TABLE VI-12

SCHEME IV - LAND DISPOSAL

Dredge Site	Suisun Bay	Mare Island	Napa River[1]	Petaluma River[1]	Pinole Shoal	Richmond L. W.	San Rafael Cr[1]	W. Richmond Channel	Richmond Harbor	Oakland Harbor	San Francisco	Redwood City
Disposal Site	Petaluma Land Disposal Site											
Distance Miles	22	15	23	3	10	16	14	16	13	28	29	47
Run 1												
Least cost only[3]	(A)[2] 0.78	(A) 0.70	1.21	(L) 1.22	(I) 0.58	(A) 0.80	1.09	(A) 0.69	(I) 0.79	(A) 0.97	(A) 0.91	(A) 1.05
Hopper only[4]	(D) 1.36	(D) 1.16			(D) 0.84	(D) 1.37		(D) 1.10	(D) 1.21	(D) 1.18	(D) 1.98	(D) 2.64
Clamshell only[4]	(H) 1.20	(H) 1.24		(H) 1.24	(H) 1.10	(H) 1.06		(H) 1.13	(H) 1.05	(H) 1.33	(H) 1.23	(H) 1.43
Hydraulic only[4]	(S) 1.94	(S) 1.04			(S) 1.03	(S) 1.70		(S) 2.11	(S) 1.60	(S) 2.12	(S) 3.25	(S) 3.18
Run 2												
Least cost only[3]	(A) 0.84	(A) 0.85	(B) 1.02	(H) 1.05	(I) 0.70	(B) 0.89	(B) 0.92	(A) 0.77	(B) 0.78	(G) 0.99	(B) 0.92	(J) 0.97
Hopper only[4]	(D) 1.74	(D) 1.47			(D) 1.03	(D) 1.75		(D) 1.39	(D) 1.54	(D) 2.87	(D) 2.60	(D) 3.50
Clamshell only[4]	(H) 1.01	(H) 1.02	(H) 1.15	(H) 1.05	(H) 0.93	(H) 0.99	(H) 1.21	(H) 0.95	(H) 0.87	(H) 1.09	(H) 1.00	(H) 1.16
Hydraulic only[4]	(S) 1.71	(S) 0.88	(V) 2.65	(V) 1.60	(S) 0.87	(S) 1.49	(V) 3.42	(S) 1.99	(S) 1.41	(S) 1.83	(S) 2.98	(S) 2.90

1/Large hydraulics and hoppers not practical at dredge site due to narrow or shallow dimensions of waterway.
2/Equipment combinations - See Page VI-46 for equipment letter codes.
3/Least cost utilizing any system whether currently available, would require extensive engineering and testing prior to use.
4/Cost for currently available systems only equipment available although not necessarily presently located in the Bay area.

Source: Dredge Disposal Study, Appendix J (1974).

199 million cubic yards of in-place dredged material (26,900 cubic yards per acre). Costs for land disposal site development and operations were estimated to be as follows:

TABLE VI-13

SITE DEVELOPMENT COSTS FOR PETALUMA LAND DISPOSAL AREA

Dredge Material	Estimated Cost
1. Unprocessed Material* Unit site development cost (Includes capital costs of acquisitions and development and O & M costs)	$0.19/cubic yard
2. Processed Material** Unit site development cost (Includes costs of (1) plus site preparation and processing costs.	$0.59/cubic yard

* Material placed hydraulically in disposal ponds with no further treatment than decantation of water.

**Material which has, in addition to the above, been improved by mechanical working to provide an engineering fill.

6.172 The costs presented in Table VI-12 include $0.19/cubic yard for site development (unprocessed material). Utilizing land disposal even upon a large scale would escalate dredging costs 100% over Scheme I. The land disposal alternative will always require construction of new transfer facilities, equipment, and pipelines.

e. Scheme V - Delta Island Reclamation (Table VI-14)

6.173 The Sherman Island Land Disposal Site (7200 acres) is approximately equal in size to the Petaluma Site. The site will support approximately 116 million cubic yards of dredged material. Site development costs are $0.17 for unprocessed material and $0.66/cubic yard for processed

TABLE VI-14

SCHEME V - DELTA ISLAND RECLAMATION

Dredge Site	Suisun Bay	Mare Island	Napa River 1/	Petaluma River 1/	Pinole Shoal	Richmond L. W.	San Rafael Cr. 1/	W. Richmond Channel	Richmond Harbor	Oakland Harbor	San Francisco	Redwood City
Disposal Site	Sherman Island Land Disposal											
Distance Miles	20	29	37	48	33	45	44	44	42	57	57	76
Run 1												
Least cost only 3/	(A) 2/ 0.91	(A) 0.83	(A) 1.34	(B) 1.45	(I) 0.71	(A) 0.92	1.21	(A) 0.82	(I) 0.91	(A) 1.09	(A) 1.03	(A) 1.18
Hopper only 4/	(D) 1.36	(D) 1.85			(D) 1.91	(D) 2.93		(D) 2.39	(D) 2.91	(D) 3.79	(D) 3.56	(D) 4.05
Clamshell only 4/	(H) 1.29	(H) 1.38		(H) 2.60	(H) 1.32	(H) 1.40		(H) 1.47	(H) 1.41	(H) 1.73	(H) 1.60	(H) 1.78
Hydraulic only 4/	(S) 2.00	(S) 1.49			(S) 1.70	(S) 3.12		(S) 3.97	(S) 3.34	(S) 3.36	(S) 5.35	(S) 4.72
Run 2												
Least cost only 3/	(A) 0.96	(A) 0.87	(B) 1.14	(B) 1.23	(I) 0.83	(B) 0.91	(B) 1.04	(A) 0.89	(B) 0.90	(G) 1.11	(B) 1.04	(J) 1.09
Hopper only 4/	(D) 1.72	(D) 2.39			(D) 2.48	(D) 3.88		(D) 3.14	(D) 3.85	(D) 5.06	(D) 4.74	(D) 5.41
Clamshell only 4/	(H) 1.11	(H) 1.16	(H) 1.44	(H) 2.19	(H) 1.10	(H) 1.17	(H) 1.96	(H) 1.19	(H) 3.18	(H) 1.43	(H) 1.30	(H) 1.41
Hydraulic only 4/	(S) 1.67	(S) 1.32	(V) 3.69	(V) 5.58	(S) 1.50	(S) 2.87	(V) 8.76	(S) 3.68	(S) 3.09	(S) 3.00	(S) 5.02	(S) 4.38

1/Large hydraulics and hoppers not practical at dredge site due to narrow or shallow dimensions of waterway
2/Equipment combinations - See Page VI-46 for equipment letter codes.
3/Least cost utilizing any system whether currently available, would require extensive engineering and testing prior to use.
4/Cost for currently available systems only equipment available although not necessarily presently located in the Bay area.

Source: Dredge Disposal Study, Appendix J (1974).

material. Costs presented in Table VI-14 include $0.17/cubic yard for site development. Due to the remoteness of the Delta from the center of gravity of dredging in San Francisco Bay, the cost of material transport and disposal is approximately 10% higher (0.94 to 0.95/cubic yard) than land disposal at Petaluma.

f. Scheme VI - Marshland Development (Table VI-15

6.174 A 5,000-acre portion of the Petaluma River Land Disposal Area was selected as a representative example of a marsh development area. The average elevation of this area is approximately 2.3 feet MLLW. Tidal range in this part of the Bay is 6.1 feet and the Mean Tide Level is 3.35 feet MLLW. Assuming that an optimal marsh creation area would have a final elevation sloping from MHHW (6.1 feet MLLW) to Mean Tide Level, the average depth of fill which could be accommodated in this area would be 2.45 (say 2.5) feet. Considering that in marsh development areas disposal volume will be approximately equal to shoal volume, this site would support only about 20 million cubic yards of dredged material (4,000 cubic yards per acre). Capital costs and operation/maintenance costs for the development of a 5,000-acre marsh development area are similar to those expenditures required for the development of a land disposal area (unprocessed material) of similar size. However, the unit cost for site preparation of material deposited in marsh development areas is significantly higher ($0.65 per cubic yard) because less material is accommodated per unit area than in the land disposal areas (4,000 cubic yards/acre vs. 26,900/acre). In addition, planting of marsh development areas, if required, will cost an additional $1,000 per acre or $0.25 per cubic yard. The costs presented in Table VI-15 include $0.65/cubic yard for site development. The weighted average of least cost equipment combinations for this scheme is $1.27 to $1.32/cubic yard. Exclusive use of this alternative would increase the average annual cost of dredging three-fold over the utilization of Scheme I.

TABLE VI-15

SCHEME VI - MARSHLAND DEVELOPMENT

Dredge Site	Suisun Bay	Mare Island	Napa River1/	Petaluma River1/	Pinole Shoal	Richmond L. W.	San Rafael Cr1/	W. Richmond Channel	Richmond Harbor	Oakland Harbor	San Francisco	Redwood City
Disposal Site	Petaluma Land Disposal Site											
Distance Miles	22	15	23	3	10	16	14	16	13	28	29	47
Run 1												
Least cost only3/	(A)2/1.24	(A) 1.16	1.67	(L) 1.68	(I) 1.04	(A) 1.26	1.55	(A) 1.15	(I) 1.25	(A) 1.43	(A) 1.37	(A) 1.51
Hopper only4/	(D) 1.82	(D) 1.62			(D) 1.30	(D) 1.83		(D) 1.56	(D) 1.67	(D) 1.64	(D) 2.44	(D) 3.10
Clamshell only4/	(H) 1.68	(H) 1.70		(H) 1.70	(H) 1.56	(H) 1.52		(H) 1.59	(H) 1.51	(H) 1.79	(H) 1.69	(H) 1.89
Hydraulic only4/	(S) 2.40	(S) 1.50			(S) 1.49	(S) 2.16		(S) 2.57	(S) 2.06	(S) 2.58	(S) 3.71	(S) 3.64
Run 2												
Least cost only3/	(A) 1.30	(A) 1.31	(B) 1.48	(H) 1.51	(I) 1.16	(B) 1.35	(B) 1.38	(A) 1.23	(B) 1.24	(G) 1.45	(B) 1.38	(J) 1.43
Hopper only4/	(D) 2.20	(D) 1.93			(D) 1.49	(D) 2.21		(D) 1.85	(D) 2.00	(D) 3.33	(D) 3.06	(D) 3.96
Clamshell only4/	(H) 1.47	(H) 1.48	(H) 1.61	(H) 1.51	(H) 1.39	(H) 1.45	(H) 1.67	(H) 1.41	(H) 1.33	(H) 1.55	(H) 1.46	(H) 1.62
Hydraulic only4/	(S) 1.17	(S) 1.34	(V) 3.11	(V) 2.06	(S) 1.33	(S) 1.95	(V) 3.88	(S) 2.45	(S) 1.87	(S) 2.29	(S) 3.44	(S) 3.36

1/Large hydraulics and hoppers not practical at dredge site due to narrow or shallow dimensions of waterway.
2/Equipment combinations - See Page VI-48 for equipment letter codes.
3/Least cost utilizing any system whether currently available, would require extensive engineering and testing prior to use.
4/Cost for currently available systems only equipment available although not necessarily presently located in the Bay area.

Source: Dredge Disposal Study, Appendix J (1974).

4. Summary.

6.175 The figures presented in Tables VI-9 through VI-16 are valid only within the limits of the assumptions previously described. Overall, the weighted averages for the least cost solutions to the six schemes provide a general summary of the relative economic efficiency of the various disposal alternatives. The following is a summary of the information discussed in this section.

TABLE VI-16
WEIGHTED AVERAGES FOR "LEAST COST ONLY" ALTERNATIVES

SCHEMES	EQUIPMENT ESTIMATES ONE	TWO
I. Closest Aquatic	$0.41/cu.yd.	$0.44/cu.yd.
II. Closest Aquatic Seaward	0.44	0.44
III. Ocean Disposal	0.78	0.71
IV. Land Disposal	0.81	0.86
(Processed Material)	1.21	1.26
V. Delta Island Reclamation	0.94	0.95
(Processed Material)	1.43	1.44
VI. Marshland Development	1.27	1.32
(With Planting)	1.52	1.57

F. REDUCE SHOALING RATE

6.176 In the early 1960s the San Francisco District conducted studies on reducing shoaling and maintenance dredging in the Bay utilizing the San Francisco Bay hydraulic model (215). Tests included structural plans to either prevent shoaling in the navigation channels or to increase flushing of the channels, and selection of alternative aquatic disposal sites to reduce the amount of sediments returning to the channels. In Mare Island Strait, for example, plans tested included flood by-passing, barriers, combinations of tidal ways, barriers and tide gates, training walls and contraction dikes, and diversion of fresh water inflows. At that time, all of the plans tested proved more costly than the authorized dredging program. One matter of concern common to every scheme for reducing shoaling is whether such plans would merely transfer the shoaling to some other reach of the navigation-channel system with no net reduction in the total amount of maintenance dredging.

G. DEVELOPMENTS IN DREDGING TECHNOLOGY

6.177 1. Dredging Equipment. This section discusses contemplated developments in dredging equipment and techniques which may have both direct and indirect effects on the environment. A general description of existing dredging equipment is provided in Appendix A.

6.178 In the past, the dredging industry has not had the funds or trained personnel for innovative design. Similarly, Corps equipment has generally been of a conservative design, subject to Army regulations and budget restrictions. Major improvements in dredging equipment do not seem likely without a significant upgrading of technical skills and research. However, several possible improvements have been suggested for the various dredges. Some of these suggestions are being studied by the Corps' Waterways Experiment Station (20).

6.179 Ellicott Machine Corporation and others suggest the possibility of designing the cutterhead of a hydraulic dredge in such a manner that the blades act as a pump "impeller." This would be particularly applicable in soft materials and should result in greater solids concentration; thus greater output and reduced turbidity may simultaneously result.

6.180 Also being investigated, in order to increase output and reduce turbidity, is the potential of a swivel-mounted cutterhead which will be able to cut directly into the spoil bank rather than from the side, as is now the case.

6.181 Another suggested modification of the hydraulic suction dredge is the addition of pump-down capability. This technique could provide a means of discharging material close to the bottom, with negligible material dispersion. The dredge draghead design would have to be altered so that the same head could be used for both dredging and dumping. Basically, the draghead would have to be capable of directing the flow of dredged material upward during the dredging mode as well as discharging the flow in a horizontal direction during pump-down operation. This pump-down modification has also been suggested for barges and scows.

6.182 Automated ladder swing and depth control equipment is available on the world market today, although not widely used since it was only recently developed by the Europeans. Such controls tend to automate the dredging process and, in many cases, can result in less disturbance of the bottom.

6.183 Some aggregate dredgers use "covers" or "shields" atop their cutterheads in order to define and shape the desired flow regime required for most efficient production. This "shield" is often shaped like an inverted bowl and placed over the top of the cutterhead.

6.184 More accurate flow measuring equipment may help achieve precise production and thus reduce the total amount of dredging. Since we desire, from an environmental standpoint, maximum solids concentration in the pipeline, it is necessary to operate very close to a "clogging" situation. An automated vacuum/pressure control device has been suggested which would add water into the suction line in the event of solids overloading.

6.185 An air-lift type of dredge of Italian manufacture is currently being evaluated by the Corps. This device removes material hydraulically, but the initial lift is provided by compressed air. This type of dredge is best operated from a barge or wharf, and so is not generally applicable to dredging of main shipping channels in San Francisco Bay.

6.186 Specialized dredges have also been contemplated. The ability to optimize such equipment for a given set of circumstances offers a real potential for minimizing undesirable environmental effects of the dredge and disposal operation.

6.187 For clamshell dredges, a bucket attachment has been proposed which would hydraulically force the jaws of the bucket closed without requiring an upward pull as in conventional systems. This allows bigger "bites" and tends to disturb both load and bed material less.

6.188 Short-range electronic equipment, such as radar, sonar, transponders, and visual devices, is presently available at reasonable cost for accurate control of dredging operations. This control can ensure that only necessary dredging is accomplished.

6.189 Certain chemical additives may also result in more efficient dredging operations. The use of a "wetting" or friction-reducing chemical has demonstrated the ability to increase both production and solids concentration by up to 15 percent and yet prevent the intake from clogging. However, it must be noted that we do not know what, if any, effects the use of such chemicals has on the environment.

6.190 Elimination of the cutterhead and use of suction dredging will reduce turbidity. Hopper dredges operating in San Francisco Bay are plain suction dredges and do not use cutterheads. If it is necessary to use the cutterhead, reduced speed will also reduce turbidity. Deep cuts increase solids concentration and reduce turbidity. Elimination of the "cleanup" backsweep will also cut down on unnecessary bottom disturbances.

6.191 Precise and frequent surveys, use of historical data and predictive techniques, and accurate dredging and inspection can reduce the quantities of material to be dredged.

6.192 Many undesirable effects can be ameliorated by timing work so as to have minimum environmental impact. Nearby oyster reefs can be protected by operating only with suitable current conditions, dredging to avoid turbidities around beaches can be scheduled out-of-season or during the night, winter dredging decreases the effect of oxygen sag, and operations can be curtailed during fish and wildlife migrations. These and other measures are being employed by some Corps of Engineers Districts at the present time.

6.193 Although these modifications in dredging equipment and techniques have been contemplated, few, if any, have yet been considered for use in the San Francisco Bay Area. An upcoming study by the Waterways Experiment Station on reduction of turbidity by modifying equipment, and the dredging technology report now being prepared as part of the San Francisco District's Dredge Disposal Study, may shed further light on this aspect of dredging.

6.194 2. Disposal Equipment. Several devices or techniques have been considered for use in disposal operations, but it should be noted most of these devices or techniques would substantially increase the cost of dredging.

6.195 One such device is a vertical barrier known as a silt curtain. These vertical barriers are polyvinylchloride-type floating "screens" which have effectively prevented the spread of dredge turbidity. They have been used around both the dredging and disposal operations with success and are not unduly expensive. Their use in currents, however, will present problems proportional to the current and may not be feasible in many cases.

6.196 Pneumatic bubble screens have been considered for use in a wide variety of circumstances involving the creation of a "barrier" to floating or suspended materials. Two facts have become immediately apparent: (a) current velocity must be minimal, and (b) power requirements to supply adequate compressed air are high. It would appear that the technique is not practical at this time.

6.197 Long-distance pipeline disposal has been considered for Bay Area dredgings, with the terminus at the 100-fathom disposal site. Three disadvantages are: (a) the large initial investment; (b) the inflexibility of the system; and (c) any failure of such a system would entail costly repairs. This system has already been discussed on the previous pages as an alternative disposal method.

6.198 Road and rail haul of dredge spoil has also been considered. Such a ground transportation system would require suitable types of dredge material, dewatering facilities, rehandling equipment, and final disposal areas accessible in terms of distance and road/truck facilities. This system is generally considered too costly to be feasible.

6.199 A certain amount of handling care can reduce the undesirable and visible effects of dredging. Such measures include the avoidance of spills when loading scows or discharging into confined areas, limiting or avoiding hopper dredge overflows, washing down equipment only in the dredging and disposal areas, trimming scow loads to prevent spills, and the general close supervision of operations to reflect environmental concern.

6.200 More accurate disposal of dredged material may be possible by use of precise visual and electronic navigation techniques and by use of downspouts to precisely place the dredged material with a minimum of adverse effects on the water column. Special modification may permit hopper dredges to use their dragarms for this purpose, as mentioned earlier.

6.201 Chemical treatments to improve dredge material prior to dredging are feasible. Chemical oxidizers, such as chlorine, offer the potential for dredge material improvement prior to or during dredging

6.202 Flocculation, or clumping, of dredged material occurs during disposal operations in San Francisco Bay, primarily due to the mixing of fresh and salt water. This clumping causes the dredged material to drop down through the water column. Flocculation may be aided by the addition of chemicals to allow more rapid settling and reduce turbidity. No successful chemicals have yet been developed, and use of this technique may require a silt barrier to enclose an open water "treatment area."

6.203 A series of several types of small, specialized cones known as hydrocyclones has been suggested to separate the finer polluted particles from the larger and relatively clean material. This device is already used in the paper industry and may require a confined disposal area or surge tank. Other filters, such as centrifuge have also been suggested.

6.204 Treatment of land-disposed dredge material in a manner similar to sewage has been considered. The land disposal site would be regarded as a treatment plant where vacuum filters would separate out the larger solids from the liquid effluent, and sludge would be hauled by truck or rail to an inland disposal site. Disposal of highly organic dredge material directly into a city sewage treatment plant has been tested in other parts of the country and found to be difficult to coordinate, and would simply overwhelm the capacity of a typical treatment facility.

6.205 Mechanical aerators and pneumatic bubbler systems may be used to stabilize or oxidize highly organic dredge material. By satisfying the oxygen demand associated with organic materials, aeration may improve overall water quality.

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6.205 Mechanical aerators and pneumatic bubbler systems may be used to stabilize or oxidize highly organic dredge material. By satisfying the oxygen demand associated with organic materials, aeration may improve overall water quality.

6.206 Incineration of dredged material may be feasible in harbor areas where sludge is readily available with a sufficiently high volatile solids content.

6.207 Most of the above disposal techniques and equipment, as well as the proposed dredging equipment, would involve considerable cost increases and have not yet been seriously considered for use in Bay Area dredging.

Relationship between Short-Term Uses of Man's Environment & Long-Term Productivity VII

SECTION VII

RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND LONG-TERM PRODUCTIVITY

A. SHORT-TERM USES

7.001 In the context of this section, maintenance dredging and disposal operations are considered short-term uses of man's environment even though they are recurrent activities that extend over an indefinite time period (so long as the project is not de-authorized). The purpose of continued maintenance of the existing Bay navigation projects, as discussed earlier, is to assure safe navigation, which in turn, helps sustain the waterborne commerce and military mission of the U.S. Navy in the Bay region. Maintaining safe, navigable waterways in the Bay has paralleled the economic growth of the Bay region and the Central Valley since 1868, when the Corps dredged its first channel in the Bay. Waterborne Commerce records (see, for example, Table II-68) are indicative of the vital importance of these maintained waterways, and navigation channels are just as important a transportation media as interstate highways and flyways. For certain types of commodities, transport by waterway is more economical than by land or air.

B. LONG-TERM PRODUCTIVITY AND EFFECTS

7.002 1. Socio-economic Productivity. The socio-economic setting of the Bay Area and the influence of maintaining the existing projects on the soical and economic well-being of the region have been described, in detail, in Section II. The dependence of the social and economic welfare of the region becomes even clearer under Economic Impacts in Section IV.

7.003 As one can see from these sections, maintenance dredging is an important and necessary activity of the Bay region which, from an economic productivity point of view, has contributed to the regions growth. Maintaining the various projects cannot, in itself, be considered as a factor to social and economic growth inducement but nevertheless, has played a part in satisfying the demand for growth. In this sense, local short-term uses of man's environment has maintained and enhanced the long-term, social and economic productivity of the Bay region.

7.004 2. Environmental Productivity. It has been shown that dredge/disposal operations do alter the aquatic environment to some extent at the specific sites of operation. There is natural recovery at the project and aquatic disposal sites even under frequent dredging and disposal, such as at Mare Island Strait (biannual dredging) and the Alcatraz Disposal Site (disposed at several times a year). Recovery occurs, as is apparent of Redwood City Harbor, Pinole Shoal Channel-San Pablo Bay Disposal Site, Mare Island Strait-Carquinez Strait Disposal Site (224, 245), but maximum recovery is probably not reached for those projects requiring annual or more frequent dredging.

7.005 Maintenance dredging in the Bay has been taking place for decades and for those animals dwelling at the bottom of the older projects, dredging disturbances would now be considered a part of a periodic, "natural" perturbation. In other words, routine dredging of existing projects - that is, without expanding the projects- will neither maintain nor enhance existing bottom productivity but neither will there be further degradation because the existing bottom fauna at the project site, after so many maintenances, would seem to have finally adapted to the additional perturbation (now considered a part of the "natural" variation in the environment) over a long-term period.

7.006 Usage of the designated Bay disposal sites are relatively recent but detrimental effects tend to be subdued by the highly changing conditions of currents and sediment movements at these sites. All of the aquatic disposal sites in the Bay and at the San Francisco Bar are in relatively high energy areas where currents and sediment transport are ever changing with daily and seasonal factors. Animals resident to these areas must be well adapted to these variable conditions; otherwise they would not be there. Over a long-term period, resident species of the disposal sites, will become adapted to regular disposal (like the resident species of the project sites to dredging) and eventually accept disposal as a natural perturbation. Observed rapid recovery at the disposal sites seem to indicate an ability to adapt after a given area has been covered with dredged material. Similarity in sediment grain size (Bay mud disposed on Bay mud; sand disposed on sand at the Bar) lessens the long-term impact of disposal because the habitat type (sediment composition) does not change.

7.007 With respect to chemical release during sediment agitation and biological uptake, there is good evidence that both occur (see Section IV); however, the significance of both is still very much under study. Studies to date indicate that the degree of chemical release during sediment disturbance is extremely small for most metals (in the order of sub-parts per billion). How much a given species can accumulate metals before the concentration becomes chronic depends on the species. Many worms, clams, fishes, etc. naturally concentrate certain metals many times (commonly thousands of times) over in-situ water and sediment levels. Such high accumulations probably have a biological function but there is also a probable threshold limit after which the metal becomes toxic. The threshold limit not only depends on the species but also on the given population adapted to local conditions. The toxic level of a metal for a given species might be higher for a population in Mare Island Strait than for a population in Tomales Bay, for example, or vice versa, depending on local conditions and the particular metal in question.

7.008 Maintaining the Bay's navigation channels also contributes, in part, to secondary long-term effects. These secondary or indirectly-related effects result from port, marina, and certain military and commercial operations that are dependent on the safe navigation channels. Long-term impacts from these various operations stem from inadvertent oil spills, runoff, waste discharge, air pollutants from ships and autos as well as other operations-related sources.

Irreversible & Irretrievable Commitments of Resources Resulting from Maintenance Dredging & Disposal Activities VIII

SECTION VIII

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES RESULTING FROM MAINTENANCE DREDGING AND DISPOSAL ACTIVITIES

A. IRRETRIEVABLE LOSS OF MARINE LIFE

8.001 1. Bay Waters. Regular maintenance dredging of the discussed projects and disposal in the Bay have been on-going for many years and thus there have been some irretrievable losses of marine life, particularly the bottom invertebrates in the local channels, basins and aquatic disposal sites. There is strong evidence from the San Francisco District's studies and related studies from other parts of the country that recolonization of the bottom does take place even though the sites are regularly dredged and disposed upon. However, under frequent dredging and disposal, recolonization species and rate can be altered such that only those species that can acclimate to frequent sediment disturbance will survive. Prevention or thwarting full recolonization by frequent sediment disturbance over time (e.g., certain channels of Richmond Harbor have been annually dredged for over 55 years) can be considered an irretrievable loss as a result of continuous disturbance of the bottom habitat.

8.002 Irretrievability does not necessarily imply irreversibility. Should maintenance dredging and disposal stop at any given site, natural shoaling as well as unimpeded recolonization (barring other natural and/or man-made activities that could influence the situation) will immediately begin. A climax community would eventually be reached by the marine life at the site but whether it would be identical to its former (undredged or undisposed) condition would depend upon the local conditions of the site. Assuming no natural environmental changes or other influences, the difference between the predredged or predisposed condition and the climax community attained after dredging or disposal has ceased, would be the irreversible (and irretrievable) loss.

8.003 2. Ocean Waters. There is no evidence of any irretrievable or irreversible loss of marine life resulting from annual maintenance dredging and disposal at the San Francisco Bar channel (203, 252). Dredging and disposal disturbance at the Bar is minor and short-term compared to the dynamic coastal and twice-daily tidal currents affecting the bar environment.

8.004 Disposal at the 100-Fathom Disposal Site up until now, has been infrequent because of the cost of the long haul distance. The diversity of life and productivity of the site have already been alluded to. Based on the joint observations of the U.S. Navy and the Corps, Bay sediments can reach the bottom in bulk, 100 fathoms down, and cover the bottom. Bottom fauna incapable of deep burrowing would be smothered. Introduced non-compatible sediments would inhibit recolonization by indigenous species if the sediments are not dispersed. It is conceivable that increased use of the ocean for disposal, particularly for "polluted" dredged material, could irretrievably reduce the productivity of the area, especially when one considers the Gulf of the Farallones as a feeding, nursing and spawning ground for many commercially important fish (see Plate II-52).

B. IRRETRIEVABLE COMMITMENT OF UPLAND AREAS DUE TO LAND DISPOSAL

8.005 The one land disposal site that might be used for dredge disposal has been described for Redwood City Harbor. Land disposal for San Rafael Creek, San Leandro Marina, New York Slough and Suisun (Slough) Channel is even more tentative and thus is not discussed. Since four endangered or rare species are considered inhabitants near the proposed Redwood City Harbor disposal site, loss of habitat for these and other wildlife could be an irretrievable loss. Permanent irretrievability and irreversibility would depend on future use and development of the filled site.