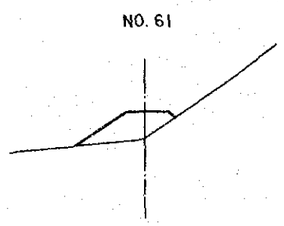

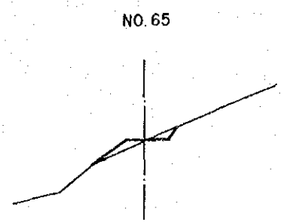

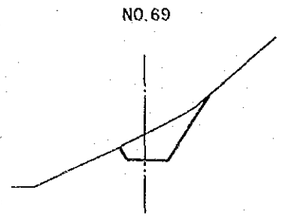

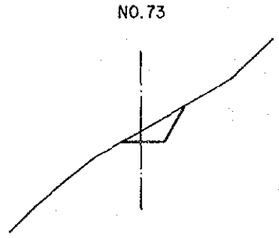

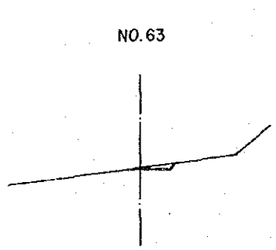

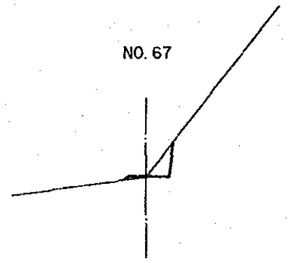

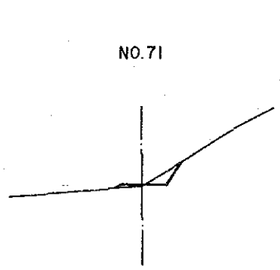

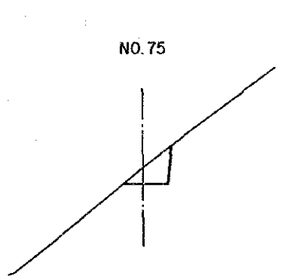

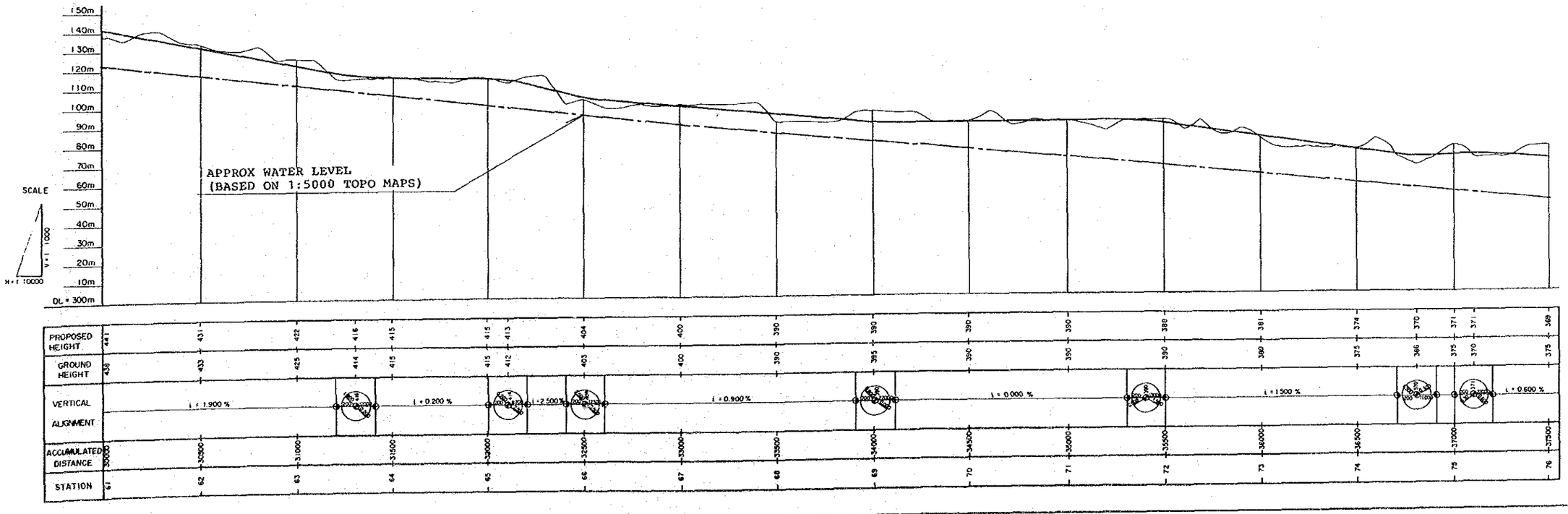

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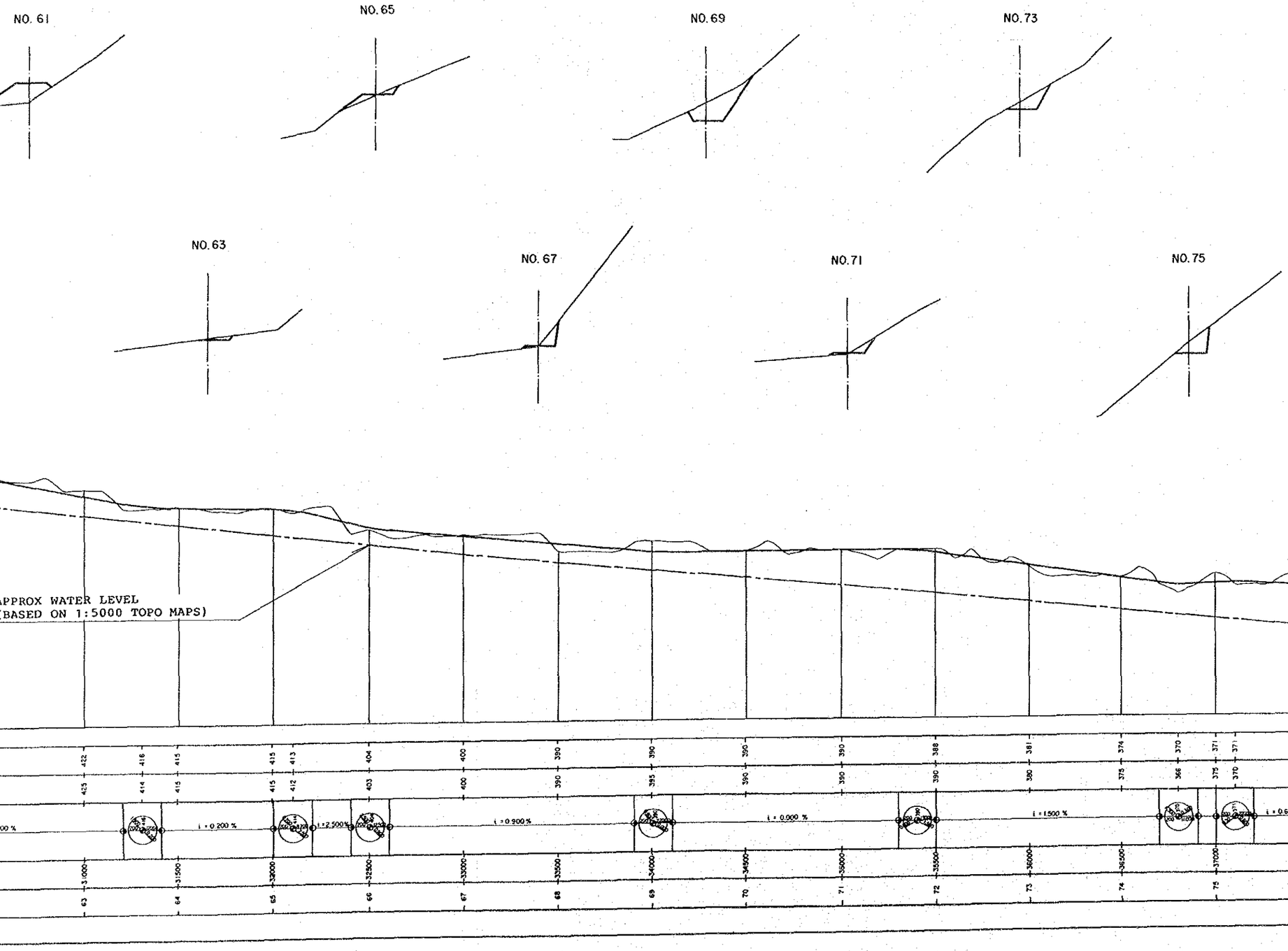
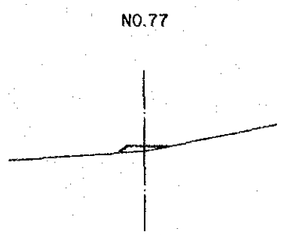


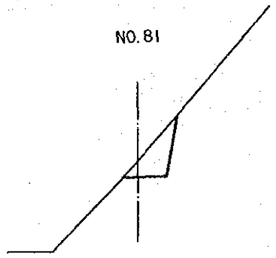
NOTE :
CROSS SECTION SCALE : 1:500

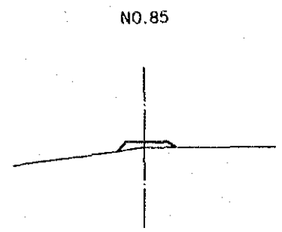
ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

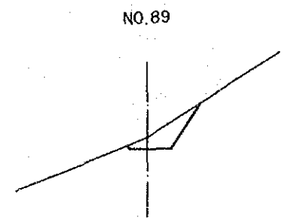
ACCESS ROAD
CROSS SECTION AND PROFILE (5 of 16)
No. 61 ~ No. 76
OPTIMUM ROUTE (ALT-B)

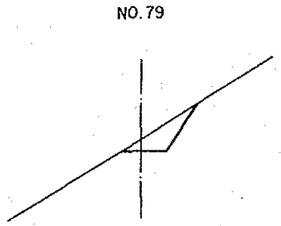
DWG. ACR - 34 | DATE JUNE 1987

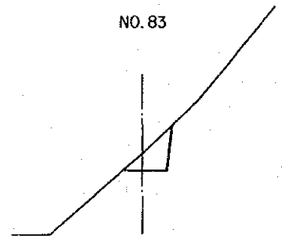


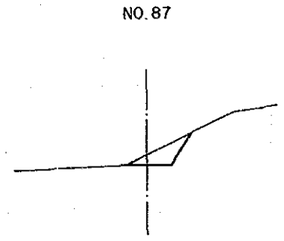


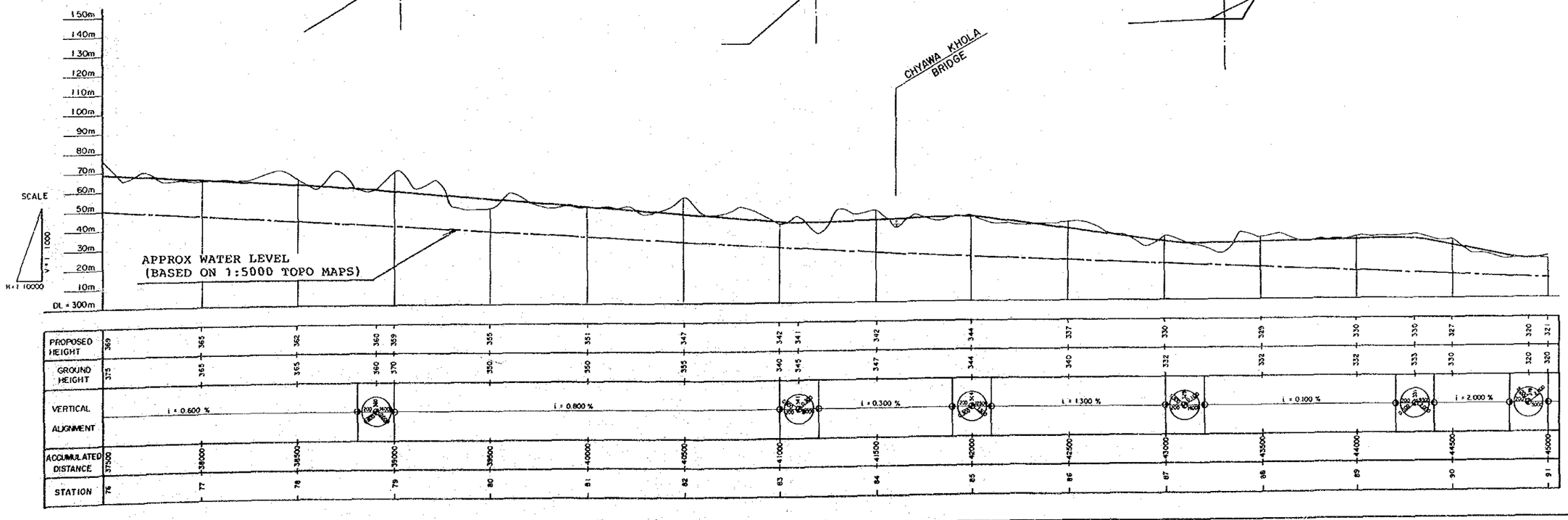












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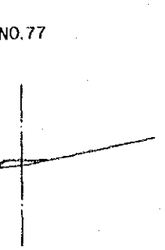
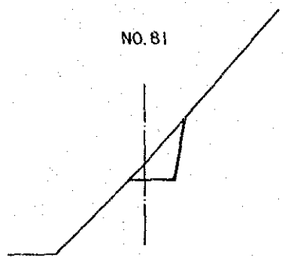
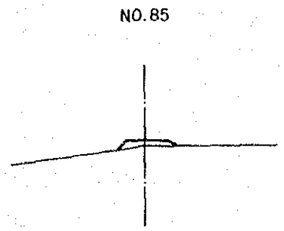
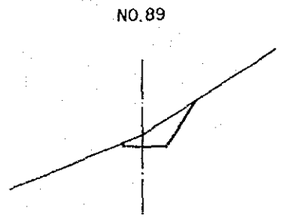
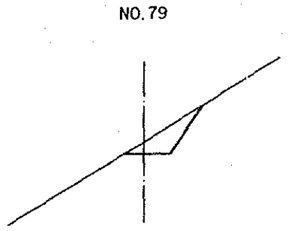
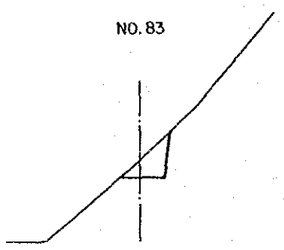


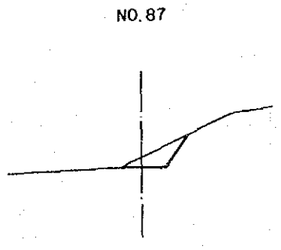


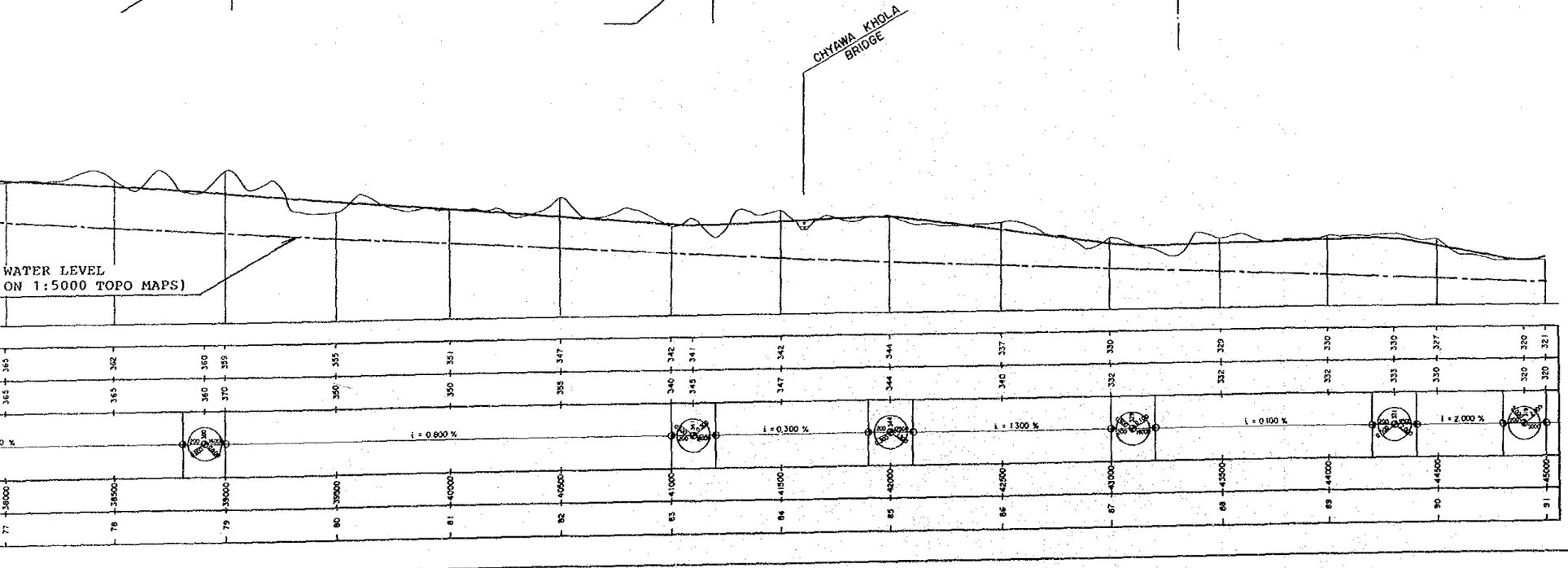






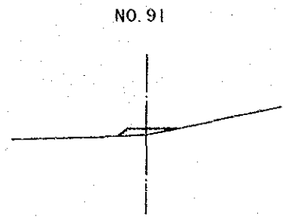


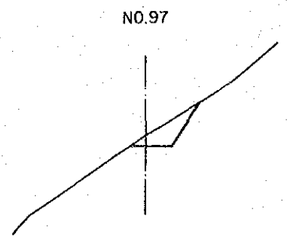


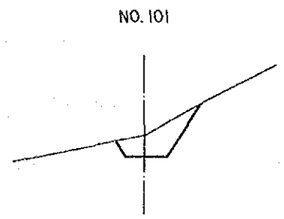


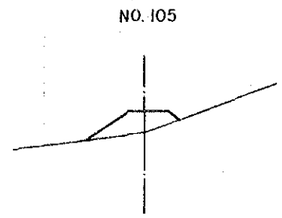
NOTE :
CROSS SECTION SCALE : 1:500

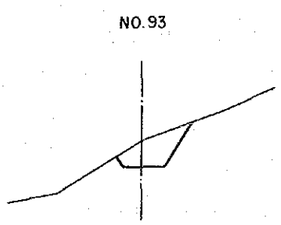
ARUN 3 HYDRO POWER PROJECT FEASIBILITY STUDY	
ACCESS ROAD CROSS SECTION AND PROFILE (6 of 16) No. 76 ~ No. 91 OPTIMUM ROUTE (ALT-B)	
DWG. ACR – 35	DATE JUNE 1987

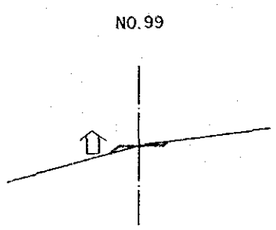


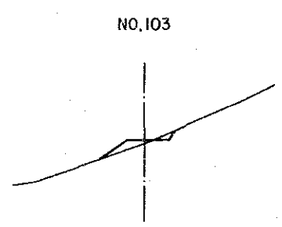


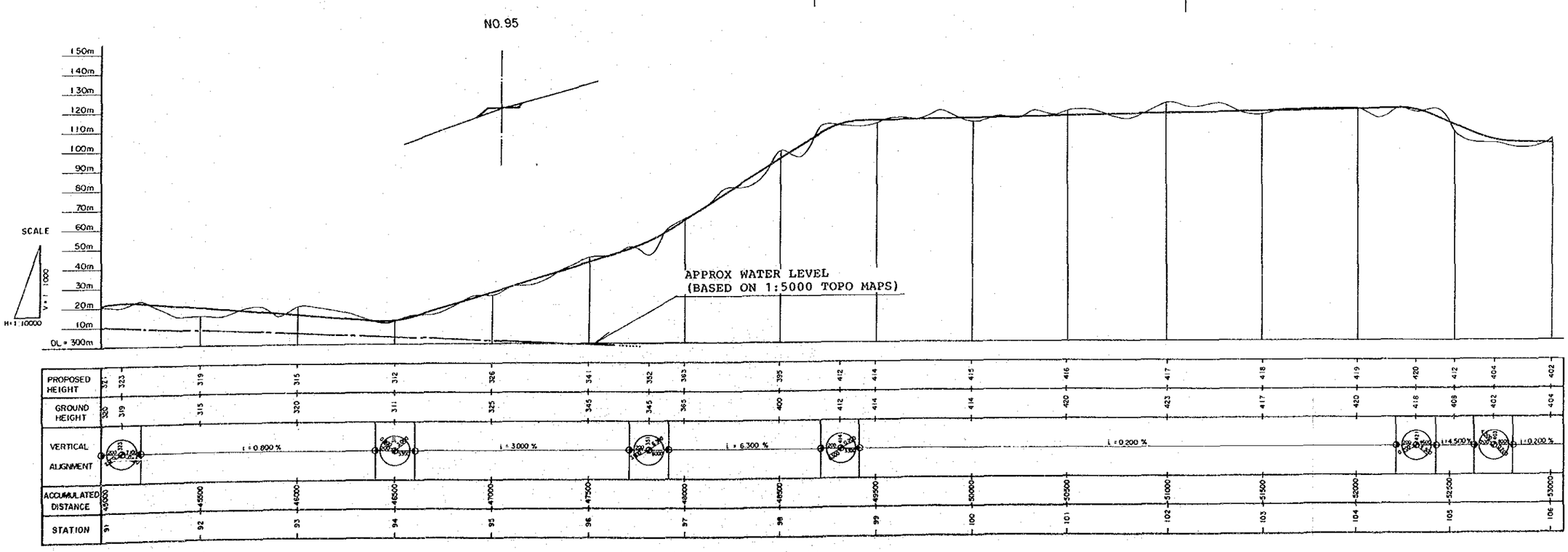












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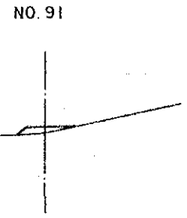
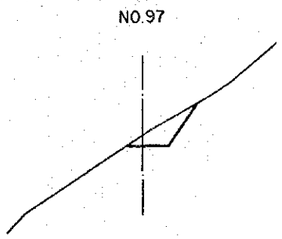
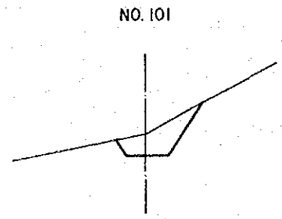
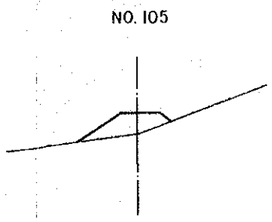
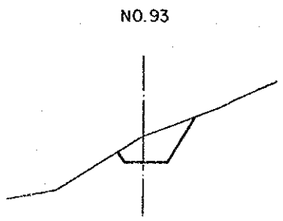
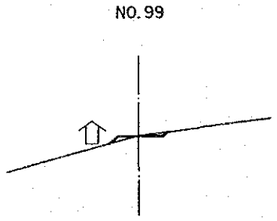


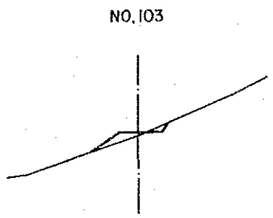


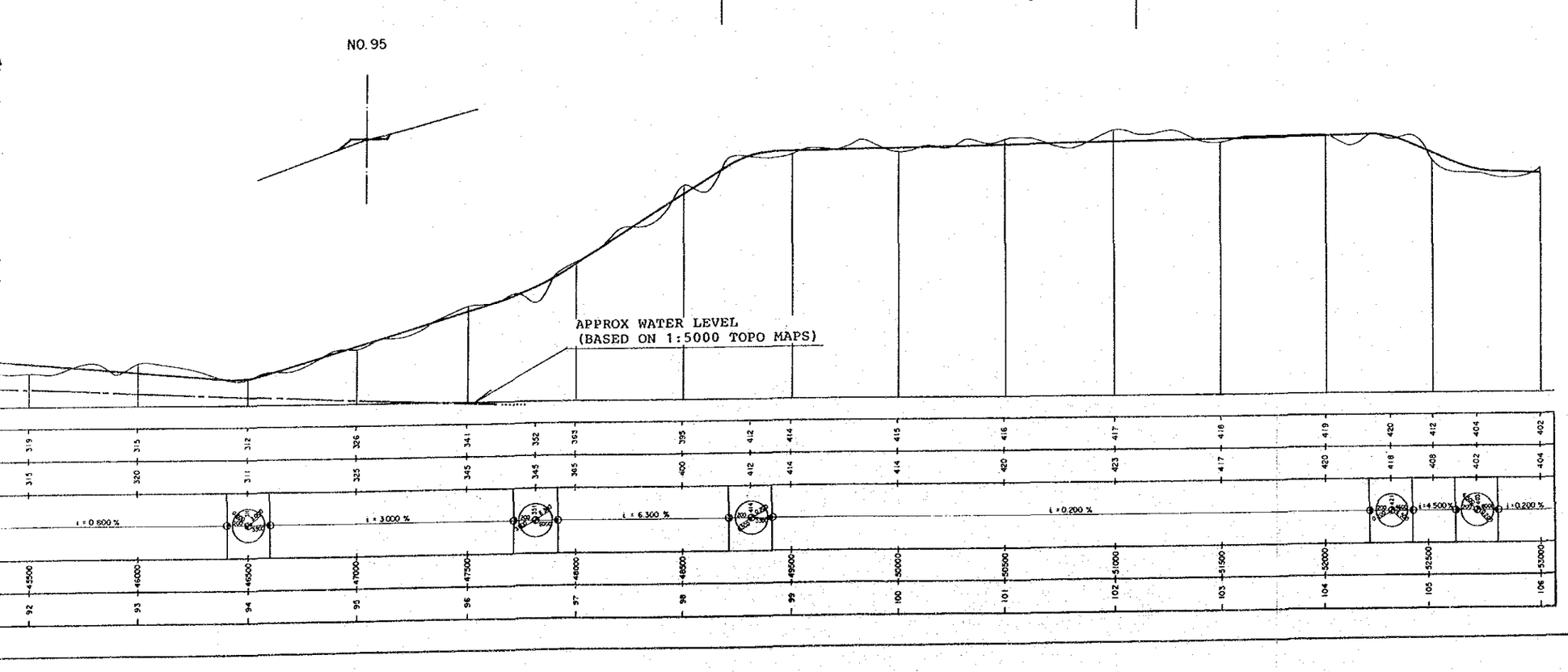












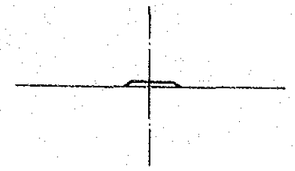
NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

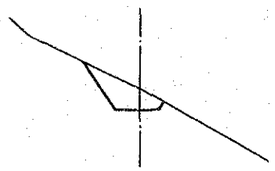
ACCESS ROAD
CROSS SECTION AND PROFILE (7 of 16)
No. 91 ~ No. 106
OPTIMUM ROUTE (ALT-B)

DWG. ACR – 36 | DATE JUNE 1987

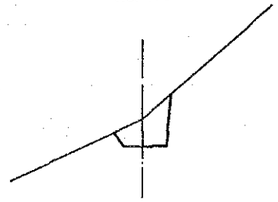
NO. 107



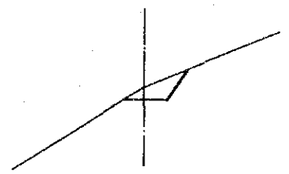
NO. 111



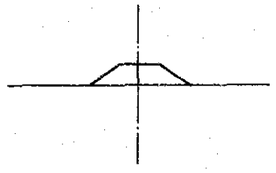
NO. 115



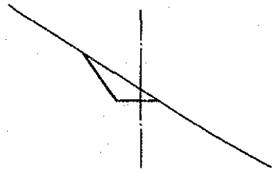
NO. 119



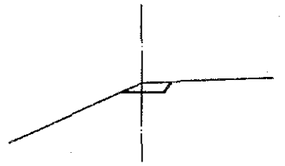
NO. 109



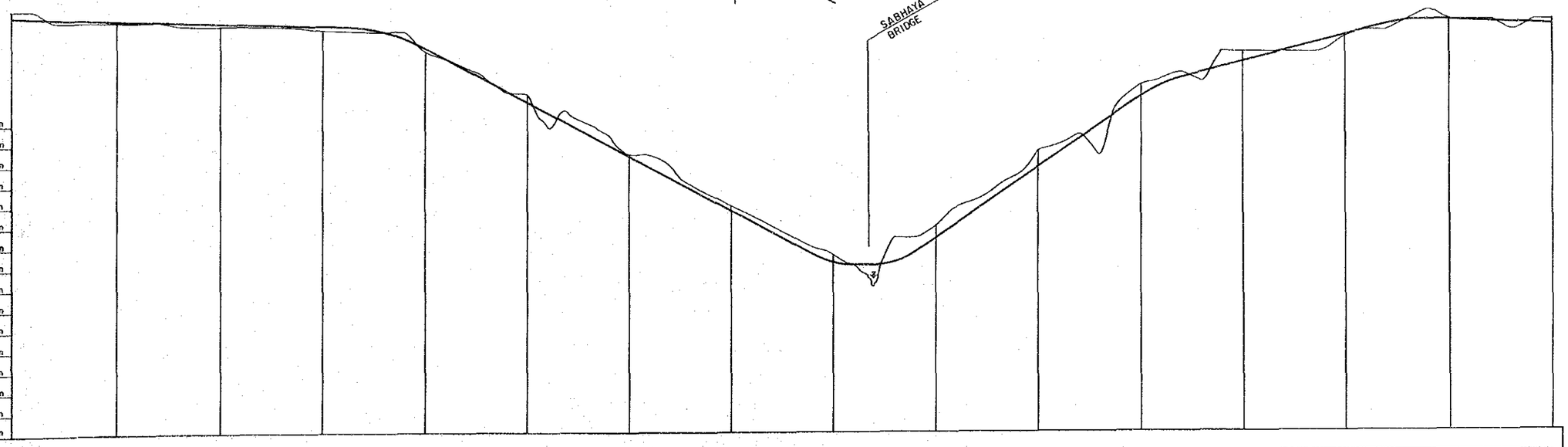
NO. 113



NO. 117



SABHAYA KHOLA BRIDGE



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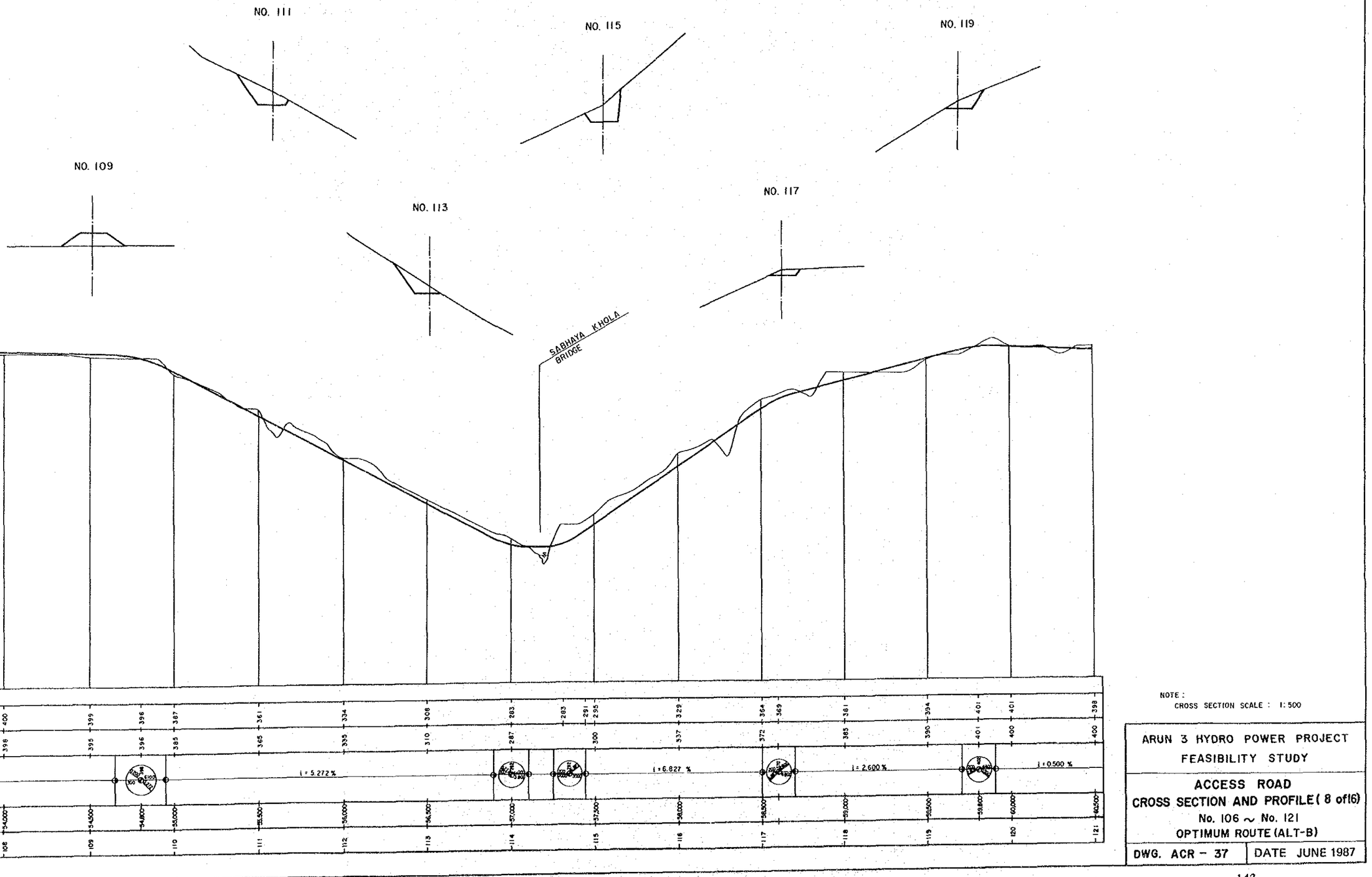
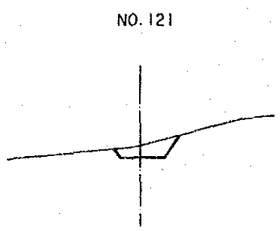
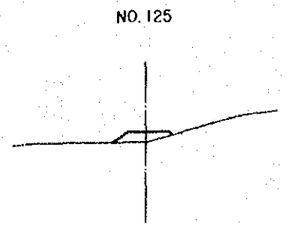
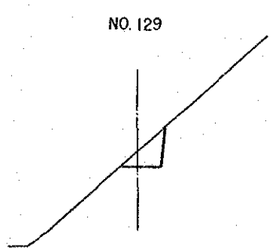


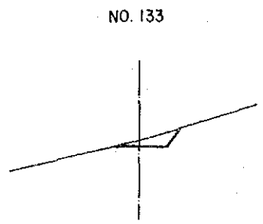
NOTE :
CROSS SECTION SCALE : 1:500

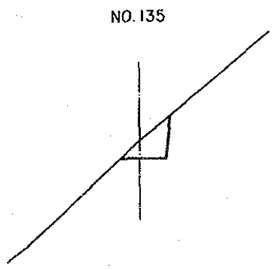
ARUN 3 HYDRO POWER PROJECT FEASIBILITY STUDY	
ACCESS ROAD CROSS SECTION AND PROFILE (8 of 16) No. 106 ~ No. 121 OPTIMUM ROUTE (ALT-B)	
DWG. ACR - 37	DATE JUNE 1987

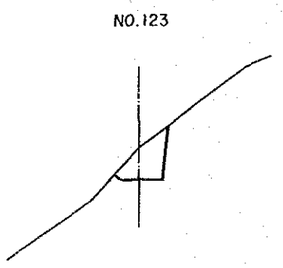


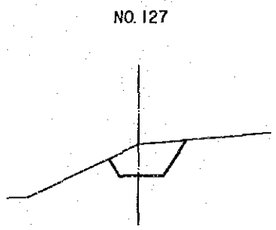


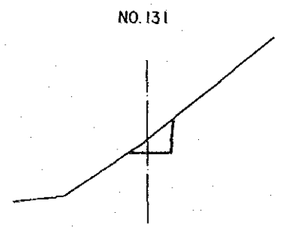


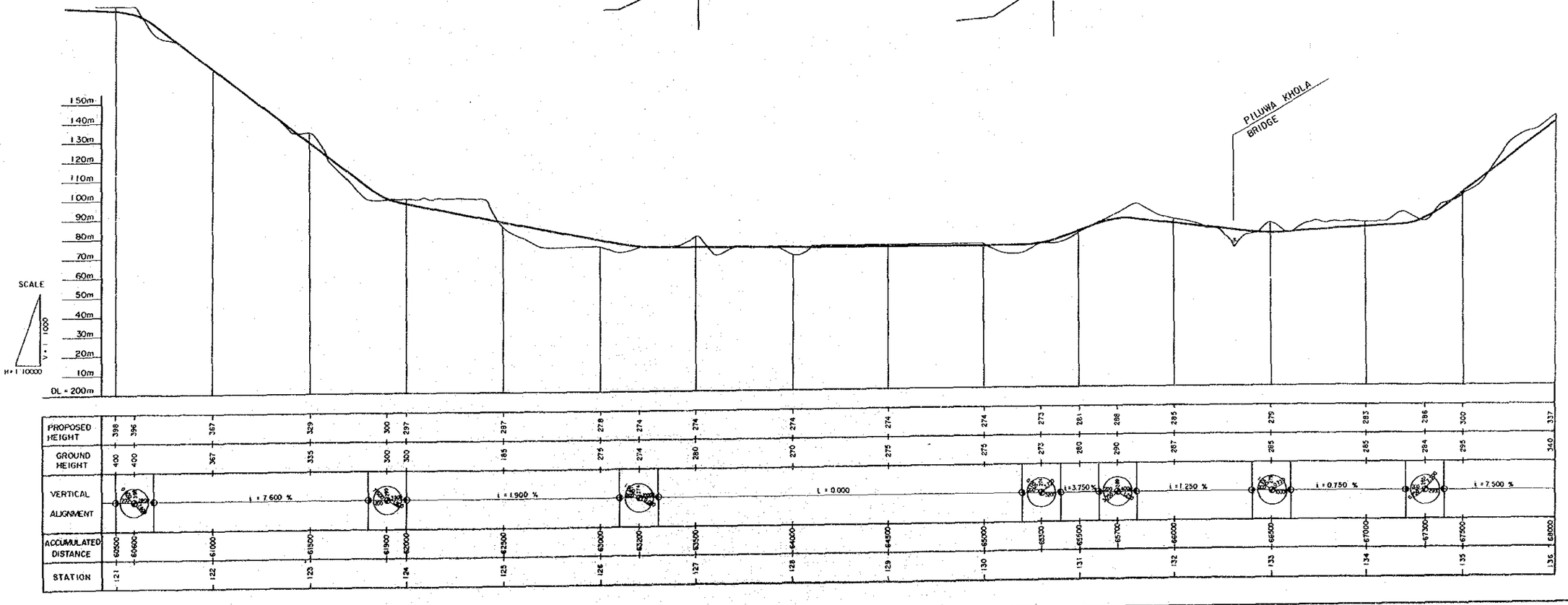












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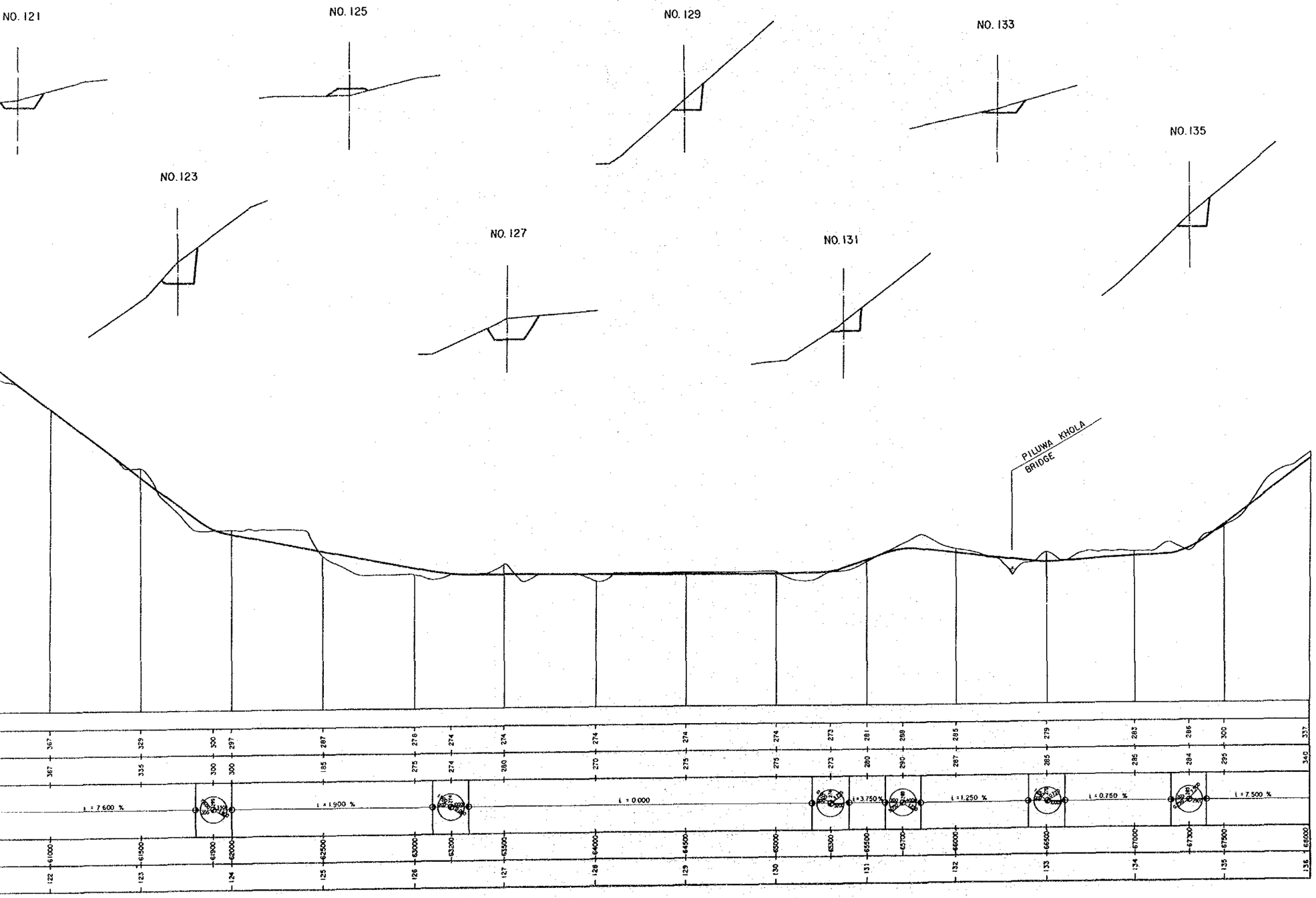
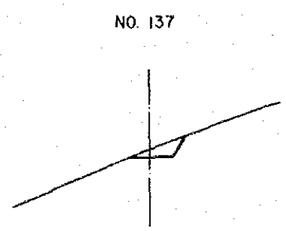


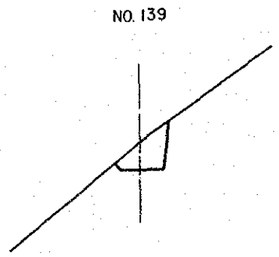
NOTE :
CROSS SECTION SCALE : 1:500

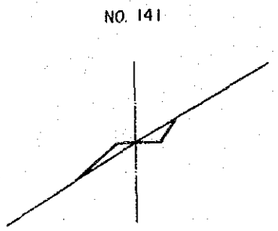
ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

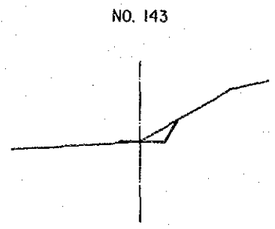
ACCESS ROAD
CROSS SECTION AND PROFILE (9 of 16)
No. 121 ~ No. 136
OPTIMUM ROUTE (ALT-B)

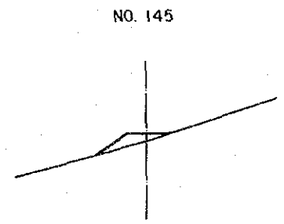
DWG. ACR – 38 | DATE JUNE 1987

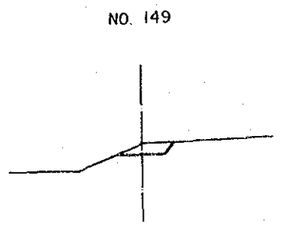


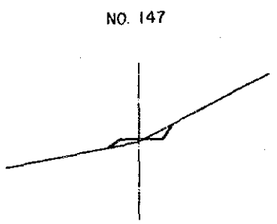












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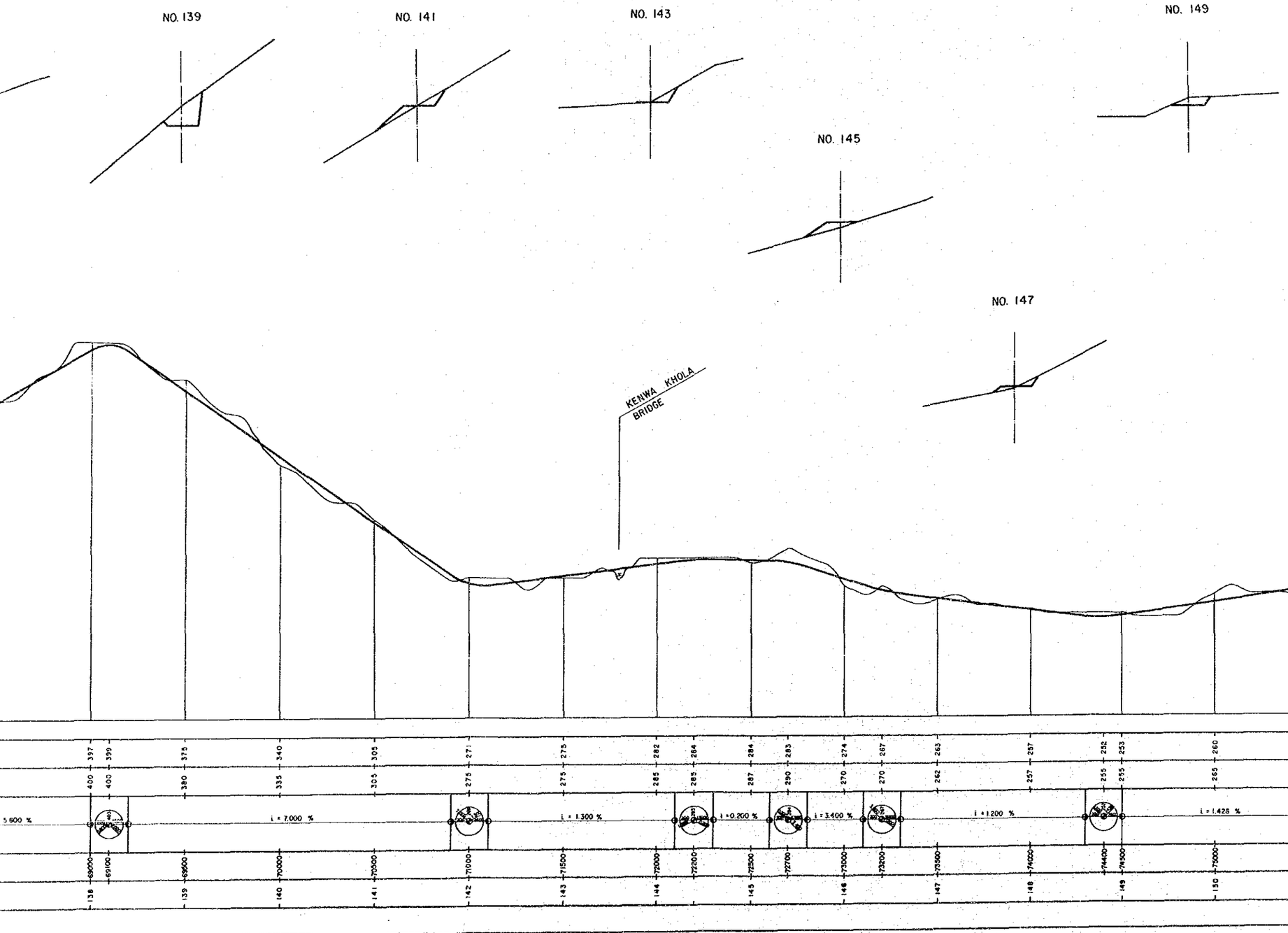
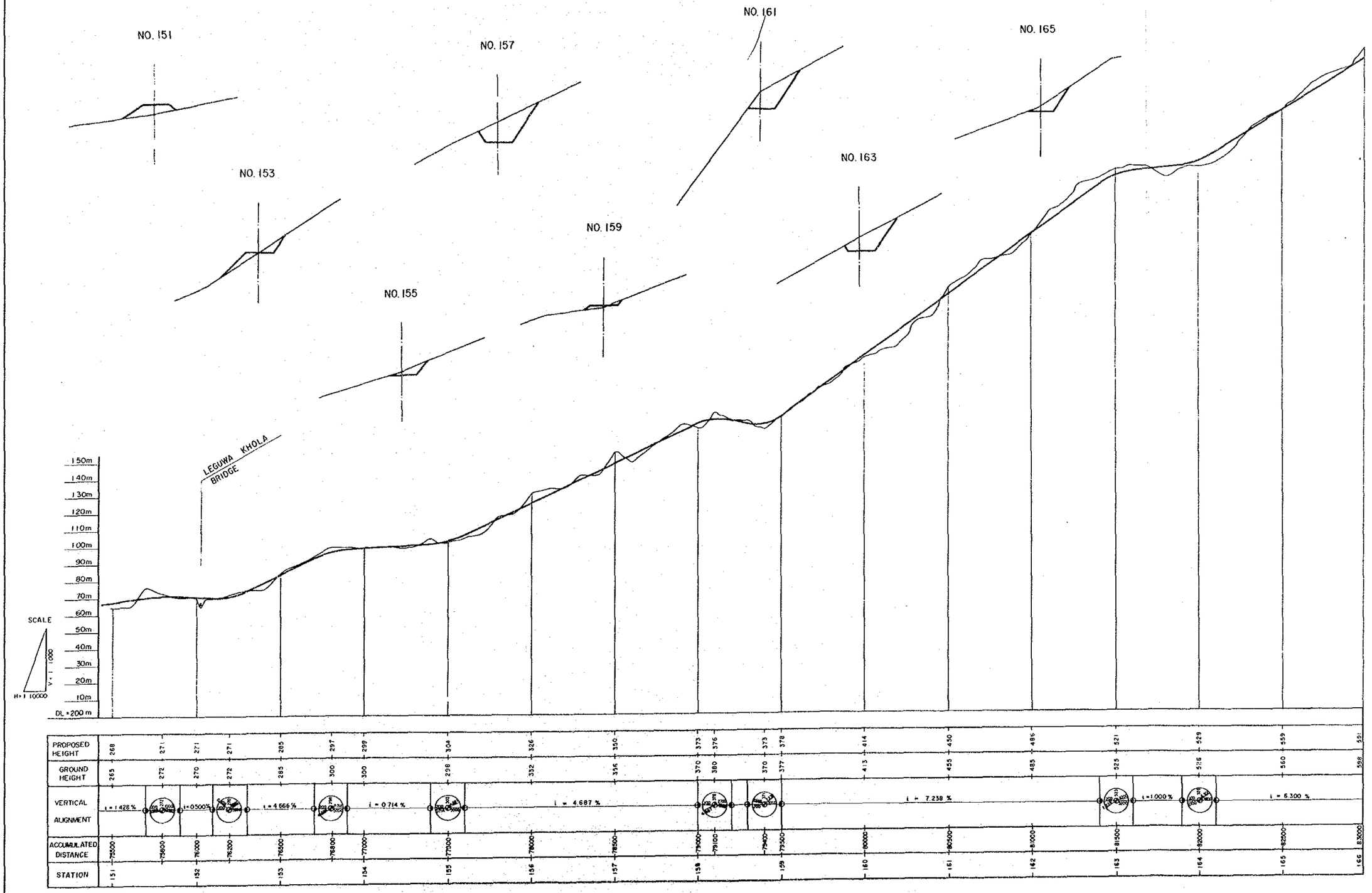


NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT FEASIBILITY STUDY	
ACCESS ROAD CROSS SECTION AND PROFILE (10 of 16) No. 136 ~ No. 151 OPTIMUM ROUTE (ALT-B)	
DWG. ACR - 39	DATE JUNE 1987



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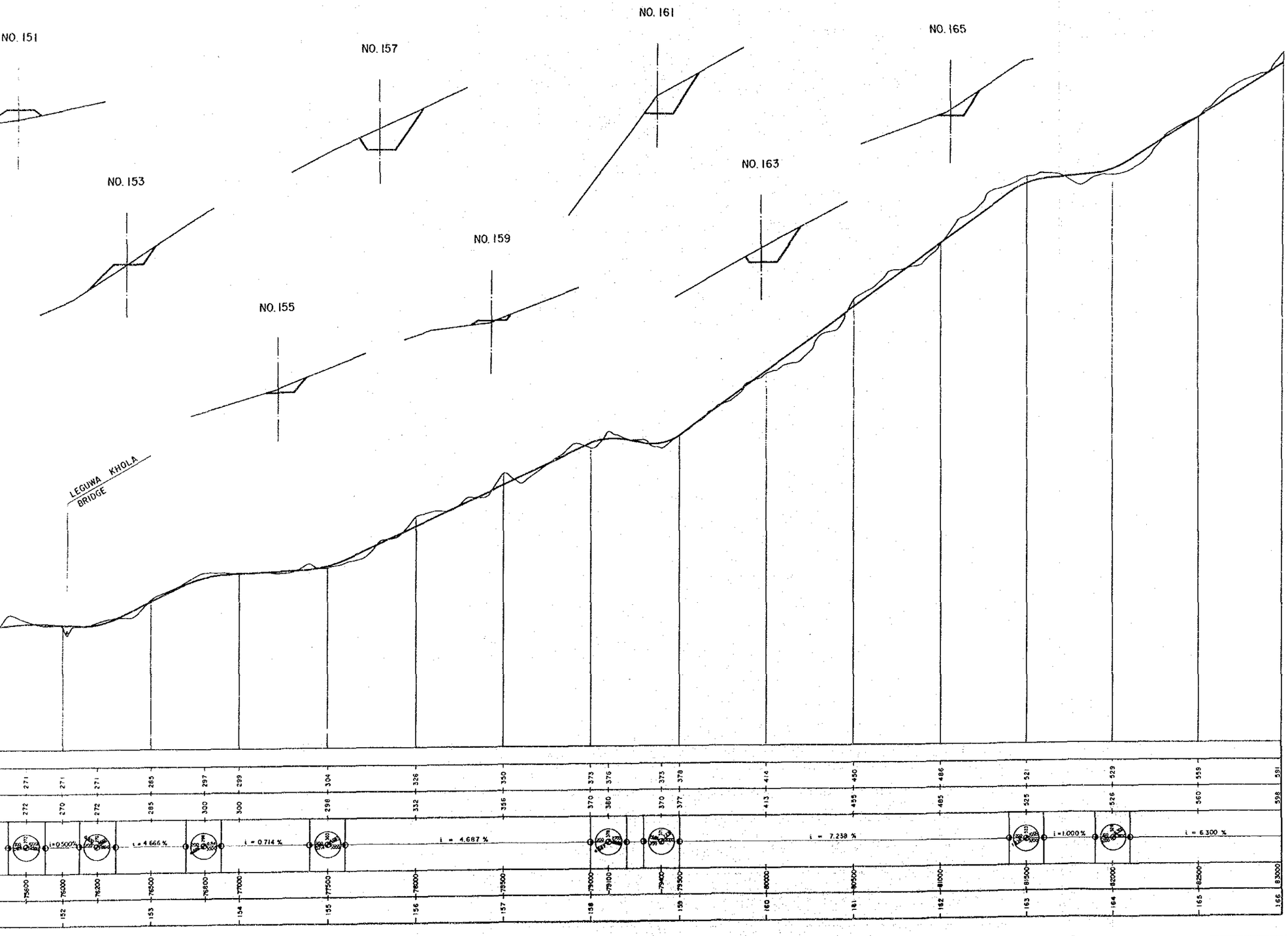
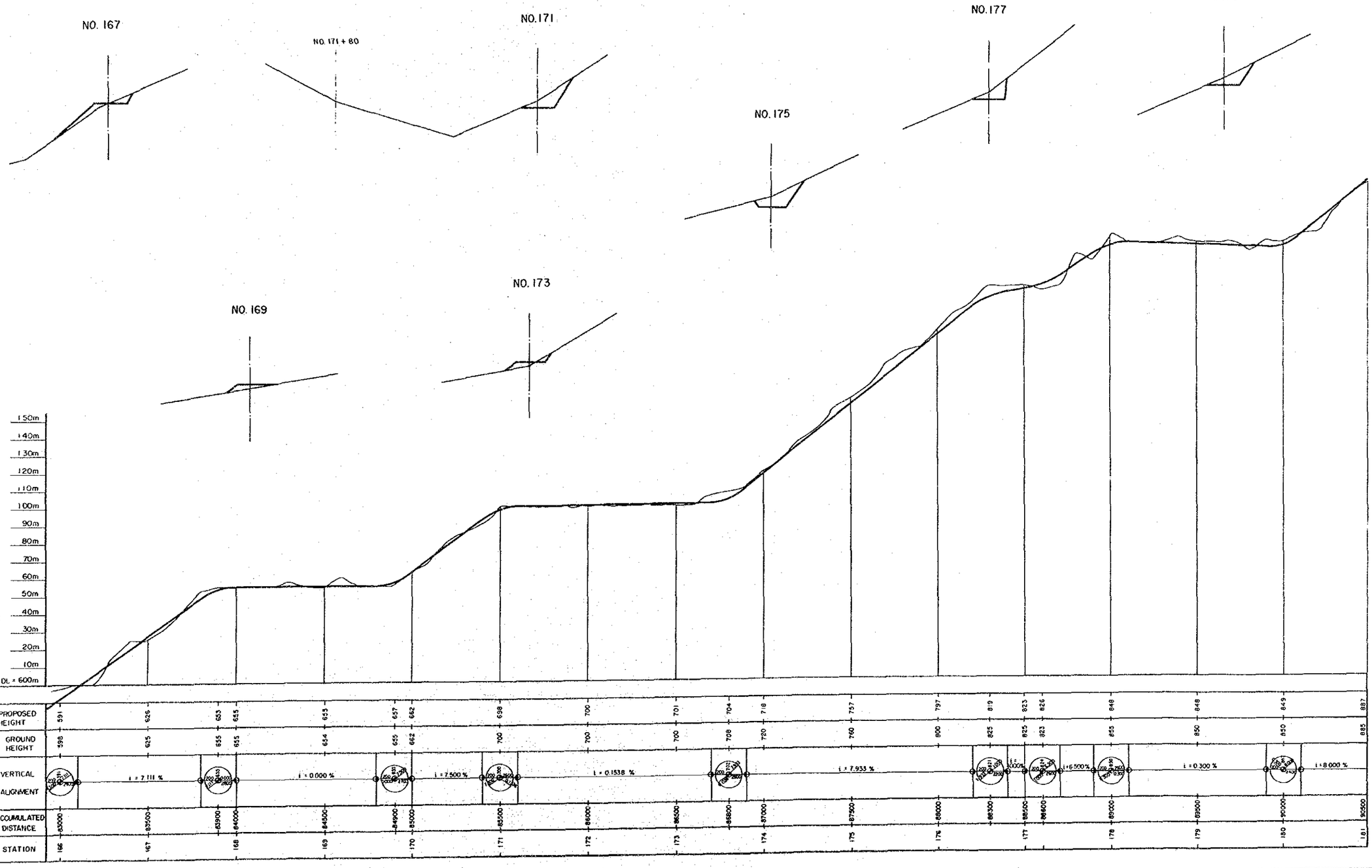


NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

ACCESS ROAD
CROSS SECTION AND PROFILE (11 of16)
No. 151 ~ No. 166
OPTIMUM ROUTE (ALT-B)

DWG. ACR - 40 | DATE JUNE 1987



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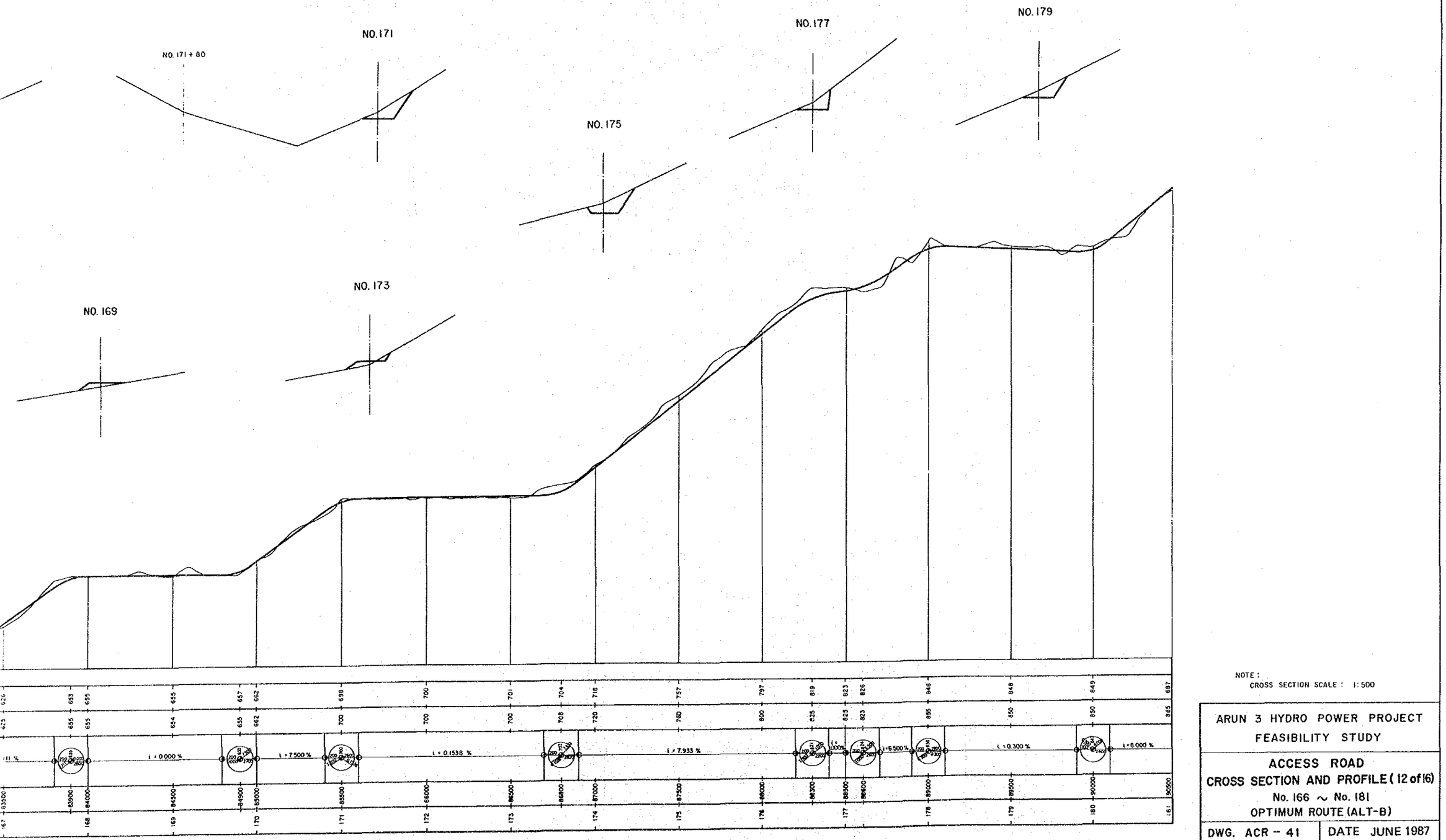
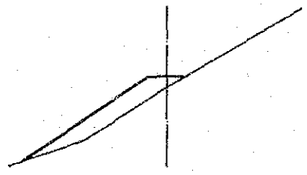


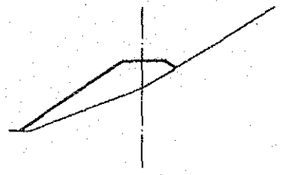
NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT FEASIBILITY STUDY	
ACCESS ROAD CROSS SECTION AND PROFILE (12 of 16) No. 166 ~ No. 181 OPTIMUM ROUTE (ALT-B)	
DWG. ACR – 41	DATE JUNE 1987

NO. 181



NO. 187



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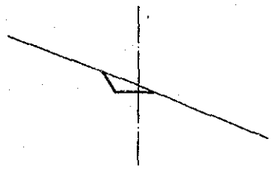
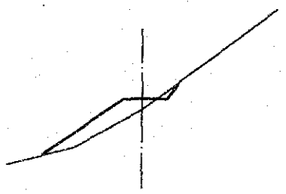
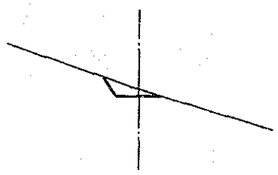


NO. 195

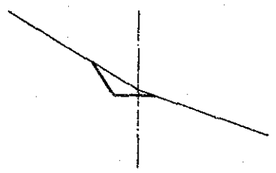
NO. 183



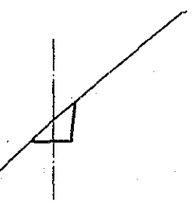
NO. 189



NO. 193



NO. 185



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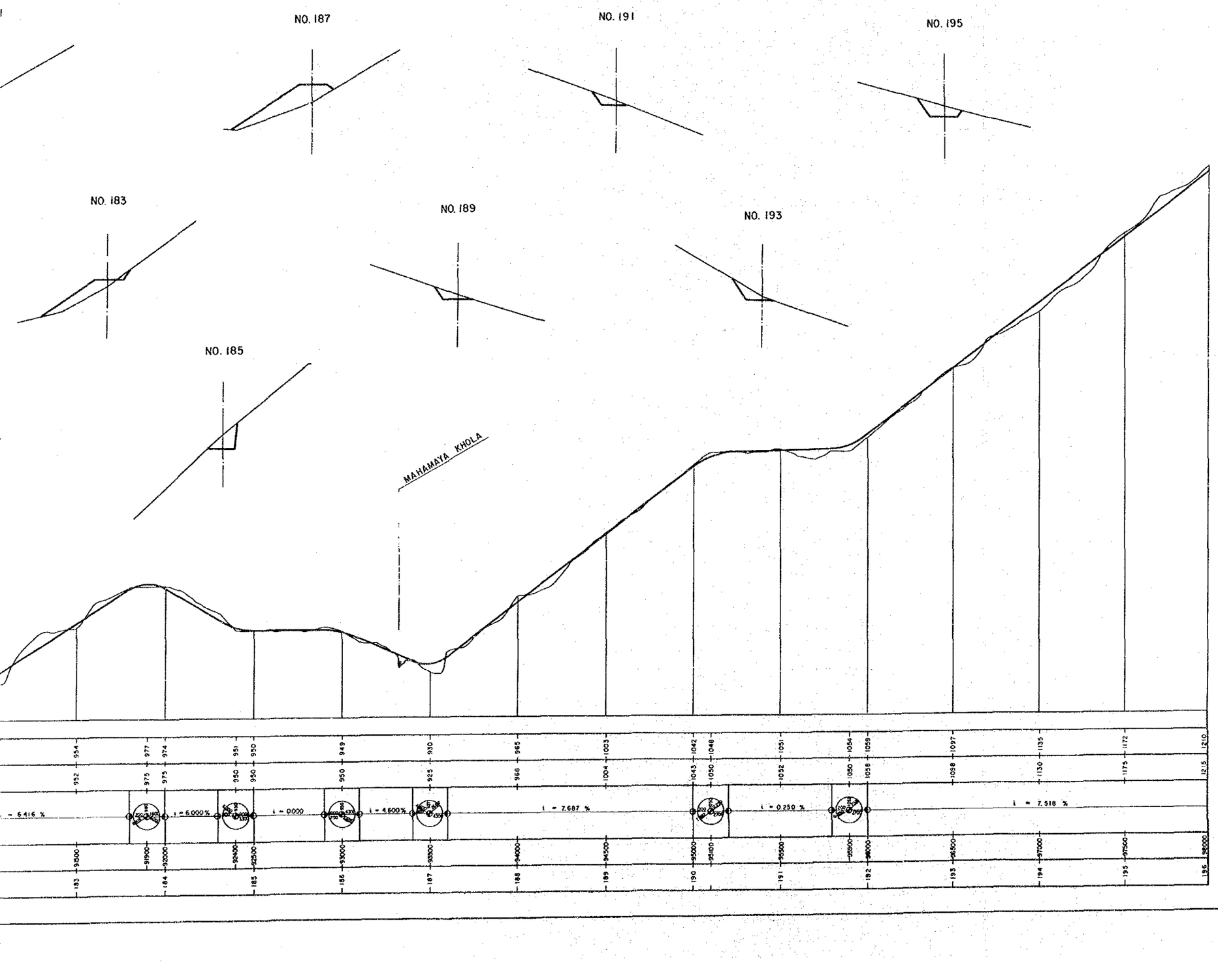
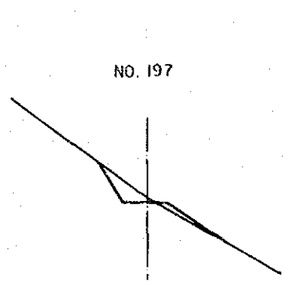


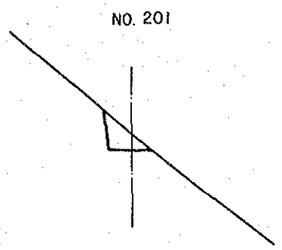
NOTE :
CROSS SECTION SCALE : 1:500

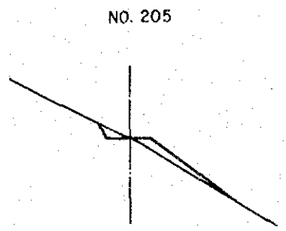
ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

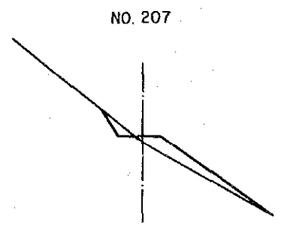
ACCESS ROAD
CROSS SECTION AND PROFILE (13 of 16)
No. 181 ~ No. 196
OPTIMUM ROUTE (ALT-B)

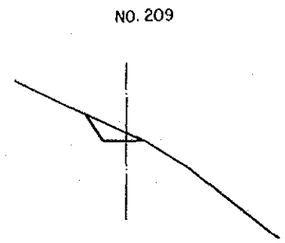
DWG. ACR - 42 | DATE JUNE 1987

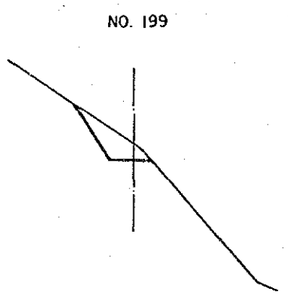


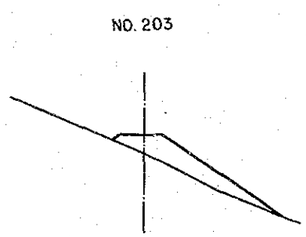












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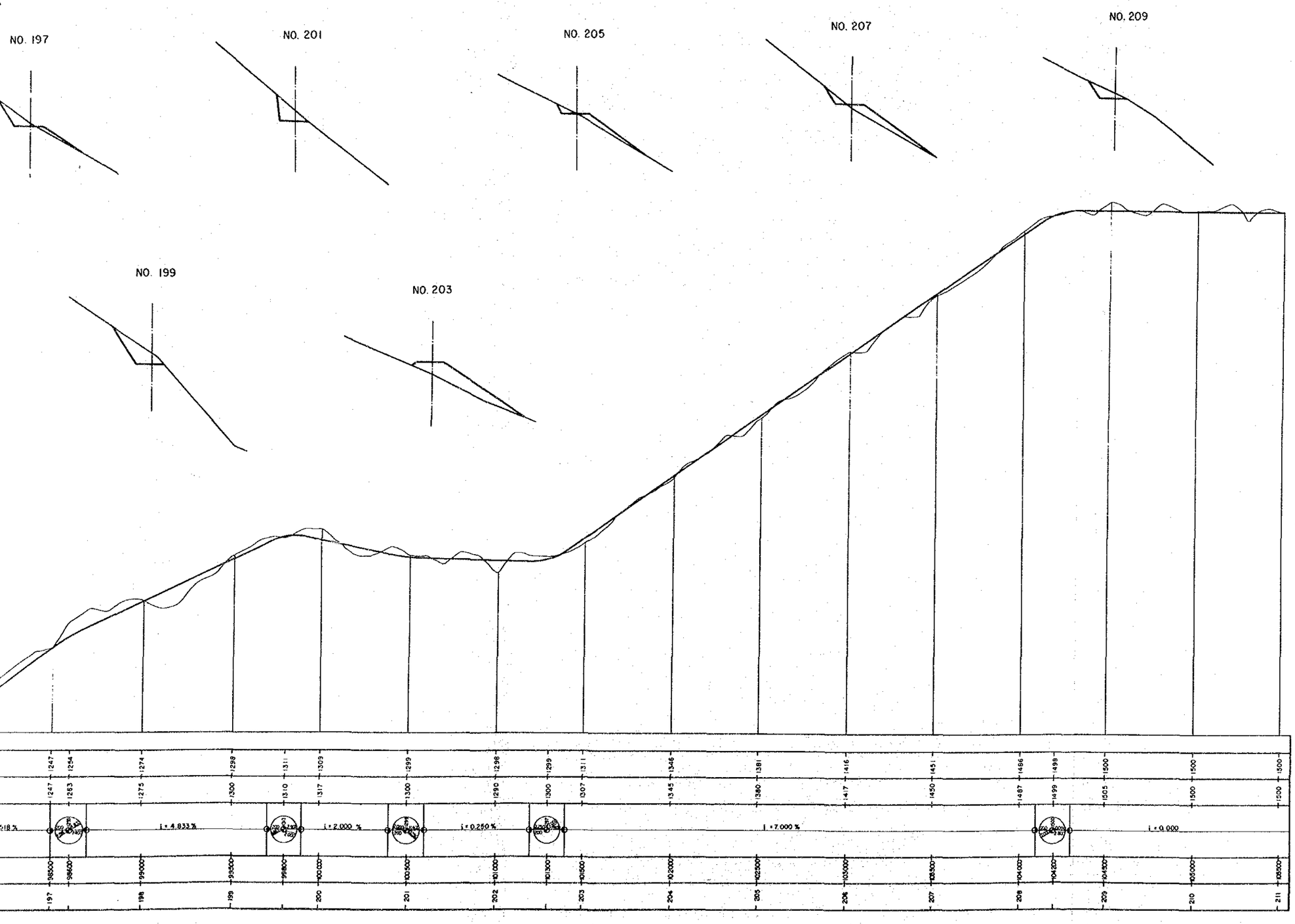
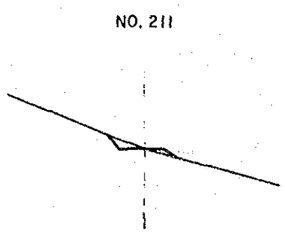


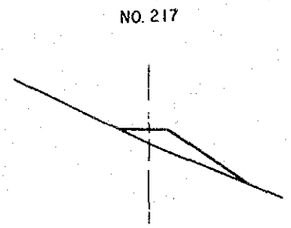
NOTE :
CROSS SECTION SCALE : 1:500

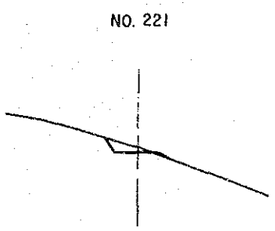
ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

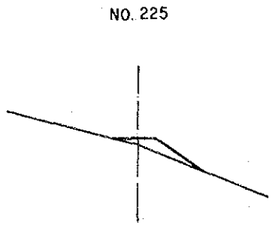
ACCESS ROAD
CROSS SECTION AND PROFILE (14 of 16)
No. 196 ~ No. 211
OPTIMUM ROUTE (ALT-B)

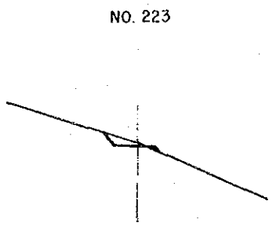
DWG. ACR - 43 | DATE JUNE 1987

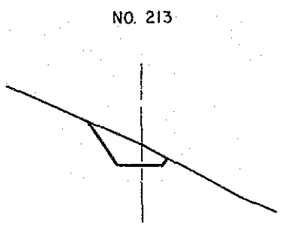


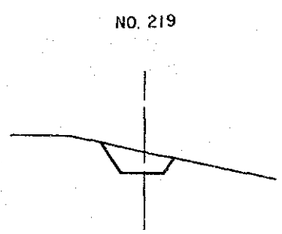


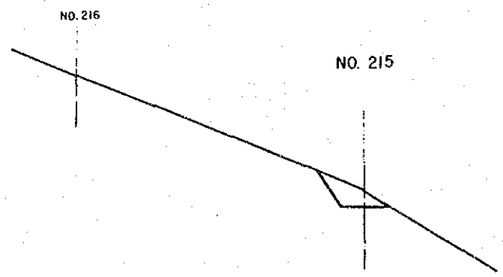


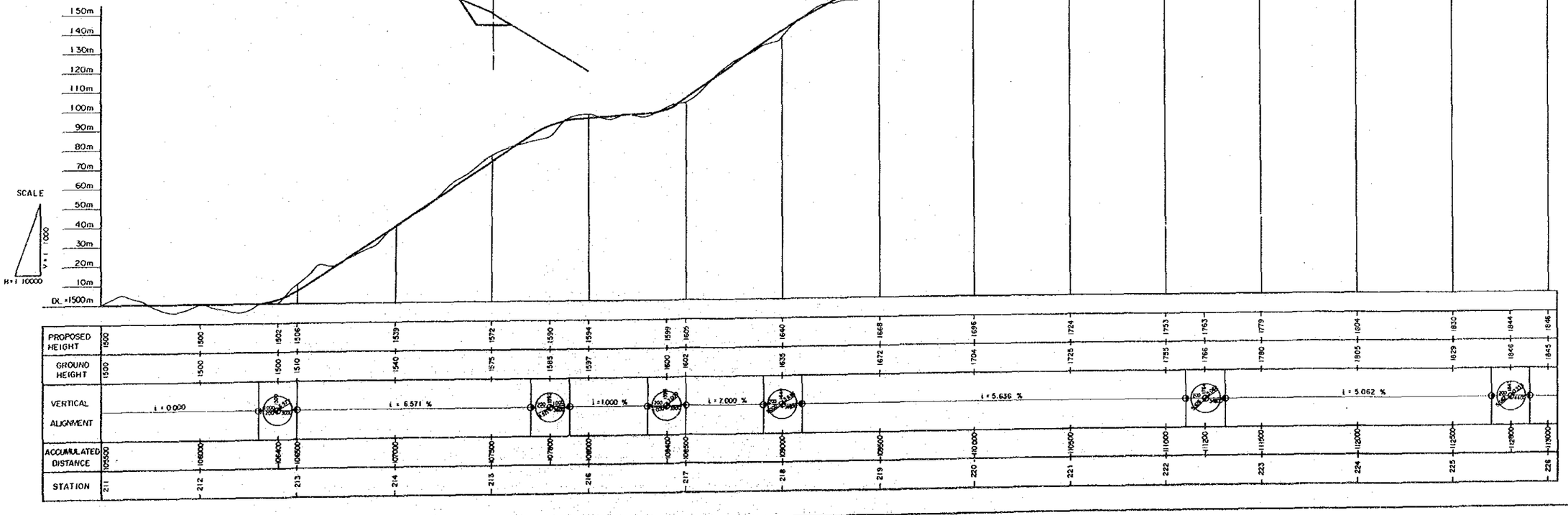












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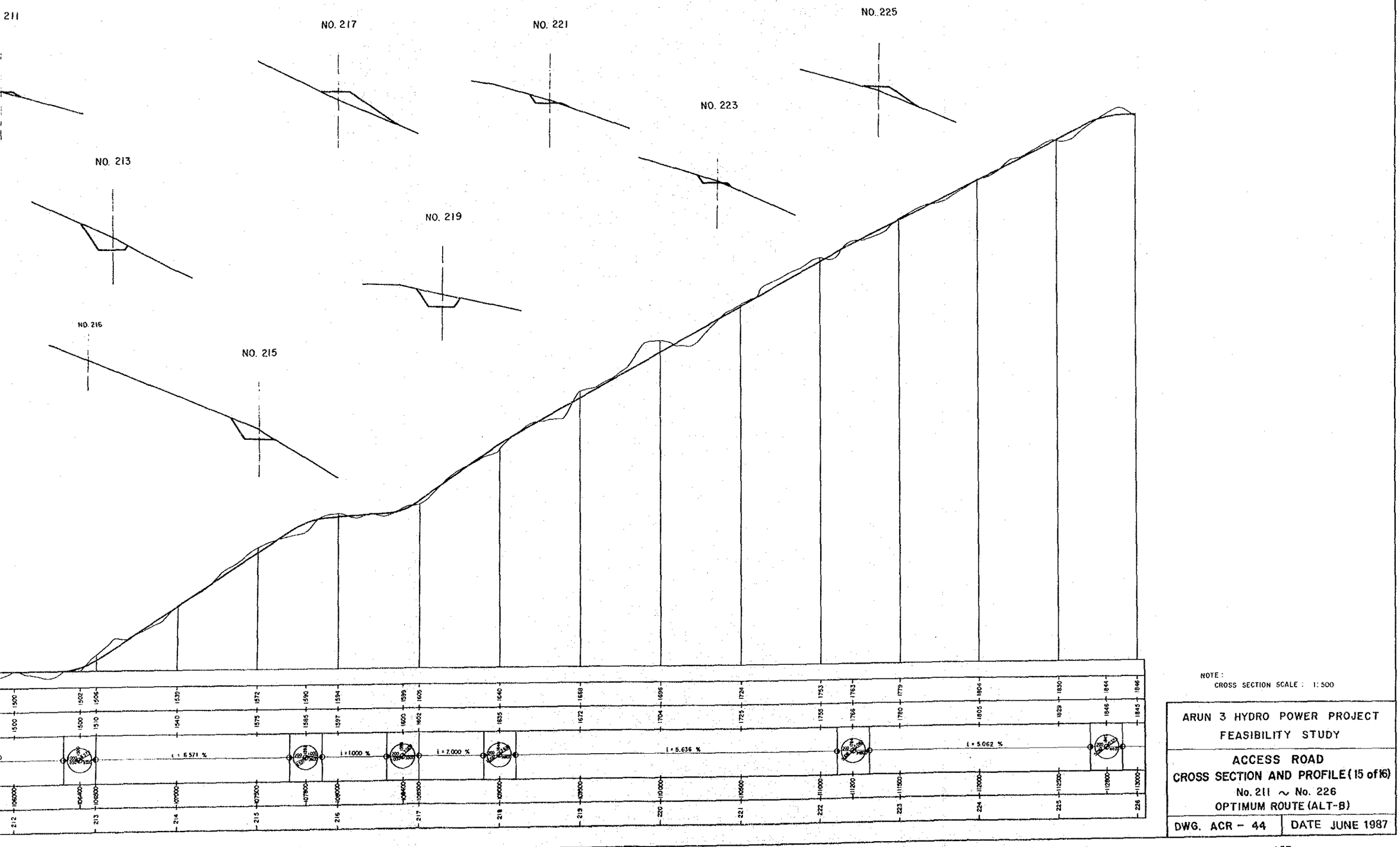
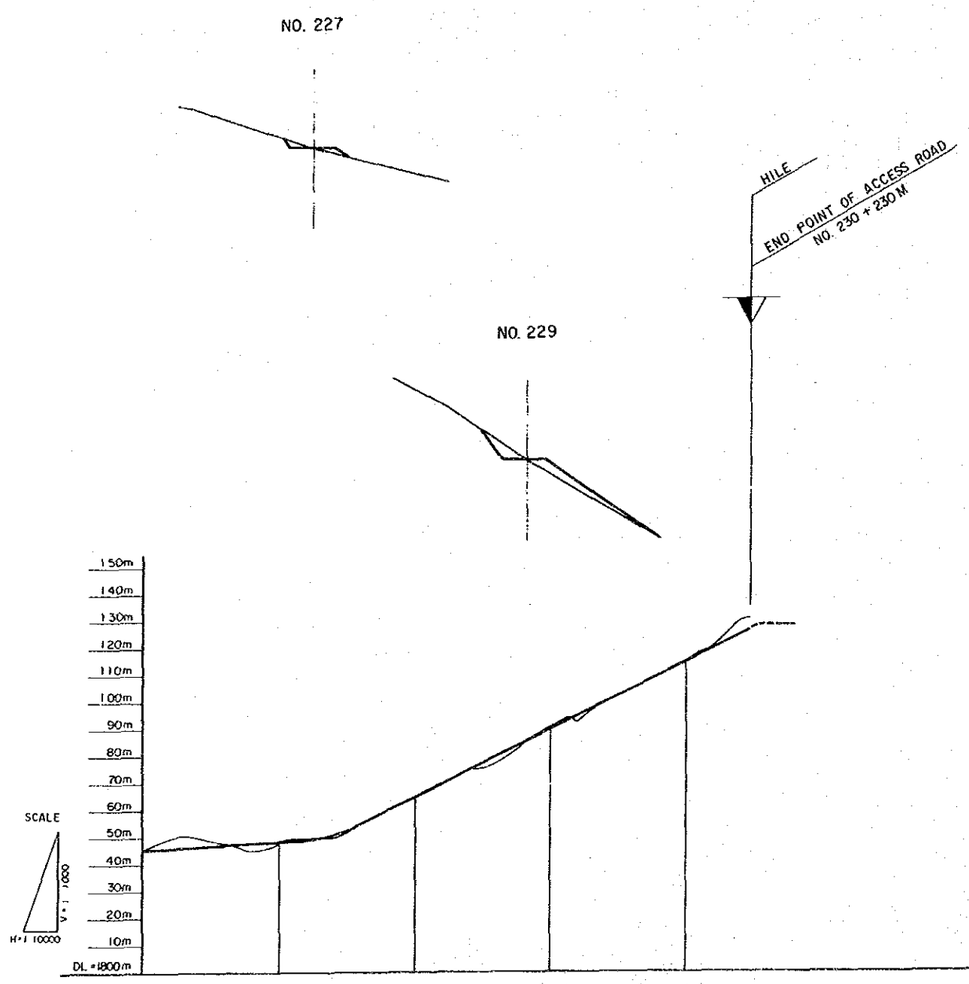


NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

ACCESS ROAD
CROSS SECTION AND PROFILE (15 of 16)
No. 211 ~ No. 226
OPTIMUM ROUTE (ALT-B)

DWG. ACR - 44 | DATE JUNE 1987



PROPOSED HEIGHT	1846		1848	1851	1865	1890	1916	1927
GROUND HEIGHT	1845		1848		1865	1890	1915	1930
VERTICAL ALIGNMENT		i = 0.555%				i = 4.967 %		
ACCUMULATED DISTANCE	113000		113300	113700	114000	114600	115000	115230
STATION	226		227		228	229	230	230 + 230M

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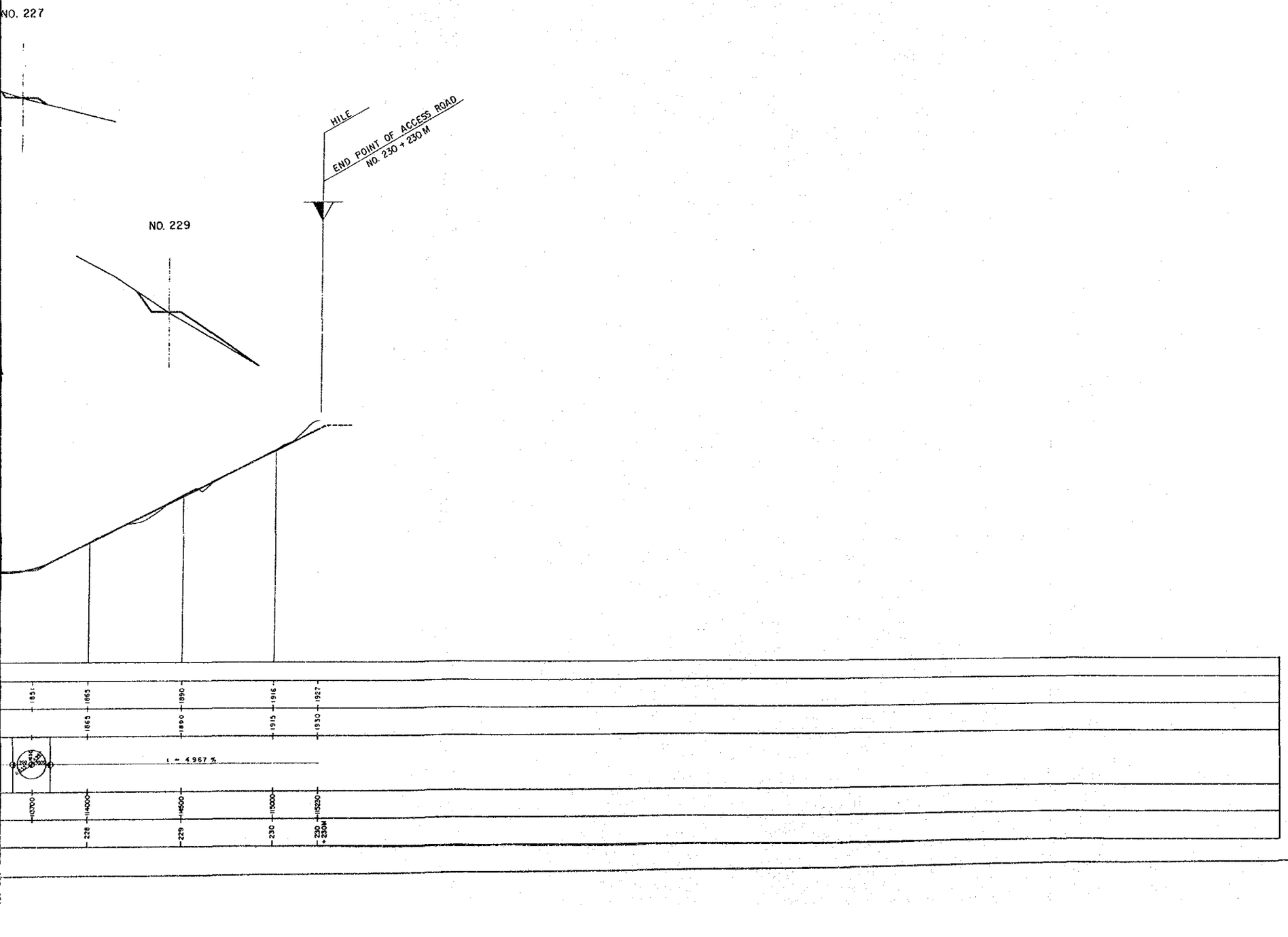


NOTE :
CROSS SECTION SCALE : 1:500

ARUN 3 HYDRO POWER PROJECT
FEASIBILITY STUDY

ACCESS ROAD
CROSS SECTION AND PROFILE (16 of 16)
No. 226 ~ No. 230+230
OPTIMUM ROUTE (ALT-B)

DWG. ACR - 45 | DATE JUNE 1987

APPENDIX

A. SITE INVESTIGATION

B. ORIGIN DESTINATION SURVEY (O&D)

C. GEOLOGICAL SITE-SPECIFIC OBSERVATION

D. DRAWINGS OF ALTERNATIVE ROUTES (1:10,000)

APPENDIX–A SITE INVESTIGATION

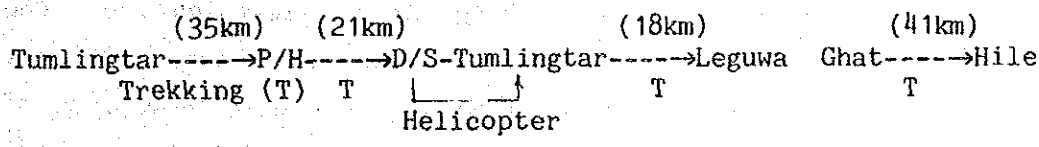
APPENDIX

1.0 SITE INVESTIGATION

1.1 General

The present field survey was conducted to collect information for the planning of the access road for the construction of the Arun River Hydropower Station. According to the plan, two major routes--a hillside and a riverside route--have been specified. Both routes orginate from Hile and pass through towns and villages such as Tumlingtar and Khandbari and terminate at the dam site. The planned extension of the road is from 115 to 158 kilometers. This site investigation was conducted mainly along riverside route (ALT-B) for two weeks.

The surveying course started on foot at Tumlingtar and proceeded to Khandbari, and on to the powerhouse and dam sites for Arun-3. Six days later, the team returned to Tumlingtar and conducted an alignment observation over the proposed alignments from Leguwa Ghat to Hile by helicopter. This observation was conducted to find the most appropriate route for field survey on foot. Based on the results of the aerial observation, the field survey was conducted over the riverside route and a nearby trekking trail. Under this investigation, information for each route regarding natural conditions (soil, topography, etc.), social/economic conditions (paddy fields, gardens, villages, etc.) and other necessary topics were collected. The investigation route is illustrated below.



1.2 Results of the Site Investigation

The results of the present site investigation are described below for each individual interval of the course.

1.2.1 Tumlingtar - Powerhouse Segment (35 kilometers)

Tumlingtar is a long narrow flat terrace located between the Sabhaya Khola and Arun River. The surfacial topographical feature of this area consists of two flat benches at approximate elevations of 430 meters and 460 meters. The surface of the area is covered with reddish brown soil with some rocks exposed. The main trekking trail runs along the Arun River from Hile to Khandbari.

The official location of Tumlingtar is in Sankhuwasabha District in Koshi Zone where there is an all-season airport operating daily flights to Kathmandu and Biratnagar. The aircraft used are Twin Otters.

Along the trekking trail there are houses scattered on the flat part of the area. Most of this flat land is mainly covered with corn plantations. The trekking trail runs through these plantations and the Tumlingtar area toward Khandbari, into the mountains. The slope of the course over this flat area is about 0 to 5%. As the trail rises from the lower bench to the upper level the gradient is 12 to 20%. In the mountain area, the trekking trail continues along the ridge of the mountain toward Khandbari. One of the proposed routes is on the left side of the flat terrain in Tumlingtar, along the Arun River (riverside route). The other route runs along the mountain side heading upstream of Sabhaya Khola (hilltop route). The hilltop route is characterized by rough geological features, and the drawback of the riverside route is the excessive extension straying away from Khandbari. Between elevation 600 meters and 800 meters, there are quite a number of paddy fields irrigated by seepage groundwater.

Khandbari is a town along the mountain ridge at an elevation from 1060 meters to 1130 meters. In the center of the town there are many commercial and residential areas as would be expected in this capital of the Sankhuwasabha District. Khandbari is a commercial town where commoditities and goods are supplied by porters from Dhankuta and Hile. The hilltop route passes through the center of Khandbari where the steep, frequently narrow streets are flanked by houses and shops. Moving of buildings and reshaping of the slopes will be necessary if a motorable road is to be constructed through such areas. To avoid this it is necessary to reroute and pass the access road through the

cultivated land either on the left or right side of the town and somewhat below it.

After Khandbari at the middle point between Maruwa and Rangma the trekking trail branches to the left toward the Arun River and northward toward Chiple and Num. The northward branch is the main trail into the northern portion of Sankhuwasabha and for tourists to Makalu Base Camp.

At this point the investigation course was shifted toward the powerhouse onto the minor trail. From the three kilometer point, the trail cuts through a standing rock wall where Chyawa Khola can be seen on the left. The land far below this side of the trail is comparatively flat with many paddy fields and plantations under cultivation. The trekking time required from Khandbari to the powerhouse site was three days and two nights. Along this part of the trail there are many plantations and paddy fields with corn, millet, and other crops under cultivation. The elevation of the area along this route is about 1200 to 1500 meters. Important towns and villages on the way are Gairiangl, Yamachaung, etc. The scale of map used in this site investigation was 1:50,000; however, some enlargement will be necessary to plan the construction of the access road as the valley is very narrow and deep. Exposed rocks were also observed on the surface of the mountains at the powerhouse site. The features of the land along Arun River cannot be seen from the trail at this spot. Therefore, on the following day an aerial investigation of the area was made and it was discovered that there are some parts of the route that require difficult excavation through cliffs. However, construction of an access road along the Arun River is considered possible.

1.2.2 Powerhouse - Dam Site Segment (21 kilometers)

The powerhouse site selected is at Pikhuwa. This spot is a long narrow terrace of about 300 x 50 meters with an elevation of 550 meters. A part of the terrace is covered with paddy fields. The width of the Arun River on the east side of this terrace is about 40 to 50 meters. This terrace is covered with shrubs and grass and there is no sign that the terrace has been inundated before. The slope of the land on the right bank of the Arun River facing the hills is about 34 to 35° with gradual increase in the steepness as distance from the river increases. At an

elevation of 1200 meters the trail followed turns toward the dam site along the contour line. At Rata Khola there is a bridge about 30 meters long. The geomorphological features of this area are very rough with large trees and a valley so deep and wide that a conventional bridge cannot cross the river. This section of the route is known for its steepness with an elevation difference from 650 meters to 1200 meters. It is thought that the construction of the access road along the Arun River will be easier than that of the hilltop route although some rock walls and difficult spots were observed along river route when later observed from a helicopter.

At the dam site at Num, the Arun River flows southward with greater speed. Downstream of this site the Pekishindar Suspension Bridge joins the banks of the river. In addition, at an elevation of 800 meters to 840 meters there is a large terrace of about 150 x 300 meters on the left bank downstream from the dam site. Paddy fields and plantations can also be seen in this area. The survey team camped here for the night.

The terrace is surrounded by mountains and large trees where Num Khola and Khokda Khola merge with the Arun River. The access road is planned to cross this confluence of rivers toward the dam site several hundred meters upstream.

1.2.3 Tumlingtar - Leguwa Ghat Segment (18 kilometers)

The section of the access route from Tumlingtar to Chainpur and Hile was first studied by helicopter. A field survey on foot was conducted over the route along the Arun River.

The confluence of the Arun River and Sabhaya Khola is located to the south of Tumlingtar. The survey was carried out along the main trekking trail which extends southward after crossing Sabhaya Khola with a suspension bridge of about 132 meters at which a fee must be paid upon crossing. This bridge is used by a large number of porters. Sabhaya Khola is the river with the biggest drainage basin in the project area. The Sabhaya yields high quality aggregates for construction materials. It is estimated that about 30,000m^3 of aggregates for the construction of the ridge can be obtained from confluence accumulation of the river. The abutment and retaining wall of the suspension bridge crossing

Sabhaya Khola were constructed from boulders collected locally. This section of the route passes through a flat terrace beside the river and then crosses the Sabhaya into an area with rougher geomorphological conditions. Soil in the area is reddish clay. Rocks are ferrites not appropriate as construction materials.

Other rivers found near this section of the route are Piluwa Khola and Kenwa Khola. In addition, before Khare there is a dry riverbed which overflows in the rainy season. The problem of access road construction over this section is a question of how best to pass through the cliff and cross Piluwa Khola.

The width and depth of Piluwa Khola at the end of June were 40 meters and 50 centimeters, respectively. Based on this river stage, it is estimated that the width of the river will be 100 meters in the flood season. This section of the route ends at Kenwa Khola which flows through terraces with paddy fields downstream. Here the Arun River gradually turns around the tip of the terrace toward Leguwa Ghat. The terrace bordered by this river evidenced no indication of being flooded.

There were two landslide spots--one at each extreme end of the terrace where the current of the Arun River strikes sharply with the land. Kenwa Khola is a small river with flooded areas where a large amount of gravel is accumulated. The flooded areas are severely inundated in rainy seasons.

1.2.4 Leguwa Ghat - Hile Segment (41.0 kilometers)

Many paddy fields are found along the Leguwa Khola and near the junction of the Arun River. The minor bed of the Leguwa Khola is about 20 meters wide. There is a suspension bridge (70 meters) crossing the Leguwa River at about 1.0 kilometer upstream of the river mouth. This bridge is a part of the main trekking trail to Hile. In order to study the bridge site, the team surveyed the bank about 3 kilometers upstream of the Leguwa Khola. Indications of landslide were found on the left bank of the Leguwa Khola. As the features of the river differ very little within 3 kilometers from the river mouth, the crossing point can be selected in any place. The selection of the road alignment should be made in such a way that no paddy fields will be destroyed.

At the town of Leguwa there is a 316-meter long suspension bridge crossing the Arun River on a trail leading to Bhojpur. The main trekking trail continues with a gentle gradient as far as the crossing at Mangmaya Khola. There is a suspension bridge at the Mangmaya Khola. At the crossing point of Mangmaya Khola there are many rest areas and tea shops for trekkers. The survey team left the main trail and climbed up to the altitude of 600 to 700 meters to Baspani Village to investigate the landslide trace. According to the study, it was concluded that the foundation of the ground at the spot has stabilized. In the ravine of Baspani there are some naturally growing pine trees, suggesting a change in geological features.

The survey team crossed the upper stream of the Mangmaya Khola and proceeded to Hattikharka Village. Along this route there are also many pine trees growing. Hattikharka is a large village with a school and water supply located at an altitude of 1500 meters. The main crop cultivated by the villagers is maze. The next village, Pakhriwas is an area with cool climate and good soil conditions located at an altitude of 1670 meters, 6.0 kilometers from Hile on the main trekking trail. This town is active with small markets and a large population. There is an agricultural research center donated by the Government of England at Pakhriwas.

1.2.5 Hile - Sindnuwa Segment

Hile is a hilltop town with its importance as the entrance to the Koshi Zone in the northern part of Nepal and at the same time serves as the main route to Dhankuta and Dharan.

The survey team carried out a site investigation by car from Hile to Sindnuwa along the hilltop route, in order to collect information for the construction planning. This road is planned to go to Tehrathum and Phidim but also provides access to the northern part of Nepal. It was constructed by manpower and the surface of the road is covered with gravel. It is about 5 meters wide with numerous emergency parking areas. The horizontal alignment of the road shifts up and down the mountain with the minimum possible turning radius and a gradient of less than 13%. Most parts of the road were constructed by the cutting operation.

The structure of this road consists of shoulder ditches, drainage, gabion bases, and stone masonry. Most of the problems with roads in Nepal are slope failure and drainage blocking by soil and gravel carried by rainwater. These phenomena were very apparent along this recently constructed section of road.

APPENDIX–B ORIGIN DESTINATION SURVEY (O&D)

APPENDIX

1.0 ORIGIN DESTINATION SURVEY (O & D)

1.1 General

An origin and destination study is a planning tool to assist transportation planners and economists in development of roadway systems. Basically an O & D survey seeks to determine the two ends of a person's trip, and the frequency and purpose of each trip. Sometimes other special data are collected during the survey to aid in projecting the future travel desired, primarily through socio-economic parameters. In any event, the goal is to be able to predict future travel patterns within a defined system. Data collection is a finite sample of current travel patterns within the system.

1.2 Study Design

Several different methods of data collection are common. The most frequently used are: (a) home interview, (b) postcard, and (c) roadside interview. For a corridor study, such as that for the Arun-3 project, the roadside (trail) interview, along a series of screen lines, appears most appropriate.

Two questionnaires were prepared for use by field surveyors (see Appendix D). One form was for recording type of goods, weight, origin, destination and payment. This form applied to all porters and is common with the DOR Nepal. A second questionnaire was prepared for use in obtaining socio-economic data. This second form was applied in interviews of all travelers.

In addition, data were to be collected from different offices such as the Food Corporation, Agriculture Input Corporation, District Technical Office, District Forestry Office, etc. to supplement other information in determining total goods carried by porters throughout the year and their transporting cost, origin and destination. Analysis of data was to be accomplished on an IBM-PC microcomputer.

1.2.1 Main Markets

Through inquiry of local people, district administrative and other offices, it was found that Hile of Dhankuta District, is the only main marketplace for Sankhuwashaba District. A wide variety of goods are transported from Hile, by porters, to different market areas of Sankhuwashaba, as well as the northern region of adjoining Bhojpur District. Small shopkeepers in Chainpur, Tumlingtar and Mane Bhanjyang are the local market source for much of the individual purchases. Khandbari, the district headquarters, supports the largest and most important market in the district. Clothing, food grains, salt, oil, etc. are transported to Hile from Dharan or Biratnagar by truck. All local export products, mainly food grains, are carried by porters to Hile, where they are sold. Very limited quantities of only a few items are transported through the airfield at Tumlingtar.

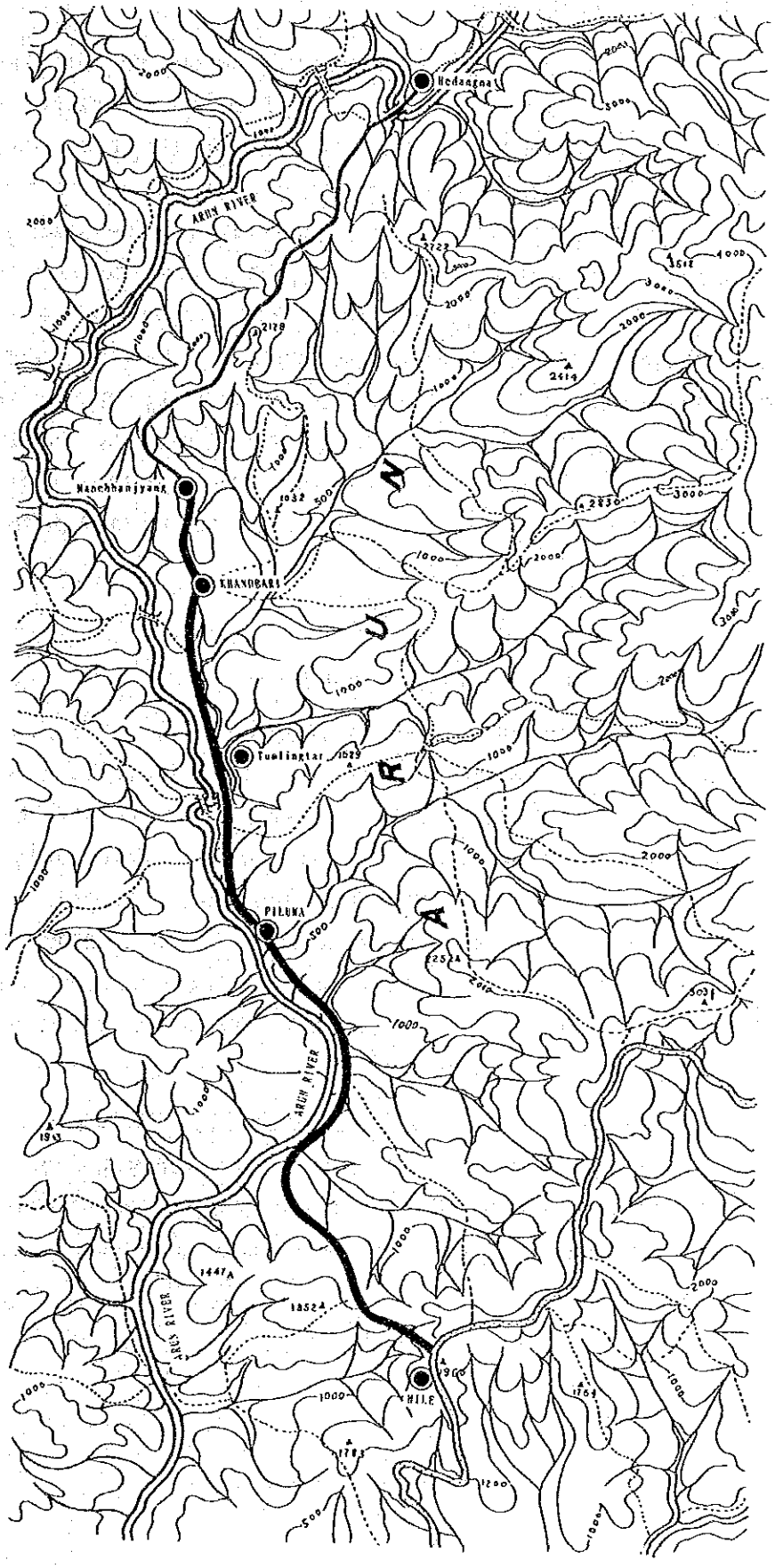
1.2.2 Alternative Access

Air service into Tumlingtar is the most convenient means of access for people able to afford the air fare and wishing to go into the central and northern portion of both Sankhuwashaba and Bhajpur Districts; otherwise, one must walk in from Hile. Air service to Tumlingtar is daily from Kathmandu, as well as Biratnagar. Buses connect Hile with Dharan, with frequent service. A local bus also travels northeast from Hile to Jhorbhati. Access form Jhorbhati into the interior of Sankhuwashaba is not frequently used according to local sources.

1.2.3 Survey Stations

During the field survey, it was determined principally through interviews of local police posts, that five locations are sufficient for collecting interviews. Figure 7.1 shows the location of these stations at Hile, Piluwa, Tumlingtar, Khandbari and Mane Bhanjyang. A suspension bridge at Leguwa Ghat yields access west into Bhojpur. A trail east at Piluwa goes to Chainpur, the second largest volume market of the Sankhuwashaba District. Access to Dingla is west on a trail from Tumlingtar.

FIGURE 1.1 Locations of O-D Survey Stations



1.3 Data Collection

1.3.1 Station Operation

Data collection at the five stations was conducted simultaneously for a seven-day period, from 27 June to 3 July, during daylight hours. June-July is not a representative time to collect the best data for several reasons. It is a peak planting time with many persons diverted to agricultural employment rather than portering. The Team witnessed this fact in trying to hire porters during the field reconnaissance and data collection. Moreover, exported farm products are at a minimum during this period and most traffic is inbound. A third factor is that the monsoons decrease tourist travel. Ordinarily, there is a sizeable number of trekking parties, this being the access to Makalu I and other popular climbs. To overcome some of this problem, district offices, merchants, innkeepers, etc., were interviewed in an attempt to capture all possible sources of information.

1.3.2 Factors Affecting Data Collection

The illiteracy of porters and villagers, plus a natural distrust of the "government" interviewers, make it difficult to convince individuals of the importance of the data, thereby limiting the completeness or reliability of some answers. This was particularly apparent in reviewing responses to the earnings question. Certain goods, such as herbs and precious stones, both products of the Sankhuwashaba District, require HMG license. It is known that illegal export exists, although the quantity is unknown and illegally exported items may have been reported as salt or some other product.

The principal factor affecting data collection is the rainy season. As a result, it was difficult to stop each and every porter long enough to obtain the required data. Not only are there fewer porters during this period, but the load each carries tends to be less.

1.4 Seasonal Adjustment

The seasonality of trail usage is reported by the Department of Roads, based on Dharan-Mulgat trail surveys. Appendix D is a graphic reproduction of the DOR'S findings. Based on this graph, all traveler traffic is at an annual low during the period of data collection for this Study. Thus, an adjustment must be made by multiplying all passenger traffic by a factor of 1.92. Porter traffic shows far less seasonality, which is logical, and has in fact almost recovered to an annual average by the first of July, when it is about 85% of average. Therefore, porter traffic is multiplied by an adjustment factor of 1.18 to bring it up to the annual average.

1.5 Corroborating Alternative Data Sources

1.5.1 District Exports

As noted previously, virtually no goods are being transported to Hile from the outlying area of the district during the rainy season. To gain insight into this segment of the transportation system, government offices and local merchants have been consulted. District export data are shown in Table 1.1.

TABLE 1.1 District Export Data

Type of Goods	Weight of Goods/Year (kg)	Portering Rate/kg (Rs)	Total Wages (Rs)
Precious Stones	20,000	3.25	65,000
Oranges	40,000	3.00	120,000
Herbs	220,000	3.00	660,000
Ghee	55,000	3.00	165,000
Pulse	20,000	3.00	60,000
Total	355,000		1,070,000

Based on these data, there are about 32 porter trips of 30kg on an average annual day of export goods. This does not correspond to the information recorded in the field interviews. Considering seasonal adjustment, an expected export trip rate should have reported approximately 27, whereas according to notes of the survey team leader,

> "...it was not possible to get data on goods being transported from different parts of the district to Hile,...."

1.5.2 Major Importers of Goods

Nepal Foods Corporation and Agriculture Input Corporation are major goods importers though Hile. An interview with Nepal Foods Corporation revealed that in the 1985-86 year, 16,030 Oquintles (106.3t) of rice were contracted for transport by porters to Khandbari, where it was distributed to villages. Nepal Foods paid Rs 2.6175 per kg. This value corresponds closely to the standard wage paid porters per day at Khandbari. However, the total weight is about 8% of the total reported through the adjusted porter trip interviews.

Interviews with Agriculture Input Corporation, an importer of fertilizer, pesticides and other goods, reported imports in 1985-86 of 220t. The corporation pays transporters Rs 2.50 per kg. The total weight of this source is about 76% of the total annualized volume derived from the trail side interviews.

1.6 Computer Analysis

1.6.1 Hardware Used

The analysis of data on an IBM-PC, with two disk drives and an 80-column green display monitor, was used under a MS-DOS operating system. Floppy diskettes (5.25 inch) were used for data storage and hard copy (print out). The results were obtained using a 132-column dot-matrix printer (EPSON FX-100).

1.6.2 Software Adopted

A popular data base management package, dBASE-III, was used for data storage, retrieval and other manipulation purposes. It is possible to

write one's own programs using dBASE-III language. A program (command file) was developed to perform the job needed for the analysis. The program can generate results, as per attached computer out-put sheets, simply by inputing origin and destination codes and the number of days required to travel from the origin to the destination.

1.6.3 Data Preparation and Coding

For computer analysis, raw data obtained from the field survey must be coded properly into acceptable computer form, before processing. The reliability of the information obtained after processing mainly depends on the proper coding and cleaning of raw data. In this analysis, origins and destinations were first identified and proper codes were given to ease the processing. Besides five survey stations (#1,2,3,4 & 5), some other important places were also considered and coded accordingly. See Figure 1.1.

1.6.4 Grouping of Goods

Coordinating with the survey team leader, nine categories of goods were developed, namely:

1. Rice (Paddy)
2. Oils (Edible Oils & Kerosene)
3. Clothing (Ready-made Garments & Clothes)
4. Fertilizer (Different Types)
5. Sugar
6. Salt
7. Construction Materials (Cement, Rod, Pipes, etc.)
8. Food Stuffs (Flour, Food Grains, Vegetables, Biscuits, Confectionary, Milk, etc.)
9. Miscellaneous (Soap, Cigarettes, Stationery, Drugs, Firewood, Pots, etc.)

1.6.5 Data Analysis Strategy

For every pair of origin and destination, two types of traffic flow patterns were considered, namely: cargo flow pattern and traffic flow pattern. Cargo flow includes the flow of categories of goods in kilogrammes, wages (in Rupees) received, and number of porters used in carrying goods. Traffic flow includes total porters, total travellers and total animals used for transportation. All the above information were computed in per day trips.

1.7 Socio-Economic Questionnaire

1.7.1 Development of Questionnaire

In addition to the standard, 'where did you come from? where are you going?' questions, and in response to data sought by the World Bank, a set of special questions was asked to reveal a socio-economic profile of the area. (Wages paid were included in the standard O & D as described previously). A copy of the questions in this part of the survey is found in Appendix D, as well as those suggested by the World Bank.

1.7.2 Results of Questionnaire

Porters and villagers passing were requested to answer the questions. Questionnaires were filled out by interviewers with responses provided by people from different age groups, sexes, localities. Some merchants, as well as local leaders and villagers, were also interviewed. At the beginning it was a little difficult to convince the villagers of the purpose of the questionnaires, but slowly this problem was solved. Following are the results obtained from the questionnaires. Nearly 500 porters and travellers were interviewed.

1. Sankhuwasabha district is situated in the eastern part of Nepal. It is a hilly region. There are limited lands to be cultivated and no irrigation facilities are available. Because of this fact, agricultural production is very low and low-income villagers cannot subsist merely on agriculture. Similarly, there are no industries where local laborers can find employment. As a result, low-income villagers become porters as a regular occupation. Khandbari, the district headquarters, is the point through which

tourists and mountaineering expedition teams go to Mt. Makalu. Expedition teams usually hire local people, mostly males, as porters. Females and schoolboys also act as porters, if they are free from domestic responsibilities. Males carry loads every day of the month. In a family, 3-4 members are engaged in this profession.

2. Male porters can generally carry loads of 75kg, but there are some male porters who can lift loads of 100-110kg. Female porters can carry loads of 50-55kg, whereas schoolboys carry loads of 30kg. Wages are paid to the porters at the rate of Rs 2.50 to 3.00 per kg. A porter can earn nearly Rs 40/per day, excluding expenditures.

3. All kinds of goods are carried in response to requirements of local merchants and government offices. Porters also carry loads for their personal use; such as salt, kerosene oil, and other goods. The Hile-Piluwa-Tumlingtar-Khandbari trail is the only main trail along which porters travel. In the rainy season, the number of porters walking this route is nearly 150, whereas in the winter season it reaches up to 1000 per day.

4. Villagers earn some money by selling domestic products such as ghee, fruit, etc. They carry their products to Hile to sell and bring back goods for others. Such income covers some of their daily necessities; however, the wages which they receive as porters are the main income from which they fulfill their basic requirements. Wages received from portering provide for minimal substinence.

5. It is certain that portering will no longer be a viable occupation after construction of a motorable road. However, most of the porters and villagers feel that a motorable road is essential for the betterment of their life and are pleased to learn that a motorable road will be constructed in the near future. All the villagers expressed their willingness to work at the road construction site. Because of difficult access, villagers have largely confined their lives within the periphery of their own villages and there are very few villagers who have gone beyond Hile. After the construction of this road, most porters expressed

the intention to seek employment in construction and other development activities which are envisioned to be encouraged by improved access into the area. They hope that a large development program will be launched which will change and improve their pattern of life.

6. Some of the porters were concerned that construction of the road will cause them to lose their jobs; however they are still optimistic about other, better alternatives for their existence. Merchants, office holders, local leaders, and other villagers look forward eagerly to a bus transit service and transport of necessary goods by truck.

Cold Station:- 1

O & D Survey Date:- 21/3/1972

Station Hill Date Time: 4.20

Traffic type (Porter, animal)	Good types code		Good weight unit	Quantity	Origin 1	Destination	Payment Per day	R tr
2	1	चावल	किलो	60×2=120	हिले	चेनपूर 21	60- मन	
90 -	4	दाना मल	किलो	40×90=3600	हिले	चेनपूर 21	60- मन	
2 -	6	नून	किलो	60×2=120	हिले	खादवारी 4	900- "	
3 -	1	चावल	किलो	40×3=120	हिले	"	900- "	
4 -	6	नून	किलो	40-	हिले	भोजपूर 51	60- "	
3 -	8	मैदा	किलो	60-	हिले	तोपूजुग 21	930- "	
9 -	1	चावल	किलो	40-	हिले	पारवीवास 12	240- "	
2 -	6	नून	किलो	60-	हिले	पारवीवास 12	240- "	
2 -	1	चावल	किलो	60-	हिले	खादवारी 4	900- "	
4 -	8	मैदा	किलो	40-	हिले	भोजपूर 32	300-	
5 -	1	चावल	किलो	80-	हिले	मुगा 12	300- "	
2 -	9	खुदरा माल	किलो	40-	हिले	भोजपूर 32	60- "	
4 -	4	मल	किलो	20-	हिले	भोजपूर 32	60- "	
92 -	1	चावल	किलो	60-	हिले	खादवारी 4	900- "	
6 -	9	खुदरासामान	किलो	20-	हिले	भोजपूर 32	60- "	

Questionnaire for Origin and Destination Survey (Specimen)

Station: Time: Date: Male/Female:

Profession: Age:

(1) Origin: (2) Destination:

(3) Time taken to reach the proposed station:
(a) With full load: (b) With ordinary load:
(c) With no load:

(4) Purpose of travelling:

(5) Are you a professional porter?

(6) How many days you are involved in the job of porter in a month?

(7) What weight can you carry?

(8) What wages do you get per kg/quintle?

(9) What kind of goods are you carrying this time?

(10) What kind of goods do you usually carry?

(11) What kind of goods are generally brought to your village from the major marketing places such as Dhankuta,Hile,Khadbari.

(12) How many porters walk through this way per day/per month?

(13) In which months do most of the porters involve in carrying goods to and fro?

(14) Is there any means of transporting goods besides porters?

(15) If so,What is the transporting cost per kg/quintle? and how much time does it take?

(16) Are there other alternative paths porters generally use?

(17) How much do you personally expense on the way from origin to destination point?

(18) What is the number of your family members?

(19) Is your income obtained from this job sufficient to run your family?

(20) Do you have any other income-source?

(21) Which is the nearest place where you go for marketing? and within how many times do you reach there?

(22) Do you think that the present level of your income will decrease after motorable road is constructed?

(23) After motorable road is constructed, will you carry your loads as a porter? Or you will carry by bus?

(24) Are you eager to be a worker in the site of construction?

(25) Do you feel motorable road will make your life easier & better?

Arun III Access Road - Preliminary survey

Suggested O-D survey questionaires.

1. Where do they live ?

2. Where are they going ?

3. Distance travelled- How long does it take for them to travel from origin to destination ?

4. Purpose of travel
   (a) Social visits / leave
   (b) School / Clinics, hospital
   (c) Markets or travel connected with carring a livelihood
   (d) Other- specify, e,g. gather fire wood, fodder

5. What are they carrying ? How much do they weigh ? If more than one type, pick the primary cargo in terms of weight.

6. Means of carrying cargo,
   (a) Animal - what kind ?
   (b) Human poterage
   (c) Combination of (a) x (b)

7. Nearest road (motorable) from place of residence- Km (or- day of walking)

8. How often do they make such trips ? Once/ twice a week / month/ year, etc,

Source:World Bank

9. Primary means of livelihood- farmer, traders, shop keepers etc,

10. Income level. Rs. / year (or approximate)

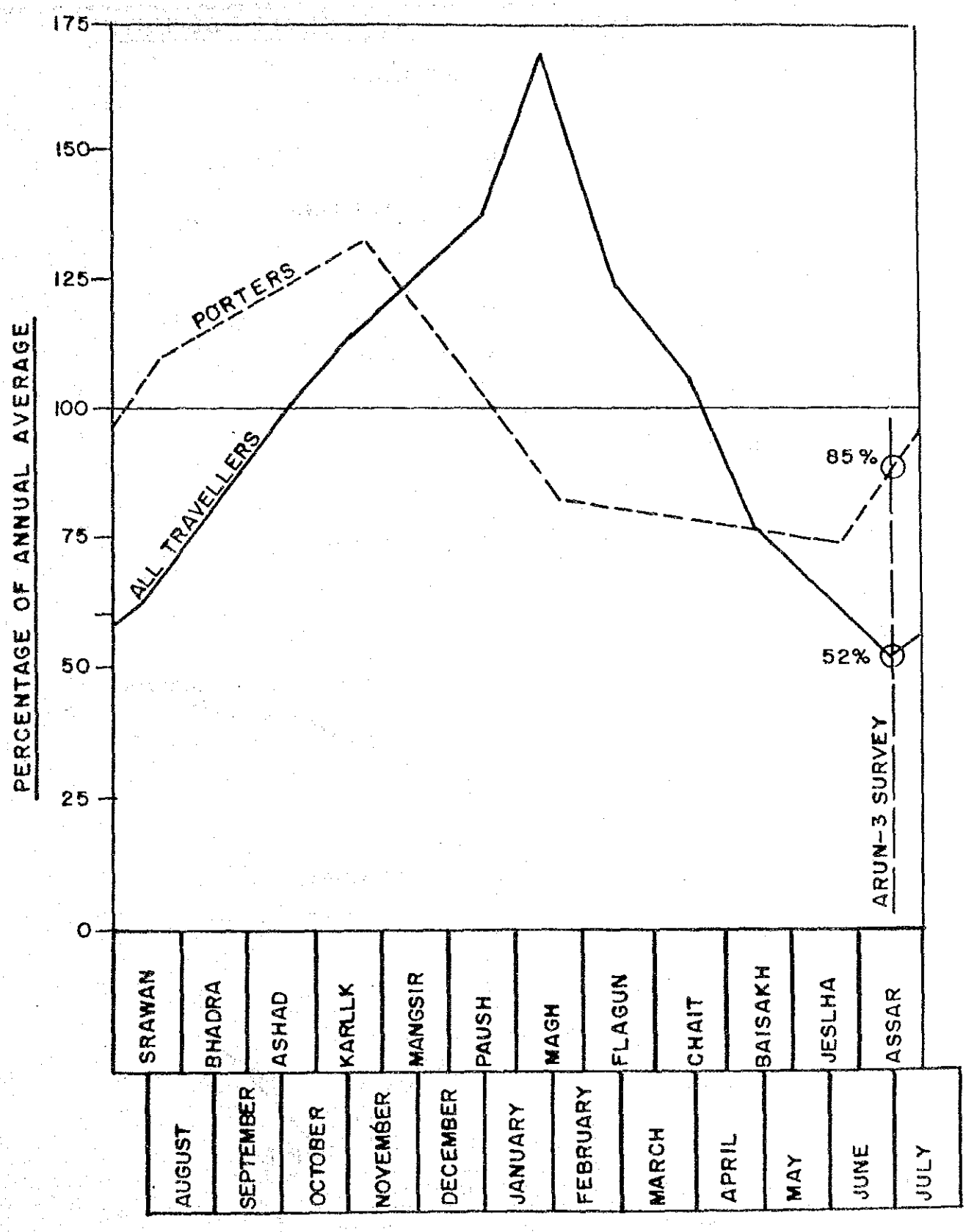
1. If possible, Pls interview all pedestrious outside villages, town ,cities, in addition to porters, if they seem to be travelling long distance.

2. Define Road influence areas within which the O-D survey is conducted (e.g. one day of walking from either side of the road alignment or nearest mountains or R/A boundaries,

3. Record the names of stations and dates / times where the interviews are conducted.

SEASONALITY OF TRAFFIC FLOW

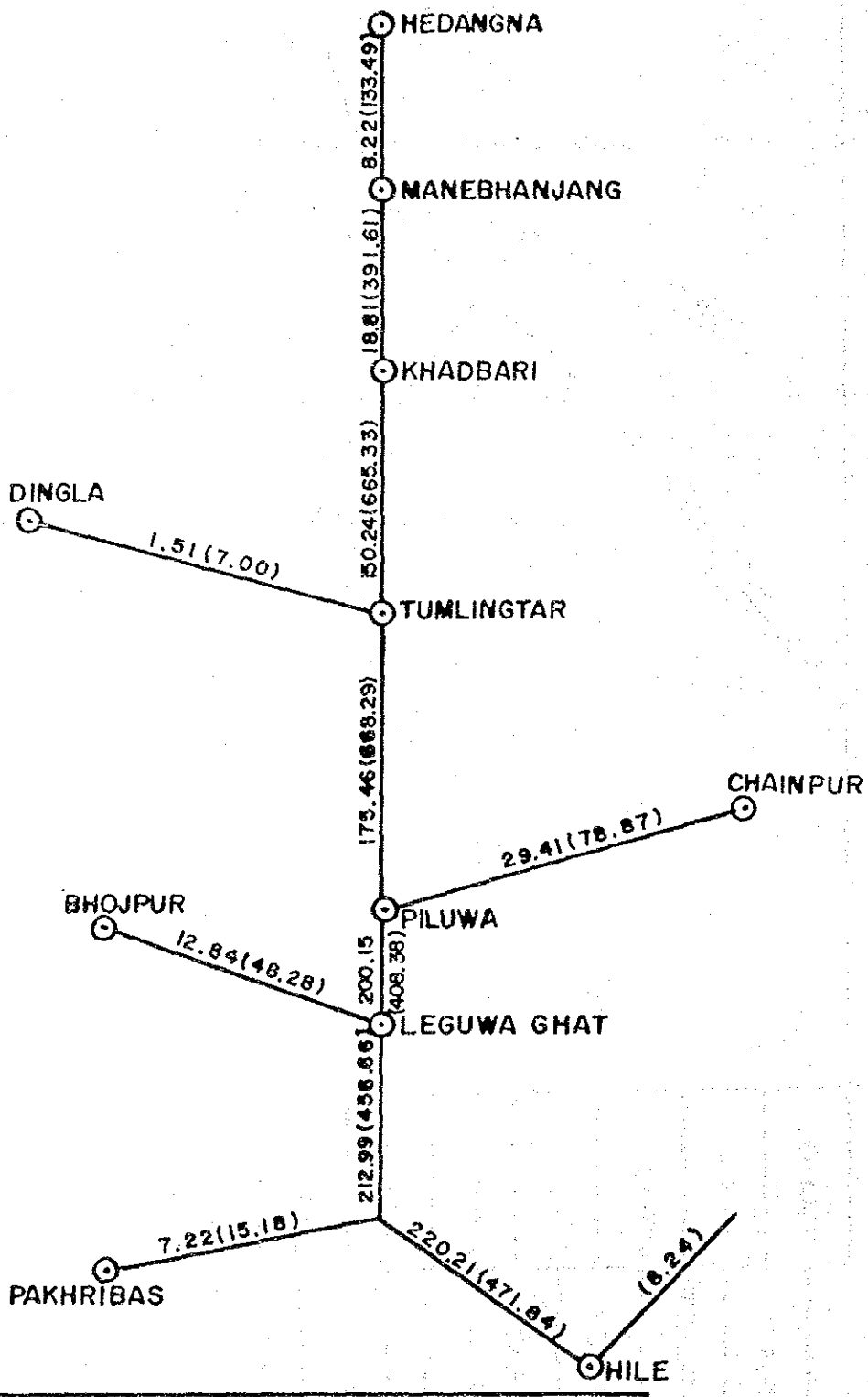
(BASED ON DHARAN MULGHAT TRAIL SURVEYS)



ORIGIN AND DESTINATION SURVEY FOR ARUN-3

FLOW CHART FOR PORTERS AND TRAVELLERS

AVERAGE DAY — SEASONALLY ADJUSTED

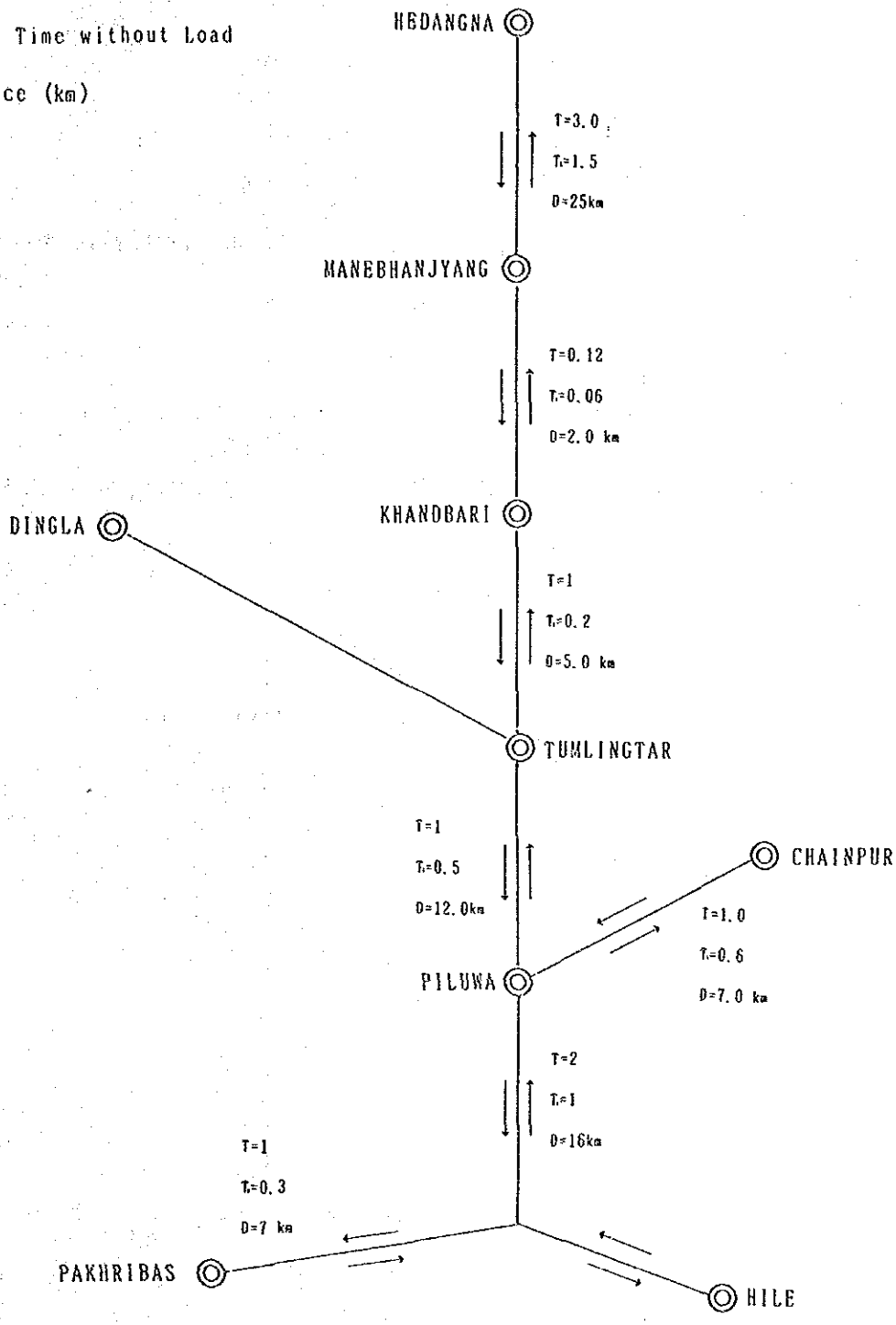


7.22(15.18)	NO. OF PORTERS (NO. OF TRAVELLERS)

T --Travel Time with Load in Days

T_1 --Travel Time without Load

D --Distance (km)



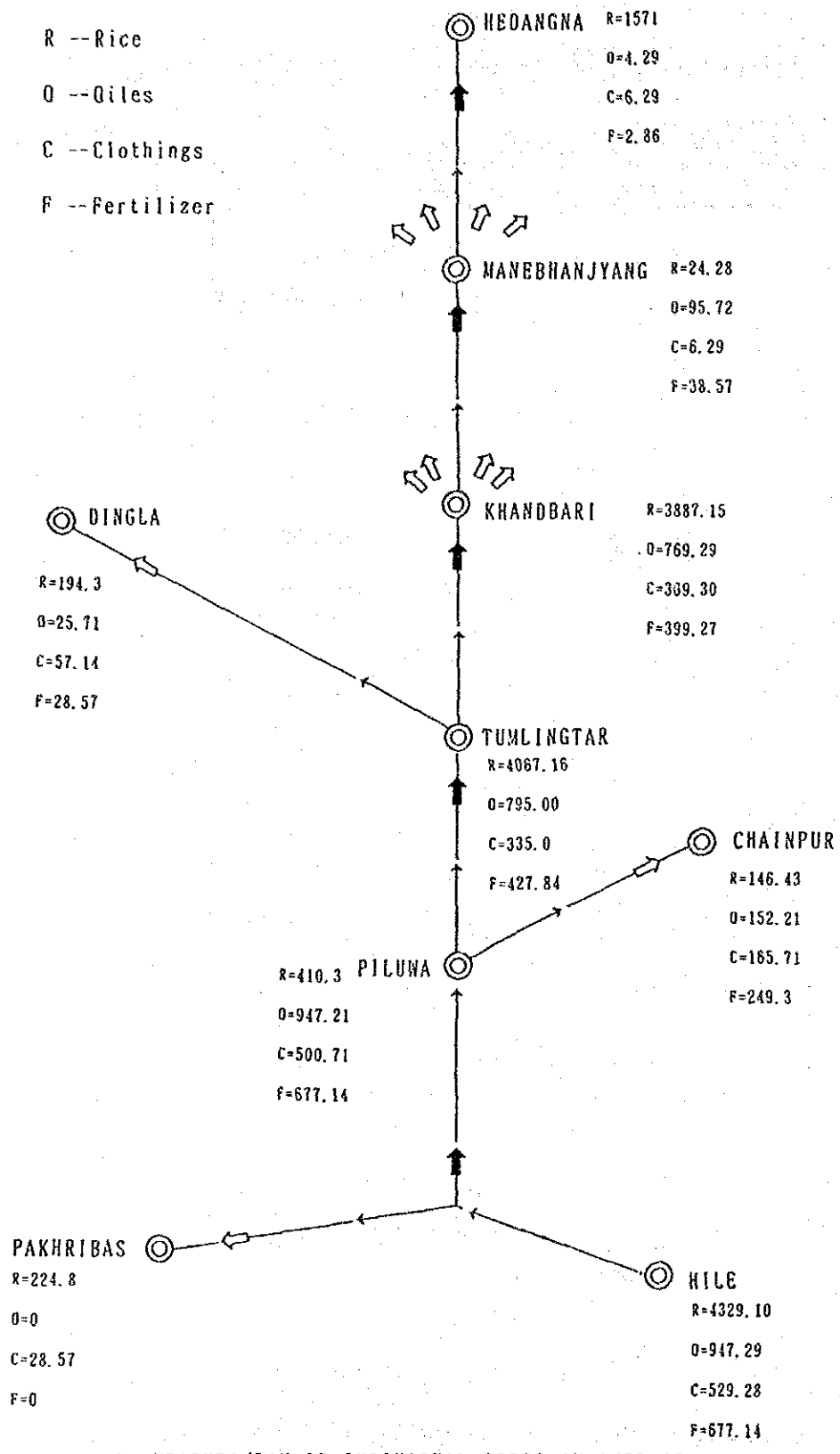
LAY OUT FOR DISTANCE AND TIME FOR TRAVEL

Seven Day (6/27～7/3, 16hours/day) Average

ORIGIN AND DESTINATION SURVEY

FOR

DHANKUTA (HILE) -ARUN III SITE ROAD PROJECT



FLOW CHART OF WEIGHTS/DAY OF INDIVIDUAL GOODS IN AVERAGE

(ALL WEIGHTS ARE IN kg)

ORIGIN AND DESTINATION SURVEY

FOR

DHANKUTA(HILE)-ARUN III SITE ROAD PROJECT

APPENDIX–C GEOLOGICAL SITE-SPECIFIC OBSERVATION

APPENDIX

1. Geological Site-Specific Observation

The field observations reported herein are those made along Alternative B between Hile and the powerhouse. The common alignment of Alternatives A and B were observed between the powerhouse and the dam.

1.1 Hile-Pakhriwas Segment

- Lithofacies: Thinly foliated micaceous schistose gneiss, melancratic granitic gneiss.
- Geostructure: Strike varies NS-N30°W, dip 12°E-32°E.
- Weathering: Rocks are highly weathered. Thickness of soil exceeds 4m in some places.

1.2 Pakhriwas-Leguwa Ghat Segment

- Lithofacies: Granitic gneiss and garnet-bearing mica gneiss on ridge tops; phyllite with compact thrust slab covers most of the area.
- Geostructure: Strike varies from N20°E, 20°E at Pakhriwas, N65°W, 30°NE at Baspani, and N20°W, 35°E at Leguwa Ghat.
- Weathering: Weak rocks are rather fresh. Thin soil covers the area.
- Remarks: At the steep slope 2km east of Pakhriwas, some springs are observed along the assumed thrust boundary of gneiss and phyllite.

  In the phyllite, some minor thrust with compact slab of gneiss was observed. Minor landslides are common in the phyllite underlying the slab. Road alignment is carefully designed to avoid the slide area.

Since the geostructure of the bedrock is dipping to the mountain, the ground is considered as probably stable. Small, but active landsliding was observed in the middlecourse of the Mangmaya Khola (see Geologic Hazard Map).

A cliff of argillized phyllite near the junction of Leguwa Khola and the Arun, and the danger of rock fall in a few places, are the only dangers of possible instability of this segment. No other geologic hazard is presumed.

1.3 Leguwa Ghat-Tumlingtar Segment

- Lithofacies: Thinly laminated/foliated phyllite, banded limestone.
- Geostructure: Strike varies from N40°E, 30°SE to N30°W, 40°NE; in general NS, 30°E.
- Weathering: Rocks are mostly fresh, cropping out along the Arun River without soil cover.
- Remarks: An approximately 400m long cliff of phyllite is on the east bank of the Arun River, 1km north of Leguwa Ghat. Cliff phyllite shows slightly dipping geostructure of N20°E, 10°E, forming stable but steep topography.

Further north, close to the junction of Kenwa Khola to the Arun River, active clayey landslide is observed. The width of the slide is about 50m and the length is about 150m, forming a riverside cliff 10m high caused by washing out of the slide front.

There is another landslide just upstream of the junction, considered to have started to slide recently. Along both sides of the sliding block, fresh gulleys are being formed. The block does not reach the Arun yet.

There are several more additional cliffs along the Arun which may cause rock fall. In short, no important geologic hazard is observed in this segment, except for the active landslide close to the Kenwa Khola-Arun junction.

1.4 Tumlingtar-Powerhouse Segment

- Lithofacies: River terrace sediments (sand and gravel) and phyllite with banded quartzite cover most of the area. Augen gneiss covers the area around the powerhouse site.
- Geostructure: Strike varies from NS, 30°E to N30°E, 35°E.
- Weathering: Mostly fresh along the river. Phylitte is easy to exfoliate when weathered.
- Remarks: The geology of the river terraces at Tumlingtar is composed of loose sand and gravel. Since it is loose and not resistant to erosion, many gullies are being formed, suggesting the possible danger of slope failure at the edge of river terraces.

  Also, in the rainy season, surfacing gravel for a road routed in this area may subside into muddy soil, causing high maintenance cost in the future. Use of geofabric should be considered.

The geology of the downstream of the Kagwa Khola and the Arun river junction is mainly composed of phyllite and intercalated banded quartzite. Since the geostructure is dipping to the mountain, ground is considered as probably stable.

The geology between Kagwa Khola and the powerhouse site is mainly composed of compact augen gneiss, forming very steep topography.

In this segment, no important geologic hazard is presumed, except for possible rock fall in a few steep places.

1.5 Powerhouse-Dam Site Segment

- ○ Lithofacies: Augen gneiss, micaceous schistose gneiss, granitic gneiss, minor amount of amphibolite.
- ○ Geostructure: Strike varies from N20°E, 30°E, 35°E to N50°E, 50°SE; in general, N30°E, 35°SE.
- ○ Weathering: Mostly fresh with thin cover of soil.
- ○ Remarks: The Arun River in this segment has deeply incised the compact gneiss, forming very steep topography. Intercalated zone of micaceous schistose gneiss is easily exfoliated to form relatively gentle-sloping topography cultivated by rural people. Due to the steep topography, rock fall is the most possible hazard.

  Two (2) kilometers upstream from the powerhouse site, a landslide was found on the left (south) bank of the Arun, having a width of 600m, a length of 1000m and an elevation differential of 600m. No indication was found to suggest recent sliding of the area.

  In the Num there is a large landslide on the east-facing slope of the left bank of the Arun River. No evidence showing recent activity was found, and this location is considered to be stable now.

Large active landsliding was found on the right bank of the Arun River, the opposite side of Num. The size of the sliding block is about 1000m wide and 2000m long, and the elevation differential is about 600m. Fresh-walled gullies are being formed at the center and both sides of the block. Huge rock falls are observed at the top of the sliding block. This slide may cause a natural damming up of Arun River if rapid slip-down occurs.

Continuous observation is needed in this sliding area once construction is started. Road alignment is designed 100m + above the riverbed in this section.