

BOLINAS LAGOON STUDY

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1. Topographic Study
2. Hydrographic Study
3. Oceanographic Study
4. Geologic and Soil Study
5. Soil and Erosion Study
6. Sediment Inflow Study
7. Ecological Study
8. Pollution Study
9. Marine Facility and Legal Research

WATER RESOURCES
CENTER ARCHIVES

DEC 1967

UNIVERSITY OF CALIFORNIA
BERKELEY

NEED AND SCOPE

Detailed topographic information is necessary as the base information for almost every other study in the proposed Study Program. It has been found, however, that very little detailed information exists. Present U.S.G.S. maps are to a scale too small to effectively serve as a planning tool for a study as detailed as the one proposed, and other proposed projects in the general region in addition to the Harbor District plans combine to indicate that a more accurate, wider scope, topographic survey of the region is needed. Furthermore, clarification is needed of the mean low tide line throughout the Lagoon since it has an effect upon property boundaries, implied navigational easements, etc.

Considerable information can be developed from a topographic survey on the soils and geologic makeup of a region, and it would seem reasonable that the scope of study be formulated in such a manner that the maximum amount of information in this respect would be available from the aerial survey.

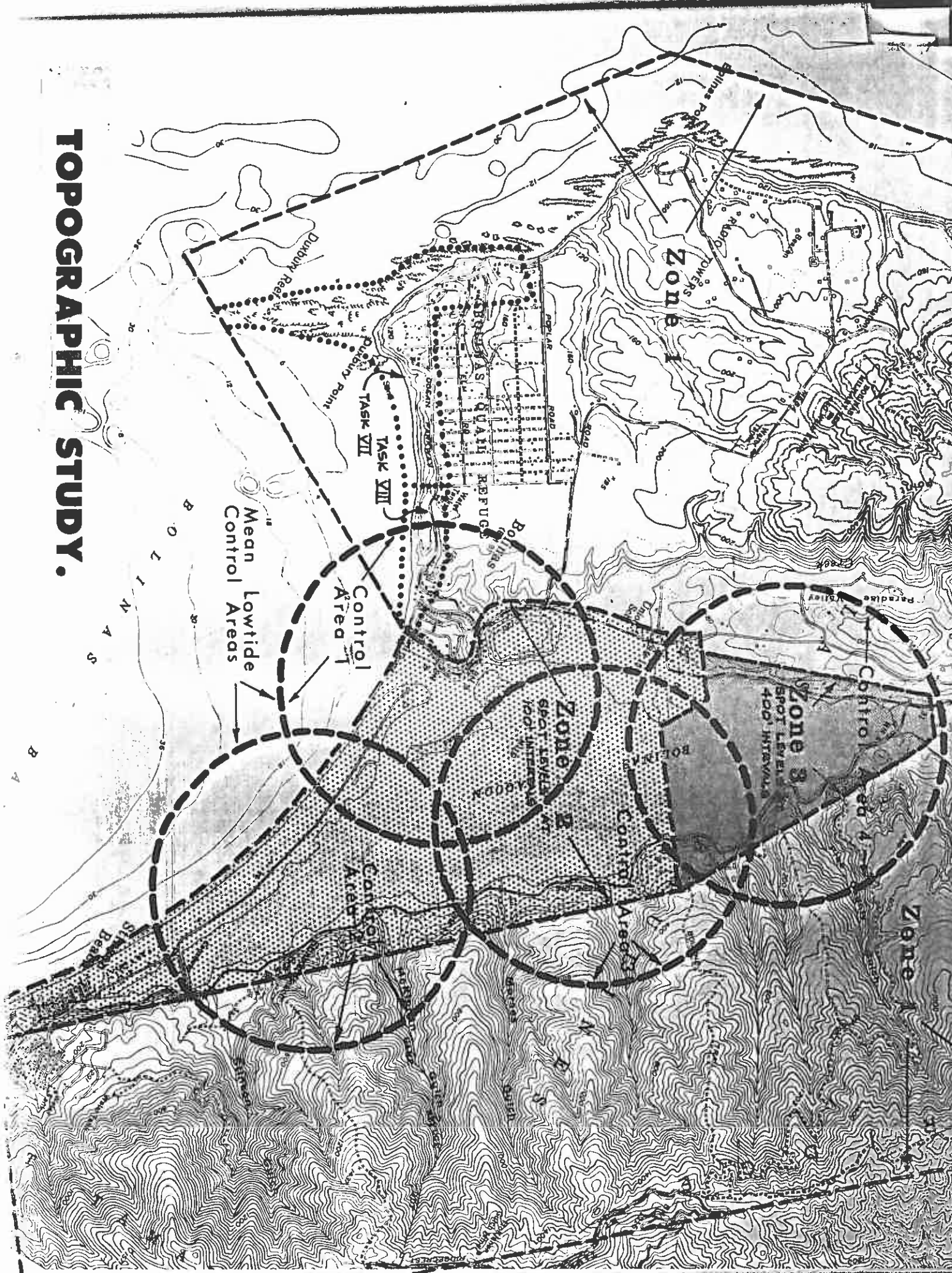
METHOD

A consultant engineering firm will be selected to carry out all, or a number of, the following tasks:

1. Stereoptic aerial photography of the region affected.
2. Plotting of topographic maps of the Lagoon itself showing spot levels in the southern end of the Lagoon where most activity is expected at a relatively close interval and spot levels at the northern end of the Lagoon at a wider interval. (Scale- 1":100')
3. Preparation of a photographic workmap at a scale of 1": 500 ft. as a planning tool. This map may be in color.
4. Hydrographic surveys of the areas of the channel permanently under water as supplementary information to the topographic map.
5. Aerial photography and mapping of the mean low tide line as defined by detailed monitoring studies carried out by U.S.G.S. into the tidal fluctuations at various points within the Lagoon.
6. Plotting of areas of the Bolinas Headland from the channel mouth to Agate Beach in the region where headland erosion may be supplying great quantities of silt material to the flow through the channel mouth.
7. Surveying and plotting of beach profiles on the sandspit and outside of the channel mouth to supplement and replace the most recent ocean bottom survey made in this area by the United States Geological Survey in 1928 -- this work to be undertaken as a portion of the oceanographic study which will include beach profiling as a necessary portion of the work.

FUNDING

The Study will be funded jointly by the Bolinas Harbor District and the County of Marin on a 50 - 50 basis. It is anticipated that the budget for the Study will be \$12,000.

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NEED

Silt materials generated outside of the Lagoon and transported to it through the channel mouth, and the main drainage patterns of the watershed lands, are dispersed within the Lagoon in a predictable way. Similarly, sediment materials already within the Lagoon is redispersed by tidal action during the normal seasonal cycles. In order to properly understand the activity within the Lagoon, to plan for it in the future, and to control its flow and effect, it is essential that this dispersion and movement within the Lagoon be measured accurately by scientific methods.

SCOPE

The Hydrologic Study of the Lagoon will include the plotting of sections depicting the bottom profiles of salient flow pattern channels within the Lagoon, and by a series of progressive surveys establishing the change and siltation buildup in these channels during the normal seasonal cycles; a study of the mineralogical content of the sediments within the Lagoon to establish the source and relative quantity; and fluorescent sand or radioactive sand tracer studies and dye tracer studies to track the movement of various types of silt material from the source points to the point where they are deposited within the Lagoon.

METHOD

This entire study will be undertaken by the United States Geological Survey. Bottom profiling within the Lagoon will be undertaken by conventional surveying methods or may be done with the use of special laser beam equipment now being tested by U.S.G.S. Mineralogical study of samples will be carried out by optical and x-ray diffraction methods in U.S.G.S. laboratories in Menlo Park and sand tracer studies will be carried out by dosing the Lagoon with tracer materials at the various inflow sources and then establishing by sampling and analysis in the laboratory the relative degree of dispersion and main sedimentation areas. Dye tracer studies will be carried out at typical times within the seasonal cycle over a one year or eighteen month period to establish the general water circulation patterns within the Lagoon which affect sedimentation transport.

FUNDING

The cost of this Study will be borne in the following ratio:

Bolinas Harbor District	--	25%
County of Marin	--	25%
United States Geological Survey Department of the Federal Government	--	50%

The total cost of this segment of the Study has been budgeted at \$29,100.

NEED

The general purpose of the entire Study Program is to establish the controlling factors and ground rules for placement of a small craft harbor within the natural environment of the Lagoon as it stands at present. Since a large portion of the attraction of the Lagoon as a boating area is dependent upon access to the fishing grounds in the ocean between Bolinas Bay and Farallon Islands, access to the ocean through the channel mouth is an essential feature of any plan anticipating the use of the Lagoon for this purpose. Present in the waters immediately adjacent to the channel mouth and the sandspit are a complex balance of tidal currents and movements of sand materials which keep the sandspit in its present state of balance and the Lagoon in a relative state of imbalance as it silts up. It is necessary in any plan for the future to provide a solution which will create a balanced system both within the Lagoon and outside of it and in order to do this a detailed study of the tidal and sand movements outside of the channel mouth is essential.

SCOPE

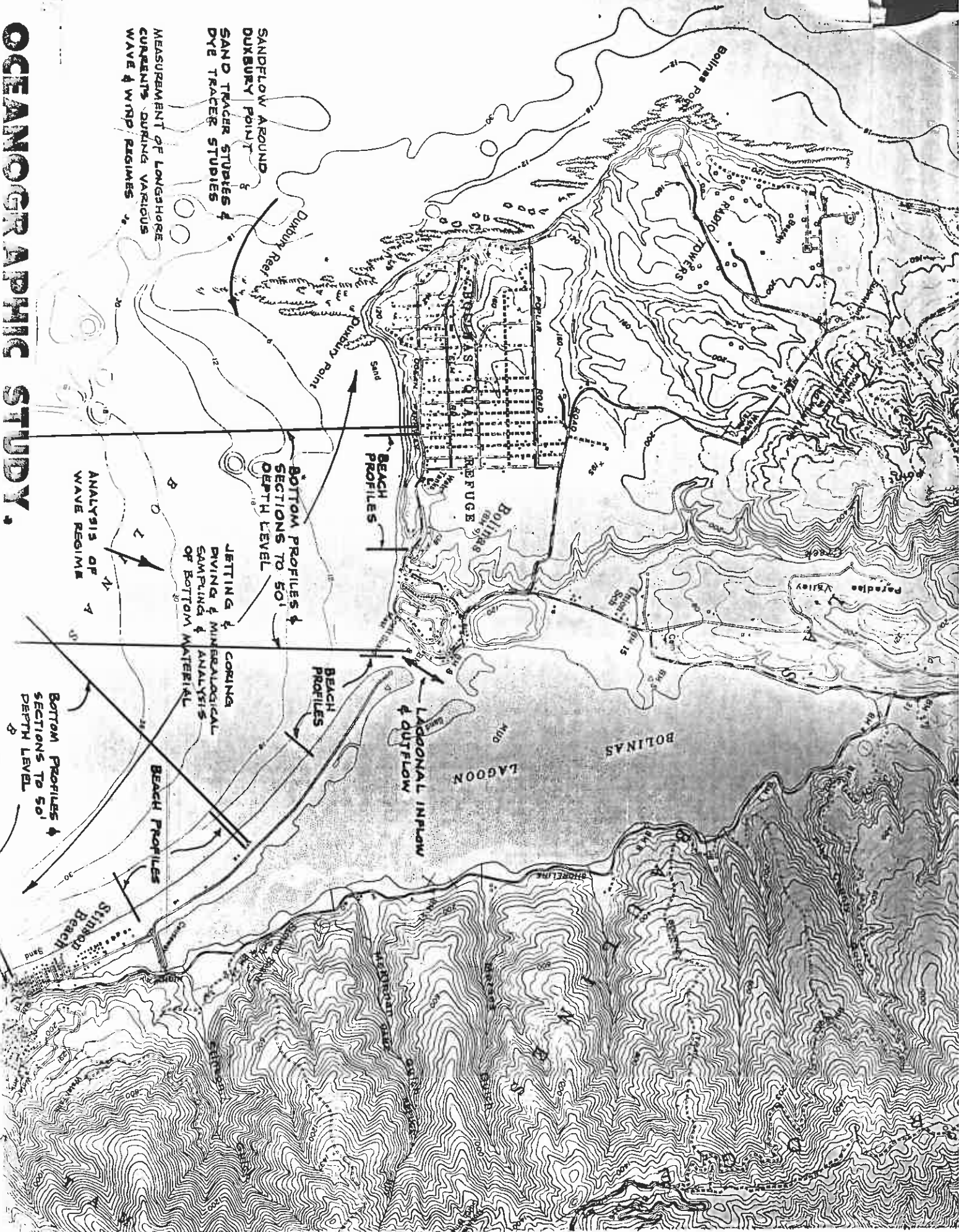
The Oceanographic Study will include investigation into the seasonal on-shore off-shore movement of sand between Duxbury Point and Rocky Point, placing emphasis on the portion of the beach along the Bolinas Headland where known erosion is occurring.

METHOD

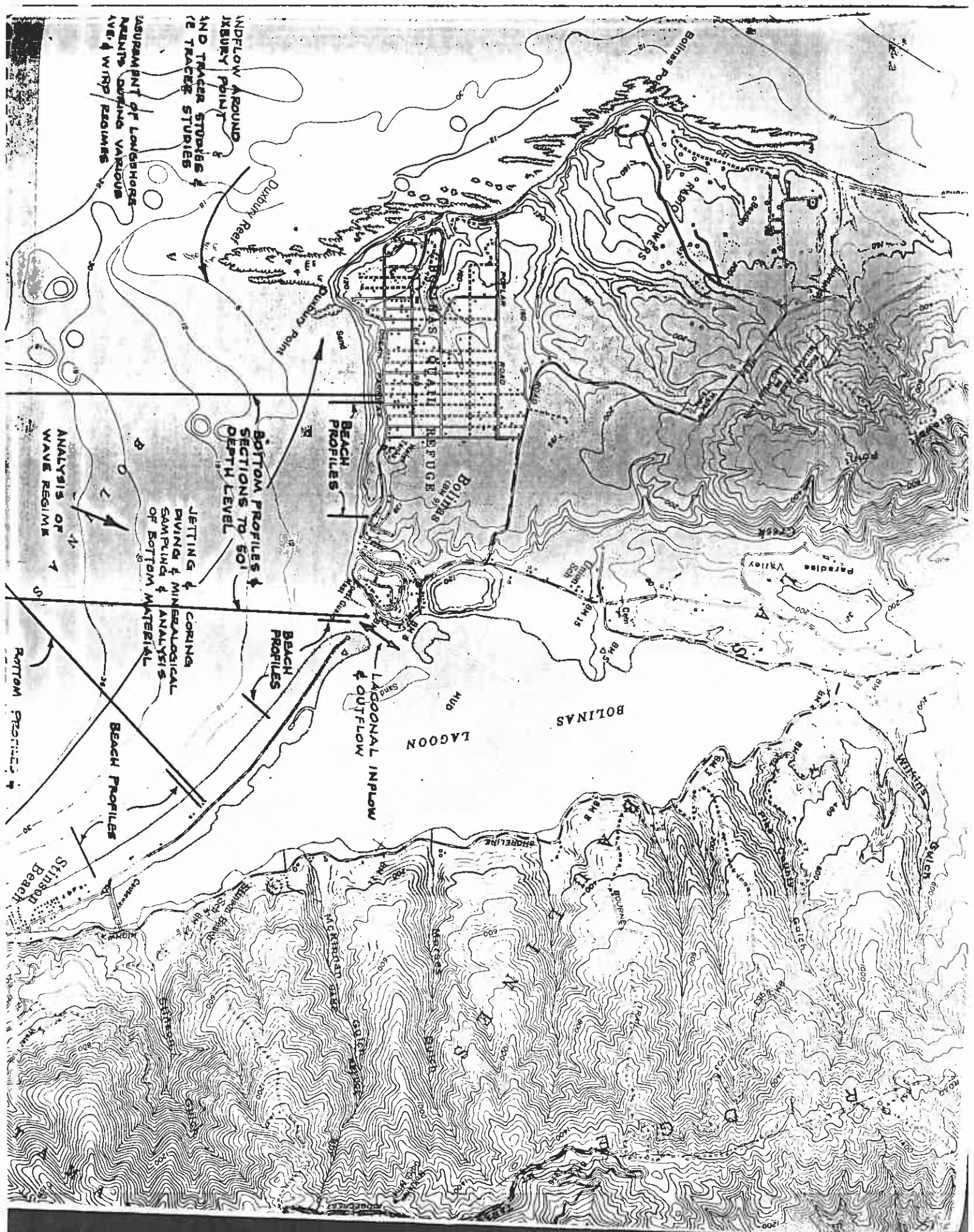
Historical data will be compiled relating to the area, and field surveys will be carried out to obtain regularly scheduled beach and bottom profiles to determine normal seasonal variations, in particular after one or more storms of high intensity. Jetting and coring will be carried out at selected locations to establish the sand overburden, and diving inspection and mineralogical analysis of the bottom sediments both on the beach and offshore will be taken. Longshore currents will be measured during various wave and wind regimes and fluorescent sand tracer studies will be carried out to analyze travel patterns and diffusion rates. Analysis and correlation of this data will provide a usable report providing the base information for design of channel mouth controls and providing information absolutely essential to further consideration of this aspect of the project by the Corps of Engineers. In addition, this study may be extended to cover a compilation of meteorological information about the region including placement of a number of weather stations and visual observation of wind, fog, and rainfall conditions throughout the area on a schedule covering a full range of seasons.

FUNDING

The Oceanographic Study is expected to be carried out by a consultant engineering firm expert in this field. A budget of \$15,000 has been set for the Study.



OCEANOGRAPHIC STUDY.



NEED

Bolinas Lagoon lies astride the St. Andreas Fault, in an area where seismic activity is predictable. The Lagoon and much of the low-lying land surrounding it has as its soil base a collection of alluvial or sand materials deposited by stream flow or tidal action. These materials require detailed analysis before an accurate determination can be made of how they may react in earthquake or normal loading conditions. The reaction of the waters of the Lagoon themselves to the forces of an earthquake involving lineal displacement, such as that predictable in this region of the St. Andreas Fault, should be analyzed in order to determine the effect of an earthquake shock upon floating structures. Analysis of the geologic conditions underlying the Lagoon and the ocean bottom to the south should be made to trace the St. Andreas Fault and the geologic conditions on either side of it, in order that an accurate prediction can be made of the potential location of maximum activity in an earthquake.

SCOPE

The study will be, by necessity, of a relative preliminary nature, arriving at the information necessary for the planning program proposed. Information generated must be of sufficient detail to make possible logical and well informed decisions, but the precise design of structures and facilities, and the tests necessary for them, will be delayed until the development plan phase of the project.

METHOD

This study will be carried out in two separate phases.

Phase 1 will be undertaken by the United States Geological Survey as a portion of their St. Andreas Fault Study Program, which is already under way, and financed by a Federal appropriation and grant. Special equipment and boats have been manufactured for the study, and it is expected that sub-bottom profiling, using a sonic boomer and pinger, will be undertaken in October of 1967. Negotiations are under way with private industry firms to examine the cost and scope of supporting studies that may be necessary to fill out U.S.G.S. study to cover the entire Lagoon, but for the moment it is anticipated that this additional work will not be necessary. Sub-bottom profiles will be correlated with test holes, drilled to a depth equal to the probable effective depth scope of the sonic equipment. These profiles are expected to provide information up to a depth of 300 feet below the surface of the water.

Phase 2, which may be carried out concurrently with Phase 1, will consist of jettings and control borings throughout the Lagoon, examining the depth of overburden and its characteristics. Negotiations are under way to have this work included in part within the scope of the U.S.G.S. study.

FUNDING

At this time it is anticipated that much of the cost of this study will be borne either by the U.S.G.S. St. Andreas Fault Study, already authorized and funded, or by a portion of the budget of one of the other studies already outlined for the Bolinas Lagoon. Programs are at this time being developed for the scope of work for the study in general, prior to finalization of negotiations with outside agencies.

It is estimated that the value of the scope of work encompassed by this study would be in the region of between \$25,000 and 30,000.

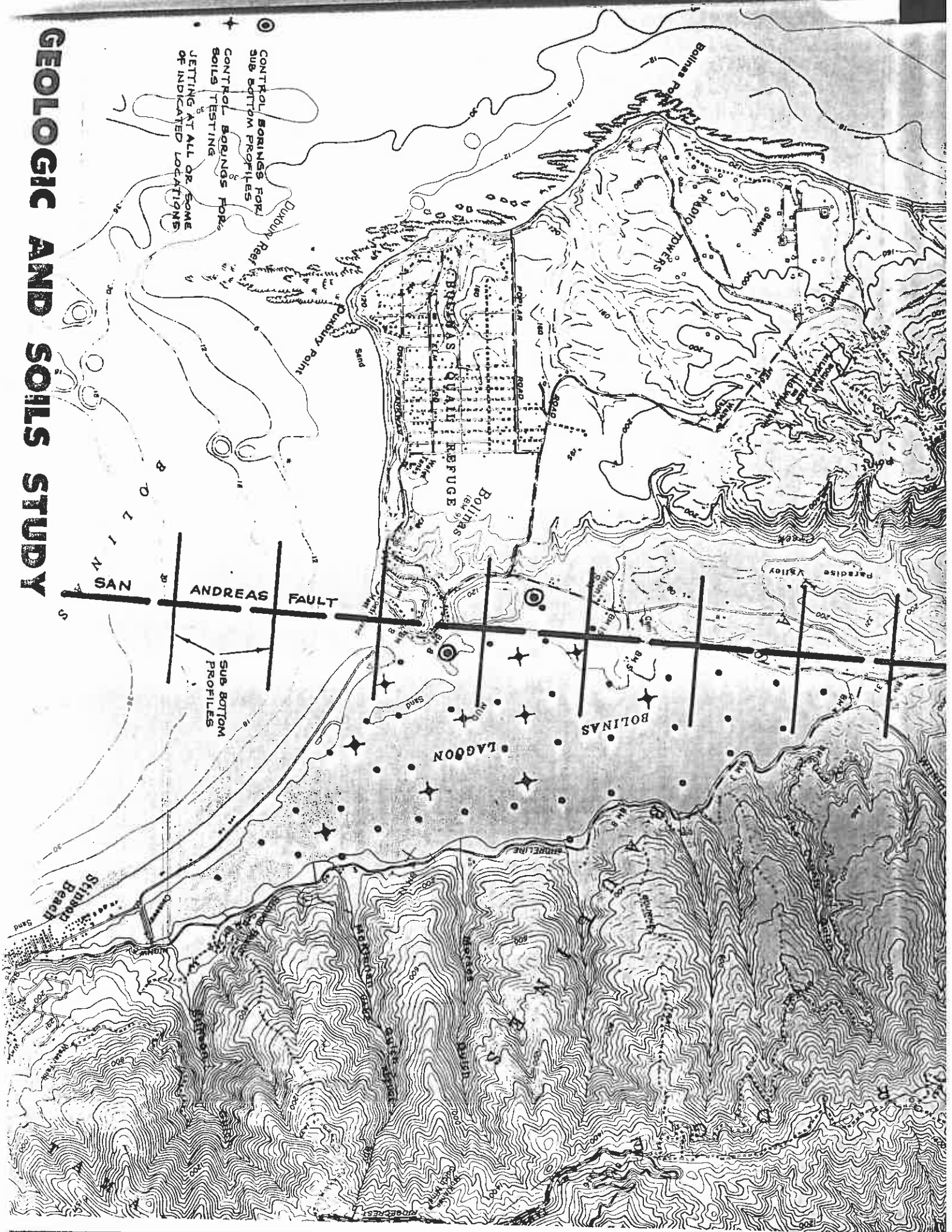
GEOLOGIC AND SOILS STUDY

○ CONTROL BORINGS FOR SUB BOTTOM PROFILES
 + CONTROL BORINGS FOR SOILS TESTING
 • JETTING AT ALL OR SOME OF INDICATED LOCATIONS

Bolinas Towers
 Bolinas Quail Refuge
 Bolinas Lagoon
 Andreas Fault
 Duboy Reef
 Duboy Point
 Sand
 Shoreline
 Stimson Beach
 Bolinas

-
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CONTROL BORINGS FOR
SUB BOTTOM PROFILES
CONTROL BORINGS FOR
SOILS TESTING
JETTING AT ALL OR SOME
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NEED

The Bolinas Lagoon watershed consists of steeply hills and ravines on the east side, sloping directly into the Lagoon, and a mesa and steep cliffs ringing the Lagoon on the west side. Rainfall runoff characteristics are quite different for the two sides of the Lagoon, and soil characteristics are totally different, since the Lagoon is divided by the St. Andreas Fault, with rocks of the Franciscan formation on the east side, and rocks of the Merced formation on the west side. Rainfall and erosion characteristics, therefore, vary greatly throughout the watershed. Heavy rains produce considerable sediment materials under present drainage conditions, but it is reasonable to expect that this condition will be worsened by the changes in the topographic characteristics of the watershed due to the development which is predicted for the region during the decades to come. It is therefore essential that a soil and erosion study be carried out for the entire watershed to establish the general rules for food planning, development, and grading ordinances and to analyze points of control of erosion runoff at some points in the hills themselves.

SCOPE

The study will cover the entire watershed area feeding the Lagoon with a detailed standard soil survey. The watershed will be mapped according to soil series, slope and erosion conditions, and internal drainage conditions, and recommendations will be made on remedial measures in areas where problems, or potential problems, exist.

METHOD

The soil survey will be undertaken by the Soil Conservation Service of the United States Department of Agriculture as a part of their Marin County Survey. Plotting will be on aerial photographs to a scale of 1:20,000. Aerial photography for this study has already been undertaken and is in hand. Field work will be coordinated with the Marin County Public Works staff, and reports will be coordinated with the Bolinas Harbor District and the County of Marin. Recommendations will be made on vegetative and erosion control, and in the planning of erosion control structures as needed.

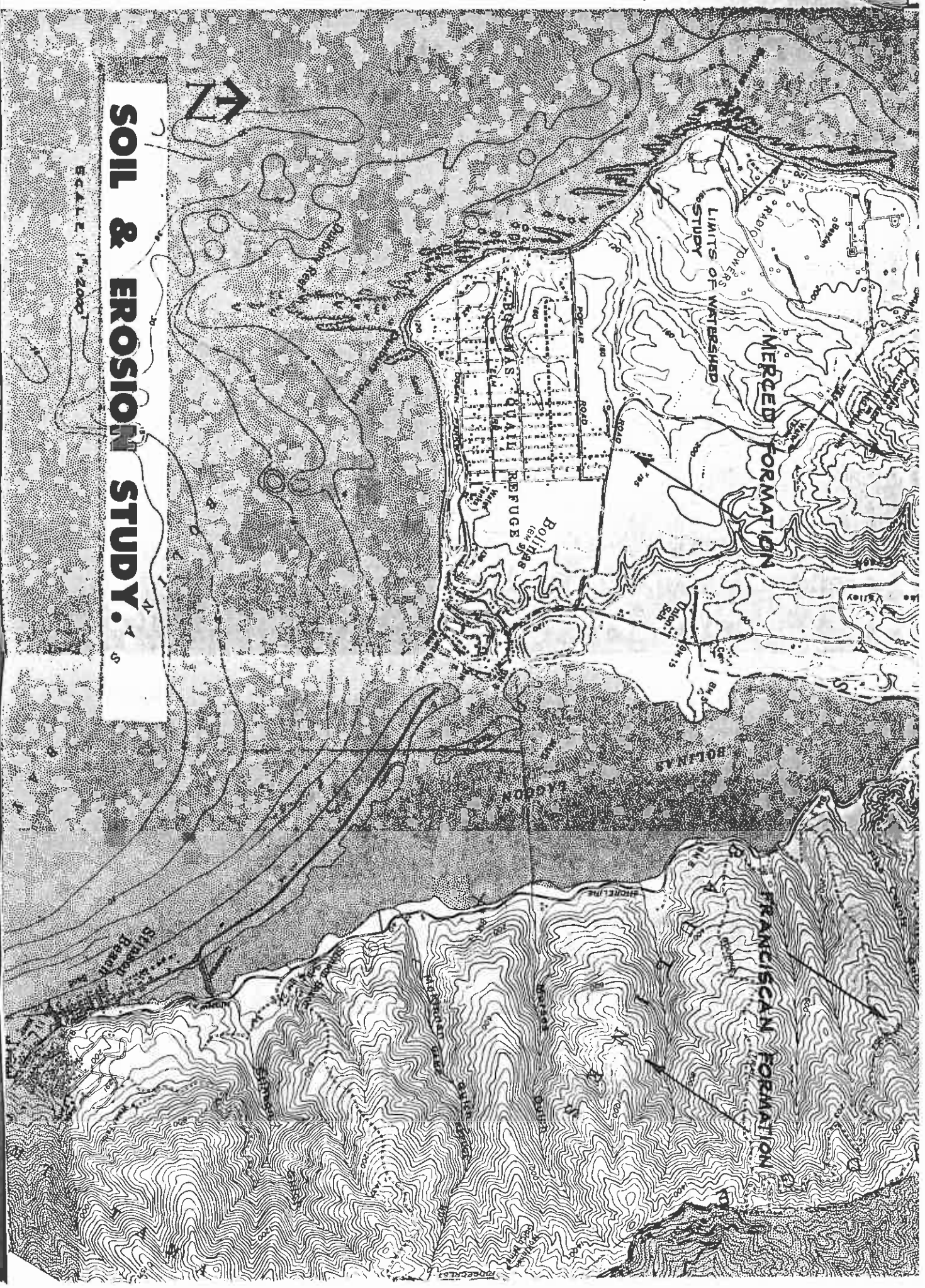
FUNDING

The entire cost of this study will be borne by the Soil Conservation Service of the United States Department of Agriculture. The value of the study is estimated at \$

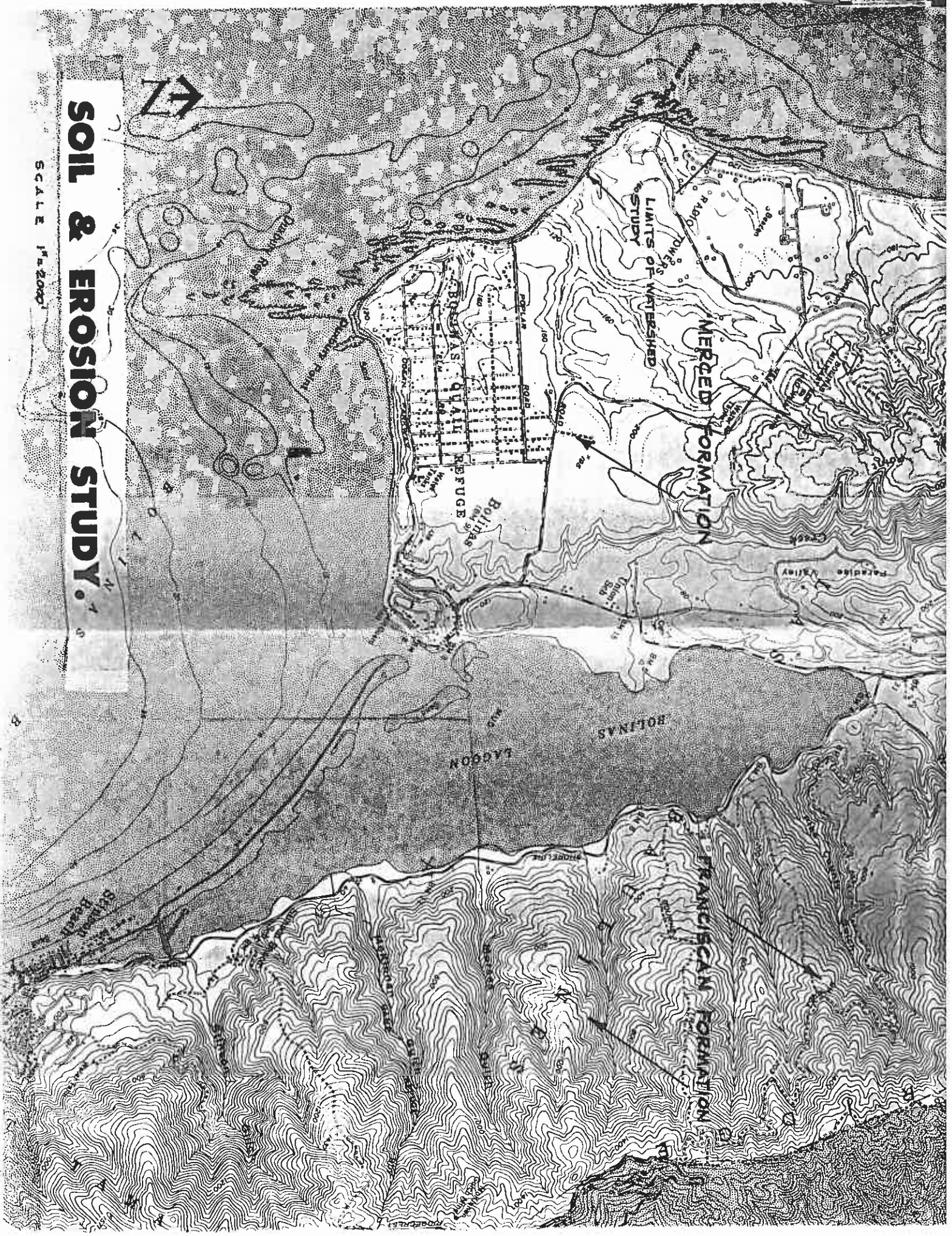


SCALE 1"=2000'

SOIL & EROSION STUDY.



SCAUE 1st 2020



NEED

Bolinas Lagoon is typical of estuarian lagoons of its type in that constant erosion in its watershed lands and constant inflow of silt material carried in by tidal action tend together to gradually fill the Lagoon with silt, eventually turning it into a marshland meadow in the manner evidenced by other examples of the same process which have been allowed to continue unchecked. If Bolinas Lagoon is not to be obliterated as a body of water, this sedimentation process must be checked and the Lagoon must be placed in a condition of equilibrium where it is self-maintaining and the self-annihilation process is eliminated. In order to arrive at methods of controlling the problem, highly scientific measurements and tests have to be carried out to accurately define the processes which are, in fact, having their effect upon the Lagoon, and the Sedimentation Study is directly aimed at this purpose.

SCOPE

The Sedimentation Study will measure the inflow of water and siltation material into the Lagoon at each of the major source points. These will include the various drainage gullies leading from the watershed lands, and also the channel mouth itself. Measurements of the channel mouth will be structured to compensate for the fact that material passes into the Lagoon on the flow tide and out of the Lagoon on the ebb tide and that some of the material entering the Lagoon from the watershed lands finds its way out again through the channel mouth. It is anticipated that this study will provide the physical data which, when coordinated with the Soil Conservation Study and the Hydrographic Study, will provide a complete picture of present day sedimentary activity within the Lagoon, as well as providing a comprehensive tool for planning the physical environment for the Lagoon for the future.

METHOD

All Studies will be undertaken by the United States Geological Survey. Special equipment has been built to undertake the Studies and a large number of the initial measurements at the channel mouth and in other locations have been taken and are being analyzed and compiled into meaningful form. The Study will include the following field of analysis:

1. Measurement of the fresh water inflow from the watershed lands.
2. Measurement of the sediment inflow from the watershed lands and analysis of the characteristics of the material generated at this source.
3. Measurement of the sediment transport through the Lagoon entrance and analysis of the characteristics of the material generated at this source.
4. A study of the littoral drift characteristics of the water immediately adjacent to the channel mouth.

FUNDING

The cost of this Study will be borne in the following ratio:

Bolinas Harbor District	--	25%
County of Marin	--	25%
United States Geological Survey Department of the Federal Government	--	50%

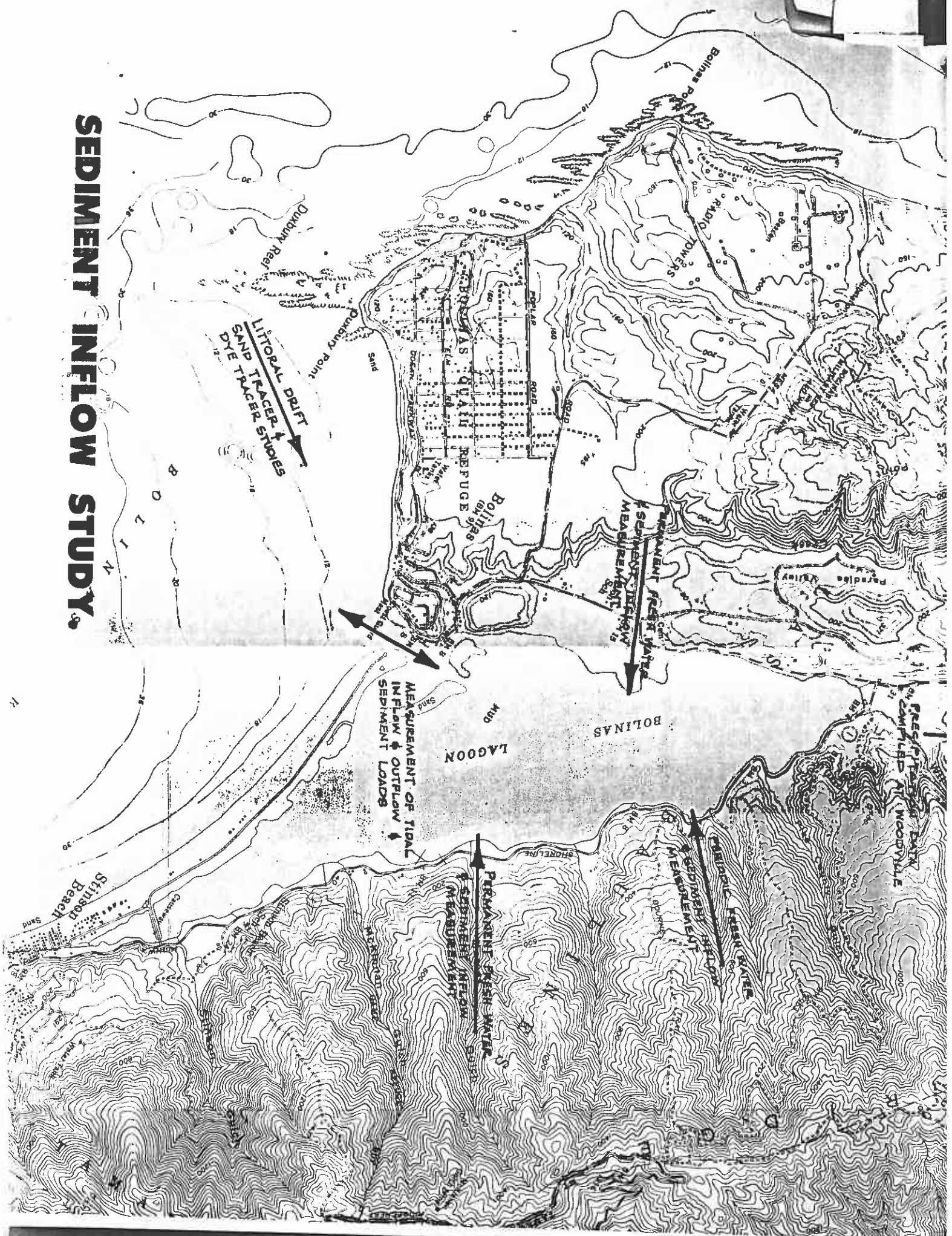
The total cost of this segment of the Study has been budgeted at \$40,000.

SEDIMENT INFLOW STUDY.

The map displays the Bolinas area with various geographical features and study locations. Key locations and features include:

- Bolinas Point**: Located at the top left of the map.
- Duxbury Reef**: Located near Bolinas Point.
- Duxbury Point**: Located near the center of the map.
- Bolinas Quail Refuge**: Located near the center of the map.
- Bolinas Lagoon**: Located near the center of the map.
- Stinson Beach**: Located at the bottom left of the map.
- Roads**: Labeled as "PORT AR ROAD" and "ROAD".
- Contours**: Elevation lines are shown throughout the map.
- Study Areas**:
 - LITORAL DRIFT SAND TRACER & DYE TRACER STUDIES**: Indicated near Duxbury Point.
 - PERMANENT FRESH WATER SEDIMENT INFLOW MEASUREMENT**: Indicated near Bolinas Lagoon.
 - MEASUREMENT OF TIDAL INFLOW & OUTFLOW SEDIMENT LOADS**: Indicated near Stinson Beach.
- Other Features**: "RADAR TOWERS" are located near the top right, and "BOLINAS" is labeled near the bottom right.

SEDIMENT INFLOW STUDY



It has been established that Bolinas Lagoon represents a rich environment for the propagation of a diverse ecological population, and is one of the region's more valuable water resources. It seems evident that some physical change must take place in the Lagoon if it is to be either saved as a body of water from the siltation process which is now under way, or if it is to be useable by man. It is essential that these changes be carried out in such a way as to be compatible to the greatest degree with the natural environment into which they are introduced, and in order to properly set the guide lines for controls on these changes, comprehensive knowledge of the natural environment must be gained to act as a guide line.

Apart from the fact that the ecology in the Lagoon is itself a natural resource worthy of recognition and preservation, it should be recognized that another major resource of the Lagoon is the prolific salmon fishing grounds lying offshore and reaching out as far as the Farallon Islands. It would seem that this fishery is not dependent upon spawning runs or other normal activities of the salmon, but rather on the presence of a permanent feeding ground fed to a large part by the food chain cycle originating in the Lagoon itself. Damage to the ecology of the Lagoon could mean damage to the source of food for the salmon fishery, resulting in the potential elimination of the fishing ground, which is itself the reason for the desire for small craft facilities in the Lagoon. To preserve this natural source, it is therefore essential that food development within the Lagoon be carried out in such a manner that its localized damage to the ecologic conditions will be minimal.

SCOPE

The ecological study of the Lagoon will have as its aim a scientific and biologic analysis of the existing conditions and of the marine invertebrates and terrestrial vertebrates utilizing or depending upon the waters or the shallows of the Lagoon. Habitat areas will be mapped, and vertebrates and invertebrates will be listed by habitat and role, as will the plants of the Lagoon. Key index species will be selected as control specimens for analysis of the major trophic food cycles, their distribution, frequency and role, and their sensitivity to pollutants. The habitats of these species will be analyzed to arrive at guide lines for habitat preservation maintenance and construction. The study will culminate in a series of recommendations for maintenance of desirable water quality in the Lagoon, providing the guide lines for successfully designing facilities that will combine preservation of the natural habitat and use of the Lagoon by man into a compatible whole.

METHOD

This work will be undertaken by Resources and Ecology Projects, headed by Dr. Joel F. Gustafson of San Francisco State College, and scientists and professors from the College of Marin and San Francisco State College working as a team. A preliminary report will be available in August of 1968 and a final report is expected early in 1969.

FUNDING

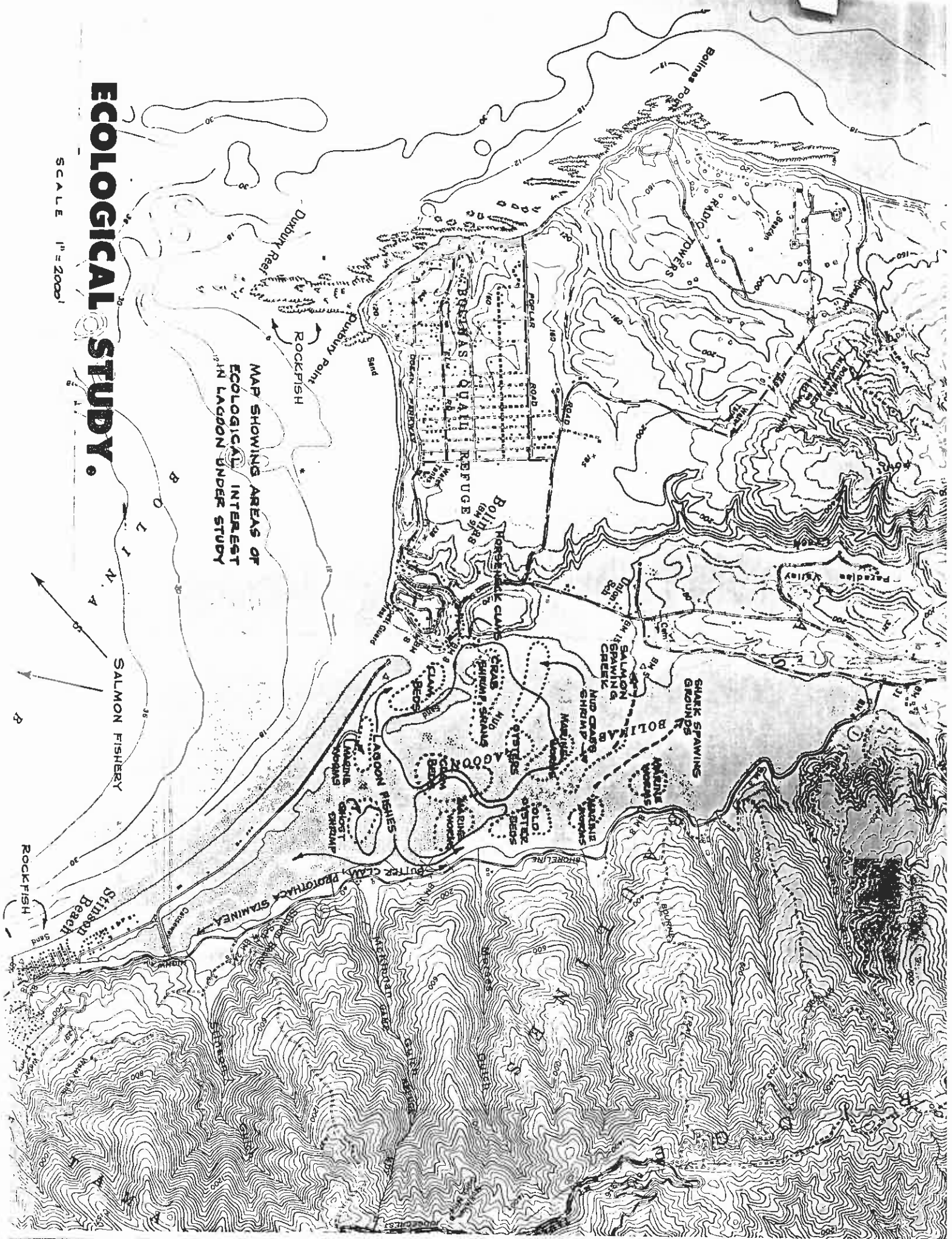
This program is jointly supported by County, Harbor District and Conservation sources. Participation in the \$6,000 stipulation will be as follows:

Bolinas Harbor District	--	\$2,000
County of Marin	--	2,000
Marin Conservation League	--	1,000
Audubon Canyon Ranch	--	1,000

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ECOLOGICAL STUDY:

SCALE 1" = 2000'



NEED

Placement of marine recreational facilities in virgin areas, or enlargement of existing facilities, almost always carried with it some degree of effect on the natural ecological and water quality resources of the chosen site by pollutants of one form or another, generated by the marine facilities imposed on the environment. Search for information on this potential effect reveals that almost no definitive scientific information is available to guide the hand of the marine facility planner with respect to pollution control and effect, in projects being designed. The purpose of the pollution study would be to carry out a scientific program of research, with a view to arriving at a control manual for use industry-wide, in the design of marine facilities, and in particular for use in the Bolinas Lagoon project, which would be a good demonstration project for this purpose.

SCOPE

The Pollution Study Program included in the Bolinas Lagoon Study will act as a pilot program for a full scale scientific analysis to be undertaken under a Federal grant. The study at this stage would be limited to a comprehensive analysis of existing information on the subject, drawing from information generated in studies of the San Francisco Bay as well as other areas. From this analysis of existing material it will be possible to establish the areas where information is most lacking and, therefore, to formulate a program of analysis to be done under the Federal Pollution Grant Program, which will cover the field in as total a manner as possible. Though the investigations within the scope of the Bolinas Lagoon Study Program are intended as the seed for a much larger investigation, the intent is, nevertheless, to structure these investigations in such a way that their end product would be a comprehensive report of the existing information on the subject available today, which will in itself be a useable document irrespective of whether or not the full program goes ahead.

METHOD

Expert consultants will be engaged to work under the coordination of Harbor District and County staff, to collect and analyze existing data relative to the various forms of pollution and degrees of production of pollution generated by various forms of marine recreation facilities and related type facilities. Consultants will be selected for breadth of prior experience on the subject. A general report will be developed relating to the pollution tolerance levels of various forms of ecology and water quality conditions generally encountered in projects of this type, and these tolerance levels will be equated as far as possible, working with present day information with the pollution production levels. The consultants will address themselves to analyzing the points where information is lacking (which are known at this time to be quite wide in scope), and a work program will be set up for scientific analysis study on the subject, which would be undertaken as a part of the Federal Study Program. A general report would be produced, which would be useable in the application for the Federal grant approval.

It is anticipated that the scope of work under the Federal program would be such that on-site analysis would be made on a number of varying marine facilities, incorporating varying standards of slip design and housing various forms of water-borne craft. In some cases a continued program of analysis is under way in some of the larger existing facilities, and information will be drawn from these programs as the study progresses. It is expected that special consultants, local health authorities, engineering concerns, and research laboratories of major related industries will be involved in the over-all study. Detailed analysis of the various forms of ecological life generally encountered in marine recreation projects, their characteristics and tolerance levels, and the various levels of water quality required in facilities of this kind will be carried out both in the laboratory and on the field. An attempt will be made to develop a comparable index system for both pollution production potential of various types of facility, and of pollution tolerance levels of the various forms of environment, in order that these may be equated, taking into account specific local conditions in any given project during the design phase as a control for the methods and elements used in the design of marine facilities, and of the method of operation within those facilities when they are complete.

FUNDING

The pilot program under the Bolinas Lagoon Study Program is budgeted to cost \$5,000, funding for which is to be provided in the amount of \$3,000 by the Bolinas Harbor District, and \$2,000 by the County of Marin. The full scale program of study is expected to cost in the region of \$50,000, and will be funded by the Federal pollution grant to be applied for at a later date.

It is likely that if the Federal grant discussed above is forthcoming, the Bolinas Lagoon small craft facility could become a demonstration project under the terms of the Federal Pollution Grant Program, and be qualifying for financial assistance in construction of the testing facilities, which in this case could be slips and docks in various configurations, pollution spread control measures, etc., which could greatly assist in the economic feasibility of constructing a small craft recreation facility in the Lagoon.

UDY.

ARCH.

NEED AND SCOPE

Early in the program of planning analysis for the Bolinas Lagoon project it became obvious that very little specific information existed with relationship to the potential degree of use, and tributary population areas which will use the facilities in the Lagoon in the future. It is evident that a great deal of use is made of the farallon salmon fishing grounds, and that considerable recreational traffic is already present in the region, with present day limited access provisions and limited population demands. It is anticipated that in the future demand for recreation for the small craft facilities will be forthcoming from not only residents of the immediate watershed, but from residents of a growing Marin County. Development of a highway linking Pt. Reyes national seashore (and therefore Bolinas Lagoon), with Highway 101 and points north and south, including San Francisco and a growing Marin County, will also provide a direct link with highway routes already planned and under way, linking to the Sacramento Valley and the vast population sources growing up in those regions. Already a considerable recreation traffic is noticed, originating from the Sacramento Valley, composed mainly of people fleeing the hot Valley for the cooler coast. Improved highway conditions will greatly exaggerate this trend.

It is anticipated that boating traffic will increase greatly between San Francisco Bay and Bolinas Lagoon if a small craft facility is available to service it. The growing boat population of the San Francisco Bay region will serve to further exaggerate this potential source of traffic. The development of the Pt. Reyes national seashore and small craft facilities at Pt. Reyes or Drakes Bay, and the burgeoning development of Tomales Bay, will further provide a network of small craft facilities up the coast that will increase the importance of the role of Bolinas Lagoon as a small craft facility. Commercial fishing problems and harbor refuge problems in the region will have to be solved in the near future if the needs of the people of the State are to be properly served, and it is important that the views of the commercial fishing industry be properly understood with relationship to Bolinas Lagoon prior to making decisions of a planning nature for the Lagoon itself.

Study is therefore necessary to analyze these various factors and others that impinge upon the future of the Bolinas Lagoon region, in order that a proper prediction of the future trend of the region can be formulated for use as a planning tool.

METHOD

Contact will be made through questionnaires and direct communication with a meaningful cross-section of the representatives of the planning, boating, and commercial fishing industry interests, and various statistical sources will be tapped to arrive at growth projections, etc. A consultant firm, such as Arthur D. Little, Inc., will be engaged to undertake the specialist market study which will probably be a part of the study program.

It is evident that there is a strong conservationist interest in the Lagoon, aimed at preservation of its natural environment. Many studies in the over-all study program have been structured to take into account full analysis of the natural resource which conservationists and Harbor District sources, and the like, desire to preserve. A part of the statistical research program may be oriented to polling the general public opinion regarding the future of the Lagoon, attempting to obtain, through a carefully planned sampling, an indication of the balance of opinion on the matter of the future of the Lagoon. It is hoped that such a sampling may throw a different light upon the errant "public opinion" reflected by the press in the past, which was controlled almost entirely by a group who were able to be the most vociferous and did not take into account those with strong opinions, who had neither the opportunity nor the inclination to voice them loudly in public, but who may be willing to express them through a private poll. Since the Bolinas Lagoon project has become such a controversial matter, it seems important in the interests of the public that some light be thrown on this aspect of the matter, since it concerns itself directly with the emotional environment within which the statistics and facts generated by the general study program will be viewed.

FUNDING

The entire cost of this study will be funded by the Bolinas Harbor District. The anticipated cost of the study has been budgeted at \$5,000.

STATISTICAL RE