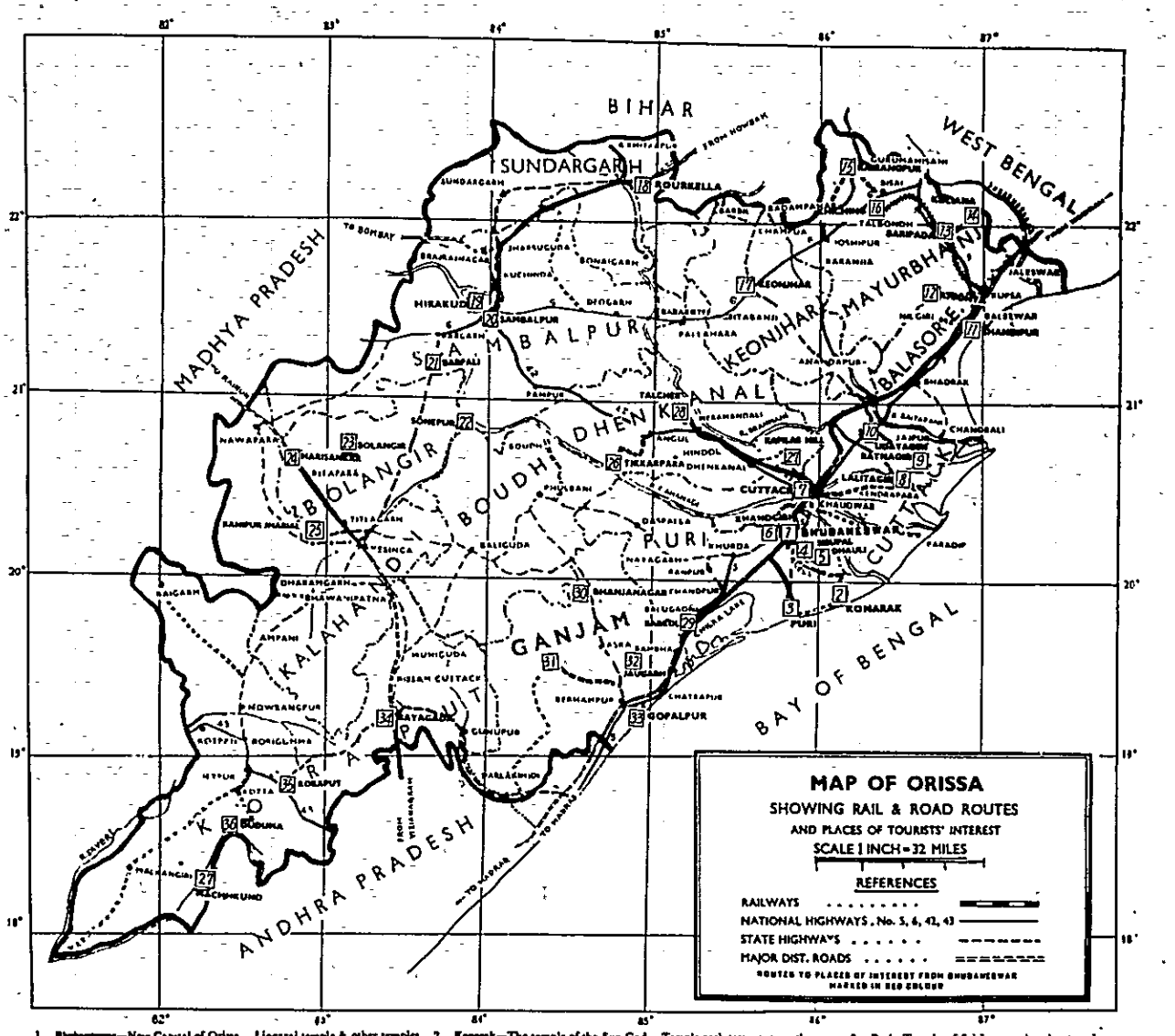
REPORT
OF
RECONNAISSANCE SURVEY
ON
DEVELOPMENT PROJECT OF STATE OF ORISSA

JAPANESE SURVEY MISSION
DISPATCHED BY
OVERSEAS TECHNICAL COOPERATION AGENCY
MARCH 1963



1. **Bhubaneswar**—New Capital of Orissa. Lingaraj temple & other temples. 2. **Konarak**—The temple of the Sun God Temple architecture is worthseeing 3. **Puri**—Temple of Sri Jagannath, other temples, Sea beach, Health resort. 4. **Simpal Garh**—The ruins represent a well fortified city. The site is under excavation 5. **Dhauli Hill**—Wonderful Edicts of King Asoka. 6. **Khandgiri Hill**—Thickly covered with trees. Series of Jain caves. 7. **Cuttack**—Business Centre and old Capital of Orissa. 8. **Lalitagiri**—Number of Buddhist relics, caves and images of Buddha. 9. **Ratnagiri**—Contains many Buddhist relics. 10. **Udayagiri**—Famous for its sculpture. Caves—Ranigumpa and Ganesh Cave. 11 **Chandipur**—Health resort on sea-cost—9 miles from Balasore 12. **Ajodhya**—Many Hindu & Buddhist temples. The image of Tara Famous for Soap-stone utensils. 13. **Baripada**—Temple of Chamunda Many images—Parashnath, Risabha and Mahabir 14 **Kaliapa**—Famous for paleolithic implements. 15. **Rairangpur**—Centre of the iron-mining area 16. **Khiching**—Chamunda temple. Museum. 17. **Keonjhar**—Badaghagra water falls, Gandhamadan mountain. 18. **Rourkella**—Hindusthan Steel Factory 19 **Hirakud**—Hirakud Dam with reservoir. 20. **Sambalpur**—Famous Samaleswari temple. The textile fabrics are excellent. 21. **Barpali**—Centre of village uplift and welfare work of the Friends Society. 22. **Sonepur**—A beautiful hilly place. Famous for Tussar-Silk fabrics. 23. **Bolangir**—Several temples and images at Patnagarh 25 miles by road. 24 **Hari Sankar**—Beautiful spot. Natural spring 25. **Rampur Jharial**—Site of a large number of temples, vast ruins and the unique brick built temples. 26. **Tikharpara**—Dense forests infested by tigers, elephants and other animals. A Bamboo Depot. 27. **Kapilas Hill**—Important Health resort Temple on the Hill. 28. **Talcher**—Coal mining centre. Nice sanctuary of wild beasts. 29. **Barkul**—On the shores of the Chilka lake. Place of fishing and boating. 30. **Bhanjanagar**—Famous for Bell-metal works. Artificial lake and Reservoir within one mile towards Udayagiri. 31. **Taptapani**—Sulphur-spring 32. **Jaugarh**—There is an Asokan rock edict. 33. **Gopalpur**—on—sea—coast. A quiet Health resort. 34 **Rayagada**—Sugar mill. Scenic forest land. 35. **Koraput**—It stands 3,000 ft. above the sea level. It's high plateaus are worthseeing. 36. **Dudume**—Water falls. 37 **Machkund**—Hydro-Electric Project.

INTRODUCTORY REMARKS

1. Outline of the survey conducted by the Mission is shown under the General Discussion, 1 - 5, "Summary of Findings".

2. The detailed discussions are presented in the order of 1st Group (plans undertaken under the cooperation between the State Government and Central Government) including Mining, Road, Port and Harbour; and 2nd Group (those planned independently by the State Government).

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1. Introduction

Contents

REPORT ON SURVEY OF OVER-ALL DEVELOPMENT PROJECT OF ORISSA STATE, INDIA

1. INTRODUCTION

1 - 1 Dispatch of Survey Mission:

Despite of the fact that the State of Orissa, India, is abundant in various natural resources, most of mineral, agricultural and hydraulic resources have been left undeveloped due mainly to divided administrative jurisdictions in the past as well as to lack of modern transportation.

Thus, the level of production in the State is low with a resultant lower living standard of inhabitants as compared with other states.

An effective and over-all development of the State has long been desired, and the State Government of Orissa, since 1947, has planned various economic development projects, some of which are already underway. Some of the projects are being executed jointly with the Central Government, others being undertaken, at the present time, by the State Government independently.

Among these projects, the following have already been materialized with noticeable results:

(1) Construction of the multi-purpose HIRAKUD dam for power generation, irrigation and flood prevention,

(2) Construction of Rour Kela steel plant,

(3) Expansion of educational institutions including those for technical education,

(4) Agricultural improvement including model farms, and

(5) Development of industrial area around Cuttack.

Judging from these outstanding achievements so far accomplished it is obvious that an integrated and rational execution of more extensive program will contribute a great deal to the economic development of the State as well as to the people's welfare.

The State is especially abundant in underground resources. Japan is

not only one of the largest export market for Indian iron and other ores but also India is the largest source of iron ore supply for Japan; There has been a close technical co-operation between India and the related industries of Japan concerning the development of the State, especially mine exploitation, and since 1956 survey teams were sent twice by the Japanese mining, construction and steel industries.

The Central Government of India as well as the State Government are desirous of having a more extensive cooperation of Japan on the governmental level, and the project has been under preliminary negotiation between His Excellency Shri Manubhai Shah, Minister of International Trade and other competent officials of the Central Government of India, His Excellency Shri Patnaik, Chief Minister and other State Government officials on one side and His Excellency Koto Matsudaira, Japanese Ambassador to India on the other side.

As a result, a request was made by the Government of India to the Japanese Government in May 1962 for the dispatch of a mission to conduct a survey of mine development, construction of port facilities for shipping ore and general development of the State of Orissa.

In response to the request, the Japanese Government decided its policy to send a composite survey team and has commissioned the Overseas Technical Cooperation Agency, an organization established for the purpose of implementing governmental technical cooperation of this kind, to undertake the survey.

The Agency, after consulting extensively with the government authorities and private companies, has selected most competent experts in various fields concerned and organized a survey mission to be sent to the State of Orissa, India.

1 - 2. Member of Mission:

(Refer to the attached table 1)

Table - 1.

MEMBERS OF THE SURVEY MISSION

Team	Name	Assignment	Occupation (at the time of survey)
Chief of the Mission	Shinichi Shibusawa	Coordination	Director General, Overseas Technical Cooperation Agency
	Seiichi Tsuruga	Liaison	External Service Division, Overseas Technical Cooperation Agency
Mineral Resources	Mochimasa Nango	Iron Works	Assistant Chief, Fuji Iron & Steel Co., Ltd.
	Minoru Tomita	Iron Works	Purchasing Dept., Yawata Iron and Steel Co., Ltd.
	Takeo Miyake	Mining	Deputy General Manager, Kamaishi Mine Office, Nittetsu Mining Co., Ltd.
	Tatsuo Ugai	Mining & Survey	Assistant Chief, Mining Section, Nittetsu Mining Co., Ltd.
	Tamotsu Nakajima	Geology	Geologist, Geological Section, Nittetsu Mining Co., Ltd.
	Shinro Ueno	Coal Mining	Chief, Safety Section, Hohusho Mine, Nittetsu Mining Co., Ltd.
Port & Harbour	Moichi Miyazaki	Overall planning of Port and harbour	Technological Councellor, Port & Harbour Bureau, Ministry of Transportation
	Yasuo Hisada	Coastal Engineering (Drift sand)	Deputy Chief, Disaster Prevention Section, Port & Harbour Bureau, Ministry of Transportation
	Makoto Norisugi	Dredging	Chief, Reclamation Engineering Division, Toa Harbour Works Co., Ltd.
	Tomokichi Sugawara	Loading Machines	Deputy Manager, Transportation Equipment Design Department, Ishikawajima-Harima Hvy. Ind. Co., Ltd.

Tractors & Farming Implements	Masatake Sakamoto		Manager, Plant Engineering Dept. Komatsu Mfg. Co., Ltd.
Fishery	Kiichiro Yamahira	Fishery Administration	Deputy Chief, Data & Statistics Section, Investigation & Research Division, Fisheries Agency
	Hiroshi Nishimaki	Refrigeration Process	Chief, Designing Sec., Construction Department, Kinoshita & Co., Ltd.
Small Enterprises	Yoshihiko Matsukata		Consulting Engineer, Japan Consulting Institute
Power Generation	Konosuke Kuroiwa		Public Utilities Research Section, Public Utilities Bureau, Ministry of International Trade and Industry.
Coal Chemistry	Yasuo Karazawa		Chairman of Technical Committee, Japan Tar Industry Assoc., Inc.
Road & City Planning	Yoshiro Watanabe		Planning Engineer, Regional Planning Section, Planning Bureau, Ministry of Construction.
	Total: 19		

1 - 3. Survey Program:-

Out of 19 members of the mission, 6 members in charge of mining, farming implements, electric power, fishery, medium and small enterprises and liaison arrived at New Delhi on November 15, 1962; while, the chairman of the mission and other 11 members in charge of fishery, port & harbor, road and coal chemistry arrived on November 19, 1962; the other member who is to take charge of mining (coal) joined the mission at Calcutta on December 25, 1962.

The advance 6 members had a preliminary discussion on November 17 at the Ministry of Commerce and Industry with Vice Minister Prasad and nine other officials of the Indian Government to hear the policy of survey desired by India: On November 20, the entire mission had a joint meeting with the officials of both Central Government (Minister of International Trade and eight other officials) and State Government of Orissa (Governor Khosla, Chief Minister Patnaik and 7 other officials) to confirm mutually the basic policy of survey and also to review the details of survey in each field by the competent experts of both parties.

Upon its arrival at Bhubaneswar, Capital of Orissa State, on November 25, 1962, the mission held a meeting with 17 officials of the State Government including Mr. SHIBARAMAN, Senior Vice Minister, to work out a survey schedule for each division. The schedule which is shown on the attached sheet was finalized by the agreement of both the State Government and Mission.

The survey was conducted mainly within the State of Orissa, but several members of the mission inspected some institutions in other states such as the Poona Hydraulic Power Research Center in Bombay State, etc. for the purpose of collecting related data as well as for comparing with similar or related establishments in other state.

The Mission members left India during the period from the middle of

December 1962 to the end of January 1963, but most of the members had meetings with the authorities of the Central Government in New Delhi or Calcutta to exchange views and opinions on the results of the survey.

(Attached table 2)

1 - 4. Object of Survey:-

During the joint meeting in New Delhi and the subsequent meetings, explanation was made by the Indian authorities on their suggested objects to be surveyed. The overall development of Orissa State may be classified into two groups according to their suggestion.

1 - 4 - 1.

The first group of objectives embodies development of iron ore mines in Tomka-Daiteri district and other mines and also the construction of road and Paradeep Port for the purpose of transporting and shipping ores.

The project is the "Pivot" of the present development program of the State and the planning and execution of the project is being undertaken by the joint effort of both State and Central Governments.

A preliminary project concerning the construction of road and cannal for the transportation of ore as well as excavation of harbor site has been prepared and a part of the construction work has recently been started.

The mission was requested to make comment and recommendation on the project and its execution. The port harbor and road team of the mission was entrusted with the work. (the project also included city planning around Paradeep).

As for the development of mineral resources, mining team conducted an extensive survey of various mines in the State and studied the amount of reserves and quality of ores by means of boring tests and chemical analysis of ores.

1 - 4 - 2.

The second group of objectives includes farming implements, fishery,

Table - 2.

ITINERARY OF SURVEY

TEAM	NUMBER OF DAYS	Nov. 15	Nov.18	Nov. 28	Dec. 13	Dec. 18	Dec. 23	Dec. 25	Dec. 29	Jan. 21	Jan. 29
Chief of Mission	31		Consulation	Consultation with State Govt. & Survey	Finalizing of survey						
Coordination Team (1 member)	41	Consultation	Lv. Tokyo Ar.New Delhi	Lv.New Delhi & Ar.Orissa via Calcutta Same as above	Ar.New Delhi via Calcutta	Lv.New Delhi Ar. Tokyo	Finalizing of survey				
Mining Team (Mining, Survey, Geology)	76	Lv.Tokyo Ar.New Delhi		Same as above Same as above			Ar.New Delhi via Calcutta	Lv. New Delhi Ar. Tokyo	Survey	Finalizing of survey	
Mining Team (Iron-making) (2)	45	Same as above		Same as above Same as above			Finalizing of survey Dec. 24		1 Mining Engr. returned Japan via Calcutta	Ar. New Delhi via Calcutta	Lv. New Delhi Ar. Tokyo
Mining Team (Coal Mining) (1)	31		Lv. Tokyo Ar.New Delhi	Same as above			Ar. New Delhi via Calcutta		Lv. New Delhi Ar. Tokyo		
Power Generation Team (1)	41	Consultation		Same as above			Finalizing of survey		Lv.Tokyo & Ar. Orissa via Calcutta	Ar. New Delhi via Calcutta	Same as above
Tractor, Farming Implement Team (1)	41	Lv. Tokyo Ar. New Delhi Same as above		Same as above Same as above			Same as above	Lv. New Delhi Ar. Tokyo			
Small Industries Team (1)	41	Same as above Same as above		Same as above Same as above			Same as above Same as above	Same as above			
		Same as above		Same as above			Same as above	Same as above			
Chemical Industry Team (1)	41		Same as above	Same as above			Finalizing Dec.24 of survey	Dec. 28			
Port & Harbour Team (4)	31		Lv. Tokyo Ar.New Delhi Same as above	Same as above Same as above			Ar. New Delhi via Calcutta		Lv. New Delhi Ar. Tokyo		
Fishery Team (2)	31		Same as above Same as above	Same as above Same as above	Ar.New Delhi via Calcutta Same as above	Lv. New Delhi Ar. Tokyo					
Road Team (1)	4		Same as above Same as above	Same as above Same as above	Same as above Same as above	Same as above			Dec. 28		
					Same as above				Lv. New Delhi Ar. Tokyo		

medium and small enterprises, electric power and coal chemistry. At present the State Government is planning to develop these objectives without any help from the central government. Whether the projects are to be carried out independently by the State Government or they are to be included in the Central Government's program is a matter to be decided in the future between these two governments.

Thus, no concrete plans have been made for most of these fields, and the State Government expected the mission to comment and express opinions on the planning and other basic matters concerning these projects: The mission, therefore, exchanged views and made recommendations to the State Government mainly on the basic policy, order and method of execution and surveys and investigations necessary for the implementation of the plan.

In view of the technical character of the mission, it purposely refrained from entering into any trade or financial aspect of the projects. The report contains evaluation of cost for some of the projects as viewed from the technical standpoint, but it does not deal with the financing aspect of the projects since the matter concerns mainly the State or Central Government.

1 - 5. Summary of Findings:

Though the survey results of each Team will be discussed in detail in the section of Details of this report, the findings may be summariezed as follows:

1 - 5 - 1. Mining Industry:

1.) Summary of Findings and Objects of Survey:

The mines surveyed by the Mining Team are as follows:

a) Iron Mine: General survey of seven operating mines and two unexploited areas in Iron Belt and Daiteri. Detailed survey of one unexploited mine for the purpose of shaping its development plan.

b) Chromite Mine: General survey of three operating mines, and three un-

explited or idle mines.

c) Manganese Mine: General survey of one mine in Iron Belt area.

d) Coal Mine: Investigation of four mines and unexploited outcrops in Talcher coal field.

2.) Conditions of Ore Deposits:

a) Iron Ore Deposits:

(1) Iron Belt Area: All the ore deposits in this area are hematite deriving from Banded Hematite Quarzite. Their scale is one of the largest in the world, and the deposits account for 32% of the total reserves of hematite deposits in India. The mine development has shown a rapid progress in recent years, and in 1961 4,500,000 tons of ore were produced from 53 mines in this area. Since the southern part of this area has many deposits left unexploited simply because there is no road, this area will have a bright prospects provided that transportation facilities such as railroads are improved in the future.

(2) Daiteri Area: This is an isolated area of iron deposits located to the south of the above mentioned Iron Belt, and is also hematite deriving from in Banded Hematite Quarzite. As a result of detailed survey on two primary ore deposits and four float ore deposits, the total reserve has been estimated to be 5,500,000 tons. As for the grade of ore, it is estimated at the stage of prospecting so far conducted that Fe (in total Fe) content is 58% in crude ore and 60% in lump concentrate, and the lump-fine ratio is 50:50. As regards general plan of mining, in order to produce 2,000,000 tons of concentrate per year, 4,000,000 tons of crude ore must be mined, which will require open-cut mining by using such large-size machines as drill masters, 4-yd^3 shovels, 22-ton dump trucks, etc.

The crushing and sizing plant is to be built at a place 1.6km south to the triangular point, and washing of ore is to be carried out all the year round by means of two crushing systems.

The hoppers for loading trucks are to be built at a place on 110m

level which is 5km east to the point. The concentrate of +1/2" - 4" size may be hauled to the hoppers by a 4.5km long down-hill conveyor.

As for accessory facilities, a $66^{kv}/\ 11^{kv}$ substation is to be built by power supplier for the purpose of supplying substations in various facilities with 11 Kv power. Water supply can be obtained by pumping up from Kusai Nara which is situated about 8km east to the deposit area.

Besides above, a service center will be built at the Saddle Portion (about 760m level) of the Daiteri Hill, and housing accommodations and welfare facilities will be built at the town site in Talpada area.

The total investment cost for producing annually 2,000,000 tons of concentrate is estimated to be approximately ¥7,700 million, and the production cost at mine per ton of concentrate including operating cost, depreciation and interest charges (term of redemption: 10 years, rate: 5%) and taxes is surmised to be a little under ¥933.

Ore hoppers with a capacity of 10,000 tons of ore will be built at the end of the down-hill conveyor, and the ore will be transported 145km to Paradeep Port by 20-ton trailer trucks in accordance with the proposition of the State Government of Orissa. The shift in which the trucks are operated will be 8 hours, and the trucks may complete a round-trip of 290km in seven hours (excluding one hour for lunch) at an average speed of 40km/hr. This means that the transportation of ore will require 250 trucks; and assuming that the rate of operation is 85%, the total number of trucks required will be 294. The total cost of these trucks will be about ¥4,300 million and the running cost between the mine and Paradeep Port will amount to ¥977.20, including depreciation and interest charges.

Since the loading charge at the Paradeep Port is estimated at about ¥40/ton at the Paradeep Port, the F.O.B. cost of ore at the Paradeep Port will be ¥1,950/ton in total. As regards the trucking cost, it is calculated on the basis of 3,000,000-ton hauling in consideration of the State Govern-

ment's proposal to include additional 1,000,000 tons of ore to be mined by manual labour at Tomka, Daiteri float ore and Sukinda.

b) Cromite Deposit:

In Skinda area surveyed by the team, the existence of about 40 banded lodes small as well as large, has been found in ultrabasic rocks. Though the scale varies from place to place, most of them are less than 100m long and 10m wide with reserves of at most tens of thousands tons. Lump ore consisting of coarse grains which is found in the eastern part of the area has about 56% of Cr_2O_3, and shows considerably high Fe content locally substantial variation of chemical composition being noticeable.

The actual output in 1961 was about 20,000 tons. The ore is mined by a primitive open-cut mining with man power, and the operation is suspended in case under-ground water level is reached. Most of the deposits have not yet been made clear even as to their reserves. Since there is sufficient room for further prospecting, this area will continue to play an important role in the domestic supply of chromite ore with further increase in the proved reserves even though each individual deposit is not so large.

c) Manganese Deposit:

Manganese ore deposits exist in shale of a stratum underlying B.H.Q. strata. They are residues derived from weathered shale. Rich ores are distributed in clay near the surface of ground, forming small lense or lump, but all are of small scale. The deposits are apparently different from large deposits of Gondite-series type.

d) Coal Deposit:

The State of Orissa has two coal fields, Talcher and Rampur, but the survey has been made only on Talcher coal field.

Coal seams presently confirmed are upper seams No.1 and No.2 and lower seam in the lower Gondwana Baraker Seams, but all are non-coking and bituminous, and, except for the lower seam, they are with high ash content

owing to insufficient parting of coal seams. The reserve in the currently developed area of 10 miles^2 is estimated to be about 100 million tons, and underground mining at three places and open-cut mining at one place are being carried out to mine the lower seam.

In an area of 10miles^2 in the vicinity of already developed field, test boring works were conducted and a reserve of about 300 million tons has been confirmed. Development of two coal mines is now under study.

As seen in the above, a coal reserve of approximately 400 million tons has already been confirmed within the area of 20 miles^2, and several coal mines are in operation. Furthermore, the area which is know to have the distribution of Baraker Series but not yet investigated extends to 190 miles^2. There is also a distribution of Mohadiva Series over 500 miles^2 which is believed to have Baraker Seam at its lower part.

Depending on the results of future prospecting, the prospect of this extensive area of 700 miles^2 is very bright future for development. However, since the coal seams other than the lower seam which is presently mined involves a problem of inferior quality, study should be made as to the methods of preparation and effective utilization of coal.

1 - 5 - 2. Road Construction and Trucking:

(1) Survey Policy Concerning Ore Road Plan:

The construction of the road was started in September 1962, and as of the end of November 1962, approximately 1/6 of the total length was under construction. During the survey, study was made, with the emphasis on the 1st stage project, on the ore road project undertaken by the State Government for the distance between Tomka Daiteri iron ore mine and Paradeep Port.

(2) Comment on the 1st Stage Road Project:

(a) Further study should be made on the routing of the road to minimize transportion time and cost. Recommendation is made to take some measures to preclude oxcart and other lowspeed vehicles as well as to install central safety zone and frontage road.

(b) As for the construction of road, consideration should be made to provide for 50miles/per hour speed driving in the future. Recommendations have also been made on various points of construction which requires further technical improvements such as width, pavement, grade of longtitudinal section, bridge, side slope protection, etc.

(c) It is desirable to install a service station for the transporting workers and vehicles at such places as mine, port and a place in between. It will be necessary to secure a site for necessary terminal facilities in order to assure a continuous smooth transportation of ore.

Various facilities and control systems to ensure a smooth control of traffic are also required. Furthermore, it is advisable to make further study on the comparison with railway transportation, possibility of revising the road project to cope with the progress of development of roadside area.

(3) Comment on Ttransportation Methods:

Transportation plan prepared by the State Government intends to transport 25 tons of iron ore on a 20-ton trailer truck which will make two round-trips a day, with 360 working days a year. However, this plan involves considerable difficulty and is not considered practical. In view of the actual circumstances, the annual working days should be 300 days even under the most favourable condition; The maximum load that a 20-ton truck can take is 22 - 23 tons. For these reasons, the transportation cost prepared by the State Government will show approximately 25% increase.

1 - 5 - 3. Development Plan of Paradeep New Port:-

(1) Policy of Survey:

A plan to develop a large scale port capable of accommodating large ocean going vessels at Paradeep has been a long pending problem for the State Government of Orissa. In 1961, upon appointment of Mr. Patnaik as Prime Minister, the State Government appropriated in the State budget a

survey cost for the development of a new port, and requested "Rendel Parmar Tritton Company", a consulting firm in England, to prepare the port construction plan. The consulting firm which maintained a close collaboration with the State Government, prepared a plan (which is referred to as Rendel Parmar Plan hereunder). Though the fundamental priciples were accepted by the State Government, the plan involved many undecided matters as to its details, on which the mission was requested to make concrete suggestions.

The Rendel Parmar Plan divides the construction of Paradeep Port into two stages; the first stage work to be completed in a few years aims at the construction of port facilities capable of shipping 2,000,000 tons of iron ore annually, and the second stage work is to develop the port into a large scale general port with miscellaneous cargo berth, petroleum berth and dockyard, keeping pace with the development of Orissa State.

Accordingly, in this survey, the mission has adopted the policy to make suggestions and recommendations, with emphasis on the 1st stage work expected to be executed within a few years, concerning the plan, design and method of execution of construction work after reviewing the Rendel Parmar Plan.

(2) Comment on General Planning:-

It is almost impossible to make any forecast as to the future development of Paradeep Port which is to be built as an ore shipping port located between Calcutta Port and Visakhapatnam Port. Any attempt to make a forecast must refer to other existing ports with similar conditions. From this view point, study is made on the general plan of Paradeep Port (Overall plan embodying both the 1st and 2nd stage works of the Rendel Parmar Plan) taking Visakhapatnam Port as the sole basis of study.

The scope of general plan of Paradeep Port should include about 10 berthes for miscellaneous cargoes in addition to five berthes for ore handling, with sufficient provision for future expansion. The normal lines of quay wall and breakwater should partly be changed in order to minimize

possible filling-in of navigation route by sand drift as well as for the convenience of incoming and outgoing of ships. These revisions suggested are as shown in Fig. 1.

It is considered that various industries centering around the Paradeep Port will be developed in the following order:

Shipment of ore will introduce import of coal, sundry goods and petroleum products for ships and ore transporting vehicles, and also export of agricultural products, which will then be followed by machine repairing industry and ship-building, establishment of a navy base, food processing industry, oil refining and construction of thermal power plant. This district, with the port in its center, will grow as the center of industrial development of the State of Orissa. Further growth will be seen in commerce and other third stage industries to give the inhabitants employment with higher income, thereby contributing to the elevation of living standard.

(3) Comment on the 1st Stage Program (1st stage work of Rendel Parmar Plan):-

The first stage project intends to construct ore berth, cargo handling equipment, route, moorage and other port facilities necessary for accommodating 60,000-ton ore carrier to ship annually 2,000,000 tons of iron ore. It also includes the construction of a slip way and berthes for miscellaneous cargoes. The results of survey on the first stage project are as follows:

(a) Rendel Parmar Plan underestimates the amount of drift sand which is one of the primary considerations for planning. However, since it is extremely difficult to make an exact estimate of drift sand with the existing data and information available today, further effort should be made to obtain more accurate estimate on the quantity of drift sand by conducting on-the-spot survey along with the execution of construction work.

In this connection, since the layout of the breakwater is the most important factor in protecting the route from possible blockade by sand drift, it is of special importance to the port. After the Rendel Parmar

Plan was submitted, the State Government undertook experimental work at the research center and now considers modification to the plan as the result of their experiments. The mission does, of course, suggest further deliberate study on the layout of breakwater, but it also considers that the combination method of sand trap and island breakwater as suggested in the Rendel Parmar Plan involves certain danger at the present stage where no definite estimate of drift sand has been established: A layout which is sufficiently flexible to allow fluctuation in the amount of drift sand should be employed. The changes suggested by the mission are as shown in Fig. 1.

(b) As for the size of ore carrier, the Rendel Parmar Plan suggests 60,000 D.W.T. ships, but, in consideration of such matters as cost of transportation, recent trend in ore boat construction, conditions of port facilities in ore importing countries, etc. the mission has come to a conclusion that the most appropriate size of the ore carriers to be considered under the 1st stage project is 40,000 - 50,000 D.W.T. class.

Furthermore, some revisions have been suggested as to the depth of route, turning basin and berth included in the 1st stage work as a result of the study made on the draft of the above stated ships, efficiency of cargo handling, employment of sailing schedule taking advantage of high tide, etc. In consideration of the cargo handling method and the construction of quay wall, the appropriate length for berth will be the length of the ship concerned plus some margin.

(c) As for the construction schedule of the first stage work, the Rendel Parmar Plan intends to complete it by the end of 1965. Although it is not impossible to carry out the construction schedule, in order to assure the completion within the suggested period, it will be necessary to change construction methods at the same time increasing number of construction machines to be used. However, as a natural result some increase in the cost of construction and also technical assistance from the advanced countries

will be unavoidable.

Although the Rendel Parmar Plan suggests to employ pier type construction of quay wall for the ore berth, in view of the condition of fundation and necessity of expeditious execution of work, it is advisable to employ cell type quay wall with sheet piles. As for the construction of breakwater, the rubble mounted breakwater as suggested by the Rendel Parmar Plan can hardly be considered appropriate in view of the cost and schedule of construction. It is recommended to build a composite breakwater by using rubbles for foundation and caisons for the upper part.

(d) In so far as cargo handling equipment is concerned, the Rendel Parmar Plan lacks in detailed study, and changes have been suggested as to the details of the plan. For instance, cargo handling equipment on each berth for the shipping of iron ore were to be used exclusively for each berth, but recommendation has been made to revise the plan so that the equipment may be used commonly for all berthes. As for the equipment at the ore yard, the type of reclaimer suggested by the Rendel Parmar Plan is to be changed to shovel-wheel type reclaimer, and by reducing the capacity of each reclaimer to 1/2, the number should be increased so that the handling capacity has enough flexibility to cope with any possible break-down of the machines. Furthermore, as the annual working days employed in the State Government Plan are rather immoderate, they should be reconsidered. Recommendation is also made to assure sufficient maintenance work and also provide enough spare parts of the equipment.

(4) Possibility of Future Technical Assistance:-

(a) Employment of Japanese Engineers:

Because of the absence of port facilities in the State of Orissa, the State Government has no engineering staff except the recently employed Chief Engineer who was formerly with Madras Port. Therefore, no detailed planning or designing has been made. In order to construct a large scale

new port at Paradeep, it will be necessary to have at least several high-class engineers and substantial number of supervising staff.

The construction of Paradeep Port, in particular, requires highly specialized knowledge on the disposition of sand drift: The plan and design would have to be revised and changed during the process of construction. Besides, in order to execute more economically the construction of structures, it is necessary to have specialized engineers.

Though it is not clear if such engineers and technicians may be found within India, since many of Japanese engineers have abundant experience on the construction of similar ports and are well qualified for such work, it is advisable to send Japanese engineers by selecting them from those of medium standing. These engineers will also contribute a great deal to the training of Indian harbour engineers who are required by the State Government of Orissa.

(b) Execution of Work:

Technique in India concerning the construction and manufacturing of harbour structures and cargo handling equipment merely follows the conventional British methods and is not much advanced. It will be economical to introduce advanced Japanese technics.

Judging from this viewpoint, there is a great possibility of exporting Japanese harbour work technique, and it is hoped that Japanese harbour construction companies and cargo handling equipment manufacturers take initiative in receiving the orders.

As discussed above, there will be a great possibility of technical collaboration between India and Japan in connection with harbour construction, but it is considered that execution of road construction work may be carried out satisfactorily by the engineering staff of the Stage Government. However, it is considered that Japanese contractors may have a possibility of receiving contracts for the actual execution work of road construction.

1 - 5 - 4. Farming Implements:-

(1) Since Pakistan, which had been the main source of staple food supply, became independent, the State of Orissa, main producer of rice in India, has been obliged to make a large contribution to the increased production of rice. In India, as in Japan, rice is grown in paddies, but bullocks are the only source of power in paddy cultivation. Therefore, materialization of a plan to mechanize the bullock-powered cultivation work for the purpose of increasing rice production has naturally come to be highlighted.

The effect of such mechanization is well proven by the fact that a model farm run by the Japanese at Chakuli village in the outskirt of Sambalpur has attained crops five times more than average crops in India mainly through mechanization of the farming in order to complete necessary work in a short time as occasion calls: On the other hand, the Central Rice Research Institute at Cuttack has long been making experimental work on the mechanization of farming work with convincing results. For these reasons, the State Government presumably has decided to promote the mechanization of agriculture.

The mechanization of agriculture means cultivation by machines, its keypoint being replacement of bullock-drawing with tracter, and the object of the survey is to find out the most suitable size, type and number of machines to be used as well as to make study on the matters to be considered for the manufacture of such machines including the scale of manufacturing.

As a result of the survey, the mission has come to conclude that, in order to achieve increased production of rice, it is absolutely essential to mechanize the farming work to the maximum extent, and, for this end, the primary prerequisite will be that the machines, which are to be as powerful as practicable, should be sufficiently low-priced so that many farmers may purchase them with the assistance of the Cooperatives. Though there are

many conditions to be taken into account, the 7 - 8 HP class cultivators manufactured by K.K. Kubota Tekkosho which were used previously in the district have been selected. As for the manufacture of the machines, with an annual production of 5,000 as the target of the 1st stage, a detailed program will be worked out to undertake home-manufacturing of the machines in five stages.

This report has been prepared to provide basic data necessary formulating the actual production program. Such actual program is to be separately submitted by competent personnel in charge of production.

1 - 5 - 5. Fisheries:-

(1) Outline:

Survey on the actual conditions of fisheries along the coast of Orissa State has proved that the present fishery operations with no central fishing port are still in the stage of further development, and the present technical level is extremely primitive and traditional: Fish caught by marine fishing is very limited. Only coastal fish within a short distance is caught, and exploitation of off-shore fishery resources is the task to be solved in the future. It is apparent that the State Government authorities are endeavoring to improve the present low level fisheries.

The followings are some of the matters pointed out by the mission as a result of its survey:

(a) Fisheries in Chandipur:

Gillnet fishing carried on at the time of survey had a good result, but effort should be made to improve the fishing implements as well as to have diversified operations with trolling, drift gillnet fishing, long-line fishing, etc. so as to make this district a future center of fishery operations with fishing port facilities.

(b) Fisheries at Chilka-Lake:

Chilka Lake which is well known for its abundant shrimp resources

plays an important role in the fishery economy of Orissa State. According to the statistics shrimp accouts for more than 30% of the total catch in the Lake, but the amount has been steadily decreasing. Even though there may be biological as well as geographical reasons for such decrease, measures should be taken to assure a continued maximum production of shrimp resources in the Lake.

(c) Paradeep Fishery Base:

The fishing base must have been planned for the territorial reasons. The fish caught in this district are of little economic value. To obtain fish with higher economic value, exploitation of off-shore fisheries must be undertaken.

(d) As for the fresh water fisheries, the important task is how to connect permanently the aquatic resources of Hirakud Reservoir with the fishery operations of the neighboring villages. Due consideration should be made on the cultivation of resources in the reservoir; the "stock sampling" presently undertaken is considered as one of the important measures.

The fresh-water fish breeding in Mahanadi River, which is suitable for tropical climate, is considered excellent.

(2) Development Policy for Fisheries:-

The development plan of fishery operations in the State of Orissa should be pushed forward with an aim to attain the goal of planned modern fisheries.

Matters calling for immediate attention will be as follows:

(a) Construction of Modern Fishery Base:

A fishing port is indispensable for the improvement of present low level fisheries. The fishing port is the keypoint which links together the production at sea and processing of marine products on land. The port should be fully equipped with such necessary facilities as refrigirators and processing plants; If off-shore and pelagic fisheries are to be

positively undertaken, living accommodations for fishermen must also be taken into due consideration. It is also necessary to establish fishery road network in line with the general development program of the district so that "Quick handling of marine products" may be attained to solve the problem of distribution.

(b) Motorization of Fishing Boats and Improvement of Fishing Gears and Methods:

(i) Motorization of fishing boats is the fundamental problem for fishing operations. Judging from the present actual circumstances, D 10HP - D 20 HP engines which are very convenient for the coastal fishing by gillnet and long-line are considered to be suitable. (Recently developed outboard engines may also be considered). As for the type of boats, those with light draught yet with higher stability will be desirable.

(ii) There are many varieties in the so-called "Gillnet", which require further ingenuity and elaboration in their use. Study on the improvement of net materials for drift gillnet, bottom gillnet, etc. and also on synthetic fiber is essential.

As for angling operations, research should be made on the trolling with artificial baits, etc. Effort should also be made to improve implements to be used for trawling, especially for the operation of trawling net for shrimp at the present stage.

(c) Education of Fishermen and extension work of Technical Improvement:

It is necessary to educate fishermen through extension work of technical improvement of fishing operations: Effort should be made to bring up "Fishermen with ingenuity and self-will" instead of conventional and self-righteous fishermen.

(d) Cooperative Organization of Fishermen:

Cooperative organization of fishermen can not be achieved without their own enthusiasm and initiative. It should be planned to promote

joint sales of fish and joint purchase of fishing materials by fishermen themselves which in turn will necessitate joint financing and credit operations. This is the short-cut to a sound management of fisheries.

(e) Strengthening of Research Work:

In general, the field of research on fisheries is very extensive. The Biological Station as well as Technological Research Station in the State of Orissa is very active. The subjects of research which is still on the way to further progress should be not be too academic, but they should be in line with the objectives of the administrative authorities. Even though the research work may involve problems of different nature such as a problem to be solved expeditiously or a problem requiring fundamental work for a long period of time, research should be carried out keeping close touch with the policy of administration.

Some of the maters requiring immediate research work will be as follows:

(i) Research on the exploration of fishery ground (Mainly exploration of continental shelf),

(ii) Research on Deep-Sea Fishery (Research and study on line fishing of tuna, deep-sea trawling, etc. for further development of fisheries),

(iii) Research on aquatic products processing technique (Especially, the maintenance of freshness of fish), and

(iv) Research staff and equipment (Expansion of facilities).

(f) Introduction of Advanced Foreign Fishery Technique:

The above discussed (i) - (iv) are the techniques to be introduced from the advanced countries, and it is safe to say that Japan is the most advanced country on these points. Staff of the State Government should receive a systematic training in Japan in order to establish and implement future policy with extensive knowledge.

The most effective way to learn actual operation technique will be to

invite those who are engaged in fishery operation in advanced countries for actual demonstration.

1 - 5 - 6. Small Enterprise:

(1) Scope of Object:

Though the extent of small enterprises in India is not necessarily clear, there is a classification, in general, of "Small Industry" or "Small Scale Industry" as against "Village Industry" or "Cottage Industry".

All the above industries are in the form of home industry or small factory, but since the governmental protection and assistance to small enterprises differ from those given to other industries, the government defines the boundary: At the present time, those with the invested capital of less than Re.500,000 fall under this category of small enterprises.

(2) Village Industry:

The most important ones are handloom and khadi but village industry also includes numerous businesses such as hand pounding of rice, village oil industry (using bullocks), leather making, gur and khandsari (using bullocks or small engines), sericulture, coir, apiculture, manual paper-making, pottery, blacksmith, etc. As the government is also greatly interested in handicraft, it gives a guidance through a design center and promotes handicraft making by establishing sales center.

(3) Small Industry:

For the purpose of industrialization of cities, industrial estates were built in five places under the Central Government's 2nd Five Year Plan. Buildings, electricity, water supply and drainage systems are offered. The government provides technical assistance as well as training of technicians through its facilities such as precision machines, forging factory, mould making plant, plating equipment, etc.

(4) Financial Assistance:

Besides the financial assistance given through special banks, financ-

ing up to 90% may be made to prospective industries in need of fund under the pilot project scheme.

(5) Cooperatives:

Each industry has its own cooperatives with the support of the government. The 3rd 5-year Plan intends to enforce the establishment of cooperatives for the handloom in particular.

(6) Present Status of Small Enterprises in Orissa State:

During the inspection of industrial estates in New Delhi, Madras, Bangalore and Calcutta, small factories engaged in the manufacture of spectacle frames and pencils were found to be doing very well with more than half of their production being exported; while, those in Orissa which made a belated start would not be able to withstand even the competition within the domestic market unless production is increased by enhancing the local demand. Thus, the most important thing is to improve the general standard of living by increasing the people's income.

What is keenly felt in connection with the problem is the importance of popularization of education, adjustment of population (cause of excessively poor labor force) and improvement of breed of cattle (expense for purchasing feed for non-productive dairy cattles is very high). However since these problems are close by related with the people's religion and conception of life, they may not be changed instantly.

1 - 5 - 7. Electric Power:

(1) Keeping pace with several 5-year economic development plans, electricity demand in the State of Orissa has been showing a rapid growth, and it is estimated that, in fiscal 1962, the maximum demand and the annual demand will reach 190 MW and 1,000,000,000 KWH, respectively.

Industrial demand occupies remarkably large portion of the demand for electricity, and metal refining industries such as aluminum, steel making and ferro-manganese industries, in particular, account for the majority of

the demand. Therefore, the present daily load factor is as high as 90%.

(2) On the other hand, in order to cope with the increase in electricity demand, power generating facilities has been rapidly expanded with the construction of Hirakud hydraulic power plant, etc., and the present total capacity of power generating plants in the State of Orissa amounts to more than 350 MW. Although the actual capacity of Hirakud hydraulic power plant drops considerably during the rainy season owing to the lowered water level of the dam and rising water discharging level, the supply capacity is still substantially larger than the present demand, and the demand and supply of electricity is well stabilized.

(3) As for the future trend of electricity demand, the State Electricity Board estimates that the maximum electricity demand will increase to 500MW in 1965-66 and 860MW in 1970-71: It also expects that the industrial demand will continue to be the largest and that the demand by metal refining and chemical industries will show especially large increase. To meet such increase in demand, construction of both Talcher thermal power plant (250MW) and Balimela hydraulic plant (360MW) has already been started. However, because of the fact that the actual electricity demand in recent years has been lower than the estimated value in the above mentioned forecast and that the demand forecast was made only on the maximum electricity, it will be necessary to make a proper review on the future trend of electricity demand not only in terms of KW but also of Kwh: The starting time of operation in each unit at Talcher and Balimela should also be reviewed in the light of the revised demand forecast.

(4) Judging from the expected increase in high load factor demand by the metallurgical and chemical industries as well as the construction of Balimela hydraulic power plant with a large scale peak supplying capacity, expansion of firm power supply by the development of Talcher thermal power plant, etc. will be come more important in the future development of elec-

tric power resources.

(5) Since the State of Orissa is abundant in hydraulic power resources and construction of multi-purpose dam for irrigation and flood control will be undertaken, development of hydraulic power plant to meet peak demand may be considered. However, on the basis of demand composition as descussed above, future development of hydraulic power generation should be studied from the overall viewpoint including the electricity systems in the neighbouring states. It is advisable to study also a possible connection of power transmission systems with those of other states.

In order to select the most economical site for hydraulic power generation, it is advisable to make more detailed and accurate study and investigation on hydraulic power resources.

1 - 5 - 8. Coal Chemistry:-

Low temperature tar of 120,000 ton/year and gas light-oil of 120,000 ton/year may recovered as a by-product of 500,000 ton/year pig iron production by the use of coke manufactured from Talcher coal by low temperature carbonization. If these chemical by-products are treated by refining process such as distillation and chemical treatment, 46,000 ton/year of fuel oil for internal combustion engines and 20,000 ton/year of tar acid products may be manufactured. However, since the low temperature carborization industry has not been established in India and none of such products is on the market, any attempt to industrialize the low temperature carborization should be preceded by a careful study on its profit making aspect.

1 - 5 - 9. Development of Cities:-

(1) In line with the iron ore development project, emphasis of the survey is placed on the development of Paradeep harbour city.

Character of City: Center of traffic for the shipment of iron ore amounting to 2,000,000 ton/year.

Scale of City: Population of 20,000; Built-up area being 826 ha.

Land Use: The land space will be used as follows;

(Commercial & Business: 5%, Harbour: 12%, Industrial: 21%,)

(Residential: 28%, Park & Green Zone: 34%.)

(2) Harbour area and related business area will be constructed first, which will be followed by the construction of residential area. To provide for the future need, site for industrial area shoud be secured.

Open space including green zone should be secured. Buildings are to be of medium height brick construction, and the density of population is planned to be 80 - 120 persons/ha.

Planning of Important Facilities: Basic facilities for industries (traffic, land, water supply) and facilities for living environment (sewerage, park) will be built to provide fundamentals of the city.

1 - 6. Acknowledgement:-

Throughout the entire sojourn of the mission in the State of Orissa, the State Government was good enough to offer to the members lodging accommodations, transportation facilities, assistance and cooperation for the survey.

All members are most grateful to His Excellency, Shri Kholsa, Governor of the State of Orissa, His Excellency, Shri Patnaik, Chief Minister, and other officials of the State Government for their valuable cooperation and warm hospitality without which it would not have been possible to accomplish their task within the limited time.

The mission also expresses its sincere tanks to His Excellency Shri Manubhai Shan, Minister of International Trade, and other officials of the Central Government for their kind assistance extended to the mission.

2. Mines

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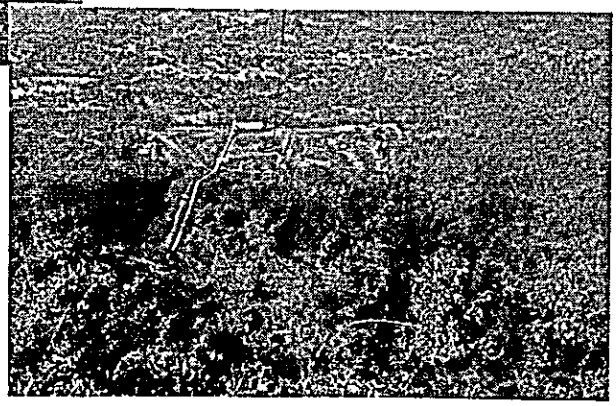

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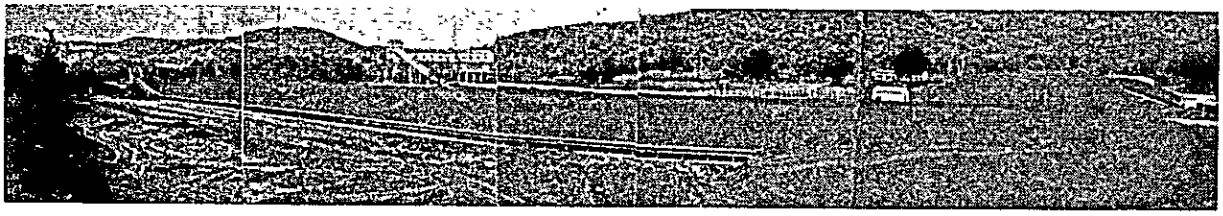

3. Downhill conveyor, BARSUA MINE as seen from its crushing plant

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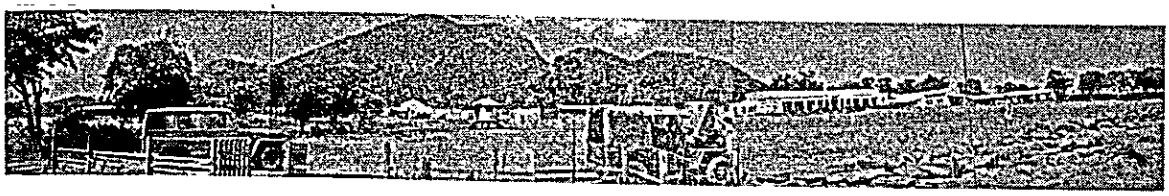

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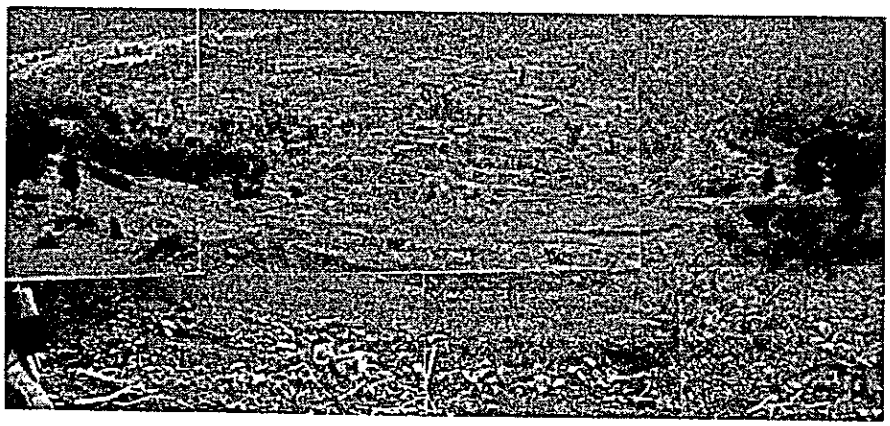

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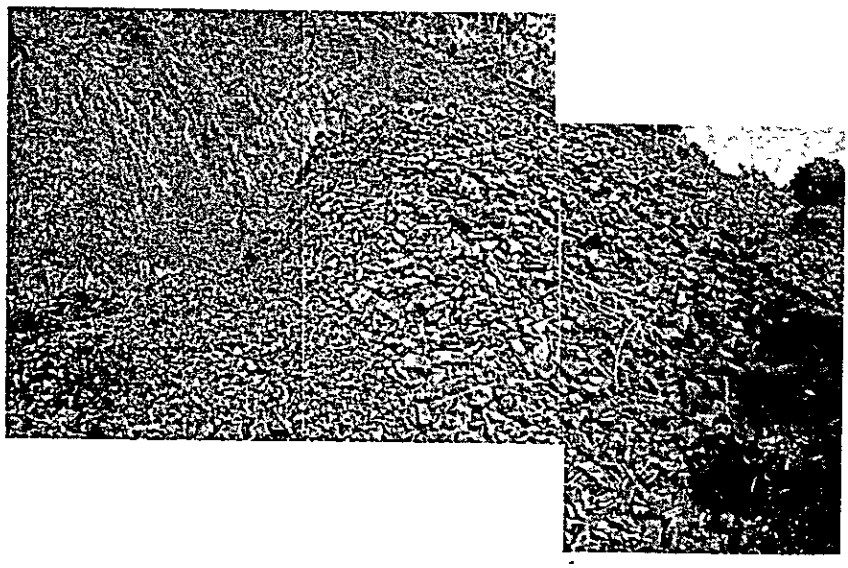

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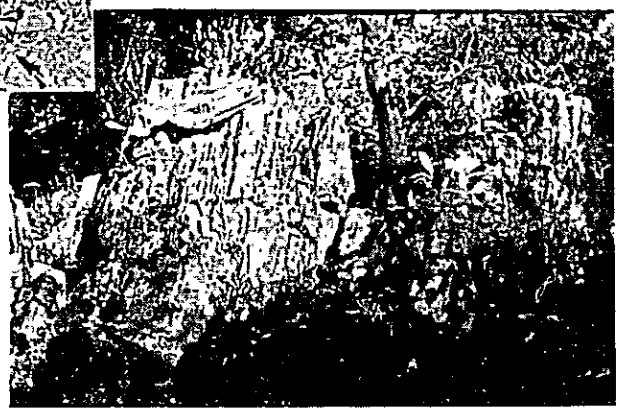

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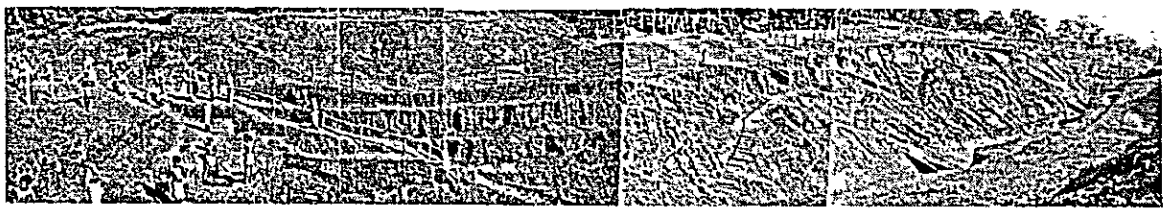
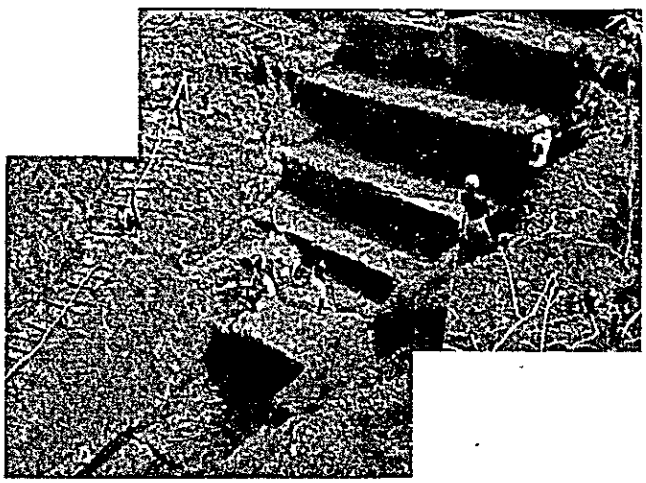


13. A working face of Chromite Mine, SARUABIL.



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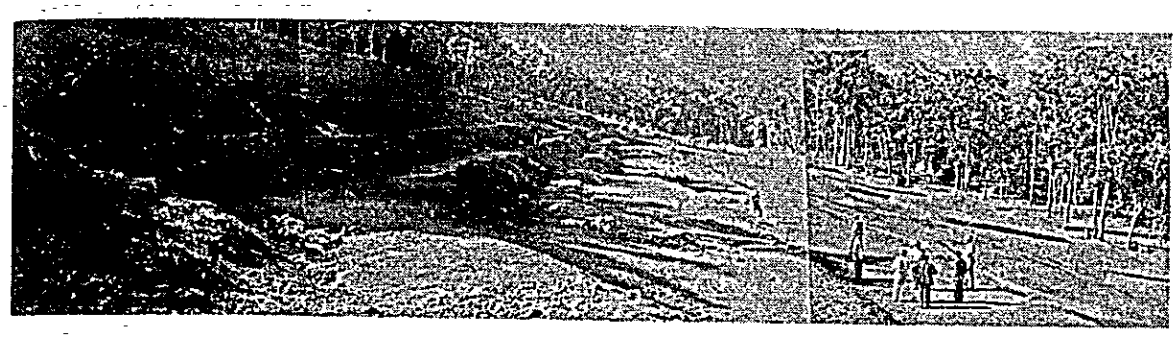

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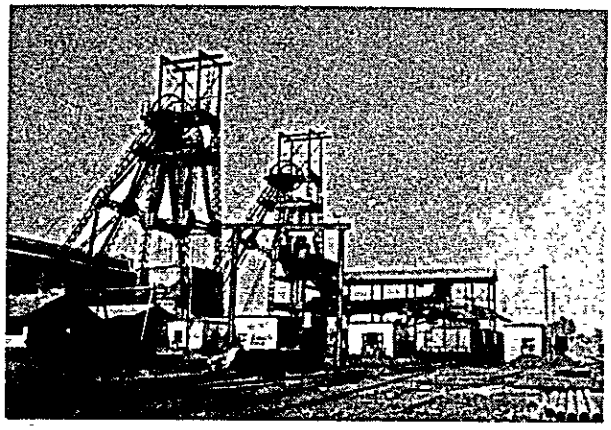
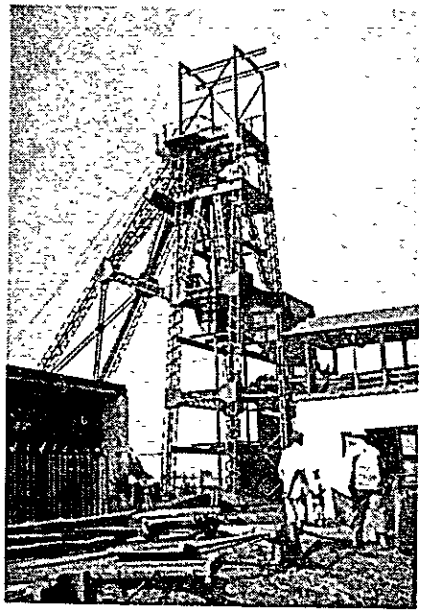


16. Shafts and loading yard, TALCHER COAL MINE.



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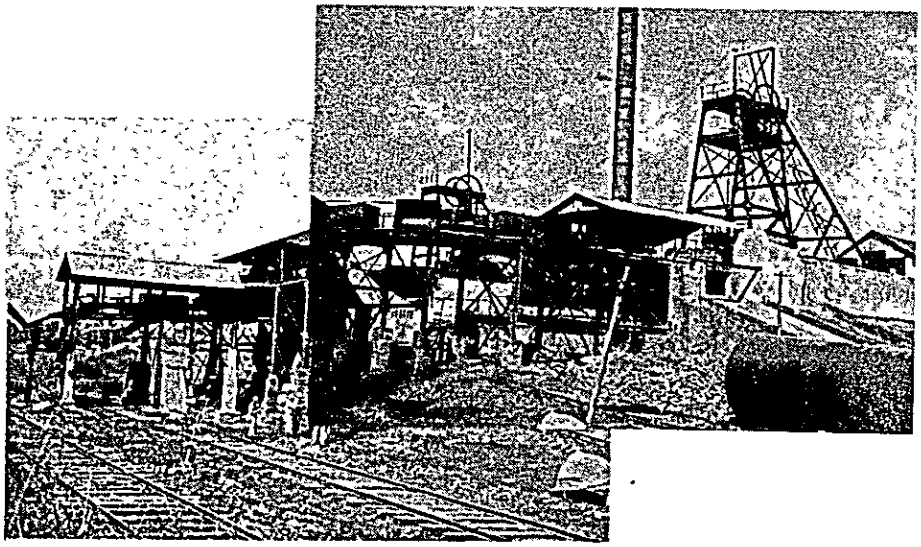

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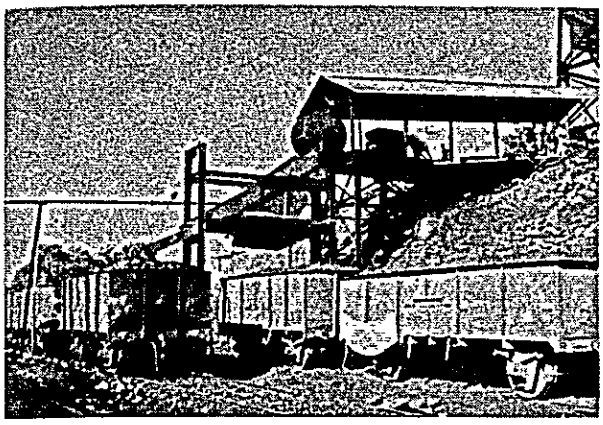

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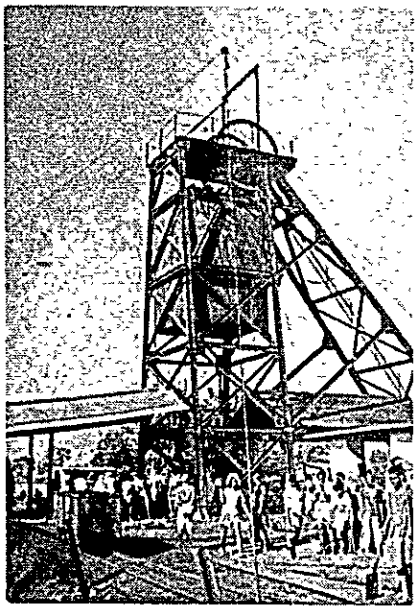

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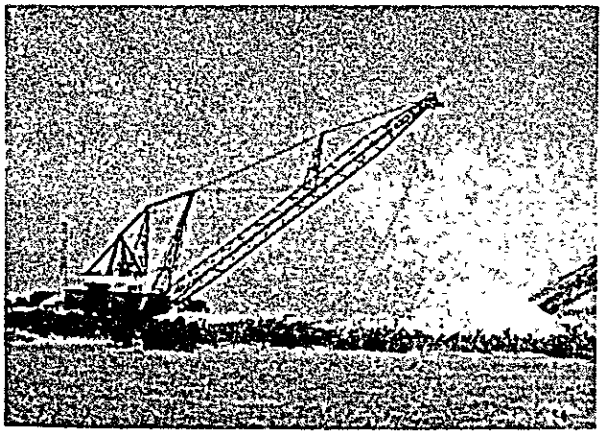

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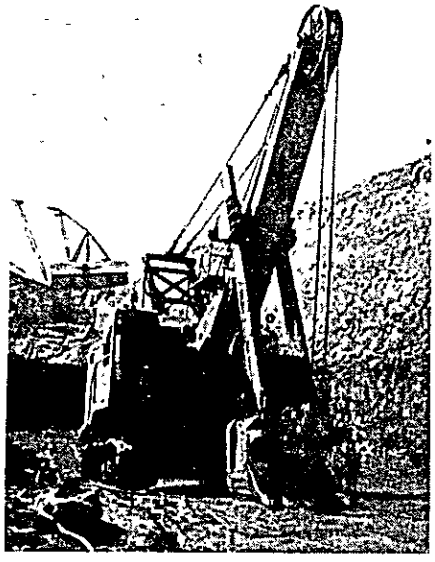

23. A loading shovel,
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2. Mines

2 - 1. Outline of Survey:

The Mission conducted the survey and observation of iron mines, chromite mines, manganese mines and coal mines in Orissa State, India. The main purpose of the survey of the mines and their conditions are as follows:

(1) Iron Mines:

Detailed survey of one un-exploited area and shaping of its rough development plan as a link in the chain of the General Development Programme for Orissa State.

Through the observation and general survey of seven operating mines and two un-exploited areas, the Mission undertook confirmation of the iron ore deposits in the area and recognition of their future prospect.

(2) Chromite Mines:

General survey of three operating mines, and three un-exploited or idle mines as well as examination in outline of reserve and quality of ore.

(3) Manganese Mines:

Observation of one mine, and recognition of scale and quality of manganese ore deposits in the area.

(4) Coal Mines:

Recognition of scale of the coal field and its future prospect through the confirmation of the present state of investigation and observation of four coal mines and two outcrops in Talcher Coal Field.

(Attached Chart 1)

The following litelatures were used as referential data in undertaking the on-the-spot survey as well as in preparing this report.

1 Techno-economic survey of Orissa, 1962: National council of applied economic research.

2 H.C. Jones: The iron ore deposits of Bihar and Orissa, 1934: G.S.I. LXIII-2.

3 M.S. Krishnan: Bulletins of the geological survey of India, Series A No.9 Iron ore, Iron and Steel.

4 Report of the experts committee on schedule - A - minerals Orissa State iron-ore 1958: Government of India, Ministry of Steel Mines & Fuel, Department of Mines.

5 Iron ore deposits in India, 1963: Japan Geological Survey Institute.

6 Interim report on iron mine development in Tomca-Daiteri Area, Orissa, India; 1956: K.K. Kinoshita-shouten.

7 Report on overall investigation of iron mine development in India, 1958: Indian Iron Ore Long-term Development Survey Team.

8 G.H.S.V. Prasada Rao: Progress report of the field reason, 1952-53, G.S.I.

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10 M.N. Deekshitulu: A report on the iron ore deposits in South Sukinda, Cuttack District, Orissa 1955: G.S.I.

11 B. Bharagava: Report on iron ore of Sukinda area 1956.

12 Dr. B.D. Prusti: Report on the iron-ore deposit of Tomka-Daiteria Area: 1958.

13 N.K. DAS: Report on preliminary mineral appraisal and geology of Gandhamardan iron ore deposits, Keonjhar, Orissa; 1962.

14 M.S. Krishnan: Bulletins of the geological survey of India, Series A - economic geology, No.7 Chromite: 1953.

15 P.C.D. Hazra, Chromite (Orissa).

16 V.R.R. Khedker & B.N. Jayaram, Report on the recommendations for the reservation of area for the state exploitation of manganese ore in Orissa.

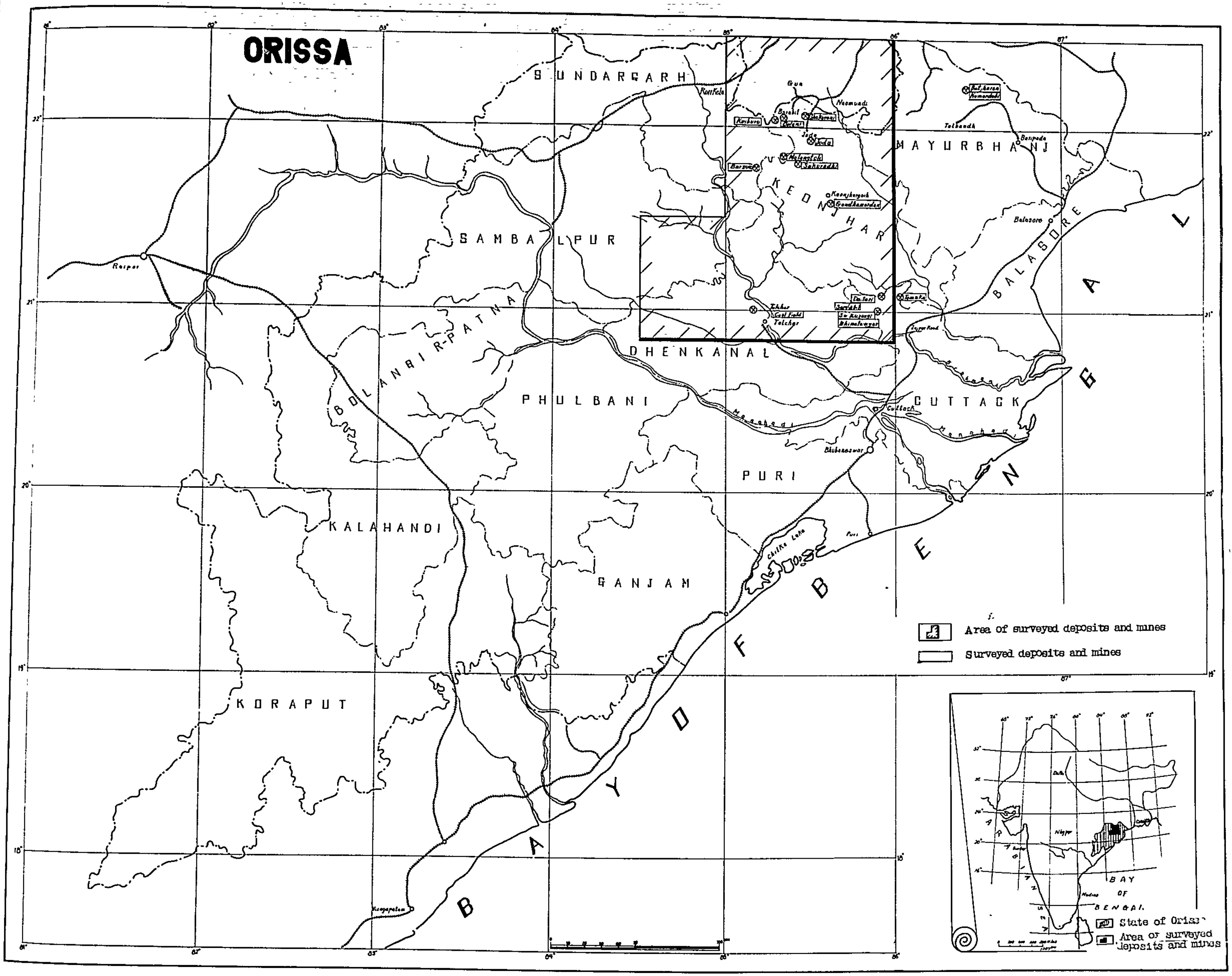

ORISSA
SUNDARGARH
MAYURBHANJ
KEONJHAR
SAMBALPUR
BOLANGIR-PATNA
DHENKANAL
PHULBANI
CUTTACK
BALASORE
PURI
KALAHANDI
GANJAM
KORAPUT
BAY OF BENGAL
Chilka Lake
Raipur
Cuttack
Bhubaneswar
Puri
Balasore
Baripada
Keonjhargarh
Talcher
Area of surveyed deposits and mines
Surveyed deposits and mines
BAY
OF
BENGAL
State of Oris:
Area of surveyed deposits and mines

Chart 1

17 A report on the final phase of the explanatory operation for coal in Talcher coal field, Orissa: I.B.M. by PURKAYASTHA & A. HUNDEY.

18 Report on the regional coal survey station: Council of Scientific and Industrial Research, Central Fuel Research Institute, 1959.

19 Not yet published statistical data on mining production by Bureau of Mining, Orissa State Government.

2 - 2. Conditions of Mineral Resources Surveyed:

2 - 2 - 1. Iron Ore Deposits:

(1) Area Surveyed:

The area surveyed includes the iron ore deposit area in Orissa which belongs to the so-called "Iron Belt" where huge iron ore deposits are still left to be exploited despite that rapid development of the deposits are being made with sharp increase in ore output keeping pace with the construction of steel plants, as well as Daiteri Area which exists independently south to the Iron Belt.

(2) Type of Deposits:

All the iron ore deposits are of Jaspilite type iron ore stratum origin, which are embedded in Banded Hematite Quartzite of the Newer Dharwar Series which belong to Archean Era, and play the most important economical role among the iron ore deposits in India.

The deposits are formed by the hematite rich portion of Banded Hematite Quartzite and the iron enriched portion of banded quartz brought out by the desilicification due to weathering. The scale is very large and extends over 1,000 m in length and 500 m in width, and many of the deposits have ore reserve of more than 100 million tons.

(3) Iron Ore:

Ore is mainly hematite accompanied, in some areas, by magnetite, martite and unknown manganese mineral. It is also found with latelite, goethite and

limonite near the surface throughout the entire area.

The ore, in general, is classified into (1) massive hematite, (2) laminated hematite, (3) powder hematite, (4) lateritic hematite, (5) hematite breccia and (6) consolidated hematite debris, but the majority seems to be laminated hematite.

The stratigraphic of this area is as follows according to Mr. H.C. Jones.

Newer - Dolerite dykes and sills	Kolhan Series	ARCHEAN
Ultrabasic igneous intrusive rocks		
Granitic rocks		
Shales with epidiorite and ash beds		
Banded hematite-quartzite with iron ore bodies	The Iron ore series	
Shales with occasional thin sandstone and calcareous bands	(Newer Dharwar Series)	
Lime stone (in place)		
Purple sandstone with a basal conglo. imports sometimes with bonds of conglomerate		
Hornblende and mica schists and quartzites	Older Dhamar	

(4) Importance in India of Iron Ore Deposits Surveyed:

The amount of ore reserve of main iron ore deposits in India is as follows: (as of 1958)

Kind of Ore	Proved (1,000,000 tons)	Probable (1,000,000 tons)
Hematite Ore	5,316	17,630
Magnetite Ore	605	1,610
Limonite Ore	500	2,000
Total	6,421	21,240

Bonai and Keonjhar areas visited during the survey have 1,636 million

tons of proved ore reserve, and account for approximately 32% of the total proved ore reserve of hematite ore in all India. The output which amounted, in 1957, to approximately 2,000,000 tons, or 40% of the total production in India, was increased in 1961 to 4,500,000 tons with 53 mines, which are capable to meet further demand. Besides, there are still many deposits in the south to the area which are left unexploited at present owing to the absence of transporting facilities. The Malangtoli area inspected this time is also estimated to have more than 100 million tons of ore reserve, and its development plan is being prepared subject to the railway construction to this area by the Central Government.

However, no particular survey has been made on the individual deposits except for surface investigation. Since the iron ore series in this area, in particular, show a horizontal distribution, their vertical distribution may not necessarily be large, however great the horizontal distribution may be. Therefore, the most important thing to be undertaken prior to the future exploitation and other programs will be recognition of the extent of depth distribution. The recognition of the extent of depth distribution by test boring works is desirable.

(5) Some Problems Common to the Deposits in this Area:

The iron mines in this area involve three common problems. Discussion is made on the problems as it will be of some use to the future development plan of Daiteri Deposit.

* The extent of the secondary enrichment of the ore body:

Since all the deposits, though there are some variations depending on the individual deposits, are enriched to have more than 60% T.Fe as a result of the secondary enrichment by weathering, the quality of ore body in B.H.Q. which is not yet subjected to such degeneration will have a lower Fe content. Though the extent of such lowering in quality may not be generalized, when the deposits exist at the top of mountains about 800 - 900 m above sea-level

and are of similar conditions, the depth of rich ore body extends to 100 m at maximum, and the object depth at the time of exploitation is 50 - 70 m.

* Existence of Powder Hematite and the Accompanying Problem of Ratio of Lump to Fine Ore:

The ore body is a kind of Residual deposits and is apparently formed through removal of silica by alkaline underground water caused by weathering of rock-forming minerals, remaining of hematite grains and their condensation as well as by coagulation of limonite or laterite. Especially, the coagulation action seems to be limited to the shallow part of the underground and it does not affect as deep as the desilicification action does. Thus, powder hematite generally exists underneath massive hematite to reduce the percentage of lump ore of the ore body. Since powder hematite is usually found below the depth of 30 m and its proportion suddenly increases below 60 m, it will be necessary to consider as much as 50% ratio of five ore even in case where the mining depth is 70 m.

* Lowering in Quality due to Existence of Such Low Grade Ores as Lateritic hematite, vein laterite, etc.

At present, Indian iron ore is required to have more than 60% T.Fe. But, lateritic ore is, in general, of low grade bearing about 50% of Fe or so. It usually exists to the depth of about 6 m from the surface, and its irregular distribution is also found in the ore body, especially in the laminated ore body.

Therefore, the mixture of these lower grade ores is inevitable to some extent, and the average quality of ore in mining is about 58% Fe. The main reason of keeping above 60% Fe is that float ore is being mined together or the mine has unusually high proportion of massive ore in the ore body.

It will require considerable effort to maintain 60% Fe under the large scale mechanical mining operation in the future.

(6) Daiteri Iron Ore Deposit:

The deposit is located independently far south to the main ore deposit area. It is not a typical deposit of B.H.Q. origin but is smaller and the major part consists of laminated ore which is considered to be derived from iron bearing shale.

Since the deposit was investigated in detail, on the request of the State Government of Orissa, as to the adequacy of its development to produce 2,000,000 tons a year as a part of the Paradeep Project, the detailed discussion on the deposit will be made separately.

(7) Magnetite Deposit, Betjharan and Kumardubi, at Mayubhanj Area.

At the end of the survey schedule, the Mission inspected magnetite ore deposits which are completely different from the afore-said iron ore deposits. The deposits are titanium and vanadium bearing magnetite ore deposits with irregular massive shape which are seemingly ore deposits due to magmatic segregation embedded in ultrabasic rock. Investigation of the distribution was just commenced by the mining engineer of the State Government who had their base at the Luhasila Camp, and nothing was made clear as to the conditions of geology and ore bodies except for the discovery of outcrops.

Since one day inspection was not sufficient for the survey of deposits as well as for the estimation of ore reserve, and because the study as to whether or not the ore can be used for iron ore was considered most important in view of the fact that the ore is complex ore, the investigation was limited only to the study of sample pieces.

The deposits in the area are ore deposits due to magmatic segregation produced in the form of thin lense or pocket in ultrabasic igneous rocks, for instance gabbro etc. Their outcrops are rather small of several hundreds square meters and are accompanied by some float ore distribution. The ore consists of magnetite, ilmenite, hematite, rutile, coulsonite, goetite, spinel, oolite, silica, and maghemite.

According to the analysis made previously by India, the chemical composition is as follows; Utilization of the ore as vanadium ore is apparently being considered.

Deposit	V_2O_5	TiO_2	T.Fe	SiO_2 +	Al_2O_3
Betjharan	1.0	10.0	555	2.0	
	1.5	14.0	60	4.0	
Gargari	?	4.86	65	3.83,	1.84

As a result of analysis of such components of T.Fe, FeO, TiO_2 and V, it has been found that the average value of nine test pieces from the area shows high TiO_2 and V content with T.Fe being 58.81, FeO 4.155%, TiO_2 13.37% and V being 0.553%. Judging from the ore reserve and also from the chemical composition, the ore is not usable as iron ore. It is advisable to undertake the survey of deposits and their ore reserve only after separation of TiO_2 and V from the ore is successful.

2 - 2 - 2. Chromite Ore Deposit:

(1) Area Surveyed:

Chromite deposits embedded in ultrabasic rock are found in various places in India and their existence has been reported in such places as Andaman Islands, Assam, Bihar, Bombay, Hyderabad, Kashmir, Madras, Mysore and Orissa.

In the State of Orissa, chromite ore deposit is known to exist in Keonjhar Nausahi area and Cuttack Skinda area, of which the latter was surveyed by the Mission this time.

The Skinda area is a flat land of about 8 km long along the Damasal Nala which runs westward between Tomka Daiteri Range and Mahagiri Range, both of which lie east and west.

(2) Type of Deposit:

The deposit is embedded in ultrabsic rock which penetrates into the

above mentioned Iron-Ore Series, mother rocks of iron ore deposits. They are also covered with conglomerate and grit of the Kolhan Series. The area has six mines with 40 ore bodies in total, but their scale is variable from the largest No.10 ore body of Bhinatangar of Tata Iron and Steel Company which extends 920 m in length and 20 m in width to the smallest pocket which has only several hundreds tons of ore reserve at most. All of them show a distinct banded distribution and consist of coase grain banded lode, course grained lump ore or compact lump ore where the chromite crystal, which shows completely idomorphic crystal of octahedron, exists as the paragenesis with other rock-forming-minerals. Compact lump ore is consisting of fine grain chrome minerals, which presents somewhat vague banded structure and has low quality but high iron content and also mother rocks isn't received alteration but a little serpentinization as compared with former. Although there some difference in time of deposition between them, all seem to be ore deposits due to magmatic segregation and not hydrothermal deposits.

(3) Importance in India of the Chromite Ore Deposits Surveyed:

The total reserve of chromite ore in India is estimated to be approximately 1,500,000 tons, while, the reserve in this area is considered to be about 200,000 tons.

As for the output, the State of Orissa produced in 1957 68,000 tons or 87% of the total production in India, and 38,000 tons in 1961 (of which Skinda area produced 22,000 tons). The mines are capable to double the production even under the present condition if there is a further demand, but as a result of the Indian Government's export ban on the lump ore, the domestic demand which is dull is not large enough to warrant full operation of mines, and some of the mines were apparently about to be suspended.

The Government of India plans at present to build a ferro-chrome plant in Skinda area, and, in order to preserve the resources for future demand from domestic plants, the Government has prohibited, beginning January 2,

1962, export of lump chromite ore almost completely as explained below:

Condition of Export Ban: Any lump ore which meet the following conditions: Cr_2O_3 + 38%, FeO - 22%, SiO_2 - 10%, Al_2O_3 + Cr_2O_3 -54%.

(4) Conditions of Mines Surveyed or Inspected:

Most of the mines surveyed or observed are for the banded lodes which are in the range of less than 100 m long and 10 m wide, with individual reserve of tens of thousands tons. The method of mining is primitive and ores above the level of underground water are mined by man-power, hand-picking, and screening.

As for the quality of ore, those belonging to the deposits formed horseshoe in the eastern part of the area seem to have as high as 56% of Cr_2O_3 content; while, those in sheet form deposits are lump ores consisting of fine grains which seem to contain 50% of Cr_2O_3 with considerable variation in quality, and their SiO_2 and Fe contents show locally large variation, thus presenting various problems in relation to a large scale mining operation.

(5) On Prospecting:

As the area is covered extensively with laterite, even the distribution of ultrabasic rock can not be found on the surface, and the prospecting is very difficult. On the other hand, there is a large possibility of finding the existence of unknown deposits. This area, except for the existing 36 mining claims has been appointed as a government reservation area where private enterprises are not allowed to establish any mining zone, and some prospecting are being carried out by the Orissa Mining Corporation and two or three new outcrops have been discovered. Although the scale of each individual ore body is not so large, the area will apparently play an important role in the future chromite production of India.

2 - 2 - 3. Manganese Ore Deposit:

(1) Area Surveyed:

The principal manganese ore deposits in the State are found in such areas as Jamda-Koira Area, Koraput-Kalahandi Patna Area and Bolangir-Patna Area, of which the one in Jamda-Koira Area is the largest. One of the mines in the area, Bichakundi-D Mine was observed by the Mission.

(2) Type of Deposit:

The principal mangenese ore deposits in the State of Orissa exist in shale underlying iron ore strata in the above mentioned Iron Series, and there are worked the ore shoot of residual manganese deposits deriving from weathered shale. The manganese ore is mainly pyrolusite with some psilomelane, and the average quality is about 45% Mn with 10% ± Fe and 3% ± P. The mangnese ore is in the form of small lump and the deposits are of small scale existing in clayey shale near the surface of ground. They seem to be different type of manganese deposits from the Gondite Series type which distribute extensively in the central India and embodies world-known manganese ore deposits.

(3) Condition of the Mine Inspected and Its Importance in India:

The total reserve of the above three areas in the State is 21,730,000 tons, or 16% of the total reserve in India. The actual output in 1957 was about 380,000 tons, or 23% of the total production of manganese ore in India. The 49 mines in the State of Orissa produced 380,000 tons in 1961.

The Bichakundi - D Mine is a typical mine in this area under the control of TISCO, but its scale is small. Pyrolusite of irregular lump embedded in reddish violate clay deriving from weathered shale is mined, and its yield is about 60 - 62%. The ore is hand-spalling and hand-picking to be classified into three brands. The mining operation is very inefficient which depends entirely on mahual work, and 2,500 labourers per day are employed for a monthly production of 3,000 tons of manganese ore. 5,000 labourers are

employed in six mines run by TISCO for a total production of 10,000 - 11,000 tons per month. It seemed that most of the mines were medium or small scale mines which were not suitable for a mass-treatment of one brand of ore.

Analysis of the samples obtained during the inspection is as follows:

Kind	T.Fe	SiO_2	Al_2O_3	S	P	Mn	% of Output
High Grade	3.57	1.04	3.61	0.018	0.243	53.75	25%
Medium Grade	10.95	2.10	7.01	0.015	0.171	44.61	45%
Low Grade	18.77	4.22	7.66	0.013	0.141	35.24	30%

All of the above are manganese dioxide ores, but they are used for ferro-alloy and steel making as "Metalic ore". Attention should be paid to the high content of Phosphorus.

2 - 2 - 4. Coal Deposit:

(1) Area Surveyed:

The State of Orissa has two coal fields of Talcher and Rampur, both of which are to mine coal seams in Gondwana System. The Mission surveyed only Talcher Coal Field.

The Talcher Coal Field is situated approximately 120 km north-west to Bhubaneswar, Capital of the State of Orissa. At present, the eastern part of the coal field is being developed and its vicinity is partly surveyed and the reserve is confirmed, but its western part as well as northern part is still left unexplored. But judging from the geological condition, an extension of the coal seam is expected. Thus, the coal field has a very bright future prospect.

(2) Geological Feature and Condition of Coal Deposit:

(i) Geological condition of the Talcher Coal Field is as follows: (W.T. Blanford, 1854)

Triassic Sys.	Upper-Gondwana	Mahadeva-series	600 m
Permian Sys.	Lower Gondwana (	Barakar series	500 m
Upper Carboniferous Sys.)		Talcher series	150 m

Unconformity

Archean

The distribution area of these Gondwana Sys. extends to 700 mile^2. All the three coal seams are distributed in the lower Gondwana and Barakar Series, and the typical conditions of existence are as follows: The quality of coal is all non-caking bituminous coal with a little high ash content.

Upper Barakar (110m - 163m Average 136.0m)	Alternating shale & sandstone	7.82 m
	Coal band	1.66
	Alternating shale & s.s. clay	12.07
	Coal band	0.39
	Alternating shale & s.s	4.99 - 5.70
	Upper seam No.2	16.89 - 25.02
	(" coal portion)	(7.92 - 10.43)
	Shale with thin coal band	42.28 - 53.09
	Upper seam No.1	11.68 - 44.41
	(" coal portion)	(5.20 - 22.81)
	Sand stone	11.26 - 14.67
Middle Barakar (30.0m - 60.0m)	Pebbly sandstone	30.0 - 60.0m
	Sanstone	33.30 - 50.0m
	Coal band	0.1 - 1.5
Lower Barakar (197m - 257m Average 227m)	Sandstone	11.86 - 19.52
	Lower seam	15.0 - 20.0
	(" coal portion)	(1.93 - 11.90)
	Sandstone	10.87 - 13.27
	Coal band	0.1 - 0.13

The coal seams run almost horizontally without any fold, but because of much fluctuation caused by the block movement, there are hardly any area with all the three seams. There are many areas where upper parts are absent and the lower parts directly exists near the surface of ground.

(ii) Condition of each seam is as follows:

a) Upper seam No.2: Confirmed by test boring works but not yet exploited.

Total thickness of coal seam	16.89m - 25.02m
Thickness of coal	7.92m - 10.43m

With much inclusion of shale, coal is of low grade.

Ash: 31.9%, Fixed carbon: 49.78%, S: 0.62%

b) Upper seam No.1:

Total thickness of coal seam	11.68m - 44.41m
Thickness of coal	5.20m - 22.81m

Though it is the largest scale coal seam in Talcher field, coal is low grade with much shale band. Confirmation has been made by test boring works but not yet exploited. Coal is non-caking, with 39 - 43% ash content, 27 - 29% of fixed carbon, 24 - 26% of volatile matter and 3,555 - 3,890 Calories. The coal seam is very thick and so the quantity is very large. The main purpose of the survey was to investigate the efficient utilization of the coal seam, but since no sample was available and nothing was done except for confirmation by test boring works, experiment and other works practically could not be undertaken.

Although it seems that improvement of quality could be expected by washing, the result of test made by NCDC revealed that it was not effective.

c) Lower seam:

Total thickness of coal seam	15.0m - 20.0m
Thickness of coal	1.93m - 11.90m

With a complete parting in the coal seam, the seam is further

divided into three parts, and the lowest part consists of coal with practically no impurities and its thickness in average is about three meters. The coal is non-caking coal with 7.6% of ash content, 11.09% moisture, 45.57% fixed carbon, 35.74% of volatile matter and 6,265 Calories of Calorific value, and is used as general-purpose coal.

(3) Importance in India of Talcher Coal Field:

India at present places great emphasis upon coal. India looks for much from coal as her basic industry, and she will continue to do so in the future. Since her independence, India has completed its first and second 5-year plans and is presently undertaking the third program. It produced 54,000,000 tons of coal in 1960, the last year of the second 5-year plan, and intends to produce 97,000,000 tons in the last year of the present third 5-year plan, or 1965. To this end, development of new coal mines by NCDC and others together with increased production by the existing mines are being strongly pushed forward, which are illustrated in the following three tables.

Table 1: Actual Coal Production and Target of India & Orissa:

	India		Orissa	
	Target (million tons)	Actual Production (million tons)	Orissa (million tons)	Actual Production (million tons)
2nd 5-year plan (1956-1960)	60	54.6 (1960)	1.2	0.78 (1960)
3rd 5-year plan (1961-1965)	97		4	0.97 (1961) 1.05 (1962)

Table 2: Actual Coal Production by Coal Fields in Orissa.

	Talcher Field (Dhenhanal Dist.)	Hingir-Rampar Field (Sambalpur District)	Total of State
1959	290,000 tons	320,000 tons	610,000 tons
1960	360,000	420,000	780,000
1961	570,000	400,000	970,000
1962	720,000	330,000	1,050,000

Table 3: Production Target of Coal by Mines in Talcher Field.
(million tons)

	Talcher	Deulbera	So.Balanda	Nandira	Jagannath	Handidhna	Total
1963	0.22	0.19	0.4			undecided	0.81
1964	0.5		1	0.5		"	1.55
1965	0.5		1	0.5	1	"	3

As shown above, the per cent of the State's production to the total production of coal in the entire India was 1% in 1960, which is expected to be increased to 4% in 1965, the last year of the third 5-year plan. Thus, the relative importance of coal production in the State of Orissa will gradually increase in the future.

(4) General Conditions of Coal Mines in Talcher Area: (Refer to attached List of Mines)

Underground mining at three places and open-cut mining at one place are being carried on within an area of about 10 miles^2 to mine the lower seam, of which one mine (underground, temporarily suspended due to mining right trouble) is run by a private enterprise and the rest are operated by the National Coal Development Corporation. This area has coal reserve of about 100,000,000 tons, and the production in 1963 is projected to be 810,000 tons.

The three underground mines (Deubera, Talcher and Handidhua) is operated by the center shaft method developed 30 years ago, and owing to skill of workers and employment problems, the mines are not modernized and the operation is not efficient. (About 10 ton/labourer/month)

In order to raise working efficiency of coal face, improvement of local ventilation, mechanization of unloading and face hauling should be considered. Betterment of mining efficiency by the employment of longwall working and integration of pits should also be worked out. Since the mines observed have very favourable natural condition, the productivity will show substantial improvement if suitable measures were taken. Subject to the future changes

in coal seam, it would be necessary to do coal washing. It is most effective to use suitable coal for suitable places; while, it will be important to keep a certain fixed quality.

The followings are some of the remarks on Handidhua Mine being operated by the State:

(a) Efficiency of face loading labourer is considered too low. This fact might have some relation with the wage system. Some measures to stimulate their morale should be considered.

(b) Work conditions of the very end of the pit should be improved through better ventilation control. Use of local electric fans is recommended.

(c) Trial use of bucket-loader is recommended for face loading.

(d) Though hauling nearby the coal face is done by hand-pushing, it would be advisable to simplify face hauling through the adoption of conveyor or hoist.

(e) It is advisable to try the longwall working. It may be helpful to start first with wooden poles, wooden beams and V-shape conveyor, and after getting skilled use steel poles, kappe and panzer conveyor. In addition, if the work is mechanized through the employment of drum-cutter, etc. substantial improvement of work efficiency can be expected.

(f) In connection with the above (e), by decreasing number of pits in the mine, overall efficiency of the mine should be improved.

(g) Main hauling is carried on by means of an endless, but the steep inclination on the way limits the capacity. The inclination should be made uniform as much as possible. It is also recommended to study the employment of various kinds of locomotives and conveyors.

(h) As discussed before, there is a need for washing under the present condition, but washing process will become more necessary if the mining methods are changed (to mechanical loading, longwall working, etc.).

Despite the above mentioned matters, the production cost of coal is low owing to favourable coal seams and natural conditions as well as to low labour cost (ordinary labourer costs 3 - 5 rupee/day). The price of coal is officially fixed over the entire part of India, and it is about 21 - 24 rupees in the State of Orissa.

It is reported that the open cut mine of South Balanda is a fully mechanized mine opened at the end of 1961, and the production is about 60 ton/labourer/day with the production cost being about one-half of that of other underground mines.

(5) Conditions of Prospecting and Future Exploitation:

In an area of 10 miles^2 in the vicinity of already developed mining area, test boring works covering 15,678 m in total was made by I. B. M. during the period from 1957 to 1961. As a result, the total reserve was estimated to amount to approximately 300,000,000 tons, a part of which has been mined by open-cut mining as mentioned above. But all the open-cut mining are operating to mine a part of the lower seam. Besides, a plan is made to develop two mines, Nandira and Jagannath, in the area already prospected, for the purpose of mining lower seam and upper seam No.1 with estimated production of 500,000 tons in 1965 and 2,000,000 tons in 1967, respectively.

As seen in the above, a coal reserve of approximately 400,000,000 tons has been confirmed with the area of 20 miles^2 of Talcher Coal Field. The area with Barkar Series which has not been explored extends over 190 miles^2, and out crops of coal seam have just been confirmed in some part. Furthermore, there is a distribution of Mohadiva Series over 500 miles^2 which is believed to have Baraker Series at its lower part. The area is considered to have a bright future prospect. However, except for the lower seam, the coal involves some question as to its quality, and further study should be made on such matters as washing, effective utilization of coal, etc.

(6) Conclusion:

As discussed previously, most of the coal mines in the State of Orissa are operated by the N.C.D.C. and the development is apparently being steadily carried out by the I.B.M.

In brief, the potentiality of Talcher Coal Field is extremely large, and it will be very prospective coal field subject to further study on the utilization and also to the increase in demand by other industries.

2 - 3. Report on the Survey of Daiteri Iron Ore Deposit:

2 - 3 - 1. Outline:

(1) Introduction:

Daiteri iron ore deposit was surveyed twice for a total of 18 days from December 7, 1962 to December 19, and also from January 14, 1963 to January 18, and a conclusion has been obtained as to its ore reserve, quality and future prospect of exploitation. However, since the conclusion is, as mentioned below, not yet complete, it is necessary to undertake futher prospecting on the basis of the result of the present survey and also to carry out detailed investigation at the time of its development.

(2) Location, Transportation and History:

(i) Location:

The area surveyed is Daiteri Area which is located in the center part of the Topo Sheet No. 73G/16, and the deposit extends over Cuttack and Keonjhar Districts.

The Daiteri triangulation point is situated in Long. 85° 48' 30" E. and Lat. 21° 6' 20" N., and 874.8 m above sea level. The deposit area covers an area 1,500 m S.S.E. and 2,000 m S.W.W. from the triangulation point.

(ii) Accessibility:

There is a railway for a distance of about 320 km from Calcutta to Jajipur Road Station which is south-west to Calcutta, and the straight distance from there to Daiteri is 38 km. It takes about four hours to reach

Talpada at the foot of mountain by a truck road which runs on the N.N.W. side of Daiteri Tomka Range through Damanipal, from Talpada to the deposit at the top of the mountain, it takes about 20 minutes by jeep.

At the time of the Mission's survey, construction of an express highway between Paradeep and Tomka, and a mine road from Tomka to the mine was commenced.

(iii) History:

Since Mr. Bhargava (Serajuddin Co.) investigated this deposit in 1956, survey has been repeated by Messrs. Miyake and Takase (Kinoshita Co.) in 1956 and by the Indian Iron Ore Long-term Development Survey Team (Japan Consulting Institute) in 1958. Since then, prospecting of the deposit by means of pit and test boring works has been carried on by the engineers of the Mining Bureau of Orissa State Government. Besides, geological survey was conducted by Mr. P. Rao (G.S.I.) during the period from 1952 to 1954 and a geological map has been prepared.

(3) Topography:

The Daiteri Mountains where the deposit exists runs east to west forming the Daiteri Tomka Range, and Mt. Daiteri (2,870 ft.) and Mt. Tomka (2,567 ft.) are especially prominent. Directly below the crest line is, in general, sheer cliff and the topography is steep. In the north and east of the Range are extensive catchment basins of Kusai Nala and Ganda Nala which form a plateau; while, the south of the Range faces the Mahagiri Range through the catchment basin field of Saruabil area. Except for the steep cliff parts, the entire area is a primeval forest of Saruhwood, and cultivated field can be found only in some part of the vicinity of Talpada village. The forest is not so bushy and walking in the forest is not too difficult, but since the area is a habitat of wild elephants and tigers, sufficient care should be exercised.

MAP OF DAITERI IRON ORE DEPOSITS

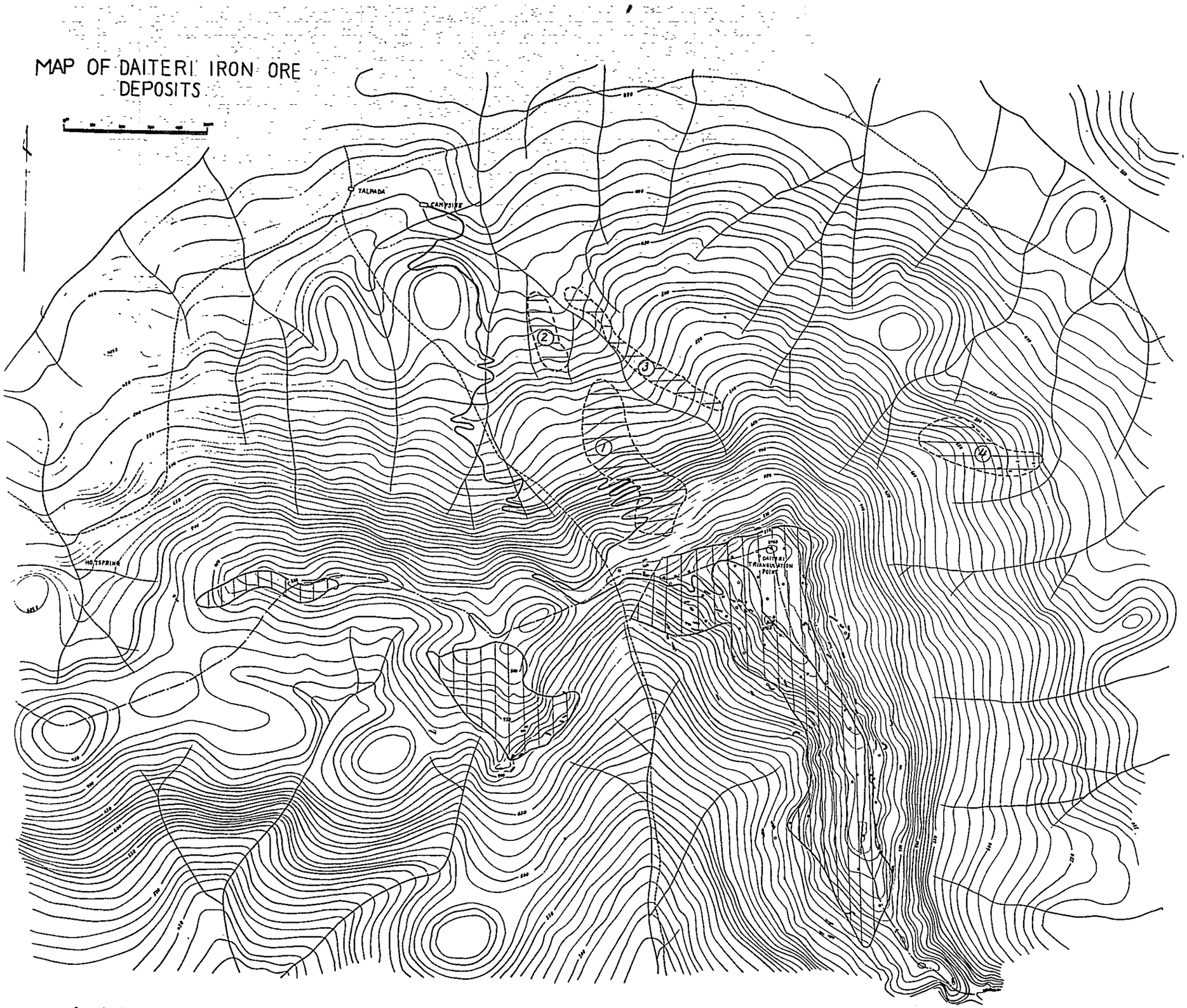


Chart 2

Topographical map No. 73G/16 issued by Government of India is used.

A range of lode ore in situ

A range of float ore

(4) Climate:

Temperature varies extremely throughout a year, and it falls to 40°F during the winter season of December - February, but the average mid-day temperature in the summer season of May - June goes up as high as 105°F. Annual amount of rainfall is 55", and the area is not a healthy place.

(Attached Chart 2)

2 - 3 - 2. Geological Feature and Ore Deposit:

(1) Geological Feature:

The entire deposit area consists of shale, feruginaus shale, and banded hematite quartzite which belong to New Dharwar Series (so called Iron Ore Series) of the Archean Era, and, in the area south to the deposit area, there are distributions of ultrabasic rocks which penetrated into them at the end of their deposition as well as of quartzite and conglomerate of Kolhan Series of Proterozoic era which covers them unconformably.

The strike of Iron Ore Series is N.W. 30° - 20°, and, general dip is, S.W. 70° or so. Local variation is considerably intense, and, especially in the area near the top of Mt. Daiteri, the direction changes to N.W. 70° - E.W. in the northern part beyond the triangulation point, and the dip becomes to 60°S. with distinct development of feruginaus shale.

According to Mr. Prasada Rao, the geology and stratigraphy of this area is as follows:

Recent to Recent:	Alluvium and Laterite
	Pegmatite and Quartz Veins
Newer Dolerite Suit	Quartz Porphyries
	Dolerite
	Pyroxenites
	Peridotites

Kolhans	Meta-Gabbro and Ultrabasics
	Quartz Grits and Arkose
	Conglomerate
Iron Ore Series	Porphyritic Granite and Porphyritic Granite-gneiss
	Biotite Granite-gneiss
	Banded Hematite-quartzite
	Banded Cherty Rocks
	Banded white and red Jaspers
	Ferruginaus Shale, Cargoneceous Shale and Variegate Shale
	Sericite Phyllite, Quartz-Sericite Schists
	Hornblende Chlorite Schists and Lavas
	Quartzites, Quartzite Schists, Micaceous Quartzites

(2) Ore Deposit:

(i) Outline of Ore Deposit:

Similar to the principal iron ore deposit areas near the State Boundary between Orissa and Behar, the deposit is origined from the so-called Jaspli type iron ore stratum which is embedded in Banded Hematite Quartzite in the Iron Ore Series of Newer Dharwar of the Archean Era, and is said to be formed by the enrichment of iron as a result of the weathering and desilicification of banded quartz and hematite rich portion of Banded Hematite Quartzite.

The development of Banded Hematite Quartzite in this area is of smaller scale as compared with the above principal deposit areas; and, judging from the condition of mother rocks and the kind of ore, substantial part of the ore body is considered to be origined from iron bearing shale and Mn and P contents are seemingly somewhat higher than those of the deposits in the principal areas. Most of the ore is laminated ore with some lateritic hematite, and massive hematite can hardly be found. Powder hematite has been confirmed at some lower part by test boring works and is assumed to exist at the bottom part of the ore body. As for the gangue, various types of laterite contain-

ing partly goethite are noticeable near the surface of ground, and they grow in thickness especially in the topographically saddle-shaped places, causing increase in the depth of stripping. Laterite also distributes irregularily in the ore body, thereby lowering grade of the ore body and its lump ratio.

Three In Situ deposits of Daiteri Deposit, Sindermundi Deposit and another small unnamed deposit are lined from east to west, and at the foot of mountain are some float ore deposits derived from these deposits.

The main deposit in the area is Daiteri Deposit of which the past surveys were concentrated. Prior to the Mission's survey in January 1963, the State Government of Orissa conducted primary surface survey, and four boring works for a total length of 229.73 m have also been completed even though the per cent of core recovery was not so good. Prospecting by deep pit at 30 places was also progressing, and it was also planned to undertake more extensively test boring works and prospecting tunneling of 250 m.

(ii) Daiteri Deposit:

The deposit is the main deposit surveyed this time. In the southern part, its strike is N.W. 70° and dip is 70°S. The deposit is embedded in Banded Hematite Quartzite and deflects near the central Daiteri triangulation point changing the strike to NW 20° - EW and the dip to 60°S, and it finally disappears into iron bearing shale. The scale is large and extends over 1,500 m in total length and 300 m in maximum width.

For the reasons of its origin as mentioned above, the most important factors in determining the reserve and grade of the deposit are considered to be estimation of the lower limit of rich ore body, lowering of grade and lump ore ratio due to intercalation and existence of powder hematite in the bottom part, which will be discussed below:

a) Estimation of Depth of Rich Ore Body:

For the reasons mentioned below, the profile map of the estimation of ore reserve is drawn on the assumption that the scope of reserve estimation

is up to maximum 70 m from the surface of ground. Accordingly, the lower limit of ore body is at a level 690 m from sea level.

According to the results of the past three test boring works, the depth of ore body was estimated to be 62.56 m at No.1 bore hole more than 60.40 m at No.2 bore hole, 44.40 m at No.3 bore hole, respectively. However, since both No.1 and No.3 holes are at the west end of the ore body, and No.3 hole, in particular, is in the part which is treated as the outside of ore body, they are not appropriate to measure the lower limit. Therefore, estimation of 70 m has been made in consideration of the conditions of No.2 hole and cross sections of ore body.

The deposit deflects noticeably at the center part, both sides of which have show dip and enter into lower stratum of shale, and the extension of depth is apparently not too hopeful not only for the reason of its origin. But the difference between the upper and lower levels of outcrop at each section is as follows, and the maximum depth at the main part of the ore body is considered to be 70 m.

A - A' Section 75m	B - B' Section 140m	C - C' Section 90m
D - D' Section 74m	E - E' Section 90m	F - F' Section 97m
G - G' Section 125m	H - H' Section 88m	I - I' Section 55m
J - J' Section 15m	K - K' Section 30m	L - L' Section 30m
M - M' Section 30m	N - N' Section 40m	

b) Estimation of Amount of Ore Reserve and Average Quality:

The followings are the conclusion obtained from the estimation on the scale of ore body and average quality made on the basis of the results of sampling by deep pit at 28 places (average depth: 7m, total length of sampling: 196.5m) conducted by the State Government of Orissa prior to the survey by the Mission. Since the per cent of core recovery of the previous test boring works was less than 50%, their results were not used for the estimation of quality as it was considered that they were useful for the determina-

Table of samples by pit

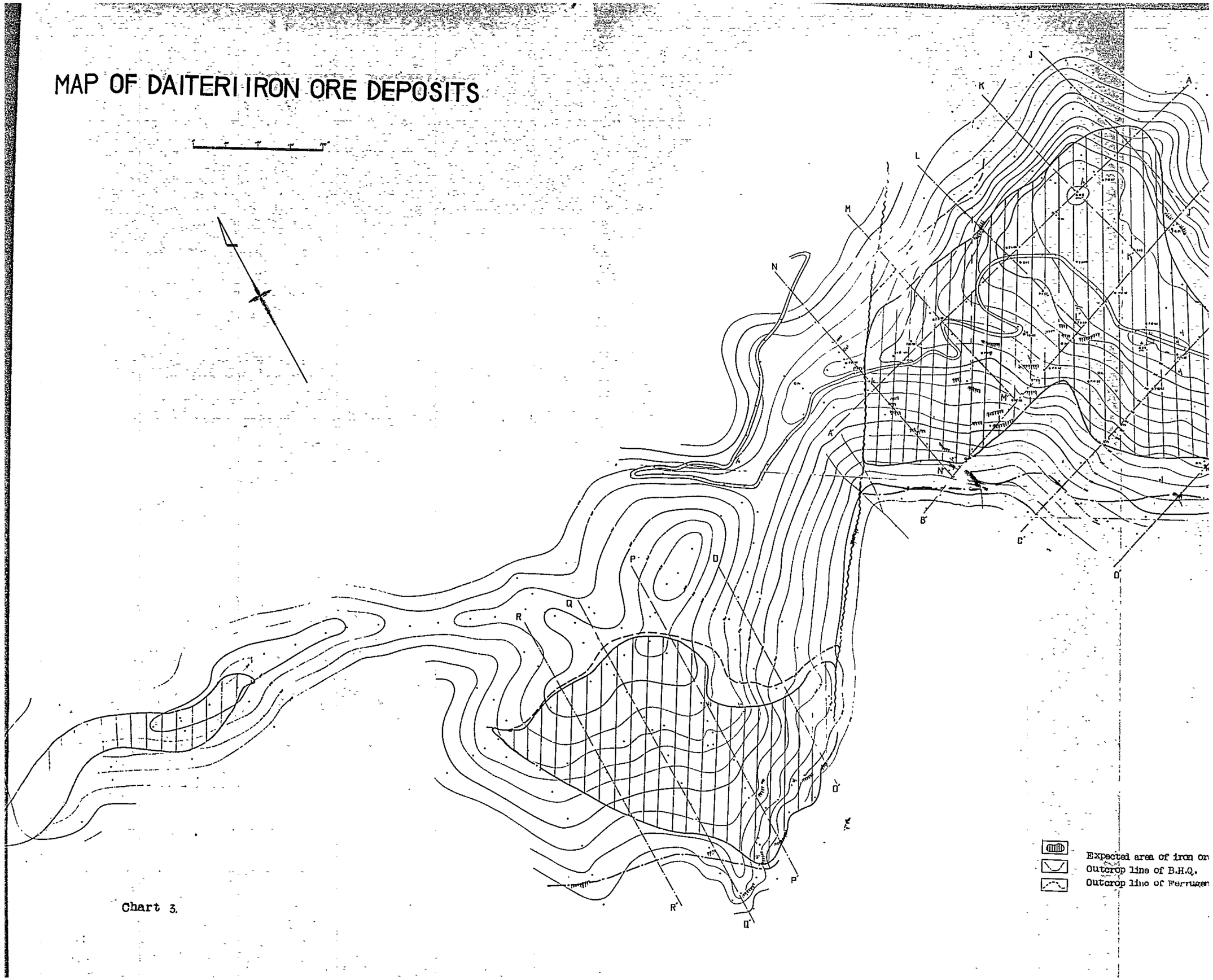
Location	pit No.	depth classified	width of sample collection	sample No.	overburden disposal & kind of ore	analysis result								
						T. Fe	SiO_2	Al_2O_3	P	S	Mn	FeO	As	combined water
near Bench Mark 37	39/58	0 ~0.9	0.9	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.9~3.3	2.4	S- 23	stripping rock	59.51	1.58	2.69	0.134	0.002	0.099	1.05	0.005	9.00
		3.3~3.6	0.3	S- 25	within ore-body Porous laminated Ore	59.58	1.93	2.05	0.126	0.002	0.060	1.17	0.006	8.43
		3.6~5.9	2.3	S- 24	" " " "	58.57	2.76	3.21	0.090	trace	0.055	2.49	0.005	7.52
		average	2.6		average within ore-body	58.75	2.65	3.07	0.093	—	0.055	2.34	0.005	7.62
near Bench Mark 31	37/58	0 ~1.4	1.4	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.4~2.9	1.5	S- 27	within ore-body Porous laminated Ore	58.42	2.04	5.38	0.048	0.005	0.429	0.377	0.007	8.23
		2.9~3.7	0.8	S- 26	" " " "	59.82	1.35	2.71	0.060	0.002	0.269	0.837	0.007	7.25
		average	2.3			58.90	1.80	4.44	0.052	—	0.373	0.536	0.007	7.88
near Bench Mark 281	34/58	0 ~1.0	1.0	S- 30	within ore-body laminated Ore	62.78	0.564	3.59	0.098	0.004	0.044	0.523	0.006	5.18
		average	1.0			62.78	0.564	3.59	0.098	0.004	0.044	0.523	0.006	5.18
near Bench Mark 181	32/58	0 ~0.6	0.6	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.6~2.8	2.2	S- 33	stripping rock	58.73	1.36	4.62	0.090	0.006	0.006	0.669	0.006	6.71
		2.8~4.0	1.2	S- 32	within ore-body Porous laminated Ore	62.31	1.21	1.97	0.050	0.001	0.104	0.837	0.004	6.71
		average	1.2			62.31	1.21	1.97	0.050	0.001	0.104	0.837	0.004	6.71
near Bench Mark 23~24	31/58	0 ~1.4	1.4	S- 34	within ore-body laminated Ore	65.40	0.606	2.11	0.067	—	0.079	0.837	0.005	3.26
		average	1.4			65.40	0.606	2.11	0.067	—	0.079	0.837	0.005	3.26
near Bench Mark 24~186	30/58	0 ~0.2	0.2	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.2~2.0	1.8	S- 35	within ore-body laminated Ore	61.69	0.634	3.07	0.109	—	0.049	1.00	0.005	6.49
		average	1.8			61.69	0.634	3.07	0.109	—	0.049	1.00	0.005	6.49
near Bench Mark 23~164	25/62	0 ~1.6	1.6	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.6~2.4	0.8	S- 39	stripping rock	46.98	2.86	14.51	0.180	—	0.022	0.523	0.007	—
		2.4~5.4	3.0	S- 38	"	56.16	0.334	8.19	0.151	—	0.013	0.544	0.005	—
		5.4~6.9	1.5	S- 37	"	59.50	0.240	5.28	0.132	—	0.033	0.607	0.006	—
		6.9~8.9	2.0	S- 36	"	58.96	1.13	6.24	0.116	—	0.016	0.335	0.007	—
		average	7.3			56.60				—	—	—	—	—
between Bench Mark 23~24	24/62	0 ~2.2	2.2	—	stripping soil	—	—	—	—	—	—	—	—	—
		2.2~4.5	2.3	S- 42	stripping rock	50.94	1.26	11.27	0.208	—	0.013	0.732	0.011	—
		4.5~7.3	2.8	S- 41	"	50.47	1.50	12.73	0.176	—	0.031	0.523	0.008	—
		7.3~8.5	1.2	S- 40	within ore-body laminated Ore	63.56	0.260	3.45	0.044	—	0.042	0.439	0.005	9.31
		average	1.2			63.56	0.260	3.45	0.044	—	0.042	0.439	0.005	9.31
between Bench Mark 22~160	29/58	0 ~2.5	2.5	—	stripping soil	—	—	—	—	—	—	—	—	—
		2.5~5.0	2.5	S- 43	stripping rock	47.98	1.76	14.40	0.125	—	0.055	0.732	0.008	—
		average	2.5			47.98	1.76	14.40	0.125	—	0.055	0.732	0.008	—

between Bench Mark 17 — 148	23/62	0 ~2.4	2.4	—	stripping soil	—	—	—	—	—	—	—	—	—	
		2.4~3.2	0.8	S- 48	within ore-body Porous laminated Ore	59.66	0.966	6.25	0.103	—	0.044	0.627	0.004	—	
		3.2~4.4	1.2	S- 47	〃 Vein laterite	50.04	2.54	12.09	0.118	—	0.035	0.837	0.006	9.85	
		4.4~8.0	3.6	S- 46	〃 Porous laminated Ore	55.61	1.27	8.13	0.104	—	0.049	0.732	0.010	8.66	
		8.0~9.0	1.0	S- 45	〃 Vein laterite	53.28	0.940	10.83	0.131	—	0.044	0.627	0.007	4.64	
		average	6.6			54.73	1.41	9.02	0.110	—	0.045	0.722	0.008	8.21	
between Bench Mark 131 — 132	20/62	0 ~1.7	1.7	S- 53	stripping rock	58.49	2.76	5.48	0.078	—	0.075	0.920	0.004	—	
		1.7~3.7	2.0	S- 52	〃	60.65	1.90	4.22	0.072	—	0.055	0.481	0.005	—	
		3.7~5.7	2.0	S- 51	within ore-body laminated Ore	57.54	2.70	4.70	0.075	—	0.088	0.418	0.005	8.39	
		5.7~7.7	2.0	S- 50	〃 Vein laterite	53.43	3.45	7.26	0.102	—	0.064	0.669	0.006	12.49	
		average	4.0			55.48	3.07	5.98	0.088	—	0.076	0.543	0.006	10.44	
between Bench Mark 112 — 113	17/62	0 ~1.4	1.4	—	stripping soil	—	—	—	—	—	—	—	—	—	
		1.4~2.6	1.2	S- 59	within ore-body laminated Ore	64.51	0.660	1.79	0.038	—	0.121	0.523	0.006	4.51	
		2.6~4.1	1.5	S- 58	〃 〃	64.44	0.536	1.65	0.128	—	0.159	0.627	0.009	10.86	
		4.1~5.2	1.1	S- 57	〃 〃	51.24	1.96	12.07	0.130	—	0.044	1.150	0.007	4.99	
		5.2~6.0	0.8	S- 56	〃 〃	56.18	1.55	7.51	0.115	—	0.154	0.502	0.007	8.48	
		6.0~8.0	2.0	S- 55	〃 〃	58.19	1.22	5.25	0.096	—	0.093	0.523	0.007	7.07	
		8.0~9.0	1.0	S- 54	〃 Vein laterite	51.24	3.35	10.97	0.125	—	0.088	0.502	0.005	9.60	
		average	7.6			58.28	1.41	5.96	0.103	—	0.108	0.629	0.007	7.59	
between Bench Mark 115 — 116	16/62	0 ~1.0	1.0	—	stripping soil	—	—	—	—	—	—	—	—	—	
		1.0~3.5	2.5	S- 71	stripping rock	60.66	2.30	4.01	0.058	0.006	0.115	0.418	0.007	—	
		3.5~4.6	1.1	S- 70	〃	57.11	3.30	5.00	0.075	0.023	0.132	0.356	0.006	—	
		4.6~8.0	3.4	S- 69	〃	53.09	6.07	6.41	0.088	—	—	—	—	—	
		8.0~8.3	0.3	S- 68	within ore-body laminated Ore	64.82	0.784	1.76	0.035	0.002	0.181	0.564	0.007	3.89	
		average	0.3			64.82	0.784	1.76	0.035	0.002	0.181	0.564	0.007	3.89	
between Bench Mark 19 — 78	12/62	0 ~2.3	2.3	—	stripping soil	—	—	—	—	—	—	—	—	—	
		2.3~4.3	2.0	S- 76	stripping rock	60.27	1.42	4.55	0.097	—	0.857	0.753	0.005	—	
		4.3~4.9	0.6	S- 75	〃	49.47	2.88	13.17	0.141	0.027	0.401	0.335	0.007	—	
		4.9~6.7	1.8	S- 74	〃	48.28	5.08	13.14	0.125	—	0.121	0.523	0.010	—	
		6.7~6.8	0.1	S- 73	〃	58.83	1.34	4.13	0.115	—	0.211	0.418	0.008	—	
		average	6.8			54.24	—	—	—	—	—	—	—	—	
near Bench Mark 74	11/62	0 ~3.2	3.2	—	stripping soil	—	—	—	—	—	—	—	—	—	
		3.2~5.5	2.3	S- 79	within ore-body laminated Ore	57.26	1.45	4.39	0.101	—	2.20	0.502	0.010	7.13	
		5.5~7.0	1.5	S- 78	〃 〃	58.40	1.24	4.29	0.105	—	1.79	0.251	0.009	6.65	
		7.0~9.0	2.0	S- 77	〃 〃	54.64	1.32	4.76	0.062	—	4.20	0.669	0.004	6.00	
		average	5.8			56.72	1.35	4.48	—	—	2.78	0.494	0.008	6.61	
near Bench Mark 72	10/62	0 ~1.6	1.6	—	stripping soil	—	—	—	—	—	—	—	—	—	
		1.6~3.2	1.6	S- 83	within ore-body laminated Ore	62.35	0.708	3.08	0.094	—	0.060	0.418	0.008	5.89	
		3.2~5.2	2.0	S- 82	〃 〃	54.64	1.15	8.56	0.090	0.003	0.069	0.481	0.008	9.65	

Location	pit No.	depth classified	width of sample collection	sample No.	overburden disposal & kind of ore	analysis result								
						T. Fe	SiO_2	Al_2O_3	P	S	Mn	FeO	As	combined water
		5.2~7.4	2.2	S- 81	within Ore-body Lateritic Ore	56.97	1.26	6.36	0.120	0.004	0.064	0.418	0.009	9.20
		7.4~9.2	1.8	S- 80	〃 Laminated Ore	62.89	0.600	1.93	0.079	—	0.914	0.209	0.008	4.72
		average	7.6			58.89	0.950	5.19	0.096	—	0.265	0.384	0.008	7.56
near Bench Mark 60	1/62	0 ~0.8	0.8	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.8~2.3	1.5	S- 87	within Ore-body Laminated Ore	62.12	1.22	3.54	0.094	—	0.082	0.439	0.007	5.30
		2.3~4.6	2.3	S- 86	〃 Lateritic Ore	61.77	0.918	4.09	0.088	—	0.055	0.418	0.005	6.21
		4.6~6.6	2.0	S- 85	〃 Vein Laterite	50.47	3.83	12.62	0.129	0.024	0.070	0.460	0.007	8.50
		6.6~7.8	1.2	S- 84	〃 Fe Shale	44.64	1.55	19.61	0.077	—	0.060	0.439	0.005	11.90
		average	7.0			55.67	1.94	9.06	0.099	—	0.065	0.437	0.006	7.64
near Bench Mark 54	13/62	0 ~0.9	0.9	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.9~2.7	1.8	S- 95	within Ore-body Laminated Ore	61.58	0.984	2.96	0.057	—	0.044	1.19	0.005	6.00
		2.7~4.9	2.2	S- 94	〃 〃	62.35	2.97	4.13	0.069	—	0.044	1.42	0.004	6.59
		4.9~7.2	2.3	S- 93	〃 Porous Laminated Ore	62.35	1.58	2.23	0.087	0.026	0.049	0.669	0.005	5.52
		7.2~8.7	1.5	S- 92	〃 Laminated Ore	61.89	1.03	1.83	0.097	—	0.079	0.418	0.006	6.97
		average	7.8			62.08	1.72	2.86	0.077	—	0.051	0.925	0.005	6.21
near Bench Mark 236	4/62	0 ~0.8	0.8	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.8~2.4	1.6	S- 99	stripping rock	56.57	0.878	6.90	0.116	0.018	0.082	0.314	0.006	10.83
		2.4~5.4	3.0	S- 98	within Ore-body Lateritic Ore	59.30	0.710	4.72	0.102	—	0.044	0.293	0.007	8.30
		5.4~7.4	2.0	S- 97	〃 Laminated Ore	62.51	0.354	1.45	0.092	—	0.121	0.377	0.003	7.67
		7.4~8.4	1.0	S- 96	〃 Vein Laterite	58.49	0.518	5.08	0.107	0.003	0.154	0.335	0.006	9.80
		average	6.0			60.23	0.550	3.69	0.099	—	0.088	0.328	0.006	8.34
near Bench Mark 238	6/62	0 ~1.6	1.6	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.6~2.5	0.9	S-103	stripping rock	58.57	1.25	5.95	0.070	—	0.049	0.409	0.004	
		2.5~4.5	2.0	S-102	within Ore-body Laminated Ore	58.57	2.48	5.38	0.112	—	0.077	0.633	0.008	7.83
		4.5~6.5	2.0	S-101	〃 〃	59.61	2.21	4.49	0.083	—	0.110	0.593	0.005	6.22
		6.5~8.5	2.0	S-100	〃 Lateritic Ore	58.64	3.56	5.45	0.067	0.002	0.075	0.418	0.003	5.88
		average	6.0			58.94	2.75	5.10	0.087	—	0.087	0.548	0.005	6.64
near Bench Mark 88	8/62	0 ~1.5	1.5	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.5~2.0	0.5	S-108	stripping rock	60.08	0.760	4.06	0.102	—	0.093	0.817	0.008	—
		2.0~3.4	1.4	S-107	〃	56.03	2.960	6.30	0.103	—	0.044	0.552	0.007	—
		3.4~5.0	1.6	S-106	within Ore-body Laminated Ore	63.90	0.350	1.26	0.085	—	0.121	0.490	0.007	6.29
		5.0~6.5	1.5	S-105	〃 〃	59.88	1.030	3.19	0.141	—	0.128	0.572	0.007	6.83
		6.5~8.0	1.5	S-104	〃 〃	60.50	0.554	2.15	0.129	—	0.068	0.613	0.005	9.33
		average	4.6			61.51	0.63	2.17	0.117	—	0.105	0.555	0.006	7.45
		0 ~0.7	0.7	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.7~2.1	1.4	S-112	stripping rock	60.60	0.738	2.57	0.125	—	0.027	0.552	0.005	—

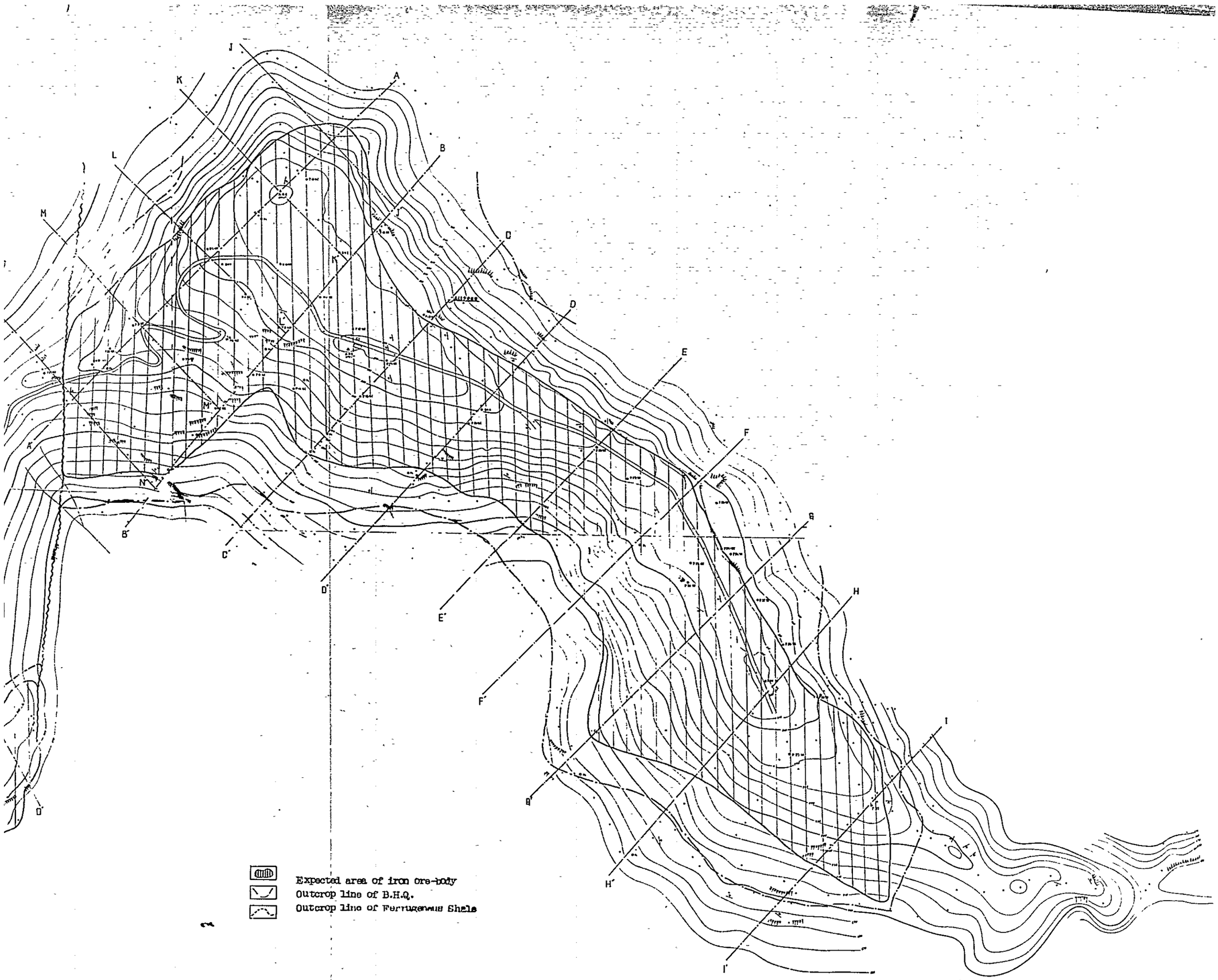
near Bench Mark 90		2.1~5.1	3.0	S-111	stripping rock	58.92	0.852	3.70	0.145	—	0.033	0.531	0.005	—
		5.1~7.5	2.4	S-110	within ore-body Porous laminated Ore	58.92	1.50	5.03	0.095	—	0.035	0.450	0.006	6.97
		7.5~8.1	0.6	S-109	〃 Vein laterite	55.94	1.46	6.38	0.119	—	0.044	0.388	0.008	10.78
		average	3.0			58.32	1.49	5.29	0.099	—	0.036	0.437	0.006	7.73
near Bench Mark 90	14/62	0 ~1.8	1.8	S-116	stripping rock	61.68	1.66	5.08	0.031	0.003	0.020	0.429	0.006	—
		1.8~2.8	1.0	S-115	within ore-body laminated Ore	63.83	0.814	2.63	0.030	—	0.016	0.511	0.008	3.78
		2.8~4.8	2.0	S-114	〃 〃	60.91	2.84	4.25	0.040	—	0.013	0.409	0.007	4.71
		4.8~6.8	2.0	S-113	〃 〃	61.22	2.43	4.57	0.030	—	0.016	0.470	0.004	3.73
		average	5.0			61.61	2.27	4.05	0.034	—	0.014	0.453	0.006	4.13
near Bench Mark 92~93	7/62	0 ~0.5	0.5	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.5~2.5	2.0	S-120	stripping rock	58.42	0.702	1.74	0.040	0.028	4.560	0.204	0.007	—
		2.5~4.5	2.0	S-119	within ore-body	61.43	1.41	4.25	0.050	—	0.131	0.511	0.010	5.54
		4.5~6.5	2.0	S-118	〃 Powderly Hematite	62.89	1.50	2.49	0.040	—	0.044	0.572	0.007	5.76
		6.5~8.5	2.0	S-117	〃 〃	63.90	0.902	2.24	0.047	—	0.038	0.613	0.008	5.14
		average	6.0		〃 〃	62.74	1.270	2.99	0.045	—	0.071	0.565	0.008	5.48
near Bench Mark 240	5/62	0 ~1.0	1.0	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.0~3.0	2.0	S-125	stripping rock	59.88	1.19	3.72	0.082	0.001	0.009	0.409	0.006	—
		3.0~4.0	1.0	S-124	〃	46.27	6.72	12.15	0.098	—	0.033	0.429	0.007	—
		4.0~6.0	2.0	S-123	within ore-body Porous laminated Ore	53.06	3.02	8.93	0.052	—	0.020	0.306	0.008	9.87
		6.0~7.0	1.0	S-122	〃 Powderly Hematite	55.56	2.03	8.35	0.070	—	0.031	0.409	0.008	7.94
		7.0~9.0	2.0	S-121	〃 laminated Ore	63.13	1.50	1.61	0.036	—	0.022	0.531	0.008	6.38
		average	5.0			57.58	2.21	5.88	0.049	—	0.023	0.416	0.008	8.08
near Bench Mark 63	3/62	0 ~0.6	0.6	—	stripping soil	—	—	—	—	—	—	—	—	—
		0.6~2.2	1.6	S-130	stripping rock	56.18	1.12	4.80	0.059	0.002	0.020	0.490	0.010	8.40
		2.2~4.2	2.0	S-129	within ore-body laminated Ore	59.81	0.748	4.09	0.053	—	0.033	0.593	0.006	8.70
		4.2~6.0	1.8	S-128	〃 〃	57.11	1.65	5.66	0.056	—	0.044	0.490	0.006	10.03
		6.0~8.2	2.2	S-127	〃 〃	59.08	1.59	2.87	0.047	—	0.046	0.409	0.008	9.00
		average	6.0			58.73	1.32	4.11	0.051	—	0.041	0.494	0.007	9.20
near Bench Mark 64	22/62	0 ~1.1	1.1	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.1~2.6	1.5	S-134	stripping rock	56.41	1.10	8.99	0.100	—	0.042	0.511	0.006	—
		2.6~3.6	1.0	S-133	within ore-body Porous laminated Ore	58.65	2.96	5.17	0.154	—	0.066	0.552	0.009	7.12
		3.6~5.6	2.0	S-132	〃 Massive Hematite Ore	60.81	1.63	3.40	0.248	—	0.066	0.470	0.006	7.74
		5.6~7.6	2.0	S-131	〃 〃	59.96	1.77	2.33	0.247	—	0.093	0.490	0.008	7.66
		average	5.0			60.03	1.95	3.32	—	—	0.076	0.494	0.008	7.58
near Bench Mark 61	2/62	0 ~1.8	1.8	—	stripping soil	—	—	—	—	—	—	—	—	—
		1.8~3.3	1.5	S- 91	stripping rock	52.32	2.07	9.85	0.091	—	0.027	0.418	0.006	—
		3.3~4.5	1.2	S- 90	〃	48.00	2.37	13.98	0.074	0.006	0.013	0.586	0.009	—
		4.5~5.8	1.3	S- 89	〃	60.35	5.13	15.30	0.077	—	0.031	1.15	0.008	—
		5.8~7.5	1.7	S- 88	〃	57.84	1.97	5.89	0.079	0.097	0.031	0.314	0.007	—
		average	7.5			—	—	—	—	—	—	—	—	—
average of analysis for all samples within ore-body						59.15	1.57	4.81	0.088	—	0.236	0.578	0.007	7.30

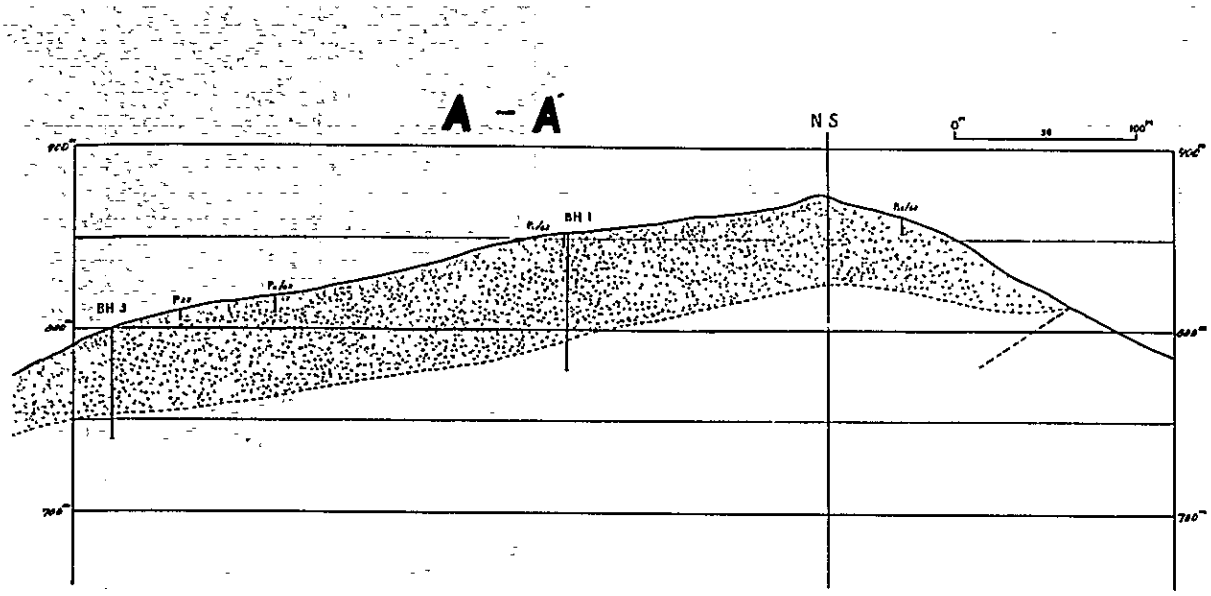
MAP OF DAITERI IRON ORE DEPOSITS

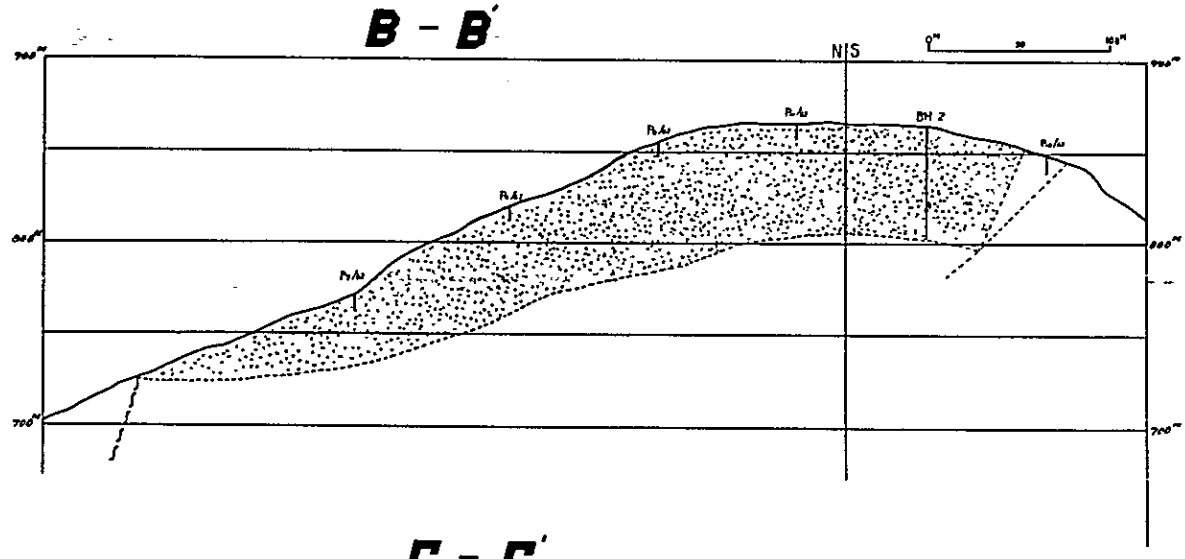


Expected area of iron or
Outcrop line of B.H.Q.
Outcrop line of Ferruge

Chart 3.


J
K
A
L
B
M
C
K
D
E
F
G
A
M
N
B'
C'
D'
E'
F'
G'
H
B'
H'
I
I'
D'
Expected area of iron ore-body
Outcrop line of B.H.Q.
Outcrop line of Ferruginous Shale





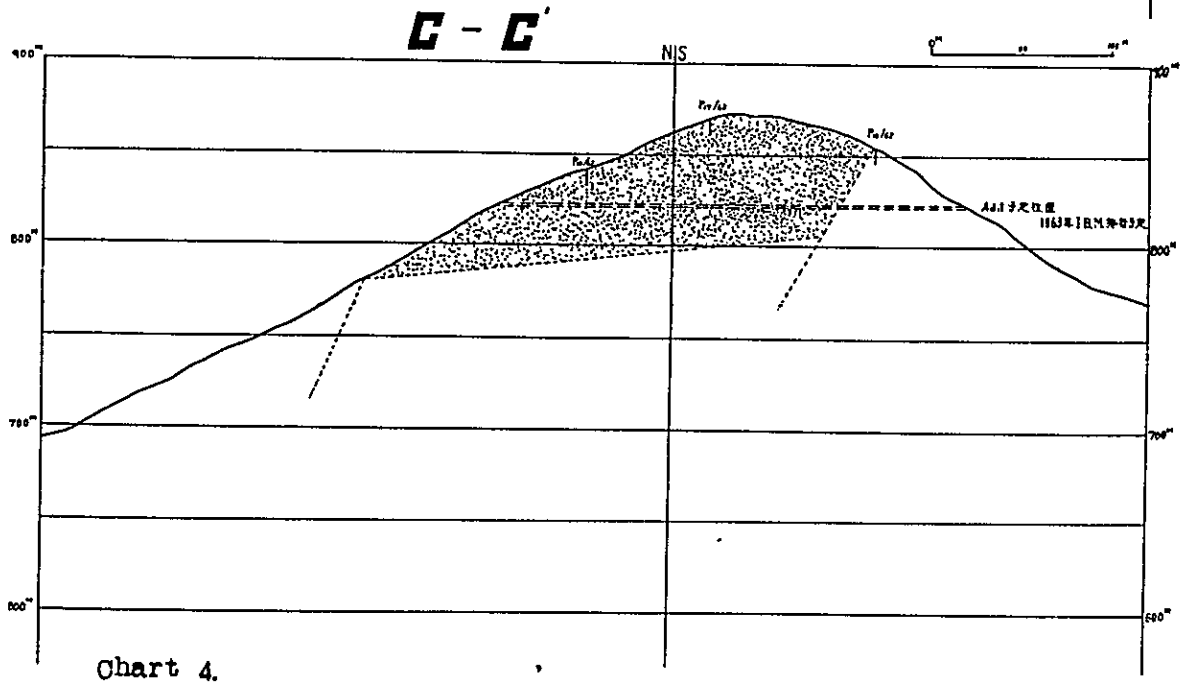
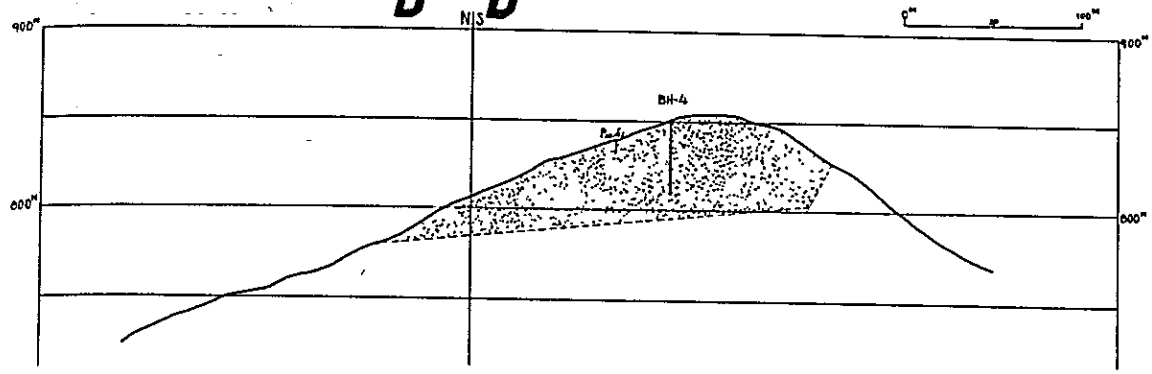
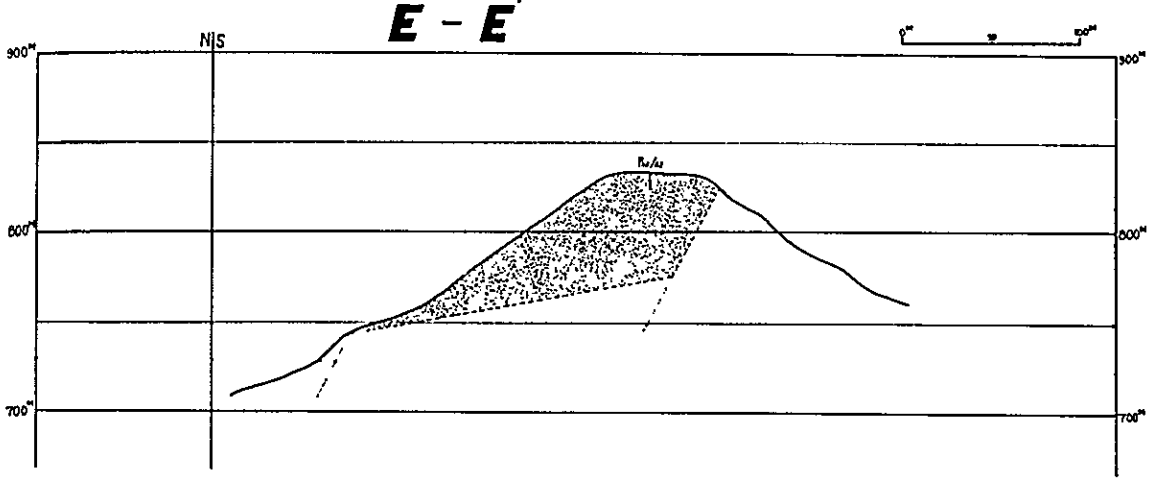


Chart 4.

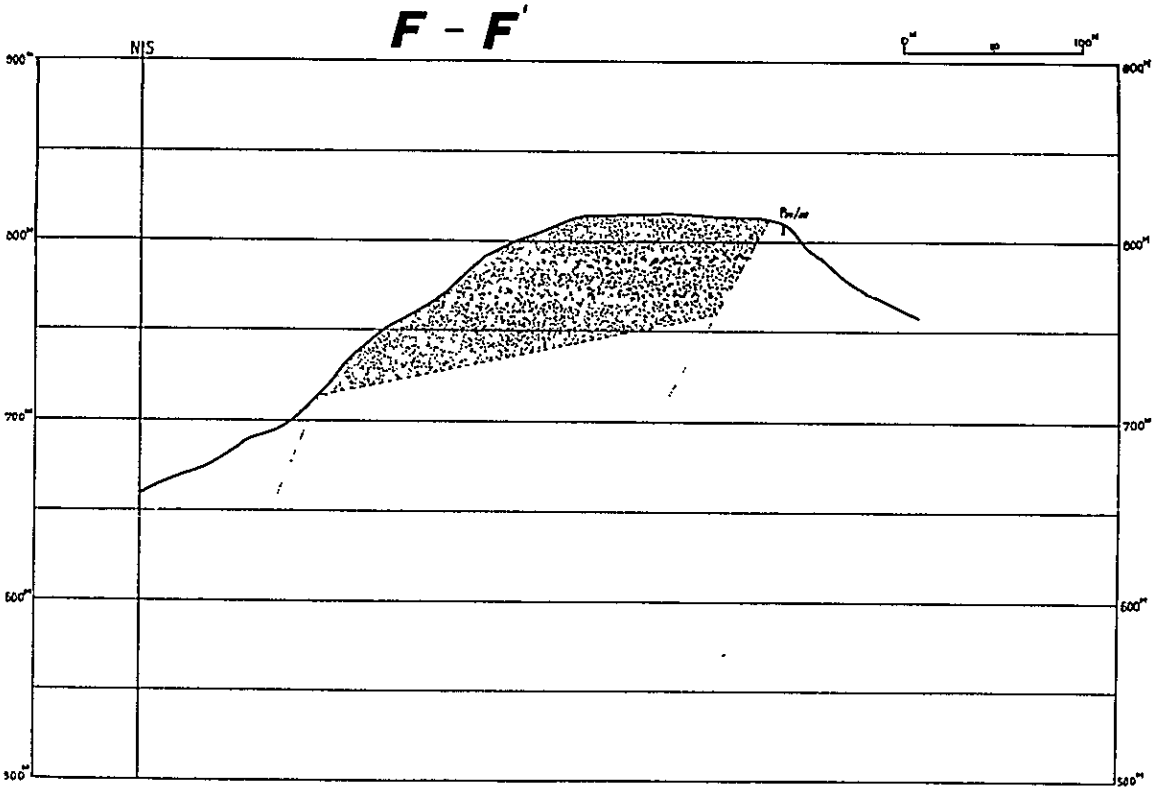
D - D'



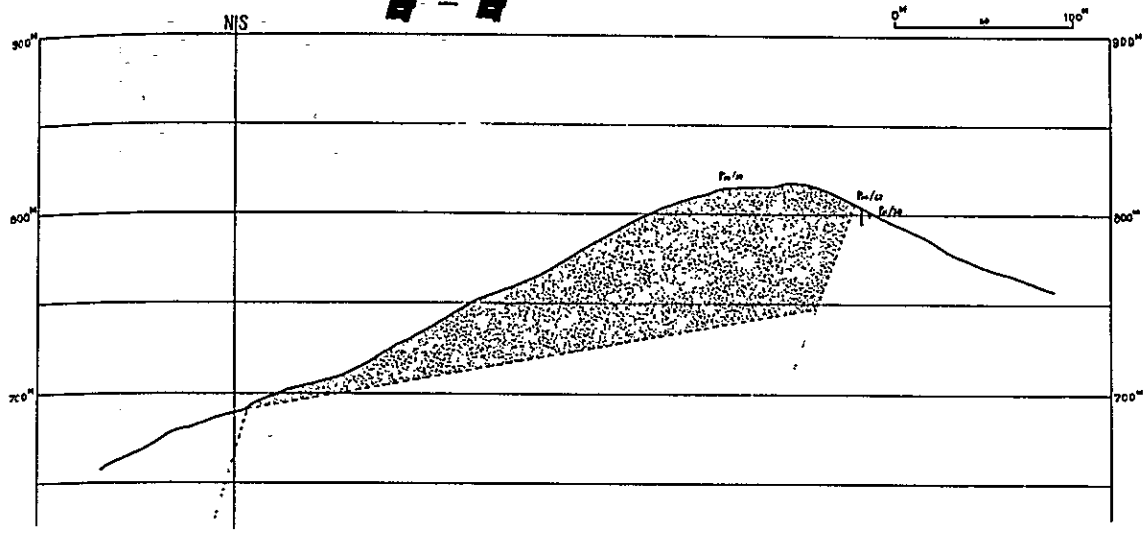
E - E'



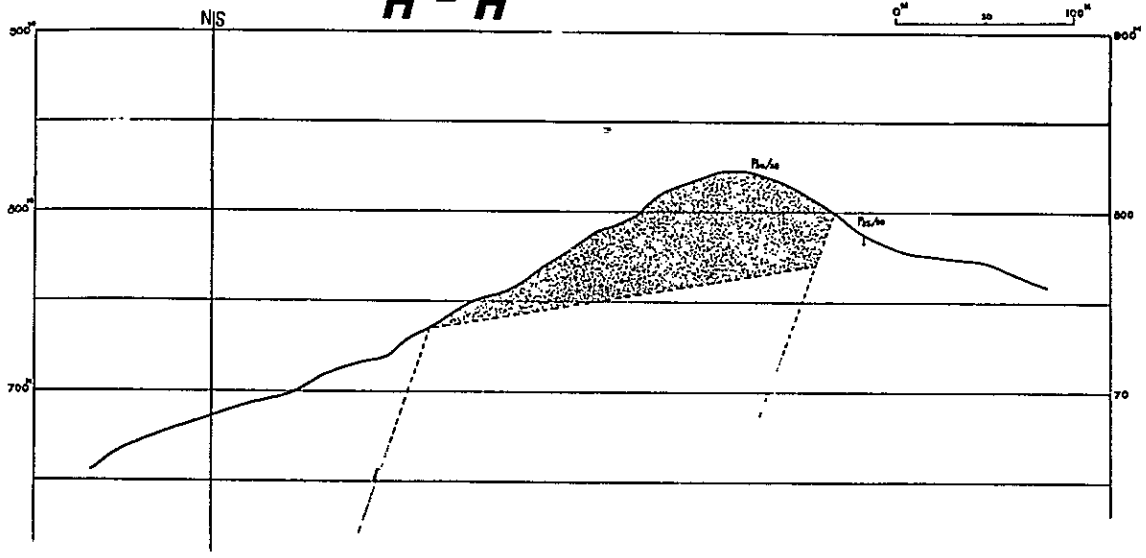
F - F'



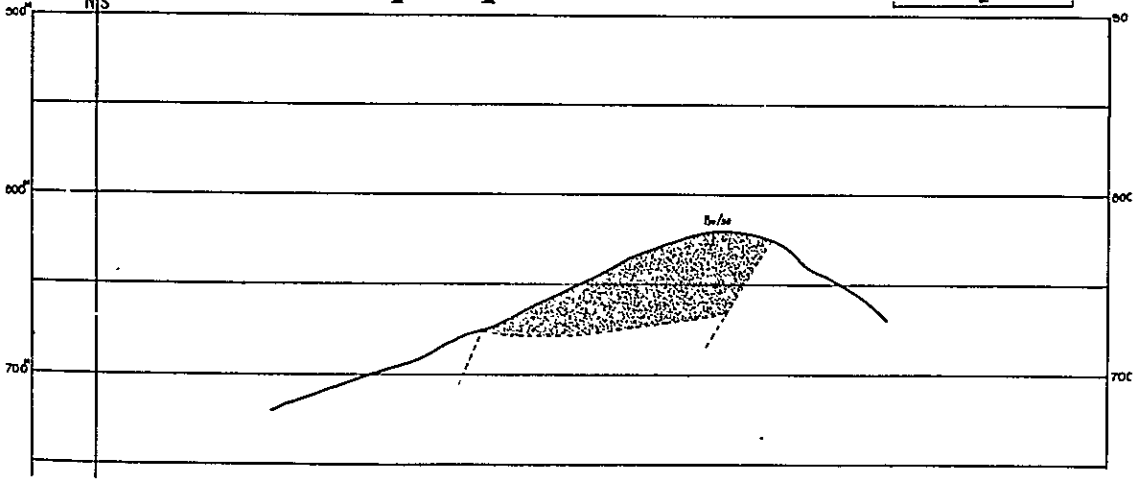
G - G'

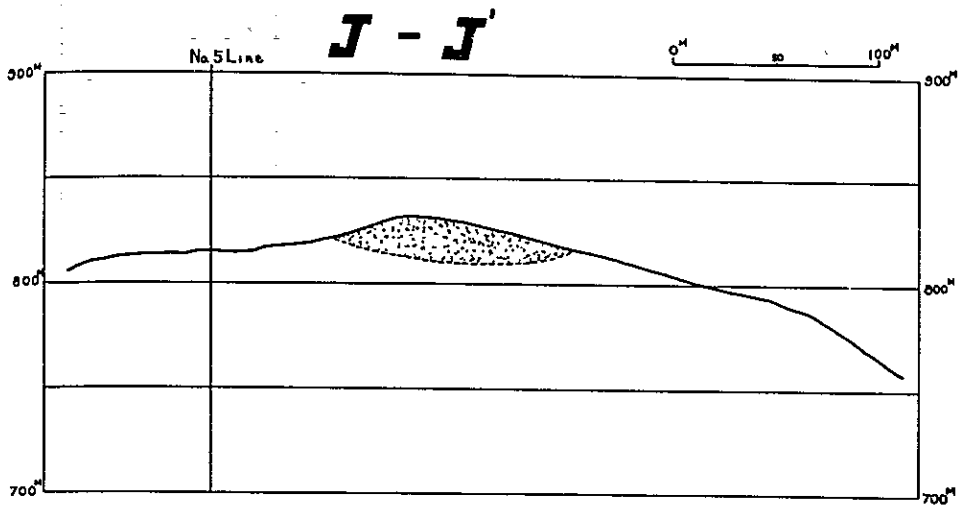


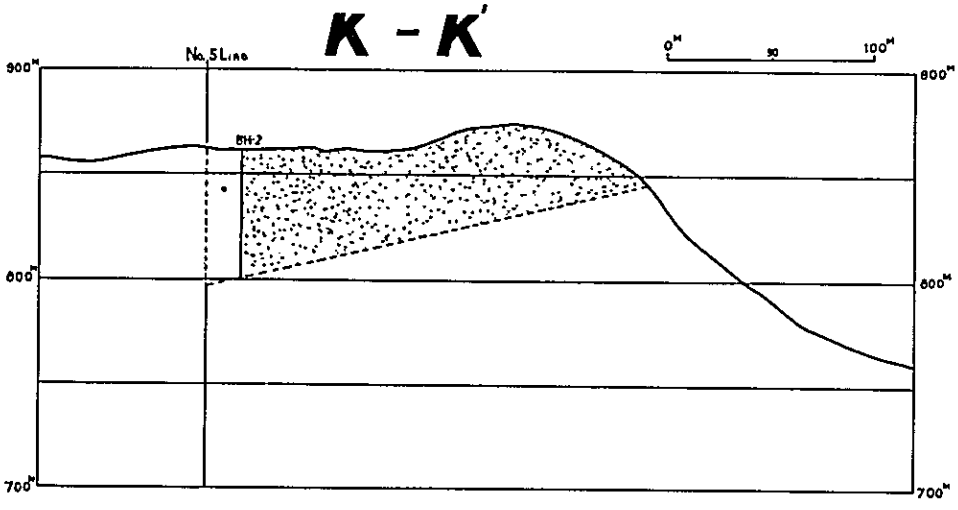
H - H'



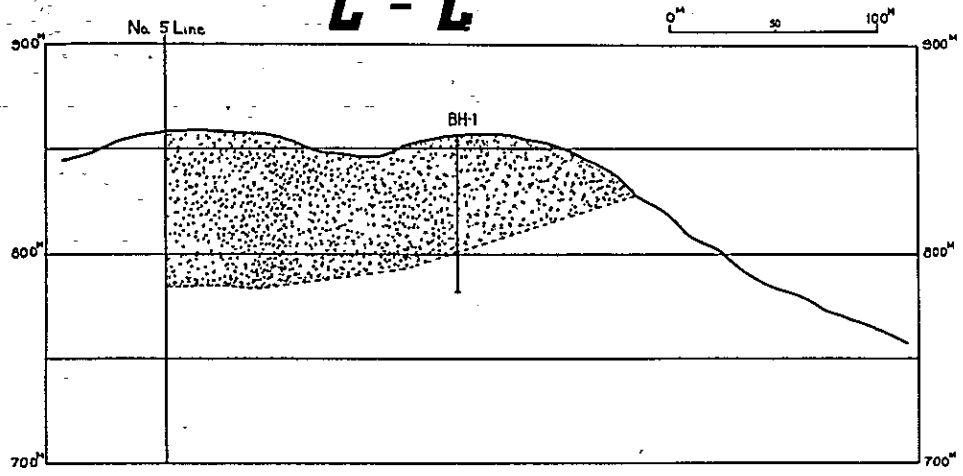
I - I'



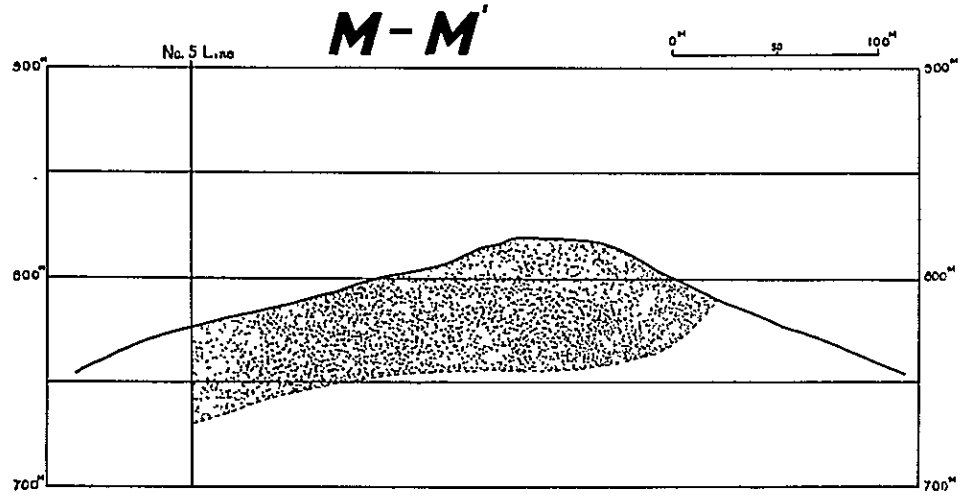

J - J'
No. 5 Line
0M
50
100M
900M
800M
700M


K - K'
No. 5 Line
0M
50
100M
900M
800M
700M
BH-2

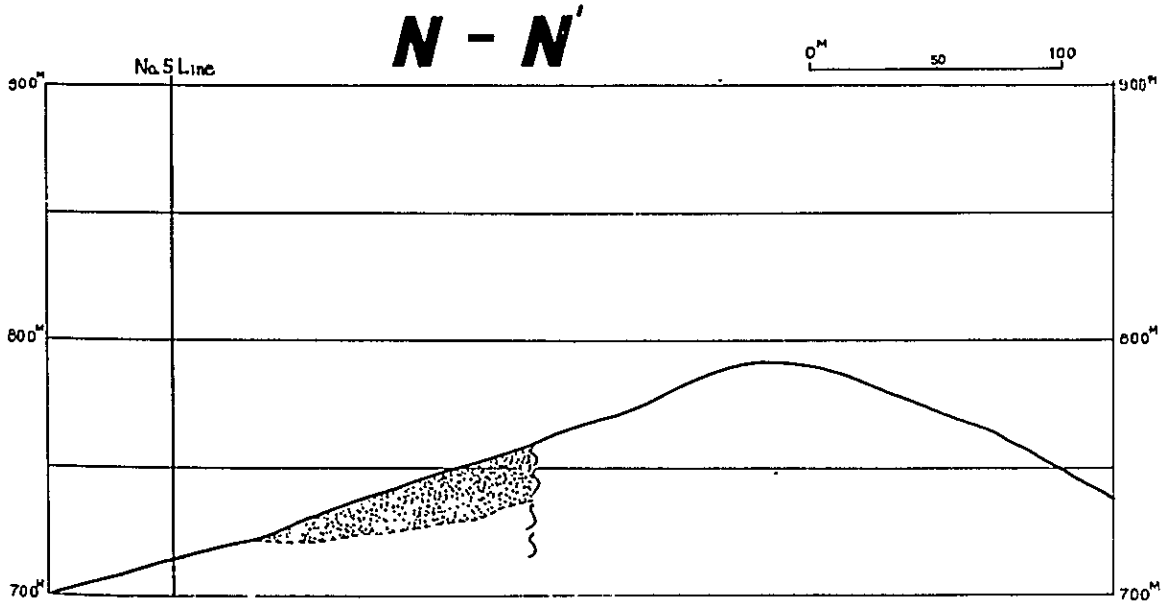
L - L'


No. 5 Line
0M
50
100M
900M
BH-1
800M
700M

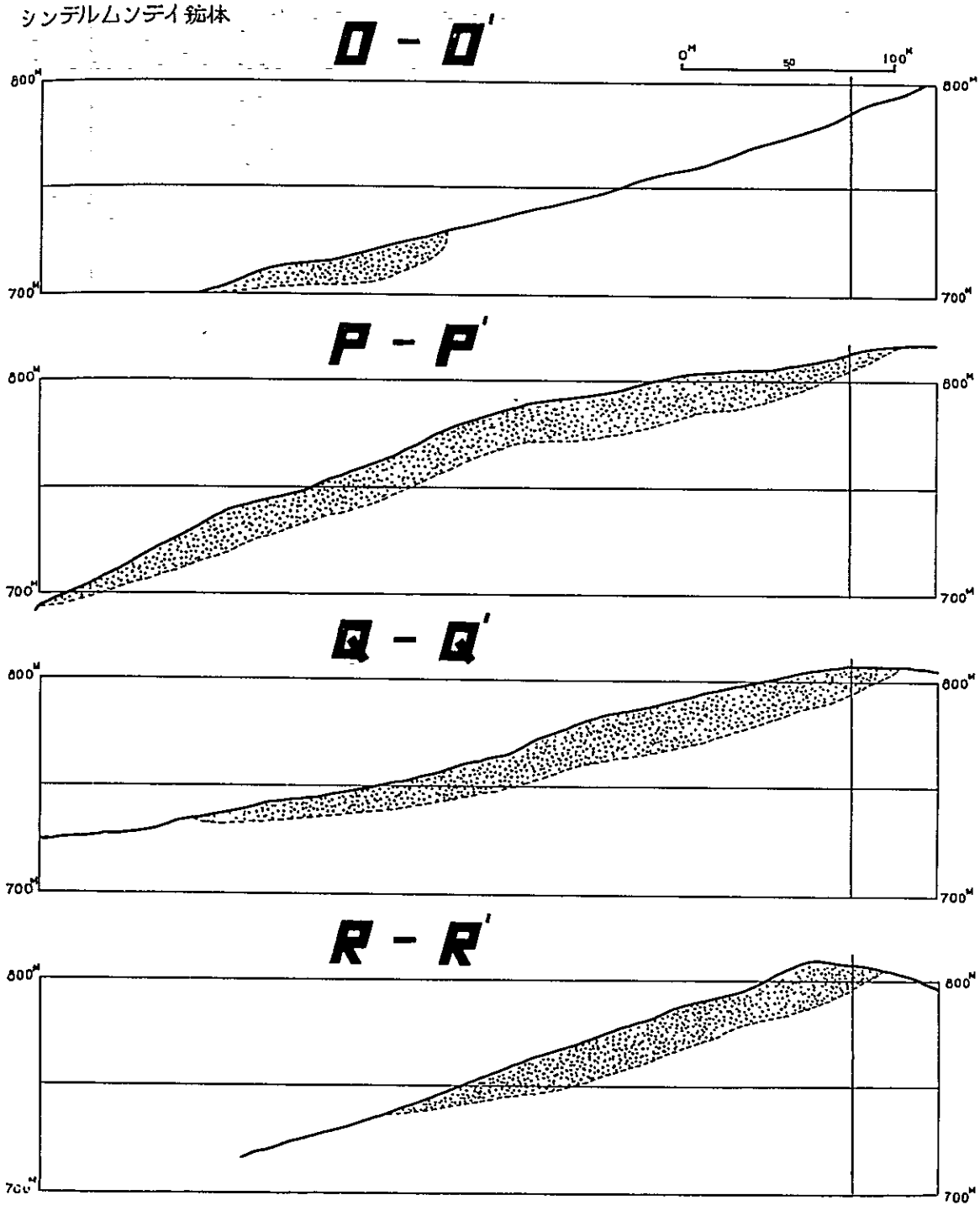
M - M'


No. 5 Line
0M
50
100M
900M
800M
700M

N - N'


No. 5 Line
0M
50
100
900M
800M
700M

シンデルムンデイ鉱体



tion of the scale of ore body but not for the estimation of quality.

T.Fe: 59.15%, SiO_2: 1.57%, Al_2O_3: 4.81%, P: 0.088%

FeO: 0.578%, Mn: 0.236%, As: 0.0066%, Moisture: 7.30%

With some allowance for mixing of stripping rock, the quality of crude ore in mining is estimated to be 58% Fe. However, such estimation of quality is strictly under the present condition, and involves the following problems:

* The estimation is based on the assumption that the condition found to 10m below the surface of ground is similarly applicable to the depth of 70m.
* The positions of pits are not chosen to represent correctly the entire ore body after the confirmation of the scale of ore body, and so they are partial.

In order to correct these points, therefore, it is necessary, in the future prospecting, to make confirmation of the bottom part by tunneling, to improve the accuracy of test boring data of the lower part sufficiently enough to be used for the determination of quality by improving core recovery, and to determine the position of each prospecting pit to represent accurately the quality of entire ore body.

(Attached Chart - 3)

(Attached Chart - 4)

c) Ratio of Lump Ore to Fine Ore:

As a result of the calculation of lump to fine ratio based on the samplings, + 10m/m : - 10m/m = 62.1 : 37.9 has been obtained.

In collecting samples, as the sampling was made in such a way as to have all the lumps in natural soil in + 10m/m, this can be considered to represent the lump-fine ratio of natural soil.

Since all the samples are collected from the places less than 10m deep

from the surface of ground, and because most of fine ore derives from irregularly distributed laterite which is easy to be pulverized, and does not reflect the effect of powder hematite which exists mostly in the deeper part, there is a possibility of having higher fine ratio in the lower part.

However, judging from the conditions of nearby mines, it is considered that the amount of laterite decreases at the depth where powder hematite exists and that there will be little difference in the ratio of lump ore to the depth of 70m as a whole. Thus, the above value was applied to the entire ore body.

In view of the tendency of laterite being concentrated in fine ore, + 10m/m lump ore was checked as to its T.Fe and Al_2O_3 content. As a result, T.Fe was calculated to be 61.20% and Al_2O_3 3.37%, and the ratio of the former to ore was +2.05% and that of the latter became - 1.08%. The above result implies that the mixture of low grade laterite in the ore body can be for the most part removed by crushing and washing and the grade of concentrate may be increased to 60%.

d) Specific Gravity:

Since it was considered, as a result of computation of specific gravity in natural ground, that all the samples showed changes in their existing conditions as in natural ground and their average value was close to that of crushed ore, this was not applied to the specific gravity in natural ground. Instead, typical lump samples for each kind were selected and their specific gravity was computed. And from the specific gravity thus computed and also from the estimated ratio of distribution of each different ore obtained by pit survey, the specific gravity in natural ground of the entire deposit has been computed to be 3.22. The basis of calculation is as shown on the attached table.

(iii) Other Deposits:

As for the deposits other than the Daiteri Deposit, the survey was

Data for estimation of average grade and specific gravity by kind of ore

Kind of ore	grade									specific gravity of ore in place (metric weight ton/1 m³)	apparent specific gravity of crude ore (broken) (metric weight ton/1 m³)
	T.Fe	FeO	SiO_2	Al_2O_3	P	S	Mn	As	combined water		
Massive Ore	61.23	0.328	1.50	3.43	0.13	—	0.042	0.005	3.76	3.51	2.59
Laminated Ore	60.72	0.342	1.34	3.49	0.08	—	0.212	0.004	4.02	3.39	2.16
Porous Lamimated Ore	58.30	0.439	1.98	4.99	0.09	—	0.057	0.003	3.70	3.07	2.08
Lateritic Ore	56.89	0.308	1.89	7.66	0.09	—	0.025	0.004	2.42	3.28	2.07
Vein Laterite	52.46	0.469	3.06	9.81	0.12	—	0.063	0.005	8.18	2.15	1.92
Surface Laterite	51.73	—	2.23	10.53	0.13	—	—		—	—	1.77

Data for estimation of specific gravity of entire ore-body

kind of ore	specific gravity of ore in place	apparent specific gravity of crude ore (broken)	estimated proportion
Laminated Ore	3.39	2.16	47.3
Porous Laminated Ore	3.07	2.08	18.4
Lateritic Ore	3.28	2.07	16.3
Massive Ore	3.51	2.59	9.8
Vein Laterite	2.15	1.92	8.2
average	3.22	2.15	

Estimated proportion for estimation of specific gravity cannot be used for estimation of grade of entire ore-body

Data for estimation of lump–fine ore ratio and of grade of lump ore (to be shipped)

Pit №	width of sample collection	ratio of lump ore (out of 100%)	grade of lump ore +10 m/m size				grade of washed lump ore +10 m/m size			
			Fe grade	difference from crude ore grade	Al_2O_3 grade	difference from crude ore	Fe grade	difference from crude ore grade	Al_2O_3 grade	difference from crude ore
	m	%	%		%		%		%	
39/58	2.6	74.6	61.33	+2.58	1.43	−1.64	61.68	+2.93	2.03	−1.04
37/58	2.3	74.5	60.41	+1.51	3.55	−0.89	61.99	+3.09	3.96	−0.48
34/58	1.0	97.9	65.83	+3.05	2.14	−1.45	61.89	−0.89	3.33	−0.26
32/58	1.2	81.6	62.82	+0.51	2.41	+0.44	62.97	+0.66	2.14	−0.17
31/58	1.4	89.2	63.87	−1.53	4.41	+2.30	65.20	−0.20	3.18	+1.07
30/58	1.8	62.0	61.43	−0.26	3.01	−0.06	63.29	+1.60	2.10	−0.97
24/62	1.2	67.2	64.86	+1.30	2.46	−0.99	65.59	+2.03	1.73	−1.72
23/62	6.6	51.6	58.57	+3.84	6.93	−2.09	56.66	+1.93	7.43	−1.59
20/62	4.0	49.6	60.27	+4.79	2.44	−3.54	60.38	+4.90	2.89	−3.09
17/62	7.6	55.2	60.29	+2.01	4.90	−1.06	61.08	+2.80	4.23	−1.73
16/62	0.3	90.5	66.81	+1.99	1.25	−0.51	64.16	−0.66	1.90	+0.14
11/62	5.8	51.5	60.19	+3.47	4.16	−0.32	59.44	+2.72	3.47	−1.01
10/62	7.6	44.6	60.95	+2.06	4.18	−1.01	62.10	+3.21	3.73	−1.46
1/62	7.0	67.8	58.18	+2.51	7.75	−1.31	59.47	+3.80	7.34	−1.72
13/62	7.8	60.6	64.24	+2.16	1.18	−1.68	63.56	+1.48	1.44	−1.42
4/62	6.0	79.0	61.76	+1.58	2.41	−1.28	59.03	−1.20	4.09	+0.40
6/62	6.0	55.7	62.84	+3.90	3.43	−1.67	62.46	+3.52	2.55	−2.55
8/62	4.6	62.6	62.60	+1.09	1.66	−0.61	61.51	0	1.74	−0.43
9/62	3.0	32.8	61.58	+3.26	2.66	−2.53	59.49	+1.17	4.14	−1.15
14/62	5.0	33.9	66.32	+4.71	2.22	−1.53	64.03	+2.42	2.91	−1.14
7/62	6.0	23.5	62.74	0	4.11	+1.02	63.20	+0.46	3.06	+0.07
5/62	5.0	56.4	60.82	+3.24	4.00	−1.58	58.63	+1.05	5.49	−0.39
3/62	6.0	49.6	58.85	+0.12	4.66	+0.55	58.98	+0.25	4.61	+0.50
22/62	5.0	62.0	62.05	+2.02	2.33	−0.69	59.97	−0.06	2.57	−0.75
Average		62.1	61.45	+2.30	3.66	−1.05	60.95	+1.80	3.71	−1.10

lump ore +10 m/m
washed lump ore +10 m/m
) means { Fe 61.2 %
Al_2O_3 3.73 %

Table bases of ore reserve calculation by deposits

Daiteri

block	Square measure of basic whole sections	distance between sections	volume of ore-body				specific gravity	amount of reserves	remarks
			total volume	volume of soil to be stripped	volume of rock to be stripped	ore-body volume after deducting overburden (soil & rock)			
B section	22,880 ㎡	m	㎥	㎥	㎥	㎥			o grade of ore in the ore-body Fe 59.15% specific gravity 3.22
〜 C 〃	11,760	150	2,598,000	66,000	168,000	2,364,000	3.22	7,612,080	
C 〃	11,760								o ratio of soil to be stripped against ore reserves 0.013㎥/t
〜 D 〃	8,960	145	1,502,200	69,580	129,920	1,302,700	3.22	4,194,694	
D 〃	8,960								o ratio of rock to be stripped against ore reserves 0.023㎥/t
〜 E 〃	7,000	170	1,356,600	85,680	40,800	1,230,120	3.22	3,960,986	
E 〃	7,000								o ratio of lump ore as in the ore-body against reserves 62.08% (+10%)
〜 F 〃	11,520	145	1,342,700	90,625	47,125	1,204,950	3.22	3,879,939	
F 〃	11,520								
〜 G 〃	15,000	160	2,121,600	100,320	327,360	1,693,920	3.22	5,454,422	o grade of lump ore Fe 61.45%
G 〃	15,000								o volume of lump ore 49,709,455 × 62.08 = 30,859,629t
〜 H 〃	8,560	150	1,767,000	41,850	176,700	1,548,450	3.22	4,986,009	
H 〃	8,560								o average depth of soil to be stripped 1.2m (max 2.4m)
〜 I 〃	4,920	230	1,550,200	43,470	91,770	1,414,960	3.22	4,556,171	
I 〃	4,920								o average depth of rock to be stripped 2.2m (max 7.3m)
〜 D Southward	0	120	295,200	9,720	12,960	272,520	3.22	877,514	
J section	1,320								total 3.4m
〜 K 〃	8,840	55	279,400	11,220	20,570	247,610	3.22	797,304	
K 〃	8,840								
〜 L 〃	12,040	145	1,513,800	51,040	22,330	1,440,430	3.22	4,638,184	
L 〃	12,040								
〜 M 〃	12,560	145	1,783,500	41,760	66,120	1,675,620	3.22	5,393,496	
M 〃	12,560								
〜 N 〃	1,560	150	1,059,000	19,950	48,450	990,600	3.22	3,189,732	
N 〃	1,560								
〜 D Westward	0	90	70,200	6,480	11,880	51,840	3.22	166,924	
合 計		1,855	17,239,400	657,695	1,163,985	15,437,720	3.22	49,709,455	

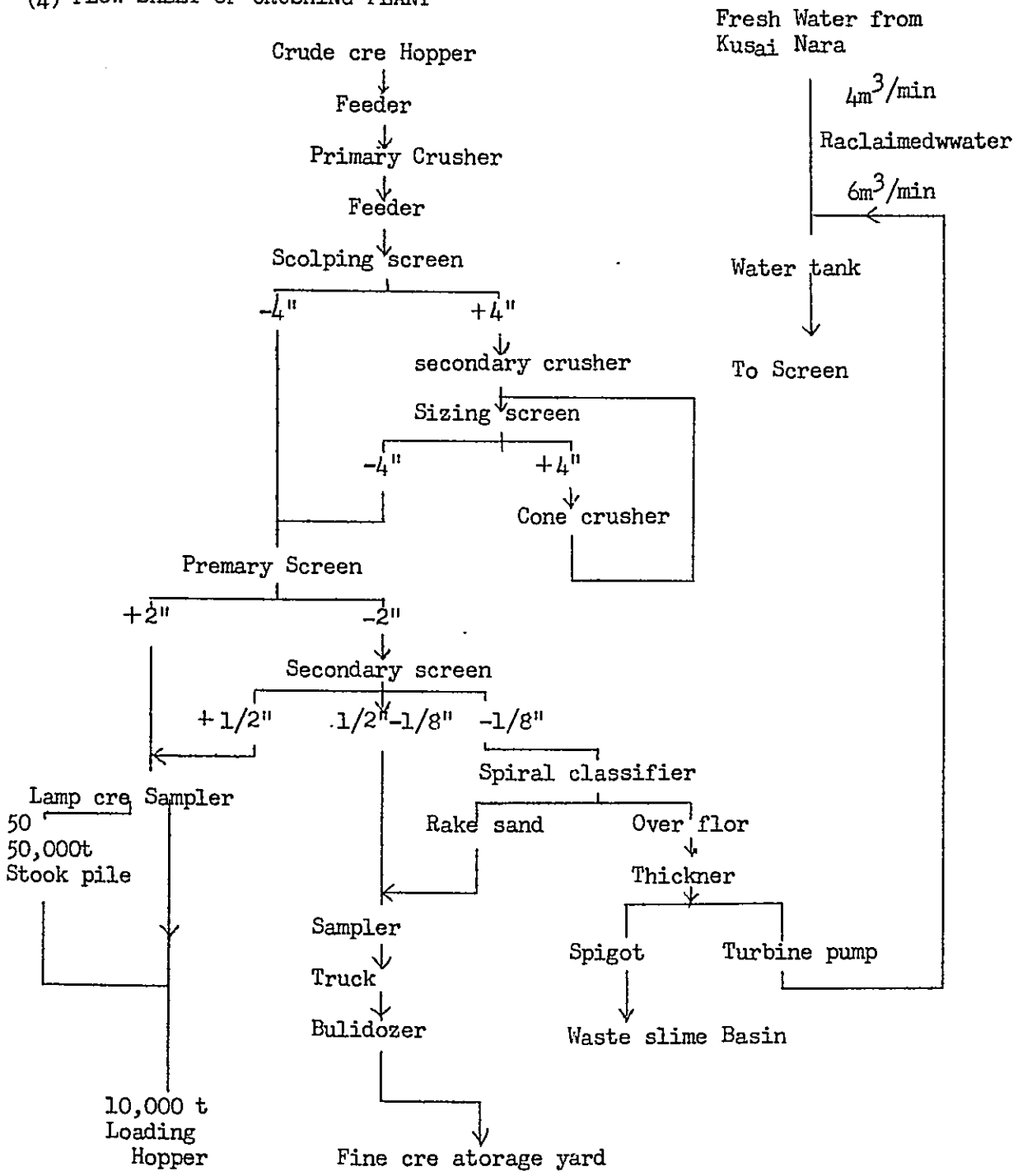
Sindurymundi

block	Square measure of basic whole sections	distance between sections	volume of ore-body: total volume	volume of ore-body: volume of soil to be stripped	volume of ore-body: volume of rock to be stripped	volume of ore-body: ore-body volume after deducting overburden (soil & rock)	specific gravity	amount of reserves	remarks
S section ~ R "	0 ~ 3,400	95	161,500	13,585	15,675	132,240	3.22	425,812	o grade of ore in the ore-body Fe 58.92% specific gravity 3.22
R " ~ Q "	3,400 ~ 4,800	95	369,000	32,760	37,800	298,440	3.22	960,976	o ratio of soil to be stripped against ore reserves 0.041 m³/t
Q " ~ P "	4,800 ~ 4,720	100	476,000	49,400	57,000	369,600	3.22	1,190,112	o ratio of rock to be stripped against ore reserves 0.047 m³/t
P " ~ O "	4,720 ~ 1,160	120	352,800	42,120	48,600	262,080	3.22	843,897	o average depth of soil to be stripped 1.3m
O " ~ & Eastward	1,160 ~ 0	85	32,866	4,420	5,100	23,346	3.22	75,174	o average depth of rock to be stripped 1.5m total 2.8m Only the part east zero section was calculated as 1160×85×1/3; the other part was calculated as 1/2
total		495	1,392,166	142,285	164,175	1,085,706	3.22	3,495,971	

float

block	area	square measure of area where ore is distributed	depth	yield (against 1)	volume of ore-body	specific gravity	reserves	remarks
①	Dniteri West side of triangle	82,000	5	0.5	205,000	3.40	697,000	grade of ore in the ore-body 60.72 % (average of laminated ore)
②	" "	20,000	5	0.5	50,000	3.40	172,000	specific gravity 3.40 (average of laminated ore)
③	" "	35,000	5	0.5	87,500	3.40	297,000	
④	" East side of triangle	46,250	10	0.6	277,500	3.40	943,500	
total					620,000	3.40	2,109,500	

(4) FLOW SHEET OF CRUSHING PLANT



limited only to the confirmation of scale of ore body and kind of ore on the surface ground. But, in the inference of the condition of the Daiteri deposit, amount of ore reserve of Sindermundi deposit and four float ore deposits has been estimated. As to the unnamed deposit at the extreme west end of the area, because the ore is low grade lateritic consolidated ore and no accurate scale of ore body was available, estimation of reserve amount was not made.

(3) Amount of Ore Reserve:

Computation on the amount of ore reserve based on such factors as mentioned above show the ore reserve in Daiteri Area to be as follows:

Name of Deposit	Amount of Reserve(t)	Amount of Stripping Soil (rock) (m^3)
Daiteri Deposit	49,709,455	1,801,680
Sindermundi Deposit	3,495,971	306,460
Float Ore Deposits	2,109,500	620,000
Total	55,314,926	2,728,140

As regards the float ore deposits, since only four deposits surveyed are included, there will be some increase in the amount of reserve. The basis of calculation is as shown on the attached table.

(4) Future Prospecting:

The above calculated values for reserve amount, grade, etc. are those under the present condition and are estimated on the basis of the data obtained from the sharrow parts of underground at the limited points. Therefore, it will be necessary to improve the accuracy of these values in the future development and other programs pits, test boring works and prospecting tunnels. In undertaking such investigations, the following matters should be taken into due consideration:

(i) Pits:

The position of each pit should be arranged to represent accurately

the entire ore body. In the actual execution, work should be commenced at the edge of the ore body and places of saddle-shape where more laterite ore is found.

(ii) Test Boring Works:

The position should be arranged same as in the case of pits, and effort should be made to improve the core recovery.

(iii) Prospecting Tunnels:

In order to find out the condition of the lower part of the ore body, prospecting tunnels should be made at 70 - 100m deep from the surface of ground, and they should be made at right angle with the strike of ore body. The grade, kind, and lump-fine ratio of ore obtained must be recorded correctly and accurately.

2 - 4. Daiteri Deposit Development Plan:

2 - 4 - 1. Outline:

The development plan is based on the construction of a loading hopper, at a place about 4 km. east from Daiteri deposit and about 150 m. level (S.L.), for the loading of concentrate to the transporting trucks and hauling of ore to the hopper by means of down hill conveyors. (Refer to attached Chart No. 5)

The object deposits of the plan are Daiteri Deposit and Sindrimundi Deposit which is situated west to the Daiteri Deposit. The former has a reserve of about 49,000,000 tons of ore, while the latter has about 3,400,000 tons. Though the entire amount of reserve is to be mined, the amount of crude ore necessary to produce annually 2,000,000 tons of concentrate with Fe content of more than 60% and of +1/2" ~ -4" will be 4,000,000 tons on the assumption that the yield is 50%. Besides, since the ore reserve at the bottom of the deposits and float ore existing nearby the deposits are also to be mined, there will be considerable increase in future production.

For the mining method of the deposits, open-cut mining will be employed.

Since substantial quantity of vein laterite and laminated ore exists irregularly to lower the grade of crude ore mined and lump-fine ratio, at least three working faces should be made and maintained continuously to assure uniform quality of products.

As a means to improve product quality, a washing equipment is installed at the Crushing & Sizing Plant so that it may also be used for the prevention of dust at the time of crushing as well as of Jamming of ore in the hopper. Besides, -1/2" fine ore is stored at a suitable place beneath the crushing room so that it may be recovered to meet possible demand in future. (however, if there is no possibility of fine ore utilization in future, fine ore is dumped into the south side valley so that fine ore storing cost and initial investment cost may be decreased. Accordingly the cost of products can be lowered.)

Although annual working days are considered to be 300 days, actual working days of a year are planned to be 275 days in consideration of mechanical break-down of machineries and equipments, lowering of work efficiency during rainy season, etc. The operation is based on two shifts a day.

2 - 4 - 2. Production Plan:

	Output		Quality	Size	Yield
	Annual Production (t)	Daily Production (t)	Fe %	inch	%
Crude Ore	4,000,000	14,600	58.0		
Concentrate	2,000,000	7,300	60.0	+1/2 ~ -4	50

(Remarks): Although the lump-fine ratio in natural condition is estimated to be 62:38, the final lump-fine ratio is set at 50:50 in consideration of increase in fine during the subsequent handlings such as mining, crushing & sizing, hauling by conveyor, etc. Quality of ore is estimated to be 58% providing some allowance for mixing of rock.

2 - 4 - 3. Mining Plan:

(1) Outline:

The main object of the mining plan is Daiteri Deposit, and with the progress of working faces, mining operation will be developed to Sindrimundi deposit, too.

Daiteri deposit which covers a block of about 427,000m^2 on the south of the Daiteri triangulation point will be mined by advancing mining benches from west to east. The height of bench is to be 12 meters, and the first bench is set at a place 12 m below the top of mountain, the second bench 12 m below the first bench and the third is 12 m below the second bench. In order to maintain a continuous operation of all the three benches, new working faces should be prepared.

(2) Mining:

In consideration of the strike of deposit, it is desirable to carry on the mining operation, in principle, from the west side to east. In view of the scale of production plan, it will be advantageous to employ large size machinery. Therefore, it is planned to use three drill masters having bit diameter of 6" - 9" for drilling and three crawler drills as auxiliary drilling machines and also seven jack hammers as rock drills for secondary blasting of large lump after primary blasting.

(3) Loading:

In order to improve work efficiency of loading as well as to save power for secondary blasting, four shovels having dipper capacity of 4 cyd (including spares) will be used for the loading of ore blasted. It is also planned to use two shovels with dipper size of 2 1/2 cyd for stripping of overburden and rock.

(4) Hauling:

Ore loaded by shovels is hauled to the crushing plant by dump trucks.

The most suitable size of a dump truck is, in general, 4 - 5 times of the dipper size of a shovel, and in view of the capacity of the dipper, 22-ton dump trucks are planned to be employed. In consideration of the distance of four kilo-meters from the initial face to the crushing plant, it is planned to use 30 trucks, including four spare trucks. For the stripping of overburden and rock, four dump trucks of 15-ton will be used. All the trucks are of rear dump type for a convenient dumping operation.

(5) Others:

For the purpose of improving quality of products and efficiency of drilling operation, stripping of overburden and rock must be made sufficiently. To this end, three 20-ton class bulldozer will be used in combination with the above mentioned machineries, and four additional bulldozers are also planned to be used for the clearing of blasted ore, boulders, etc. as well as for dumping yard of overburden construction of road and other purposes. In order to increase the efficiency of transportation and to reduce the mechanical break-down and wearing of machineries, one motor grader and one road roller will be kept in operation to clear boulders and dropped ores from the road. One sprinkler truck will be provided for the purpose of sprinkling of road, as the area will become very dusty during the dry season.

For the convenience of transporting workmen and heavy machinery, an incline of 550 HP will be installed between the town site of Talpada area (350m level) and the saddle portion (750m level), thereby increasing operation efficiency and rationalization of material transportation.

(6) Road Plan:

(a) Face Road: A face road of 4,080m is planned for Daiteri and Sindrimundi deposits. The road will be of 12m width and with no paving, and with the progress of faces, branch roads will be made for the setting up mining benches.

(b) Transporting Road (Main mine road): The road will be used by the dump trucks for the hauling of iron ore loaded at the face to the crushing plant, and it will be of 15m width, of which 12m will be paved. The road will have a branch to the service center. The total length of road is 4,400m, and for the convenience of ore hauling by trucks, the road as well as the above mentioned face road will have inclination less than 6% and the radius of hair pin curve of more than 25m.

2 - 4 - 4. Crushing and Sizing Plan:

(1) Outline:

The center of crushing plant is about 1,600m south to Daiteri triangulation point, and the top level of plant is at 680m level. The height of the plant is required to be about 67m, and therefore, the bottom part of the plant will be at about 610m level. Thickeners will be installed below the plant for the recovery of water. A stockpile having a capacity of 50,000 tons will be provided beneath the plant and at about 530m above sea level, while, a hopper for loading trucks will be installed at a flat land of 110m level which is about 5km east to the triangulation point. A distance of about 4.5 km from the crushing plant to the hopper through the stockpile will be connected by the belt conveyors. The washed fine ore will be accumulated at a slope facing east which is situated north to the stockpile so that the fine may be recovered in future. Slime waste produced by washing will be discharged to the valley on the west side of the deposit through a tunnel of about 700m length from the east side to the west.

(2) Amount of Ore to be Treated:

Assuming that the annual production of concentrate is 2,000,000 tons and daily operation is for 10 hours on two shift basis, the amount of ore to be treated will be 1,460t/hr. in crude ore, 730t/hr. in concentrate and 730t/hr. in fine ore.

(3) Processing and Equipments.

In view of the fact that the dipper size of the shovel to be used for mining is 4 cyd, the plant will have two jaw crushers of 60" x 84" as the primary crusher. These crusher will have sufficient capacity. Crushing operation will be made in three stages and products will be all under 4". The plant will be equipped with Primary jaw crushers, secondary gyratory crushers and tertiary cone crushers. In order to screen fine ore, 1/2" mesh horizontal screen will be used, but for the protection of 1/2" mesh and also for better efficiency, 2" mesh screen will be installed before the 1/2" screen. Washing will be undertaken throughout a year, and washed fine ore will be accumulated on the east side slope, while the slime produced by washing will be discharged to the valley on the west side of the deposit. Though about $10m^3$/min. of water will be required for washing, $6m^3$/min. of water will be recirculated by installing a thickener. Accordingly, the amount of new water required will be $4m^3$/min.

(4) Flow Sheet of Crushing Plant:

2 - 4 - 5. Auxiliary Equipment:

(1) Electric Power:

Electric power to be used for the development of the iron ore deposit will be supplied at 66 KV. The 66KV/11KV receiving substation to receive and transform the supplied power is planned to be built by the supplier (according to Mr. B. Ranshit, Executive Engineer, Electric Construction Division), and the cost therefor is not appropriated in the construction budget. The receiving substation will be built at the center part of the down hill conveyor, about 500 m level, to supply the mine's substation, which, in turn, distribute electric power to each plant of the mine.

(2) Repaid and Maintenance:

Since the operation is highly mechanized, complete facilities for

repair and maintenance must be installed in order to insure high rate of operation and longer durable life of various machines, equipment and vehicles by undertaking satisfactory maintenance, checking and repair works.

These facilities which are to be maintained until the termination of mining operation are planned to be erected at the saddle portion at about 760 m level between Daiteli and Sindrimundi mines. The site is considered to be topographically best suited with no disturbance to the mining operation.

It has been decided to use this area as the service center, where the above mentioned plants, storehouses, oil tanks and all other facilities will be rationally installed.

(a) Machine Shop:

The shop is to undertake ordinary maintenance work and emergency repairing, and is connected with each operating site through the main mine road. The shop will have storehouses for tools and spares as well as staff office and resting place for workers.

(b) Garage:

Garages will be built for checking and minor repairing of various vehicles, and all the vehicles will be parked collectively at the motor pool. A washing yard for the vehicles will also be provided.

(c) Electric Repair Shop:

For the maintenance and control of various electric machines, an electric repair shop with repairing equipment and testing machines will be installed.

(d) Carpenter Shop:

A carpenter shop with material storehouses and workers' rest place will be built for wood work, plastering and painting works.

(e) Gravel Plant: A gravel plant will be installed for the production of gravel to be used for repairing of face road, transporting road, etc. and

also for the production of aggregate for concrete to be used for construction works.

(3) Water Supply:

Water for washing use, plant use and for town site will be supplied by pumping from Kusai Nara about 8 km east from the deposit. In total, water of $6m^3$/min. will be required; i.e., $0.6m^3$/min. for the town site, $4m^3$/min. for washing process at the crushing plant and $1.4m^3$/min. for the cooling of compressors and other purposes will be required. In preparation for the flood season, a simple sedimentation pond will be built at the inlet to keep the water intake tower free from sand, etc. Drinking water for the town site and other places must be treated by sedimentation and filter as well as by chlorine sterilizer.

(4) Administration and Welfare Facilities:

(a) General Office: General Office will be installed near the terminal of the incline at 350m level, which is most convenient for the control and administration of all the working places.

(b) Check Office and Gate Keeper Lodge:

Since all the workers of the mine must go through the check office, it should be located at a suitable place along the town road which runs from the town site to the incline terminal. The check office is to control coming and going of the workers.

(c) Latrine, Canteen and other Facilities:

All these facilities will be installed in an appropriate arrangement at the service center at 760m level. The facilities are for the convenience of employees working in the service center and its vicinity. As for other facilities, boring stores and fuel tanks will be installed in the service center.

(d) Housing Accommodation, Hospital and School:

All such facilities for the employees as houses, hospitals and schools

will be built in a flat land east to Talpada Area. A market for the purchase of daily necessities will also be built.

(e) Ordinary Vehicles:

The following vehicles will be purchased for transportation, communication and also transportation of materials:

i	Jeep	(7)	For communication in and out of the mine
ii	Station Wagon	(1)	Same as above
iii	Truck (5 ton)	(5)	For material transportation
iv	Fuel Truck	(1)	For fuel service to work sites
v	Explosive Van	(1)	For transportation of explosives
vi	Ambulance Car	(2)	For transportation of patients

2 - 4 - 6. Initial Investment Cost:

Initial investment cost is appropriated by each department.

	(Unit: ¥ 1,000)
Mining:	1,180,573
Concentration:	3,303,550
Electric Power:	218,100
Repair & Maintenance:	138,442
Water Supply:	409,596
Road & Structures:	104,760
Administration:	719,455
Development Preparation:	372,512
Import Tariff on Machines & Equipment:	461,600
Customs Clearance & Transportation:	153,873
Transportation at Site:	50,000
Total:	7,112,461
Reserve for Machines & Equipment:	482,000
Import Duties on Spares:	72,000

Reserve Fund (Contingency):	50,000
Total:	604,300
Grand Total:	7,716,761

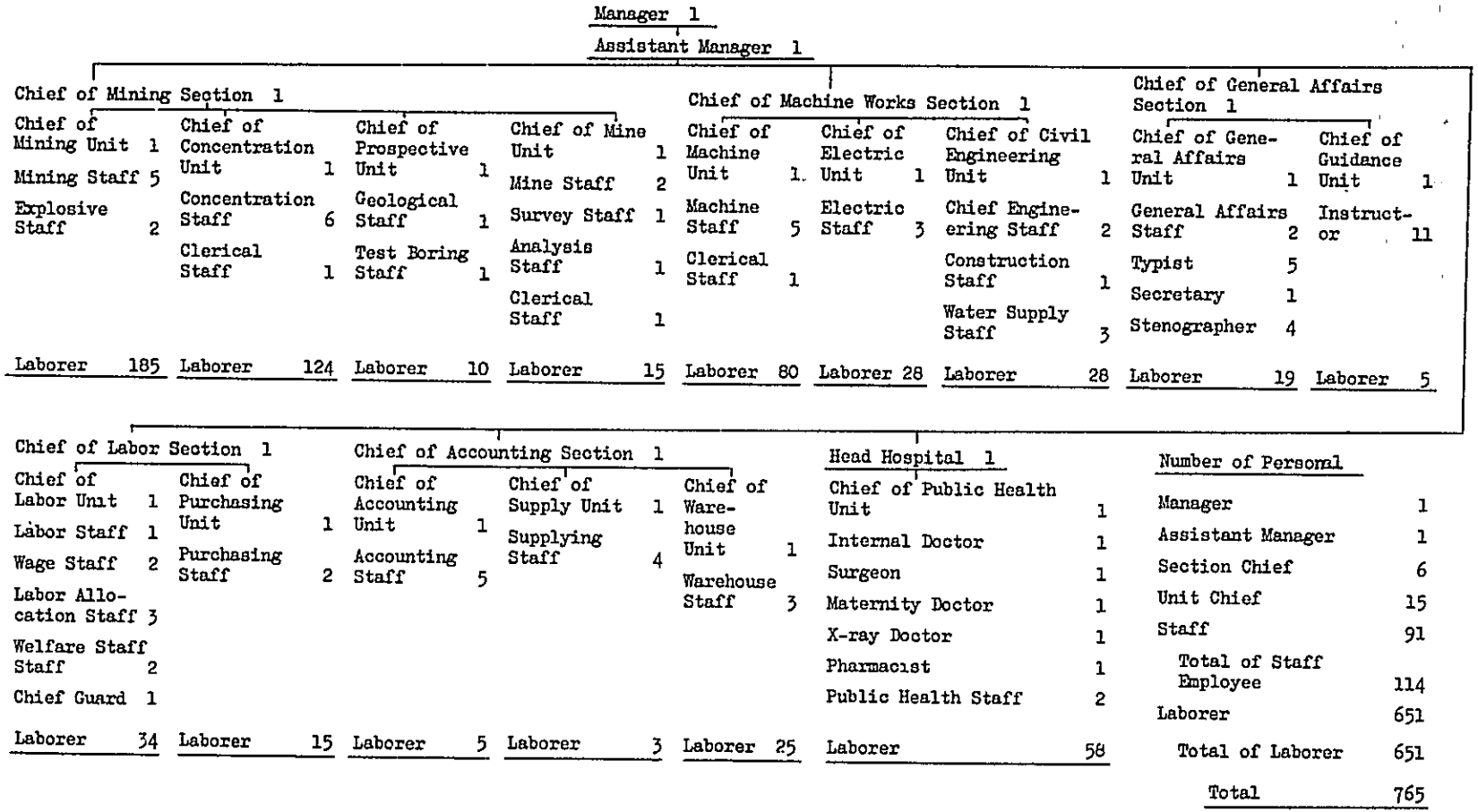
2 - 4 - 7. Operating Cost:

The operating cost is appropriated as follows:

	Per Day (¥)	Per ton of Concentrate (¥)	
Mining	2,161,750	296.13	
Repair & Maintenance	293,053	40.14	
Administration	239,425	32.80	
Total at Mine	2,694,228	369.07	
Depreciation & Interest (10 yrs. 5%)	3,349,320	458.81	(Depreciation includes no reserve. 7,112,461,000 x 0.1295 ÷ 275)
Taxes & Duties		105.00	Mining Tax, etc. Rs. 1.4/t.
Cost at Mine		932.88	(Rs. 12.438)

2 - 4 - 8 Personal Plan

Organizational chart of Personal Plan



Number of Personal	
Manager	1
Assistant Manager	1
Section Chief	6
Unit Chief	15
Staff	91
Total of Staff Employee	114
Laborer	651
Total of Laborer	651
Total	765

2 - 4 - 9. Cost of Ore Transportation from Daiteri to Paradeep:

From a economical point of view, trucking of ore for a long distance of 145 km can not be supported. Not to mention of the cost involved, the natural conditions of intense heat and torrential rainfall will impose unexpected restriction on the transportation in terms of amount, maintenance, safety of work and technique. Since the special circumstances encountered in laying railways is beyond description, the cost of transportation is given for a reference despite the reluctance on the part of the Mission. Furthermore, although the trailer-trucks are not suitable from the standpoint of their construction for such long distance hauling, they are included in the calculation upon the strong request with a reason that the trailer-trucks can be domestically manufactured in India. However, such initial investment costs as costs of road construction, garages and trucks are not included herein in accordance with the discussion made at the time of survey.

(1) Condition of Transportation:

Distance: One way: 145 km

Road: Pavement: Asphalt

Effective Width: 7.2 m (24')

Total Width: 14.4 m (48')

Truck: 20-ton load Trailer.

Though the effective width of 7.2m is what was presented by the Indian party, it is not sufficient, from the standpoint of safety, for trailer-trucks of 2.5m width to travel at an average speed of 40km/hr.

(2) Specification of Truck:

Tractor: Drive: 6 x 6, Breadth: 2.500m, Dead Weight: 9,740kg.

Engine: 200 Hp, Max. Speed: 55km/hr.

Trailer: Capacity: 20 tons (Side dump)

Tire: 9 x 20 - 14 pr. - 8 tires.

(3) Number of Trucks Required:

(i) Production:

Annual Production: 3,000,000 tons (Daiteri: 2,000,000 t,
Others: 1,000,000 t)

Daily Production: 10,000 tons (Actual working days: 300 days/yr.)

Production per Shift: 5,000 tons (2 shift/day)

(ii) Amount of Ore to be transported by one Truck:

One way distance of 145 km means a total of 290 km in a round trip. Assuming that the average speed is 77% of the maximum speed, the travelling time required for completing one round trip will be:

145km x 42km/hr. x 60min./hr. = 414 min.

Assuming further that it will take six minutes for starting, stopping, loading and unloading, the cycle time will be:

414 min. + 6 min. = 420 min. = 7 hrs.

All the refueling, minor repair, etc. will be made during one hour lunch time and rest time at the mine or the repair shop on the way. And, one cycle per truck per shift will be 20t/truck/shift.

(iii) Total Number of Trucks Required:

5,000 t/shift ÷ 20t/truck/shift = 250 trucks.

Assuming the rate of operation being 85%;

250 ÷ 85% = 294 trucks.

(To maintain the operation rate of 85%, maintenance and repairing must be enforced very strictly).

(iv) Cost of Transportation per Ton of Ore:

Depreciation & Interest Charges:

Maintenance & Repair Costs:

Labour Cost:

Taxes and Others:

Total: ¥977.20/ton (Rs.13.03)

As for the dead weight and load of the above trailer trucks were checked with Mr. Miyazaki, Mission member in charge of road. Since the capacity of bridges is 45 tons, there will be no problem.

2 - 4 - 10. Referential Data:

Plan to Produce 1,000,000 tons of Ore at Tomka Mine and Float Ore Deposit (by manual mining):

(1) Outline:

Upon the request of the State Government, approximate calculation is made on a plan to produce 1,000,000 tons of ore at Tomka mine and float ore deposit existing nearby Daiteri Deposit.

Since Tomka mine is capable to produce 300,000 tons with the present facilities, the rest of 700,000 tons are planned to be produced at float ore area.

(2) Production Plan:

	Output		
	Annual Output	Daily Output	Quality
Concentrate	700,000	2,550	60%

(Remarks) Actual working day is 275 days a year, and operation is on 2 shifts basis.

(3) Method of Mining:

In view of the fact that float ore is mined, open-cut mining by man-power will be employed.

(4) Method of Loading:

Though loading will be by man-power, two of 50-ton pocket will be built to reduce the waiting time of trucks for loading. Ore will be transported by trucks for a distance of about 2 km to the ore bin which is located at the midway of the Daiteri conveyor presently planned. A transporting road will be built for the entire distance of 2km.

(5) Number of Trucks Required:

The number of trucks is planned on the basis of transporting 2,550 tons per day or 1,275 tons per shift. Assuming that the average speed of trucks is 25km per hour, it will take 10 minutes to complete one round trip. Assuming further that it takes 6 minutes for loading and unloading, it will take 16 minutes for a truck to complete one cycle. Assuming that the actual working time for transportation is 300 minutes,

300 minutes ÷ 16 minutes = 17 cycle/shift.

If 5-ton trucks are to be used, amount of ore to be transported in one shift will be: 5 tons x 17 = 85 tons, and

1,275 tons ÷ 85 tons = 15 (trucks)

Assuming that the rate of operation of trucks is 85%, 19 trucks will be required.

(6) Initial Investment Cost:

Truck (19)	
Road Construction	
Housing Accommodations	
Offices, etc.	
Total	¥ 463,550,000
Import Duties, Customs Charges, etc.	6,080,000
Grand Total	¥ 469,630,000

(7) Operating Cost:

	Per Day	Per Ton of Concentrate
Repairing of Trucks		
Wage Cost		
Housing Accommodations, etc.		
Total at Mine	¥ 489,915	¥ 192.12
Depreciation & Interest	60,817	86.72
Taxes and Others		105.00

	Per Ton of Concentrate
Cost at Mine	¥ 383.84

After the ore bin, ore can be transported by Daiteri belt conveyors, its cost is not included herein. Because the plan is executed in connection with the development of Daiteri, some of the equipment, etc. may be used commonly, thereby decreasing the cost somewhat.

2 - 5. Conclusion:

The main point of the Orissa State development program is considered to be the development of the Daiteri Iron Ore Deposit. Though the reserve may not be sufficient to warrant fully its development, the development will involve no problem because depreciation can be made economically, and also increased reserve can be expected at Sindrimundi area and others.

On the other hand, since the Nayagara Area in the northern part of the State has a reserve considered to be semi-permanent, a railway should be laid, at the earliest possible time, between the Port of Paradeep and the terminal of existing railway at Banspani, and a branch line should also be constructed from Nayagara to Malangtoli Block through Purunadihi (Refer to Photo). This will solve the problem of reserve and the trucking problem, and also reduce the transportation cost. The freight charge of Japanese National Railway is about 3 yen (4N.P.)/Ton·Km.; but assuming that the freight is 4 yen (5N.P.)/T.K., the freight cost for the distance of 150 km from Paradeep to Daiteri will be Rs.8, which is a saving of about Rs.4 per ton of iron ore.

The construction of railway will not only improve the competitive power of the abundant iron ore resources in the northern part of Orissa but also stimulate the development of agriculture and forestry in the vast area along the railway and other industries utilizing surplus electric power generated at the Hirakud Dam. It will contribute immensely to the progress

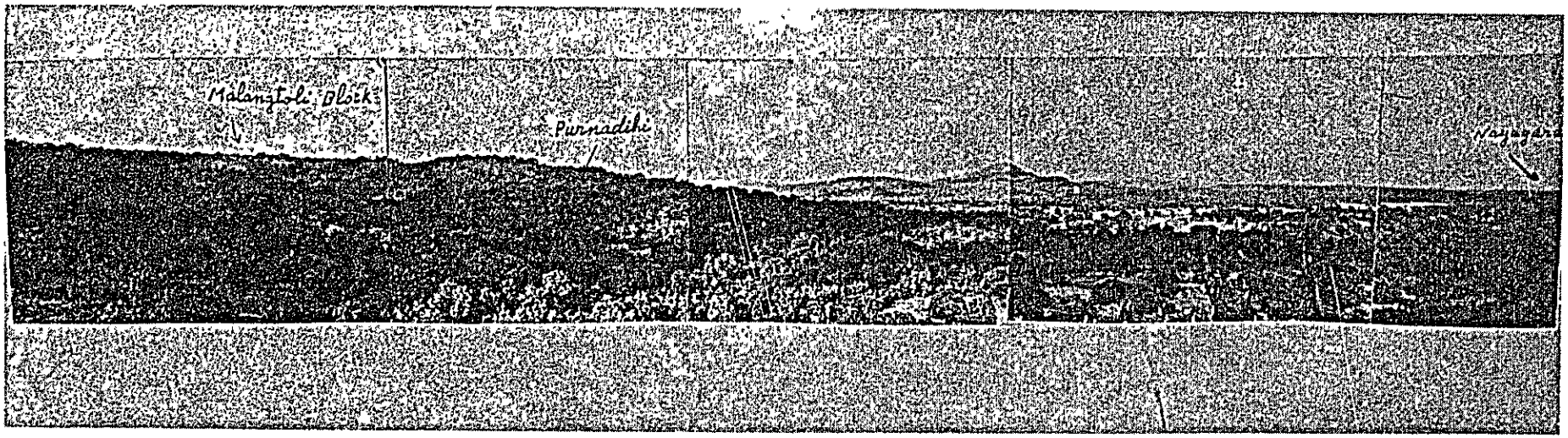
of the State.

Therefore, if the Central Government of India has any plan to launch into the construction of railway, it should make its utmost effort to include such a program in the next 5-year plan.

Unless there is another specific object in constructing the highway, the trucking of ore via express highway should be reconsidered, because, apart from the construction cost of the highway, purchase of trucks and garages alone costs ¥4,500 million (Rs. 60 million).

The point which was specially noted in this plan was to keep of 60% Fe of ore, but it is not too difficult to secure the quality if the mining is carefully planned and unstinted endeavour is made. However, since the shovel mining involves certain difficulty in attaining precise selective mining, loss of some ore can not be helped. The important thing is to minimize such loss through a continued effort of regulating the quality of ore.

Sincere appreciation is hereby expressed to Mr. S.K. Ghose, Mr. K.S. Ramchandram, Mr. S. Pathoshi, Mr. H.K. Chatterjee, Mr. M. Robertson, Mr. N.K. Das and Mr. S.D. Gosh of Orissa Mining Corporation and Dr. B.D. Prusti, Mr. B.K. Mohanty, Mr. N.K. Kar and Mr. Behara of the Mining Department of the Government of Orissa for their kind cooperation and also to those at various mines who were kind enough to grant the mission with the opportunity to visit their mines.


Malangtoli Block
Purnadihi

PROPOSED LAYOUT OF FACILITIES FOR DAITERI IRON ORE DEPOSITS

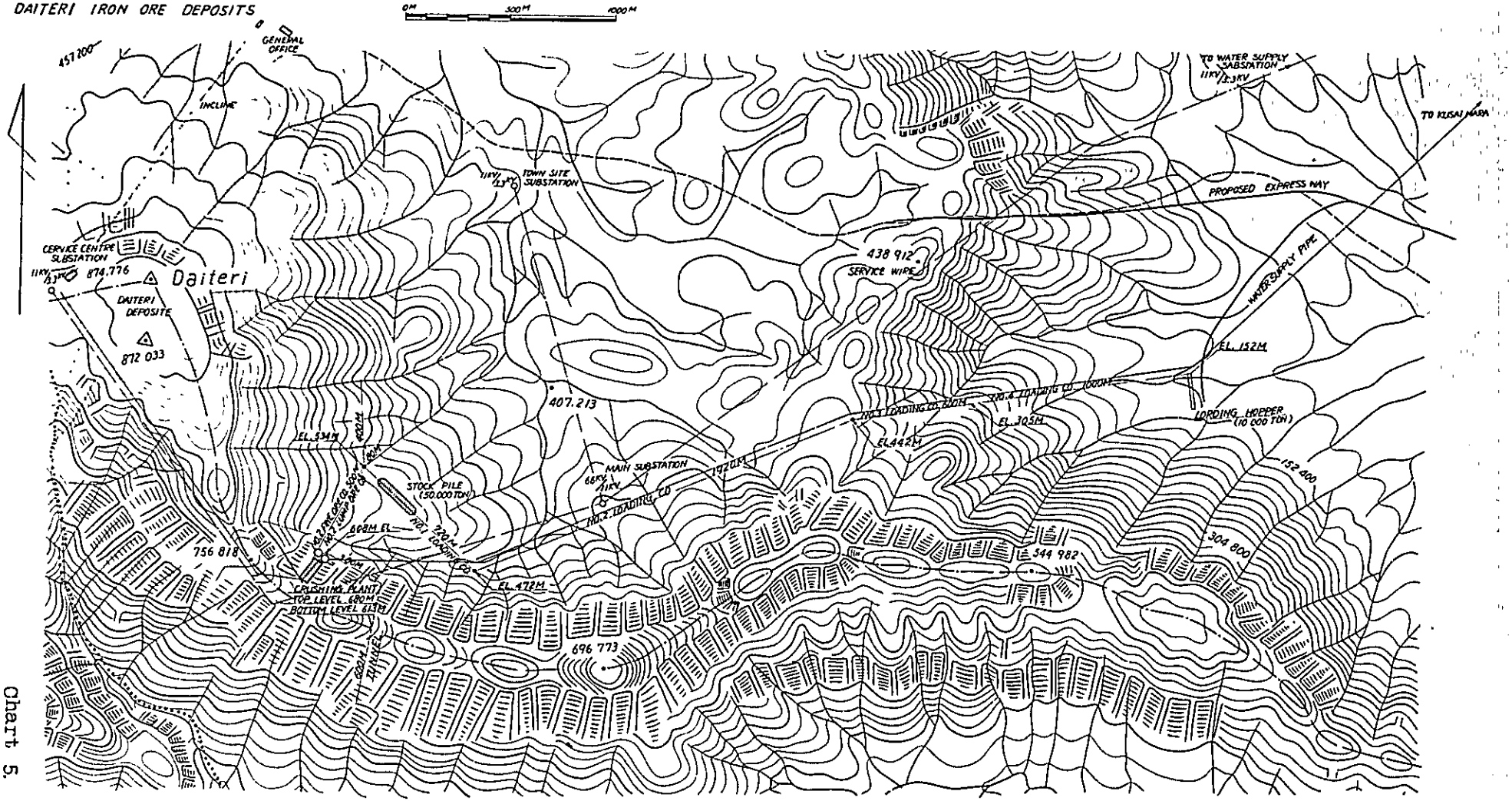


Chart 5.

3. Road Construction Plan and Trucking

C O N T E N T S

3. Road Construction Plan and Trucking:

3 - 1. Introduction:

In planning the construction of road, prudent consideration should be paid, in general, to dispose by the most economical method of transportation the volume of traffic to be generated by the prospective land utilization planned in accordance with the general economic development program: The road should also serve various functions of land utilization.

The project considers first the area from Daiteri and Tomka Mines to Paradeep Port which will play an important role in the development of the State of Orissa, especially the development of natural resources. Under the 1st stage project, it will be used as an exclusive road for transporting annually 2,000,000 tons of iron ore, but the road is to be functioned as an expressway in future.

3 - 2. Present Status (As of End of November 1962):

The total length of road is 96 miles according to the State Government Plan. Some sections in mountaineous district and Paradeep harbour district have been under construction since September 1962, and Road foundation work has been completed in some sections.

The following Table - 1 shows the present status of construction work:

Table - 1: Present Status of Road Construction by Sections.

Section	Milage	Status of Work	Remarks
Daiteri-Tomka	15	Not yet Started	
Tomka-Duburi	7	Entirely under construction	Refer to Fig.-1 (Standard cross Section)
Duburi-Gobargoti	3	Not yet started	
Gobargoti-Pankpal	3	Foundation completed	
Pankpal-River Brahmani	2	Not yet started	

Brahmani River Bridge	1	Started	Refer to Fig.-2 (Bridge plan)
Brahmani-Paradipghrh	60	Not yet started	
Paradipghrh-Paradeep Port	5	Partly under construction along with canal work	May be used for construction purpose
Total	96		

Thus, the distance under construction is 16 miles which is 1/6 of the total length of the road. All the works are carried on by man-power with an exception of rolling work by roller which is practically the only mechanized work.

3 - 3. 1st Stage Project:

3 - 3 - 1. Road Project:

(1) Character of the Project:

The road is to be exclusively used for the transportation of annual amount of 2,000,000 tons of iron ore in line with the development of iron ore resources, and no consideration will be made on its relation to the railway project.

(2) Planning of Route (refer to Fig.-3):

In selecting the route, a policy should be established to minimize the time and cost required for transportation from Daiteri and Tomka Mines to Paradeep Port. The road construction plan prepared by the State Government of Orissa is, in general, in conformity with such policy. However, because a railway is planned to be constructed in future in parallel to the road on the same level, the road plan itself tends to be affected by the railway project. Since the planned road is capable to transport ore even if it grows several folds, the routing should be planned entirely independent from the railway plan. A complete geological survey should be made as to the foundation ground of road so that the road may be constructed on the ground with little

Fig. 1 Typical Cross-Section

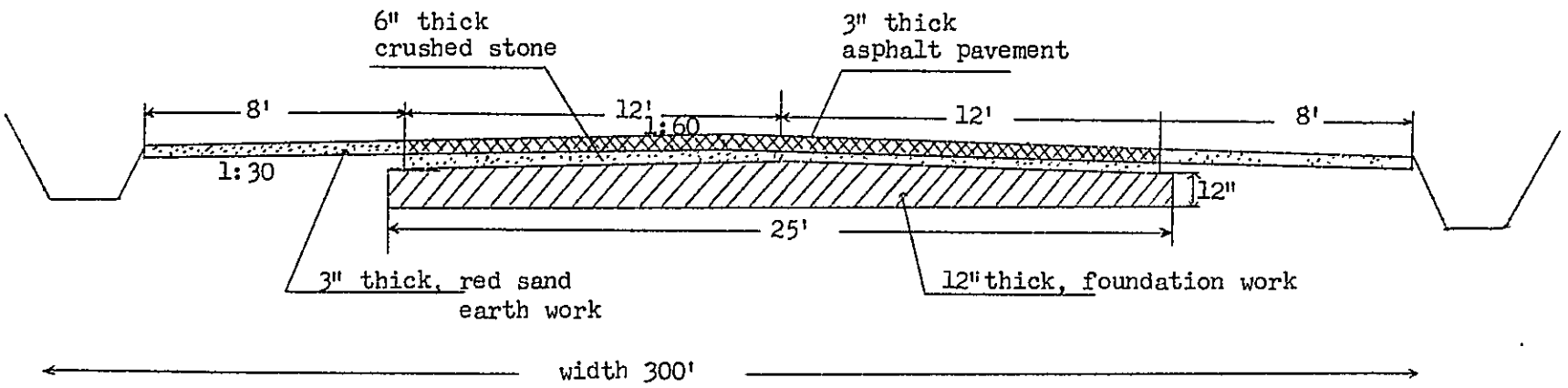


Fig. 2 Brahmani River Bridge

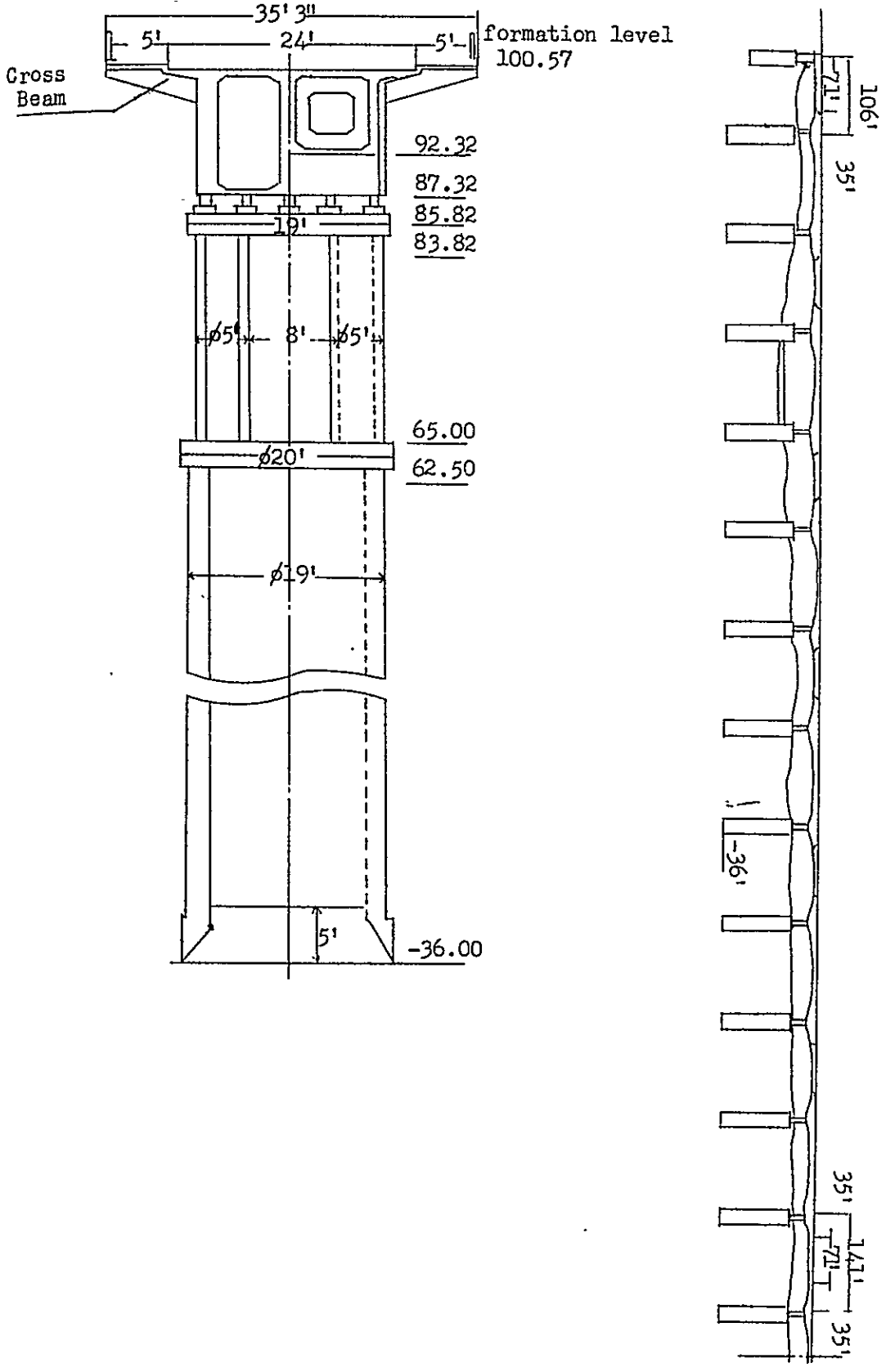
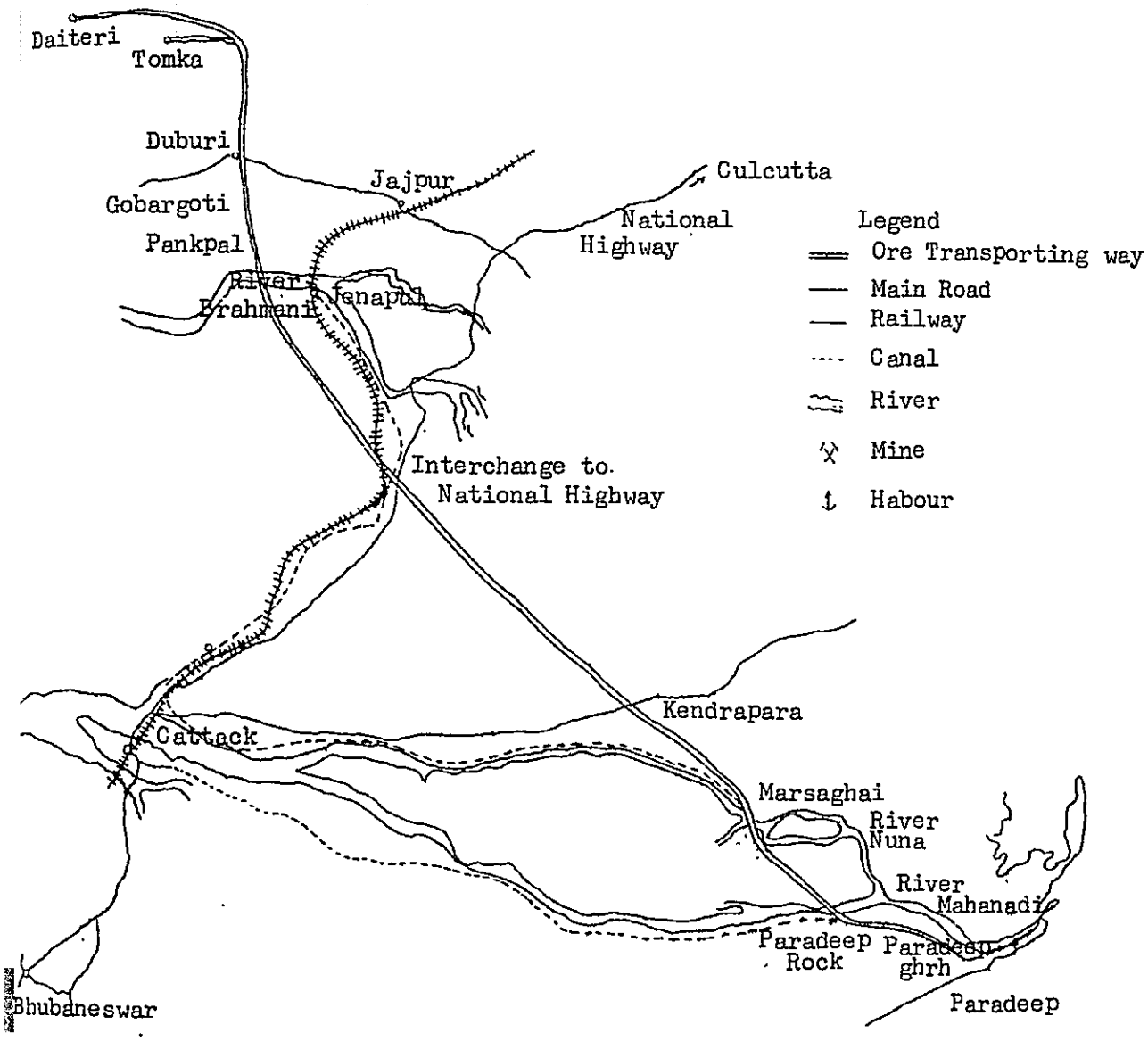


Fig. 3 Route of Ore Transporting Way
S = 1 inch/4 miles



sinking.

In connection with the above discussion, further review should be made on the following two districts:

(i) Vicinity of crossing with the Madras-Calcutta National Highway:

This area is planned not only to have the central service base for the ore road but also to undergo industrialization in succession to Chowduar City. In view of this and also in order to take advantage of nearby hills should be planned for a comparison with the present plan prepared by the State Government.

(ii) Section between Marsaghai and Paradeep Lock:

Since the present plan prepared by the State Government is to run through an area which will steep for about 15 days in rainy season and also to cross Nuna River and Mahadina River, the costs of road construction and maintenance will be substantially large. Therefore, it is advisable to prepare another plan which will not cross Nuna River and wet area for a comparison with the present plan.

(3) Requirements of Motor-car Freeway:

(i) Control of Access:

Because the road is for an exclusive and continuous handling of comparatively high-speed traffic with heavy load, it is absolutely necessary to preclude different type of traffic from the road. Especially, a fence should be built for the entire length of the road to prevent cattles, men and ox-carts from coming in to the road. Besides, in view of the characteristic of this road, use by ordinary high-speed cars should be discouraged as much as possible, and it is advisable, for this end, to provide no interchange except the one at the crossing with national highway.

(ii) Separation of Road:

In order to asure a safety traffic by avoiding friction which is likely take place in vis-a-vis traffic, lanes should be separated by directions.

For this purpose, it is recommended to employ such central separation zone as shown in Fig.-4 instead of a mere marking. It is especially recommended to provide curb sections with a necessary slope as required under the Road Construction Cord of India as well as to install the central separation zone, lighting and guard-rail and other protective measures (refer to Fig.-5).

Fig.-4: Deformed Median Strip

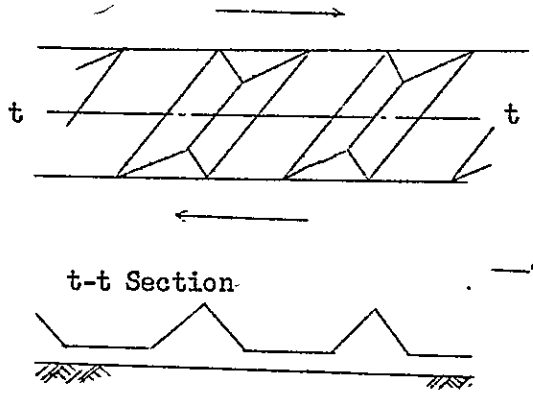
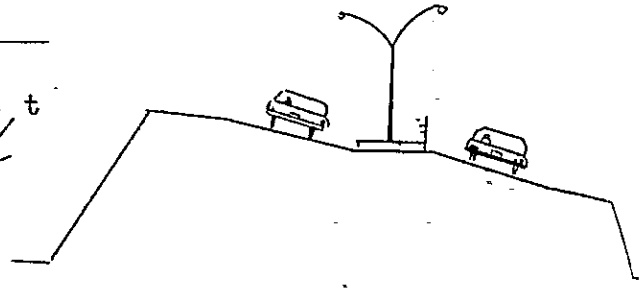


Fig.-5: Cross Section of Curve



(iii) Frontage Road:

In order to consolidate the existing roads which will be cut off by the project and also to promote an orderly development of roadside urban districts, a frontage road should be built on both or one side of this exclusive road.

3 - 3 - 2. Construction of Road:

(1) Designed Speed:

According to the Road Construction Cord of India, the designed per-hour speed is set at 50 miles (30 miles for cruising), but this road project employs a speed of 40-50 miles.

However, as the road will be used, for sometime to come, exclusively for

iron ore transportation, an average speed of 25-30 miles may be considered, judging from the capacity of ore truck. The road may be used in future for other purposes in addition to ore transportation, and it is desirable to make the road suitable for 50-mile speed by making partial improvements on its construction.

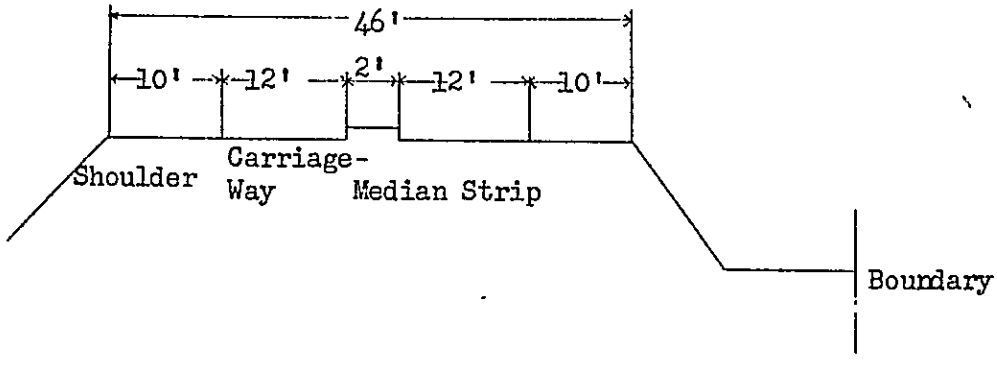
(2) Width:

To transport 2,000,000 tons of iron ore to Paradeep Port, the required amount of daily traffic is estimated to be 584 trucks, which, of course, varies depending on the capacity of trucks and driving speed. Accordingly, a road with two lanes is satisfactory, and the presently planned breadth of 24 feet is sufficient. However, the width or road shoulder should be at least 10' in consideration of the transporting trailer-trucks. Besides, for the sections in the planned urban area, a frontage road should be provided.

Although the road may not have much traffic for the time being, since 20-25 ton trucks travel continuously on the road, the above discussed central separation zone should be built, for which additional width of 2-3' will have to be provided.

From the foregoing discussions, a road with 46' width at surface as shown in Fig.-6 should be considered.

Fig. - 6: Construction of Width.



Note:

Estimated daily traffic volume required for transporting 2,000,000 tons of iron ore per year will be as follows:

(Assumption): Yearly working days - 300 days,

Number of daily trips of each truck - 2 round trips,

Load to be carried by each truck - 22.8 tons.

$$\text{Number of trucks required:} = \frac{\text{Amount of ore transported annually}}{\text{Annual working days x Load per truck x No. of round trip}}$$

$$= \frac{2{,}000{,}000 \text{ tons}}{300 \times 22.8 \times 2} = 146$$

Daily volume of traffic = No. of daily trip per truck x No. of truck

$$= 4 \times 146 = 584$$

(3) Paving:

Because soil mechanics study on the strength of road bed soil was not made, no accurate evaluation of the paving work included in the plan (3" thick asphalt + 6" thick macadam + 12" thick foundation work) can be made (refer to Fig.-1). However, in the section between Kendrapara and Paradeep Lock, the road bed contains considerable amount of silt (for a distance of about 4 miles), and, according to the investigation made by the State Government, the C.B.R. value is 2 - 4. Therefore, it will be necessary to undertake additional foundation work of 6" or so for this particular section.

(4) Grade:

According to the present plan, the grade of road is 2%, but in the hilly district near the mine, the limit of grade should be made 4% as provided for in the Road Construction Cord of India.

(5) Bridge:

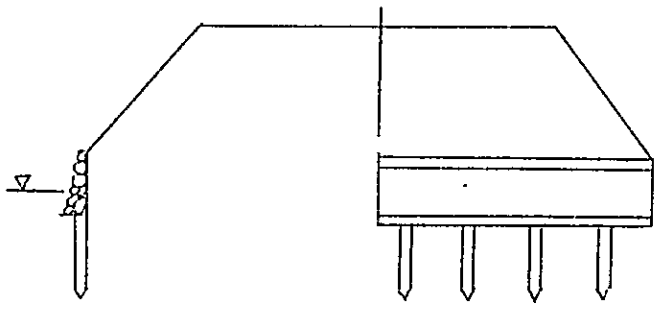
All the large scale bridges which cross Mahanadi River and Brahmani

River are R.C.C. Balanced Cantilever Box-Girder bridges, but it is advisable, in consideration of riverbed and economy of construction, to make a comparative designing of other types which would allow a longer span for the part with largest water depth (for example, a combination of Langer type and Gerber type). As for the load, it is planned to employ "2 trains IRC Class A loading" or "1 vehicle of IRC Class AA", whichever gives more stress: However, in view of the breadth of bridges (2 lanes) AA class load of 70 tons should be adopted. Since it is considered that the type of bridge may be changed in future to employ Class A load, consideration should be made also on the load limit of 50 tons including impact load. Judging from the above, the ore truck with 20 - 25 ton load (total weight: 35 - 40 tons) is within the load limit of bridges.

(6) Side Slope:

As a whole, an easy slope of 1:2 is employed. This is effective for the prevention of possible sinking of road in the delta area with unfavourable bearing force of soil. Especially, the section between Marsaghai and Paradeep Lock steeps for a considerably long time during the rainy season, and so it is necessary to protect the toe of slope by masonry work as well as to build many culverts across the road in order to prevent erosion and also to withstand soakage. Furthermore, it is advisable to execute foundation piling to minimize the sinking of such work (refer to Fig.-7).

Fig.-7: Protecting Work in Lowland Area



(7) Estimated Cost of Construction:

The project estimate for construction of an express high way for Daiteri Mines to Paradeep Port made by the State Government of Orissa amounts to 147,200,000 Rupees (approximately ¥11,000 million).

However, reconsideration on the following three points would result in a saving of approximately 9.8 million Rupees (¥735 million) (Refer to Table-2):

* Reduction of embankment in the agricultural districts (Road surface of 6-8' high is reduced to 1/2).
* Reduction of width of road site from 300' to 200'
* Change of the type of bridge to Langer type

The amount thus saved should be allocated with priority to the expansion of road surface from 40' to 46', construction of central separation zone and installation of lighting facilities especially at the curves.

Table-2: Review of the Estimated Cost of Construction.

Kind of Work	Present Estimate	Revised Estimate
Embankment Work	12,489,216 Re	7,495,500 Re
Procurement of Site	6,932,000	4,615,000
Bridges	25,500,000	22,950,000
Total	44,921,216	35,060,500
Difference		-9,800,716 (=¥735 million)

3 - 3 - 3. Iron Ore Transportation:

(1) Facilities Related to Transportation:

(i) Service Facilities:

Since the transporting operation is carried on all day long, service stations with lavatory and water supply facilities should be built every

15 miles or so for the drivers' rest: It is also advisable to build service centers with a refueling station, truck repair-shop, lodging accommodation, stand, etc., at such three places as the vicinity of interchange with Calcutta-Madras national highway, Paradeep Harbour and the mine.

(ii) Terminal Facilities (Connecting facilities of harbour and mine):

Sites for terminal facilities should be secured for the purpose of ensuring a continuous transport of ore and to connect it with cargo handling facilities at the port.

In calculating the required area, it is assumed that parking time of one truck for cargo handling, checking, refueling and recess is in average 30 minutes and average daily working time of 584 trucks is 22 hours as well as that each truck travels at a two-minute interval. Accordingly, during a 30-minute period, the terminal will have 15 trucks. Though the space taken up by one truck is 2.45m x 13m, it is assumed to be 7m x 22m with some marginal space, or 2,310 m^2 of terminal area for 15 trucks.

Assuming that each 1/3 of the total number of trucks are to be accommodated separately at the mine, central base (near interchange) and port area in the event of occurance of any accident or disturbance in transporting ore, a parking lot of 7,500 m^2 for 49 trucks (1/3 of 146 operating trucks) will be required at each of these three places.

(2) Present Status of Transportation and Transportation Cost:

There are three route which have been in use for iron ore transportation from Tomka Mine to Paradeep Port; namely, A, B, and B' as shown in Fig-8 and Table-3.

Table-3: Detail of Transportation Routes

Route	Course (by relaying different means of transportation)
ROUTE A	Tomka ---(Road)---> Jajpur ---(Railway)---> Cuttack ---(Canal)---> Paradeep
ROUTE B	Tomka ---(Road)---> Janapur ---(Canal)---> Paradeep (via Marsaghai through Nuna River)
ROUTE B'	Tomka ---(Road)---> Janapur ---(Canal)---> Paradeep (via Cuttack through Birupa & Mahanadi Rivers)

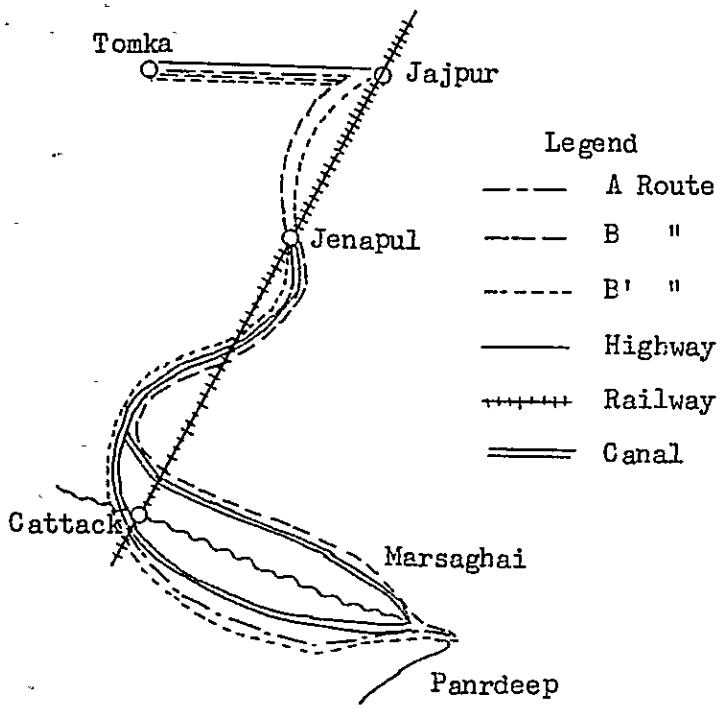
For the last three years, transportation via Route A, which is mainly used in dry season, has been the largest, occupying 2/3 of the total, while, Route B ranked in the second place. The detail is as shown in Table-4.

Table-4. Actual Results of Ore Transportation by Routes.
(1959 - 1962)

(Unit: Ton)

Route	1959 - 1960	1960 - 1961	1961 - 1962
A	32,332	17,727	20,259
B	2,332	4,358	10,720
B'	2,332	-	70
Total	36,996	22,085	31,049

Fig. 8 Transporting Route



* Transportation Cost:

Transportation of ore via all the existing three routes has been being made by relaying different means of transportation; This method takes considerable amount of time and results in higher intermediate transportation cost. Route A is the cheapest amount the three routes as shown in Table-5.

Table-5. Transportation Cost per Ton of Iron Ore.

Route	Cost delivered at ship	Shipping at mine	Intermediate transportation	Harbour charges & others
A	50.42 Re	7.25	30.07	13.10
B & B'	51.09	7.25	31.62	12.22

Note - 1: Cost delivered at ship = Shipping cost at mine + Intermediate transportation cost + Harbour charges & others.

The intermediate cost via the planned road is 12-13 Rupees per ton (Note-2), which is approximately 40% of the present cost of 30-31 Rupees. With 2,000,000 ton/year of ore, this will mean a saving of approximately 36 million Rupees, i.e. 18Re x 2,000,000 tons = 36,000,000 Re.

Note - 2: Basis of calculation of intermediate transportation cost:

Annual amount of ore to be transported: 2,000,000 tons.

Tonnage to be carried by one truck: 22.8 tons.

Transporting Distance: 320 Km (200 miles)

Ore transported per day per truck (2 round-trip/day): 45.6 tons

Annual working days: 300 days.

Number of trucks required: 161 trucks (including 15 spare trucks)

(3) Problems:

Since the exclusive road has a function similar to a belt-conveyor, various facilities and equipment to assure a continuous flow of ore trucks

should be fully provided, such as signal and communication devices for all the cars in operation, preparation of wreckers, constant maintenance of road surface including sweeping-off of ore dust, lighting for travelling at night, and especially signs to show dangerous parts of the road during rainy season.

3 - 3 - 4. Future Prospect:

(1) Character of Road:

The State Government of Orissa intends to use this road indefinitely as an exclusive road for ore transportation. It is expected, however, that when the Port of Paradeep has grown, in future, to handle more than 2,000,000 tons of iron ore and also substantial amount of cargoes other than iron ore, this road will be utilized not only for ore transportation but also for hauling of general cargoes. In such a case, the road will have to have another function as an ordinary express highway.

(2) Road Project:

The road project prepared by the State Government of Orissa considers, in addition to the site for road, a site for railway to be constructed along the road with a view to the development of not only Daiteri and Tomka mines but also Nayagarh mine. Judging from the geography of the district, however, iron ore of Nayagrh district may also be transported via the railway route of Barshu-Talcher-Thermal Station-Baran-Paradeep which can also be utilized for the transportation of Rhurkera iron ore. On the other hand, even if the shipment of iron ore from the Daiteri-Tomka district increases substantially to 2,000,000 tons, the road will still have a large enough marginal capacity.

With the improvements on interchange systems, construction of a separate road, etc., the road will sufficiently handle increased traffic, especially that of ordinary automobiles, without making any change to the overall plan. In order to cope with future development of road-side area, it would become necessary to have bus stop service on the road as well as to construct the bridge piers to provide for future increase in the number of lanes.

3 - 4. Methods of Transportation:

3 - 4 - 1. Review of the Plan Prepared by India:

It is intended in this section of the report to review the plan and running cost sheet obtained from the chief engineer of the State Government of Orissa who is in charge of the plan. Calculation included in his plan is not reasonable in some respect as a result of over-emphasis on cost saving. Correction to the calculation would result in approximately 25% increase in the cost.

The first problem is that the plan is based on 360 work days per year. Because of this, work at the mine, cargo handling and hauling work are all to be carried on 360 days, thereby leaving no time for repair and maintenance of the machines and equipment. The work days should be limited to maximum 300 days, and further shortening is more ideal in consideration of torrential rains during the rainy season and also work stoppage at the time of storm.

The second problem is related to the excess overload of trucks. The State Government plans to purchase Japanese trailer trucks which are presently being considered by the Defence Ministry of India for military use. Although the normal capacity of one truck is 20 tons, the truck is to be loaded with 24-ton load which is beyond the manufacturer's guarantee. The manufacturer claims that the maximum limit of overload is 14%.

The third problem arises from the fact that operation of 150 trucks will require 300 drivers and substantial number of workers for repair and maintenance. This, in turn, requires rest houses and welfare facilities for the workers in addition to the repair shops and parking lots for trucks. The State Government plans to build in the midway between the port and mine a service center with such facilities, but additional facilities should be provided also at the port and mine. Further, each of the three places should have about 7,500 m^2 site for emergency parking.

3 - 4 - 2. Model and Number of Truck and Running Cost:

Model: Maximum load: 20 tons, semi-trailer W-15 model.

Actual capacity: 14% more than normal maximum load, 2 knots

300 work days per year.

Number of trucks required: $\frac{2,000,000 \text{ t/year}}{300 \text{ days} \times 22.8\text{t} \times 2} = 146$ trucks

Spare: 10% = 15 trucks.

Total number of trucks to be purchased: 161

In addition, several wreckers will be required for service purposes.

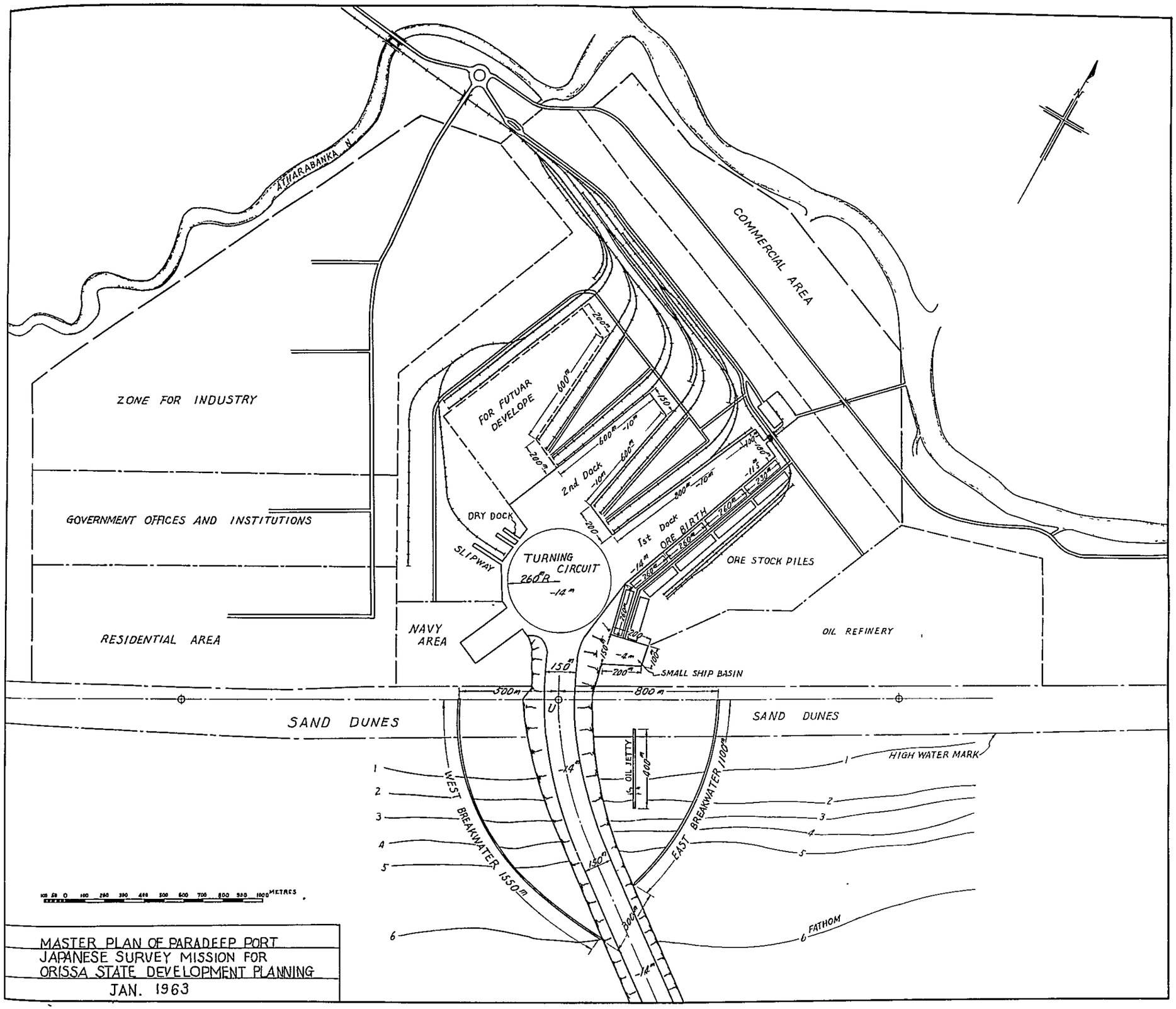
The above required number of trucks is 21 trucks more than 140 trucks planned by the State Government. Besides, as against the running cost of 9.4 rupees per ton per mile included in the State's plan, the cost estimated by the manufacturer is ¥890 which is about 25% increase. The estimate is based on an assumption that the distance between mine and Paradeep Port is 100 miles. Assuming that the CIF price of one truck is ¥6,000,000, the total purchasing price of 161 trucks will be ¥966,000,000.

The truck presently considered by both the State Government and manufacturer has no built-in device for side-dumping or rear-dumping. (Ore is dumped by lifting with 20-ton capacity hoist on the hopper.) In case of a failure in the feeder or stacker at the port, the ore storing operation will have to be stopped and the trucks departed the mine must be held at the Port and service center until the failure has been repaired. In order to avoid this, ore bins with about 3,000-ton capacity will be required even for the storing of half day supply. But the construction of such ore storage facilities is difficult, it may be necessary to close the entire operation for a half day, provided that such stoppage will not take place more than several times a year.

4. Paradeep port Development Plan and ore Road Construction Plan

C O N T E N T S

C O N T E N T S (Cont'd)



MASTER PLAN OF PARADEEP PORT
JAPANESE SURVEY MISSION FOR
ORISSA STATE DEVELOPMENT PLANNING
JAN. 1963

4. Paradeep Port Development plan and Ore Road Construction Plan

4 - 1. Transportation in India and Financing Source:

Before entering into discussion on the Paradeep Port project and the road project to link the Port with Tomka and Daiteri Mines, matters relative to transportation in India and financial sources will be discussed.

4 - 1 - 1. Background of Transportation:

The area of India which is 3,260,000 Km^2 is about nine times as large as 370,000 Km^2 area of Japan, while the population is 450,000,000 or 4.5 times of the population of Japan. Therefore, the density of population is one-half of that of Japan. The major part of India belongs to the tropics with hot climate. The people's action is slow and many of them are in lower income brackets.

The National income of India is Rs.145,000 million, which is the same as that of Japan: Accordingly, her per capita income is 1/4.5 of that of Japan.

On the other hand, the birth rate for the past 10 years is 12%, which is about twice as much as Japan's birth rate of 11%. The rate of growth of national income for the same period is 42% (4% per annum), and 16% growth of per capita income during the same period (1.5% per annum) is very low compared with Japan's annual growth rate of 6.5%. During the last 10 years, agricultural production increase by 41%, industrial production by 84% (Annual rate of growth is about 7%).

Of the mining production, the growth is most noticeable with the production of iron ore. In every place of India, one sees practically nothing but a field and plateau as far as the eye can reach, and apparently no improvement work has been made on rivers.

The Government of India has been making strenous efforts in improving the living standard of the people through the enforcement of its economic five-year plan since 1950. The third 5-year plan is being carried out at present.

Table-1. Main Economic Indices:

ITEM	UNIT	1950-51	1955-56	1960-61	% of increase from 50-51 to 60-61
Population	Million persons	316	397	438	21
National Income (1960-61 value)	Rs.10 million	10,240	12,130	14,500	42
Per Capita National Income	Rupee	384	306	330	16
Agricultural Production Index	1945-50=100	96	117	135	41
Industrial Production Index	1950-51=100	100	139	194	94
Mining (Iron Ore Coal	Million tons Million tons	3 32	4 38	11 55	234 69
Value of Export	Rs. Million	624	609	645	3

What India is abundant in are vast area of arable land, inexhaustible underground resources and unlimited man power. However, owing to the belated modernization of industries, the development of economy requires importation of foreign technology and machinery. This naturally increases her import, and, together with little growth in export, results in a deficit in the

international balance of payment, thereby compelling India to depend on investments and loans from foreign countries.

4 - 1 - 2. Present Status of Transportation:

As regards the coastal transportation in India, the condition is not known owing to the absence of data, but judging from the number of boats for coastal shipping, the annual amount of transportation is considered to be 10,000,000 tons - 15,000,000 tons (290,000 gross tons and 3 voyages per month). Since the water transportation is proportionately bigger than land transportation, the average distance of transportation is estimated to be less than railway.

Table-2. Growth of Transportation:

ITEM	UNIT	1950-51	1955-56	1960-61	% of increase from 50-51 to 60-61
Railway Freight Transportation	Million tons	92	114	154	68
Railway Freight Transportation	100 million-ton miles	270	365	537	100
Average Transportation Milage	Mile	294	316	347	
Automobile	1,000 cars	300		600	100
(of which commercial vehicles)	1,000 cars	(120)	(120)	(210)	(81)
Road Transportation	100 million-ton miles	34	55	106	216
Road (incl. national highway & paved road)	1,000 miles	980	1,220	1,440	400
Vessel (coastal)	1,000 tons	220	240	290	350

Assuming that the amount of transportation by coastal shipping is 15 million tons and the average transport distance is same as the railway (347 miles), the coastal shipping transportation will be 5,000 million ton

miles.

The relative importance of different methods of domestic freight transportation is highest in the case of railway transportation with 53,700 million ton miles or 78% to the total, which is followed by road (10,600 million ton miles or 15%) and also water route (5,000 million ton miles or 7% to the total). The railway has been developed well and is crowded. It is rather peculiar phenomenon to have faster growth of transportation than the growth of economy. Compared with 42% growth of national income during the past 10-year period, 94% increase in industrial production index and 41% growth of agricultural production index, the volume of transportation increased by 100% during the same period from 34,200 million ton miles to 69,300 million ton miles. This growth is rather peculiar to India as the growth of transportation in such countries as Japan and the United States of America keeps pace with the growth of national income.

The number of automobiles is only 600,000 as against 1,440,000 miles of paved road including national highway, which fact means that one automobile runs every 2.4 miles. Since most of the automobiles are concentrated in such big cities as Calcutta, Bombay, Delhi, etc., the paved raods in local districts are practically vacated. However, with annual growth rate of more than 10%, the road transportation has been increasing; and the railway transportation has steadily been increasing at an annual rate of 7% (twice as much as the growth rate of national income). Contrary to such remarkable growth of both road and railway transportation, the coastal shipping shows annual growth of only 2 - 3%, being retarded by the progress of railway and road. The ralative importance of coastal shipping in the domestic transportation is also declining. Water route and canal facilities that are unable to cope with the modernization and growth in size of ships are also being retarded.

As regards the port and harbour facilities, the main emphasis is placed on the facilities for external trade and little has been done on the facilities

for internal trade and fisheries.

4 - 1 - 3. Investment into Transportation Facilities:

The following table-3 shows the actual results of the 1st and 2nd 5-year programs, and estimated expenditures and fund allocation under the 3rd 5-year plan for the development of transportation facilities:

Table - 3. Investments into Transportation Facilities.
(Unit: Rs.100 million)

ITEM	1951-56	1956-61	1961-66	Remarks
Railway	26	86	89	
Road	13	22	27.7	
Port & Harbour	2.7	3.3	15.3	
Vessels	1.9	4.8		
Others	4.1	7.9	7.1	Commercial airlines & Tourism
Total	47.7	124	139.1	

Note: The amount for "Port and Harbour" excludes the World Bank loans and the Port Authorities' own fund. But 1,500 million rupees for 1961-66 include Rs. 200 million of own fund and also fund for lighthouses and coastal shipping.

Figures for the 1st 5-year program are the actual results and those for the 2nd plan are estimated reults and the figures for the 3rd plan are allocated amount of expenditures.

The actual examples in the past reveals that in some cases the actual expenditures were less than the allocated amount and in others the actual investment exceeded the allocated budget amount. The budget amount is spent by making a flexible adjustment depending on the cases.

The relative importance of the investment ear-marked for transportation is substantially large, occupying 25% in the first 5-year program and 27% in the second, but it declined to 19% in the third 5-year plan. The investment

into railway is by far the largest, which is followed by road investment. As regards the port and harbour facilities, the total amount of investment including the World Bank loans and own fund is Rs.500 - 600 million, which is spent preferentially on the main port projects.

The aggregate of the planned amount for each item under the third 5-year program exceeds, in some cases, the allocated budget amount, which is especially noticeable in the cases of railway, road and main ports. Rs.1,530 million included in the Table-3 are to cover expenditures for ports, vessels, lighthouses and coastal shipping: Rs.550 million are for vessels, 140 million for lighthouses and some amount for coastal shipping, which in all total to Rs.570 million, thus leaving Rs.960 million for port facilities. On the other hand, however, the amount required for the port and harbour plan is 1,300 million rupees; namely Rs.800 million for main ports, Rs.250 million for Falucka barrage (against aand accumulation in Calcutta Port), Rs.100 million for new ports (Mangalore Port and Tuticolin Port), and 150 million rupees for small port projects. Thus, no budget has been appropriated for the construction of Paradeep Port, but the appropriation of same will be made under the third or fourth program upon the alteration of the project through subsequent negotiations between the State Government and Central Government. Nevertheless, the development of Paradeep Port has been decided and the construction is underway at the responsibility of the State Government.

4 - 1 - 4. Outline of the State of Orissa:

The State of Orissa is situated to the south-west of Calcutta, facing the Bay of Bengal. With the total area of 60,000 milles^2 and population of 17 million, the State is abundant in various natural resources, agricultural products and water power resources. However the average income of the inhabitants is 2/3 of the average of the whole India, or 1/7 - 1/8 of the average income in Japan. The main reason for such low income is that the

State is not yet industrialized with insufficient railway and port facilities. The present capital of the State of Orissa is Bhubaneswar, but this city is purely government office city and the economic center of the State is still the old capital of Cuttack.

There are three canals centering around Cuttack, but none of them is fully utilized. Although roads are paved, there are little modern traffic, and the roads are still used substantially for ox-cart traffic. The living conditions of inhabitants are poor, and their houses present a striking contrast to modern government office buildings.

Efforts were made without success to find out how the required amount for the construction of Paradeep Port and ore transporting road was appropriated by the Indian Government (both Central and State Governments) as well as to study if financing of such amount was possible. The construction work was actually underway under chief Minister Patnaik, but it was not possible to learn from the budget the appropriation of the required amount. Further study by specialists of this point is desired.

However, Chief Minister Patnaik and other government officials concerned are most enthusiastic about the execution of the projects. It was concluded that the investment for the construction costs of port and exclusive ore road was made at the responsibility of the State Government and the financing was apparently made with the independent income of the State Government or with a part of the loans from the Central Government.

The following Table-4 is to show the budget included in the third 5-year program for the transportation facilities under the jurisdiction of the State Government of Orissa:

Table - 4.

(Unit: Rs.100,000)

ITEM	2ND PROGRAM	3RD PROGRAM
	(Estimated Results)	(Allocated Amount)
Road	557	800
Road Transportation	25	46
Tourism	2	5
Total	584	851

The amount under the third program in the above Table-4 is 5.3% of the estimated total expenditures of the State Government (Amount allocated by the Central Government) amounting to 1,600 million rupees. Besides above, expenditures amounting to about Rs. 120 million are planned by the Central Government or with the subsidy of the Central Government for the projects related to the State Government of Orissa. Of the amount, the expenditures to be borne by the Central Government and by the State Government during the periods of 1961-62 and 1962-63 are as follows:

Table - 5.

(Unit: 100,000 rupees)

	Total	Amount borne by State Gov't	Amount of Central Gov't Subsidy	Amount of Central Gov't Subsidy
1961-62	447	31	229	186
1962-63	631	29	262	339

The amount of Rs.120 million includes, as a part of the 5-year program, Rs.5 million for water transportation and Rs.9.9 million for the construction of Paradeep Port.

Expenditures for the road projects are also appropriated for the last two years. Though there is no direct contribution by the State Government

for such expenditures, most of the amount is to be loaned by the Central Government.

Table - 6.

(Unit: Rs.100,000)

	1961 - 62			1962 - 63		
	Total	Central Gov't Subsidy	Loan	Total	Central Gov't Subsidy	Loan
National Highways	90	-	90	137	-	137
Main Roads	20	20	-	9	9	-
Water Route Transportation	10	-	10	13	-	13
Paradeep Port	23	-	23	40	-	40

4 - 2. Harbour Projects:

4 - 2 - 1. Actual State of Paradeep Port:

(1) Location and Condition of Paradeep Port:

The Port of Paradeep is about 220 miles south of Calcutta and 280 miles north of Vizagapatam and is situated on the right-hand shore of the estuary of Mahanadi River in the State of Orissa which lies on the east coast of India.

The port is the newest minor port in India, and the vicinity is for the most part still covered with jungle. The port is utilized, at present, as an off-shore loading port during fine weather seasons except the monsoon season. As for the port facilities, the port has a 40,000 - 50,000 ton capacity ore yard and two small scale wooden landing piers. The port also owns two 250-ton barges, three small barges and one tug-boat. In addition, three large-size self-propelling barges will be completed soon. In the coast near the estuary of Mahanadi River, drift of sand is very intense,

and a shoal is developed. Though the water depth at the shoal is 0' to -1', there is a route of -6' deep in the shoal, and several hundred ton capacity barges can navigate by taking advantage of the tide range of 7 - 8'.

The main advantage of using the port lies with the fact that Paradeep Port is connected to three canals, namely, High Level Canal, Kendrapara Canal and Taldanda Canal. These canals were primarily used for the irrigation of nearby paddy and cropped lands, but the completion of Hirakud Dam in the upper steam of Mahanadi River has resulted in a constant flow of substantial amount of water to enable navigation of small-size wooden boats.

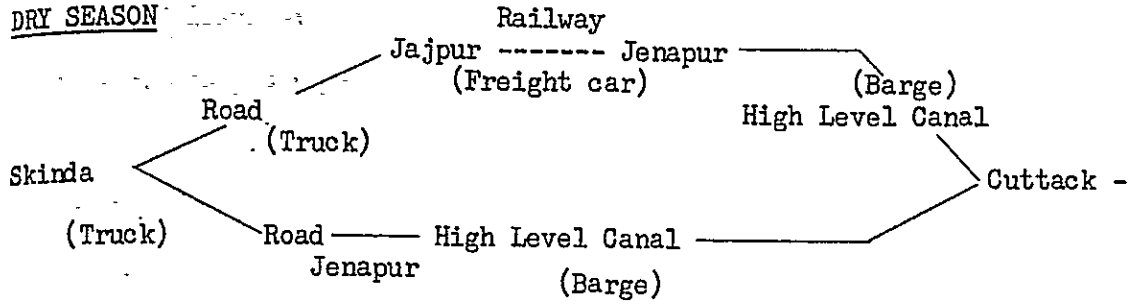
The water-depth of all the canals is 6' - 7', effective breadth is more than 30', water-depth at the lock-gates 6' - 7' and the total effective width is 117'. Barges of about 100-ton capacity can sufficiently navigate.

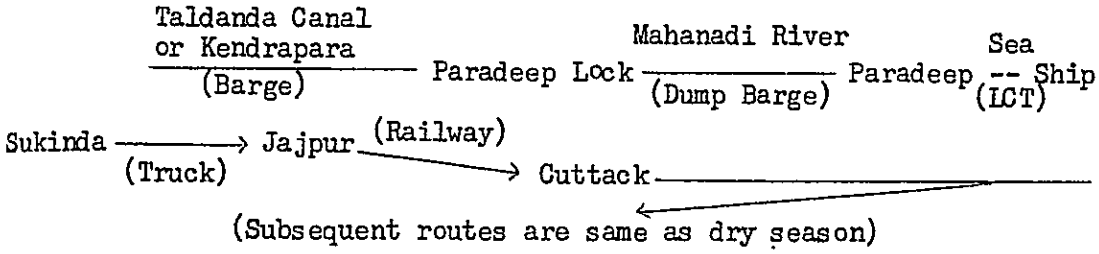
The conditions of weather and sea in the vicinity of Paradeep Port are as shown in Table - 7, but the characteristic is that frequency of cyclone and depression is highest in India as in the case of the estuary of Hooghly River. Therefore, compared with such places as Vizagapatam, Madras and Bombay there will be more cases where the outgoing and incoming of ships to the port are restricted owing to abnormal weather.

(2) Present Utilization of Paradeep Port:

The majority of cargoes handled is iron ore, and off-shore loading of approximately 50,000 tons of iron ore was made by barge in the period from December 1961 to April 1962. The iron ore is transported from Sukinda and Daiteri districts via road, railway and canal to Paradeep Port, where it is stored temporarily before being loaded by barge on to a ship anchored about one mile off shore.

The route of transportation differs from dry season to wet season as explained below:





Although the daily loading capacity to the ship was 800 tons in 1961, the capacity will be increased to 1,200 - 1,500 tons/day through the expansion of barging capacity and loading from ore yard to barges.

Except for the loading to the ship, all the handlings are carried on by man-power at the present time, and barges on canals are also drawn by man-power taking several days from Cuttack to Paradeep Lock.

Iron ore shipped by Sukinda Mine amounts to about 300,000 tons a year as of 1962, of which 50,000 tons of ore are transported via the above discussed routes to Paradeep Port to be exported. Cost of Transportation from the mine to the ship through Paradeep Port is Rs.41 - 42 including shipping charges and stevedoring, which is about 2 - 3 rupees higher than the transportation through Calcutta Port. The difference equals to that of harbour charges between Calcutta Port and Paradeep Port. Thus, under the present transportation condition, it is cheaper to transport the ore through Calcutta Port.

(3) Reason for Constructing New Port at Paradeep:

It has been a long pending task of the State Government of Orissa to

construct a large scale all-weather port which is always available to large size ships as a gate to the State of Orissa and to export iron ore of more than 2,000,000 tons a year.

In 1951, by hiring the service of a French harbour survey team, discussion on the development of a large scale port as well as basic investigation was started.

At that time, Japan became to require a stabilized supply of large amount of iron ore as a result of rapid production increase by the steel industry, and leading Japanese steel manufacturers and trading firms started to undertake the survey of iron mine development abroad. In 1956, India conducted the survey on the development of Tomka and Daiteri Iron Mines and also the related development of Paradeep New Port. Further in 1957-1958, investigation was made by a technical mission of the Japanese Government on the mines at Rourkela, Bailadila, Sukinda (Tomka Daiteri) districts as well as on the related railways and port facilities.

As a result of these two investigations, the Sukinda Mine in Orissa was recognized by both Japan and India as the object of mine development program. However, it was concluded that the immediate construction of a large-scale port at Paradeep was impossible financially as well as technically, and decision was made to export most of iron ore to be mined at the mines in Orissa through Calcutta Port and Vizagapatam Port at least for the time being.

Since the Port of Paradeep was appointed as Minor Port, it has been shipping yearly several 10,000 tons of iron ore.

Subsequently, it was planned that the Port would handle 500,000 tons of iron ore as a medium port, but the State Government of Orissa, by appropriating the survey fee in its 1961 budget, requested the Rendel Parmar Consultant Company in Britain to work out a harbour plan. The Consultant has prepared a plan (hereinafter referred to as Rendel Parmar Plan) under a close cooperation with both the Central and State Governments. Although

the general principles of the Rendel Parmer Plan were accepted by the Indian Government, the details involved many undertain points, the re-investigation of which was requested to the Survey Mission.

Upon the determination of the project, the State Government started purchasing the necessary site, and further at the beginning of this fiscal year (1962), it commenced a full-scale construction of the new port with the budget of 10,000,000 rupees. Later, the Central Government decided that the State Government was to bear the entire amount of cost for the first stage work, and apparently granted the State Government with the authorization to make Rs.40,000,000 of foreign exchange expenditures.

The report of the Mission, therefore, has been prepared from the standpoint of making suggestions and recommendations to the Indian Government on such matters as plan, design and the methods of execution of work by reviewing the Rendel Parmer Plan.

Table 7 - 1

Climatological Table

Saugor Lat 21°39' N Long 88°30' E
Based on observations from 1871 to 1940

Month		Mean Barometric Pressure	Temperature Mean of Highest in the month	Temperature Mean of Lowest in the month	Humidity	Mean monthly total Rainfall	Wind: No. of days with wind force: 8 or more	4-7	1-3	0	Wind: Percentage No. of days of wind Direction: N	NE	E	SE	S	SW	W	NW	Calm
		Md	°F	°F	%	in													
January	I	1016.7	81.9	51.2	83	0.41	0	1	29	1	35	26	4	2	7	9	6	10	1
	II	1013.5	--	--	63	--	0	1	29	1	26	11	1	7	37	12	1	2	2
February	I	1014.5	86.3	54.3	81	1.15	0	3	23	2	22	19	4	2	14	20	9	10	1
	II	1011.3	--	--	67	--	0	3	25	0	13	5	1	8	52	15	1	4	2
March	I	1011.4	93.2	64.0	76	1.29	0	14	16	1	8	4	1	2	28	39	10	7	0
	II	1007.8	--	--	74	--	0	15	16	0	3	2	1	8	66	18	0	1	1
April	I	1008.2	92.7	71.2	77	1.17	0	17	12	1	2	1	1	5	49	37	3	2	0
	II	1004.3	--	--	76	--	0	21	7	2	0	0	0	5	72	22	1	0	0
May	I	1004.6	93.9	71.7	78	4.52	0	19	11	1	2	3	3	10	50	28	3	2	0
	II	1001.2	--	--	78	--	0	21	10	0	2	3	3	18	59	13	1	1	1
June	I	1000.1	93.9	74.7	81	11.63	0	16	13	1	2	6	5	8	38	32	5	3	1
	II	997.5	--	--	80	--	0	20	10	0	2	1	3	19	47	22	5	2	0
July	I	999.4	91.5	75.9	85	15.54	1	17	13	0	3	7	7	8	24	39	9	3	1
	II	997.0	--	--	82	--	1	21	9	0	1	0	5	14	46	27	6	1	0
August	I	1001.2	90.7	76.0	87	13.28	0	15	15	1	3	6	7	12	23	35	10	4	1
	II	998.5	--	--	83	--	0	18	13	0	2	1	3	16	45	26	6	1	0
September	I	1005.2	91.2	75.5	84	10.35	0	8	20	2	4	10	10	11	26	24	10	4	1
	II	1002.3	--	--	81	--	0	8	21	1	5	3	7	11	43	21	4	3	3
October	I	1010.7	90.3	69.7	81	8.07	0	3	27	1	19	20	10	5	9	14	11	13	1
	II	1007.6	--	--	78	--	0	3	25	3	14	15	10	12	21	14	3	3	8
November	I	1014.4	86.6	60.2	78	1.28	0	3	27	0	43	31	3	1	2	4	4	13	0
	II	1011.3	--	--	68	--	0	1	28	1	32	28	3	1	13	10	3	6	4
December	I	1016.9	81.2	51.9	80	0.21	0	2	28	1	53	24	2	1	1	4	4	11	0
	II	1013.5	--	--	64	--	0	1	30	0	47	17	1	2	7	8	2	5	1

N.B. The hours of observations have been indicated in the above statement as follow:

I Stands for observations at 08.30 hours

Table 7-2 Station - Sambalpur Lat. 21°28' N Long 83°58' E Height Above M. S. L. 487 Ft Based on Observations from 1891 to 1940

Month		Pressure	Air Temperatuer										Humidity		Cloud Amount		Rainfall						Mean Wind Speed	Weather Phenomena * No. of Days With					
					Mean (of)		Mean (of)		Extreme																				
		Mean at Station Level	Mean Dry Bulb	Mean Wet Bulb	Daily Max	Daily Min	Highest in the Month	Lowest in the Month	Highest recorded	Date and Year	Lowest recorded	Date and Year	Relative Humidity	Vapour Pressure	All Clouds	Low Clouds	Mean monthly Total	Mean No. of Rainydays	Total in Wettest Month With Year	Total in Driest Month With Year	Heaviest Fall in 24 Hours	Date and Year		Precipitation of or more	Thunder	Hail	Dust Storm	Squall	Fog
		mb	°F	°F	°F	°F	°F	°F	°F		°F		%	md.	Tesof S		in		in	in	in		m.p						
January	I	1000.2	91.9	57.3	81.8	55.0	87.6	45.2	93	30	41	3	74	14.1	2.2	0.7	0.43	0.9	4.08	0	2.12	22	2.1	3	2	0	0	0.4	0.2
	II	996.5	79.7	63.8	-	-	-	-	-	1889	-	1918	38	13.0	2.3	0.7	-	-	1919	-	-	1921	-	-	-	-	-	-	-
February	I	997.9	66.7	60.5	86.3	59.4	94.0	50.9	100	28	43	7	69	15.2	2.1	1.6	0.94	2.0	5.40	0	2.17	22	2.4	4	3	0.1	0	0	0.2
	II	994.1	82.7	66.0	-	-	-	-	-	1896	-	1934	80	14.3	2.8	1.1	-	-	1933	-	-	1901	-	-	-	-	-	-	-
March	I	995.2	75.6	65.0	95.7	66.8	103.4	57.6	110	23	52	3	54	16.4	1.8	0.8	0.86	1.7	5.51	0	1.77	25	2.5	4	4	0.1	0	0.4	0.4
	II	990.7	92.4	68.2	-	-	-	-	-	1888	-	1921	25	12.4	2.9	1.3	-	-	1894	-	-	1891	-	-	-	-	-	-	-
April	I	991.7	84.4	71.7	1030	74.9	109.3	66.9	113	30	58	2	51	19.7	2.4	0.5	0.59	1.6	3.52	0	1.78	20	2.9	3	5	0.2	0.4	0.3	0
	II	989.7	100.3	71.4	-	-	-	-	-	1889	-	1905	21	12.7	3.7	1.2	-	-	1909	-	-	1909	-	-	-	-	-	-	-
May	I	987.8	89.7	76.1	1065	81.2	112.4	73.6	117	27	69	5	51	24.0	3.0	0.9	1.08	2.3	5.26	0	4.25	25	3.3	5	8	0	0.6	0.9	0
	II	982.8	103.1	74.3	-	-	-	-	-	1892	-	1937	25	15.8	4.5	2.4	-	-	8191	-	-	1891	-	-	-	-	-	-	-
June	I	984.1	85.4	77.7	97.5	80.5	110.8	74.0	116	5	67	28	99	28.0	6.5	3.7	10.09	10.7	32.35	4 14.4	10.02	12	4.0	16	15	0	0.7	0.3	0
	II	980.3	90.2	78.1	-	-	-	-	-	1935	-	1903	62	27.0	8.2	4.8	-	-	1918		-	1882	-	-	-	-	-	-	-
July	I	983.7	80.2	77.3	87.2	77.1	94.7	73.2	105	1	65	1	87	30.1	8.3	7.7	20.56	19.6	41.96	7.43	15.80	20	3.9	27	15	0.2	0	0.1	0
	II	980.9	82.2	78.5	-	-	-	-	-	1902	-	1910	85	31.3	9.6	6.3	-	-	1892	1911	-	1889	-	-	-	-	-	-	-
August	I	985.4	79.7	77.0	86.7	76.9	91.8	73.6	95	18	70	20	88	30.1	8.3	6.5	19.04	18.9	35.83	4.75	10.47	22	3.6	25	15	0	0	0	0
	II	982.4	82.5	78.3	-	-	-	-	-	1920	-	1239	83	30.9	9.5	5.8	-	-	1907	1892	-	1934	-	-	-	-	-	-	-
September	I	989.2	81.0	77.6	88.7	76.0	92.9	73.5	97	30	69	29	85	30.2	6.3	4.0	9.05	11.4	22.31	1.25	6.80	6	2.8	16	16	0	0	0	0
	II	985.9	84.1	78.3	-	-	-	-	-	1930	-	1921	77	30.1	8.1	3.9	-	-	1884	1899	-	1921	-	-	-	-	-	-	-
October	I	994.8	77.5	72.9	88.8	71.5	92.5	63.2	97	17	55	31	79	25.4	3.4	1.5	2.14	3.5	10.94	0	6.84	5	2.3	9	5	0	0	0	0
	II	991.2	83.6	75.0	-	-	-	-	-	1920	-	1921	66	25.6	5.0	2.1	-	-	19.36	-	-	1936	-	-	-	-	-	-	-
November	I	998.6	68.9	64.9	83.9	61.3	88.8	53.0	93	1	46	30	75	18.0	2.6	0.9	0.81	1.0	6.24	0	4.18	2	2.1	6.1	0.2	0	0	0	0
	II	995.0	79.1	67.8	-	-	-	-	-	1896	-	1926	53	17.9	3.8	1.0	-	-	1930	-	-	1930	-	-	-	-	-	-	-
December	I	1000.7	61.4	57.2	80.2	53.8	84.6	46.3	90	19	40	5	76	14.1	1.7	0.4	0.17	0.3	2.59	0	1.54	20	1.9	0.6	0.2	0	0	0	0
	II	996.9	7.8	63.3	-	-	-	-	-	1902	-	1902	47	14.3	2.4	0.6	-	-	1885	-	-	1885	-	-	-	-	-	-	-
Annual total Or Mean	I	992.4	76.0	69.5	90.5	69.6	112.9	45.2	117	-	40	-	71	22.1	4.1	2.5	6576	73.9	90.86	36.80	15.80	-	28	114	88	0.6	1.7	2	0.8
	II	988.6	86.3	71.9	-	-	-	-	-	-	-	-	52	20.5	5.2	2.8	-	-	1929	1915	-	-	-	-	-	-	-	-	-
No. of Years	I	45	45	45	60	60	60	60	60	-	60	-	45	45	45	60	60	60	60	60	60		60	10	10	10	10	10	10
	II		5	5							-		5	5	5														

* Frequencies above 2.0 are given only in whole number

4-2-2. Conception of Master Plan:

According to the project of the State of Orissa, the Port of Paradeep is conceived mainly as a shipping port of iron and other mineral ore. However, as it will become the only modern port between Calcutta and Vizagapatam, the utilization of the Port will depend on the future exploitation of mineral resources and also the economic development in general of the large hinterland.

Under the present circumstances, it is still difficult to make a forcast in regard to the possible extent of such exploitation or development. In other words it is hardly possible to determine the capacity of the future port on the basis of existing data. However, the actual condition of the other similar ports, especially that of Vizagapatam, will provide valuable indication for the construction and accommodation of the Port both from the technical and other points of view. The port of Vizagapatam has, at present, three ore berthes (for iron and manganese ores), one coal berth and three berthes for miscellaneous cargoes: it also has two oil-tanker berthes for oil refinery and six buoy-berthes. Two additional berthes are under construction in order to meet the expected increase in iron ore shipment in future. The port also has a navy base.

In other words, the port has, besides the ore berthes, two berthes for oil refinery, one for coal, three for miscellaneous cargoes and six for other purposes; and it may be reasonable to expect that Paradeep Port will have a similar capacity, or it will have, besides ore berthes, about 10 berthes except those for oil refinery. The port should of course be provided with ample space for expansion of berthes in order to meet future development.

In case if the oil berth capable to moor ships of 100,000 tons is to be constructed, it is advisable to build two berthes in the outside of the port

by making jetty, because handling of such large tankers in the turning basin will require additional depth and area. Since India is in the proximity of the crude oil producing districts, there is a question as to whether or not such large size tankers will be in use. It is not unreasonable to plan first the construction of oil berth in the outside of the port, and then review the matter of ship size to be moored at the time of construction of oil refinery.

Though three berthes are being considered for ore export on an assumption of future shipment of 5,000,000 tons, it is advisable to provide enough space for additional two berthes near the presently planned ore berthes (site for oil berth) if there is any possibility of shipping 10,000,000 tons to 15,000,000 tons of ore in the future. Assuming that one berth is capable to handle 2,000,000 tons, five berthes can easily handle 10,000,000 tons.

The port should be planned to have, besides five ore berthes, about 10 berthes for miscellaneous cargoes and other purposes so that it may have enough room for future expansion.

For the convenience of incoming and outgoing of ships, the normal line of quay should be changed. With due consideration to the above matters, the overall plan illustrated in the attached chart is recommended. The order of industrial developments centering around the port is considered to be as follows:

The construction of port will stimulate the export of ores at the outset and then import of coal, sundry goods, petroleum products for vessels and ore transporting cars and thereafter export of agricultural products, machine repairing industry, construction of shipyard, establishment of navy base, food processing industry, oil refining, construction of thermal power etc. Thus, the district will become the center of industrial development of the State of Orissa and will promote the growth of commerce and other third industries, providing people with jobs with higher income and also

contributing a great deal to the elevation of living standard.

Of the master plan, those technical matters which are included in the first stage work will be discussed in the following section.

4-2-3. First Stage Construction Work:

The main emphasis of our survey was laid on the first stage construction work.

The first stage work includes construction of one berth for miscellaneous cargo handling and a slip way as well as the construction of port facilities capable to export iron ore of 2,000,000 tons annually by using 60,000 ton class ore carriers.

(1) Prerequisits to the Plan:

(a) Sand Drift:

Rendel Palmer & Tritton, Ltd. reports that sand drift on this coast is generated by S.W. monsoon and moves from S.W. to N.E., and that the amount of drift sand is the same as in Madras and Vizagapatam, or, 1,000,000 tons to 1,500,000 tons a year which is the actual amount of drift sand in both ports.

However, judging from the direction of coast line, topography of sea bottom and bed matters, there is only a limited similarity between Paradeep Coast and Coasts of Madras and Vizagapatam has a cliff called "Dolphin Nose" on the south side of the port and the water depth at the shore is 6' ~ 8' with the grade of sea bottom being much steeper than that of Paradeep. On the other hand, the direction of coast line at Madras differs by about 60°; and the effect of wave on the sand drift during the S.W. monsoon season can hardly be the same as in the case of Paradeep.

Size of sand which forms the sea shore is found to be larger at both Madras and Vizagapatam, and drift of sand by the same wave is considered to be much more intense in the case of Paradeep coast.

Thus, the assumption by Rendel Palmer & Tritton, Ltd. on the amount of drift sand is based leaves some question even when the topography of sea coast alone is considered.

Discussed below are some of our comments on this matter:

In estimating the amount of drift sand, we have also taken the stand on the basis of actual results of Vizagapatam and Madras: Our conclusion is that sand drift at Paradeep coast is most noticeable in the direction of from S. W. to N.E. with the annual amount of more than 2,000,000 tons, and also that consideration should be made on the substantial amount of drift sand which moves southward from the estuary of the Mahanadi River mainly during the cyclonic storm season. The bases of the estimate includes the followings:

(i) The conventional view regarding the amount of drift sand at both Madras and Vizagapatam should be corrected as follows:

(Estimate based on the data of actual survey at Madras and Vizagapatam.)

Madras: 1,300,000 - 1,500,000 tons per year.

Vizagapatam: 1,000,000 - 1,200,000 tons per year.

(ii) Judging from such matters as the direction of coast line, topography, bed matters and height and direction of wave, the amount of drift sand at Paradeep coast is substantially larger than those at both Madras and Vizagapatam stated in the above (i).

(iii) Frequency of cyclone and depression in Paradeep coast is twice as much as that in Vizagapatam and three to four times of that in Madras. Since the sand drift caused by one severe cyclone is expected to amount to as much as 200,000 tons, it is estimated that the sand drift under such abnormal weather will be several hundred thousand tons more than that in Madras or Vizagapatam: The sand drift due to the cyclonic storm moves mostly from N.E. to S.W.

(iv) In general, the sea bottoms near the estuaries of large rivers

have small reliefs which are likely to cause sand drift: Paradeep coast which lies between the Mahanadi River and Devi River is expected to possess such reliefs of sea bottom.

Since it is difficult to estimate at present exact amount of drift sand from the foregoing view points, detailed on-the spot survey must be made along with the construction of breakwater during the construction work in order to make more accurate estimate.

It must be added that the figures given herein represent nothing but very approximate estimate.

(b) Type and Draught of Vessels:

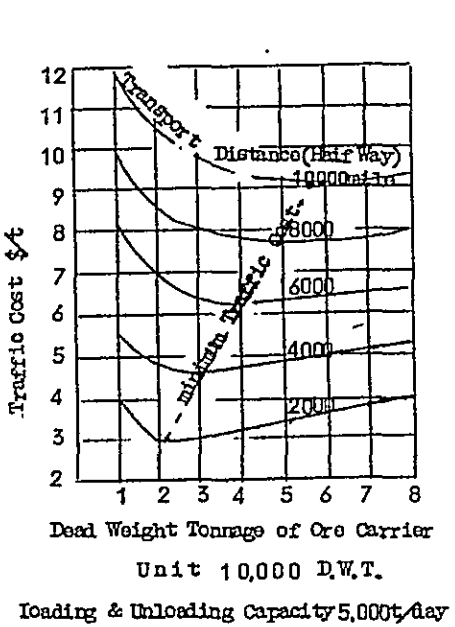
Authorities concerned of the State Government of Orissa are considering 60,000 dead weight ton ore carriers or oil tankers and 10,000 gross ton cargo vessels as the types of vessels to be moored in the first stage and they seem to be recommending full draughters of 11.9 meters and 9.5 meters for those carriers and cargo vessels respectively.

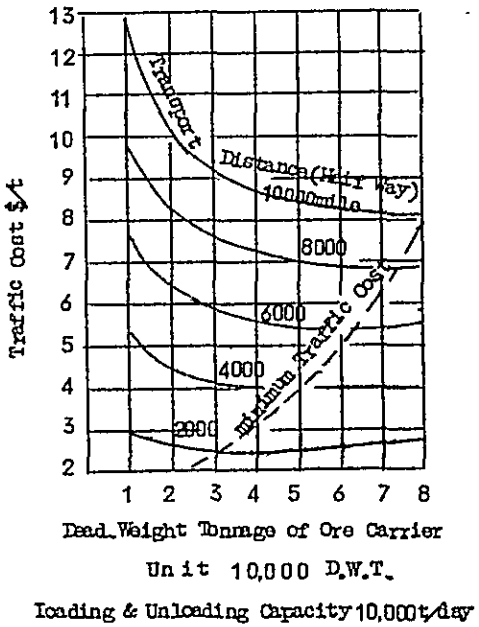
Selection of the most desirable size of ore carriers has been under study for several years in Japan: The study proves that the most suitable size which may minimize transportation cost is determined by such factors as transport distance and cargo handling capacity at loading and unloading ports, which is illustrated in the Table 8. The Table explains that, in the case of transport of iron ore to Japan for the average distance of 4,600 miles, the most economical size of the ore carrier is 30,000 - 40,000 dead weight tons if the average cargo handling capacity is 1,000 tons per hour or 5,000 tons per day, and 40,000 - 80,000 dead weight tons if the average cargo handling capacity is 2,000 tons per hour or 10,000 tons per day, and also carriers of larger than 50,000 dead weight tons become most desirable if the average cargo handling capacity is 4,000 tons per hour or 20,000 tons per day.

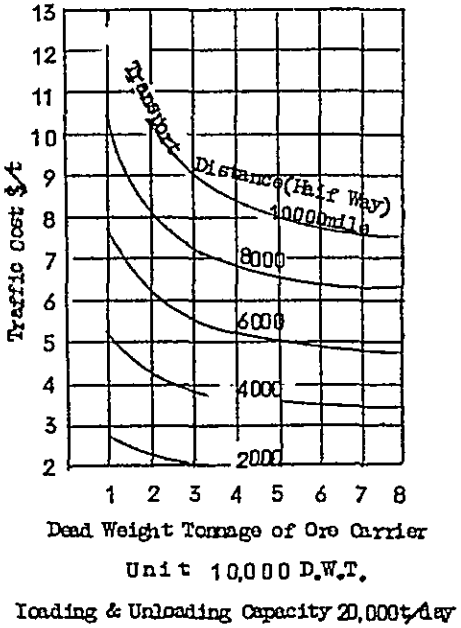
Because it seems to be difficult to expect many loading and unloading ports to have average daily cargo handling capacity of more than 20,000 tons

Table 8

Distance To Traffic Cost







at present or in the near future, the above discussion indicates that there will be, at least for some time to come, little need of mammoth vessels of more than 40,000 - 50,000 dead weight tons. As a matter of fact, most of the ore carriers now being built in Japan are of 40,000 - 50,000 ton class.

However, if the one-way transport distance is more than 6,000 miles, mommoth ships of 60,000 - 80,000 dead weight tons will become more economical provided that hourly cargo handling capacity of more than 2,000 tons is available: Nevertheless, the saving in the freight cost in this case is less than 5% compared with that of 50,000 dead weight ton class carriers.

Therefore, taking into consideration also the fact that it would take some time before the cargo handling and other port facilities of Paradeep Port can be operated efficiently, it may be appropriate to consider 40,000 - 50,000 dead weight ton ships as the object ore carriers of the first stage construction work.

As for the cargo vessels, the recommended size of 10,000 gross tons is considered to be reasonable in view of the fact that many experts estimate the standard size of cargo vessels for the coming several years to be in the range of 10,000 - 15,000 gross tons.

Assuming that the largest ship to be taken into account under the first stage work is the ore carrier of 50,000 dead weight tons, its full draught will be 11.5- 12 meters: In order to satisfy the draught, the route is normally to be provided with a margin of additional water depth of two meters, and the anchorage and berth are with water depth of 1.5 meters in addition to the full draught of ships.

(Note) A 60,000 dead weight ton ore carrier will have a full draught of 12 - 12.5 meters, which requires water depth of 14.5 meters at the route and 14 meters at anchorage and berth. If the ships can take advantage of tide, the required water depth may be a little less than the above at the route and anchorage but not at the berth.

(c) On the Experiment with Model:

The report of Rendel Palmer & Tritton, Ltd. reveals that the master plan has been determined by the result of an experiment made with model of Paradeep Port submitted by the Central Water & Power Research Station to the State Government of Orissa in 1961. However, it also suggests that another model experiment is necessary regarding the layout of port with the "U" point of the Indian Navy Survey Station as the center of route because the experiment, on which the report of Rendel Palmer & Tritton, Ltd. is based, was made at the time when the center of route was at the "T" point of the Indian Navy Survey Station.

As suggested by the report, the Central water & Power Research Station is at present conducting a model experiment on the case where the center of route has been transferred to the "U" point. According to the explanation given at the time of our visit at the Research Center, the layout of new port would have to be revised as follows although no final conclusion has been made:

(i) Two breakwaters on the west side should be connected.

(ii) The east side breakwater should be extended.

(iii) The sand trap to be installed on the east side of approach channel which is sheltered by a detached breakwater should be removed to the outside of the west breakwater and dredging should be made by the dredging plant installed on the breakwater.

We are also in support of the revision of the original plan prepared by Rendel Palmer & Tritton, Ltd. in accordance with the result of the experiment made by the Research Center. However, since it is extremely difficult to maintain similarity in the model experiments on the drift sand disposal, prudent studies should be made before making the final decision on the details of layout and also scale of breakwater, sand trap, etc. It is also necessary to obtain as many as possible the data of actual survey on the spot and other

related data without overestimating the result of experiments.

(2) Scale and Layout of Port Facilities:

(a) Channel and Turning Basin:

(i) Water Depth:

With regard to the water depth of channel and moorage, the report of Rendel Palmer & Tritton, Ltd. suggests 12.25 meters at the approach channel and 11.75 meters at both the entrance channel and turning circle.

In the case of 50,000 ton (dead weight) ore carriers, at the full draught is 11.5 - 12 meters as discussed in the foregoing 2-3-1-(2), the required water depth will be 14 meters at the approach channel and 13.5 meters both at the entrance channel and turning basin. However, as far as the entrance channel and turning basin are concerned, the water depth is overestimated and may be decreased if the fact is taken into account that large ships call only several times a month and that they can utilize the top half tide which is higher than the mean tide and remains for five to six hours.

Since the half tide at Paradeep is approximately 1.3 meters in average, the required water depth will be 12.7 meters at the approach channel and 12.2 meters at the turning basin. (The datum level is Admiralty Chart Datum.)

In the case ore carriers of 60,000 dead weight ton class are considered, the following depth will become necessary:

Approach Channel: - 13.2 meters.

Entrance Channel & Turning Basin: - 12.7 meters.

(ii) Width:

Judging from the actual experience at Vizagapatam Port, width of 190 meters for the approach channel is sufficient for ships of 20,000 - 30,000 dead weight tons. However, in the case of 50,000 - 60,000 dead weight ton ships, the width is considerated to be somewhat too small, though a precise judgement can hardly be made in the absence of actual experience or example. Therefore, it is advisable, in the first stage work, to execute the construc-

tion work in accordance with suggestion by Rendel Palmer & Tritton, Ltd, with ample room for expansion of width.

Concerning the width of entrance channel and the diameter of turning circle, the plan should also be provided with certain flexibility for the second stage work.

(iii) Others:

Though the report of Rendel Palmer & Tritton, Ltd, includes nothing on the moorage of tugboats and other small boats for harbour works, certain moorage space at the back of turning circle should be reserved for them.

(b) Berth:

As the ore berth, a jetty berth with water depth of 12.7 meters, length of 155 meters and width of 15 meters is recommended by the State Government of Orissa. However, with due consideration to such matters as better and convenient utilization and possible reduction of dredging work, we recommend a quay type berth which is similar to the new ore berth now under construction at the Vizagapatam Port.

As for the water depth, in case of 50,000 dead weight ton ships, depth of 13.5 meters will be necessary on the premise that cargo handling is completed without shifting ships: While, in the case of 60,000 dead weight ton ships, the ore berth should have a water depth of - 14.0 meters. Since the average cargo handling capacity should be increased in the case of larger ships, we are of opinion that shifting of ships during the cargo handling operation as suggested in the report of Rendel Palmer & Tritton, Ltd. should be avoided.

Taking into consideration the interrelationship between the method of cargo handling and structure of quay, we recommend berth length of 265 meters which will provide certain marging in addition to the length of ship. However, in the case of 60,000 dead weight ton ships, the berth should be 275 meters long.

No particular comment is made by us on the cargo berth, but in consideration of; the use of same as the idle berth for ore loading, it is advisable to provide ample length.

(c) Breakwater:

The layout of the breakwater plays an important role in the function of the port, and the report of Rendel Palmer & Tritton, Ltd. also discusses this matter in very detail.

As referred to in the foregoing discussion in 2-3-1-(3), the original arrangement of breakwater recommended by Rendel Palmer & Tritton, Ltd. now being reviewed by the State Government of Orissa on the basis of the result of experiment made by the Research Center. We also desire that the layout will be studied further with great prudence.

The sand trap and detached breakwater recommended by Rendel Palmer & Tritton, Ltd. have shown satisfactory result at the Vizagapatam Port. However according to the literature, this counter-measure against sand drift was employed only after a long observation of the actual condition of sand drift around the mouth of Vizagapatam Port including the valuable experience of failure of sand drift blocking up several times the route during the construction work. It can be said, in other words, that the layout recommended by Rendel Palmer & Tritton, Ltd. is based on successful operation of Vizagapatam Port which owed greatly to special experience of skilled engineers.

It seems to us, therefore, that a substantial risk would be involed if this method is applied at the Paradeep coast where the sand drift is expected to be much more intense and the actual condition of the sand drift has not been made clear.

If the layout of breakwater has to be decided at the present time when no concrete estimate can be made as to the amount of drift sand, its distribution by different directions and seasons, etc., the layout should be of such nature as to have minimum risk on the function of the port even when the

estimate proves somewhat the contrary.

Although it is rather conventional, we should like to recommend two breakwaters on the east and west sides of the port in a shape of embracing the approach channel. The head of west breakwater should be extended to the point where water depth is - 10 meters so that it may prevent the route from getting buried by the sand drift from S. W. On the other hand, the head of east breakwater should be extended to the point where water depth is - 8 meters in order to protect the route from the intense sand drift which moves rapidly southward from the estuary of Mahanadi River during the cyclonic storm. It is also recommended that the east breakwater be located north east of the original plan prepared by Rendel Palmer & Tritton, Ltd. in order to provide for the oil jetty to be constructed in the future. Thus, by shortenning the distance between the heads of two breakwaters while extending the distance between the roots, the force of wave coming into the port can be weakened.

The crown height of breakwaters of 9.55 meters recommended in the report of Rendel Palmer & Tritton, Ltd. is considered to be excessive. With a careful selection of the most appropriate shape of cross section, the crown height of approximate 6.0 meters (H.W.L. 2.64 m + W.H. 5.5 m x 60%) will be sufficient to prevent storm wave from going over the breakwaters excessively at the time of cyclone. However, it is desirable that experiments with models will be conducted before making the final decision on the crown height and cross section of the breakwaters. It is also advisable that the shore between the breakwaters and also both sides of entrance channel are of such construction as to eliminate wave.

(3) Estimate on the Scale of Maintenance Dredging:

According to the report of Rendel Palmer & Tritton, Ltd., drift sand amounting annually to 1,000,000 to 1,500,000 tons will be held by the sand t trap: 2/3 of the drift sand which will accumulate near the entrance channel will be removed by a suction dredger, while the remaining 1/3 which will

accumulate near the entrance channel will be removed by a suction dredger, while the remaining 1/3 which will accumulate near the mouth of sand trap will be removed by two travelling sand pump mounted on the frame installed over the sand trap for the distance between the shore and the detached breakwater. In other words, this method is designed to catch the entire amount of drift sand by the sand trap and remove it completely.

As discussed in the foregoing 4-2-3-1-(1)(a), however, the amount of drift sand on which this plan is based differs from our opinion. Therefore, if the amount of drift sand is in the neighbourhood of our estimate of 2,000,000 tons, the employment of this method of detached breakwater and sand trap will naturally require larger amount of maintenance dredging work from the first stage, thereby leaving little flexibility.

On the other hand, under our suggested plan of uilding two breakwaters on the east and west sides of the port, it is expected that one suction dredger will keep the route free from any serious disturbance at least for several years after the completion of the breakwaters, even though there may be accumulation of sand on the outside shore of the breakwaters. In the meantime, therefore, various data on the actual conditions of sand drift may be collected and experiments can be made in order to determine the required maintenance dredging work, places of dredging and the best suited dredging equipment.

(4) Reclamation Plan:

The height of reclaimed land included in the original plan is 5.5 meters. However, if considered from the facts that the High Water Lever and Highest High Water Level are 2.5 meters and 5.5 meters respectively while there seems little possibility of suffering damages from flood which may take place only once in several decades and that the original plan itself indicates a shortage of dredged earth, 4.00 - 4.50 meters will be sufficient as the height of reclaimed land. Regarding residential district, however, it is desirable to

reclaim up to 5.5 meters in case damages from flood should be taken into consideration.

By lowering the height of reclaimed land, reclaiming cost as well as construction cost of quays and other structures may be reduced, and also better and more efficient cargo handling may be achieved.

4-3. Execution of Construction Work:

4-3-1. Present Status of Paradeep Port Construction:

In accordance with the Paradeep Port Development Program, survey of harbour area and construction of temporary roads have already been started. The road for a distance of about four miles from the Guest House to the construction site and the road to residential district have been completed.

The harbour area was formerly a marsh of about 2.3 meters high thickly wooded with mangroves, but most of the trees have been cut down at the base, and branches are burnt. Some 800 laborers are said to be employed for this work, which will be increased to 2,000 in the future. They live in primitive houses on the coast or plain, but better living accommodations for them, we understand, will be provided with by the rainy season.

All the tree roots in the harbour area will be removed by dry work with the labor force and also with machines to be purchased so that excavation work will be pushed forward as much as possible before dredgers become available.

On the sands between dune and beach are colored surveying piles to show the center line and both edges of the entrance channel, and the scale of work can be found at a glance.

Approximately 80% of the canal and the road which is a part of ore road running from Paradeep Rock to the hinterland of the port has been completed: The intention is presumably to use them for the transportation of construction materials, and there were pontoons for the use of temporary bridges at the place crossing the creek.

Warehouses are under construction at certain part of the residential area, and pipe truss and brick are being unloaded at the nearby creek; Roads in this neighbourhood will be completed before long. The State Government invited tenders, in November 1962, for dredgers (drag suction for maintenance dredging) and dredging work included in the first stage program (volume of earth to be dredged: 6,500,000 m^3), and the tenders will be made soon. According to the notice of tender, the dredging work is to be commenced in March 1963 and completed in 18 months. Tenders will also be invited soon for the transport of building stone for the breakwater; The State Government is fully determined to expedite materialization of the plan even at any cost.

4-3-2. Execution Plan and Construction Schedule:

The first stage work as is included in the report of Randel Palmer & Tritton, Ltd. to complete a port capable to export iron ore of 2,000,000 tons annually by the end of 1965 seems to involve considerable difficulties in various aspects, and some increase in the construction cost as well as technical assistance from foreign countries should be taken into consideration. Because the port is to be constructed by excavation, dredging work and construction of ore berth must be carried on simultaneously: The other problem is that dredging of the approach channel must be sheltered by the breakwater in order to protect the channel from wave and sand drift.

For the assembling of cargo handling equipment, a part of ore berth must be completed six months prior to the completion of final work at the latest; in other words, piling of ore berth must be made as the bed is excavated, and the construction of ore berth including laying of railway must be completed in 16 months. The breakwater should be built at least to the height of H. W. L. before the start of dredging of 2,000,000 m^3 for approach channel.

The construction schedule prepared with due consideration to the above matters is shown on the attached data.

4-3-3. Dredging Work

(1) Work Method and Assignment of Dredgers:

Volume of earth to be dredged under the first stage work will be as follows:

Turning Circle	:	1,425,000 m^3
Ore Berth	:	1,905,000 m^3
Slipway	:	42,000 m^3
Entrance Channel	:	1,068,000 m^3
Approach Channel	:	2,081,000 m^3
Total	:	6,521,000 m^3

Excavation of a part of inland by dry work and removal of tree roots in the surface layer will be effective in avoiding blocking-up of the suction head of a dredger at the time of dredging work. But, the dry work excavation should not go beyond -1 meter, because excavation work deeper than surface layer becomes more difficult owing to penetrating water from sand layer and may invite the danger of flooding in rainy seasons as well as lowering of work efficiency. Besides, the deeper the land is excavated, the higher becomes the excavation cost.

Of the above mentioned volume of earth to be dredged, it is advisable to make the dredging of the approach channel at the final stage of work as it will have to be dredged in the open sea; Even if it is dredged in the earlier stage of work, the approach channel may be filled up again by drift sand during the monsoon season, and also the operation of dredgers outside of dune involves considerable danger as there is no shelter in an emergency. Excavation of inland should be started with the excavation of creek in the shortest distance by small size suction dredgers which can be disassembled, and preliminary dredging of a pocket with depth and width large enough to enable the operation of large size suction dredgers should be made by such small size suction

dredgers at the site for ore berth (size of pocket; depth: -5 m or more, width: 60 m or more, length: 90 m or none). The reason why a collapsible dredger is recommended is that since the work may have to be started in the monsoon season, the dredger may be unloaded at a nearby port and assembled at the site in case if it can not be brought in from the open sea.

Although the pocket for the large size dredger can be excavated by dry work without using the small size dredger, it will be more advatageous to employ the small size dredger which can also be very useful for the finishing of side slope, inner filling of cell quay, reclaiming of the back and dredging of slipway.

In order to complete the entire work within the scheduled period with one large-size dredger, a cutter suction dredger with the main pump of 4,000 P. S. will be required.

Dredging of dune area and entrance channel should not be made at an earlier stage of work in order to keep the construction of ore berth free from the effect of wave: Their dredging should be started at the end of 1964, and the dredging of the entrance channel should be carried on toward the offing, keeping pace with the progress of breakwater construction.

Dredging of the approach channel should be taken over by the drag suction dredger for maintenance dredging use, which will be ready in the early part of 1965; the cutter suction dredger will be better employed in the second stage of dredging work.

According to the boring bar chart, the earth in this area is, for the most part, of comparatively soft sand which could easily be dredged, but sufficient amount of spares for cutters, pump casings, impellers, steel pipes, etc. which will be worn out considerably should be prepared.

As for the method of actual reclamation, the area should be partitioned into several sections by embankment so that each section may be finished to

the planned ground height separately. This method will prove to be more advantageous in the utilization of the land after reclamation. It is necessary to install overflows at each section so that flow of runoff mud into creek and canal may be avoided.

(2) Cost of Dredging Work:

If the land to be reclaimed is within the distance of 3,000 meters (including floaters), the cost of dredging will be approximately ¥420 per cubic meter, or approximately ¥2,740,000,000 in total; while the amount estimated by Randel Palmer & Tritton, Ltd. for the dredging work of the first stage program is 36,000,000 rupees (¥2,720,000,000).

4-3-4. Berth & Others

(1) Construction of Berth:

As for the construction of ore berth, because the existing foundation is rather good, it is recommended to employ a cell type quay with straight sheet piles which is best suited for a rapid execution of work. Judging from water depth of the berth and other factors, the appropriate diameter of the cell will be about 26 meters; Structure of quay is designed so that dredging is possible up to -14 meters. Distance between the centers of cells is 27.8 meters, and the 11 cells will give the additional berth length of 275 meters. In the case of extension of the berth during the subsequent stages, more cells can be driven in by an arc connection. The sheet piles to be used are straight sheet piles, for instance, manufactured by Yawata Iron and Steel company in Japan (weight: 54.2 kg/m), and the length of piles is 23 meters for the first half and 18.0 meters for the latter half; the crown height of the driven pile is + 2.5 meters, (Please refer to the attached chart of cross section.)

(2) Outline of Work Method:

The method to be employed is the "Underwater guide Method"; A piling boat is floated on the guide-ring which is supported in the water, and makes

circling work; The cell is finally clossed from the outside. The guide-ring is to be assembled on land, and installed by a 50 ton class crane barge in such a way as to have the top end at -2.0 to -2.3 meters. To support the guide-rings, H-pile of 10 - 15 meter long are used and driven by means of monkey hammer. In order to provide yards for sheet pile storage, processing, assembling of guide-rings, etc., a temporary revetment of -2 meters or so should be built near the ore berth to be built under the second stage work.

Since each cell can be built separately, the work can be expedited by increasing the number of piling boats. But, two sets of guide-rings must be prepared for each boat. The sea bottom at the work site should be dredged to the depth of -13 meters in the front side and -11 meters in the back, and also -2 meters for a distance of about 35 meters beyond the back side; This dredging work is to assure efficient operation of the piling boats in cell and arc driving. The dredged part can be refilled by small-size dredgers after the inner filling of cells has been completed.

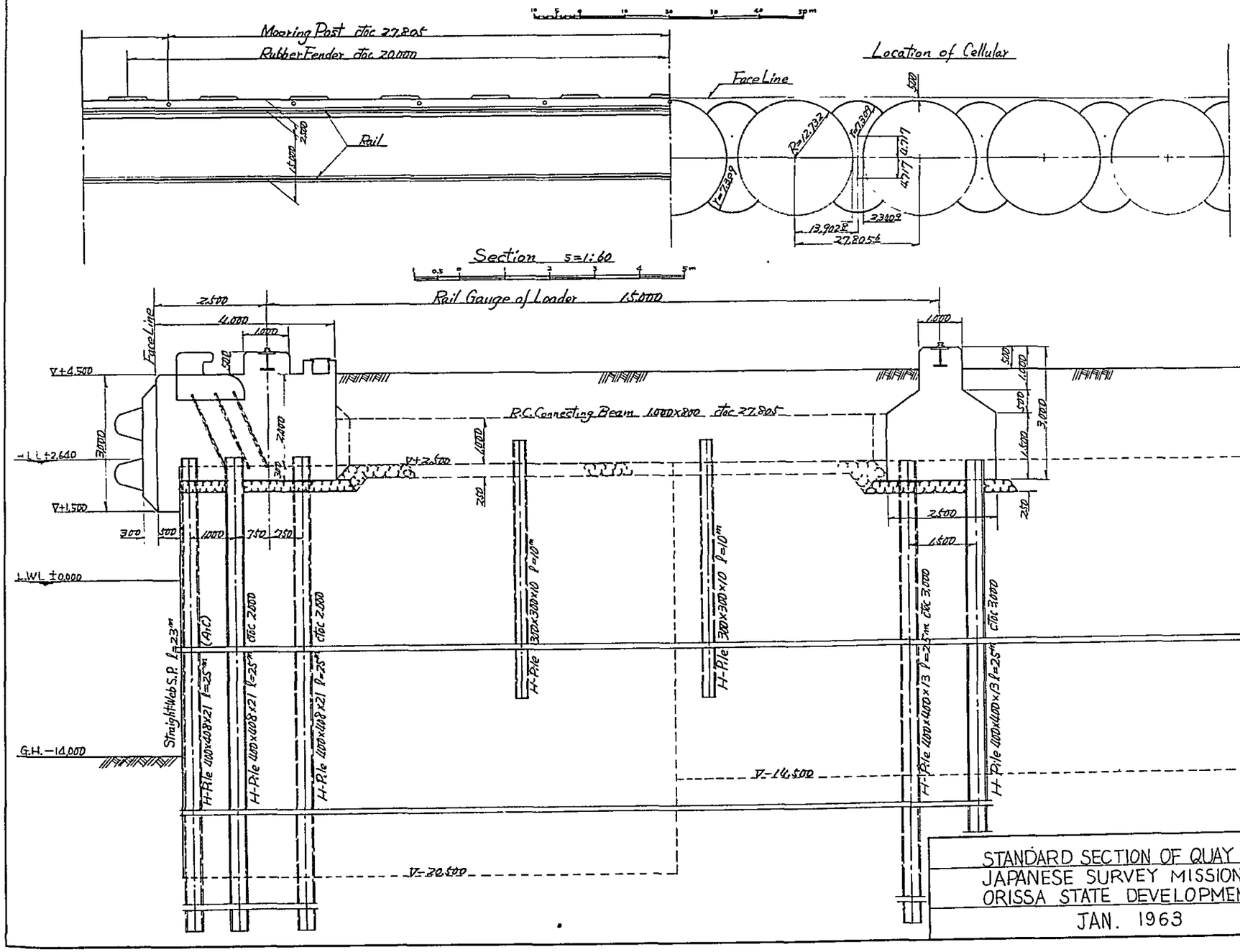
(3) Cost of Work:

The construction cost of berth is estimated to be approximately ¥3,100,000 per meter (please refer to Table 9), but is also subject to the following conditions:

(a) Vessels, machines and materials required for the work are as explained in the Table 10 and Table 11, but the cost do not include any transport cost or freight. In case they are sent or transported from Japan, the costs included in the bottom columns of the respective Tables should be added.

(b) Labor costs are calculated on the basis of charged wages in Japan. Since the cell work requires special experience, it may be difficult to obtain the skilled laborers in India. If the skilled laborers are to be recruited from Japan, they will require labor cost of four to five times.

(c) The cost of building stone is the price at the site, but the costs of other materials are based on the prices in Japan. (Costs of all the works



STANDARD SECTION OF QUAY WALL
JAPANESE SURVEY MISSION FOR
ORISSA STATE DEVELOPMENT PLANNING
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included hereinafter are calculated on the same basis.)

(Note): Comparison of labor cost in Japan and that in India shows that the cost of an ordinary laborer is ¥600 - ¥1,000 in Japan; while, the cost in India is 2 Rs. - 3 Rs. (¥150 - ¥225), which is approximately 1/4 of the Japanese cost. However, since the efficiency of Indian laborer can not be estimated owing to the different climate, custom, work condition, etc. it is simply assumed to be 1/4 of that of Japanese laborer. In other words, as far as the labor cost is concerned, the cost in Japan is simply adopted, and if the efficiency of the Indian laborer is more than what is estimated, the actual cost will be smaller.

(d) Cost of civil engineering work on ore yard: (The work includes ore yard, road and drainage facility, but excludes foundation work for machine installation. The cost is not included in the construction cost of berth.)

300 m x 130 m = 39,000 m^2

¥6,900 per square meter

Total Cost : ¥269,100,000.

No accurate cost can be obtained unless calculation is made in details on each item of ore yard equipment.

TABLE - 9

Outline of Construction Cost of Ore Berth:

Material Cost (including sheet piles, H-piles, steel bars, cement, aggregate, etc.)	:	¥431,000,000
Work Cost	:	¥300,000,000
Rent for Machines & Vessels	:	¥ 94,000,000
Other Costs	:	¥105,000,000
Total	:	¥930,000,000
Cost per Meter : $\frac{¥930,000,000}{300}$	=	¥ 3,100,000

(Construction Length; Appr. 300m: Effective Length; Appr. 275 m.)

(Note): The sheet piles should be given electric anticorrosive treatment, which will require approximately ¥36,000,000 (domestic price in Japan).

TABLE - 10

Main Materials Required (per berth):

Cement:	1,900 tons
Rail:	50 tons
Sheet Pile:	3,200 tons
H-Pile:	2,700 tons
Other Steel Materials:	1,000 tons
Aggregate (including rubble):	10,200 tons

(Note): Of the above, steel products alone weight 6,950 tons. In case if they are purchased from Japan, the freight including handling charges will amount to ¥57,000,000.

TABLE - 11

Machines and Vessels Required:

Crane Barge (50 ton class):	1
Piling Boat (also to be used as Crane Barge) (30-ton class):	2
Boat to Supervise Diver Boats:	6
Tug-Boat (180 HP - 70 HP):	2
Crawler Crane (7 - 13 tons):	1
" " (13 - 20 tons):	2
" " (25 tons):	1
Bulldozer (also to be used as Tractor-shovel):	3
Dump-car:	10
Tripod Derrick:	1
Compressor ($3m^3$/min.):	3
Turbine Pump with Engine:	5

(Note): Transportation cost of the above machines and vessels from Japan will be ¥130,000,000 including handling charges.

4-3-5. Breakwater:

(1) Cross Section of Rubble Breakwater:

The attached chart is a standard cross section of the breakwater submitted by Indian side. Its crown width is 8 meters, height is + 6.6 meters, and the grade of sea side is 1:2.5 to the depth of -0.85 meters and 1:1.75 for the part below -0.85 meters: The grade on the route side is 1:1.5. Assuming that the maximum wave height is 18' (5.5 m), the size of revetment stone is appropriate in consideration of the side slope of 1.25. The total amount of building stone required is 500,000 m^3; Assuming that the total length of the east and west breakwaters is 1,530 meters, the average amount of stone required per meter will be 330 m^3.

(2) Production of Stone and Method of Transport:

Hariduspur is the only source of stone supply to the construction work of Paradeep Port, but is 95 miles away. The estimated annual production is 183,000^{3}m, but it is said to be possible to increase the output depending on the requirement. There are two ways of transportation; namely, transport by barges through canal and also by trucks on land. If the entire amount of annual output is transported by trucks, it will require in total 200 trucks of 4.5 m^3 loading capacity on the assumption that the trucks are operated 25 days a month and 8 months a year with the daily hauling of 915 m^3. The present condition of the road will allow to expect only one round trip a day because of other traffic and cattles on the narrow road. As for the canal, because there are several lock-gates and the dike is not much higher than the water level, it will be difficult to transport a large amount of stones unless substantial improvement is made on the canal. However, as it is conceivable to use a large number of barges continuously at slow speed, transport

by barges may be more practicable than by trucks.

(3) Cost of Work:

The price of stones acquired in the neighbourhood of construction site is approximately ¥5,700 per cubic meter, which is two to three times as much as that in Japan and about three times of prices in other districts of India such as Bombay, etc. Therefore, if the rubble type breakwater is adopted, the price of required stones per one meter length will amount to as much as ¥1,900,000. This means that 70% of the work cost of breakwater construction (approximately ¥2,700,000 per one meter length) estimated by the Indian side is accounted for by the acquisition price of stones: Since it is reasonable to consider about 30% of the total cost of work as stone piling cost, the cost of rubble breakwater will become much higher compared with the actual cost of a similar breakwater in Japan.

Therefore, in order to reduce the construction cost of the breakwater, it is necessary to employ other type breakwater which requires smaller amount of building stones.

The report of Randel Palmer & Tritton, Ltd. estimates the work cost of the breakwater construction to be approximately ¥1,400,000 per meter, which is, judging from the actual experiences in Japan, considered to be appropriate. By selecting the best suited and most desirable type of breakwater, the cost of work at Paradeep Port may be reduced to what is estimated in the report of Randel Palmer & Tritton, Ltd.

(4) Breakwater of Casisson Construction:

A breakwater using caissons is extensively employed in Japan, and the cost of construction is comparatively small. (Please refer to the attached sheet of construction cost of breakwater.)

Since the Paradeep Port Program includes the construction of a slipway, the caisson may be manufactured and temporarily placed by taking advantage of

the slipway; and in the meantime, construction of rubble embankment to the water depth of -5 meters or so and riprap foundation for the caissons is executed. Then, simultaneously with the excavation of dune, the caissons are taken out and installed permanently, thus making it possible to construct the breakwater easily in a short period of time. In case where the caissons are manufactured in India, it is necessary to undertake a careful control of cement quality and also of manufacturing process.

4-4. Cargo Handling Equipment:

4-4-1. Comment on R. P. T. Plan:

(1) This report embodies our views and opinions on the ore loading equipment to be installed at Paradeep Port on the basis of the Rendel Palmer Plan and with due consideration to the results of our on-the-spot survey and existing condition of port facilities at various places of India, especially the expansion project of Vizagapatam Port.

(2) The plan proposed the State Government is to install, by the end of 1965, the loading equipment capable to ship iron ore of 2,000,000 tons annually; It is planned to construct one berth with one ore loader which is capable to handle hourly 2,000 tons of iron ore. The berth is to be large enough to moor 60,000 ton class ore carriers in the future, but is to moor carriers up to 30,000 ton class for the time being. The cargo handling equipment of the ore yard which is located at the back of the berth is suitable to handle the ore and also can be used for the shipping of iron ore of 5,000,000 tons per annum in the future without any modification. At that time, one more additional ore berth will have to be built and another ore loader of 2,000 ton/hour must be added; Such additions will also require expansion of related facilities such as belt conveyers and handling equipment at the ore yard.

(3) As far as loading capacity is concerned, even when iron ore of 5,000,000 tons is shipped yearly, two berthes with two ore loaders of 2,000 ton/hour

capacity each are sufficient as stated in the plan of Rendel Palmer & Tritton, Ltd. However, quays and belt conveyers are planned in consideration of future construction of the third berth.

(4) According to the report of Rendel Palmer Plan concerning the ore loading oquipment, each loader is installed for the exclusive use at one berth, and neither the berthes nor the rails of travelling loaders are connected. This means that even when 60,000 ton class ore carriers are moored in the future, the loading of ore will have to be made by only one loader of 2,000 ton/hour capacity, thus taking 30 hours for loading ($\frac{60,000 \text{ tons}}{2,000 \text{ t/hr.}}$). Assuming that the ore loader can be operated 10 hours a day, the loading of ore will require three days.

If the No. 2 Berth is constructed in future in connection with the No.1 Berth, and the rails of two travelling loaders are also connected, the two loaders can undertake the loading work simultaneously for one carrier: Excep for the case where two carriers are moored at the same time, two loaders can always be engaged in the loading of ore on to one carrier, thereby shortening the loading time by one-half. For this purpose, the position of the loader conveyers should be changed, and tall travelling trippers should be employed to transfer ore to the loades. This will also eliminate the elevated steel structures for conveyers, thereby reducing the construction cost and also assuring a easier maintenance.

(5) Among the cargo handling equipment at the ore yard, the type of reclaimer suggested in the Rendel Palmer plan should be improved to a reclaimer of shovel wheel type which travels on the travelling rail of the stacker. As for the capacity, it is recommended, for the sake of perfect maintenance of the reclaimer, that the originally planned one reclaimer of 2,000 ton/hour should be changed to two reclaimers of 1,000 ton/hour each.

The reason for the recommended change is that even if one reclaimer should have to be kept idle owing to a breakdown or mishap, the other can handle up

to 75% of the required total capacity of 2,000 ton/hour by working on three shifts: This is considered to be quite adequate for such operation in the locality where industries are not highly developed.

(6) Since iron ore is brought into the port continuously day and night through a year, it is most economical to send the incoming ore directly to the ore loader and then on to the ship without storing it at the ore yard: This will also increases the life of reclaimers.

In handling ore of 2,000,000 ton/year as planned under the first stage work, assuming that the annual working days are 285 days and that daily operation time is 15.5 hours on two shifts, the tonnage of ore to be transported hourly will be 450 tons (7,000t/15.5 hrs.), and the required capacity of reclaimers can be reduced by the equivalent amount.

With two shifts operation per day, the capacity of ore loader will be 20,000 ton/day (2,000 ton/hour x 10 hours), which is approximately three times of the transporting capacity of 7,000 ton/day, and the anual working days will be 100 days (2,000,000 tons/2,000 ton/hour x 15 hours x 0.65).

(7) Any breakdown of the cargo handling equipment at the port will cause very serious problem, and, in such a case, shipping of ore at the mine will have to be suspended. However, since the ore loaders and conveyers are required to be operated about 100 days a year as discussed above, there will hardly be any suspension of work for a long time if sufficient maintenance work and spares are provided.

The problem, if any, will arise in connection with the receiving belt conveyer system and the 1,000 ton/hour ore stackers which are to be operated to handle the ore transported by trucks continuously day and night for 300 days a year. Though these are hardly have any breakdown with the main parts being belt conveyers, it is a dvisable to provide enough spare parts and sufficient maintenance work whenever possible. In case where the operation of these equipment should be suspended, trucks might be able to unload ore around

the ore yard provided that all the trucks are of automatic sidedumping type. If this not practicable, the midway service center should be notified to stop the shipping of ore at the mine and also all the trucks must be parked at the service center and the port. The parking lots at these places should be large enough to accomodate all the trucks in operation. (The parking yard may be outdoor.)

(8) Among the ore handling equipment, the machine which is most complicated and likely to have mechanical breakdown is the reclaimers. But, since the reclaimers will not have to be operated when no carrier is in, and because the annual operating days are about 100 days as discussed above, sufficient maintenance work can be made; Nevertheless, it is recommended to prepare ample supply of spare parts.

As discussed above, if two reclaimers each having capacity of 1,000 ton/hour are installed instead of one reclaimer of 2,000 ton/hour capacity recommended in the Rendel Palmer Plan, tree - shift operation of one reclaimer alone can handle 15,000 tons a day without fail, and if the directly transported ore of 7,000 tons is added, a loading capacity of 22,000 ton/day will be guaranteed.

(9) Transport of iron ore by trucks on the ore road for the shipment of 2,000,000 tons annually (7,000 ton/day, 2 ships basis) as planned under the first stage work can be carried out satisfactorily by making a partial revision (as discussed below) to the plan prepared by the State Government of Orissa. However, in case of transporting 5,000,000 tons a year as intended under the second stage work, whether or not it is appropriate to increase the number of trucks for the purpose of handling additional 3,000,000 tons is a very serious problem which must be reviewed carefully in the future.

We are of opinion, same as the Rendel Palmer Plan, that even if the railway transportation is employed, a plan should be worked out to connect it with the existing belt conveyers through newly installed car dumpers,

hoppers and feeders, without making any change to the present first stage work. Of course, such a plan should include as a part of the port facilities necessary area and places for the side-line, loaded car line and empty car line.

(10) Concerning the trucking plan, the State Government of Orissa assumes annual operation of 360 days to reduce the cost of ore transportation. However, it is extremely difficult, if not impossible, to carry out such operation judging from the conditions of mine, labor control at the ore handling plant of the port and the maintenance of machines and equipment. The number of work days should be shortened to 300 days a year or less and made uniform through the entire plan.

(11) Although it may not be desirable from the viewpoint of administration of port facilities, it is necessary to install a machine shop for simple repairing of trucks and also welfare facilities for the drivers besides the parking yard at the port as discussed above, because 150 to 200 trailer dump trucks will be in operation and arrive every 1.5 to 2 minutes. If possible, the repairing shop should be used not only for the repairing of trucks out also for the repairing of ore handling equipment.

(12) Other port facilities such as the central office of cargo handling, weighing equipment for trailer trucks, power transformer station, water and oil supply equipment for the vessels, etc. are as included in the Rendel Palmer Plan and are not discussed herein.

4-4-2. Breakdown of Construction Cost:

(Unit: ¥1,000,000)

ITEM	FIRST STAGE (2,000,000 t/yr.)	SECOND STAGE (5,000,000 t/yr.)
(1) Receing Hoppers, Feeders & one set of Belt Conveyers:	26,500	24,000
(2) Ore Stacker with Rail (1,000 t/hr):	12,000	10,500
(3) Ore Reclaimer (1,000 t/hr) (2):	25,000	25,000
(4) Ore Loader with Rail (2,000 t/hr):	14,500	13,500
(5) Transformer Station, Electric Lights, Weighing Machine, Office, etc.:	10,000	4,000
(6) Spares (Electricals, Machine Parts, Belts):	5,000	5,000
(7) Taxes (Assumed)	9,000	7,000
Total	102,000	89,000

(Conditions):

(1) The above costs were estimated on the assumption that hotels for supervisors and living accommodations for workers and other living and welfare facilities are fully prepared in Paradeep.

(2) It is necessary to complete unloading wharf of machines, railway construction for crane and road to transport machines to the ore yard. It is assumed that a floating crane (30 ton class) for unloading machines will be hired.

(3) If the assembling work at the site and manufacturing of steel structures are contracted in India, payment in Rupees in the amount of less than 30% of the total may be made.

4-4-3. Estimated Ore Loading Cost Under the First Stage Program:

Total Cost of Machines and Equipment included in the First Stage Work:		¥1,020,000,000
Rate of Annual Instalment with 20-year Depreciation and 6% Interest per annum		0.0872
Amount of Annual Instalment of Interest Payment & Depreciation (¥1,020 million x 0.0872):	Appr.	¥ 88,900,000
Wage Cost (¥15,000/mon. x 12 mons. x 60 workers):		¥ 10,800,000
Electric Power Cost -Appr. 2,000KW-(6NP/KWh):	Appr.	¥ 14,000,000
Repairing Cost (2%):		¥ 20,000,000
Cost of Wear and Tear (1%):		¥ 10,000,000
Total :		¥ 143,700,000

Loading Cost per Ton of Iron Ore: $\frac{¥\ 143\ \text{million}}{2\ \text{million tons}}$ = ¥71.8

4 - 5. Technical Assistance and Training of Technicians:

Upon the commencement of the construction of the Port of Paradeep, the State Government of Orissa which previously had no port facilities hired Mr. Shriniverson who was formerly with Madras Port as the Chief Engineer in charge of the entire construction program. However, because of no personnel who is well experienced in the harbour construction, little has been done on the details of the project and designing. The Mission was also requested strongly to make technical advice and recommendation on the project and execution of actual work.

Many technical advices were given on the project at site. However, as discussed in this report, since the disposal of drift sand is a very difficult problem, there will be many cases where changes and revisions to the project and design will be necessitated as a result of observation during the process of construction.

An economical execution of the construction of structures (such as breakwater and berthes) would require specialized engineers. One

experienced engineer for the investigation of sand drift and changes of project (extension and revision of direction of breakwater) and two engineers for the designing and supervision of construction work (one for dredging work and the other for structures) will be necessary.

Whether or not such engineers may be found in India is not certain, but it is desirable to have Japanese engineers stationed in India for helping the chief engineer. The engineers can be readily selected from the middle class engineers in Japan.

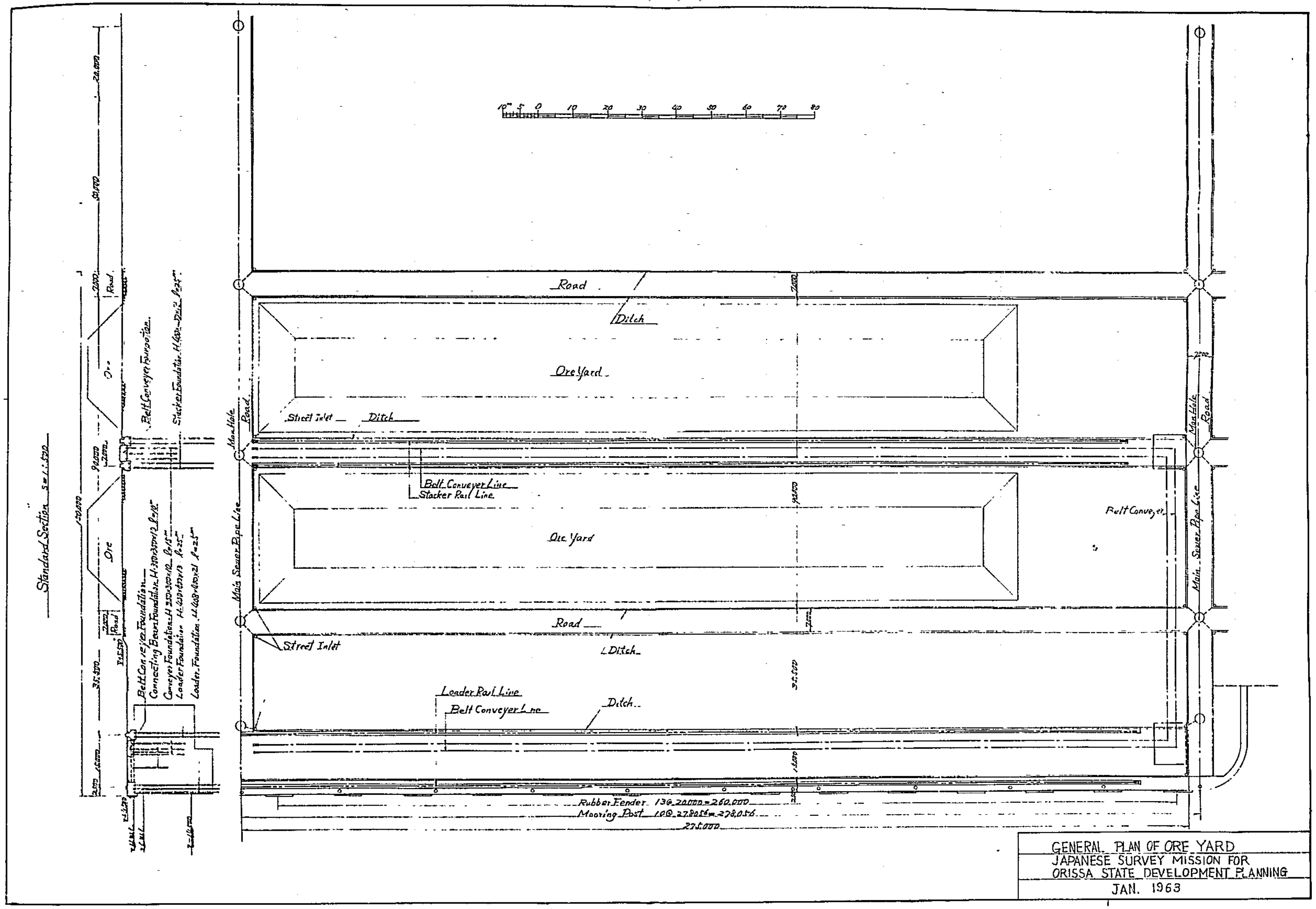
Should there be any difficult problem which can not be handled by these engineers, higher class engineers may be temporarily sent to India specially to work out a solution of such problem.

As for the construction of structures, since the Indian technique has made no progress but merely follow the conventional British method, it would be more economical to induce the Japanese technique. The lower class engineers should be trained at such places as Bombay, Vizagapatam, Calcutta, etc. and assigned to the work at Paradeep.

As far as concerns the harbour work, it is advisable to hire the service of Japanese engineers, but road construction work can be handled sufficiently by the engineering staff of the State Government of Orissa. It is also added that the Japanese contractors are very well qualified to undertake the construction works.

Attached Figures:

1) General Arrangement of Ore Handling Plant.
2) 2,000 t/hr. Ore Loader.
3) 1,000 t/hr. Ore Reclaimer.
4) 1,000 t/hr. Ore Stacker.
5) Hopper, Feeder & Truck Dumping Device.

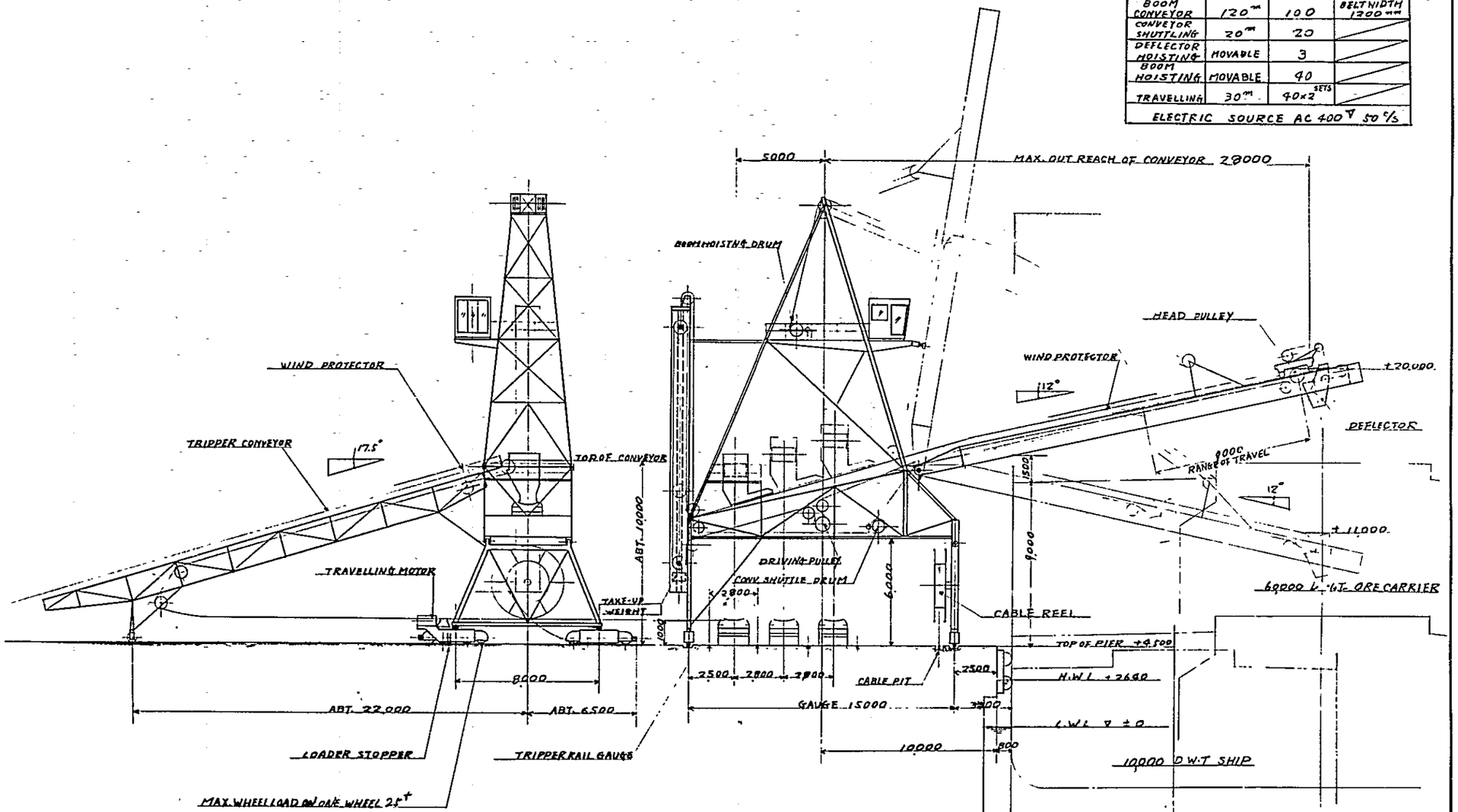


GENERAL PLAN OF ORE YARD
JAPANESE SURVEY MISSION FOR
ORISSA STATE DEVELOPMENT PLANNING
JAN. 1963

SPECIFICATIONS

	SPEED m/min	MOTOR kW	REMARKS
BOOM CONVEYOR	120 m	100	BELT WIDTH 1200 mm
CONVEYOR SHUTTLING	20 m	20	
DEFLECTOR HOISTING	MOVABLE	3	
BOOM HOISTING	MOVABLE	40	
TRAVELLING	30 m	40×2 SETS	

ELECTRIC SOURCE AC 400 V 50 ~/s

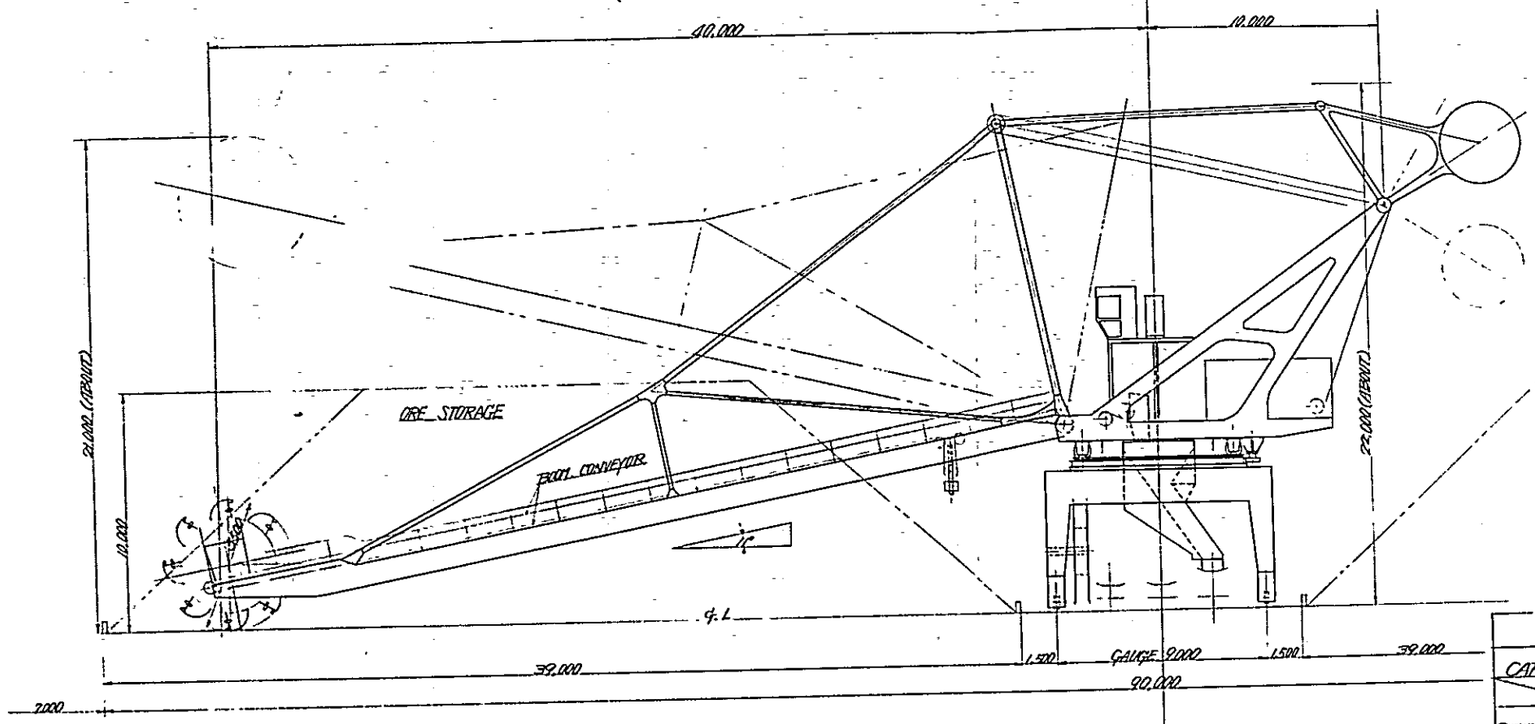


ORE LOADING CAPACITY = 2000 M.T/H

ORE HANDLING EQUIPMENT
2000 T/H SHIP LOADER

JAPANESE SURVEY MISSION FOR
ORISSA STATE DEVELOPMENT PLANNING

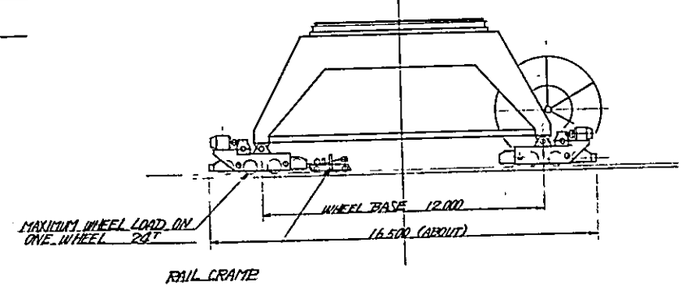
N₂ EC-10507



SPECIFICATION			
CAPACITY	1000 T/H		
	SPEED M/MIN	MOTOR KW	REMARKS
BUCKET WHEEL	0~5 REV.	50	USED OIL MOTER
SLEWING	MOVABLE	15	USED OIL MOTER
DERRICKING	5	20	
TRAVELING	30	25HP × 4	
BOOM CONVEYOR	120	50	
RAIL CRAMP	MOVABLE	0.75HP × 2	
ELECTRIC	SOURCE	AC 600V	50 CY.

ORE STORAGE CAPACITY: (ONE SECTION 165m L)

$10^{m} \times (39^{m} - 11^{m}) \times (165^{m} \times 0.8) \times 2.2\,t/m^{3} \doteqdot 80{,}000\,t$

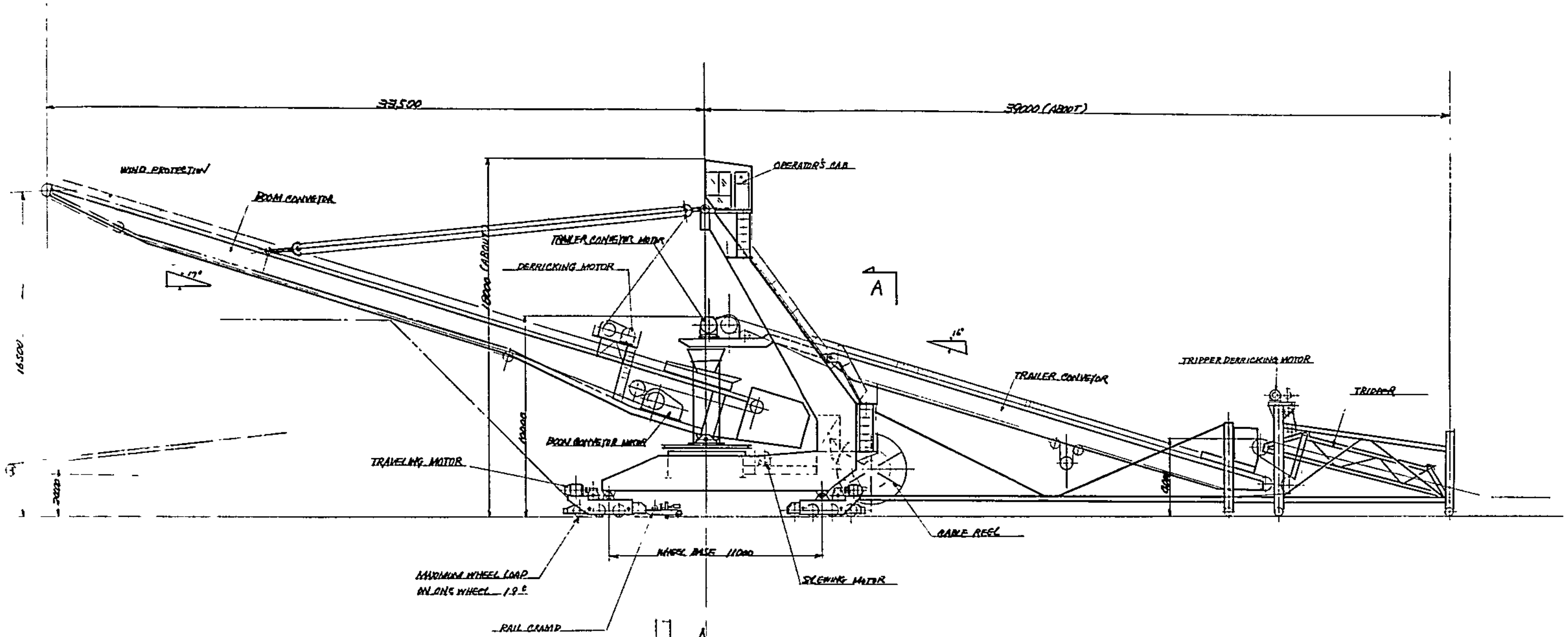


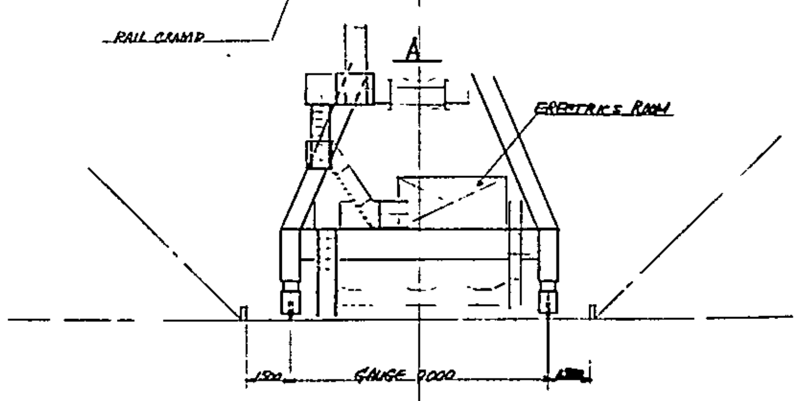
ORE HANDLING EQUIPMENT
1000 T/H WHEEL TYPE LOADER

JAPANESE SURVEY MISSION FOR ORISSA STATE DEVELOPMENT PLANNING

T. Inoguchi
K. Mukoto

1/2 EC-10508





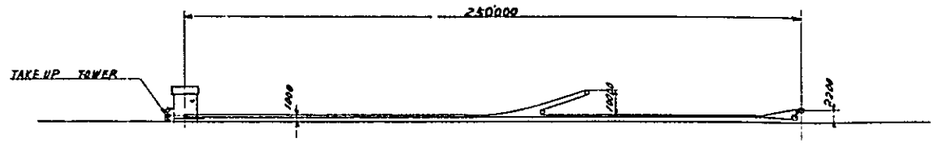
SPECIFICATION			
CAPACITY	1000 t/H		
	SPEED M/MIN	MOTOR KW	REMARKS
BOOM CONVEYOR	90	50	BELT WIDTH 1050
TRAILER CONVEYOR	90	40	BELT WIDTH 1050
DERRICKING	5 AT THE BOOM END	15	
TRAVELING	30	20 × 4 SET	
SLEWING	1/5 R.P.M	7.5	
TRIPPER DERRICKING	MOVABLE	5.5	
RAIL CRAMP	MOVABLE	0.75 × 2 SET	
ELECTRIC SOURCE	AC 400V	50 c/s	

ORE HANDLING EQUIPMENT.

— 1000 t/H STACKER —

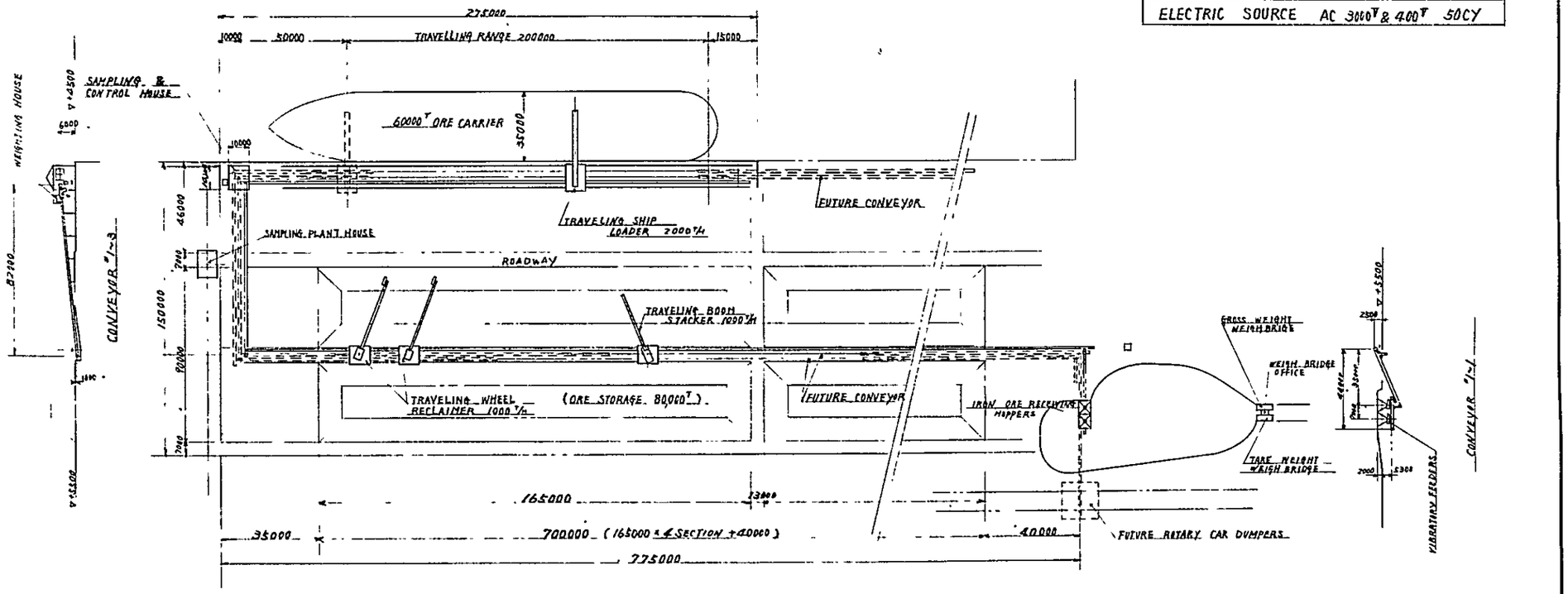
JAPANESE SURVEY MISSION FOR ORISSA STATE DEVELOPMENT PLANNING

		T. Sugawara
Y.	EC-10506	K. Ukukata

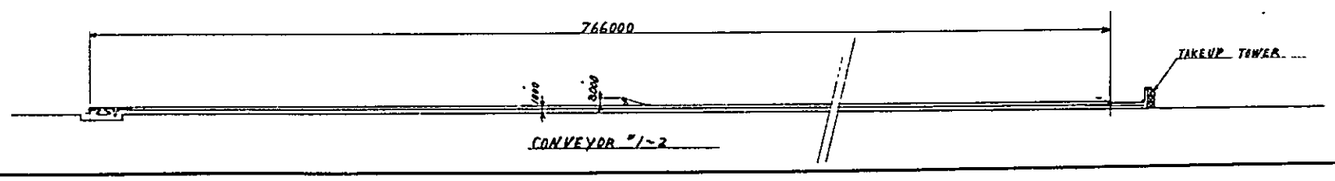


CONVEYOR #1~4

SPECIFICATION					
CONVEYOR NUMBER	CAPACITY T/H	BELT SPEED M/M	MOTOR POWER KW	BELT WIDTH, MM	LENGHT M
1 - 1	1000	90	50	1050	44
1 - 2	2000	120	200 x2	1200	766
1 - 3	"	"	100	"	82
1 - 4	"	"	250	"	250
ELECTRIC SOURCE AC 3000V & 400V 50CY					



ORE STORAGE CAPACITY = 80000T x 8 SECTIONS = 640000T (FUTURE)



ORE HANDLING EQUIPMENT
CONVEYOR ASSEMBLY

JAPANESE SURVEY MISSION FOR ORISSA STATE DEVELOPMENT PLANNING

T. Iwamura

P | EC- 10505 | K. Uchida

Appendix . PART I

A. INTRODUCTION

This document, and the accompanying Master Plan folio of drawings is a Report on the proposed development of a Deep Water Port at Paradeep.

The Report includes a brief history of work done on the project up to date, together with the Consulting Engineer's recommendations, estimates of cost, possible construction methods and a provisional construction programme.

B. SUMMARY OF CONCLUSIONS

1. The Consulting Engineers concur with the opinion of the Central Water & Power Research Station that it is practicable to construct a deep water port at Paradeep with a Lagoon Type Harbour.
2. A suitable site for the harbour would be that with the centre line of Entrance channel at Indian Naval Survey Station 'U' south of the Mahanadi River.
3. The coastline south of the mouth of the Mahanadi River near this point can be considered as stable and substantial movements are unlikely.
4. Initially one Iron Ore berth should be sufficient for a throughput of 2 million tons per annum to be loaded into ore carriers of up to 60,000 tons, deadweight.
5. In the first stage of development one Cargo berth capable of accommodating vessels of up to 14,000 tons, gross register, should be built.
6. Ultimately the port can be developed to include 3 Iron Ore loading berths, 19 Cargo berths, an oil dock with two berths, and ship repair yard having two dry docks.
7. An area can be set aside for future development as a Naval Dockyard.
8. It is estimated that the first ore carrier could dock in October, 1965, and the cargo berth could be opened in mid 1968. Prior to

the latter date cargo vessels could use Buoy Berths.

9. The cost of the Main Port Construction work for the initial development would be approximately Rs. 11.7 Crores of which about 25% might be foreign exchange. This sum does not include the cost of Ore Handling equipment and stockyard, Dredger, Harbour Craft, Roads, Services, Buildings, and Canal Extension. These additional items are expected to cost a further Rs. 4.5 Crores of which about 45% might be foreign exchange.

10. The cost of the additional Main Port Construction Work for the Ultimate Development would be approximately Rs. 40 Crores. This Ultimate Development would not be required for very many years though another Ore berth and additional Cargo berths might be necessary in the not too distant future.

11. Passage of the largest ships in the Channels and Turning Circle will be limited to the upper half of each tide as is often the case in waters. Ships will be able to lie afloat at their berths at all stages of the tide.

12. A dredger will be required for the continuous maintenance dredging of the Sand Trap, and Approach Channel and the occasional dredging necessary in the Entrance Channel and Docks. This dredger should be able to do some of the initial dredging of the Sand Trap and Approach Channel, but a further dredger will be necessary for the initial dredging of the Entrance Channel and Turning Circle.

13. Modifications to the Master Plan layout may be necessary after the model tests have been completed at the C.W.P.R.S., Poona.

14. Areas set aside for the township and industrial development are shown on Master Plan Drawing No. PP/23.

15. Almost all the land for the development shown will have to be raised in level and it is intended that the excavation from the Turning Circle

Channels and Docks be largely used for this purpose. There will not be sufficient spoil available from the Port excavations for the reclamation of the whole of the area required.

C. TERMS OF REFERENCE

An agreement for the preparation of a Report on the Development of a Port at Paradeep and for the subsequent design and supervision of construction of the works was made between the Government of Orissa and the Consulting Engineers in a document dated the 24th November 1961.

The following extract from this document deals with the scope of the works and the services to be provided by the Consultants.

"SCOPE OF THE WORKS:

(a) The Government of Orissa propose to mine and transport iron ore and to ship this and other commodities from a new Port to be constructed at/or near Paradeep. Whilst the Consulting Engineers would be pleased to give any help required in connection with the transport of the ore the services covered by this Agreement are in connection with the design and construction of the Port and the development of the Port Area only.

(b) The Consulting Engineers understand that:

(i) The State Government approve the general concept of the layout recommended in the Report of the intermediate Ports Development Committee but agree that the Consulting Engineers may recommend such minor revision of the detailed siting and layout as they consider desirable following their study of the information available.

(ii) The Interim and Final Reports of the C.W.P.R.S., Poona, will shortly be made available for reference by the Consulting Engineers, and that the Government will arrange for the C.W.P.R.S., Poona, to carry out such further investigations as the Consulting

Engineers recommend.

(iii) The Port is to be designed to be capable of exporting 5 million tons of iron ore per annum and that three mechanised berths are contemplated for this purpose, the first of which should be in operation 2-1/2 years from the start of the work.

(iv) Provision is to be made in the initial scheme for importing about 50,000 tons of coal per annum and facilities for the handling of phosphate rock imports, oil and general cargo.

(v) The layout of the Port is to be such that it can later be expanded to provide further general cargo berths and an oil berth.

(vi) A Master Plan is to be drawn up showing the general lines of the initial and future Port Development. It is at present intended that the first stage of Port development is to provide for a connexion to the extension of the Taldanda Canal and that the Master Plan shall provide for the future development of additional berths, moorings and sites for a shipbuilding yard, an oil refinery, naval base, etc. Access for barges is to be provided between the Port and the Mahanadi River or a creek thereof. Areas are to be indicated for industrial and residential development.

(vii) The Port is to be located inland of the present shoreline and it is to be connected to the sea by a channel cut more or less at right angles to the coast. The entrance to the channel from the sea is to be protected by a breakwater or breakwaters as may be found necessary, and the littoral drift is to be catered for by a suitable sand trap and dredging.

SERVICES TO BE PROVIDED BY THE CONSULTING ENGINEERS:

The duties of the Consulting Engineers in connection with the Port are to be divided into two Phases, as follows:

PHASE I

(a) The preparation of a Master Plan for the Port Area showing the arrangement of the initial requirements and the future developments, the areas to be reserved for residential and industrial purposes and the alignments of road and rail access to the site. This plan is to be discussed and agreed with the Government of Orissa.

(b) The preparation of a Project Report for the Government giving, in addition to the agreed Master Plan, a brief description of the installation to be constructed in the initial stage, and of the provisions for possible future expansion; together with a preliminary estimate of cost of each of the main features. The Project Report will define the scope of the initial or first stage work which is to be designed and constructed in Phase II and will give a Programme for it.

(c) The land survey of the Port Area as may be necessary and the investigation of available data and information relating to the works.

(d) Advice as to the necessity for additional investigations of conditions of sub-soil, tide, weather, by hydraulic model investigations and the necessary associated hydrographic survey".

This Report deals with PHASE I quoted above: PHASE II deals with the subsequent detailed design and supervision of construction of the works.

D. HISTORY OF PROJECT

In 1948 the Port (Technical) Committee recommended investigation into establishing a port between Vizagapatam & Calcutta to develop trade and Industry in Orissa and neighbouring states.

Surveys, investigations and collection of data were made by the Central Water Power, Irrigation and Navigation Commission for various potential Port sites.

In 1951 a French Mission of Consulting Engineers was invited to India by the Central Government to assist them in selecting the most suitable site for a deep water port on the Orissa Coast. The Mission examined several sites and came to the conclusion that the Mahanadi River was the most suitable. It was recommended that port facilities should be located within the estuary with an approach channel dredged through the bar and protected by breakwaters on either side. Model tests were proposed to determine the best method of stabilizing the mouth of the river.

In 1952 the Indian Navy at the request of the State Government surveyed the approaches to the Mahanadi River and adjoining coastline as far out as the 10 fathom line.

In 1954 the Ministry of Transport provided a loan for model tests to be carried out by the Central Water and Power Research Station at Poona and shortly afterwards model tests began. Model tests were encouraging, though, at this time the possibility of a Coastal Harbour was also being considered, due to the various disadvantages of an Estuarine Harbour referred to later in this Report.

At that time Japanese interests were investigating the possibility of securing the export of iron ore from Orissa and they submitted a comprehensive and encouraging report on the development of both the iron ore mines and a port at Paradeep. This report, recommended a Coastal Harbour, as against an Estuarine one, for the export of two million tons of iron ore per annum.

In 1958 Paradeep was declared a Minor Port and experimental loading of iron ore by lighters into ships standing at anchorage in the open sea in the fair weather season was started. The ore was brought down from the mines at Tomka 144 kilometres (90 miles) away by road, rail and Canal. This method was slow and expensive, and, pending consideration by the Government of India of the proposal for the establishment of an all weather deep water

port at Paradeep, it was proposed to deepen the canals, improve the locks and introduce motor launches for towing barges in an Intermediate scheme for exporting up to half a million tons of Ore per annum using Paradeep as a lighter port.

Thus the development of Paradeep as a Port is becoming increasingly important, not only for opening up the rich hinterland of Orissa and encouraging industry, but to serve as the outlet for a valuable mineral export.

Consideration of Estuarine and Coastal Type Harbours

Investigations and model tests carried out the C.W.P.R.S. up to 1958 indicated that a Coastal Type Harbour was preferable to an Estuarine Type Harbour, among the disadvantages of the latter being the following :-

(i) The Mahanadi River is estimated to bring down about 28 million tons of sediment load annually. As the sea bed at the river mouth is very flat the tendency for the formation of a bar was noticed which would necessitate the extension of breakwaters from time to time.

(ii) There may be some navigational difficulties as river current velocities of 6 to 7 knots were observed in the modeal for a flood discharge of 10,600 cubic metres per second (3,000,000 cu. secs.).

(iii) Considerable maintenance dredging would be necessary to maintain a 244 metre (800 ft.) wide channel near the port site and the 305 metre (1,000 ft.) diameter turning circle site.

(iv) It would not be possible to maintain a deep channel for admitting ore carriers without resorting to constant dredging.

(v) The right bank training wall on the outside of the curve

would probably require considerable maintenance from time to time due to high velocity of flow alongside.

(vi) The deep water channel hugs the southern breakwater due to the curvature imposed by the river upstream. Heavy discharges in the river might undermine this breakwater.

As a result of these observations, it was decided by the C.W.P.R.S. that alternative proposals should be investigated and model studies were accordingly carried out for a Coastal Type Harbour, at a point some 6-1/2 kilometres (4 miles) south of the Mahanadi River where the coastline appeared to have been stable over the last 60 years.

The proposal was that a harbour of 97 to 114 hectares (240 to 280 acres) should be formed by two breakwators similarly arranged as Madras Harbour with the entrance at the North East corner and an approach channel running North East and East. Various alternative arrangements of breakwater alignment, width of entrance etc. were tested and the effects of waves on the breakwaters and inside the harbour studied.

These tests proved the feasibility of a Coastal Harbour. However, the great length of breakwaters necessary, most of which would be in deep water, would be very expensive as the nearest quarry site for suitable stone is over 80 kilometres (50 miles) away. In addition to this costly item, there would be the problem of dealing with the littoral drift which would necessitate the extension of the breakwaters and continous sand pumping and dredging as at Madras.

It was concluded that in view of the high capital cost and maintenance problems the Coastal Harbour would not be an economic proposition and that a further alternative should be investigated.

Lagoon Type Harbour

Model tests were then commenced on a Lagoon Type Harbour as Provided at Vizagapatam. This type of harbour has an advantage that

construction of berths, quays, etc. is relatively cheaper because this can be done in the dry before the entrance channel is opened up. Further advantages over the Coastal Type Harbour are that better protection against cyclones is afforded and phased development is possible.

The site initially chosen for the Lagoon Type Harbour was about half-way between the mouth of the Mahanadi River and the Coastal Harbour site, opposite Indian Navy Survey Station 'T'. The result of these model studies was satisfactory and showed that such a harbour could be successful.

However calculations showed that due to the shape of the sea-bed contours there was a concentration of wave energy at the harbour entrance which could be dangerous to shipping and prove costly for the upkeep of breakwaters. In addition to this hazard there was the factor of the potential instability of the river mouth and adjacent coastline due to the interaction of the river discharge and the littoral drift which might be a danger to the harbour and the port installations.

The site had the further disadvantage that the closeness of the river severely restricted development on one side of the port area and thus made difficult the provision of a good layout for a possible large ultimate development.

It was therefore decided to move the harbour mouth some 1800 matres south west to a point opposite Indian Naval Survey Station 'U'. At this point the seabed contours do not cause a concentration of wave energy and there is no risk of the harbour and the port installations being damaged by movement of the river mouth.

Although this site does not permit the construction of a large ship lock between the port area and the Mahanadi River the Consulting Engineers do not feel that this is a disadvantage. The site is considered suitable for the phased development of as many berths as are likely to be required for a port in this situation and there is therefore no need to give

consideration to the construction of deep water quays along the right bank of the Mahanadi River. In this connection it should be noted that in the results of the model tests on the estuarine harbour the C.W.P.R.S. drew attention to the scour which occurs in the River at the proposed site for the quays - this would present problems during construction and maintenance.

The main part of this Report gives details of the investigation for the establishment of the Lagoon Type Harbour with its entrance opposite Indian Naval Survey Station 'U'.

E. MAIN PROPOSALS

It is proposed that a Lagoon type Harbour should be constructed, initially, as shown on Master Plan Drawing No. PP/24 to be capable of being extended over the years until the Full Development as shown on Master Plan Drawing No. PP/23 is reached.

The Harbour is approached by a dredged channel which is protected by 3 rubble breakwaters giving an entrance width of not more than 500 metres (1,650 ft.).

Inside the breakwaters an Entrance Channel approximately half a mile long leads into a Turning Circle. From the Turning Circle three arms lead off to form the wet docks having the necessary iron ore handling berths and cargo quays. Other arms are provided for a future Naval Dock area and oil berths.

STAGE I

During the initial development, Stage I, the breakwaters will be constructed to their ultimate size. However, dredging of the Approach and Entrance Channels and Turning Circle will only be sufficient for the passage of the size of vessels to be accommodated at this stage of the development.

It is proposed under Stage I that one Ore Berth for vessels up to 60,000 D.W.T. and one cargo berth 185 metres (607 ft.) long for vessels

up to 14,000 G.R.T. should be constructed; in addition to this one Buoy berth will be provided.

The Ore Berth will be provided with handling equipment for an annual throughput of 2 million tons of iron ore. The ore will be delivered by road to the stockyard where it will be stacked and reclaimed by tractor shovels. The ore will be carried to the berths by a conveyor and loading of the ships will be by a mobile ship loader running on tracks on the jetty. Details of the ore handling arrangement are given on Drawing No. R/14. Facilities for the import of limited quantities of oil products will be provided at this berth.

The Cargo Berth will be equipped with one transit shed. The design of the berth will be such as to allow for the ultimate installation of dock side cranes but initially the cargo will be loaded or unloaded by ships gear and handled on the quay by fork lift trucks. The cargo will be transported to and from the port by road or canal. The facilities provided under this stage should be sufficient to enable up to 200,000 tons of general cargo and small parcels of bulk cargo including coal to be handled per year.

A 300 ton slipway for slipping Coastal & Harbour Craft has been included in the layout as well as limited workship facilities.

The Taldanda Canal has been shown to be extended from the Athrabanka creek to the Port and access to the harbour provided through a lock to enable canal craft to proceed alongside ships if necessary; otherwise canal borne cargo can be handled at the barge basin and taken to the transit shed or quay.

A major road will connect the Port with the hinterland.

Full Development

The Full Development as shown on Master Plan Drawing No. PP/23 allows for 3 ore berths, to accommodate one 60,000 D.W.T. and two 30,000 D.W.T. ore carriers, 19 Cargo berths each 185 metres (607 ft.) long to

receive vessels up to 18,000 G.R.T. and an Oil Dock equipped with 2 berths for 100,000 D.W.T. Oil Tankers.

It is estimated that 3 to 4 million tons of general cargo could be handled over the cargo berths in addition to bulk cargoes at the iron ore and oil berths.

The initial development of the Port has been so arranged that the Approach and Entrance Channels can later be dredged to allow 100,000 D.W.T. Oil Tankers to have access to the Port.

The Ore Dock can be extended to cater for a throughput of at least 5 million tons of ore per annum. Modification of the ore handling arrangements will be necessary for this quantity and the layout has been made designed for road transport of the ore from the mines but could be adapted to rail transport should this be introduced at a later date.

It is proposed to introduce a completely mechanised system for receiving the ore and stacking out, as described later in this report and shown on Master Plan Drawing No. PP/15. Modification would not necessitate scrapping any existing equipment as the initial conveyor system could be extended. Receiving hoppers into which the ore would be discharged direct from rail wagons, a slewing boom stacker for stacking out, and bucket wheel reclaiming machines would be added. Two mobile ships loaders would be required for the two new berths.

In view of the possibility of the introduction of rail transport at a later date the cargo quays have been arranged with rail tracks and tracks for dockside cranes. Details of the proposed quay layout are shown on Master Plan Drawing No. PP/18.

The Oil Dock will be provided with two berths of the 'tee' Head jetty type. The jetty heads would be equipped with suitable hose handling gear and connected to the shore by a short road approach and pipetrack.

The Port will by this time have become one of the major ports on

the Eastern seaboard of India and as such it should be equipped with adequate ship repair facilities. It is therefore proposed that two dry docks be constructed. The smaller dry dock would be for coastal craft and be approx. 105 metres (350 ft.) long x 18 metres (60 ft.) wide and the larger dry dock approx. 230 metres (750 ft.) long x 35 metres (115 ft.) wide.

A fitting out berth would be provided along the southern perimeter of the Turning Circle and the workshop facilities considerably extended.

By this time it is probable that the area reserved for a Naval Dockyard between the ship repair yard and the Entrance channel would be developed.

F. ACKNOWLEDGMENTS

In the preparation of this report much information has been obtained from outside sources and grateful acknowledgment is due particularly to the following : -

The C.W.P.R.S. Poona for information concerning the Model Tests and Meteorological information.

The Meteorological Department of the Government of India for details of cyclonic storms and other information reproduced from C.W.P.R.S. reports.

The Meteorological Office, Air Ministry, London, for information reproduced in Appendix G.

Officials and staff of the various departments of the Government of Orissa, particularly the Public Works Department, regarding the marine and land surveys, quarry sites etc.

The Report of Intermediate Port Development Committee dated April 1960.

In Appendix I is given a list of all the major documents which have been referred to.

RENDEL, PALMER & TRITTON.

Appendix

PART II

This part of the Report deals in more detail with the information collected to enable the feasibility of constructing the Port at the chosen site to be confirmed and gives full details and estimates of the cost of the works proposed.

1. LAND SURVEY

The Consulting Engineers Representative responsible for the preliminary land survey arrived on the site in November 1961. Detailed survey work was commenced in January 1962 and it has now been substantially completed. The purpose of this survey was to provide basic information including the position of the coast line, the extent of the dunes and swamp, ground levels and position of creeks and watercourses intersecting the site.

The approximate area covered by the survey was a strip up to 3,500 metres (11,500 ft.) wide extending from just south of the mouth of the Mahanadi River south west along the coast for 9,500 metres (31,000 ft.)

The base line for the survey was a line connecting up the Indian Navy Survey Stations, R, S, T, U, V, and X which are situated on the sand dunes just landward of high water mark and approximately parallel to the coast line. Main survey lines were cut through the swamp and jungle at right angles to the base line at roughly 1,000 metre intervals: these lines were subsequently traversed by theodolite and level. A number of intermediate lines were surveyed and in the Port area traverses were made at right angles to the main survey lines.

Drawing No. R/1 is a survey plan of the Port Area and shows the position of the various survey lines.

Drawing No. R/2 shows typical cross sections through the proposed Port Area; line U-U6 being normal to the coast on the centre line of the proposed Entrance Channel and line U1A - U1B being parallel to the coast

through the proposed Turning Circle.

The result of this survey shows there is a belt of sand dunes immediately landward of high water mark approximately 200 metres (680 ft.) wide whose maximum height in places is 7 metres (23 ft.) above general ground level.

Behind the dunes the site consists of mangrove swamp and light jungle, the general level of which is about 2.4 metres (8.25 ft.) above Admiralty Chart Datum. From the table in paragraph 7 it can be seen that this level is just below that of the highest monthly average of high water levels and well below that of the highest high water level recorded from May 1951 to April 1953. The area is intersected by a number of watercourses and creeks all of which are tidal.

A sand ridge running from South to North commences approximately at survey point "V" and is about 1,500 metres (5,000 ft.) behind the sand dunes at line UT. This ridge is the remains of a line of coastal sand dunes and is approximately 150 metres (500 ft.) wide with a maximum height of 6.7 metres (22 ft.) above Datum. Inland of this ridge the jungle and swamp continue until the Athrabanka Creek is encountered at approximately 3,250 metres (10,500 ft.) from the coast on line "U".

2. AIR SURVEY

An air survey of the port area and its immediate surroundings was flown in April 1962.

The large scale mosiac and maps of the port area to a scale of 1:2500 which are to be prepared from the survey have not yet been received. These are required to enable the detail between the main survey lines to be filled in.

3. MARINE SURVEY

The Government of Orissa carried out a marine survey of the approaches to the Mahanadi River between December 1961 and March 1962.

This survey, carried out by hand sounding, extended from Indian Navy Survey Station 'R' south westwards to Station 'W' and was carried out as far as the 10 fathom line.

The result of this survey in the form of soundings based on Admiralty Chart Datum are given in Drawing No. R/3 and a comparison between the positions of the coastlines on the surveys of 1889, 1930, 1952 and 1962 is shown on Drawing No. R/4.

It is rather difficult to locate the exact position of the "coast line" for the 51/52 Indian Navy Survey, however, a comparison of the latest survey with that carried out in 1951/52 indicates that the coastline has moved as follows :-

Opposite Indian Navy Station	'W'	advanced seawards approximately	20 metres	(65 ft.)
"	'V'	"	60 metres	(200 ft.)
"	'U'	"	40 "	(130 ft.)
"	'T'	movement nil		
"	'S'	receded approximately	40 "	(130 ft.)
"	'R'	"	40 "	(130 ft.)

At 'S' the sea bed has been lowered and the contours have generally moved towards the shore.

At 'T' the sea bed contours remain practically unchanged as far out as the 4 fathom line beyond which the sea bed contours have again moved towards the shore.

At 'U' (i.e. on the centre line of the proposed approach channel) the sea bed contours remain unchanged as far out as the 7 fathom line beyond which the sea bed contours have again moved towards the shore.

At 'V' the contours of the seabed are substantially unchanged.

A comparison between the latest survey and the 1889 chart shows that in the vicinity of the proposed harbour the coast line has advanced

seaward by the following approximate amounts :-

Opposite	I.N.	Station	'W'	advanced	seaward	150	metres	(500 ft.)
"	"	"	'V'	"	"	175	"	(575 ft.)
"	"	"	'U'	"	"	160	"	(525 ft.)
"	"	"	'T'	"	"	200	"	(650 ft.)
"	"	"	'S'	"	"	375	"	(1,230 ft.)
"	"	"	'R'	"	"	350	"	(1,150 ft.)

However it must be borne in mind that the scale to which the 1889 survey is drawn is such that an error in scaling from this chart of 1/100th of an inch represents a distance of 60 to 90 metres (200 ft. to 300 ft.) and that the geodetic position of False Point Lighthouse on the 1952 and 1962 surveys is some 10 seconds east of the position plotted on the 1889 Chart survey - this represents a distance of approximately 200 metres (650 ft.) measured at right angles to the coast line. If the position of the lighthouse is made coincident for the two surveys and all the survey information is plotted relative to the lighthouse which is of course how it was actually recorded then, within the limit of plotting and scaling errors it can be said that the coastline has not advanced appreciably between the dates of the earliest and latest surveys.

The Consulting Engineers view is that on a coast of this type with a substantial movement of beach material considerable fluctuation of the position of the shoreline can occur from time to time without there necessarily being any permanent advance or regression. With a predominant littoral drift from the south-west to the north-east the silt brought down by the Mahanadi River does not have any significant effect on the configuration of the coastline to be the south west of the mouth.

4. BOREHOLES AND SITE INVESTIGATION

During the period January to April 1962, 13 boreholes were sunk over the area of the site as follows :-

3 No. offshore bores on line of Entrance Channel in depths varying from 5 to 6-1/2 fathoms of water.

2 No. Land bores on centre line of Entrance Channel.

8 No. bores in main Port area.

The exact position of these boreholes is shown on Drawing R/5.

Boring was carried out by Shell and Auger equipment in 6" and 8" diameter cased holes.

Bores No. 4 and 5 were carried down to a depth of 45 metres (150 ft.) below ground level while the remainder of the land boreholes were taken down to a depth of about 30 metres (100 ft.)

Graphical presentation of the borelogs is shown in Drawing Nos. R/6, 7, 8 & 9.

The borelogs show that the site is a typical delta area with a considerable depth of varied alluvial deposits interspersed with sand deposited by the sea.

The depths at which the various deposits were encountered varied considerably, but the bores indicate some degrees of uniformity as follows:-

Depth below existing ground level	Level relative to Admiralty Chart Datum Metres	Description of Strata
From existing G. L.	+ 2.5.	Varies from loose fine
to 6 - 7. metres	-3.5 or -5.0	sand over full depth to alternate layers of silty sands, sandy clays and soft clays.
From 6 - 7-1/2 metres	-3.5 or -5.0	Silty clays or medium/lo
to 10 - 51-1/2 metres	-7.5 or -13.0	grey silty fine sand.
From 10 - 15-1/2 metres	-7.5 or -13.0	Firm silty clay with
to 17 - 21-1/2 metres	-14.5 or -19.0	layers of silty sand.

From 17 - 21-1/2 metres	-14.5 or -19.0	Dense fine silty sand.
to 28 - 33-1/2 metres	-25.5 or -31.0	
Below 28 - 33-1/2 metres	-25.5 or -31.0	Very stiff clay.

The ground water level was just below the surface at the time the borings were made.

Vane tests were carried out in some of the soft clay deposits while Standard Penetration Tests were taken in the silts and sands.

The Vane Tests show that the upper clays are very soft and likely to consolidate considerably under load or if drained; however friction piles could probably be founded in the clays below 15 metres (50 ft.).

The Standard Penetration Tests indicate that the sands and silty sand above a depth of 17 to 21-1/2 metres (56 to 71 ft.) are loose to medium while below that depth they are dense and would be suitable for founding end bearing piles.

Undisturbed samples were taken of the cohesive soil and jar samples with the occasional bulk sample from the non-cohesive soils. These were forwarded to the specialist contractors laboratory for testing; so far test results of only a few samples have been received.

A series of in-situ permeability tests were made in borehole No. 12. Preliminary calculations indicate that the coefficient of permeability of the silty sands is of the order of 10^{-4} or 10^{-5} cms. per sec. which would afford poor drainage, while the sandy clays have a coefficient of 10^{-6} or 10^{-7} cms. per sec., which means they are practically impervious. Preliminary calculations indicate that due to low permeability of the soils a considerable amount of the main bulk excavation in the turning circle area and part of the entrance channel could be done in the dry with side slopes of 1 in 4 without excessive pumping. However the low permeability would cause poor drainage of the slopes and local instability of the slopes might

occur during the construction period.

In general it can be stated that foundations of any consequence must be supported by piles except where large differential settlements can be tolerated; a possible exception being in the area of the inland sand ridge where surface footings might be permitted.

All the above observations are based on a study of the borehole logs and field tests only. Until further test results are received it is not possible to give more specific details concerning safe bearing capacity, permeability, side slopes for cuttings etc.

5. METEOROLOGICAL INFORMATION

A summary of the main meteorological information for the area is given in Appendix 'G'.

Cyclonic Storms

Paradeep is situated in a cyclonic area and plots of all known cyclonic storms between the years 1891 and 1923 and the years 1938 and 1953 are shown in Drawings Nos. R/10 and R/11 respectively.

These storms are likely to come from any point of the compass and the resulting storm waves have been taken into consideration in the design of breakwaters, model studies etc.

Although in restricted waters cyclonic storms have raised water levels considerably above normal, on an open coast such as at Paradeep the effect is very much less. In many cases recorded 'flood levels' are in fact the heights to which wave crests were driven under the influence of the local winds. It is thought that the level given in paragraph 7 for a storm wave at False Point Lighthouse is such a level. Where adequate shelter to a port is provided by substantial harbour entrance works the rise of water level in the port due to cyclonic conditions is likely to be small.

Winds

On Drawing No. R/12 are diagrams of wind forces, frequency and

directions plotted from records taken by the Orissa Government during 1959 to 1961.

During March to September the S.W. monsoon occurs and the predominant wind is from the south west with some variations to both west and south. The Strength generally varies between Beaufort force 3 and 5, but there are some periods when the force increases to 6 and during June and July occasional periods occur when the strength is force 7 or even higher.

During October to December the predominant winds are from the north and north east. Forces during this period, the N.E. monsoon, are generally much less than during the S.W. monsoon period and seldom exceed force 4.

Waves

Wave direction is predominantly from the South West from April to September with a normal maximum height of 2.75 to 3.0 metres (9 to 10 ft.).

From November to January waves are from the North East and East with a maximum height varying between 2.5 to 3 metres (8 ft. and 10 ft.).

Drawing R/13 shows diagrams of wave height frequency and direction recorded during 1959 to 1961. During storms these wave heights can be exceeded by a considerable amount. Appendix H gives a table showing the maximum wave heights computed from synoptic weather charts by using Hindcasting Technique for Paradeep. It can be seen that the location of the fetch area considerably affect the resultant wave height at the coast and that under certain conditions waves up to 5 to 6 metres (17 to 20 ft.) could occur offshore of the harbour site.

Due to the shoaling effect the height of deep waves from certain directions is reduced near the coast. Wave reflection diagrams prepared by the C.W.P.R.S. Poona show that due to the configuration of the shore line off Indian Naval Station 'T' orthogonals from the south and south-east would converge and there would be a concentration of wave energy at this point

resulting in waves rather higher than the theoretical wave height. This phenomena does not occur at point 'U'. Wave orthogonals from the south west, east and north east tend to diverge resulting in waves lower than the theoretical height.

All the above has been taken into consideration in siting the harbour entrance and the positioning of breakwaters; however slight adjustments to these may be necessary after results of the latest model tests are available.

A Wave gauge has recently been set up near the proposed harbour site. Gauging is now in progress and will continue so that an accurate record of wave heights can be made to assist in the final design.

Currents

The Prevailing Ocean surface current runs approximately parallel with the coast. From February to April this current runs from S.W. to N.E. with a maximum velocity of about 1/2 to 3/4 knots. From August to October this current runs from N.E. to S.W. with a maximum velocity of about 3/4 knots.

Observations made by the Orissa Government Hydrographer during the recent marine survey indicated that in addition to the Ocean current there was a tidal stream set on the surface having a maximum velocity of 1 to 1-1/2 knots at Spring tides for both ebb and flood. This current was more pronounced inshore tailing off to a maximum of 3/4 to 1 knot outside the 10 fathom line.

The general direction of this tidal stream set was parallel with the coast, with flood running in a north easterly direction and the ebb in a south westerly direction. It was noticed that the movement was mainly a surface one and the effects rapidly decreased with depth.

The above tidal stream observations were made during the months from October to January - outside this period velocities and directions may

be different.

6. LITTORAL DRIFT

Littoral drift is mainly caused by waves striking the shore line at an oblique angle under the influence of winds blowing from a particular direction over a period. The breaking waves disturb the beach material and it is moved progressively along the foreshore following the direction of attack of the waves.

On this coast the main wave generating influence is the strong south west monsoon and this causes the waves to strike the shore at an angle of up to 30°. During the north east monsoon the wave direction changes and a reverse drift results but, because of the lighter winds and shorter duration of this monsoon the overall resultant drift is from the south west to the north east. This is confirmed by the long spit of sand which forms on the south west side of the mouth of the Mahanadi River deflecting it to the north east. This spit extends progressively north east until an occasion arises when, due to a temporary cessation of predominant drift or a flood discharge of the River, a breach is formed near the root of the spit and the River forces a new exit. Then either the spit reforms or it continues to move north east as a shoal or island until it joins the north east shore, and a new spit develops on the south west side of the new mouth.

Information obtained at both Madras and Visagapatam shows that the south west to north east littoral drift along the coast is of the order of 1 to 1-1/2 million tons per annum. From the general configuration of the coast there is no reason to consider that the littoral drift at Paradeep is likely to differ substantially from this amount.

7. TIDE AND OTHER LEVELS

During the site survey work a detailed analysis was made of the levels and reliability of the various datums which have been used and these

were correlated with the land survey datum. Satisfactory agreement was eventually arrived at.

All levels in the Report on the drawing refer to Admiralty Chart Datum and are in metres.

The following is a table of Key levels which have been used in the design of the works.

Heights above:

Indian Mean Sea level (feet)	Project Datum (metres)	Admiralty Chart Datum (metres)	Description
19.7-29.6	56 - 59	7.5 to 10.5	Height of coastal sand dunes.
14.74	54.50	6.05	False Point B.M.
14.5	54.43	5.98	Height of storm wave recorded at False Point Lighthouse 1885.
13.2	54.0	5.55	Average level of ground after reclamation.
11.5	53.50	5.05	Proposed Quay level.
5.6	51.70	3.25	Highest high water recorded from May 1951 to April 1953 (Bhatighar Creek - 21st Oct. 1952).
3.6	51.09	2.64	Highest monthly average of high water level (Bhatighar Creek)
2.6	50.8	2.4	General existing ground level in port area.
0.00	50.00	1.55	Indian Mean Sea level.
-0.7	49.80	1.35	Lowest monthly average of mean water level from May 1 1951 to April 1953 (Bhatighar Creek 19 Feb. 52).
-3.14	49.05	0.60	I.N. Bhatighar Creek Datum.

Heights above:

Indian Mean Sea Level (feet)	Project Datum (metres)	Admiralty Chart Datum (metres)	Description
-3.8	48.85	0.40	Lowest low water recorded from May 1951 to April 1953. (Bhatighar Creek - 11 April 1952).
-5.05	48.45	0.00	Admiralty Chart Datum.

8. TYPICAL SHIP DIMENSIONS

The following table gives typical key dimensions of Ore carriers, Cargo Vessels and Oil Tankers which have been used as a basis for the layout of the Port.

Types	Length	Beam	Loaded Draft
30,000 D.W.T. Ore Carrier	655 ft. 199 m.	90 ft. 27.5 m.	33 ft. 10.1 m.
60,000 " "	800 ft. 224 m.	115 ft. 35.1 m.	39 ft. 11.9 m.
18,000 D.W.T. Oil Tanker	560 ft. 171 m.	71 ft. 21.6 m.	30 ft. 9.2 m.
32,000 " "	673 ft. 205 m.	85 ft. 25.8 m.	35 ft. 10.7 m.
45,000 " "	750 ft. 228 m.	97 ft. 29.5 m.	39 ft. 11.9 m.
65,000 " "	845 ft. 257 m.	112 ft. 34.2 m.	42 ft. 12.8 m.
100,000 " "	900 ft. 275 m.	134 ft. 40.9 m.	48 ft. 14.6 m.
8,000 G.R.T. Cargo Vessel	450 ft. 137 m.	64 ft. 19.5 m.	28 ft. 8.5 m.
14,000 " "	550 ft. 168 m.	70 ft. 21.4 m.	31 ft. 9.5 m.
18,000 " "	650 ft. 197 m.	85 ft. 25.9 m.	35 ft. 10.7 m.

It is considered that most cargo vessels using the port will be

in the 8,000 to 14,000 G.R.T. range or less, with only a few in excess of 14,000 G.R.T. even after the full development of the Port.

Stage I of the Development provides for:-

60,000 D.W.T. Ore Carriers or Oil Tankers

14,000 G.R.T. Cargo Vessels.

The Full Development provides for:-

100,000 D.W.T. Oil Tankers

60,000 D.W.T. Ore Carriers

18,000 G.R.T. Cargo Vessels.

9. DREDGED DEPTHS

The paragraphs headed 'Tide and other Levels' gives the values of the 'Lowest monthly average of mean water levels' and 'Lowest low water level' recorded during the period May 1951 to April 1953. These results were recorded over a relatively short period at the Bhatighar Creek tide gauge which was subject to some influence from the flow of the Mahanadi River, but from observations made during the site survey and consideration of all the tidal data they are considered to be reasonably accurate and have been used to determine the dredged levels for the Master Plan. They may however require some minor adjustment at a later date when more information is available. Even if lower levels than these do occur they will be infrequent and the use of the port will only be restricted if the lower levels coincide with the presence of a ship of the maximum draft for which the port is designed.

In calculating the effective draft required 1.2 metres (4 ft.) has been added to the draft of ships to allow for clearance and siltation in addition to which a further 0.5 metres (1.5 ft.) has been added for the Approach Channel to allow for the pitch and roll of the ships.

Ships of maximum draft for the respective stages of development will be able to enter the Approach and Entrance Channels and Turning Circle

on the top half of the tide cycle when the monthly average of mean water levels is the lowest recorded (see paragraph 7). All the berths provide 1.2 metres of water below the keel of ships when the water level is the lowest low water recorded.

Below is a table giving dredged levels and depths of water for various points in the harbour. All these levels are referred to Admiralty Chart Datum.

	Stage I	Ultimate Development
	Dredged Level (Metres)	Dredged Level (Metres)
Approach channel	-12.25	-15.00
Entrance channel and Turning Circle	-11.75	-14.50
Ore Berths	-12.70	-12.70
Cargo Berths	-10.50	-11.50
Oil Berths	-	-15.80

Add 0.40 metres for minimum water depth at berths.

Add 1.35 metres for minimum water depth in channels at half tide level.

10. SUPPLY OF STONE

Investigation by the Orissa Government's Geologist has shown that there is no stone available locally which is suitable for concrete aggregate or breakwater stone.

Stone from the Netkunpur outcrops consist of Khondalite and laterite which are not suitable.

The nearest hard durable stone is found at Harridespur some 80 kilometres (50 miles) north west of Paradeep, (see drawing No. PP/12 in the Master Plan) where there are a number of hillocks of igneous rock in which quarries are already being worked. The rock is granulite (charnockite) formed by the contact metamorphosis of basalt or gabbro.

Samples of the rock were submitted for petrological report and found suitable for concrete aggregate and breakwater stone. Boulders should be available from the quarry.

The proposed quarry site is approximately 3 kilometres (2 miles) west of Harrisdespur Railway station and 6 kilometres (4 miles) from National highway No. 5. The high level canal from Birupa flows within 3 kilometres of the site and the proposed Expressway, the road by which the iron will be brought from the mine to the Port, passes through the site.

At present the quarry is being developed to provide metalling for the construction of the Expressway.

An overhead power transmission line to the quarry and a compressor house are being built. Two gyratory sccondary crushers have been set up and a primary crusher is being installed. A new dock is to be constructed at the canal and a crane erected for loading stone into barges.

It is proposed by the P.W.D. that the stone should be transported to the canal by road and thence by existing canals and the Taldanda Canal extension to the Athrabanka creek. At this point all stone will be off-loaded. Boulders for use as armouring to the breakwaters will be loaded into lorries and taken by road to the stone storage area at the root of the West breakwater. Stone for the core of the breakwaters can be either loaded into bottom opening hopper barges which will be towed out to the breakwater site or at a later date, loaded into lorries and dumped progressively outwards from the shore.

Stone for concrete aggregates, pitching etc. will be taken by lorry from the Athrabanka to stockpiles within the Port Area.

The approximate quantity of stone required for pitching and construction of breakwaters described in later paragraphs is given below. In addition to these figures additional stone will be required for metalling of roads and hard standings and concrete work.

8 to 10 ton blocks	200,000 tons
3 ton blocks	350,000 tons
15 lb to 2 ton blocks	270,000 cubic metres*
Stone for pitching	140,000 cubic metres*

* measured loose

11. MODEL TESTS

As mentioned earlier in this report extensive tests have been carried out by the Central Water and Power Research Station at Poona.

These tests were started over six years ago and dealt with Estuarine, Coastal and Lagoon Type harbours.

Results of the tests and conclusions have been excellently reported in the Stations Annual Research Memoirs. In this report particular reference is made to the 1958 Memoirs and the "Interim report on hydraulic model investigations for a lagoon and coastal harbour proposals" submitted by the Station to the Government of Orissa in late 1961.

It is not proposed to give details in this Report of the model tests for the estuarine and coastal type harbours as these have been presented by the C.W.P.R.S.; however a brief description of the latest model tests for the Lagoon type harbour will indicate how the final proposals for the harbour layout have been derived.

A geometrically similar rigid bed model of the approaches to the Mahanadi River to a scale of 1/150 was constructed covering three miles of coastline.

A lagoon type harbour was superimposed on the model with centre line of approach opposite Indian Naval Survey Station 'T'. This site being chosen so that the Athrabanka Creek could be used for the harbour basin thus decreasing the quantity of excavation and providing a waterway connection between the harbour and the Mahanadi River.

The harbour consisted of an Approach channel and Entrance channel

which connected the basin with the sea.

Two breakwaters on the West and one on the East of the approach channel were provided to protect the Entrance channel and a sand trap located immediately to the south side of the Entrance channel.

The following major series of tests were conducted:-

1. Waves from the East. - 5.2m (17 ft.) high
2. Waves from the S.S.E. - 4.5m (15 ft.) high
3. Waves from S.W. - 5.2m (17 ft.) high.
4. Waves from 17° West of South - 5.2m (17 ft.) high.

As a result of these tests the following modifications were considered necessary:-

1. Extension of the east Breakwater to reduce wave disturbance at the Entrance particularly in respect of waves approaching from the East and North East.
2. Curving the approach channel Eastwards, and realignment and extension of the Island Breakwater to avoid the direct entrance of waves from S.S.E. into the harbour.
3. Reduction in the length of the West Breakwater.
4. Increasing the gap between the Island and West Breakwaters to improve the efficiency of the Sand trap.
5. Deepening the Sand trap.

The layout shown on the Master Plan incorporates the modifications referred to above, although of course for the reasons already stated in paragraph D preceding the position of the entrance has been moved to opposite Indian Naval Survey Station 'U'.

Now that the location of the port has been finally settled further model tests are to be conducted at Poona to check the final alignment of the breakwaters and the Port layout.

MAIN PROPOSALS

12. FULL DEVELOPMENT

The layout of the port as envisaged for the full development is shown on Master Plan drawing No. PP/23. This plan provides for the Full Development of the port area and allocates adjacent land areas for development as residential, government offices and industrial sites as will be required in conjunction with a large port.

The layout shown on the Master Plan provides the following main facilities:-

(i) Nineteen cargo berths capable of handling three to four million tons of general cargo per annum.

(ii) Three iron ore loading berths for the export of upwards of five million tons of iron ore per annum.

(iii) An oil dock with two jetties to accommodate large tankers to supply the adjacent refinery.

(iv) Dry docks, a slipway and repair workshops.

The major items governing the layout are:-

(a) The entrance to the port must be adequately sheltered from predominant storm waves and siltation must be kept to a minimum.

(b) As many berths as possible should be orientated so that they are parallel to the direction of the predominant stronger winds.

(c) The port should be capable of development by stages without disorganisation of the operating area whilst the new construction is proceeding

(d) Access to the port area by road, rail and canal is required with as little interference as possible between the various transport systems.

(e) Adequate storage and stacking areas are required for the effective handling and transhipment of the potential throughput of the port. In this connection it must be noted that the facilities do not provide for warehouse storage as it is considered that for efficient port operation this should be provided in the industrial and commercial areas away from the transhipment storage.

Of these items the one which requires particular comment here is that regarding transport facilities. Although the development of port is at present being planned in relation to road and canal transport the Consulting Engineers consider that when the full development is reached some rail facilities may be required if the fullest use is to be made of the port. During the discussions in Bhubaneswar this point was raised and it was agreed that the Master Plan layout should include full rail facilities so that the Government of Orissa could add them at a later date should they be required.

The major facilities to be provided are described in more detail in subsequent paragraphs but the following details are of interest at this stage:-

(a) Approach Channel

The channel will be dredged to -15.0 metres over a bottom width of 150 metres (492 ft.).

(b) Entrance Channel

This will be dredged to -14.50 metres over a width of 120 metres (394 ft.).

(c) Turning Circle

This will be widened and deepened beyond that provided in the Stage I Development to provide a minimum diameter of 520 metres (1760 ft.) at a dredged depth of -14.50 metres.

(d) Ore Berths

Three berths will be provided, one having a length of 215 metres (705 ft.) to accommodate 60,000 D.W.T. ore carriers and two having a length of 155 metres (510 ft.) for 30,000 D.W.T. carriers. Each berth will be fitted with loading equipment suitable for loading ships without having to move them along the berth during loading.

(e) Cargo Berths

Nineteen cargo berths will be provided each being 185 metres (607 ft.) and having a dredged depth alongside of -11.50 metres. Each berth will have a transit shed and will have facilities for dockside crane and rail tracks.

(f) Oil Dock

An Oil Dock will be constructed and berths provided for two 100,000 D.W.T. Tankers. This dock will be approximately 530 metres (1740 ft.) long and 125 metres (410 ft.) wide. The dredged level will be -15.8 metres.

Each berth will consist of a jetty head approximately 60 metres (200 ft.) long and 15 metres (50 ft.) wide. Dolphins will be provided for mooring the tankers. The jetty head which will be equipped with hose handling gear will be connected to the shore by a short approach arm on one side of which the pipe track from the refinery will be accommodated.

The entrance to the Oil Dock should be provided with an oil boom to prevent spillage into the dock entering the harbour.

(g) Dry Docks and Fitting Out Berths

The Full Development includes the provision of two dry docks, one for coastal craft, tugs and small vessels, the other for vessels up to 220 metres (725 ft.) in length.

It is suggested that the smaller dry dock be 105 metres (350 ft.) long x 18 metres (60 ft.) wide and the larger one 230 metres (750 ft.) long

x 35 metres (115 ft.) wide.

These docks will be sited next to the Slipway for 300 ton displacement ships sited on the southern periphery of the Turning Circle provided in the Stage I Development.

A fitting out berth 175 metres (575 ft.) long is provided by utilising the quay wall of the Turning Circle between the dry docks and area reserved for the Naval Dockyard. If necessary the alignment of the quay on this part of the turning circle could be adjusted to give a longer fitting out berth.

(h) Naval Dockyard

An area of approximately 26 hectares (65 acres) has been set aside for development as a Naval Dockyard. The area shown for this on the Master Plan drawing No. PP/23 includes a wet dock approximately 300 metres (990 ft.) by 120 metres (395 ft.).

13. STAGE I DEVELOPMENT

The Stage I Development has been planned to provide for one iron ore loading berth and one general cargo berth together with the minimum of ancilliary installations. The proposed Development for Stage I is shown on Master Plan drawing No. PP/24. This layout provides for the following main installations.

(a) One iron ore loading berth to accommodate ore carriers of up to 60,000 D.W.T.

(b) One cargo berth, with transit shed, to accommodate cargo vessels up to 14,000 D.W.T. (10,000 G.R.T. approximately).

(c) A slipway for harbour craft of up to 300 tons displacement.

(d) Road and canal access.

It is envisaged that these facilities will allow 200,000 tons of cargo per annum to be handled over the cargo berth in addition to the bulk cargo shipped over the iron ore loading berth. Additional cargo could be

handled by using lighters for loading or unloading ships at the buoy berth. These facilities should enable an initially satisfactory level of trade to be established. As the track of the Port developes further berths can be added in accordance with the Master Plan.

The following are the main details of the proposals:-

(a) Approach Channel

This channel will be dredged so that the side slopes are at the position required for the full development although initially dredging will be only to -12.25 metres. The bottom width of the channel will be 190 metres (623 ft.).

(b) Entrance Channel

The Entrance will be dredged to -11.75 metres and will have a bottom width approximately 170 metres (557 ft.). The side slopes will be formed in the position required for the Full Development and pitched with stone.

Inland of the sand dunes the ground will have to be built up to +5.0 metres on either side of the channel to prevent flooding of the surrounding land at high tide.

(c) Turning Circle

The turning circle will be dredged to -11.75 metres to a minimum diameter of 360 metres (1250 ft.).

Those side slopes which will be in the position required for the Full Development will be pitched with stone.

(d) Berths

The iron ore loading berth for the 60,000 D.W.T. carriers will consist of an open jetty 155 metres (510 ft.) long and 15 metres (50 ft.) wide constructed with a reinforced concrete deck carried on piles and connected to the shore by a short approach of similar construction. Dredged level at this berth will be at -12.70 metres giving a draft of 13.10 metres at lowest low water level.

It will be possible to load 30,000 D.W.T. carriers without moving them but larger vessels will have to be warped along to allow loading at the end hatches. Ore loading equipment for a throughout of 2 million tons of iron ore per annum, as described later in the Report, will be provided.

The Cargo Berth will have a solid quay wall and have an effective length of 185 metres (607 ft.). The distance between the face of the quay and the front of the transit shed will be 19 metres (63 ft.). This width will allow for the future installation of dockside portal cranes and two broad gauge rail tracks.

Dredged level will be -10.50 metres giving a depth of 10.90 metres at lowest low water level.

(e) Cargo Handling

In this stage transport of cargo to and from the port will be by road and canal.

A transit shed approximately 135 metres (445 ft.) long x 45 metres (148 ft.) wide will be constructed at the cargo berth. Loading platforms protected by canopies 7.5 metres (25 ft.) wide will be provided at the rear and both ends of the shed. Drawing No. PP/18 of the Master Plan indicates the layout of these sheds, though of course this drawing refers to the Full Development.

In the early stages all cargo will be loaded or offloaded by ships cranes or derricks.

Open stacking areas will be provided behind the transit shed for items which do not require to be kept covered.

(f) 300 ton Slipway

A 300 ton Slipway, for shipping harbour craft, together with workshop facilities will be provided at the South East of the Turning Circle.

14. BREAKWATERS

Even though the main port facilities are to be limited in the Stage I Development it will be necessary for the breakwaters to be constructed to their final form to provide adequate shelter for ships and protection to the entrance works.

As referred to in paragraph 11 the breakwaters shown on the Master Plan drawings No. PP/23 and PP/24 have been located as determined by the model tests at the C.W.P.R.S. Poona. The relation of the breakwater layout to the littoral drift is described in the subsequent paragraph but the main details of the breakwaters are given herein. Further model tests are still required to determine the optimum position and minimum size of the breakwaters to give the most suitable opening for sand movement with the minimum wave action in the harbour.

The western end of the Island Breakwater is terminated in 3 to 3-1/2 fathoms of water, there being a gap of not less than 215 metres (705 ft.) between this breakwater and the West Breakwater. This gap is sited where the transportation of sand due to littoral drift is expected to be a maximum so that the material will pass through the gap into the sand trap. The width of the Entrance between the Island Breakwater and the East Breakwater is approximately 500 metres (1650 ft.).

The Island Breakwater has a top level of +9.55 m throughout its length and the East Breakwater has a top level of +9.55 m at the seaward end reducing to +5.55 m at the root. The West Breakwater has a top level of +7.55 m reducing to +5.55 m at the root.

Seaward slopes of all breakwaters are 1 in 2-1/2 and armoured with 8-10 tons stone blocks. Slopes on the harbour side are 1 in 1-1/2 and armoured with 3 ton blocks.

The East and West Breakwaters can be constructed by end tipping from the shore with the armour blocks being placed by travelling crane.

The Island Breakwater can be constructed by bottom dumping barges up to low water level, after which end tipping can be carried out by lorries travelling over the Trestle from the shore. The armouring blocks will again be placed by travelling crane.

In order that repair work after exceptional storms can be carried out exeditiously it would be advisable to have a reasonable stock pile of large blocks of stone readily available at the site.

15. MAINTENANCE DREDGING AND SANDPUMPING

To protect the harbour from waves from the south and south west, the predominant direction, a breakwater is required but if this were solid it would cause the littoral drift to accumulate on the west side and this would eventually spread around the breakwater and across the entrance as at Madras and elsewhere. Therefore, an opening will be provided in the breakwater for the sand to pass through and collect in a trap on the inside from which it can be dredged or pumped. The gap between the West and Island Breakwaters so formed must be in the region where main sand movement takes place, which is the breaker zone. The waves causing the bulk of the movement will be the larger predominant waves, say 1.8 m (6 ft.) to 3.25 m (10 ft.) although the even larger storm waves will cause a quantity of movement disproportionately greater than the period during which they occur. Thus account should be taken of waves up to say 4.5m (15 ft.). Therefore it is important that the seaward end of the opening should be beyond the point at which the waves break i.e. in at least 5.5m (18 ft.) of water at low tide. Landward of this point movement of sand will take place over the whole width of the sand covered by the water. If the opening between the breakwaters were too small the sand would build up against the west side of the west breakwater and cause the whole beach profile to move forward; this would cause the line at which the waves break to move seaward and increase the amount of sand in movement seaward of the Island breakwater;

this in turn would mean that more sand would move along the outside of the Island Breakwater and across the harbour entrance. If the opening were very large and the West Breakwater were very short then virtually all the sand in transit would pass landward of the Island breakwater; but this would expose the harbour area to excessive wave action. A compromise has therefore to be arrived at so that as much as possible of the sand in movement passes behind the Island breakwater and the wave action in the harbour from waves passing the west end of the Island breakwater is kept as small as possible.

Model tests made at Poona show that with 2.1 m (7 ft.) high waves from the South West and an opening between the breakwater of 215 m (70 ft.) wave heights in the sand trap area would be 0.6 m (2 ft.) to 1.1 m (3-1/2 ft.). Thus 3.25 m (10 ft.) to 4.5 m (15 ft.) waves offshore might produce waves of 1.5 m (5 ft.) to 2.1 m (7 ft.) in the sand trap area.

To ensure efficiency of the sandtrap the opening should be not less than 215 m (705 ft.) even at the risk of increasing wave action in the sand trap area. It is proposed that the sand deposited in the trap area should be removed by two methods; that carried well across towards the harbour entrance will be removed by a suction dredger, and that deposited near the entrance to the trap will be removed by two travelling sand pumps attached to a gantry running out to the Island Breakwater.

As stated in paragraph 6 it is anticipated that the littoral drift material arriving from the south west which will have to be dealt with will be between 1 and 1-1/2 million tons per annum. It is proposed that approximately one third of the material should be dealt with by sand pumping plant and that the remainder should be dealt with by dredger. In order to prevent a dangerous regression of the shoreline on the north east side of the harbour and the consequent movement of the mouth of the Mahanadi River to the south west it is essential that some of the littoral drift

material trapped by the harbour works should be redeposited on the north east side. It is therefore proposed to provide both the dredger and the sand pumping plant with facilities to enable this to be done. The material not required for replenishment of the beach can be either dumped at sea or pumped ashore for reclamation purposes. In view of the present low level of much of the land zoned for development it will be necessary to obtain as much material as possible for reclamation. The amount of material which can be made available for this purpose can only be decided from the comparison of beach cross sections taken at regular intervals after the shore works have been commenced.

The sand pumping plant with an effective capacity of some 500,000 tons per annum might be mounted on a barge attached to the gantry running out to the Island Breakwater; This gantry will carry the sand delivery line and will also be used for access for the construction of the Island Breakwater.

It is proposed that the delivery line should pass under the Entrance Channel and discharge on the beach north east of the East Breakwater.

In view of the shape of the sand trap the maintenance dredger will have to be a manoeuvreable craft and consequently kept as small as possible. A suitable dredger would be a sea-going trailing suction dredger with twin suction pipes as recommended in the Consulting Engineer's letter to the Government of Orissa reference 640/2/96,900 dated 1st June 1962.

In this letter it is suggested that direct diesel drive for both pumps and propulsion would be cheapest and that the craft should be capable of a speed of 10 knots. The dredger would require hoppers to carry 1,500 tons and would have to be capable of dredging to a depth of 17 m (55 ft.) below water level. It should be capable of pumping ashore out of its hopper up to a maximum distance of 1,220 m (4,000 ft.) and a maximum static head of 9.1 m (30 ft.).

Only the minimum accommodation for men should be provided to enable the dredger to do a sea journey; normally the crew could live ashore.

Such a dredger might cost Rs. 80 lakhs if built in Europe or Japan and possibly 50% more if built in the United States. It is considered that a cutter is not necessary, but if, in order to make the dredger suitable for work elsewhere, a cutter were included, this would add approximately 25% to the price.

In Appendix C a sum of Rs. 84.75 lakhs has been allowed for the provision of the dredger, which would include the land pumping line. The cost of the Civil works including the jetty and moorings which would be required for the dredger to berth at while pumping ashore has been included in the main Port Construction estimate.

16. RECLAMATION

Based on a reclamation level of +5.55 metres for the general ground there will be sufficient material from the various excavations and dredging in Stage I to reclaim 265 hectares (650 acres). The excavated and dredged material obtained from subsequent construction up to the Full Development stage would provide sufficient material for the reclamation of a further 345 hectares (850 acres). The total area which can be reclaimed by using material from the Dock excavations is therefore approximately 610 hectares (1,500 acres) of which about 325 hectares (800 acres) are required for the port, leaving 285 hectares (700 acres) of land for other uses.

Master Plan Drawing No. PP/23 shows areas which have been set aside for the Oil Refinery, Industrial, Commercial, Governmental and Residential purposes, the total area being approximately 1,100 hectares (2,700 acres). Most of this land will have to be reclaimed and as only sufficient material for the reclamation of 285 hectares (700 acres) will be available from the port excavation, material from elsewhere will have to be obtained. This might be obtained from the maintenance dredging and

pumping ashore of the littoral drift. Of the 1 million cu. metres which it is anticipated will be available annually about 50% might be required for replenishment of the north east side beach. The remaining 500,000 cu. metres would reclaim an area of about 16 hectares (40 acres). At this rate 65 years would be required for the full reclamation. As the development of the port is likely to proceed more quickly than this, the amount of littoral drift which can be used for reclamation purposes will be of great importance and it will be necessary to reduce as much as possible the quantity discharged at sea and on the north east beach.

17. ESTIMATES

Totals for the various estimates are given below and further details are given in the Appendices referred to.

It should be noted that the following items are not included in the estimates of expenditure for the main port construction:-

(a) road to port.

(b) the extension of the Taldanda Canal to the Athrabanka Canal and into the port area.

(c) housing.

(d) temporary roads and drainage

(e) harbour craft and maintenance dredger.

(f) ore handling and loading equipment.

(g) electric power, water and other services.

(h) Port Buildings other than transit sheds.

Appendix A - Stage I, Main Port Construction:

to October 1965	Rs. 6.5 crores
after October 1965	Rs. 5.2 crores
Total	Rs. 11.7 crores

Appendix B -	Additional for Full Development	Rs. 40.0. crores
Appendix C -	Stage I ancillary Works (not included in the main port construction)	Rs. 4.5 crores
Appendix D -	Stage I Ore Handling Plant (not included in the main port construction but included in Appendix C)	Rs. 0.6 crores
Appendix E -	Iron Ore Handling Plant for Full Development (not included in the main port construction)	Rs. 1.5 crores
Appendix F -	Stage I - Foreign exchange assessment	

18. QUAY LAYOUT

The proposed quay layout is shown on the Master Plan Drawing No. PP/18.

Each berth is 185 metres (607 ft.) long and will be dredged to - 11.50 metres in the Full Development. This berth length will permit all the berths to be occupied by cargo vessels up to 14,000 G.R.T. capacity. The water depth available will enable 18,000 G.R.T. cargo vessels to be accommodated at all stages of the tide. In common with bulk carriers the size of cargo vessels is increasing and it is anticipated that although the majority of the larger vessels using the port will be in the 8,000 to 14,000 G.R.T. range the largest ones will be of the order of 18,000 G.R.T. These have a length of about 197 metres, (650 ft.) which is more than the berth length. The chances of more than one or two such vessels being in the port at any one time is remote and so it is not necessary to design the quay

layout to accommodate vessels of this size simultaneously at all berths. With an adequate number of berths such as are provided for in the Full Development it will almost always be possible to have a vessel shorter than that for which the berths have been designed, at a berth adjacent to that occupied by the largest vessel.

Each berth has a transit shed 135 metres (445 ft.) long by 45 metres (148 ft.) wide with loading platforms at the end for lorries and at the rear for either lorries or rail wagons. The platforms are protected by canopies.

The quay apron between the face of the berth and the shed is 19 metres (63 ft.) wide. This will enable two broad gauge rail tracks and a standard dockside portal crane track to be provided and leave room for road vehicles to pass between the transit shed and the rail wagons.

Behind each transit shed are two further rail tracks and then an open stacking area for the reception of cargoes not requiring covered storage. Master Plan Drawing No. PP/23 shows sets of sorting rail sidings for each dock. These are arranged so that they can progressively be added as the port develops without dislocating those already existing. The main reception and dispatch sidings would be on the west side of the Athrabanka Creek outside the port area.

19. ORE HANDLING ARRANGEMENT

General

The requirement for Stage I is for two million tons of iron ore to be shipped annually through the port.

The ore handling scheme proposed is based on the ore being delivered to the port by road vehicles but, by incorporating suitable equipment for unloading and stacking and additional conveyors it could be easily adapted to handle ore delivered by rail should this method of transport be introduced at some future date.

Various methods for stacking and reclaiming the ore, transporting to the berth, and loading ships have been considered.

The simplest arrangement for stock piling the iron ore would be by means of a belt conveyor mounted directly above the stock pile area on trestles incorporating a travelling tripper discharging ore to form a stockpile on the ground. Reclaiming would be by means of a tunnel under the stockpile and the ore would be fed by gravity through a series of outlets in the tunnel roof onto a belt conveyor carrying the ore to a fixed ship loader. The advantage of this scheme is the low capital cost of the mechanical handling plant and the berth; however, there are very important disadvantages some of which are:-

1) The reclaiming tunnel outlets may become choked should the ore contain any cohesive material or become sticky during period of heavy rain; this has been experienced at Puerto Ordaz, Venezuela where an underground system was employed for reclaiming iron ore.

2) There would be great difficulty in selecting the various grades of ore to mett customers specification also there would be lump size separation with the fine material tending to stay in the middle of the stockpile.

3) The ore must be stacked to a considerable height to make this method of reclaiming by gravity economic, thus imposing considerable loading on the reclaiming tunnels and the ground. On this site settlement of the ground would be substantial and it would be necessary to carry the reclaiming tunnel on piles.

4) There would be a considerable volume of dead material as only a 'wedge' of material over the tunnel can be reclaimed unless additional plant is employed for the removal of this dead material.

5) Any system employing a fixed ship loader would suffer from the major disadvantage that the ship would have to be constantly moved during the loading operation to bring each hatch under the loader. The additional time involved would reduce the effective throughput of the berth.

As far as the Consulting Engineers are aware there are no modern bulk handling installations of the capacity proposed for Paradeep incorporating a fized ship loader.

As the iron ore will probably be transported to the Port in heavy tipping vehicles with trailers a convenient method of receiving the ore into stock would be by discharging the contents in the stockyard area where the ore would be formed into stock piles by tractor shovels. These shovels would also be used for reclaiming and feeding a surface conveyor system for transporting the ore to a ship loader.

From a review of experience at other iron ore shipping ports it is apparent that although large carriers are being built the average size of cargo is controlled by the considerable number of small carriers in use. Even allowing for the progressive increase in the average size of vessels it is considered that the installation at Paradeep should be designed for an average cargo size of 15,000 tons. For an annual export of 2 million tons of ore one berth would be sufficient on the basis of working 16 hours per day 250 days a year with a berthing occupancy of 50%. Experience elsewhere has shown that where jetty occupancy is higher than about 50% bunching of ships occurs resulting in delays to the ships.

To meet these requirements a travelling ship loader capable of operating at a peak rate of 1,680 tons per hour would be required on the berth.

The Full Development requirement of an annual throughput of 5 million tons could be met by operating the equipment at the first berth at a peak rate of 2,000 tons per hour and providing a second berth with an identical installation. However, with only two berths it would be necessary to work additional shifts or days to deal with the concentration of vessels which would occur periodically. As this might not be acceptable from an operational point of view and as the requirement might still further increase three berths have been shown in the Full Development layout on Master Plan Drawing No. PP/15.

Proposed Plan for Stage I

As mentioned above in Stage I the iron ore will be received into the stock area by road. For an annual shipment of 2 million tons of ore on a two eight hour shift working day with 250 working days per year, the average daily quantity of ore handled will be 8,000 tons. If this is delivered throughout the 16 hour working day ore will be received into the stockpile at the rate of 500 tons per hour.

It will be seen from the Report drawing No. R/14 that ore can be discharged into the stockyard area by tipping lorries or manually by shovelling from lorries or trailers. The ore would then be picked up by tractor shovels and formed into stockpiles 3.0m (10 ft.) high. At a Works in the United Kingdom where this system is used experience shows that 3-1/2 cubic metre (4-1/2 cubic yard) tractor shovels operating over a distance of 20m (65 ft.) have a capacity of approximately 420 tons per hour. On this basis four tractor shovels loading into two mobile hoppers feeding the ship loading conveyor would have a peak reclaiming rate of 1,680 tons per hour. The shovels would not operate at this rate over the full period

required for loading a carrier and the overall reclaiming rate would probably be of the order of 1,250 tons per hour. This rate is considered to be ample allowing for stoppages of the ship loader whilst it was moved between hatches, etc. At this same works the ore is delivered into the stockpiles by a fully mechanical system which produces a more suitable stockpile layout that would be produced by the arrangement proposed here in which the lorrries are discharged straight into the stockyard. It is probable, therefore, that only four shovels would have a lower reclaiming rate than 1,250 tons per hour. In this case, if the full capacity of the berth is to be used, additional shovels and feed hoppers would be required. However this can only be settled after experience has been gained and it is assumed for the purposes of this Report that initially five machines, four working and one standing by, would be provided.

This proposed scheme may need modification when full details are available regarding the particular vehicles chosen for the transport of the iron ore.

Reclaimed ore would be loaded into ships by a mobile travelling ship loading tower operating on tracks along the jetty. The travel of the loading tower would be 120 metres (390 ft.) which would serve all ore carriers up to 30,000 D.W.T. without it being necessary for them to be moved during the loading operation. Larger carriers up to 60,000 D.W.T. would require some moving during the loading period. (Ultimate development would include lengthening the first jetty to enable ore carriers up to 60,000 D.W.T. to be loaded without it being necessary for them to be moved). The boom conveyor on the loader will shuttle athwart ships to enable it to oad a 60,000 D.W.T. ore carrier, and shuttle completely within the tower structure and luff to a near vertical position to enable it to clear the ships rigging when the tower is travelling along the jetty.

The installation would include sampling equipment to obtain ore samples and for crushing and weighing the samples. The samples extracted would be required to be sent to a laboratory for analysis as this equipment is not included in the plan. All ore will be weighed on entering the plant and a continuous cumulative record of the weight of ore loaded into ships by the ship loader would be made.

The cost of the ore handling equipment for Stage I is estimated to be approximately Rs.61 Lakhs (See Appendix D) and the Civil works for the ore storage area are estimated at approximately Rs.11 Lakhs.

Proposed Plan for Ultimate Development

Details for this arrangement are shown on Master Plan Drawing No. PP/15. The full lines indicate a fully mechanised handling arrangement which could eventually be adopted for Stage I and the chain dotted lines show how this system could be extended to handle 5 million tons per year for the Ultimate Development.

This drawing shows an arrangement for receiving the ore from road vehicles, however, it could easily be adapted for rail wagons. A suitable layout for rail tracks is shown on Master Plan No. PP/23.

The conveyor system would be arranged to perform the following duties:-

1. Deliver ore from road or rail transport to stockyard.
2. Deliver ore from road or rail transport directly to ship.
3. Deliver ore from stockyard to ship (as in Stage I).
4. Deliver one grade of ore to the Stockyard and simultaneously another grade of ore from the stockyard to the ship.

5. Simultaneously load ore into ships from the Stockyard and receiving hoppers.

Ore would be stock piled by means of a self propelled luffing and slewing boom stacking machine. This would be capable of forming separate piles of various grades of ore and would have a single boom, which could rotate in a horizontal direction and luff in the vertical direction.

Reclaiming from stockpile would be by two mobile bucket reclaiming machines, each having a maximum capacity of 2,000 t.p.h. These machines would be designed to travel on crawler tracks and would be capable of slewing and luffing. The reclaimed ore would be delivered from rotary buckets into the tail of a conveyor which would discharge it through a chute onto a boom conveyor. The boom conveyor slews and luffs independently of the rotary bucket boom and discharges ore into one of the two self propelled reclaiming hoppers.

From the reclaiming hoppers the ore would be carried to the mobile ship loading towers as in Stage I, however, further ship loading equipment would be necessary for the additional one or two berths.

The installation would also include extra sampling and weighing equipment to cater for the increased tonnage.

The Additional cost of the ore handling equipment for the Ultimate Development assuming three berths equipped as described above will be approximately Rs. 147 lakhs (See Appendix E). The Civil Works for extending the stock area will cost approximately Rs. 10.0. lakhs. If however, 2 ore berths were provided instead of 3 a saving in the cost of Ore Handling equipment of approximately Rs.40.0 lakhs would be made. The Resulting saving in the cost of the additional Ore berth would be approximately Rs. 78 Lakhs as given in Appendix B.

20. COMMUNICATIONS AND TRANSPORT

At present the area is not served by any roads other than tracks.

Roads

It is understood that the Port is to be connected at an early stage by the projected Expressway serving the hinterland and mine area. This road will cross the Mahanadi River at the approximate position shown on the Key Plan and enter the port area as indicated on the Master Plan drawings by a bridge over the Athrabanka creek.

A provisional layout for roads within the dock area is shown on the Master Plan Drawing Nos. PP/23 and 24. The road layout for the Full Development provides for vehicles access to all the quays with the least mutual interference between road and rail working. If as development proceeds it becomes apparent that rail connection is not to be provided the road layout can readily be revised to provide more direct access to the quays.

Canal

It is understood that early in the construction programme the Taldanda canal will be extended and connected through a lock to the Athrabanka Creek; the connection with the Creek being south west of the road bridge site. Later in Stage I the canal is to be extended from the Creek to the Port.

To avoid the necessity for making a crossing of the canal by the main road and the railway within the port area, the entry to the canal to the port from the Athrabanka Creek has been sited to the north east of the road and rail bridge site. This means that traffic between the two sections of the canal will have to pass along part of the Creek and under the road and rail bridge. The canal to the port will require locks both where it joins the canal and where it joins the port water area. The latter lock has been sited on Master Plan Drawing No. PP/24 so that it will be clear

of the additional cargo quays and ore berths proposed for the Full Development. A Barge basin is provided within the port area. Barges can either be loaded at the quay alongside the basin or lay-by in the basin awaiting transit through the lock for loading or unloading at ships in the port.

Railway

In Stage I it is not proposed that the port should be served by rail, however for the Ultimate Development rail transport will probably be required and for the reasons given in paragraph 12 a full rail layout has been shown in the Full Development Master Plan drawing.

It should be noted that the main reception and despatch sidings do not appear on the drawing as they should be outside the port perimeter. Their exact location can only be decided when further survey work north and west of the Athrabanka Creek has been done.

21. PORT BUILDINGS

It is envisaged that up to October 1965 no permanent port buildings will be constructed.

After this date it will be necessary to build a small port office which could either be located outside the main gate or inside the port near to the ore and cargo berths. In view of the distance of the main gate from the port operating area, in the initial stages it might be advantageous to have the office in the latter position.

Eventually a larger port office will be necessary. This should be constructed out-side the port so that access to it can be obtained by personnel of commercial and operating organisations without their having to pass through the Customs control at the main port gate.

It will also be necessary to construct and office for the Harbour Master at a position affording a good view of the Harbour approaches and Dock basin.

The Port site will need to be enclosed by a substantial fence to provide security and to meet Customs requirements.

22. SERVICES

Electricity

It is understood that transmission lines will be extended to the Port to enable a supply of electricity from existing sources to be used.

It is difficult to estimate the likely 'demand' during the construction period as it depends on the extent to which electrically-driven plant is used, however it is considered that supply of 500 K.W. should be sufficient for lighting the site, buildings, and housings.

The 'demand' for the Port at the end of Stage I will be approximately 2,500 K.W., including the sand pumping plant, power for which must be provided by mid-1964.

For the Full Development power will be required to operate the Dock side crances and additional ore handling equipment which will increase the 'demand' to a total of approximately 6,000 K.W.

Water Supply

At present there is no public water supply in the vicinity and it is envisaged that a supply could be obtained from wells within a few miles inland of the site or alternatively an intake could be installed on the canal extension North of the Athrabanka Creek. For Stage I a supply of between 100,000 and 200,000 gallons per day will be required. It is recommended that the main supply line to the port should be capable of carrying at least 500,000 gallons per day so that it will not need duplication until well on in the development.

Sewerage and Drainage

In stage I raw sewage from the port can be treated by septic tanks sited at strategic points with the effluent discharging into the Athrabanka Creek.

Providion for dealing with considerable surface water run off should be provided by a system of open ditches integrated with existing creeks as shown on the Consulting Engineer's drawing No. PP/21 accompanying the notes on Mr. H. Scrutton's visit to Orissa (30th April 1962 to 4th May, 1962). This drawing shows that the area to be excavated is protected from flooding by a continuous low bund which is formed by constructing the roads for the first development on embankments.

Run off to the S.W. of the site drains into a series of ditches leading to a main drainage ditch and thence into the Gani Galia Creek. Run off from the rest of the site drains into the Tanto Galia creek or subsidiary creeks.

As these creeks are tidal it will be necessary to dam them and provide tidal flap culverts through the dams so that tidal water is kept from the port site and drainage and reclamation of the area can proceed.

While the above scheme is primarily for drainage during construction it can be developed to deal with all surface run off in Stage I.

Fire Fighting

It is considered that under Stage I simple facilities for fire fighting should be provided in the form of fire tenders and trailer pumps.

Ultimately a full system incorporating pressure mains and hydrants will be required but this is not considered necessary until well into the future.

23. HARBOUR CRAFT

By the time the dredging commences in October, 1964 it will be necessary to have at the port the first of the harbour craft required for the maintenance of the port installations and the efficient handling and servicing of the dredgers and, subsequently, vessels using the port. Ultimately craft will be required particularly for the following duties:-

a) Ferrying pilots to and from ships in the approaches.

b) Assisting ships into their berths and manoeuvring in the Turning Circle.

C) Receiving ships mooring lines and communication with ships lying at the buoy berth.

In order to carry out these functions it is considered that the minimum of craft to be provided should be:-

1 No. Habour Tug.

2 No. Personnel launches one fitted with echo sounder equipment for taking soundings.

2 No. Mooring launches.

1 No. Pilot Boat.

In addition to these craft it may also be considered necessary to provide an Ocean-going Tug. However this has not been allowed for in the estimates.

Moorings for these craft would be provided at the Southern end of the cargo berth where the quay runs East and West.

STAGE I PROPOSALS

24. CONSTRUCTION PROGRAMME

The proposed construction programme for Stage I is shown on drawing No. R/15. This programme has been drawn up to meet the requirement of commencing loading iron ore in October 1965 whilst at the same time keeping the expenditure on the items mentioned in Appendix A within the permitted limit of 6.5 crores up to the same date. The work would not be stopped at that time and must continue until the breakwaters are complete and capable of withstanding storms and until all slopes have been pitched with stone. In addition it is desirable that one cargo berth

be completed and that the slipway for maintaining harbour craft has been constructed. This further work would continue with an expenditure of 2 crores/annum until completed. It should be noted that the programme shows items, mainly those listed in Appendix C, which are not included in the above figures for expenditure but which are essential for the successful implementation of the project, as it is understood that these will be covered by separate budgetary approvals.

The programme provides that at October 1965 the works will be sufficiently far advanced for the first cargo or iron ore to be loaded. At this stage the construction of the Island Breakwater will have advanced far enough to provide shelter to the harbour entrance under all except the worst conditions; the Approach and Entrance Channels and the Turning Circle will have been dredged sufficiently to allow access for 30,000 D.W.T. ore carriers; and one ore berth will have been completed and provided with ore handling and loading equipment.

In any event it is considered desirable that the Island Breakwater be commenced first. As soon as any breakwater is started the flow of the littoral drift will be impeded and sand will begin accumulating. To commence the Western Breakwater first would result in the shore line being pushed forward at this point, and it is considered as little interference with the littoral drift as possible should be caused in the early stages.

The Island Breakwater, as has already been stated, would be commenced by depositing run-of-the-quarry stone from bottom-opening barges and a large quantity could be deposited in this way without greatly affecting the movement of sand. At the same time the gantry to the Island Breakwater, which also would not impede sand movement, would be constructed.

The upper part of the breakwater and the large blocks of stone for armouring the face would all be transported over the gantry and by

October 1964 the sand pump should be installed to assist in maintaining the littoral movement.

The programme is based on the main construction works commencing in January 1963 and in order to allow this a number of ancilliary works should be completed by that date. These are:-

(a) A road to the port, including the bridge over the Athrabanka Creek.

(b) The extension of the Taldanda Canal to Athrabanka Creek.

(c) Temporary site roads and drainage works

(d) Temporary housing for construction personnel.

(e) Water and power supplies to the Port.

Apart from the cutting for the entrance channel the sand dunes would be left undisturbed as a protection to the Port from the weather and it would be desirable for the Protection work that the Forestry Department has done on the stabilization of the sand dunes to be extended so as to reduce as soon as practicable the nuisance of wind blown sand. This would include, in due course, the side slopes of the entrance channel.

General site clearance and the main excavation works should be commenced as soon as practicable with the object of removing as much as possible of the bulk excavation in the dry by earthmoving plant before the dredging breaches the line of sand dunes. This material would be spread over the Port area and consolitated as the work proceeds so that as great an area as possible of land above extreme high water is available for port use.

It is envisaged that if the canal extension works go ahead according to programme the dumping of stone for the Island Breakwater

could commence after the 1963 monsoon season. When the construction of the Island Breakwater is well under way the wave attack on the foreshore will be affected and the deposition of littoral drift material will commence. It is estimated that by October 1965 when the port is to be opened for traffic it will be necessary to have dredged 2.7 million cu.metres of in situ material and 1.5 million cu.metres of sand and littoral drift. If the sand pumping plan can be installed in 1964 some 0.5 million cu.metres of the littoral drift can be disposed of by means. The maintenance dredger is not likely to be delivered until well into the latter half of 1964 and it is therefore apparent that it will not be possible for this craft to be used for all the initial capital dredging as well as for the remaining part of the littoral drift. It will therefore be necessary for another dredger, either contract or from another port, to commence the capital dredging after the 1964 monsoon season.

From the foregoing it can be seen that the delivery of the port maintenance dredger and the sand pumping plant is a vital part of the programme. If they are to be delivered by the due date then orders for them must be placed well before the end of 1962.

After October 1965 the deepening of the Approach and Entrance Channels, the Ore Dock and the Turning Circle by the dredgers will be proceeded with and the pitching of the underwater slopes will be completed. The Cargo Berth and Slipway and workshops will be constructed and the East and West Breakwaters will be placed.

In 1968 Phase I will be completed by putting into use the Cargo Berth and the Ore Jetty being capable of accommodating 60,000 D.W.T. ore carriers.

25. CONSTRUCTION METHODS

So that the bulk of the excavation for the Entrance Channel, Turning Circle and Dock can be carried out in the dry by earth moving plant it is proposed to leave the seaward edge of the sand dunes in position as long as possible. Once these are breached the remainder of the main excavation will have to be completed by dredger. It is considered that as the permeability of the soil is relatively low it should be possible to adopt this method without the use of excessive pumping or uneconomic dewatering methods.

This method of working has the advantage that the construction of the Ore Jetty can be done in the dry. It is also proposed to limit the initial excavation for the ore dock to that required to give access to 30,000 D.W.T. ore carriers so that the Cargo Berth can also be constructed in the dry.

As far as possible side slopes will be excavated in the dry to their final position so that as much as possible of the protective pitching can be placed before the excavation is flooded. Where this is not possible it will have to be tipped from barges after the dredging has been completed.

APPENDIX A

ESTIMATE OF COST FOR STAGE I OF THE MAIN PORT CONSTRUCTION

	To October 1965 Rupees Lakhs	After October 1965 Rupees Lakhs	Total Rupees Lakhs
Earthworks & dredging	257	111	368
Pitching to submerged slopes	42	37	79
Breakwaters	140	135	275
Ore berth	72	-	72
Cargo berth and transit shed	-	160	160
Slipway and workshops	-	19	19
Sand pump and gantry	82	-	82
Miscellaneous including navigation equipment and buoys	5	-	5
	598	462	1,060
Contingencies 10%	60	46	106
Totals	658	508	1,166
	say 6.5 Crores		say 11.7 Crores

APPENDIX B

ESTIMATE OF ADDITIONAL COST FOR MAIN PORT CONSTRUCTION TO FULL DEVELOPMENT

	Rupees lakhs
Earthworks and dredging	471
Two Ore Berths and additions to Stage I Berth	164
Eighteen Cargo Berths including Transit sheds	2,481
Oil Dock	115
Dry Docks	453
	3,684
Contingencies 10%	368
Total	4,052

say - Rs. 40 crores

Note: If only one additional Ore Berth is provided there will be a saving on the above figure of Rs. 78 lakhs.

APPENDIX C

ESTIMATE OF COST FOR STAGE I DEVELOPMENT -

ANCILLIARY WORKS

(not included in the Main Port Construction)

	Rupees lakhs
Ore Handling Plant (for details see Appendix D)	61
Ore Stock Area	11
Dredger and pipeline	85
Harbour craft	75
Internal Roads	66
Services	62
Port Buildings	14
Canal Extension	39
	413
Contingencies 10%	41
	454

Say - 4.5 Crores

APPENDIX D

ESTIMATE OF COST OF STAGE I ORE HANDLING PLANT

(not included in the Main Port Construction)

	Rupees lakhs
Weighbridges and office	0.8
Stocking and reclaiming conveyor	5.4
2 - Travelling reclaiming hoppers	5.5
Conveyor to sampling house	2.2
Sampling control and weighhouse	0.7
Sampling equipment	4.7
Weighing equipment	0.3
Jetty Conveyor	2.4
Jetty conveyor supporting structure	1.7
Ship Loader and rails	10.9
Electrical equipment power dist., lighting, control etc.	6.8
Tractor shovels	11.6
Erection	8.0
	61.0

say 0.6 Crores

Note: This total is included in Appendix C.

APPENDIX E

ESTIMATE OF ADDITIONAL COST OF IRON ORE HANDLING PLANT FOR THE FULL DEVELOPMENT

(not included in the Main Port Construction)

	Rupees lakhs
Receiving hoppers and feeders	2.1
Belt conveyor and Junction Tower	0.7
Stocking out belt conveyor	4.9
Boom stacker and rails	6.8
Two Reclaiming belt conveyors	20.6
Two travelling reclaiming hoppers	5.4
Two bucket wheel reclaiming machines	41.0
Two belt conveyors to sampling house	2.1
Gantry for above belt conveyors	0.7
Sampling, control and weigh house and equipment	0.8
Two jetty belt conveyors	13.2
Supporting structure for above conveyors	7.5
Two ship loaders with rails	22.0
Electrical equipment power dist., lighting etc.	2.7
Erection	16.7
	147.2

Say Rs. 1.5 Crores

5. Farming Implements

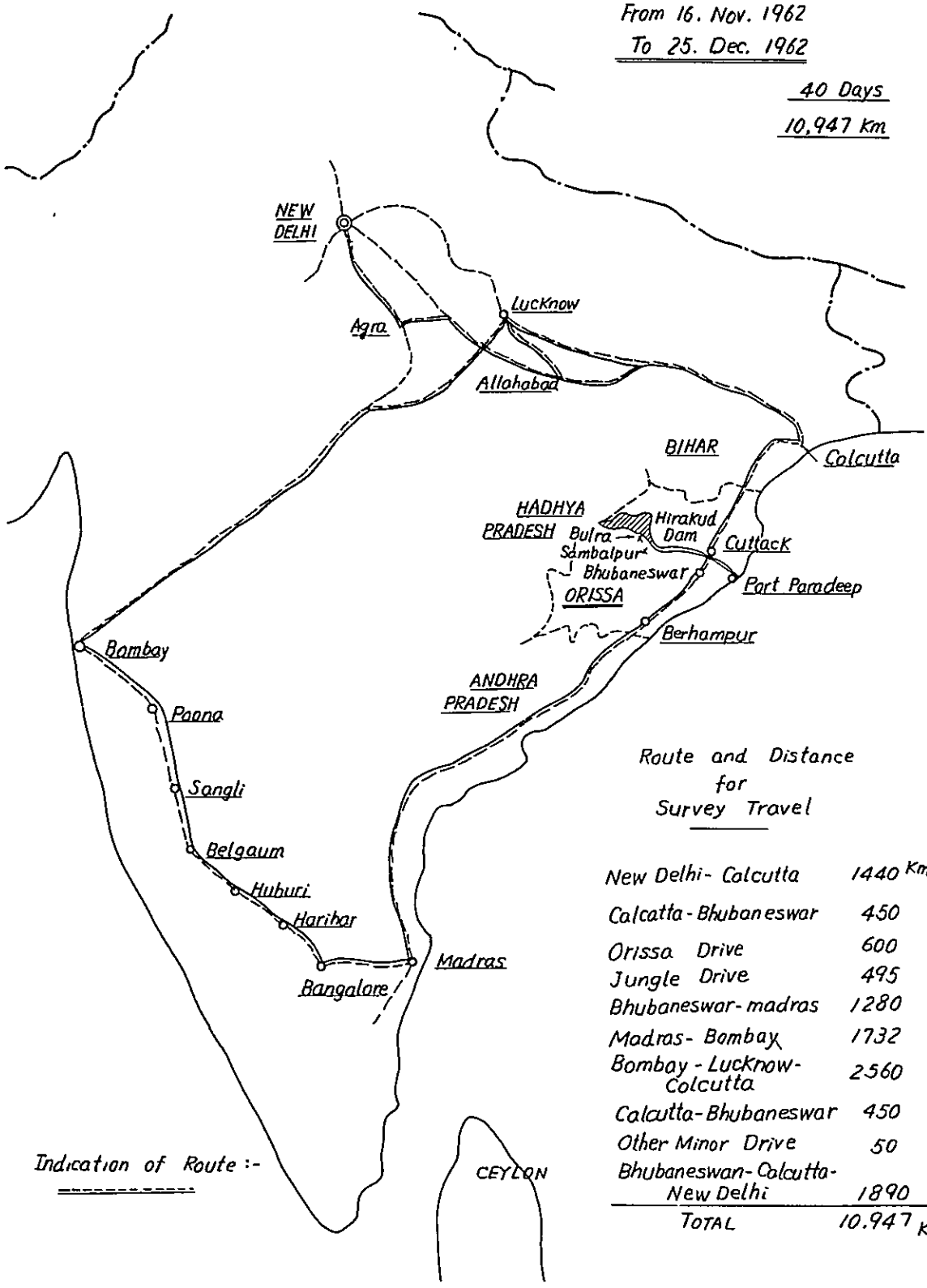
C O N T E N T S

ALL INDIA SURVEY ROUTE

Farming Implement Team

From 16. Nov. 1962
To 25. Dec. 1962

40 Days
10,947 km



Indication of Route :-

Route and Distance for Survey Travel

New Delhi - Calcutta	1440 Km
Calcatta - Bhubaneswar	450
Orissa Drive	600
Jungle Drive	495
Bhubaneswar - madras	1280
Madras - Bombay	1732
Bombay - Lucknow - Colcutta	2560
Calcutta - Bhubaneswar	450
Other Minor Drive	50
Bhubaneswan - Calcutta - New Delhi	1890
TOTAL	10.947 Km

5. Farming Implements

5 - 1. Outline of Survey:-

5 - 1 - 1. Purpose of Survey:

As a part of the overall development program of the State of Orissa, the State Government intends to increase agricultural production and improve farmers' income through mechanization of agriculture. For this end, it plans to induce Japanese type farming machines for a domestic manufacturing in India.

The primary purpose of the Farming Implement Team of the Mission is to conduct a basic investigation to prepare data and information necessary for the materialization of the above-mentioned plan.

The primary purpose of the survey is to make a recommendation on the appropriate method of collecting and studying basic data necessary for the selection of agricultural machines which are suitable for the farming population with low purchasing power as well as for the building of a plant to manufacture such machines in order to provide as many farmers as possible with agricultural machines which are already in the stage of practical use.

5 - 1 - 2. Objects of Survey:

(1) Necessity of the Mechanization of Agriculture.

(2) Research on the Mechanization of Agricultue made by the Central Rice Research Institute.

(3) Farming Implements actually in Use.

(4) Demand and Purchasing Methods of Agricultural Machines.

(5) Selection of Type of Farming Machines.

(6) Prerequisits to Prospective Site for the Construction of Farming Machine Manufacturing Plant.

(7) Present Condition of Metal Working Industry in Orissa State.

(8) Present Condition of Metal Working Industry in Other States.

(9) Technical Training of Engineers and Workers.

5 - 2. Actual Situation of utilizing Farming Implement

5 - 2 - 1. Actual Situation of Farm:

Rice is the staple food in India. Since the independence of Pakistan which had been one of the main sources of rice supply to India, a part of the important supply source has been lost; and the Government of India, for the purpose of securing the staple food supply, has been endeavouring to attain the increased production of rice as one of its important national policies.

The State of Orissa is situated on the east coast of India, and is, together with Madras State which lies south of Orissa, one of the leading rice producing districts. Especially, Orissa State has a vast delta formed by Mahanadi, Brahmani and Baitarni Rivers (refer to Map-1) as the center of rice production. Although other crops are also grown in the State, a comparison of rich crop with other crops indicates that the former accounts for more than a half of the total crop both in terms of cropped area and output. (refer to Table 1) Accordingly, machanization of agriculture in Orissa State means that of rice farming.

The total area of Orissa State is 38,487,000 acres, and cultivated area having agricultural income is 15,125,000 acres, of which rice field occupies 9,560,000 acres or 62% (3rd 5-year plan as of 1958 - 59).

The climate in India, as a whole, is warm with abundant rainfall (refer to Map-2), and it is possible to harvest rice three times a year if all other conditions are met: The same is true with the State of Orissa, but conditions vary noticeably depending on localities. Comparison of cropped area of each locality is shown in Table 2.

Temperature in Orissa State is 80°F in January, 101°F in April-May and 95°F in July. The rainfall, which varies depending on districts, is in the range of 55" - 63", 81% of which is during June - September period. As it is clear from the Table - 2, area under rice is concentrated in winter with the percentage being as much as 86% which nearly corresponds to that of

rainfall of 81%.

Table 1.* Area under principal crops and their contribution to total agricultural output, 1955-56

Crops	Total cropped area (%)	Agricultural Output (%)
Rice	62.3	74.2
Wheat	0.1	0.1
Millets and other cereals	2.0	2.1
Pulses	7.8	6.8
Oil seeds	3.4	1.9
Jute	0.7	1.5
Sugar-cane	0.4	2.0
Tabacco	0.1	0.5
Cotton	0.2	0.03
Others	23.0	10.87
Total	100.0	100.0

* Techno-economical survey of Orissa.

Same as in Japan, rice plant grown in Orissa State is wet-land rice plant, which is also raised in small-plotted paddies. The Government of India, recognizing the excellence of Japanese rice plant, has been endeavouring in cross-fertilizing rice plants grown in both countries with successful results. Since rice plant is grown in paddy, it is natural that cropped area corresponds to the seasonal pattern of rainfall, but the difference between the cropped area for winter rice and that for autumn rice seems to

Table 2.[a)] Areas under rice (Acres) 1958 - 59

District	Physical regions	Winter	Autumn	Summer	Total	%	Type of soils
Balasore	Deltas	1,072,800	2,100	400	1,075,300	11	Alluvial
Bolangir	River basins	630,800	40,100	100	671,000	7	Red, Black
Cuttack	Delta	1,146,000	124,400	11,000	1,281,400	13	Alluvial
Dhenkanal	North Plates River basin	248,400	56,400	100	304,900	3	Black, Red Laterite
Ganjam	Eastern hills River basins	603,500	29,800	--	633,300	7	"
Kalahandi	Eastern hills	404,000	170,000	300	574,300	6	Black, Alluvial Red, Black
Keonjhar	Northern plateau	447,600	117,700	--	565,300	6	Red
Koraput	Eastern hills River basins	620,000	147,000	300	767,300	8	Red, Laterite
Mayurbhanj	Northern plateau	728,100	97,700	100	825,900	9	Red
Phulbani	Eastern hills	243,900	45,300	--	289,200	3	Red, Black, Laterite
Puri	Deltas Eastern hill	854,600	37,700	6,600	898,900	10	Alluvial, Laterite
Sambalpur	Northern plateau River basins	791,200	324,800	4,600	1,120,600	11	Red, Black
Sundergarh	Northern plateau	458,200	94,600	100	552,900	6	Red
Total		8,249,100	1,287,600	23,600	9,560,300	100	
%		86	13	1	100		

Note: a) These data are from 3rd 5 year plan and Techno-economic survey.

be excessively great, leaving aside the fact that cropped area for summer rice to be grown in the season with no rainfall is as small as 1 %.

As for irrigation, during 1955-56, only 2,400,000 acres or 17% of the total cropped area in Orissa State were irrigated by cannals, reservoirs and wells, but additional 2,560,000 acres are planned to be irrigated during the period of 1961 - 71 (Techno-economical Survey).

5 - 2 - 2. Shape of Paddy and Mechanization:

Unlike other fields, paddy must hold certain amount of water for certain period of time. Thus, the bottom of paddy must be flat, and if not, it should be leveled. Because there are few mountains in India and all the mountains are bold, there are hardly any river with constant running water. Many paddies induce water from reservoirs built to hold rainwater. Despite that it takes considerable man-power to make a new paddy owing to such circumstances, paddies which are located farther from a river are smaller in size and more irregular in shape, as the land is not densely populated.

A reservoir to hold rain-water must be built in such a place as to collect not only rainfall on the reservoir but also rainfall on nearby hills; it should also be conveniently located to have the largest possible paddy at its foot. However, since such ideal location can not be found everywhere, the amount of water collected in the reservoirs is small. Besides, substantial amount of water evaporates during the summer season and also leak into ground, and by the time rice crop is over, water in reservoirs has exhausted. Thus, secondary crops can not be grown unless they require little water.

Furthermore, there are seemingly many places where no secondary crops can be raised, which is presumably the reason for many farmers being in destitute.

Regardless of country, farmers will not change the shape of their cropped fields by any subsequent reasons once the fields have been made, nor

are they willing to give up their own lands for a joint operation. Once a paddy is made in irregular shape, it remains forever to be odd-shaped, making the subsequent paddies made next to it also irregular. As long as low speed bullocks are used in cultivation, the odd shape paddy involves little problem, but when the cultivation work has been mechanized, the odd shape paddy which requires many turns for direction change would result in additional labour and excessive load on the machines. Farmers with low level of knowledge who are not familiar with handling of machines can hardly judge if any undue load is on the machine, and the machines are apt to have more failures, which, in turn, incur additional costs for repairing. For this reason, farmers, in general, are reluctant to use machines.

5 - 2 - 3. Farming Implements in Use:

Bullocks are the only power source used in agricultural work in India, and are used not only for cultivation but for threshing haulling and pumping. Accordingly, the farming implements presently in use are for the most part bullock-powered implements. Their kinds, uses, and numbers based on the data presented by the State Government of Orissa are as shown in Tables 3 and 4.

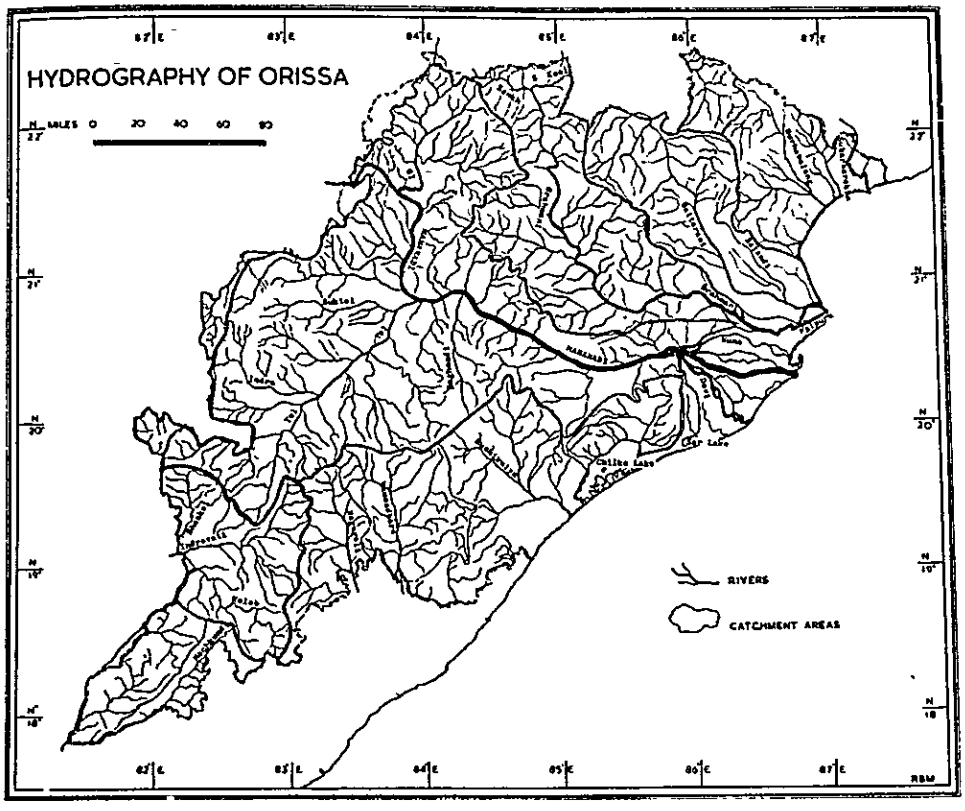
Number of tractors officially registered in the State of Orissa is only 149, and mechanization of farming work is the task to be undertaken hence. Bullock-drawn implements are also steadily improved; The implement manufactured by Voltas Company in Bombay is a riding type bullock drawn implement with the so-called "Otto frame" which is a special frame developed by the company, and tires similar to those of automobiles. The improvement made on this implement has reached nearly the point of mechanization.

The followings are some of the actual examples of tractors in use at farming villages:

(1) Takarada Village (Ganjam District):

The tractor used is 35 Hp class tractor manufactured by Fergusons

Map I


HYDROGRAPHY OF ORISSA
MILES 0 20 40 60 80
RIVERS
CATCHMENT AREAS
RBM

Map II

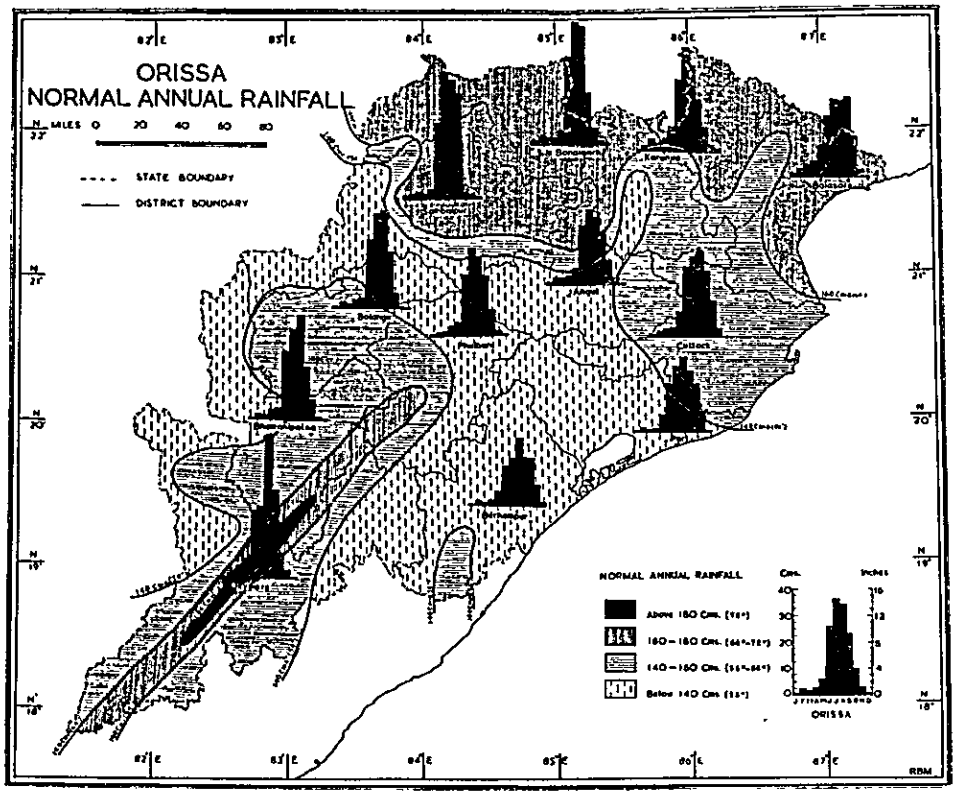

ORISSA
NORMAL ANNUAL RAINFALL
MILES 0 20 40 60 80
STATE BOUNDARY
DISTRICT BOUNDARY
NORMAL ANNUAL RAINFALL
ORISSA
RBM

Table 3. Kind of implements

Name	Use
Narrowed duckfoot plough	1st ploughing
Wide duckfoot plough	Subsequent ploughing
+ Mould board plough	Ploughing, puddling
Spike tooth narrow	Paddling
Wooden ladder	Clod crushing and levelling
Cultivator	Cultivation after 1st ploughing
Ridging plough	Ridging for sugar cane and potato
Japanese weeder (Takakita)	Paddy interculture
Plannet junior hoe	Row crops interculture, high land
Japanese paddy thresher	Threshing paddy
Duster and sprayer	Pest control
Sugar-cane crusher	Gur making
Bullock carts	Hauling

Table 4. Number of implements

Name	Q'ty	Remarks
Ploughs	613,340	
Bullock cart	245,190	Excluding figures for 4 districts
Sugar-cane crusher	3,473	"
Tractor	149	Departmental agency
Electric operated pump	290	"
Diesel operated pump	356	"

Company. The followings are the report prepared by Mr. Rodha Krisna Pradhan, Cultivator of Takarada and Sorapanch, Dhobolpur:

(a) Dry Land Ploughing:

Land area	8 acres	
Ploughing depth	5 - - - 7"	
Working hours	8 Hr/day	
Expenditure:		
Fuel	10 gls.	Rs. 31.87
Petrol		0.50
Mobiloil		1.00
Pay of the driver		4.00
Wear and tear charges		2.00
Total		39.37

Per acre expenditure : Rs. 5.00 (say Rs. 40.00)

(b) Wet Land Ploughing:

Land area	6 acres	
Working hours	8 Hr/day	
Expenditure		
Fuel	12 gal	Rs. 45.00
Petrol		0.50
Mobiloil		2.00
Pay of driver		4.50
Extra wage to remove brake from paddler		2.00
Total		56.50

Per acre expenditure Rs. 9.42

(c) Threshing:

Threshing of the produce of 3-1/2 acres of paddy crop

Working hours per charge		3-1/2 hours.
Expenditure		
Fuel	4 gals	Rs. 12.75
Petrol		0.50
Mobil Oil		1.00
Wear and ter charges		1.50
Labour charges - 8 labour's		8.00
Cleaning and soring charges		36.00
Two labours		6.00
Total		Rs. 42.00

(d) Charges:

Ploughing by ccuntry plough in dry condition:

Ploughing depth	3--- 3-1/2"
Number for ploughing	2/acre
Charge for ploughing(@Rs.3.00)	Rs. 6.00

Ploughing in wet condition:

Number for ploughing	3/acre
Charge for ploughing(@Rs.3.00)	Rs. 9.00

Threshing in local method:

Charge for cattle	5ns	Rs. 4.00
Charge for labour	1ns	Rs. 1.50
Cleaning of cattle	1ns	Rs. 2.00
Wastage to cattle		Rs. 1.00
Total		Rs. 8.50

Condition:-

The produce of 0.60 acres of paddy:	12 ns.
The produce of 0.60 acres of straw:	5 ns.

(2) Tractor Threshing:

At this farm, only ear-heads of rice plant are reaped and spread on the ground, on which tractor travels for threshing. Since grains of Indian rice are likely to fall off ears, Japanese type thresher is not suitable. At other farms where no tractor is used, threshing is done by pulling around by bullock a teak log of 1" dia. and 6' length on the ears of rice plant spread on the ground.

(3) Tiliki Village (Bhanjnagar District):

The tractor in use is U.S.S.R. make (T-14). The land is made by clearing jungle. The land-owner is the chairman of Agricultural Cooperatives of this district and is an enthusiast of mechanization. The report presented by this village is as follows:

Information sheet on tractor cultivation at Tiliki in Bhanjnagar Panchayat Samiti

Total area under tractor cultivation		Ac. 150.00
Details of crops grown		
1) Paddy	a) Early	Ac. 20.00
	b) Medium	40.00
	c) Late	30.00
2) Area under rabi crop	a) Horse gram	13.00
	b) Mustard	2.00
	c) Beans	1.00
	d) Mung	24.00
	e) Gingelly	5.00
	f) Ragi	5.00
3) Vegetables	a) Tomato	1.00
	b) Brinjal	1.00
	c) Pumpkin	1.00
	d) Chilli	2.00
4) Orchard	Total	150.00

Working conditions

Average working hours of tractor per day	6.00 Hr.
Total number of day tractor worked	15 days
Year of operation (new purchase)	During khariff 1962

5 - 3. Mechanization of Agriculture:

5 - 3 - 1. Necessity of Mechanization:

The rainy season in Orissa often has a torrential rain. However, since no accurate forecast as to the beginning of such heavy rainfall can be made, if the torrential rain visits too early, the seed beds prepared are washed away; while, if it delays plants hardly grow owing to water shortage. Thus, farmers are obliged to complete required work in a short period of time, and are kept terribly busy during the work seasons. However, since there are only 30 days in average which are available for such farming work as ploughing in the entire rice raising season, if the works to be done in these 30 days are mechanized to attain better efficiency, remaining time may be utilized for such other works as expansion of cropped area, etc. Furthermore, when it has become possible to raise such other cash crops as sugar cane, tabacco, ground-nuts, oil seeds, etc. with the progress of irrigation work, farmers will be kept increasingly busy as preparations for such second crops will have to be made while rice growing is in progress. With an aim to reduce such excessive labour of farmers and attain increased output as well as to achieve more speedy and efficient farming work, the Central Rice Research Institute has been undertaking a research work on the mechanization of work hitherto carried on with bullock power, from various standpoints including work efficiency, production cost, etc.

As it is clear from the foregoing discussions, the mechanization of agriculture is essential from the viewpoint of farming work, but another

important cause of the mechanization is a labour shortage in farming as a result of mobilization of labour force by other industries. Since farming work requires heavy physical labour, it is natural that farming labour force tends to flow into other works requiring less labour. Although the State of Orissa is still underdeveloped, the development of its abundant iron ore and other metalic resources will show a remarkable progress with the encouragement of the Central Government, which, in turn, will mobilize farming labour force, thereby causing increased shortage of labour. Table 4-1 which shows a comparison of distribution of employment by industries in 1951, 1961 and 1971 reveals that during the 20-year period, employment in other industries than agriculture will show as increase of approximately 2,500,000 persons as against the increase of 1,130,000 in agriculture.

Table 4-1 Distribution of employment by industries (1951, 1961 and 1971)

Category	1951	1961	1971
Agricultural and allied activities	4,041,000	4,954,000	5,175,000
Factory industry	24,000	79,000	175,000
Non-factory industry	385,000	430,000	525,000
Mining	40,000	82,000	277,000
Power	Neg.	6,000	38,000
Construction	49,000	199,000	350,000
Tertiary	1,076,000	1,030,000	1,700,000
Total	5,615,000	6,780,000	8,240,000

* Techno-economical survey of Orissa.

The agriculture mechanization plan considered by the State Government of Orissa intends to mechanize completely the present paddy of 10,034 million acres under the 3rd 5-year program, and further to increase the acrage of paddy field as shown in Table 5.

Table 5. Implementation program by scale of farm and kind of crops.
(The development programme during the Third Plan Period)

Unit: million acres

Name of crops	Less than 2 acres	2---4 acres	5---9 acres	10---19 acres	20 and above	Total crop acres
Paddy	0.645	2.634	3.046	2.468	2.323	11.116
Gram, Millet & Pulses	0.102	0.415	0.480	0.389	0.367	1,753
Wheat	0.001	0.006	0.007	0.005	0.005	0.024
Vegetables	0.008	0.034	0.039	0.032	0.030	0.143
Green manuring	0.406	1.659	1.918	1.554	1.463	7.000
Cotton	0.012	0.047	0.055	0.044	0.042	0.200
Oil seed	0.029	0.118	0.136	0.111	0.104	0.498
Sugar cane	0.004	0.015	0.018	0.014	0.014	0.065
Tobacco	0.012	0.047	0.055	0.044	0.042	0.200
Ground nut	0.004	0.017	0.019	0.016	0.015	0.071
Total	1.223	4.992	5.773	4.677	4.405	21.070

5 - 3 - 2. Study Made by the Central Rice Research Institute Concerning the Mechanization of Agriculture:

Since 1947, the Central Rice Research Institute has been carrying our various studies on the mechanization of rice plant raising in paddy, and the result was reported by Mr. M. L. Taneja of C.R.R.I. under the subject of "Observations on mechanization of paddy cultivation at the Central Rice Research Institute, Cuttack", at the Engineering Session of the Second All India Rice Research Workers Conference. (C.R.R.I. is the abbrevation of Central Rice Research Institute).

C.R.R.I. owns 155 acres of ordinary farm and preparation of soil is made by machines in the dry season and in the rainy season as well. The report embodies the result of its study for the past five years on the adequacy of motor-powered farming implements for ordinary rice growing under wet condition as well as required expenses for the use of such equipment. The report does not contain, however, such matters as the merits and demerits of mechanization and the result of more extensive application of mechanization, the detail of which was included in the report entitled "Mechanizing the padding of rice lands" which was submitted by Dr. Richraria to the Agricultural Engineering Symposium held at Kharagpur in 1960. (The report is not attached herewith as it was not available.) The outline of the result of the Institute's study is introduced herein as it is of great value and help to those who will handle or manufacture the machines as well as to those who will be in charge of guidance of mechanization and also training program.

5 - 3 - 3. Fundamental Thought in Promoting Mechanization of Farming Work:

Emphasis of agricultural policy in India is on the promotion of rice crop, and the mechanization of farming work is adopted as a means to achieve this end. As in Japan, rice is grown on paddy, which involves no problem during rainy season with abundant rainfall. However, because dry season accounts for 2/3 of a year, not many districts have rice crop twice a year despite that

considerable effort is being made to increase irrigated area. Especially, in the State of Orissa, soil is dried and hardened in dry season, making it very difficult to plough by small power. Though foreign made large-size tractors of 30-50HP are used for the cultivation of such lands, the tractors, which are originally intended for use in vast land, are not suitable for the paddies in India with irregular small plots. Therefore, in order to make the best use of such large size tractors, rearrangement of paddy plotting becomes necessary; but such rearrangement can hardly be made owing to the farmers' attachment to their own land. Besides, many of farmers who are with low income cannot afford such expensive tractors of large size, which have to be kept idle during the dry season due to no work to be done.

Therefore, the primary condition required in mechanizing farming work in India is that the machines should be priced low enough to be purchased by anybody, while, the second condition is that they may be used conveniently in irregular-shaped small paddies. Another condition is that the machines should be of sturdy construction and not be broken even used violently by farmers with little knowledge of machine. Although there are still some more conditions of less significance, small size cultivators of 7HP class are considered to satisfy the above requirements. The excellent quality of small size cultivators exported by Japan has apparently been recognized by the State Government of Orissa, and their domestic manufacturing in India has come to be considered.

5 - 3 - 4. Demand and Purchase of Agricultural Machines:

(1) Demand:

Although tractor type farming machines are employed in Indian agriculture, they are not extensively used for such reasons as high cost, irregular shape of lands which are not suitable for machine cultivation, and low level of farmers' knowledge on machines. (Refer to Table 4) . But, a model farm at Chakli, Sambalpur, which is run by Japanese has been very successfully operated by using Japanese type small cultivators and other implements: The

success has created a sensation and visitors are pouring in for observation.

Even though it is obvious that the mechanization of agriculture will bring about a great effect, its overall effect will be extremely limited unless the mechanization is undertaken extensively on a larger scale. Since the machines are to be purchased by individual farmers with different purchasing power, there will be considerable demand for the machines if the price is attractively low. To generate the demand, there will be lots of problems to be overcome such as financing, education, etc. The writer has been greatly impressed by the authorities of the State Government of Orissa who are launching into the mechanization of agriculture with a determination to create the demand by their own effort.

Table-6 which is supplied by the State Government of Orissa is to show number of farms and total acreage by land area owned. Of the farms listed in Table-6, those which are of less than 2 acres (occupying 30% of total farms) will not have sufficient power to purchase machines, but if the mechanization is made on the remaining 70% which owns in aggregate 13,777,000 acres or 94% of the total cultivated land, a remarkable effect can be expected. The majority of this class is the farmers of medium standing with 2 - 9 acre land which accounts for approximately 60% of the total number of farms. Therefore, if the machines were acceptable by the medium class farms, there will be a huge demand for them.

The above discussion deals only with the situation in the Stage of Orissa, but since such machines will be well accepted by other States, there will be a tremendous demand, provided that the machines are of superior quality and responably low priced.

(2) Purchase:

As discussed above, many farmers in India are with small financial strength, and those who can afford to buy various kinds of machines are large farms with more than 20 acres land which occupies only about 3 %.

Table 6. Number of farms and total acreage land area wise.

Land area	Number of farms	%	Total acreage (acres)	%
Less than 2 acres	835,901	29.5	835,901	5.8
2---4 acres	1,138,554	40.0	3,415,663	23.7
5---9 acres	564,130	19.8	3,948,910	27.4
10--19 acres	220,650	7.8	3,199,482	22.2
Above 20 acres	82,000	2.9	3,012,125	20.9
Total	2,839,720	100	14,412,081	100

Table 7. Ratio of outlay (Overhead charges, labour charges, expenses for fertilizers, etc.) to produce unit value:

(Government Farm Derras)

Name of crop	Cost per acres (Rs)	Value of production (Rs)	Profit (Rs)
Paddy	228	280	52
Maize	240	300	60
Groundnut	276	300	24
Sugarcane	1,200	1,280	80
Jute	270	450	180
Vegetables	324	500	176
Potato	648	800	152

Therefore, in order for the middle class farms to purchase machines, an organization to make financing becomes necessary. For the adjustment of village economy, India has, at present, an organization called "Panchayat system". The organization of Panchayat may be summerized as follows:

Although the number is not fixed, a village consists of approximately 500 households and 10 of such villages form Panchayat. Thus, one Panchayat consists of about 5,000 households. 10 of such Panchayat form a block and the consolidation of blocks is called "Zila Parishad" which belongs to the District Cabinet. The organization is a district autonomy organization, which, seemingly, receives a financial assistance from the government.

Each Panchayat has its own cooperative which undertakes a joint operation of central storing of agricultural products, sales, purchase of fertilizer as well as financing for purchase of farming implements, seeds, fertilizer, etc. The borrowing are repaid with the proceeds of sales of products, but the organization also extends long term loans up to 10 years. In other words, for the borrowing to purchase a machine of Rs.3,000, the annual repayment will be Rs.300 under the 10-year installment repayment. According to the report prepared by the State Government of Orissa, agricultural income and expenditures are as follows (Table 7).

Though the number of crops per year expected from a land varies depending on the circumstances, assuming that farms in general have three crops a year in average, the annual income per acre will be Rs.130 - 200. In the case of farmer with 5-acres of land, for example, because his annual income is Rs.650 - 1,000, it is impossible for him to purchase a Rs.3,000 machine and pay Rs.300 every year. In fact, it would be difficult to buy even Rs.1,000 machine which requires yearly installment payment of Rs.100. However, if he is thoroughly convinced that the machine will help reduce production cost and bring about additional income, he may be interested in buying it. It will require considerable education work, guidance and services to generate farmers' interest.

5 - 3 - 5. Selection of Type of Agricultural Machine:

(1) Standard for Selection of Machine:

To expect the greatest effect of mechanized agriculture, the largest possible number of machines should be employed. For this end, the machines should be of such type as may be purchased by 1,130,000 households of middle class farms with 2-4 acre lands that occupied 40% of the total farms. From this viewpoint, the riding type tractors with high horse-power will be disqualified. Besides, such large-size tractors are not suitable for the use at many small plots of land with irregular shape.

Therefore, the machine to be considered as the object of mechanization will be walking tractors to replace bullocks with machines. Merry tiller of 3HP class which are moderately priced will satisfy the above requirement as they can be conveniently used for the tilling of soft soil land with sufficient irrigation.

As discussed in the foregoing sections, however, 2/3 of a year is very dry and rice crop can not be expected more than once a year except for the places along rivers with abundant water-flow. Besides, as soil is sticky and hardened during the dry season, edges of implements can hardly cut into ground, thus making it impossible to cultivate with small light-weight machines. Because of this, small size tillers of 3 HP class can not be used for almost 2/3 of a year. Since farmers with low financial power can hardly afford to leave the machines idle for such a long period, the machines should also have a function to undertake other works. Works during the farmers' slack season will be hauling of products and also hauling work in connection with construction works. As far as transportation is concerned, the most efficient way is to carry as heavy load as possible by one hauling. However, the unfavourable condition of existing roads presents problem in this respect. Although the main highways are paved and in excellent condition, small roads from villages to the main highways are extremely bad. And, in some

cases, many stones of about 4" diameter which were laid when the roads were built are bared, making the roads very rough: To make the matters worse, oxcarts have grooved in the road surface by the width of their wheels, thereby causing great registance to the travelling of vehicles.

Even such rough roads would not present any problem to the slow moving oxcarts, but it would require considerable power for a faster moving tractor to travel. The tillers of 3 HP class can hardly satisfy such requirement.

Judging from the above conditions, the State Government of Orissa have obviously concluded that cultivators of 7-8 HP class manufactured by K. K. Kubota Tekko which are presently used in some part of India are the most suitable machine for the agriculture mechanization in Orissa State in consideration of their efficiency and other features. It is also apparent that the excellent results obtained by using this type machine at the model farm operated by Japanese staff at Chakli, Sanbalpur, have been one of the main reasons for selecting the machine.

(2) Structural Requirements:

(A) Prevention of Overload:

Agricultural machines, in general, are made for an easy handling by non-expert of machines, or, rather, by those who have little knowledge of machines. But, however skillfully it may be used, the machine can not handle work beyond its capacity, and it can not demonstrate fully its capacity if it is not used correctly. Failure will take place when the machine is operated beyond its capacity. Among the causes of troubles are, for the most part, excessively deep thrusting of the implements into ground, hard soil and existence of foreign substance. If such causes were repeated the sticking of engine would occure, or parts of machine would be broken, thereby requiring, in some cases, several months for repair. Such failure would make famers dislike the use of machines and disturb greatly the popularization of mechanization movement. In order to prevent the occurance of such unfavorable troubles, it is

necessary to educate farmers not to operate the machines to excess, and also to to provide some devices which will adjust such excess or indicate that the machine is being used beyond capacity.

(B) Simplification of the Construction of Machine:

Among machines of similar type and same price, those with wider application and multiple adjustment will have a better market, which fact tends to make the construction of machines increasingly complicated. While, in India, even though the machines are required to have multi-application, it is better to have simplier construction even at a sacrifice of a part of applications.

Complication of construction under fixed weight, price and dimensions is often followed by the lowering in strength of parts, which, in turn, increases the causes of failures. Simple parts attached to the outside of a machine can be replaced easily, but the complicated mechanical failure inside of the machine can not be repaired by farmers even if they have replacing parts.

(C) Consideration on Road Condition:-

The main highways are paved and in excellent condition but village roads are in terrible condition. Paving stones of about 4" diameter are laid, but because of the use by oxcarts for many years, the wheals have made two grooves in the road at a distance of 4.5'. Moreover, the road surface is washed off by heavy rains and the paving stones are exposed to make the road very rough. Attention should be paid to the fact that the roads are, as described above, by no means suitable for vehicles, and also that the space between left and right wheels of the machine should be made adjustable within the range of 3.5 - 4.5' depending on the required conditions.

(D) Countermeasures against Muddy Water:

Because the machine is mainly used for paddy farming, rotating parts should be made completely water-proof to keep them free from muddy water which would cause wear and tear and mechanical failure. Effort should be made also to keep the chains, etc. for power transmission absolutely free from muddy

water.

(E) Durability of Edges of Implements:

Because iron content of soil is high and soil often contains sand, the edges of implements which wear out easily should have a construction to allow easy replacement: The edges should be made with such shape and material to assure higher durability.

(3) Engines:-

All the large size riding tractors presently in use in India are equipped with diesel engines, and the diesel engines are also used for pumps. The main reasons for the use of diesel engine are better fuel economy, easier handling than gasoline engines and less electrical parts which are apt to have frequent failure. This is true with the large size riding tractors, but it is a matter calling for a deliberation to see if the diesel engine should be employed for the walking tractors for the same reasons as mentioned above. Since there are pros and cons as to the use of diesel engines for the walking tractors in the State of Orissa, it has been decided to test, prior to the actual production of machines, each 100 tractors with diesel engines and gasoline (or kerosene) engines for a comparative study of economy and other merits and demerits. At any rate, deliberate study should be made with due consideration to the fact that the walking tractors should be as low priced as possible as they are to be purchased by farmers with low financial capacity and also be of light-weight for manual handling as well as that even the diesel engine will have a mechanical failure and parts for replacement are difficult to obtain in case of such mechanical failure.

Because fuel for these machines must be obtained from abroad, it is a great burden on India with unfavourable foreign exchange balance. Though coal liquefaction is being studied as a means to reduce the foreign exchange burden, it has not been realize due to high cost of production. However, a large amount of coal for coal chemistry is produced at Talche Field of Orissa State,

it would be advantageous from the standpoint of national policy to use kerosene made from coal even at a little higher price if the production cost of same is not unduly higher than the price of importer kerosene. However, as this is the question of cost balance, it should be decided only after repeated studies.

5 - 4. Plan for Indigenous Production of Agricultural Machines:

5 - 4 - 1. Policy of Planning:

Since the State of Orissa is backward in the industrial development, it seems that there is hardly any machining industry which can be utilized in the indigenous production of agricultural machines.

In order to achieve the indigenous production of agricultural machines with the final goal of 5,000 machines a year, under such present circumstances, it should be planned to start first with assembling of imported parts and attain a full-fledged indigenous production through a series of progressive stages.

Therefore, the plant should be fully provided with equipment necessary for machining, casting and forgoing. During the period of low production, however, there will be some cases where certain machinetools have large excess capacity. Although it is ideal to install a machinetool at the time when it is assured of enough production, all the necessary machines should be installed even if they have excess capacity.

Though the initial goal of production is 5,000 machines, the plant should be constructed to have mass production process even with a larger investment cost, in view of the huge potential demand for the products. Furthermore, it is necessary to plan to simplify the work by installing single purpose machines and also automated machines which can handle many processes simultaneously because it will be difficult to employ machine operators who can manipulate the ordinary machinetools skillfully.

Financial burden to be incurred by the installation of casting and forging equipments may be too excessive with the production scale of only 5,000 machines. If there are factories that can cooperate in such work, the plant may take advantage of their service; but, in view of the large potential demand, there will certainly be a time in the near future when the installation of such equipment becomes essential.

To develop the State of Orissa into a "Ruhr in Europe", it is desirous to establish a policy, in planning the plant construction, to make it a model plant of mass-production. Effort should be made, however, to minimize the initial investment for overall cost-saving.

5 - 4 - 2. Metal Working Industry

(1) Present Status of Metal Working Industry in the State of Orissa

The first thing to be considered in establishing a new machine manufacturing plant is a plan to minimize the capital investment. This could be easily attained if the country, as a whole, has a high industrial level with active related industries. In case where the domestic industries are not matured, however, all the works required for own production must be carried out by the plant itself, which, in turn, necessitates more equipment with larger capital investment. Besides, if the related industries have not enough production, or their technical level is still low, whatever necessary for own production must be prepared by the plant itself as the related industries are not in a position to extend any help.

Visits made to various plants in other States during the survey show that, except for the plants located in the proximity of big cities where various industrial plants and factories are in operation, all the plants have a large number of equipment to produce most of the things for own use with an exception of very special parts. From this viewpoint, effort has been made to visit various plants especially metal working plants, to see how much help they can extend to our new plant in Orissa State. Because of the limited

time available, however, inspection could not cover all the related plants and factories, and it is regreted that no definite opinion can be formed at this moment.

Judging from what has been seen, however, the existing plants are not in a position to be of any help or assistance to the manufacturing of agricultural machines, provided that those plants visited are typical ones in Orissa State. The principal reason is that the contemplated production of agricultural machines will employ a mass-production process and all the parts must have a full interchangeability, whereas none of the existing plants has such production process, and despite that each individual product has excellent quality, it may not be used unconditionally when considered from the standpoint of mass-production. Inasmuch as the managements of existing plants are very capable, they will be able to extend great assistance to the planned machine production when they have come to know what is being manufactured and install necessary equpment with skilled labour. By that time, the new plant will be in a full operation with increased production, and will be in a position to receive their cooperation. It is firmly believed that, by making effort in exploring the industry to obtain as many cooperators as possible, the operation of plant will become not only profitable but also an impetus to the development of related industries in the State of Orissa.

The plants in Orissa State which were visited during the survey were as follows: Acknowledgement must be made for the kind cooperation extended by the managements of all the plants in taking time out to show us the plants.

1. Cuttack Industrial Estates.
2. National Foundry
3. Hirakud Work-shop
4. Multipurpose Industry (Khuntuni)
5. Kalinga Tube Company
6. Titaghur Paper Mills Company, Ltd.

When the person who will be in charge of production has been appointed, he should inspect once again the above mentioned plants and other related factories to see their present capability to cooperate as well as their future prospect, before making the final decision on the quality and quantity of equipment to be installed at the new plant.

The lines of products of the above mentioned plants are not included in this report as they are beyond the scope of the present survey.

(2) Present Status of Metal Working Industry in India:

(a) Type of Mass-production Plant:

Construction of the new plant should be planned on an assumption that the plant is not built in the highly industrialized city or its vicinity but in a place where no supporting industries are in existence.

As a result of the survey on the actual status of Indian industries, it has been found that, in other states of India, there are many plants in similar conditions which are independent with little help from other domestic industries. The industrial plants may be classified into two groups. One is the plants with a sole aim to carry out home-production of certain foreign machines under a technical collaboration with a foreign producer; while, the other group consists of plants belonging to the old established large plutocratic company which kept expanding its subsidiaries, and the subsidiaries carry on their business by mutual cooperation among themselves.

(b) Companies Engaged in Home-Manufacturing of Foreign Machines:

Out of the plants inspected, the following three plants fall in this category:

NAME OF COMPANY	PRODUCT
Goodearth Manufacturing Company	Eicher Diesel Tractor
Standard Motor Product India	Passenger Car
Hindustan Motors	Passenger Car

All the above plants manufacture certain machine under a collaboration with foreign manufacturer. Home-manufacturing of a foreign machine is first started with the assembly of machines imported in a form of knock-down, and the extent of home production is then gradually increased by expanding necessary equipment. The operation can be carried out without having any cooperation of other domestic manufacturers as the foreign company provides all the necessary assistance. In case where the capacity of an equipment to be installed for the manufacturing of certain parts of the machine is in far excess of required production, the plant may either keep importing such parts or have them made by other domestic manufacturers. The fundamental policy is, however, to use its own products except for such purchase parts as ball bearings and electrical parts. All of them are very fine companies and produce excellent products. Of the above three companies, the two automobile manufacturers have substantial equipment: while the Goodearth Mfg. Company is now and plans to attain an annual production of 3,000 tractors in three years.

(c) Plants Related to Financial Combines:

Of the plants inspected during the survey, the plants under this category are the following five plants which belong to Kirloskar Family.

Kirloskar Electric Company

Kirloskar Machinetool Company

Kirloskar Pump Company

Kirloskar Oil Engine Company

Kirloskar Pneumatic Company

All these companies too use their own products except such purchase parts as bearings, etc. However, castings are supplied by the Machinetool and Pump Companies which have casting shops. Some of the plants have as old as 52 years' history, and are well equipped with various kinds of machinetools. Their operation can be carried out smoothly by mutual cooperation of the sister companies without asking for cooperation of outside companies. These companies

also produce high quality products and contribute a great deal to the industrial development of Orissa State.

(d) Methods of Placing Orders with Specialized Parts Makers:

Ball bearings, oil seal, clutch lining, tire, electrical parts of automobiles, special castings (die cast products), etc. which are not manufactured by the machine manufacturers are ordered to specialized parts makers. But, owing to the limited production capacity of the parts makers, the parts can not be obtained immediately. Therefore, it is advisable to place an order for one year need so that the parts may be supplied whenever necessary.

5 - 4 - 3. Method to Promote Indigenous Production:

The followings are a plan for indigenous production of agricultural machines prepared in the light of the present condition of the State of Orissa and the opinion of the State Government:

(1) Kind of Machine to be Manufactured:

The State Government of Orissa is desirous to start production and also to carry out indigenous-manufacturing of only one particular kind of machine as stated below:

Kind of Machine: Kubota 7-8HP class cultivator and a set of its proper attachments.

Conditions:

(a) Though air-cooled diesel engine is being considered, kerosene or gasoline engine may be employed.

(b) The machine will be used mainly for works relative to paddy farming, but it will also be used for hauling work

(c) Approval of the State Government shall be obtained as to the efficiency of the machine itself and specifications and efficiency of the attached implements (including trailer).

(d) Basic farming work for which the machine will be used

includes ploughing, harrowing, fertilizing, seeding, ridging, weeding, trailer-hauling, etc. but the detailed specification should be discussed with the State Government.

(2) Test to Determine Specifications:

Since the above machine is presently being used in India to some extent, its outline is known. As it is necessary, however, to examine in detail the suitability before its actual production and use in the State of Orissa, test to determine the specifications of machine will be made in two stages as mentioned below:

(a) 1st stage test:

Number of machines to be tested: 3 sets (including one spare set)

Machines to be tested: Main body of machine and attached principal implements (including trailer).

Nature of test: Field tests in various places on the two sets (one set being spare).

Purpose of test: To find out if there is a need of any improvements for the use in Orissa State.

(b) 2nd stage test:

Number of machines to be tested: 200 sets including principal attachments.

Machines to be tested: Machines with improvement work made as a result of the 1st stage test.

Engine of the machine: 100 sets with air-cooled diesel engines, and another 100 sets with air-cooled kerosene or galoline engines.

Nature of test: Field test at various places in Orissa State.

Purpose of test: a. To find out if further improvements are necessary.

b. To compare a diesel engine and kerosene or gasoline engine for their economy and handling.

(c) Dispatch of testing staff:

(i) Testing staff for the 1st stage test: 9 persons to be dipatched upon delivery of machines to be tested.

Details of staff members:

Leader:	1
Design Engineer:	2
Operator:	2
Machining Technician:	2
Total	7

(Note) The reason for having two persons for each job category (except the leader) is that the test will be conducted at two different places.

(ii) Staff for the 2nd stage test: Staff for the test will be decided later.

(iii) Procurement of machine and expenses to be borne:

Procurement of machine: To be purchased by India with her foreing exchange. Expenses to be incurred by the staff and testing: To be borne by India.

(Note) Details of testing methods and expenses will be discussed when the subject matter becomes more concrete.

(3) Details of Collaboration:

(a) Kind of Collaboration:

Whether a capital tie-up or technical collaboration is made for the construction of plant and manufacturing of agricultural machines will be decided by the mutual agreement between the Central Government and Japanese manufacturer.

(b) Drawings:

All the drawings shall be furnished by the manufacturer.

(c) Personnel to Give Production Guidance:

Chief engineer, leading engineers, assistant engineers and some foremen shall be stationed in India at the expense of India.

(d) Training of Apprentice:

10 personnels will be sent to Japan every year for five years for the purpose of acquiring technique of designing, process control, handling of machine-tools, assemblying of machine, heat treatment, casting, forging, etc. The training, which will be given to those who are candidate for supervisory staff and foreman, will last for 10 months. The expenses shall be borne by India.

(4) Matters Relative to Production:

(a) Demand:

The State Government of Orissa will assume full responsibility for the consumption of products.

(b) Annual Production:

The output will be gradually increased in the following five steps. The length of each stage has not been determined as it depends on the skill of engineers and workers available in India.

STAGE	1st	2nd	3rd	4th	5th
OUTPUT	1,000	2,000	3,000	4,000	5,000

(The above should include 15% service parts)

(Note) Stages subsequent to the 5th stage are not considered at this moment.

(c) Substance of Indigenous-Production:

Indigenous-production will be stepped up in five stages, as in the case of above stated production so that the machine may be completely indigenous-manufactured in the 5th stage (Table 8). However, in case where the technical level of employees is low, it may be necessary to defer the stages so that production increase and progress of indigenous-production may be attained alternately (This particular matter is not taken into consideration in this

discussion.)

Table - 8. Deletion Plan

STAGE	1st	2nd	3rd	4th	5th
% of indigenous-production	10	30	50	80	100
Assembly	Ind. Production	Ind. Prod.	Ind. Prod.	Ind. Prod.	Ind. Prod
Sheet metal, welding & Smithery works		I.P.	I.P.	I.P.	I.P.
Ordinary machining & heat treatment			I.P.	I.P.	I.P.
Mass production & special machining			I.P.	I.P.	I.P.
Engine				I.P. (Assembly only)	I.P. (Totally)
Casting & Forging					I.P.

(d) Materials and Parts:

(i) Parts:

((i)) At the beginning of the 1st stage of indigenous-production, the machine should be supplied in the form of "knock-down" of large group classification. The grouping should be made smaller with the progress of skill so that all the parts may be disjointed and sent by the end of the stage.

((ii)) All the parts are to be imported in the 1st stage.

((iii)) In the second stage and thereafter, all the parts except those to be processed indigenously will be imported and the parts to be indigenously machined will be imported in the form of materials (such as bars, sheets, castings and forgings).

(ii) Semi assemblies:

((i)) Engine: Finished products are to be imported during the 1st, 2nd and third stages. In the 4th stage, engines will be imported in the form of parts to be assembled domestically. In the 5th stage, the entire part

of engines will be home-manufactured.

((ii)) Bearings, brake-linings, clutch-linings, chains, oil-seals, electricals pumps and tires are available within India, but it should be planned to make a thorough investigation and testing before using such home-made parts.

(iii) Metal Materials:

((i)) Bars and steel sheets without any specific requirement may be procured in India if the dimensions are satisfied.

((ii)) Cold rolled bars, colled rolled sheets, special steel products that are required and heat treatment are to be imported throughout all stages.

((iii)) Non-ferrous metal materials are to be imported throughout all stages.

((iv)) Wooden materials will be procured domestically in India.

(e) All the equipment should be prepared in advance to meet the production requirement in each stage so that the production under each stage may be started without any hindrance. (Refer to the following Table-9, in which "*" denotes time of installation and "Addition" includes additional machines for engine manufacturing.

Table - 9. Installation Plan.

STAGE	PREPARATORY	1st	2nd	3rd	4th
Expected Output	1,000	2,000	3,000	4,000	5,000
Assembly Equipment	*		* Add.		* Add.
Small Processing Eqt.	*		* Add.		
Sheet Working, Welding & Smithery		*		* Add.	* Add.
Ordinary Machinetools (lathe,milling machine, drill, shaper, small grinder)			*		* Add.
Multiple-Spindle Drill			*		* Add.
Special Machinetools,Copy lathe, 2-phase milling machine,grooving machine, various grinders, gear cutter, spline broach, boring machine,threading machine,Buffing,Fineboring)				*	* Add.
Press, Shear, Roll, Hammer & Gas Equipment		*		* Add.	
Machinetools for Engine					*
Casting & Forging Eqt.					*
Monorail	*		* Add.		* Add.
Overhead Crane			*		* Add.
Surface plate	*		* Add.		* Add.
Storage Equipment (wood working, metal saw, monorail, weigher, fork-lift, etc.)	*	* Add.		* Add.	
Painting Equipment	*(partly)	* Add.		* Add.	
Various Jigs, Central Grinding Equipment	*	* Add.		* Add.	* Add.
Inspection Tools & Eqt. (incl. tester)	*	* Add.	* Add.	* Add.	* Add.
Shelves.	*	* Add.	* Add.	* Add.	* Add.
Washing Facilities	*	* Add.		* Add.	

(Note) 1. In the 2nd and 4th stage, two-shift work schedule should be employed gradually to prevent undue increase in capital investment cost. (1-shift: 8 hours)

2. All the equipment will be installed by the end of the 4th production stages.

3. Machines to be installed in the 5th stage are only those in need of additions.

4. Of the ordinary machinetools, lathes, milling machines, up-right drills and shapers may be procured domestically in India provided that their delivery can be made in time.

5. Other Works: Land preparation, building of structures, electric work, water piping, drainage work, etc. will be undertaken by India in accordance with the drawings supplied by Japan.

6. Living Accommodations & Welfare Facilities:
Individual living accommodations for the engineering staff from Japan are to be built by India with due consideration to the requirements made by Japan. The housing facilities for Indian employees will be built by India in proportion to the increase in production.

7. Engineering Standard: All the engineering standards are in accordance with the standards set forth by the Government of India, and in the absence of such Indian standard they will be governed by JIS. Metric system will be employed for the unit of measurement.

8. Training: A training center will be built first to train the workers.

9. Initial Service: An established service system will be required when the machines are produced in quantity, but during the initial stages when the amount of production is small, a small-scale service group will be organized. The full-fledged service system is created under different category.

(5) Prerequisites to Prospective Sites for the Construction of Farming Machines:

The prospective site for the machine manufacturing plant should be decided by the State Government of Orissa. The following factors should be taken into due consideration in making a final decision on the plant site. Some explanation will be made by refering to Cuttack and Burla.

(A) Railway Transportation:

The site should be the center of railways from various places. Attention should be directed to the fact that excessive changes of lines would often casue delays and losses in transporting materials and parts for machine production as well as shipping products to destination.

(B) Distance from Consumers:

The plant should have proximity to consumers. This would have such advantages as less delivering cost to consumers and more efficient service.

(C) Electric Power Supply:

As the plant grows in future, its power consumption will increase. Since the heat treatment and casting equipment require a large amount of power, the plant should be located in a place where the electric power supply is abundant.

At present, the power supply in Cuttack District is made by Hirakud Power Station, but since many larger power consumers are expected to be on this line, the actual condition of electric power supply should be investigated before selecting the district. On the other hand, since Burla is in the proximity of Hirakud Power Station, there will be no problem of power shortage.

(D) The Site Should be Free From Flood:

State Orissa is hilly but has few mountains. Any heavy rainfall on the places with such topography would bring about local floods owing to poor draining. The plan site should have a good water draining even if it is

located on high land.

(E) Labour Supply:

Some people say that Cuttack district has not much surplus labour due to construction of many large plants which take up village labour force. In such district, wages tend to go up with resultant higher cost of production. Burla district, on the other hand, is said to have surplus labour force due to absence of large industrial plants. This is the matter to be taken into due consideration for reducing manufacturing costs.

(F) Thought of Laborers:

Some people say that laborers in Cuttack district have, in general, radical thoughts and are likely to have labour disputes. Attention should be paid to the fact that any labour dispute is very detrimental to the plant operation. It is also told that inhabitants in Burla district are obedient and hardworking.

(G) Proposed Site for Plant:

With due consideration to the matters discussed above, the writer recommends that the plant should be built in Burla District.

(6) Technical Training of Engineers and Workers:

The term "Engineers" used herein in this report means engineers of agricultural, mechanical and plant controlling; and "Workers" means those who are engaged in operation of machinetools, assembly of machines and other jobs within a manufacturing plant.

(a) Agricultural Engineers:

The term "Agricultural Technology" implies numerous fields of technology. In the field of agricultural development, for the rice plant alone, there is such an organization as the Central Rice Research Institute that undertakes research work on the problems of soil, fertilizer, blight and vermine damage, methods of raising, irrigation, etc. There is also an agricultural college for the training of agricultural engineers, but the object of its training is

confined to the conventional cattle-farming.

It is of vital importance to have engineers who are capable to make study on the mechanized methods of seeding, transplanting, weeding, ploughing and tilling as well as to give guidance to local farmers. Furthermore, the selection of suitable secondary crops is another problem to be solved by the agricultural engineers. Besides such specialized agricultural engineers, the mechanization will require a large number of those who are capable to teach farmers the handling of agricultural machines, methods of maintenance, etc.

Assuming that the output of agricultural machines is 1,000 in the first year and keeps increasing by 1,000 every year, the cumulative total of machines in the fifth year will become 15,000 as shown below:

YEAR	OUTPUT OF EACH YEAR	CUMULATIVE TOTAL
End of 1st year	1,000	1,000
End of 2nd year	2,000	3,000
End of 3rd year	3,000	6,000
End of 4th year	4,000	10,000
End of 5th year	5,000	15,000

In other words, by the end of 5th year, 15,000 machines will be in use, which can hardly be taken care of by the village level workers assigned to each Panchayat. Therefore, training of engineers should be made prior to the starting of machine production.

Unduly excessive load tends to shorten the working life of machines and also cause mechanical failures. Moreover, insufficient maintenance will result in such failures as inferior operation of sliding parts and seizure. Since such troubles will become a great obstacle to a smooth mechanization of agriculture, it is absolutely essential to have engineers to educate farmers who actually operate the machines. For the training of the above mentioned maintenance engineers, the graduates of technical schools should be trained

at the manufacturing plant for certain period.

(b) Plant Control Engineers:

As regards plant control engineers, since it is planned to train several engineers in Japan every year, no particular discussion is made. However, since the contemplated plant is to employ a mass-production process it is necessary for them to acquire mass-production technique which is not taught in Indian universities. Furthermore, since specially designed machinetools for mass-production will be used, they should master handling of such special machinetools as well as guidance of workers.

(c) Workers:

As in the case of engineers, some of the workers will be trained in Japan. However, compared with the substantial number of total workers to be employed at the plant, those to be trained in Japan are very insignificant in number. Therefore, effort should be made to employ skilled workers, but it is doubtful if many skilled workers are available within the State of Orissa; while, in order to mobilize workers from other states, the wage should be attractive. However, since it is apparent that the government operated plant has certain limit in the amount of wage paid to the workers, they would have to be trained within the plant. It is recommended to provide a training center in the plant for the training of workers.