

# Isthmus of Tehuantepec

R. A. Miles

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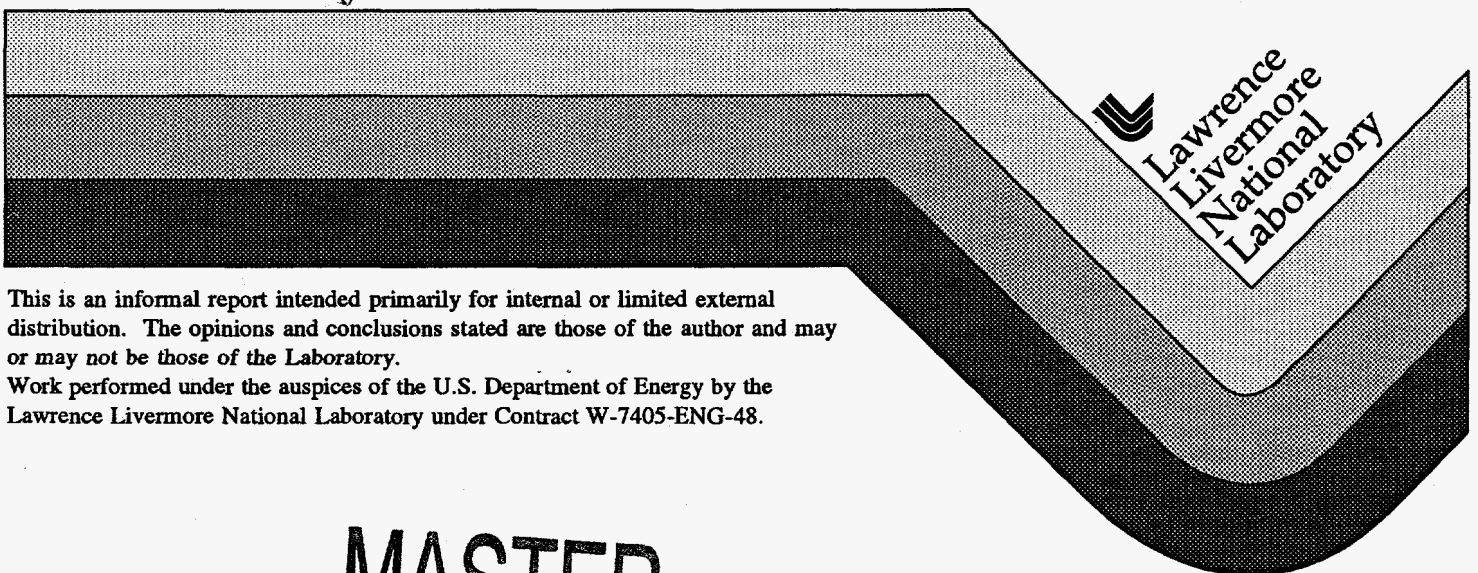
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March 25, 1958



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25 March 1958

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Good report.  
Smy

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MEMORANDUM

TO: Distribution [REDACTED]

FROM: Robert A. Miles

SUBJECT: Revised Report - Isthmus of Tehuantepec

Enclosed for your information and retention is one copy of a preliminary report on the Isthmus of Tehuantepec as a location for a non-military application of nuclear devices. This report is a revised and combined version of two previous reports, one by Cliff Bacigalupi and Fred Warren, and one by Robert Miles, both dated 24 February 1958. It is requested that the two previous reports be destroyed.

This report is intended to provide preliminary information to personnel within the Laboratory and will be used as a base or starting point by the Non-Military Applications Study Committee in developing a final report.

Enclosure

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ISTHMUS OF TEHUANTEPEC INVESTIGATION

for

OPERATION PLOWSHARE

Prepared by:

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Fred J. Warren

Test Operations

UCRL, Livermore

March 25, 1958

The following report on the Isthmus of Tehuantepec is circulated within the Laboratory for information. It is intended as a preliminary report to be used by the Non-Military Study Committee in completing their preliminary analysis. A formal report shall follow. Comments and questions are solicited.

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PART I

HISTORY OF THE TRANS-ISTHMIAN CANAL

AT TEHUANTEPEC

The idea of communication between the Pacific and Atlantic oceans across the Isthmus of Tehuantepec is as old as the Spanish conquest of Mexico when Spain was one of the world's great imperialist powers. Cortes was the first to foresee the enormous strategic advantages such communication would give the Spanish crown for control of the high seas and safety from pirate raids upon Spanish shipping. However, Cortes succeeded only in building a road across the isthmus.

After independence from Spain had been won, Mexico sent two exploring parties to survey the isthmus and weigh the feasibility of a canal. They came back with nearly identical reports suggesting a water route from the Gulf of Campeche to the head of the Coatzacoalcos river, and from there by land to Tehuantepec and the Pacific. New revolutions flared, and nothing more was heard of the project.

A later survey party and exploration group headed by Jose de Garay was granted a concession by the Mexican government to survey the isthmus and make a proposal on a water-way connecting the two oceans. After nearly two years Garay sold his concession to England, who in turn sold it to the United States. Since the Mexican government had just lost considerable amounts of land to the United States in the southwest, the U. S. party was told to leave, and nothing more was accomplished.

Some years later a scheme was offered in which a system of overland rails, several wide, would permit fully loaded ships to be carried over the land by three locomotives, and then be put into tunnels and canals. Finally in 1896



a small railway was built piecemeal by different concessionaires and later on it was improved and extended. It was formally inaugurated in 1907, at a total cost of over \$40,000,000. Most of this money ended up in the pockets of London and New York bankers, and corrupt railway and government officials.

This long <sup>controversy</sup> hassle played an important part in a canal being built at Panama, although the Isthmus of Tehuantepec was preferred. Since the early 1900s many people have proposed the trans-continental canal, but either revolutions, war, or political upheaval have prevented any positive action. The ricketly Tehuantepec Railway of today is a sad ending for the many ambitious projects and attempts made during four hundred years to establish a communication between the oceans.

Since the end of World War II there have been other proposals for building a canal at Tehuantepec by both the United States Navy and the Corps of Army Engineers. The Corps of Engineers recently completed a survey of the area to study the feasibility of such a canal.

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PART II

GEOGRAPHY OF THE ISTHMUS

The Isthmus of Tehuantepec lies between the Bay of Campeche on the north and the Gulf of Tehuantepec on the south. The major port city on the north shore is Puerto Mexico, or Coatzacoalcos, which was once a great port, but is now reduced to a fishing town at which only stray ships call. The rail terminal, like the docks, has seen better days. Puerto Mexico lies approximately 800 miles southwest of New Orleans, and is the port of entry for ships going into the Coatzacoalcos river which winds it's way for twenty-two miles to Minatitlan. Minatitlan is the only prosperous city on the Gulf side of the isthmus because it is the site of one of Mexico's largest oil refineries, and supplies Mexico with a large portion of her oil and petroleum.

The country between Puerto Mexico and Minatitlan is low and rolling, and heavily vegetated along the rivers. The dense jungle which bisects the isthmus starts just a few miles inland. The jungle is classed as a tropical rain forest, and extends into the mountains. It is extremely dense and full of giant trees hung with creepers, ragged palms, great taro leaves, and covered with wild morning-glory. There are areas of large bamboo forests, making travel through the jungle very difficult. Occasionally the bleached skeletons of great silk-cotton trees rise above the dense level of the jungle and provide a sunny perch for large black vultures. The floor of the jungle is fairly free of dense vegetation, but is crawling with a myriad of insects, lizards, and snakes. Many rare and exotic birds live in the trees, and screech at people who invade their dense green<sup>n</sup> refuge. Monkeys are also abundant, and delight in performing their acrobatics high in the trees.

(J.C.)

The eastern section of this jungle is the home of the Jaguar, which is both feared and worshiped by the natives living in and near the jungle. In addition

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to the jaguar, the jungle contains many ocellot, and wild cats. Because of the abundance of game, these jungle killers seldom attack man. Other wild game includes tapir, a species of wild boar, deer, rabbits, and fox, but the natives have not put these animal skins to any particular use. The lakes along the Atlantic slope are infested with alligators and the jungle and dry Pacific slopes both contain the deadly rattle-snake and coral-snake. The jungle also hosts swarms of bees which busy themselves with making wax and honey. The lakes and rivers contain an amazing variety and abundance of fish, and the tortoise shell found near Morro on the Pacific coast is unsurpassed. There is also an abundant supply of pheasant, wild turkey, partridge, quail, wild pigeon, and ducks. On the high Atlantic slopes in the mountains a small area is plagued with vampire bats, which have proven to be a menace to both men and livestock.

The Iguana, a giant lizard, inhabits both the northern and southern portions of the isthmus, and is eaten by the natives who consider it a delicacy. The southern Iguana is a brown and tan color, while his brother in the jungles to the north is green.

The people of the isthmus differ in their appearance and customs from one area to another. The Pacific plains are inhabited by several groups of Indians, the most numerous abundant being the Huave and Zapotecs. Some Indian tribes live in the mountains and seldom, if ever, communicate with others, and are for the most part self-sufficient. Most of the Indians in the northern part of the isthmus live in the jungle, and hunt and farm, and sometimes catch fish for their living.

The area of lagoons on the Pacific shore is one of the most inhospitable areas in which human beings can subsist, consisting of treeless and unprotected sand beaches that are ravaged by four months of cold, biting north winds and

sandstorms, four months of scorching drought, and four months of floods. It is infested with ants, fleas, mosquitos, and can produce very little food. The people that inhabit this region are chiefly of the Huave tribe, and live largely on fish, turtle eggs, and what little they can grow in their desolate soil.

The people of the Pacific slopes are industrious, and spend most of their time farming, bartering, weaving, or fishing. Tehuantepec has a large market place where people from all over the area come to sell or trade their shrimp, fish, turtle eggs, chickens, corn bread, chili, coffee, chocolate, oranges and bananas. The people of the market place usually wear their oldest and most tattered clothes in order to gain pity in their business deals. When at home, they wear fine silks, serge, and felt hats. The Indians own sheep, goats, oxen and horses. They use the sheep's wool, yoke the oxen to their carts, and ride the horses for sport or sell them. Many of them rarely eat meat, and live chiefly on fish, shrimp, chili, eggs, etc.

The major cities of the isthmus and their populations, as of 1950, are as follows:

Juchitan	14,550
Tehuantepec	20,000
Minatitlan	18,539
Puerto Mexico	13,740
Union Hidalgo	3,200

As the population map shows, most of the people of the isthmus live either on the Pacific or Atlantic slopes, with sparse settlement in the jungle and mountain areas.

The jungle is quite productive in it's wild claim on the land. Many hardwood trees, such as mahogany, are cut and brought out for commercial use. Due

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to a severe lack of transportation this industry has not been developed to any great extent. The natives which live in the jungle clear areas and plant corn, or other crops, in the dark rich soil. When abandoned these fields become open grasslands and are soon swallowed up by the jungle.

The isthmus enjoys a tropical climate, which does not get as unbearably hot as other areas at the same latitude. The mean yearly temperature runs between 77° and 82°, and rarely gets below 60° or above 105°. The Atlantic slope gets from 80 to 100 inches of rain per year, while the Pacific slope receives considerably less. Just prior to reaching the summit of the low ridge of mountains, the vegetation changes abruptly from a lush, dark green to the arid, hot plains of the Pacific which are covered with brush of gray and rust, cactus and thorny low bushes, and clumps of palmetto on brown rolling hills.

More detailed weather information is contained in the weather charts accompanying this report.

Transportation in the isthmus is quite varied, with the Pan American Highway running through the Pacific plains, railways crossing the isthmus to the north and to the southeast, boat travel on some of the larger rivers, and air travel to most sections of the isthmus. Following is a table of landing fields:

TOWN	RUNWAY LENGTH	ALTITUDE	TYPE OF FIELD
Ixtepec	10,000 feet	83 feet	Civil-Military
Minatitlan	4,300 "	90 "	Civil
Puerto Mexico	3,000 "	15 "	Emergency
Nanchital	3,000 "	50 "	Emergency
Salina Cruz	4,000 "	30 "	Emergency

The landing field at Ixtepec is the largest and most important field in this

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area, and is used and controlled jointly by the Mexican Air Force and Civil authorities. It's large runways can handle most of the large planes in existence today.



Part III

PURPOSE AND USEFULNESS OF A CANAL ACROSS THE ISTHMUS OF MEXICO

The geographical features of the western hemisphere have created a navigational problem from the time that man first sailed the seas. The distance required to circumnavigate the American continents, and the dangers involved in traveling certain portions of the route, led first to a search for the fabled "Northwest Passage" and when this failed, the construction of a canal across the strip of land connecting the two continents at its narrowest point. This channel, named the Panama Canal, furnished an all-weather passage between the Atlantic and Pacific Oceans and resulted in an enormous increase in the amount of shipping serving the Americas.

Although still of the utmost importance to both commercial and military interests, the existing canal has two major drawbacks; first, it is highly vulnerable to hostile action, a condition that has existed from the time it was first opened. Secondly, the size of ships has been gradually increasing until at the present time several of the largest vessels now in service are not capable of utilizing this passage. As new ships are constantly being built, it is probable that this figure will continue to increase.

Therefore, it is proposed to build a second canal, to be located on the Isthmus of Mexico. Although this second channel would not significantly shorten the present route, it would definitely counteract the two major disadvantages of the Panama Canal mentioned earlier. It would provide an alternate route, with the subsequent possibility that at least one of the canals would remain open in case of enemy attack. It would also be constructed to accommodate the largest existing vessel and probably any ship to be built

in the future. This, then, is the proposal presently under discussion and the subject of the following portions of this report.

Part IV

WHY TEHUANTEPEC?

When you examine a map of the American isthmus, many places appear favorable for the construction of an inter-ocean canal. The first possibility in the north part of the isthmus is the isthmus of Tehuantepec, then Guatemala, Nicaragua, and Panama. Since Panama already has a canal we may rule it out and talk about the other three possibilities.

Nicaragua was at one time considered a possible site for the construction of a canal, however the canal would have been 168 miles long, and cut through mountains similar in height to those at Tehuantepec. The lowest pass through the mountains along the canal route is 760 feet above sea level.

Guatemala offers a canal route much shorter than Nicaragua or Tehuantepec, but the lowest pass is approximately 7,000 feet high.

Both Guatemala and Nicaragua are subject to frequent seismic activity, which occasionally becomes severe. Two cities which lie on the proposed Nicaraguan canal route have been destroyed seven times in the last three centuries.

The isthmus of Tehuantepec has several very favorable features to offer, and a few that are unfavorable. The isthmus is 120 miles wide, and a canal linked to the Coatzacoalcos river would be approximately 116 miles long. A low range of mountains divides the isthmus, but several rivers have cut through its slopes, making the construction of a canal along these routes possible.

Before undertaking such a project, one must be able to justify the large expenditure of money and time that would be required to complete this project.

The most obvious advantage of another inter-ocean canal through the Americas is that the Panama Canal cannot handle the large ships of today, and in the future, it will not be able to handle the volume of shipping that can pass through it's locks. A report by the Governor of Panama in 1947 stated that the Panama Canal was somewhat vulnerable to surprise attack, and would become more so with the improvement of modern weapons. Since Tehuantepec is less than a thousand miles from the United States, defense would be easier in case of an all-out attack against the canal. Another significant advantage to the Tehuantepec project is the mileage difference between the Panama and Tehuantepec canals.

This is illustrated by the following table:

FROM	TO	MILEAGE BY WAY OF - -		SAVING
		TEHUANTEPEC	PANAMA	
New Orleans	San Francisco	3,294 mi.	5,000 mi.	1,706 mi.
New York	San Francisco	4,744 mi.	5,858 mi.	1,104 mi.
New York	Honolulu	5,918 mi.	7,393 mi.	1,475 mi.
Galveston	Tehuantepec canal	680 mi.		
Galveston	Panama canal		1,400 mi.	720 mi.

This substantial saving of time and money would be valuable to military as well as commercial shipping. A ship the size of the USS Forrestal is unable to pass through the Panama Canal, and during some parts of the year, it cannot pass through the Strait of Magellan because of ice. The proposed size of the

Tehuantepec canal could easily accomodate a ship the size of the Forrestal, or even larger ships. The Forrestal is 252 feet wide at the flight deck, and draws 35 feet of water. Following is a comparison of size of the Panama Canal and the proposed Tehuantepec canal:

CANAL	LENGTH	DEPTH	WIDTH
Panama	51 miles	41 feet	300 feet
Tehuantepec	120 miles	60 feet	900 feet or 600 feet

The variation in width of the Tehuantepec canal stems from the possibility of having either one channel 300 yards wide, or a double channel each with a width of 200 yards, crossing the isthmus. The merits of each will be discussed in a following section.

Part V

PROBLEMS OF CANAL CONSTRUCTION  
AT TEHUANTEPEC

The geography of the Isthmus presents problems that are not unnatural to any excavation project. As was stated in Part II, the latitude of this portion of Mexico places it well within the tropics. The area is characterized by periods of high temperatures and humidity, and the northern portions of the isthmus receive 80 to 100 inches of rain each year. The terrain is generally flat, except for the ridge of mountains that separate the northern and southern portions of the isthmus. Dense vegetation, and an abundance of wildlife that is peculiar to jungle areas characterize the northern portion, while the south is dry, with sagebrush and cactus covering the hillsides. There are people living along most of the proposed canal route, but there are no heavy concentrations of people or towns except on the coastal plains.

The geological structure of the isthmus of Tehuantepec poses no serious problems for cutting a narrow channel through the entire length of the isthmus. There are various outcroppings of limestone, marble, tufa, and sandstone, but no large masses of granite or gneiss such as the surrounding Sierras contain. The lowland plains of both the Atlantic and Pacific slopes are composed of a soft alluvium and can easily be excavated by conventional methods.

There is little or no seismic activity on the isthmus, and everything on the isthmus bears the mark of stability and the absence of any active volcanic force. This is a point of great importance where the stability and permanence of large structures are concerned; and in this respect, this portion of Mexico

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is less liable to motions of the ground than Guatemala or Nicaragua.

A rough preliminary estimate of the amount of dirt that would have to be displaced by building: (1) a single canal, approximately 116 miles long, 300 yards wide, and 60 feet deep, and (2) a double canal, 116 miles long, 200 yards wide each, and 60 feet deep, indicates the following:

- (1) 1,061,632,000 cubic yards of dirt would be removed,  
for single canal,
- (2) 1,306,624,000 cubic yards of dirt would be removed,  
for double canal,

or 244,992,000 cubic yards less for the single channel canal. These figures are used as examples only, and were calculated from figures that did not take into account the rise of the ground or the additional excavation required for other facilities of the canal.

The single canal would permit ships of even the largest size to safely pass each other in the channel, while the double channel would provide complete safety to ships traveling in opposite directions.

There are two possible ways of using nuclear devices in the Tehuantepec project: (1) Surface or sub-surface bursts which would result in large craters and require less post-detonation excavating; (2) Bury the devices so that they are nearly contained, and shatter the rock formations for easier excavation by conventional methods. This method would also decrease fallout, making a higher total yield possible, and would be particularly advantageous if a sea-level canal were being constructed. Either method or a combination of both could be used.

However, due to the nature of the soil on either side of the low range

of mountains, it appears that conventional methods of canal digging could be used, and the nuclear devices would then be utilized only in the higher elevations and for removing any large obstacles.

WATER SUPPLY. There are numerous streams and rivers all through the isthmus which carry enough water to supply a canal through the entire length of the isthmus. Using figures computed by a Naval expedition through the isthmus several years ago, the canal will require an estimated 1,700 cubic feet of water per second to supply the locks and canal. The total yield of only the larger rivers of this area is approximately three times the amount needed, and if dams or artificial lakes were formed by stream diversion, an ample supply of water and water power would be on hand at all times. The construction of a sea-level canal would be difficult because the mountain ridges dividing the isthmus rise to approximately 700 feet or more in the passes, making extensive excavating necessary. The Pacific ocean is two feet higher than the Atlantic at the isthmus, which would create a current from south to north in the canal.

ROUTE. The exact route of the canal should be determined by a survey of the area. The Coatzacoalcos river provides 22 miles of navigable water on the northern side of the isthmus, but the remaining 116 miles of channel would have to be cut overland and go through the most advantageous place in the mountains. Following is a table showing the heights of several passes through the mountains of the isthmus:

La Chivela	780 feet
Masahua	843 feet
West Piedra Parada	800 feet
East Piedra Parada	825 feet
Tarifa (Portillo)	684 feet
Convento	750 feet



I have chosen Tarifa pass not only because it is the lowest, but because it is close to rivers which have cut valleys into the mountains, making excavation much easier. Map No. 4, shows a profile of the ground from Laguna Superior to the Plain of Tarifa, which is the approximate route of the southern branch of the canal.

FUEL SUPPLY. The isthmus of Tehuantepec contains a good supply of crude oil at Minatitlan, which is refined and shipped to other parts of Mexico. Since Minatitlan lies on the proposed canal route, it should be considered a good source of fuel for ships passing through the isthmus. In 1948 this refinery produced 6,056,400 bbl. of oil. There are other petroleum sources in the jungle, however because of the lack of transportation these fields have not been tapped or developed.

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Part VI

METHOD OF OPERATION

A. General Operational Information

This project far exceeds the scope of any of the proposals so far considered in both the amount of earth to be moved and the time, effort and capital required. In such things as personnel and equipment and the methods of housing, transporting and maintaining these items, it becomes necessary to completely revise the general procedures previously advocated for other sites. One possible recommended schedule follows, covering some of the general problems expected to arise during the course of events.

The initial group to arrive at the work site would be a small party of approximately ten men. This group could be considered an advance party paving the way for a larger preliminary survey team. It should be possible to fly this group, together with their equipment, to the site, using an existing town as an initial base camp. Using helicopters primarily, the advance party would obtain very basic information on the proposed route of the canal including direction, approximate heights along the route, type of terrain and general area characteristics. The group would spend approximately two months on-site, moving their base of operations from time to time as necessary.

Upon the completion of work by the advance party, a fullscale survey and construction force would proceed to the area. Their mission would be to make a complete survey of the entire route, to include geological samples and contour data. In addition, the work force would construct a pioneer road along the entire route, to be used both during the survey and subsequent operations. It is estimated that this phase would require 150 men and six months to complete.

All equipment for this party would be shipped by water to the area, including portable housing and feeding accommodations. It is recommended that a rolling camp be used, utilizing heavy-duty van trailers adapted to meet the various needs of a construction force of this size. By this method, it would be possible to eliminate problems arising from distances involved, as the camp would move in conjunction with the progress of the work party. When this portion of the job was completed, it would be possible to proceed with actual construction preparing for the creation of the canal.

This final step would require the largest work force and therefore more facilities than any of the preliminary parties. To decrease the time required for completion, work would be accomplished simultaneously along the entire route. To support this program it is felt that four camps would be necessary. Two of these would be fixed camps, one located approximately twenty miles inland from the end of the route (See Map No. 5). Each of these camps in turn would support a rolling camp of the type recommended for the survey party. These two rolling camps would be responsible for supporting the work on the central portion of the overall route, and would move accordingly as the work progressed. Very preliminary estimates of personnel levels and time schedules are the only type possible at this time. Manpower levels are placed at 800, with a period of approximately three to five years required to complete the actual excavation, depending on results of the survey and operational problems encountered on-site.

As a peacetime application of nuclear energy, this project would be finished upon the completion of the earth-moving portion of the project. However, this would be only the beginning of another and much greater undertaking.

[REDACTED]

To make the canal useable, a great deal of additional work would be necessary. This would include stabilizing the sides of the channel, constructing railroads and highways, installing electrical facilities and a myriad of other construction tasks. No estimate of the support required for this work is attempted, but a tentative cost analysis is included in Part VIII, Engineering and Construction, to assist in giving some idea of the vast magnitude of the complete project.

#### B. Transportation

In spite of the many differences involved in this project as compared with others already considered, basic transportation problems would be very similar. Once on-site, personnel would rely on military-type vehicles for all local movement. Four-wheel drive models would be mandatory, and the variations in terrain along the route would probably require the use of some tracked vehicles. Helicopters and possibly light aircraft would be necessary to provide rapid movement between the many worksites, especially in view of the distances involved.

Practically all equipment would move via water between the ZI and job site. Exceptions would be limited to small items and priority cargo, which could move by air. Personnel, as usual, would be flown to and from the site.

The two rolling camps considered necessary would be completely mobile to provide maximum flexibility. Major components would include van trailers adapted to serve various functions and the necessary prime movers, sufficient heavy-duty flatbed trailers and tractors to move construction equipment, an adequate supply train and numerous personnel carriers. In short, they would be completely self-sufficient camps with a mobile capability.

[REDACTED]

### C. Communications

The overall distances involved within the proposed test site are something less than the distance between the two atolls comprising the EPG. Suitable radio communication within this area could be obtained through the use of standard military equipment, with probably a relay station required atop one of the higher terrain features. Short-range transmitters would enable each of the four camp sites to establish operational and administrative nets to coordinate their own activities. It would be advantageous to set up a telephone network between the two outermost, or fixed camps. If the two remaining, or rolling, camps could be tied in to this system by means of a radio link, greater flexibility would be possible.

Another communication requirement consists of establishing and maintaining radio contact with the ZI, including a classified capability. Long-range equipment may possibly be already in existence and available for our use. The classified link would in all probability have to be installed by operational personnel. In either case, further investigation is necessary to determine how these fixed requirements could best be met.

### D. Personnel Problems.

Extensive planning would be necessary to arrive at Laboratory figures that would be engaged either directly or indirectly in on-site work. The estimated length of the project would necessitate constant rotation, and the resultant indoctrination and utilization of a much larger number than would be required on-site at any given time.

Facilities within the several camp sites should be as nearly identical

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as possible, and roughly commensurate with existing test sites. Working conditions would most closely approximate the EPG, but local climate and terrain characteristics would be the final determinant of levels of efficiency. A study of known diseases prevalent in the area in question would be necessary to provide the best medical protection for personnel traveling to the job site.

[REDACTED]

## Part VII

### LOGISTICS

#### A. Existing Facilities

Established cities on both ends of the proposed canal route offer a starting point when considering logistical problems. Both Coatzacoalcos and Salina Cruz have airstrips, although they are only emergency fields. Being coastal towns, they should also offer limited but adequate facilities for berthing and unloading ships. Minatitlan, twenty miles south of Coatzacoalcos, has a municipal airport and probably above average harbor facilities. Tehuantepec has a combination civilian and military airport. Nanchital, located between Coatzacoalcos and Minatitlan, has an emergency field. It is probable that some of these establishments also have long-range communications facilities, if not radio, at least telephone or teletype. In addition, population levels indicate the presence of hospitals, maintenance shops and related installations.

#### B. Method of Supply

As stated earlier, ocean transportation would be called upon to deliver practically all equipment and supplies to the test site. Whether commercial or military vessels were used would be immaterial. The fact that the site lies fairly close to a heavily traveled supply route, i.e., the Panama Canal, indicates that shipping rates should not be exorbitant. Staging areas and supply depots both in the ZI and at the site would have to be established to accommodate the heavy influx of material during the build-up phase. Once the equipment arrived on site, a distribution system would be necessary to channel the material to the different camp sites.

[REDACTED]

Personnel transportation between the ZI and the test site could be by either commercial or military aircraft, or a combination of the two. A transfer point would be necessary, at which individuals would debark from the initial aircraft and obtain transportation to specific locations within the site. Some type of scheduling would be required to provide a continuous opportunity for movement between the ZI and the site. This procedure would not only eliminate any isolation of the test site, but furthermore permit emergency personnel travel and also rapid delivery of small critical items.

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Part VIII

ENGINEERING AND CONSTRUCTION

A. Base Camp Facility

Because of the long duration of the construction period, permanent camps must be constructed to house approximately 800 men for long periods of time. It is felt that camp construction would best be adapted to the needs of the situation by utilizing two types of camps, as follows:

1. Two permanent camps capable of housing approximately 300 men each would be erected - one on the Atlantic Coast and one on the Pacific Coast ends of the proposed canal. These camps would contain necessary shop facilities, medical facilities, communications structures, recreational facilities, etc. and would be the same type of camps as built at EPG for a normal test operation.
2. Because of the long distance over which work is to be accomplished, two additional camps would be required. Each of the additional camps would be capable of housing approximately 100 men. In order to always have the camp at the work site, it is recommended that these two intermediate camps be made mobile, that all facilities be furnished in trailer mounted units. These rolling camps could then be moved as the job progresses and could also be evacuated during firing of devices.

B. Miscellaneous Construction

Because of the distance over which work is to be accomplished, it will be necessary to do a large amount of auxiliary construction consisting mainly of

roads and airstrips. Very roughly, this type of construction can be summarized as follows:

1. Roads

In order to effectively perform construction and device placement along the entire route of the proposed canal, it is anticipated that approximately 200 miles of improved roads would have to be constructed. These roads would consist of bladed areas through the jungle and constant maintenance would be required. The roads are to connect the work sites to the existing highway running parallel to the canal site and the necessary roads along the proposed route of the canal.

2. Airstrips

Because of the large distance to be traversed, several small airstrips capable of landing C-47 type aircraft would be constructed. These would consist of a bladed area covered with military type landing mat or other suitable surfacing to insure safe operation of the aircraft.

C. Heavy Equipment Requirements

There is no heavy equipment available in the area that could be utilized for the construction of the proposed canal. The entire quantities must necessarily be shipped, making necessary very careful advanced planning. Because of a lack of knowledge of the exact magnitude of the job and the type of terrain to be worked, it is not possible at this time to make an itemized list of the heavy equipment required. However, based on the proposed magnitude of the job, it is estimated that approximately Ten Million Dollars would be required to purchase the necessary equipment.

[REDACTED]

D. Time Schedule

Based on present knowledge of the job to be done, following is a general schedule of operations:

- |                                                                  |                    |
|------------------------------------------------------------------|--------------------|
| 1. Advance Party Survey                                          | Two Months         |
| 2. Evaluate Data of Advance Party and Organize Main Survey Force | Six Months         |
| 3. Full-Scale Survey                                             | Six Months         |
| 4. Evaluate Data from Main Survey and Organize Main Work Force   | Twelve Months      |
| 5. Construction and Excavation Work                              | Forty-eight Months |

The schedule as outlined above represents the minimum amount of time that would be required assuming that necessary air transportation is available from the ZI to job site and return.

E. Cost Analysis

Because of the magnitude of the job and in the absence of specific information on the amount of work to be done, a cost analysis is extremely difficult at this stage of planning. Very roughly, for a canal 150 to 160 miles in length, made of the following components:

Channel length to be dug - - - - -	118 miles
Lagoon on the Pacific coast to be dredged- - -	17 miles
Navigable Coatzacoalcos river on the Atlantic coast - - - - -	22 miles
	<hr/>
	157 miles

the order of magnitude costs might be:

1. Heavy Equipment	\$ 10,000,000
2. Base Camp No. 1 (300 man)	600,000
3. Base Camp No. 2 (300 man)	600,000
4. Rolling Camp No. 1 (100 man)	400,000
5. Rolling Camp No. 2 (100 man)	400,000
6. Scientific Facilities - 100 Stations at \$50,000 each	5,000,000
7. Manpower Advance Party 10 men - \$2,000/mo. for 2 months	40,000
8. Manpower Main Survey 150 men - \$2,000/mo. for 6 months	1,800,000
9. Manpower Main Work Force 800 men - \$2,000/mo. for 4 years	76,800,000
10. Miscellaneous Materials for Roads, Airstrips and Local Communications	<u>5,000,000</u>
	\$100,640,000
25 percent Contingency	<u>25,160,000</u>
TOTAL. . . . .	\$125,800,000

The above does not include any allowance for transportation of equipment from the ZI to job site, air support to fly personnel to or from the work site, or to provide local air support at the job site.

F. Post Detonation Construction

At this time it is impossible to arrive at an approximate cost for the construction of the canal after the excavation work has been completed. However, from extrapolating the data from jobs of similar magnitude done in other parts of the world, it is assumed that the post detonation construction would be in the order of several billion dollars.

Part IX

CONCLUSION

This report has attempted to present a preliminary analysis of some of the basic problems that would be encountered in building a canal across the Isthmus of Tehuantepec. It should be realized that a great deal of additional planning would be necessary before any actual construction work could be started.

This project undoubtedly would provide greater commercial advantages than any of the other four (Boothia Peninsula, Point Barrow, Simpson Strait, and Nome) already considered. There is little question that a second canal between the Atlantic and Pacific Oceans would be heavily traveled. The fact that the proposed canal could accommodate the ships presently barred from the Panama Canal because of excessive size should also be considered. In addition, an alternate for the existing canal is desirable in case of hostile action or natural catastrophe that could close one of the canals.

Because of the advantages that a canal through the Isthmus of Tehuantepec would provide, further studies of possible construction techniques, surveys, and economic studies should be made to determine costs, length of construction, and desirability of the canal project.

PART X

BIBLIOGRAPHY

Survey of the Isthmus of Tehuantepec - 1872 - by Don Jose de Garay  
TC 785 G3, U. of Calif. Library, Berkeley

Reports of Explorations and Surveys of the Isthmus of Tehuantepec - by  
Robert W. Shufeldt - TC 785, U. of Calif. Library, Berkeley

Maps of the Isthmus of Tehuantepec - B. Fallon, 1852 - F 1359 W5, Atlas  
U. of Calif. Library, Berkeley

Isthmus of Tehuantepec - Williams - F 1359 W5, U. of Calif. Library, Berkeley

Meteorological Review of Mexico, published by the Mexican Government, 1950.  
U. of Calif. Library, Berkeley

Report of the Governor of The Panama Canal - Under Public Law 280, 79th  
Congress, 1st Session - 626.9 P191G, Volumes I, II, IV  
War Department Library, Washington D.C.

Map: World Aeronautical Chart #644, Tehuantepec Isthmus, Scale 1:1,000,000

Map: Army Map Service, E-15, Istmo de Tehuantepec, July 1954,  
Scale: 1:1,000,000

Rand-McNally World Atlas, New Census Edition - 1951

SUBJECT  
**PROPOSED CANAL**  
**ROUTE - TEHUANTEPEC**

DRAWN BY  
**BACIGALUPI**

DATE  
**2/25/55**

BUILDING NO. ROOM NO.

**SKETCH**

RADIATION LABORATORY  
 UNIVERSITY OF CALIFORNIA - BERKELEY

APPROVED BY \_\_\_\_\_ DATE \_\_\_\_\_

JOB NO. TAG NO.

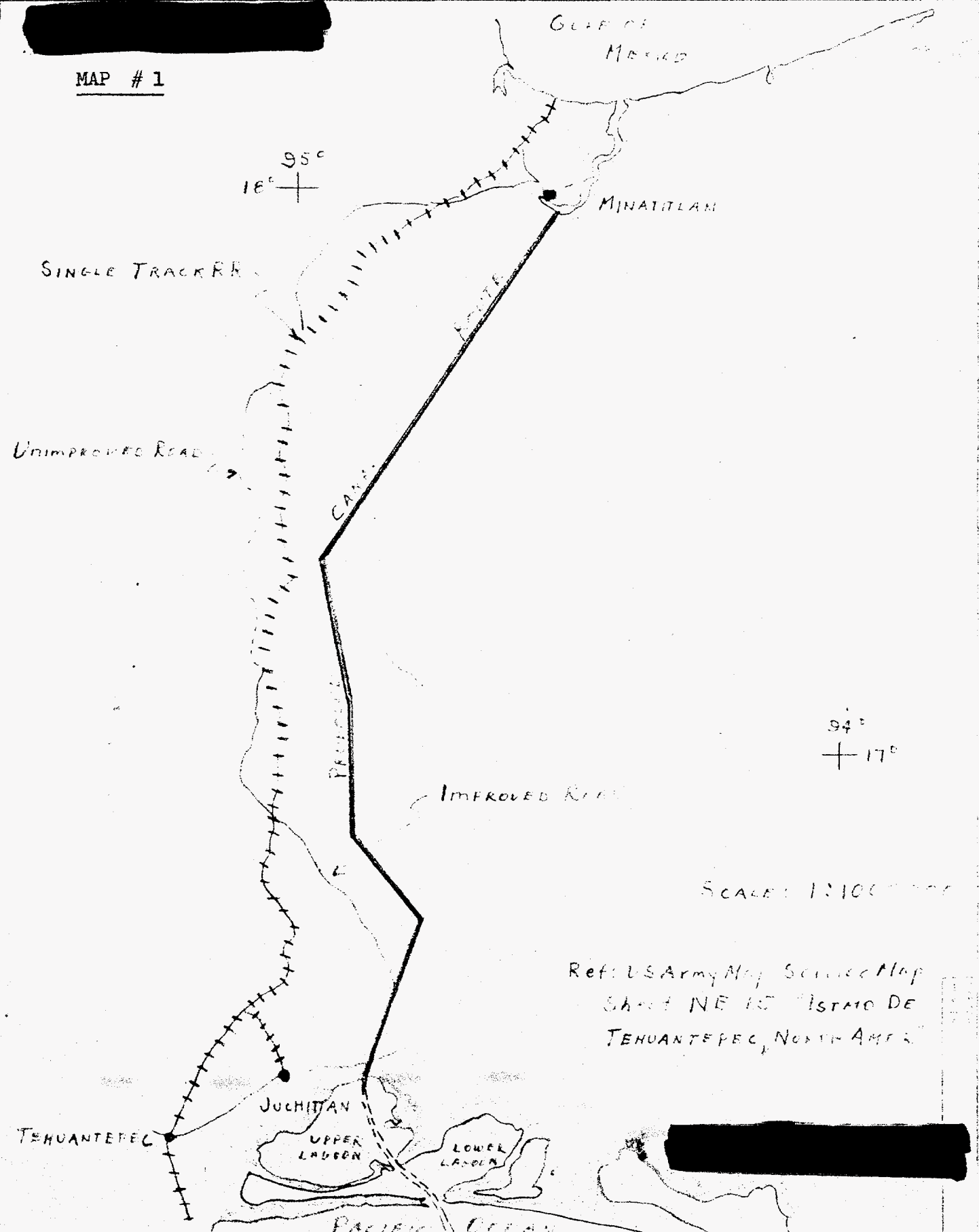
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DATE ISSUED DATE RECD.

DELIVER TO \_\_\_\_\_



MAP # 1



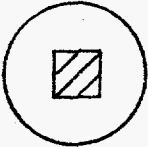
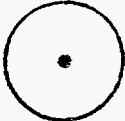






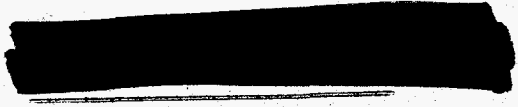
MAP #2

DISTRIBUTION OF POPULATION FOR  
THE Isthmus of Tehuantepec

This map illustrates the distribution of the people along the proposed route for the canal. The unpopulated area directly south of Minatitlan is a high, rugged mountain area.

R. Miles

-  10,000 to 20,000
-  5,000 to 10,000
-  2,000 to 5,000
-  500 to 2,000
-  500 or less
-  Ranches or chicle camps





GULF OF CAMPECHE



□ TUXTLA

□ YUCATECO

□ YUCATECO

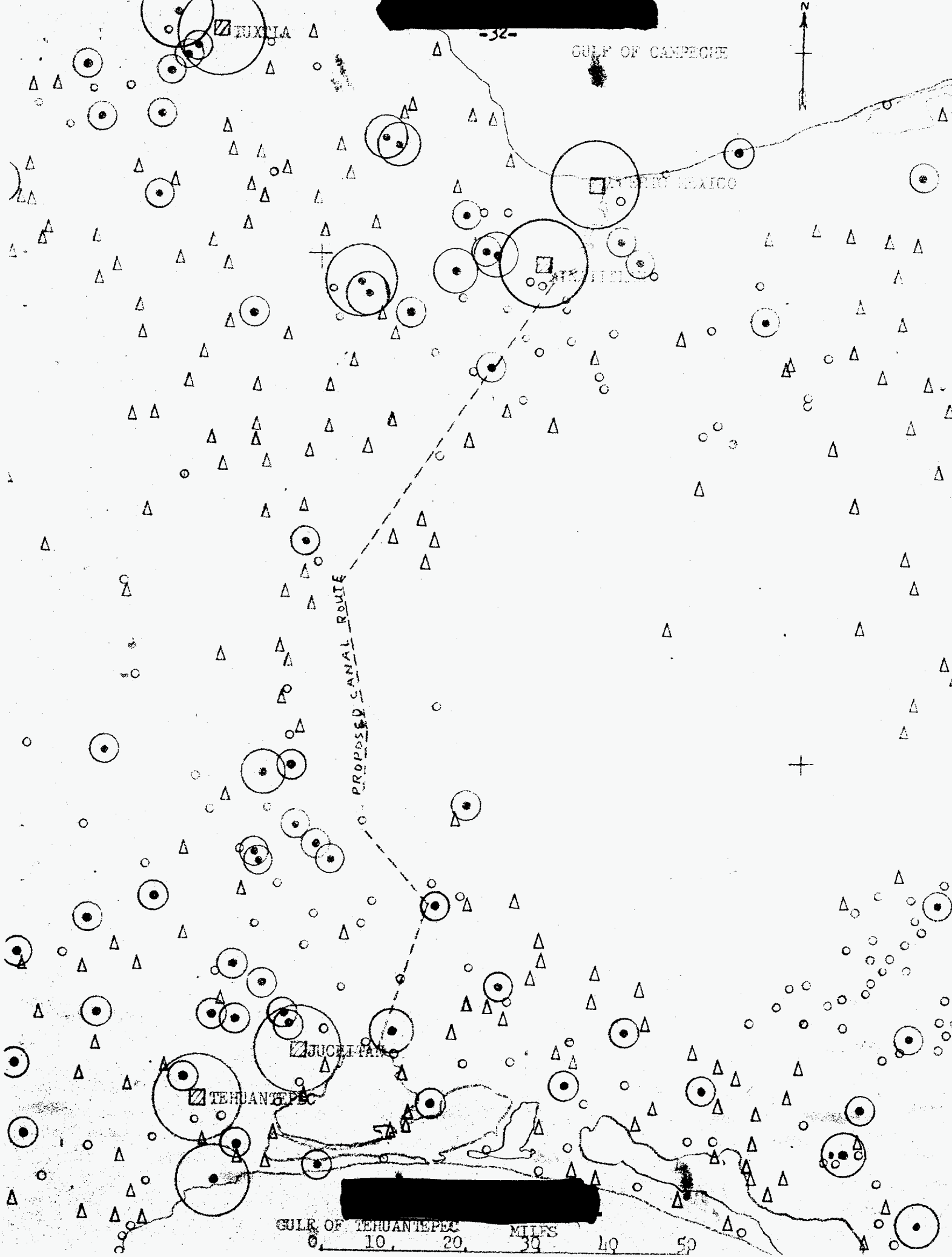
PROPOSED CANAL ROUTE

□ YUCATECO

□ TEHUANTEPEC

GULF OF TEHUANTEPEC

0 10 20 30 40 50 MILES



MAP #3

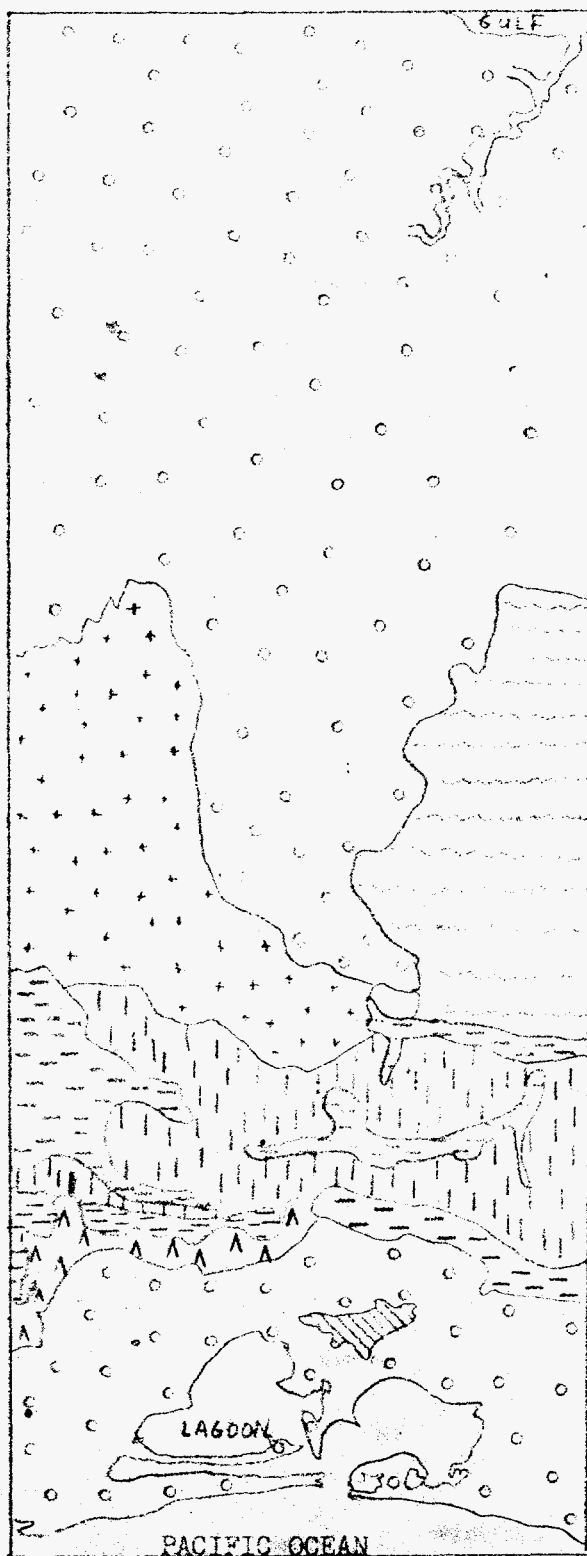
GEOLOGY








of

THE ISTHMUS OF TEHUANTEPEC

R. Miles

GEOLOGICAL MAP OF Isthmus of PANAMA



-  ALLUVIUM
-  GRAVEL
-  SHALE & GNEISS
-  SANDSTONE
-  LIMESTONE & MARBLE
-  GNEISS & GRANITE
-  QUARTZITE & LIMESTONE

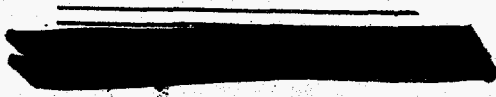


MAP #4

GROUND PROFILE  
FROM  
UPPER LAGOON TO THE TARIFA PLAINS

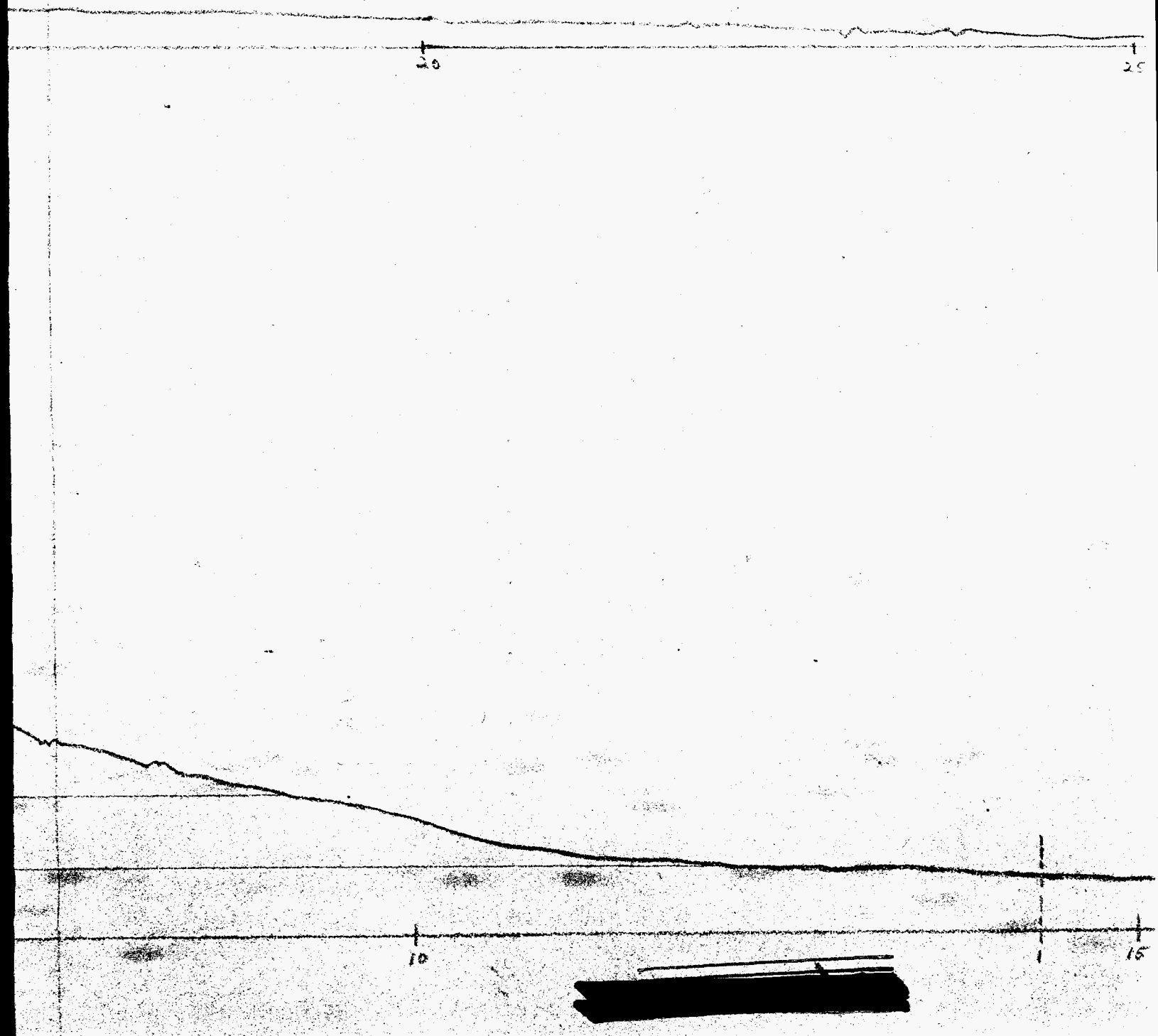
Map illustrates the average ground profile from the lagoon area of the Pacific ocean to the Tarifa Plains. The ground from the Tarifa Plains to the Atlantic is a slow, even slope, with a few small, rolling hills after one leaves the mountains.

R. Miles



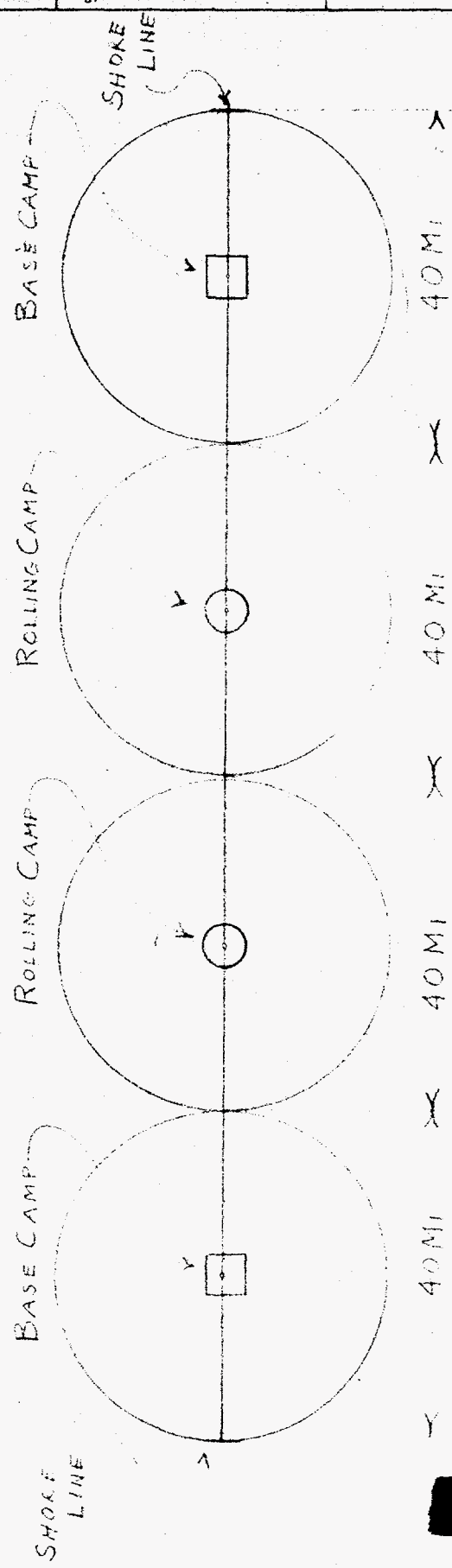


Parifa Pass to Upper Lagoon



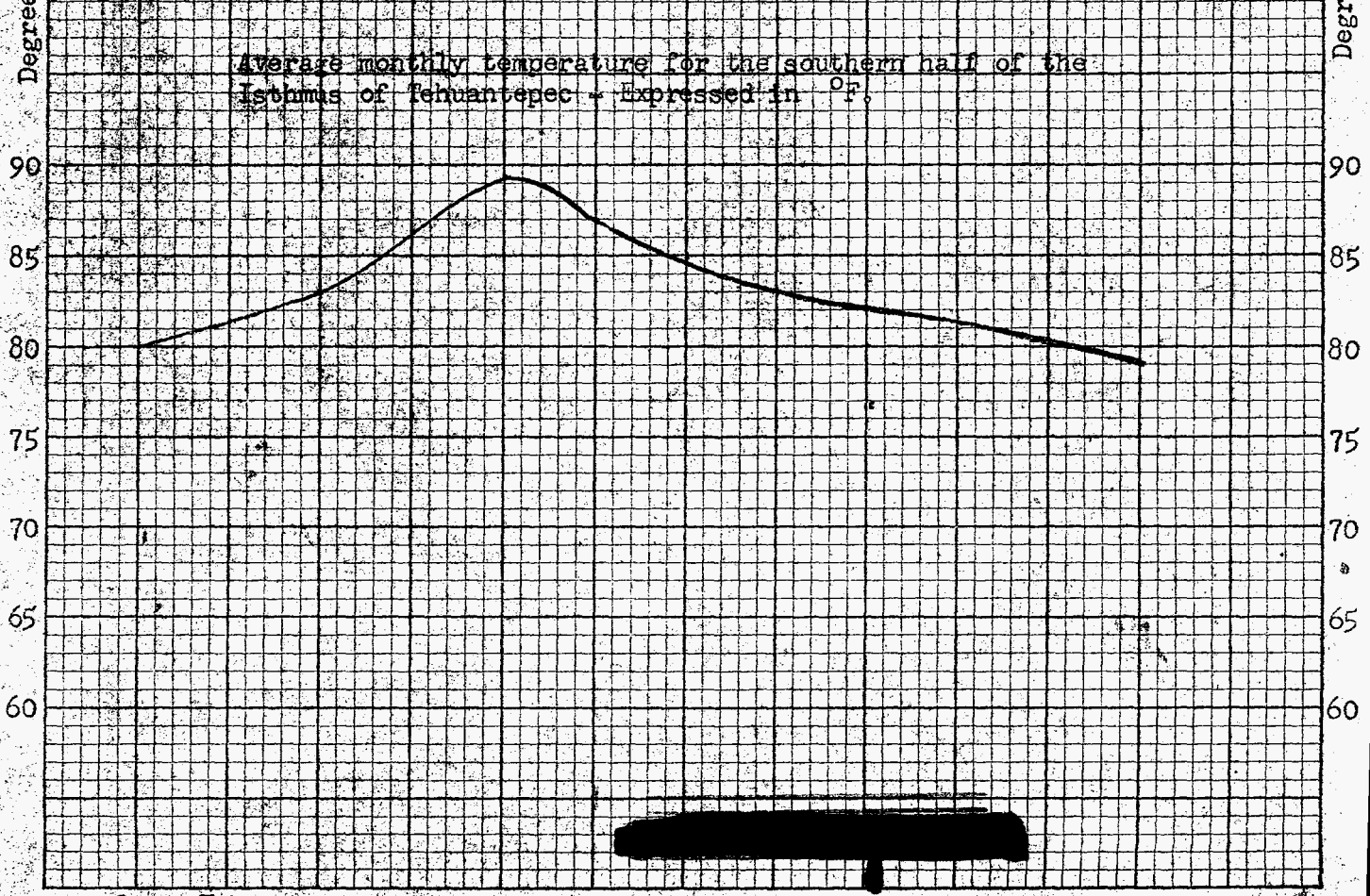
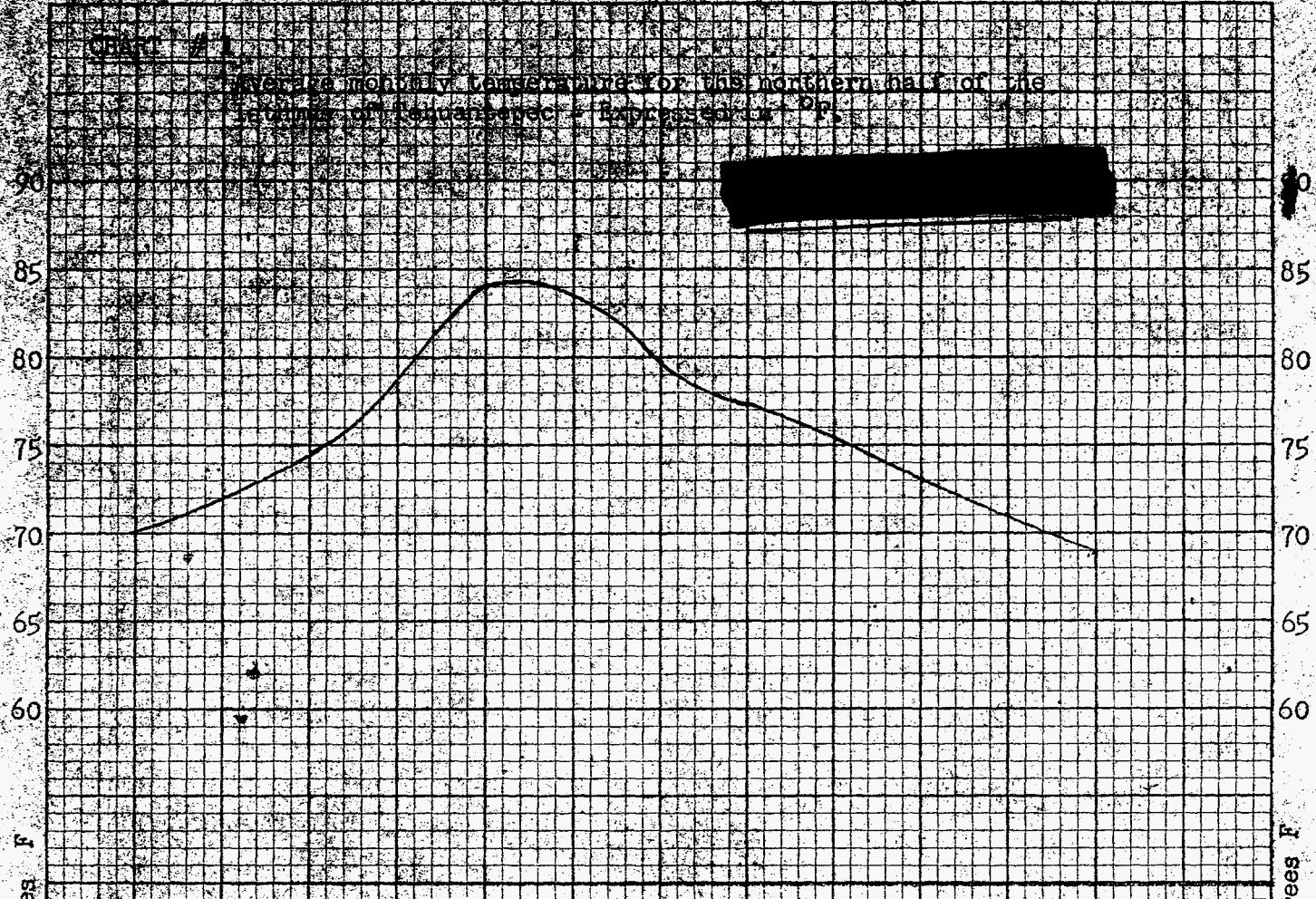
SUBJECT <b>LAYOUT OF CAMPS</b>		<b>SKETCH</b> RADIATION LABORATORY UNIVERSITY OF CALIFORNIA - BERKELEY		JOB NO.	TAG NO.
DRAWN BY <b>C BACIGALUPI</b>				SERIAL NO.	NO. REQD.
DATE	BUILDING NO.	ROOM NO.	APPROVED BY	DATE ISSUED	DATE REQD.
				DELIVER TO	

MAP # 5



SCHEMATIC LAYOUT OF CAMPS AND  
AREAS OF RESPONSIBILITY

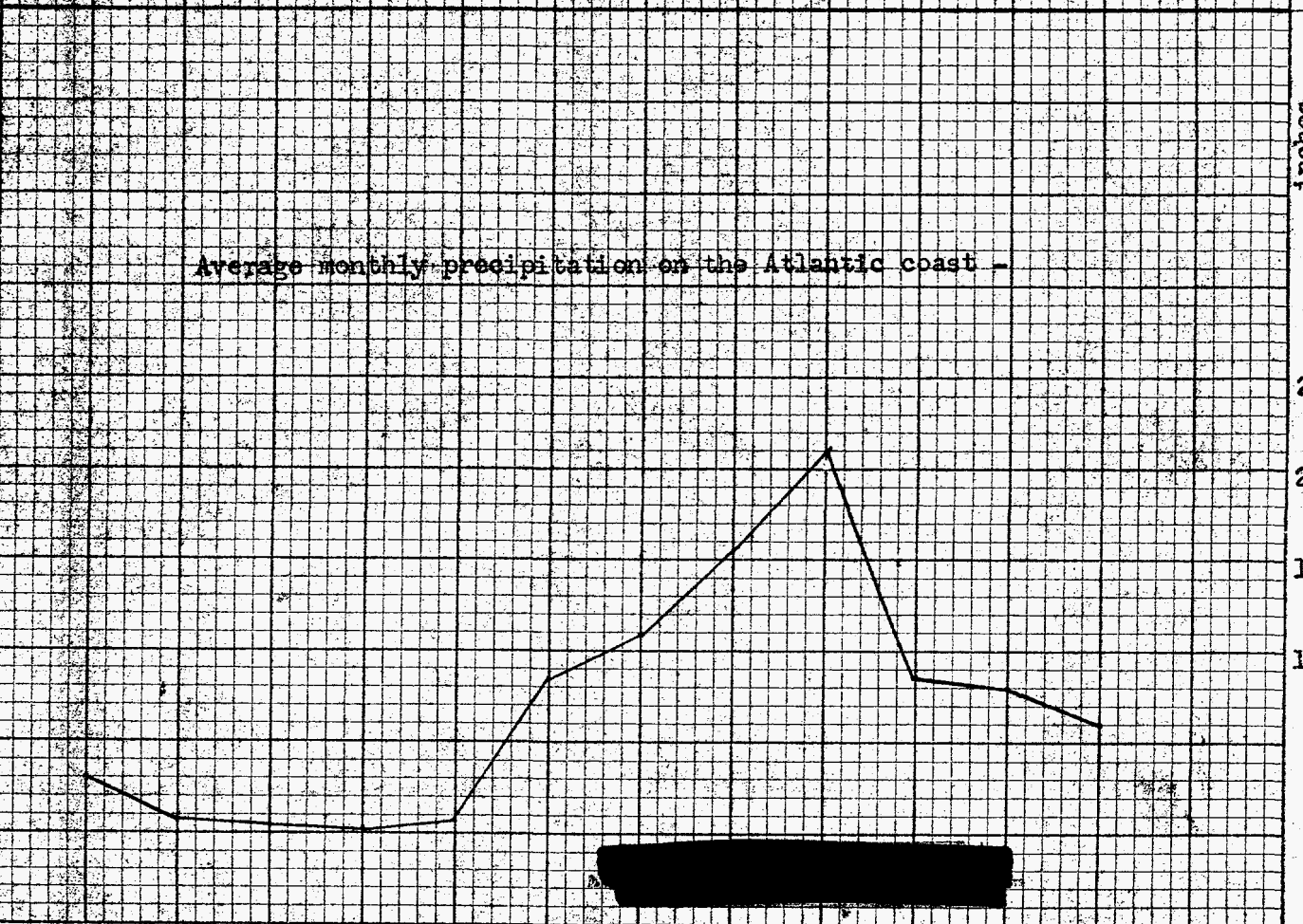
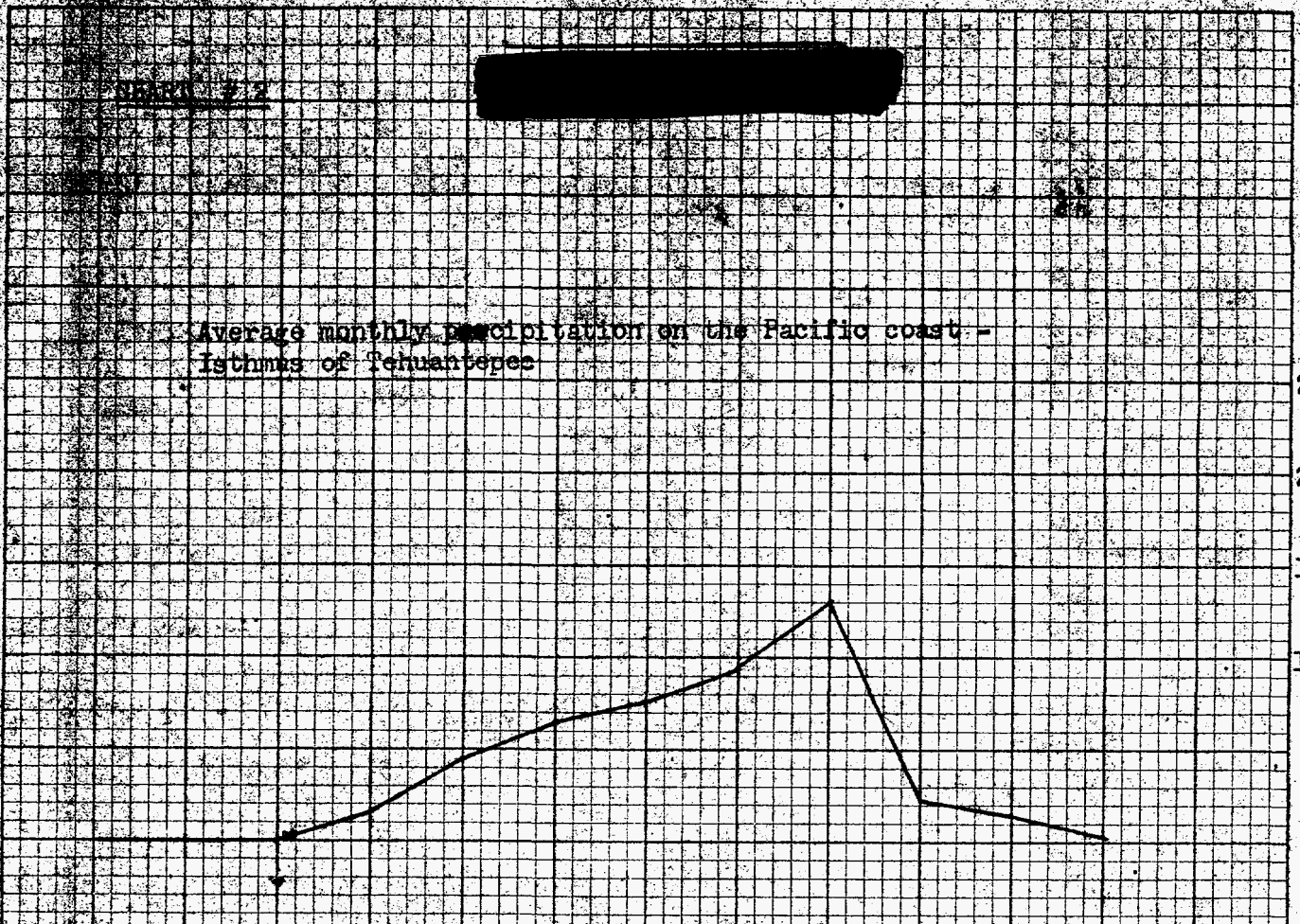
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec



Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

K&E 5 X 5 TO THE 1/2 INCH KEUFFEL & ESSER CO. MADE IN U.S.A.



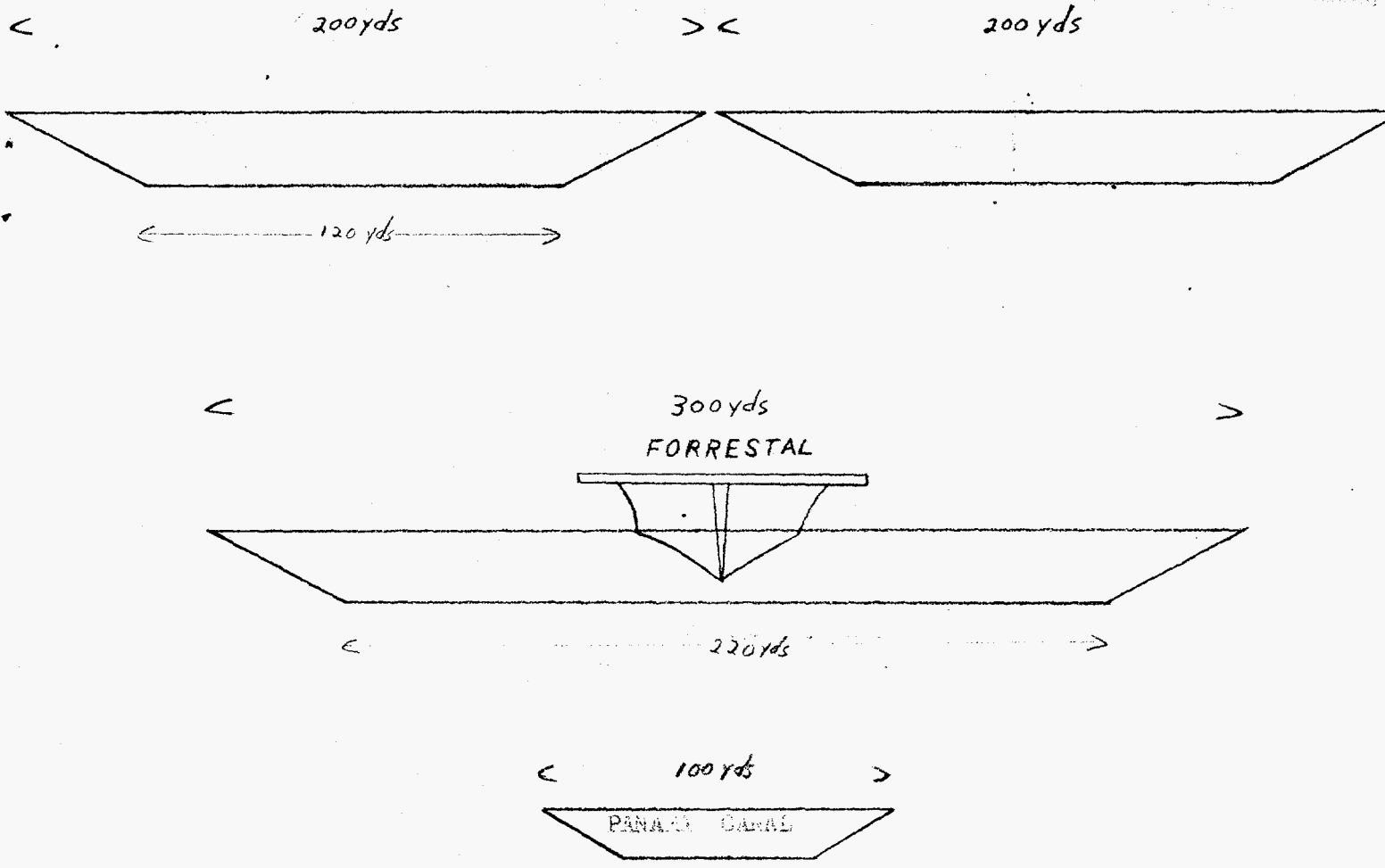


5 X 5 TO THE 1/2 INCH  
KEUFEL & ESSER CO.  
MADE IN U.S.A.





CHART # 3



Shown above are the comparative sizes of the two proposed canals and an outline of the USS Forrestal to show why the canals should be wider and deeper than the Panama canal.

R. Miles

