ENGINEERS, ENVIRONMENT AND INVOLVEMENT

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There are two obvious facts about the fishery in the San Francisco Bay Region: first, it is badly degraded, and second, this has come about primarily because of man's activity in that area. Beyond those two facts lies a great deal of speculation.

Which of man's activities has been most inimical to the environment? Hydraulic mining in the late nineteenth century? Industrial waste discharges? Municipal sewage?

What effect do individual elements of discharges have on the fishery? Is there a synergistic effect? What criteria should be established? Under what sampling and testing procedures?

There are still more questions to be answered than have been resolved...and getting these answers is going to be a formidable task, both lengthy and expensive. When we have the greatest trade deficit in history, an unfavorable balance of payments, a labor dispute, a high unemployment rate and rising shipping costs, any additional burden on ports and shippers should be carefully evaluated before being imposed. We should not proceed by speculation, but by evaluation. There would then be no question on the necessity for adopted water quality standards.

My District gave the Fish and Wildlife Service $130,000 to conduct tests on the effect of turbidity, caused by dredging, on the fishery. More study is needed.

We are also spending an additional amount which will approach $1,000,000 on the environmental effects of channel deepening and maintenance dredging. It is obvious that the State Regional Water Quality Control Boards, the Fish and Wildlife Service, and the State Department of Fish and Game also need millions to evaluate the effect of various waste materials on the fishery.

The Environmental Protection Agency has established tentative criteria in the areas of:

	% Dry Wt. X 10^{-4}
Chemical Oxygen Demand	50,000 (or 5%)
Oil - Grease	1,500
Total Kjeldahl Nitrogen	1,000
Volatile Solids	60,000

Trace Materials:	
Lead	50.0
Mercury	1.0
Zinc	50.0

Until the necessity for the adoption of these as permanent standards becomes apparent, or changes appear warranted, they should be considered guidelines only and balanced against other demands on our resources.

The film I will show illustrates one of the first steps taken in this field. It is on dredging, sampling and testing on the San Francisco Bar.

NARRATION FOR DREDGING FILM
BAR CHANNEL

In common with all major ports located at the mouths of rivers, the harbors of the San Francisco Bay Region are repositories of silt borne by streams originating in upland areas. This material must be removed each year in order to preserve the existing water-borne commerce of the region.

Two additional factors complicate this task. The first of these is the relatively small fresh-water inflow compared to the volume of the tidal prism--the amount of sea water flooding and ebbing with each tide. This relationship results in a mixing action of salt and fresh water considerably inland from the Golden Gate. The silt, therefore, tends to fall out and be deposited in the estuary itself.

As an example, studies show that about ten million cubic yards of material enter the Bay each year; of this amount, only about four million yards pass through the Golden Gate. River flows and tidal action tend to disperse this amount throughout the north and central bay system. Further dispersion or recirculation of silt happens when winds create shore-line turbulence; bottom material is gradually moving in most parts of the Bay.

The result is that the Corps of Engineers annually dredges an average of seven million cubic yards. Some of this is, as we have noted, recirculated material.

The second complicating factor is the existence of the huge shoal outside the Golden Gate known as the San Francisco Bar. The Bar literally surrounds the entrance to the Bay at a radius of about six miles. It lies 25 to 40 feet below the surface. Because of waves and swells, ships must have at least a ten foot clearance in order to pass safely over the Bar. This means that without a dredged channel vessels drawing over 15 feet could not enter the Bay without risk.

The Corps of Engineers maintains a passage, known as the Main Ship Channel, across the Bar. This channel is 2000 feet wide, 50 feet deep, and about three miles long.

We are using hopper dredges to maintain and deepen the bar channel and to maintain interior channels for the ports of San Francisco, Richmond, Oakland and Redwood City. A channel across the shoals of San Pablo Bay at a depth of 35 feet affords access to terminals at Mare Island, Carquinez Strait and Suisun Bay as well as the inland ports of Stockton and Sacramento.

The maintenance vessels are called "hopper" dredges because the dredged material is deposited in bins, or hoppers, within the ship itself. The largest of these craft on the West Coast is the US hopper dredge "Biddle." The "Biddle" is also the only hopper dredge on the West Coast capable of dredging on the Bar.

Since 1959, when the channel was deepened to 50 feet, the "Biddle" has dredged an average of 580,000 cubic yards each year. We will now tour the vessel and see how this is done.

There is only one clue to its function that would be noted by the casual observer: this is the location of the two huge pipes on either side of the ship. It is through these pipes that the material is pumped into the vessel while dredging is underway.

This sand comes up in a slurry--a mixture of sand and water. As this mixture enters the hoppers, the sand settles to the bottom and gradually builds up to a full load. As it does so, the excess water is discharged through overflow vents. The hoppers ultimately fill with solid material to their capacity of about 3000 cubic yards. This takes from 45 minutes to an hour on the Bar.

Depending on its location in the channel, the "Biddle" arrives and begins dumping in the disposal area within 15 to 30 minutes after loading.

The dumping process begins with the opening of levers controlling large valves at the bottom of the hoppers. These open to release the sand directly beneath the vessel. As the material is closely packed, this takes some additional time as the ship slowly cruises along. In this fashion, material is slowly dispersed over a considerable area. This prevents large amounts from building up in one area, which would tend to smother any bottom life.

Our investigation of the channel and bar was underway concurrently with dredging.

This chart shows the sampling areas for toxicity. Bottom samples were taken from the three areas shown.

The cross-hatched areas on this second chart show the locations from which benthic--bottom life--samples were gathered.

The third chart shows a test section used in our spoils dispersion investigation on June 10th. As you know, the littoral drift is generally from north to south depending on the oceanographic season.

These are all areas in which the divers worked. Towill, Inc., was our contractor and furnished the equipment to make the tests.

The divers were thoroughly briefed on what was needed and where to take samples.

They placed various markers underwater after surface buoys had been established. These included stakes and measuring plates. They took water samples, attempted to photograph underwater conditions, and checked benthic organisms. Core samplers brought up material from the Bar. Conditions literally drove them to exhaustion and many times they had to be helped aboard the Boston Whaler.

In benthic sampling, the divers found one three-inch crab and a number of sand dollars. In some areas on the Bar there were 12 to 24 of these things in a square foot; they have small spines on the shell that make them extremely mobile. Open one up and there doesn't seem to be anything there--they're all shell and stomach.

Each diver was thoroughly debriefed so that each dive could be logged and conditions recorded. Here you see some of the sand dollars.

These dives took place prior to the first release in the selected disposal area. The plume from the dredge quickly dissipates and has one unforeseen effect: the divers reported that the water clears appreciably after dumping. We think this is because the dredged material takes the finer silt and sand out of suspension.

After dredging, the divers returned to the markers to document changes that might have occurred.

Samples were also taken aboard the dredge. On December 28, 1970, water and sediment samples from the Bar were taken to our South Pacific Division Laboratory in Sausalito. They were subjected to analysis for mercury and other heavy metals.

The first test is for mercury content.

The second uses an atomic absorption unit--which is similar to EPA's atomic absorption spectrophotometer--to analyze heavy metals content.

Samples were taken on April 5th as well as during dredging on June 5th. All of these were taken with an EPA biologist as part of the crew; a biologist from Fish and Game was also present.

Testing was done in the EPA Laboratory in Alameda, California. We will take a look at a few of these.

Heavy metals analysis was done with an atomic absorption spectrophotometer. This instrument uses a single wavelength light source to determine the concentration of the particular element being studied.

Mercury analysis is accomplished when the necessary reagents are added to the test bottle containing the sample. Air is bubbled through the solution to carry the mercury vapor to the atomic absorption spectrophotometer. The instrument response is drawn out on the strip chart recorder, where the sample results can be compared to standards.

This is the Kjeldahl (Keldall) nitrogen determination test. The sample is digested in acid, boiled to distill off the nitrogen and collected in a receiver. The nitrogen content is then determined by titration--that is, a substance is introduced and the amount of that substance needed to produce a reaction tells you how much of the element you're looking for is in the solution.

Volatile solid determination is made by weighing the material, then heating it to 600 degrees C. Volatile solids are dissipated at this temperature. Such solids are organic material.

The chemical oxygen demand test shows individual units on hot plates. The samples are digested in acid solutions and then titrated to determine how much of the chemicals were used up.

The test for oil and grease is a process of cycling an organic solvent through the sediment sample. This removes the oil and grease material. The excess solvent is then boiled off, leaving the oil and grease residue.

As I have indicated, these studies are by no means completed nor are the results conclusive. Studies that have been initiated will be continued as necessary and new ones considered during the next eighteen months. These will be:

A. Toxicity Study. Although study results so far have indicated the materials from the Main Ship Channel are not polluted by current EPA guidelines, samples from future dredging operations will be collected and analyzed.

B. Water Quality Study. Monitoring of the physical water quality parameters will be continued during future operations both before and during dredging and disposal.

C. Benthic Study. Post-dredging sampling for the benthic study will be continued. Samples will be collected and analyzed periodically between dredging seasons to establish seasonal variations in background population of bottom organisms. This information, together with data from post-dredging samples, bottom deposition measurements and current studies, and bioassay on key fish species (market crab, English sole and sand dab), will be used to determine the "smothering" effect of dredging disposal on indigenous marine organisms of the bar and to establish seasonal criteria and operational procedures for minimizing potential adverse impact on the marine environment.

I have with me two copies of the report made on these initial investigations if anyone is interested, and a single copy of the Fish and Wildlife report. The latter is available from the Portland Office of Fish and Wildlife.