SECTION 3. PROGRAM FOR DEVELOPMENT OF MINE TOWN

Concrete program for development of mine town based on the Mining Laws as well as on the studies made up to now is covered in this Section. In Clause 1, the entire layout and land use, and plans for transportation system, housing and site grading are shown; and in Clause 2, the type and scale of market, school, hospital and other facilities are established, while in Clause 3, a study of plan for water supply and drainage system as well as technical detail was conducted. The last Clause 4 on housing program was specially included for it was judged that this program would be a very important factor in development of mine town.

3-1. Land Use Planning

(1) Concept for Land Use

Land use planning was based on studies of previous Section and in strict accordance to the Mining Laws. Effort was made to attain an efficient and favourable housing environment and to make various facilities available to people of surrounding areas an open type layout was planned. As to size of the town, a population of 9,500 mine workers and their family or a total town population of 12,500 after 10 years of mine operation was considered, so population growth to a certain degree can be handled within the town site.

From a total site area of 297 hectares, the entire layout was planned in 116 hectares of gently sloped land on east side of the site avoiding the steeply sloped land along Pollac River. The green belt in steeply sloped area will be preserved which will contribute to improvement of town environment. The irrigation stream flowing through this

area can be utilized in existing condition.

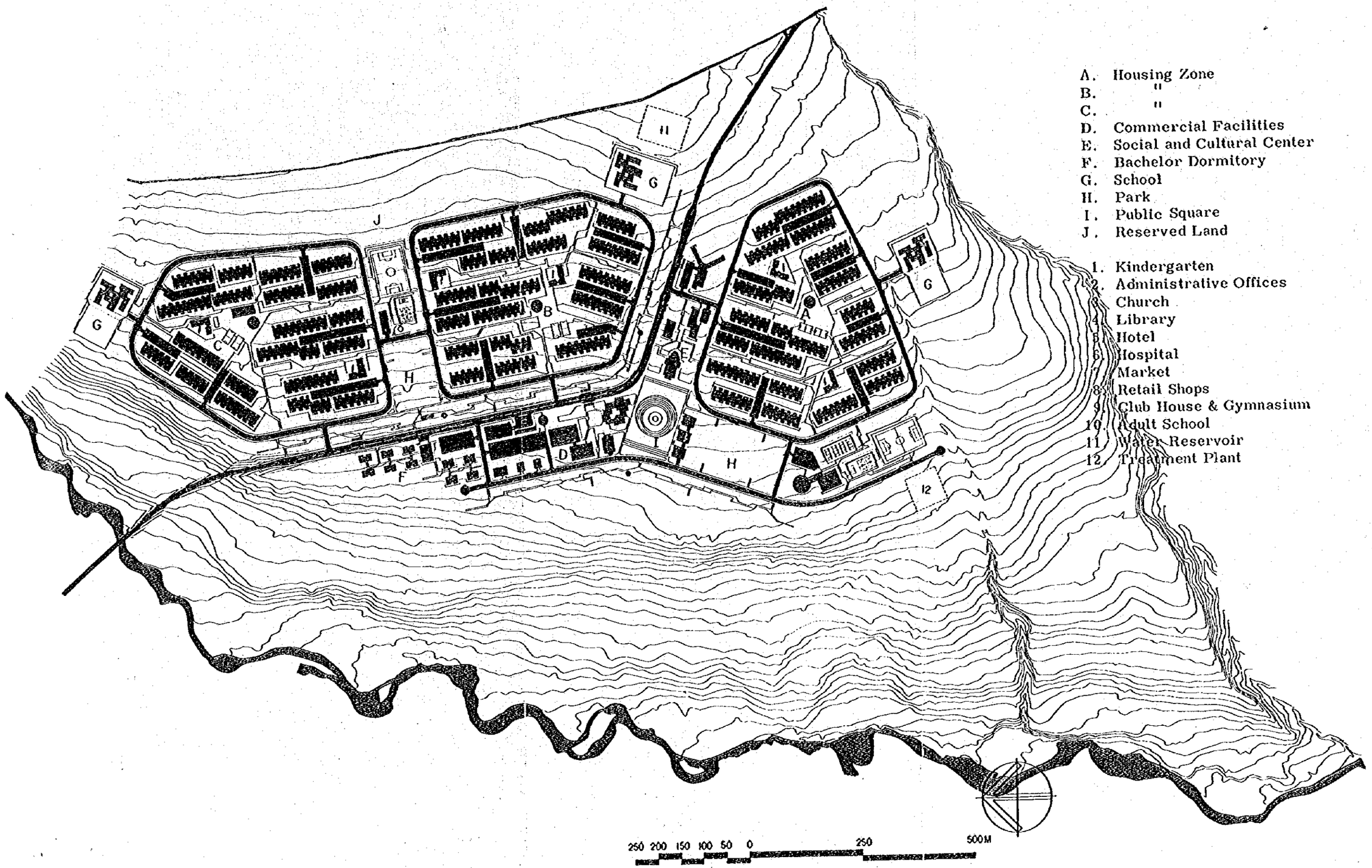
Dwelling areas will be formed of 3 zones each with area of 16 - 17 hectares and one school district. Each zone will be provided, basically, with one school and two kindergartens for 500 family houses and bachelor dormitories are separately planned along the main road. For service enterprise related population and for future growth, 14 hectares of reserved land will be allotted east of B and C housing zones. Considering the drawing effect of locating principal facilities along southwest side of the main road, administrative offices, commercial facilities and social culture facilities were planned around central public square. Between housing zones and in the areas for central facilities; parks, green belts, sports facilities etc. are provided as open spaces to act as buffer zones.

As shown in Table 3-311, the area of the site for housing is 66.85 hectares, 8.19 hectares for central facilities, 19.41 hectares for welfare facilities, 12.90 hectares for transportation system, etc. and these areas are respectively 57.63 %, 7.06 %, 16.73 % and 11.12 % of the 116 hectares of land area development.

Table 3-311 Land Use Ratio

Facility		Area (Hectares)		Ratio to A (%)		Ratio to B (%)
Land for Housing	Family House	48.81	66.85	42.07	57.63	22.51
	Bachelor Dormitory	3.77		3.25		
	Reserve Land	14.27		12.30		
Land for Central Facility	Central Square	1.68	8.19	1.45	7.06	2.76
	Admin. Office	0.45		0.39		
	Commercial	4.16		3.59		
	Cultural	1.90		1.64		
Land for Educational Facility	Kindergarten	0.90	5.40	0.78	4.66	1.82
	School	4.50		3.88		
Land for Medical Facility			1.25		1.08	0.42
Land for Welfare Facility	Sports	6.37	19.41	5.49	16.73	6.54
	Park	4.01		3.46		
	Green Belt	9.03		7.78		
Land for Trans-portation System	Main Road	3.22	12.90	2.78	11.12	4.34
	Other Roads	9.68		8.34		
Land for Water Supply and Treating Facility			2.00		1.72	0.67
Sub-Total (A)			116.00		100	39.06
Unused Land			181.00			60.94
Total (B)			297.00			100

FIG. 3-311 GENERAL LAYOUT PLAN



A. Housing Zone
B. "
C. "
D. Commercial Facilities
E. Social and Cultural Center
F. Bachelor Dormitory
G. School
H. Park
I. Public Square
J. Reserved Land

1. Kindergarten
2. Administrative Offices
3. Church
4. Library
5. Hotel
6. Hospital
7. Market
8. Retail Shops
9. Club House & Gymnasium
10. Adult School
11. Water Reservoir
12. Treatment Plant

FIG. 3-312 PHOTOGRAPH OF MODEL (ENTIRE VIEW)

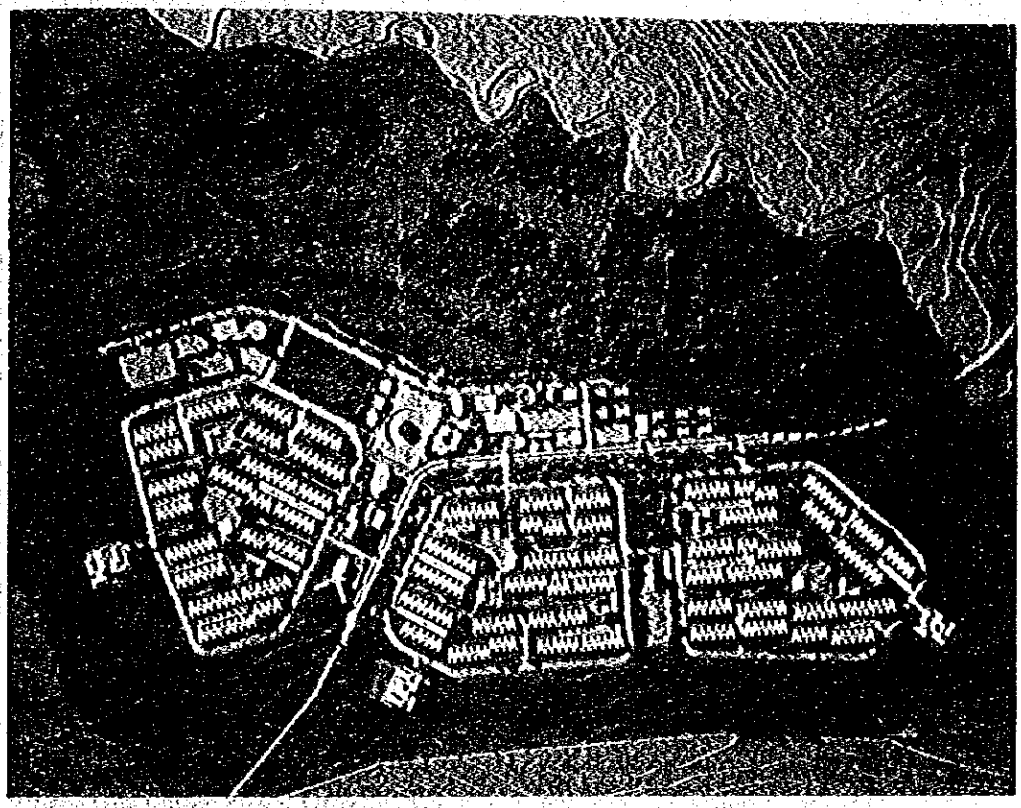


FIG. 3-313 PHOTOGRAPH OF MODEL (CENTRAL FACILITY ZONE)

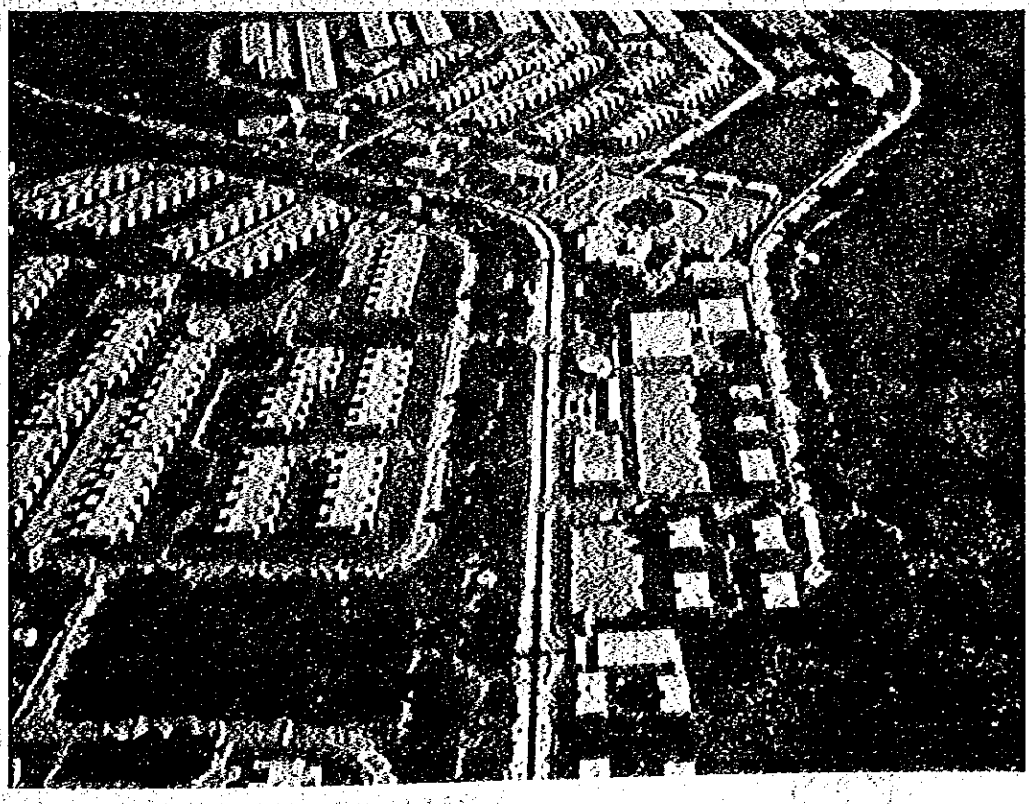
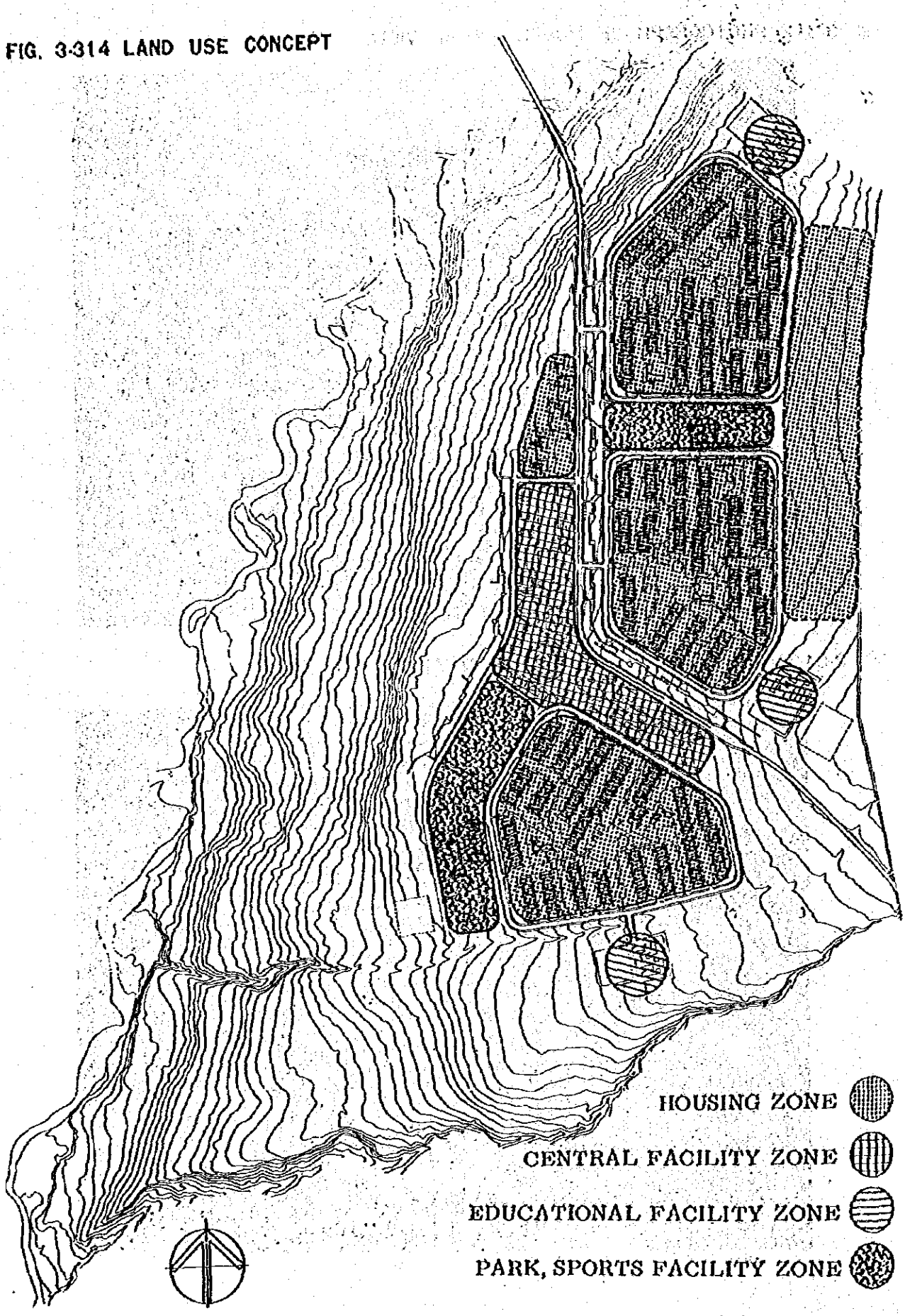


FIG. 3-314 LAND USE CONCEPT



(2) Transportation Program

The total length of the main road is 2,030 meters and in the central part of the town the road with 2 meter median strip is 21 meters wide with sidewalks 4 meters wide on both sides.

This main road will connect with the National Highway No. 8 by access road shown in Figure 3-315. As 1,500 meters long connecting road, a greater part of the existing road will be improved and widened to 9 meters. The distance from the town center to Michiquillay Mine is approximately 20 kilometers. The maximum gradient of the main road is 6 % and the road will be provided with 5 bus stops and one bus turning point for travelling to places of works, shopping areas, Cajamarca and other towns. (See Figure 3-316, Table 3-312, Figures 3-317 and 3-318)

Streets 15 meters wide around each housing zone will have a sidewalk 3 meters wide on both sides and in order to insure the safety of the residents this street will be connect to the main road at only one point. The maximum gradient of the street will be 7 % and the total length 6,450 meter. Paths for strolling will be provided in each housing zone and in green belts and will connect to the sidewalks of the main road and 15 meters wide street to provide a place of leisure as well as to increase the safeness and comfort of the resident.

Parking space for the residents will be provided by a dead end street extending from the 15 meters wide street; and all vehicles other than for emergency are prevented from entering the housing zone.

Main roads, streets and paths were provided with trees and lights to maintain security and beauty of the town.

Table 3-312 Road Statistics

	Length		Sidewalk		Bus Stop		Median Strip	
Main Road	Width 9m 870 m	2, 030 m	—	Both Side 4m	—	5 Stops	—	Width 2m
	Width 21m 1, 160 m		Both Side 4m		5 Stops		Width 2m	
Sub-Road	Width 15m	6, 450 m	Both Side	3m	—		—	

FIG. 3-315 ROAD PROGRAM FOR SANTA MARGARITA AREA

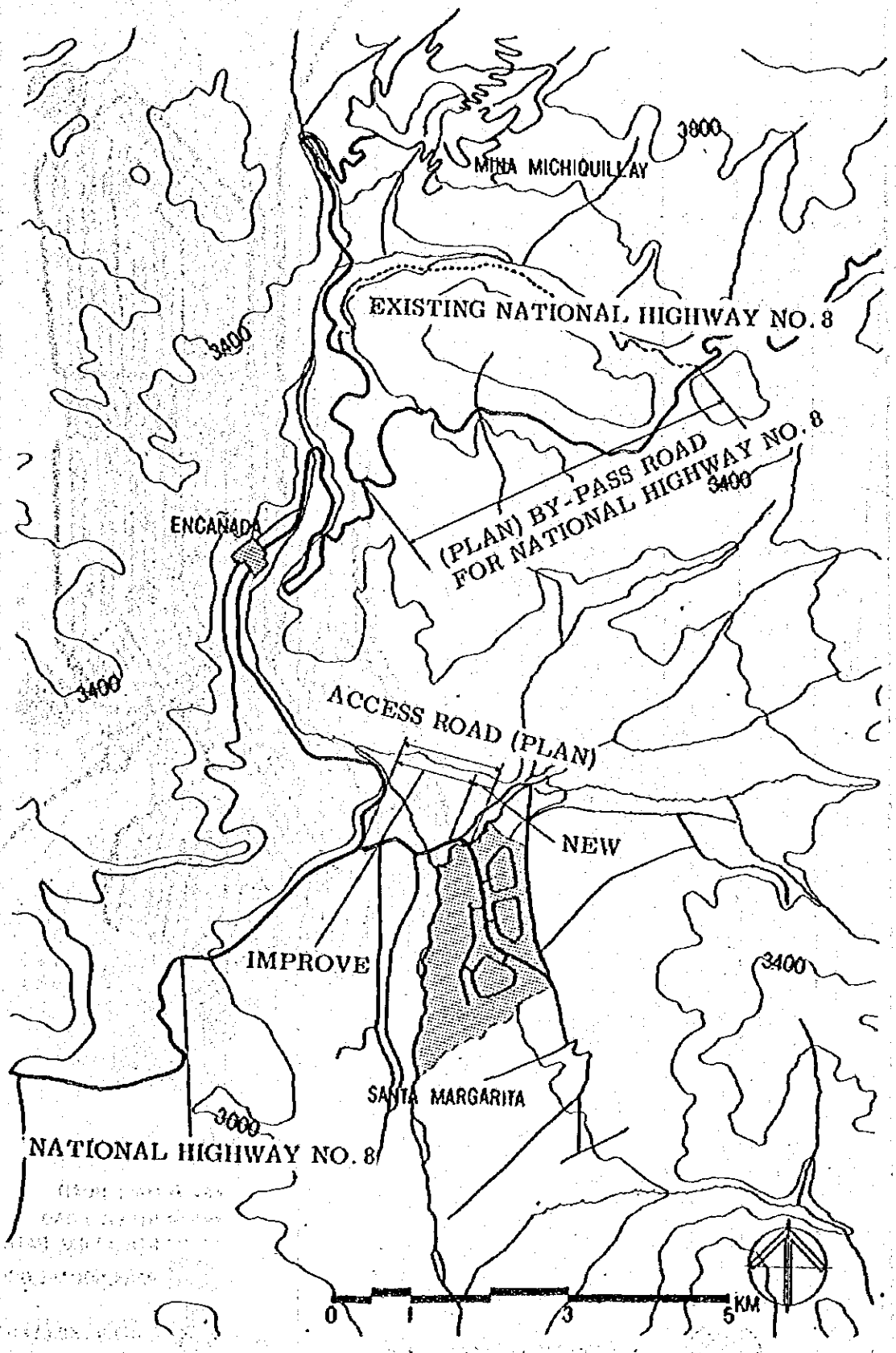
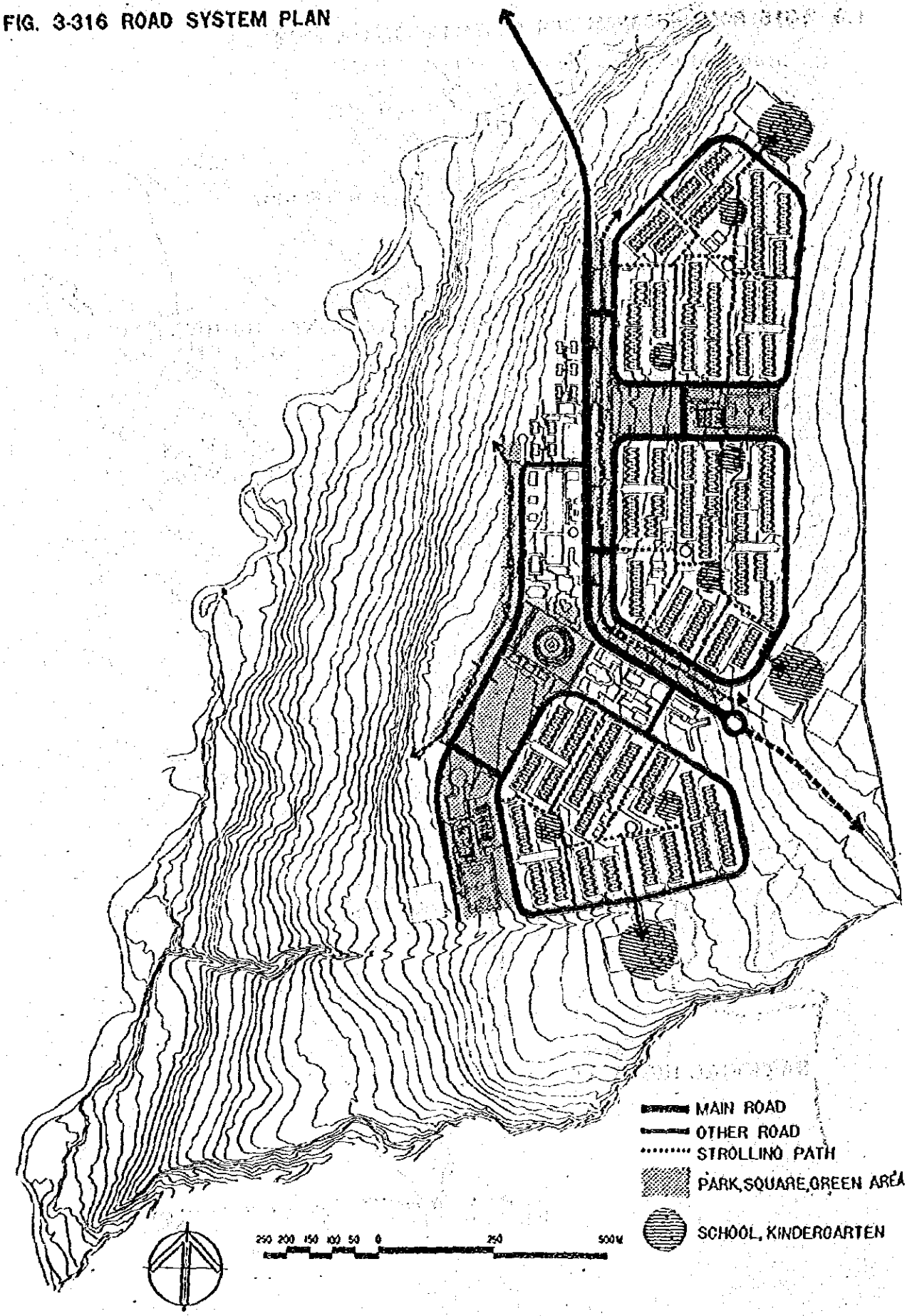


FIG. 3-316 ROAD SYSTEM PLAN



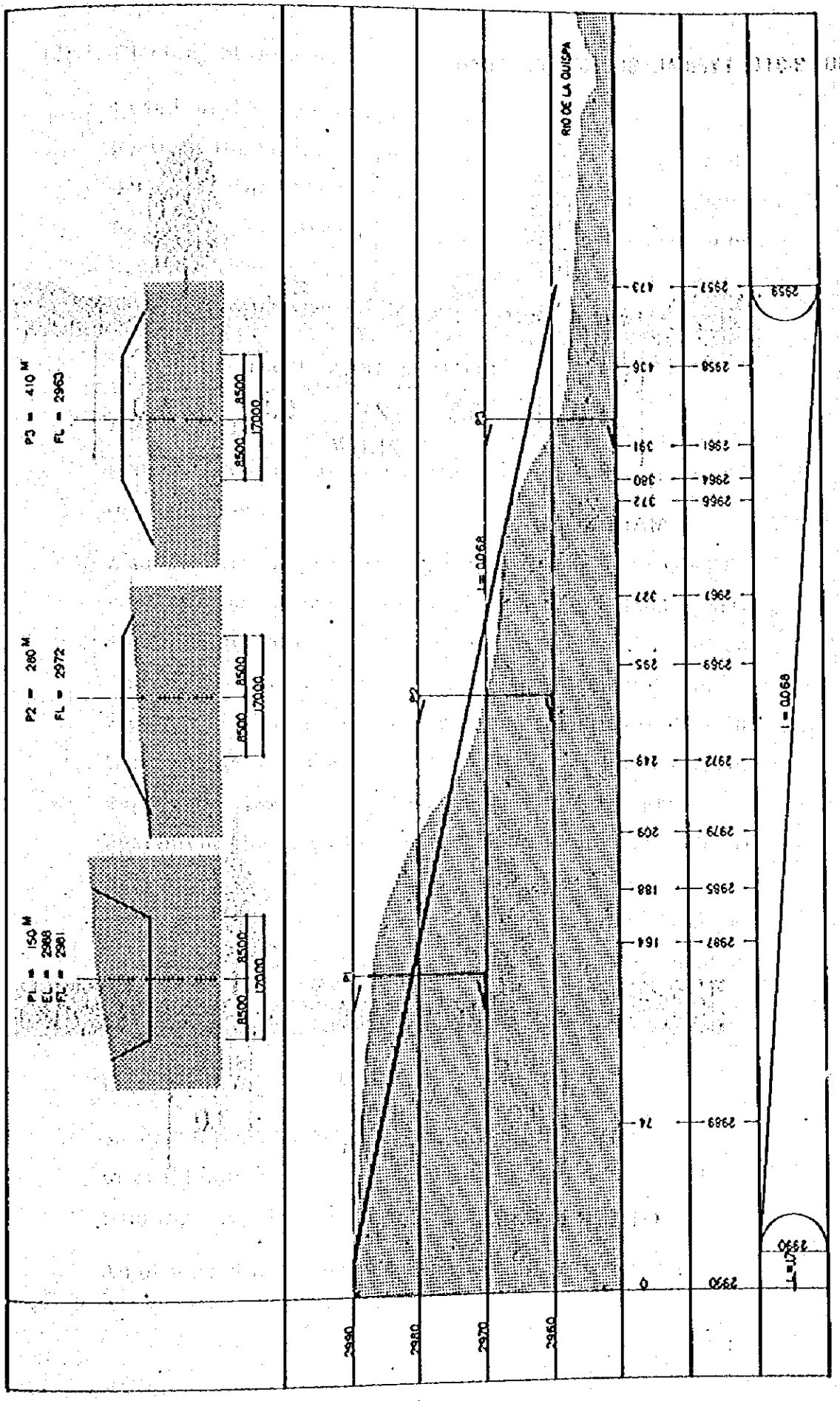
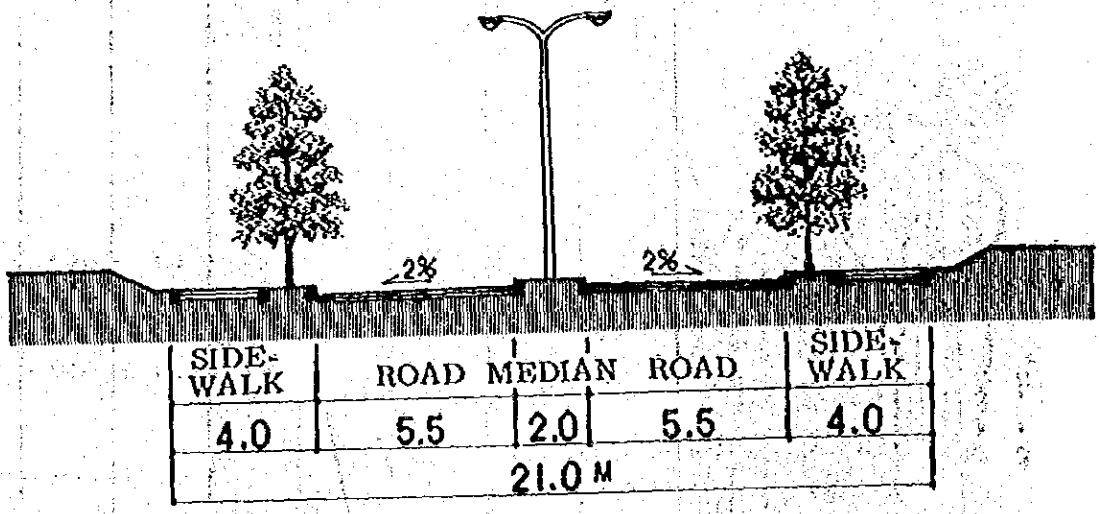


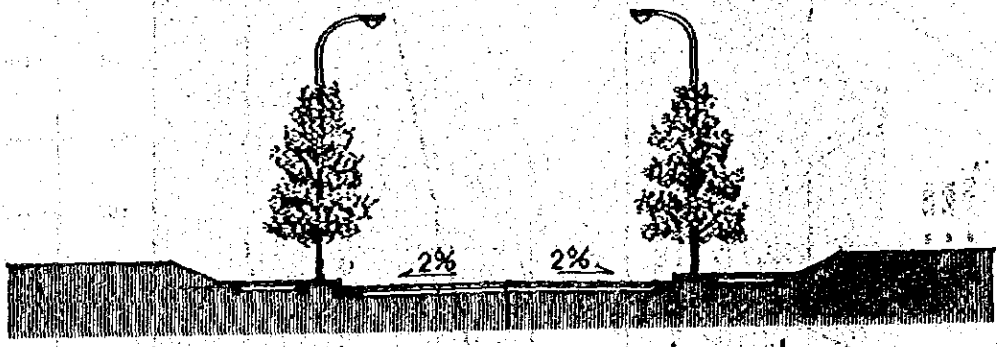
FIG. 3-317 LONGITUDINAL AND TRANSVERSE SECTION OF MAIN ROAD

FIG. 3-318 TYPICAL SECTION OF ROAD



SIDE-WALK	ROAD	MEDIAN	ROAD	SIDE-WALK
4.0	5.5	2.0	5.5	4.0
21.0 M				

MAIN ROAD



SIDE-WALK	ROAD	SIDE-WALK
3.0	9.0	3.0
15.0 M		

OTHER ROADS

(3) Planning of Housing Zone

Based on the population program mentioned in previous Section, the required number of house units was planned; but as shown in Table 3-313, the shortage in living quarters for bachelors will be met by placing 3 bachelor men in one house unit for married man. Therefore, 144 one man room and 96 three man room or total of 240 rooms will provide quarters for 432 bachelors, and for married men 1,428 family units initially, and the construction of additional 152 units by 10th year of mine operation will provide adequate living quarters for both bachelors and marries men.

As mentioned in previous Clause, one housing zone will consist of about 530 family units, 1 school, 2 kindergartens and in center of the zone a small square, meeting hall and 2 mini-sized football fields are planned. One block of 2 storeyed continuous row of houses consisting of 40 - 60 family units with court for each unit will be laid out facing eastwest following the contour of the site. The group of apartment blocks will enclose a dead end street which will be a parking space for the residents. Strolling paths leading to kindergarten, small square and mini-sized football field can be used for safety; and in going to school and to central district a high degree of safety is insured by the use of strolling paths, and sidewalks of 15 meter road and main road.

School is planned in area adjacent to each housing zone to avoid noise from the school and to provide sufficient land for any future additions.

As observed in Toquepala and other mine towns, car

ownership rate will also be high for this town, so in planning of parking space one car per family was assumed.

Bachelor dormitory zone will be completely separated from family housing zone by locating the dormitories in area adjacent to commercial area in west side of the main road. Ten blocks of bachelor living quarter each consisting of 24 bed rooms or a total of 240 bed rooms will be provided with dining and recreational facilities.

The density of population for the entire site (297 hectares) which will be 42.1 per hectare and 107.8 per hectare for the area of development (116 hectares) is lower compared to urban Cajamarca (166.8 per hectare, as of 1972) and other surrounding towns, so space for greater density is available.

Table 3-313 Program for Contruction of Houses and Dormitories

Year of Operation	Mine Workers		Bachelor Dormitory		Family House		*1 Excess Deficiency		
	Bachelor	Married	No.of Beds	Total	No.of Units	Total	Bachelor Deficiency	A. Family Unit Excess	A x 3 Possible No. of Bachelor Accommodation
0	646	1,354	432	432	1,428	1,428	204	74	222
5	497	1,503	0	432	100	1,528	65	25	75
10	423	1,577	0	432	52	1,580	–	3	9
15	420	1,580	0	432	0	1,580	–	0	0
20	437	1,563	0	432	0	1,580	55	17	51
25	452	1,548	0	432	0	1 580	20	32	96
30	467	1,533	0	492	0	1,580	35	47	141

*1 The shortage of rooms for bachelors will be met by placing 3 bachelors in one surplus family unit.

*1. The shortage of rooms for bachelors will be met by placing 3 bachelars in one surplus family unit.

(4) Site Grading Plan

In planning of site grading, existing topography of the site will be utilized to keep the scope of grading and the volume of earth movement to a minimum. Since large scale structures will be constructed in sites for central, school and sports facilities requiring large flat areas, soil stability will be secured by minimizing the volume of fill. Existing topography of the housing zone will be retained as much as possible by grading only the areas required for construction of blocks of apartment. In order to provide for drainage of surface water, road surface elevation will be kept 20 - 30 cm lower than elevation of ground around apartment blocks.

If the site is divided into 50 meter grids, the volume of earth work will be :

Fill	120,000 m^3
Cut	300,000 m^3

and if the percent of well and shrinkage is disregarded, the volume of surplus material will be 180,000 m^3, but the surplus can be disposed of in unused areas within the site.

FIG. 3-319-1 TOPOGRAPHY BEFORE GRADING

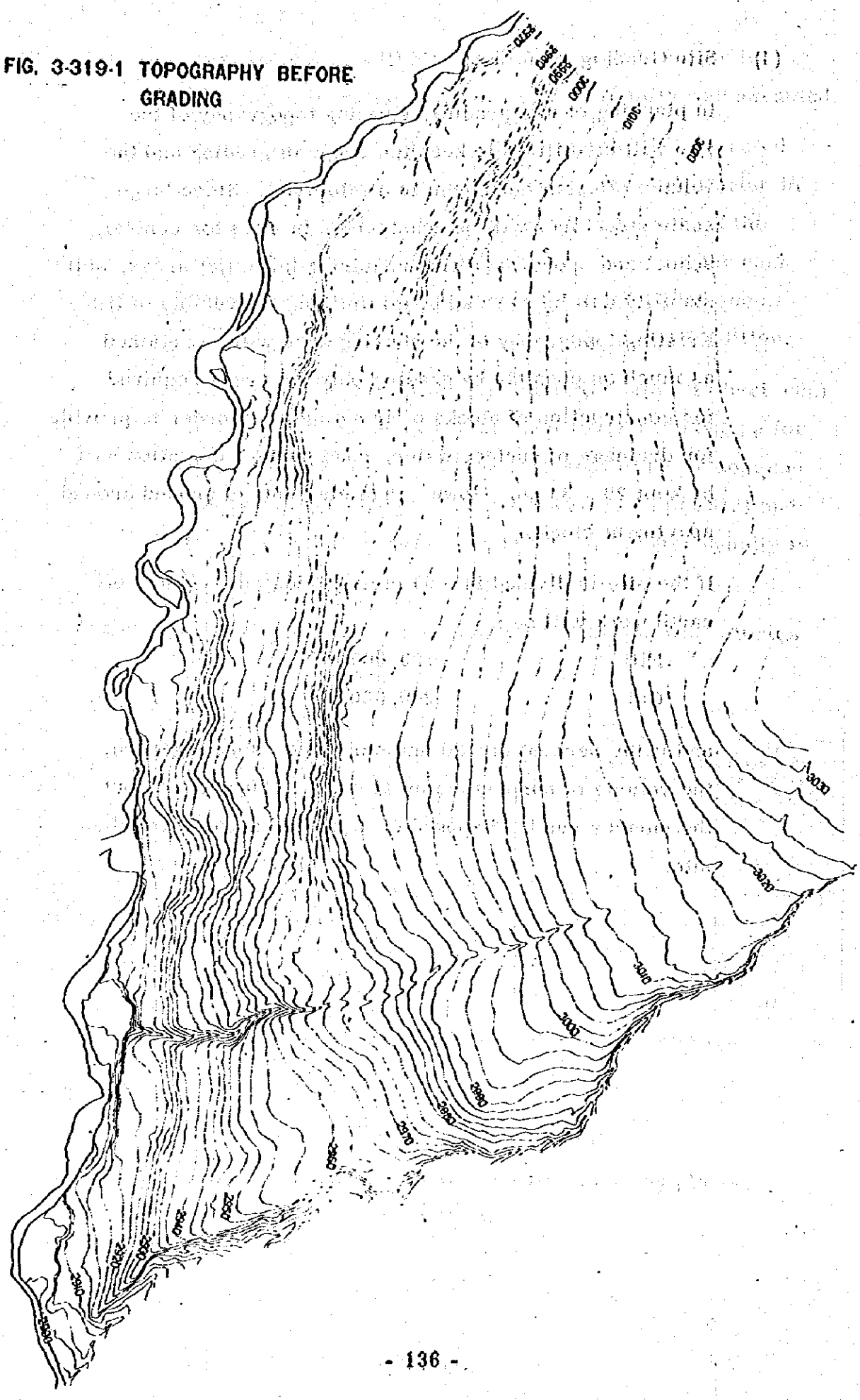
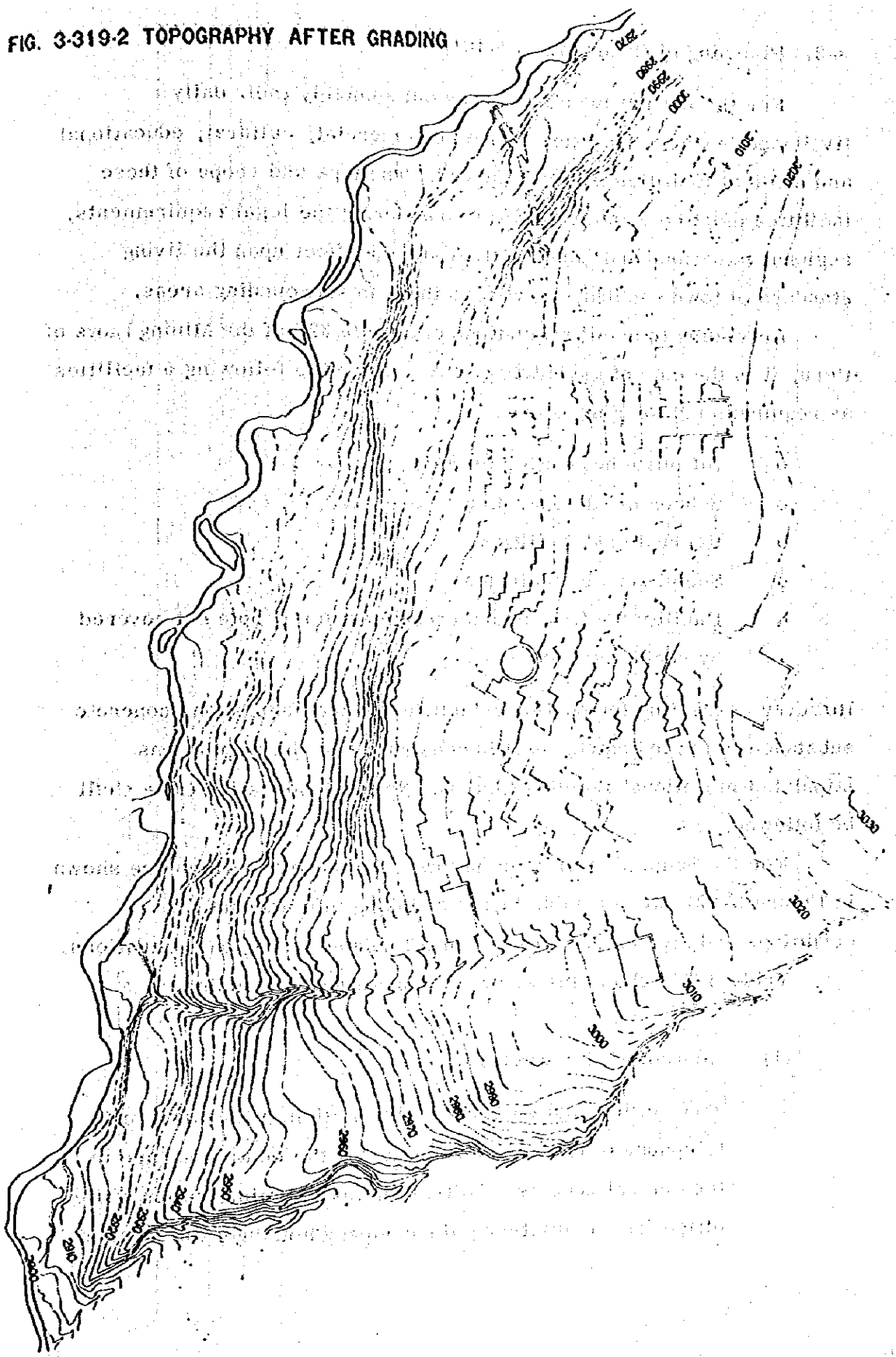


FIG. 3-319-2 TOPOGRAPHY AFTER GRADING



3-2. Planning of Community Facilities

For the town residents to carry out smoothly their daily livelihood, various facilities such as commercial, cultural, educational and medical facilities will be required. The type and scope of these facilities must be established after considering the legal requirements, regional situations and future outlook and the effect upon the living standard of town residents as well as those in surrounding areas.

According to detail regulations of Article 326 of the Mining Laws of Peru, it is the duty of the enterprise to provide the following 5 facilities as requirements for a mine town:

- o Adequate houses for workers
- o School and its operation
- o Recreational facilities
- o Social service facilities
- o Facility for free medical treatment for people not covered by social security

However, excepting for portion established in the regulation, concrete substance is not indicated, so it is construed that the regulations stipulated in National Building Code and National Education Code shall be followed.

For the Santa Margarita mine town, the facilities which are shown in Figure 3-321 were established after taking into account above conditions and studies in Sections 1 and 2 related to regional situations.

Table 3-322 shows the stages for construction planning.

(1) Administrative Facilities

Town office, police station, fire station, post office and telephone office were located facing the central square in the central zone as facilities for town administration while office for administering the company housings was located

TABLE 3-321 LIST OF FACILITIES

Facility			Required by Law	Sphere of Influence: Santa Margarita	Sphere of Influence: Surrounding Area Included	Construction Time: During Construction	Construction Time: Before Operation	Construction Time: After Operation	Site Area (M2)	Total Floor Area (M2)	Basis for Establishing the Scale	Contents of Facility
Housing		Family House		○	○	△	○	○	488,100	157,000	99.36M2 x 1,580 Units = 156,989 M2	1,580 Unit
		Bachelor Dormitory	○	○	○	△	○		37,700	7,500	60.00M2 x 6 Block = 3,360 M2 299.00M2 x 4 Block = 3,976 M2	240 Rooms, accomodate 432 men
		Bachelor Dinning Hall		○	○	△	○			500	3 M2 x 150 Men = 450 M2	Accomodate 150 men
		Parking			○		○					Family house 1 car/Household
Commercial	Administrative	Town Office		○					4,500	650		
		Police Station				○	○			900		
		Fire Station				○	△					
		Post,Telephone Office		○		○	○			350		
		Housing Admin.Office			○		○			100		
	Commercial Service	Bank				○		○		400		2 Banks
		Market		○		○	△	○		2,700		Super market type + Open air stalls
		Store				○		○		1,400	40 M2 x 35 Store = 1,400 M2	35 Stores
		Restaurant				○		○				
		Repair Shop				○	○	△		1,000		Gas station, Car, Appliance and Furniture Repair
		Hotel				○		○		1,500		30 Rooms
Educational Cultural	Educational	Kindergarten		○	△	△	○		9,000	3,600	540 M2 x 8 = 3,240 M2	6 Kindergartens - 3 years, 6 Class/Kindergarten
		School	○	○	△	△	○		45,000	9,000	2,750 M2 x 3 = 8,250 M2	3 Schools - 9 years, 27 Classes/School
		Adult School		○	△		○			300		1 School
	Social Cultural	Church	○	○	△	△	○			1,000		
		Meeting Hall		○			○			750	250 M2 x 3 = 750 M2	3 Meeting Places, 6 Mini Soccer Fields
		Library			○			○		600		
		Motion Picture Theater	○		○		○			900	2 M2 x 450 Seat = 900 M2	2 Theaters, 300 Seats + 150 Seats
Medical Welfare	Medical	Hospital	○		○	△	○		12,500	4,000	40 M2 x 100 Bed = 4,000 M2	100 Beds
	Welfare	Club House	○	○		△	○		63,700	1,800		
		Sports Facility	○		○	△	○	△				1 Gymnasium, 2Soccers, 4 Basket Balls, 2 Volley Balls, 4 Tennis Courts
		Central Square		○	△		○		16,800			
		Park		○	△		○		40,100			2 Squares
		Green Area		○	△		○		90,300			Walk Paths, Meeting Place
Basic Livelihood	Transportation	Main Road			○	○			32,200			Width=21M, Length=2,030 M, 5 Bus Stop
		Other Roads		○		○			96,800			Width 15M, Length =6,450 M
	Supply Treatment	Water Supply		○		△	○		10,000			Water Intake, Supply Reservoir
		Sewer Drainage		○		△	○		6,000			Treatment Plant
		Story Drainage		○	△	○						
		Power Distribution		○		○			1,000			Sub-station
		Rubbish Disposal		○								

Table 3-322 Stages for Facility Construction Planning

Sphere of Object
- Mine worker and family
- Mine workers and service related workers and family
- Include surrounding region

□□□□ Partial use during construction

Facility			Construction Period	Years of Operation: 0 - 5th Year	5th - 10th Year	10th - 15th Year	15th - 20th Year	20th Year and Over
Dwelling Facility		Family House	□□□□□□□□					
		Bachelor Dormitory	□□□□□□□□					
Commercial Facility	Administrative Facility	Town Office						
		Police, Fire Station	□□□□□□□□					
		Post, Telephone Office	□□□□□□□□					
	Commercial Service Facility	Bank						
		Market	□□□□□□□□					
		Shops, Restaurant			(15 Stores)	(25 Stores)	(35 Stores)	
		Repair Shop						
		Hotel						
Educational Cultural Facility	Educational Facility	Kindergarten	□□□□□□□□	(4 Classes x 6)	(5 Classes x 6)			
		School	□□□□□□□□	(8 Classes x 3)	(27 Classes x 3)			
		Adult School						
	Social, Cultural Facility	Church	□□□□□□□□					
		Meeting Hall						
		Library						
		Motion Picture Theater						
Medical, Welfare Facility	Medical Facility	Hospital	□□□□□□□□					
	Welfare Facility	Club House						
		Sports Facility	□□□□□□□□		(Expansion, Addition)			
		Square, Park, Green Area						
Approximate Population of Santa Margarita	Mine Worker and Family			7,900	8,900	9,400	9,500	9,300
	Service related Worker and Family			600	2,000	3,100	3,900	4,800
	Total			8,500	10,900	12,500	13,400	14,100

in commercial zone.

Whether to place both Santa Margarita and Encanada District under the same administrative office must be left to the judgement of Peruvian authority; but in any case at 10th year of mine operation a population of 12,500 will be residing in the town so facility for branch office type of administrative service will become necessary. Judging from the scale of the town, eastablishment of police station, fire station, post office and telephone office will be necessary. Detail regulation of Article 326 of the Mining Laws of Peru requires establishment of post office and telephone office; but since the nearest post office is located in Los Baños Del Inca the sphere of benefit resulting from the establishment of post office in this town will be great.

The basis of computation is indicated below:

Table 3-323 Standards of Compuration for Administrative Facilities

Facility	Floor Area Computation	Regional Population
Town Office	Regional Population x 5/100	12,500
Police, Fire Station	Regional Population x 60/10,000	15,000
Post, Telephone Office	Regional Population x 110/10,000	30,800

(2) Commercial Facilities

Two banks, market, shops, restaurants and repair-maintenance shops were located in north side of the central square as commercial facilities; and attaching importance to environmental aspect, the hotel was located on east side of the central square in social-cultural facility zone.

As mentioned in previous Section, there are some retail stores in Encañada but the stores are small in scale and lacking in variety and quantity of goods. Outside of Cajamarca and San Marcos, almost no concentration of commercial facilities can be observed. Therefore, with the Urban sphere of Santa Margarita shown in Figure 3-214 in Section 2 as object, the scale of commercial facilities was established. Market will consist of a super market and several open air type stalls, and all together 35 retail shops including restaurant, etc., were planned. Repair and maintanance shops will include gasoline service station and car, electrical appliance and furniture repair shops providing wide range sphere of services. However, the timing for construction of facilities other than market and repair shops should be coordinated with the condition of population settlement in Santa Margarita and surrounding areas after the start of mine operation. Initially, at start of mine operation, the existing facilities in Cajamarca should be utilized.

(3) Educational Facilities

A total of 3 schools and 6 kindergartens as mentioned in previous Section will be located in housing zones and a school for workers will be established in the commercial zone.

Presently, reform of educational system is taking place in Peru, so a school for 9 school year system in accordance with new educational system was planned and the transition of number of pupil was determined from Table 3-325 that was based on population planning in previous Section. The school, in accordance with the National

Education Code, will be of type CEB-III 1080 A and each school will be composed of 9 grades, 18 classes, and after the 5th year of mine operation there will be 27 classes and a total of 1,080 pupils while kindergarten will be of 3 year system with each kindergarten having 4 classes and after the 5th year of mine operation there will be 6 classes and 180 children, so the planned schools and kindergartens are allowed greater margin than the margin stipulated in National Education Code to meet future increases in number of school children.

Table 3-324 The National Education Code

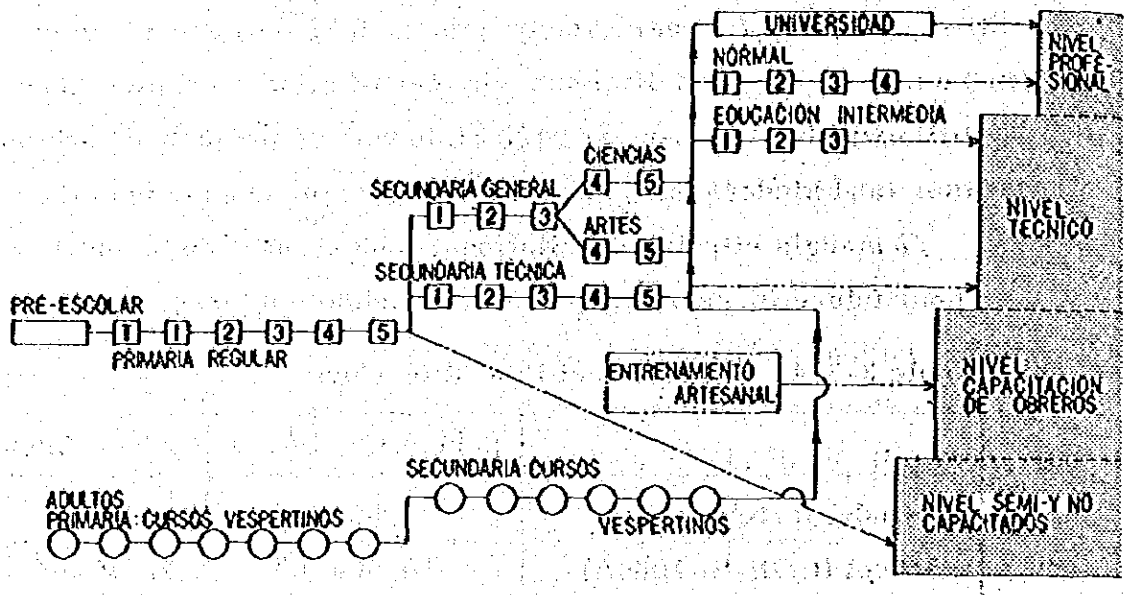
	School Land Area	Floor Area
Kindergarten	1,500 m^2	540 m^2
School (CEB-III 1080A)	10,500 m^2	2,750 m^2

Table 3-325 Transition in Number of School Children in Santa Margarita

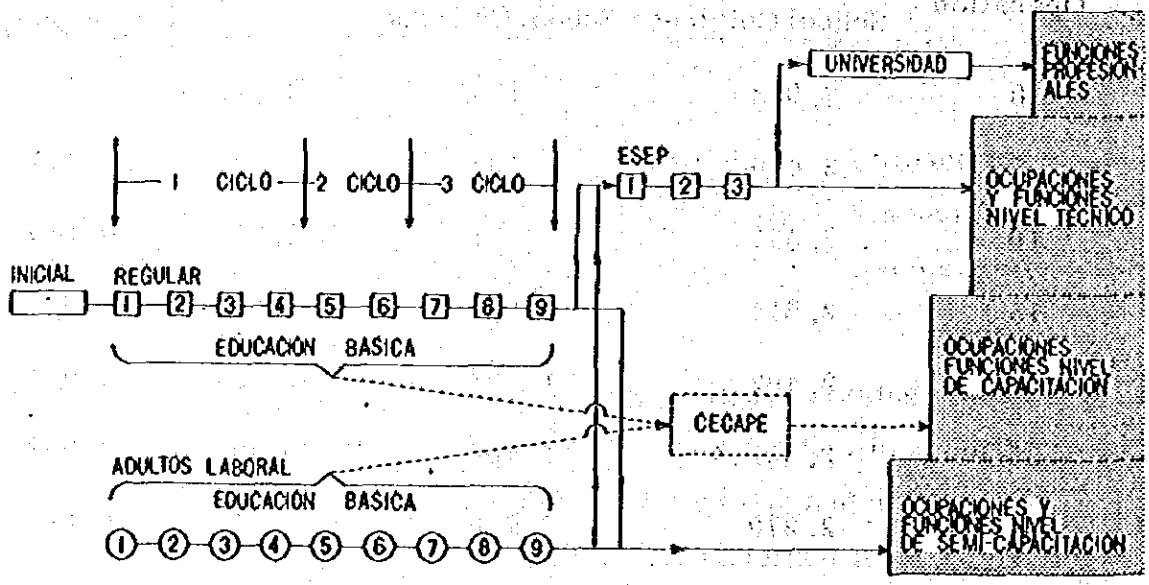
Year of Operation	Mine Workers' Number of School Children	Service Workers' Number of School Children	Total	Rate of Increase (For 5 years)
0	2,022	153	2,175	-
5	2,406	496	2,902	0.334
10	2,551	771	3,322	0.145
15	2,514	960	3,474	0.046
20	2,402	1,193	3,595	0.035
25	2,302	1,480	3,782	0.052
30	2,270	1,746	4,016	0.062

FIG. 3-321 EDUCATIOUAL SYSTEM OF PERU (PUBLICATION #2 OFFICE OF EDUCATION)

OLD EDUCATIONAL SYSTEM



NEW EDUCATIONAL SYSTEM



(4) Social and Cultural Facilities

For social-cultural facilities, a church and a library were located in west side of the central square, and 2 motion picture theaters in the commercial zone and a meeting hall in each housing zone.

Since religious activity flourishes and 96 % of the population are Catholics in Peru, church can be found in almost every community. Going to a movie theater in Peru is the most popular recreation together with playing or attending football matches, so establishment of a motion picture theater is required by detail regulations of Article 326 of the Mining Laws. Two theaters with seating capacity of 300 and 150 where many varieties of motion pictures can be shown are planned.

(5) Medical Facility

From environmental viewpoint and future expansion, a general hospital is planned in the central zone.

Santa Margarita belongs to the 7th Medical Area - Cajamarca structure of the Central Hospital in Cajamarca City. For population of 440,000 in the 7th Medical Area, the only general hospital available is the Central Hospital in Cajamarca City; and clinics having more than 10 beds are found only in Cajabamba City. As mentioned in Clause 1 in the previous Section, the level of medical standards for this Area is the lowest in Peru and considering the present concentration of 60 % of medical facilities in Lima Region and medical program in other regions, a 100 beds hospital was planned for this town.

Assuming a high degree of medical treatment, the total hospital floor area was obtained with following equation:

$$\text{Total Floor Area } (m^2) = \text{Number of Bed} \times 40\ m^2$$

(6) Sports Facilities

Two sport parks having a football field, basketball court, etc. are planned in area adjacent to the housing zone.

Football is the most popular sport in Peru followed by basketball and volleyball. However, facilities for these sports are available only in urban district such as Cajamarca and Los Baños Del Inca. Since there is no gymnasium and the only sport facility available in areas surrounding Santa Margarita is a mini-football field now, the demand for sports facility is very high.

The sports park adjacent to housing zone "A" will have 1 football field, 4 tennis courts, 2 basketball courts, 1 volleyball court and gymnasium with club house while each sport park for "B" and "C" zones will have 1 football field, 2 basketball courts and 1 volleyball court.

3-3. Planning of Water Supply and Treatment System

(1) Water Supply Program

In planning of water supply system, the selection of water source and water intake method is important, so a long range investigation of water volume and quality is necessary. The source of water for this town can be Quispa River and water well; but data for both cases not being available, for this program, it has been assumed from the site investigation conducted in March 12, 1976 that the volume of water from Quispa River will be sufficient for

this planned water supply system, so a study of a system based on general water supply system with Quispa River as water source was conducted.

As future matter, while conducting a more detailed investigation of water volume and quality of Quispa River, a study of possible utilization of subsurface water by investigation of water volume and quality by establishing test and observation wells together with investigation of soil structure is necessary.

A. Planned Population for Water Supply System

Population to receive supply of water was determined from planned urban population as shown in following Table.

Table 3-331 Planned Population for Water Supply System

Year of Operation	Planned Urban Population	Planned Population for Water Supply
0 year	8,475	8,500
5th year	10,886	11,000
10th year	12,546	12,500
15th year	13,376	13,500

B. Planning of Volume of Water Supply

1) Maximum daily water demand per person

The maximum daily water demand by each person will include demand for living water by residents as well as water for schools, hospital and commercial facilities. The water demand per person in the planned population for water system according to scale of the facilities and result of demand forecast based on the primary unit is considered generally as one type of index.

Here, a maximum daily water demand per person is assumed as 300 liters for this study. A population of 12,500 is assumed as the population for water supply system 10 years after start of mine operation as shown in Clause 1 of this Section.

From following equation, a planned maximum daily water demand of 3,750 m^3 is obtained and this will be 156.25 m^3/hour.

Planned maximum daily water demand = Planned population for water supply x

Planned maximum daily water demand per person = 12,500 x 300 Liters/man/day

= 3,750 m^3/day

Planned maximum water demand per hour = Planned maximum daily water demand / 24 hour

= 3,750/24

= 156,25 m^3/hour

C. Source of Water

Quispa River was selected as source of water for the town and generally, in the case of using river as a source of water, a long range investigation of following must be conducted.

1) Volume of water and water level
   a) Volume and level during drought season
   b) Average volume and level
   c) Volume and level during flood season

2) Water quality

a) Relationship between rainfall and turbidity

b) Water quality change during the year

For this study, it has been assumed that the volume and quality of water from this source are suitable as water supply for the town. Figure 3-331 and Table 3-332 show the result of investigation.

In determining the location of water intake, concrete studies must be conducted on the relationship between intake location and water supply district, relationship between flow and river condition, river fluctuation condition, ease of intake facility construction, water utilization other than town water supply etc. For this study, the northwest end of the water supply district was selected as point of intake.

If sub-surface water is to be used as source of water, investigation of water volume and quality and sub-soil structure must be conducted with boring tests and observation wells.

A simple measurement of the river water flow rate is shown below.

FIG. 3-331 LOCATION OF WATER VOLUME INVESTIGATION

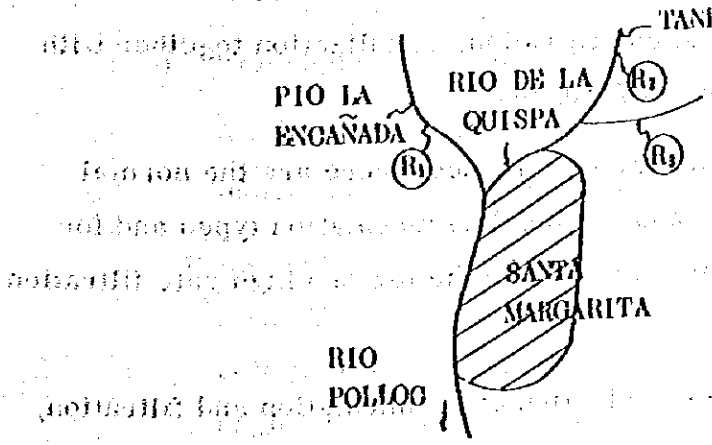
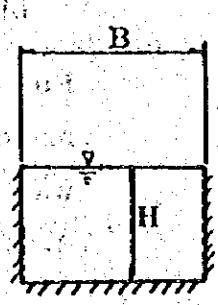


Table 3-332 Result of Water Volume Investigation

	R	R	R
H(m)	0.25	0.30	0.50
B(m)	5.00	5.00	5.00
V(m/s)	0.833	1.00	0.833
Q(m^3/d)	89,850	129,600	179,700



Q; Water Volume per day
V; Water Velocity per second

Note 1. Date of measurement March 12, 1976

2. Location in river with uniform width and depth was selected and piece of wood drifted and time measured (average of 3 times). The rate of water flow in winter season (min. flow rate period) is approximately 1/2 of the flow rate in March. (According to Minero Peru)

D. Water Purification Method and Flow Sheet

In general, there are 3 types of water purification method as shown below:

1) Sterilization only
2) Sedimentation, filtration and sterilization
3) Sedimentation, filtration, sterilization together with other special facilities

Also, for sedimentation methods there are the normal sedimentation and chemical sedimentation types and for filtration methods there are the low and high rate filtration types.

When using a combination of sedimentation and filtration,

It is normal to use the following combination:

Standard sedimentation → Low rate filtration

Chemical sedimentation → High rate filtration

Dependent upon the quality of water source, water purification method may be limited; but in general the following standards for selection of purification method will be applicable:

1) In case of sterilization only:

a) Colitis germs (100 ml MPN) under 50

b) Normal bacteria (1 ml) under 500

c) Standards for judging potable water are applicable to other items.

2) For slow filtration tank:

a) Colitis germs (100 ml MPN) under 50

b) BOD under 3 ppm

c) Average annual turbidity under 10 degrees

Annual Maximum Turbidity:

- Under 10 degrees → Sedimentation tank not required
- 10 - 30 degrees → Standard sedimentation in tank
- Over 30 degrees → Sedimentation tank with chemical treatment possible

3) For rapid filtration tank:

Applicable to water quality other than water quality indicated in above 1) and 2).

As previously mentioned, normally, chemical sedimentation tank will be used in combination with high rate filtration tank. In the case of a combination with rapid cohesion sedimentation tank, at minimum turbi-

dity of over 5 degrees to under 3,000 degrees, the fluctuation width of both water quality and water volume must not be excessively large.

There are other various methods of water purification; but for this study the standard sedimentation → low rate filtration method was adopted after conducting an overall judgement of construction and maintenance costs as well as technical level of administrative personnel and future of the water source.

Purification process flow and overall flow are shown in Figure 3-332 and Figure 3-333.

FIG. 3-332 FLOW DIAGRAM FOR WATER PURIFICATION

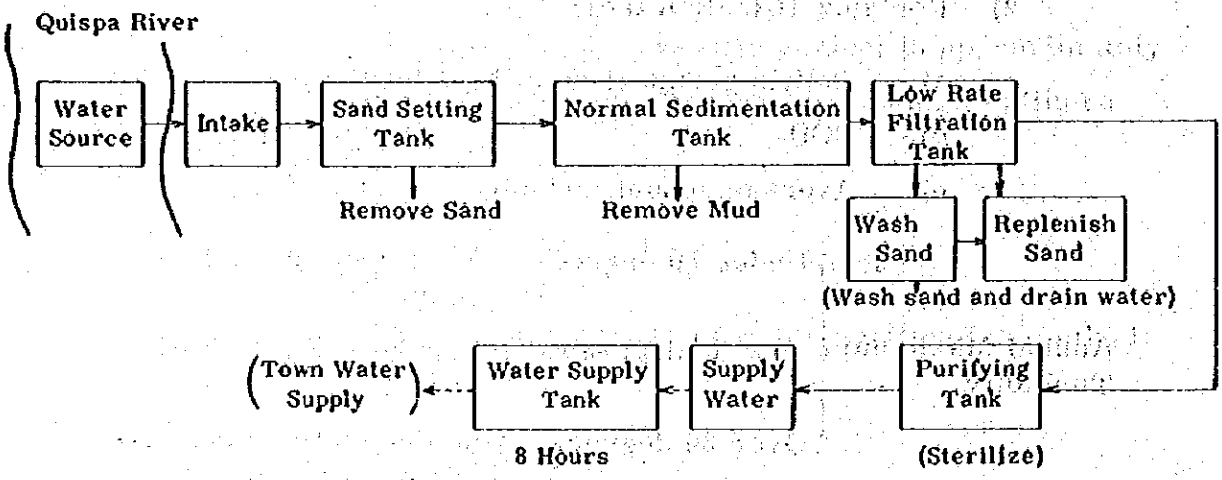
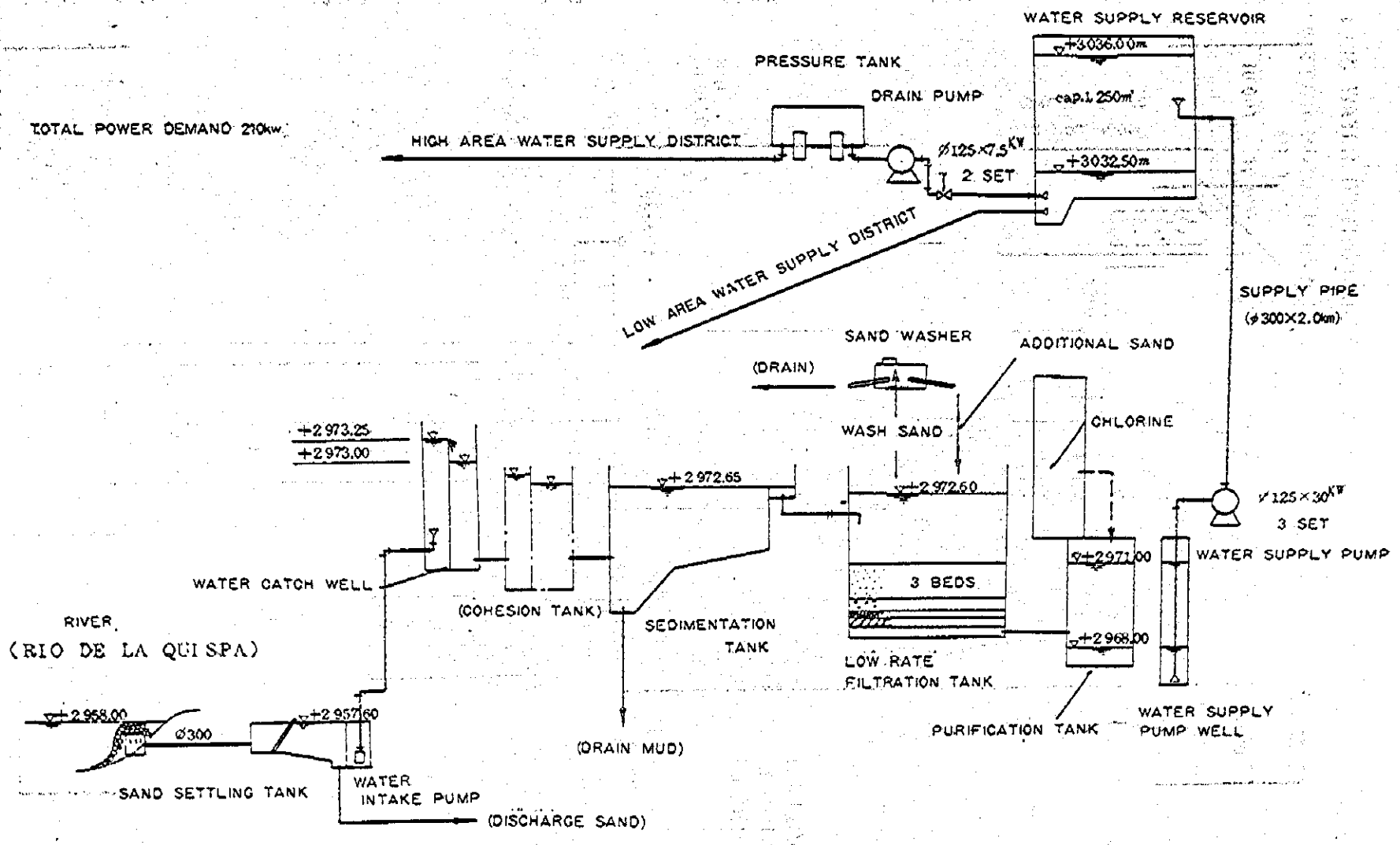


FIG. 3-333 OVERALL FLOW DIAGRAM



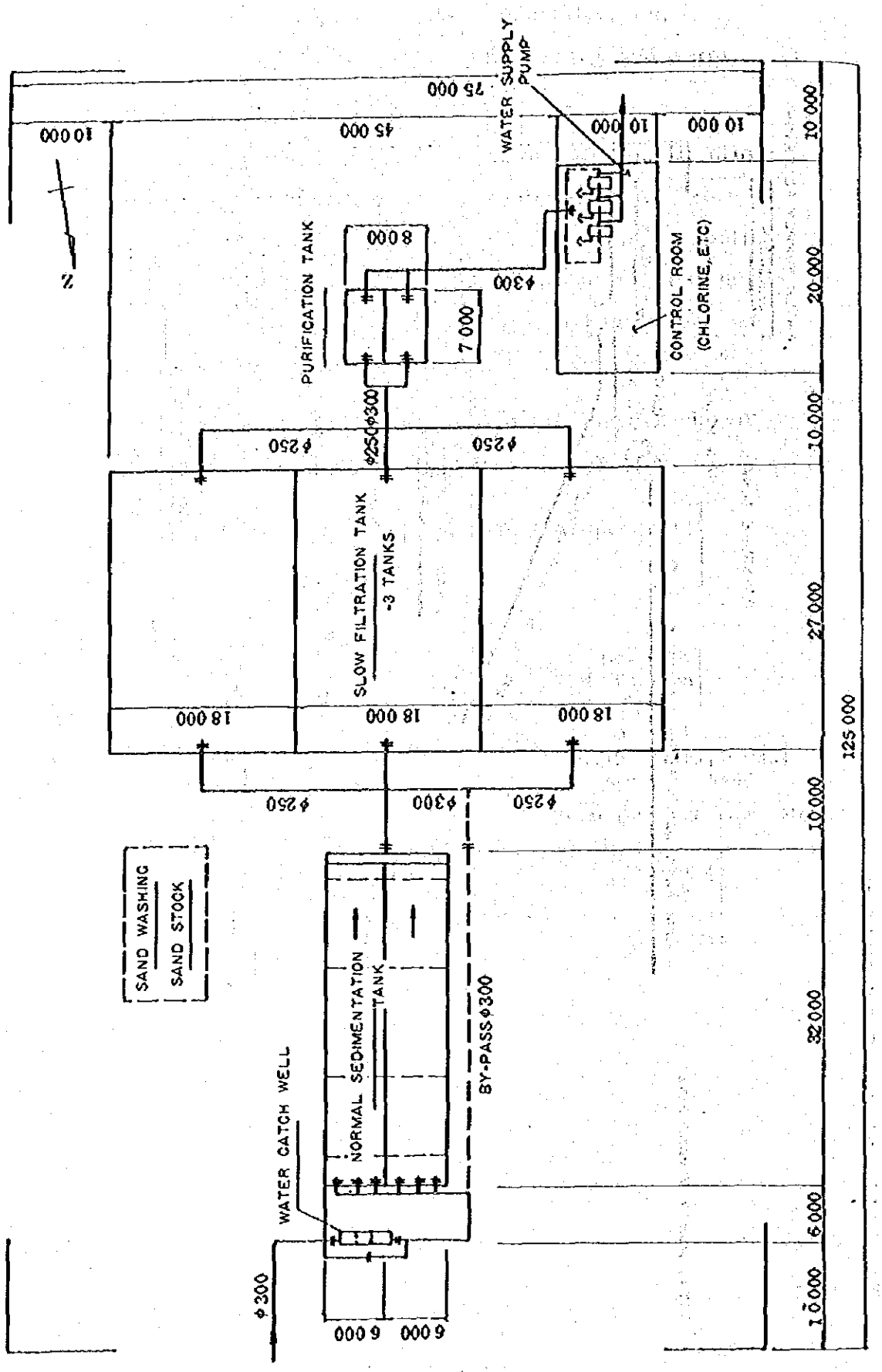
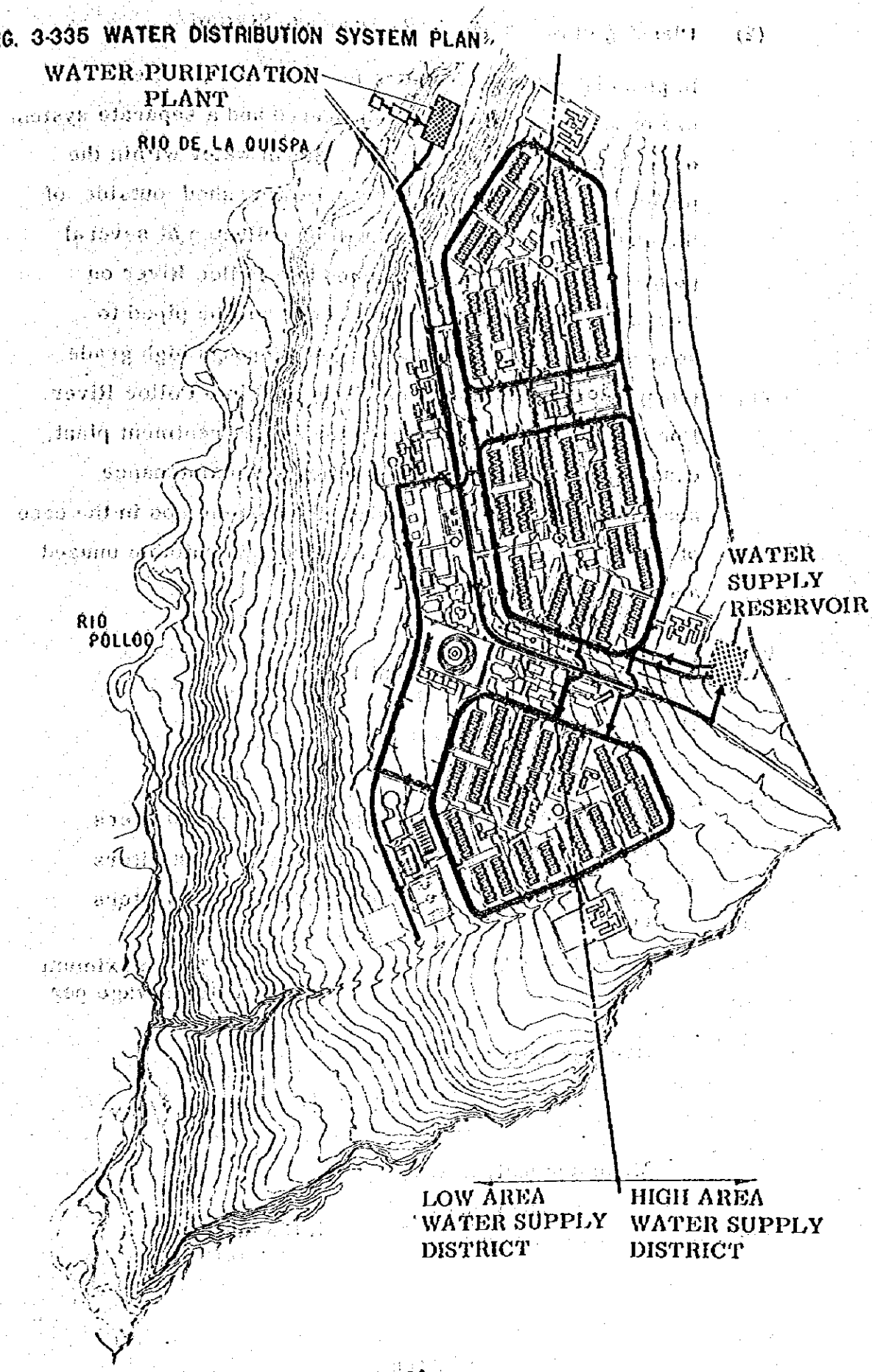


FIG. 3-334 ROUGH LAYOUT OF WATER PURIFICATION PLANT

FIG. 3-335 WATER DISTRIBUTION SYSTEM PLAN



(2) Planning of Storm and Sewer Drainage System

In planning a drainage system for mine town, the efficient use of the ground slope was considered and a separate system of drainage method was adopted. Storm water within the planned mine town site and from water shed outside of the district affecting the town will be collected at several points in the town site and drained into Polloc River on west side of the town. Sanitary sewer will be piped to sewer treatment plant and after going through high grade treatment the effluent will be discharged into Polloc River. For the disposal of sludge from the sewer treatment plant, considering the costs of construction and maintenance accompanying disposal of sludge, the best method in the case of this town will be to dispose the sludge in suitable unused area within the town site.

A. Planning of Sewage Treatment Plant

1) Planning standards

Population	12,500
Average daily sewage per person	200 liters
Maximum daily sewage per person	300 liters
Maximum daily (by time discharge) sewage per person	400 liters
Subsoil water	10 % of maximum daily sewage per person

Average daily sewage

$$\frac{12,500 \times (200 + 300 \times 0.1)}{1,000} = 2.875\ m^3/day$$

Maximum daily sewage

$$\frac{12,500 \times 300 \times 1.1}{1,000} = 4.125\ m^3/day$$

Maximum daily (by time discharge) sewage

$$\frac{12,500 \times (400 + 30)}{1,000} = 5,375 \text{ m}^3/\text{day}$$

Sewage characteristics	BOD	200 ppm
	SS	300 ppm

Object of treatment

BOD	20 ppm
SS	70 ppm
pH	5.8 - 8.6
Coli bacteria	Less than 3,000 bacteria/cc
Odor	None
Color	Close to colorless

2) Flow diagram

Raw sewer collected from each district will flow by gravity to sand settling tank where large suspended solids are first removed by screen in front of the settling tank. After removal of solids, the sewer is sent to aeration sand settling tank where sand is removed, and after entering comminutor the suspended solids in the sewer are broken down automatically and then enters the control tank. From control tank the sewer is pumped into aeration tank where the sewer together with the activated sludge returned from final settling is aerated and the organic matters in the water are decomposed by good air treatment. Sludge and liquid are separated in the sedimentation tank and after sterlizing the liquid in chlorination contact tank the effluent is drained by gravity and discharged into the river. The sludge, after sedimentation, is withdrawn continuously with air lift pump and surplus sludge

is returned to sludge digesting tank and sterilized. The stable and sterilized sludge is sent to sludge concentration tank and after drying by sun the sludge is removed.

3) Scale and area of treatment plant

Rough layout of treatment plant will be as follows;

FIG. 3-336 TREATMENT PROCESS FLOW AND ROUGH LAYOUT OF TREATMENT

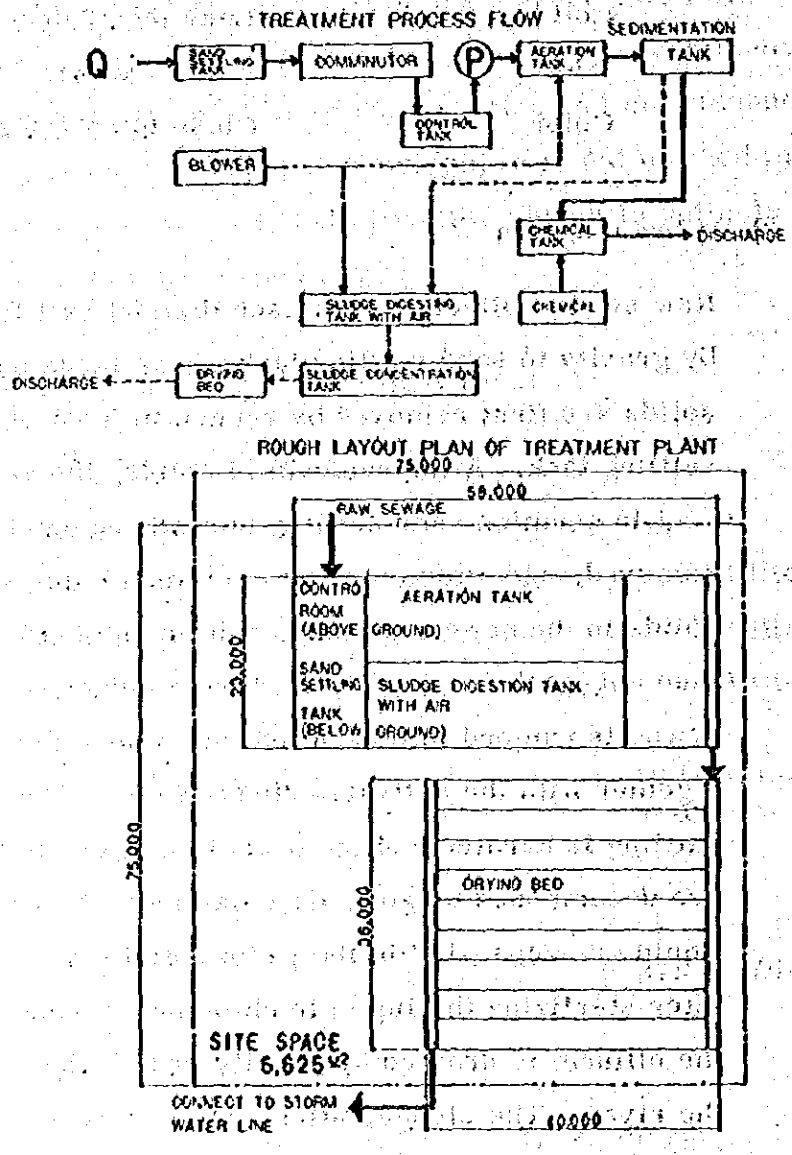
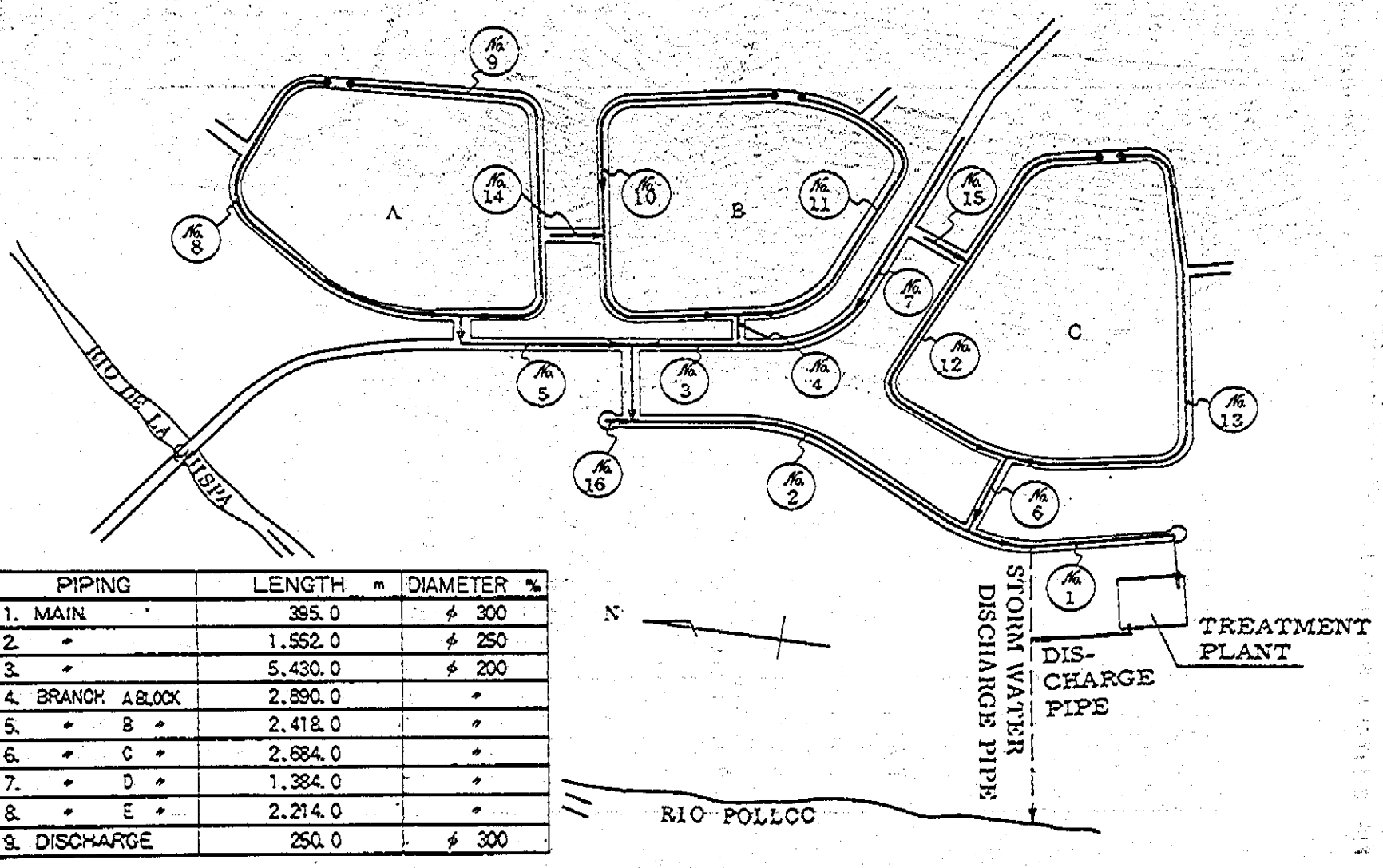
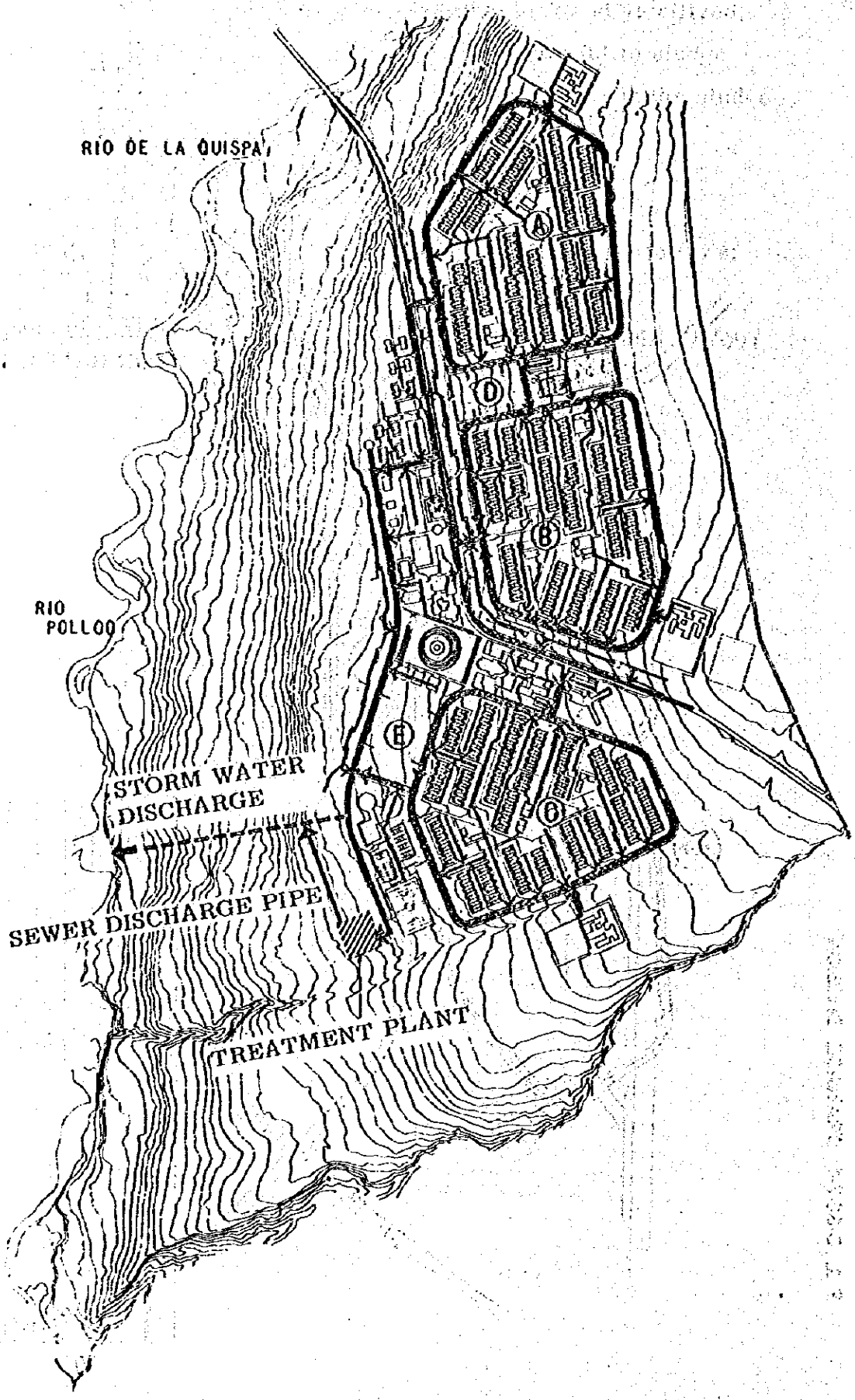


FIG. 3-337-1 DRAINAGE DIVISION



PIPING	LENGTH m	DIAMETER ㎜
1. MAIN	395.0	ϕ 300
2. "	1.552.0	ϕ 250
3. "	5.430.0	ϕ 200
4. BRANCH A BLOCK	2.890.0	"
5. " B "	2.418.0	"
6. " C "	2.684.0	"
7. " D "	1.384.0	"
8. " E "	2.214.0	"
9. DISCHARGE	250.0	ϕ 300

FIG. 3-337-2 SEWER DRAINAGE SYSTEM DIVISION PLAN



2. Flow Rate and Piping

Table 3-333 Flow Rate and Piping

a. Main Line

Piping Line	Population Man	Sewer Volume m^2/sec	Average Slope 0/00	Flow Velocity m/sec	Pipe Diam. mm	Av. Earth Cover m	Length m	Number of Manhole @m Each
No. 1	12, 500	0.0578	6.5	1.052	300	1.40	395	@ 20.0 20
No. 2	8, 500	0.0391	8.0	1.015	250	1.20	785	@ 50.0 16
No. 3	4, 500	0.0208	10.0	1.135	250	1.29	184	@ 20.0 10
No. 4	4, 000	0.0185	20.0	1.607	250	1.67	60	@ 20.0 3
No. 5	4, 000	0, 0185	8.0	1.015	250	1.20	386	@ 50.0 8
No. 6	4, 000	0.0185	13.0	1.294	250	1.20	137	@ 50.0 3
No. 7	500	0.0023	10.0	0.954	200	1.59	570	@ 20.0 29
No. 8	2, 000	0.0093	10.0	0.954	200	1.41	750	@ 20.0 38
No. 9	2, 000	0.0093	10.0	0.954	200	1.41	742	@ 20.0 38
No. 10	2, 000	0.0093	10.0	0.954	200	1.36	930	@ 20.0 47
No. 11	2, 000	0.0093	10.0	0.954	200	1.51	590	@ 20.0 30.
No. 12	2, 000	0.0093	10.0	0.954	200	1.44	725	@ 20.0 37
No. 13	2, 000	0.0093	10.0	0.954	200	1.40	840	@ 20.0 48
No. 14	2, 000	0.0093	10.0	0.954	200	1.36	115	@ 20.0 6
No. 15	2, 000	0.0093	10.0	0.954	200	1.44	110	@ 50.0 2
No. 16	2, 000	0.0093	10.0	0.954	200	1.20	58	@ 50.0 1
	12, 500	0.0578	6.5	1.052	300	1.40	250	@ 50.0 5

b. Branch Line

District	A Block	B Block	C Block	D Block	E Block
Pipe Diameter (mm)	ϕ 200	ϕ 200	ϕ 200	ϕ 200	ϕ 200
Length (m)	2, 890	2, 418	2, 684	1, 384	2, 214
Manhole @ 50.0m	58 each	48 each	54 each	28 each	44 each

C. Storm Water Drainage System

1. Computation Formula for Rainfall Runoff

$Q = CIA$ Rational Method

Q : Runoff (m^3/sec)

I : Intensity of rainfall (from Clause 2 in Section 2 assume 30mm/hr.)

C : Coefficient of runoff (development area C=0.6 other C=0.3 assumed)

A : Area of watershed (ha)

2. Watershed Division

Table 3-334 Watershed Division

	Watershed Division	Area of Each Division ha		Coefficient of Runoff C
Planned District (A)	I	Ⓐ	18.63	0.6
		Ⓑ	12.46	0.3
		Ⓒ	2.82	0.3
	Total Area 46.24 ha	Ⓓ	2.01	0.6
		Ⓔ	4.90	0.6
		Ⓕ	3.49	0.6
		Ⓖ	1.93	0.6
	II	Ⓗ	4.54	0.6
		Ⓘ	2.72	0.6
		Ⓙ	18.09	0.6
	Total Area 48.06 ha	Ⓚ	15.71	0.3
		Ⓛ	7.00	0.6
Total Area 130.70 ha	III	Ⓜ	8.90	0.3
		Ⓝ	18.37	0.6
	Total Area 33.62 ha	Ⓞ	2.45	0.6
		Ⓟ	3.90	0.6
	IV	Ⓠ	2.78	0.3
Outside of (A)	V	Ⓡ	150.00	0.3

3. Pipe Line and Manhole in Each Watershed Division

Table 3-335-1 Watershed Division I

a. Main Line

Line No.	Drained Area (ha) Each Line	Drained Area (ha) Additional	Rainfall m^3/sec	Average Slop 0/00	Flow Velocity m/sec	Pipe Diam. mm	Av. Earth Cover m	Length m	Manhole @m Each
No.1	5.46		0.137	10.0	1.467	o 350	1.20	150	@ 50 3
No.2	2.94	8.40	0.284	6.5	1.540	o 500	1.20	260	@ 20 13
No.3	7.00		0.175	8.0	1.450	o 400	1.20	210	@ 50 4
No.4	3.73	19.13	0.645	5.0	1.719	o 700	1.20	240	@ 20 12
No.5	2.43	21.56	0.767	4.0	1.689	o 800	1.50	305	@ 50 6
No.6	3.23		0.162	7.0	1.467	o 350	1.20	220	@ 20 11
No.7	2.82		0.071	10.0	1.306	o 300	1.20	100	@ 50 2
No.8	4.20	10.25	0.442	5.5	1.616	o 600	1.20	195	@ 20 4
No.9	2.01		0.101	7.0	1.227	o 350	1.20	115	@ 20
No.10	2.10	14.36	0.648	5.0	1.719	o 700	1.20	250	@ 50 5
No.11		35.92	1.414	3.5	1.845	o1000	1.50	135	@ 20 6
No.12	5.42		0.271	6.0	1.479	o 500	1.20	350	@ 50 7
No.13		41.34	1.685	3.0	1.822	o1100	1.50	100	@ 50 2
No.14	4.90		0.245	5.0	1.439	o 500	1.20	300	@ 50 6
No.15		46.24		2.5	1.996	□1100 x1100	1.50	490	@ 50 10

b. Sub-main and Branch Line

Line	Diameter mm	Length m	Average Earth Cover m	Number of Manhole @ m Each	Remarks
Sub-main	o 300	3,140	1.20	@ 30 105	
Branch	o 250	1,971	1.20	406	Storm Catch Basin

Table 3-335-2 Watershed Division II

a. Main Line

Line No.	Drained Area (ha) Each Line	Drained Area (ha) Addi-tional	Rainfall m^3/sec	Average Slope 0/00	Flow Velocity m/sec	Pipe Diam. mm	Av. Earth Cover m	Length m	Manhole @ m Each
No. 1	4.78		0.120	4.0	1.023	o 400	1.50	480	@ 50 10
No. 2	1.07	5.85	0.173	4.0	1.116	o 450	1.50	200	@ 20 10
No. 3	1.61	7.46	0.254	5.0	1.349	o 500	1.50	325	@ 50 7
No. 4	10.93		0.273	5.5	1.416	o 500	1.50	380	@ 50 8
No. 5	8.37	19.30	0.692	5.5	1.804	o 700	1.50	360	@ 20 18
No. 6	2.81	22.11	0.833	4.0	1.689	o 800	1.50	230	@ 50 5
No. 7	0.97		0.049	5.0	1.036	o 350	1.20	150	@ 50 3
No. 8	7.54	8.51	0.426	5.0	1.540	o 600	1.50	330	@ 20 17
No. 9	1.03	9.54	0.477	5.0	1.719	o 700	1.50	135	@ 50 3
No. 10		31.65	1.310	3.0	1.707	o1000	2.00	60	@ 20 3
No. 11	1.82	40.93	1.654	2.8	1.760	o1100	2.00	180	@ 50 4
No. 12	3.23	44.16	1.816	2.5	1.764	o1200	2.00	140	@ 20 7
No. 13	2.54		0.127	4.0	1.023	o 400	1.50	280	@ 50 6
No. 14	1.36		0.068	5.0	1.036	o 350	1.20	210	@ 50 4
No. 15		46.70	1.943	2.6	1.800	o1200	2.00	60	@ 50 1
No. 16		48.06	2.011	1.5	1.636	□1200 x1200	2.00	360	@ 50 7

b. Sub-main and Branch Lines

Line	Pipe Diam. mm	Length m	Average Earth Cover m	Manhole @ m Each	Remarks
Sub-main	o 300	3,810	1.20	@30 127	
Branch	o 250	2,210	1.00	490	Storm Catch Basin

Table 3-335-3 Watershed Division III

a. Main Line

Line No.	Drained Area (ha) Each Line	Drained Area (ha) Addi-tional	Rainfall m3/sec	Average Slop 0/00	Flow Velocity m/sec	Pipe Diam. mm	Av. Earth Cover m	Length m	Manhole @m Each
No.1	6.70		0.168	7.0	1.356	o 400	1.50	345	@ 50 7
No.2	10.30	17.00	0.683	3.0	1.461	o 800	1.50	355	@ 20 18
No.3	0.47	17.47	0.706	3.0	1.461	o 800	1.50	165	@ 50 3
No.4	5.60		0.225	7.0	1.479	o 450	1.50	205	@ 20 10
No.5	2.45	8.05	0.123	4.0	1.023	o 400	1.50	195	@ 50 4
No.6	5.00	13.05	0.475	3.5	1.437	o 700	1.50	370	@ 50 8
No.7	1.10	14.15	0.530	3.5	1.437	o 700	1.50	170	@ 50 4
No.8		31.62	1.236	3.0	1.707	o1000	2.00	60	@ 50 1
No.9	1.20		0.060	5.0	1.036	o 300	1.20	200	@ 50 4
No.10	0.80	33.62	1.296	3.0	1.707	o1000	2.00	100	@ 50 2
No.11		33.62	1.296	2.5	1.872	□1000 x1000	2.00	435	@ 50 9

b. Sub-main and Branch Lines

Line	Diameter mm	Length m	Average Earth Cover m	Number of Manhole @m Each	Remarks
Sub-main	o 300	2,140	1.20	@30 72	
Branch	o 250	1,380	1.00	306	Storm Catch Basin

Table 3-335-4 Watershed Division IV

a. Main Line

Line No.	Drained Area ha	Rainfall m^3/sec.	Average Slope 0/00	Flow Velocity m/sec.	Pipe Diameter mm	Average Earth Cover m	Length m	Manhole @m Each
No. 1	2.78	0.139	10.0	1,467	ϕ350	1.20	405	@20 20

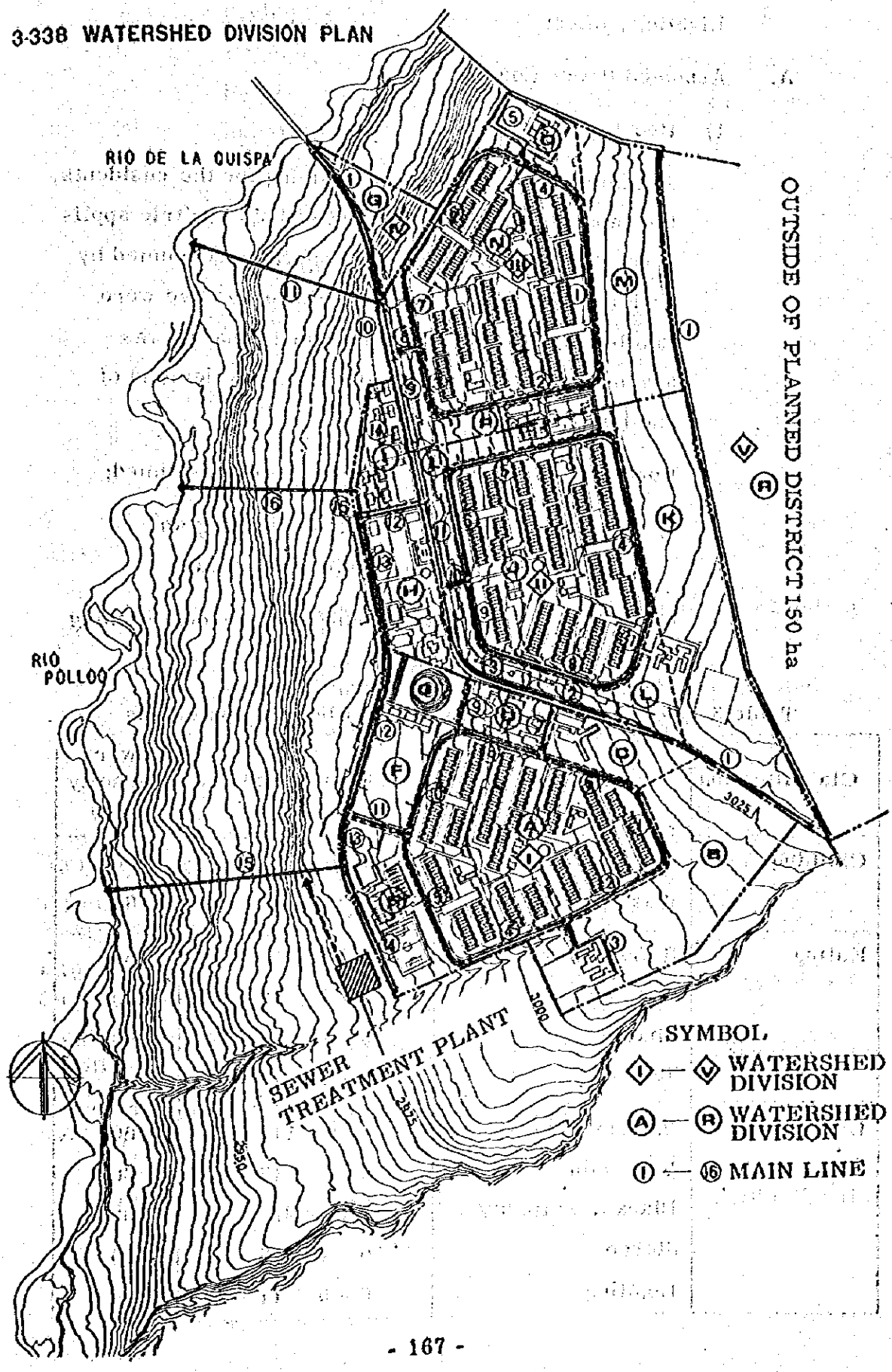
b. Branch Line

Line	Pipe Diam. mm	Length m	Average Earth Cover m	Manhole Each	Remarks
Branch Line	ϕ 250	126	1.20	28	Storm Catch Basin

Table 3-335-5 Watershed Division V (Outside of planned Area)

Line No.	Drained Area ha	Rainfall m^3/sec	Average Slope 0/00	Flow Velocity m/sec	Pipe Diameter mm	Average Earth Cover m	Length m	M Manhole @m Each
No. 1	150	3.75.	2.5	2,342	⊔1400 x1400 ⊓1400	0	1,600	0
No. 2		3.75	2.5	2,342	x 1400	2.0	600	@50 12

FIG. 3-33B WATERSHED DIVISION PLAN



(3) Program for Electric Power Distribution and Street Lighting System

A. Assumed Power Load

1) Housing Facility

Assuming a future standard of living for the residents, the capacity for each type of household electric appliance was established and the energies consumed by each appliance for each hour of average use were totalled; and the maximum consumed energy was assumed as maximum electrical energy demand of one family house unit.

Furthermore, following conditions were assumed:

a) Kerosene will be the fuel for heating and source of energy for daily livelihood.

b) Annual temperature being low, air conditioning will not be provided.

Table 3-336 Capacity of Household Electric Appliances

Classification	Appliance	Hours Used	Power Capacity (VA)
Clothing	Iron	14 - 15	600
	Washing machine	19 - 21	130
Eating	Refrigerator	All day	150
	Toaster	6 - 7 , 18 - 20	600
	Mixer	6 - 7 , 18 - 20	200
	Juicer	6 - 7 , 18 - 20	200
Living	Vacuum cleaner	9 - 11	200
	Ventilator	6 - 7 , 17 - 20	60
	Black & white TV	18 - 21	150
	Stereo	10 - 13 , 18 - 22	400
	Lighting	6 - 9 , 17 - 22	400

If electrical appliances are assumed to be in use during the hours noted in above Table 3-336, the total capacity of the appliances used during the hours between 18 - 19 hours can be anticipated as approximately 2 KVA.

2) Other Facilities

Following power density was assumed:

Store	70 VA/m^2
School	25 VA/m^2
Office	30 VA/m^2
Hotel	55 VA/m^2
Theater Hall	95 VA/m^2
Hospital	55 VA/m^2
Outdoor Facility	1 VA/m^2
Street Lighting	See Clause on street lighting

3) Electric energy consumed by each facility computed with above power density is as shown below:

	Load	Demand Percentage	Maximum Power
Housing Facility	3,328 KVA/H	50 %	1,664 KVA/H
Commercial Facility	342 KVA/H	70 %	239 KVA/H
Educational - Cultural Facility	546 KVA/H	70 %	382 KVA/H
Medical - Welfare Facility	422 KVA/H	70 %	295 KVA/H
Basic Livelihood Facility	212 KVA/H	70 %	148 KVA/H
TOTAL	4,850 KVA/H		2,728 KVA/H

With percentage of demand as 50 for housing facility, 70 % for other facilities and 1.2 as diversity factor, the entire town will require a total electric energy of approximately 2,273 KVA/H.

B. Street Lighting Plan

1) Road :

Main road will be provided with 68 highway type light poles (2 - 400 W mercury vapor lamp) in median strip spaced at 30 meters distance. Other roads will be provided with 1 - 400 W mercury vapor lamp highway type light poles along the sidewalk next to the road and spaced at 60 meters distance. (See Figures 3-318).

2) Others:

Squares, parks and green areas will be provided with 1 - 200 W mercury vapor lamp crime prevention light pole for each 1,000 m^2 of area.

C. Power Distribution Plan

Santa Margarita substation will be located adjacent to bachelor dormitory facing the main road for this location is favorable from view point of maintenance and power distribution plan. At this substation, 220 KV extra high voltage will be transformed to 4 KV and distributed by overhead wiring.

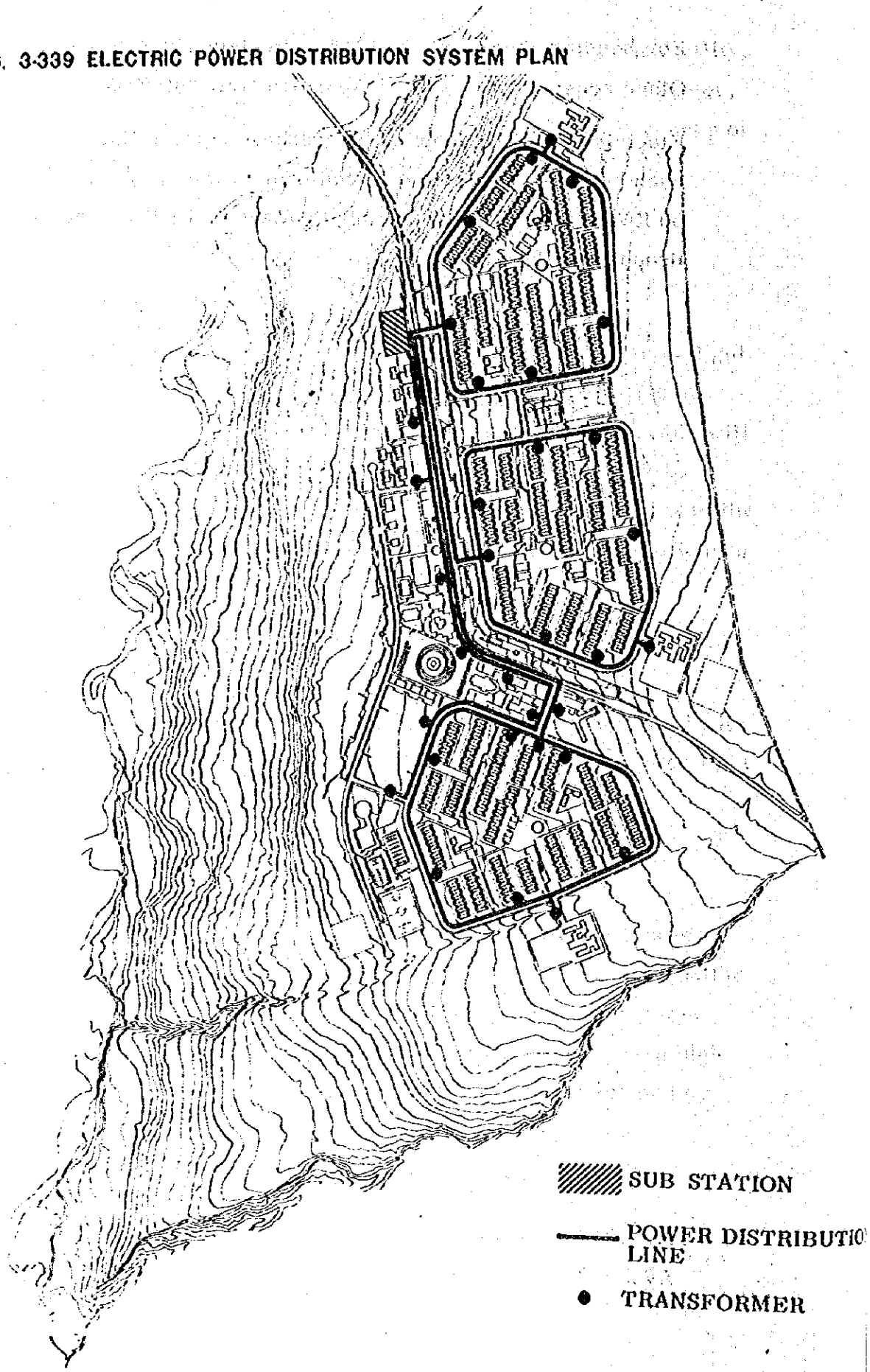
Power distribution will consist of following blocks:

For housing zone A	Approximately 652 KVA
For housing zone B	Approximately 638 KVA

For housing zone C	Approximately 638 KVA
Other zones	Approximately 800 KVA

Electricity will be supplied by overhead service line to each building from pole mounted transformer (3 ϕ 3W 50 KVA as standard) where high voltage of 4 KV will be dropped to 220 V.

FIG. 3-339 ELECTRIC POWER DISTRIBUTION SYSTEM PLAN



(4) Rubbish Disposal

Rubbish and garbage from the mine town are to be disposed by filling suitable unused area for a period of time after start of mine operation; but at later date with increase in rubbish and change in rubbish type a facility with suitable method of disposal must be considered.

3-4. Proposal Related to Housing

Article 326 of Mining Laws of Peru stipulates 5 functions for a mine town that must be fulfilled in construction of a new mine town and the construction of houses for workers comes at head of the list. This is the responsibility of the enterprise operating the mine, so the dwelling facilities for this program will be constructed and owned by the enterprise. Furthermore, according to detail regulations of the Article on housing supply system, all mine workers have the right to be furnished with company house free of charge. Namely, in case the enterprise enters into employment agreement with a worker, first of all the bachelor shall be provided with a room and if the worker is married or marries after employment by the company, the worker shall be furnished with suitable family dwelling within 6 months upon application by the worker. This right to live in company house shall cease 30 days after termination of employment agreement and the tenant must vacate the house within the 30 day period. In this Clause, the following proposal is made with housing situation, housing standard and living condition of Peru as well as above mentioned conditions and regulations of National Building Code taken into consideration.

(1) Layout of Family Housing Blocks

Each family housing zone will be sub-divided into 5 - 6 neighborhood blocks and each block will consist of group of 2 storeyed continuous row of houses with a total of about

100 family units and this row of houses will be laid out around a dead end street which branches off from the loop road and serves as parking area. Figure 3-341 shows a typical neighborhood block of houses. Area within the housing zone is completely shut off from vehicular traffic and all open spaces between each row of houses and between each neighborhood block will be open to the residents. A network of strolling paths connecting to kindergarten and small square with a meeting hall and mini-football field will be laid out and in each neighborhood block, 1 - 2 playground will be located near the strolling paths. The strolling path will have a minimum width of 3 meters to permit entry of vehicle in case of emergency. According to the detail regulations of Article 326 of the Mining Laws, the distance between adjoining rows of housing shall be greater than 7 meters; but for this program the minimum distance is 18 meters and the distance of row of houses in one neighborhood block to the row in adjoining block is more than 31 meters. As plan for 2 storeyed continuous row of houses, this distance is adequate and there will be no problem of sunlight, ventilation and noise.

(2) Outline of Plan for Family House

A. Legal Conditions:

Detail regulations of Article 326 of the Mining Laws stipulate that required rooms and facilities for family house shall be provided and the size of the house and minimum dimension of each room must be in accordance to the National Building Code. The main requirements are indicated below:

Type of House	Under 3 story, single unit or apartment
Bedroom	Minimum of 1 room For every 3 persons ages 5 years or more - 1 additional room. Area - More than 10 m^2, Minimum width - 2.80 m
Living Dining Room	Area - More than 16 m^2, Minimum width - 3.00 m
Kitchen	Area - More than 6 m^2
Toilet,Shower,Wash Room	Separate from living dining room and kitchen
Ceiling Height	Minimum of 2.3 m
Stairs	Effective width - More than 1.00 m 2 x (riser) + (tread) = 0.60 - 0.64 m Minimum tread width - 0.25 m
Washroom	1 washroom per 4 family units or washroom in each unit
Facility	Water supply, sanitary drainage, electric system. House located at elevation more than 3,000 meters above sea level, heating system must be provided.
Courtyard and Garden	More than 30 % of land area

B. Main Points of The Program:

Santa Margarita as mentioned in Section 2, is looked upon to assume the role of nucleus town for this sector; but on the other hand, especially at initial stage of operation its function as housing town for the mine should take precedence. Therefore, in the development of the town the planning of house and housing zone is an important factor that will

affect the quality of the entire program. By planning a comfortable and efficient house, an intensive utilization of the site is possible resulting in effective wide open space which will improve the environment of housing zone and provide opportunity for community activity, so here with the usefulness of the housing to regional social structure as objective, the adoption of 2 storeyed continuous row of houses retain the merit of detachedness and proximity to ground of a single dwelling while on the other hand it has the merit of short construction time and efficient space form of apartment housing. Also, apartment type house can readily be adapted to modern construction method using standardized precast concrete components. The traditional architectural style of Peru was adopted as much as possible for room layout, courtyard and exterior appearance.

C. Outline of Design :

Unit Plan :

Unit plan for a typical house unit with 3 bedrooms is shown in Figure 3-343. Module of 1.4 m was adopted with frontage of 7.2 m, depth of 14.2 m and land area of 103.68 m^2 for a typical house unit. First floor will have 1 bedroom, living room, dining room, kitchen and other rooms with service function, while on 2nd floor, 2 bedrooms, toilet, washroom and shower are located. The size of the master bedroom on 2nd floor is 3.6 m x 4.8 m.while the other 2 bedrooms are 3.6 m x 3.6 m in size. Two courtyards are provided inside and each courtyard is given its own function. The courtyard facing the living room and kitchen has an environmental and beautifying function of providing ventilation and sunlight;

and with large openings in the rooms facing the courtyard a living room with feeling of greater space and a kitchen with bright working space are achieved. Also, gardening by the resident will enhance the view from living room. The other courtyard will have the function of service area so heating and hot water supply room, laundry and washroom will face this courtyard. This courtyard will be mainly used for drying clothes and the openings facing the courtyard will be held to minimum sizes. The outside courtyard at entrance side is the approach for the house and the 1st floor bedroom has a large opening facing this courtyard. This courtyard is effective in maintaining privacy by shutting off outside noise and vision. The roof area over the kitchen can be used as future room space. Furthermore, in this proposal, the same continuous pattern for each house unit was maintained; but in actual execution of this housing program a combination of several variations to break the monotony of exterior and to allow selectivity to residents should be considered.

Table 3-341 Table of Areas for Family House Unit

		Area (m^2)	Dimension (m x m)	Legal Standard
Site Area (A)		103.68	7.2 x 14.4	
Court-yard	Outside courtyard	25.92	3.6 x 7.2	
	Courtyard-1	12.96	3.6 x 3.6	
	Courtyard-2	8.64	2.4 x 3.6	
	Sub-total (B)	47.52	——	Over 30 % of site area*
1st floor	Bedroom	12.96	3.6 x 3.6	Over $10m^2$, min. width 2.8 m
	Living, Dining room	17.28	3.6 x 4.8	Over $16m^2$, min. width 3.0 m
	Kitchen	8.64	2.4 x 3.6	
	Laundry	2.88	1.2 x 2.4	
	Hotwater, heating room	1.80	1.2 x 1.5	
	Toilet, Wash room	1.80	1.2 x 1.5	
	Storage room	1.08	0.9 x 1.2	
	Hallway, Stair	9.72	——	Stair effect width min. 1.0 m
	Sub-total (C)		——	
2nd floor	Master Bedroom	17.28	3.6 x 4.8	Over $10m^2$, min. width 2.8 m
	Bedroom	12.96	3.6 x 3.6	Over $10m^2$, min. width 2.8 m
	Shower, Toilet, Washroom	3.60	1.5 x 2.4	
	Hallway, Stair	9.36	——	
	Sub-total (D)	43.20	——	
Total Floor Area (C + D)		99.36		
Space for Extension		12.96	3.6 x 3.6	

* B/A x 100 = 45.9 % $>$ 30 %

FIG. 3-341 TYPICAL NEIGHBORHOOD BLOCK OF FAMILY HOUSE

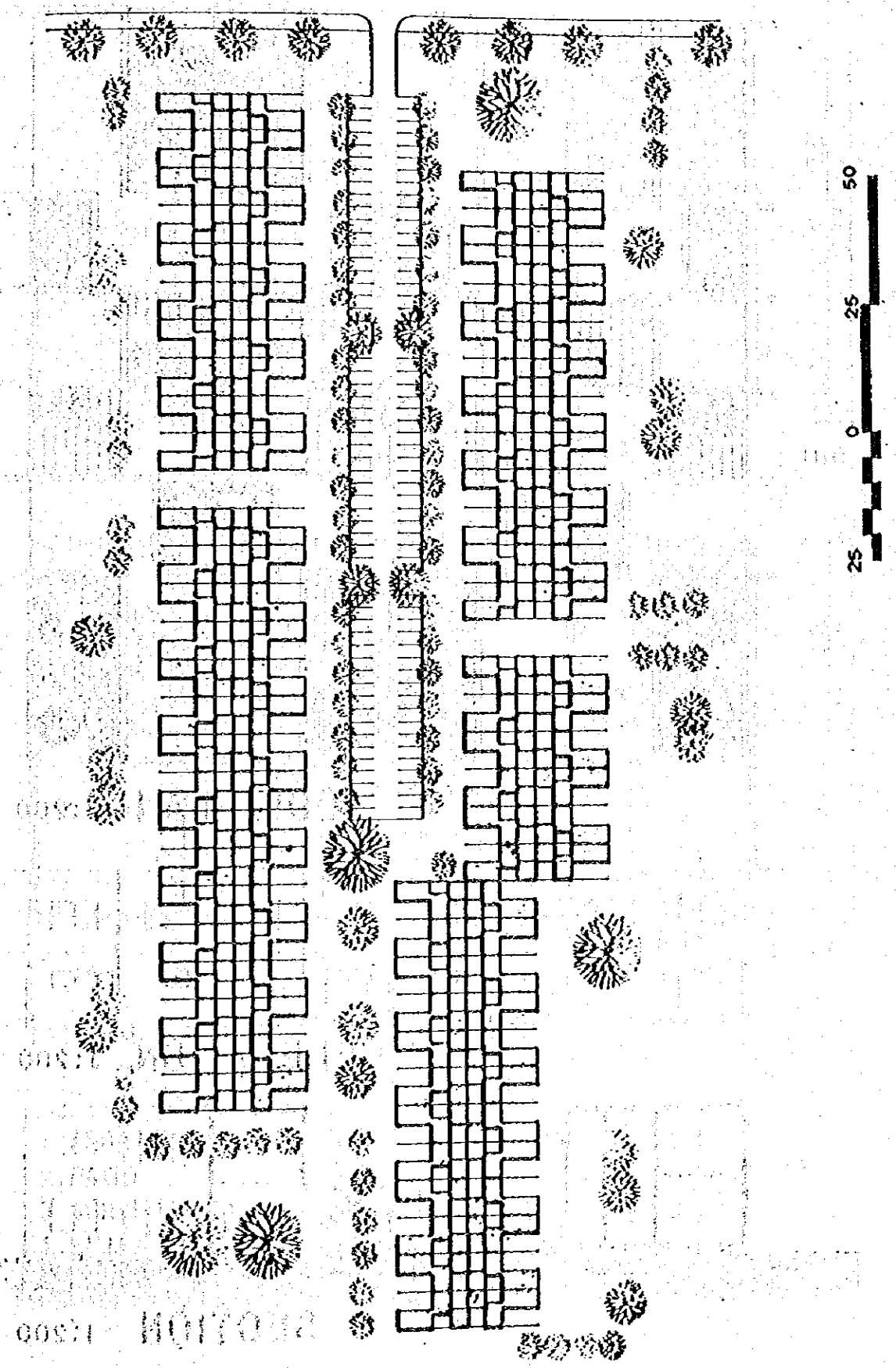


FIG. 3-342 FAMILY HOUSE ROOF PLAN, ELEVATION AND SECTION

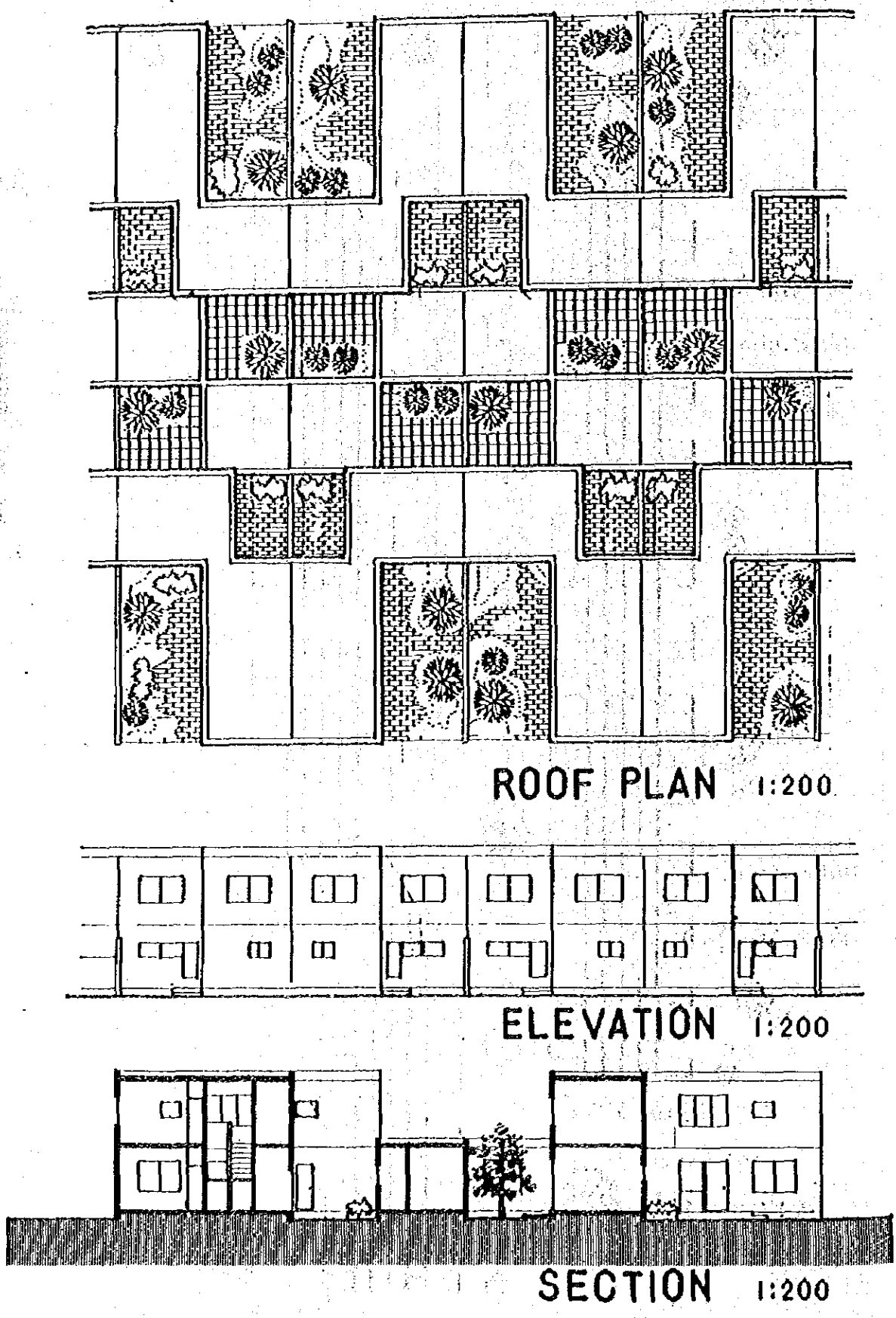
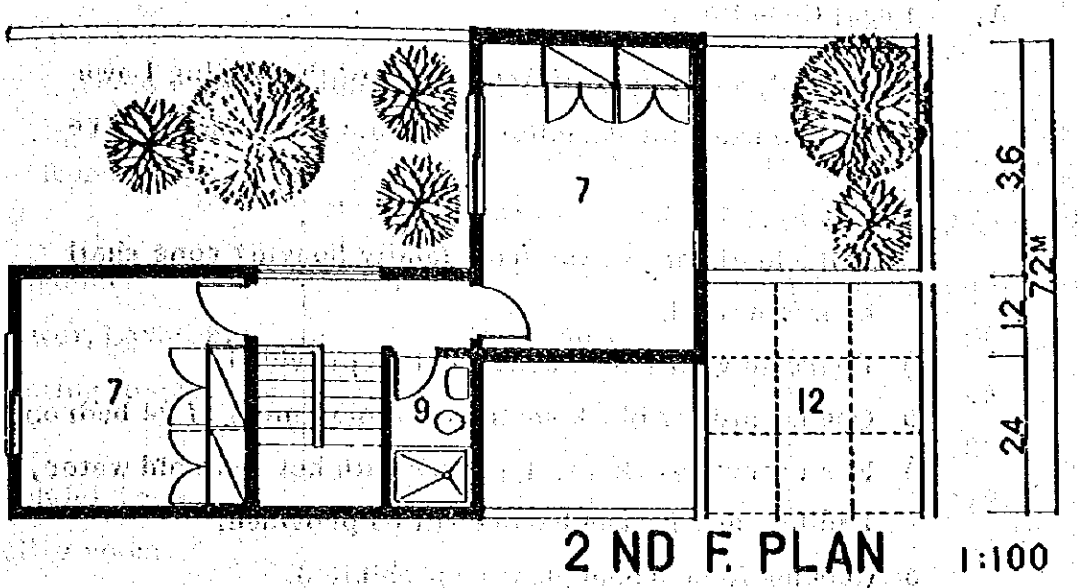
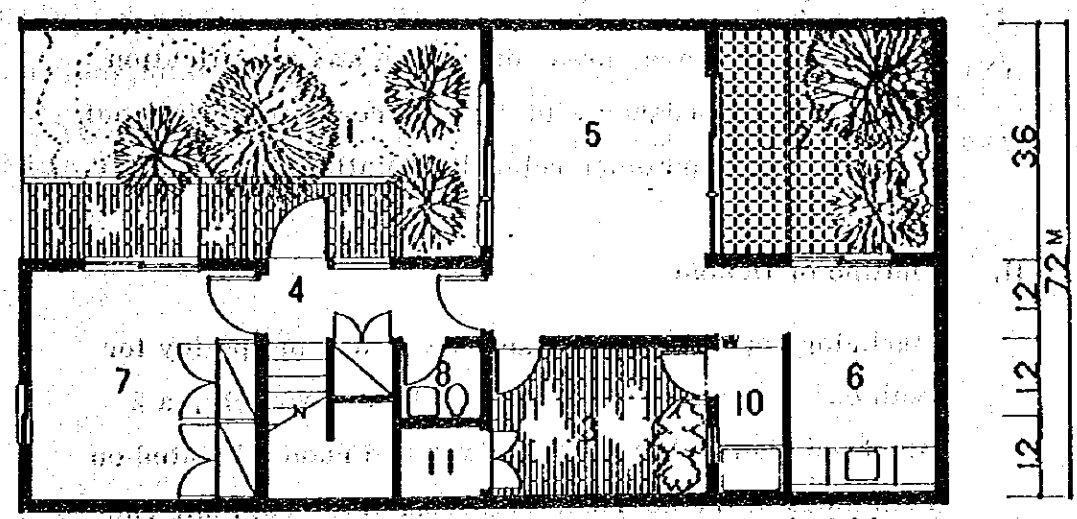


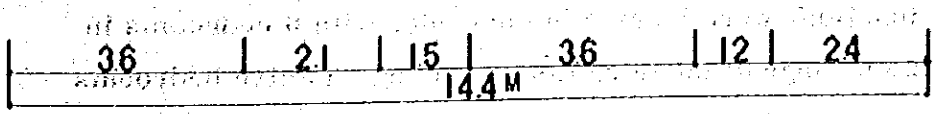
FIG. 3-343 FAMILY HOUSE FLOOR PLAN



2 ND F. PLAN 1:100



1 ST F. PLAN 1:100



1 FRONT YARD
2 PATIO
3 SERVICE YARD
4 ENTRANCE
5 LIVING ROOM
6 KITCHEN
7 BED ROOM
8 WATER CLOSET
9 SHOWER ROOM
10 LAUNDRY
11 BOILER
12 FUTURE EXTENSION

(3) Outline of Plan for Bachelor Dormitory

A. Legal Conditions:

The detail regulations of Article 326 of the Mining Laws related to bachelor dormitory stipulate following requirements:

- o Suitable distance away from family housing zone shall be maintained.
- o Bedroom with 1 or 3 beds shall be provided.
- o One dormitory block shall have a maximum of 24 bedrooms.
- o For every 4 workers, 1 shower with hot and cold water, 1 toilet, and 1 wash basin shall be provided.
- o Cooking in bedroom shall be prohibited.
- o Dining hall shall be provided.

In addition to above, area, dimension and specification shall be in accordance with the requirements of National Building Code and other related regulations.

B. Outline of Design

Bachelor dormitory was planned with a same policy for both one man and three man room type. Namely, a 2 storeyed plan with central hallway and rooms located on both sides of the corridor was adopted for both one and three man room type dormitory. Rooms having a service functions were located in the center with 6 bedrooms in both wings of the dormitory building. Twelve bedrooms in each floor or a total of 24 bedrooms were provided in one dormitory building. Space over the entrance hall was considered as meeting place and recreation room for the dormitory residents. Shower, toilet and wash rooms were located conveniently in central part of each floor. Table

3-342 shows the floor area of one dormitory according to type.

Table 3-342 Table of Areas for Bachelor Dormitory

Room Name	1 Man Room Dormitory		3 Man Room Dormitory	
	No. of Room	Area (m^2)	No. of Room	Area (m^2)
Bedroom	24	288.0	24	600.0
Shower, Lavatory	2	60.0	2	91.0
Meeting, Recreation	1	30.0	1	45.5
Hall	1	18.0	1	26.0
Laundry room	1	10.5	1	12.0
Kettle room	2	6.0	2	7.0
Boiler room	1	9.0	1	10.5
Storage room	1	12.0	2	21.0
Corridor, Stair	-	127.5	-	179.0
TOTAL FLOOR AREA		561.0 m^2		994.0 m^2

FIG. 3-344 BACHELOR DORMITORY (1 MAN ROOM) FLOOR PLAN

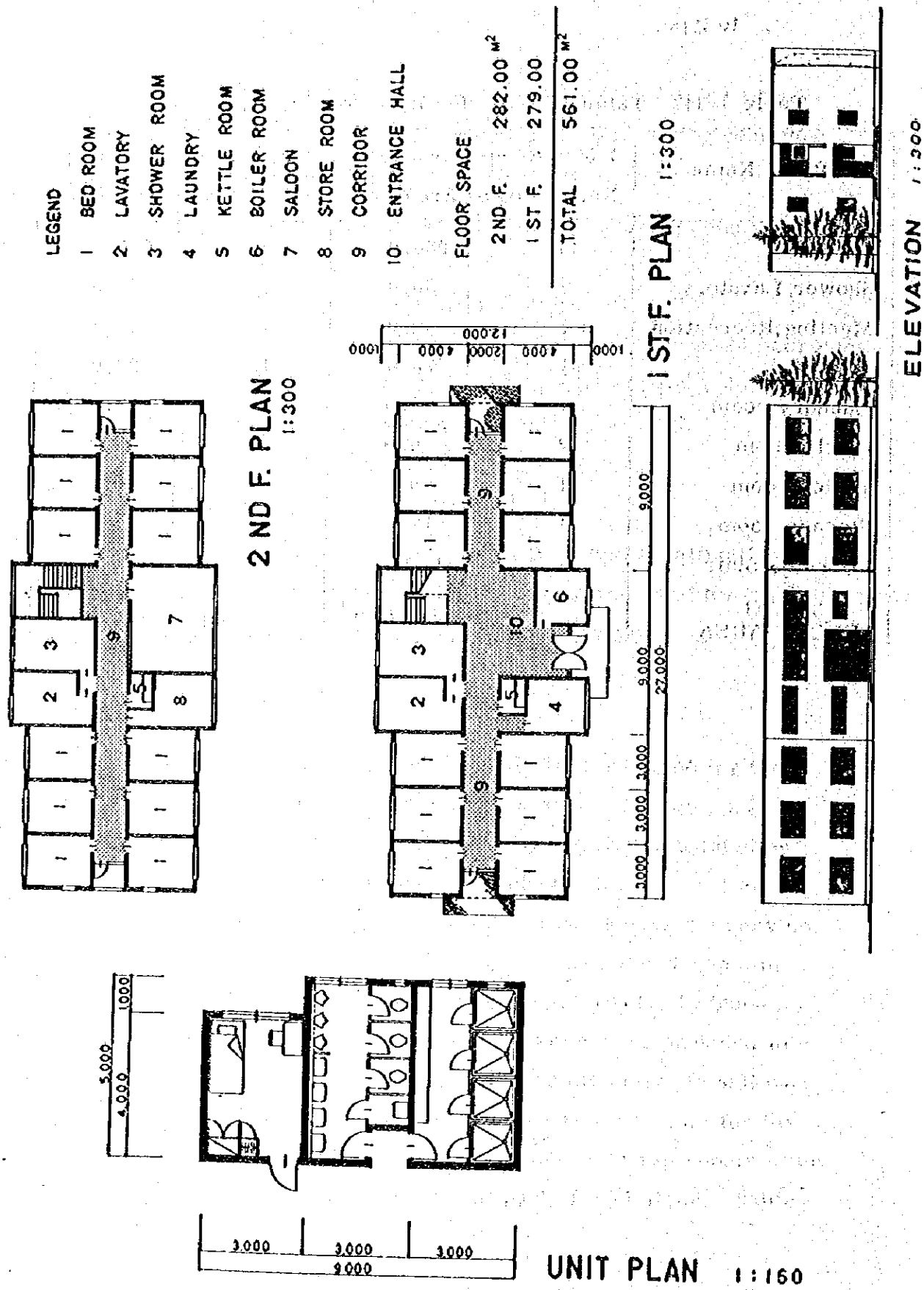
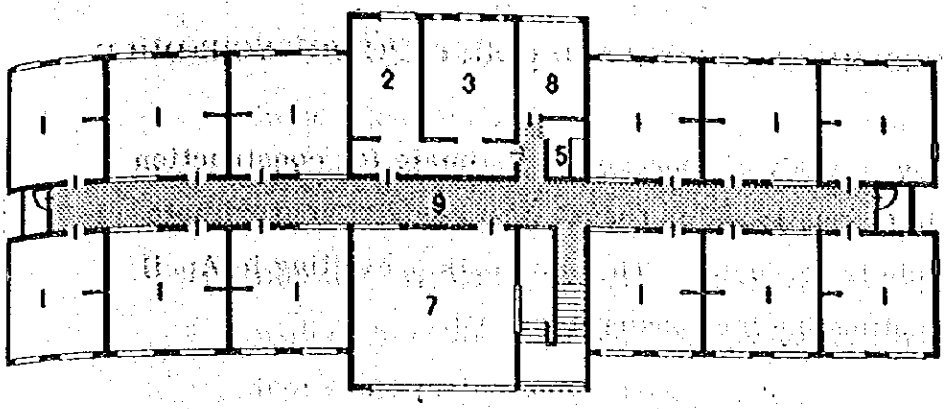


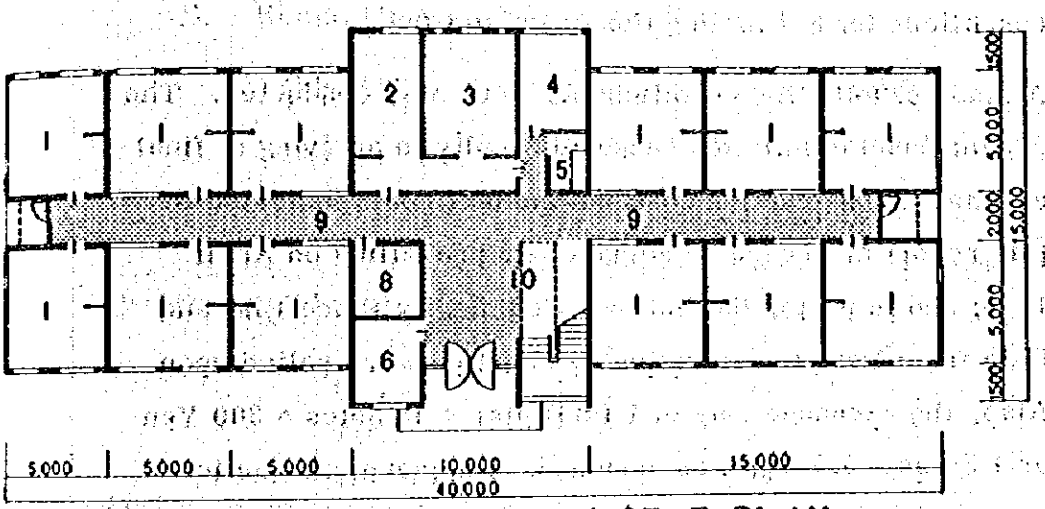
FIG. 3-345 BACHELOR DORMITORY (3 MAN ROOM) FLOOR PLAN



2 ND F. PLAN 1:300

LEGEND

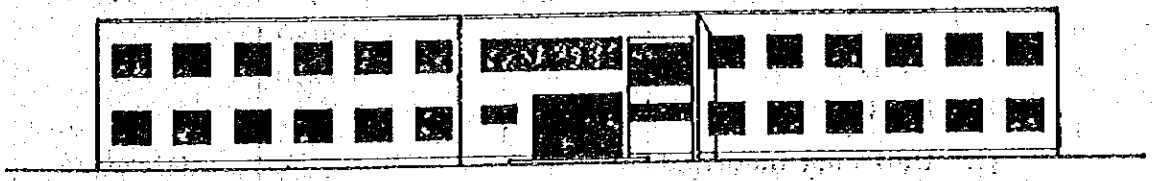
1 BED ROOM
2 LAVATORY
3 SHOWER ROOM
4 LAUNDRY
5 KETTLE ROOM
6 BOILER ROOM
7 SALOON
8 STORE ROOM
9 CORRIDOR
10 ENTRANCE HALL



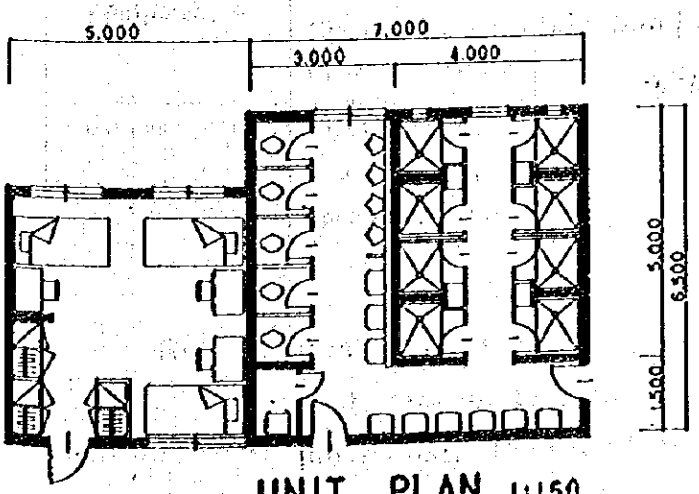
1 ST F. PLAN 1:300

FLOOR SPACE

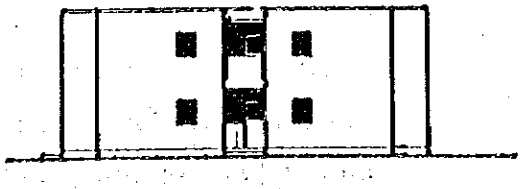
2 ND F.	500.00 M²
1 ST F.	494.00
TOTAL	994.00 M²



ELEVATION 1:300



UNIT PLAN 1:150



ELEVATION 1:300

SECTION 4 CONSTRUCTION COST AND CONSTRUCTION SCHEDULE

In this Section, a study of approximate estimate for construction cost is conducted in Clause 1; and in Clause 2, a study of approximate construction schedule is conducted. The unit costs prevailing in April 1976 were used in estimating the construction cost.

4-1 Study of Construction Cost

(1) Conditions for Estimating Construction Cost

A study of following conditions A. to G. was conducted. The recent trend in inflation causes difficulty in arriving at final estimated construction cost; but the unit costs indicated in this report are based on actual costs prevailing on April 1976; and in parts, the National Commodity Price List and Data from Peru Construction Association were relied upon. Also, the exchange rate of 1 US Dollar = 45 Soles = 300 Yen or 1 Soles = 6.7 Yen was assumed. Furthermore due to devaluation of Soles in June 28, 1976 the rate of 45 Soles per 1 US Dollar in April has changed to 65 Soles per 1 US Dollar.

A. Labor wage scale
B. Rental cost of principal equipments
C. Unit cost installed
D. Unit price and unit price fluctuation of principal material
E. Local and imported materials
F. Construction quantity
G. Others

A. Labor Wage Scale

In construction industry of Peru, direct labor employment system is common with very little sub-contracting. Labor wage scale by skill is 700 Soles/Day for foreman, 570 Soles/Day for skilled labor and 480 Soles/Day for common labor with 80 % social insurance compensation, travelling and tool costs included in each case.

B. Rental Cost of Principal Equipments

Table 3-411 Rental Cost of Principal Equipments
(Camara Peru and De La Construccion)

Item		Service Life (Year)	Residual Cost (%)	Annual Depreciation	Annual Rental (Note-1)
1. Haul Equipment	Small Truck	4	25	18.75	70.28
	Automobile	5	25	15.00	66.10
	Large Truck	4	25	18.75	85.28
	Tractor	7	25	10.71	56.32
	Trailer	8	20	10.00	54.95
2. Construction Equipment	Scraper	5	25	15.00	66.10
	Shovel	9	20	8.89	53.72
	Crane	11	20	7.27	51.90
	Grader	8	25	9.34	54.84
3. Paving Equipment	Asphalt Sprayer	6	25	12.50	68.31
	Paver	8	20	10.00	54.95
4. Supplementary Equipment	Generator	6	25	12.50	58.30
	Electric Welder	4	25	18.75	70.28
	Conc. Block Plant	6	25	12.50	58.31
5. Others	Light Equipment	3	-	33.33	83.66
	Heavy Equipment	6	25	12.50	58.31
	Special Instrument	2	-	50.00	82.25

Note 1. Rental cost includes purchasing interest, insurance cost, storage fee, spare parts cost and maintenance labor cost. Cost for fuel and operator are not included.

C. Unit Cost Installed

Table 3-412 Unit Cost

(April 1976)

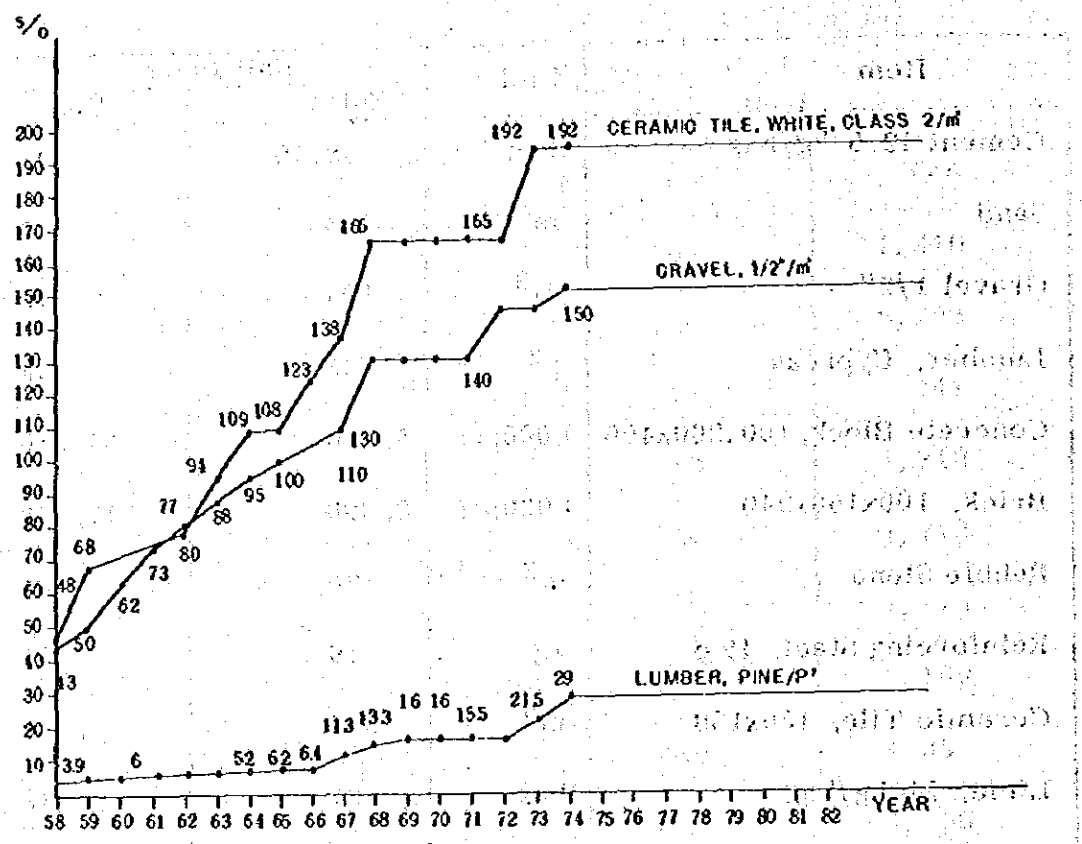
Item	Unit	Unit Price	
		Soles	Yen
Excavation	m^3	185	1,240
Reinforced Concrete fc = 210 kg/cm^2	m^3	940	6,298
Re-bar installation 19ϕ	kg	21	141
Brick Work (for wall)	m^2	200	1,340
Concrete Block (thickness 150)	m^2	260	1,742
Cement Mortar (for wall) 1:3	m^2	175	1,173
Plaster (for ceiling)	m^2	164	1,100
Ceramic Tile (for wall)150x150	m^2	650	4,355
Floor Parquet	m^2	677	4,536
Aluminum Window	m^2	1,750	11,725
Glass 3 m/m	m^2	624	4,180
Oil Paint (for mortar surface)	m^2	70	469
Form Work (repeat use 10 times)	m^2	210	1,407
Sanitary and Electric Work (within building)	%	20% of total building cost	

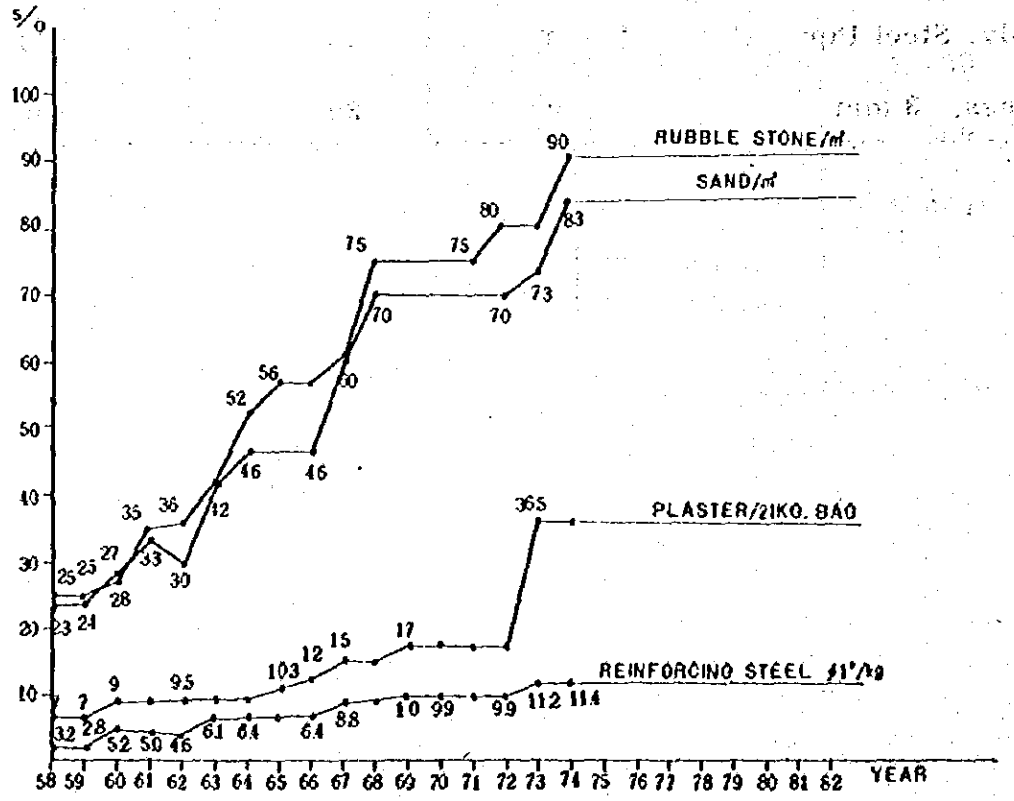
D. Unit Price and Unit Price Fluctuation of Principal Materials

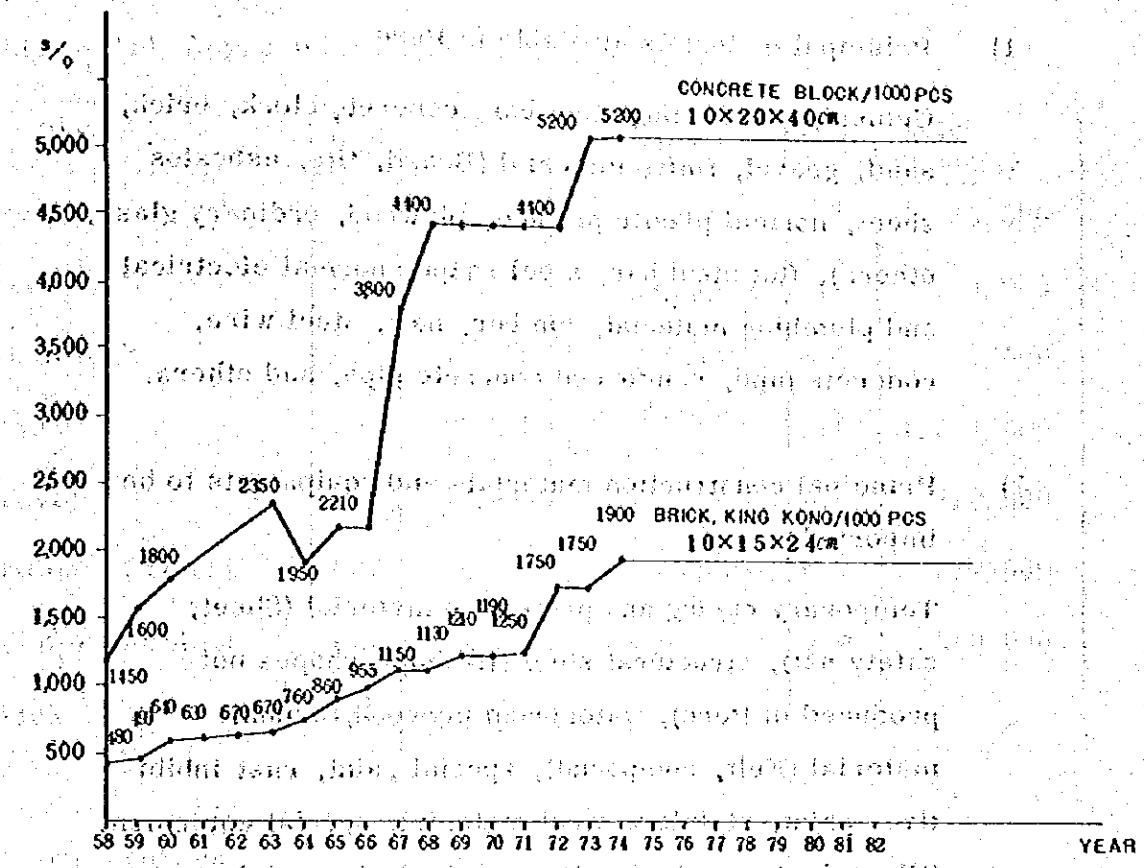
Table 3-413 List of Unit Price of Principal Materials (April 1976)

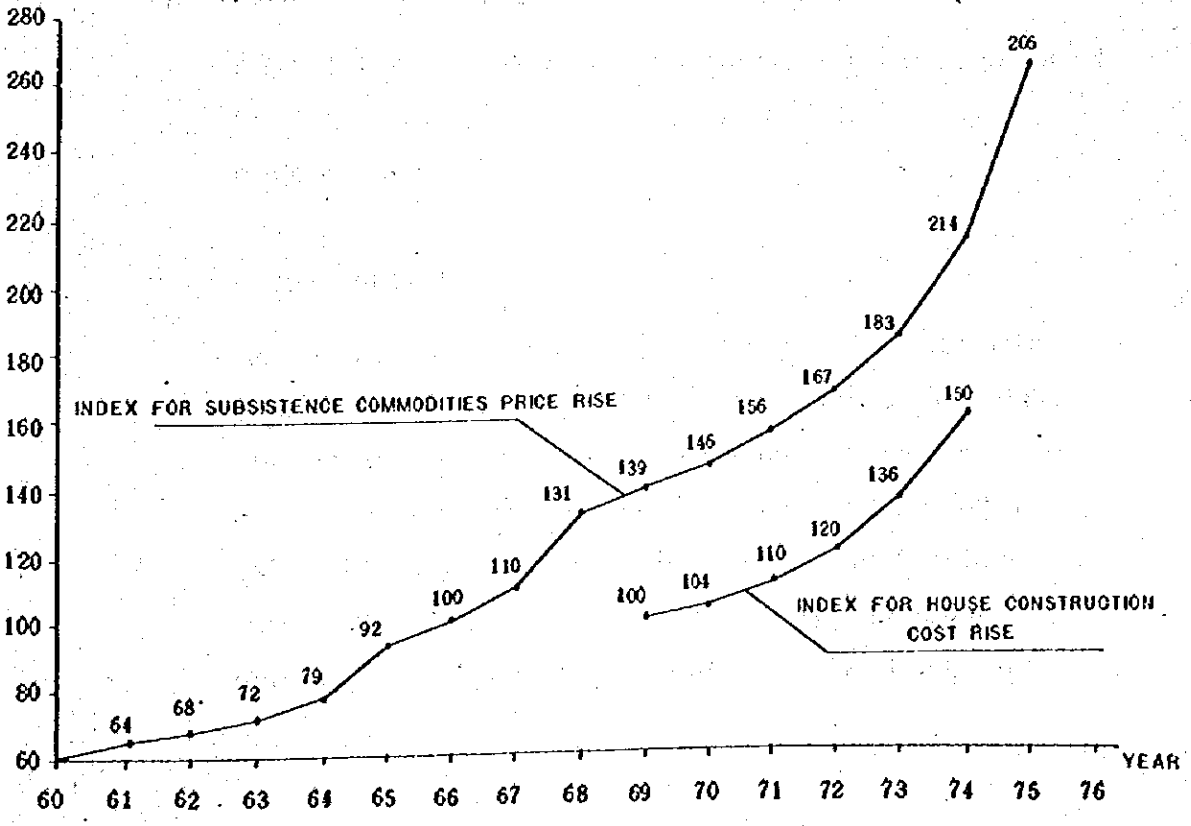
Item	Unit	Unit Price	
		Soles	Yen
Cement 42.5 kg/bag	bag	48.70	326
Sand	m^3	106	710
Gravel 1/2"	m^3	106	710
Lumber, Cypress	p^2	25	168
Concrete Block, 100x200x400	1,000pcs	5,200	34,840
Brick, 100x150x240	1,000pcs	2,600	17,420
Rubble Stone	m^3	120	804
Reinforcing Steel, 19 ϕ	kg	10	67
Ceramic Tile, 150x150	m^2	230	1,541
Lime, 21 kg/bag	bag	37	248
Concrete Drain Pipe 8"	m	65	436
Galv. Steel Pipe 1"	m	78	523
Glass, 3 mm	p^2	29	194

FIG. 3-411 PRICE FLUCTUATION OF PRINCIPAL MATERIALS






%
CONCRETE BLOCK/1000 PCS
10×20×40cm
BRICK, KING KONO/1000 PCS
10×15×24cm
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
1450
1600
1800
2350
1950
2210
3800
4400
4100
5200
5200
1900
1750
1750
1190
1250
1150
1130
960
860
760
670
670
630
610
480
58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82
YEAR


INDEX FOR SUBSISTENCE COMMODITIES PRICE RISE
INDEX FOR HOUSE CONSTRUCTION COST RISE
280
260
240
220
200
180
160
140
120
100
80
60
206
214
183
167
156
146
139
131
110
100
92
79
72
68
64
150
136
120
110
104
100
60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76
YEAR

E, Local and Imported Materials

1) Principal materials available in Peru

Cement, reinforcing steel bar, concrete block, brick, sand, gravel, finish material (Board, tile, asbestos sheet, normal plastic product, plywood, ordinary glass, others), flat steel bar, steel shape, normal electrical and plumbing material, lumber, nail, steel wire, concrete pipe, reinforced concrete pipe, and others.

2) Principal construction materials and equipments to be imported

Temporary curing and protective material (Sheet, safety net), structural steel (H-shape, shapes not produced in Peru), waterproof plywood, asphalt material (Felt, compound), special paint, rust inhibitive paint, stainless steel material, special equipment (Electrical, sanitary, air conditioning) special steel plate, special construction equipment and others.

F. Construction Quantity

Table 3-111 Approximate Construction Quantity

Item	Unit	Total Quantity	Item	Unit	Total Quantity
Excavation (Building)	m³	71,000	Ceramic Tile	m²	55,000
Concrete	m³	103,000	Form Lumber	m³	3,000
Formwork	m²	878,000	Finish Lumber	m³	4,000
Sand	m³	90,000	Wall Cement Mortar	m²	1,311,000
Gravel	m³	73,000	Plaster	m²	330,000
Ordinary Cement	ton	35,700	Door & Window	m²	37,000
Reinforcing Steel	ton	9,300	Painting	m²	1,210,000
Brick	m²	649,000			

G. Others

1) Aggregate, concrete, etc.

Aggregates and concrete for construction will be supplied from plant to be installed in vicinity of the site by the mine company.

2) Outline of buildings

House is to be of standard Peruvian construction with continuous footing, rigid frame, flat roof, light weight slab ceiling and single standard brick (cabeza) on exterior wall. Finishes will be, in general, mortar paint with portion of floor with vinyl tile and ceiling with 2 coats of plaster. Galvanized steel pipe and plastic pipe will be used for water supply piping with

concrete drain pipe on ground floor and cast iron drain pipe on second floor. Vinyl insulated wires will be placed in steel or plastic conduits. Lavatory, shower, bathtub and toilet will be provided as sanitary fixtures. Built-in furniture such as food shelf and kitchen equipments are included in the estimate. Curtains are to be the responsibility of the individual resident.

(2) Computation of Construction Cost

From conditions studied in (1), the direct construction cost is 1,690,000 thousand Soles (see Figure 3-415). The total construction cost including technical and overhead expense is 2,112,500 thousand Soles. (see Table 3-417)

Table 3-415 Direct Construction Cost

	Quantity	Amount (1,000 Soles)	Amount (1,000 Yen)	Remarks
Civil Work	102 ha	67,000	446,900	
Road Work		103,200	691,440	
Main Road	3.22 ha	(25,760)	(172,592)	
Other Road	9.68 ha	(77,440)	(518,848)	
Park & Green Area	LS	34,000	227,800	Including outdoor sport facility
Water Supply System	LS	75,000	502,500	
Drainage System	LS	147,000	990,260	Including sewer treatment plant
Electrical System	LS	115,200	771,840	Sub-station not included
Power Distribution		(97,040)	(650,168)	
Street Lighting		(18,160)	(121,672)	
Architectural Work	LS	1,147,800	7,690,260	See Table 3-416 for breakdown by building
Total		1,690,000	11,323,000	

Note 1 : 1 Soles = 6.7 Yen

Table 3-416 Construction Cost by Building

	Quantity (m^2)	Unit Price (Soles)	Amount (1,000 Soles)	Amount (1,000 Yen)
Family House	142,000	6,500	923,000	6,184,100
Bachelor Dormitory	7,300	5,000	36,500	244,500
Bachelor Dining Hall	500	5,000	2,500	16,750
Police · Fire Station	900	8,000	7,200	48,240
Post · Telephone Office	350	7,000	2,450	16,415
Housing Administration Office	100	7,000	700	4,690
Market	2,700	4,000	10,800	72,360
Repair Shop	1,000	5,000	5,000	33,500
Kindergarten	3,600	7,000	25,200	168,840
School	9,000	5,500	49,500	331,650
Adult School	300	5,500	1,650	11,055
Church	1,000	11,000	11,000	73,700
Meeting Hall	750	6,000	4,500	30,150
Motion Picture Theater	900	10,000	9,000	60,300
Hospital	4,000	12,000	48,000	321,600
Club House · Sports Facility	1,800	6,000	10,800	72,360
Total	176,200	-	1,111,300	7,445,710

Note : Construction of facility after start of mine operation is not included.

Estimate for kindergarten and school was based on scale of school after 5th year of mine operation.

Table 3-417 Total Construction Cost

Item	Amount (1, 000 Soles)	Amount (1, 000 Yen)	Remark
Direct Construction Cost	1, 690, 000	11, 323, 000	
Technical Expense (Note 1)	169, 000	1, 132, 300	10% of Direct Cost
Overhead Expense (Note 2)	253, 500	1, 698, 450	15% of Direct Cost
Total	2, 112, 500	14, 153, 750	

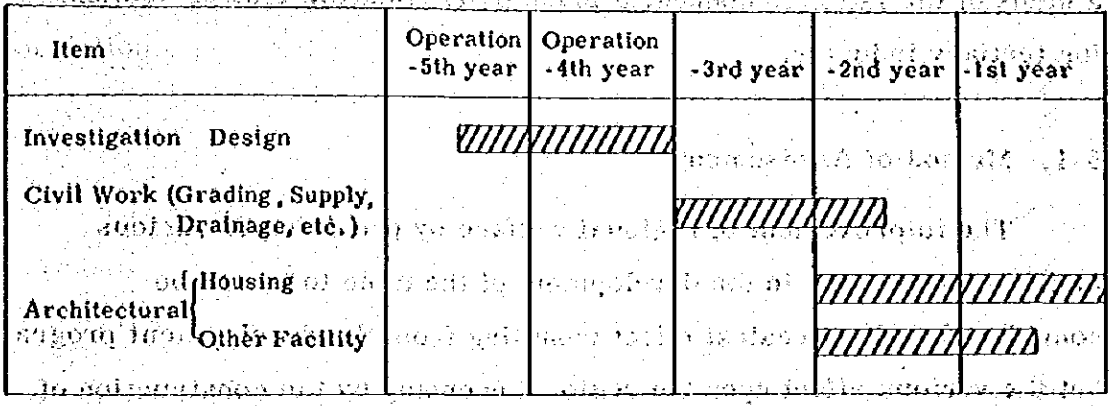
Note 1. Investigation, survey, design, management expenses.

Note 2. Temporary facilities and reserve expenses.

4-2. Study of Construction Schedule

According to Michiquillay Mine Development Program, five year period is required for development of the mine, so the construction of mine town must be completed within the same period. Figure 3-421 shows the approximate construction schedule. Site grading and construction of houses and other buildings will require approximately 3 years and 1.5 years for investigation and design or a total of 4 years for completion of the construction program.

FIG. 3-421 APPROXIMATE CONSTRUCTION SCHEDULE



SECTION 5. EFFECTS OF MINE TOWN DEVELOPMENT PROGRAM

This Section mentions the effects from development of mine town and the basic point of view is shown in Clause 1. Namely, the direct effect from mine town development is the improvement of regional welfare from development of various facilities; but as a secondary effect the establishment of the town will accelerate the absorption of surplus labor force and improvement of income level of the region. As to the former in Clause 2. study of each facility is conducted based on the type and scale established in Clause 2 of Section 3. In Clause 3, a study of the latter is conducted principally from the side of demand for tertiary industry.

5-1. Method of Assessment

The improvement of regional welfare by provision of various facilities necessary in the development of the mine town can be considered as the greatest effect resulting from the development program; but the various effect upon the regional economy by the construction of the town and by later inflow of permanent population must also be considered. However, in discussing the effects of development of the mine town, it would be natural to grasp the relationship between mine and town development as well as above points and to consider town development as a factor in overall development program.

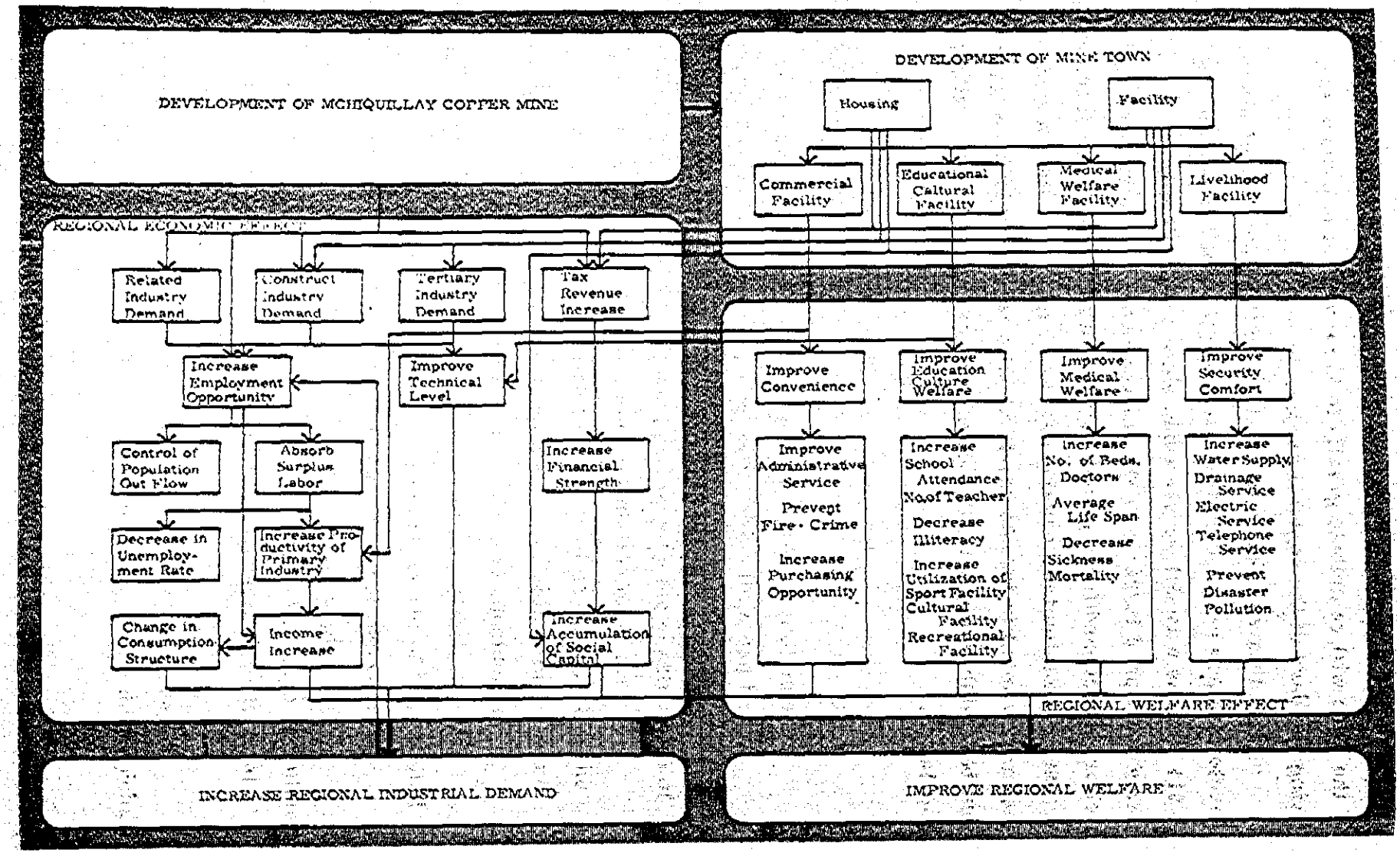
Efficient utilization of resources and improvement of the national economy are the aim of mine development project; but increase in employment opportunities and accumulation of social capital can be pointed out as effects upon the region. These effects will also stimulate the demand for regional industries contributing to regional industrial production.

Cajamarca, where Michiquillay mine is located, is an region in northern Sierra area that is still behind in developing, so the increase

in level of income and the effect of various facilities in development of the mine will contribute greatly to improvement in welfare and living standard of the regional people.

From this viewpoint, the analysis of the effects of mine town development was conducted with the basic concept indicated in Figure 3-511 used as a model for the study while a numerical study of the items mentioned in Table 3-521 was conducted for the study of regional welfare effect; and for regional economic effect a high rate of contribution by the mine town development was assumed to make a study of the improvement in income level and increase in employment opportunities in the tertiary industries induced by the permanent settling of population.

FIG. 3-511 EFFECT OF MINE TOWN DEVELOPMENT



5-2 Regional Welfare Effect

Table 3-521 shows a general index indicating the state of development of various facilities for the mine town which was determined in Section 3 and the contributing side resulting from the development of facilities. Table 3-522 shows the assessment of the effects from the development of these facilities.

The effects resulting from the development of the mine town is expressed in following manner. First, by considering the condition and scale of similar facilities established in surrounding regions, the sphere of influence by the facilities, and the population of the sphere in 1972 and the estimated population in 1983 are shown; and then the effects of the number of facilities on the population were shown. In expressing the effects prior to development of facilities, the population in 1972 was used and after the development, the estimated population in 1983 was used. Moreover, where numbers could be used in expressing the effects, other method of expression was used together. Population receiving benefits from the facilities is roughly the same as the population in affected sphere for that year.

In Table 3-521 and 3-522, only facilities giving benefits to the residents of Santa Margarita and to the residents in surrounding areas excluding mine workers are shown; but in this Section, individual analysis of facilities such as post office, telephone office, commercial, school, motion picture theater, hospital and sports having great effect, especially, upon surrounding areas are conducted.

Table 3-523 shows the result of personal interview held with influential persons in 4 districts, Los Baños Del Inca, Namora, Matara and Jesus, surrounding Santa Margarita. The district's representative opinion was asked as much as possible; and the interviews were very helpful in learning the actual living conditions of the residents in surrounding areas.

Furthermore, if the road linking Santa Margarita and Namora

is developed during the construction of Namara Dam, the sphere of urban Santa Margarita shown in Figure 3-214 in Section 2 will expand and the effect resulting from the development of facilities will become greater. (see Figure 3-522)

(1) Post Office and Telephone Office

As shown in Figure 3-525, almost every town in each district of Cajamarca Basin has a post office; but areas surrounding Santa Margarita do not have any, so the residents of Encañada and other surrounding districts will have to travel about 10 km to reach the nearest post office in Los Baños Del Inca. Therefore, the establishment of a post office will effect the entire sphere of Santa Margarita, so by 1983 26,800 person (including 7,900 mine workers) and their families will be able to utilize the facility.

Telephone office is planned along with post office as necessary facility for the mine town and the establishment of long distance telephone call center and public telephones will also benefit the residents in surrounding districts.

(2) Schools

In Santa Margarita, 3 schools are planned for each housing zone. As to schools in districts around Santa Margarita, quantitatively it is at least sufficient and the students are able to go to schools in their respective neighborhood district. Therefore, the above school is planned only for school children in Santa Margarita with mine workers' children as principal group; but since this planned school is a mine school year system conforming to the present new school system in the educational reform undergoing in

TABLE 3-521 INDEX FOR ASSESSMENT OF FACILITIES DEVELOPMENT

Facilities			Required By Low	Welfare Index	Benefits
Commercial Administration	Administrative	Town Office	○		Improve administrative services
		Police-Fire Station		Crime-Fire-Extinguishing rate	Maintain security-Prevent crime-Improve fire fighting activity and handling of emergency case
		Post-Telephone Office	○	Call distance-No. of circuits-Phone popularization rate	Increase information exchange activity
	Commercial Services	Bank		Utilization distance	
		Market	○	No. of facility rate-Floor area-Utilization distance	Increase purchasing opportunity-Increase consumption-Enlarge market for surrounding products
		Store		Same as above	Same as above-Diversify livelihood
		Restaurant		Same as above	Diversify eating habits
		Repair Shop		Same as above	Maintain properties-Increase livelihood conveniency
		Hotel		Number of rooms	Increase conveniency of visitors
Educational & Cultural	Educational	Kindergarten	○	No. of facility rate-Attendance rate-Distance	Increase opportunity for child education
		School		Same as above-Illiteracy rate	Increase opportunity for school education
		Adult School		No. of facility rate	Increase opportunity for adult education
	Social Cultural	Church	○		Increase church activities
		Meeting Hall		No. of facility rate-Distance-Utilization rate	Increase community activity-Leisure activity
		Library		No. of facility rate-No. of books-Utilization rate	Increase reading opportunity
		Motion Picture Theater	○	No. of facility rate-No. of seats-Utilization rate	Increase leisure activity
Medical & Welfare	Medical	Hospital	○	Doctor-Bed-Sickness-Death rate-Average life span-Distance to Hospital	Improve level of medical insurance
	Welfare	Sports	○	No. of facility rate-Distance-Utilization rate	Maintain improve physical strength & training-Increase leisure activity
		Central Square		No. of facility rate	Increase community activity
		Park		No. of facility rate-Area per person	Improve living environment-Secure play area
Basic Livelihood	Transportation	Main Road		Time shortening rate	Improve transportation between regions-Secure route for flow of goods
	Supply and Treatment	Water Supply		Use spread rate-Supply capacity	Secure water supply-Improve sanitary level
		Drainage		Use spread rate-Treating capacity-Disaster rate	Improve sanitary level & environment
		Power Transmission		Use spread rate-Supply capacity	Secure energy for livelihood-Increase spare time-Increase livelihood conveniency

TABLE 3-522 ASSESSMENT OF EFFECTS FROM FACILITY DEVELOPMENT

*1. Population of 1972 - Approximate number from 1972 census
" " 1983 - Estimate based on 1961 and 1972 census
*2. Of the population, 7, 900 are composed of mine workers and families.

Facility			Number and Scale	*1 Sphere of influence	(1972 population, 1983 ")	Assessment prior to development (1972)		Assessment after development (1983)		*2 Population benefitted after development (1983)
Commercial	Administrative	Town Office	1. (Establish on judgement of administration. Floor Area - 650 M^2)	Santa Margarita	(8,500)	-		1 Office	1.18 Office per 10,000 pop.	8,500
		Police-Fire Station	1. (Floor Area - 900 M^2)	Sphere of Santa Margarita	(15,300 26,800)	1 Station	0.06 Station per 10,000 pop.	2 Stations	1.82/10,000 pop.	11,000
		Post-Telephone Office	1. (Floor Area - 350 M^2)	"	(15,300 26,800)	0	-	1 Office	0.37/10,000 pop.	26,800
	Commercial Service	Bank	2. (Floor Area - 200 M^2 x 2)	"	(15,300 26,800)	0	-	2 Banks	0.75/10,000	26,800
		Market	1. (Floor Area - 2,700 M^2)	"	(15,300 26,800)	0	-	1 Market	0.37/10,000 pop.	26,800
		Store	35. (Floor Area 40M^2 x 35)	"	(15,300 26,800)	19 Stores	12.4/10,000 pop.	54 Stores	20.1/10,000 pop.	26,800 +α
		Restaurant		"	(15,300 26,800)					26,800 +α
		Repair Shop	5. (Gas station, Car, Appliance, Furniture repare)	"	(15,300 26,800)	0	-	5 Shops	1.87/10,000 pop.	26,800 +α
		Hotel	1. (30 guest rooms Floor area - 1,500 M^2)	Cajamarca Province	(262,200 247,800)	9 Hotels		10 Hotels	-	-
Educational-Cultural	Educational	Kindergarten	6. (3grades, 6 classes/kindergarten Floor area - 540 M^2 x 6)	Santa Margarita	(8,500)	-		6 Kindergartens	7.06/10,000 pop.	8,500
		School	3. (9 grades, 27 class/school Floor area - 2,750 M^2 x 3)	"	(8,500)	-		3 Schools	3.53/10,000 pop.	8,500
		Adult School	1. (Floor Area - 300 M^2)	Sphere of Santa Margarita	(15,300 26,800)	0	-	1 School	0.37/10,000 pop.	26,800
	Social-Cultural	Church	1. (Floor Area - 1,000 M^2)	Santa Margarita	(8,500)	-		1 Church	1.18/10,000 pop.	8,500
		Meeting Hall	3. (Floor Area - 250 M^2 x 3)	"	(8,500)	-		3 Places	3.53/10,000 pop.	8,500
		Library	1. (Floor Area - 600 M^2)	Sphere of Santa Margarita	(15,300 26,800)	0	-	1 Library	0.37/10,000 pop.	26,800
		Motion Picture Theater	2. (Seat - 300 & 150 Floor Area - 900 M^2)	"	(15,300 26,800)	0	-	1 Theater	0.37/10,000 pop.	26,800 +α
Medical-Welfare	Medical	Hospital	1. (100 Sick Beds Floor Area - 4,000 M^2)	7th Medical Administration District	(456,400 552,000)	2 Hospitals	0.04/10,000 pop. 4.8Bed/10,000 pop.	3 Hospitals	6.8Bed/10,000 pop.	26,800 +α
	Welfare	Sports Facility	1 Gym, 2 Soccer Fields, 4 Basketballs, 4 Tennises, 2 volleyballs	Cajamarca Valley	(157,400 195,600)	7 Facilities	0.45/10,000 pop.	8 Places	3.29/10,000 pop.	24,300 +α
		Central Square	1. (Ground Area - 16,800 M^2)	Santa Margarita	(8,500)	-			1.98M^2/Man	8,500
		Park-Green Area	2 Park (Park - 40,100 M^2 Green - 90,300 M^2)	"	(8,500)	-			15.34M^2/Man	8,500
Basic Livelihood Facility	Transportation	Main Road	Width - 21 M, Length 2,030 M	"	(8,500)	-				-
	Supply-Treatment	Water Supply	t/day	"	(8,500)	-		In use	100%	8,500
		Drainage	Storm-Sewer Drainage	"	(8,500)	-		In use	100%	8,500
		Power Distribution	Kw	"	(8,500)	-		In use	100%	8,500

TABLE 3-523 RESULT OF PERSONAL INTERVIEW

Questions	Person Interviewes and His Answers			
	Resident of Los Baños Del Inca Laborer(30years, Jr. High School)	Resident of Namora Engaged in business	Resident of Matara School Teacher	Resident of Jesus Engaged in manufacture and selling baskets
How many trips do you make to Cajamarca?	2 Times/Day	2 Times/Week	1 Time/Week	1 Time/Day
What means of transportation and condition of transportation?	Bus, Micro-bus Bus - 10 Trips/Day, Micro-bus - Micro-bus - 20 Trips/Day	Truck, small truck 4 trips/Day	Truck 11 Trips/Day	Bus 4 Trips/Day
Where is your main purchasing done at?	Cajamarca, market place in L.B. Del Inca	Namora for foodstuff, Cajamarca for clothings and special foods.	Matara for foodstuff, Cajamarca for clothing.	Cajamarca
How many days per week is the market open in your district?	Daily. Open air market on Sunday, and many utilize this market	Daily. Not many customers on week days. Many on Sunday.	No permanent market. Market under construction now.	Open Thursdays and Sundays
How many times do you attend church?	Catholic - Each Sunday Protestant - Every day	Sundays	Sunday and Thursdays	Sundays
How many own car in your district?	15 Person	2 Person	4 Person	8 Person
What percent of families have shower facility?	Very small.	Almost none with shower.	Very small.	Very small.
How many times per week do you take shower?	Go to hot spring once a week.	Majority once a week. Use river and canal.	Majority once a week in river and canal	Majority once a week in river and canal
What is the main occupation of people in your district?	Farming, stock raising (mainly sheep), chicken raising	Agriculture, business, hat and guitar making.	Agriculture, stock raising (Mainly sheep)	Agriculture, business, basket making
What is the main recreation in your district?	Dance, drink beer, football.	Football	Football, volleyball.	Football. Have recreation field.
What inconveniences in livelihood do you have in your district?	Lack of rice, sugar. Have water and electric supply.	Want water, electricity supply and drainage system.	Want water electricity and drainage. Road improvement	Want water, electricity and drainage. Improve town.
In your district, what does the people want now?	Want house and land suitable to farming and stock raising.	Farming land, livestock, automobile.	Farming land and livestocks, house.	Land for stock farm, live stocks. Want to own a store.

FIG. 3-521 SPHERE AFFECTED BY DEVELOPMENT OF FACILITIES

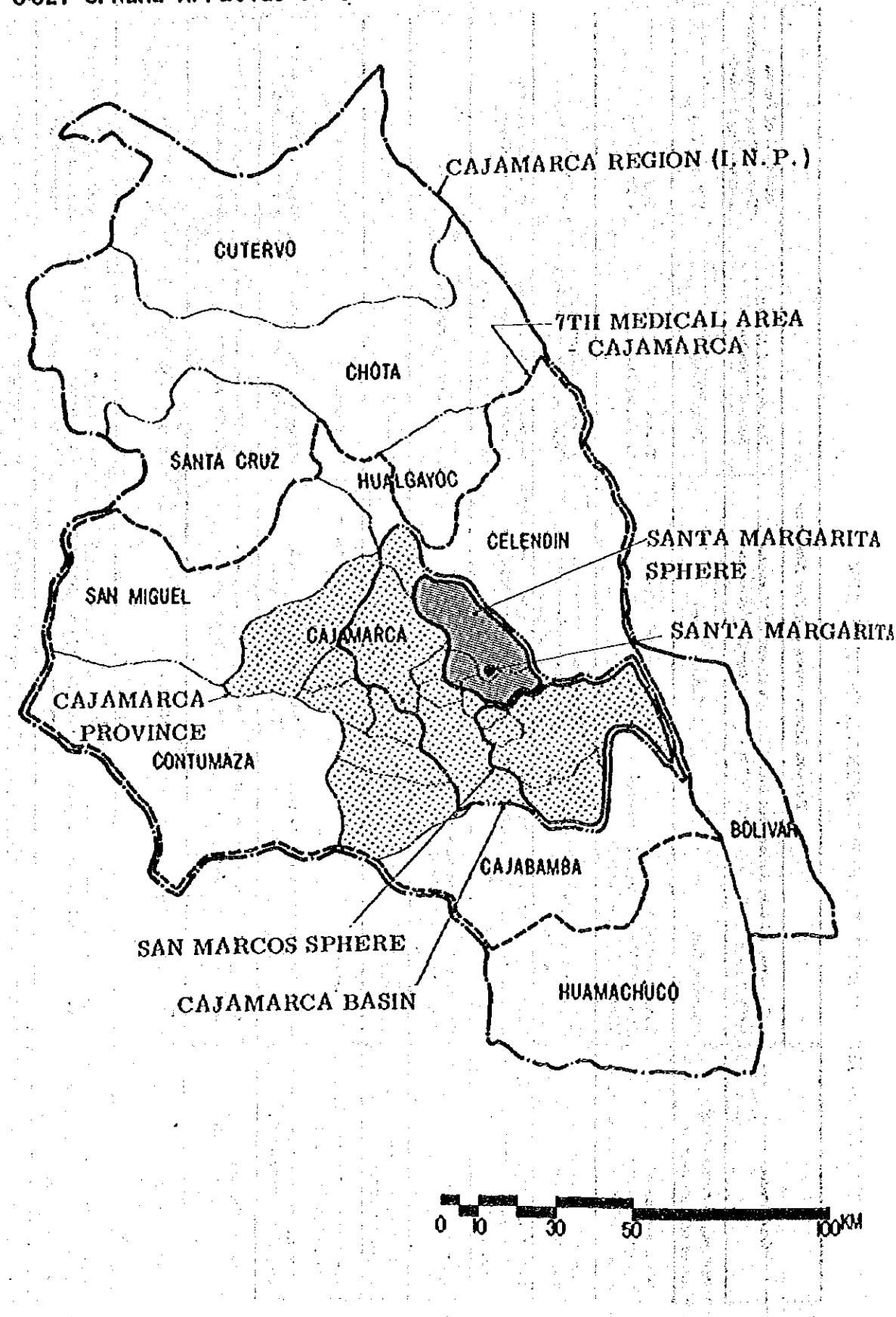
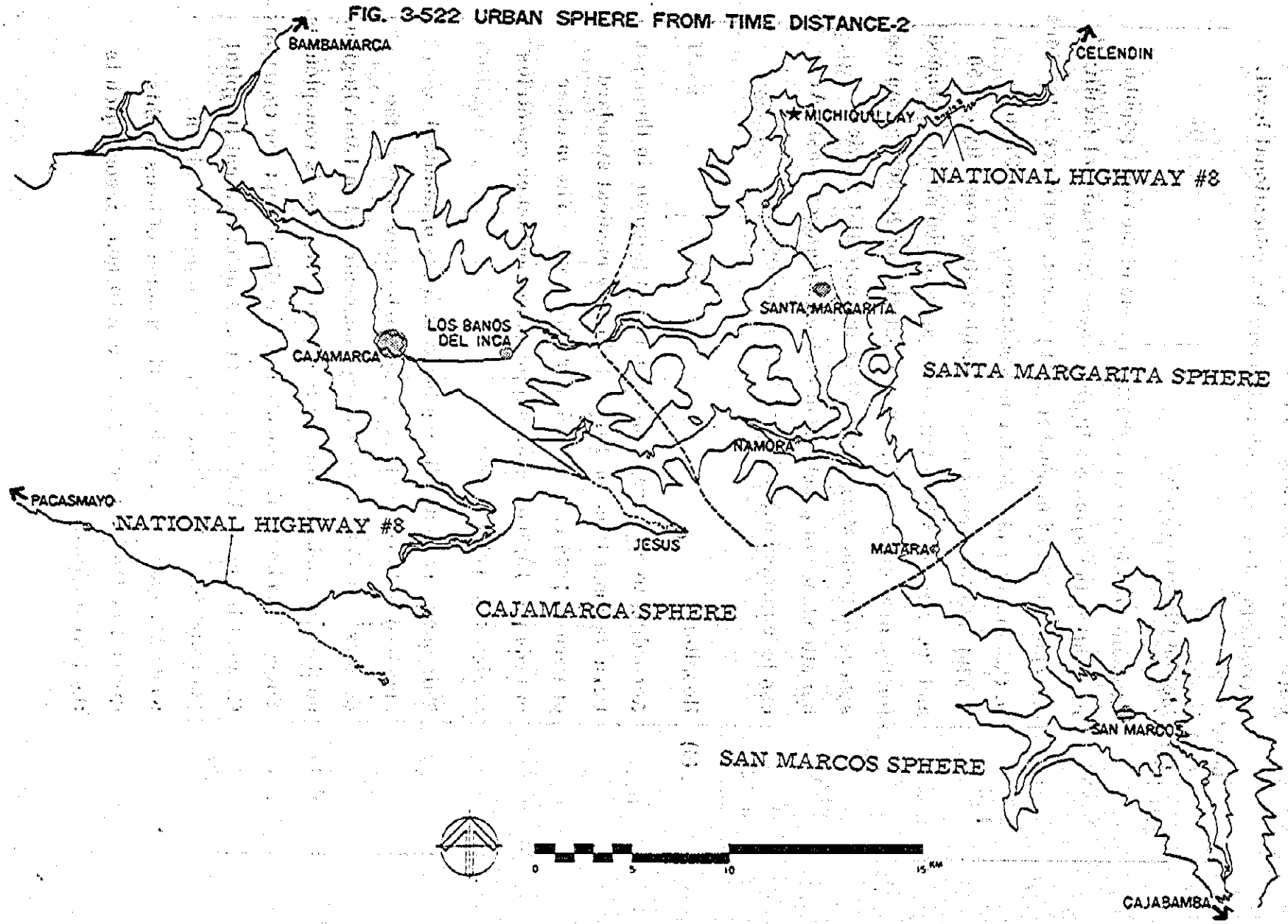


FIG. 3-522 URBAN SPHERE FROM TIME DISTANCE-2



Peru, this school will be valued as model school for surrounding districts with relatively low educational level.

(3) Motion Picture Theater

Attending motion picture theater is one of the most popular recreation in Cajamarca Region where recreational facilities are relatively few in number. At present, there are 4 theaters in Cajamarca and 1 theater in San Marcos. (see Figure 3-528) Motion picture theaters with seating capacity of 150 and 300 viewers with a total floor area of 900 m^2 are planned for the new mine town. The population of 26,800 within the sphere of Santa Margarita will be the potential movie fans, but attendance of people from entire Cajamarca Basin Area can be expected depending on the attraction.

(4) Hospital

According to plan drawn up for medical program in the Peru National Plan for 1971 ~ 1975, the medical standard of Peru in 1969 is as shown in Table 3-524. The number of beds per 10,000 population for Japan and other countries is shown in Table 3-525.

This shows realistically the backwardness of medical standard in Peru, moreover, approximately 60 % of the doctors and 45 % of the beds are concentrated in Lima Region, so the low medical standard in outlying regions is conspicuous. There is no hospital to mention especially except for Cajamarca General Hospital (145 beds) and Cajabamba Central Hospital (35 beds) in the 7th Medical Area - Cajamarca which Santa Margarita is included. The number of beds in this district is 218 beds or 4.8 beds per 10,000 person which is the lowest nationally.

Table 3-524 Medical Standards of Peru (1969)

Region	Total		Per 10,000 Population	
	Doctor	Sick Bed	Doctor	Sick Bed
National	6,870	30,596	5.2	23.2
Lima Region	4,263	13,374	14.1	44.3
Cajamarca Department	68	528	0.7	5.4
7th Medical Area - Cajamarca (1972)	-	218	-	4.8

Table 3-525 No. of Beds per 10,000 Population by Sickness Group in Various Countries

Country	Year of Investigation	Total	Tuberculosis	Mental	Others
Peru	1969	23.2	-	-	-
Japan	1969	100.7	18.1	21.6	61.0
Argentine	1968	56.7	-	-	-
America	1968	82.6	1.1	25.6	55.9
Philippines	1967	13.8	0.4	2.0	11.3
France	1968	106.0	13.8	52.8	39.3
West Germany	1968	110.6	5.0	18.2	87.4
Italy	1968	102.9	10.0	21.8	71.0
Sweden	1968	145.8	4.6	43.2	98.0
U.S.S.R.	1968	104.6	11.6	10.4	82.7

The hospital for this program will be a general hospital with 100 beds; and of this number 50 beds are to be allotted to 7,900 employees of mine industry (1983) and the remaining 50 beds are for other residents in Santa Margarita and surrounding districts.

As an effect of Santa Margarita General Hospital Development, Table 3-526 shows the comparison of number of beds per 10,000 person for years 1972 and 1983. The plan for increasing the number of beds (from 35 to 50 beds) for Cajabamba Central Hospital and the plan for a new Celedin Central Hospital (50 beds) were taken into consideration in the planning of this hospital.

Table 3-526 Effect from Development of Santa Margarita Hospital

	1972			1983					
				Mine Workers not included			Mine Workers included		
	Population	Beds	No. of Beds per 10,000	Population	Beds	No. of Beds per 10,000	Population	Beds	No. of Beds per 10,000
Santa Margarita Sphere	15,300	0	0	18,900	50	26.5	26,800	100	37.3
Cajamarca Basin	157,400	145	9.2	185,700	195	10.5	193,600	245	12.7
7th Medical Area-Cajamarca	456,400	218	4.8	544,100	327	6.0	552,000	377	6.8

Without including the number of beds allotted to mine workers, the number of beds per 10,000 for the sphere of Santa Margarita is above the national level; and if included it will approach the level for Lima Region. For Cajamarca Basin, without including the beds for mine workers, the percentage in beds will increase 34 % and 69 % if included; and this, excluding Lima Region, will approach the

national figure of 16.9 beds per 10,000. However, in order to raise the level of the entire 7th Medical Area Cajamarca to the level of 16.9 beds, 550 additional beds are required and to approach the national average 900 more additional beds must be provided.

(5) Sports Facility

The national sport in Peru is football, however in recent years volleyball and basketball are gaining in popularity; but the general level of physical training is still low. This is due to lag in physical education; and if compared to other countries the weight given to physical education in school is low. From standpoint of facilities, the trend towards better facility can be seen in the National Education Code.

Also, as to facilities in surrounding districts (see Figure 3-528) the majority of the facilities, excepting those in Cajamarca, consists of simple football fields, so 2 football fields, 4 basketball courts, 2 volleyball courts, 4 tennis courts were planned in 2 athletic parks for this program.

Santa Margarita is considered as the sphere for utilization of these facilities; but with increase in leisure time greater community activities through sport events can be anticipated throughout the entire Cajamarca Basin.

FIG. 3-523 THE 7 TH MEDICAL AREA-CAJAMARCA

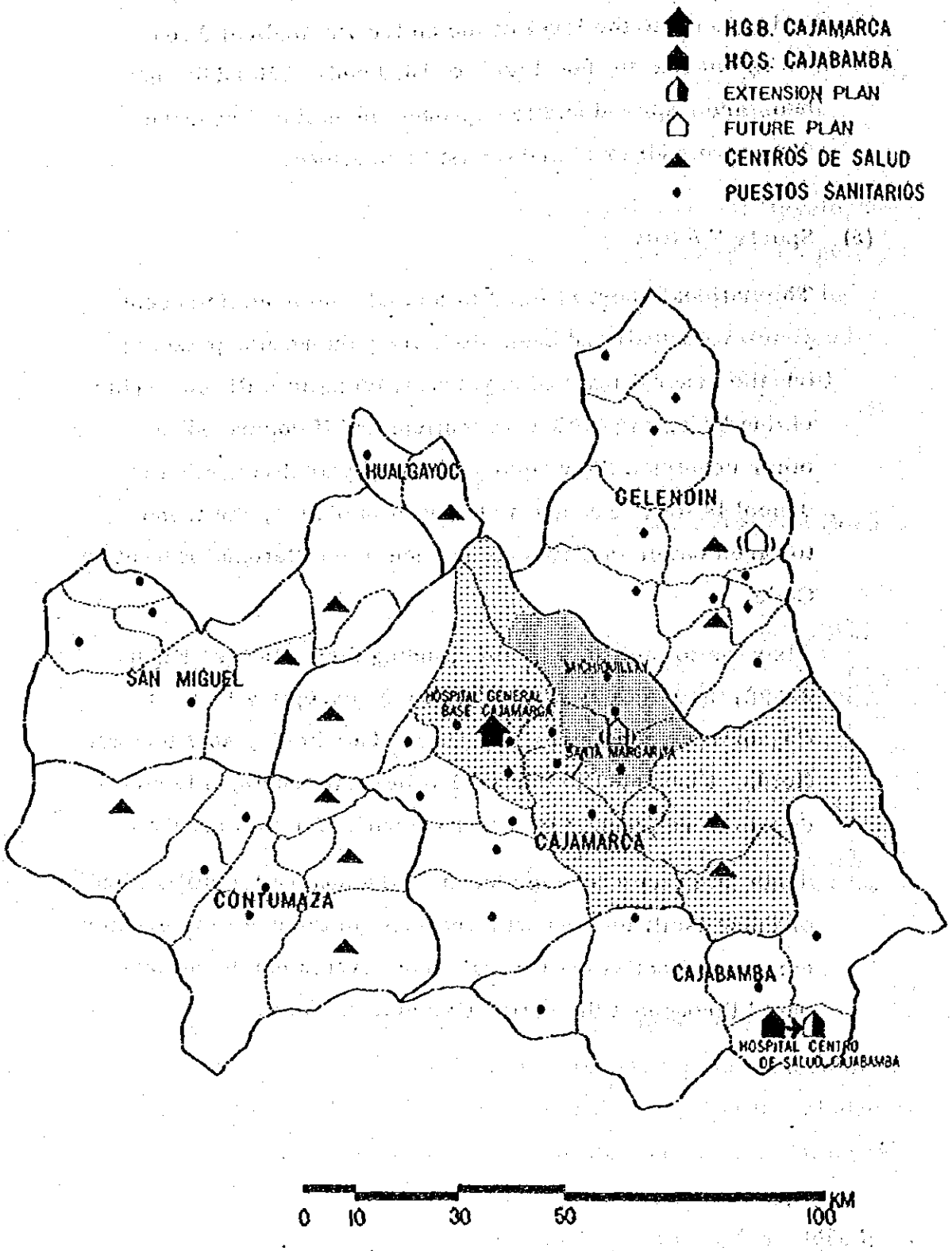


FIG. 3-524 SPHERE OF BENEFIT FROM ESTABLISHMENT OF ADMINISTRATIVE FACILITY

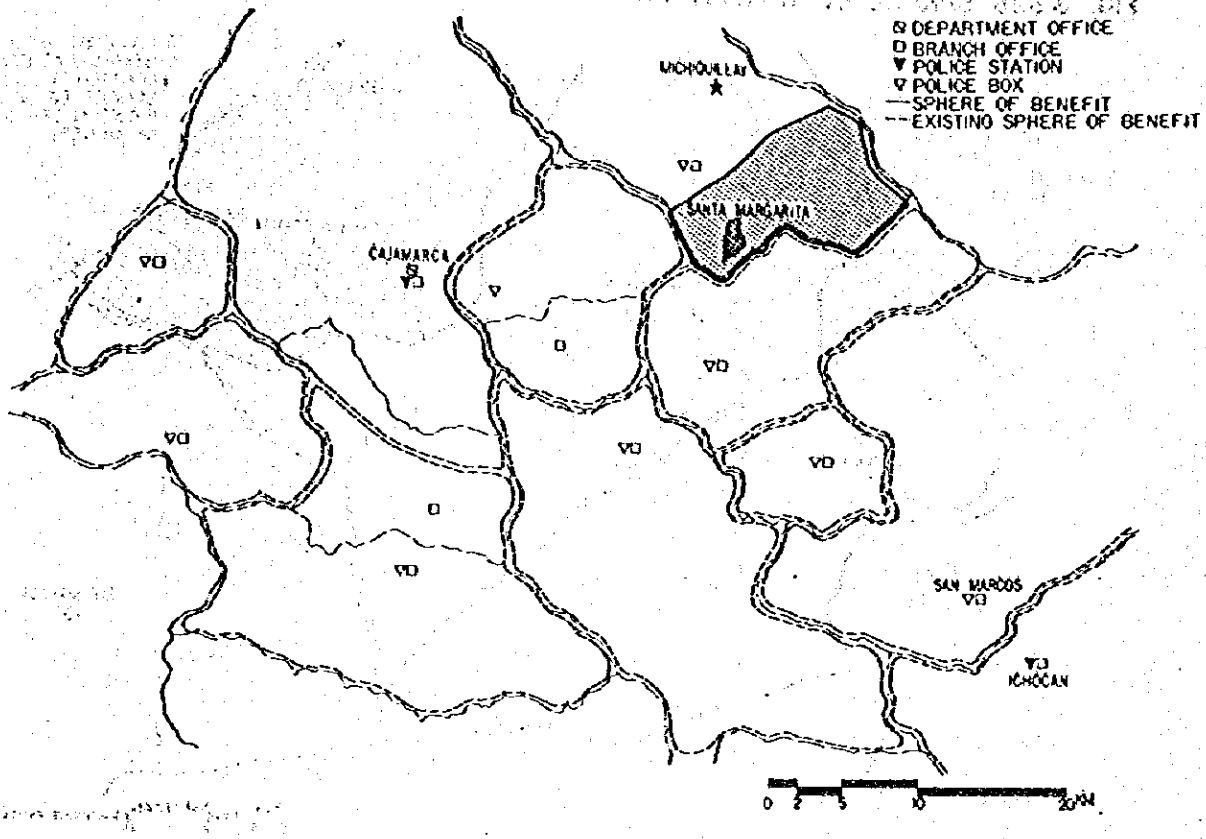


FIG. 3-525 SPHERE OF BENEFIT FROM ESTABLISHMENT OF COMMUNICATION FACILITY

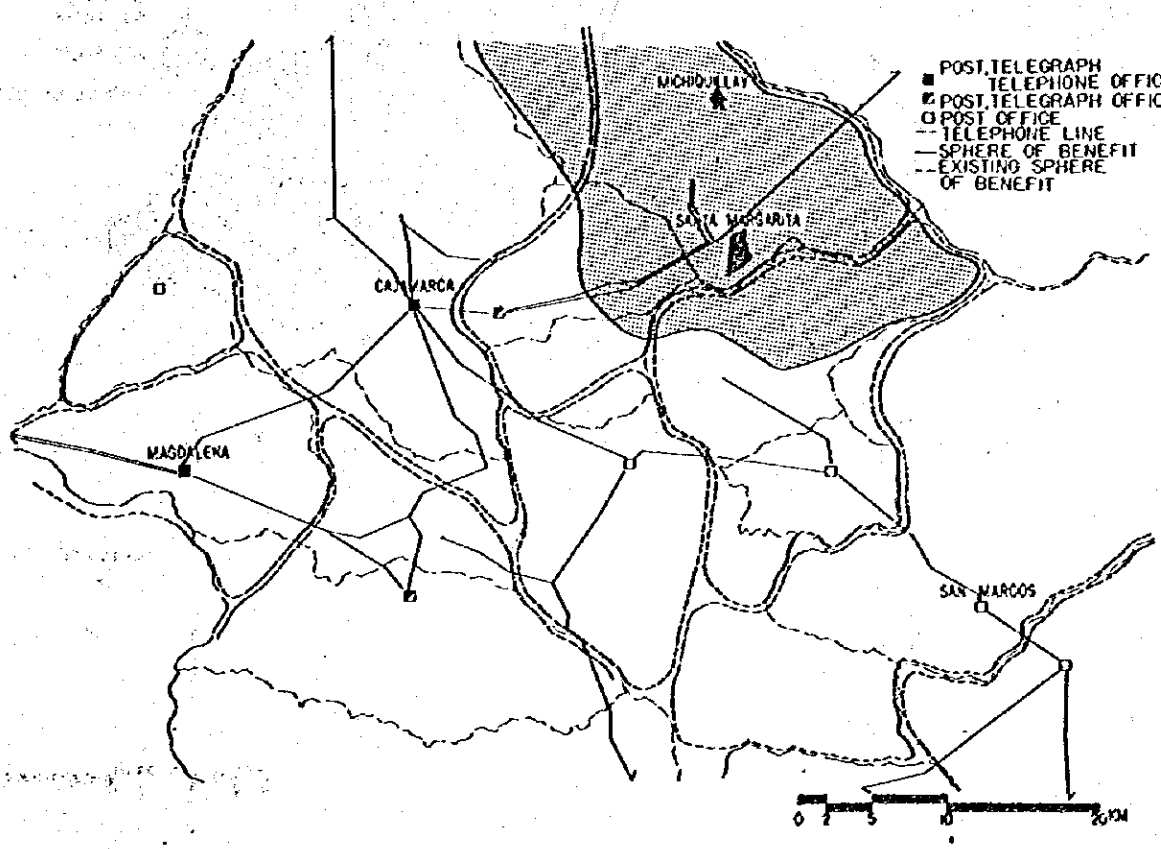


FIG. 3-526 SPHERE OF BENEFIT FROM ESTABLISHMENT OF BANK

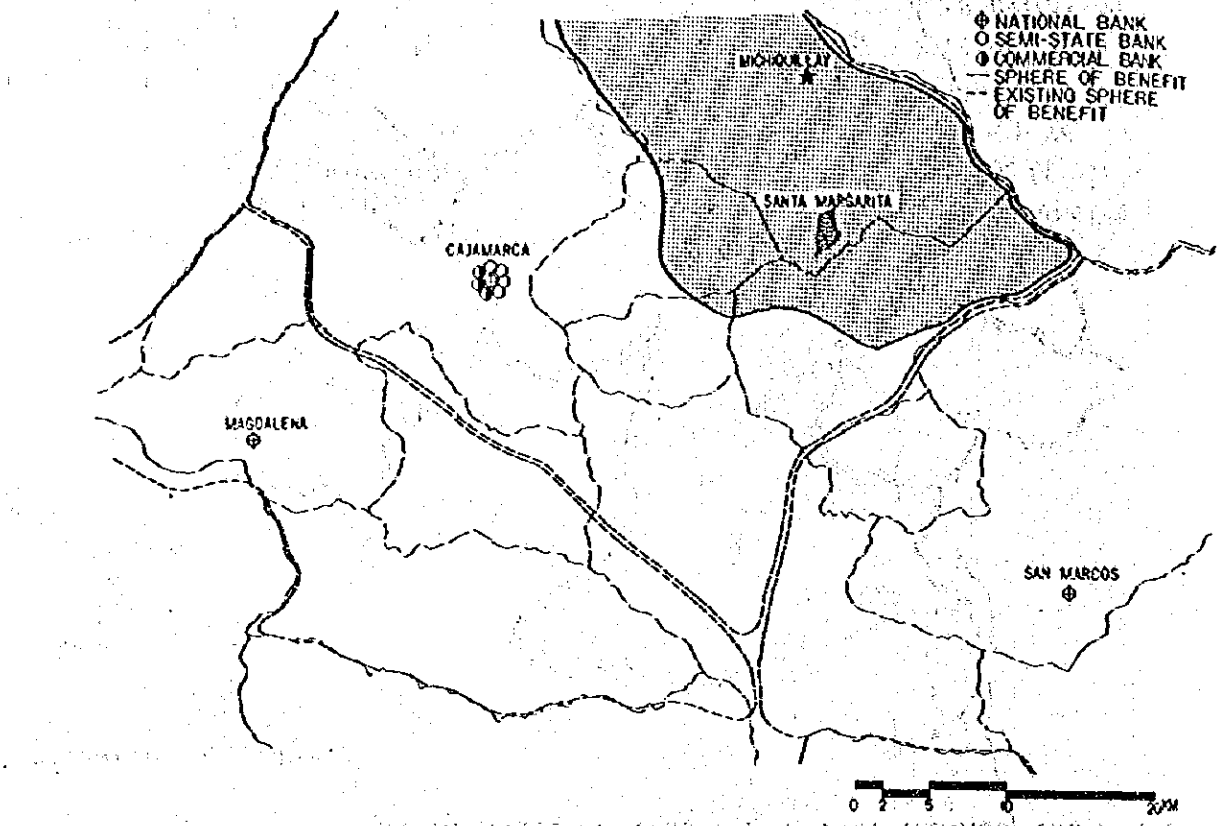


FIG. 3-527 SPHERE OF BENEFIT FROM ESTABLISHMENT OF COMMERCIAL FACILITY

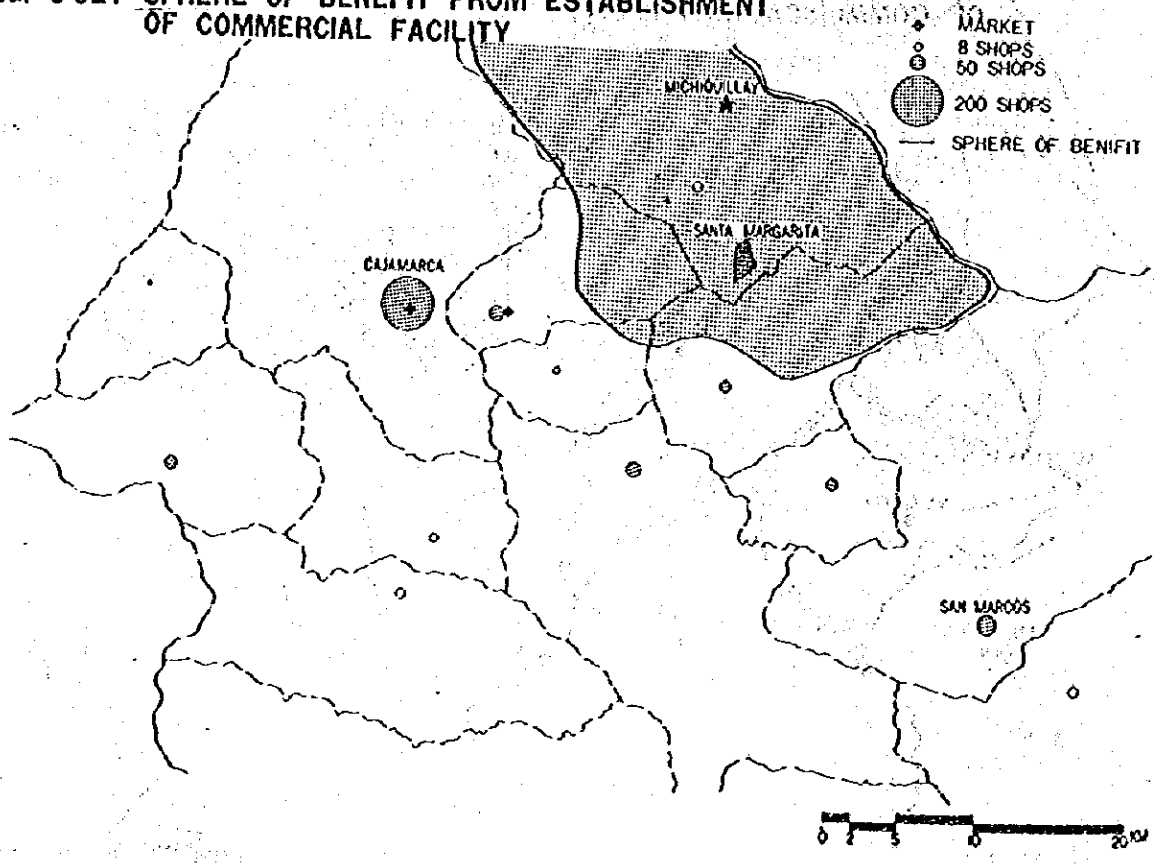
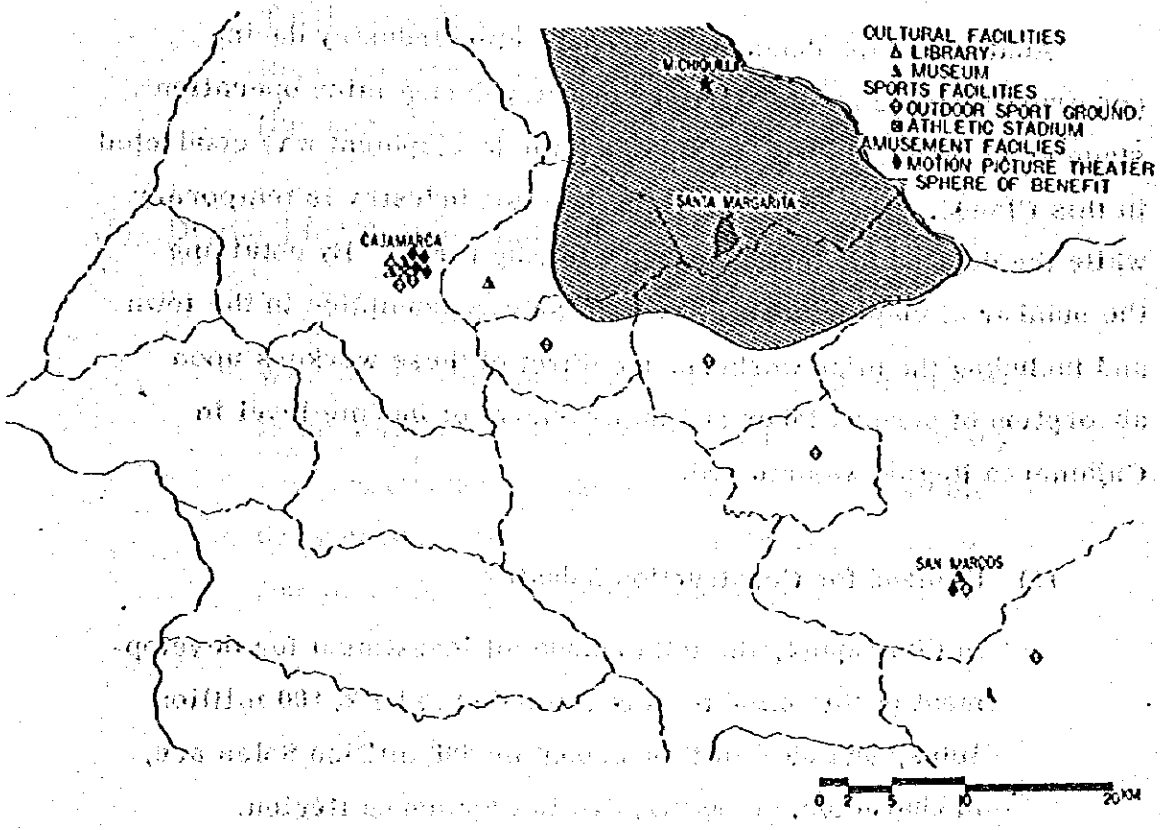


FIG. 3-528 SPHERE OF BENEFIT FROM ESTABLISHMENT OF SPORTS FACILITY MOTION PICTURE THEATER AND CULTURAL FACILITY



5-3. Regional Economic Effect

Analysis of the demands for construction industry during construction stage and for tertiary industry during mine operation stage as economical effects of mine town development was conducted in this Clause. The demand for construction industry is temporary while the demand for tertial industry is long range. By obtaining the number of employed workers from total consumption in the town and including the mine workers, the effect of these workers upon absorption of surplus labor and improvement of income level in Cajamarca Region was studied.

(1) Demand for Construction Industry

In this report, the total amount of investment for development of this mine town is estimated to be 2,100 million Soles, and 30 % of this amount or 600 million Soles are, in character, to be invested in Cajamarca Region.

The number of employees in Cajamarca Region resulting from this demand for construction industry is calculated by using the total number of workers obtained from construction schedule plan in Section 4, the total number of working days and Cajamarca Region employment rate in the following equation. If regional employment rate is assumed as 1, the number of regional employees will be 1,400 men; but since the wage rate for construction worker is relatively high, it would be reasonable to assume 700 men as a number of regional employees when 0.5 is assumed as the rate of regional employment.

$$\text{Number of employees(Men)} = \frac{\text{Total workers (man days)}}{\text{Total working days (days)}} \times \text{Regional employment rate}$$

Total number of workers	1,400,000 man days
Total working days	1,000 days
Regional employment rate	0.5
Number of employees	700 men

(2) Demand for Tertiary Industry

A) Total Amount of Consumption in The Mine Town

With the settling of mine workers and their families in the mine town, the demand for tertiary industry with service enterprise as a nucleus to serve the daily needs of these residents will be stimulated. During construction stage, adequate services are also needed, of course; but these demands are temporary and some of these services will extend into mine operation stage and continue to serve the needs of the mine workers, so here a study will be conducted only on the demand for tertiary industry during mine operation stage.

The greatest factor in giving rise to tertiary industry is total amount of consumption, so here again the computed total amount of consumption in the mine town is taken as demand for tertiary industry. The total amount of consumption is obtained by following equation using mining industry's total expense and mine industry's rate of consumption in the mine town (rate of local consumption), total income of mine workers, mine worker's spending habit and rate of local consumption and multiplying effect.

Total amount of consumption in the mine town (Dollars)
= Multiplying effect x {(Total expense of mining industry (Dollars) x rate of local consumption)

+ Total income of mine workers (Dollars) x Spending habit x Rate of local consumption)

By using the following values, total annual consumption in the mine town will be 19,000 thousand Dollars.

Where : Total expense of mining industry = 33,425 thousand U.S. Dollars Note 1.

: Rate of local consumption by mining industry = 0.05

: Total income of mine workers = 8,231 thousand U.S. Dollars Note 2.

: Mine worker's spending habit = 0.75

: Rate of local consumption by mine workers = 0.50

: Multiplying effect $1/(1 - \alpha) = 4.0$

where: α = spending habit of tertiary industry worker = 0.75

Therefore : Total amount of consumption in mine town = 19,000 thousand U.S. Dollars Note 3.

B) Number of Regional Employees for Mine Town

The number of regional employees resulting from tertiary industries was estimated from the total amount of consumption in mine town as follows:

$$\text{Number of regional employees} = \frac{\text{Total amount of consumption in mine town (Dollars)}}{\text{Production per man in tertiary industry (Dollars)}} \times \text{Regional employment rate}$$

Where : Production per man in tertiary industry = 4,430 U.S. Dollars/man Note 4.

: Regional employment rate = 0.75

Therefore : The number of regional employees in tertiary industry = 3,200 men ...① Note 5.

The number of mine workers is estimated as 2,000 and if the rate of employment from the region is 0.55, the number of men from this region employed as mine workers will be 1,100 men.

Number of employees = Mine worker x Rate of regional employment

Where : Number of mine workers = 2,000 men

: Rate of regional employment = 0.55

Therefore : The number of regional employees as mine workers = 1,100 men..... ②Note 6.

Therefore : The total number of regional employees = ① + ② = 4,300 men

C) Absorption of Surplus Labor and Income Increase

According to statistic of population for Cajamarca Region in Section 1, 85 % of the working population are engaged in agricultural industry with extremely low added value productivity and it is assumed that the potential unemployed in the agricultural industry makes up a considerable number of surplus labor in this region. High level of income will be assured for the mine town workers; and if these workers are sought from above mentioned agricultural workers, the productivity of agricultural industry will increase and the

income level of the remaining agricultural workers should improve.

Here, if all of the total regional employees are sought from the agricultural workers.

The rate of income increase for agricultural workers

$$= \frac{\text{Number of agricultural workers}}{\text{Number of agricultural workers} - \text{Number of regional employees} + \text{Family members}}$$

Where : Number of agricultural workers in Cajamarca Region = 214,000 men

: Family members = Number of regional employees x 2 = 8,600 members

Therefore : The rate of income increase for agricultural workers = 0.064 Note 7.

and : The income of remaining agricultural workers will increase 6.4 %.

If appropriate number of agricultural population and supplus labor are obtained from the limit of total agricultural production for this region :

The limit of total agricultural production (Dollars)
= Top limit of cultivated area (ha) x Top limit of agricultural productivity (Dollars/ha)

Where : Top limit of cultivated area = 220,000 ha Note 8.

: Top limit of agricultural productivity = 342 U.S. Dollars/ha Note 9.

Therefore : Limit of total agricultural production = 75,240 thousand U.S. Dollars Note 10.

The appropriate number of agricultural population (men)

$$= \frac{\text{Limit of total agricultural production (Dollar)}}{\text{Agricultural production per man (Dollar)}}$$

Where : Agricultural production per man = 443 U.S. Dollars Note 11.

Therefore : Appropriate number of agricultural population = 170,000 men Note 12.

Regional surplus labor (men) = Regional agricultural population − Appropriate agricultural population (men)

Therefore : Surplus labor = 44,000 men

So, the total number of regional employees including their families can absorb 9.7 % of the surplus labor.

The above study was based only on the demand for tertiary industry resulting from the development of the mine town; but in reality as can be seen from examples of other mine development in Peru, the investiments in Cajamarca Region from the entire mine development will greatly increase the total regional production, stimulate demand for regional industry, absorb much of surplus labor force and increase the income of the regional people.

Note 1. Computed from commodity cost + expense (Average of 2 - 10 years operation) in feasibility report of Michiquillay Project.

Note 2. Computed from labor cost mentioned in above report.

Note 3. Total consumption of mine town

= 4.0 (33,425 x 0.05 + 8,231 x 0.75 x 0.5)

= 19,031.5 thousand U.S. Dollars

≒ 19,030 thousand U.S. Dollars

Note 4. Assumption equivalent to mine workers income per man production per man for tertiary industry

= 8,231 thousand U.S. Dollars ÷ 1,858 men

= 4,430 U.S. Dollars/man

Note 5. Number of employed = (19,030 thousand U.S. Dollars ÷ 4,430 men) x 0.75 = 3,222 men ≒ 3,200 men

Note 6. Number of employed = 2,000 x 0.55 = 1,100 men

Note 7. Rate of income increase for agricultural workers

$$= \frac{214,000}{214,000 - (4,300 + 8,600)} - 1$$

= 0.064

In this case, the number of workers in one farming family is assumed as 3 persons and if this number is 2, the rate of increase will be 0.042.

Note 8. Mountainous topography was considered and assuming a present increase of 10.0 % the area will be 220,000 hectares.

Note 9. The agricultural production per hectare for this region is close to the national average production and production is high for certain products. Taking into consideration only the increase in production amount

due to expanded sales outlet by development of infrastructure, a 15.0 % increase in production was assumed.

297.7 U.S. Dollars/ha x 1.15 = 342 U.S. Dollars/ha

Note 10. Limit of total agricultural production

= 342 U.S. Dollars/ha x 220,000 ha
= 75,240 thousand U.S. Dollars

Note 11. The ratio of national added value productivity for the year 1970 between agricultural and mining industry is:

Agricultural industry/Mining industry = 0.085

Therefore, assuming 10 % of the income per man in mining industry as the amount of production per man in agriculture, the agricultural production is assumed as 443 U.S. Dollars per man.

Exception : The ratio for this region is 0.077.

Note 12. Appropriate population for agricultural sector

= 75,240 thousand U.S. Dollars/443 Dollars/man
= 169,800 men ≒ 170,000 men

Note 13. Regional surplus labor force = 214,000 men - 170,000
= 44,000 men

PORT DEVELOPMENT PROGRAM

CHAPTER 4
PORT DEVELOPMENT PROGRAM

SECTION 1. SOCIAL AND ECONOMIC FEATURES AND POTENTIAL IN PACASMAYO DISTRICT

1-1 Social Features in Pacasmayo District

Pacasmayo City was once prosperous due to its harbour facility and related commerce and service industries. Since its opening in 1884, the port of Pacasmayo played a role as a port for shipment of various agricultural products and yields from surrounding farm villages such as rice, corn and fruit etc., as well as products from neighbouring industrial plants such as cement, sugar and mineral products. At the same time, the port of Pacasmayo also played a vital role as a distribution centre for various cargoes destined for mountain area.

However, due to the construction and opening of the port of Salaverry in 1965 the volume of cargoes showed a considerable decrease and related service industries consequently became stagnant and in addition, young working population drained out of the city because of new construction of sugar plants and paper manufacturing mills in surrounding area. Besides, the city lost its function as a distribution and commercial centre in the local district due to the development of land traffic and transport system and as a result the city was on decline since then and the people were concerned with the lag in development.

1-2 Economic Features in Pacasmayo District

The production in cement industry a key industry in this district, has remained on the same level due to the slow economic activity. The volume of cargoes decreased drastically due to more efficient neighbouring ports and land transportation and the port lost its vital role. On the other hand, due to concentration of fishing centres in northern Paita or southern Chimbote, the fishing net manufacturing mills

were also seriously affected by the setback like other commerce and service industries in such a way that as a whole, the economy of the city has been entirely stagnant for the past several years. The only industrial development available to Pacasmayo City was the equipment expansion of Pacasmayo Cement Plant and in spite of the city's important locality as a mid-point for traffic and transport between Cajamarca, Trujillo and Chiclayo, the city's role was limited to as a relay point only for the passing traffics.

In this respect, great expectation is placed on the shipment of copper concentrates from Michiquillay Mine. Furthermore, the anticipated increase in export of various agriculture products and yields from the development of Jequetepeque farms in the surrounding area and recovery of related industries as well as new industrial possibility are also expected. At the same time, promisingly expected are increase in the output from Jequetepeque-Zaña and corresponding increase in fertilizers requirement depending on progress of the program.

1-3 Development Potential in Pacasmayo District

If future development projects for Peruvian economy, anticipated economic policy as well as development projects currently under way are considered, those natural, topographical and social conditions in Pacasmayo District provide very high potentials. That is, water resources are rich while a hydraulic power station is also under planning in neighbouring area and power cables for mass transmission are already available up to Chimbote which are expected to further extend to the north.

From topographical viewpoint, both backland and surrounding Eten and Salverry having a desert or adjoining residential area are restricted technically by topography and sand drifting etc. and thereby have less possibility for development, while here in Pacasmayo the huge backland consists of solid conglomeratic

layers. Furthermore, it is almost connected with Pan American Highway and closely related with other neighbouring districts and as already explained, its locality as well as environmental conditions can well cope with the increasing demand for cargo transportation in line with the development of various projects.

For instance, beginning with 11 mines which are presently under prospecting in the Department of Cajamarca, there are many mines in the north which have not as yet been developed but under exploration aiming at export for the future and in this respect Pacasmayo is located at approximately 200 kilometre away from the mine area in Cajamarca Department and therefore it can provide higher efficiency in transportation resulting in lower transportation cost and thereby sufficient competitive power can be secured for export trade.

On the other hand, Pacasmayo can also play a vital role as a key point for the transportation of increasing agricultural yields from the surrounding farm villages to Lima which is the largest place of consumption as well as to the southern region.

At present, the development of food processing or preservation techniques is under investigation in the food section and accordingly there is a possibility that Pacasmayo can one day become a giant supply centre with the establishment of food-stuffs collecting and processing center in this area.

At the same time, it is also anticipated that the current machiney industries in Trujillo and Chiclayo particularly automotive parts and accessory manufacturing role by Andes Group is great and in future these parts manufacturing industries may develop into assembly type industries.

It is also anticipated that Pacasmayo in relation to Cajamarca region via Route 8 would be able to play a role as either a base for distribution of various materials including consumer goods or a relay point for land traffic and transportation. It will not be a dream that this area can develop as coastal industrial zone particularly thanks to its huge

backland locality.

Taking all the above factors into consideration, it should be admitted that Pacasmayo has a promising potential to grow as a core of Peruvian development or its modern industries. Therefore, any easygoing way of industrial induction and invitation as well as at-random-developments which may possibly hamper the desirable future progress in this area have to be avoided and it can be said that now is a time to consider and elaborate the future urban development plans and land utilization projects based on the above mentioned industrial configuration.

SECTION 2, NATURAL CONDITIONS IN VICINITY OF THE PROPOSED PORT SITE

2-1 Topography (Sea Figure 4-211, 4-212)

(1) Location : Pacasmayo Port is located in northern Peru at 7°24' south latitude and 79°35' west longitude with South Pacific on the west and Andes on the east. The port is approximately 15 - 20 km from the western foot of West Cordillera which forms the western range of the Andes Mountain Ranges.

(2) Jequetepeque River : North of the port is the Jequetepeque River and the well cultivated valley formed by this river as a passage to Cajamarca Highlands. The portion of the waterway that irrigates Jequetepeque plains penetrates a plateau with elevation of 13 - 15 m above sea and flows into this bay. Towns and villages are located around this small valley.

(3) Plateau : The top of the north and south plateau is flat and arid with well compacted gravel, so in an emergency light airplane can use it as landing field; but this plateau, excluding the shoulder of the valley where the town is located, is not utilized.

(4) Irrigation : The east side of the plateau is relatively well irrigated with wide expanse of cultivated land mainly for rice plants.

(5) Wind Blown Sands : According to interpretation of aerial photographs, there are many lines of white belt stretching

approximately north and south along the coast in northern Peru which were formed by coastal dune sands blown inland by prevailing wind and these wind blown sands can even be observed in cultivated land near Pacasmayo.

(6) Water Depth : At depths of 2 - 3 meters, the sea bottom has a gentle slope and extends continuously for a distance of approximately 350 meters from shoreline. At depths of 3 - 9 meters, the bottom slopes steeply and the width is about 250 meters in average. The depth of 9 meters is on the average 650 meters from the beach; and the sea bed beyond this depth again has a gentle slope with almost a flat topography. South of the lighthouse, the sea bed is sharply sloped and there are many reefs causing large breaking waves. (see Figure 4-213)

(7) Coastal Sand Ridge : The sand ridge is in the area with depth of 2 - 3 meters and in this vicinity littoral drift due to waves and coastal current was observed. It is believed that sea bed topography will undergo considerable change with seasons.

FIG.4 -811PLAN OF AREA AROUND PACASMAYO CITY

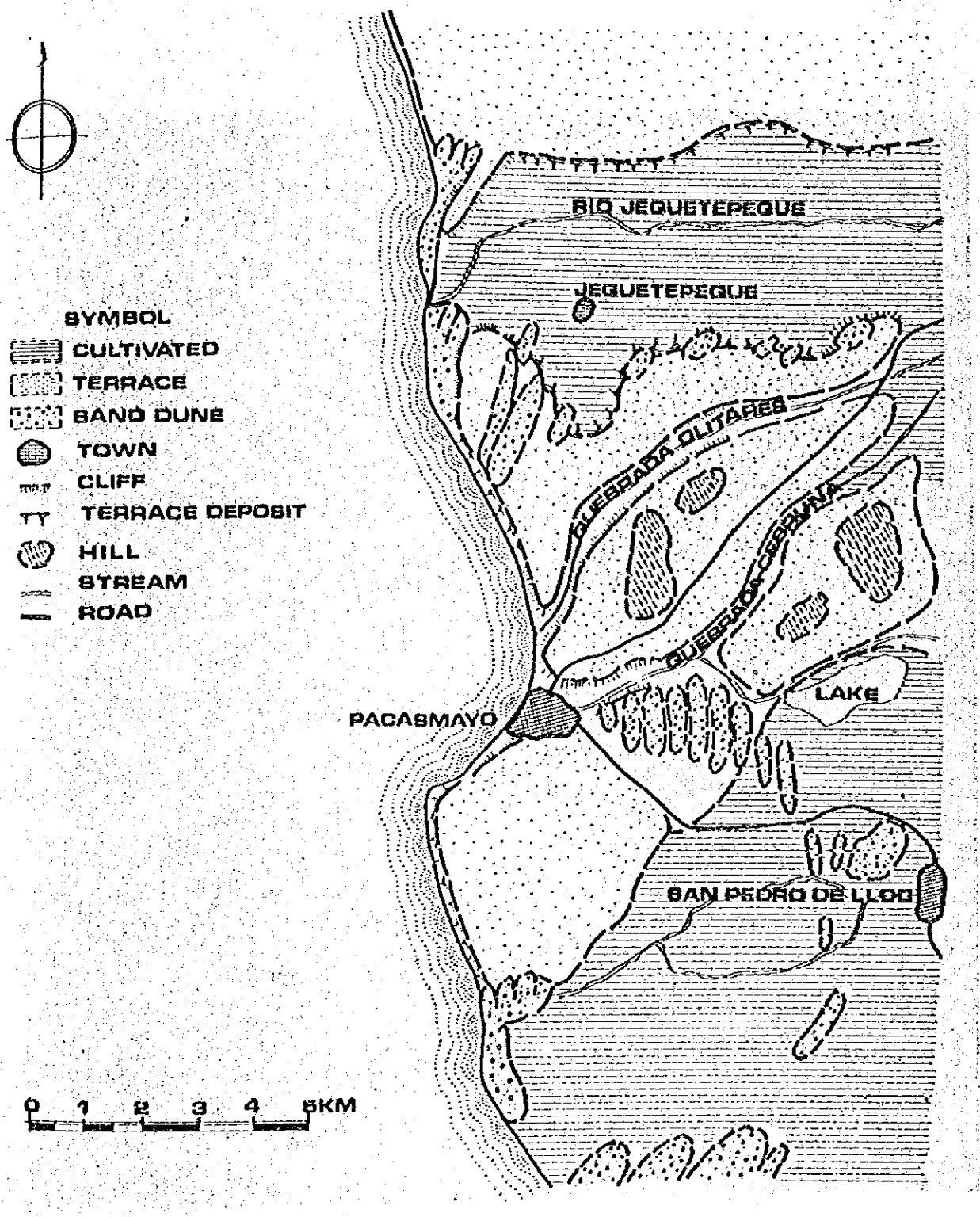
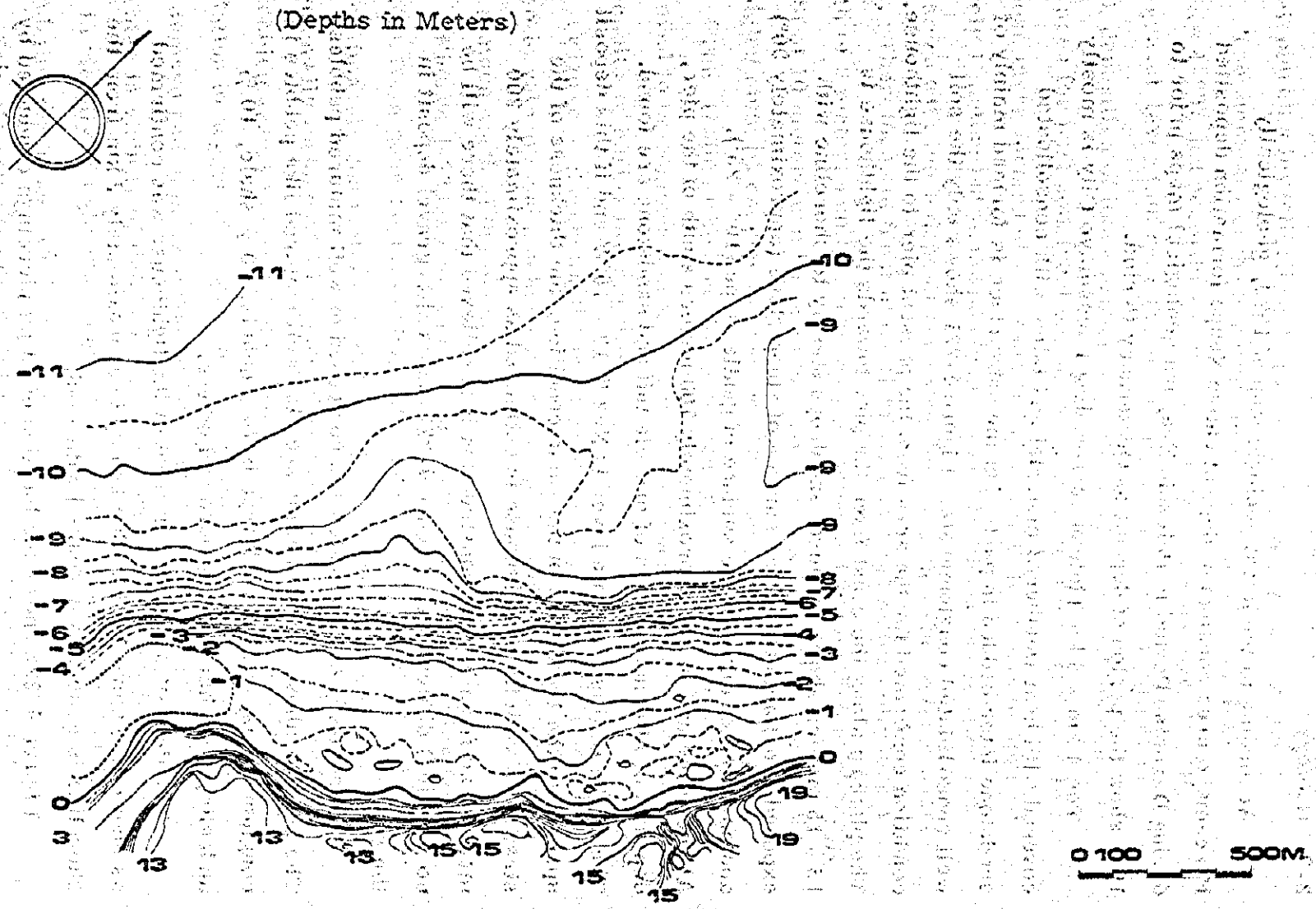


FIG. 4-212 AERIAL PHOTO OF PACASMAYO CITY

FIG.4 -213 WATER DEPTH IN VICINITY OF PACASMAYO CAPE



2-2 Geology

According to the latest geologic map of 1973, geologically Pascamayo area consists of deposit called Ñaupe formation deposited during Devonian Period in Palezoic Era, but geological maps prior to 1973 show the period of deposit as Quaternary Period.

The 4 km x 8 km plateau surrounding Pacasmayo City is mostly covered with heat weathered material and talus with consolidated sandstone inter-bedded in parts; but the subsurface is formed mainly of well consolidated conglomerate. Figure 4-221 shows only the soil condition confirmed for the area from the present pier to the lighthouse. The plateau along the coast from the pier towards the lighthouse is 13 - 15 meters above sea level and drops steeply to shoreline with exposed conglomerate on the surface of steep slope (approximately 50°) and covering of talus on the surface of gentle slope (10° - 25°). At shoreline and in sea approximately 700 meters south of the pier, deposits of alternate layers of breccia tuff and sandstone are found. The strike of this alternate layer is N52°W 12 - 15°W and if this deposit spreads to the lighthouse in the same condition, the thickness of the stratum in vicinity of lighthouse is estimated as approximately 200 meters, so from harbor construction it is believed that there will be no technical difficulties. Figure 4-221 shows silt - gravel deposit in the sea.

Deposited conglomerates are composed of well matured pebbles. The pebbles above the shoreline are also well matured like pebbles in conglomerates; and the rock type is 70 % quartz, 10 % shale, 10 % andesite, 5 % chert, 2 % gabbro and others.

The deposit at sea bed in front of the lighthouse was confirmed as shown in Figure 4-222. Sea bed up to approximately 2 km from the shoreline is generally deposited with sand.

Figure 4-223 shows the location of 13 jet piercings conducted by water jetting at sea bed with pressure of 5 kg/cm^2 and 1 boring after excavating by hand down to depth of 2.5 m from ground surface. The

results of boring investigation are shown in Figure 4-224 and results of jet-piercing investigations in Figure 4-225 to 4-226-1 ~ 4-226-3.

The summary of these results of investigation is shown in Figure 4-227 and according to this summary, the sand layer is thick and gravel layer thin near the shoreline; but there is a tendency of thick deposition of loose gravel under the sand layer. Of the assumed sea area for port construction, the area in front of the lighthouse has a loose layer formed of fine sand and gravel with thickness of approximately 1 meter; but in northerly direction the thickness becomes 1.5 - 3 meters with loose deposit becoming thicker with distance from shoreline. Therefore, in front of the lighthouse and 550 meters offshore a depth of 9 meters can be secured by dredging and 700 meters offshore a depth of 10 meters can be secured. To secure a depth of 11 meters the dredging must be carried out beyond 850 meters offshore.

The stratum which could not be penetrated by jet-piercing is believed to be composed of well consolidated conglomerate in contrast to results of boring investigation.

Figure 4-228 shows the location of 9 prospecting points for seismic velocity and another point on the plateau located approximately 700 meters north of the pier.

Figure 4-229-1 shows the seismic velocity column for the coastal plateau from point approximately 700 meters north of Pacasmayo City to approximately 300 meters south of the lighthouse; and the conglomerate is generally formed of 3 layers of decomposed structure. Weathering of conglomerates in coastal area investigated is not uniform and shows variation in degree of weathering. Conglomerates in plateau north of Pacasmayo and in plateau south of the lighthouse compared to conglomerates in vicinity of lighthouse show a greater weathering. The sea bed in vicinity of lighthouse appears to be most suitable as bearing foundation for underwater structures.

Seismic velocity column for ground at shoreline is shown in Figure 4-229-2. Also, a comparison of seismic velocity for plateau

1.8 km northeast of the lighthouse and for ground at shoreline is shown in Figure 4-229-3. Sand is deposited in vicinity of shoreline so the sensitivity of remotely located wave detecting bob was small; but seismic velocity of 1.7 km/sec. can be considered as seismic velocity for breccia tuff and this stratum is believed to continue to a depth of at least 10 meters from sea surface in vicinity of 1.8 km northeast of the lighthouse.

The elastic wave velocity for ground in vicinity of lighthouse is shown in Figure 4-229-4. Vicinity of lighthouse is divided into 4 elastic wave velocity zones as shown below:

Velocity Zone	Boundary Line of Zone	Velocity of Elastic wave (km/sec)	Assumed Lithofacies
1	Zone thickness of approx. 1.5 m from ground level.	0.6	Condition of extreme loosening of compacted conglomerate
2	From bottom of 1st zone to approximately 5 m above water surface	1.9	Compacted conglomerate starting to loosen
3	From bottom of 2nd zone to approximately 8 m below water surface	2 - 2.5	Very little loosening of conglomerate
4	Depth greater than 8 meters from water surface.	6 - 7	Almost no loosening of conglomerate

Velocity zone No. 3 in vicinity of lighthouse is in the sphere of hard rock so the bearing capacity of this ground is believed to be sufficient. Zone No. 2 can be excavated with rippers; but zone No. 3 has a seismic velocity that will require light blasting.

The seismic velocity of sea bottom bedrock is assumed to be 0.6 km/sec for deposit of sand and loose gravel to a depth of 1 - 2 meters below sea bed, 2 - 3 km/sec at 1 - 2 meters to 5 - 6 meters depth and 7 km/sec at greater depth. Therefore, at depth 1 - 2 meters from sea

bed, suction method of excavation is possible; but beyond this depth light underwater blasting will become necessary.

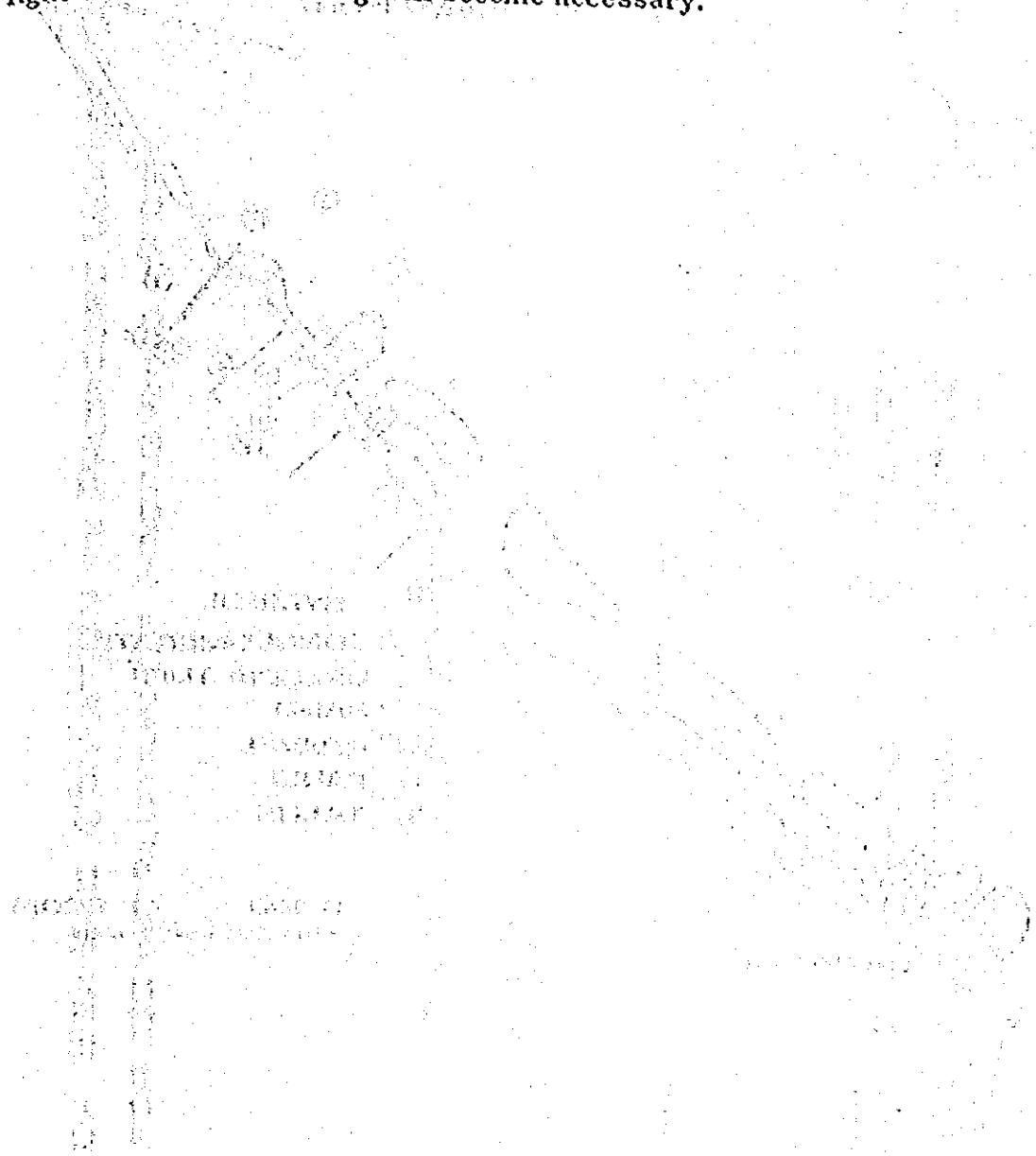


FIG.4 -221 GEOLOGICAL SURVEY MAP OF PACASMAYO PORT

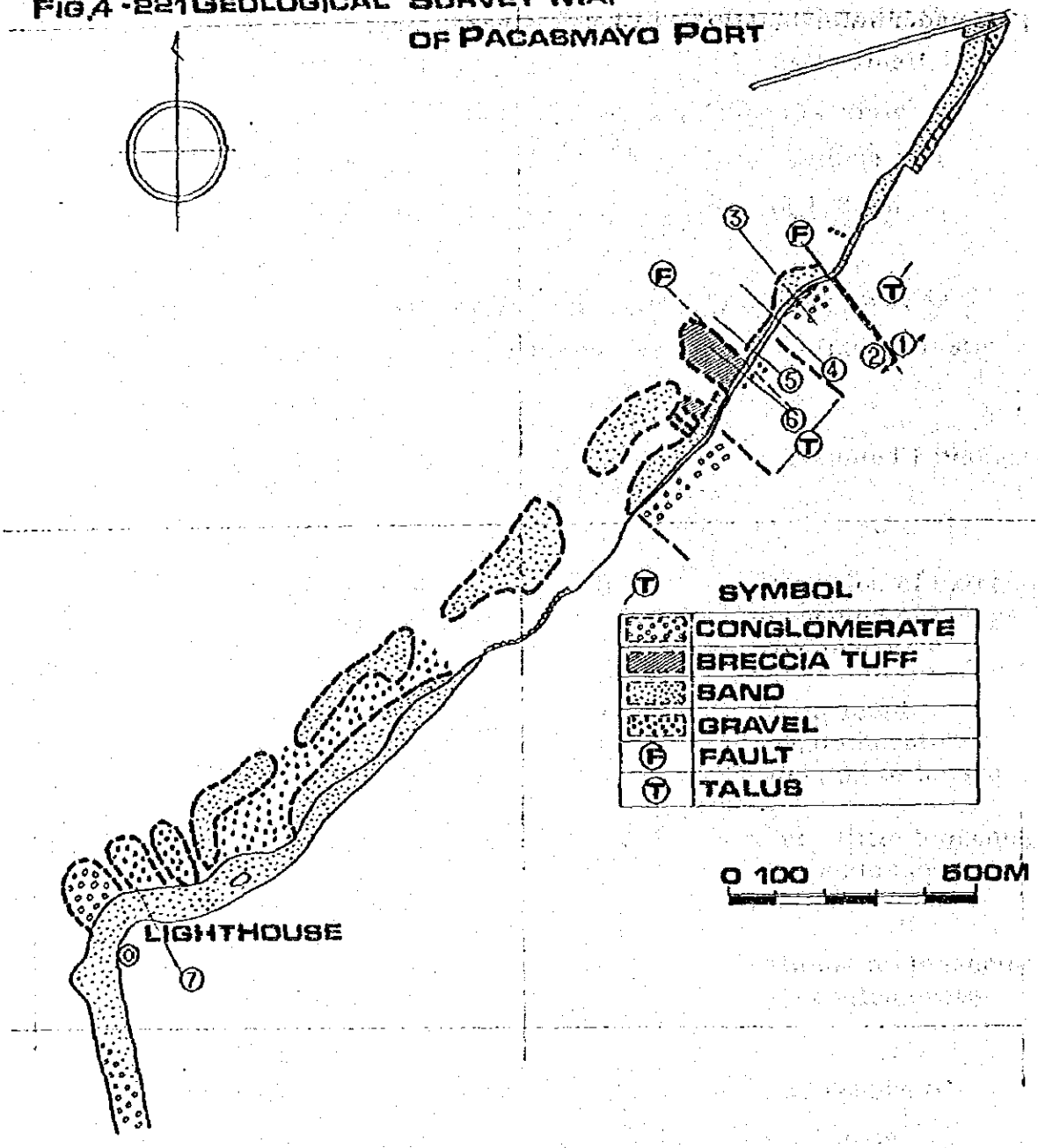


FIG.4-222 OUTLINE OF SEA BED CONDITION IN PROPOSED WATER AREA FOR CONSTRUCTION OF PACASMAYO PORT

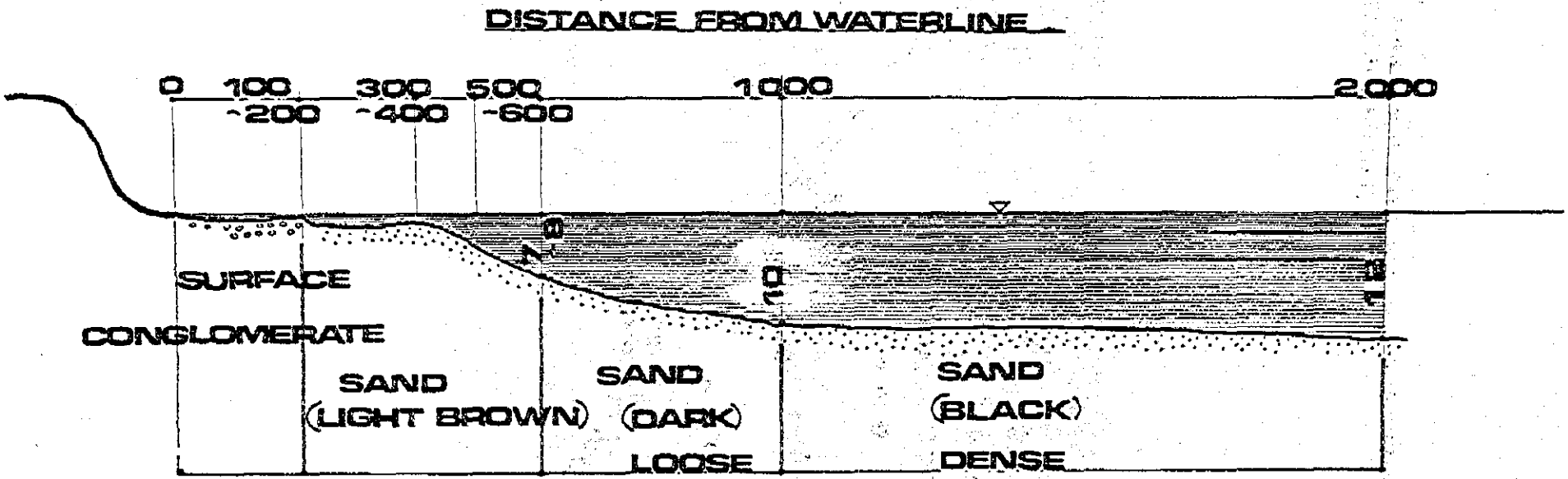


FIG. 4-223 JET PIERCING LOCATION PLAN
PACASMAYO PORT

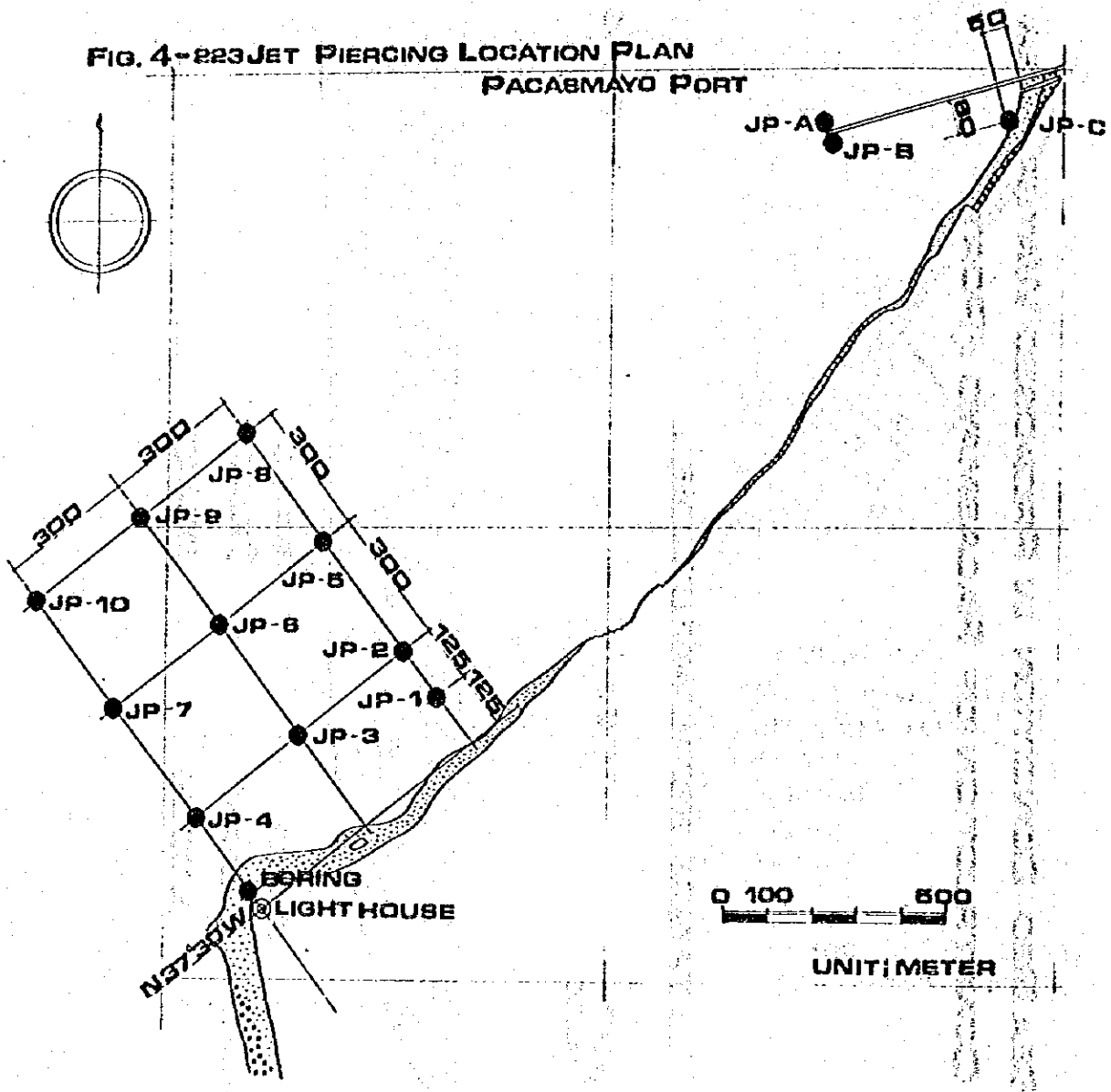


FIG. 4-224 BORING LOG FOR BEACH IN FRONT OF LIGHTHOUSE

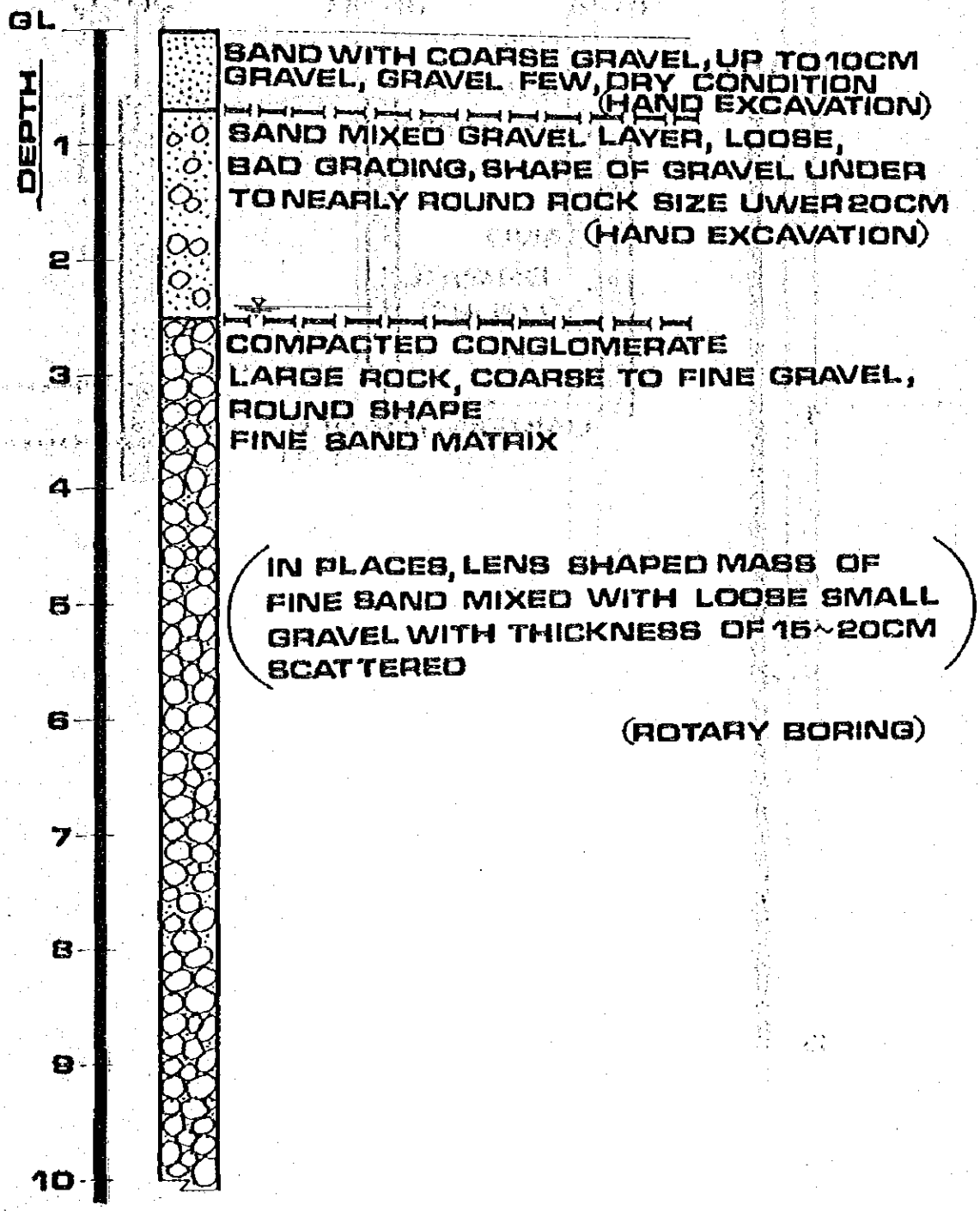


FIG.4-225 JET PIERCING BORING LOG IN VICINITY OF EXISTING PACASMAYO WHARF

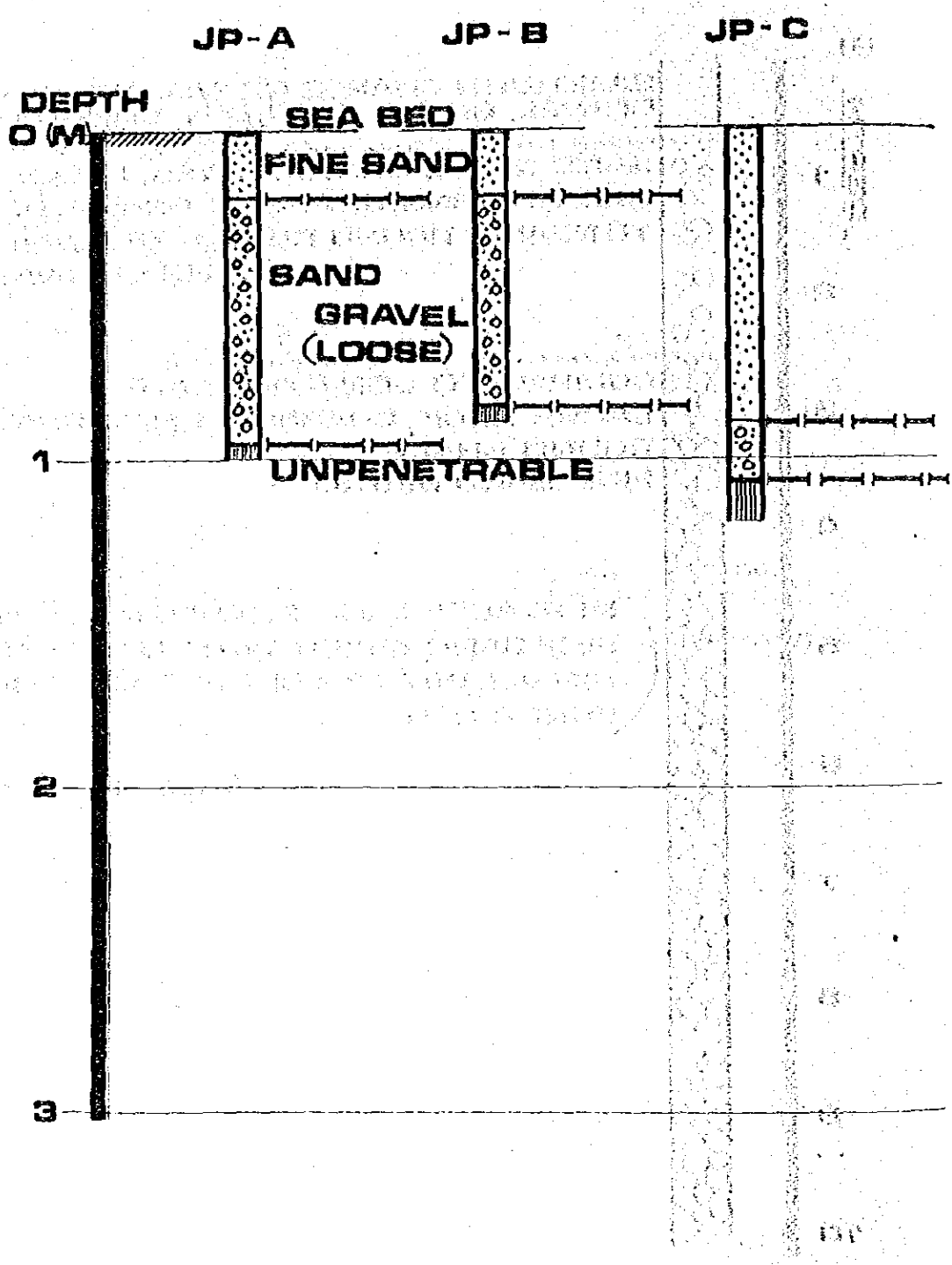


FIG. 4-226-1 JET PIERCING BORING(1) FOR PROPOSED SITE FOR PACASMAYO PORT CONSTRUCTION

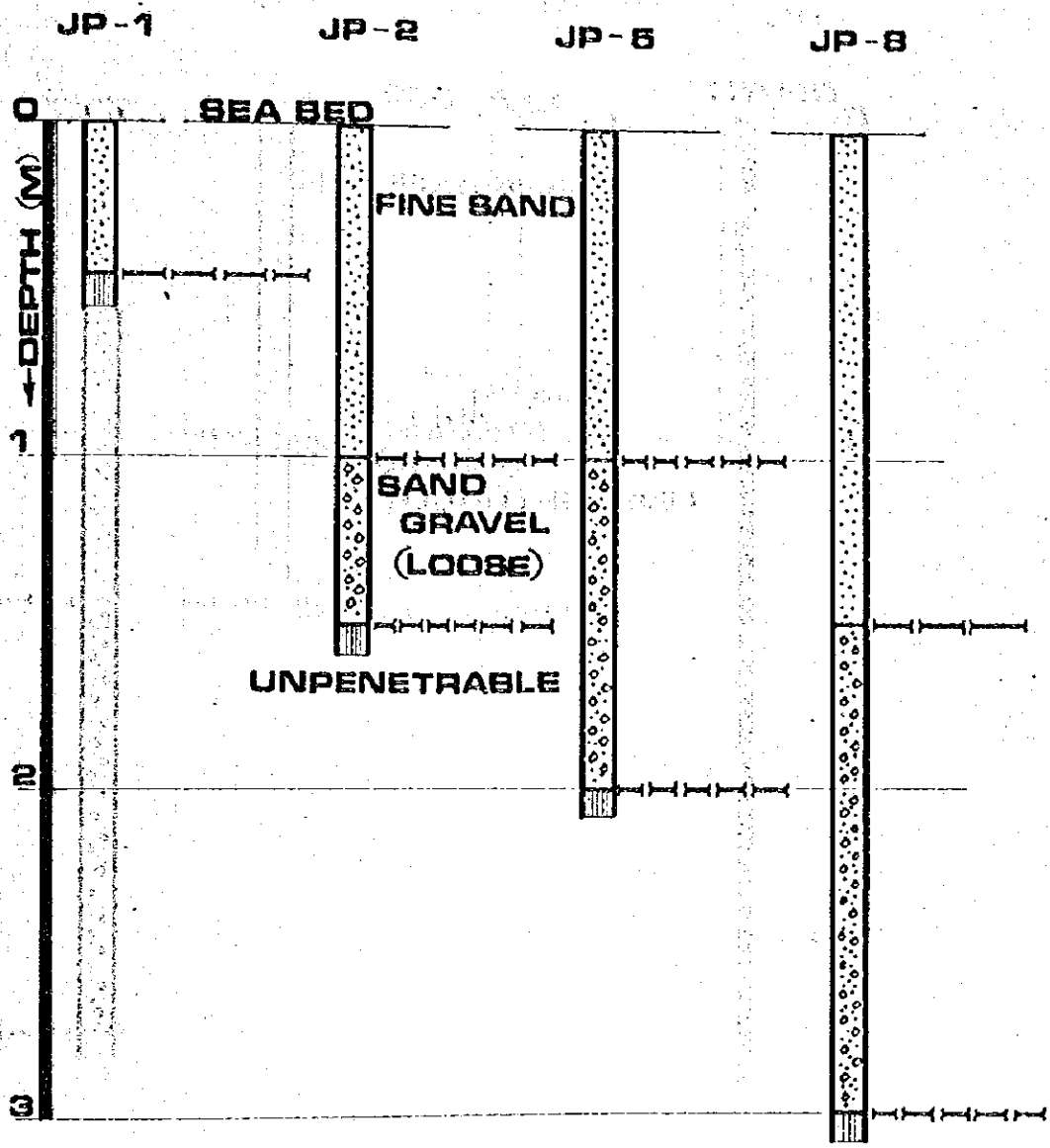


FIG.4-226-2 JET PIERCING BORING LOG (2) FOR PROPOSED SITE FOR PACASMAYO PORT CONSTRUCTION

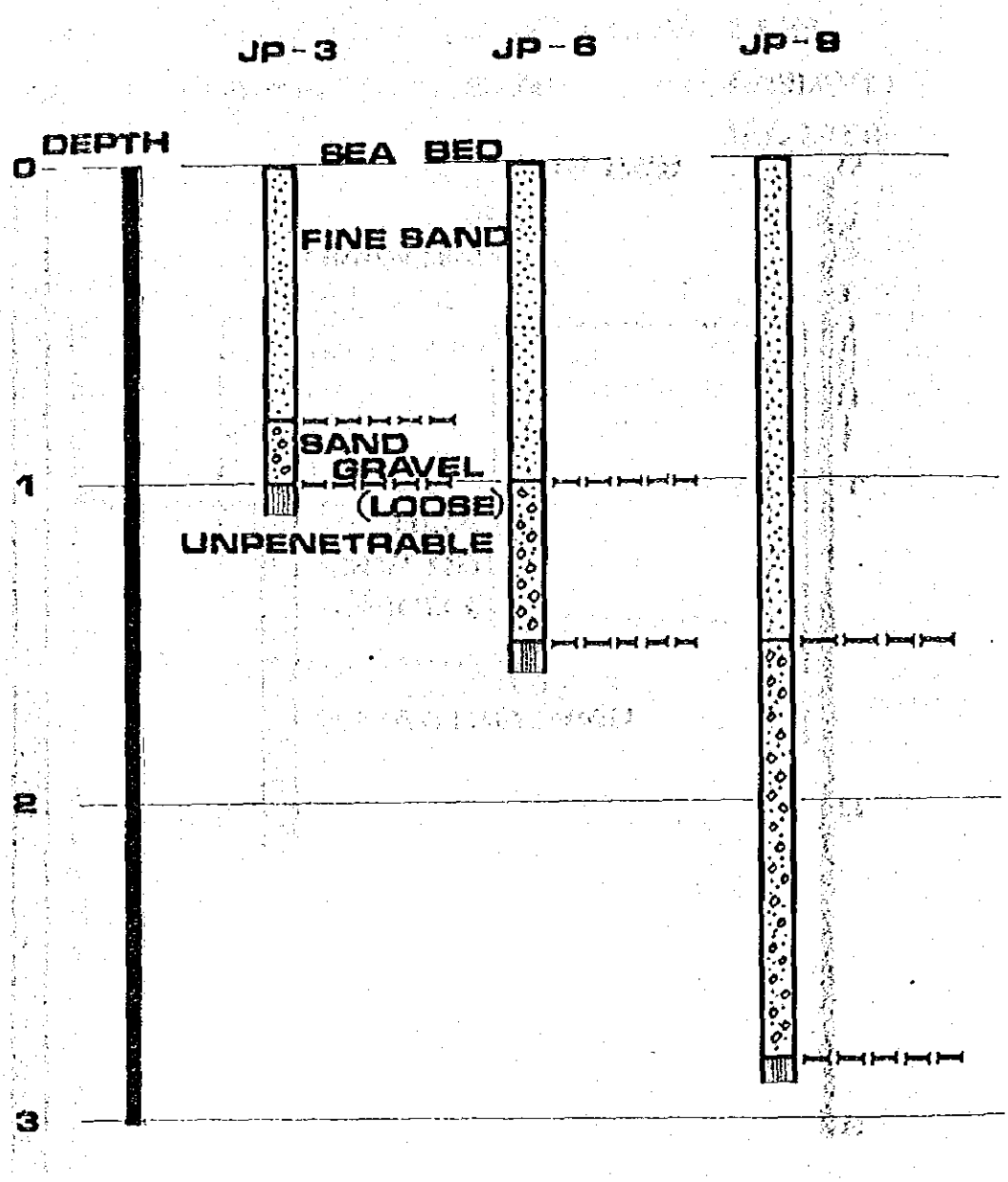


FIG.4-226-3 JET PIERCING BORING LOG(3) FOR PROPOSED SITE OF PACASMAYO PORT CONSTRUCTION

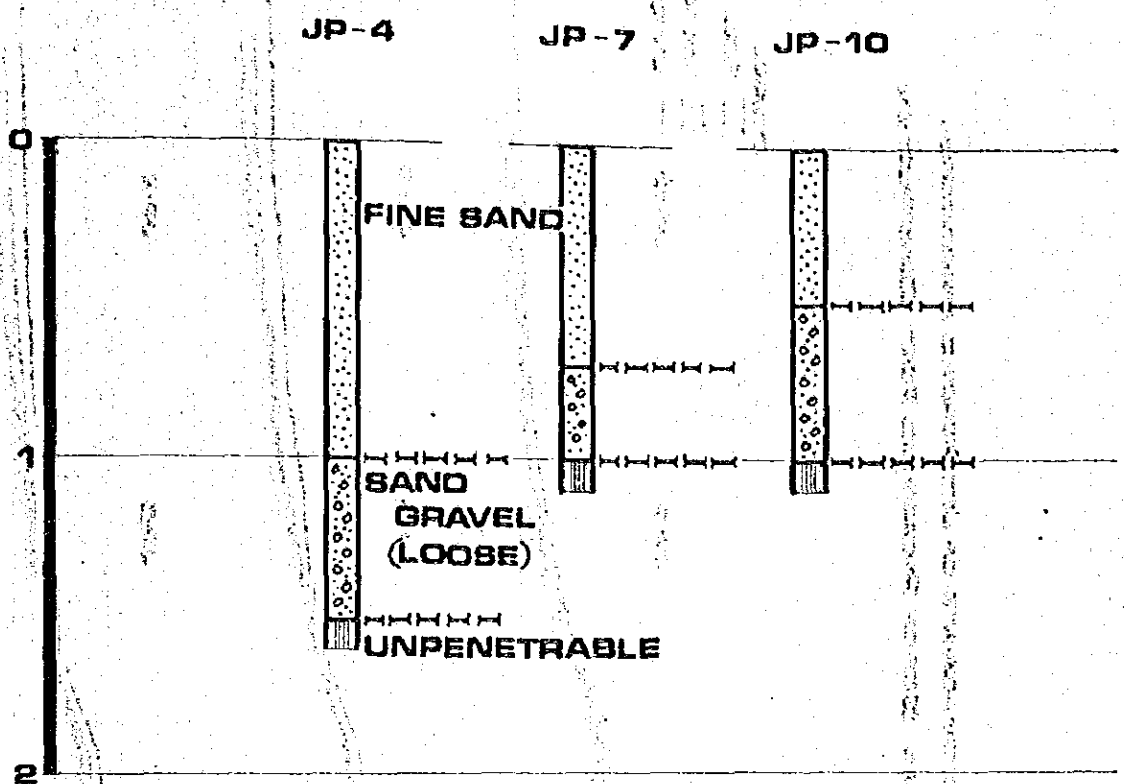


FIG.4-227 SECTIONAL PLAN BASED ON RESULTS OF JET PIERCING INVESTIGATION FOR PROPOSED SITE OF PACASMAYO PORT CONSTRUCTION

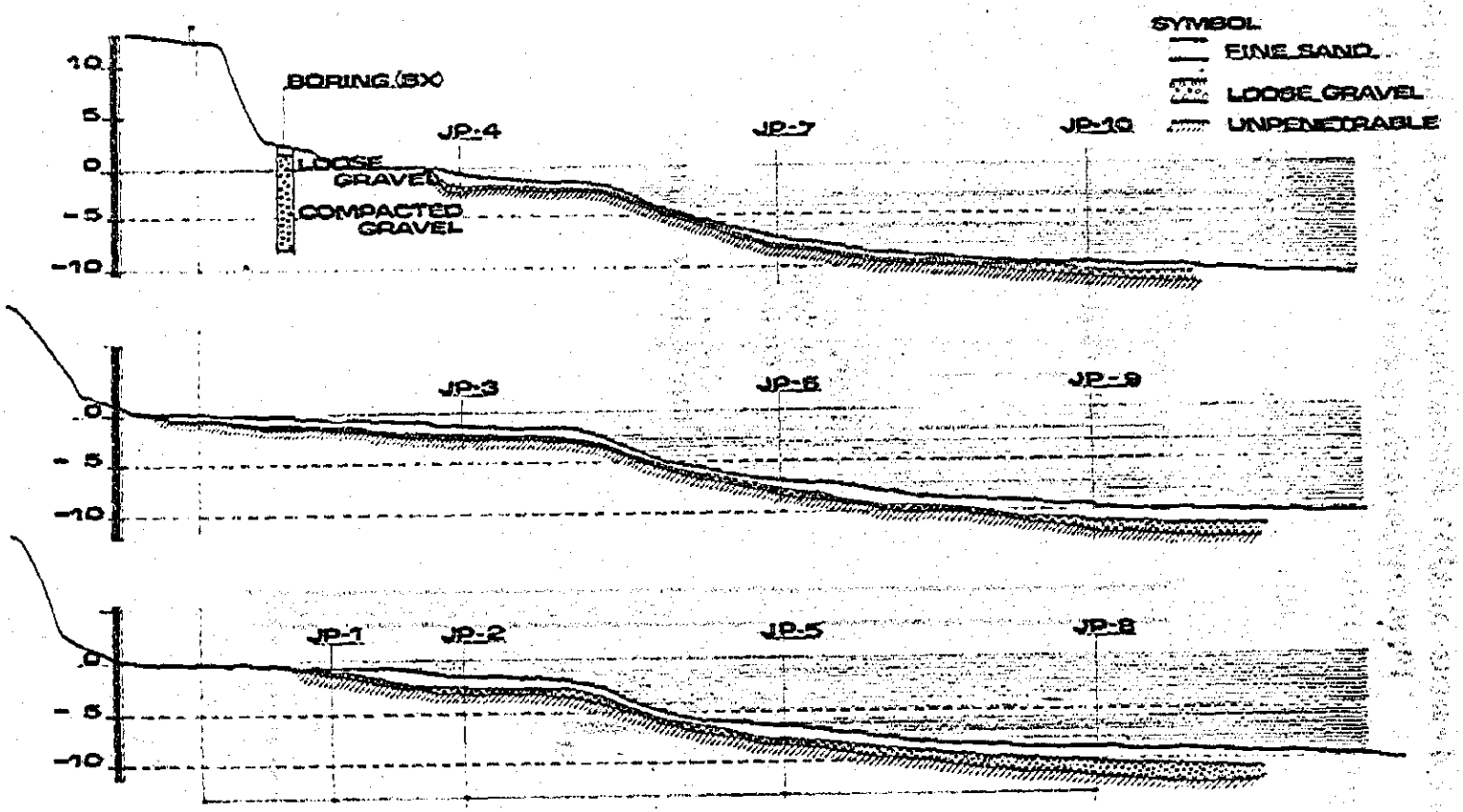


FIG.4-228 LOCATION PLAN FOR ELASTIC WAVE INVESTIGATION FOR PACASMAYO PORT

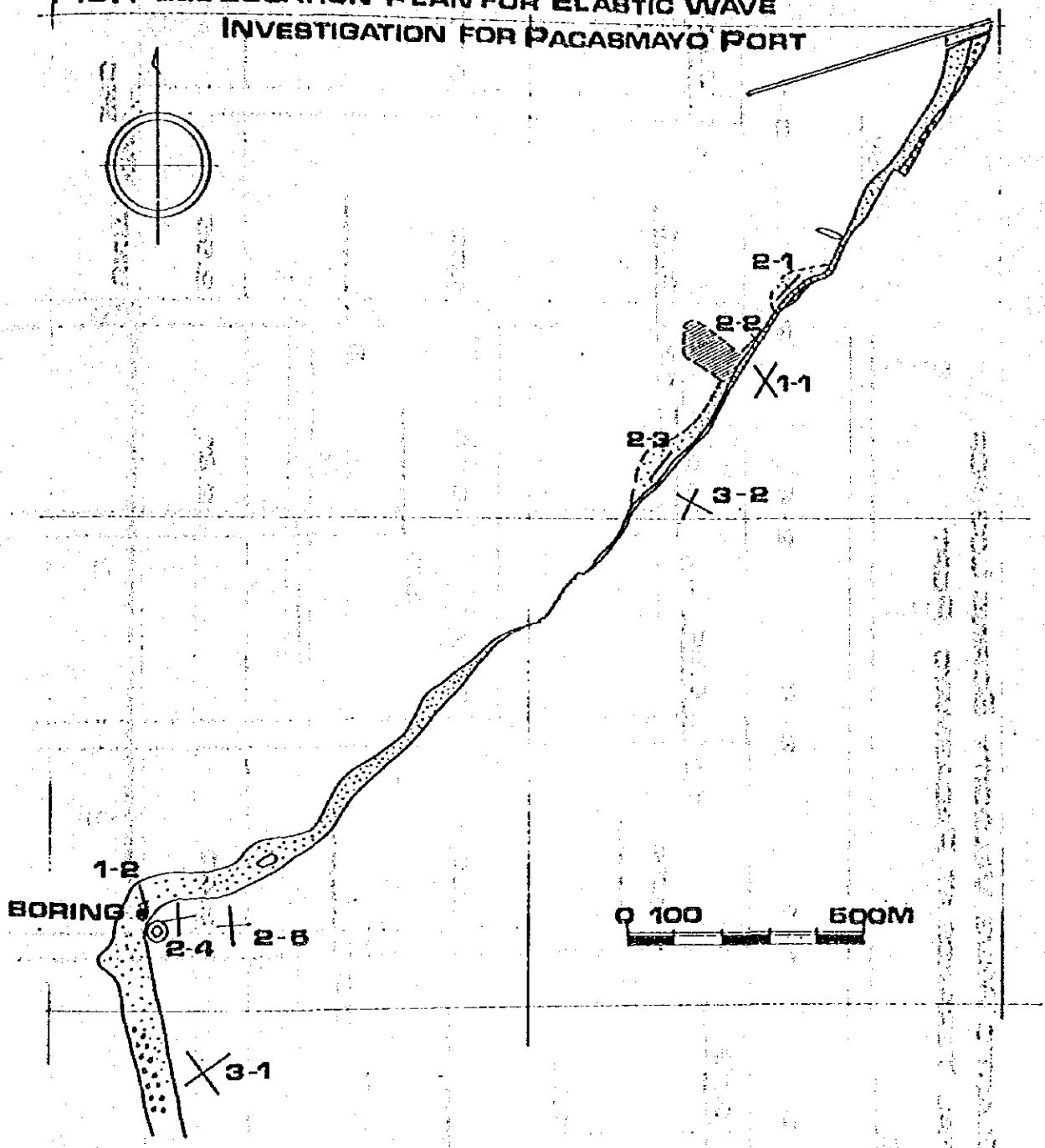


FIG.4-228-1 ELASTIC WAVE VELOCITY BORING LOG FOR COASTAL TERRACE AT PACASMAYO PORT

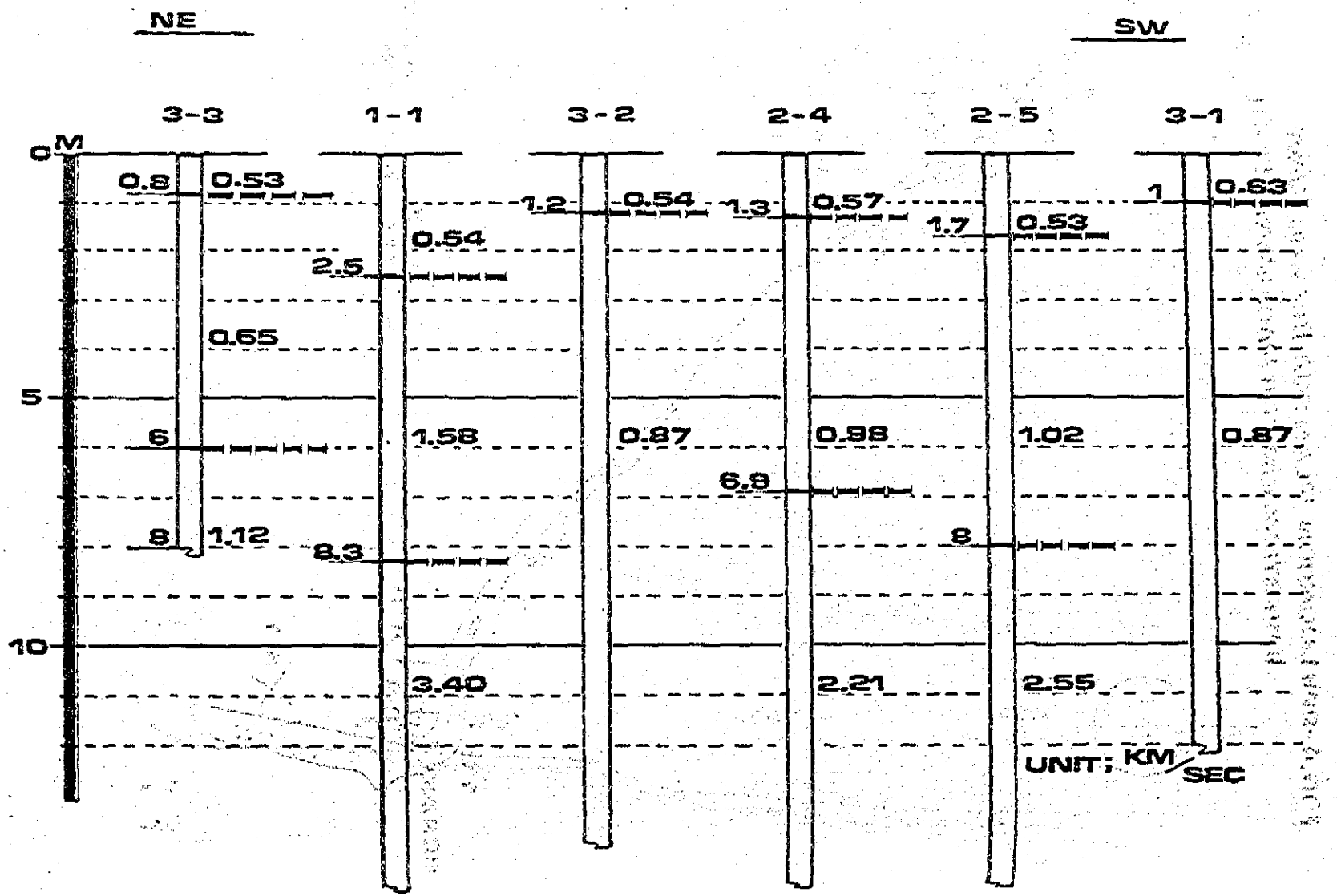


FIG4-228-2 ELASTIC WAVE VELOCITY BORING FOR COASTAL TERRACE AT PACASMAYO PORT

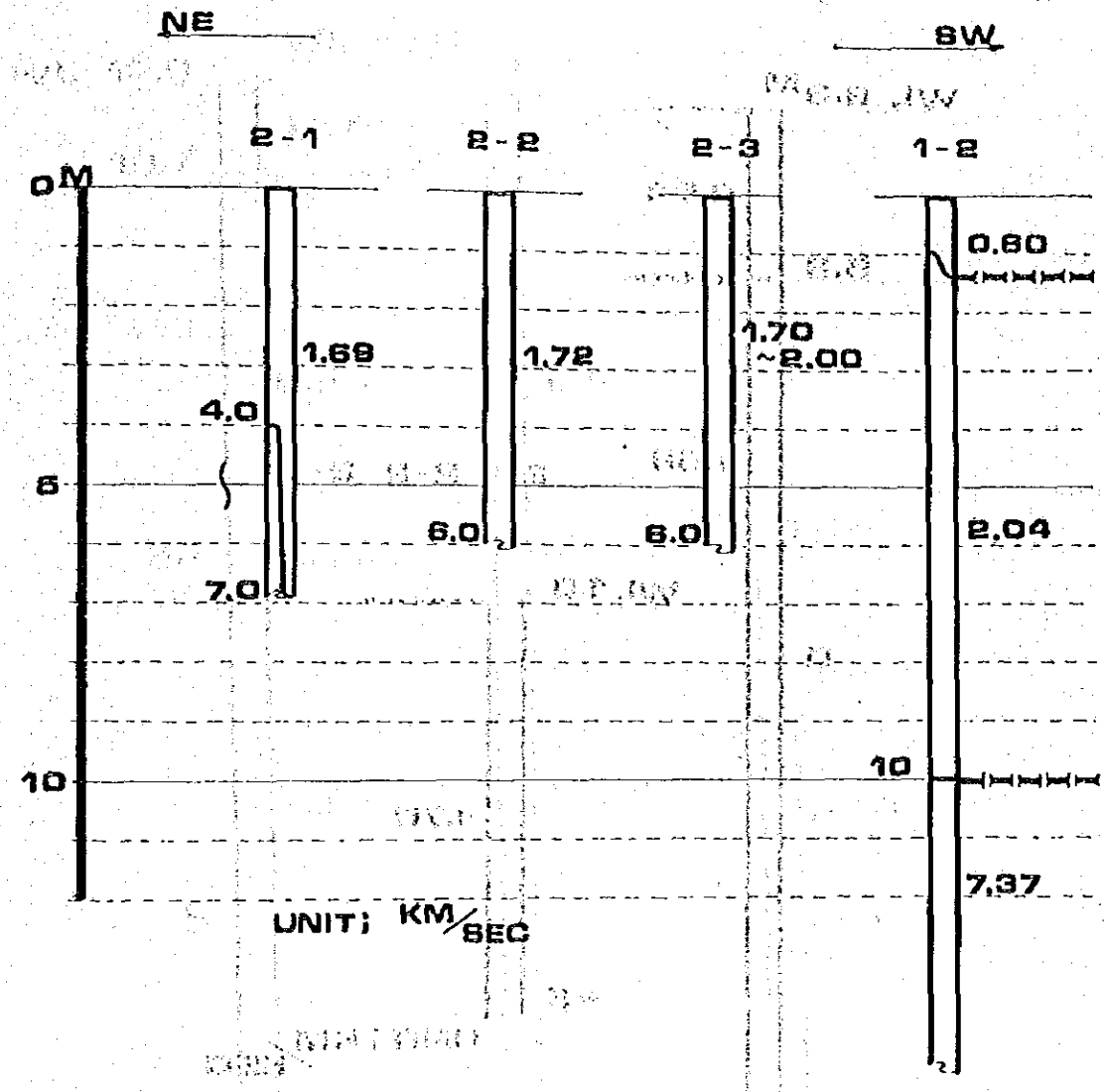


FIG.4-228-3 ELASTIC WAVE VELOCITY BORING LOG FOR VICINITY OF 1.8 KM NORTHEAST OF PACASMAYO LIGHTHOSE

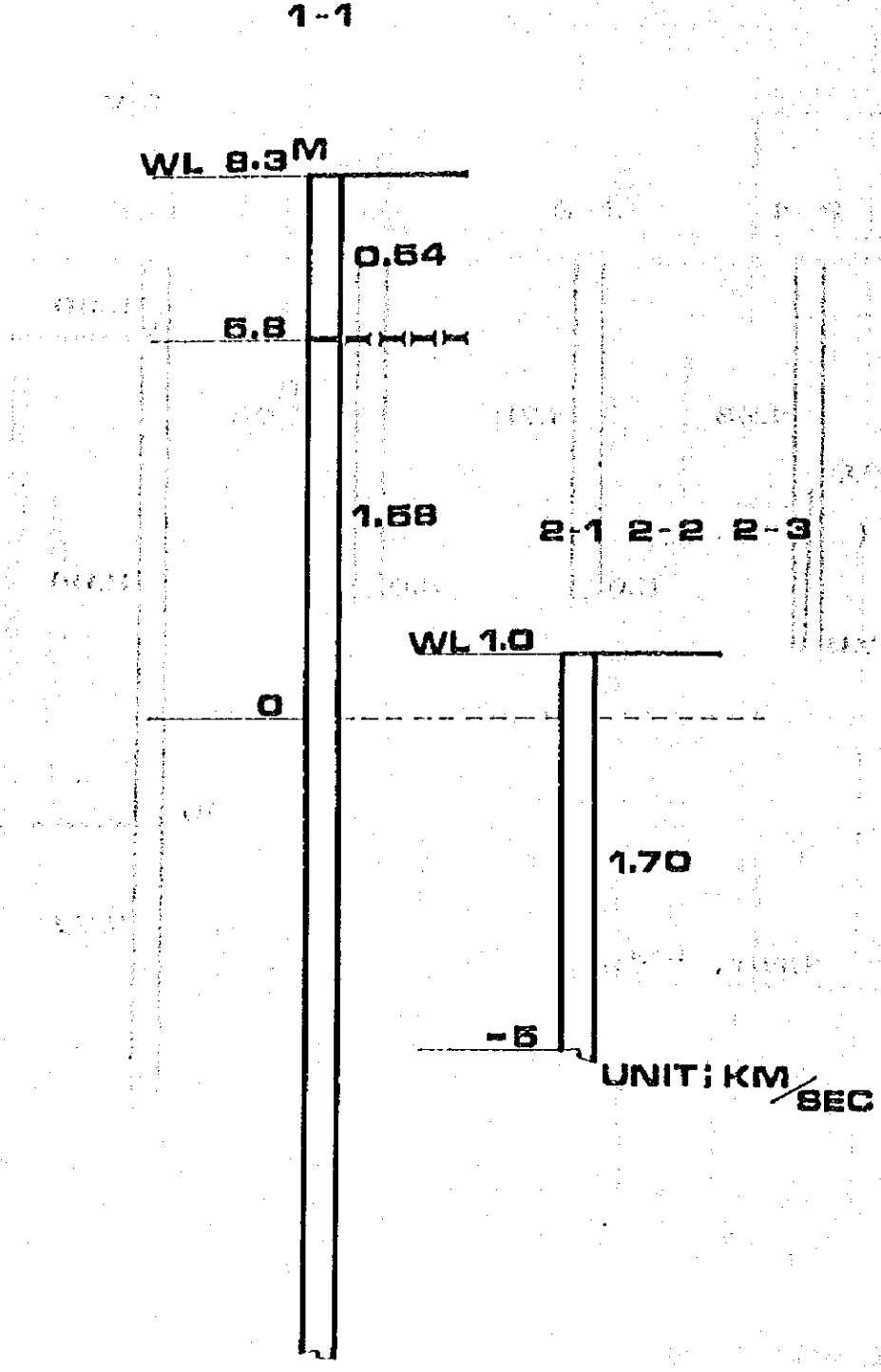
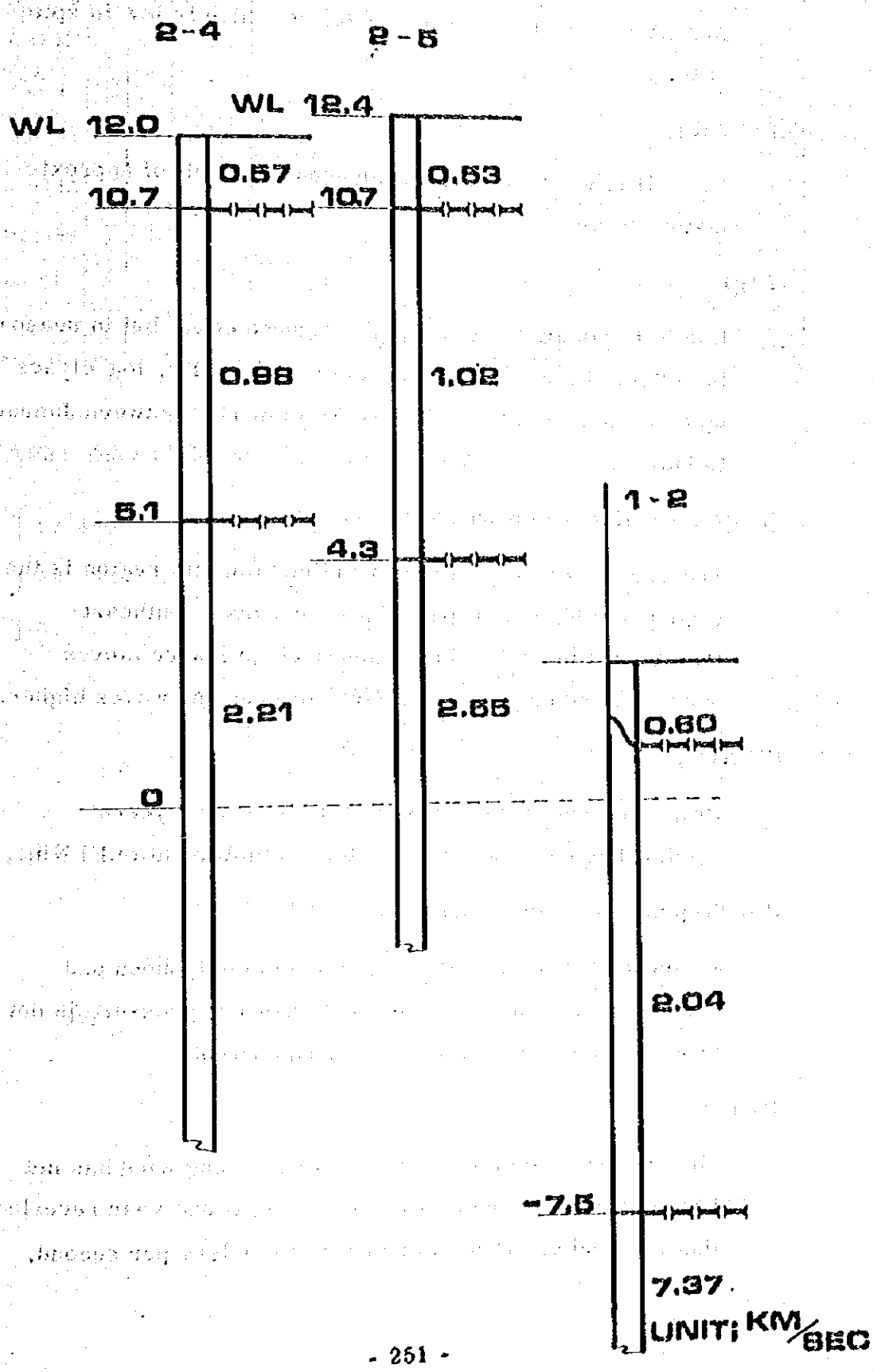


FIG.4-229-4 ELASTIC WAVE VELOCITY BORING LOG FOR VICINITY OF PACASMAYO LIGHTHOUSE



2-3 Weather

(Temperature)

Annual average temperature is 20.7°C which is low in spite of the low latitude.

(Rainfall)

Rainfall is extremely little with annual rainfall of approximately 40 mm.

(Fog)

Due to Humboldt Current fog is produced often; but in season the effect of fog in the bay is small. Generally, fog clears up by noon hour. Least fog occurs in months between January to March.

(Subtropical High Atmospheric Pressure)

The principal factor influencing climate in this region is the subtropical high atmospheric pressure over southeast Pacific; but in winter this atmospheric pressure moves north so southerly wind becomes stronger and waves higher.

(El Niño)

From past records, it is said that for several years rainfall has increased with southward movement of El Niño.

(No Tropical Low Atmospheric Pressure)

A distinctive feature of this climate is the typhoon and cyclone generating tropical low atmosphere pressure is not produced due to cold Peruvian ocean current.

(Wind)

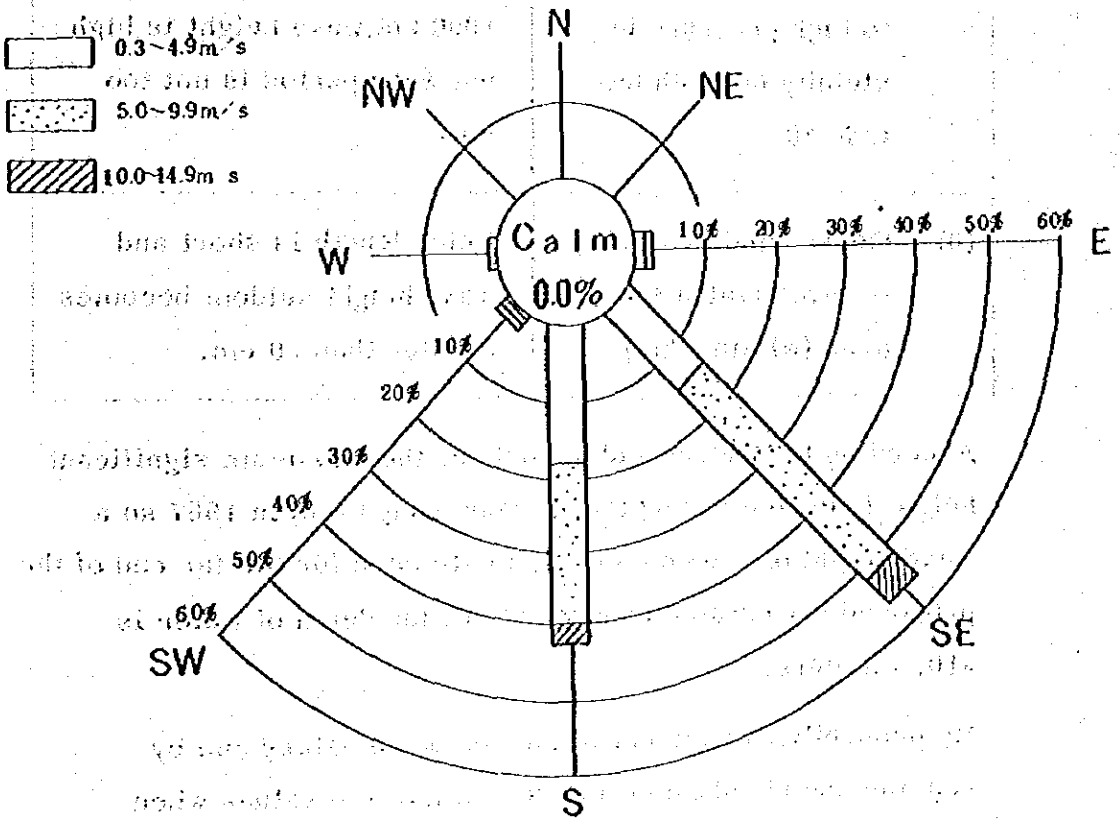
Most of the wind blows from south but strong wind has not been observed. Observations for the past one year revealed that all wind velocities were under 15 meters per second.

Table 4-231 Number and Rate of Wind Occurrence (1975/4 ~ 1976/3)

Velocity \ Direction		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
CALM	Time																	
	%																	
03~ 49 m/sec	Time					4		161		191		4						365
	%					0.4		14.7		17.7		0.4						33.1
50~ 99	Time					3		106		210		11		1				161
	%					0.3		37.2		22.0		1.0		0.1				60.5
100~149	Time							44		18		4						66
	%							4.0		1.6		0.4						6.0
150~199	Time																	
	%																	
200以上	Time																	
	%																	
Total	Time					7		611		454		19		1				1092
	%					0.6		56.0		41.6		1.7		0.1				100.0

Note: Investigation at roof of the port office

FIG. 4-231 WIND DIAGRAM FOR PACASMAYO PORT



2-4 Marine Phenomenon

(1) Wave

(Wave height)

Wave height was obtained from weather charts of 1957 to 1975 and Bretschneider method was adopted.

Following 3 sources for wave generation can be considered:

(1) Southerly wind due to medium latitude high pressure in vicinity of south latitude 30 - 40°	Since there is 3,000 km of decay distance, wave height is mostly 30 cm, and wave period is fairly long
(2) SSE to SSW wind due to high pressure in vicinity of south latitude 20°	Decay distance of less than 1000 km, wave height is high but wave period is not too long
(3) Ocean wind in vicinity of investigated sea area (within 5 km)	Fetch length is short and wave height seldom becomes greater than 50 cm.

According to Bretschneider method, the maximum significant height indicated during the 18 year period was in 1967 so a wave height of 4.08 meters was estimated for the far end of the proposed breakwater location where the depth of water is -10.5 meters.

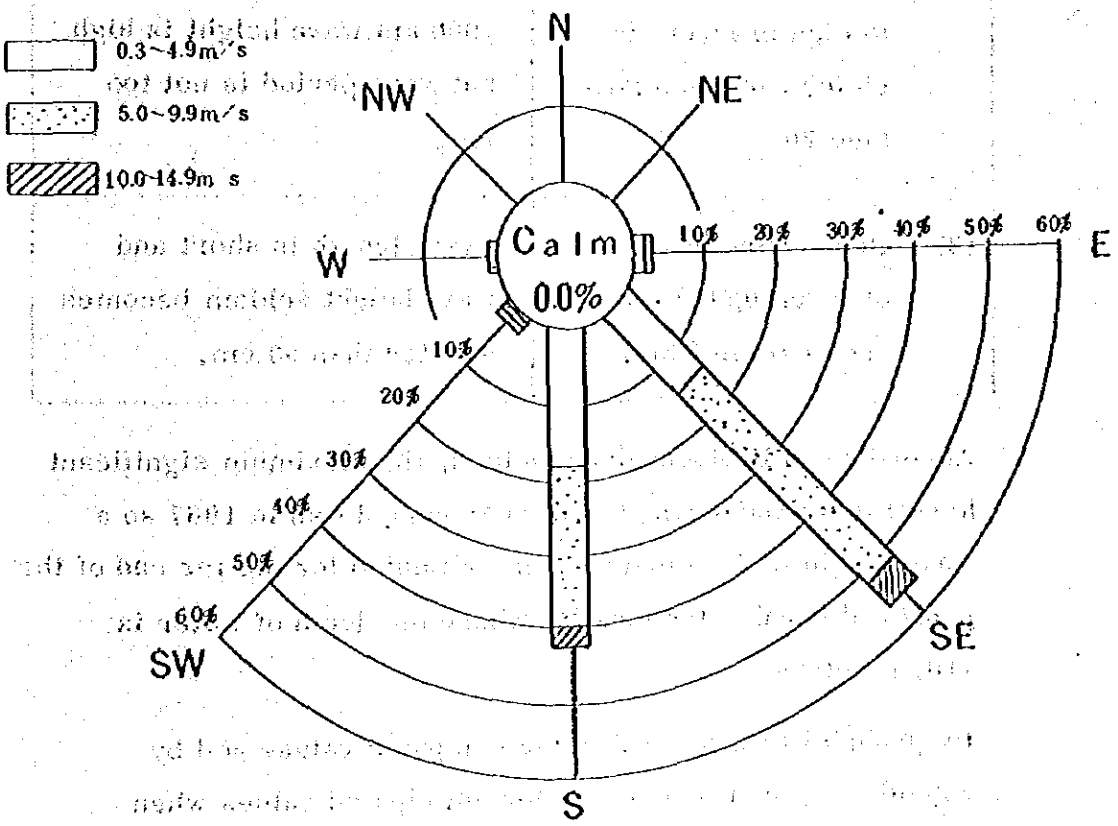
By probability treatment of the computed values and by considering standard errors for anticipated values when recurrence period is assumed as 50 years, an estimated wave height of 4.90 meters was obtained for this location.

Table 4-231 Number and Rate of Wind Occurrence (1975/4 ~ 1976/3)

Velocity \ Direction		N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	Total
CALM	Time																	
	%																	
03~ 49 m/sec	Time					1		161		191		1						365
	%					0.4		14.7		17.7		0.4						33.1
50~ 99	Time					3		106		210		11		1				161
	%					0.3		37.2		22.0		1.0		0.1				60.5
100~149	Time							44		18		4						66
	%							4.0		1.6		0.4						6.0
150~199	Time																	
	%																	
200以上	Time																	
	%																	
Total	Time					7		611		454		19		1				1092
	%					0.6		56.0		41.6		1.7		0.1				100.0

Note: Investigation at roof of the port office

FIG. 4-231 WIND DIAGRAM FOR PACASMAYO PORT



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By probability treatment of the computed values and by considering standard errors for anticipated values when recurrence period is assumed as 50 years, an estimated wave height of 4.90 meters was obtained for this location.

The wave height of 4.90 meters was adopted as design wave height in determing the location and structure of the breakwater. Prominent wave direction is in SSE - SSW direction; but refraction at breakwater location was obtained at interval of 8 - 22 seconds. Refraction diagram is shown in Figure 4-241. Wave diffraction occurring in the harbor with breakwater for waves in the same direction is shown in Figure 4-242. See Figure 4-243 for diffraction diagram of wave in SW direction which is believed to have the greatest effect in the harbor.

So,from these diagrams, it is believed that after the breakwater is constructed the water inside the breakwater will be sufficiently calm.

FIG. 4-241 REFRACTION DIAGRAM

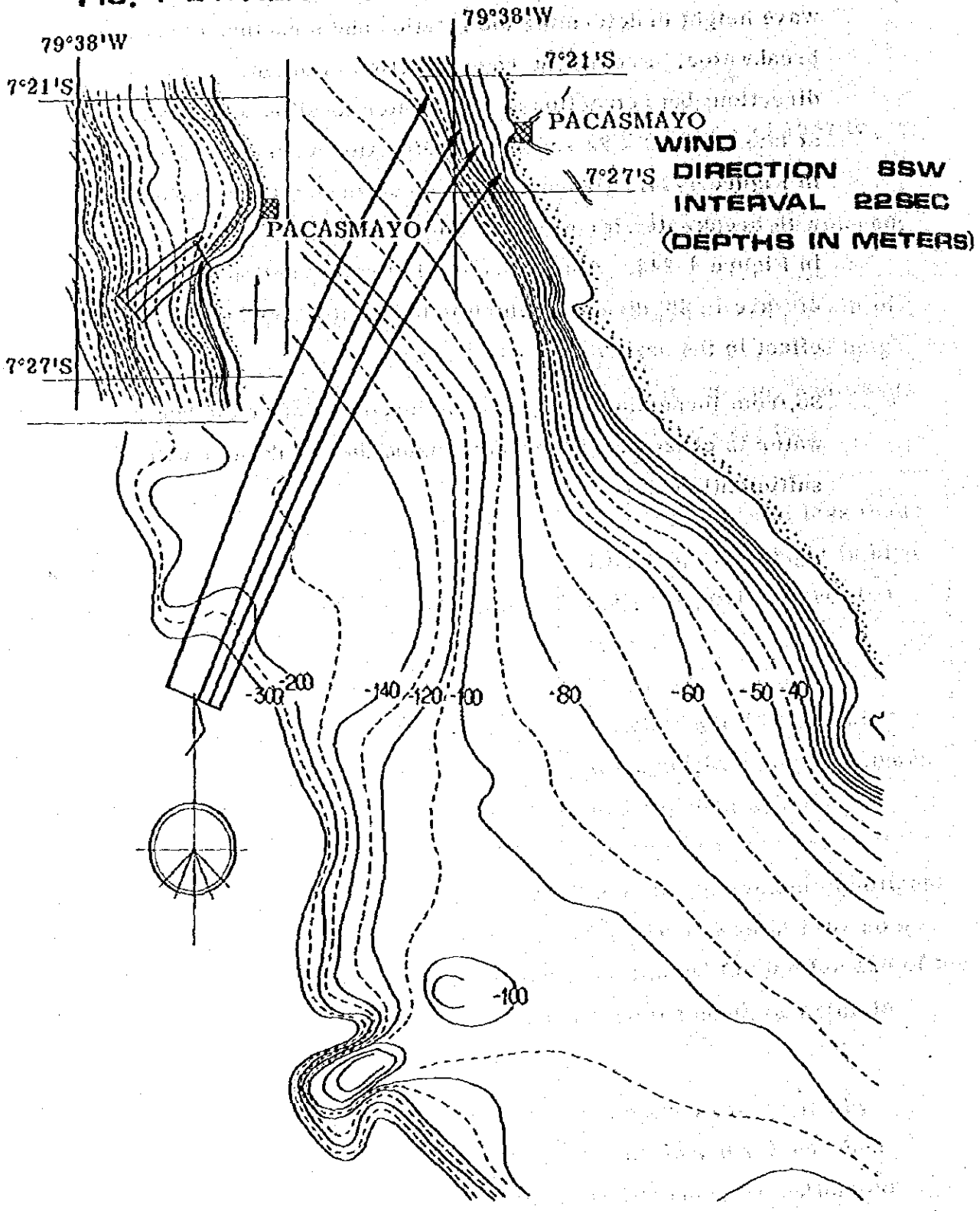


FIG. 4-242 DIFFRACTION DIAGRAM (SSW 15SEC)
FOR INSIDE OF HARBOR
(WATER DEPTH -8M)

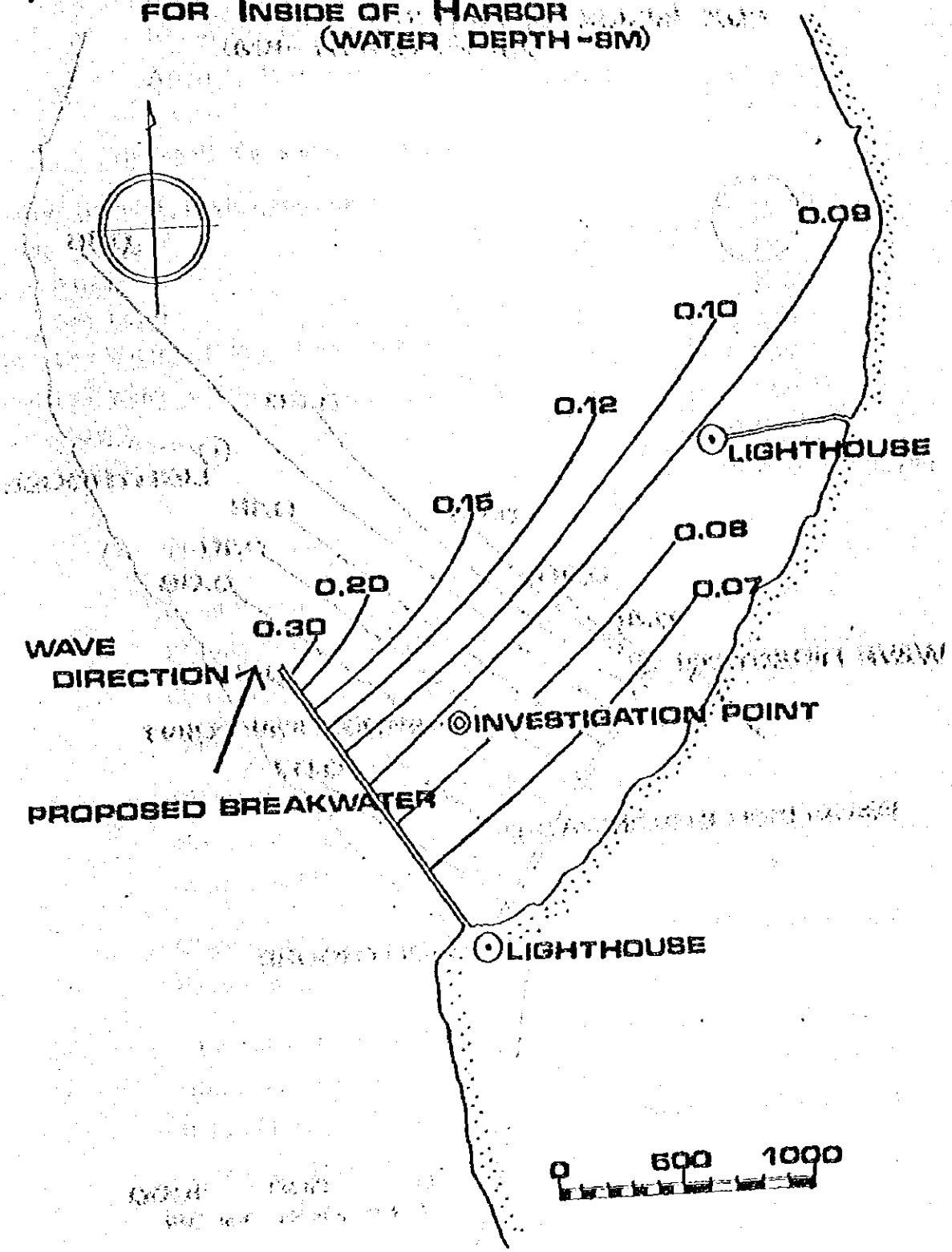
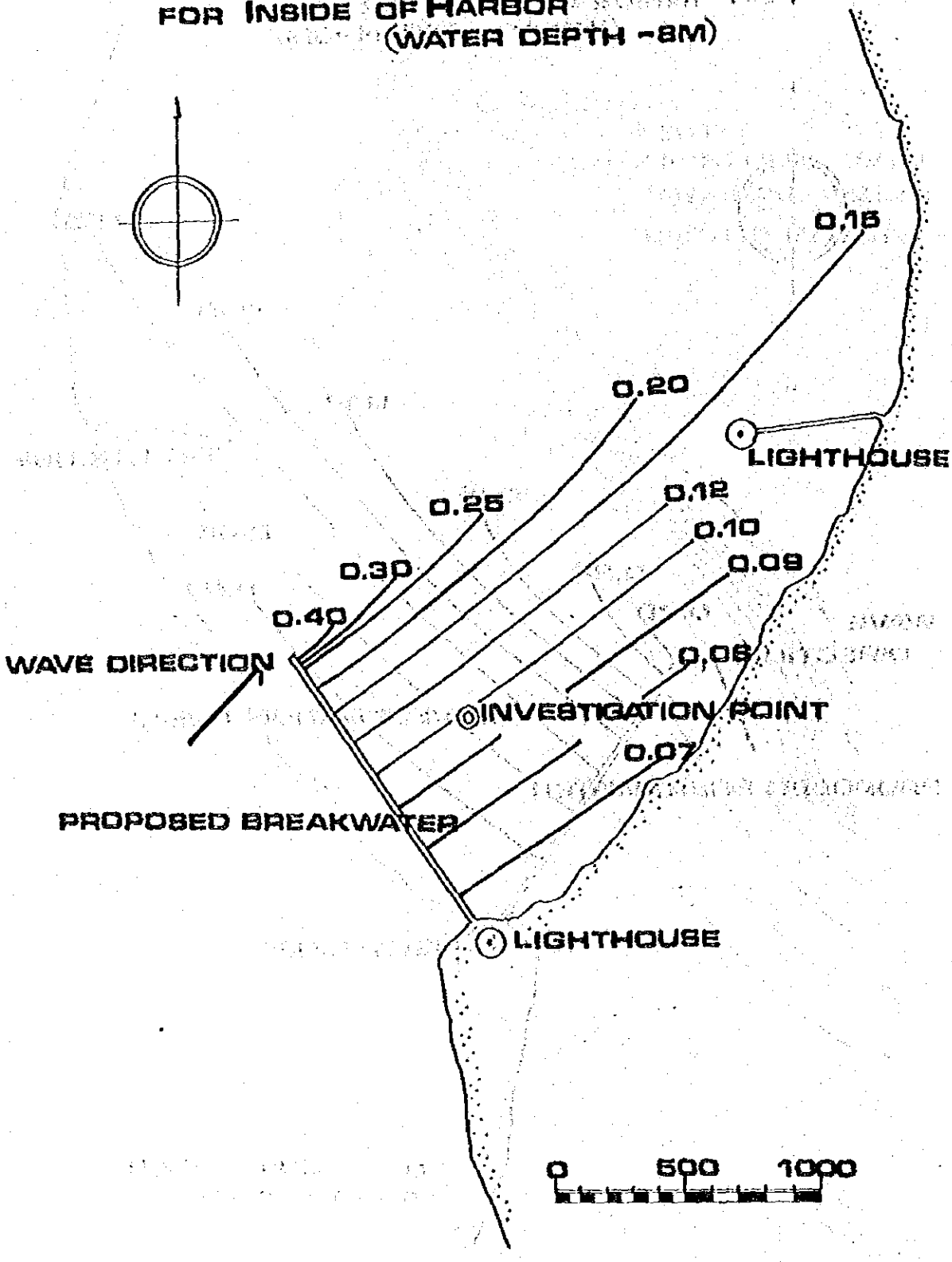


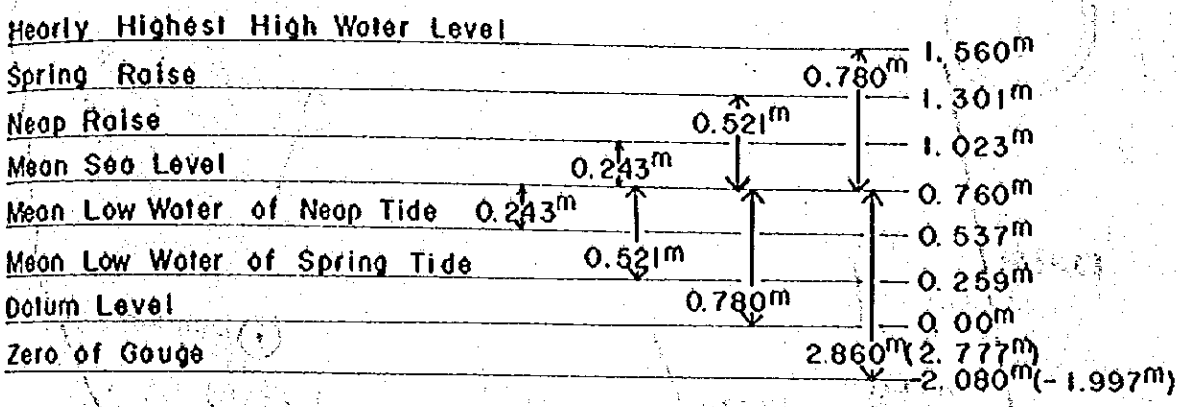
FIG.4-243 DIFFRACTION DIAGRAM (SW15SEC)
FOR INSIDE OF HARBOR
(WATER DEPTH -8M)



(2) Tide

Results of tide level observations for March 16, 1976 to April 5, 1976 were analyzed to obtain following tide levels.

Hormonic Constants of Tide



(3) Tidal current

Results of tracking floats during spring tide are shown in Figure 4-244. Offshore, a stable tidal current in N.NW. direction was observed. At location No. 1, this value is approximately two times the value at neap tide.

Floats nearest to shore (approximately 0.35 km) were observed to be moving in direction of shore and is believed to have ridden the swirl produced near the shore.

Closer to shore, the current moves in direction of shore and becomes slower.

From the analysis of results of current observation using floats and current meter, with the construction of breakwater it is believed that current inside the breaker will be in clockwise direction as shown in Figure 4-245.

FIG.4-244 TRACKING OF FLOATING MARKERS DURING SPRING TIDE

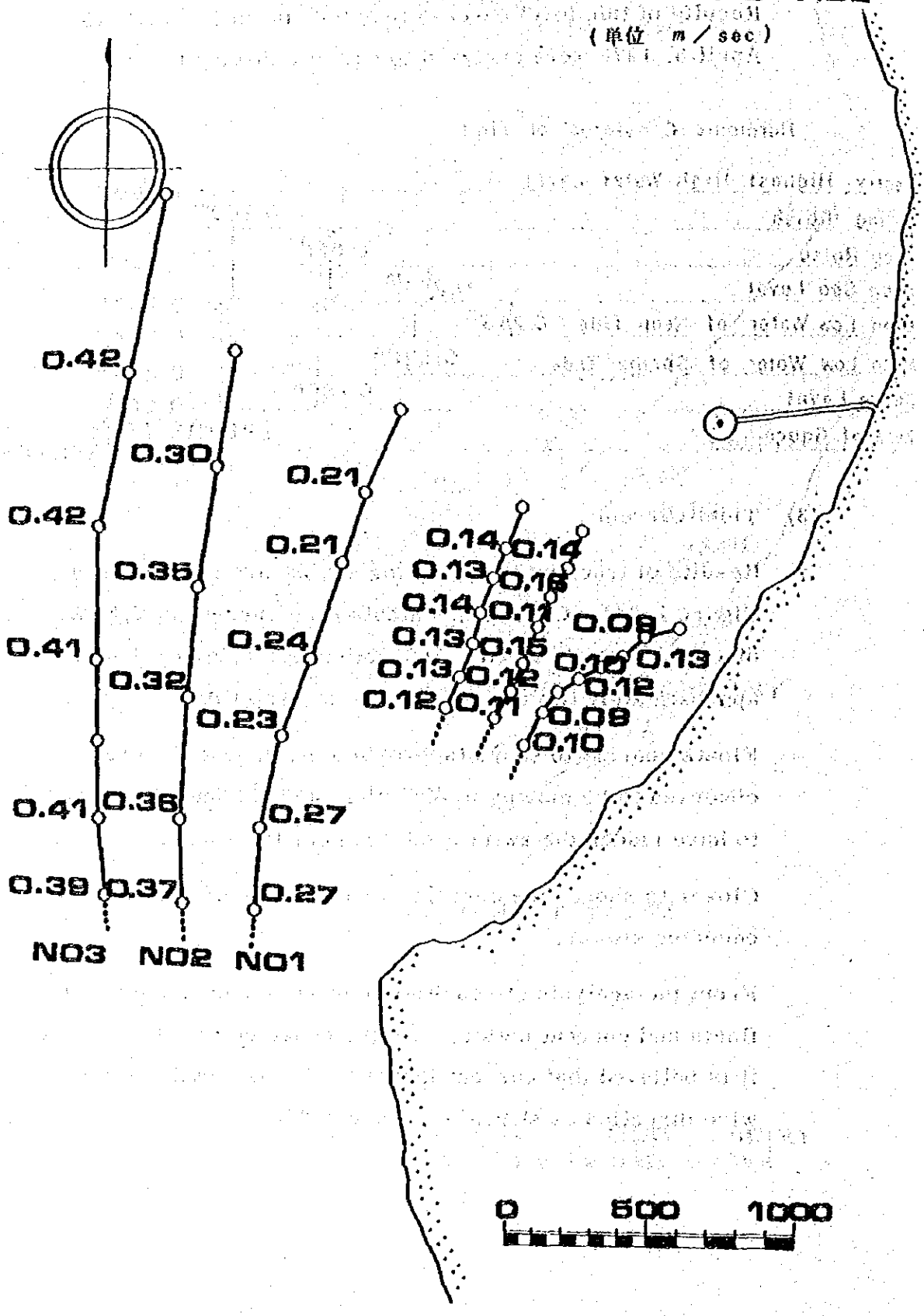
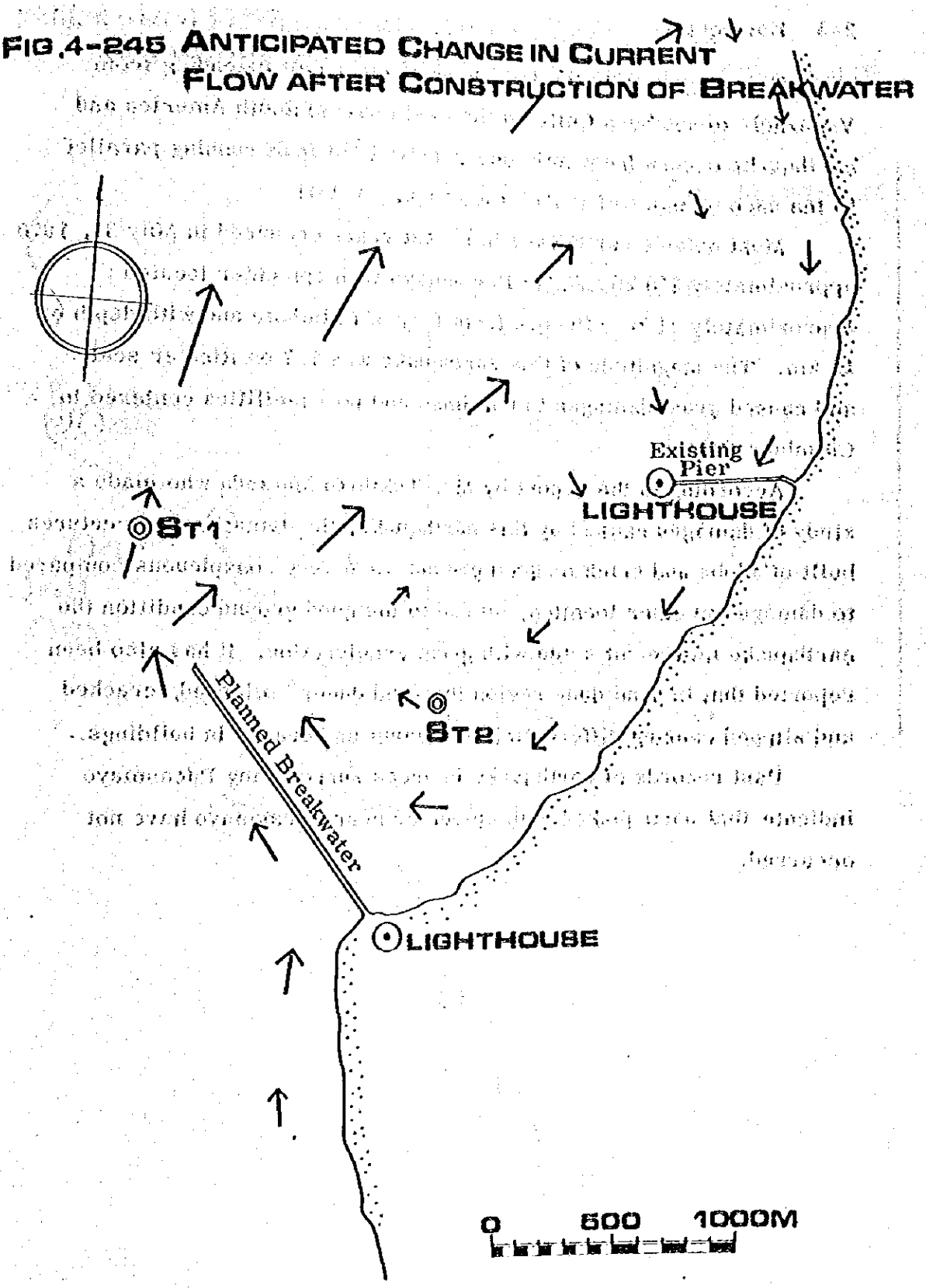


FIG.4-245 ANTICIPATED CHANGE IN CURRENT FLOW AFTER CONSTRUCTION OF BREAKWATER



2-5 Earthquake

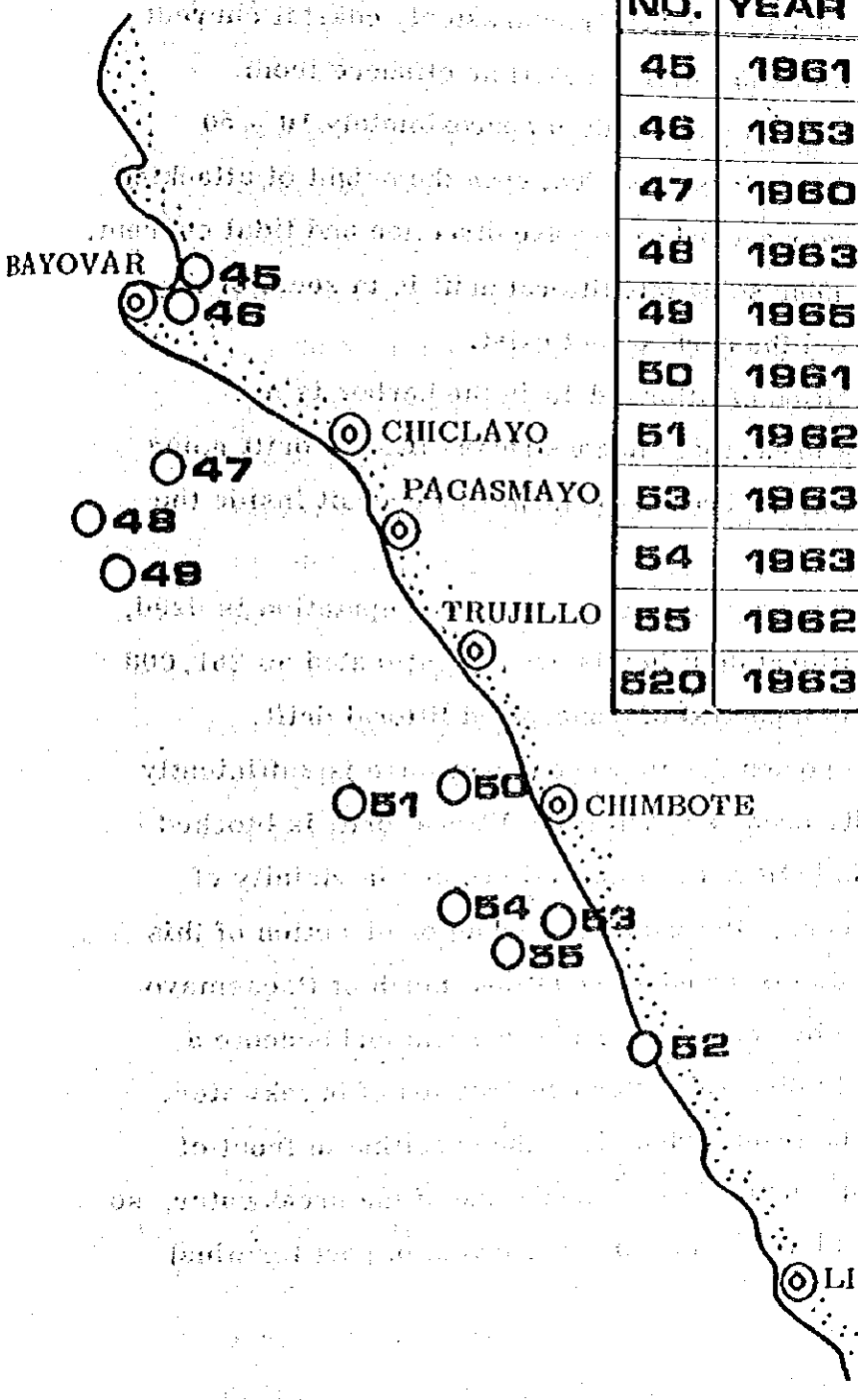
This region is in the Pacific earthquake belt extending from Venezuela to southern Chile on the west coast of South America and earthquake occurs frequently due to activity of fault running parallel to the deep offshore of Peru. (See Figure 4-251)

Most notable earthquake in recent years occurred in May 31, 1970 approximately 250 km SSE of Pacasmayo with epicenter located approximately 25 km offshore from City of Chimbote and with depth of 56 km. The magnitude of this earthquake was 7.7 on Richter scale and caused great damages to buildings and port facilities centered in Chimbote City.

According to the report by Mr. Tokihiko Matsuda who made a study of damages caused by this earthquake, the damages to structures built of adobe and brick on good ground were very conspicuous compared to damages in other location, so due to the good ground condition the earthquake movement acted with great acceleration. It has also been reported that in sand dune region the sand dunes collapsed, cracked and slipped causing differential settlement and cracks in buildings.

Past records of earthquake in areas surrounding Pacasmayo indicate that earthquakes with epicenter near Pacasmayo have not occurred.

FIG. 4-251 REPRESENTATIVE EARTHQAKES IN AREAS AROUND PACASMAYO 1953 ~ 1965



NO.	YEAR	MAGNI.	REMARK
45	1961		
46	1953	5.6	
47	1960	6.7	
48	1963	6.5	
49	1965	5.9	
50	1961		
51	1962	6.1	
53	1963		
54	1963	5.9	
55	1962	6.3	
520	1963	7.0	

SCALE ; 1:5,000,000

2-6 Littoral Drift

In vicinity of lighthouse where wave energy is concentrated due to effects of refraction, littoral drift due to wide breaker zone and violent disturbance was observed. Silty and clayey materials contained in the littoral drift and carried by north northeasterly coastal current are observed moving almost parallel to coastline offshore from Pacasmayo City as turbid belt with width of approximately 10 - 50 meters. The width of this belt is dependent upon the height of attacking wave and the flow will vary according to wave direction and tidal current. The source of sand for nourishing this littoral drift is in south of the lighthouse and sands from the north do not exist.

At present, deposition of littoral drift in the harbor is not confirmed; but after the breakwater is constructed littoral drift going around the extreme end of the breakwater arm will deposit inside the breakwater.

If wave carrying energy obtained from wave computation is used, the volume of coastal littoral drift in this area is estimated as 261,000 tons per year and this is a portion of transported littoral drift.

The direction of erosion due to predominant wave is sufficiently north of the present city area, so even if the littoral drift is blocked by the breakwater, it is believed that coastal erosion in vicinity of existing pier will not occur. However, depending on direction of this predominant wave, sands disturbed at coastline north of Pacasmayo City will be transported by southerly coastal current and become a littoral drift in southerly direction after construction of breakwater. This littoral drift will be transported along the coastline in front of Pacasmayo City and into the harbor on north side of the breakwater, so this point must be considered in planning the layout of port terminal facilities.

SECTION 3. CONCEPT OF PORT DEVELOPMENT

3-1 Prerequisite for Present Situation on Traffic and Transportation and Harbour Planning

(1) Present situation on traffic and transportation and plans thereof.

The traffic system of Peru develops through coastal regions where main industries are located alongside the Pan American Highway. The Sierra (mountainous district) that occupies 30 % of the country's area and Selva (tropical district) occupying 60 % of the same are connected to each other with the Pan American Highway by way of Grade-2 national road. Out of those important main items of the country's development target such as; promotion of social unification and integration, the development of resources as well as promotion of various industrial activities, agriculture and stock farming, manufacturing industry and mining industry are given particular importance and in order to support these industries, the road development is currently being planned within the range of traffic and transportation plannings.

As shown in Table 4-311, the ratio of developments between roads and harbours, is approximately 60 % for the former and 20 % for the latter and shows no change when compared to '71 - '75 Plan and '75 - '78 Plan. However, it is observed that the proportion for ship-building industry is being raised for the improvement of traffic and transportation efficiency which is attributed to the country's concept to increase the number of Peruvian flag vessels in marine transportation particularly in the field of international trades as well as coastal trades in the continent in addition to traffic congestions

in land transportation as explained later.

At present, there are 37 ports being operated in this country of which 23 ports are under the administration of ENAP.

Ports at Callao, Salaverry, San Martin and Matarani are some of the important public port facilities of Peru.

As specific harbour facilities are such as Talara of oil, Pampilla owned by Petro Peru, San Nicolas as a shipping port of iron ores from Marcona Mines, Ilo in Southern copper refinery and last but not least port of Bayovar recently constructed.

Regarding import/export cargoes the total number of self-owned vessels is 46 as shown in Table 4-312, but the tonnage per vessel is also low and accordingly the transport efficiency is also not good. In 1972, 93 % of the total export and 77 % of import depended on foreign chartered vessels.

The total volume of marine cargoes handled in 1974 was about 25 Mio. ton as shown in Table 4-312 of which more than 80 % was handled by 4 top ranking ports and except Callao, some cargo concentrations were observed for the port which was related with specific products or industries in surrounding regions.

(2) Port Development Plan

Out of the total capital investments on traffic and transportation segments, approximately 22 % is allocated for port development in line with the organic relationship with other factors such as export promotion, support of industrial development and contribution for local developments as well as related social unification and integration. Investment plans are as per

Table 4-314 and new tendencies are incorporated in constructing wharfs and purchasing loading and unloading facilities and equipment for Iquitos that is a river port in eastern portion, improving port facilities and equipment of Yurimaguas and Pucallpa so as to utilize resources such as fruit and lumbers from tropical zones as well as activating social interchanges in those regions. The largest new harbour investment in pacific coast is the construction project for a new berth in Chimbote for increasing the unloading capacity of iron ores which are expected to be supplied as raw materials for steel production increase/expansion at Chimbote Iron Works planned by Sider-Peru Iron and Steel Corporation.

For those public ports such as Callao and Matarani, the expansion work is presumed to be continuously carried out in future.

As far as other surrounding ports in connection with this project are concerned, the preparation works mainly dredging work at Salaverry port will soon be completed while for Eten the feasibility study for remodelling and improvement has already been carried out under the necessary planning, but the detailed time schedule as well as budget arrangements have so far not been materialized.

Table 4-311 Traffic and Transportation Plan

Unit : 1 Mio. Soles

%

	Plan 1972 - 1975			Plan 1972 - 1975		
	Investments	Constituent %	Segment wise Ratio	Investments	Constituent %	Segment wise Rate
1. Road construction	10,051	43.9	60.1	12,162	39.0	60.1
2. Road administration	3,094	13.5		6,264	20.1	
3. Road traffic restrictions	624	2.7		295	1.0	
4. Harbours	2,252	14.2	19.2	2,867	9.2	19.8
5. Merchant fleet	1,140	5.0		3,322	10.6	
6. Air navigation facilities	906	4.0	4.0	1,240	4.0	4.0
7. Railways	570	2.5	2.5	1,429	4.5	4.5
8. Survey and investigation	880	3.9	3.9	548	1.7	1.7
Sub- Total	20,517	89.7	89.7	28,127	90.1	90.1
Others	2,365	10.3	10.3	3,091	9.9	9.9
Grand Total	22,682	100.0	100.0	31,218	100.0	100.0

(Data : Prepared from INP medium term plan and others)

Table 4-312 Volume of Cargo-Handling at Main Ports

(Unit : 1,000 ton)

Name of Ports	1973				1974			
	Dry	Wet/ liquid	Total	Share (%)	Dry	Wet/ liquid	Total	Share (%)
San Nicolas	9,422	116	9,538	43.1	10,452	116	10,568	42.4
Callao	2,873	1,244	4,117	18.6	3,177	1,250	4,427	17.8
Talara	32	3,193	3,225	14.6	42	3,372	3,414	13.7
Chimbote	749	168	917	4.2	989	351	1,340	5.4
Salverry	454	424	878	4.0	421	416	837	3.4
San Martin	174	248	422	1.9	263	293	565	2.2
Matarani	123	--	323	1.4	314	--	314	1.3
Others	1,240	1,469	2,709	12.4	1,400	2,052	3,452	13.8
Grand total of Peru	15,267	6,862	22,129	100.0	17,058	7,850	24,908	100.0

Data : Recompiled from ENAPU

Table 4-313 Number and Type of Vessel by Ownership Classification

as of 31-12-1973

Unit : 1,000 ton

Classification of Ownership		Private		National	
		Number of Vessel	Loading Capacity	Number of Vessel	Loading Capacity
For foreign trade	Freight vessels			14	187,274
	Freight vessels	17	97,119		
	Exclusive vessels				
For coastal trade	Freight vessels	3	72,823		
	Tanker	2	8,073		
	Tanker			6	72,206
	Exclusive vessels	1	15,171		
	Total	26	229,599	20	259,480

Data : From Medium term transportation plan, 1974, the Ministry of Traffic and Communication

Table 4-314 Investment by Related Marine Traffic and Transportation Organizations 1975 - 1978

Related Organizations	Total Amount	Investment up to 1974	Investment Expected		Expenditure after 1978
			1975 - '76	1977 - '78	
The Ministry proper	2,332	31	1,462	563	276
Continuous investment	92	31	40	23	--
Improvement investment	563	0	23	245	268
New investment	1,704	0	1,399	295	10
Chimbote	619	0	619	--	--
Norte Chico	350	0	350	--	--
Others	735	0	430	295	10
ENAP	2,786	1,068	1,089	629	--
Continuous investment	2,786	1,068	1,089	629	--
Callao	1,088	401	471	216	--
Matarani	386	176	61	149	
Iquitos	137	32	105	--	--
Chimbote	41	22	29	--	--
Salaverry	56	48	8	--	--
Cost of Facilities	799	288	329	182	--
Others	279	101	86	82	--
Others	19	0	14	5	--
Total	5,137	1,097	2,565	1,197	278

Data : Prepared from medium term traffic and transportation plan,

As far as Port of Pacasmayo is concerned, there is no plan at present.

(3) Relations with Neighbouring Harbours.

Table 4-315 shows a summary of the history of Port of Pacasmayo and its neighbouring harbours, affected districts, main cargoes and main roles of basic facilities and so on.

These harbours have connections not only with relevant locations, but also with various cities around Andes regions, comprising a lot of populations and related enterprises; however, as shown in Table 4-315, the volume of cargoes handled has been either remaining on the same level or only showing a slight increase in such a way that the rate of growth for all 4 ports is only 0.9 % in average for dry cargoes and 1.1 % in case of wet/liquid cargoes, which is presumed to be attributed to the belated industrial developments in these regions as one of reasons in addition to relatively poor transportation efficiency and services due to lack of harbour facilities as well as less prepared warehouse arrangements and machinery equipment.

Looking at those figures on a basis of whole country, it is presumed that much of the increasing volume of cargoes can be absorbed by activated land transportation assumed from the growth for commercial fields by 4.9 % in average during 1970 - 1974. However, in these regions, taking into consideration such as; machinery industry in Trujillo, a backland of Salaverry, various industry segments in Chiclayo mainly based on chemical industry there, stock farming and plantation business in Jaen that is under the influence of various industries in Chiclayo, promotion of economic interchanging by means of utilization of river ports

with Amazonas regions, project for iron and steel production expansion in Chimbote, etc. it is now well presumed that details and contents as well as handling volume of cargoes in harbours for those regions would largely change, including those cargoes which are newly added to such ports. These outlooks can be summarized in a bit daring manner regarding a change to come in near future other than Pacasmayo that is mentioned later as Table 4-316.

Table 4-315 Table of Development on Harbour-wise Volume of Cargoes Handled (Unit : MT)

		1970	1971	1972	1973	1974	1975
Eten	Dry cargoes	77,991	89,909	81,342	74,103	75,432	30,429
	Wet/liquid cargoes	-	-	-	-	-	-
	Total	77,991	89,909	81,342	74,103	75,422	30,429
Pacasmayo	Dry cargoes	49,110	26,676	27,832	62,676	26,813	919
	Wet/liquid cargoes	-	-	-	-	-	-
	Total	49,110	26,676	27,832	62,676	26,813	919
Salaverry	Dry cargoes	356,459	452,382	460,311	454,366	420,964	216,931
	Wet/liquid cargoes	369,898	427,393	444,001	424,201	416,374	182,165
	Total	726,357	879,775	904,312	878,577	837,338	399,096
Chimbote	Dry cargoes	964,277	869,694	846,617	749,535	988,858	527,895
	Wet/liquid cargoes	371,529	328,639	297,691	168,146	350,875	207,541
	Total	1,335,806	1,198,333	1,144,308	917,681	1,339,733	735,436
Grand Total	Dry cargoes	6,012,105	6,239,857	6,622,298	5,497,933	6,280,225	7,823,762
	Wet/liquid cargoes	6,015,132	6,332,696	6,018,372	6,133,918	6,879,360	5,392,939
	Total	12,027,237	12,572,553	12,640,670	11,631,871	13,160,083	13,216,701

(Data ENAP)

Table 4-316 Changes in Cargoes Handled

	Change of current cargoes	Cargoes newly added
Salaverry	Those subject to increase: paper (export/ outgoing) Wheat (import)	Steel plates for automotive (incoming) Parts for machinery industry (import. incoming). Machinery industrial products (export) Tractor, tooling machines Automobiles
Eten	Those subject to increase: paper and pulp (export/outgoing) Fertilizer (incoming)	Lumbers (outgoing) and fruit (Banana and other outgoings) from Amazonas region. Processed foodstuffs (sausages etc.), Chemical products (resins, rubber chemical), Bleaching pulps (export and outgoing) in Chiclayo.
Chimbote	Those subject to increase: Iron ores (incoming) Iron and steel (outgoing)	Processed marine and agua products upon completion of 2nd fishery center construction work. (export). (canned fish meat, frozen products)

Table 4-317 Role of Surrounding 4 Ports

Item \ Name of Harbour		Pacasmayo	Salaverry	Eten	Chimbote
Construction (fiscal year)		1884	1875	1874	1945
Improvement		1948	1965		1968
Sphere of influence Area (Km^2)		9,600	21,180	62,600	30,600
Population (head)		410,000	680,000	1,020,000	705,000
City		Pacasmayo Country (State of Liberta) State of Cajamarca and other regions	Other district of Liberta State excluding Pacasmayo Trujillo, Bolivar Huamachuco	Lambayeque Ferrehafe Chiclayo Jaen Hualgayoc Chota Chachapoyas Rioja — Lambayeque State; Cajamarca State (Amazonas State) (San Martin State)	Huaroz Ayha Antonio Raymondi, and others. Ancash State
		Fertilizer, mineral cement, rice	rice, molasses, mineral, canes, paper	Sugar, fertilizer, pulp, urea, jute	fish power Iron ore (Marcona Product) Cast iron
Number of enterprises influenced. (above 5 personnel)	Industry	87	238	320	75
	Comm	46	153	165	73
Facility	Wharf (meter)	533 x 10	225 x 25 225 x 30	843 x 10	185 x 16 54 x 18 265 x 25
	Warehouse (m^2)		For sugar 7,200 cargoes 2,300		1,800

Data : Prepared from ENAP "Harbours in Peru"

3-2 Basic Framework Required for Development of Pacasmayo Port

For a materialization of development planning, the following matters have to be complied with : -

To solve the factors for regional social and economic problems.

To contribute to smooth promotion of economic development plans in neighbouring areas.

To effectively utilize the regional potential.

To establish and maintain organic connections and correlations with the country's traffic systems as well as its improvement and preparation projects.

The following is a summary of various factors required in the investigation of Pacasmayo port development plan: -

(1) Conditions required

(A) Solution of problematic points which Pacasmayo City as well as its citizens are encountered with.

Increase in related demands accompanied by the opening of the port which initiates the activation of economic activities.

Enhancement of working rate (recruitment) as well as increase in people's income.

Effective utilization of high level manpower. (Rate of non-illiteracy is optimum.)

Re-unification of family integration for the people.

Increase in tax revenues and thereby possible compliance for flexible and versatile administrative demand and requirements.

(B) Contribution for neighbouring districts

To act as outgoing functions for agricultural products from Jequetepeque-Zaña and for stable supply of necessary raw materials and reduction in cost of transportation.

To play a role in outgoing of yields from Cajamarca district which is within a sphere of influence.

Stable supply of machinery and necessary capital goods as well as reduction in cost of transportation.

Promotion for utilization of non-developed natural resources.

(C) Achievement of a role within traffic and transportation systems.

Substitution of neighbouring ports.

Substitution of land traffic and transportation.

Contribution for expanding coastal trade.

(D) Consideration for regional and industrial development for the future.

Contribution for promoting those existing industries.

Promotion for (particularly in Cajamarca district) developing non-prospected mineral resources, as well as improvement for economicality of development plans.

Basic preparation for bringing up new industries.

Consideration for utilization of huge backlands available in the area.

Application of non-utilized natural resources.

(E) Economy

To maintain economy in the cost of construction and harbour expenditure as well as enhancement of rate of operations of harbour facilities.

(F) Technical and natural conditions

To provide a margin for utilization in favour of fishing boats from neighbouring coasts.

To prevent any occurrence of environmental pollution and other problems.

To prevent deterioration of functions due to sand drifting etc.

To prevent traffic congestions which might be caused by rush of vehicles into the area.

(2) Conditions desirable to Pacasmayo Port

(A) Provision of chances for employment giving consideration to its features.

In parallel with minimization of fixed cost in harbour expenditure, some margins for manpower segment (utilization of barges etc.) should be left so as to give leeways for a chance of temporary employment.

To provide the surrounding farmers a chance of employment during their leisure season.

(Preservative processing of collected agricultural products, packing work at the site etc.)

(B) Full compliance with increase of cargo volume.

Smooth outgoing functions for fine copper yields from Michiquillay Mine.

Possible smooth countermeasures against the increasing cargo volume brought by the development and progress of the Project.

(C) The construction work should be based on the Project which can fully cope with those various changes.

(D) Stable development of surrounding regions.

The overall plans to invite other related industries as well as services by utilizing the vast backlands should be elaborated so as to initiate early coming up of such related industries and services.

Harmonization of local people and incoming labours such as construction and transport workers.

3-3 Increase in Volume of Cargoes and Countermeasures by Land and Marine Transportation

(1) Growth in volume of cargoes

Due to active public investment as well as promotion of powerful industrial development projects and particularly due to switching from priority investment to fishery and mining industries in early '70s towards the agricultural and industrial segments, more importance is being attached to such agricultural and industrial developments according to the development plan for 1975 - 1978 and consequently, some industry-wise production increase is anticipated from the medium term plan as shown in Table 4-331 and its total

increase in average is estimated at 8 %.

The growing rate in demand is estimated at 11.7 % in case of INP medium term plan while the Ministry of Traffic and Communication is estimating the rate of growth for bulk cargoes in export trade at 9.4 % and the total growth for industrial chemicals only is estimated at 11.5 % in average.

Assuming that the correlative factor between the production output and cargo volume is high, then growth in the volume of cargoes can be anticipated something like above figures.

The growth in the past is totally 10.2 % as shown in the separate sheet, which is, just between 8.0 % and 11.5 % and giving consideration to public investment, progress in industrial developments etc., it is expected that at least this much increase in the volume of cargoes would continue hereafter too.

(2) Shift from land transportation to marine transportation

The rate of growth in registration of trucks mainly engaged in the current cargo transportation is 5.3 % as a whole during 1970 - 1974 while the rate is 4.9 % in case of confining to commercial vehicles.

Apart from the anticipated restrictions on this growth due to stricter import restrictions on various capital goods/products, should the above growing rate be continued, then the same at the time of port operation will be $\frac{(1.102)^7}{(1.049)^7} = 1.412$.

Therefore, it is necessary to improve the transportation efficiency by 41.2 % during said period, however, the Ministry of Traffic and Communication has pointed out the following

points on land traffic in its medium plan.

The road network can not cope with the increasing volume of traffic, particularly in case of urban centers, the road planning has remained unchanged since 17th or 18th century and thus it is difficult to construct up-to-date road crossings.

Due to either flood or sand storm, 73 % of roads is seasonally cut off. The controversial road congestions are accelerated due to shortage of parking areas, insufficient preparation of road signposts, and occupation of roads by open-air stall quarters.

Due to no exclusive spaces being available for maintenance and services, passages are in most cases used for such work.

Due to absence of facility for loading and unloading of cargoes, the work is being done on the street.

Nearly 78 % of those transportation companies is private companies and consequently the managerial situation and condition are unstable.

For solving above points of problem as shown in before mentioned Table 4-311, investments for road maintenance and administration included in the plan of '75 - '78 in comparison with that of '71 - '75 are 2.02 times against 1.37 times of whole investments while 2.92 times against the freight fleet.

Taking such points of problem and investment policy into consideration, there exists a sufficient possibility for shifting from land transportation to marine transportation and it is also assumed that for smooth promotion of industrial activities as well as maintenance of national life such a change-over policy would also be necessary.

Table 4-331 Main Industrial Production Output

(Unit : 1000 ton)

		Quantity of Product		Rate of Growth in Average (%)
		1975	1978	
1.	Agricultural products	3,747	4,985	10.0
2.	Marine and agua products	1,855	2,480	10.2
3.	Industrial Chemicals	4,987	7,136	12.7
4.	Mineral products	10,288	11,732	4.5
5.	1 + 2 + 3 + 4	20,877	26,333	8.0
6.	Petroleum	33	115	
7.	1 + 3	8,734	12,121	11.5

Data : From INP data.

Table 4-332 Development of Capital Goods/Products Production Index

(1967 = 100.0)

Classification of capital goods \ Fiscal year	1970	1971	1972	1973	1974	Rate of Growth in average
Consumption goods	113.7	129.0	138.3	147.7	155.4	8.2 %
out of which; foodstuffs	113.2	128.7	140.2	146.9	154.0	
drinks	111.6	130.3	136.5	153.8	180.1	
Intermediate products	118.3	131.1	153.9	169.1	183.5	11.6 %
out of which; rubber goods	127.0	135.6	149.6	164.0	172.2	
Chemicals	124.6	146.8	186.1	209.4	225.3	
Capital goods/ products	111.2	120.5	149.9	178.2	189.2	14.3 %
out of which; Metal products	115.3	136.3	158.8	171.3	203.2	
Electric machinery, electric appliance	144.0	169.1	202.0	250.1	282.1	
Total	115.1	128.7	145.5	159.0	169.3	10.2 %

Data : Prepared from data at Central Reserve Bank of Peru

3-4 Estimate of Volume of Cargoes

(1) Establishment of prerequisite conditions for estimate.

In order to assume items of cargoes and quantities anticipated after the opening of the port, the following conditions and prerequisites are taken into consideration:

(A) For concrete projects such as development plans etc. their time-schedules as well as substances ;

Michiquillay Project.

Jequetepeque-Zaña Development Project.

Industrial Development Plans for Trujillo etc.

(B) Trend of economic policy to this region:

Encouragement of expansion for acreage under cultivation for the improvement of self sufficiency in food supply as well as mass fertilization for better yields and productivity.

Promotion of outgoing shipments to large consuming areas such as Lima metropolis for stabilizing food prices.

Adoption of subsidy (low freight charges) for fertilizers.

Induction of supporting price system for fruit.

(C) Demand in this region : -

Improvement of working rate and income by industrial developments and thereby realization of sound expansion of general expendable demand including durable consumer goods. (Slightly higher growth than average in the whole country.)

(D) Forecast for structural changes in traffic and transportation

Changes in the structure of cargoes as considered in line with before mentioned traffic and transportation plan and accompanied change of roles of each port.

In view of various traffic conditions (particularly occurrence of restrictions and limitations) involving land traffic, a switching over to the marine traffic and transportation will be expedited.

Adoption of strategic cargo-wise freight rate. (Low freight charges for fertilizers and those for cement will be decided according to market situation and principle.)

Giving consideration to these factors, the estimates on item-wise volume of cargoes are being made,particularly such factors are well considered in calculating the volume of cargoes as well as economic benefit of the harbour in financial analysis vide 5 - 6.

(2) Estimates of items

For estimates of items, the compilation is being made in due course of order from those which have higher probability according to the following order:

(A) Sugar

Sundry goods to be despatched for Cajamarca region heavy oil for Pacasmayo cement.

Iron ores from small and medium scaled mines.

Above products are either presently utilizing other port facilities or depending on other transportation means out of those which have already been produced in this area or

carried outside. They are also anticipated to be apparently less expensive in cost in case of utilizing this port.

(B) The following items are expected to be produced in the near future based on the materialization of projects and also anticipated to be less expensive than utilizing other harbour facilities or traffic means as far as their costs are concerned:

- o Fine copper from Michiquillay and gunpowder required for excavation, or
- o Machinery and equipment for repair.
- o Cement.
- o Rice.

(C) Those which are indispensable for promotion of project

Chemical fertilizers are required for shifting to IRR type rice cultivation as specified in food planning of the medium plan.

(D) Those which are required in view of overall policy of the country.

Fertilizers for various crops for improving their yield and productivity as well as increased yield of import substituting farm products.

(E) The following farm products are presumably added to new cargoes in the event of construction and opening of the new port, thanks to a possibility of added value being obtained from simple processing or improved transportation methods:

High class farm products such as fruit and vegetables (tomato) and other farm products which can absorb costs by mass transportation.

The estimates have been made as above explained.

(3) Method of estimate on quantity

As a principle, the quantity-wise estimates have been based on the following method:

(A) Those which are specified as "planned value" have been adopted as they are; i.e., copper output from Michiquillay.

(B) Trial calculation by related values specified as concrete planned value (harvest per acreage and suppliability to consuming places).

- o Rice in Jequetepeque area.
- o Sugar

(C) The product whose necessary quantity can be determined for actualizing the planned value of (a) and (b) is being adopted its quantity which is currently presumed.

- o Fertilizers for rice. (mass fertilization for shifting to IRR type rice cultivation.)

(D) Those having their actual records but their quantities for the future development can not be clarly anticipated:

- o For those which have no specific conditional changes to determine their demand for the future, the growth in the past has been taken as a reference and its value of developing trend has been adopted. Growth of auto-

mobiles. (Due to estimates for alternative plan from Regional Land Transportation Bureau.)

- o For those which are politically clear with an increase in demand numerical value, such changeable conditions have been taken for granted. (Improvement of ratio on fertilization acreage by political subsidizing funds system).
- Fertilizers for other than rice.

Besides, the following items are also prospected:

Grains and fish meal for stock farming feeds which are anticipated to increase in line with stock farming promotion in Cajamarca district the plan of which is included in the current project and its tendency. Incoming items of capital goods beyond Cajamarca as well as livestocks, tuberous roots like potato, traditional arts and crafts, lumbers and wood products, which are expected to be developed in future. Furthermore, shipments of various lumbers and fruit from the back country can also be considered. However, because of absence of volume for such products, these estimates do not include them.

(4) Item-wise estimates on cargo volume

The volume of cargoes has been assumed by-item according to the principle of (3) giving consideration to various conditions and situation of (1) as follows:

(A) Rice

The acreage of rice is based on the medium term plan of '75 - '78 but the growing rate is assumed to become dull from 1982 as a turning point. On the other hand, however,

as far as the acreage crop is concerned, it is also assumed that in Jequetepeque-Zana District the total target for shifting to IRR type rice cultivation would be completed as such that the acreage harvest there is assumed as 5500 kg/ha. For the rest of the regions, the assumption is being made as such that as of 1985 IRR type rice would occupy 50 % of whole rice cultivation while the other 50 % would still be conventional rice and according to the average growth in the past, the crop is estimated at 4,250 kg/ha.

The crop is expected to be consumed by inhabitants in northern area and mid-southern coastal regions and such regional rice consumption is being deducted according to region-wise population ratio so as to assume the quantity for shipments, i.e., surplus rice.

The quantity of such surplus rice at Pacasmayo Port is anticipated to gradually increase in relation to the land transportation and from Jequetepeque-Zana District the following percentage per year is assumed;

1982 ..... 70 %, 1985 ..... 75 % and 1990 ..... 80 % respectively.

From the rest of the regions, the following figures are assumed;

1982 ..... 10 %, 1985 ..... 15 % and 1990 ..... 20 % respectively.

(B) Fertilizers

The estimates on fertilizers are based on the assumption of energetic promotion of crop increase by means of mass

fertilization in future in line with the country's food policy.

The original unit of applicable fertilizers is assumed with a classification on discrepancies between rice crop and others, as well as differences in the growth for consumption.

Regarding rice cultivation, the acreage is being estimated from the rice acreage of (a) and propagation of IRR type rice for which mainly urea type fertilizers are anticipated to be consumed by 50 % and remaining 50 % proportionately by ammonium sulfate type fertilizers.

For those crops other than rice, it is assumed that the application of fertilizers in Jequetepeque-Zana region in 1985 and 1990 will be 90 % and 95 % respectively. For rest of the regions, the average annual growth rate of 6.3 % during '70 - '74 worldwide consumption based on RAO statistics is adopted on the whole.

The assumption on the volume of cargoes to be handled at Pacasmayo port is based on the prerequisite that its handling in Jequetepeque-Zana region in 1982 is 100 % and for other districts, (Cajamarca and others) 20 % of those utility volume in relation to producing districts is to be handled and consequently it is anticipated that the figure in 1985 and 1990 will be 25 % and 30 % respectively. The consumption of chemical fertilizers per ton in 1975 was estimated at 27 kg/ha which is an average in Central and South America based on FAO statistics.

(C) Sugar

The countrywide yields anticipated by '75 - '78 plan are 995,000 ton in 1975 and 1,120,000 ton in 1978 respectively and its growth rate is 4.4 % per year in average. However,

this numerical value is higher than the growth rate of 3.3% in average during 1971 - 1974 and considering the slack in international demand and the country's policy to increase crops of other agricultural products (wheat and corns which are presumed to be continuously imported.) it is anticipated that greater increase in acreage would not be feasible, though there might be some partial change-over to other cultivation.

Therefore, in spite of possible increase in unit crops brought by application of fertilizers, the growth rate on absolute quantity is presumably and relatively liable to slow down as follows:

The growth rate during '78 - '82 ..... 2.0 % per year.

The growth rate during '83 - '85 ..... 2.0 % per year.

The growth rate during '85 - '90 ..... 1.0 % per year.

'90 and onward ..... decrease by 1 % per year.

The growth rate on the domestic demand is assumed as follows:

For '78 - '82 ..... 6.0 %

For '83 - '85 ..... 5.0 %

For '86 - '90 ..... 4.0 %

The demand inside and outside the region is set up by population ratio same as before and deducted accordingly, and the rest is determined as export quantity.

The volume of cargoes to be handled at Pacasmayo Port is set up as follows : -

For export quantity in 1982 ..... 15 %

For export quantity in 1985 ..... 20 %

For export quantity in 1990 ..... 25 %

The anticipated shipments to consuming places are based on the assumption that cargo handled at Salaverry Port will be taken over by Pacasmayo Port as well as substitution of land transportation as such that the annual handling in 1982, 1985 and 1990 would be 6 %, 10 % and 15 % respectively.

(D) Other agricultural products

Of various agricultural products planned in Jequetepeque-Zana region, except rice, laurel pears and tomatoes, among fruits are taken up as an object of consideration. According to '73 statistics, 77 % of shipment of such fruits even in Cajamarca are for Lima.

The consumption of such fruits in the region in 1982 and 1985 and onward is anticipated as 20 % and 30 % respectively due to improvement in people's food habit and the rest is expected to be shipped to Lima. However, in view of deterioration of freshness due to evaporation of juice caused by the nature of such fruits, 80 % of products will still depend on the land transportation in 1982 while this percentage is also expected to reduce to 40 % in 1990 thanks to gradual development in related technology such as better washing, selection of quality, packing and preservation process etc. Furthermore, it is also anticipated that the volume of cargo from Cajamarca region would be added by 30 % to the assumed cargo volume judging from the ratio on actual records.

(E) Other general sundry goods

For the absolute quantity of cargoes, those mainly sent from Lima are considered as objectives based on the actual records obtained from '73 statistics. Giving consideration to standardization of income due to the regional investment promotion and activation of various industrial activities, a figure of 15 % is estimated based on the anticipation that the growing rate of gross demand for '75 - '78 assumed by the medium term plan would be slightly exceeded.

Regarding those sundry goods imported from Japan and other sources, the estimate is made with the anticipation that the quantity of output planned at Michiquillay mines will also show the same growth rate as above.

(F) Cement

The cement output in 1978 is based on 1 Mio. ton per year specified by the medium term plan. For further growth after 1978, the output is being assumed based on the anticipation that 80 % of the growing rate of 6.4 % on public and private fixed capital formation, namely the demand of 5.1 % would be supplied. 'Out of such output volumes, 90 % is anticipated to be consumed in the region for various industrial and social facilities, dam construction, irrigation courses as well as road construction works. The rest of the volumes is expected to be shipped from Pacasmayo to Bayovar Paita regions in the northern area.

(G) Petrochemical products

The main petrochemical product is heavy oil consumed by Pacasmayo Cement. Its original unit is 100kg (SP kiln) per

ton and whole quantity required for the above production is expected to be unloaded from Pacasmayo port. Furthermore, petrols for tractors and automobiles, kerosine oil for household are also considered as objectives and the growing rate of which is calculated in line with increase in the number of automobiles as well as expansion of general consumption as follows:

1982 - 1985 ..... 12 %

1986 - 1990 ..... 10 %

and 1990 onward ..... 8 % respectively.

Table 4-341 shows various volume of cargoes calculated according to the above methods.

Table 4-341 Estimates of Cargo Volumes by Item

Unit : 1,000 MT

	1 Fine copper ores	2 Rice	3 Fruits	4 Sugar	5 Fertilizer	6 Cement	7 Sundry goods	8 Petro-chemicals	2～7 General Cargoes Total	Total
Operation Start-up (1982)	370	105	14	79	25	50	37	311	310	991
2nd year	370	109	17	90	28	58	43	339	345	1,054
3rd year	370	113	20	103	31	67	49	370	383	1,123
4th year	370	118	23	117	34	76	57	408	425	1,203
5th year	370	123	25	119	37	85	66	441	455	1,266
6th year	370	128	27	121	40	95	76	476	487	1,333
7th year	370	133	29	123	42	106	87	514	520	1,414
8th year	370	138	31	125	44	119	100	560	557	1,487
9th year	310	143	34	128	47	134	115	610	601	1,581
10th year	370	148	37	115	48	147	132	670	627	1,667
11th year and onward	10% increase per year	5% "	5% "	10 % "	5% "	10% "	15% "	7% "		

SECTION 4, PORT DEVELOPMENT PROGRAM

4-1 Present Condition of Harbor Facilities

(1) Present condition of harbor facilities in Pacasmayo Port

A. Condition of existing pier

The existing pier for barge was constructed by Enrique Meigg Co. in 1884 and the original length was 800 meters. Due to damages by wave the pier was repaired in 1948.

The present length is 535 meters with width of 10 meters and the pier projects out almost perpendicular from the shoreline. (see Figure 4-411)

Rails are laid on wood sleepers placed on top of the pier. (see Figure 4-412)

The substructure of the pier is a very simple construction with 5 inch diameter iron pipes screwed into sea bed with spacing of 4 - 5 meters in longitudinal and transverse direction. These piles are connected in both directions with 1 - 3 inch pipes. The depth of pile embedment is 1 - 6 meters and it is recorded that this depth varies with hardness of soil condition. (see Figure 4-413)

This pier is not strong enough to support trucks and jeeps excepting light railway type truck, locomotive and crane utilizing rails laid on the pier.

Paint is constantly applied as pier maintenance; but from rust condition, quality and amount of paint applied, it would be reasonable to assume that under present usage the life of the pier would not be very long.

The height at extreme end of the pier is approximately 3 meters from water line; and the water depth at this point

is approximately 4 meters so the pier is constantly affected by swells.

B. Condtions of cargo handling

According to marine chart up to water depth of 5 fathoms the shallow beach extends for a distance of 1 mile from shoreline, so at present cargoes are transferred from ship anchored offshore to lighters and transported to the existing pier. (see Figures 4-414 and 4-415) Cargo handling between lighter and pier is conducted with 4 rail mounted cranes with capacity of 1 - 3 tons.

The cargo is moved from pier to warehouse on open freight car or truck pulled with light locomotive.

Six lighters of approximately 100 gross tons were confirmed; and the lighters are anchored approximately 1/2 mile from end of the pier when not in use. Tug is usually in vicinity of the pier.

Pier rail extends into warehouse located in front of the pier. The warehouse and the land are privately owned and all cargoes are processed through this warehouse.

It cannot be said that the present cargo handling facility is excellent; but from the 79,754 metric tons of cargo handled in 1963 with this system and maximum export volume of 39,928 metric tons in 1973, it can be assumed that a system of cargo handling and capability of laborers are available to a certain degree.

No vessel made port entry for more than 3 months at beginning of 1976; but in spite of this long layoff from work cargo handling operation was carried out smoothly for a vessel which entered port in April.

(2) Conditions of neighboring port

A. Salaverry Port

1. General conditons

The construction of this port for City of Trujillo, the largest city in northern Peru, was started in 1956 and completed in 1965.

The port is protected on the south by a breakwater 1,300 meters in length and has 2 - 225 meter long wharves providing 4 berthing spaces. The water depth at berthing area is 30 feet as initially planned. (Figure 4-416)

The volume of cargo handled annually in this port has steadily increased from 320,000 tons for the first year of port opening in 1957 to 800,000 to 900,000 tons for years following 1971. Of the cargoes handled at Salaverry Port,sugar export and oil import heads the list and these 2 cargoes accounted for 78 % of total cargoes handled in 1974 and 80 % in 1975. For loading sugar, 2 bulk loaders each with capacity of 300 ton per hour are provided while submarine pipeline owned by the Government is used to unload oil from offshore tankers.

In 1975, 43,071 tons of general cargo consisting mainly of ore for export, 113,348 tons of import of which 69 % was grain and 16,999 tons of domestic trade cargo or a total of 173,418 tons were handled in this port.

The number of vessels making port entry in 1975 was 244 and this number is broken down to 158 foreign ships and 86 domestic ships.

At any rate, the volume of cargo excepting oil, for 1976

was 485,148 tons, so the annual volume of cargo handled at one berth is 121,290 tons; and if the length of the berth is 180 meter the annual volume of cargo handled per meter length of the berth will be 674 tons. Actually, of this 485,148 tons of cargo 326,080 tons consist of bulk sugar handled with loaders; and if this is considered, the volume of cargo handled in this port is extremely low if availabe dock facilities are considered.

2. Technical problems of Salaverry Port

The biggest problem facing Salaverry Port at present is deposition of sand in the harbor; and another problem of equal importance is the coastal erosion in north of Salaverry Port. As another problem, it has been reported that long period wave invading the harbor causes difficulty in cargo handling by tossing berthed vessel.

In planning of Pacasmayo Port, the phenomenon of sand deposition and coastal erosion occurring at Salaverry Port must be studied with great care.

a) Problem of sand deposition within the harbor

According to report prepared jointly by Port Authority and Ministry of Fishery, (ENAPU y Ministerio de Pesqueria, Mediciones y Estudio de la Erosion en Salaverry, April 1975). The volume of dredging within the harbor between August 1970 to August 1974 was recorded as 3,150,000 cubic meters. By simply dividing by 4 years, the annual volume will be 800,000 cubic

meters; but the theoretical value computed at the same time with wave transporting energy will differ with equations used, however, a value of 0.83 - 1.47 x 10^6 m^3 per year was indicated. In any case, the volume of transported deposits was assumed as 1 x 10^6 m^3/year and this value can be used hereafter.

The location with most conspicuous deposition is in the harbor side at extreme end of breakwater arm; and from this vicinity the deposition spreads toward the harbor in tongue shaped projection. Water depth in vicinity of breakwater is almost zero. (Figure 4-417)

For this reason, the turning basin located in this vicinity and the channel leading to the basin were moved to the north side to allow movement of vessels to dock area. On the other hand, the shoreline at south side of the breakwater has advanced considerably since the breakwater was constructed.

If the uniform southearly direction of waves, the northerly movement of coastal current from SSE direction along the coast, the existence of sufficient sand deposit on the beach to become a source of nourishment for littoral drift, and from wave and sea bottom condition, the great disturbance of sea bottom caused by wide breaking wave are considered, it can be assumed that the littoral drift produced by above conditions deposits at shore end of the breakwater on seaward side and that part of this sand deposit passes around the

breakwater into the harbor.

Judging from sea chart for vicinity of Salaverry Port, the depth at extreme end of the breakwater is not believed deep enough compared to the port depth required to allow entry of ships of expected size. The extreme end of this breakwater, initially, being located in shallow water and in coastal area with conspicuous littoral drift, great amount of sand moved around the breakwater into the harbor. In the case of Pacasmayo Port, sand deposit is found inside the present harbor or in the vicinity; but in any case, as a port location in northern coast of Peru with conspicuous phenomenon of littoral drift, the construction of the breakwater will be a race against sand deposition. At this time, the important point is the water depth at extreme end of breakwater and in the determination of this water depth it will be necessary to study Salaverry Port in greater detail.

From the conspicuous advance of shoreline at updrift side in spite of littoral drift moving around the breakwater into the harbor, it must be assumed that deposition of sand at downdrift side will occur if the breakwater is extended. The method for disposing this sand deposit will greatly affect maintenance cost.

At present, there are 2 dredgers operating here; but it has been said that another dredger would be added.

b) Coastal erosion north of Salaverry Port

According to report mentioned in 1), greatest erosion is observed at point 500 meters north of groin #3 which is located at north end of the harbor and the shoreline at this point is recorded to be receding. The following shows the great recession of the coastline:

- o 150 meters during 10 year period between 1957 to 1967
- o 180 meters during 13 year period between 1957 to 1970
- o 200 meters during 15 year period between 1957 to 1972

The change in the shoreline is shown in the chart prepared by Port Authority based on aerial photographs taken in 1942 prior to construction of Salaverry Port and in 1967, 1970, 1972 and 1974; and this chart shows the extensive recession of coastline from breakwater to point approximately 5 - 6 km away in vicinity of Las Delicias.

According to observations made during this investigation, the coastal erosion at Las Delicias has progressed more since the chart was prepared and showed a non uniform recession. It is assumed that the scour and erosion of shoreline in this area have occurred due to reflection of waves by rock strewn at shoreline and small jetty and by strong coastal current. This indicates that measures against coastal erosion must be considered in planning of the port.

c) Effect on cargo handling operation by invasion of long period wave

Information was received from Port Administration Office at Salaverry Port that ships had to leave port 16 times in 1975 because of difficulty in mooring vessels due to rolling and pitching caused by undulation of water surface in the harbor.

This situation occurs between March to June; and normally, this happens only 4 to 5 times a year; so the figure of 16 times is abnormal.

Immediately after the opening of port to vessels in 1965 this problem was taken up. It has been reported by George Wimpey Corporation of England, the constructor of this port, that change in water surface of more than 50 cm in one minute caused extremely complex tossing of moored vessels. Also, from tests conducted on model of the harbor, the lengthening of existing groin in leeward side would be an improvement; but utilization of special mooring method would be more economical compared to former method. However, a special mooring method is not used at present, so when condition mentioned above occurs, the ship is forced to take shelter off-shore.

Therefore, the 3 technical problems of Salaverry Port are closely related to problems of Pacasmayo Port. Extending the present breakwater or constructing a second breakwater may solve a greater part of the problem; but blocking of littoral drift moving north and cutting off source

of sand nourishment for littoral drift will increasingly advance coastal erosion unless condition of wave coming to this coast changes or sand is supplied by artificial means or the coast protected with solid revetment, jetty and offshore breakwater. In any case, besides the enormous expense required in dredging operation, a great financial burden can be anticipated in solving the problems facing this port.

FIG.4-411 LOCATION OF PACASMAYO PORT

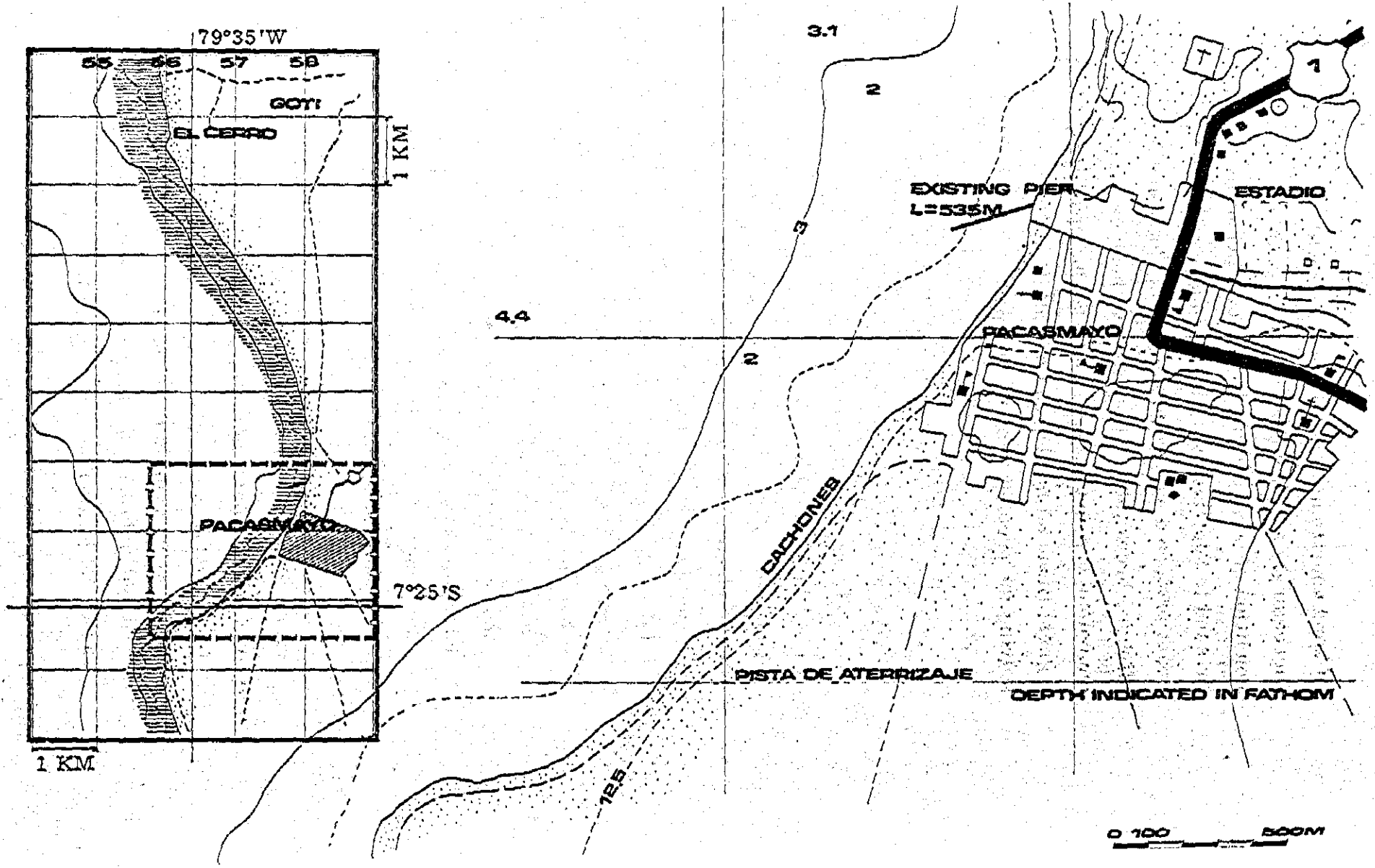
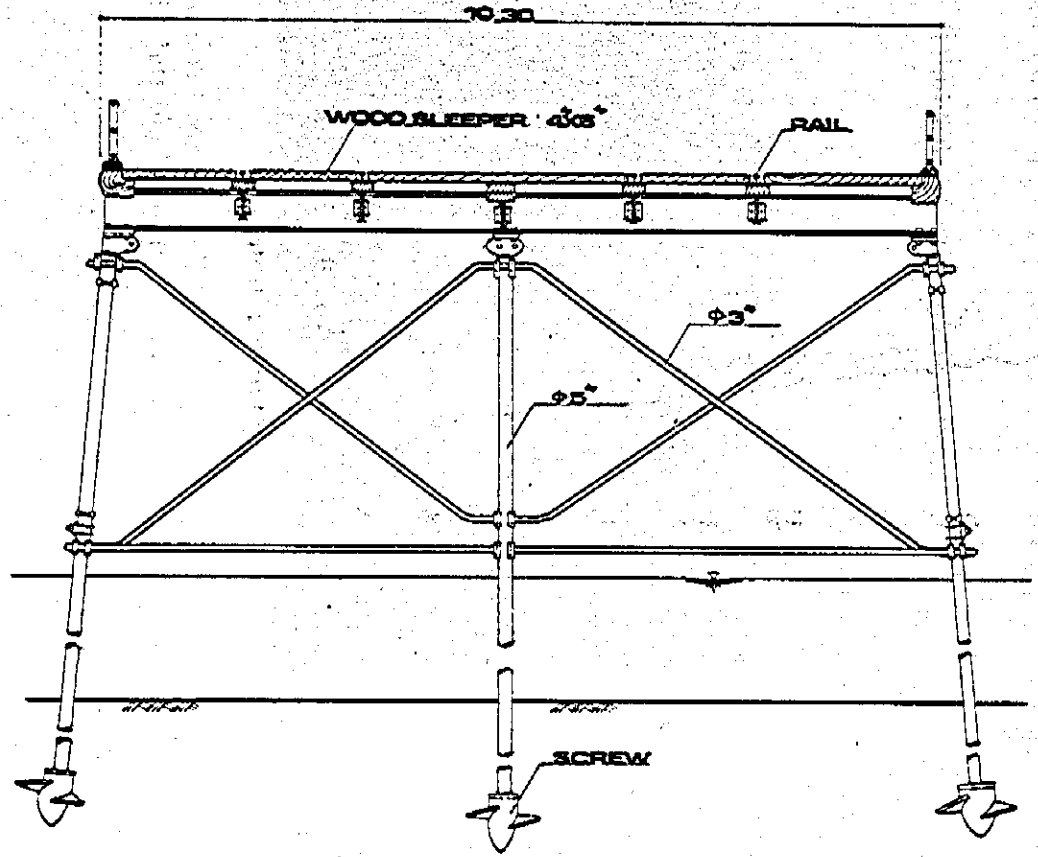
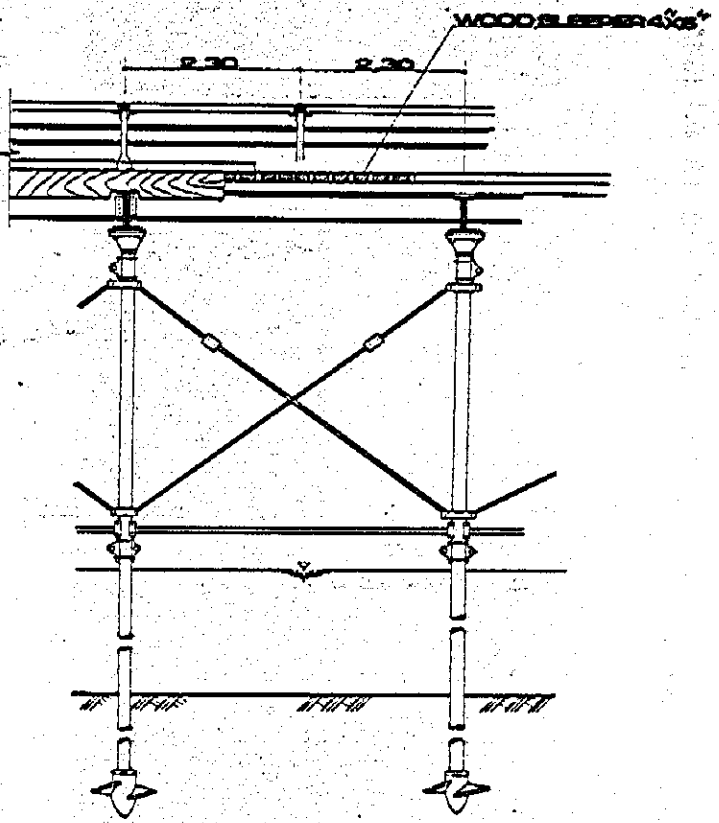


FIG. 4-412 EXISTING PIER AT PACASMAYO PORT



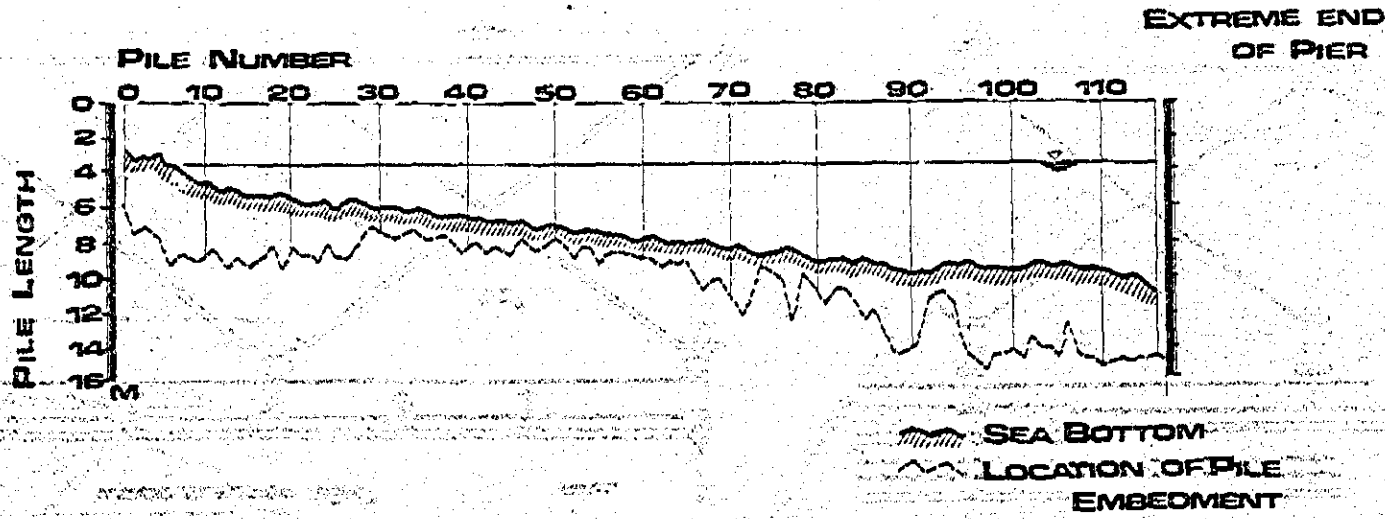
(INFORMATION SUPPLIED BY ENAPU)

A-SECTION



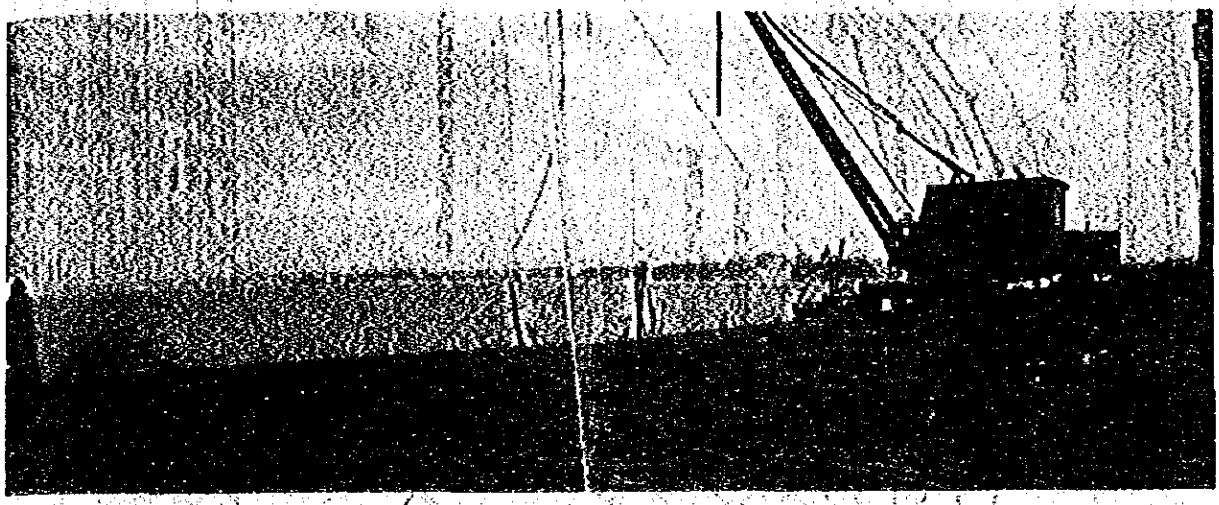
B-LONGITUDINAL DIRECTION

FIG.4-413 DEPTH OF PILE EMBEDMENT
FOR EXISTING PIER AT PACASMAYO PORT



INFORMATION : BY ENAPU

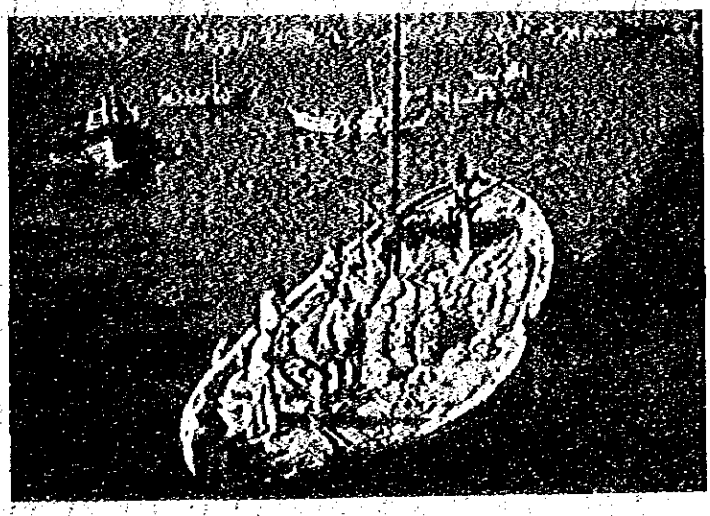
FIG. 4-414 CARGO HANDLING AT PACASMAYO PORT (1) (Photo taken in April 1976)



Per width 10 meters, length 633 meters
Rail mounted crane - 4 sets (1, 2, 2.5 and 3 ton capacity)

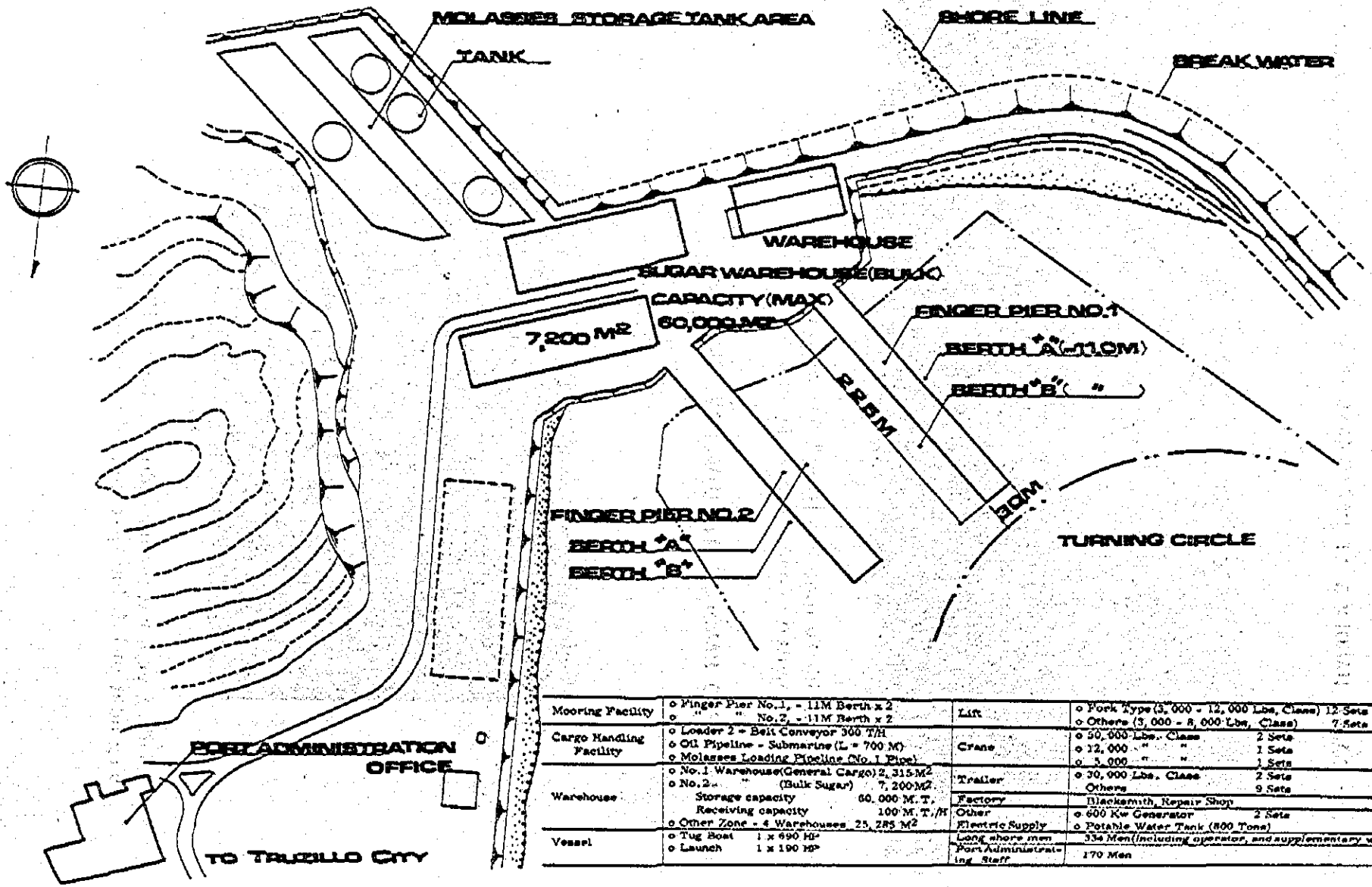
FIG. 4-415 CARGO HANDLING AT PACASMAYO PORT (2)

(Photo taken in April 1976)



Loading general merchandise in bags with pier crane.
Tug boat in left background, other crafts are fishing boats.

Fig.4-416 Facility at Salaverry Port



Mooring Facility	○ Finger Pier No.1, - 11M Berth x 2 ○ " " No.2, - 11M Berth x 2	Lift	○ Fork Type (3,000 - 12,000 Lbs, Class) 12 Sets ○ Others (3,000 - 8,000 Lbs, Class) 7 Sets
Cargo Handling Facility	○ Loader 2 - Belt Conveyor 300 T/H ○ Oil Pipeline - Submarine (L = 700 M) ○ Molasses Loading Pipeline (No.1 Pipe)	Crane	○ 50,000 Lbs. Class 2 Sets ○ 12,000 " " 1 Sets ○ 5,000 " " 1 Sets
Warehouse	○ No.1 Warehouse (General Cargo) 2,315 M² ○ No.2 " (Bulk Sugar) 7,200 M² Storage capacity 60,000 M.T. Receiving capacity 100 M.T./H ○ Other Zone - 4 Warehouses 25,285 M²	Trailer	○ 30,000 Lbs. Class 2 Sets Others 9 Sets
		Factory	Blacksmith, Repair Shop
		Other Electric Supply	○ 600 Kw Generator 2 Sets ○ Potable Water Tank (800 Tons)
Vessel	○ Tug Boat 1 x 690 HP ○ Launch 1 x 190 HP	Long shore men	334 Men (including operator, and supplementary worker)
		Port Administrating Staff	170 Men

FIG.4-417 CONDITION OF SAND DEPOSIT INSIDE HARBOR AT SALAVERRY PORT

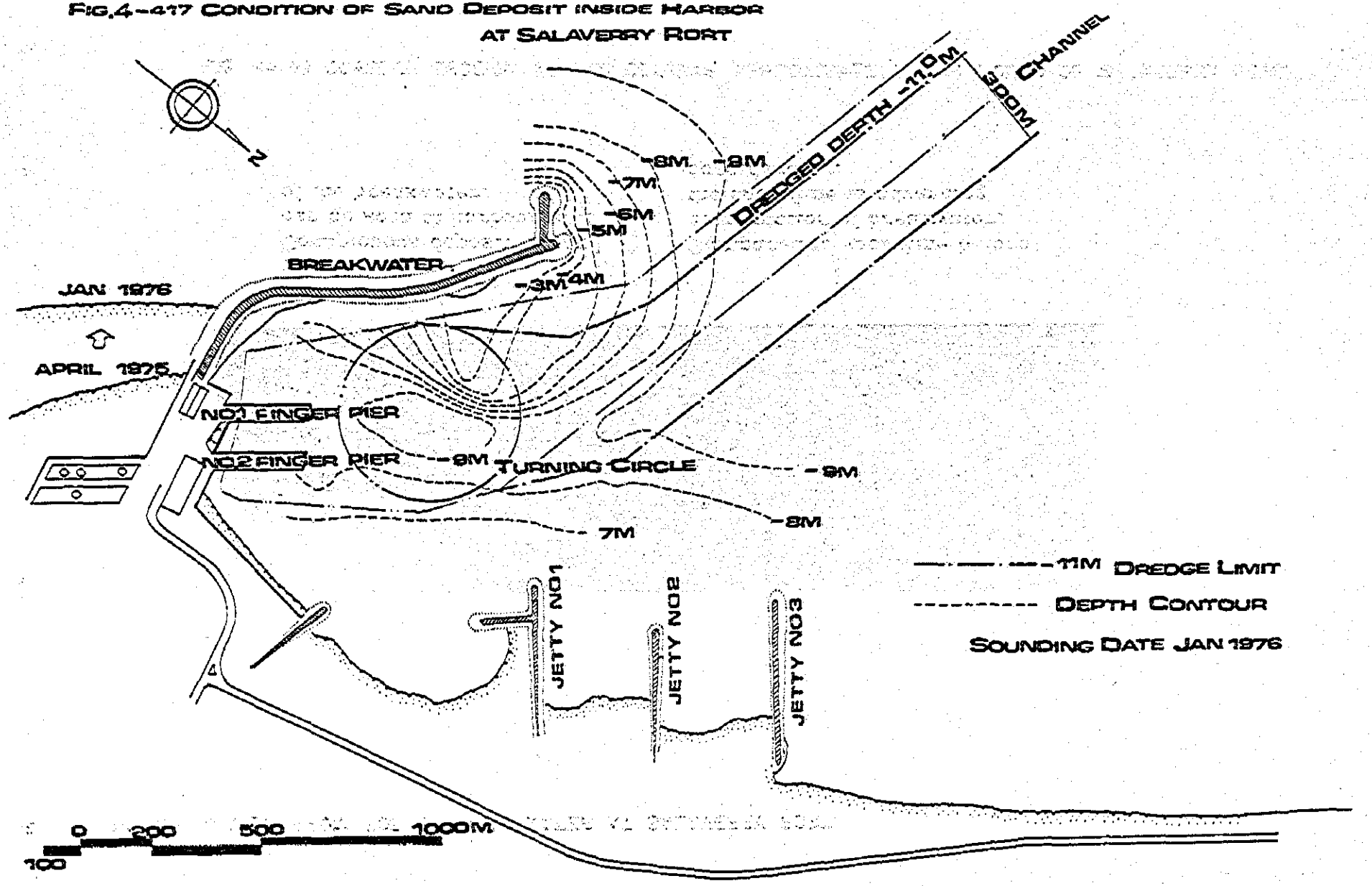


FIG. 4-418 VIEW FROM TOP OF BREAKWATER AT SALAVERRY PORT

Conspicuous deposit of sand can be seen at harbour side of the breakwater.

Compared to shoreline before construction of breakwater, the shoreline is advancing considerably.

FIG. 4-419 COASTAL EROSION AT LAS DELICIAS (APPROXIMATELY 5KM NORTH OF SALAVERRY PORT)