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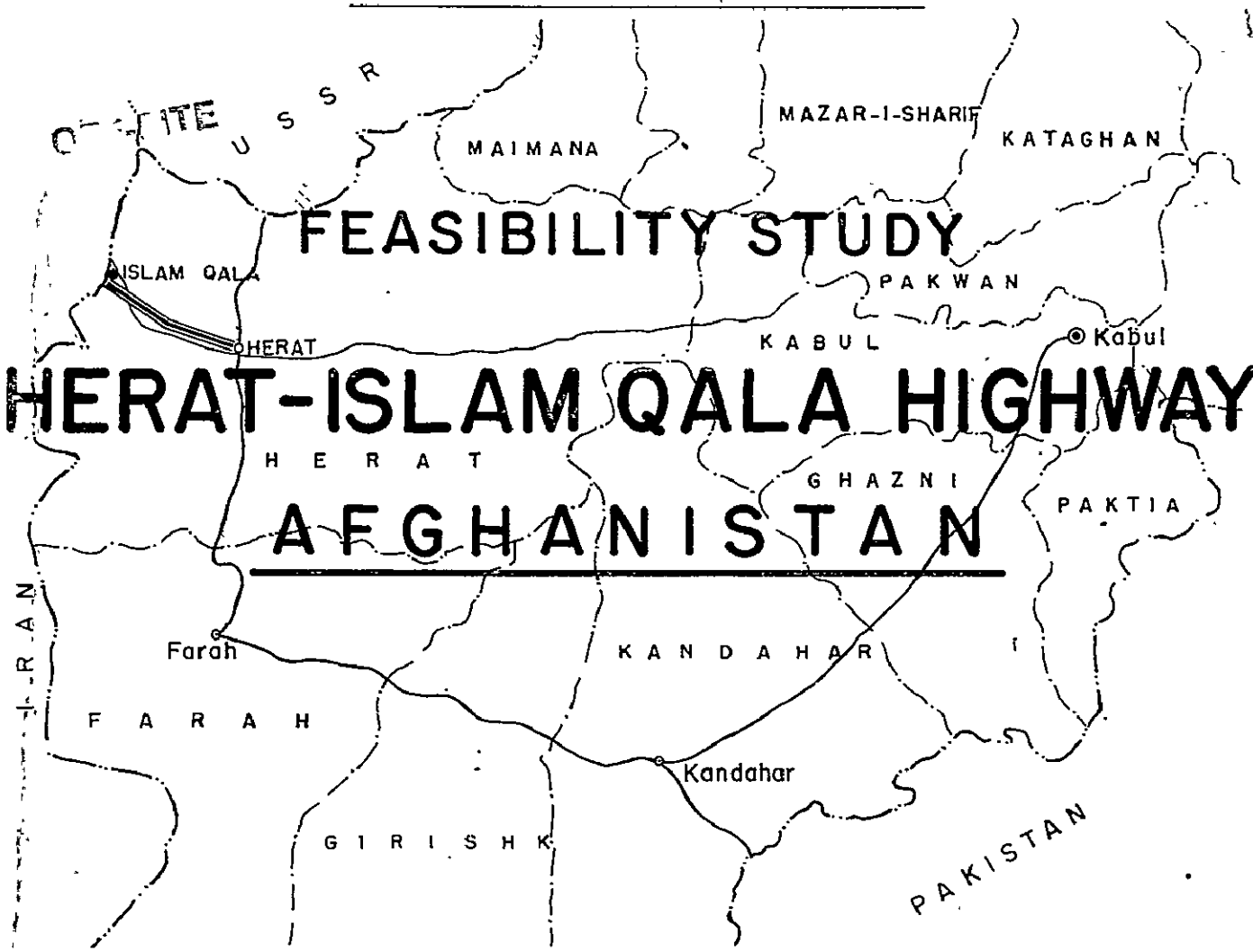

FEASIBILITY STUDY

HERAT-ISLAM QALA HIGHWAY

AFGHANISTAN

PREPARED BY
U. S. ARMY ENGINEER DIVISION
MEDITERRANEAN
LEGHORN ITALY

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CORPS OF ENGINEERS

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REPORT ON FEASIBILITY OF IMPROVING HIGHWAY FROM HERAT TO AFGHANISTAN - IRANIAN BORDER

ROYAL GOVERNMENT OF AFGHANISTAN

PREPARED BY

U. S. ARMY ENGINEER DIVISION
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PREFACE

This report is submitted in response to Project Implementation Order 306-AD-31-AD-2-2-30047 issued by the United States Agency for International Development 9 March 1963 to the Chief of Engineers, U.S. Army, Washington, D. C. Requirements for the investigation and report are quoted from parts of the aforesaid document:

> "The Corps of Engineers will furnish the necessary number of qualified personnel, equipment and materials to make the required topographic and drainage survey, and to carry out all such other steps necessary to establish the proper and most economical location of the road and to prepare the preliminary design and reasonable firm estimates of costs of construction of the road. All such activities shall be carried out in accordance with generally accepted engineering practices. Cost estimates shall be prepared under the assumption that an American construction contractor will be employed, and that all cement, steel, asphalt if required, construction equipment and administrative and supervisory services will need to be procured outside of Afghanistan. It is to be assumed that adequate common and semi-skilled labor can be obtained in Afghanistan. A detailed report shall be prepared and submitted to USAID Afghanistan for presentation to the Ministry of Public Works for consideration and further action. Such report shall be sufficiently detailed and comprehensive to serve as a basis on which an AID Loan Application can be completed and presented and to satisfy Sec. 611 of the Foreign Assistance Act of 1961. Prior to final preparation of said report a preliminary draft shall be submitted to AID/W for review. Subsequently, 25 copies shall be prepared - 5 each for AID/W, C of E, RGA, and USAID/A."

Conduct of the investigation and preparation of the report was assigned to the Division Engineer, Mediterranean Division, U. S. Army Corps of Engineers, Leghorn, Italy. The economic feasibility portion of this report was furnished by the U.S. Country Team in Afghanistan. Criteria for the report is set forth in Chapter IX of Manual "Feasibility Studies Economic and Technical Soundness Analysis Capital Projects", dated June 1, 1962 by Dept. of State, AID. A summary of the principal features and findings of the investigation follows.

REPORT ON FEASIBILITY OF IMPROVING HIGHWAY FROM HERAT TO AFGHANISTAN-IRANIAN BORDER

INTRODUCTION

A consideration of the economic feasibility of constructing a modern highway from the City of Herat in northwestern Afghanistan to Islam Qala on the Iranian border must be viewed in the light and context of the history and objectives of the USAID program for economic and social development in Afghanistan and commitments made to the Royal Government of Afghanistan for such assistance.

Although U.S. assistance to Afghanistan actually started in 1950, the grant aid provided from that year through 1955 was only token in nature. Major U.S. grant aid began in 1956 in support of the development of air transportation. Increased assistance continued into 1957, the year of preparation of the First Five Year Plan for economic development, a plan designed to provide for a firm foundation on which the future economy of the country could be built. Included was the construction of a country-wide modern highway network that would eventually provide connecting links between the major cities and with the borders of Pakistan and the Soviet Union. It is to be borne in mind that at the time this decision was taken, most roads of Afghanistan were little more than animal trails. Furthermore, the country is completely land-locked, has no navigable rivers nor railways, and with the nearest port of sea entry being Karchi, Pakistan, a distance of about 1125 kilometers from Chaman, the closest border point in Pakistan. It was clear that, without the construction of a basic highway system, it would be almost futile to undertake a long-range economic and social development program. The successful development of agriculture and industry, basic objectives of the AID program, is dependent to great extent on the ready and free movement of goods both internally and to border outlets. The movement of imported goods, on which Afghanistan must depend to a large extent, demands a modern road system over which these goods can move swiftly and economically to central distribution areas. Furthermore, a basic road communication system throughout the country has considerable internal political and social significance, factors which are in line with US objectives. This is demonstrated by a freer movement of people and easier and more frequent contact of government officials with the remote areas resulting in a greater feeling of identity on the part of these people with their government. Without a ready and free communication of people, both internally and externally, social advance and political cohesiveness will be restricted.

Under the First Five Year Plan, the U.S. agreed to provide assistance in the form of commodities, equipment and technical advice on construction of that portion of the highway network in

the southern part of the country that would connect the major cities of Kabul and Kandahar and which would continue on to Spin Baldak on the Pakistan border where a railway connects on the Pakistan side at Chaman. In addition, agreement was reached to provide advice and assistance in the paving of the highway from Kabul to Torkham on the Pakistan border. Under the Second Five Year Plan, which started in 1962, the Royal Government of Afghanistan proposed to construct a road from Herat to Islam Qala on the border of Iran. This would put the final links in the overall highway system and give Afghanistan ready access to both Iran and Pakistan.

Subsequent to the presentation of the Second Five Year Plan, a series of meetings were conducted between Royal Government of Afghanistan officials and the USAID/Afghanistan Director to discuss their proposals and consider those elements of the Plan that might qualify for US assistance. The assistance of the US Government was offered in the form of a grant to perform the engineering work and a loan for the actual construction of the Herat-Islam Qala road, providing a loan application is received from the RGA and favorably acted upon.

SECTION I: SUMMARY

1. Location, Nature and Extent of Proposed Work.

The work proposed in this study consists of providing an all-weather highway to replace an existing, substandard and frequently impassible road between the City of Herat, Afghanistan and the Iranian border. The improved road, approximately 124 kilometers long, will follow with minor straightening the northernmost alignment of two existing roads for approximately 75 kilometers, and the remaining 49 kilometers will follow a new alignment. A regional map and a vicinity map of the area are shown on Plates Nos. 1 and 2, respectively.

2. Relation to Other Highways or Transportation Facilities.

The highway will connect in the outskirts of Herat with the Afghanistan National Highway System now under construction. When the system has been completed, a continuous cross-country highway will be achieved which will connect the major cities of the country and eventually become an important transportation link in a transcontinental highway across southern Asia. There are no other transportation facilities in the country except air transport which is presently being improved and expanded.

3. Major Features of Design.

The proposed improvements include a gravel surfaced roadway 5.52 meters wide on a raised embankment, where necessary to provide drainage, and of sufficient width to provide shoulders 1.2 meters wide. Included in the proposed improvements are one structural steel bridge to cross the Hari River and three reinforced concrete bridges to cross deep washes.

4. Prior Reports.

Data contained in report "Basic Data on the Economy of Afghanistan" U.S. Dept. of Commerce 1962, was used in the preparation of this report.

SECTION II: ECONOMIC ASPECTS AND BENEFITS

1. Position of Project in Overall Program:

a. Present Highway System: In 1957 the First Five Year Plan for economic development was prepared which included initiation of a construction program for a country-wide network of modern highways. The Second Five Year Plan starting in 1962 continued the highway construction program. Considerable work has been accomplished under the Plans as the result of aid grants from the United States Government through the Agency for International Development (formerly the International Cooperation Administration) and from the Soviet Government. The present highway system in Afghanistan, thus, consists of completed segments of modern highways connected by segments of improved sub-standard roads and by segments of still unimproved roads. Modern highways have been constructed between the following points:

Kandahar to Spin Baldak on the Pakistan border - 105 kms.

Kabul northward - 64 kms.

Kabul to Torkham in vicinity of the Khyber Pass - 130 kms.

Shindand to Chehil Dukh Taran on the Soviet border-220 Kms.

In addition, the highway between Kandahar and Kabul, a distance of 482 kilometers is presently under construction.

b. Present Transportation Systems other than Highways: Afghanistan is a landlocked country with neither navigable streams, pipelines nor railroads except for a 10-km spur-line from Kushka, USSR. Highway and air transport are the only available transportation facilities. A modern highway system is considered more flexible to the needs of the country than railroads and construction of such a system would preclude the necessity for constructing railroads except for short extensions into Afghanistan territory from railheads in neighboring countries. Construction of airports and attendant facilities and furnishing aircraft represents a major portion of the foreign assistance programs for the country. Modern international airports have been constructed at Kabul and Kandahar under the First and Second Five Year Plans, as well as operational airports at Herat, Kunduz, Jalalabad and Mazar-i-Sharif. Daily domestic service is maintained and regular scheduled international flights are made to Tehran, Beirut, Frankfort, New Delhi and other points.

c. Extent to which Inadequacies of Transport are Retarding Economic Growth: Afghanistan is still in the first stages of economic and social development. The lack of adequate means of

transportation in the past, both within the country and to other countries, has resulted in an economy at the bare subsistance level because there is no incentive to produce in excess of that which could be transported to a nearby market. The successful development of a sound agriculture program and the establishment of an industry even on an initial small scale is vitally dependent on access to adequate transportation facilities. The movement of imported goods, important to the social and economic development of the country, must also depend on rapid and economical means of transportation.

d. National Program for Highway Development and Priority of Project Within the Program: The National Program for Highway Development is set forth in the First and Second Five Year Plans which provide for a basic network of highways approximately 2100 kilometers in length as follows:

Kabul to Torkham on the Pakistan border.

Kabul to Kandahar.

Kandahar to Spin Baldak on the Pakistan border.

Kabul to Qizil Qala on the Soviet border.

Kandahar to Chehil Dukh Taran on Soviet border via Herat.

Herat to Iranian border via Islam Qala.

Construction has been started on all these highways except for the Herat to Iranian border highway, which is the subject of the study reported herein. Some segments of the above highways have been completed as noted in Para 1a. Assistance is now being furnished by the U.S. Government for the construction of the first two highways listed above which are located in the southern region of the country. Assistance was also furnished by the U.S. Government to construct the Kandahar to Spin Baldak highway now completed. The government of the USSR is providing the assistance for constructing the two highways which extend to the Soviet border. The improved Herat to Iranian border highway was proposed for the Second Five Year Plan and will provide a necessary additional international link with the national highway system. For this reason, planning for this project has top priority over other contemplated highway projects.

2. Relation to Other Transport Systems.

Distribution of Traffic Among the Various Types of Transport: The only other available transportation system in the country is air transport. Although there is an operational airport at Herat, there is no direct air service at the present time from Herat to points outside Afghanistan. The improvements proposed herein would stimulate an increased flow of vehicular traffic but would have little, if any, effect on present air traffic at Herat.

3. Availability of Vehicles and Operating Personnel:

a. In accordance with vehicle registration data furnished by a representative of the RGA Ministry of Planning, the total of registered vehicles in Afghanistan at the end of 1962 in round figures included approximately 10,000 trucks, 1400 busses and 700 private passenger vehicles and taxis. In addition, it is esitmated that Foreign Missions, business organizations and contractors operate another 600 to 750 passenger vehicles and approximately 200 trucks. Approximately 70% of all vehicles operate in the province of Kabul, 15% each in the provinces of Herat and Kandahar and the remaining 15% is distributed over the other provinces. Accordingly, it is estimate that the number of vehicles in the Herat province at the end of 1962 amounted to 800 trucks, 210 busses and 100 to 150 passenger vehicles. Afghanistan has been devoting, in recent years, a sizeable portion of its foreign exchange reserve for the import of motor vehicles, primarily trucks, of which 3152 were imported during the period of the First Five Year Plan ending 1961. Thus, the First Five Year Plan promoted a yearly average growth in the number of trucks registered of approximately 9%.

b. This year a transport equipment loan of between 2 and 5 million dollars has been authorized by the United States. The loan will be used for the purchase of cargo trucks, spare parts, tires and lubricants. It is believed that Afghanistan will continue to give high priority to the import of cargo-carrying type vehicles to accommodate the general trends of its increasing production and the increasing import and export activities. Operating personnel for current traffic demand is adequate in number and experience and it is believed that all future increased demand for operating personnel can be met by the continuing and substantially successful efforts to increase available operator forces in anticipation of rising demand.

4. Maintenance Facilities:

a. The overland transport effort in the country already severely taxed by numerous sub-standard roads is further handicapped by the acute lack of adequate maintenance shop facilities and the innumerable difficulties attending the procurement and maintaining adequate spare part stocks. The reason for this lack of maintenance capability stems from the very late date at which the country began to reorient itself towards development of roads and overland transport facilities improvements.

b. It is evident that the development of a system of overland highways will, with the increased number of highway transport vehicles, increase the demand for vehicle maintenance capability, but it may also be anticipated that the development of overland road nets will tend to eliminate many of the current impediments attending maintenance requirements. The new highway net is bound to promote governmental and private efforts to procure modern transport equipment and, as their number will increasingly

replace the presently poorly maintained equipment, a more orderly and predictable effort to maintain spare parts stocks will facilitate the future maintenance task.

c. Recent and current sizable road construction activities have furnished proff that, given the opportunity for on-the-job training as provided in these undertakings, local labor can readily be trained in the necessary skills required to satisfactorily operate and maintain transport as well as heavy construction equipment. It is therefore believed that in all aspects of maintenance endeavour the current difficulties connected therewith will be overcome as improved highways will promote the up-dating of transport equipment, a better flow of maintenance tools and spare parts and further ease the short supply of trained maintenance personnel.

5. Fuel: Petroleum explorations have been made principally in the northern areas of Afghanistan but the results of the explorations are not known. There is no petroleum production in the country at the pesent time. However, POL products are readily available and are obtained from Iran, the Soviet Union and through Pakistan. The price differential for these products favors Iran as a supplier but existing transportation facilities favor the Soviet Union. It is believed that Iran becomes the major supplier of POL products to Afghanistan in the event transportation facilities between the two countries were improved.

6. Effect on Development in the Project Area:

a. Existing Roads: The proposed improved highway is located in the valley of the Hari River which rises in the mountainous central region of the country and flows westward past Herat, turns northward at the Iranian border and finally disappears in the desert area of Turkmenshaya SSR. There are two existing roads which follow the Hari River Valley from Herat towards Islam Qala. Those roads join at a point approximately 3 kilmmeters east of Islam Qala. The southernmost road crosses the Hari River at a point approximately 28 kilometers west of Herat and follows the south side of the valley while the northernmost road follows the north side of the valley and crosses the Hari River approximately 75 kilometers west of Herat. The northernmost road has been given preference for improvement on the basis of economic and engineering considerations.

b. Description of the area: The valley of the Hari River consists of relatively flat, semi-arid desert country. Vegetation in the area is confined primarily to the vicinity of the river where extensive irrigation systems permit cultivation on both banks. Land on the northern and southern edges of the valley is semi-arid with brush vegetation which is used for fuel and sufficient grass after winter and spring rains to permit grazing. The area has a scarcity of rainfall with an annual average of 186 mm (7.3 inches) measured at Herat over an eight-year period. Rainfall occurs

mainly between December and March. Infrequent rain storms of high intensity may be experienced. Summers are dry and hot with daily maximum temperatures ranging from 30 to 40 degrees C. (86 to 104 F.). Average daily minimum temperatures of 0 degrees C (32 degrees F) occur during the winter months and some snow and frost may occur. During the months May to August the area is subjected to high winds, known locally as the 120-day winds.

c. Agriculture: Grains and livestock are the principal agricultural commodities produced in the area; however, considerable quantities of rice, oilseeds, clover, fruits and nuts are also grown. A silk industry is being developed in the Ghurian Section. Wheat is the most important grain crop followed by rice, corn and barley. Some cotton is produced and the Royal Government of Afghanistan has plans to greatly increase production of cotton in the Herat Province during the next few years. Sheep and goats are the most important livestock raised in the area, and some cattle are raised where sufficient and suitable grazing land is available. Agricultural production statistics for the area are not available. Estimated annual production in the Herat Province for the following commodities are:

Wheat	200,000	Metric	tons
Rice	8,000	"	"
Corn	75,000	"	"

The livestock population of the Province in 1962 totalled:

Sheep and Goats	4,600,000	(Excl Karakul sheep)
Cattle	360,000	
Karakul sheep	700,000	

There are no agricultural processing industries in the area.

d. Industries: There are a number of small-scale industrial establishments in Herat. Manufactures include: spinning, weaving and finishing of textiles; knit goods; carpets, leather tanning and manufacture of leather goods; soap; pottery; metal goods; furniture and confestions.

e. Population: A census of the population of Afghanistan has never been taken. However, a recent U.N. population sampling made in the City of Herat, including the town proper and villages in the Herat Municipality, indicated a population of 87,500. The population of Herat Province is estimated by the Royal Government of Afghanistan at approximately one million. Herat is the largest city in the province.

f. Estimate of Volume of Exportable Surplus Commodities. An appraisal of the anticipated economical development in the Herat province is rendered difficult for lack of statistical records pertaining to past experience in the Area. On a national basis efforts to develop statistical records on economic activities have been made to initially record the impact of the first 5 year plan on the national economy of Afghanistan. Abstracts of these records, as contained in an analysis made by the UN economic mission to Afghanistan, are included hereunder, to refect general trends and to permit their use for an estimate of future trends.

TABLE A

Production (in'000 tons)

	1956/57	1957/58	1958/59	1959/60	1960/61
Foodgrains	3,449	3,250	3,544	3,622	3,676
Commercial crops ..	137.0	153.0	176.0	186.0	193.0
Fruits	248.0	248.0	270.0	250.0	305.0
Vegetables	475.0	500.0	500.0	500.0	500.0

TABLE B

PRODUCTION OF CEREAL

Production (in '000 tons)

	1956/57	1957/58	1958/59	1959/60	1960/61
Wheat	2,200	1,983	2,254	2,240	2,279
Corn	624	627	644	700	700
Barley	325	357	357	369	378
Rice	300	303	303	313	319
Total	3,449	3,290	3,544	3,622	3,676

TABLE C

PRODUCTION OF COMMERCIAL CROPS

Production (in '000 tons)

	1956/57	1957/58	1958/59	1959/60	1960/61
Raw cotton	22.0	44.0	53.0	47.0	54.0
Sugar beet	33.0	37.0	35.0	44.0	44.0
Sugar cane	38.0	30.0	38.0	45.0	45.0
Oilseeds	42.0	42.0	50.0	50.0	50.0

TABLE D

AVERAGE YIELDS OF CEREALS AND COMMERCIAL CROPS
(in tons per hectare)

	1956/57	1957/58	1958/59	1959/60	1960/61
1. Cereals					
Wheat	1.00	0.90	1.01	1.01	1.02
Corn	1.30	1.28	1.30	1.40	1.40
Barley	1.00	1.02	1.06	1.07	1.08
Rice	1.50	1.50	1.51	1.51	1.52
2. Commercial crops					
Raw cotton	0.600	0.700	0.800	0.780	0.830
Sugar beet	10.0	10.0	10.0	11.0	11.00
Sugar cane	25.0	25.0	25.0	25.0	25.0
Oilseeds	0.3	0.3	0.3	0.3	0.3

TABLE E

AVERAGE YIELDS OF FRUITS AND VEGETABLES
(in tons per hectare)

	1956/57	1957/58	1958/59	1959/60	1960/61
Fruits	4.51	4.51	4.50	4.16	5.08
Vegetables ..	5.00	5.00	5.00	4.50	5.00

TABLE F

Source: Ministry of Agriculture, Statistics Department

LIVESTOCK POPULATIONS (in million heads)

	1957	1958	1959	1960	1961
Horses	0.22	0.24	0.25	0.27	0.28
Mules and bullocks ..	0.02	0.02	0.02	0.02	0.02
Cows	1.9	2.3	2.4	2.6	2.7
Goats	-	1.5	1.7	1.4	1.4
Arabic sheep	13.6	18.6	13.4	15.5	15.5
Karakul sheep ...	2.8	3.4	4.1	4.6	4.7
Camels	0.24	0.18	0.28	0.34	0.34
Donckeys	0.74	0.81	0.91	1.2	1.3
Total	19.52	27.05	23.06	25.93	26.24

Taking the estimated values for principal commodity production in the Herat province as indicated in para 3c. above and comparing these values to the national (1961/62) commodity product it is found that the province contributes the following percentages of the national product.

TABLE G

	National Product	Province Product	% of national Product
	(in 1000 of metric tons)		
Wheat	2,279	200	8.78
Rice	319	8	2.51
Corn	700	75	10.7
	(in million heads)		
Sheep and goats	16.9	4.6	27.7
Cows	2.7	.36	13.3
Karakul sheep	4.7	17	14.9

Based on an estimated population for the country of approximately 13.000.000 and an estimated province population of 1.000.000 the Herat province population equal to approximately 7.3% of total population appears to contribute a greater than proportional percentage share to the national product for all principal commodities except for rice. Particularly in livestock production the provinces productivity appears to be substantially above the national level of production and it is in this category that the greatest potential export capability may therefore be anticipated. In accordance with export data furnished by representatives of the RGA Ministry of planning, animal husbandry in the province in the years 1960 to 1962 was the source of following export revenues to the country for exports of wool and carpets only.

TABLE H

(expressed in 1000 of Afghanis)

	1960	1961	1962	% increase over period
Carpets	4,642	6,243	25,531	450%
Wools	31,112	33,337	210,618	577%

It is recognized that the above indicated activity increase cannot be used as basis to establish growth trends as it is recognized that it is a phenomena rather singular to countries in their early phase of economic development. The sole conclusion that may be drawn is that these figures along with the comparative production data above confirm the existence of a potential source of exportable surplus in an already active commodity produced in the Herat province. Only scant information is available to assess past export experience for this area with regards to volume, however in the absence of reliable statistical data and for the purpose of providing at least an estimate of export volume the following is presented.

The Levant Express agent in Mashed estimated that the 1962-1963 volume of import and export handled through Islam Qala-Herat amounted to 50.000 tons for Imports and 20.000 tons for exports. These figures appear to be confirmed by the estimate furnished by the Afghan Trade agent at Mashed who indicated that the total Import and Export volume amounted to approximately 78.000 tons. The Afghan Trade Agent further estimated that the commercial cargo volume for 1962/1963 will reach a volume of 100.000 tons for both imports and exports, not including another 137.000 tons of estimated Imports to government and foreign agencies and business firms.

In the light of the rising trend percentage increases shown in Table H above an increase in total import and export tonnage from 78.000 to 100.000 tons appears sufficiently conservative to accept it as a probable value for estimating pro-

jected export activities. With a total export and import volume rise amounting to 22.000 tons the prorated share of export would amount to 5.600 cons per year assuming that the respective import and export values will remain in the same proportional relationship. Since most of the exports from the Herat province represents commodities produced in the province it may also be assumed that the estimated increase in export tonnage closely parallels the estimate of the volume of exportable surplus commodities and thus this volume could be estimated to amount to the following quantities based on a yearly volume rise of 5.600 tons.

1964	25.600 tons per year
1974	81.600 tons " "
1984	137.600 tons " "

g. General Economic Effect of Additional Commerce Anticipated as a Result of the Proposed Project: The proposed improvement would facilitate the flow of agricultural and manufactured commodities to both domestic and Iranian markets. Commerce generated as a result of the proposed project will be of general economic benefit in the form of an increased agricultural income; a rise in the production of various agricultural commodities; a stimulation of local manufactures as a result of the increase in purchasing power in the rural areas and a rise in imports and exports in trade with Iran and the Free World. A general rise in living standards will follow.

6. Anticipated Economic Benefits

a. Increase in Tax Receipts

At the present time are no special tax measures such as road or bridge tolls, sales taxes or local gasoline taxes in the province of Herat. However the economic activities increases, as may be anticipated with the completion of an all weather Highway through the province, should result in higher tax receipt from local business manufacturing establishment and producers. A tangible benefit is estimated to result from increased customs revenues. Presently substantial duties are levied on all imported goods, which in accordance with officials of the Coordination Department of the RGA Ministry of Planning average approximately 25 to 30% of the purchase value of the imports. Duties collected on exports average approximately 2.5% of the initial sales value.

Based on above values for duties on imports and exports it is estimated that customs revenues in the province of Herat, which in

1961/62 registered a total import value of 139,000.000 Afs and a total export value of 98.000.000 Afs, amounted to approximately 38,000.000 Afs ($775.500) on imports and 2.450.000 Afs ($50.000) on exports. As the proposed highway will create more favorable conditions of access to foreign markets it is believed that the provinces foreign trade activities will substantially increase. Estimates of the rate of rise of foreign trade for the province can not be based on observation of past trends related to the provinces activities, as statistical data thereon is not available. For the purpose of an estimate of projected foreign trade activities of the province it is therefore assumed that a parallel may be made between the national and the provinces past foreign trade activities. Statistics on national foreign trade indicate that imports have risen from a value of 646 million Afs in 1951/52 to a value of 3,045 million Afs in 1961/62 and exports have increased from a value of 731 million Afs in 1951/52 to 1,354 million Afs in 1961/62. This represents a yearly average rise of 239 million Afs in import and 62.3 million Afs in export value. Applying these values to the 1961/62 foreign trade figures of the province the provinces import rise would correspond to approximately 10.9 million Afs and the export rise to 4.5 million Afs per year. A yearly increase of 10.9 million Afs in import value (8% of present value) would, if continuous over a 20 year life period of the project road, result in a yearly average value of approximately 248 million Afs for imports and a 4.5 million Afs yearly increase on export value would result in a yearly average value of approximately 143 million Afs for exports for the province.

In turn customs revenues would increase from a 1961/62 of approximately 38 million Afs for imports to an average of 68 million Afs and revenues on exports from a 1961/62 value of 2.45 million Afs would increase to an average of 3.5 million Afs per year. It is recognized that customs revenues collected in the province of Herat are also derived from trade activities with the provinces northern neighbor and that therefore only a portion of the additional revenues anticipated may be considered as a benefit connected with the incentives created by the proposed project.

Information obtained from representatives of the Ministry of Planning indicates that the foreign trade activities with the west and through the project area is estimated to amount at present to slightly more than half of the total provinces foreign trade. It was further estimated that with the proposed improved access to western markets the proportional share of the provinces foreign trade therewith will substantially increase, especially so, if current negotiations with Iran concerning procurement of POL

products from that Source will result in obtaining a better quality products at a lesser cost as that presently obtained by the RGA Monopoly.

Summarizing the above it is anticipated that the proposed road will effectively contribute towards the provinces increased foreign trade activity with the west which in turn will generate additional customs revenues estimated to amount to at least one half of the total estimated additional revenues of 31 million Afs or approximately 15.5 million Afs ($316,000) annually.

b. Reduction in Transportation Costs: Economies in transportation costs resulting from construction of an improved road between Herat and Iranian border will come principally from greater vehicle utilization generated by higher road speeds and reduced vehicle operation and maintenance costs as the result of improved road conditions. Cargo trucks now require at least four hours to traverse the 130 kilometers from Herat to Islam Qala when floods or adverse weather do not interrupt the flow of traffic. An improved all-weather road should permit average speeds of 65 km per hour and eliminate lengthy delays due to impassible road conditions. The report on Economics of Highway Engineering by the Inland Transport Committee of ECAFE contains cost data on vehicle operation which shows that the cost per mile on good grade pavements is approximately one half of that on low grade roads. Recent rate quotations for transporting freight from Mashed, Iran to Herat, Afghanistan average approximately $0.05 per metric ton per kilometer. Applying a conservative 40% reduction to the present freight rate, a saving of $0.02 per metric ton per kilometer is obtained for cargoes moved over the improved road.

Assuming that the cargo traffic volume, which is currently estimated to consist of 50,000 tons of imports and 20,000 tons of export, will increase at approximately the same rate of yearly increase as the Afghan national foreign trade volume increased during the past 10 years (from a value of 1.377 million Afs in 1951/52 to a value of 4399 million Afs in 1961/62) the average yearly trade tonnage moving over the project road during a 20 year period would be approximately 223,000 tons and the corresponding ton km value would be 223,000 tons x 124 km = 27,652,000 ton km. In addition it is estimated that inland cargo traffic will add thereto at least one fourth of the volume of the estimated tonnage of the yearly crop production of 283,000 tons (see par 3c above). Assuming that this cargo will be transported an average distance of approximately 62 km (half the distance between Herat and Islam Qala) the additional ton km quantity would be approximately 4,340,000 ton km. At a saving of approximately $0.02 per ton km the savings in transportation cost would amount to approximately $639,000 per year.

c. Increased Income to Area Served: Spoilage and damage to perishable produce transported to market over substandard roads and loss in quality suffered by livestock driven to market would be drastically reduced and upon reaching market would command higher prices. Broadening the market for all commodities produced in the area would enable the producer to dispose of his products in the most favorable market. Increased income from products now produced will follow and more dependable access to a broadened market will stimulate increased production in the area.

d. Lower Costs of Other Planned Development Projects Which will be Served by This Project: A number of projects are planned for the Herat area under the Second Five Year Plan. Projects planned include the construction of grain silos, POL storage depots, several slaughterhouses, several irrigation projects including a dam across the Hari River, electricity and water supply systems for the City of Herat and installation of an automatic telephone exchange in Herat. When completed most of these projects will require the transportation of commodities to and from the processing plant and/or storage facility. Savings in the purchase of equipment and construction materials for the project may be effected through importation over improved highways via Iran.

e. Gains by Opening New Land for Settlement by Outside Population, Presently Unemployed or Underemployed: All cultivable land in the area is being utilized at the present time. Opening new land for cultivation will depend on developing additional irrigation systems. Regulation of the river flow from the proposed dam across the Hari River will insure a more dependable water supply for irrigation purposes.

f. Direct Benefits to Local Population through Local Expenditure of the Project Funds Themselves for Labor, Materials, Food, Rent, etc.: Herat Province would receive considerable benefits through local expenditure of project funds during the life of the construction contract. All unskilled and some semi-skilled laborers would be hired locally by the contractor and would receive direct benefits in the form of wages. In addition to the direct payroll benefits, other types of expenditures such as local food purchases and housing rentals would be made. There are some houses available for rent in Herat which presently are not of acceptable standards and would require some utility improvements. Fresh fruits, vegetables and meats (mutton and beef) are available locally. Experience has shown that construction activity in a community nearly always stimulates the local economy. In addition to actual economic benefits, training of local people in the various crafts required for constructing the road will also be beneficial.

SECTION III: ENGINEERING ASPECTS AND TECHNICAL SOUNDNESS

1. Present and Future Traffic Generating Activites.

a. Size, Distribution and Economic Generating Activities: The area to be immediately served by the proposed improved road is located in the portion of the Hari River Valley west of Herat in Northwestern Afghanistan. However, the greatest economic benefit to be derived from the project will accrue to the country as a whole by providing a connecting highway link with Iran. A large portion of the Afghanistan population is nomadic and livestock raising is their principal occupation. The more settled people engaged in agricultural or stockraising pursuits live in numerous overcrowded villages located in the proximity of their farms or pasture lands. There are relatively few large cities in the country. The alrger city dwellers are engaged principally in trading, handicrafts and limited industrial work.

b. Nature and tonnage of cargo imported into, exported from, and passing through the area: Imports into area in 1961/1962 consisted of following by major commodities:

POL	25,000 Tons
Cement	20,000 Tons
Aviation Fuel	10,000 Tons
Textile Fabrics	5,000 Tons
Miscellaneous Machinery, Tires, etc..	10,000 Tons

Exports from the area in 1961/62 consisted of the following by major commodity:

Fruit and Vegetables	7,000 Tons
Hides-Fur	1,000 Tons
Textile Fibers	12,000 Tons

In addition there is a substantial export activity in progress in the flow of cattle, sheep, and goats that are driven to markets in eastern Iran overland and by-passing local customs control on both sides of the border.

The proposed project road, it is believed, will also make it more profitable for the producer to truck-haul cattle and sheep from the eastern areas of the province bringing it to market in Iran in the shortest time and at maximum weight which largerly will compensate for the customs and transportation cost.

A substantial increase in POL products may also be anticipated in accordance with officials of the RGA Ministries of Commerce

and Planning who have expressed their belief that, if it were not for the present difficulties connected with transport, the principal source of POL products would be Iran as products from that country are of higher quality than those presently obtained by the RGA POL Monopoly. Further it is believed, that with an improved highway link to Iran, POL products therefrom could be marketed at lower cost in the western provinces, than products presently imported over the northern road.

c. Schools: Some of the small villages between Herat and Islam Qala have no schools and no schools are available to the children of the nomadic tribes. A new road would serve as a means of transporting children from outlying areas to schools in Herat.

d. New Types and Amount of Traffic Expected to Develop as a Result of Project: The economy of Northwest Afghanistan is now in the early stages of development and is expected to expand rapidly as projects provided for in the Second Five Year Plan are completed. Agriculture, which is presently the principal economic activity of the area, is at a subsistence level. However, with improved transportation and access to a broader market, agricultural production including livestock raising should increase. Recent trade talks have been held between officials of the Iranian and Afghanistan Governments in which a plan for exchanging Afghanistan sheep for Iranian POL products was discussed. The success of such a plan will depend largerly on an adequate highway connecting the highway networks of both countries. The highway from the Iranian border to Meshed, Iran a distance of approximately 240 kilometers, is also badly in need of improvement. It is understood that plans for improvement of this road are under consideration by the Iranian Government with completion scheduled for 1967.

e. Projections of Present Traffic without and with the Proposed Project: It is believed that the traffic on this road without the proposed project would not increase at a rate comparable to the estimated trend of Afghan foreign trade activities, but that the existing roads extremely poor condition will continue to exercise its limiting effect on all attempts to improve trade activities in and through the area. It is significant that the Levant Express Agent in Meshed who estimated that the 1962 trade tonnage over the road would be approximately 70,000 tons, further indicated his belief trade tonnage in the coming year would amount to only 25,000 tons for imports and 8 to 10,000 tons for exports. Although this low estimate is not considered realistic by RGA officials nor is it substantiated in the light of the foreign trade progress of the past 10 years, it is considered significant

and indicative of the beliefs shared by all interested officials and traders, that the difficulties addtending expeditious and economical movement of cargo through the project area continue to restrict the areas trade activities and production potentials.

With an improved road facilitating transport of goods on a year-round basis, with the risks of loss and damage to goods in transit essentially removed and with the feasibility of orderly scheduling given by the existence of an all-weather highway, it is believed that in view of the provinces more favorable locations in regards to foreign markets the areas import and export traffic will increase substantially to a level at least equal to, and possibly exceeding, nationwide import and export traffic averages, At present the provinces participation in the nations import and export activities is popilation-percent-wise below the national level in that in 1961/62 the provineas imports amounted to only 5% of the national imports and exports amounted to 7.5% of the national export values whereas the provinces population amounts to approximately 8% of the countries total population.

It is further interesting to note that the import-export ratio for the province in 1961/62 was 1.3 whereas the nationwide ratio was a less favorable 2.24.

In addition to the foreign trade tonnage increases the project road will certainly also generate an increased inland trade hauling activity between the vicinal areas of production and the markets in adjacent twons and villages. The amount of potential increase cannot be readily determined for lack of record data. however, considering the tonnages of the estimated annual production in the provinces which amounts to approximately 283,000 tons for wheat, rice and corn (See Section II para 6c) it is believed that at least 25% of this tonnage is presently moved to inland markets over the existing roads and that at least that much will be in the future be transported over the proposed road.

In conclusion it is estimated that projected tonnage over the proposed raodway may reach the following yearly average:

Current foreign trade tonnage	70,000
Current inland trade tonnage	70,000
Average additional trade tonnage	140,000
Estimated average tonnage with [illegible] project . . proposed project.	280,000

2. Traffic Capacities

The present road cannot be classed other than a fair weather road. As such, no attempt is made to assign a theoretical capacity to the road. A traffic count taken during the preliminary survey

showed that the traffic was predominately trucks and ranged from 0 to 47 vehicles during the daylight hours. No count was necessary during the hours of darkness as the road is not usually travelled at night. The Traffic count was made by the survey team compared favorably with traffic figures furnished by the customs office at Islam Qala. Excessive overloading of cargo trucks, as much as 300% in some cases, was noted. Some overloading of cargo trucks is to be expected in areas where there are either no laws restricting wheel loads or such laws are not enforced; however, the probable reason for the excessive overloading in this case is the long travel time involved. Restricting cargo loads to a maximum allowable axel load consistent with good highway usage would result in an immediate increase in truck traffic density. With an anticipated yearly average of 280,000 tons and a maximum anticipated traffic of approximately 400,000 tons over the project road it is estimated based on an average loading of 10 tons to 12 tons per vehicle and approximately 300 days of hauling per year the average traffic density would amount to approximately 80 to 90 trucks per day to which should be added approximately 6 busses and approximately 15 to 20 private passenger vehicles. Total projected average traffic density is not believed to exceed 110 vehicles per day.

3. Design Criteria

a. General: Criteria for the geometric and structural design of a proposed improvements was selected from "Geometric Design Standards for Highways other than Freeways", published by the American Association of State Highway Officials as amended by USAID/Washington Circular Airgrams NA-5 and MA-25 and U.S. Army Corps of Engineers Engineering Manuals 1110-345-290 and 1110-345-291. Good design practice dictates that the design of small traffic volume roads should be based on a projected 10 to 25 year period. A theoretical average daily traffic colume of 300 vehicles, was adopted for design. A Class E road is the minimum standard twolane highway and covers an average daily traffic volume between 20 to 1000 vehicles depending on terrain and traffic conditions. A Category IV composition of traffic consists of the following:

	Per Cent
Passenger cars, panel or pick-up trucks	15
Two-axel trucks	75
Three-four-and five-axel trucks	10

The traffic composition selected meets USAID requirements for loading as set forth in Airgram NA-5, Highway-Design Loading. Road surface is gravel in conformance with Airgram NA-25, Sub

Highway Design Policy, which specifies that the road surfacing shall be select material, gravel or crushed stone traffic bound type when the current average daily traffic is under 100 vehicles. The following specific criteria were used:

Maximum speed	90 Km P.H.
Road Width	5.52 meters
Road Shoulder Width	1.2 meters
Maximum Passing Light Distance	564 meters
Maximum Curvature	5°
Maximum Vertical Curve (Grade)	7%
Average Daily Traffic	300 vehicles
Design Index*	4
California Bearing Ration (CBR) Percent	
Subgrade, in-situ	3
Subgrade, compacted to 90% CE-55 max. density	6
Sub base, select, compacted to 95% CE-55 max.dens	10
Sub base, compacted to 100% CE-55 max. density	25
Base, compacted to 100% CE-55 max. density	80

*The design index is obtained from the relationship of Class road to category.

b. Flexible Pavement Design: Based on the above criteria, the following pavement thickness, as shown on Plate No. 3, was obtained:

Base course thickness	13 cm. (5 in.)
Subbase course thickness	15 cm. (6 in.)

c. Rigid Pavement Design: Concrete dip sections. totalling nearly four kilometers in lenght, are provided for passing shallow (sheet flow) drainage water over the highway in areas where it is impractical to collect the flow in ditches and pass the water under the highway in culverts. Non-reinforced Portland Cement Concrete pavements for this purpose were designed in accordance with procedures set forth in U.S. Army Engineer Manual 1110-345-292, "Rigid Pavements for Roads, Streets, Walks and Open Storage Areas", dated 30 June 1961, using an estimated subgrade reaction (k-value) of 225 pounds per cubic inch and a flexural strength for concrete equal to 600 pounds per square inch at 28 days. The resulting thickness of concrete pavement is 18 cm (7 in.). A typical concrete dip section is shown on Plate No. 4.

d. Bridges: There is an existing, narrow, multi-span bridge estimated to be approximately 200 years old spanning the Hari River in the vicinity of the new proposed river crossing. The bridge is supported by grouted rubble stone piers spaced approximately 12 meters apart. The condition and alignment of the bridge is such that it cannot be used in the proposed improve-

ment plan. The bridges for this project have been designed for a width of 6.7 meters and for H 20-16-44 loading in accordance with Standard Specifications for Highway Bridges published by the American Association of State Highway Officials (1961 Edition). Structural steel design was selected for the bridge crossing the Hari River based on overall economy and consists of a structural steel frame on steel piles with a reinforced Portland Cement Concrete deck slab. This type of design allows construction to be performed in a minimum amount of time using only one crane. The short span bridges across washes will be reinforced Portland Cement Concrete poured in place on concrete pier foundations. This design was chosen as being the most economical because no large construction equipment would be required. Typical bridge sections are shown on Plate No. 5.

4. Surveys and Engineering Data

a. Description of Extent of Preliminary Studies and Surveys used to Arrive at Proposed Locations: A reconnaissance of the existing north and south roads, between Herat and Islam Qala, was made during the period 2 through 6 April 1963 by personnel of the Royal Government of Afghanistan, USAID/Afghanistan and U.S. Army Engineers for the purpose of selecting the most feasible route for the engineering survey. A route generally following that of the existing northern most road was selected for the following reasons:

(1) The existing northern route is 7 kilometers shorter than the existing southern route.

(2) Alignment of an improved route following the southernmost route is more restrictive because of irrigation projects and drainage facilities that would be required are more numerous and costlier than those required on the northern route.

(3) Abundance of good aggregate sources within relatively short haul distances compared to the haul distances which would be necessary on the southern route.

(4) Soil conditions along the selected route are generally more favorable. Photographs 1 though 9 show the condition of the existing road along the proposed route at the time of the reconnaissance.

b. Preliminary Alignment and Plan-Profile with Established Grades: Field surveys consisted of running an open traverse by the transit-stadia method and establishing elevations by differential

leveling checked by trigonometric leveling. The strip of territory covered by the survey has a width of 60 meters where the final alignment of the road was not in question and has a width up to 400 meters where it is evident that some realignment would be required. Sufficient topography was obtained to provide for design of drainage facilities. Survey data are presented graphically on Figures 1 through 29 which show the proposed road alignment, location of bridges and drainage structures and finished grade of the road. The finished grade was established at an elevation sufficiently high to provide an adequate freeboard above normal flood stages in the valley and conforms to criteria for maximum grade and sight distances set forth in paragraph 3a. above.

c. Rainfall and Runoff Data and Calculation for Stream Flow Estimates: There are presently no drainage structures along the existing road alignment. Natural drainage ways such as streams, ditches and washes cross the existing road at random locations. The following rainfall data for Herat collected during an eight-year observation period was obtained from the Hydrologic Service Division, U.S. Department of Commerce.

Average Precipitation in mm.

January	61	July	0
February	33	August	0
March	38	September ...	0
April	8	October	0
May	5	November	8
June	0	December	33

Average annual: 186 mm (7.3 in.)

For computation purposes, a maximum rainfall intensity of 2.54 cm (1 in.) for a one-hour storm based on a 10-year frequency was used. (To be verified during final design stage.) Based on findings of the reconnaissance and preliminary computations of runoff quantities, it was determined that approximately 135 ten-meter long pipe culverts (one meter in diameter) and 4 ten-meter long box culverts (1 x 3 meters) would be required on the project to provide proper drainage for road protection and uninterrupted irrigation. For simplicity in construction, the pipe sizes are standardized throughout the project for 1 meter diameter culvert pipe. Rip-rapped side slopes of road embankments and drainage ditches will be provided to prevent erosion during periods of high water velocities. Rip-rapped diversion dikes and interceptor ditches will be used to control concentrated run-off to culverts where wide flat sheet flow conditions prevail. However, reinforced Portland Cement Concrete dip-sections will be used where flood

control structures prove to be uneconomical. Typical sections of the proposed drainage structures are shown on Plate No. 4.

d. Soils and Materials:

(1) Geology: The proposed road alignment runs roughly parallel to and several kilometers south of a range of low mountains and hills for a distance of approximately 56 kilometers westward from Herat. The mountains in the vicinity of Herat are composed essentially of hard conglomerates. Further to the West, the mountains are lower in elevation and are composed of softer rocks such as silt stones and shales. Surface soils found along this reach of road consist mostly of silty sands and gravels with some areas of silt. In the reach of road between approximately kilometer 56 and the vicinity of the Hari River bridge (km 96), the proposed road winds through low hills composed of conglomerates, sandstones, silt stones and shales. Much of the material is weathered and relatively soft but some of the strata are hard and will require blasting during grading operations. Between the Hari River bridge and Islam Qala (approximately 21 kilometers) the proposed road runs roughly parallel to and several kilometers north of a range of hills. The surface soils found along the alignment between the Hari River bridge and the vicinity of Islam Qala consist essentially of silty sands while surface soils found between Islam Qala (kilometer 115) and the Iranian border to the West (kilometer 123.3) are mostly silty clay. The depth of the water table elevation below natural ground surface exceeds 5 meters along the entire road location except in the vicinity of the Hari River.

(2) Soils: Test pits were excavated at approximately 800 meter intervals along the proposed road alignment. The pits were ganerally excavated to a depth of 1 meter except at small bridge or large culvert locations where they were excavated 2 to 3 meters in depth. The location of the test pits are shown on Figures No. 2 through 29 and graphic logs of soils encountered are shown on Figures No. 30 and 31. It will be noted that bed rock was encountered in only one test pit. Results of classification tests, including Atterberg Limits and sieve analyses, performed on typical soil samples are tabulated in Table I. A limited number of field density tests were performed in the test pits in order to determine the natural in-place density of typical soils and the results of these tests are shown in Table II. Table III shows the results of laboratory tests performed on 5 composite soil samples sent to the U.S. Army Engineer Division Laboratory at Athens, Greece. No deep borings were made at the proposed bridge location over the Hari River at this time. However, such investigation will be required during preliminary design stage.

(3) Aggregates: Explorations for aggregate for subbase and base course materials and for Portland Cement Concrete were confined to gravel deposits in the immediate vicinity of the road since there appeared to be sufficient material in these deposits for the work contemplated. Samples were taken from three locations along the road and sent to the U.S. Army Engineer Division Laboratory for performance of suitability tests including gradation, Atterberg Limits, specific gravity, soundness, stripping, alkali reactivity, petrographic examination and Los Angeles abrasion tests. Results of these tests are shown in Tables IV and V. Gradation tests were performed in the field laboratory on samples obtained from two locations considered suitable only as source of subbase material. Pertinent data on these aggregates are shown in Table IV.

5. Construction Standards

It is proposed that construction work on this project will be performed in accordance with U.S. Army Engineer Guide Specifications covering the type construction planned.

6. Availability of Local Resources and Equipment

a. Personnel: Semi-skilled and unskilled labor are locally available in sufficient numbers for prosecution of the project. Skilled labor, technicians and supervisory personnel must be recruited outside the country.

b. Construction Materials: Only water and aggregate including base and subbase materials are available in the project area. All other required construction materials including POL products must be imported to Afghanistan.

c. Housing, Food and Repair Shops: Some housing is available in Herat which will require minor renovations. Construction camps will be necessary at other points along the road location. Some foods, including fresh vegetables and fruits and some meats, are available on the local economy. However, it will be necessary for the contractor to supplement these supplies and to maintain a commissary facility which carries all items not locally obtainable such as, but not limited to, tobacco, toilet articles, canned and frozen foods and household appliances. Shops for equipment repair and maintenance should be provided at the construction camps. Suitable camp sites are available throughout the project.

d. Construction Equipment: All highway construction equipment presently in Afghanistan is being utilized on other projects. It is assumed therefore that it will be necessary to import substantially all such equipment required for this project.

e. Local Subcontractors: Use of local subcontractors on any phase of the proposed work is not considered feasible.

7. Special Construction Problems Foreseen

a. Climatic Conditions: Climatic conditions are not considered sufficiently severe to seriously disrupt construction schedules. An average annual total rainfall of 186mm (7.3 inches) is experienced during the winter months. Approximately 25 percent of the road location is subject to inundation as the results of flash floods of short duration (approximately 1 week including inundation, draining and drying to workable conditions). Daylight hours are approximately the same as are experienced in the southern United States.

b. Construction Detours: Construction and maintenance of detours for the low density local traffic will not be difficult during the greater portion of the year and will consist of grading roadways adjacent to the proposed roadway in reaches under construction. Construction of more adequate detours or maintenance of auxiliary towing equipment in construction areas will be required during the rainy season.

c. Lead-time for Mobilization of Equipment and Materials: It is estimated that a lead-time of 5 to 6 months will be required to mobilize equipment and materials from points in the United States.

d. Evaluation of Possible Major Causes of Delay: No major causes of construction delays are foreseen. The proposed road for the most part is located on relatively flat land not subject to slides and no major earthquakes have been recorded. Afghanistan has a stable government and no political disturbances or labor troubles are expected.

8. Plan for Execution of Projects:

a. Sequence of Construction Operations: The sequence and schedule for performing construction operations are shown on Plate No. 6.

b. Grading Operations: Embankment material is available from side borrow for most of the road. Coarse aggregate and select material for subbase is available in sufficient quantities in selected pits along the route. Portable crushing equipment will be required to produce base course material from roadside pits. No long haul distances or construction of haul roads are involved in obtaining suitable construction materials.

c. Construction Method: The proposed improvement will be more expeditiously and economically performed by the use of conventional heavy raod building equipment.

d. Method of Contracting for Engineering, Construction and Construction Supervision: Contract document preparation and construction supervision will be accomplished by U.S. Government forces which will also enter into engineering service contract to perform certain additional soils investigation work (deep boring). Construction contract will be awarded based on lowest qualified bidder response to advertisement restricted to U.S. contractors.

9. Maintenance Organization

Maintenance of the existing roads north and south of the Hari River between Herat and Islam Qala is performed under the direction and supervision of the provincial Director of Public Works department located in Herat. Under this general supervision, a fluctuating number of soldiers perform the required maintenance work on an emergency basis. This force, that may vary in number between 20 and 150 as seasonal demand may require, performs all maintenance tasks essentially unsupported by equipment as the equipment assigned to the Public Works organization is largely deadlined due to lack of repair, parts and due to its old age. Equipment as available consists of one Water Truck, one Motor Grader and one Dump Truck. It is therefore concluded that at this time there exists no maintenance organization as such capable to perform the required maintenance of an all-weather road and that the need exists to completely organize and equip such a force. It is therefore proposed that the Director of Public Works in Herat establish an organization composed of civil employees and laborers and that in support of this organization the necessary maintenance equipment be obtained.

The organization would function under the direction of one civil engineer responsible to the Director of Public Works. The civil engineer would be supported by one assistant and by two field supervisors, the latter of which would each manage and direct a force of approximately 10 laborers. Under the civil engineer's supervision, the employ of and the maintenance of the equipment should be entrusted to an equipment specialist who, in turn, would supervise approximately 6 equipment operators-mechanics and approximately 5 laborers.

Equipment estimated to perform effective maintenance of the project road is listed in Section IV, paragraph 2. Personnel with adequate training and experience for recruitment of the organization's requirement, it is believed, will become available with the phase-out of manpower requirement at the end of construction.

SECTION IV: FINANCIAL ASPECTS

1. Estimated Capital Cost

a. Land and right-of-way: In accordance with PIOT, all land required will be provided by the Royal Government of Afghanistan.

b. Engineering Cost:

(1) Preliminary Engineering: No additional cost is anticipated for preliminary engineering which is considered completed with the finalization of this report.

(2)	Additional surveys & test borings	$ 50,036
(3)	Preparation of contract documents	- 210,000
(4)	Supervision & Inspection	540,000
	Total Engineering Cost	$ 800,036

c. Construction Cost: Total Constr Cost $6,751,664.

The above cost is reflected in the detailed estimate evaluations on the following pages and is summarized hereunder:

	US Dollar Requirement	Local Currency Requirement in Dollar Equiv.
Direct Contract Cost	$ 2,643,871	212,399
Equipment Ownership Cost	992,583	
Equipment Shipping Cost	121,164	
US Non-productive payroll	602,861	66,973
Local Non-productive		58,644
Constr. Camp and plant	235,100	10,750
Misc. General Expenses	416,250	50,850
Home Office Overhead	163,242	
Contingency	520,465	40,000
Contractor's Profit	616,512	
Total Contract Cost	$ 6,312,048	$ 439,616
Total Cost Construction	6,751,664	
Total Cost Engineering	800,036	
Total Initial Cost	$ 7,551,700	

DIRECT COST ESTIMATE

Item	Unit	Unit Quanti	Unit Price material	Unit Price equipment	Unit Price local labr	Unit Price US labor	Total Unit Price	Local Currency values local labr 1/10 US labr		Total unit price US $ portion	Total local currency requirement	Total US dollar requirement
1 Unclas Excavation	cbm	696,000	-	.61	.04	.15	.80	.04	.02	.74	41,760	515,040
2 Overhaul	cbm km	205,000	-	.05	.02	.01	.08	.02	-	.06	4,100	12,300
3 Subbase Course	cbm	139,000	-	3.71	.22	1.20	5.13	.22	.12	4.79	47,260	665,810
4 Base Course	cbm	86,000	-	4.38	.34	1.39	6.11	.34	.14	5.63	41,280	484,180
5 PCC Pavement	cbm	4,725	16.18	2.58	.26	2.00	21.02	.26	.20	20.56	2,173	97,146
6 Concrete cutoff wall	cbm	4,550	10.86	2.34	.26	2.00	15.46	.26	.20	15.00	2,093	68,250
7 Expansion joints	lin.m	10,000	.60	.01	.04	.12	.77	.04	.01	.72	500	7,200
8 Contraction joints	lin.m	5,670	.45	.03	.10	.16	.74	.10	.02	.62	680	3,515
9 Riprap for dip sect.	cbm	13,100	.84	4.53	1.34	-	6.71	1.31	-	5.37	17,551	70,347
10 Grout. handpl. RR	sm	11,000	.18	.58	1.60	.55	2.36	1.05	.05	1.26	12,100	13,860
11 Con.steel culverts 38"	lin.m	2,200	20.21	1.49	2.00	1.60	25.30	2.00	.16	23.14	4,752	50,908
12 R.C. Box culverts	cbm	521	39.15	3.85	.90	11.50	55.40	.90	1.15	53.35	1,068	27,795
13 Hari River Bridge	LS	LS	367,907.00	65,636.00	22,818.00	45,636.00	501,997.00	22,818.00	4,563.00	474,616.00	27,381	474,616
14 Bridge at 103+000	LS	LS	25,206.00	3,360.00	1,680.00	3,360.00	33,608.00	1,680.00	336.00	31,592.00	2,016	31,592
15 Bridge at 106+750	LS	LS	25,206.00	3,360.00	1,680.00	3,360.00	33,608.00	1,680.00	336.00	31,592.00	2,016	31,592
16 Bridge at 108+250	LS	LS	70,831.00	9,444.00	4,722.00	9,444.00	94,442.00	4,722.00	944.00	89,720.00	5,666	89,720
									TOTAL DIRECT	COST	212,399	2,643,871
											2,856,270	
NOTE: All materials except Cement and POL products are of US origin,										Ratio Local Currency		
Cement and POL from Iran. (Estimated total cost for Iranian Cement & POL products $400,000)										to US $ portion = 8.03%		
										Ratio Local Currency		
										to US $ total = 7.43%		

INDIRECT COST ESTIMATE

EQUIPMENT OWNERSHIP COST

Description	Quant.	Aquisition Cost p/unit	Total Aquisition Cost	Ownership cost p/year in % of Aquis	Years tied up ind. transport issue	Total % charged to job	Total ownership cost to job	Metric tons/unit	Total Metric Tons	Cost RT Shipping per MT	Total Shipping Cost	Total Cost to job incl. shipping
Tractor, D8 w/Dozer	1	40,000	40,000	46	2.0	92	36,800	23.7	23.7	180	4,266	41,066
Tractor, D6 w/Dozer	1	23,000	23,000	46	2.0	92	21,160	15.0	15.0	180	2,700	23,860
Motor Scraper 12 cy	6	35,000	210,000	46	2.0	92	193,200	21.0	126.0	180	22,680	215,880
Motor Grader	3	23,430	70,290	34	2.0	68	47,797	12.8	38.4	180	6,912	54,709
Pay loader	1	45,800	45,800	46	2.0	92	42,136	10.5	10.5	180	1,890	44,026
Front end loader	2	29,137	58,274	46	1.8	83	48,367	14.5	29.0	180	5,220	53,587
Truch 12 cy	3	45,028	135,084	43	1.8	78	105,365	20.0	60.0	180	10,800	116,165
Truch Dump 6 cy	10	16,621	160,210	43	1.8	78	124,963	6.6	66.0	180	11,880	136,843
Truch Concrete Bald	3	6,700	20,100	46	1.5	69	13,869	4.1	12.3	180	2,214	16,083
Truch Pickup 3/4T	10	2,500	25,000	43	1.5	64	16,000	3.0	30.0	180	5,400	21,400
Truch Water w/Pump	2	14,935	29,870	34	1.8	61	18,220	60.0	12.0	180	2,160	20,380
Truch Water Tank 2000G	2	7,700	15,400	34	1.8	61	9,394	50.0	10.0	180	1,800	11,194
Station Wagon	5	3,000	15,000	43	1.5	64	9,600	2.5	12.5	180	2,250	11,860
Roller Tandem 5 Wt.	2	15,376	30,752	34	1.5	51	15,683	11.4	22.8	180	4,104	19,787
Roller Vibratory	3	12,375	37,175	34	1.5	51	18,959	3.2	9.6	180	1,728	20,687
Roller Wobbly Wheel	2	4,680	9,360	34	1.5	51	4,773	14.5	29.0	180	5,220	9,993
Grame Truch 35T	1	67,737	67,737	34	1.8	61	71,319	41.5	41.5	180	7,470	78,789
Pile Hammer w/heads	1	10,000	10,000	43	1.5	64	6,400	3.5	3.5	180	630	7,030
Crusher Rok Portable	2	48,567	97,134	46	1.8	82	79,649	22.5	45.0	180	8,100	87,749
Mixer Conc. 115	2	6,418	12,836	46	1.5	69	8,856	3.2	6.4	180	1,152	10,008
Vibrators Concrete	6	250	1,500	46	1.0	46	690	0.1	0.6	180	108	798
Compressor Air 600 CF	1	22,250	22,250	43	1.8	77	17,132	4.2	4.2	180	756	17,888
Compressor Air 125 CF	1	5,893	5,893	43	1.8	77	4,537	1.6	1.6	180	288	4,825
Pump Water Centr 4"	2	1,433	2,866	46	1.5	69	822	0.4	0.8	180	144	966
Truch Fuel w/Pump	1	14,900	14,900	34	2.0	68	10,132	6.0	6.0	180	1,080	11,212
Buggies Cono	12	50	600			100	600				50	650
Conveyor Portable	2	6,037	12,074	43	1.5	64	7,727	3.0	6.0	180	1,080	8,807
Roller Sheeps ft	1	2,898	2,898	34	1.8	61	1,767	2.7	2.7	180	486	2,253
Tractor Truck, 30T TR.	1	40,312	40,312	46	1.8	83	33,458	20.7	20.7	180	3,726	37,184
Welding Machine	1	10,875	10,875	46	1.5	69	7,503	2.5	2.5	180	450	7,953
Generator 25 KW	2	4,243	8,486	34	1.8	61	5,172	1.0	2.0	180	360	5,532
Generator 5 KW	2	1,000	2,000	34	1.8	61	1,220	0.5	1.0	180	180	1,400
Working & Screening Plt.	1	47,943	47,943	46	1.8	82	39,313	21.5	21.5	180	3,870	43,183
		1,285,610					992,583				121,164	1,113,747

Ownership cost = 77% of Aquisition Cost = 38.5%/year

Shipping Cost = approx 10% of Aquisition Cost.

INDIRECT COST ESTIMATE, GENERAL EXPENSES

PERSONNEL - SITE STAFF SALARIES AND WAGES

Payroll	US	3 Mo. Required	Basic Salary Year	Displacement Allowance & per diem	Payroll Burden 12½%	Total Cost/ Year	Cost per month	Total Cost to Job	10% for local expenses	Cost in US Dollars	Cost in local curr
a. Management:											
Proj Superint.	1	24	25,000	7,500	3,125	35,625	2,968	71,232	7,123	64,109	7,123
Assistant Superint.	1	21	15,000	4,500	1,875	21,375	1,781	37,401	3,740	33,661	3,740
Equipment Superint.	1	21	15,000	4,500	1,875	21,375	1,781	37,401	3,740	33,661	3,740
Grade & Embank Supt	1	18	14,000	4,200	1,750	19,950	1,662	29,916	2,991	26,925	2,991
Secretary	1	21	7,000	2,100	875	9,975	831	17,451	1,745	15,706	1,745
Office Manager	1	21	12,000	3,600	1,500	17,100	1,425	29,925	2,992	26,933	2,992
Accountant	1	21	10,000	3,000	1,250	14,250	1,187	24,927	2,492	22,435	2,492
Time Keeper	1	18	8,000	2,400	1,000	11,400	950	17,100	1,710	15,390	1,710
Personnel Officer	1	18	10,000	3,000	1,250	14,250	1,181	21,366	2,136	19,230	2,136
b. Engineering:											
Chief Civil Engineer	1	21	14,000	4,200	1,750	19,950	1,662	34,902	3,490	31,412	3,490
Soils Engineer	1	21	13,000	3,900	1,625	18,525	1,543	32,403	3,240	29,163	3,240
Survey Party Chief	1	21	12,000	3,600	1,500	17,100	1,425	29,925	2,992	26,933	2,992
Civil Engr Pavements	1	15	12,000	3,600	1,500	17,100	1,425	21,375	2,137	19,238	2,137
Civil Engr Structures	1	12	12,000	3,600	1,500	17,100	1,425	17,100	1,710	15,390	1,710
Lab Technician	1	18	10,000	3,000	1,250	14,250	1,181	21,258	2,125	19,133	2,125
c. Warehousing:											
Chief Storekeeper	1	21	10,000	3,000	1,250	14,250	1,187	24,927	2,492	22,435	2,492
Assistant Storekpr	1	18	8,000	2,400	1,000	11,400	950	17,100	1,710	15,390	1,710
Warehouseman	1	18	6,000	1,800	750	8,550	712	12,816	1,281	11,535	1,281
d. Utilities & Support:											
Camp Manager	1	21	13,000	3,900	1,625	18,525	1,543	32,403	3,240	29,163	3,240
Master Mechanic	1	18	13,000	3,900	1,625	18,525	1,543	27,774	2,777	24,997	2,777
Supply Officer	1	18	10,000	3,000	1,250	14,250	1,187	21,366	2,136	19,230	2,136
Dispatcher	1	18	7,000	2,100	875	9,975	831	14,958	1,495	13,463	1,495
Materials Expediter	1	18	7,000	2,100	875	9,975	831	14,958	1,495	13,463	1,495
e. Medical and Safety:											
Doctor	1	21	12,000	3,600	1,500	17,100	1,425	29,925	2,992	26,933	2,992
Safety Engineer	1	21	12,000	3,600	1,500	17,100	1,425	29,925	2,992	26,933	2,992
								669,834		602,861	66,973

GENERAL EXPENSES

Local Payroll	Mos. Reqd	Wages per Month	20% Payroll Burden	Monthly Cost	Total Cost to Job
1 Secretary	21	100	20	120	2,520
1 Interpreter	21	100	20	120	2,520
1 Accountant	18	130	26	156	2,808
1 Timekeeper	21	100	20	120	2,520
1 Typist	18	80	16	96	1,728
2 Lab. Techs.	30	100	20	120	3,600
2 Draftsmen	30	80	16	96	2,880
2 Instrument Men	30	120	24	144	4,320
3 Rodmen	45	65	13	78	3,510
3 Chainmen	45	65	13	78	3,510
1 Storekeeper	18	100	20	120	2,160
4 Laborers	72	50	10	60	4,320
1 Mess Manager	18	80	16	96	1,728
2 Cooks	36	75	15	90	3,240
1 Nurse	21	120	24	144	3,024
12 Guards	216	45	9	54	11,664
3 Janitors	54	40	8	48	2,592
					58,644

INDIRECT COST - GENERAL EXPENSES

CONTRACTOR'S CAMP	Qnty.	Unit	Unit Cost	Total Cost	Estimated Value Local Currency	Estimated Value US Dollars
Housing						
Trailers	5	Ea	5,000.00	25,000	500	24,500
Tents Winterized	20	Ea	1,500.00	30,000	200	29,800
Messhall Prefab	3,000	SF	12.00	36,000	1,500	34,500
Latrine, Bath & Laundry, Prefab	2,000	SF	8.00	16,000	800	15,200
Doctor's Qtrs Prefab	800	SF	12.00	9,600	600	9,000
Field Offices	3,000	SF	7.00	21,000	1,000	20,000
Warehouse	5,000	SF	4.00	20,000	1,000	19,000
Equipment Shop	3,000	SF	5.00	15,000	750	14,250
Storage Shed	2,000	SF	3.00	6,000	300	5,700
Hardstand	10,000	SM	2.00	20,000	1,000	19,000
Fencing	1,500	LM	3.50	5,250	500	4,750
Water Supply				15,000	750	14,250
Sewage Collection				5,000	700	4,300
Electrical Distribution				5,000	250	4,750
Plant Erection & Dismantling						
Crushing, Screening & Washing Plant	3	Moves	4,000	12,000	600	11,400
Concrete Plant	2	"	2,500	5,000	300	4,700
TOTAL COST CONTRACTOR'S CAMP				295,850	10,750	235,100

INDIRECT COST - MISC. GENERAL EXPENSES

	Qnty.	Unit	Unit Cost	Total Cost	Estimated Value Local Currency	Estimated Value U.S. Dollar
Travel, International						
RT US-Afghanistan	61	Ea	3,000	183,000	—	183,000
Replacement		10%		18,300	—	13,300
Travel Local						
Local Hire	80	EA	100	8,000	8,000	—
Local Replacements		20%		1,600	1,600	—
Services Supv. Organ.						
Housing- Trailers	2	Ea	5,000	10,000	500	9,500
Tents, Winterized	5	Ea	1,500	7,500	400	7,100
Field Laboratory		LS		8,000	400	7,600
Mobile Lab Trailer		LS		7,500	400	7,100
Communications Radio		LS		20,000	—	20,000
Vehicle Operation Cost						
Pickup Trucks	90	Mo	150	13,500	6,750	6,750
Sedans	48	Mo	200	9,600	4,800	4,800
Maintenance Supplies	24	Mo	800	19,200	15,000	4,200
Small Tools & Eqpmt	18	Mo	500	9,000	4,000	5,000
Constr Eqpmt Spare Pts		Lot		100,000	—	100,000
Insurance-Constr Eqpmt						
1½% per year for $1,130,000		2 yrs @ $16,950/yr		33,900		33,900
Agents at	36	Mo	500	18,000	9,000	9,000
				467,100	50,850	416,250

Recapitulation of estimated cost for construction, contingencies and engineering.

ITEM	Unit	Qnty.	Direct Unit Cost	Total Direct Cost	Total Equipment Cost	Total General Expense	Cost Home Office	Contingency	Profit	Total Item Unit Cost	Engineering Cost	Total Item Cost
Unclassified Excavation	cu.m	696,000	.80	556,800	225,369	291,681	33,500	115,000	125,000	.28	155,900	1,503,250
Overhaul	cu.m/km	205,000	.08	16,400	6,221	8,052	1,000	3,000	3,000		4,590	42,263
Subbase Course	cu.m	139,000	5.13	713,070	292,714	378,843	44,000	150,000	165,000		199,660	1,943,287
Base Course	cu.m	86,000	6.11	525,460	212,705	275,292	32,000	109,000	116,112		147,130	1,417,699
PCC Pavement	cu.m	4,725	21.02	99,319	38,462	49,780	5,000	19,000	20,000		27,810	259,371
Concrete Cutoff Wall	cu.m	4,550	15.46	70,343	26,057	33,725	3,500	13,000	14,000		19,690	180,315
Expansion Joints	Lin.m	10,000	.77	7,700	2,757	3,568	425	1,200	1,500		2,160	19,310
Contraction Joints	Lin.m	5,670	.74	4,195	1,612	2,086	248	800	900		1,170	11,011
Riprap f/dip section	cu.m	13,100	6.71	87,901	31,074	40,218	4,000	15,000	17,000		24,600	219,853
Granted handpl. RR	SM	11,000	2.36	25,960	9,177	11,877	1,200	4,000	5,000		7,270	64,484
Corr Steel Culverts	Lin.m	2,200	25.30	55,660	21,299	27,566	2,800	10,000	11,000		15,580	143,905
RC Box Culverts	cu.m	521	55.40	28,863	11,322	14,654	1,500	5,500	6,000		8,080	75,919
Hari River Bridge		LS		501,997	177,465	229,683	26,000	88,000	100,000		140,560	1,263,705
Bridge at 103+000		LS		33,608	11,881	15,377	1,500	5,500	6,000		9,410	83,276
Bridge at 106+150		LS		33,608	11,881	15,377	1,500	5,500	6,000		9,410	83,276
Bridge at 108+250		LS		95,386	33,751	43,649	5,000	15,964	20,000		26,956	240,706
				2,856,270	1,113,747	1,441,428	163,242	560,465	616,512		800,036	7,551,700
Estimate for future Double Bituminous Surface Treatment.												
1. Reshape and reconstruct Base Course				655,000	SM x $0.22/SM	$ 144,100						
2. Prime Coat				655,000	SM x $0.27/SM	$ 176,850						
3. Double Bituminous Surface Treatment				655,000	SM x $1.10/SM	$ 720,500						
						$ 1,041,450						
Engineering And Supervision						$ 104,000						
Total Estimated Cost						$ 1,145,450						

d. Summary of Estimated Initial Project Costs: All costs are expressed in dollars and dollar equivalents.

	U.S. Dollar Requirement	Local Currency Requirement
Land Right-of-way	At no cost	
Engineering Costs	700,036	
Direct Contract Cost	2,643,871	242,369
Indirect Costs	2,367,958	187,217
Contingency	520,465	40,000
Contractor's Overhead	163,242	
Contractor's Profit	616,512	
Totals	7,012,084	469,586

2. Maintenance Costs

a. In order to maintain the project road during its design life of 20 years, it will be necessary to provide for the establishment of a Maintenance organization adequately supported by appropriate equipment capability.

b. It is assumed that adequately trained personnel as well as construction equipment will become available during phase-out of construction activities. It is further assumed that the initial cost for equipment will amount to the residual value of the contractor's equipment and consequently the following initial equipment value is estimated:

Type of Equipment	Original Value	% Deprec. on Job	Residual Value
Mobile Crusher Unit (1)	48,567	20	38,853
Motor Grader (1)	23,430	15	19,915
Tandem Roller (1)	15,376	12	13,530
Trucks 6-cyl (2)	32,042	18	26,274
Trailer 25-ton (1)	12,000	10	10,800
Truck Water (1)	14,935	12	13,142
Totals	146,350		122,514

With an initial equipment cost of approximately $122,000, it is estimated that replacement requirements during a 20-year period will amount approximately to the total original value plus a percentage increase of approximately 20% to reflect rising cost index trends. Thus equipment replacement cost will amount to 146,350 X 1.2 = $ 175,620. Total anticipated equipment procurement cost to cover maintenance requirements for a 20-year period $298,620, say $300,000.

c. Equipment operation cost based on the assumption that the yearly maintenance effort will be equal to an effort required to replace approximately 5% of the Base Course and approximately 2% of Subbase and Embankment Materials is estimated to require the following equipment operations hours per year.

Crusher	200 hrs.
Motor Grader	250 hrs.
Tandem Roller	450 hrs.
Water Truck	500 hrs.
Dump Truck	1200 hrs.
Truck w/Trailer	900 hrs.

The estimated cost for equipment operations (fuel, maintenance and tires) is the following:

Crusher	200 X $5.00/hr. =	$ 1,000
Motor Grader	250 X 2.50/hr. =	625
Tandem Roller	450 X 1.50/hr. =	675
Water Truck	500 X 2.50/hr. =	1,250
Dump Truck	1200 X 2.35/hr. =	5,522
Truck w/Trailer	900 X 3.35/hr. =	3,015
Total yearly equipment operations cost		$ 12,087

d. Estimated cost for maintenance labor.

(1) Equipment operators' hours 3,500 per year plus 50% for idle and in-transit time amounts to total of 5,250 hrs. at an average cost of $0.15/hr. = $840/year.

(2) Unskilled labor, estimated requirement 10 laborers 2000 hrs. per year = 20,000 hrs. at an average cost of 0.10/hr. = $2,000/year.

e. Estimated cost for supervision and management of maintenance effort. Estimated requirement:

1 Chief Civil Engineer

1 Civil Engineer

2 Grade Foremen

1 Chief Mechanic

2 Clerical

Assuming that the supervisory organization will be engaged also in maintenance work on other roads in the province for approximately half time, the following cost would be chargeable to maintenance supervision for the project road.

Chief Civil Engineer	6 mo.X $50/mo. =	300
Civil Engineer	6 mo.X $40/mo. =	240
Foremen	12 mo.X $35/mo. =	420
Chief Mechanic	6 mo.X $40/mo. =	240
Clerical	12 mo.X $30/mo. =	360
Total yearly supervisory cost		$ 1,560

f. Recapitulation of estimated maintenance cost.

Initial Equipment Procurement Cost	$ 123,000
Replacement Cost	176,000
Yearly Equipment Operations Cost	12,100
Yearly Labor Cost	2,840
Yearly Supervision & Management Cost	1,560

SECTION V: COMPARISON OF BENEFITS AND COST

Presented hereunder are two analyses of Benefit Cost values which take into account comparative present values of Benefits and Costs without and with consideration given to residual value of the road after the analysis period.

A. Analysis of Benefit Cost ratio without consideration of residual value of the road.

1. Cost

a. First Cost:

Construction Contract Cost	$ 6,751,664
Engineering, Supervision & Inspection	800,036
Initial Maint. Equipment Procurement	122, 000
	$ 7,673,700

b. Investment:

Interest during constr. (2 yrs) 7,673,700 X 0.5 X 2 X 0.05=	$ 383,685
Total Investment Cost . 7,673,700 + 383.685 =	8,057,385

c. Annual Cost:

Interest on Investment 8,057.385 X 0.05 =	402,869
Amortization of Investment 8,057,385 X 0.030242 =	243,671
Perennial Maintenance	
Equipment operation cost (POL)	12,100
Labor and Supervision cost	4,400
Major replacement (10 years) Reserve Cost 176,000X0.03024=	5,300
Total Average Annual Cost	668,440

2. Benefits - B

a. Savings in Transportation Cost:

Amount of tonnage in 20 years using geometric progression based on national foreign trade trend over past 10 years (rate of growth = 6% comp).

Amount of tonnage in 20 years based on current foreign and local trade tonnage of approximately 140,000 tons; 140,000 X 3.0255995 = 423,583 tons.

Present worth of savings thereon at $0.02 per ton km = $2.48 per ton; 423,583 X 2.48 X 0.37688946 = $395,917

Present worth of series based on 6% volume increase (r) and 5% interest (i)

Initial years saving $347,200

Sum of all savings in 20 years - 347,200 X 22.12597

Where 22.12597 = Product of $(1+r) \times \frac{1}{(1+i)} + (1+r)^2 \times \frac{1}{(1+i)^2}$

$\ldots + (1+r)^{19} \times \frac{1}{(1+i)^{19}} + (1+r)^{20} \times \frac{1}{(1+i)^{20}} = \$7,682,136$

Average annual value over 20 years;
7,682,136 X 0.080245 = 616,453

b. Additional revenues from Customs:

Customs revenues collected on foreign trade through the province in 1961/62 amounted to approximately $825,000 and it is estimated that approximately one half of this value was obtained on trade going through the project area. It is anticipated that foreign trade activities through the project area will increase at a rate at least equal to the national foreign trade activities trend observed over the past 10 years which is considered to continue however at a slower rate of 6% per year in view of downward trend noticed over the last 5 years. Additional revenues as generated by the stimulated foreign trade activities are estimated as follows:

Amount of total customs receipts in 20 years
(Projected on trade through project area only)
412,500 X 3.0255995 = 1,248,059

Amount of additional receipts 1,248,059 - 412,500 = 835,559

Present worth of this value 835,559X0.37688948 = 314,905

Present worth of series
Additional receipts in initial year 6% of $412,500 = $ 24,750

Present worth of additional receipts for 20 years
24,750 X 22,12597 = 547,617

Average annual value of additional receipts
547,617 X 0.080245 = 43,943

Total anticipated tangible benefits:
a. Reduction in Transportation Cost $ 616,453
b. Additional Customs Revenues 43,943
$ 660,396

Total Estimated Average Annual Cost = 668,440

Benefit - Cost Ratio Based on Above = 0,988

B. Analysis of Benefit-Cost ratio under consideration of residual value of the road after 20 years and estimated as follows:

Feature	Present Value	% P.V. After 20 years	Residual Value 20 yrs. Hence
Embankment			
Unclass & Borrow	1,503,250	60	901,950
Overhaul	42,263	60	25,378
Subbase Course	1,943,287	40	777,314
Base Course	1,417,699	25	354,424
PCC Pavements	259,371	70	181,559
Concrete Cutoff walls	180,315	70	126,220
Expansion Joints	19,310	30	5,793
Contraction Joints	11,011	70	7,707
Riprap for Dip Section	219,853	30	65,955
Grouted Hand pl. RR	64,484	40	25,793
Corr Steel Culverts	143,905	50	71,952
R.C. Box Culverts	75,919	80	60,735
Hari River Bridge	1,263,705	80	1,010,964
Bridge at Sta. 103 + 000	83,276	80	66,620
Bridge at Sta. 106 + 150	83,276	80	66,620
Bridge at Sta. 108 + 250	240, 706	80	197,648
	$ 7,551,700		

Total Residual Value after 20 years - - - - - - - - - - 3,946,632

Present Worth of Residual Value
3,946,632 X 0.3768894 = $ 1,487,443

1. Cost

a. First Cost:

Initial Cost	=	7,673,700

b. Investment:

First Cost	=	7,673,700
Interest during constr.	=	383,685
Gross Investment	=	8,057,385
Salvage Presnet Worth	=	1,487,443
Total net investment cost	=	6,569,942

c. Annual Cost:

Interest on gross investment 8,057,385 X 0.05	=	402,869
Amortization of new investment 6,569,942 X 0.030242	=	198,688
Perennial Maintenance Cost	=	16,500
Major Replacement Reserve Cost		5,300
Total Average Annual Cost		623,457

2. Benefits

(Same as in preceeding analysis)	660,396
Benefit-Cost Ratio Based on Above	1,06

Conclusion: The foregoing analysis indicate that the project is economically justifiable when the residual value of the project is considered in the evaluation of the B/C ratio; and it is believed that economical justification of the project is further supported when considering the impact of the intangible benefits of the proposed project.

TABLE I

Test Pits

T. P. No.	Comp. No.	Depth cm.	L.L.	Plast. Index	Class	Grain Size (% Passing) No. 4	No. 40	No. 200
3	1	10-30	-	-	SMd	-	-	-
	2	30-60+	-	-	GMd	-	-	-
4	1	0-30	-	-	SMd	-	-	-
	2	30-60+	-	-	GMd	-	-	-
7	3	0-90+	22.6	6.0	ML-CL	99	86	55.6
8	3	8-90+	21.8	6.0	ML-CL	-	-	-
9	1	8-50	17.9	0.5	ML	96	81	56.6
10	1	0-40	-	NP	SMd	74	46	24.5
	2	40-70+	-	-	GMd	-	-	-
12	3	0-60	22.7	9.4	CL	98	83	55.8
13	2	60-75+	-	-		-	-	-
15	1	10-60+	-	-	SMd	-	-	-
17	1	8-30	18.4	0.8	GMd	63	49	27.3
	2	30-60+	-	-		-	-	-
19	2	8-60+	-	-		-	-	-
22	1	8-30	-	-	SMd	-	-	-
	2	30-60+	-	-		-	-	-
24	-	10-60+	15.8	2.4	SMd	91	70	39.2
26	1	10-60+	20.5	4.4	SMd	70	45	22.8
27	-	10-90+	21.8	1.6	SMd	76	46	27.4
28	2	28-60+	-	-		-	-	-
29	-	8-60+	-	NP	SMd	76	56	25.4
34	1	10-60+	-	-	SMd	-	-	-
38	2	10-60+	-	-		-	-	-
39	2	10-60+	-	-		-	-	-
42	1	8-30	21.2	6.1	SM-SC	64	36	20.8
	2	30-60	-	-		-	-	-
48	3	0-90+	25.9	5.1	ML-CL	100	98	73.9
49	3	0-60+	26.2	6.7	ML-CL	100	98	69.5
50	5	0-36	26.9	9.6	CL	100	95	63.6
52	1	10-90+	-	NP	SMd	91	74	22.6

contd

TABLE I - Test Pits (contd)

T. P. No.	Comp. No.	Depth cm.	L.L.	Plast. Index	Class	Grain Size (%Passing) No. 4	No. 40	No. 200
54	1	0-30	25.0	7.9	SC	80	63	45.0
	2	30-60+	23.3	6.1	GM-GC	54	34	20.4
58	3	0-50	26.8	9.0	CL	100	92	77.2
63	2	10-65+	-	-		-	-	-
63	1	8-70	-	NP	SMd	100	85	38.2
68	3	30-60+	31.1	8.4	CL	99	92	82.7
71	1	0-40	-	-	SMd	-	-	-
73	1	10-40	20.7	0.6	SMd	85	59	32.7
74	3	0-65+	-	-		-	-	-
75	1	10-65+	-	-	SMd	-	-	-
81	1	10-90+	-	-	SMd	-	-	-
83	5	10-90+	30.2	19.3	CL	100	98	86.3
84	-	8-90+	-	NP	SMd	99	87	39.5
89	2	10-75+	-	-		-	-	-
91	2	40-75+	-	-		-	-	-
94	1	0-75+	-	-	SMd	-	-	-
95	1	0-75+	-	-	SMd	-	-	-
97	5	10-40	35.1	19.4	CL	100	96	90.5
98	2	10-90+	-	NP		47	21	5.1
100	1	0-90+	-	-	SMd	-	-	-
102	1	10-60	21.9	6.0	SMu	88	57	18.3
103	1	8-40	19.9	4.1	SMd	90	73	26.7
106	-	20-90+	-	NP	SP	96	79	10.0
107	1	8-95+	-	-	SMd	-	-	-
113	-	10-90+	-	-	SP	97	55	6.0
116	2	10-90+	-	-		-	-	-
118	4	10-90+	22.8	2.3	SMd	98	90	49.6
119	4	10-75+	20.8	5.5	SM-SC	99	87	42.0
122	4	8-90+	-	NP	SMd	98	93	26.9
123	1	10-60	-	-	SMd	-	-	-
124	4	10-75+	23.2	8.7	SC	92	62	26.0
126	5	0-50	40.3	18.6	CL	99	84	51.1

TABLE I - Test Pits (contd)

T. P. No.	Comp. No.	Depth cm.	L.L.	Plast. Index	Class	Grain Size (% Passing) No. 4	No. 40	No. 200
127	-	0-90+	29.0	11.4	CL	92	73	42.3
128	-	10-90+	22.0	8.2	SC	95	87	31.5
130	-	0-40	26.4	3.9	ML	87	54	25.8
131	5	0-200+	28.3	12.5	CL	100	99	81.3
135	-	55-90+	20.0	0.7	ML	100	93	55.0
136	-	15-90+	-	NP	ML	100	96	56.6
140	4	10-90+	22.8	6.0	SMu	93	63	25.2
141	4	10-65	-	NP	SMd	92	71	23.8
142	4	10-80	-	-		-	-	-
143	4	0-90+	-	-		-	-	-
144	4	10-90+	-	-		-	-	-
145	4	0-90+	-	-		-	-	-
147	4	0-90+	-	-		-	-	-
149	4	0-90+	-	-		-	-	-
151	-	40-90	24.0	6.3	GMu	-	-	-
154	-	0-40	26.2	7.2	ML-CL	99	93	76.0
158	3	60-90+	19.0	4.0	ML	100	90	58.4
161	4	0-90+	-	NP	SMd	98	91	34.8
165	5	0-90+	26.1	10.0	CL	100	97	78.4
166	5	0-75+	-	-		-	-	-
167	5	50-90+	-	-		-	-	-
168	5	45-90+	-	-		-	-	-
169	5	0-90+	-	-		-	-	-
174	5	0-90+	33.7	9.0	ML	100	98	76.9

TABLE II

Field In-Place Density Tests

T. P. No.	Comp. No.	Depth cm	Dens. PCF	Moist %	CE-55 Max Dens (PCF)	CE-55 Opt Moist (%)	% CE-55 MaxDens	% CE-55 OptMoist
4	1	8-23	108.9	5.0	131.9	7.2	82.6	69.3
	2	40-55	116.1	3.1	139.0	6.0	83.7	51.7
7	3	15-30	98.4	4.1	123.5	10.7	79.7	41.0
8	3	15-30	95.9	3.7	123.5	10.7	77.7	34.6
9	1	10-25	91.2	5.9	131.9	7.2	69.1	81.9
12	3	15-30	107.9	5.1	123.5	10.7	87.4	47.7
26	1	13-25	106.0	6.7	131.9	7.2	80.5	93.0
84	1	15-30	96.4	9.5	131.9	7.2	73.1	131.6
97	5	15-30	100.8	13.5	122.2	12.5	82.8	108.0
143	4	15-30	93.1	7.8	128.7	8.6	72.2	90.7
149	4	15-30	98.0	7.9	128.7	8.6	76.1	91.8

TABLE III

Laboratory Soil Test Results

Comp. No.	Location	Max. Dens. CE-55 (Lbs/cuft)	Opt. Moist. CE-55 (Percent)	L. L.	Plast. Index	Class & Symbol	Grain Size Percent Passing Sieve No. 4	No. 10	No. 40	No. 200	Des. CBR @ 95% CE-55 Max
1	Occurs Generally between Sta 0+000 & Sta 97+000	131.9	7.2	-	NP	Silty Sand SMd	89	82	65	35	Note (1) 11
2	Occurs intermittently between Sta 0+00 and sta 112+270	139.0	6.0	-	NP	Grav. Silty Sand SMd	70	51	29	14	Note (2) 11+
3	Occurs Intermittently between Sta 0+00 and Sta 112+270	123.5	10.7	28	10	Sandy Lean Clay CL	97	95	90	75	Note (3)
4	Occurs generally between Sta 97+000 and Sta 112+270	128.7	8.6	-	NP	Silty Sand SMd	93	89	80	43	Note (1) 11
5	Occurs between Sta 112+270 and Sta (Iran Broder)	122.2	12.5	34	18	Sandy Lean Clay CL	100	100	98	80	Note (4)

Note (1) This material is suitable for use as select borrow material.

Note (2) This material is suitable for use as select borrow material and as subbase material when it meets subbase specifications.

Note (3) Where this material occurs in the subgrade it will require coverage with at least 6" (15 cm) of select borrow material such as that of composites 1, 2 and 4.

Note (4) Where this material occurs in the subgrade it will require compaction of the top 8 in. to 90% of CE-55 max. density and coverage with at least 13 (33 cm) of select borrow material such as that of composites 1, 2 and 4.

TABLE IV

AGGREGATE SOURCES

T. P. No.	Location	Depth cm	Qty. Avail.	Suitable For	Grain Size (% Passing)						Type
					2"	3/4"	No. 4	No. 10	No. 40	No. 200	
6	Sta 3 + 770	0-185	Unlimited	Base, PCC, Bit.	89	68	43	34	16	5.0	Gravel
44	Sta 36 + 000	0-120	Unlimited	Base, PCC, Bit.	90	70	41	30	11	3.0	Gravel
137	15M NW of Sta 96+850	0-60	Unlimited	Base, PCC, Bit.	100	77	35	22	12	3.0	Gravel
64	Sta 50+070	0-150	Limited	Subbase	100	92	64	50	30	4.5	Gravel
109	Sta 50+070	on hillside	Limited	Subbase	100	81	43	31	8	1.1	Gravel

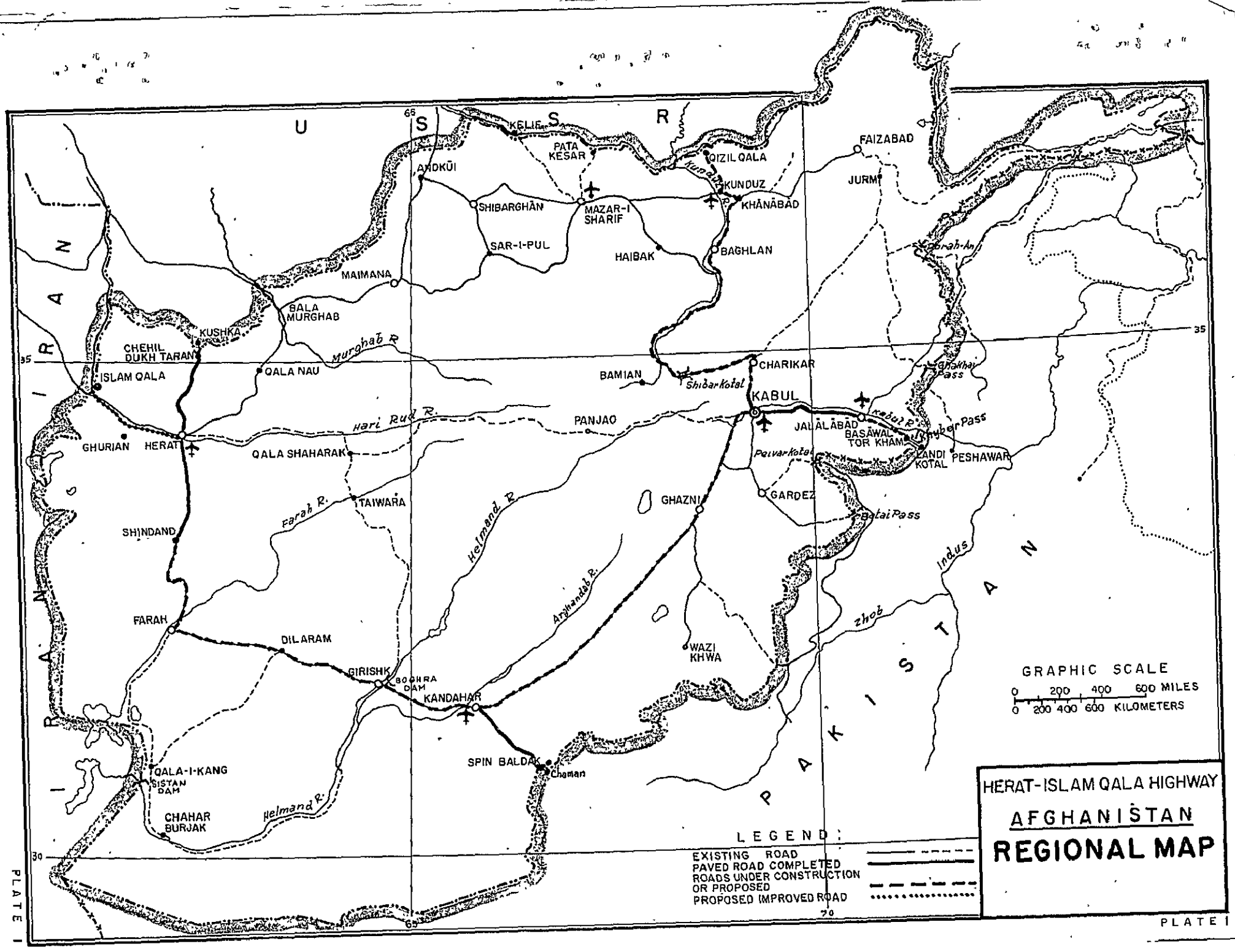
TABLE V

Results of Laboratory Tests on Aggregates

T. P. No.	Station	L. L.	Plast. index	Apprnt. Sp. Gr.	Absorp. Percent	$MgSO_4$ Sound Loss % Coarse	$MgSO_4$ Sound Loss % Fine	L.A. Abrasion Loss %	Stripp. %	Alkali Reactivity	Aggr. Type
6	3 + 770	-	NP	2.70	1.1	7.0	8.5	30.5	75 (1)	Innocuous	Gravel
44	36 + 000	-	NP	2.71	1.2	3.3	7.8	24.8	70 (1)	Slightly (2) Deleterious	Gravel
137		-	NP	2.69	0.8	1.6	4.1	22.4	75 (1)	Slightly (2) Deleterious	Gravel

(1) High percentage of stripping indicates necessity for addition of anti-stripping agent if aggregates are used in bituminous surfacing.

(2) Aggregates are slightly deleterious with respect to alkali reactivity and if used in concrete mixes they require the use of Portland cement containing no more than 0.6 percent of combined sodium and potassium oxides.


HERAT-ISLAM QALA HIGHWAY
AFGHANISTAN
REGIONAL MAP
LEGEND:
EXISTING ROAD
PAVED ROAD COMPLETED
ROADS UNDER CONSTRUCTION OR PROPOSED
PROPOSED IMPROVED ROAD
GRAPHIC SCALE
0 200 400 600 MILES
0 200 400 600 KILOMETERS
U S S R
I R A N
A F G H A N I S T A N
P A K I S T A N
KELIF
PATA KESAR
QIZIL QALA
FAIZABAD
JURM
ANDKUI
SHIBARGHAN
MAZAR-I SHARIF
KUNDUZ
KHANABAD
SAR-I-PUL
HAIBAK
BAGHLAN
MAIMANA
BALA MURGHAB
KUSHKA
CHEHIL DUKH TARAN
ISLAM QALA
QALA NAU
Murghab R.
BAMIAN
Shibar Kotal
CHARIKAR
KABUL
Ghakhar Pass
Kabul R.
JALALABAD
BASAWAL
TOR KHAM
Khyber Pass
KANDI KOTAL
PESHAWAR
Paivar Kotal
GARDEZ
Batai Pass
GHAZNI
Hari Rud R.
PANJAO
GHURIAN
HERAT
QALA SHAHARAK
Farah R.
TAIWARA
SHINDAND
Helmand R.
Arghandab R.
Indus
Zhob
WAZI KHWA
FARAH
DILARAM
GIRISHK
BOGHRA DAM
KANDAHAR
SPIN BALDAK
Chaman
QALA-I-KANG
SISTAN DAM
CHAHAR BURJAK
Helmand R.
65
70
35
30
PLATE I

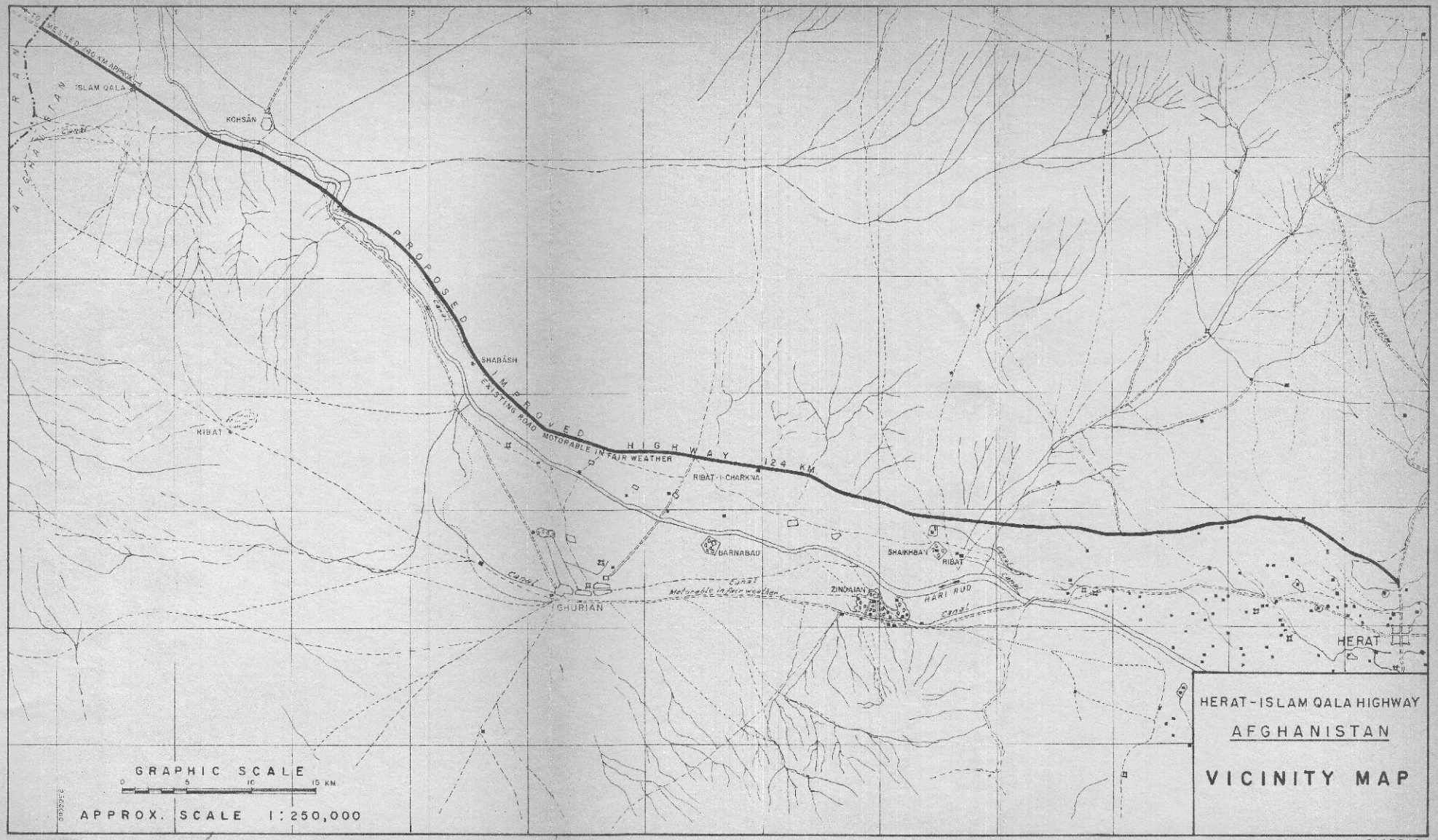
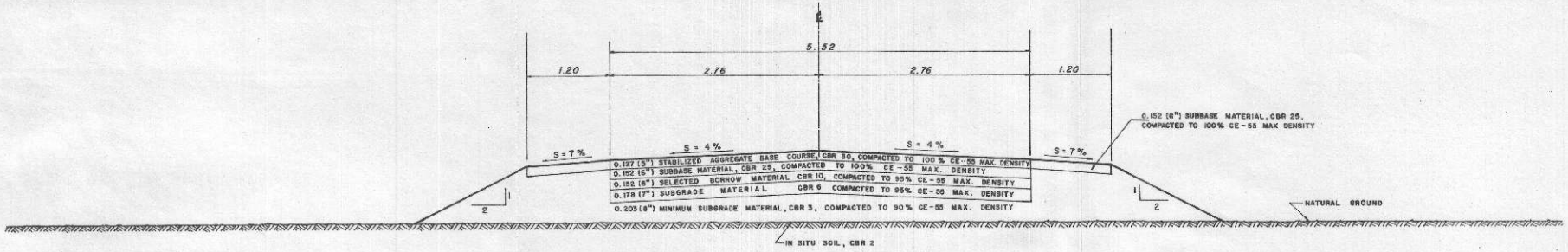

HERAT-ISLAM QALA HIGHWAY
AFGHANISTAN
VICINITY MAP
PROPOSED IMPROVED HIGHWAY 124 KM
EXISTING ROAD MOTORABLE IN FAIR WEATHER
MESHED 240 KM APPROX
IRAN
AFGHANISTAN
ISLAM QALA
KOHSÂN
SHABÂSH
RIBAT
RIBAT-I-CHARKWA
BARNABAD
GHURIAN
ZINDAIAN
SHAIKHBA'I
RIBAT
HARI RUD
HERAT
Canal
Motorable in fair weather
GRAPHIC SCALE
0 5 10 15 KM
APPROX. SCALE 1:250,000

PLATE 2



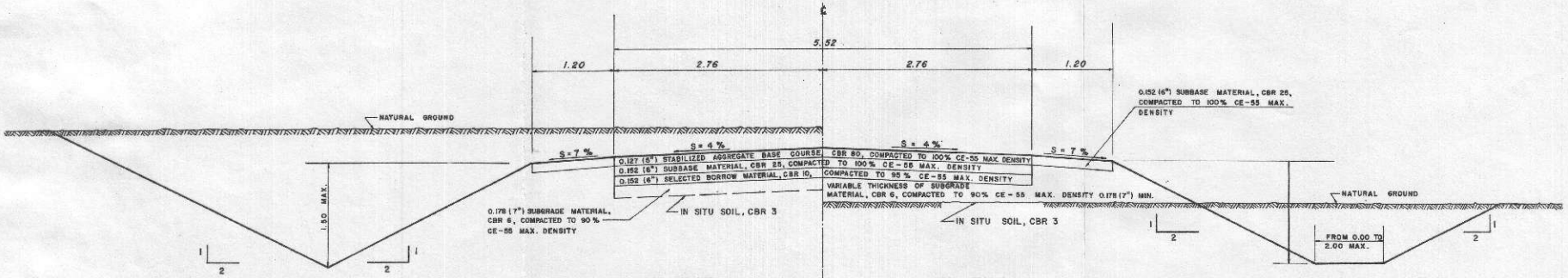
TYPICAL PAVEMENT SECTION

FROM STA. 110+000 TO STA. 123+345

BASIS OF DESIGN

DESIGN INDEX : 4

SUBGRADE CBR : 3



NOTE : IN FILL SECTION DITCH SHALL BE PROVIDED ALONG RIGHT SIDE OF ROAD ONLY.

TYPICAL PAVEMENT SECTION

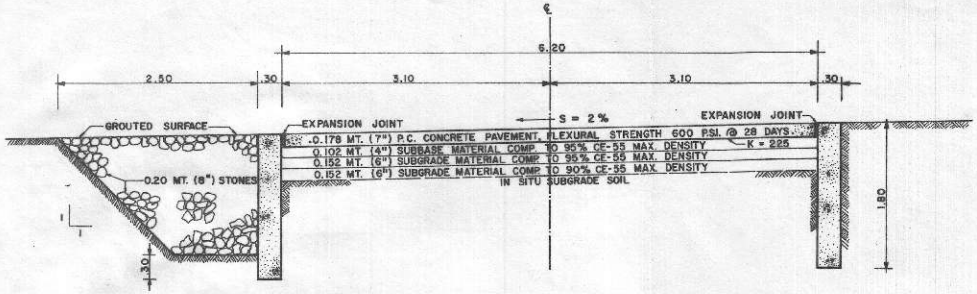
FROM STA. 0+000 TO STA. 110+000

HERAT-ISLAM QALA HIGHWAY

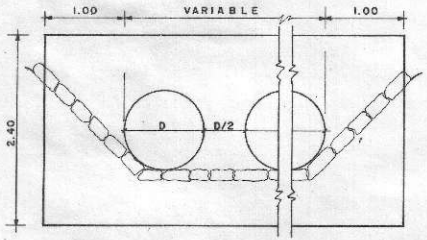
AFGHANISTAN

TYPICAL PAVEMENT SECTIONS

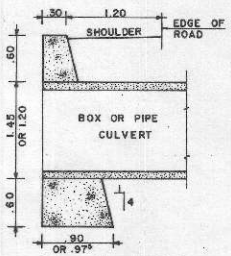
PLATE No. 3



TYPICAL CONCRETE DIP SECTION SCALE 1:50



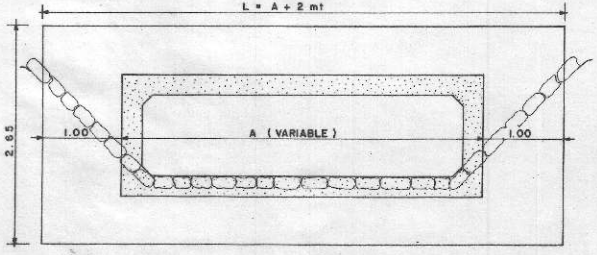
ELEVATION, FOR PIPE CULVERT



SIDE ELEVATION

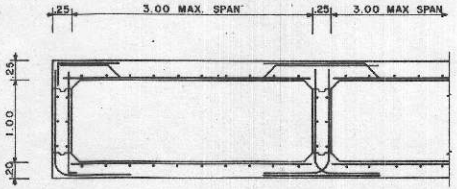
NOTES:

1 - ALL DIMENSIONS ARE IN METERS.
2 - ALL EXPOSED EDGES TO BE CHAMFERED, 25 m/m @ 45°.
3 - PROVIDE LONGITUDINAL DOWELED CONSTRUCTION JOINT AT CENTER LINE AND TRANSVERSE CONTRACTION JOINTS SPACED 4.00 MT.

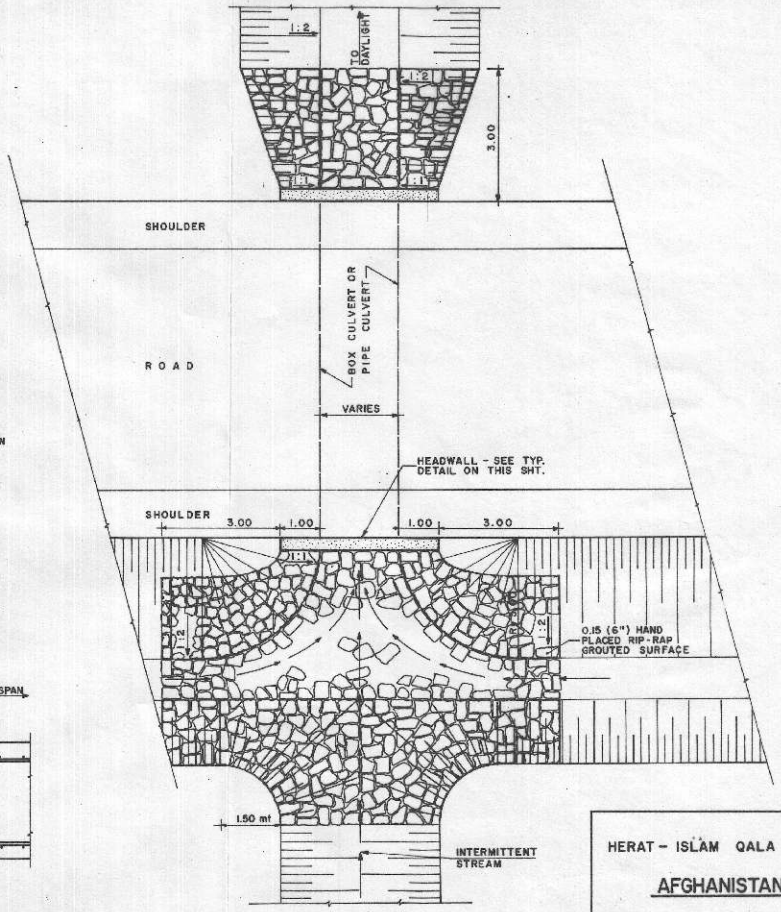


ELEVATION, FOR BOX CULVERT

TYPICAL HEADWALL DETAIL SCALE 1:50



TYPICAL CONCRETE BOX CULVERT SCALE 1:50

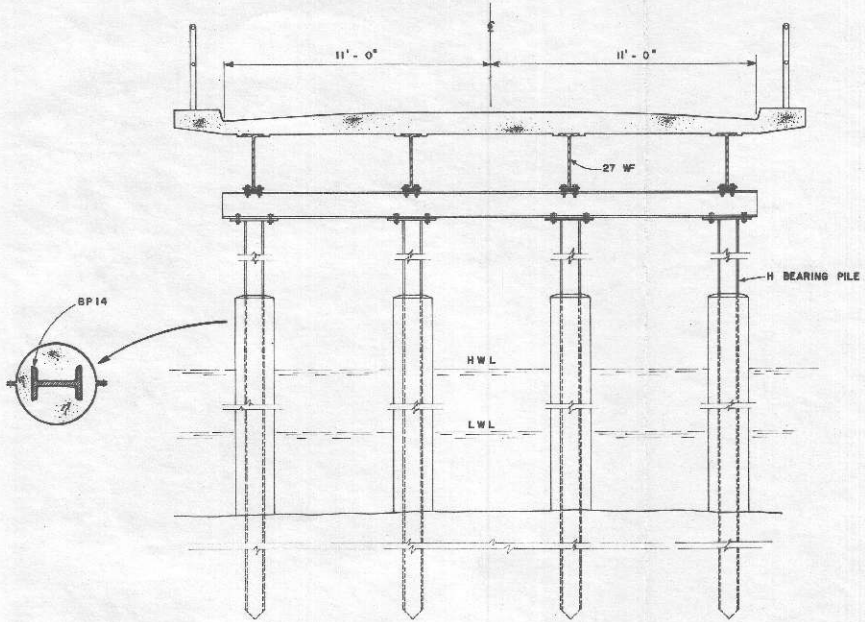


HERAT - ISLAM QALA HIGHWAY

AFGHANISTAN

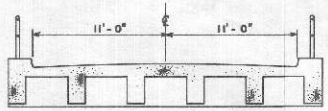
TYPICAL SECTIONS FOR DRAINAGE STRUCTURES

PLATE No. 4



TYPICAL BRIDGE SECTION FOR HARI RIVER

SCALE 1:50



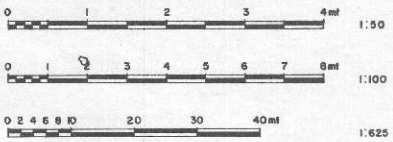
TYPICAL SECTION FOR BRIDGES AT STA. 103+015, 106+800 & 108+275 (MAX. 40 FT. SPAN)

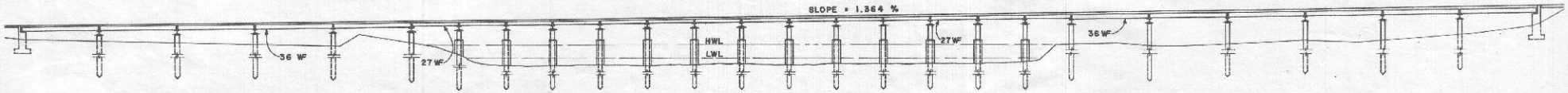
SCALE 1 : 100

STRUCTURAL NOTES :

1. THE DESIGN CONFORMS TO THE STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES OF THE AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, EIGHT EDITION, 1961.
2. BRIDGE LOADING : H20 OR H20-S16, WHICHEVER PRODUCES MAXIMUM STRESS.
   a. THE H20 REPRESENTS A TWO AXLE TRUCK OF 20 TONS.
   b. THE H20-S16 INDICATES A TRACTOR TRUCK OF 20 TON GROSS WEIGHT FOLLOWED BY A 16 TON SINGLE AXLE SEMI-TRAILER.
3. PRELIMINARY DESIGN AND COST ESTIMATE FOR HARI RIVER BRIDGE IS BASED ON FOLLOWING DESIGN CONSIDERATIONS :
   a. BRIDGE DECK – REINFORCED CONCRETE
   b. BRIDGE FRAMING – STRUCTURAL STEEL
   c. FOUNDATIONS – STEEL H PILES
   d. BEARING – FRICTION (40 TONS) ASSUMED SAND & GRAVEL
4. PRELIMINARY DESIGN, FOR OTHER THAN HARI RIVER BRIDGE, IS BASED ON REINFORCED CONCRETE T BEAMS ON REINFORCED CONCRETE PIERS AND ABUTMENTS.

GRAPHIC SCALES





HARI RIVER BRIDGE ELEVATION

SCALE 1:625

HERAT – ISLAM QALA HIGHWAY

AFGHANISTAN

TYPICAL BRIDGE SECTIONS

PLATE No. 6

FINAL DESIGN & CONSTRUCTION SCHEDULE

PRINCIPAL FEATURE	ESTIMATED COST	SCHEDULE	CALENDAR YEAR												CALENDAR YEAR																			
			J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
FINAL DESIGN																																		
ADVERTISE & CONTRACT AWARD																																		
CONSTRUCTION CONTRACT																																		
MOBILIZATION																																		
BRIDGES																																		
CULVERTS																																		
COMMON EXCAVATION																																		
OVERHAUL (FILL)																																		
SUBBASE MATERIAL (IN PLACE)																																		
P.C.CONCRETE (DIP SECTIONS)																																		
RIP-RAP																																		
STABILIZED AGGREGATE SURFACING (IN PLACE)																																		

PLATE No. 6

NOTE LACK OF DRAINAGE IN A RELATIVE FLAT AREA. NEW ROAD WOULD HAVE TO BE RAISED AND DRAINAGE DITCHES PROVIDED.

PHOTO NO. 1

PHOTO NO. 2

TYPICAL WASH(WADI). SUCH WASHES ARE TURNED INTO RAGING TORRENTS OF WATER DURING RAINS AND ARE IMPASSABLE. NOTE WHEEL MARKS ON THERIGHT WHERE VEHICLES HAD TO GO AROUND A TRUCK THAT WAS STUCK

NOTE HOW ROAD WAS WASHED AWAY BY A FLOODING WADI. ALSO NOTE CONDITION OF ROAD WHERE WORKMEN ARE ENGAGED AS WELL AS ROAD BEYOND WADI.

PHOTO NO. 3

THIS IS A VIEW OF A DRY WASH (WADI). NOTE THE ABUNDANCE OF GOOD GRAVEL ALSO THE STOCKPILES OF GRAVEL IN THE BACKGROUND

PHOTO No. 4

PHOTO NO. 5

NOTE HOW SECTIONS OF ROAD WERE WASHED OUT SUE TO LACK OF DRAINAGE. AREAS SUCH AS THIS WOULD REQUIRE DIVERSION DITCHES ON THE UPSTREAM SIDE TO DIRECT THE WATER TO A CULVERT.

PHOTO NO. 6

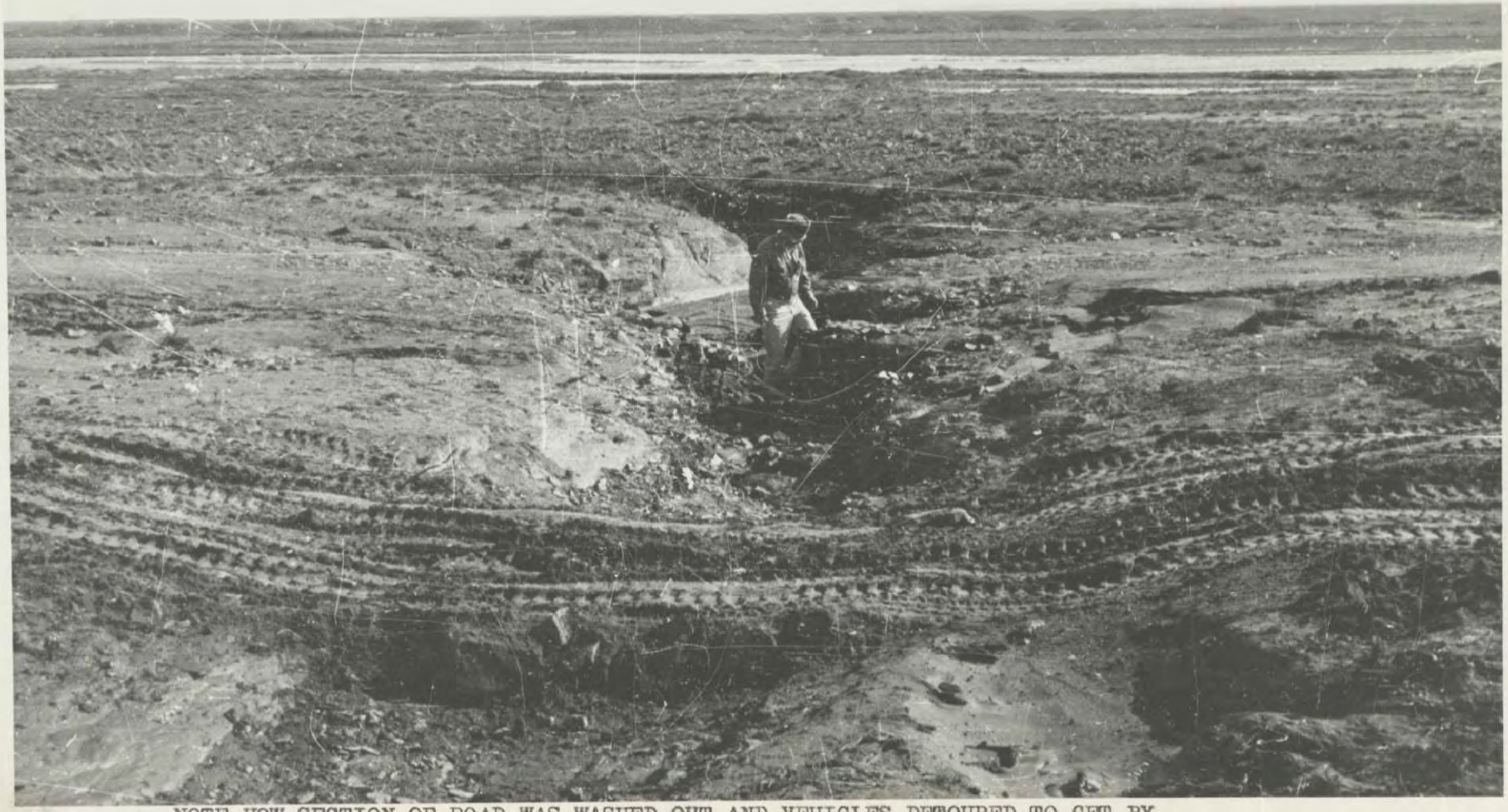
NOTE HOW ROAD WAS WASHED OUT AFTER A LIGHT RAIN. THERE WERE A NUMBER OF PLACES BETWEEN HERAT AND ISLAM QALA

PHOTO NO. 7

TYPICAL AFGHAN TRUCK. NOTE HOW CAB AREA HAS BEEN REDUCED TO INCREASE LOAD AREA TO PERMIT OVERLOADING.

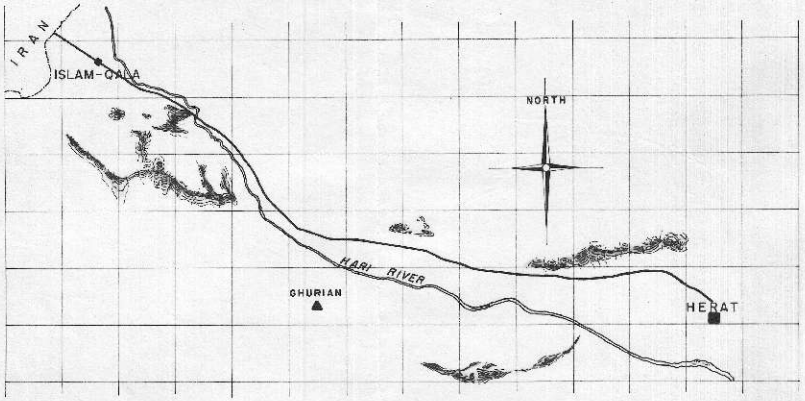
NOTE FLOODED CONDITION OF ROAD IMMEDIATELY AFTER A RAIN. BUILDINGS IN BACKGROUND ARE CUSTOMS BUILDINGS IN ISLAM QALA

PHOTO NO. 8



NOTE HOW SECTION OF ROAD WAS WASHED OUT AND VEHICLES DETOURED TO GET BY. SUCH AREAS RESULT IN A CONTINUOUS NEW ALIGNMENT OF THE EXISTING ROAD AS THE MAINTENANCE CREWS IMPROVE THE DETOUR RATHER THAN ATTEMPT TO RECONSTRUCT THE WASHED OUT SECTION.

PHOTO NO. 9



PLAN AND PROFILE OF

PROPOSED ROAD BETWEEN HERAT - ISLAM QALA - IRANIAN BORDER

FIGURES 2 THROUGH 29

APPENDIX I
FIGURE 1

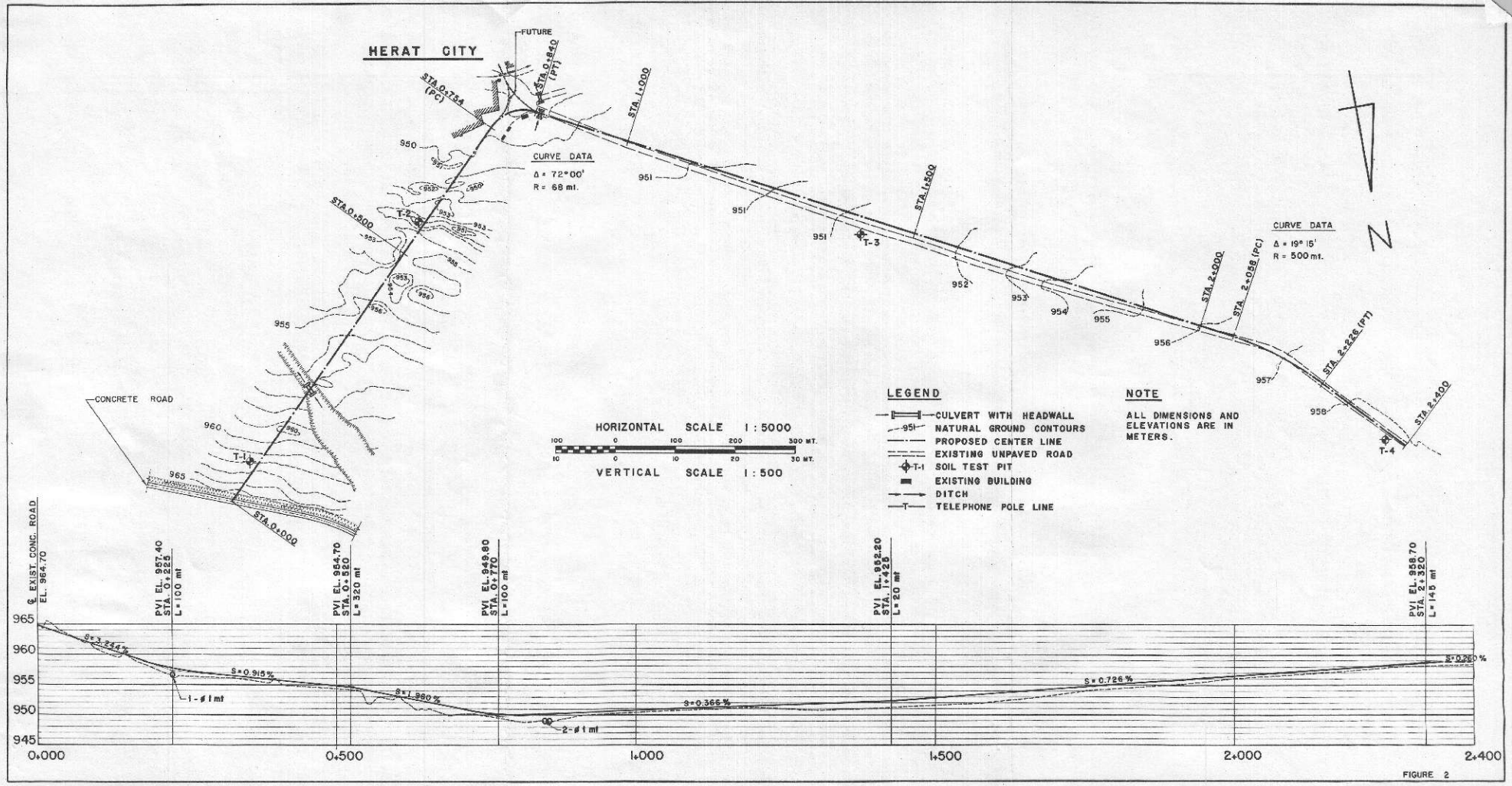

HERAT CITY
FUTURE
STA. 0+784 (PC)
STA. 0+840 (PT)
STA. 1+000
STA. 1+500
STA. 2+000
STA. 2+058 (PC)
STA. 2+228 (PT)
STA. 2+400
STA. 0+500
STA. 0+000
CURVE DATA
Δ = 72°00'
R = 68 mt.
CURVE DATA
Δ = 19° 15'
R = 500 mt.
CONCRETE ROAD
T-1
T-2
T-3
T-4
950
951
952
953
954
955
956
957
958
960
965
HORIZONTAL SCALE 1 : 5000
100 0 100 200 300 MT.
10 0 10 20 30 MT.
VERTICAL SCALE 1 : 500
LEGEND
CULVERT WITH HEADWALL
NATURAL GROUND CONTOURS
PROPOSED CENTER LINE
EXISTING UNPAVED ROAD
SOIL TEST PIT
EXISTING BUILDING
DITCH
TELEPHONE POLE LINE
NOTE
ALL DIMENSIONS AND ELEVATIONS ARE IN METERS.
℄ EXIST. CONC. ROAD EL. 964.70
PVI EL. 957.40 STA. 0+225 L=100 mt
PVI EL. 954.70 STA. 0+520 L=320 mt
PVI EL. 949.80 STA. 0+770 L=100 mt
PVI EL. 952.20 STA. 1+425 L=20 mt
PVI EL. 958.70 STA. 2+320 L=145 mt
S=3.244%
S=0.915%
S=1.980%
S=0.366%
S=0.726%
S=0.260%
1-ø1 mt
2-ø1 mt
965
960
955
950
945
0+000
0+500
1+000
1+500
2+000
2+400

FIGURE 2

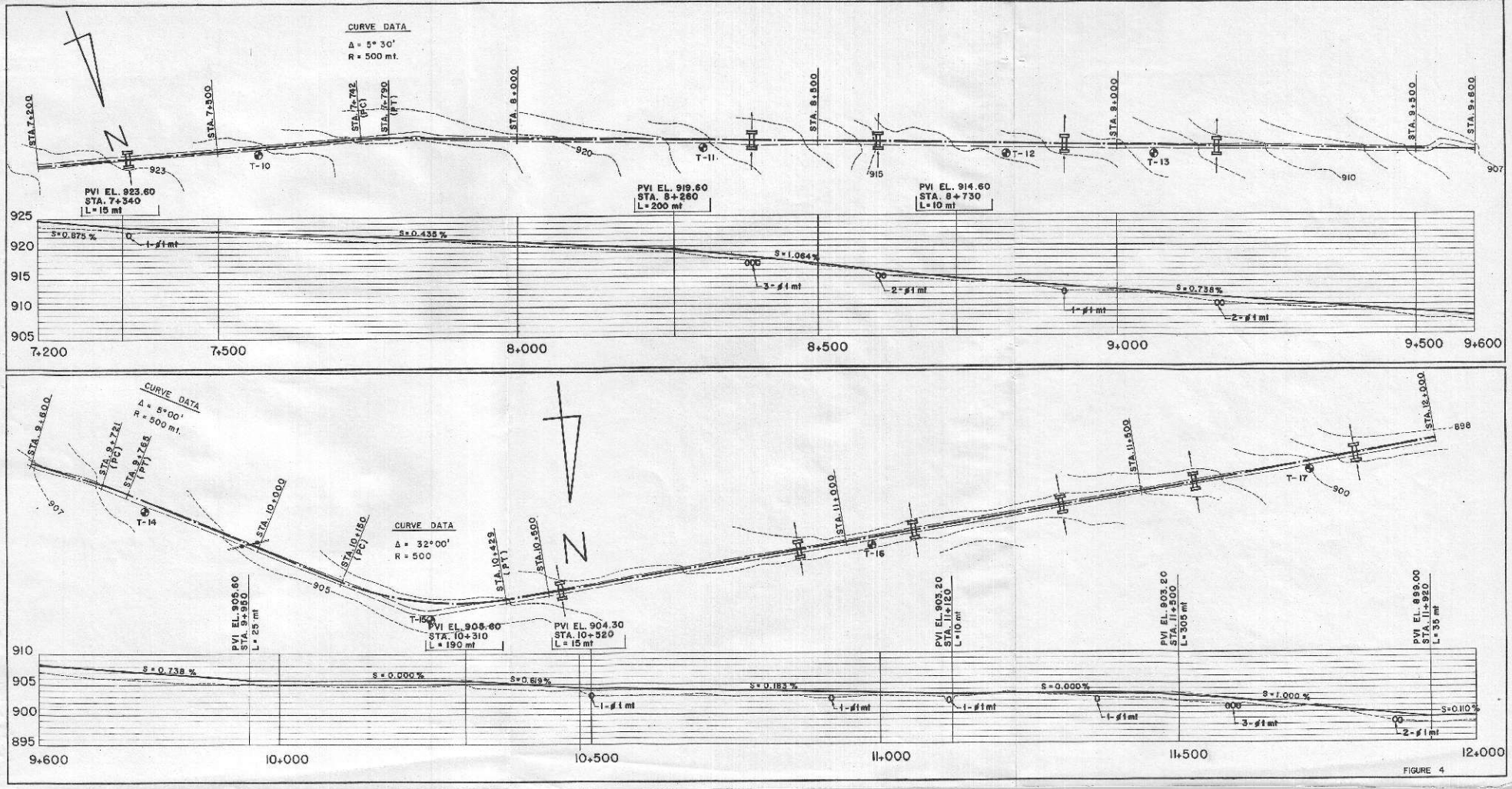

CURVE DATA
Δ = 5° 30'
R = 500 mt.
STA. 7+200
STA. 7+500
STA. 7+742 (PC)
STA. 7+790 (PT)
STA. 8+000
STA. 8+500
STA. 9+000
STA. 9+500
STA. 9+600
T-10
T-11
T-12
T-13
923
920
915
910
907
PVI EL. 923.60
STA. 7+340
L = 15 mt
PVI EL. 919.60
STA. 8+260
L = 200 mt
PVI EL. 914.60
STA. 8+730
L = 10 mt
S = 0.875 %
S = 0.435 %
S = 1.064 %
S = 0.738 %
1 - ø1 mt
3 - ø1 mt
2 - ø1 mt
925
920
915
910
905
7+200
7+500
8+000
8+500
9+000
9+500
9+600
CURVE DATA
Δ = 5°00'
R = 500 mt.
STA. 9+600
STA. 9+721 (PC)
STA. 9+765 (PT)
STA. 10+000
STA. 10+150 (PC)
STA. 10+429 (PT)
STA. 10+500
STA. 11+000
STA. 11+500
STA. 12+000
T-14
T-15
T-16
T-17
907
905
900
898
PVI EL. 905.60
STA. 9+990
L = 25 mt
PVI EL. 905.60
STA. 10+310
L = 190 mt
PVI EL. 904.30
STA. 10+520
L = 15 mt
PVI EL. 903.20
STA. 11+120
L = 10 mt
PVI EL. 903.20
STA. 11+500
L = 305 mt
PVI EL. 899.00
STA. 11+920
L = 35 mt
CURVE DATA
Δ = 32°00'
R = 500
S = 0.738 %
S = 0.000 %
S = 0.619 %
S = 0.183 %
S = 0.000 %
S = 1.000 %
S = 0.110 %
1 - ø1 mt
1 - ø1 mt
1 - ø1 mt
1 - ø1 mt
3 - ø1 mt
2 - ø1 mt
910
905
900
895
9+600
10+000
10+500
11+000
11+500
12+000

FIGURE 4

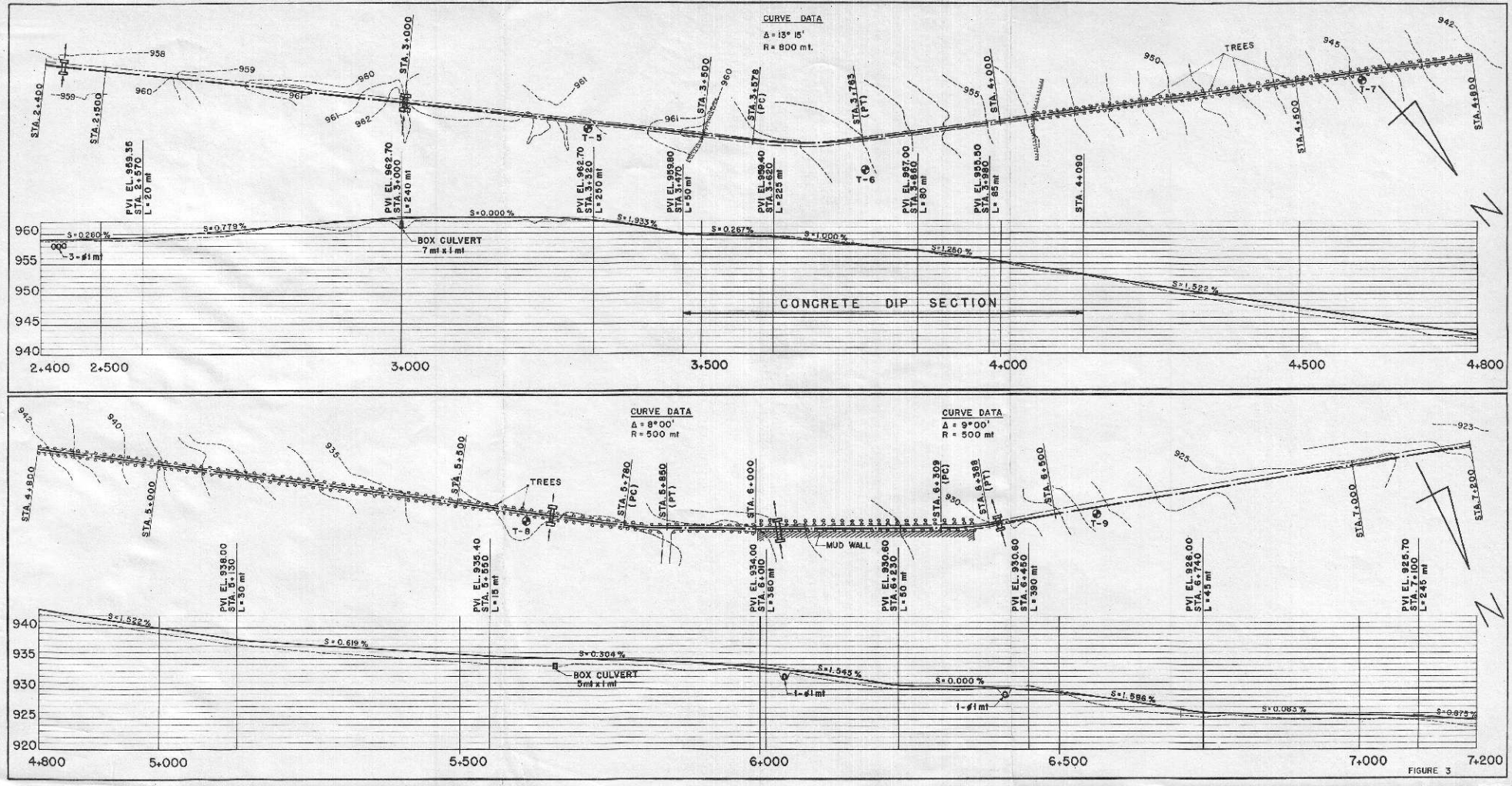

CURVE DATA
Δ = 13° 15'
R = 800 mt.
STA. 2+400
STA. 2+500
STA. 3+000
STA. 3+500
STA. 3+578 (PC)
STA. 3+783 (PT)
STA. 4+000
STA. 4+090
STA. 4+500
STA. 4+800
PVI EL. 959.35 STA. 2+570 L=20 mt
PVI EL. 962.70 STA. 3+000 L=240 mt
PVI EL. 962.70 STA. 3+320 L=250 mt
PVI EL. 959.80 STA. 3+470 L=50 mt
PVI EL. 956.40 STA. 3+650 L=225 mt
PVI EL. 957.00 STA. 3+860 L=80 mt
PVI EL. 955.50 STA. 3+980 L=85 mt
BOX CULVERT
7 mt x 1 mt
3-ø1 mt
S=0.260 %
S=0.779 %
S=0.000 %
S=1.933 %
S=0.267 %
S=1.000 %
S=1.260 %
S=1.522 %
CONCRETE DIP SECTION
TREES
T-6
T-7
960
955
950
945
940
2+400
2+500
3+000
3+500
4+000
4+500
4+800
CURVE DATA
Δ = 8° 00'
R = 500 mt
CURVE DATA
Δ = 9° 00'
R = 500 mt
STA. 4+800
STA. 5+000
STA. 5+500
STA. 5+780 (PC)
STA. 5+850 (PT)
STA. 6+000
STA. 6+309 (PC)
STA. 6+388 (PT)
STA. 6+500
STA. 7+050
STA. 7+200
PVI EL. 938.00 STA. 5+130 L=30 mt
PVI EL. 935.40 STA. 5+550 L=15 mt
PVI EL. 934.00 STA. 6+010 L=360 mt
PVI EL. 930.60 STA. 6+230 L=50 mt
PVI EL. 930.60 STA. 6+450 L=390 mt
PVI EL. 926.00 STA. 6+740 L=45 mt
PVI EL. 925.70 STA. 7+100 L=245 mt
TREES
T-8
T-9
MUD WALL
BOX CULVERT
5 mt x 1 mt
1-ø1 mt
1-ø1 mt
S=1.522 %
S=0.619 %
S=0.304 %
S=1.545 %
S=0.000 %
S=1.596 %
S=0.083 %
S=0.875 %
940
935
930
925
920
4+800
5+000
5+500
6+000
6+500
7+000
7+200

FIGURE 3

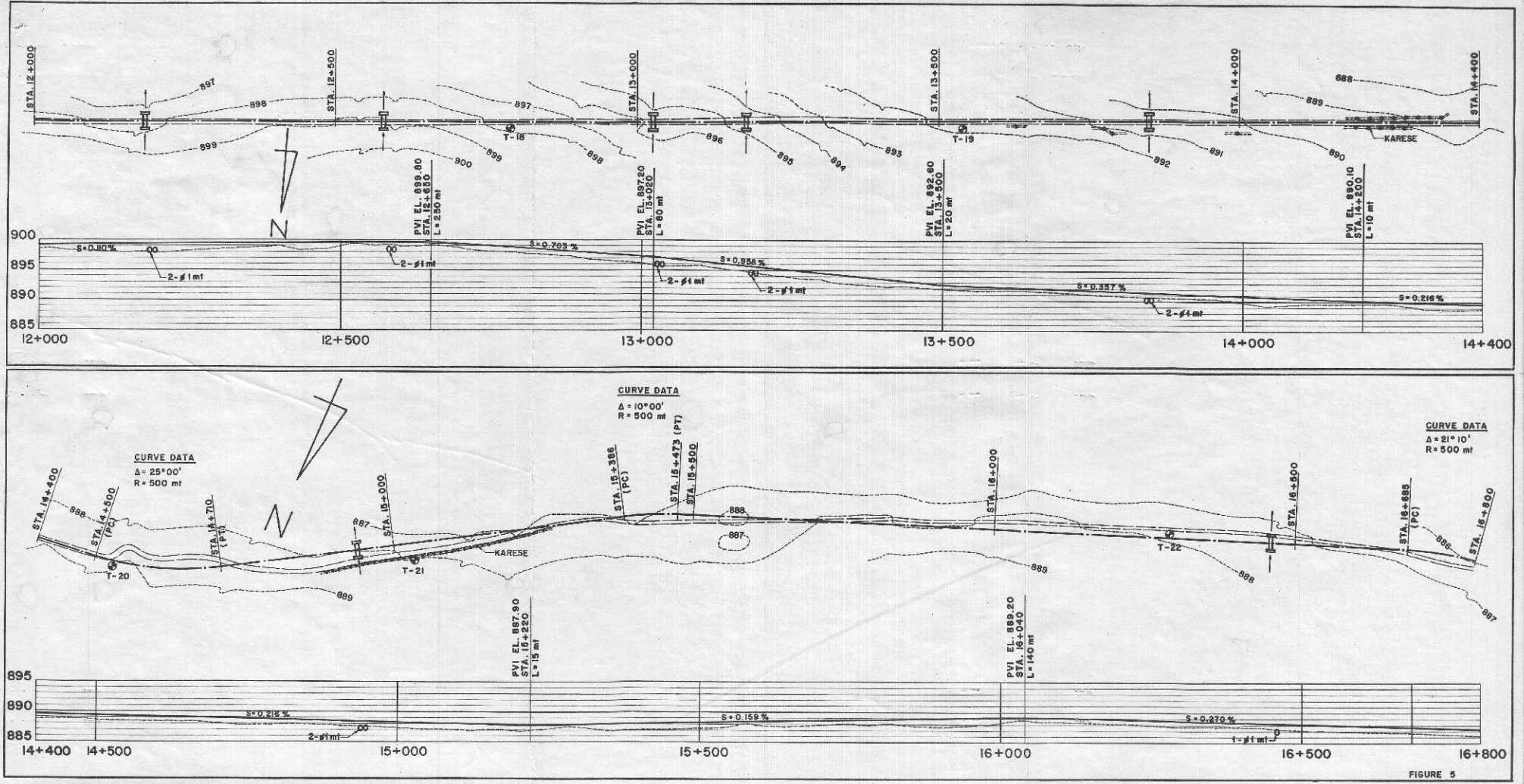
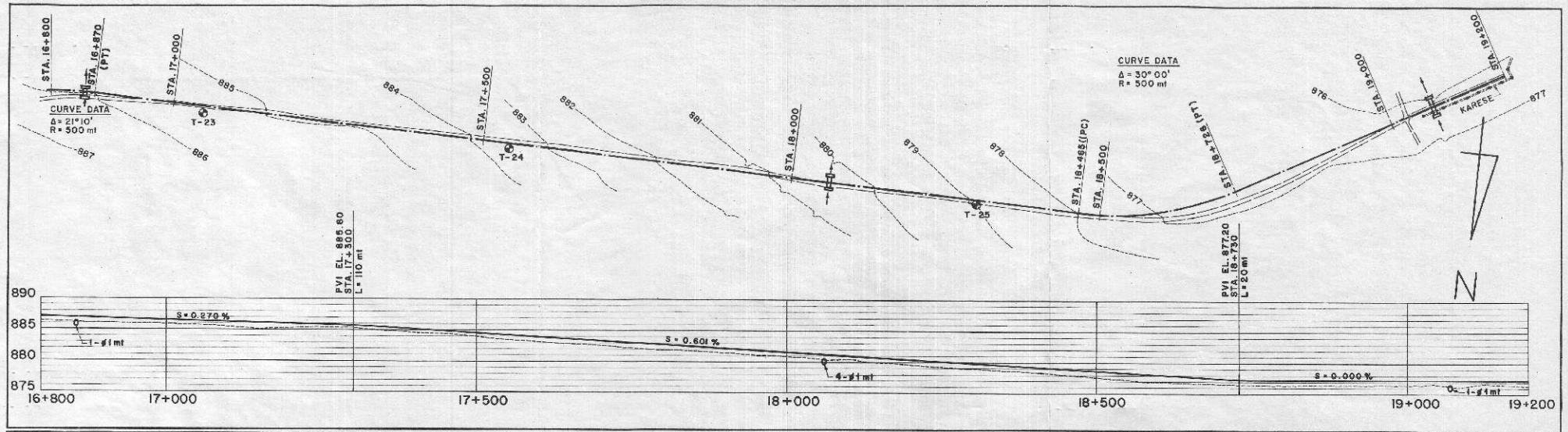

STA. 12+000
STA. 12+500
STA. 13+000
STA. 13+500
STA. 14+000
STA. 14+400
T-18
T-19
KARESE
PVI EL. 899.80
STA. 12+650
L = 250 mt
PVI EL. 897.20
STA. 13+020
L = 80 mt
PVI EL. 892.60
STA. 13+500
L = 20 mt
PVI EL. 890.10
STA. 14+200
L = 10 mt
S = 0.110 %
S = 0.703 %
S = 0.958 %
S = 0.357 %
S = 0.216 %
2-ø1 mt
CURVE DATA
Δ = 10°00'
R = 500 mt
CURVE DATA
Δ = 25°00'
R = 500 mt
CURVE DATA
Δ = 21°10'
R = 500 mt
STA. 14+400
STA. 14+500 (PC)
STA. 14+710 (PT)
STA. 15+000
STA. 15+386 (PC)
STA. 15+473 (PT)
STA. 15+500
STA. 16+000
STA. 16+500
STA. 16+685 (PC)
STA. 16+800
T-20
T-21
T-22
KARESE
PVI EL. 887.90
STA. 15+220
L = 15 mt
PVI EL. 889.20
STA. 16+040
L = 140 mt
S = 0.218 %
S = 0.159 %
S = 0.270 %
2-ø1 mt
1-ø1 mt
12+000
12+500
13+000
13+500
14+000
14+400
14+500
15+000
15+500
16+000
16+500
16+800

FIGURE 5


STA. 16+800
STA. 16+870 (PT)
STA. 17+000
STA. 17+500
STA. 18+000
STA. 18+485 (PC)
STA. 18+500
STA. 18+728 (PT)
STA. 19+000
STA. 19+200
CURVE DATA
Δ = 21°10'
R = 500 mt
CURVE DATA
Δ = 30°00'
R = 500 mt
T-23
T-24
T-25
KARESE
PVI EL. 885.60
STA. 17+300
L = 110 mt
PVI EL. 877.20
STA. 18+730
L = 20 mt
S = 0.279 %
S = 0.601 %
S = 0.000 %
1-ø1 mt
4-ø1 mt
1-ø1 mt
890
885
880
875
16+800
17+000
17+500
18+000
18+500
19+000
19+200

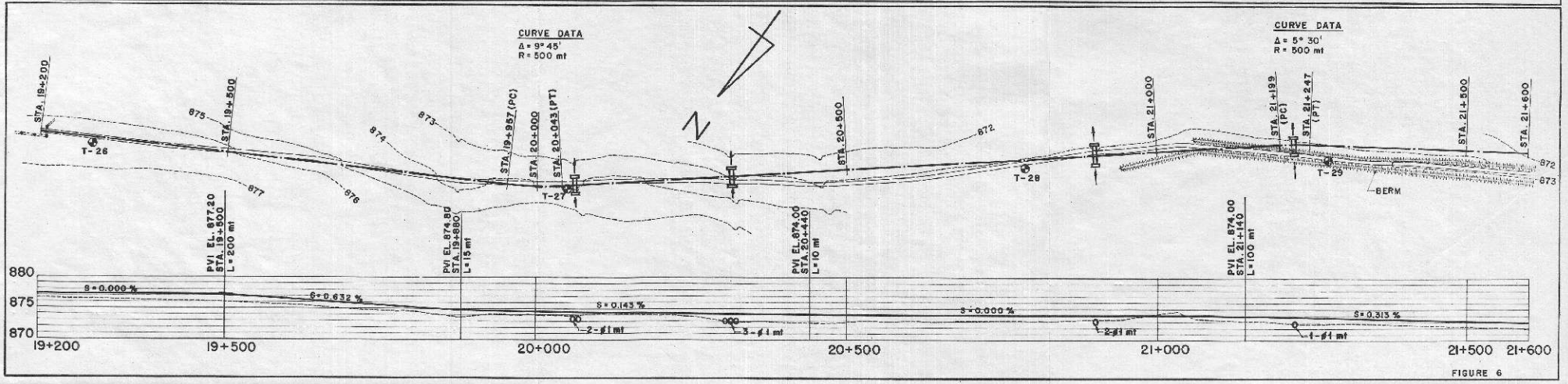
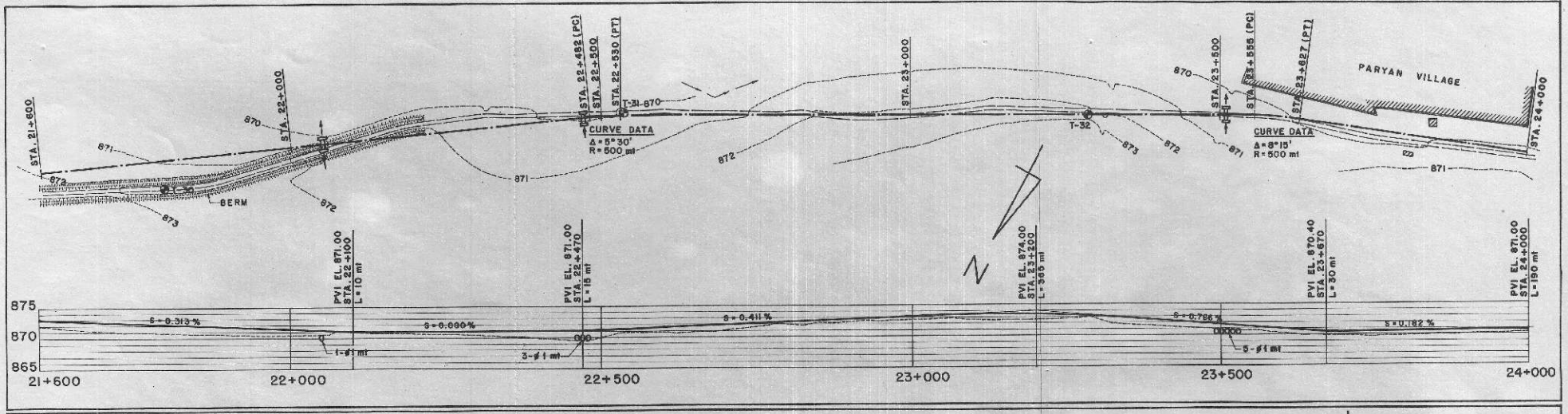

STA. 19+200
STA. 19+500
STA. 19+957 (PC)
STA. 20+000
STA. 20+043 (PT)
STA. 20+500
STA. 21+000
STA. 21+193 (PC)
STA. 21+247 (PT)
STA. 21+500
STA. 21+600
CURVE DATA
Δ = 9°45'
R = 500 mt
CURVE DATA
Δ = 5°30'
R = 500 mt
T-26
T-27
T-28
T-29
BERM
PVI EL. 877.20
STA. 19+500
L = 200 mt
PVI EL. 874.80
STA. 19+880
L = 15 mt
PVI EL. 874.00
STA. 20+440
L = 10 mt
PVI EL. 874.00
STA. 21+140
L = 100 mt
S = 0.000 %
S = 0.632 %
S = 0.143 %
S = 0.000 %
S = 0.313 %
2-ø1 mt
3-ø1 mt
2-ø1 mt
1-ø1 mt
880
875
870
19+200
19+500
20+000
20+500
21+000
21+500
21+600

FIGURE 6


STA. 21+600
STA. 22+000
STA. 22+482 (PC)
STA. 22+500
STA. 22+530 (PT)
STA. 23+000
STA. 23+500
STA. 23+555 (PC)
STA. 23+627 (PT)
STA. 24+000
PARYAN VILLAGE
CURVE DATA
Δ = 5° 30'
R = 500 mt
CURVE DATA
Δ = 8° 15'
R = 500 mt
BERM
T-31
T-32
PVI EL. 871.00 STA. 22+100 L = 10 mt
PVI EL. 871.00 STA. 22+470 L = 15 mt
PVI EL. 874.00 STA. 23+200 L = 365 mt
PVI EL. 870.40 STA. 23+870 L = 30 mt
PVI EL. 871.00 STA. 24+000 L = 190 mt
S = 0.313 %
S = 0.000 %
S = 0.411 %
S = 0.786 %
S = 0.182 %
1-ø1 mt
3-ø1 mt
5-ø1 mt
875
870
865
21+600
22+000
22+500
23+000
23+500
24+000

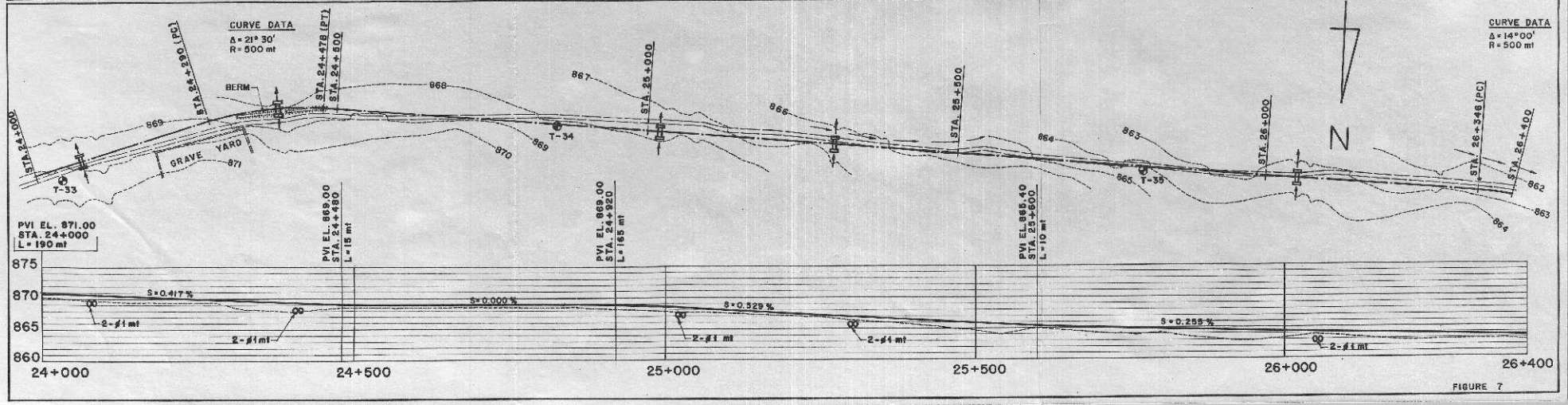
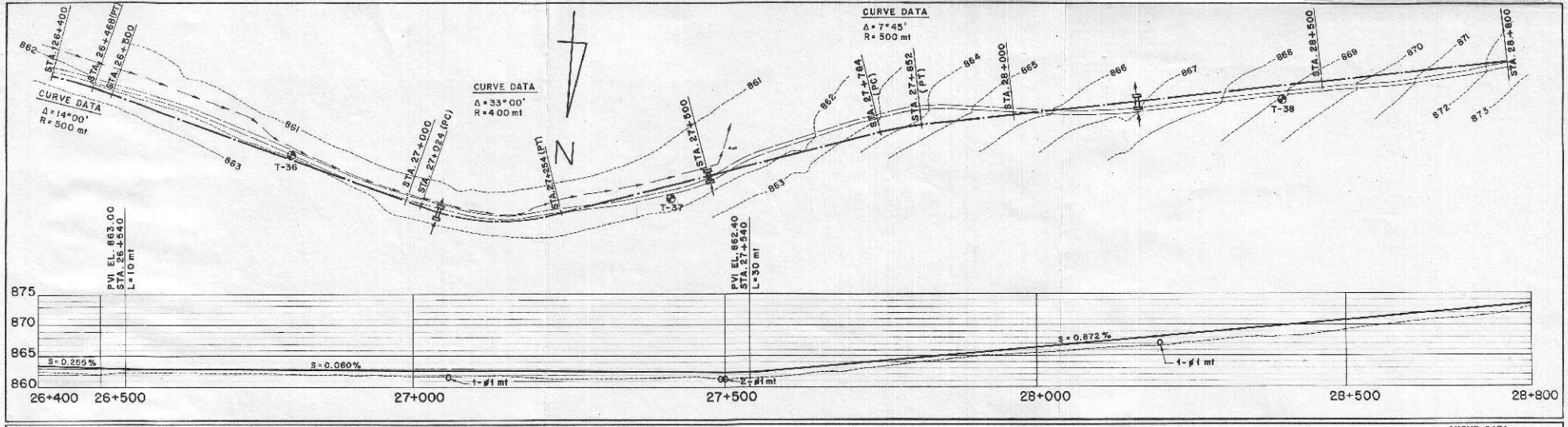

CURVE DATA
Δ = 21° 30'
R = 500 mt
CURVE DATA
Δ = 14° 00'
R = 500 mt
STA. 24+000
STA. 24+296 (PC)
STA. 24+478 (PT)
STA. 24+500
STA. 25+000
STA. 25+500
STA. 26+000
STA. 26+346 (PC)
STA. 26+400
BERM
GRAVE YARD
T-33
T-34
T-35
PVI EL. 871.00 STA. 24+000 L = 190 mt
PVI EL. 869.00 STA. 24+460 L = 15 mt
PVI EL. 869.00 STA. 24+920 L = 165 mt
PVI EL. 865.40 STA. 25+600 L = 10 mt
S = 0.417 %
S = 0.000 %
S = 0.329 %
S = 0.255 %
2-ø1 mt
875
870
865
860
24+000
24+500
25+000
25+500
26+000
26+400

FIGURE 7


CURVE DATA
Δ = 14°00'
R = 500 mt
STA. 26+400
STA. 26+468 (PT)
STA. 26+500
CURVE DATA
Δ = 33°00'
R = 400 mt
CURVE DATA
Δ = 7°45'
R = 500 mt
STA. 27+000
STA. 27+024 (PC)
STA. 27+254 (PT)
STA. 27+500
STA. 27+764 (PC)
STA. 27+952 (PT)
STA. 28+000
STA. 28+500
STA. 28+800
T-36
T-37
T-38
N
PVI EL. 863.00
STA. 26+540
L = 10 mt
PVI EL. 862.40
STA. 27+540
L = 30 mt
S = 0.255%
S = 0.060%
S = 0.872%
1-ø1 mt
875
870
865
860
26+400
26+500
27+000
27+500
28+000
28+500
28+800

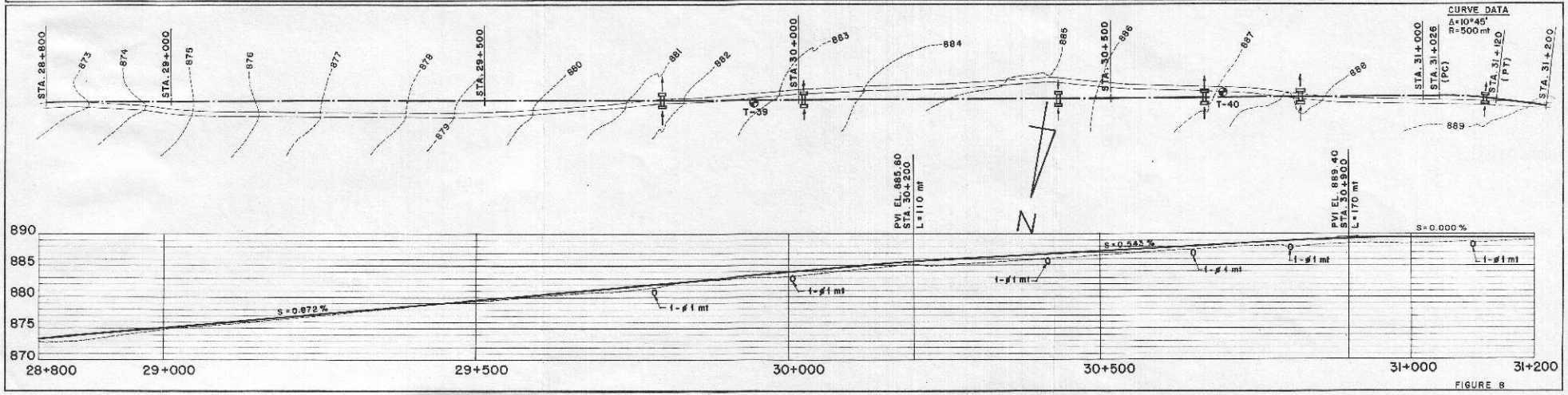

STA. 28+800
STA. 29+000
STA. 29+500
STA. 30+000
STA. 30+500
STA. 31+000
STA. 31+026 (PC)
STA. 31+120 (PT)
STA. 31+200
CURVE DATA
Δ = 10°45'
R = 500 mt
T-39
T-40
N
PVI EL. 885.60
STA. 30+200
L = 110 mt
PVI EL. 889.40
STA. 30+900
L = 170 mt
S = 0.872%
S = 0.543%
S = 0.000%
1-ø1 mt
890
885
880
875
870
28+800
29+000
29+500
30+000
30+500
31+000
31+200

FIGURE 8

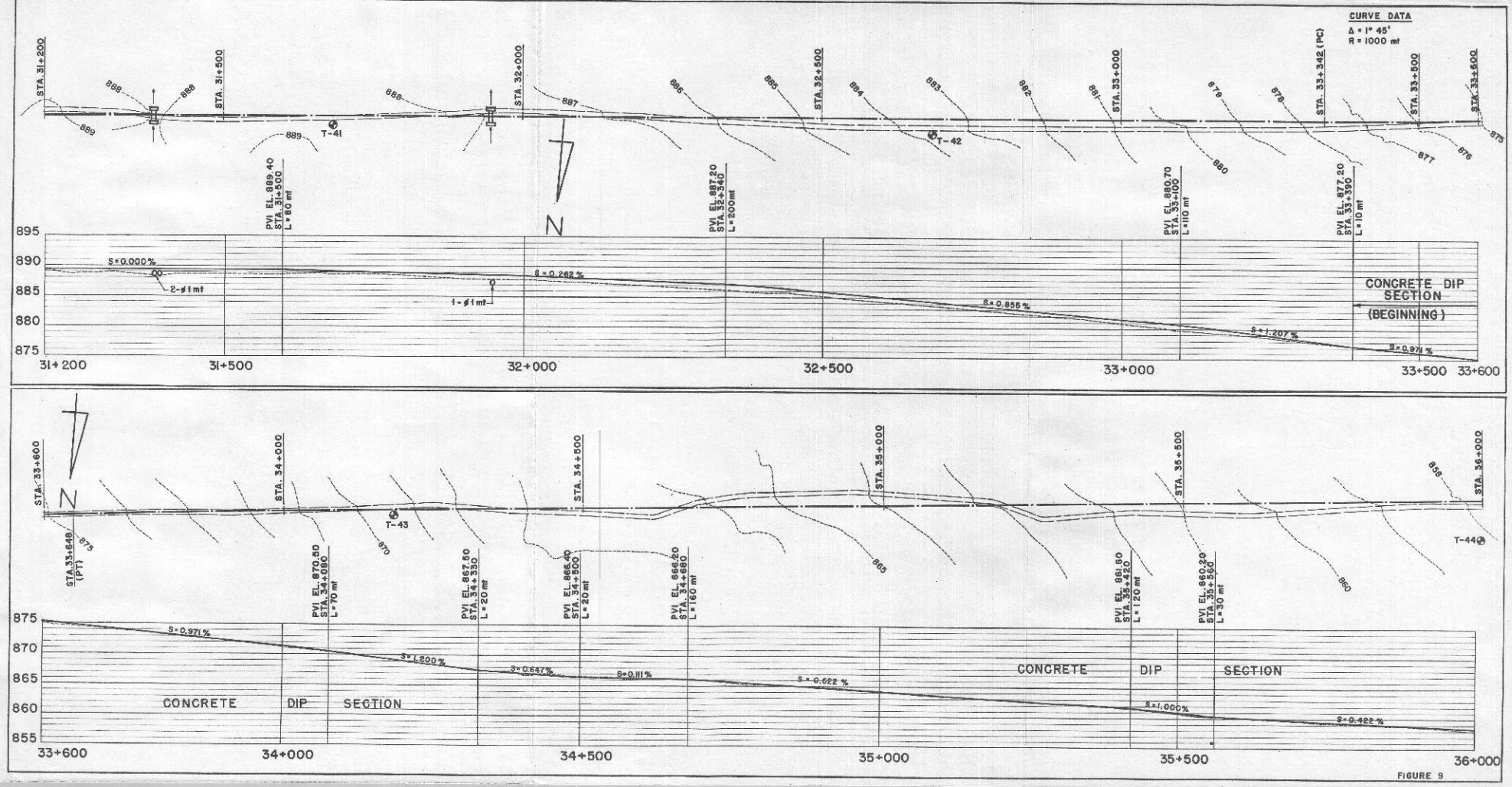
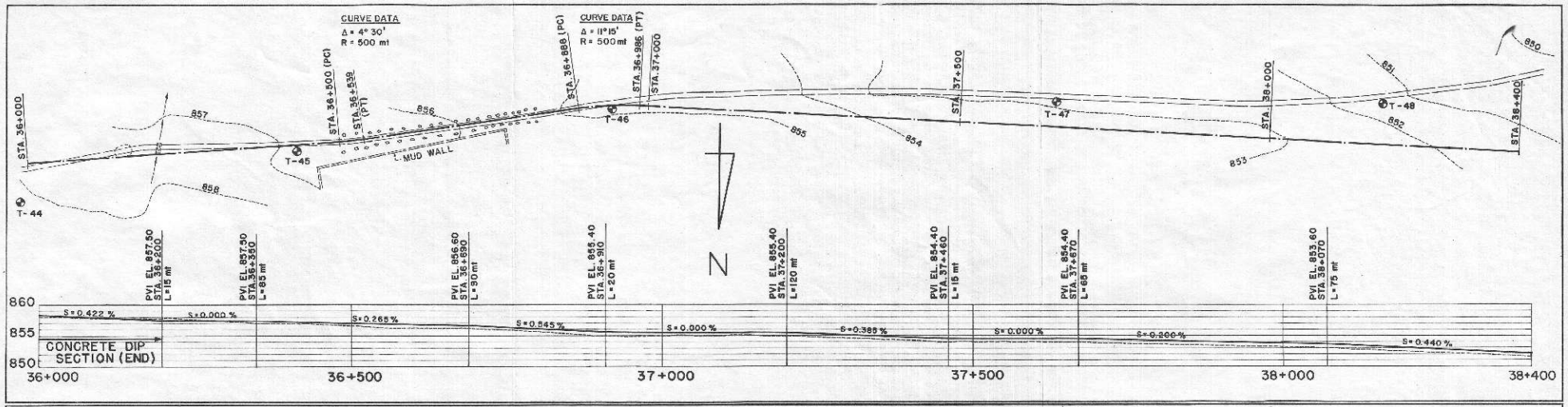

CURVE DATA
Δ = 1° 45'
R = 1000 mt
STA. 31+200
STA. 31+500
STA. 32+000
STA. 32+500
STA. 33+000
STA. 33+342 (PC)
STA. 33+500
STA. 33+600
T-41
T-42
PVI EL. 889.40
STA. 31+500
L = 80 mt
PVI EL. 887.20
STA. 32+340
L = 200 mt
PVI EL. 880.70
STA. 33+100
L = 110 mt
PVI EL. 877.20
STA. 33+390
L = 110 mt
S = 0.000 %
2-ø1 mt
1-ø1 mt
S = 0.262 %
S = 0.855 %
S = 1.207 %
S = 0.971 %
CONCRETE DIP
SECTION
(BEGINNING)
895
890
885
880
875
31+200
31+500
32+000
32+500
33+000
33+500
33+600
STA. 33+600
STA. 34+000
STA. 34+500
STA. 35+000
STA. 35+500
STA. 36+000
STA. 33+648
(PT)
T-43
T-44
PVI EL. 870.50
STA. 34+080
L = 70 mt
PVI EL. 867.50
STA. 34+330
L = 20 mt
PVI EL. 866.40
STA. 34+500
L = 20 mt
PVI EL. 866.20
STA. 34+660
L = 160 mt
PVI EL. 861.80
STA. 35+420
L = 120 mt
PVI EL. 860.20
STA. 35+560
L = 30 mt
S = 0.971 %
S = 1.200 %
S = 0.647 %
S = 0.111 %
S = 0.622 %
S = 1.000 %
S = 0.422 %
CONCRETE DIP SECTION
CONCRETE DIP SECTION
875
870
865
860
855
33+600
34+000
34+500
35+000
35+500
36+000

FIGURE 9


CURVE DATA
Δ = 4° 30'
R = 500 mt
CURVE DATA
Δ = 11°15'
R = 500 mt
STA. 36+000
STA. 36+300 (PC)
STA. 36+539 (PT)
STA. 36+868 (PC)
STA. 36+986 (PT)
STA. 37+000
STA. 37+500
STA. 38+000
STA. 38+400
T-44
T-45
T-46
T-47
T-48
L. MUD WALL
857
858
856
855
854
853
852
851
850
N
PVI EL. 857.50 STA. 36+200 L=15 mt
PVI EL. 857.50 STA. 36+350 L=85 mt
PVI EL. 856.60 STA. 36+690 L=30 mt
PVI EL. 855.40 STA. 36+910 L=20 mt
PVI EL. 855.40 STA. 37+220 L=120 mt
PVI EL. 854.40 STA. 37+460 L=15 mt
PVI EL. 854.40 STA. 37+570 L=65 mt
PVI EL. 853.60 STA. 38+070 L=75 mt
860
855
850
S=0.422 %
S=0.000 %
S=0.265 %
S=0.545 %
S=0.000 %
S=0.388 %
S=0.000 %
S=0.200 %
S=0.440 %
CONCRETE DIP SECTION (END)
36+000
36+500
37+000
37+500
38+000
38+400

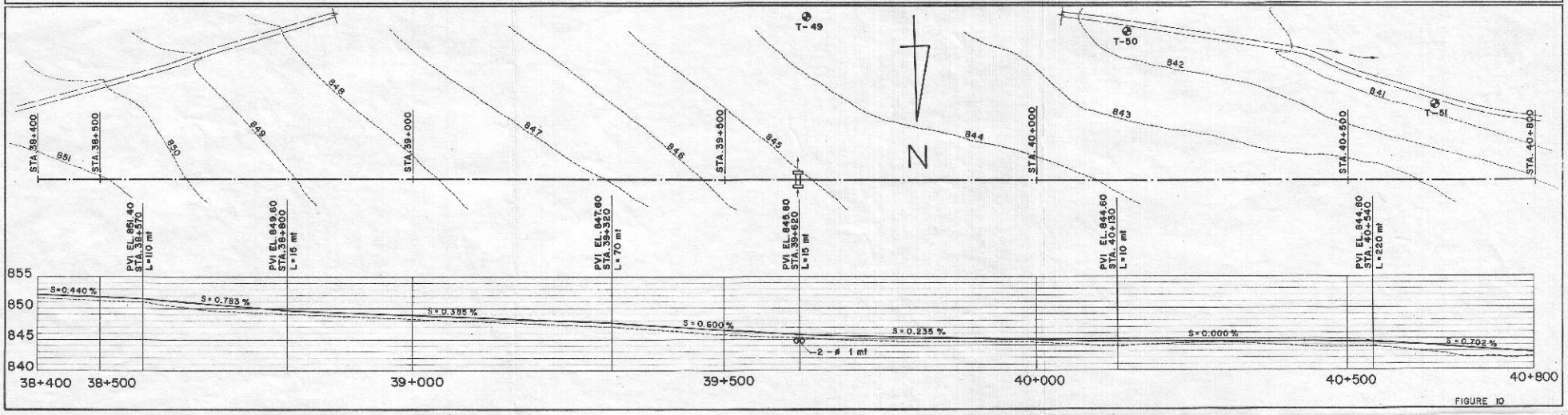

T-49
T-50
T-51
STA. 38+400
STA. 38+500
STA. 39+000
STA. 39+500
STA. 40+000
STA. 40+500
STA. 40+800
851
850
849
848
847
846
845
844
843
842
841
N
PVI EL. 851.40 STA. 38+570 L=110 mt
PVI EL. 849.60 STA. 38+800 L=15 mt
PVI EL. 847.60 STA. 39+320 L=70 mt
PVI EL. 845.60 STA. 39+620 L=15 mt
PVI EL. 844.60 STA. 40+130 L=10 mt
PVI EL. 844.60 STA. 40+540 L=220 mt
855
850
845
840
S=0.440 %
S=0.783 %
S=0.385 %
S=0.600 %
S=0.235 %
S=0.000 %
S=0.702 %
2 - ø 1 mt
38+400
38+500
39+000
39+500
40+000
40+500
40+800

FIGURE 10

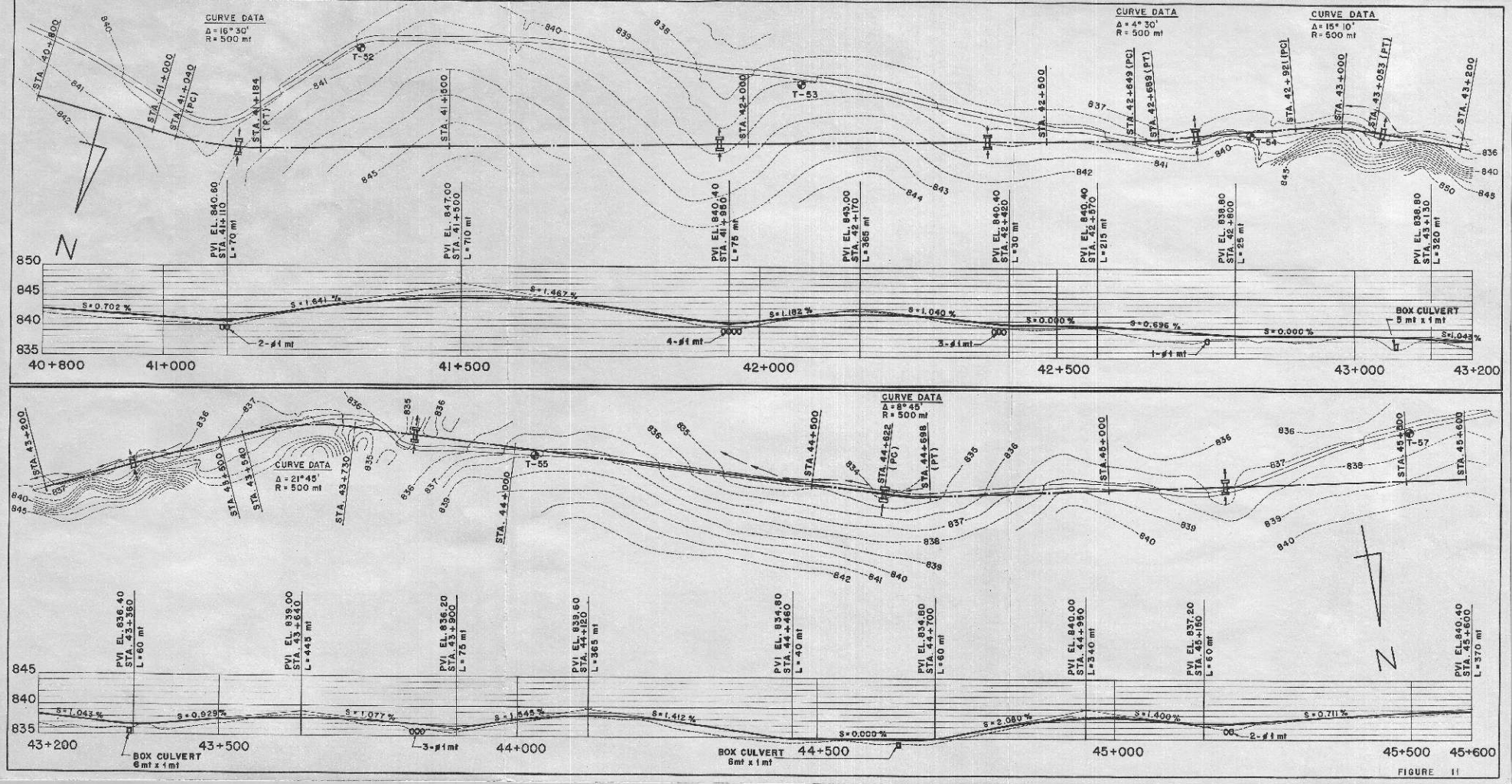

CURVE DATA
Δ = 16° 30'
R = 500 mt
CURVE DATA
Δ = 4° 30'
R = 500 mt
CURVE DATA
Δ = 15° 10'
R = 500 mt
STA. 40+800
STA. 41+000
STA. 41+040 (PC)
STA. 41+184 (PT)
STA. 41+500
STA. 42+000
STA. 42+500
STA. 42+649 (PC)
STA. 42+699 (PT)
STA. 42+921 (PC)
STA. 43+000
STA. 43+053 (PT)
STA. 43+200
T-52
T-53
T-54
PVI EL. 840.60 STA. 41+110 L = 70 mt
PVI EL. 847.00 STA. 41+500 L = 710 mt
PVI EL. 840.40 STA. 41+880 L = 75 mt
PVI EL. 843.00 STA. 42+170 L = 365 mt
PVI EL. 840.40 STA. 42+420 L = 30 mt
PVI EL. 840.40 STA. 42+570 L = 215 mt
PVI EL. 838.80 STA. 42+800 L = 25 mt
PVI EL. 838.80 STA. 43+130 L = 320 mt
S = 0.702 %
S = 1.641 %
S = 1.467 %
S = 1.182 %
S = 1.040 %
S = 0.000 %
S = 0.696 %
S = 0.000 %
S = 1.043 %
2-ø1 mt
4-ø1 mt
3-ø1 mt
1-ø1 mt
BOX CULVERT
5 mt x 1 mt
40+800
41+000
41+500
42+000
42+500
43+000
43+200
STA. 43+200
STA. 43+540
STA. 43+730
STA. 44+000
STA. 44+500
STA. 44+622 (PC)
STA. 44+698 (PT)
STA. 45+000
STA. 45+500
STA. 45+600
T-55
T-57
CURVE DATA
Δ = 21° 45'
R = 500 mt
CURVE DATA
Δ = 8° 45'
R = 500 mt
PVI EL. 836.40 STA. 43+350 L = 60 mt
PVI EL. 839.00 STA. 43+640 L = 445 mt
PVI EL. 836.20 STA. 43+900 L = 75 mt
PVI EL. 839.60 STA. 44+120 L = 365 mt
PVI EL. 834.80 STA. 44+460 L = 40 mt
PVI EL. 834.80 STA. 44+700 L = 60 mt
PVI EL. 840.00 STA. 44+950 L = 340 mt
PVI EL. 837.20 STA. 45+150 L = 60 mt
PVI EL. 840.40 STA. 45+500 L = 370 mt
S = 1.043 %
S = 0.929 %
S = 1.077 %
S = 1.545 %
S = 1.412 %
S = 0.000 %
S = 2.080 %
S = 1.400 %
S = 0.711 %
3-ø1 mt
2-ø1 mt
BOX CULVERT
6 mt x 1 mt
BOX CULVERT
8 mt x 1 mt
43+200
43+500
44+000
44+500
45+000
45+500
45+600

FIGURE 11

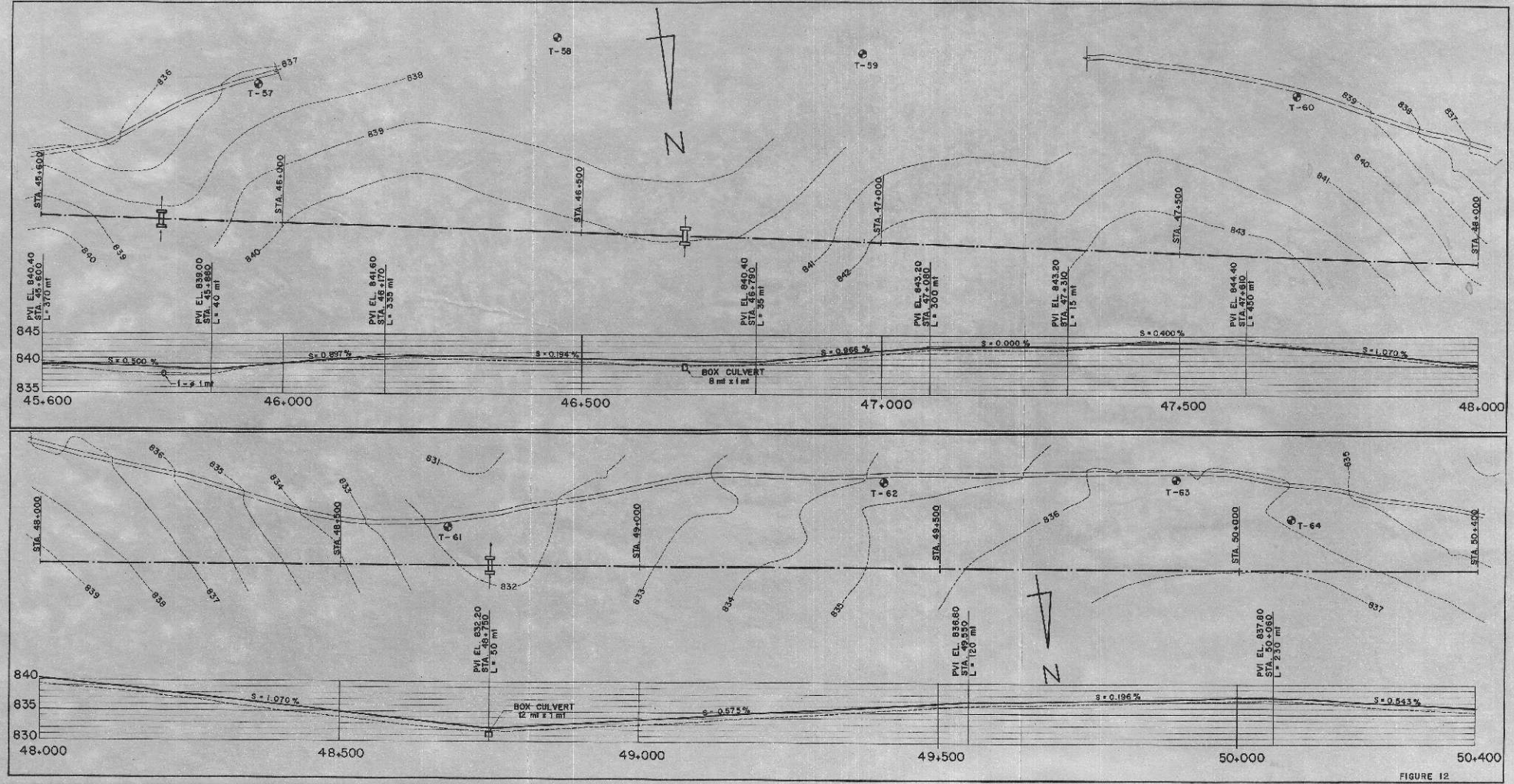

T-57
T-58
T-59
T-60
T-61
T-62
T-63
T-64
N
STA. 45+600
STA. 46+000
STA. 46+500
STA. 47+000
STA. 47+500
STA. 48+000
STA. 48+500
STA. 49+000
STA. 49+500
STA. 50+000
STA. 50+400
PVI EL. 840.40 STA. 45+600 L= 370 mt
PVI EL. 839.00 STA. 45+860 L= 40 mt
PVI EL. 841.60 STA. 46+170 L= 335 mt
PVI EL. 840.40 STA. 46+790 L= 35 mt
PVI EL. 843.20 STA. 47+000 L= 300 mt
PVI EL. 843.20 STA. 47+310 L= 15 mt
PVI EL. 844.40 STA. 47+910 L= 450 mt
S = 0.500 %
S = 0.897 %
S = 0.194 %
S = 0.966 %
S = 0.000 %
S = 0.400 %
S = 1.070 %
BOX CULVERT 8 mt x 1 mt
PVI EL. 832.20 STA. 48+470 L= 50 mt
PVI EL. 836.80 STA. 49+550 L= 120 mt
PVI EL. 837.80 STA. 50+060 L= 230 mt
S = 1.070 %
S = 0.575 %
S = 0.196 %
S = 0.543 %
BOX CULVERT 12 mt x 1 mt
45+600
46+000
46+500
47+000
47+500
48+000
48+500
49+000
49+500
50+000
50+400

FIGURE 12

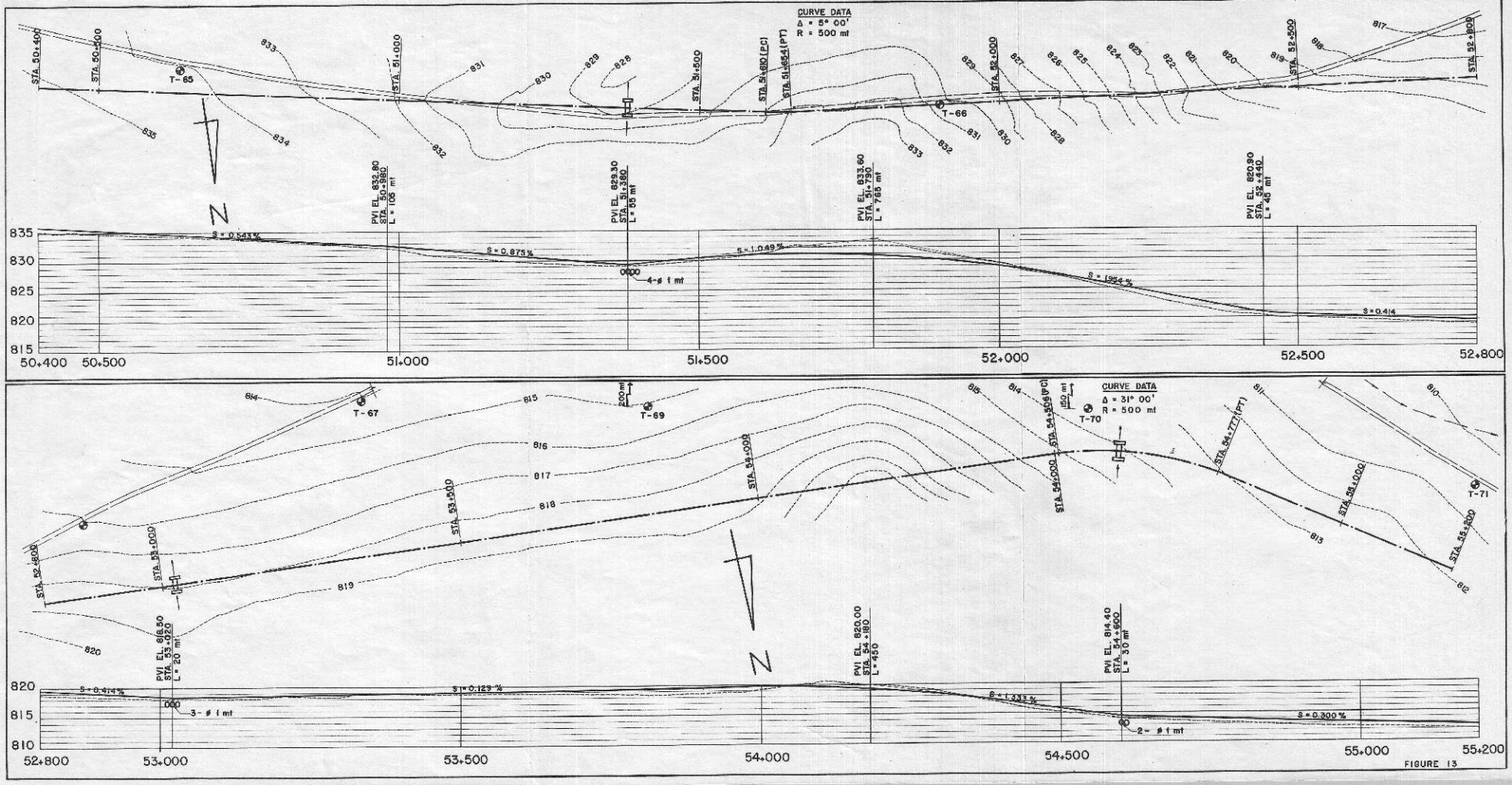
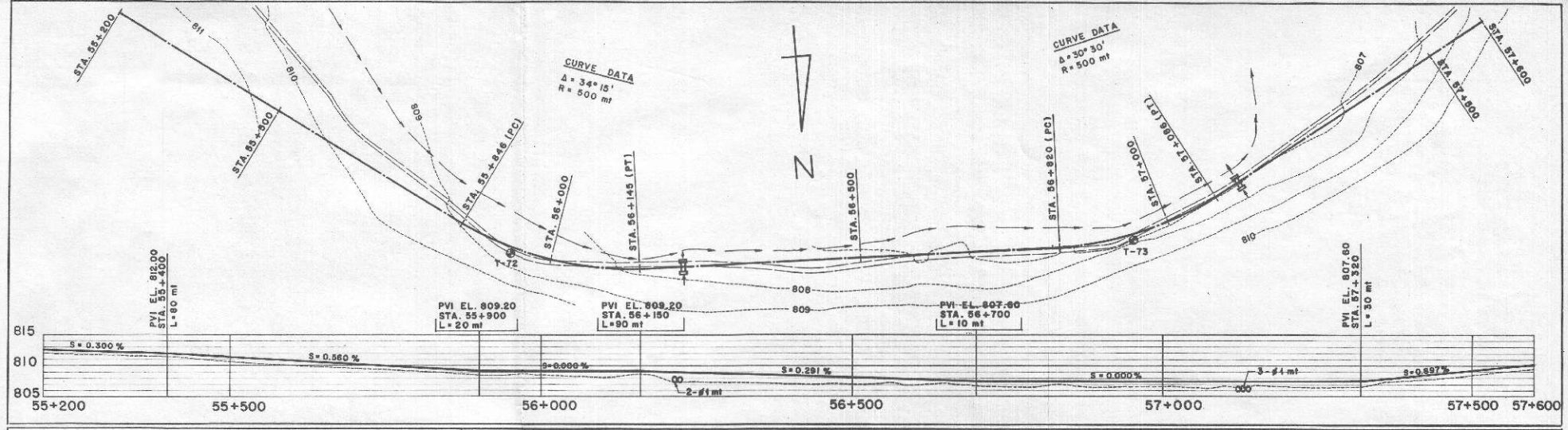

CURVE DATA
Δ = 5° 00'
R = 500 mt
STA. 50+400
STA. 50+500
STA. 51+000
STA. 51+500
STA. 51+654 (PT)
STA. 52+000
STA. 52+500
STA. 52+800
T-65
T-66
PVI EL. 832.80
STA. 50+980
L = 103 mt
PVI EL. 829.30
STA. 51+380
L = 55 mt
PVI EL. 833.60
STA. 51+790
L = 785 mt
PVI EL. 820.80
STA. 52+440
L = 45 mt
S = 0.543%
S = 0.875%
S = 1.049%
S = 1.954%
S = 0.414
4-ø 1 mt
50+400
50+500
51+000
51+500
52+000
52+500
52+800
T-67
T-69
T-70
T-71
CURVE DATA
Δ = 31° 00'
R = 500 mt
STA. 52+800
STA. 53+000
STA. 53+500
STA. 54+000
STA. 54+000
STA. 54+326 (PC)
STA. 54+771 (PT)
STA. 55+000
STA. 55+200
PVI EL. 818.50
STA. 53+020
L = 20 mt
PVI EL. 820.00
STA. 54+180
L = 40
PVI EL. 814.40
STA. 54+600
L = 30 mt
S = 0.414%
S = 0.129%
S = 1.333%
S = 0.300%
3-ø 1 mt
2-ø 1 mt
52+800
53+000
53+500
54+000
54+500
55+000
55+200

FIGURE 13


CURVE DATA
Δ = 34° 15'
R = 500 mt
CURVE DATA
Δ = 30° 30'
R = 500 mt
N
STA. 55+200
STA. 55+500
STA. 55+846 (PC)
STA. 56+000
STA. 56+145 (PT)
STA. 56+500
STA. 56+820 (PC)
STA. 57+000
STA. 57+058 (PT)
STA. 57+500
STA. 57+600
T-72
T-73
PVI EL. 812.00
STA. 55+400
L = 90 mt
PVI EL. 809.20
STA. 55+900
L = 20 mt
PVI EL. 809.20
STA. 56+150
L = 90 mt
PVI EL. 807.60
STA. 56+700
L = 10 mt
PVI EL. 807.60
STA. 57+320
L = 30 mt
S = 0.300 %
S = 0.560 %
S = 0.000 %
S = 0.291 %
S = 0.000 %
S = 0.897 %
2-ø1 mt
3-ø1 mt
815
810
805
55+200
55+500
56+000
56+500
57+000
57+500
57+600

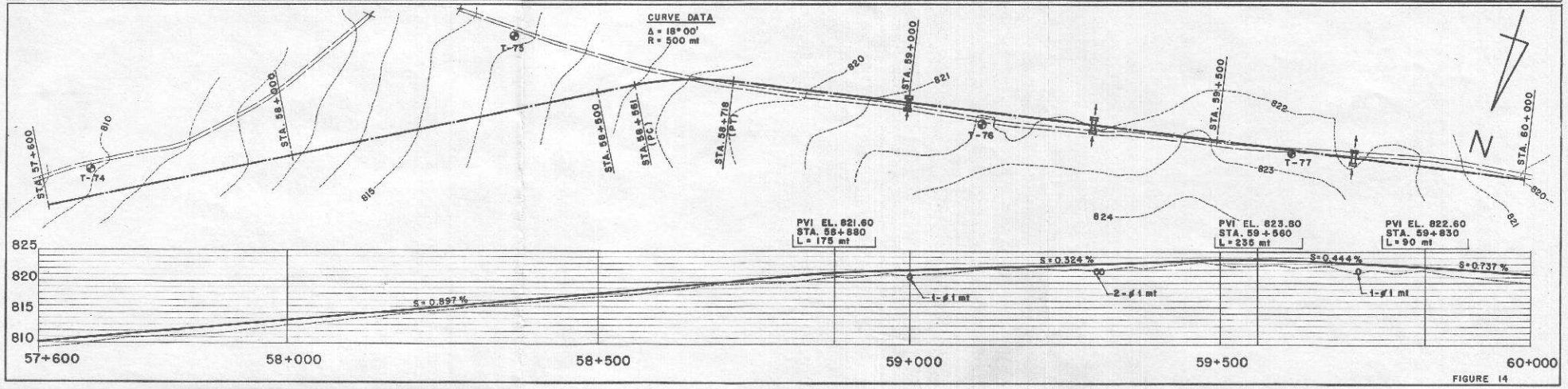
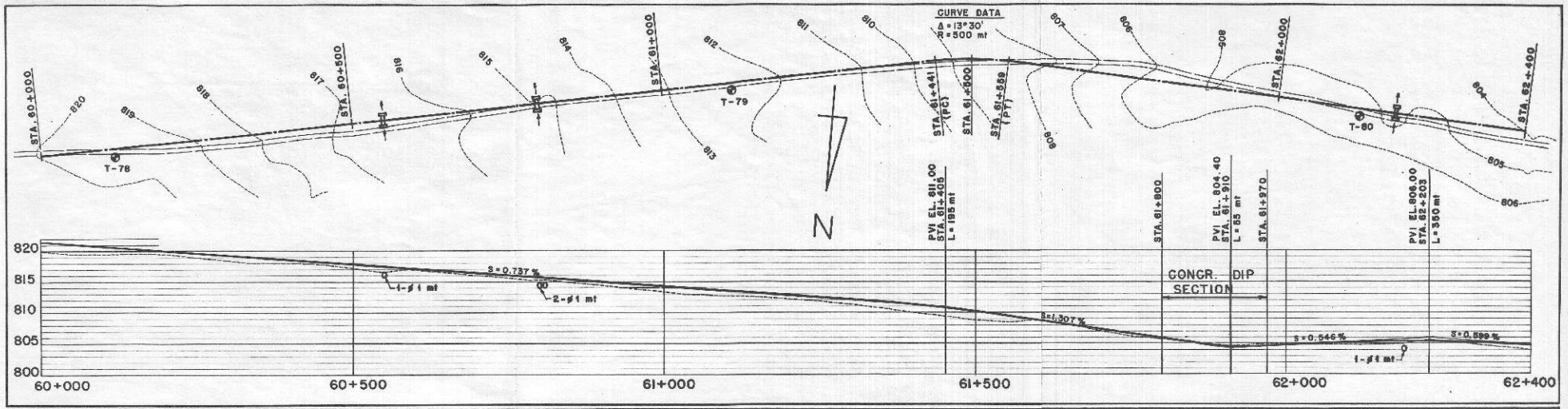

CURVE DATA
Δ = 18° 00'
R = 500 mt
N
STA. 57+600
STA. 58+000
STA. 58+500
STA. 58+561 (PC)
STA. 58+718 (PT)
STA. 59+000
STA. 59+500
STA. 60+000
T-74
T-75
T-76
T-77
PVI EL. 821.60
STA. 58+880
L = 175 mt
PVI EL. 823.80
STA. 59+560
L = 235 mt
PVI EL. 822.60
STA. 59+830
L = 90 mt
S = 0.897 %
S = 0.324 %
S = 0.444 %
S = 0.737 %
1-ø1 mt
2-ø1 mt
1-ø1 mt
825
820
815
810
57+600
58+000
58+500
59+000
59+500
60+000

FIGURE 14


CURVE DATA
Δ = 13°30'
R = 500 mt
STA. 60+000
STA. 60+500
STA. 61+000
STA. 61+500
STA. 62+000
STA. 62+400
T-78
T-79
T-80
STA. 61+441 (PC)
STA. 61+500
STA. 61+559 (PT)
PVI EL. 811.00 STA. 61+405 L = 195 mt
STA. 61+800
PVI EL. 804.40 STA. 61+910 L = 55 mt
STA. 61+970
PVI EL. 806.00 STA. 62+203 L = 350 mt
CONCR. DIP SECTION
S = 0.737 %
S = 1.307 %
S = 0.546 %
S = 0.599 %
1-ø1 mt
2-ø1 mt
820
815
810
805
800
60+000
60+500
61+000
61+500
62+000
62+400

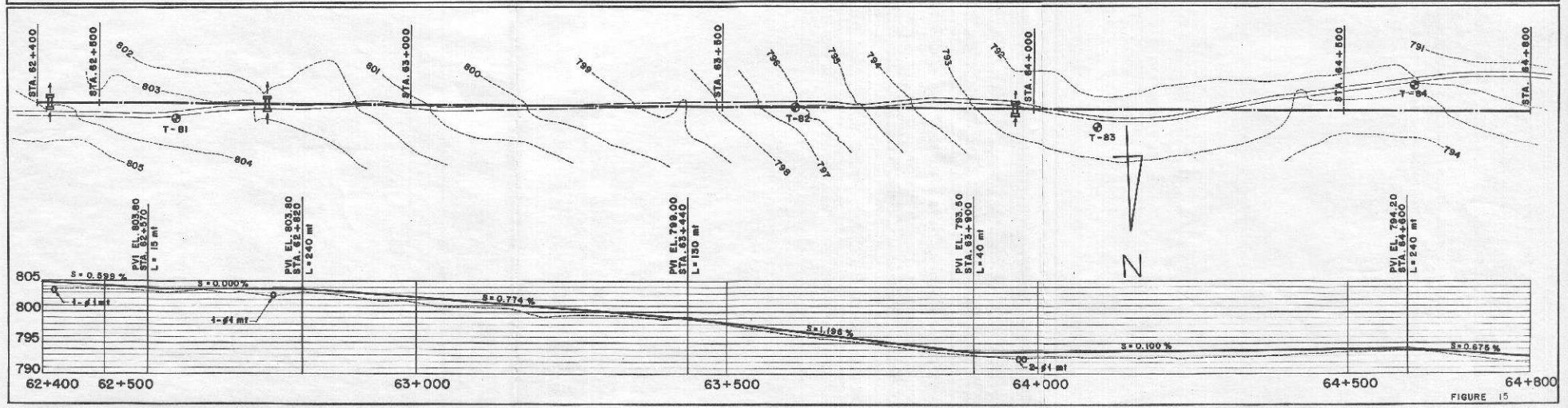

STA. 62+400
STA. 62+500
STA. 63+000
STA. 63+500
STA. 64+000
STA. 64+500
STA. 64+800
T-81
T-82
T-83
T-84
PVI EL. 803.80 STA. 62+570 L = 15 mt
PVI EL. 803.80 STA. 62+820 L = 240 mt
PVI EL. 798.00 STA. 63+440 L = 130 mt
PVI EL. 795.50 STA. 63+900 L = 40 mt
PVI EL. 794.20 STA. 64+600 L = 240 mt
S = 0.599 %
S = 0.000 %
S = 0.774 %
S = 1.196 %
S = 0.100 %
S = 0.675 %
1-ø1 mt
2-ø1 mt
805
800
795
790
62+400
62+500
63+000
63+500
64+000
64+500
64+800

FIGURE 15

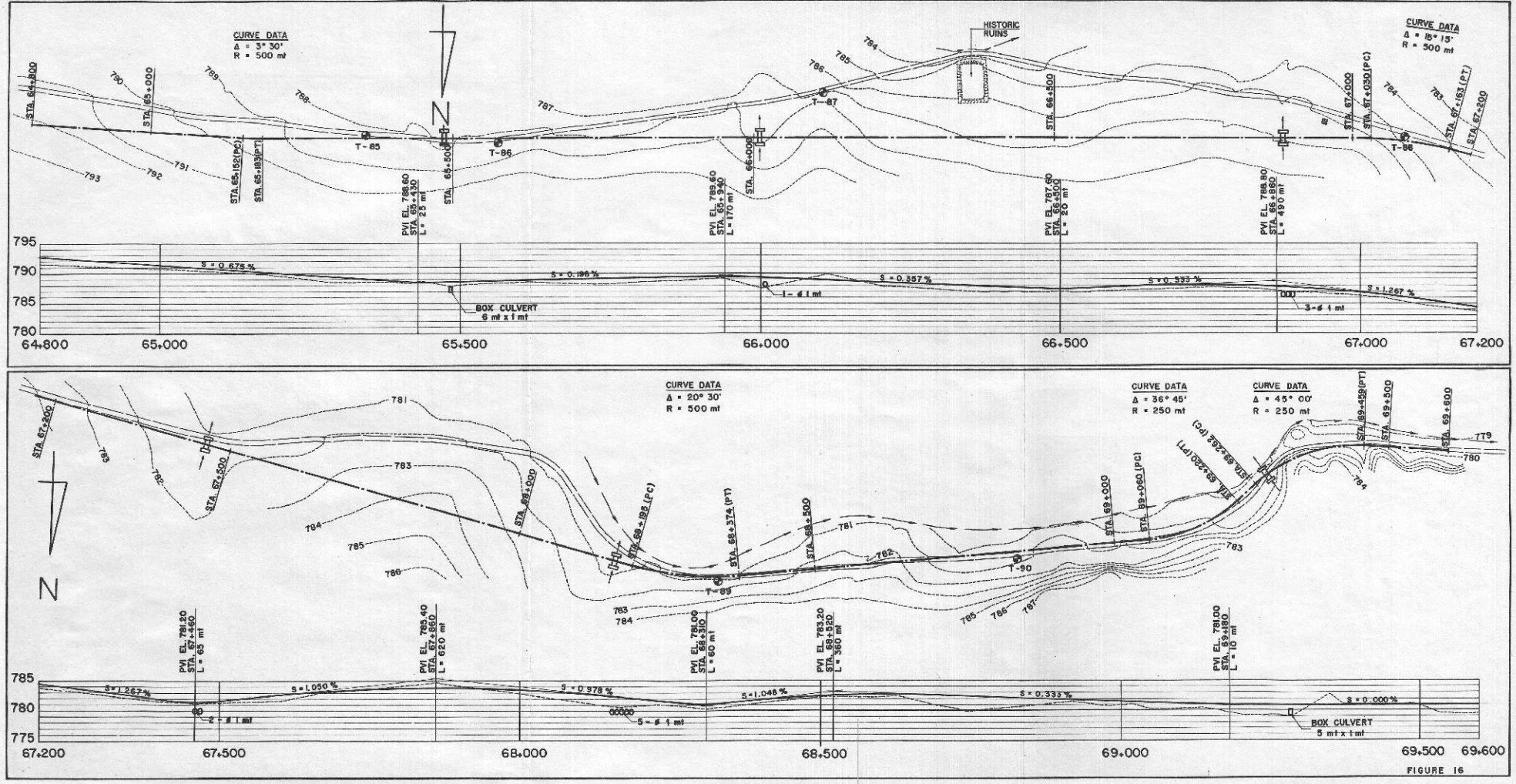

CURVE DATA
Δ = 3° 30'
R = 500 mt
CURVE DATA
Δ = 15° 15'
R = 500 mt
HISTORIC RUINS
N
STA. 64+800
STA. 65+000
STA. 65+152 (PC)
STA. 65+183 (PT)
STA. 65+500
STA. 66+000
STA. 66+500
STA. 67+000
STA. 67+030 (PC)
STA. 67+163 (PT)
STA. 67+200
T-85
T-86
T-87
T-88
PVI EL. 788.60
STA. 65+430
L = 25 mt
PVI EL. 789.60
STA. 65+940
L = 170 mt
PVI EL. 787.60
STA. 66+500
L = 20 mt
PVI EL. 788.80
STA. 66+860
L = 490 mt
S = 0.675 %
S = 0.196 %
S = 0.357 %
S = 0.533 %
S = 1.267 %
BOX CULVERT
6 mt x 1 mt
1 - ø 1 mt
3 - ø 1 mt
795
790
785
780
64+800
65+000
65+500
66+000
66+500
67+000
67+200
CURVE DATA
Δ = 20° 30'
R = 500 mt
CURVE DATA
Δ = 36° 45'
R = 250 mt
CURVE DATA
Δ = 45° 00'
R = 230 mt
N
STA. 67+200
STA. 67+500
STA. 68+000
STA. 68+310 (PC)
STA. 68+374 (PT)
STA. 68+500
STA. 69+000
STA. 69+060 (PC)
STA. 69+230 (PT)
STA. 69+258 (PC)
STA. 69+459 (PT)
STA. 69+500
STA. 69+800
T-89
T-90
PVI EL. 781.20
STA. 67+460
L = 63 mt
PVI EL. 785.40
STA. 67+860
L = 620 mt
PVI EL. 781.00
STA. 68+310
L = 60 mt
PVI EL. 783.20
STA. 68+520
L = 360 mt
PVI EL. 781.00
STA. 69+180
L = 10 mt
S = 1.267 %
S = 1.050 %
S = 0.978 %
S = 1.048 %
S = 0.333 %
S = 0.000 %
2 - ø 1 mt
5 - ø 1 mt
BOX CULVERT
5 mt x 1 mt
785
780
775
67+200
67+500
68+000
68+500
69+000
69+500
69+600

FIGURE 16

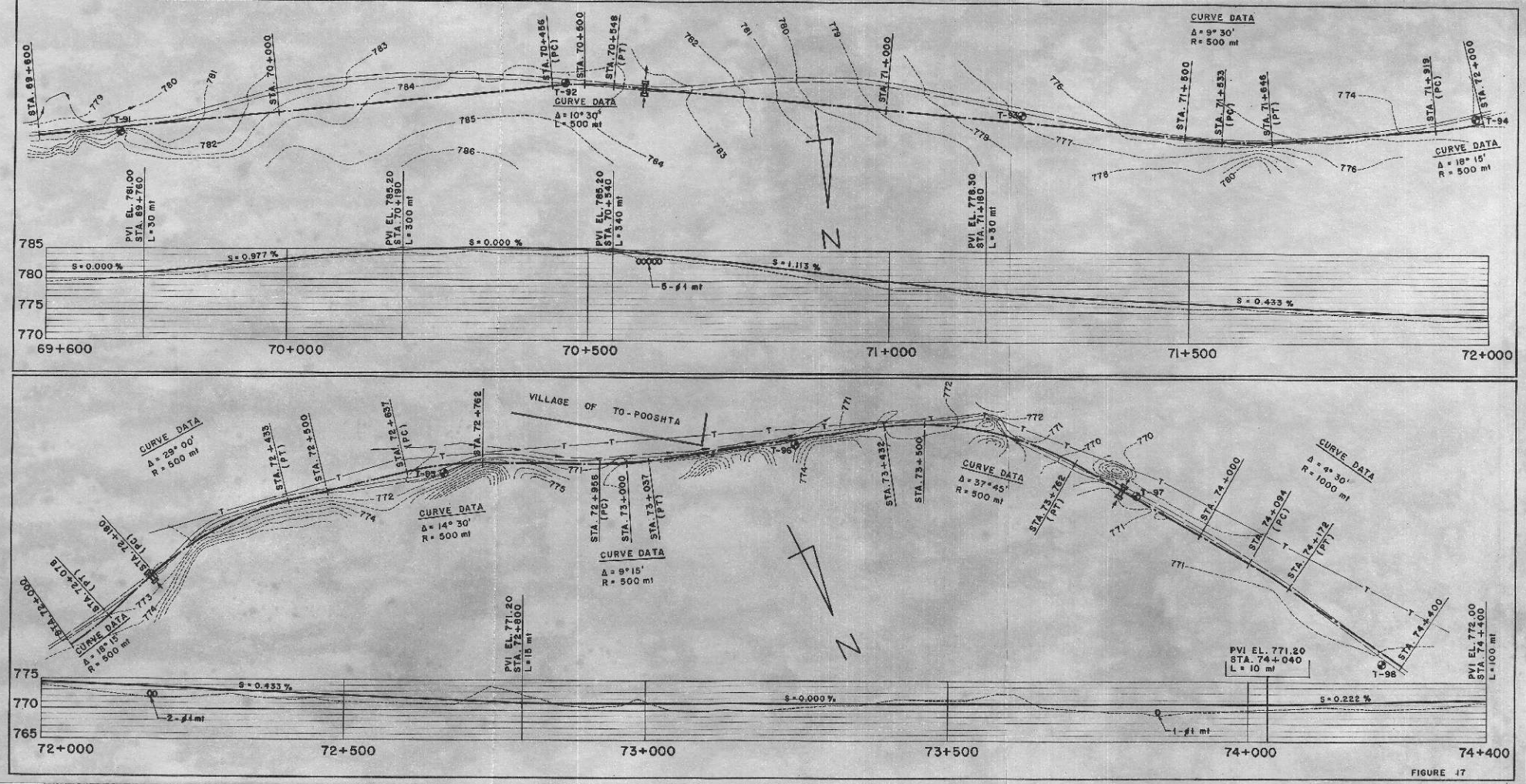
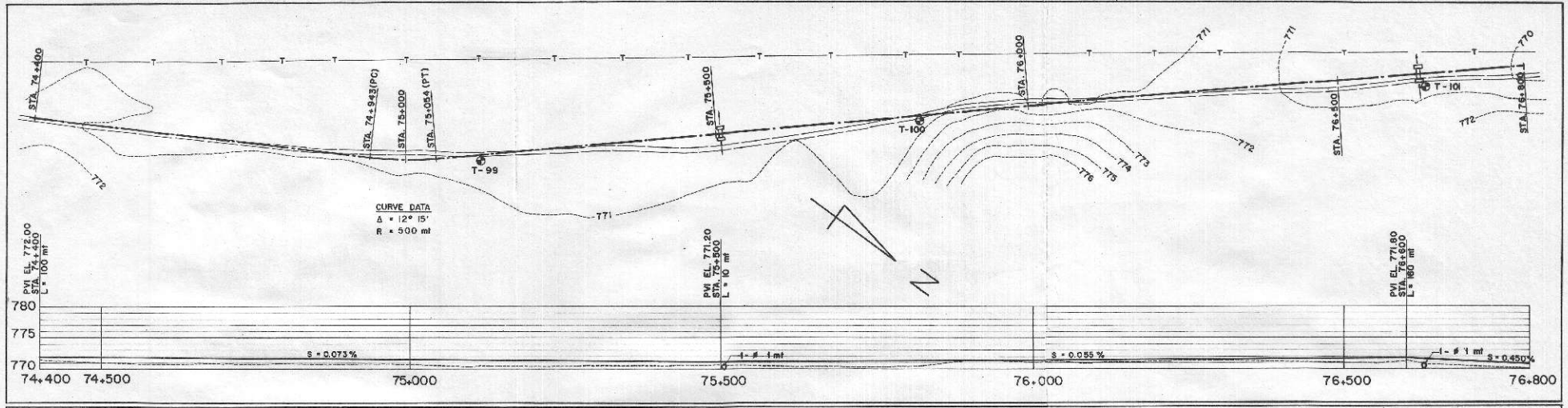

STA. 69+800
STA. 70+000
STA. 70+456 (PC)
STA. 70+500
STA. 70+548 (PT)
STA. 71+000
STA. 71+500
STA. 71+533 (PC)
STA. 71+646 (PT)
STA. 71+919 (PC)
STA. 72+000
T-91
T-92
T-93
T-94
CURVE DATA
Δ = 10° 30'
L = 500 mt
CURVE DATA
Δ = 9° 30'
R = 500 mt
CURVE DATA
Δ = 18° 15'
R = 500 mt
PVI EL. 781.00
STA. 69+760
L = 30 mt
PVI EL. 785.20
STA. 70+190
L = 300 mt
PVI EL. 785.20
STA. 70+540
L = 340 mt
PVI EL. 778.30
STA. 71+180
L = 30 mt
S = 0.000 %
S = 0.977 %
S = 0.000 %
S = 1.113 %
S = 0.433 %
5 - ø1 mt
785
780
775
770
69+600
70+000
70+500
71+000
71+500
72+000
VILLAGE OF TO-POOSHTA
STA. 72+435 (PT)
STA. 72+500
STA. 72+637 (PC)
STA. 72+762
STA. 72+956 (PC)
STA. 73+000
STA. 73+037 (PT)
STA. 73+432
STA. 73+500
STA. 73+762 (PT)
STA. 74+000
STA. 74+094 (PC)
STA. 74+172 (PT)
STA. 74+400
STA. 72+180 (PC)
STA. 72+078 (PT)
STA. 72+000
T-95
T-96
T-97
T-98
CURVE DATA
Δ = 29° 00'
R = 500 mt
CURVE DATA
Δ = 14° 30'
R = 500 mt
CURVE DATA
Δ = 9° 15'
R = 500 mt
CURVE DATA
Δ = 37° 45'
R = 500 mt
CURVE DATA
Δ = 4° 30'
R = 1000 mt
CURVE DATA
Δ = 18° 15'
R = 500 mt
PVI EL. 771.20
STA. 72+800
L = 15 mt
PVI EL. 771.20
STA. 74+040
L = 10 mt
PVI EL. 772.00
STA. 74+400
L = 100 mt
S = 0.433 %
S = 0.000 %
S = 0.222 %
2 - ø1 mt
1 - ø1 mt
775
770
765
72+000
72+500
73+000
73+500
74+000
74+400

FIGURE 17


STA. 74+400
STA. 74+943 (PC)
STA. 75+000
STA. 75+054 (PT)
STA. 75+500
STA. 76+000
STA. 76+400
STA. 76+800
T-99
T-100
T-101
CURVE DATA
Δ = 12° 15'
R = 500 mt
PVI EL. 772.00
STA. 74+400
L = 100 mt
PVI EL. 771.20
STA. 75+500
L = 10 mt
PVI EL. 771.80
STA. 76+600
L = 160 mt
S = 0.073 %
S = 0.055 %
S = 0.450 %
I - ø 1 mt
780
775
770
74+400
74+500
75+000
75+500
76+000
76+500
76+800

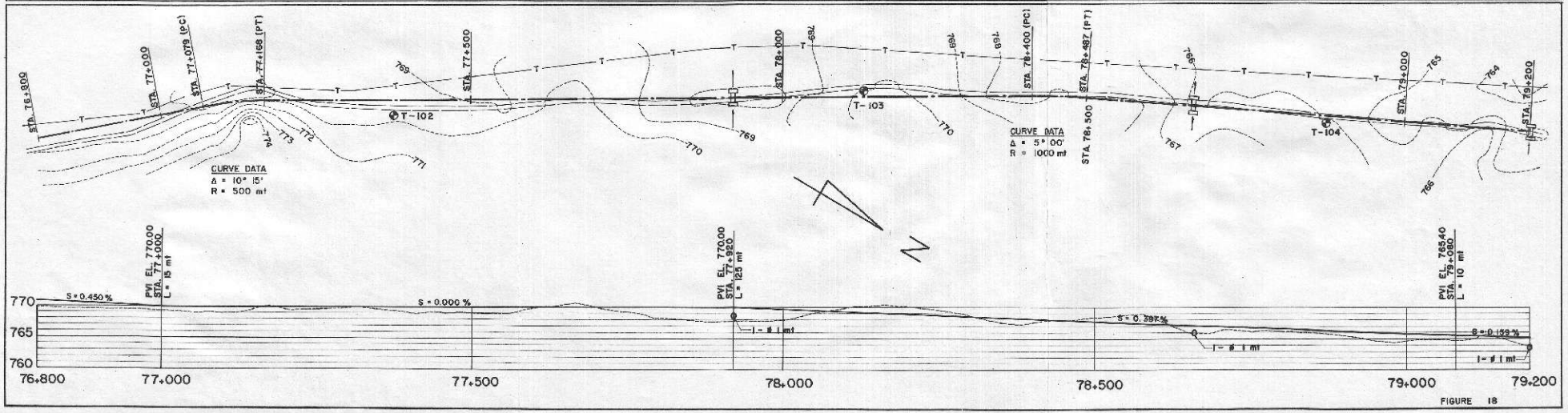

STA. 76+900
STA. 77+000
STA. 77+079 (PC)
STA. 77+168 (PT)
STA. 77+500
STA. 78+000
STA. 78+400 (PC)
STA. 78+487 (PT)
STA. 78+500
STA. 79+000
STA. 79+200
T-102
T-103
T-104
CURVE DATA
Δ = 10° 15'
R = 500 mt
CURVE DATA
Δ = 5° 00'
R = 1000 mt
PVI EL. 770.00
STA. 77+000
L = 15 mt
PVI EL. 770.00
STA. 77+920
L = 125 mt
PVI EL. 765.40
STA. 79+080
L = 10 mt
S = 0.450 %
S = 0.000 %
S = 0.397 %
S = 0.139 %
I - ø 1 mt
770
765
760
76+800
77+000
77+500
78+000
78+500
79+000
79+200

FIGURE 18

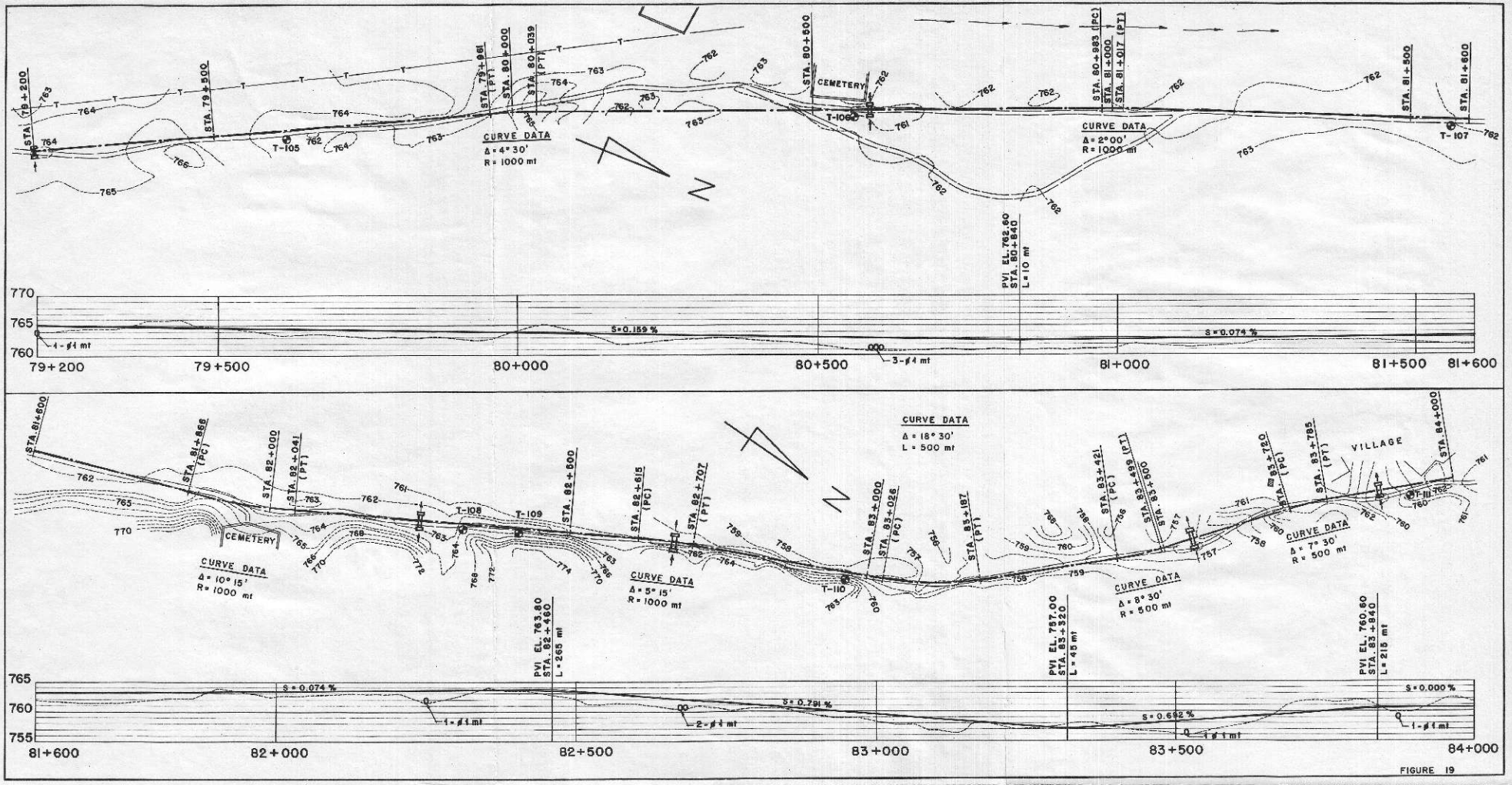
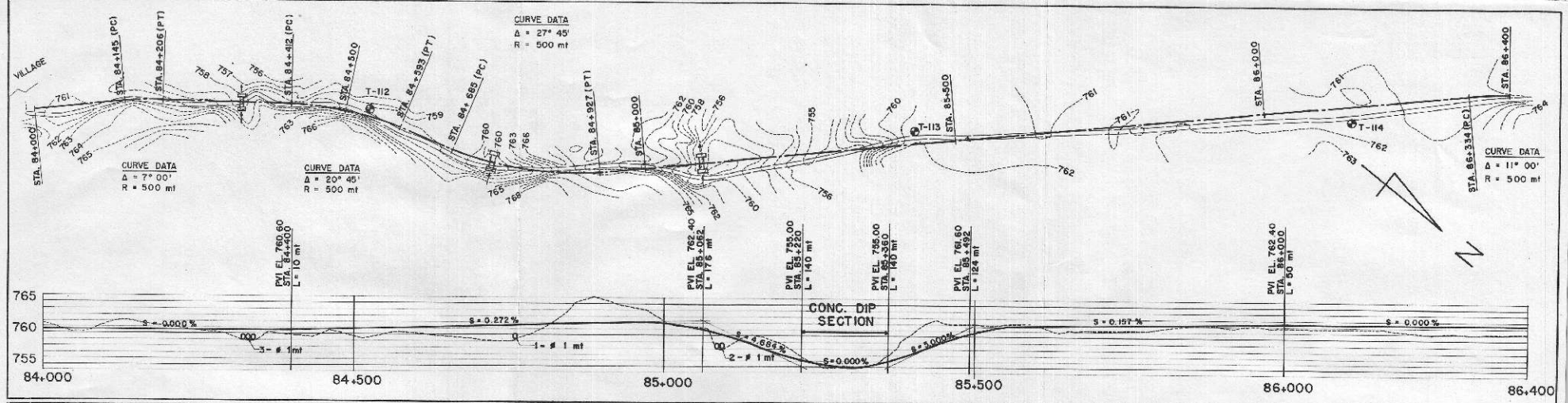

STA. 79+200
STA. 79+500
STA. 79+861 (PT)
STA. 80+000
STA. 80+039 (PT)
STA. 80+500
STA. 80+983 (PC)
STA. 81+000
STA. 81+017 (PT)
STA. 81+500
STA. 81+600
CEMETERY
T-105
T-106
T-107
CURVE DATA
Δ = 4° 30'
R = 1000 mt
CURVE DATA
Δ = 2° 00'
R = 1000 mt
PVI EL. 762.60
STA. 80+840
L = 10 mt
S = 0.159 %
S = 0.074 %
1 - ø1 mt
3 - ø1 mt
79+200
79+500
80+000
80+500
81+000
81+500
81+600
STA. 81+600
STA. 81+866 (PC)
STA. 82+000
STA. 82+041 (PT)
STA. 82+500
STA. 82+615 (PC)
STA. 82+707 (PT)
STA. 83+000
STA. 83+026 (PC)
STA. 83+187 (PT)
STA. 83+421 (PC)
STA. 83+498 (PT)
STA. 83+500
STA. 83+720 (PC)
STA. 83+785 (PT)
STA. 84+000
VILLAGE
T-108
T-109
T-110
T-111
CEMETERY
CURVE DATA
Δ = 10° 15'
R = 1000 mt
CURVE DATA
Δ = 5° 15'
R = 1000 mt
CURVE DATA
Δ = 18° 30'
L = 500 mt
CURVE DATA
Δ = 8° 30'
R = 500 mt
CURVE DATA
Δ = 7° 30'
R = 500 mt
PVI EL. 763.80
STA. 82+460
L = 265 mt
PVI EL. 757.00
STA. 83+320
L = 45 mt
PVI EL. 760.60
STA. 83+840
L = 215 mt
S = 0.074 %
S = 0.791 %
S = 0.692 %
S = 0.000 %
1 - ø1 mt
2 - ø1 mt
1 - ø1 mt
1 - ø1 mt
81+600
82+000
82+500
83+000
83+500
84+000

FIGURE 19


VILLAGE
STA. 84+002
STA. 84+145 (PC)
STA. 84+206 (PT)
STA. 84+412 (PC)
STA. 84+500
T-112
STA. 84+593 (PT)
STA. 84+685 (PC)
STA. 84+927 (PT)
STA. 85+000
T-113
STA. 85+500
STA. 86+000
T-114
STA. 86+334 (PC)
STA. 86+400
CURVE DATA
Δ = 7° 00'
R = 500 mt
CURVE DATA
Δ = 20° 45'
R = 500 mt
CURVE DATA
Δ = 27° 45'
R = 500 mt
CURVE DATA
Δ = 11° 00'
R = 500 mt
PVI EL. 760.60
STA. 84+400
L = 10 mt
PVI EL. 762.40
STA. 85+062
L = 176 mt
PVI EL. 755.00
STA. 85+220
L = 140 mt
PVI EL. 755.00
STA. 85+360
L = 140 mt
PVI EL. 761.60
STA. 85+492
L = 124 mt
PVI EL. 762.40
STA. 86+000
L = 50 mt
CONC. DIP SECTION
S = -0.000 %
S = 0.272 %
S = 4.664 %
S = 0.000 %
S = 3.000 %
S = 0.157 %
S = 0.000 %
3 - ø 1 mt
1 - ø 1 mt
2 - ø 1 mt
765
760
755
84+000
84+500
85+000
85+500
86+000
86+400

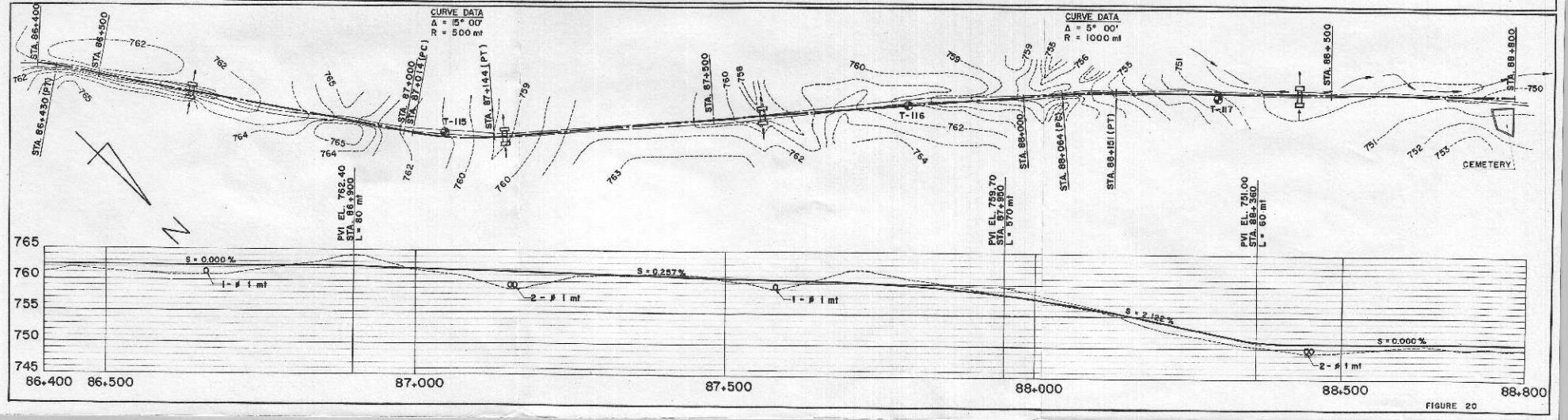

STA. 86+400
STA. 86+430 (PT)
STA. 86+500
CURVE DATA
Δ = 15° 00'
R = 500 mt
STA. 87+000
STA. 87+014 (PC)
T-115
STA. 87+144 (PT)
STA. 87+500
T-116
STA. 88+000
STA. 88+064 (PC)
STA. 88+151 (PT)
T-117
STA. 88+500
STA. 88+800
CEMETERY
CURVE DATA
Δ = 5° 00'
R = 1000 mt
PVI EL. 762.40
STA. 86+900
L = 60 mt
PVI EL. 759.70
STA. 87+950
L = 570 mt
PVI EL. 751.00
STA. 88+360
L = 60 mt
S = 0.000 %
S = 0.257 %
S = 2.182 %
S = 0.000 %
1 - ø 1 mt
2 - ø 1 mt
1 - ø 1 mt
2 - ø 1 mt
765
760
755
750
745
86+400
86+500
87+000
87+500
88+000
88+500
88+800

FIGURE 20

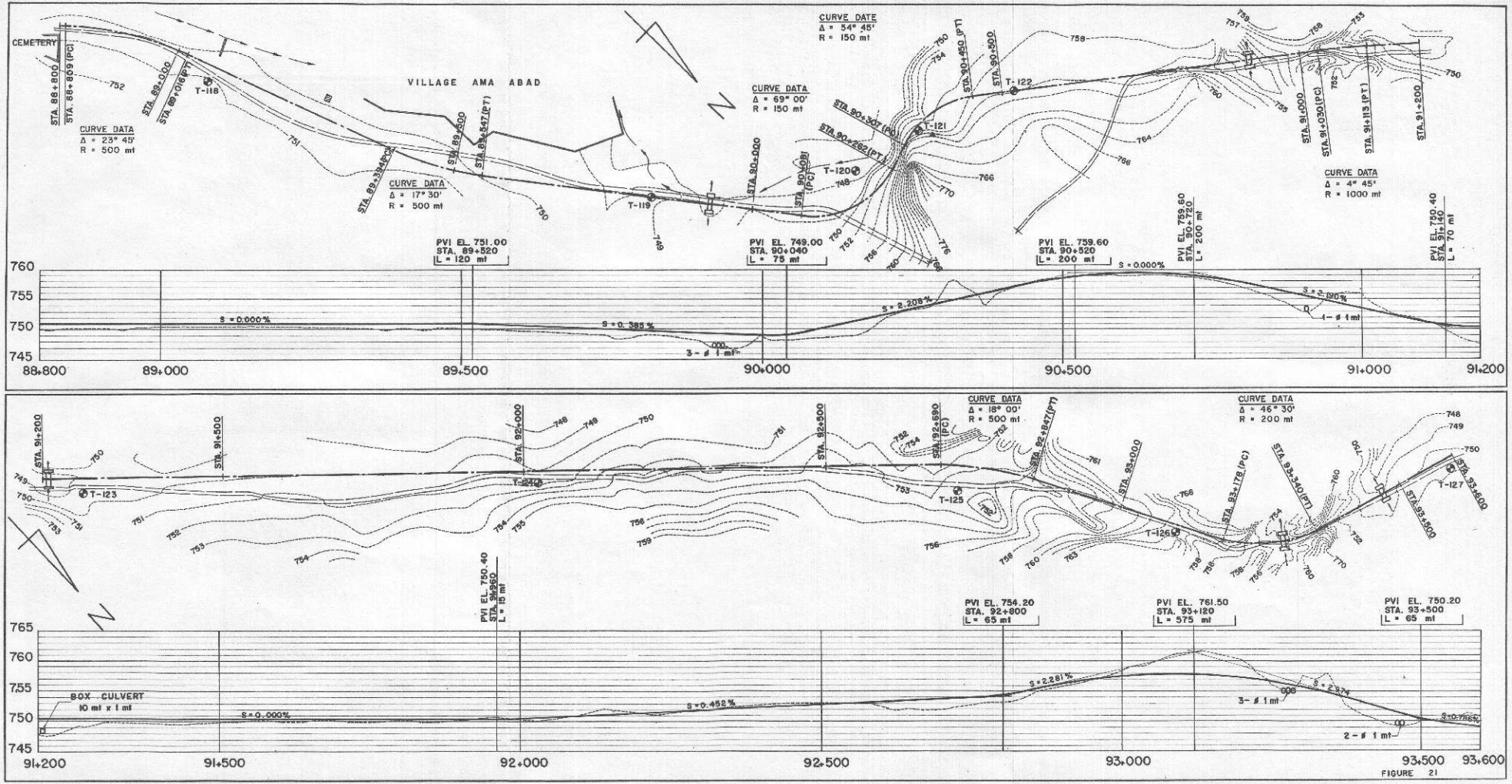

CEMETERY
VILLAGE AMA ABAD
CURVE DATA
Δ = 23° 45'
R = 500 mt
CURVE DATA
Δ = 17° 30'
R = 500 mt
CURVE DATA
Δ = 69° 00'
R = 150 mt
CURVE DATE
Δ = 54° 45'
R = 150 mt
CURVE DATA
Δ = 4° 45'
R = 1000 mt
CURVE DATA
Δ = 18° 00'
R = 500 mt
CURVE DATA
Δ = 46° 30'
R = 200 mt
PVI EL. 751.00
STA. 89+520
L = 120 mt
PVI EL. 749.00
STA. 90+040
L = 75 mt
PVI EL. 759.60
STA. 90+520
L = 200 mt
PVI EL. 759.60
STA. 90+720
L = 200 mt
PVI EL. 750.40
STA. 91+140
L = 70 mt
PVI EL. 750.40
STA. 92+950
L = 15 mt
PVI EL. 754.20
STA. 92+800
L = 65 mt
PVI EL. 761.50
STA. 93+120
L = 575 mt
PVI EL. 750.20
STA. 93+500
L = 65 mt
S = 0.000%
S = 0.385%
S = 2.208%
S = 2.190%
S = 0.452%
S = 2.281%
S = 0.786%
3 - ø 1 mt
1 - ø 1 mt
2 - ø 1 mt
BOX CULVERT
10 mt x 1 mt
88+800
89+000
89+500
90+000
90+500
91+000
91+200
91+500
92+000
92+500
93+000
93+500
93+600
760
755
750
745
765

FIGURE 21

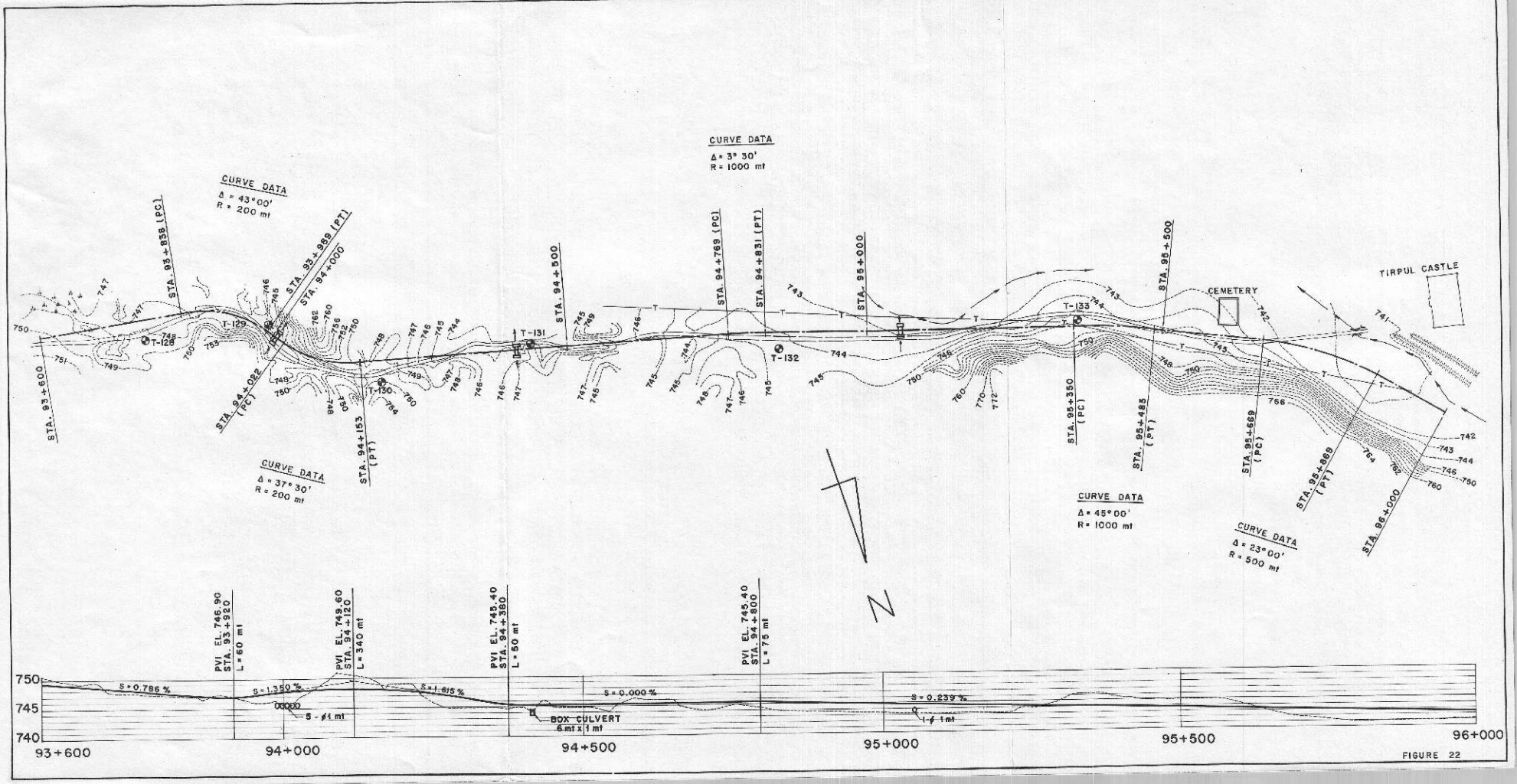

CURVE DATA
Δ = 43°00'
R = 200 mt
CURVE DATA
Δ = 3° 30'
R = 1000 mt
CURVE DATA
Δ = 37° 30'
R = 200 mt
CURVE DATA
Δ = 45°00'
R = 1000 mt
CURVE DATA
Δ = 23°00'
R = 500 mt
STA. 93+600
STA. 93+858 (PC)
STA. 93+989 (PT)
STA. 94+000
STA. 94+022 (PC)
STA. 94+153 (PT)
STA. 94+500
STA. 94+769 (PC)
STA. 94+831 (PT)
STA. 95+000
STA. 95+350 (PC)
STA. 95+483 (PT)
STA. 95+500
STA. 95+669 (PC)
STA. 95+869 (PT)
STA. 96+000
T-128
T-129
T-130
T-131
T-132
T-133
CEMETERY
TIRPUL CASTLE
PVI EL. 746.90
STA. 93+920
L = 60 mt
PVI EL. 749.60
STA. 94+120
L = 340 mt
PVI EL. 745.40
STA. 94+360
L = 50 mt
PVI EL. 745.40
STA. 94+800
L = 75 mt
S = 0.786 %
S = 1.350 %
S = 1.615 %
S = 0.000 %
S = 0.239 %
5 - ϕ1 mt
BOX CULVERT
6 mt x 1 mt
1-ϕ 1 mt
750
745
740
93+600
94+000
94+500
95+000
95+500
96+000

FIGURE 22

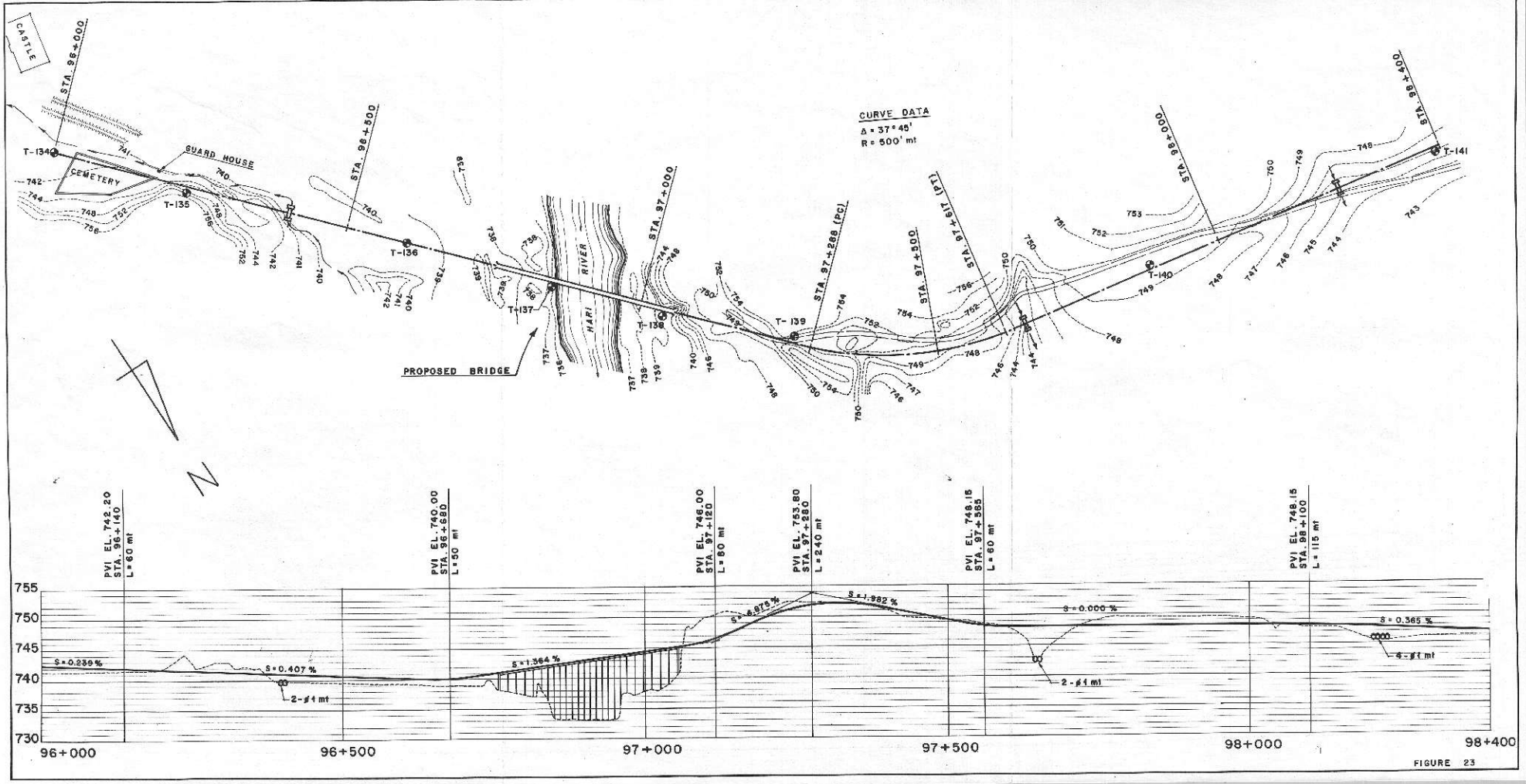
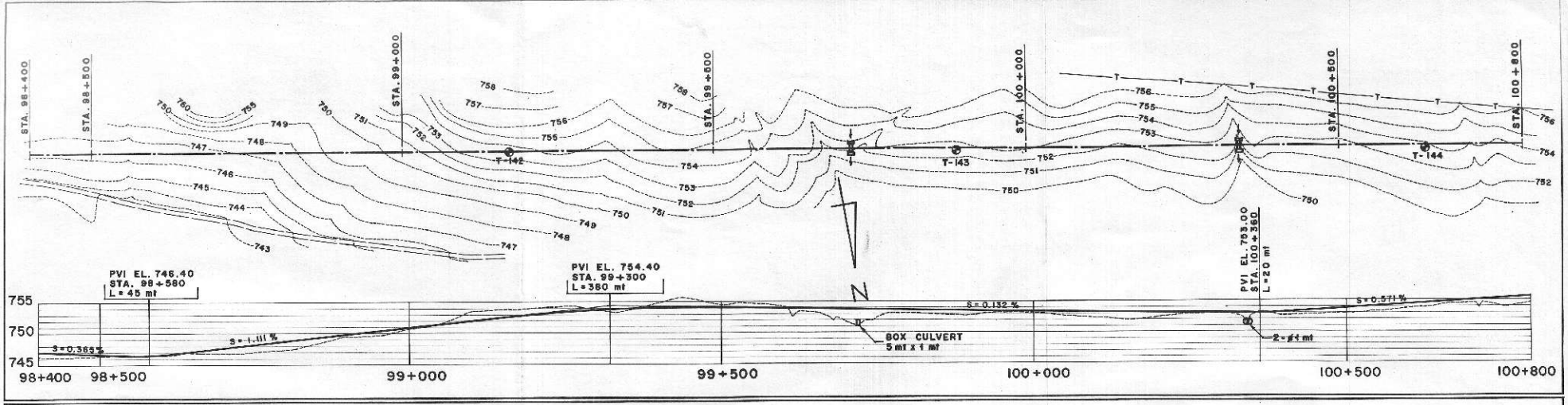

CASTLE
STA. 96+000
GUARD HOUSE
CEMETERY
T-134
T-135
STA. 96+500
T-136
T-137
T-138
HARI RIVER
STA. 97+000
T-139
STA. 97+268 (PC)
STA. 97+500
STA. 97+617 (PT)
STA. 97+800
T-140
STA. 98+400
T-141
PROPOSED BRIDGE
CURVE DATA
Δ = 37° 45'
R = 500' mt
PVI EL. 742.20
STA. 96+140
L = 60 mt
PVI EL. 740.00
STA. 96+680
L = 50 mt
PVI EL. 746.00
STA. 97+120
L = 80 mt
PVI EL. 753.80
STA. 97+280
L = 240 mt
PVI EL. 748.15
STA. 97+565
L = 60 mt
PVI EL. 748.15
STA. 98+100
L = 115 mt
S = 0.239 %
S = 0.407 %
2-ø1 mt
S = 1.364 %
S = 6.975 %
S = 1.982 %
S = 0.000 %
2-ø1 mt
S = 0.365 %
4-ø1 mt
755
750
745
740
735
730
96+000
96+500
97+000
97+500
98+000
98+400

FIGURE 23


STA. 98+400
STA. 98+500
STA. 99+000
STA. 99+500
STA. 100+000
STA. 100+500
STA. 100+800
T-142
T-143
T-144
PVI EL. 746.40
STA. 98+580
L = 45 mt
PVI EL. 754.40
STA. 99+300
L = 380 mt
PVI EL. 753.00
STA. 100+360
L = 20 mt
S = 0.365 %
S = -1.111 %
S = 0.132 %
S = 0.571 %
BOX CULVERT
5 mt x 1 mt
2 - ø1 mt
755
750
745
98+400
98+500
99+000
99+500
100+000
100+500
100+800
N

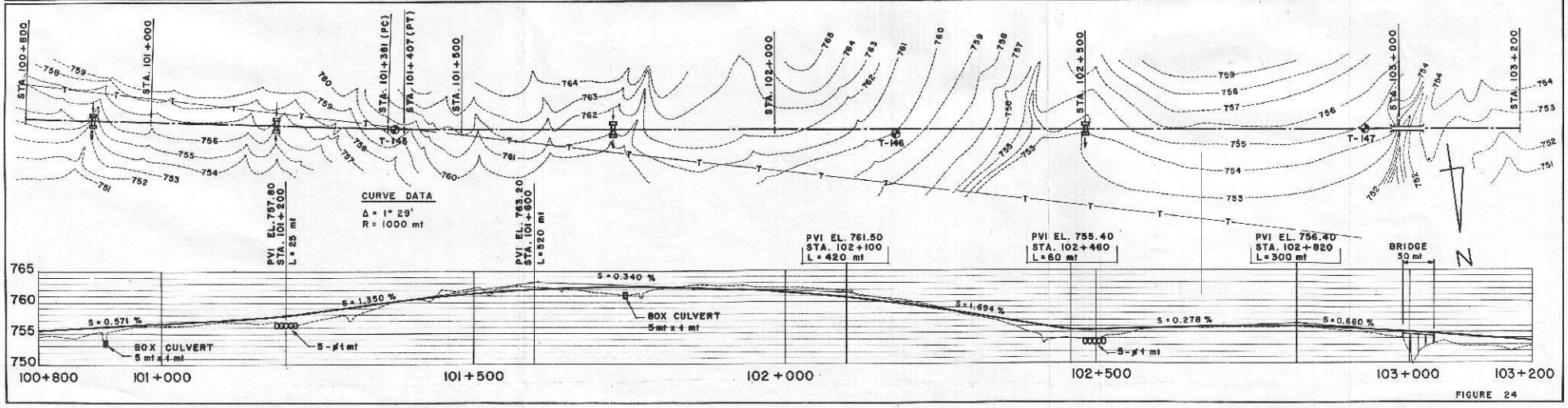

STA. 100+800
STA. 101+000
STA. 101+381 (PC)
STA. 101+407 (PT)
STA. 101+500
STA. 102+000
STA. 102+500
STA. 103+000
STA. 103+200
T-145
T-146
T-147
CURVE DATA
Δ = 1° 29'
R = 1000 mt
PVI EL. 757.80
STA. 101+200
L = 25 mt
PVI EL. 763.20
STA. 101+600
L = 520 mt
PVI EL. 761.50
STA. 102+100
L = 420 mt
PVI EL. 755.40
STA. 102+460
L = 60 mt
PVI EL. 756.40
STA. 102+820
L = 300 mt
BRIDGE
50 mt
S = 0.571 %
S = 1.350 %
S = 0.340 %
S = 1.694 %
S = 0.278 %
S = 0.680 %
BOX CULVERT
5 mt x 4 mt
5 - ø1 mt
765
760
755
750
100+800
101+000
101+500
102+000
102+500
103+000
103+200
N

FIGURE 24

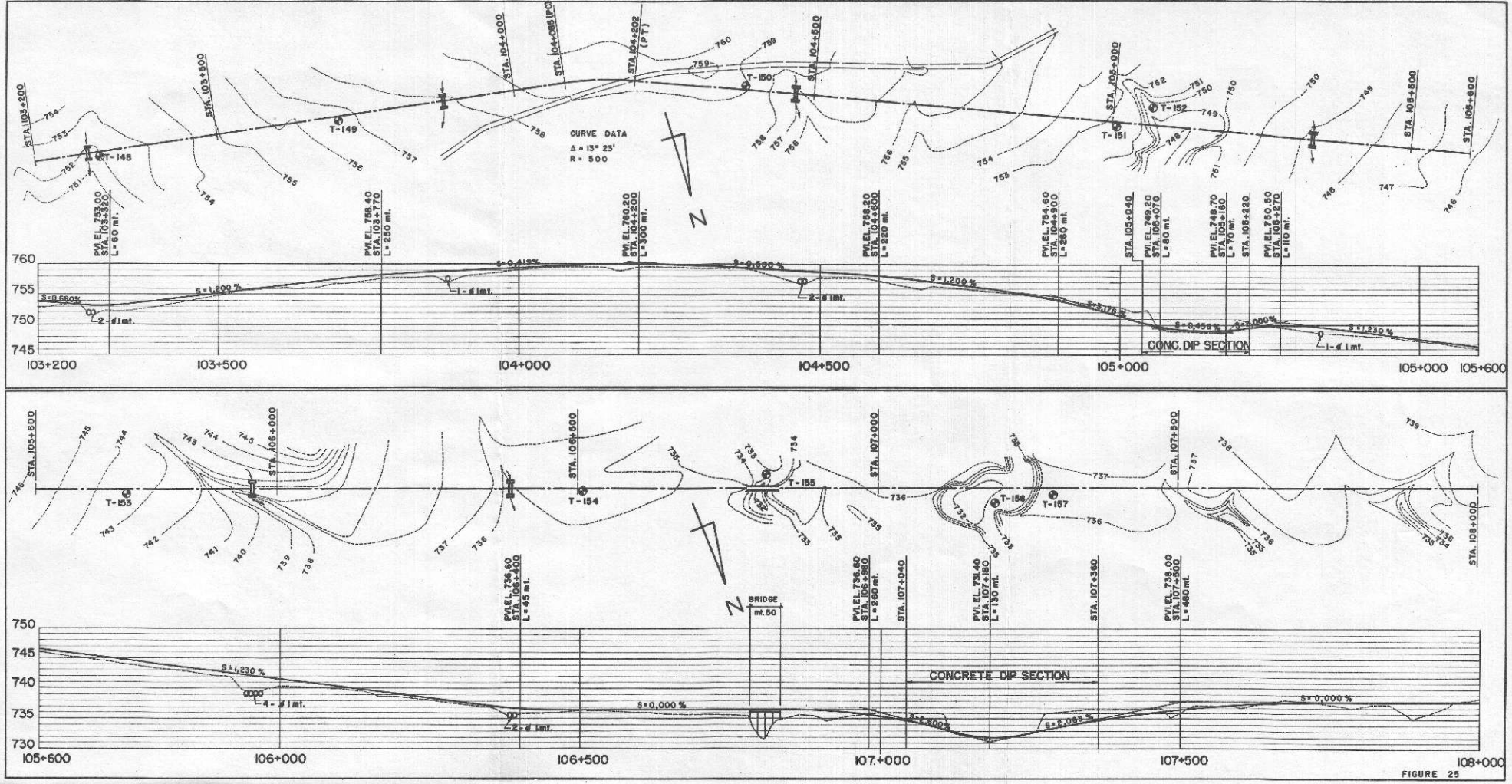

CURVE DATA
Δ = 13° 23'
R = 500
CONC. DIP SECTION
CONCRETE DIP SECTION
BRIDGE
103+200
103+500
104+000
104+500
105+000
105+600
106+000
106+500
107+000
107+500
108+000

FIGURE 25

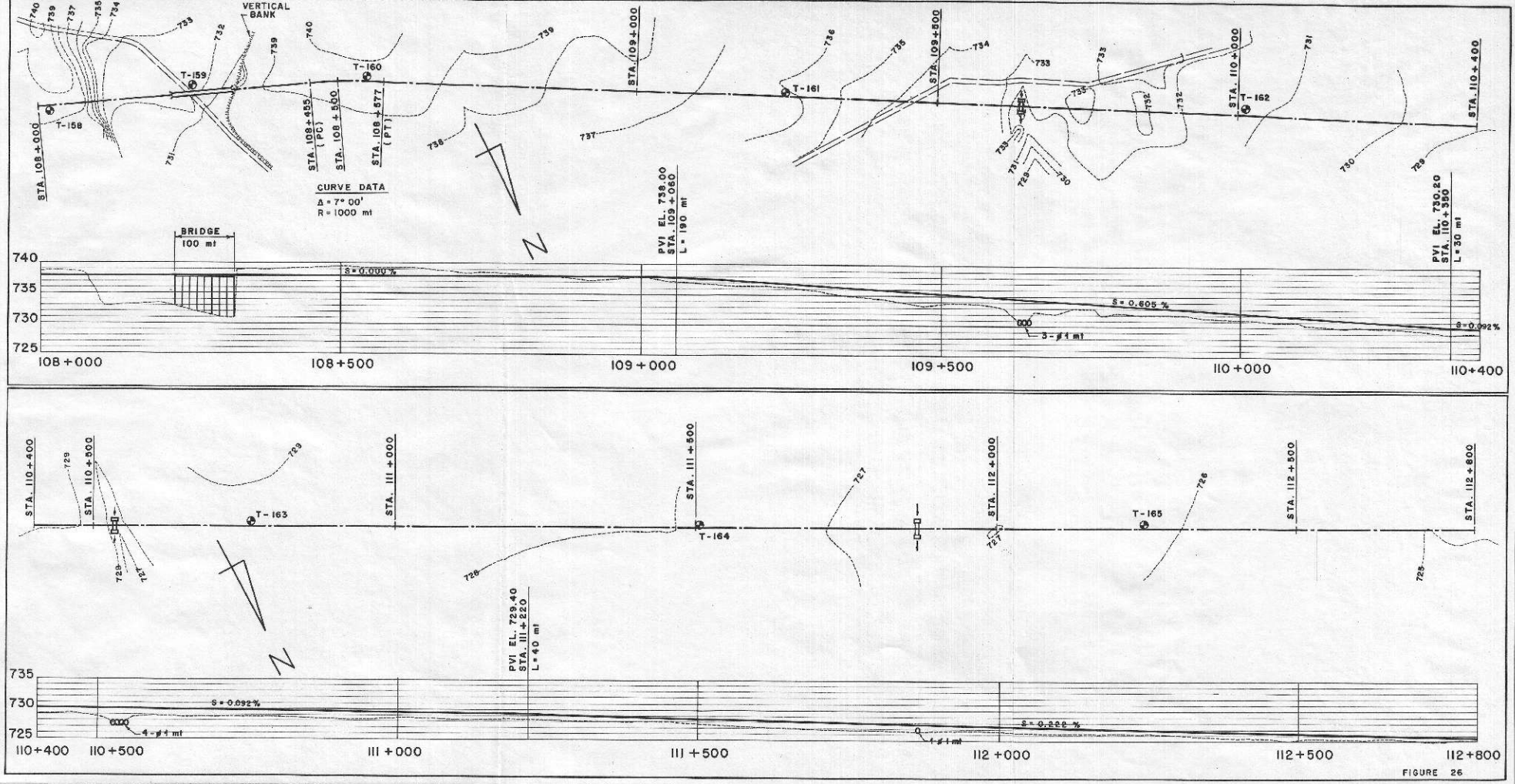

VERTICAL BANK
T-158
T-159
T-160
T-161
T-162
T-163
T-164
T-165
STA. 108+000
STA. 108+455 (PC)
STA. 108+500
STA. 108+877 (PT)
STA. 109+000
STA. 109+500
STA. 110+000
STA. 110+400
STA. 110+500
STA. 111+000
STA. 111+500
STA. 112+000
STA. 112+500
STA. 112+800
CURVE DATA
Δ = 7° 00'
R = 1000 mt
BRIDGE
100 mt
PVI EL. 738.00
STA. 109+060
L = 190 mt
PVI EL. 730.20
STA. 110+350
L = 30 mt
PVI EL. 729.40
STA. 111+220
L = 40 mt
S = 0.000 %
S = 0.605 %
S = 0.092 %
S = 0.226 %
3 - ø1 mt
4 - ø1 mt
1 - ø1 mt
740
735
730
725
108+000
108+500
109+000
109+500
110+000
110+400
110+500
111+000
111+500
112+000
112+500
112+800

FIGURE 26

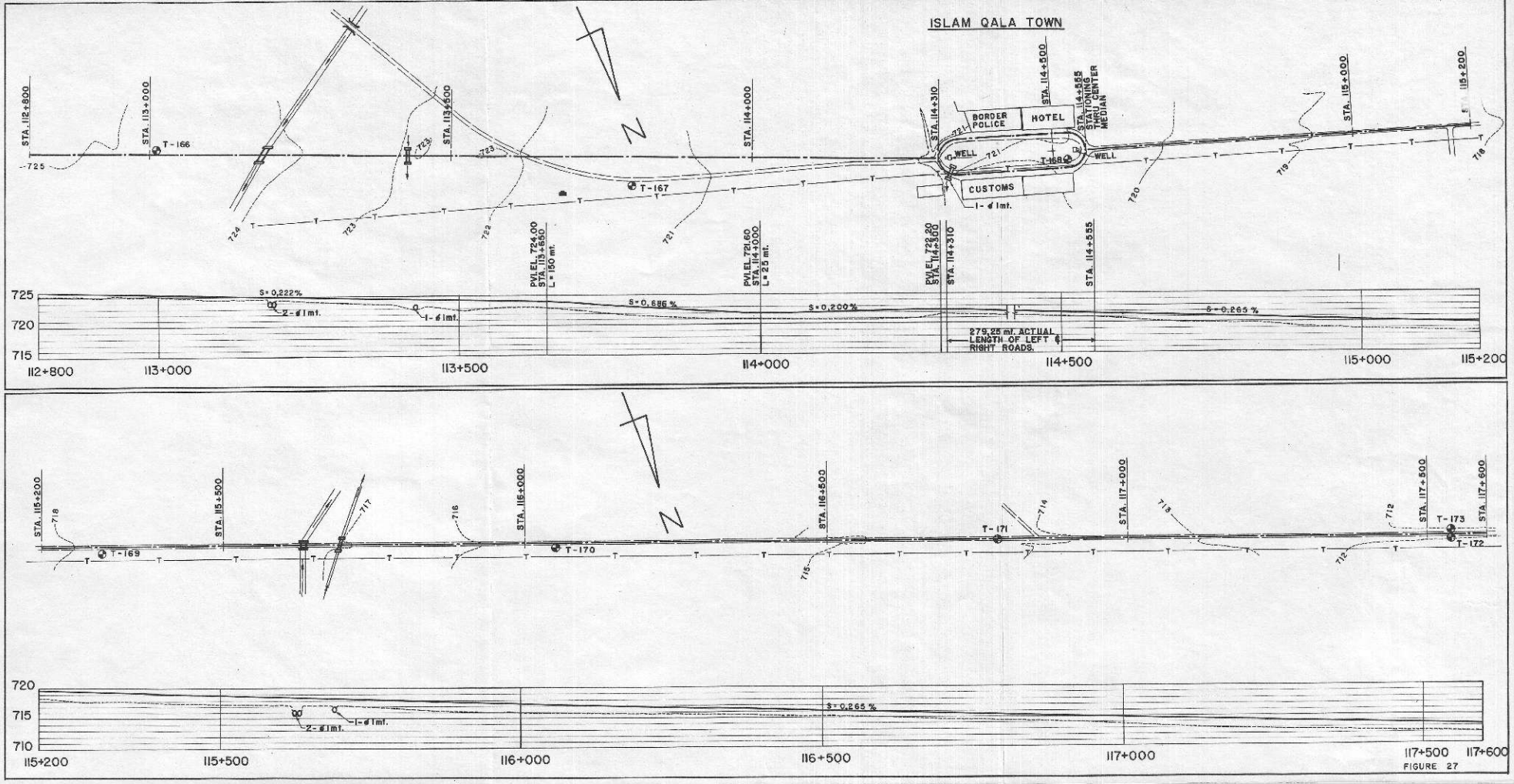
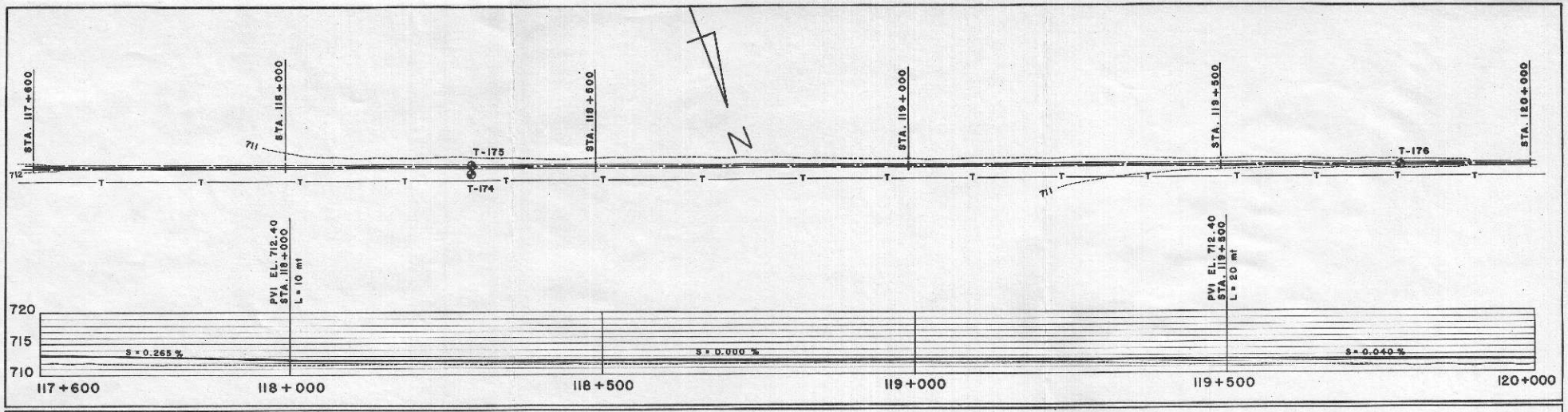

ISLAM QALA TOWN
STA. 112+800
STA. 113+000
STA. 113+500
STA. 114+000
STA. 114+310
STA. 114+500
STA. 114+555 STATIONING THRU CENTER MEDIAN
STA. 115+000
STA. 115+200
STA. 115+500
STA. 116+000
STA. 116+500
STA. 117+000
STA. 117+500
STA. 117+600
BORDER POLICE
HOTEL
CUSTOMS
WELL
T-166
T-167
T-168
T-169
T-170
T-171
T-172
T-173
1-ø1mt.
2-ø1mt.
PVI EL. 724.00 STA. 113+650 L=150 mt.
PVI EL. 721.60 STA. 114+000 L=25 mt.
PVI EL. 722.20 STA. 114+500 L=50 mt.
S=0.222%
S=0.686%
S=0.200%
S=0.265%
279.25 mt. ACTUAL LENGTH OF LEFT & RIGHT ROADS.
725
720
715
710
112+800
113+000
113+500
114+000
114+500
115+000
115+200
115+500
116+000
116+500
117+000
117+500
117+600

FIGURE 27


STA. 117+600
STA. 118+000
STA. 118+500
STA. 119+000
STA. 119+500
STA. 120+000
N
711
712
T-175
T-174
T-176
PVI EL. 712.40
STA. 118+000
L = 10 mt
PVI EL. 712.40
STA. 119+500
L = 20 mt
720
715
710
S = 0.265 %
S = 0.000 %
S = 0.040 %
117+600
118+000
118+500
119+000
119+500
120+000

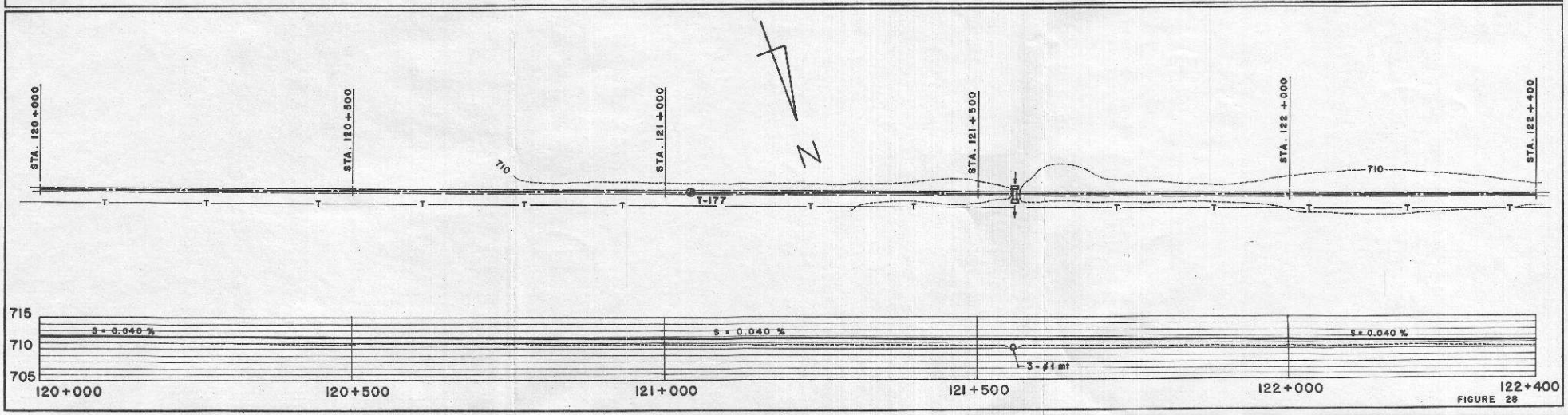

STA. 120+000
STA. 120+500
STA. 121+000
STA. 121+500
STA. 122+000
STA. 122+400
N
710
T-177
715
710
705
S = 0.040 %
S = 0.040 %
S = 0.040 %
3 - ø 1 mt
120+000
120+500
121+000
121+500
122+000
122+400

FIGURE 28

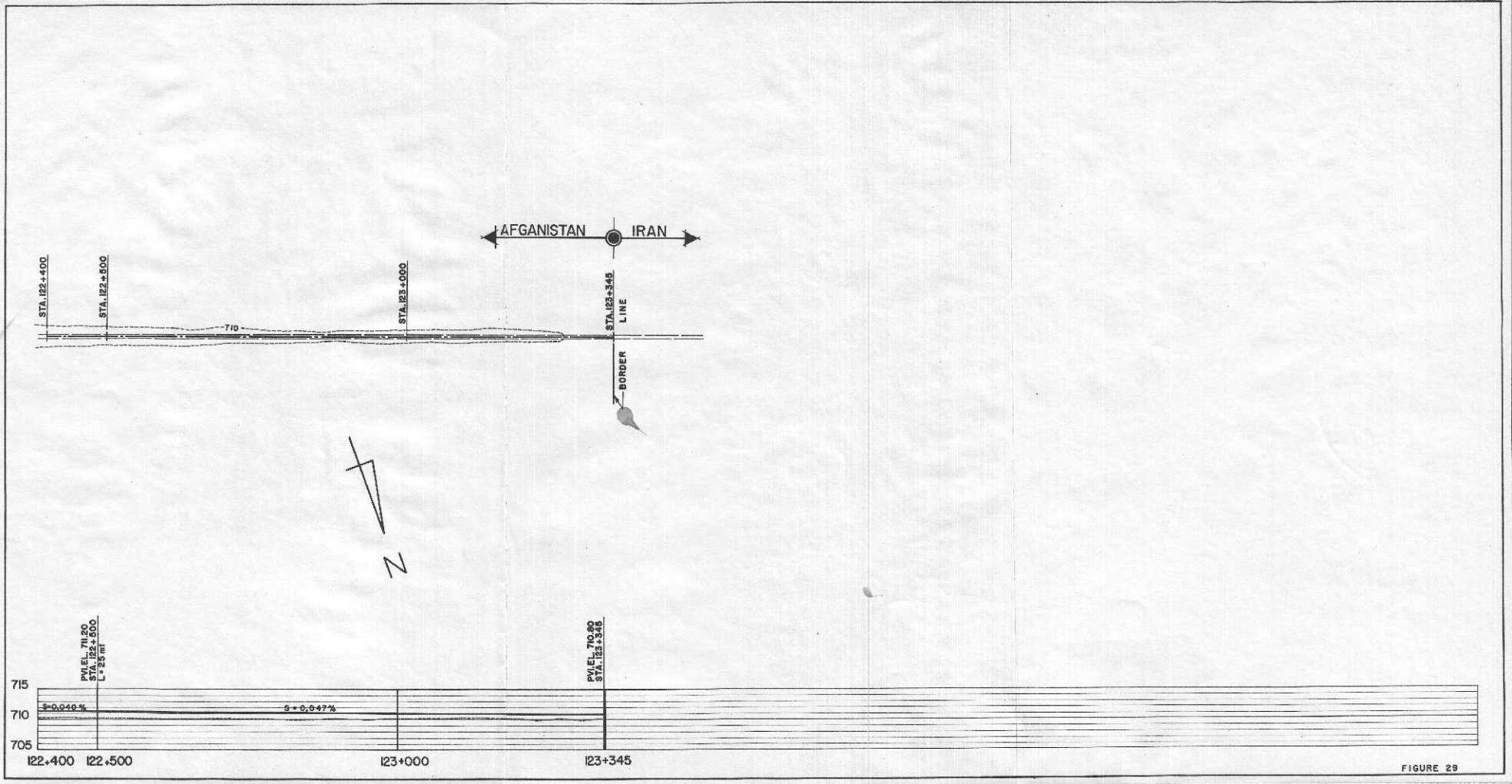
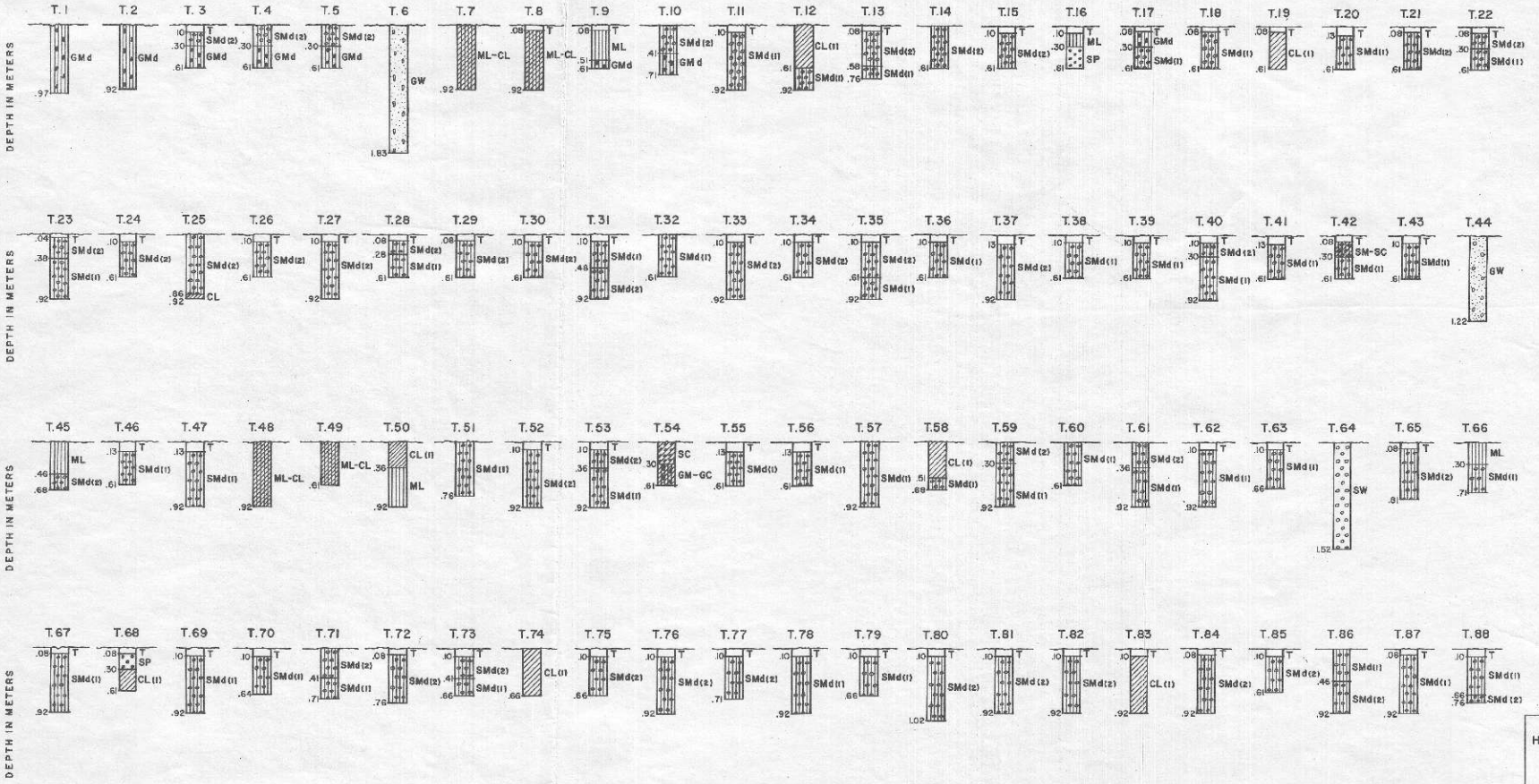

AFGANISTAN
IRAN
STA. 122+400
STA. 122+500
STA. 123+000
STA. 123+345
LINE
BORDER
710
N
PVI. El. 711.20
STA. 122+500
L = 25 mt
PVI. El. 710.80
STA. 123+345
715
710
705
S = 0.040 %
S = 0.047 %
122+400
122+500
123+000
123+345

FIGURE 29



LEGEND

T	TOPSOIL
GW	SANDY GRAVEL
GM	SILTY GRAVEL
GC	CLAYEY GRAVEL
SW	GRAVELLY SAND OR SAND WELL GRADED
SP	GRAVELLY SAND OR SAND POORLY GRADED
SC	CLAYEY SAND
SMd(1)	GRAVELLY SILTY SAND
SMd(2)	SILTY SAND
ML	SANDY SILT OR SILTY FINE SAND
CL(1)	SANDY SILTY CLAY
CL(2)	SANDY LEAN CLAY
OL	ORGANIC SILT
	SAND STONE

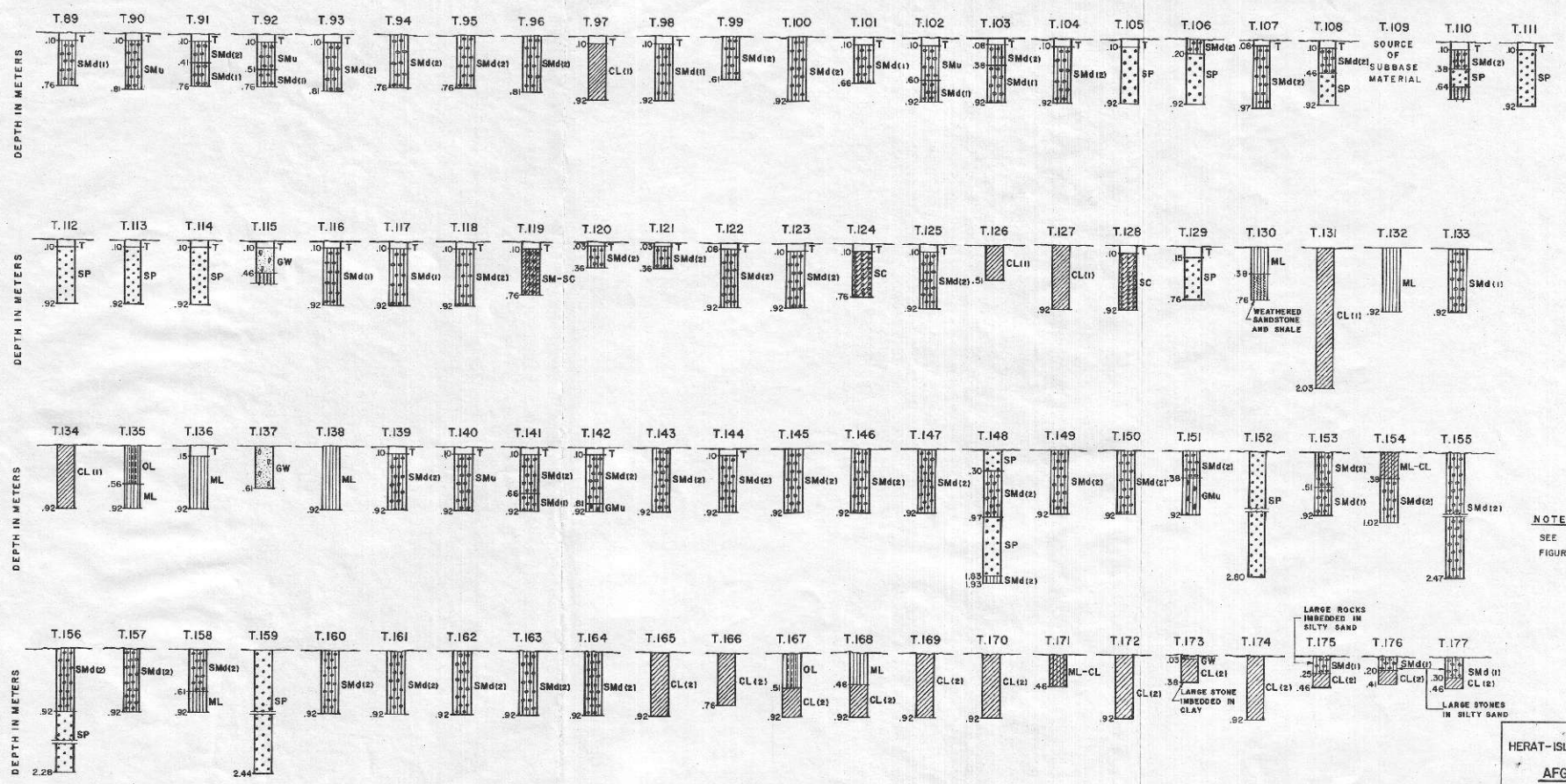
NOTES:
1 – SUFFIX d (E.G. GMd) IS USED WHEN LL < (28 AND PI < (6
SUFFIX u (E.G. SMu) IS USED WHEN LL => 28
2 – FOR LOCATION OF TEST PITS SEE FIGURES 2 THRU 29.

HERAT-ISLAM QALA HIGHWAY

AFGHANISTAN

LOG OF TEST PITS

FIGURE 30



HERAT-ISLAM QALA HIGHWAY

AFGHANISTAN

LOG OF TEST PITS

FIGURE 31