United States Department of the Interior
Water and Power Resources Service
Engineering and Research

Team No. General
Book No. 12,241

Translation No. 1654

BUREAU OF RECLAMATION DENVER LIBRARY
92014139

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

NICARAGUA

TIPITAPA-TAMARINDO PROJECT

ANALYSIS OF USBR PREFEASIBILITY REPORT

República de Nicaragua

Proyecto Tipitapa-Tamarindo

Análisis del Informe del Burec

by

Modesto Armijo Mejía
Civil Engineer - Mexico City, Mexico
November 30, 1979

Translated from the Spanish

XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

Division of Design
Engineering Services Branch
Code 283

Translation Section
Denver, Colorado
December 1979

REPUBLIC OF NICARAGUA

TIPITAPA-TAMARINDO PROJECT

ANALYSIS OF USBR REPORT

1.- OBJECTIVE

The purpose of this analysis is to show that the Tipitapa-Tamarindo Prefeasibility Report presented by the USBR to the Government of Nicaragua in May 1978 is not in the best interests of that country. This is because the Report's conclusions present a false picture of the Project's economic merits which could lead to decisions that would obstruct, totally or partially, and forever, the enjoyment of the multiple advantages that Nicaragua could derive from an integrated development of its great lakes.

Without disparaging the exceptional capability of the USBR, perhaps the most prominent institution in the world in its specialty, we must not, if for no other reason than to avoid tremendous harm to the much afflicted people of Nicaragua, conceal the fact that this Report has no value for decision making.

It is precisely because of the prestige of the USBR, whose conclusions and recommendations tend deservedly to be considered as accurate by the international lending institutions, that it is imperative to have a reliable analysis to demonstrate the lack of validity of the USBR Report. Without such an analysis, Nicaragua would find closed the doors of financing sources for this Project, with resulting economic losses for its already strained economy.

We are certain that the USBR will recognize its errors when faced with the reasonable facts presented in this analysis.

Such an acknowledgment on the part of the USBR before the Government of Nicaragua and the international financing institutions would help Nicaragua solve its financing dilemma and would speak highly of the institutional and professional integrity of the USBR.

2.- OBSERVATIONS AND COMMENTS

These refer exclusively to Volume II, which contains the major part of the important data used to prepare the Report.

The observations are presented in the order of their appearance and are designated by an identifying letter followed by the page number in Volume II dealing with the particular subject. All of it concerns the Tipitapa-Tamarindo Project.

No mention will be made of the arithmetical errors found, except for those having a strong bearing on the Project.

A 22.- The design flood for Lake Managua was estimated at 28 714 m^3/s (1 014 000 cfs) for a 6 000 km^2 (2 300 mi^2) basin. The previous data show a Creager C=186 coefficient and a Myer C=21 000 coefficient, both extraordinarily high.

B 25.- The design flood for Lake Nicaragua was estimated at 127 873 m^3/s (4 516 000 cfs) for a 26 000 km^2 (10 000 mi^2) basin, with Creager C=495 and Myer C=45 000 coefficients, both incredible.

Such data places the Lake Nicaragua Basin in a unique category in the whole world, with a flow almost double that of the Mississippi River which has a basin 113 times larger. The comparison with other large rivers is no less impressive.

C 30.- According to Table 14, the spillway of Libano Dam discharges 90 Hm^3 (millions of m^3) during the 140-hour storm over the Lake Managua Basin, that is to say, 3.4% of the volume of the flood, 2 641 Hm^3. The proposed costly spillway is so useless that its omission would produce only an additional rise of 0.09 m in the level of Lake Managua over its 1 060 km^2 area.

There is a gross error in the Table 14 calculations, not specific but which can be proved beyond any doubt by simple arithmetic. This error shows that to guarantee the maximum level indicated at hour 140, it is necessary to have a 2 840-m-long crest, or 19 times the one under consideration.

D 39.- According to Table 17, the San Isidro Dam spillway discharges 167 Hm^3 during the 220-hour storm over the Lake Nicaragua Basin, that is to say, 1.7% of the flood volume, 9 550 Hm^3. The proposed spillway is even more useless than the Libano spillway since its elimination would produce only a 0.02-m rise in Lake Nicaragua over its 8 950 km^2 area. (At most, a discharge structure of much greater capacity, with a

completely different design than the one proposed, would be required for other purposes).

There is also a gross calculation error in Table 17, not specific but which can be proved beyond doubt by simple arithmetic, and which shows that to guarantee the maximum level indicated for hour 220, it is necessary to have a 10 220-m-long crest, or 26 times the one under consideration.

E 47.- The most extraordinary results of A 22 and B 25 and the numerical erros in C 30 and D 39, justify doubting the data appearing in Table 20 which have an enormous bearing on the success of the Project.

E 47.- The difference between the average discharge at the San Isidro and San Carlos sites (Tables 20 and 19) is 29 m^3/s, corresponding to a 0.36 m runoff nappe in the extra 2 510 km^2 of basin. Such a low runoff is inconceivable given the amount of precipitation and losses due to evapotransmiration in the zone. Doubt is further increased by the difference shown on page 35 of Volume I, which increases to 75 m^3/s for a corresponding 0.93 m nappe, which is indeed incredible.

F 53.- Table 22, combined with Table 20, without any possibly necessary adjustments, shows that a pumping capacity greater than the one proposed can translate into an additional average annual energy production of some 40 Gwh at the Tamarindo Powerplant, using only the historical watershed without exceeding the final maximum water level to be established.

G 67.- It is stated that Lake Managua does not offer any significant degree of hazard to the populace in the event of a structural failure. This, in addition to the statement on page 176 saying that the Libano dam spillway would probably never spill, emphasizes the ineffectiveness of the cost of this spillway, as indicated under C 30.

H 71.- It is not true that the temporals can occur at learly any time of the year. To take this statement as fact would prevent the adoption of optimum operations from the standpoint of profitability of the Project.

I 127.- It is stated that tuff outcrops over broad areas between Panaloya, La Ceibita, and Santa Julia and underlies much of the surrounding area at shallow depth. (These tuff outcrops withstand 100 strokes in standard penetration tests and confined lenses of it are of medium to hard consistency).

J 152.- Site alternative. It is stated that the San Isidro topography and foundations seem almost ideal. However, a hydraulically rigid structure, costly to build, is proposed for this site.

As mentioned under D 39, the inclusion of a large-capacity spillway, constructed dry, in the left abutment slightly downstream from the proposed site, would make it possible to build a rock wall (with less than half of the volume of the proposed cofferdams). This spillway design will permit,

thanks to its large capacity (assumed to be 1 500 m^3/s), the operation of the Nicaragua reservoir at an average elevation 0.5 m higher than the one proposed.

K 154.- The Panaloya site was eliminated from consideration on the basis of an unfounded assertion ("lack of foundation on which to sit the pumping plant") and two subjective assessments ("the length of embankment, and the flooding of productive farm lands").

With a logical structural configuration, even though not optimum, the pumping plant exerts lifting pressures of 2 to 3 kg/cm^2, irrelevant for the conditions expressed in I 127. If the criterion implied in this unfounded assertion were valid, most of the large cities of the world would not exist.

The elimination of Panaloya constitutes the most serious error to reduce the economic benefits of the Tipitapa-Tamarindo Project. To illustrate this error, we will express its implications (increased investments or reduced benefits), in millions of dollars. The investments, based on the estimates in the Report, include interest during construction.

		US$ millions
a)	Construction of the Tipitapa inlet channel, unnecessary at Panaloya	51
b)	Current estimated costs of maintaining a)	3

	US$ millions
c) Loss of 1.3 m of head in a). The pumping energy used to make up for this loss is totally unrecoverable, as opposed to that which is used to equalize the geometric difference of levels between the lakes, of which nearly 2/3 are recovered at Tamarindo	
Additional pumping energy	19
Approximate additional electric power	14
d) 70 MW reduction in net energy of the Tipitapa-Tamarindo Project, page 277, avoidable at Panaloya (see P 265)	55
e) The loss c), added to the greater loss for upstream pumping, definitely precludes the option of using reversible units. This situation does not exist at Panaloya, and the cost implications of this proposed design, based on the parameters corresponding to Panaloya, are on the order of $20 million	Option

The implication d) is not unavoidable, see P 265, but such a view is stated in several chapters of the Report and, consequently, it contributes to an erroneous presentation of the Tipitapa-Tamarindo Project.

Altogether, the cost increases at the Libano site amount to approximately $150 million. Compared to this figure, the cost of the dike (1 500 000 m^3 of material in the most conservative alternative) and of the productive farm lands (less than 5 000 ha, without counting those that are inevitably flooded, is irrelevant.

L 154.- The argument used to reject the alternative sites for the Tamarindo dam and powerplant is groundless. Actually:

a) An intake structure as high as the dam is not necessary if the water level variations in the reservoir do not even reach one tenth of the height.

b) For a dam with a 7 500 000 m^3 volume of materials, the type of construction described on page 185: "steel penstocks, encased in concrete, and built by cut and cover methods" placed under the dam and along its main section, is unacceptable unless there were no other option.

If this solution is unsatisfactory for the proposed site, where the length of the penstocks is approximately 200 m, the extrapolation of this figure to more than 2 000 m for the purpose of ascertaining the merits of a second alternative site creates a monumental error which leads to the false assertion that "the second alternative was estimated to be from $50 000 000 to $100 000 000 more expensive than the Tamarindo Dam alternative".

Considering the proximity of the rhyolitic massif to the Tamarindo River, a design such as the one shown in Figure 1, logical from the standpoint of water intake and passage, allows the selection of a damsite which requires less than one tenth of the volume of materials shown in the Report. Waste from the excavation of the tailrace channel, as far as the rhyolites are concerned, could be used for the previously mentioned dam. An in-depth study would identify the most convenient site for the powerhouse. Figure 2 shows a possible site which, without pretending it to be optimum, would serve to demonstrate, together with Figure 1, that the argument advanced to accept the proposed site lacks validity.

The cost disadvantages of this error in site selection exceed $50 million, without taking into account the implications of Q 271 which are also a result of this error.

M 156.- "No attempt has been made to optimize the type of structure used". With a Project so vital to a small nation such as Nicaragua and which presents various unique aspects, this statement is rash coming from the exceptionally experienced and capable persons who were in charge of the study. To a degree compatible with the purpose of the study, it is imperative to optimize, even if only in rough figures, the component features that determine the feasibility of the Project. That statement, taken literally, may explain in part the blunders appearing in the Report.

N 174.- To express in written form all the data and commentary for the pumping plant is not considered appropriate. Regardless whether the plant is located at Libano or Panaloya, the general description of and the proposed characteristics for the equipment are incomplete from the standpoint of investment, energy balance, immediate and long term operating modes, and other factors associated with the amount of water that has to be pumped and the low pumping head.

The most effective way to show the above data is to present them as in Figures 3, 4 and 5, which refer to a plant at Panaloya, with four 9 MW reversible units, 200 m^3/s, 3.75 m of dynamic design head and present no special difficulties given the present state of the art, resulting from an evolutionary process that has been going on for almost half a century, but was ignored in the Report.

The objectionable features of the Report discussed under K 154 and L 154 are sufficient to justify its total revision and the preparation of a completely new document. Figures 3, 4 and 5 are presented to demonstrate that it is possible to adopt logical configurations, although not optimized, which could be applicable to the special features of the Project.

O 182.- The probability is extremely high that the proposed tailrace channel of the Tamarindo plant, requiring an investment estimated at $37 million, will prove to be unnecessary and even hazardous (page 183) along most of its length.

Selection of the sections requiring intervention can only be made on the basis of field studies that would make it possible to determine the sections of equilibrium in accordance with the characteristics of the mud and the bathymetry of the solid foundation. In other times, the estuary was between 400 and 1 000 m wide and much deeper. This diminished because of the decrease in the flows of the Tamarindo River and was worsened by mangroves and materials deposited by water and wind. The large and constant discharges of the future hydroelectric plant will tend to restore the former dimensions of the estuary, rendering unnecessary, until proven otherwise, the construction of the proposed channel. For the proposed investment to produce a benefit/cost ratio equal to the unit, the head losses would have to be reduced by 3 m.

P 265.- Under K 154, d), reference is made to this graph which makes it possible to determine the relation of the increase in channel capacity ("Tipitapa entrance and outlet channels") from 500 to 625 m^3/s without modifying the plant and its conduits, to the cost increase of approximately $9 million, including interest during construction. This increase will make it possible to operate simultaneously the 10 proposed pumping units (page 269), reducing the pumping time by 1 750 hours a year and, consequently, interrupting pumping during the hours of peak demand. The benefits of the Project are augmented by $46 million and the benefit/cost ratio of that

increase in the channel flow mounts to 6.1. There is no need to comment on this failure to develop such an important aspect of the Project, although the factual elements were at hand to study it.

Q 271.- The 77% average plant factor for Tamarindo, resulting from the errors made in L 154, is inconceivable considering the availability of the extraordinary regulating capacity of the large lakes, in addition to the fact that the location will be at 50 and 30 km from Managua and Leon, respectively, the largest urban centers of the country. Furthermore, the plant will be constructed dry, under the most ideal conditions conceivable in Nicaragua.

Holding to this extremely high plant factor will result in less efficient operation of the steam plants and, inevitably, the energy lost at Tamarindo will have to be compensated for by the plants at Rio Grande de Matagalpa, more than 250 km from Managua, or others still more remotely located.

The Tamarindo plant factor should not exceed 50% and should decrease to 35% on a long term basis, when maximum development of irrigated lands will have been achieved.

3.- CONCLUSIONS

On the basis of the results of this analysis, the Pre-feasibility Report for the Tipitapa-Tamarindo Project contains, unfortunately for Nicaragua, some very large and serious errors that make it impossible to correct. It will be necessary to prepare an entirely new report based on a revised scheme, both as a whole and in its components, using on the field information obtained.

A first attempt at revision, based on the costs given in the USBR Report, translates into an increase in benefits of nearly $200 million and in a reduction in costs of more than $150 million, with a benefit/cost ratio on the order of 1.6 instead of 0.7 as indicated in the Report.

Without passing judgment on any individual endeavor, the work performed by the group must be classified as extremely poor from a professional standpoint, and inadequately supervised. Some elementary but very significant errors can only be attributed to incompetence or negligence.

Given the nature of the most distorting errors detected in the Report, the responsibility for them is attributed as follows:

- First, to the USBR, whose previous brillant record was the main reason for entrusting that Agency with this important task and should have constituted the best guarantee of the finest professional work for this transcendental Project.

- Second, to the personnel of BID and PNUD, whose costly services, regardless of who pays for them, presuppose an above average professional capability and who should have detected at least a fraction of the errors found by the undersigned.

- Third, to the Nicaraguan technical personnel whose responsibility here is lessened by the fact that they have had fewer opportunities to acquire the broad experience required by this work. However, they are reproached for their lack of effective zeal which could have led them to prevent some of the errors in spite of their inexperience; or, if they were aware of certain errors, their lack of courage in confronting those responsible for them and thus fulfilling a very basic obligation toward their own country regardless of risk.

4.- RECOMMENDATIONS

Considering the far-reaching importance of the Tipitapa-Tamarindo Project for Nicaragua, both for immediate electrical and other benefits that could virtually transform the nation, it is recommended that:

a) This analysis be discussed with the Nicaraguan technical team members who collaborated with the USBR, whose knowledge of local factors can help clarify the complex technical problems involved. Their consensus should be obtained, with pertinent modifications since they will have the responsibility of proceeding with the corrective measures required by this unfortunate Report.

b) Once the above-mentioned modifications have been worked out, this analysis should be officially presented to the USBR with the request for the appointment of a new professional team, consisting of engineers other than those who had originally participated, to confirm or reject on reasonable grounds, as the case may be, the points made in this analysis.
The USBR should also be asked to present, if appropriate, a brief revised report to the Government of Nicaragua for the purpose of describing for the benefit of the international financing institutions, the true economic, social, and political picture of the Tipitapa-Tamarindo Project. The undersigned is willing to participate in any professional meetings with the team appointed by the USBR.

c) The Inter-American Development Bank be kept informed in the matter of this analysis and its development, and of the consultations with the USBR. That technical assistance be requested for field and office studies which might be urgent in accordance with item a) to prevent any further delays than those already suffered by the Project as a result of the Report.

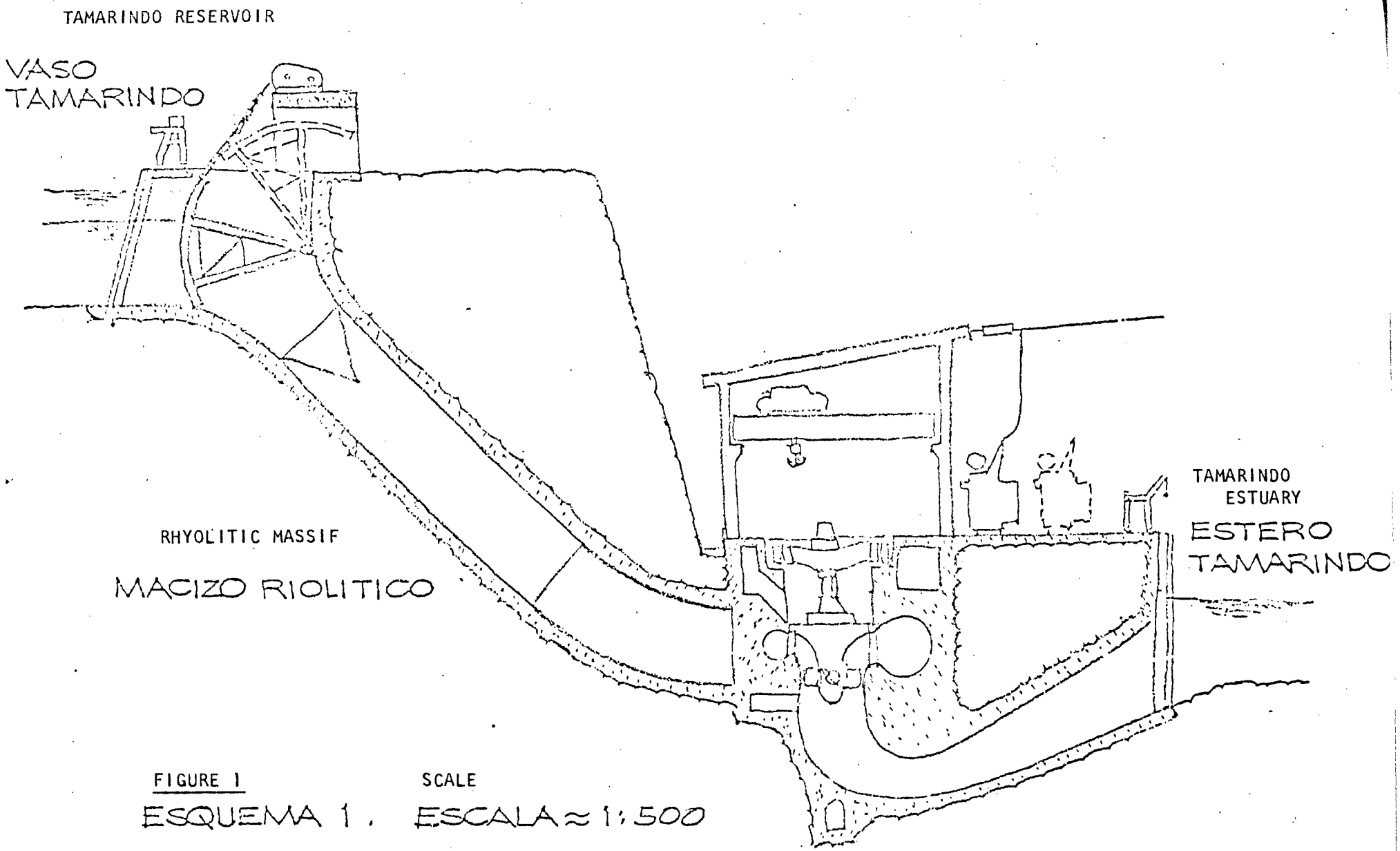


FIGURE 1 SCALE

ESQUEMA 1. ESCALA ≈ 1:500

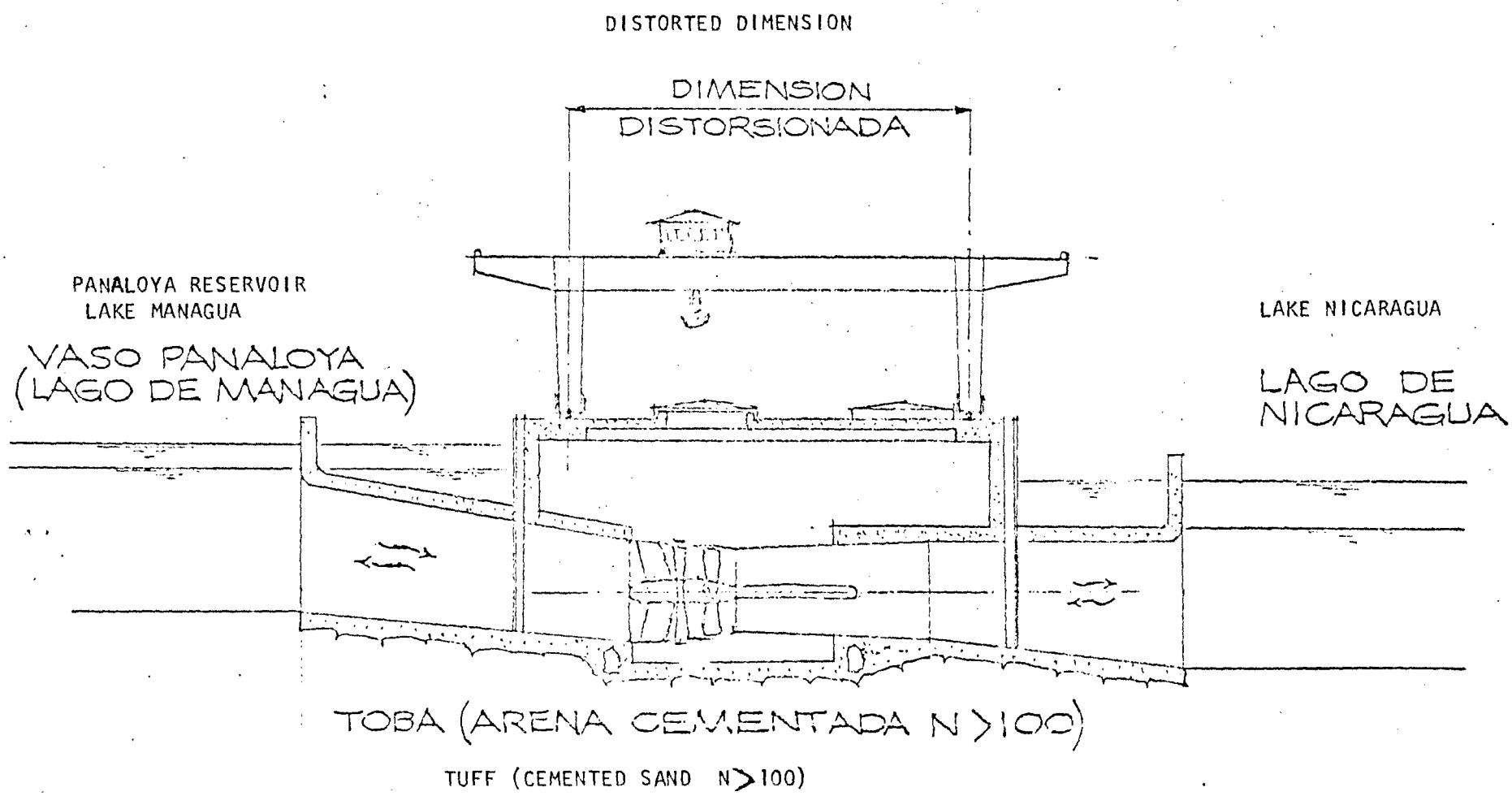
TIPITAPA-TAMARINDO PROJECT, NICARAGUA

PROYECTO TIPITAPA - TAMARINDO, NICARAGUA

PLANTA TAMARINDO

TAMARINDO PLANT

791129



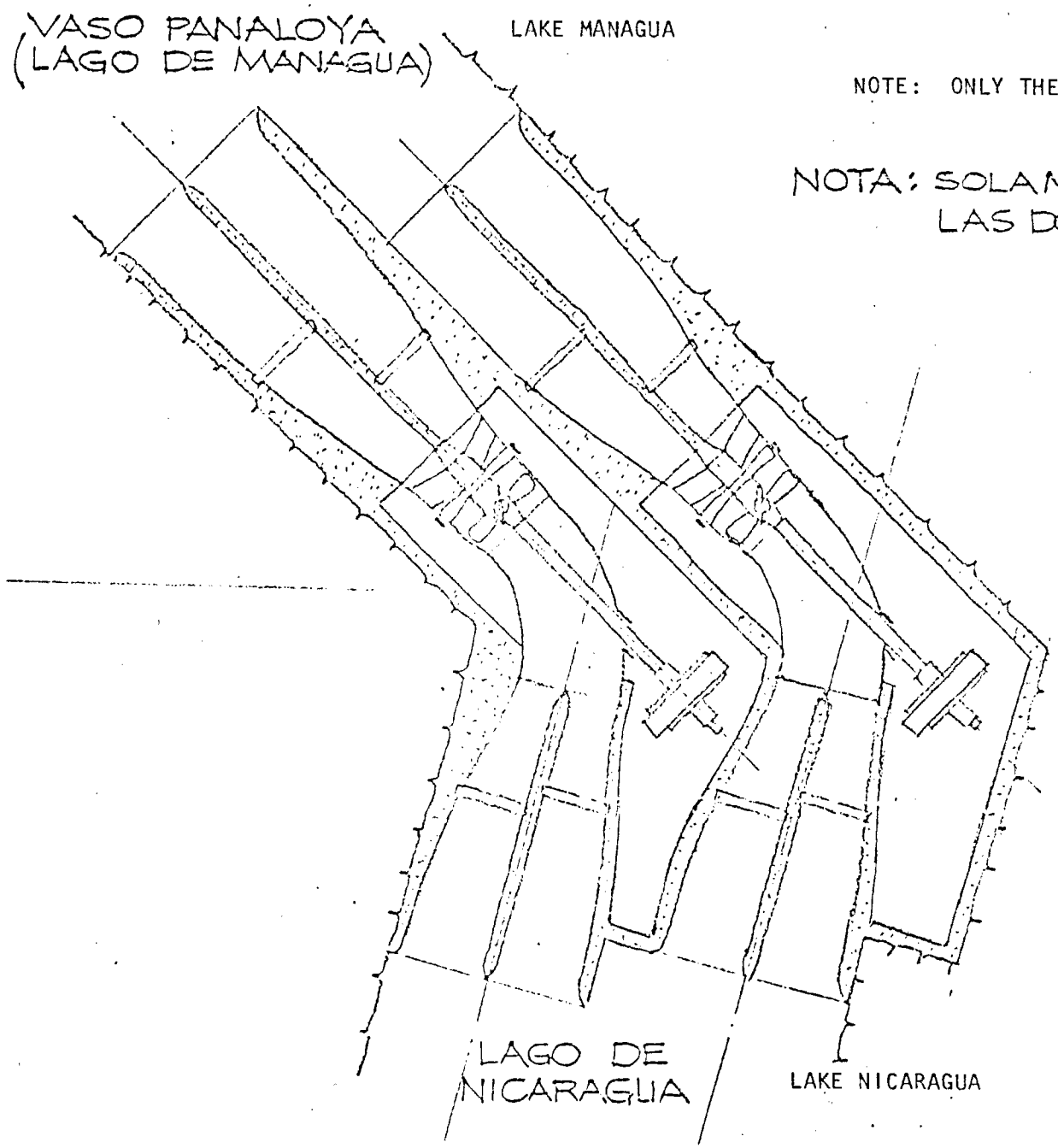
ESQUEMA 3. ESCALA ≈ 1:500.

FIGURE 3 SCALE

PROYECTO TIPITAPA-TAMARINDO, NICARAGUA.

PLANTA PANALOYA

PANALOYA RESERVOIR



NOTE: ONLY THE TWO EXTREME UNITS ARE SHOWN

NOTA: SOLAMENTE SE MUESTRAN LAS DOS UNIDADES EXTREMAS.

FIGURE 4

ESQUEMA 4

ESCALA ≈ 1:500

SCALE

PROYECTO TIPITAPA-TAMARINDO, NICARAGUA.

PLANTA PANALOYA PANALOYA PLANT

7811 29

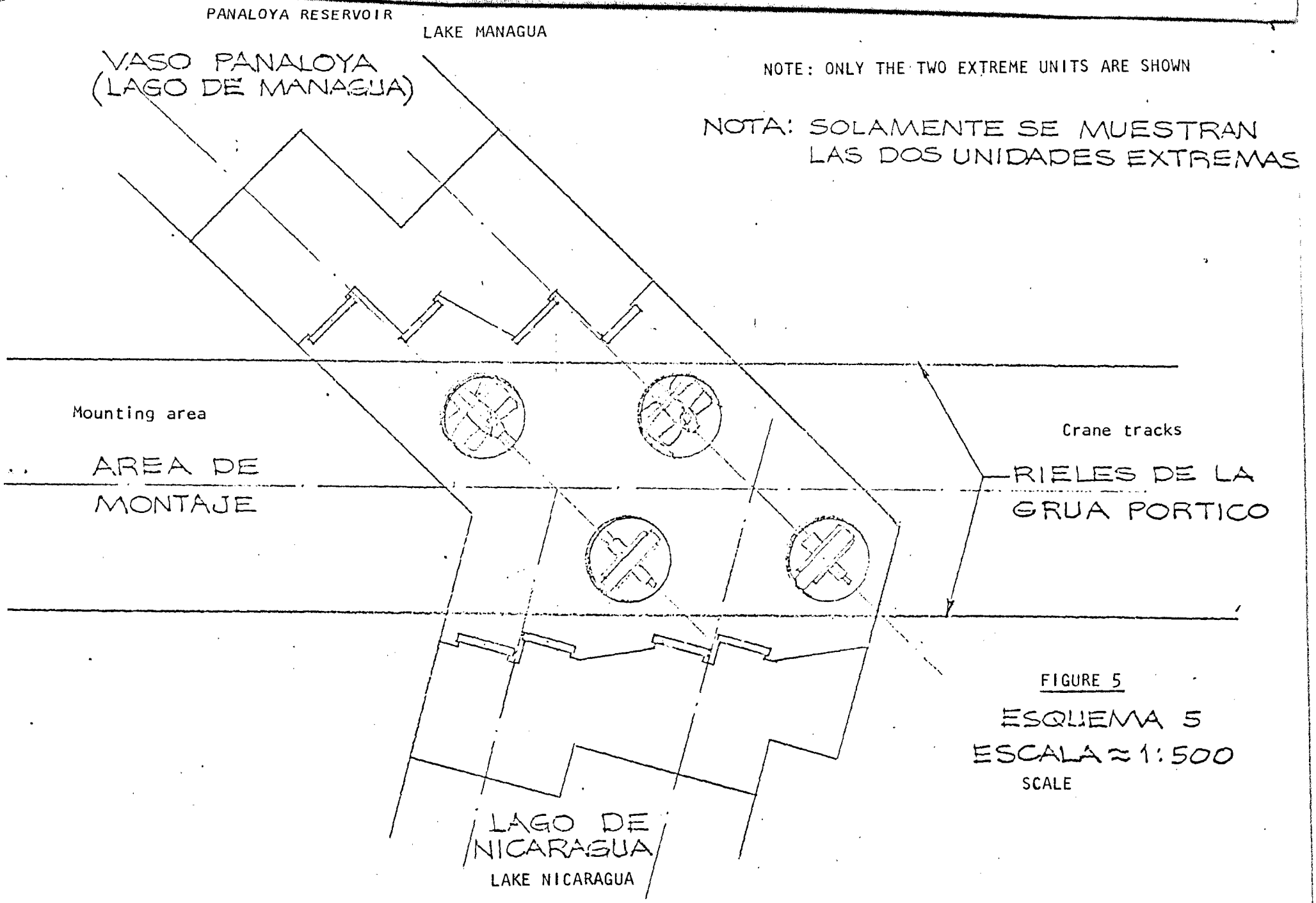


FIGURE 5

ESQUEMA 5

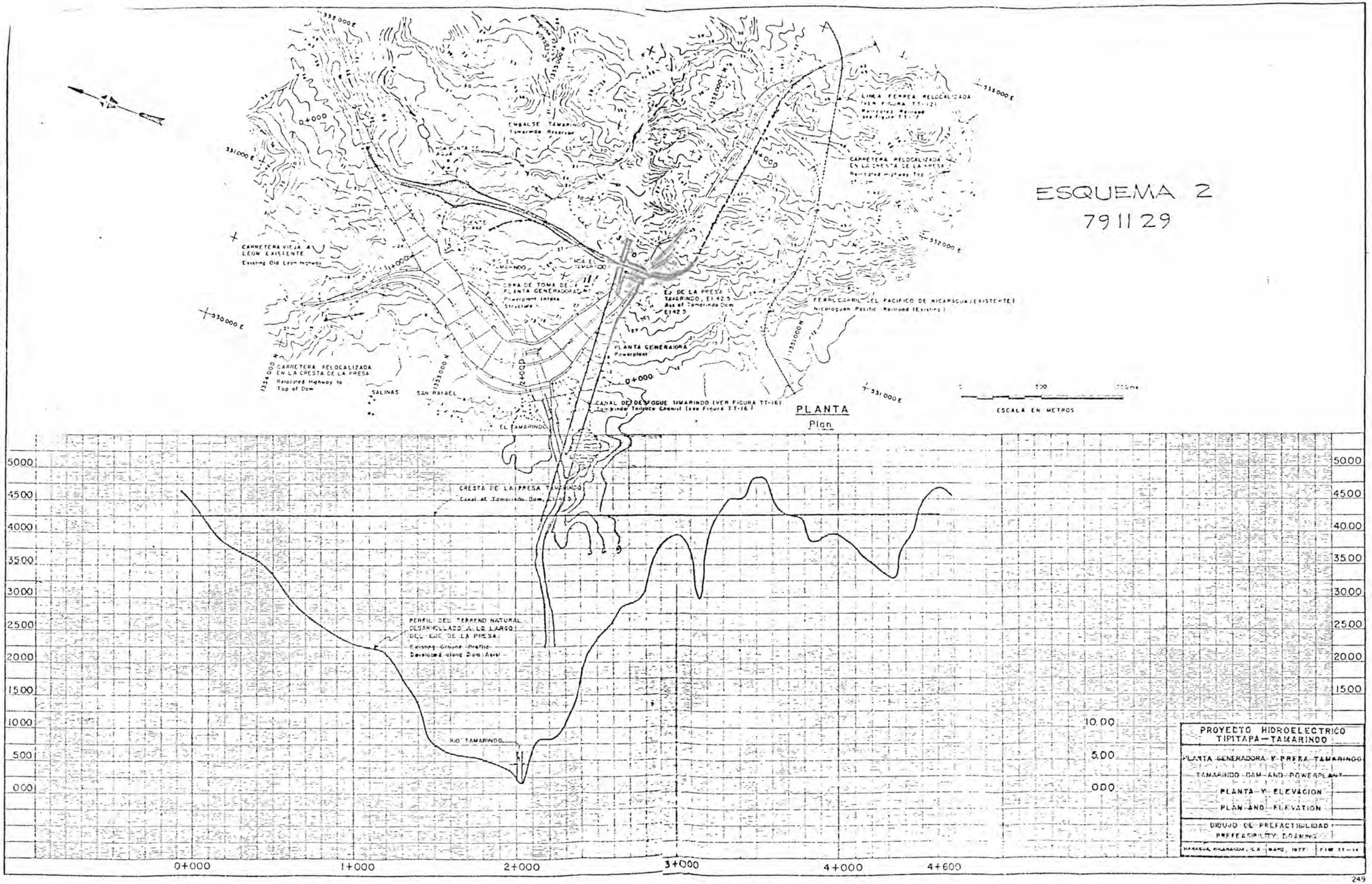
ESCALA ≈ 1:500

SCALE

PROYECTO TIPITAPA - TAMARINDO, NICARAGUA.

PLANTA PANALOYA PANALOYA PLANT

791129


ESQUEMA 2
791129
PLANTA
Plan
ESCALA EN METROS
EMBALSE TAMARINDO
Tamarindo Reservoir
LINEA FERREA RELOCALIZADA
CARRETERA RELOCALIZADA EN LA CRESTA DE LA PRESA
Relocated Highway Top of Dam
CARRETERA VIEJA A LEON EXISTENTE
Existing Old Leon Highway
OBRA DE TOMA DE PLANTA GENERADORA
Powerplant Intake Structure
EJE DE LA PRESA TAMARINDO, El 42.5
Axis of Tamarindo Dam El 42.5
FERROCARRIL DEL PACIFICO DE NICARAGUA (EXISTENTE)
Nicaraguan Pacific Railroad (Existing)
PLANTA GENERADORA
Powerplant
CARRETERA RELOCALIZADA EN LA CRESTA DE LA PRESA
Relocated Highway to Top of Dam
SALINAS
SAN RAFAEL
EL TAMARINDO
CANAL DE DESFOGUE TAMARINDO (VER FIGURA TT-16)
Tamarindo Tailrace Channel (see Figure TT-16)
CRESTA DE LA PRESA TAMARINDO
Crest of Tamarindo Dam, El 42.5
PERFIL DEL TERRENO NATURAL DESARROLLADO A LO LARGO DEL EJE DE LA PRESA
Existing Ground Profile Developed along Dam Axis
RIO TAMARINDO
PROYECTO HIDROELECTRICO TIPITAPA—TAMARINDO
PLANTA GENERADORA Y PRESA TAMARINDO
TAMARINDO DAM AND POWERPLANT
PLANTA Y ELEVACION
PLAN AND ELEVATION
DIBUJO DE PREFACTIBILIDAD
PREFEASIBILITY DRAWING
0+000
1+000
2+000
3+000
4+000
4+600
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
000
PLAN
PROFILE