceptable values on exposed seacoasts. For less exposed shores this ratio would probably result in volumetric estimates somewhat in excess of the true figure and would thus produce conservative values.

The next and equally important task is the determination of the predominant direction of littoral drift. This is most generally determined by studying the shore configuration at groins, jetties or other littoral barriers. The major accumulation of littoral material occurs on the updrift side of such barriers, however in the case of minor barriers such as short groins, seasonal variability or storm effects may obliterate the predominant trend. Care must be taken to avoid misinterpretation in such cases. Seasonal trends should be determined and evaluated where doubt exists on the basis of available evidence.

Unfortunately, or maybe fortunately, the engineer has not covered each sector of our entire shore line with structures whereby this determination of the rate of drift can be made. In the event that structures are not available on a sandy beach, or an area is to be improved that is devoid of littoral materials, another method of determining these factors must be employed. A rather long laborious method is available for use, which indicates the direction of the predominant littoral forces quite accurately, but indicates only the relative strength of the littoral forces along selected stretches of the shore.

This method of proceedure involves the use of the techniques of hindcasting wave data from synoptic weather charts to determine the wave climate over a period of years in a given area; the use of refraction diagrams to bring this wave budget into shallow water; and the use of vector diagrams to determine the resultant direction and magnitude of the wave energy which establishes the predominant direction and relative strength of the littoral movement. The predominant direction of the littoral drift is considered to coincide with the direction of the resultant of the flow of wave energy, and the relation between the strength of the littoral movement is determined to be the longshore component of the wave energy acting along its established direction toward the beach. In view of the lack of knowledge of the characteristics of the boundary conditions imposed by the surf zone it is not possible at the present time to actually relate the longshore component of the wave energy to a quantitative determination of littoral drift. In other words only the relative strengths of the littoral forces in the various related locations along a stretch of beach under study should be used.

Having established the direction and magnitude of the forces that will operate on a proposed fill the next problem to be encountered is that of selecting a suitable beach material. Unfortunately adequate criteria have not been established for evaluating the qualities of beach materials. However, a limited amount of information pertaining to the sorting of beach sands and the relation of grain size to beach slope are of value in selecting materials for artificial nourishment. When sand is deposited on a shore the waves operating in the area immediately start a sorting action on the surface layer of the fill moving the finer particles seaward leaving the coarser material shoreward of the plunge point. This sorting action continues until a layer of coarse particles compatible with the wave spectrum of the area armors the beach and renders it relatively stable. However, if the armor is broken due to a storm, the underlying material is again subjected to the sorting process. In view of this sorting process beach materials containing clay lenses or discolored particles may be used with the assurance that natural processes will clean the sand and make it an entirely suitable material for nourishment. Experience with the fills at Anaheim Bay, California, and Palm Beach, Florida, both of which contained foreign matter confirm this statement.

During the period of sorting, the beach slope is also adjusted until it becomes compatible with the grain size distribution of the sorted material. In view of this fact, a desired beach slope may be obtained by randomly placing material of a gradation that will assume the desired slope after sorting and slope adjustment. The selection of a material of the proper gradation to produce the desired slope as far as is known at the present time can only be determined by analyzing the sand taken from a beach in the surrounding area which has a similar orientation and is acted upon by the same wave forces. Sand selected for artificial nourishment should ideally contain the same gradation of materials as those found on the beach to be nourished if the original beach slope is to be maintained.

Material of coarser characteristics may be expected to produce a steeper than normal beach. Material finer than that occupying the natural beach will, when exposed on the surface, move seaward to a depth compatible with its size. Almost any source of borrow near the shore will produce some material of proper beach size. Since the source of artificial nourishment will control the cost to a major degree, evaluation of material characteristics is an important factor in economic design. At present such evaluation must be made largely on a basis of experience at other localities.

The beach crest height will be established ultimately by natural forces, that is, the cyclic changes in water level and the wave pattern. The foreshore and nearshore slopes will affect wave behavior and thus influence the natural beach crest height. If the beach fill is placed to an elevation lower than the natural crest height a ridge will subsequently develop along the crest. Concurrent high water stage and high waves will overtop the crest and cause ponding and temporary flooding of the backshore. Such flooding, if undersirable, may be avoided by fixing the berm height slightly above the natural beach crest height. If there is an existing beach at the site, the natural crest height can be determined therefrom. Otherwise determination must be made on a basis of comparison with other sites possessing similar exposure characteristics and beach material. There is at present no acceptable theoretical basis for predicting beach crest height.

Criteria for specifying berm width depends upon a number of factors. If the purpose of the fill is to restore an eroded beach damaged by a major storm, where inadequate natural nourishment is not a factor in the problem, the width may be determined by the protective width which experience has demonstrated to be required. Where the beach fill is to serve as a stockpile, the berm width should be sufficient to provide for expected recession during the intervals between artificial replenishment. It is generally considered that the toe of fill of a stockpile beach should not extend to such depth that transport of any material forming the surface of the fill would be retarded. There are no firm specifications for this limiting depth at present but available data indicate, that depths of twenty feet below low water datum on seaccasts and twelve feet on the Great Lakes may be used safely. It is obvious that the initial slope of any beach fill must be steeper than that of the natural shore area upon which it is placed. Subsequent behavior of the slope depends principally upon the characteristics of the fill material. Fills composed of material coarser than that found on the native beach will maintain a steeper than normal slope. Finer material tends to form a flatter slope. In ordinary practice the initial fill slope is designed paralled to the local or comparable natural beach slope above low water datum, and slopes of 1:20 to 1:30 from low water datum to intersection with the existing bottom. It is unnecessary to artificially grade beach slopes below the berm crest, for they will be naturally shaped by wave action.

The length of a stockpile beach may vary greatly depending upon local conditions. Lengths from a few hundred feet to a mile have been

employed successfully. Since the updrift end of a stockpile beach will be depleted first, long stockpiles are usually most suitable where a bulkhead or seawall exists to protect the backshore as erosion progresses along the stockpile.

The foregoing general discussion of the derivation and use of the basic criteria pertaining to the artificial placement of sand to maintain, rehabilitate or construct a beach clearly indicates the laok of the present knowledge and consequently presents a challenge to investigators to direct their work toward this phase of shore protection work. The principal factors which appear to warrant detailed study in order to establish more rigorous design criteria are the relations between the characteristics of beach and nearshore materials and their modes of transport; the relations between beach materials, exposure, and the resulting geometry of naturally formed beaches; and more accurate methods of determining the deficiency in material supply on an eroding beach. In the present state of knowledge laboratory experimentation may be expected to contribute only to a limited degree to the solution of these problems. It is believed that emphasis must be placed on field investigation for this purpose, particularly in the form of follow-up studies of artificial beach fills.

TYPES OF ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES

#### OFFSHORE DEPOSIT METHOD

This method of beach nourishment is constantly coming to the mind of the shore protection engineer since a large supply of beach material could be made available at comparatively low cost in connection with hopper dredge operations in coastal harbors.

A test of this type of nourishment was made in 1948 and 1949 by the Beach Erosion Board and the New York District, Corps of Engineers, Department of the Army at Long Branch, N. J. (reference 1) The city of Long Branch is located near the northern tip of New Jersey adjacent to the entrance to New York harbor. (Figure 1) It lies on a slight rise in the surrounding terrain, which slopes seaward to an elevation of 20 feet and terminates at the shore at the crest of a timber bulkhead retaining Ocean Avenue. The beach fronting the bulkhead is relatively steep and narrow and is intersected by numerous heavy rubble mound groins.

The history of the Long Branch area has been one of progressive erosion caused by the stabilization of updrift areas which formerly eroded and supplied abundant littoral material to down drift areas.

The purpose of this test was to determine the feasibility of restoring an adequate littoral drift to nourish the shore by employing natural forces to move material, dumped in relatively deep water, shoreward toward the beach.



Long Branch, N.J.



Fig. 1. Locality map, Fig. 3. Locality map, Santa Barbara, Cal



Fig. 2. Sand movement diagram, Long Branch, N.J.

The material dredged from New York Harbor entrance ohannels was placed in a ridge about 7 feet high, 3,700 feet long and 750 feet wide, lying about  $\frac{1}{2}$  mile from shore in a depth of 38 feet below mean low water, with its southerly limit on an east west line about 1500 feet north of the Long Branch Pier. Dumping at the site amounted to a total of 602,000 cu. yds. of sand. (Figure 1)

During the entire period of study, oceanographic forces effecting sand movement were recorded and the sand movement was traced by periodic hydrographic surveys covering the area from the Long Branch Fishing Pier northward to Monmouth Beach Coast Guard Station and from the bulkhead line seaward 6,000 feet to about the 42 foot depth contour (mean low water). An effort to trace sand movement through dissimilar minerals in the beach and dumped sand failed. At this point one may question the suitability of the Long Branch site for a study of this nature. Oceanographic and hydrographic data collected at the site proved its suitability since natural forces were found which were capable of moving material over the coean floor in 35 to 40 feet of water and along the beach.

The result of the sand movement during the period October 1948 after all dumping had been completed to October 1949 are depicted by net bottom changes and are shown on Figure 2. The bottom changes show accretion to be general over the offshore area including the mound. An area of localized erosion developed near the center of the mound and erosion occurred over the shoal at the southern limit of the study area. Nearshore erosion has been extensive over the year. The general accretion over the mound coupled with the extensive erosion along the shore indicates that the deposited material, during the period of observation, has not benefited the beach. While observations over a longer period may indicate some benefit, it may be concluded from present evidence that this method will not provide nourishment at a suitable rate to justify its general use.

The conclusions reached in this study confirm the findings of two similar studies, one made at Santa Barbara, California where 202,000 ou. yds. of sand were deposited in 20 feet of water (mean lower low water) in September 1935, and the other at Atlantic City, New Jersey where 3,554,000 cu. yds. of sand were deposited off the beach in 18 to 20 feet of water (mean low water) during the period April 1935 - September 1943.

Although the results of this test to artificially nourish the beach at Long Branch, New Jersey, were negative, it is felt that they have a place in this paper to guide future work along these lines.

#### STOCKPILE METHOD

Probably the first shore protection project designed specifically for employment of this method was that developed at Santa Barbara, California (Figure 3). This project has been in successful operation

since 1938. Details of the plan are contained in references 2 and 3 and only a summary will be presented herein.

The problem at Santa Barbara was created by construction of a breakwater, completed in 1929, which effectively blocked the movement of littoral drift. Material accumulated on the updrift side of the breakwater at a rate in the order of 300,000 cubic yards a year. By 1934 the impounding capacity above the breakwater was reached, and the zone of entrapment shifted to the protected waters within the harbor.

Meanwhile beaches downdrift from the harbor, being deprived of normal nourishment, were progressively eroding. By 1938 the erosion area had denuded the down drift beaches for a distance of ten miles, to a location where a large natural sand deposit served to maintain shores beyond. Offshore deposit of sand removed from the harbor by hopper dredge in 1935, described earlier, failed to aid the shore. Damages mounted and hastily built shore protection structures provided little relief.

In 1938 a cooperative project was developed on recommendation of the Beach Erosion Board providing for establishing a stockpile beach fill along 4000 feet of shore down drift from the harbor, to be initially filled and periodically maintained with material dredged from the harbor. The first fill was completed in July 1938 and replenishment has been accomplished at two or three year intervals since that date. The seventh repetitive nourishment operation is in progress at this time (October 1952).

By 1945, seven years after initiation of the project, stable conditions had been restored over the entire ten miles of previously eroding beach. No additional shore protection measures have been required since that date. The average rate of artificial nourishment in round figures, has been 300,000 cubic yards a year. The average cost is 21 cents a cubic yard. Harbor maintenance as well as shore protection is accomplished, and under the terms of the project the United States pays the cost of the former by the cheapest method (hopper dredging) at an established price of 13 cents a cubic yard. The work is accomplished with conventional pipe line dredging plant and equipment. Local interests contribute the added cost of depositing the material on the stockpile beach, an average of 8 cents a cubic yard or \$24,000 a year. Considering the length of frontage receiving protection in this project, the average annual cost is about 50 cents a linear foot. This is a mainor fraction of the cost experienced where defensive works are employed for shore protection.

A more recent example of stockpiling sand on a beach to be distributed along the down drift shore by the natural forces is the project undertaken several years ago at Palm Beach, Florida.

Palm Beach is located on the coastal lowlands of the east coast of Florida about 300 miles south of Jacksonville and 70 miles north of





Miami Beach. (Figure 4) The barrier beach on which the town has been built separates Lake Worth from the Atlantic Ocean and is breached by two inlets, Lake Worth Inlet and South Lake Worth Inlet, about 15.5 miles apart. The barrier is composed principally of sand, part of which is artificial fill over former marsh areas. There are occasional outcroppings of coquina on the barrier and in the offshore area.

Lake Worth Inlet was dredged through the barrier and two protective jetties were constructed between 1918 and 1925. The construction of the jetties have caused changes in the adjacent shore lines similar to those at a number of other inlets along the east coast of Florida where jetties have been constructed; namely, accretion north of the north jetty and erosion south of the south jetty. An accurate estimate of the rate at which the littoral drift has been impounded by the north jetty cannot be made from available historical records but a number of rough estimates have been made utilizing available information. These estimates although rough, indicate the limits of the range between which the true value probably lies. They indicate that during the 14 years period immediately following completion of the inlet and jetties, material was impounded at a rate averaging 150,000 to 225,000 cubic yards per year and that during the next seven years the rate approximated 130,000 cubic yards per year.

The removal of this quantity of material from the littoral stream which formerly nourished the Palm Beach shores has resulted in continuous erosion. The rate of erosion has been retarded by the construction of a fairly uniformly spaced field of groins but in general the groins have not maintained as wide a beach as desired, primarily because of the lack of sufficient littoral drift.

Studies made by the Beach Erosion Board in cooperation with the Port of Palm Beach District to develop a plan or plans for the rehabilitation and future protection of Palm Beach resulted in the conclusion that because of the absence of an assured natural supply of beach material an artificial supply must be furnished. (reference 4) It was also concluded that the best method of nourishing this shore would be to pump sand from Lake Worth and place it in stockpiles along the beach. The decision to use this method of nourishment was due in part to a satisfactory test of stockpile nourishment made on the beach immediately south of Lake Worth Inlet in 1944.

The recommendations made by the Board were accepted by the cooperating agency and four stockpiles of sand were placed on the beach between May and November 1948. An additional stockpile of 100,000 cu. yds. of sand was placed on the beach opposite the West Palm Beach Canal by Palm Beach County in 1949. The quantity of material placed in each of the stockpiles together with previous and subsequent placements near the northern end of the beach and the locations of the piles are shown on Figure IV and in the following table.

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Location	Date of Pl	acement	No.Cu.Yds.	Cost per Cu.Yd.
Mediterranean Ave.	Aug.	1944	300,000	35.0 ¢
	May-Nov.	1948	215,690	32.2 ¢
	July	1949	380,000	
Eden Road	May-Nov.	1948	630,600	19.3 ¢
Tangier Ave.	May-Nov.	1948	454,640	19.3 ¢
Banyan Road	May-Nov.	1948	1,035,000	19.3 ¢
West Palm Beach Canal	·	1949	100,000	•

The results obtained through the use of stockpiles to nourish the beach in the Palm Beach area can best be described by the following statements made by Mr. Norman C. Schmid, Engineer, Town of Palm Beach. "It is my opinion that artificial sand supply is the best method of beach protection that we have found in Palm Beach. The only trouble is that we have only supplied the beach with two and one half million yards and it is estimated that the project would require six million in order to bring the beach line to the 1928 location." Mr. Schmid further states that past experience shows that, "The northernmost stockpile should be replenished yearly, the others to the south every two or three years depending upon storm conditions". He concludes " - - - that the sand has moved as expected, also that the experiment even to the layman's eye has proven quite successful".

#### CONTINUOUS NOURISHMENT METHOD

One of the best examples of continuous nourishment to a beach down drift from an inlet is the sand bypassing plant at South Lake Worth Inlet, Florida. The factors pertinent to the installation of and the results obtained with this bypassing plant were thoroughly covered by Mr. Joseph M. Caldwell in the first Coastal Engineering Conference but since it is the intent of the writer to make this paper as complete as possible in the field of artificial nourishment the highlights of this installation will be briefly reviewed.

South Lake Worth Inlet is located on the east coast of Florida near the southern limit of Lake Worth which separates the mainland from the sand barrier on which the town of Palm Beach is located. (Figure 4)

This inlet was dredged through the barrier in 1927 by the South Lake Worth Inlet District to create a circulation of water in the southern end of the lake to relieve the stagnant condition of the waters. The inlet was fixed by two short jetties about 250 feet long. Due to the abundant littoral drift from north to south in this area the littoral reservoir formed by the north jetty was quickly filled and sand was carried around its outer end into the inlet where it dropped out of suspension forming a middle ground shoal.

Concurrently with the filling of the impounding area behind the north jetty and the formation of the shoal, the beach south of the inlet eroded. Property owners faced with the loss of valuable land and homes constructed numerous protective structures but due to the impounding of the natural supply by the inlet, these structures did not help in holding or building a protective beach. The failure of the

structures to protect the area clearly indicated the necessity of rebuilding the beach as a protective barrier through the restoration of the littoral drift in the area. This was done by establishing a pumping plant on the north jetty to bypass the sand across the inlet to the eroding shore. The distribution down beach of this material was left to the action of natural forces. This method had the added advantage of reducing the sand available to be carried into the inlet to be deposited on the middle ground shoal.

The pumping plant was not designed to bypass the entire quantity of littoral drift but rather to supply the quantity of material required to restore the beaches to the south. During the first five years of operation prior to World War II about 250,000 cu. yds. of sand were supplied to the beach. The benefit derived from this operation was felt almost immediately and at the end of the five year period the beach south of the inlet was entirely restored. During this period shoaling decreased over the middle ground.

The cost of moving the sand including operation, maintenance, and depreciation was about 9 cents per cubic yard. Based on current prices the figure would still be well under the 19.3 cents to 35.0 cents per cubic yard cost of the stockpile nourishment placed on Palm Beach from Lake Worth.

It is recognized that although the sand has been moved economically with a fixed plant at South Lake Worth Inlet periodic nourishment using a floating plant may be more economical at other littoral barriers.

#### DIRECT PLACEMENT METHOD

It differs from the stockpile method in that the fill is completed at one time over the entire shore to be protected. In effect it may subsequently take the form of a stockpile project since it will serve as a supply source for the down drift shore, and future maintenance may be accomplished by artificial nourishment of those areas which first demonstrate supply deficiency by erosion.

This type of beach rehabilation was used at Atlantic City, New Jersey in 1948 to quickly restore the ocean beach which was eroded to a point where it furnished little protection during fall and winter storms to the boardwalk and valuable real estate investments. (reference 5)

Atlantic City is located on the coast of New Jersey about 45 miles northeast of Cape May, the southern tip of the State at the entrance to Delaware Bay. (Figure 5) It comprises nearly one-half of the length of the barrier beach known as Absecon Island. Absecon Inlet is the northeastern boundary of the City and Island.

Because of its location near extensively developed and densely populated urban areas, being about 60 miles from Philadelphia and 125

miles from New York City, it has rapidly become the most popular resort of its kind in the country.

The ocean beach is generally wide and flat; supplied with material transported southward along Brigantine Island. The volume of sand moving along this shore cannot be accurately determined but dredging figures indicate that it may be about 400,000 cubic yards per year. The part of this quantity moved onto the Atlantic City beach by natural forces is not known. Studies show that the beach remained relatively stable prior to 1940 and then started to erode progressively for a distance of about 6,000 feet southwest of the inlet. In view of the natural condition extant in the area and the immediate need for a protective beach southwest of the inlet, the State of New Jersey and the City replenished the beaches with sand moved by hydraulic dredge and pipe line from the point of Brigantine Island across the inlet. Approximately 700,000 cubic yards of sand were deposited on the beach from the Oriental Avenue Jetty to a point about midway between Central and Hamid's Piers during the summer of 1948. This material was placed on the beach over its 6,000 foot length at a cost of 77 cents per cubic yard.

Immediately prior to placing the fill a stone jetty was constructed on the south side of the inlet to divert the channel eastward away from the beach.

Subsequent to placing the artificial fill, an existing groin was repaired and five others were constructed to retard the loss of sand from the beach. Replenishment of the material placed on the beach has not been made but will be made when necessary.

The results obtained through the direct placement of sand to the beach at Atlantic City has been as successful as the studies had indicated. Observations made at various intervals following the period of beach slope adjustment show the beach to be relatively stable. It is too early to determine maintenance requirements and costs, but indications to date are that maintenance by periodic nourishment will be both feasible and economically preferable.

In summary, it is believed that artificial nourishment is firmly established as a practicable and economic means of shore protection which must be considered and evaluated in comparison with alternative measures in the study of any erosion problem. The long term benefit of this method of protection with respect to very substantial lengths of shore is an important aspect to be considered. Extensive additional research is needed to establish proper design criteria and a more accurate basis for economic analysis of this method.

ARTIFICIALLY NOURISHED BEACHES IN THE UNITED STATES

The purpose of this section of the paper is to assemble in one document all information available in the records of the Beach Erosion Board including published references 6 to 12 pertaining to those beach

areas of the United States which have been artificially nourished or constructed. The data is presented in three parts in tabular form; the first outlines basic information on the beach required for the design of its nourishment; the second outlines information pertaining to the material available for the nourishment; and the third outlines information pertaining to the stabilized beach. Although an effort has been made to include all of the known artificially nourished beaches in the United States in the table there are undoubtedly many that have been overlooked. In several of the cases listed the purpose of the beach fill was not shore nourishment but simply selection of a convenient disposal area for dredged material. Those have been included for possible future use of the data presented(see Appendix).

#### ACKN OWLEDGEMEN T

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#### APPENDIX TABULATED DATA ON ARTIFICIALLY NOURISHED AND CONSTRUCTED BEACHES

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Locs t 'on	Norve Bay Entrance Conniel	Rappor	Earbor	Barbor	Larbos	Rethor	Reptor	Rarber			
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Description of Neteriat	Compar to fine shud	Necium to fine wand and stlt	Nectum to fine wend and stit	Refign to fine wand and whit	Fedica to fine emé uni etil	Nerton to fino shad	Medtum to fine saud and all:	Medium to Fine wand and wilt			
wentity Avatiants	Amote	Acote	Ample	Awple	ample	40010	tanle	1001+			
				BOURTSHOULT A"CONTAINED	)						
fype af ¥0.rierm at	Direct piscement with hyperaulic dreate	Offshore plasmost by a happer dredge in 20' water	Neekpils by bytraulic dredge	Stockpile by hydrumile frage	Stockyite by hydrowite drad w	Stactylle by bydraulis dardge	Stackpll= by hy-really dradge	Atsempile by hydraulic dredge			
Primary Purpose	Niepowal of usedard out fial	Buch restoration	Fore negrichart	Reeve semitthemat	Mere sourlehest	Bere noari mens	more no risharat	Shore provisionent			
Slaps of - (Defore adj Forme ors (after adj	t an 5 1 on 10		1 om 10 1 om 15	1 on 10 1 on 15	1 m 10 1 m 15	1 on 10 1 on 15	1 on 10 1 on 15	1 em 10 1 em 15			
Dimensions of Fill	0 h hi x 300' South ( * Ni x 30' Lorth	6 4 #1 x 200'	°0 Ht a 140'	1 0 Mi # 200*	r 0 MT # 500,	10 MIX 200'	10 11 x 200	t 0 Ni x 200'			
Total No of Gu Ida	010 000	505 000	5C6 H27	697 719	607 310	717 717	642 977	474 152			
fost per Qu Té	t cente	1º ceois	"l cente	17 5 ovata	1 7 cents	23 7 cm11	17	19 2 conto			
Date Plarod	1 1 1 - 1543	September 1935	andune 1038	Jane-July 1940	Jaly-4m 1042	Jan-Seat tobs	1947-June 1947	May-Juse 1949			
Lattuated Ltfe of Fill				]	1		1				

# Table 2

ANTIFICIALLY INVESTIGATION FILODO											
	ראיזער איזער איז										
Consint Area	Pacific Goven	Pacific Genta	Pacific Ocean	Pacific Ocean	Pacific Orsan	Parific Grean	Parifie Ocean	Pacific Green			
3.40	Pors Europe Calif	Port Humane Calif	Saria Monice Gelis	Venice Calif	El Sagunos Galif	El Seju do to Ocres Para Calif	Reconfo 8 ach Colif	Cabrillo Brac's Colif			
Longin of Frobies Ares	)	3 0 atles	13 0 altes	10 5 miles	f f miles	11 0 mii+e	1 C alle	0 7 2110			
äxpo sur e	SE thru B to V. Changel Islands to Sb Offsbore Islands to B	15 thru 3 to 4 Conan-1 Islands to 54 Offstors Islands to 5	8 thru th to Y Offs are lalents to B	S thru SW to d Offenore lelen's to B	S4 to 2 Offemore Jelonde to 8	Sy to b Of teors islends to B	SV to d Of a pre Jalen a to B	SE thru 3 to Ba Offs ore lairnee to 5			
Blops - Foreshors Newrenors	1 4n 15 1 4n 80	1 on 15 1 on 66	1 on 30 1 on 2 <sup>1</sup> 0	1 or 30 1 on 2 <sup>2</sup> 0	1 en 20 1 en 230	1 on 20 1 on 430	1 en 10 1 en 45	1 on 25 1 on 100 - 1 on 150			
Reach Material Characteristic	Notice to fine good	Medica to thre sand	Nedium to fine shad	Medium to fine and	Medica to fine sami	Neclum to fine sand	Vealum to f ne mata	Fiscand clay and silt			
Eate of Liitorsl Transport per year	1 000 000 ce yês	1 000 CC0 es y4s	163,000 cu yas	165 OCO on yds	165 000 cu yde	165,000 cu yês					
Pir of Liitoral-distan Franspert Same	South South	Soath Boulb	Southeast	So atbeast Southeast	Southeast Southeast	Southeest	ĺ	South-est Souturest			
			KATSRU	L AVAILABLE FOR SCIRISS	Tart .		h				
Localion	Marbor	Barber	Rarbor	Sato Dun-s	Sand Dunra	Band Dunes	Send Dunce	Los Angelee Guter Barbor			
Distance from \$111	0 2 to 1 0 aite	0 2 10 1 0 sile	0 06 10 0 5 mile	5 0 to 5 0 miles	2 0 miles	1 0 10 / 4 0120	t u miles	1 0 to 1 0 mlles			
Charmoter of Naterial	Redium to fine mand A milt (Harbor mpsil)	Madium to flos sand & silt (Norbor speil)	Nedion to fion sand with silt	Fedine to fine sand	Bedium to fine send	Herius to fine mad	Redium to fine paod	Fine sond clay and silt			
Quantity Available	4ayle	laple	ingla	Ampl-	Ample .	غ <b>ت</b> واه	Ampir	Ample			
			x	URISH SHIT & TORPLISHED							
Type of Hourishment	Dir-ot plan-ment with hydraulic dreage	Direct placearns with hydraulic drodge	Direct placement and stackpile by hydraulio drec.s	Direct placement by trucks	Direct plarment elaising from dunce	Direct place ont by paulie a ta with efuntor & trough gamps	Direct plaseneds by trucks	Direct pince-oni with hy 'roulic dredge			
Primary Purpose	Dispansi of Grodued Secondai	Brach Tratoration and discussi of unterial	Sucre Sourishnest	Peach restoration	Distant) of waterial and Brach Teresoration	Disposal of maserial and beach widening	3-sab sectoration	B ach restoration			
Blope of - (Before Adj Forestore (After Adj	1 on 25 1 on 15	1 on 25 1 on 15	1 on 10 1 on 20	1 on 3 1 on 20	1 an 10 1 an 14	1 om 6 1 on 15	1 on 3 - 1 on 5 1 on 10	1 on 60 1 on 30			
Dimensions of Fill	0 8 M1 x law *	0 3 #1 x 200*	1 G #1 x 300 <sup>4</sup>	0 6 ¥1 x 75'	1 # #1 × 200'	4 + ms × 644 1	0 h #1 x 50	° 2 H1 K 20K			
Total lic of Da 74a	1 م بنه 1	175 000	1 000 000	150 060	1,500,000	14 ~~0 000	47.010	400 000			
Cost per Da Id	20 cents	20	aj emta	47 cente		ch = conto	81 oc	20			
into placed	1539	1943	1950	1945	1136	1-45	19.117	1,27			
EntidEted Life of Pill			7 to 10 years	10 yea-a		50 y-078					

# Table 5

ANTIFICIALS : "THERE OLD ALD OL ST" CTSD FACEDS										
Tasser to approach										
DODIEL APM	Pacific Corne	Incific Room	Pacific Q.mm	Pacific Ocean	Portfic Ocean	Pacifie Goran	Pa 151c Ocean	Pacific Ocean		
Jane	Cabrillo Seac. Calif	Lon, S-Mch Callf	Anabe's Say Galif	Anchess Bay Galsf	Newport Day Callf	kierion Brura Calif	Grean Brach Calif	Ocean Netwis Galif		
Len in af Proties area	0 7 utto	f 0 ail-s	15 5 #1100	l' 4 miles	50 ml)es		1 0 \$110	1 0 mile		
Exposure	ME tiru 8 is 20 Gf's ore leignis to 8	Sheiteret by Los An, eles - Long Brach brackvatar	58 thru 8 to ¥ Ofishere Islands to SF	58 thru # to ¥ O'ichore Islands to SV	RE thru S to V Orfshors Jelands to SV	Sé thru V to FV Champel Islands to V	BW thru W is BW Changel Jalando to W	SV thro V to NV Channel leisnds to V		
Slope - Porcenare Speralore	1 se 25 1 se 100 - 1 sc 150	1 en 25 1 en 150	1 on 7 1 on 70	1 on 7 1 on 70	1 on 25 1 on 35 - 1 on 75	1 on 7 1 on 50	1 on 7 1 on 50	1 on 7 1 on 50		
Beach Maierial Conventionia	Fine send clay and	Vedius to fine and	Fing to Hed a nd with scaling	Fine to Med wind with south \$ of silt & clay	Course to fine sand	Necium to five mana	Nedium in fins pand	Netium to fins anan		
Note of Littoral Transport per year			300,006 ca 31+	300.00° ez 2M.						
Dir of Litters1-Wieter Transport Boorar	Bolibrast Bonibenst	Wg1 Jis	South - Fre op nuts Forth	Bouth - Predahinate Forth	83 - Prešesiania Northwest	South South	South	Sosta South		
	RATELLA ATALIANS FOR NOWSBOOT									
Loonsias	Les ar vire Cater Barber	douth of Los anywire River	Analisis May be ind the Barrier Beach	Anthoin Bay babing the Barrier Baach	Newport May	Mission Bay	Fivelon Bay	Fiesiva Bay		
Distant from Pill	1 0 to 1 0 miles	, G ailes	C 06 m 0 6 m12m	0 06 50 0 6 m110	1 0 10 2 0 miles	2 0 10 3 0 alies	~ 0 to 3 0 oilas	2 0 to 3 5 miles		
Character of Material	Fixe c clay and sill	indius to fisr omed	Fis to serios sand slit and alay	Fibe to sedius sand silt and clap	Common to fine shad and silt	Notion to fine which	Feitur in fine spat	Sedium to fine sand		
Quentity Available	ample	Appie after such fless	Ample .	Ample	Ample	Asple	any10	Aug1+		
			x	OFFICE ALL ALCONDITION						
Type of Hearlahaont	Dirent placement with hydraulic dreime	Direct placearni with systemlic credue	Sireot placement and stockpile with hydraulis dreige	Direct placement and stockpile with hydraulic dredge	Direct placement with hydraulic dredge	Direct placesont with hydrawile dredge	Direct placeson; with hydraulic dredge	Birect placement with hydromlic dredge		
Frimmy Furpose	Brock Protorotion	Brach residention	Sigre nouri durat	Shere nourishmen*	Disposed of gaterial and beach restoration	Disposal of dreiged material	Bouch restoration	Remain restoration		
Bleps of - (Before Acj Foreware (After Acj	1 an 50 1 an 30	1 on 10 1 on 20	1 on 7 1 on 30	1 em 7 1 em 10	1 on 10 1 on 15	1 on 5 1 on 7	1 of 5 1 m 7	1 7		
Dimensions of \$111	0 4 #1 x 500'	4.4 #1 > 306#		0 5 #1 x 1060) Johne Type	20 ¥1 x 300'	1 0 H1 x 100'	C E H1 x 500*	G B #1 × 500'		
Total No of Oa Ter	2,5%,000	614 OCC	SC , CCO	1 097 000	7,000 000	685,000	f# 100	\$7,000		
Coniper Gu Ta	lij esta	14 c r to	}	P3 casts	20 cm10	21 cm10	17 seate	17 oumi#		
Date Pissed	1,48	1º -2 m36 1,40	Jent.	Oct 1-17 to fam 1946	1974 - 1935	September Syld	1949	May 1950		
inizated Li's of Fill				1 to 5 years				L		

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# Table 4

ANTIPICIALLY MOUNTAINED FOR CO. RANKOLED BACKED										
DESCRIPTION OF BAUTRAL CONDUCTORS										
Constel Area	Pacific Gerec	Pacific Ocean	Pacific German	Atlentic Ocean	Atlantic Ocean	Atlantic Ocean	Atlantic Ocean	Atlantic Ocean		
3	Gorenete Beach Calif (Borth Island)	Coronado Buanh Calif (Silver Biracd)	Watkiki Beach Honolulu Y E	Hampton Besch J J	Sepatror Beach R 1	Yest Meyen Gond	Oak Nack & Center 1s Causeway L I N T	Orchard Beach B T		
Frobia Area	2 0 -11		2 0 alles	1 % milee	0 % m11=	1 f miles	2 1 alles	0 L mile		
Sxposure	S to SW Noint Lonn to W Los Coronados Isiando to S	3 thru 8W to V Los Coronados Islande to 8	S thru \$4 to ¥ Clear	F to ME Clear	5 to 57 Sheltered in Block Jelwoù Sound	53 thru 5 to 5W sheltered is 1 5 Sound	NE thru B to ME sheltersd is L I Sound	N taru SE to 3 sheltseed to L I Sound		
Slope - Poresions Sections	i en 20 1 en 75 - 1 en 200	1 on 20 1 on 75 - 1 ae 200	1 oo 7 = 1 oo 10 1 on 70 = 1 on 160	1 on 7 1 on 60	1 on 5 I on 20 - 1 oo 50	1 on 7 I oo 300	1 on 5 1 an 90	1 on 5 1 on 60		
Brach Material Commectarialic	Mediam to conres sund and shell	Medium to fine send and shall	Corel and and shall	Sand and shell	field Ana bas	Mediam to fine shad	Sam. and shell	Sand and sheil		
Mate of Litoral Transport per year			10 000 cu yde							
Dir of Litiorel-Vinter Transport Summer	Bortheast Bortheast	Yorthanst Northanst	South South	North Borth	Yest Yest		Kast Rast			
			MATERIAL	AVAILABLE FOR BOURI SEMI	at					
Loomtion	Channel to San Diego May	Sen Diego May	Bellows Field Kanoche B & S	Respton Marbor lolet	Marrageossti Bay Watch Bill Cove	Nev Mater Marbor Inlot	Long lelant Sound	Sand berged 3 side 2 1 pumped as beach		
Disiance froe Fttl	0 2 io 1 0 milo	2 0 to 3.0 miles	2 0 miles	0 1 10 1 0 =11.	0 6 to 1 0 mlls	1 3 mtles	0 2 to 0 5 mile	0 2 to 0 6 alle		
Character of Material	Medium to coares sand and shell	Medium to fine sand and eilt	Coral wand	Folium to fine sand wilt and shell	Sand shell an' eilt	Notion to fine shad shall and slit	Sand abolt and ellt	Sand shell ond oilt		
Quantity Available	4 <b>mp1</b> 0	Asple .	Amule	imple.	Ample	Ampio	Ample			
			ju ju	KRISENNY ACCONTLISEED						
Type of No rishesat	Pirect planement eith bydraulic dradge	Direct placement with hydraulic dradge	Direct placement by trucks	Siockplis hydraulio dredge	Direct planement by hydraulic dredge	Direct placement by hydraulic dredge	Direct placement by hydraclic dradge	Pirect placement by hydroulic descap		
Prinkry Purpose	Dispend of material and shore nourishment	Disposal of dredged enterial	Nearh restoretion	Thore neurlabetas	Beach restoration	Banch restantios	Beach restoration	Beach restoration		
Slope oz - (Before AA) Foreahore (Afier AA'	1 on 15 1 on 25	1 an 140 1 eo 2*	1 on 3 1 on 5 - 1 on 7	I on 5 1 on 7	1 on 7 1 on 5	1 mm 7 1 mm 5	I on 19 1 on 10	1 on 20 1 on 10		
Disensions of Fill	10 M1 x 300'	30 H1 x 1500	0 5 81 # 150'	0 3 z 0 4 x 0 3 Ni Triangle Steped	0 4 HL X 80'	15 11 • 250	0 7 H1 z 100*			
Total No of Cu T .	x 500 000	19,000 000	110 000	535 000	170,000	1,000,000	507 000	78 313		
Cost per Da Td	15 cente	12 5 cente	1	25 cente	]	75 omt.	17 omete	69 cente		
Date Placed	1938 - 1939	1940 - 1944	Dec 1951 to July 1952	1935	Oct 1948 - Feb 1949	July 1948 to Jan 1949	1947	1936 or 1937		
Setimated Life of Fill						ł				

# Table 5

ANTIFICIALLY BURKINGS AND COPYINICITY BRACES											
backing of anyone completions											
Corntal Ares	Atlastic Ocean	Atlantie Ocean	Atlaniic Doma	Atlactic Ocumn	Atlantic Grean	Allantic Dema	Atlantic Down	Aslantic Ocean			
Same .	Jacob Rile Park Long Jeland B Y	Goosy Island N T	Long Branch B J	Atlantic City H 2	Atlantic City 3 J	Atlaniic City 3 J	Atlantic City B J	Aliantic City B J Absoco Iclet			
Longth of Problem Aree	0 9 8520	0 7 m110	13 0 41100	lodef loite	Indefio it .	Iof of inite	Indeflaite	6 5 miles			
Supa sure	3 thru 8 in SV Clear	B thru 5 to SW Sheltsred is Lower New York Marbor	I thru I to b	WE thru ME to SW Glear	ME thru 55 to ME Clear	WE thre SE to SV Clear	HE thru SE to SV. Clear	FF 10 3			
Slope - Poreshure Searabore	I um 5 1 ce 75	1 on 5 - 1 on 7 I on 30 - 1 es 200	1 on 7 1 on 30 - 1 oo 35	1 en 5 1 eo 150	1 on 5 1 on 150	1 on 5 I co 150	I ee 5 1 en 150	1 en 5 1 en 20			
Beach Naterial Characteristic	Send and shell	Median to flos eand and shall	Median to fine sand	Nodian to flos sand and shall	Medium to flos send and shell	Follow to fine south and shell	Nedium to fine sand and shell	Nedlam to floe samd and shell			
Bate of Littoral Transport per year	[		177 000 um ¥4.	400 QCC cu yde	400 005 eu yês	400 000 cm gdm	100.000 ou yês				
Dir of Littersl-Vinter Traceport Summer	Yest Yest	Smot and doot Smot and Vest	Jorth Jorth	Southwest Southwest	Southwest Southwest	Southwest Sauthreet	Southwoot Southwoot				
ALTELLE ALTELLE TO BOOKST											
Location	Jammics May # T	Fow Tork Marbor	For Tork Barber	Aliescan Talet	Abemano Jolei	Abaseco lalat	Absocon Inlet	Abesces Islei			
Distance from Fill	1 0 mlle	0 3 to I 0 mile	3 0 m12++	10 to 20 miles	1 0 to 2 0 miles	1 0 to 2 0 miles	1 0 to 2 0 alles	0 1 to 0 5 alls			
Character of Naterial	Boad shell asd eilt	Median to fine send shell and ellt	Medium to fine sand and eist	Fedium to fine smad and shell	Medium to fine shad and shell	Nodian to fine sand	Fedium to fine shad and shell	Medium to flos sand shell and silt			
Quantity Available	Amplo	Ample		Ample	Ample	japle.	Ampl+	Ample			
			80	NISHCEFT ACTORPLISHED							
Type of Nourlabeent	Direct placement by hydraulic dredge	Direct glagment by hydraulic dredge	Stockpile is miter by hopper dredge	Offahore placement by a hopper dredge in 16' to 20' mater	Offshors plecement by a hopper dredge in 15" to 20" water	Offshere placanent by a hopper dredge in 18' to 20' water	Offshore plecement by a hopper dredge in 15' to 20' water	Direct piacement by hydraulic dradge			
Frinary Purpose	Beach restoration	Beach restoration	Banch rectoration and abore pourtement	Disposal of enterial and banch restoration	Disposal of material and baack restoration	Dieyogal of material and bearh regtoration	Disponal of material and brack restoration	Beach restoration			
Slope of - (Sefore Adj Foreshore (After Adj	1	I on 5 - 1 on 10 1 on 4 - 1 on 7						1 co 7 1 cn 5			
Diseasless of Fill	0 9 M1 = 200*	07 HL 2 5001	0 7 HL × 750*					0 5 Mi x 200'			
Total No of Ga Tao	400 000	1 700 000	601 991	792,000	900 000	50' 000	1,362 000	500 000			
Cost per Cu. TB	15 amts	21 cente		{	ļ	Į	l	77 ceste			
Dais Places	8ept 1939 - Det 1939	Aug 1922 - May 1923	Aor 1945 - Oet 1945	Арт 1935 - Mar 1936	Feb 1937 - Sept 1937	Aug 1935 - Sept 1938	Aug 1942 - Sept 1943	July 1944			
Notionted Life of Fill	L				l		ļ				

# Table 6

			ANTIFICIALLY	NOURISHED AND CONSTRUCTS	D BRACERS						
descentificar of matural conflictors											
C outal Ares	Atlartic Ocean	Atlantic Cream	Atlanti. Ocean	Atlantic Ocean	Atlantic Ocenn	Atlen*ic Ocean	Atlant c Deran	Atlantic Goran			
Sans	Atlantic City & J	Goesn Cit M J Surf Rond - 12th 8t	'ir in a Beach Wa	fri :teville N C	Pain Beach Fla Gerfon & Con Ropse	Pal- S-och Fis Vio Del Mar & Banvan Rd	Palu Broch Fin Sun ier Ave	Palo Beaut Fis Fefiserronean Ave			
Length of Frobles Area	Incefluite	Indefini e	Intefinite	"I C ailes	Intefinite	"""efi: ite	laretinite	lof of inits			
hapo sure	15 taru 5 ta 57	WE thru E to SY Clear	b trufto BK Cl+nst	E thru 5 to 8# Cl ar	"Ethro T to & Clear	NE true to B Clear	high thru E to 8 Olmer	WE thru E to 5 Cires			
Slove - For a are History	1 on 5 1 on 190 - 1 on 200	1 on 5 1 on 50 - 1 on 300	i oz 1C 1 on 60	1 on 7 1 or 1 = 1 on 20	1 on 1^ 1 on 50	1 on 10 1 on 50	1 or 10 1 on 50	1 on 10 1 on 50			
Sroca Material Cheracte istic	Fedina to fin send sad suell	Median to fige sand and shali	Nediar to five mand ero .brll	Meclus o fine sand	Sank and shell	Send and shell	Sanc and shall	Sand and shvil			
Mate of Althorni Transport per year	1×0 000 cu vá∉	1600,017 eu y i			725 000 cu 340	225 000 eu y?*	225 0CD eu y/e	224.000 cu y/s			
Dir of Littorsi- inter Trineport Sumor	Sout vert Sou vest	South est Sou hvest	South - Prefoninate North	South - Predominets Morth	South - Precominato North	South - Predoplantr North	South - Fredózinsta North	South - Pr foilnate North			
	L	L	HATERIAL	AVAILABLE FOR HOURISHM	215	L	L	A			
Iversion	Absecon Inlet	Great I <sub>t.e</sub> . Inlot	Lote Rute	Bette Communi	Le v orth and loland Voterway	Leer forth out Inland Valerway	Lake forth and Inland sterway	Lake orth and inland Waterway			
Distance from Fill	0 2 to 1 3 miles	0 f to x 5 miles	0 1 o 3 0 miles	~ 0 is 3 0 miles	↑ 2 to 2 0 miler	0 2 to 7 0 miles	0 ° to 2 ( miles	0 2 10 2 0 11+0			
Character of Abioriel	K -lum to fine sand suell say eilt	Medium to fine sand	Medius to fine shud * All env filt	Medium to fine cand	Sand, shell an ellt	Sand, shell and eilt	Sond shall and ail	Sand shell and silt			
Quantity Available	Ampio	Ample	Ample	Amole	Auro) r	arol z	Apple.	Aspin			
				URISHMENT ACCOMPLISHED							
Type of No. riuserat	Direct placement by Lydraulic dredge	Dir ot placement by hydraulic dreigs	Direct placement by hydraulic dyrigs	Direct placement by hypraulic draces	Stockpile by hypreulic (redge	Stockpile by hydraulto dredge	Sto kpile by by/freulic dredge	Stockpile by hydraulic drades			
Frienry Pusposs	Seach regionation	Reach restoration	Boach restoration	Seach restoration	Score goariebuent	Shore nourlaiment	Shore mouriement	Share no unisharat			
llope of - (Bc' 2" Adj ores ore (After Adj	1 on 7 1 on 5	1 on 10 1 on 5	1 oz 5 1 oz 7	1 cn 7	1 on 5 1 on 7 - 1 on 10	1 on 5 1 on 7 - 1 or 10	1 on 5 1 on 7 - 1 on 10	1 on 5 1 on 7 - 1 on 10			
Imeneions of Fill	1 1 hi x 200'	18 #1 x 300 <sup>1</sup>	3 3 Ni 7 3mi		0.5 31 . 400	0.8 ¥1.x №00'	D 5 WI x 4001	06 x1 = 390 '			
Total ho or Cu Ide	700 000	1 500 060	1 075 590	600 000	F30 000	1 035 0no	kishi fiko	300 000			
Cost per Cu Ta	77 cente	75 arate	fe cents	1 <sup>k</sup> cente	19 3 cenie	19 3 cents	19 3 cente	35 cenie			
Mir Placed	July 1918	1952	1952	1939	May Joks - May 1965	May 1948 - Nov 1948	Nay 1948 - Nov 1048	Aug 19bb			
dotionted Life of \$111	5 ymars	í í			- Jears	5 yesre	5 years	5 7-978			

# Table 7

METTY CLALIT, MOUNTSTOL ON CONSTANTING INVOLUTION										
DISICILIPION OF INVIAL CONDITIONS										
Seastal Area	atiuntic Ocean	Atlanije Ocean	Atlantic Domin	Atlantic Genen	Gulf of Mexica (Mississippi Sound)	Lare Michigan				
Same .	Pain Beach Fin Heilterransh ava	Pale Beach Fla Mediterranea ave	Ph.a Beach Fis Cpn ¥ Palsi Beach Camel	So th Lave worth Inlei Fis	Marrison Coonly Miss	Yorth & Fullerton Avrr	1			
Lon th of Probles Area	Istafinize	Indef laise	Indefinite	ln*efinite	Infofinite	10 #116	]			
haposurs	ME thrm & to & Closer	dE taru 1 to 8 31 mar	WB thru Z to \$ Clear	FE thru E io 8 Clear	SE thrn 5 's 5# Oat 1s 1 3 Mi South Ship Is 2 3 St South	¥ thru X to 53 Clear				
Nicpe - Yoreshors Near Tuby	1 on 10 1 on 50	1 on 10 1 on 50	1 on 10 1 on 50	1 on 5 1 on 25 - 1 on 50	1 on 10 1 on 150 - 1 on 700	3 on 7 3 on 50				
Yeach Matrial Coarscientistic	Sand ond shell	Sand and shell	Band and shell	Medium to firs sand and shell	Rrdi a to fine stat shall and clay	Sand and gravel	[			
Ante of Livioral Transport per year	*25 000 ou yds	~25 060 ~0 yds	225 000 cu 784	22" 030 cu 74+		39 600 ou yae	1			
Bir of Littorei-flated Transpert Survei	South Fredoulanss Borth	Soull - Prefeminets North	South - Predomicator Forth	South - Fre owinate North	}	South South				
			MITERIAL	AVAILABLE FOR SOURISHING	en					
Location	Lake forth and Inlan, stermy	Lak- forth and Inlast Valermay	Lave Vorin and Inland Vaterway	Worth side of Inles	Niesieelppi Sound	Lake Michlgan				
Distarte from \$111	02 to 26 milns	C.2 to 2.0 mlls:	0 Z mlls	0 1 mile	0 3 mll+	0 06 to D 6 mils				
Chars ter of Material	Sand shell and silt	Sand shall and ailt	Sand aboll and all?	Medium to fine soud and shall	Nedium to fine wand, clay and ellt	Fredum to fine sand gravel and ellt	)			
Questit- Available	Ample	imple.	Ample.		Augle					
			<b>DOM</b>	RISHARY ACCONFLISHED						
Type of bourisiumst	Stoccpile by Wy rawlic dronge	Stockpils by hydrealle creigs	Stocaplis by bydraulic dredge	Continuous - Stookpils Bypsesing Flant	Direct placement by bydraulic Gredes	Direct placement by hy traulic tredge				
Primary Purpers	Buore nourigrammt	Supre saurishment	Shore hourishment	Shore sourishment	Beach restoration	Seath restoration	]			
Slope of - (Before ad) Porsshore (After Ac)	1 on 5 1 on 7 - 1 on 10	1 en 5 1 en 7 - 1 en 10	1 on 5 1 on 7 - 1 on 10	1 m 7 1 m 7	1 an 5 - 1 an 7 1 an 7 - 1 an 10	1 on J 1 on 7				
Disentions of Fill	Co Mi τ 39ω*	∩ € ¥1 = 350"			5, D KT × 300.	1	Í	[		
Total Ba of Cu Ma	<b>۶۱</b> , fyJ	380 000	100 000	90 000	f and and	\$=0*000				
Goat p 7 Co To	32 2 Car 6			12 04536	1> 4 to 1h 4 cents	ļ ,				
Date Placed	¥64 v v - د ار1 ر Xe	July 1949	10L5	Es h 7*0r	1951 - 1652	10 14 - 1940	ļ	l i		
Patisates Life of Fill	5 Yea)	5 years	7 YARTS				1			