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PETROVIETNAM
PRE-INVESTMENT STUDY

VOLUME 2
INDUSTRIAL ZONE

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FERTILIZERS

C/F VIETNAM

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1. GENERAL DESCRIPTION OF THE INDUSTRIAL ZONE

1. Definition of the complex and industrial zone
2. Common facilities
3. Regulations

1. DEFINITION OF THE COMPLEX AND INDUSTRIAL ZONE

Throughout the study the term *COMPLEX* will be used to denote the whole comprised of :

- An oil refinery and the accompanying crude oil and finished product storage tanks
- A fertilizer plant with an ammonia unit and nitrogen fertilizer and possibly phosphatic fertilizer units
- A petrochemical plant.

The *INDUSTRIAL ZONE* will include, besides the complex :

- A harbour, the full purpose of which remains to be established but which should at least serve the needs of the industrial zone, particularly as regards raw material delivery and finished product shipping
- A residential area in which will be housed the present local inhabitants together with families of personnel working in the complex and in the other units within the industrial zone
- An electricity generating station supplying power to the whole industrial zone
- A centralized industrial and drinking water plant supplying the whole industrial zone
- A series, yet to be defined, of plants and workshops providing construction materials, mechanical services foodstuffs, ship repairs, etc...
- Networks such as roads, railways, power lines, water supplies, product transfer and transport systems, etc..

A detailed examination of the various elements within the industrial zone is beyond the scope of this study. The following chapters consist of an attempt merely to :

- Outline the future zone
- Establish the most appropriate overall layout
- Take account of the reciprocal consequences of the various alternatives.

2 . COMMON FACILITIES

Central sources will supply the industrial zone with the following :

- Electricity, from a power station scaled to meet the needs of the complex, the urban area and the harbour
- Industrial and drinking water
- Nitrogen (if the partial oxidation process is to be used for ammonia manufacture). The nitrogen production is included in the fertilizer plant.

In addition, a common service will undertake major items of maintenance and technical services for all units in the complex.

Each unit will, on the other hand, produce its own steam, compressed air and demineralized water as required.

- It appears neither necessary nor economical to produce these centrally, bearing in mind that users' specifications vary, that the distances to be crossed are responsible in particular for heat loss in the case of steam, and also that such a system is too rigid and thus presents problems for users whose processes or moment-to-moment requirements vary.

- Each unit will thus have its own utilities plant, comprising :

  - steam production
  - service and instrument air supplies
  - fuel storage and treatment facilities
  - further industrial water treatment if necessary.

Furthermore, day-to-day maintenance, inspection, fire fighting, treatment of waste water and other wastes are specific to each unit and will therefore not be centralized.

3. REGULATIONS

- The French regulations governing the arrangement and operation of crude oil, derivative and residue processing plants will be applied to the refinery and the petrochemical complex. These regulations cover :

  - Layout requirements and safe distances to be observed
  - The construction and definition of certain items of equipment and installations
  - Operating requirements.

- The fertilizer plant will be covered by the French regulations on dangerous, unhealthy and noxious units ; certain parts will if necessary be covered also by the regulations referred to above.

- The harbour area and petroleum product storage tanks outwith the refinery will come under the French regulations on liquid hydrocarbon storage, arrangements and operation.

- Pipelines will be covered by the French regulations on high pressure liquid and liquefied hydrocarbon pipelines.

- Industrial waste will be processed according to French regulations.

It is to be noted that French regulations are generally severe when compared to similar regulations in the world.

2. POSSIBLE LAYOUTS

1. Introduction
2. General characteristics of cases studied
3. Access to site
4. Project development

1. INTRODUCTION

The layout of an oil-based industrial complex within the zone selected by the Vietnamese Government is required to meet certain technical, economic and strategic objectives while at the same time taking account of constraints imposed by the site itself and environmental considerations.

Of all the possible alternatives a number have been selected for study and will be discussed in this chapter. At the end of the volume once all the components of the industrial zone and residential area have been examined, solutions will be compared on the basis of the volume of work and the investment involved.

The choice of alternative layouts and their comparison is based on assumptions as to soil type, which will require to be confirmed by soil surveys (soil strength and core analysis), the only means of reaching a correct decision on the type of foundation for the various units.

2. GENERAL CHARACTERISTICS OF THE CASES STUDIED

The choice of the five cases studied was governed by the following considerations and constraints :

- Distances over which liquid and particularly powdered products have to be moved should be as short as possible.
- Space must be allowed for future expansion
- Industrial units should be spread out, yet interconnections must not be over long
- Residential areas must be kept separate from industrial units
- There must be as little interference as possible with cultivated land.

CASE N°1 : COMPLEX IN SITE NORTH ; HARBOUR IN SITE NORTH

(drawing A.001)

- Refinery, fertilizer and petrochemical plants together in area F
- Crude oil storage within the refinery fence
- Harbour to the North of NGHI SON Island (area C)
- Power plant near the harbour (area D)

Common services required by the complex e.g. medical centre, workshops, could be installed between the road and the hills.

Areas B and D remain unoccupied and could be utilized for other light industries located near the harbour (shipyard, logistics centre for offshore operations, warehouses, etc..). Such a solution spares cultivated areas but leads to long interconnections between the complex and the harbour. On the other hand the various plants are close together rather than being scattered over all the available area

CASE N°2 : COMPLEX SCATTERED OVER SITE NORTH AND SOUTH ; HARBOUR IN SITE NORTH (drawing A.002)

- Refinery and petrochemical plant in area F
- Fertilizer plant and power plant are near the harbour (area D)
- Crude oil reserve storage capacity in area B
- Harbour to the North of NGHI SON Island (area C).

The refinery and petrochemical plants are located in a non-cultivated area. Subsoil quality appears suitable and generally foundations should not require piles except for heavy equipment. The fertilizer plant is near the harbour, thus reducing bag and bulk transport distances. On the other hand, soil quality in area D is less favourable than in case n°1.

Note that cases n° 1 and 2 require a substantial amount of earthwork, which could be minimised, i.e. by terracing the complex platforms.

CASE N°3 : COMPLEX IN SITE SOUTH ; HARBOUR IN SITE SOUTH (drawing A.003)

- Refinery and petrochemical plant in area B
- Fertilizer plant in area D
- Crude oil storage within the refinery fence
- Harbour to the south of NGHI SON Island (area E)
- Power plant near the fertilizer plant (area D).

The producing units are enclosed between NGHI SON Island and the coastal hills, and little room is left for expansion in zones B and D. In addition this solution involves :

- Extending road and rail links with major earthworks in the pass between the two hills
- Canalising the river
- A strong probability of fumes lingering.

With regard to soil type the Southern part is much more varied than the North, having in particular mudbanks alternating with soft clay and sand. This type of soil will undoubtedly mean piled foundations. In the area chosen for storage tanks a thorough soil survey must be carried out in order to determine tank foundation type.

CASE N°4 : COMPLEX IN SITE NORTH ; HARBOUR IN SITE NORTH

(drawing A.004)

- Refinery, fertilizer and petrochemical plants together in area A, with crude oil storage capacity inside the refinery fence
- Harbour to the North of NGHI SON Island (area C)
- Power plant near the harbour (area D)

The complex is sited in a level area, thus very little earthwork will be required. It is not far from the harbour, so connecting links are short.

There is room for expansion to the North and in particular to the West.

This layout leaves areas B and D free for the auxiliary harbour installations and small industries planned.

Road and rail links are short, as is the waste water discharge channel.

While soil quality appears to be good, this must be verified by means of test bores.

The major drawback with this layout is that it uses large areas of cultivated land.

CASE N°5 : COMPLEX IN SITE SOUTH ; HARBOUR IN SITE NORTH

(drawing A.005)

- Refinery, fertilizer and petrochemical plants together in areas B and D, with crude oil storage capacity within the refinery fence
- Harbour to the North of NGHI SON Island (area C)
- Power plant near the harbour (area D)

The complex is very close to the harbour, so this case involves the shortest connecting links.

On the other hand it means :

- Longer road and rail links
- Canalizing the river

and leaves little room for further extensions.

The units are surrounded by hills to the North, South and West.

Soil quality is doubtful.

3. ACCESS TO SITE

Whatever the site selected is, earthworth then civil works, will necessitate using important materials and supplies. It is difficult to convey materials and supplies to the site by road or railway, because the existing means are either inadequate or already overloaded.

From the start it is necessary to provide access by sea in order to unload materials and supplies.

For economic purposes it would be desirable that all these facilities could be integrated in the future harbour.

But taking the definitive harbour location, works' schedule etc... into account, it appears necessary to build a wharf for ships with 4 to 4.5 metres draught corresponding to ships of 1000-1500 DWT, or barges of 2000t or more, or ROLL-ON ROLL-OFF ships with shallow draught.

The West Cape at the North of NGHI-SON Island appears a favourable location for the wharf. Indeed sea bed with 4m is near and an access path to the fish harbour goes along near this point.

Construction of a wharf 150m long and about 10m wide, with aplatform 60-70m long and 20m wide together with a good access way will allow materials and supplies to be unloaded in the first phase.

Later and if the harbour works were late, a channel could be dredged in order to receive ships with a deeper draught and avoid trans-shipment (ship-barge) generating waste of time and difficulties.

4. PROJECT DEVELOPMENT

Before choosing a solution soil types, atmospheric and sea conditions must be thoroughly investigated.

Some data is already available but as such is not sufficient for final conclusions to be formed, particularly in respect of soil types and sea conditions.

Attached (Appendix 1) are standard soil survey requisitions. Requisitions for sea bed and other marine surveys are included in Chapter 3, entitled "Harbour" and in Appendix 2.

3. HARBOUR

1. Introduction
2. Study cases
3. Crude oil delivery
4. Receiving and shipping facilities
5. Project development

1. INTRODUCTION

On account of the country's geographical features, the destinations to which the products of the complex are to be sent and the inadequacy of overland transport, most of the output of the THANH HOA province complex will be shipped by sea.

The need for harbour infrastructure in the northern part of VIETNAM (the port of HAIPHONG being saturated) is a further incentive for the construction of a deep water harbour near NGHI SON Island which could then serve a wider area than the nearby industrial and urban zone alone.

In the course of discussions with PETROVIETNAM it was agreed that the harbour infrastructure described in this chapter would be merely a general framework within which the necessary raw material delivery and product shipping facilities could be set up.

The final design of the future harbour, which is outwith the scope of the present study, cannot be determined until all the necessary data has been assembled and analysed, both in the laboratory and in model form.

2. STUDY CASES

For a number of reasons connected with shore and sea features, two sites have been chosen for study, one to the North and the other to the South of NGHI SON Island.

The harbour layout schemes suggested here are only one possible solution, the main reason for this exercise being the need to outline a preliminary project to allow investment to be calculated and for such schemes to be included in the general study comparing implementation to the north and to the south of the 19°20' parallel, the harbour not necessarily being in the same zone.

2.1. HARBOUR TO THE NORTH OF NGHI SON (drawing A.001)

This location has the advantage that NGHI SON Island offers a natural barrier against south-easterly swells. The northern spur of the island could be extended by a rock-fill jetty to make the basin even more sheltered.

A sloping breakwater perpendicular to the shore and 3,500 to 4,000 metres in length will provide protection against north-easterly swells.

As the sea bed is of sand sloping gently and gradually towards the open sea, breakwater will have to be fairly long in order to reach sufficient natural depth, to keep dredging and maintenance costs to a minimum.

Clearly in order to establish breakwater measurements a balance will have to be made out taking into account :

- The state of the sea bed after dredging (slope and silt)
- Dredging costs
- Cost of breakwater materials at site
- Comparative study of the protection afforded by different layouts and breakwater lengths.

The layouts illustrated assume channel depth to be 12.50 metres which means large vessels up to 70,000 DWT will be able to use it only at high tide ; this also applies to berthing manoeuvres, as the turning basin has the same depth.

Choice of depth could be reconsidered if the volume of large vessel traffic were to increase and delays at the harbour entrance and on leaving berth had to be avoided.

Note that the depth required also justifies quays being far out from the bank, thus creating a sizeable area in the inner harbour which could be used to create level strips with open basins and piers according to requirements.

Such strips could be economically built using dredged material as backfill after construction of a encircling dyke.

Materials for these dykes and the base of the main breakwater will be quarried ; quarrying seems possible in the area.

The breakwater armour layer and pierhead protection, on the other hand, will probably require blocks of over 15 t which will have to be artificially manufactured.

The breakwater will be capped with stone flags and will have a protective wall, to allow access to the wharves in all weathers.

2.2. HARBOUR TO THE SOUTH OF NGHI SON (drawing A.003)

In order to ensure adequate natural depth and protection against north-easterly and south-easterly swells a north-west to south-east breakwater would have to be built out from the south east corner of NGHI SON Island.

This gives a fairly long channel and a very open harbour, and may have to be reconsidered in the light of further data, for example upon completion of the survey to be carried out in this area. A point of particular interest to be investigaged would be the influence of HON ME Island on north-easterly swells.

The position of the pierhead will not be decided until the direction and characteristics of south-easterly swells have been thoroughly studied. A secondary break - water might possible be built to ensure better protection for the inner harbour.

Dredging for this solution would be roughly equivalent in volume to the previous solution, and again the dredged material could be used as backfill. Note that underwater rock resurgence in the area might make rock removal necessary.

There would, however, be a saving of 20 % on the breakwater due to its being shorter than in the North solution.

Jetties and strips could be similarily constituted as in the North solution, unless sea conditions were found to vary enormously from one site to the other.

The depths of the approach channel and of the various turning and berthing areas are the same in both cases.

Preliminary harbour characteristics can be summed up in terms of volume of dredging and breakwater length as follows :

	NORTH	SOUTH
Dredging (m^3)	4 700 000	4 500 000
Harbour platform (m)	1100 x 760	700 x 500 + backfill along the Island
Main breakwater (m)	3 100	1 700
(part outwith level strips)	2 300	1 450

3. CRUDE OIL DELIVERY

There are a priori two possibilities as regards crude oil delivery :

- Tanker berthing in the harbour at suitable quays
- Unloading at sea, crude being brought in by hose and sea line.

- The topography of the area shows that depth of 13-14 metres occur fairly close inshore whereas depths of 20 metres are found only around HON ME Island.

  If large tankers (over 150,000 DWT) are to be used, a sea line of about 12 kms will be necessary, whereas with 80,000 DWT vessels it need only be 2km in length.

- Two main types of crude oil will be delivered to the refinery : local and imported crude. There is no particular advantage in using large vessels over short distances. Local crude will in most cases be delivered by medium sized vessels, i.e. 30 to 50,000 DWT. It is more economical to ship imported crude, on the other hand, in large tankers.

- Large capacity offshore unloading facilities will thus be required for imported crude only. Since possibly only small quantities will be imported, it seems preferable not to adopt this solution, at least during the early years of refinery operation.

- It is not possible to make a techno-economic comparison of unloading 60-70,000 DWT tankers in harbour and at sea using a short sea line without details on sea conditions.

  The two solutions seem a priori more or less equivalent, so that the final choice could be made at a later stage.

However, the nature of Vietnamese crude oil with its high pour point probably counts against the sea line method.

- Note also that if residual fuel oil is to be exported by 30,000 DWT tanker a certain minimum channel and berth depth is required.

- Unloading in harbour has finally been chosen for the purposes of the study.

4. RECEIVING AND SHIPPING FACILITIES

Equipment is more or less the same whatever the solution adopted.

4.1. OIL (see Volume 3, Chapter 3) (figure 3.1)

The main requirements for oil are two wharves :

- One wharf with two berths each comprising a platform and breasting and mooring dolphins.

  One of the berths -berth I- will be able to take vessels of up to 60-70,000 DWT.

  The other -berth IA- will be able to take coasters of up to 10,000 DWT, but will not be fitted out if the refinery produces large surpluses of fuel oil (shipped from berth I).

- One wharf with four berths :

  Berths II and III for coasters only up to 10,000 DWT.

  Berth IV for coasters (up to 3,000 DWT) and barges.

  Berth V for barges only (up to 500 DWT).

Each berth is equipped with adequate loading and/or unloading arms, meters and all instruments required. Reveiving berths include deballasting facilities (ballast water is sent to the refinery).

4.2. SOLID PRODUCT SHIPPING

A quay 600 to 700 m long will be used for shipping solid products, generally bagged. Facilities will include :

- 2 barge berths to take 500 DWT maximum size
- 1 coaster berth to take 3,000 DWT maximum size.

These will be fitted for speedy loading (conveyor belts or cranes as appropriate).

4.3. V.C.M.

Oil berth IV can be used for receiving VCM. In view of this it will be fitted with an unloading arm and suitable equipment.

Whichever harbour site is chosen (North or South) docks and moles can be constructed to create more unloading capacity and to extend harbour facilities e.g. shipyard, logistic centre for drilling facilities, etc...

The harbour will of course be equipped with all the necessary facilities for normal operation, e.g. refuelling systems, tug and service vessel berth, etc...

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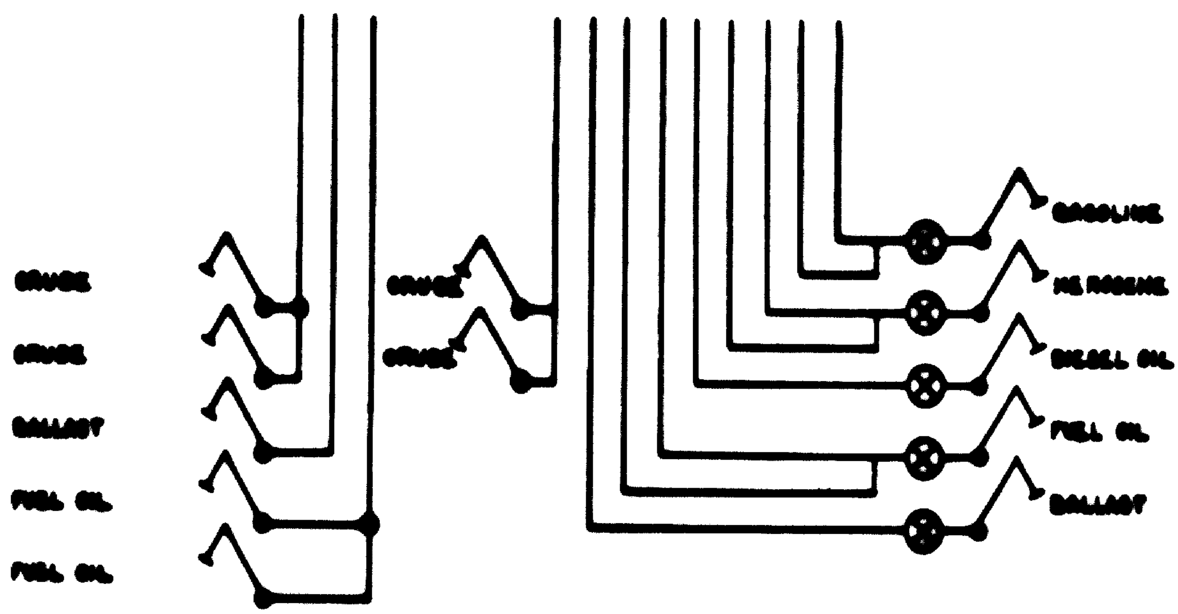
Figure 3.1

SOLUTION B
WITH FUEL EXPORT
BERTH 1
CRUDE 35/70 000 DWT
FUEL EXPORT 20 000 DWT

SOLUTION A
WITHOUT FUEL EXPORT
BERTH 1 AND 1A
CRUDE 35/70 000 DWT
COASTERS 5/10 000 DWT



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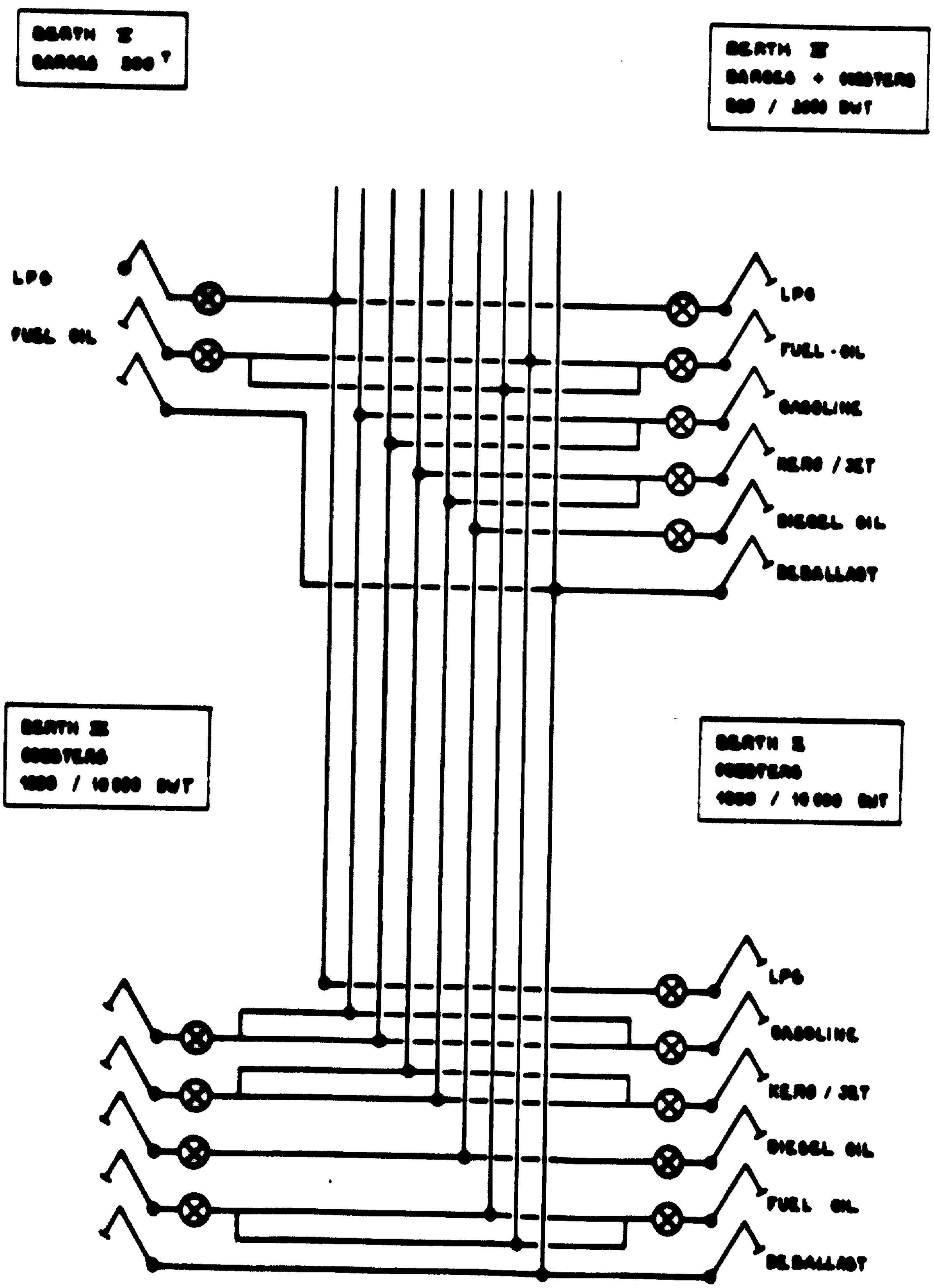
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GASOLINE
KERO / JET
DIESEL OIL
DEBALLAST
LPG
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DIESEL OIL
FUEL OIL
DEBALLAST

5. PROJECT DEVELOPMENT

The harbour implementation study cannot commence until all the necessary data has been assembled :

- Physical properties of the site
- General operation
- Local resources.

Some data is available on the physical properties of the site. Included in the Appendix is a standard requisition covering oceanographic surveys, topographical data, soundings, tests and laboratory work (see Appendix 2).

Data on general operation include :

- Expected traffic : - volume
  - kind
  - vessel type
- Proposed facilities : - slipway
  - type of dry dock
  - ship repair yards
  - storage systems
  - sheds
  - land area served

Data on local resources cover :

- Quarries - rock quality
  - granulometry
- Equipment available in VIETNAM : - marine equipment
  - dredging equipment
  - onshore equipment
- Implementation methods best suited to local conditions.

4. RESIDENTIAL ZONE AND PUBLIC FACILITIES

1. General description ; basis of the study
2. Site
3. Inhabitants and type of housing
4. Construction
5. Public facilities

1. GENERAL DESCRIPTION - BASIS OF THE STUDY

Housing and public facilities will be implemented as the first stage of a township which will eventually have a population of some 200,000.

This first step will involve construction of township to house around 50,000 innabitants in 10,000 housing units on the basis of 5 people per unit.

2. SITE

- The residential area must be far enough from the industrial zone to be free from its unpleasant aspects i.e. noise and pollution, yet close enough to allow its inhabitants to cycle to work. In addition the surroundings should be as pleasant as possible.

- An area of some 900 ha is available around the stretch of water presently being created at the mouth of the River BANG and would make a suitable site.

  The surroundings are satisfactory, the township would be by the sea and separated from the industrial zone by a wooded area or a green belt, and the stretch of fresh water will provide both a boundary and an amenity.

3. INHABITANTS AND TYPE OF HOUSING

3.1. INHABITANTS

The future township will house :

a) Present inhabitants of the area, displaced on account of the construction of the residential area and the industrial zone, whether engaged on the project or not.

b) Management and workers from other parts of VIETNAM involved in construction.

c) Specialist expatriate management and assemblers involved in supervision and unit erection.

d) Vietnamese management and workers engaged in operating and maintenance.

e) Expatriate management assisting with initial operation and maintenance.

Housing, especially for those in categories b) and c), must obviously be constructed very early on in the project so as to provide suitable accommodation close to the site for all local and expatriate personnel, from commencement of construction.

3.2. TYPE OF HOUSING

1. BASIS

A typical housing unit assumed to house 5 people and to have the following surface area :

. Main rooms	30 m^2
. Kitchen	9 m^2
. Bathroom, storage space	6 m^2
TOTAL	45 m^2

2. INHABITANTS PER HECTARE

Urban zones are of three types :

	Inhabitants/hectare
. Densely populated	250
. Moderately populated	150
. Sparsely populated	100.

Density in accommodation built in the vicinity of industrial complexes to house local and expatriate personnel is generally 70 inhabitants/hectare, for these reasons :

- There is a high proportion of common facilities to inhabitants
- Housing is of single storey type to make for ease and speed of construction.

Assuming for the first stage a township of 50,000 with a high proportion of public facilities to cope with future development and with a density of 100 inhabitants/hectare, surface area will be

$$\frac{50\ 000}{100} = 500 \text{ ha}$$

When further buildings are added, taking into account existing public facilities population density could become 120 inhabitants/hectare, i.e.

$$\frac{150\ 000}{120} = 1\ 250 \text{ ha}$$

the total land required thus being 1 750 ha. If the township is to be kept to the 800 ha site, this gives a density of

$$\frac{200\ 000}{800} = 250 \text{ inhabitants/ha.}$$

This is the equivalent of a densely populated urban area, and multi-storey blocks would have to be constructed.

A compromise would be to blend single storey detached houses with gardens with two or three-storey blocks to be used as bachelor accommodation and for some public facilities such as administration the hospital, etc...

4. CONSTRUCTION

Since 10 000 housing units and the accompanying public facilities have to be constructed in a very short time, construction will have to be industrialized.

In view of this a light prefabricating works should be set up near the industrial zone to produce concrete parts (bonders, posts, beams and panels) and -if there is clay nearly - ceramics (bricks, tiles, etc..).

The materials produced would be used in construction of the first stage of the residential area, industrial and harbour installation, and subsequently the second stage of the residential area. Cement requirements could be met either by constructing a cement works or by importing.

5. PUBLIC FACILITIES

The township will necessarily include the following :

- Administration building
- Police station
- General services building
- Shopping and crafts centre
- Restaurants and short-term accommodation
- Hospital and social services
- Cultural centre
- Sports complex
- Water purification plant (outside the built-up area)
- Drinking water and power supplies (see relevant chapters).

Helicopter landing strips will have to be built near the hospital and near the industrial zone. An airport is to be constructed to the North of the site.

5. ELECTRICITY PRODUCTION

1. Introduction
2. Purpose of the power station
3. Electricity requirements
4. Capacity
5. Type of station
6. Layout
7. Distribution to the industrial and urban zones

1. INTRODUCTION

Power supplies to the industrial and urban zones involve :

- a generating station
- a high voltage (30 kV) network supplying the consumers, who are :
  - the refinery
  - the petrochemical plant
  - the fertilizer plant
  - the harbour
  - the town of 50,000 (first stage).

This section sets out various possibilities and solutions with respect to the purpose, type and layout of the generating station.

2. PURPOSE OF THE POWER STATION

The power station is intended to supply electricity required by the industrial zone and the town.

It will not be required to feed the national grid, and will therefore be sized for the zone alone. It is not intended to link up with the national grid, initially at least, though this might be done at a later stage, in which case this power station would be the first step towards a larger station scaled to the national grid.

This station will produce solely electricity, i.e. it is not intended to provide steam for the various units in the complex, which are expected to do so themselves.

3. ELECTRICITY REQUIREMENTS

3.1. INDUSTRIAL ZONE

The units within the industrial zone are not intended to include generators contributing to the grid, but each plant will have a diesel generator to ensure emergency supplies to certain equipment in the event of a serious breakdown in the distribution system.

The power requirements of the refinery and fertilizer plant vary greatly depending on the manufacturing scheme adopted. For the refinery, only schemes with relatively low investment are being considered, i.e. from a simple scheme to one with hydrocracking, and for the fertilizer plant the three alternatives proposed by PETROVIETNAM have been adopted.

The requirements of the industrial zone are as follows :

. Refinery	8-17 MW
. Petrochemical plant	5
. Fertilizer plant	8-17
. Harbour	0.5
T O T A L	21.5-39.5 MW

3.2. URBAN ZONE

From EDF statistics and analyses relating to the developing countries, two types of user emerge, with the following average annual consumption :

- Type I users 2,000 kWh/year
- Type II users 800 kWh/year.

In a town of 50,000 people with 5 to a housing unit, the number of housing units is 10,000. Numbers of Type I and Type II users are estimated as follows :

- Type I : 20 % i.e. 2,000
- Type II : 80 % i.e. 8,000.

On this basis average annual consumption for domestic uses would be :

- Type I : $2{,}000 \times 2{,}000 = 4 \times 10^6$
- Type II : $800 \times 8{,}000 = 6.4 \times 10^6$

$$10.4 \times 10^6 \text{ kWh/year}$$

To this domestic consumption figure must be added "non-domestic" consumption covering craftsmen, traders, public services, etc.. estimated at 20 % of domestic consumption, giving :

$$10.4 \times 10^6 \times 0.2 = 2.08 \times 10^6 \text{ kWh/year}$$

This puts the town's total average annual consumption at :

$$(10.4 + 2.08)\ 10^6 = 12.48 \times 10^6 \text{ kWh/year.}$$

Peak power for the town will be : $P = \frac{W}{H}$

taking H as 2,000 hours (sum of peak periods over the year)

$$P = \frac{12.48 \times 10^6}{2{,}000} = 6{,}240 \text{ kW}$$

3.3. The range of total requirements to be met is as follows :

- Minimum 27.5 MW
- Maximum 45.5 MW.

3.4. In sizing the power station an additional requirement of 4.5 MW is allowed, which partly covers the future growth of the town (to almost double) :

- Minimum 32 MW
- Maximum 50 MW

4. CAPACITY

Once the ultimate dimensions of the refinery and fertilizer plant are known, total electric power requirements can be determined with accuracy.

At this stage three alternatives may be envisaged :

- Case A : total requirements : 32 MW
- Case B : total requirements : 40 MW
- Case C : total requirements : 50 MW.

Guaranteed capacity of the power station will be 32 MW, 40 MW and 50 MW respectively. Guaranteed capacity is here taken to mean capacity available to the grid, or net capacity, when the largest electricity generating unit is at a standstill.

There are several possibilities as to power unit number and size. The table below gives a number of simple solutions meeting guaranteed capacity requirements, while assuming a rather good reliability for each unit.

CASE	A	B	C
GUARANTEED CAPACITY (MW)	32	40	50
SOLUTION 1	2 x 32	2 x 40	2 x 50
SOLUTION 2	3 x 16	3 x 20	3 x 25
SOLUTION 3	4 x 10.5	4 x 13.5	4 x 16.5
SOLUTION 4	5 x 8	5 x 10	5 x 12.5

Solution 1, involving two units, is rejected for the following reasons :

- It is unsuited to average requirements on account of the low load ratio expected :

  $$\text{load ratio} = \frac{\text{average requirements}}{\text{net capacity}}$$

  In case A if average requirements are 25 MW the load ratio is :

  $$\frac{25}{2 \times 32} = 39\ \%$$

  In case C if average requirements are 40 MW the load ratio id :

  $$\frac{40}{2 \times 50} = 40\ \%$$

  A load of approximately 40 % is rather low if the desired efficiency is to be obtained.

- Should one unit fail, the whole comples depends on the other section alone, so that power supplies are much less reliable.

The other three solutions are acceptable provided that the reliability of each unit is sufficient to supply the total needs, even when the largest unit is at a standby.

It is much more important at this stage to define the <u>type of power station</u> possible.

5. TYPE OF STATION

The power station may be of the following types :

- Total condensation steam turbine
- Gas turbine
- Diesel.

5.1. TOTAL CONDENSATION STEAM TURBINE

This type of power station is particularly suited to medium and large capacity units (over 50 MW), the high investment being compensated by

- high efficiency
- great reliability
- wide range of possible fuels.

The latter point is important since with a refinery close by, residual fuel oil could be used as fuel.

The possibility will be considered of setting up three 20 or 25 MW units, each with :

- high pressure boiler
- condensing turbo-alternator
- auxiliary equipment, including a large cooling system.

Smaller sized units would not be economical.

5.2. GAS TURBINE

This type of power station is suited to small and medium capacity units (up to 90 MW).

Investment is lower (about three times) than for the above type, but on the other hand :

- efficiency is medium, and mediocre with a low load
- reliability depends on the fuel used
- the fuel has to be fairly noble.

On the last point, note that :

The best fuel for gas turbines is gas or distillate. Residual fuel generally contains metals which can corrode the turbine blades, so removal of such metals or at least inhibition of their corrosive action is vital.

Note that residual fuel oil from MINAS crude could be difficult to be used in gas turbines due to its lead content being over 1 ppm.

The gas turbines would therefore have to be fuelled with a distillate, at an annual consumption rate of some 90,000 tons for anaverage requirement of 30 MW.

Keeping fuel quality considerations in mind, the gas turbine type of power station remains a possibility, its exact construction (3, 4 or 5 sets) depends to a great extent on contractors' tenders.

Note, however, that to satisfy the reliability requirement a 4, 5 or 6 set type is preferable, as it is quite likely for two sets to be out of action at the same time.

5.3. DIESEL

From the capacity viewpoint this type is also suitable, and here again, for reasons of reliability a 4, 5 or 6 set type is preferable.

Investment is higher (about 1.5 times) than for the gas turbine type, but :

- efficiency is excellent, whatever the load
- residual fuel can be used as fuel.

5.4. CHOICE OF TYPE

The following table 5.1. summarizes the main pros and cons of each type for power capacity in the range of 32 to 50 MW.

Within the considered power range (32 to 50 MW) diesel groups are generally the best economic solution, the additional investment as compared with gas turbine is often recovered over less than 5 years.

Table 5.2. gives preliminary and comparative figures for the respective cost of kWh/h produced by the three types. Note that gas turbine type is heavily penalized compared with the two others by a higher fuel cost (110$/ton instead of 87$/ton).

TABLE 5.1

ELECTRIC POWER PLANT COMPARISON

CHARACTERISTICS	GAS TURBINES	DIESEL	STEAM TURBINES
Erection and start-up duration	<1.5 years	2 years	> 2 years
Reliability per unit	Average	Average	Good
Residual fuel oil utilization	Very difficult	Possible	Possible
Adequacy to requirements	Good	Good	Difficult
Unit consumption fuel/kWh	High	Low	Average
Operating labour	Low	Low	High
Maintenance cost/kWh	High	High	Average
Operating cost/kWh	High	Average	Average
Investment/kW	Low	Average	High

TABLE 5.2.

COMPARED KWH PRODUCTION COST

(EUROPEAN BASIS) MID 1978

	GAS TURBINE (8 to 20 MW)	DIESEL GROUP (8 to 20 MW)	CONDENSATION STEAM TURBINE (20 to 50 MW)
INVESTMENT ($/kW)	325	400	700
DEPRECIATION ($/MWh)	3	4	6
OPERATING COST ($/MWh)	39	24	28
of which FUEL ($/MWh)	(38)	(18)	(28)
T O T A L ($/MWh)	42	28	34

6. LAYOUT

Layout depends on the type of power station.

6.1. A total condensation steam turbine type power station required great amounts of cooling water : 5 200 m^3/h for every 20 MW.

In this complex two solutions are possible :

- Closed circuit cooling, using atmospheric coolers
- Direct cooling by sea water.

The first of these is less attractive in that it leads to lower efficiency, as the temperature of water leaving the cooler is higher than average sea water temperature (by about 2°C, i.e. 0.8 % of efficiency). In addition make-up water (treated industrial water) would be used at a rate of 200 m^3/h for every 20 MW.

For this reason a power station of this type has to be built near the sea.

If the harbour is to the North, the cooling water pumping station would be at the harbour, in order to have the intake in calm waters, and discharge would be on the other side of the breakwater to avoid warm water being recycled. The power station itself would be at most 1,000 m from the harbour (see drawing A.001).

If the harbour is to the South, the power station will be near the fertilizer plant, with the water intake from the sea to the north-east and discharge into the sea to the South (see drawing A.003)

6.2. A gas turbine or diesel type power station does not require such quantities of cooling water, so there are fewer constraints on layout.

Remembering, however, that the power station might be considerably expanded, for example after link-up to the national grid, it would be desirable at a later stage to choose total condensation steam turbines, if this is warranted by the increase in power.

Initial siting near the harbour paves the way for possible expansion.

6.3. The total site area to be allocated to the power station will be 40,000 m^2 which will allow it to double in size.

7. DISTRIBUTION TO THE INDUSTRIAL AND URBAN ZONES

CHOICE OF VOLTAGE

In view of the small area to be supplied and the average power assumed to be required, 30 kV would be a suitable voltage from the point of view of efficiency and investment.

Moreover, with this voltage it is still possible to use standard prefabricated metallic cells for the power station and supply points ; these have the advantages of ease and speed of installation, no major operation and maintenance problems, and a high safety level for users.

DISTRIBUTION

30 kV overhead lines

Three points are to be supplied :

- Refinery and petrochemical units
- Fertilizer plant
- Town

To ensure reliable supplies, each point should be fed by two lines. In the event of failure of one line, the other would supply total power needs.

This means therefore that six 30 kV overhead lines would be required.

30 kV supply points

° REFINERY AND PETROCHEMICAL UNITS

Two supply points, one per plant, each fed by one line and interconnected by a 30 kV overhead or underground line.

Should the supply from one line fail, the corresponding point - thereby deprived of power- could be fed from the other, and vice versa.

- **FERTILIZER PLANT**

The two lines run to the plant supply point. In normal operation power is supplied by one line, the other though live being held in reserve. Should the line in use break down, supply will be switched to the other.

- **URBAN ZONE**

There will be two supply points, each fed by one line, situated on the outskirts of the town at opposite sides. From there power will be fed to substations within the town for low voltage distribution.

In normal operation each point supplies about 50 % of the town's total power requirements. In the case of breakdown of one point the other would take over the total supply.

6. DOMESTIC AND INDUSTRIAL WATER SUPPLIES

1. Sources
2. Requirements
3. Treatment plant

1. SOURCE

It is planned to draw fresh water from the artificial reservoir under construction in the BANG river estuary.

BEICIP's representatives were advised that the flow would be 6 cubic metres per second and that pumping could continue throughout the year.

The latter point is important and will require to be checked once construction of the reservoir is completed, because in some cases the permanent flooding of estuary basins affected by the tides alters the balance of water tables, so that considerable losses occur by seepage.

With regard to siting the water intake, we recommend that it be as far upstream from the reservoir as possible so that the treatment plant will always be supplied from running water.

This offers a means of reducing future treatment problems due to significant changes in the physico-chemical properties of water stored in natural reservoirs and brought about by the presence or development of vegetable matter.

It should also be ascertained whether drinking water could not be supplied from underground springs and water tables near the site, reservoir water then being used exclusively in the industrial units.

2. REQUIREMENTS

2.1. DRINKING WATER

At this stage of the project a reasonable estimate of water consumption would be 100 litres per head per day, i.e. :

- for 50 000 inhabitants 5 000 m^3/day
- for 200 000 inhabitants 20 000 m^3/day.

The drinking water supply plant could be designed for 5000 m^3/day during Stage 1. It is sufficient to double this rate to cover peak demand.

The plant would therefore operate at an average rate of :

- For 50 000 inhabitants : $\frac{5\ 000\ m^3/day \times 2}{24h \times 3600\ s}$ = 115 l/s
- For 200 000 inhabitants : $\frac{20\ 000\ m^3/day \times 2}{24h \times 3600\ s}$ = 460 l/s

These figures will have to be readjusted to take account of the public buildings where water consumption is lower.

For the industrial zone (excluding the township and harbour) taking as basis a workforce of 2500 in the first stage and a consumption of 100 litres per person per day, total consumption would be 250 m^3/day giving a peak rate of :

$$\frac{250\ m^3 \times 1.5}{24h \times 3\ 600\ s} = \sim 5\ l/s$$

This would be doubled for Stage 2.

Harbour water requirements include in particular fresh water for ships, estimated at about 400 m^3/day in the first stage and double this in the second.

2.2. INDUSTRIAL WATER

It is more difficult to assess industrial water requirements for the industrial zone at this stage in the project. The following levels can be presumed :

· Refinery	200 - 370 m^3/h
· Fertilizer complex	520 - 900 m^3/h
· Petrochemical complex	about 85 m^3/h
· Power station	negligible *
· Harbour	negligible
· Various industries (estimate)	100 m^3/h

making a total of some 1 000 to 1 500 m^3/h. Requirements for Stage 2 can be estimated at about 2 000 to 3 0000 m^3/h.

Water requirements for domestic and industrial use can be summed up as follows :

	Stage 1	Stage 2
	litres/second	
· Domestic uses		
- Urban zone	115	460
- Port	10	20
- Industrial zone	5	10
TOTAL	130	490
· Industrial uses	280-420	560-840
TOTAL	410-550	1050-1330

* *Except in case of steam turbine cooled by industrial water which is not recommended.*

3. TREATMENT PLANT

3.1. RAW WATER PROPERTIES

It is assumed that raw water will :

- at all times of year have a suspended matter content of less than 1500 mg/litre ;
- be free from serious specific pollution requiring processes other than those normally employed in treating ordinary surface water.

3.2. TREATMENT SCHEME

Two separate treatments are necessary to meet requirements as estimated in paragraph 2. These are :

- Primary treatment of the total quantity required (both domestic and industrial) to obtain water suitable for most industrial uses, particularly cooling system make-up water.
- Secondary treatment to obtain domestic-quality water for both the residential and the industrial zone.

Industrial water requirements are so varied in terms of quality that a single general treatment is not possible. Each user will therefore perform a further treatment to suit specific requirements (process water, boiler water, etc..).

3.3. DESCRIPTION OF THE PLANT

1. RIVER WATER INTAKE

Raw water will be taken from the river by electric pumps fitted with cleanable mesh and filters, and sent to the treatment plant.

The intake will be sized so as to allow pump capacity to be increased without any major alterations.

2. PRIMARY TREATMENT

This consists of clarification by decantation after coagulation, flocculation and neutralization.

The clarified water will be sent by gravity to a reserve tank from where it will go to two pumping stations :

- one feeding the industrial water supply network
- the other taking the decanted water to drinking water treatment.

3. DRINKING WATER TREATMENT

This will consist of a quick acting sand filter system.

4. CHLORINATION PLANT

This will have the twin role of prechlorinating water to remove organic matter in particular and desinfecting water for human consumption.

3.4. SUPPLY NETWORK

The treatment plant will feed two separate supply networks, one taking industrial water to users in the complex and the other taking drinking water to both the town and users in the complex.

7. LIAISONS

1. Roads
2. Railways
3. Interconnections
4. Waste water disposal

1. ROADS

Roads will be of two types :

- Main roads serving the complex directly, formed of two 6 metre carriageways separated by a central reservation
- Secondary roads from the complex to the harbour and also possibly boundary roads, formed of one 6 metre carriageway with two-way traffic.

The principal approach road to the complex and to the harbour will follow the line of an existing earth road which joins up with highway n°1.

The distance between this approach road and the industrial units will be not less than 150m, firstly for safety reasons and secondly to allow the intervening space to be used for :

- pipes to and from the harbour
- pipes linking the various units
- power and communications cables
- the industrial waste water sea discharge pipe
- a cycle track.

From this main road side roads will lead off to the different plants. A crossroads will be formed to speed up traffic while observing safety requirements. The complex and other industrial zone units will be linked to the residential area by a road running north-south following the coast for the most part.

Preliminary estimates of road lengths according to the alternative layouts (see the chapter on Layout) are given below in metres :

	Main roads	Secondary roads
CASE N°1	7 300	8 900
CASE N°2	10 300	11 800
CASE N°3	11 300	11 900
CASE N°4	6 900	8 900
CASE N°5	10 200	8 600

2. RAILWAYS

Allowance has been made for the proposal widening of tracks from the present 1.1 metres to the standard 1.44 m.

As traffic on the line serving the complex and harbour will be light and slow-moving, standard 36 kg/m rail will be used with concrete sleepers and smooth stone or crushed stone ballast.

Rail access will be by means of a new line joined up with the present line and serving the various units by branch lines.

The railway approaches the complex from the north. It links up with the main line at the CUA BANG river loop, where it runs alongside the road and railway. A bridge will have to be built over the river.

To avoid holding up traffic on the highway this could be built over the new railway line.

To ensure an efficient service a marshalling yard must be built, consisting of :

- a group of sidings with three tracks roughly 500 m in lenght (depending on the length of trains on the line), one track being for arrivals, one for departures and one for through traffic.
- a set of marshalling tracks, initially perhaps four in number with room for more if required to serve the industrial and harbour zones.

The marshalling yard will be on level ground between the complex and the main railway line.

Approximate line lengths for the alternative layouts are as follows :

- CASE N°1 10 600 metres
- CASE N°2 14 700 metres
- CASE N°3 15 700 metres
- CASE N°4 9 200 metres
- CASE N°5 14 700 metres.

3. INTERCONNECTIONS

This covers links between units within the complex, shipping facilities and the centralized utility units (electricity, water, nitrogen).

It is too soon to define these in detail at this stage since production capacities have not yet been finally decided.

For the purposes of site comparison, however, a basic solution has been adopted, involving a refining scheme of average complexity, a fertilizer plant manufacturing ammonia by the partial oxidation method and also urea, a petrochemical plant producing PVC only, and the corresponding auxiliary units.

OIL

Pipelines will run :

- From *refinery to harbour*, taking the various products including export fuel oil and ballast, according to the planned flow rate. Fuel oil pipes will be insulated and marked out.

- From *harbour to crude storage tanks*

- From *crude storage tanks to refinery* (when these are not integrated)

- From *refinery to power station* (insulated, heated pipe)

- From *refinery to fertilizer plant* : insulated, heated pipe and also other pipes for by-products.

SOLID FERTILIZERS

From *fertilizer plant to harbour* by conveyor belt (see volume IV, chapter 4.6).

In the same volume the conveyor belt system is also adopted for phosphate rock if nitrophosphates are to be produced.

NITROGEN

Pipeline from the fertilizer complex air separation plant to users (refinery and petrochemical complex).

POWER LINES

These will run from the power station to industrial and urban users (see chapter 5).

INDUSTRIAL AND DRINKING WATER

Pipelines from the purification station to users (see chapter 6).

VCM

Pipeline from harbour to PVC plant.

4. WASTE WATER DISPOSAL

4.1. COMPLEX

Waste water from the complex will undergo specific treatment in each unit before being sent to a channel common to all units discharging into the sea.

This channel will also collect unpolluted water from non-contaminated zones in each unit.

On leaving each unit waste will meet the specifications laid down in the regulations referred to in chapter 1.3 so that pollution will be sufficiently low as to present no hazard to animal and plant life.

4.2. URBAN ZONE

On account of urban density a purification station will have to be built for urban waste water collected by a separating system.

The treatment plant will have to be included in the preliminary phase of the project in order to handle effluent from the construction camp, and will be expanded as the population increases.

On the basis of data presently available it is difficult to assess population growth, the estimate being 10,000 at the completion of construction and start-up rising to 50,000 and eventually 200,000 inhabitants.

In view of this the plant must be of medium size initially to facilitate subsequent expansion.

In this case if appears preferable to choose a plant based on activated sludge with aerobic sludge stabilization, on account of investment being low and operation simple, although energy consumption is somewhat higher.

8. PRODUCT PIPELINE

1. Pipeline route
2. Choice of material

In view of the inadequacy of overland transport it seems advisable to supply the HANOI region by means of a finished products pipeline.

It is estimated that some 835 000 tons, or 1 050 000 m^3 of white products (gasolines, kerosene and diesel oil) could be shipped by this means.

Although initial investment is high, pipeline transport offers a means of saving energy and cutting down road and rail traffic.

Large capacity terminal storage facilities will be required, and these are assumed to be situated to the South of HANOI.

1. PIPELINE ROUTE

On leaving the site the pipeline route meets up with the North-South railway and runs parallel to it until THANH HOA. It skirts round the west side of the town, crosses the SONG MA river and then 6 or 7 km further on meets up with highway n°1 which it follows practically up to the terminal South of HANOI, passing to the west of NINH BINH and to the east of PHULY Drawing A.010.

All built-up areas are to be by-passed in order to prevent inconvenience to the population and to avoid construction problems.

As almost all the land to be crossed is planted with rice and subject to flooding, the pipe must be weighted down to prevent it from rising when empty - this is particularly liable to happen with 10" pipe.

Bearing this in mind it is preferable to lay the pipe along the roadside whenever possible.

All river crossings will be excavated.

The estimated length of the pipeline is 210 km.

2. CHOICE OF MATERIAL

In calculating diameter account was taken of :

- the nominal rate of 1 050 000 m^3/yr of white products including gasoline, kerosene and gas oil with an average density of 0.80
- steel qualities : API 5 L grade B
  API 5 LX - X 52

  The first of these is an ordinary steel requiring no special precautions.

  The second requires more care and special welding rods.

There are two possibilities :

8" Pipe

To achieve the nominal rate with 8" pipe an intermediate pumping station is necessary.

Using three intermediate stations 1 400 000 m^3/yr could be conveyed.

Weight of pipeline : 8" pipe API 5L grade B steel : 7700 t
API 5LX-X52 : 6750 t

10" Pipe

With 10" pipe the nominal rate can be achieved directly and there is no need for an intermediate pumping station.

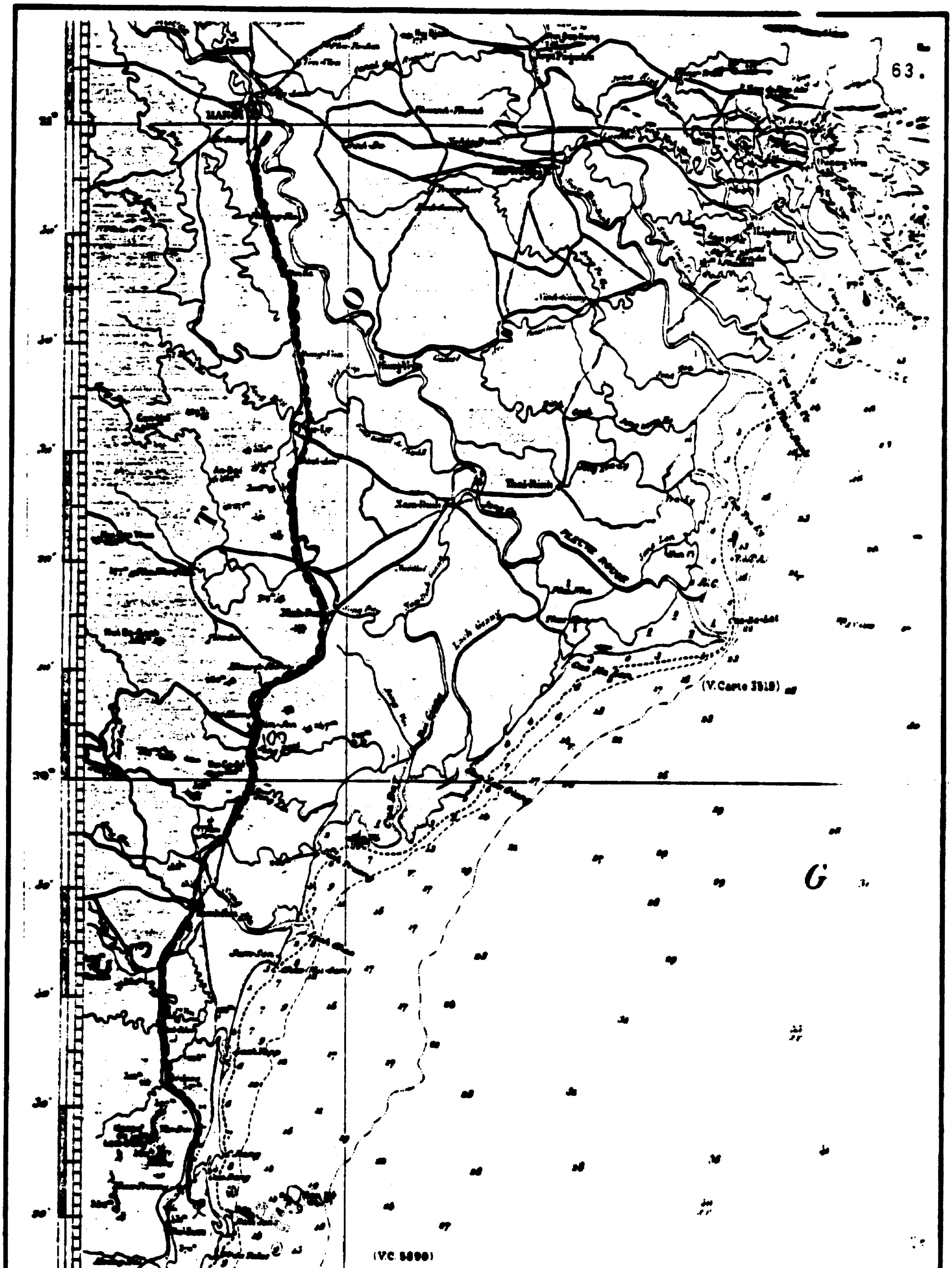
Using one intermediate pumping station 1 400 000 m^3 can be moved, and with three intermediate pumping stations the nominal rate can be doubled, i.e. 2 100 000 m^3.

Weight of pipeline : 10" pipe API 5L grade B steel : 8450 t
API 5LX-X52 : 7850 t

By choosing 10" pipe a good safety margin is ensured, the nominal rate being doubled. On the other hand if the rate is not likely to vary in the foreseeable future it would be better to use 8" pipe which involves lower investment for both the pipe itself and for construction, but which means at least one extra pumping station.

The choice of steel quality depends on the qualification of welding labour, on the ease of obtaining pipe and welding rods, and on the time required for pipe manufacture.

63.



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REV.	BY	DATE	DESIGNATION	CHK	SCALE :	78 060 - A 010	REV : 0

9. TECHNO ECONOMIC COMPARISON OF THE CONTEMPLATED SITES

The objective of this part is to compare the 5 possible locations defined in chapter 2.

For the purpose of comparison and in order to figure the overall investment cost of the industrial zone implementation (excluding town) arbitrary refining and fertilizer production schemes have been considered.

Such a selection obviously affects the auxiliaries plants such as electricity and water production facilities.

Refinery

- Capacity — 5 000 000 tons/year
- Scheme n°6 — Coking/thermal cracking
  Design 50/50 MINAS/ARABIAN crudes

Fertilizers

- Ammonia — 1000 tons/day
  process : partial oxidation
- Urea — 570 000 tons/year

Petrochemicals

- PVC — 60 000 tons/year

Power plant   Diesel 6 x 9 MW.

Case n°2 has been selected as basic case. Such a solution fits with several criteria proposed by PETROVIETNAM, i.e.

- maximum cultivated land saving
- scattering of the plants and particularly of crude oil and finished product storages
- general preference for the Northern site.

Scattering the plants and remoting them from the sea obviously make the case N°2 the most expensive to be implemented (table 9.1). However serious unknowns remain concerning the quality of soils and bottom sea concerned for case N°3, the cheapest. Only detailed surveys could provide information on that subject which could possibly modify the present ranking.

In fact the present economic comparison shows the additional cost to be spent to respect some agricultural or strategic constraints. (table 9.2).

Investments have been evaluated in the same way as defined in Volume III, chapter 3.5. Calculation have been made taking implementation conditions prevailing in developing countries ; that means high foreign currency portion (76 % as first estimate) due to large utilization of foreign high skilled labour.

Note once more that the corresponding figures are only orders of magnitude presented for comparison purpose and likely to be largely modified in a further stage.

Expenses involved by temporary facilities to be installed at the beginning of the project implementation, i.e.

- temporary wharf for receiving the first equipment
- access roads
- temporary camp and utilities

are included in the investments (erected in VIETNAM) estimated for the main production units.

TABLE 9.1

ECONOMIC COMPARISON OF THE ALTERNATIVES PROPOSED BY

PETROVIETNAM

	ALTERNATIVE I	ALTERNATIVE II	ALTERNATIVE III
MATERIAL BALANCE (tons/year)			
. Urea	200 000	450 000	570 000
. Ammonium nitrate	333 000	150 000	
. Nitrophosphate (20/30)	300 000		
. Nitric acid	10 000	10 000	
. Calcium carbonate	171 000		
RAW MATERIALS UTILITIES			
Feedstock for ammonia	fuel oil	fuel oil	fuel oil
. Phosphate rock (tons/year)	225 000	-	-
. Fuel (10^6 kcal/h)	438	394	391
. Power (kWh/h)	14 220	6 045	5 090
. Water (m^3/h)	1 510	1 210	990
ECONOMIC ITEMS (including ammonia)			
TOTAL INVESTMENT IN VIETNAM (10^3 US$)	583 000	485 000	410 000
OPERATING COST (10^3 US$)	55 210	42 610	41 375
PAY OUT TIME (years)	7.4	7.3	6.4

TABLE 9.2

SITE COMPARISON

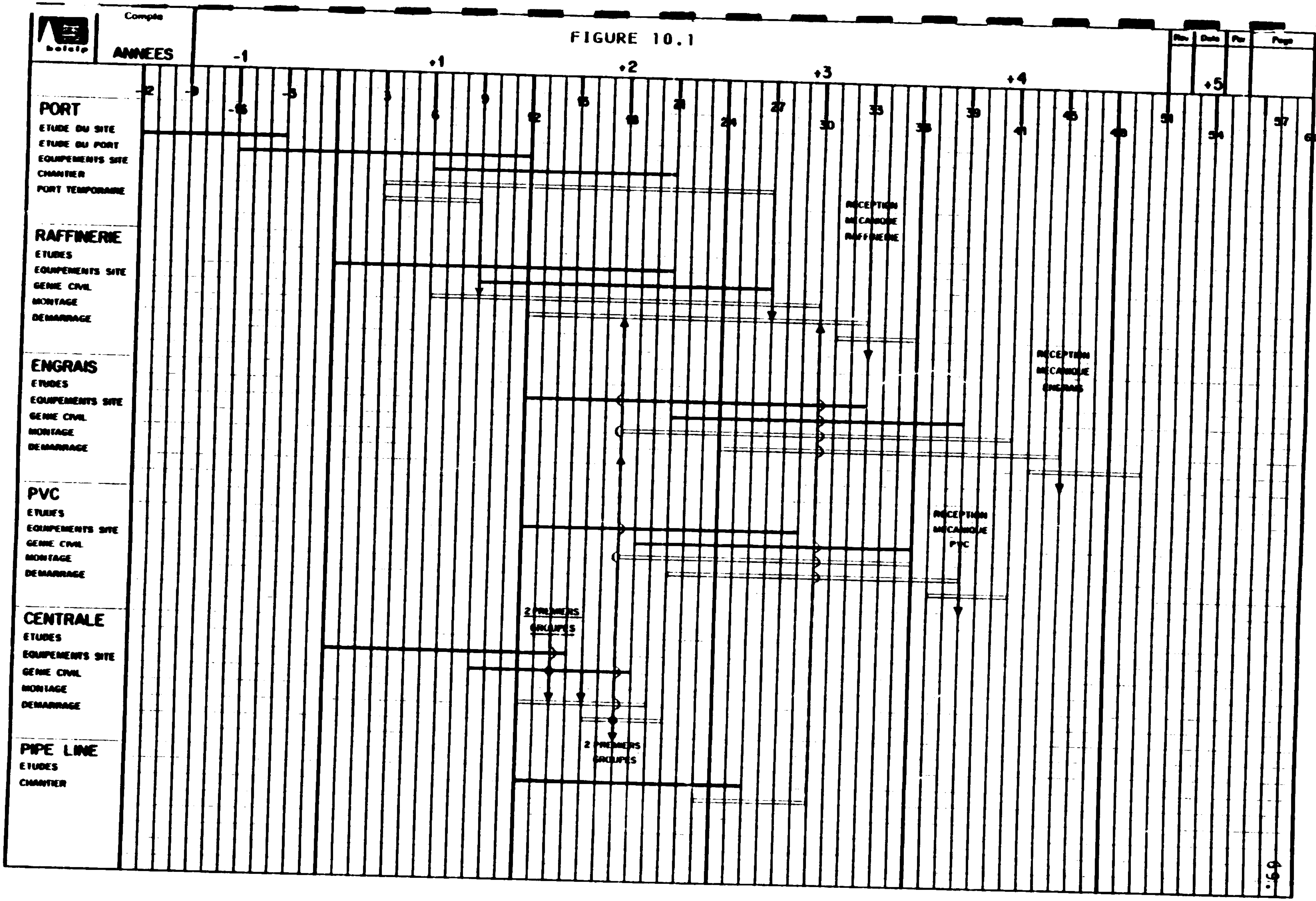
	SITE 1	SITE 2	SITE 3	SITE 4	SITE 5
INVESTMENT (10^3 $)					
. Complex	900 100	923 100	900 100	900 100	900 100
. Auxiliary facilities and corrections	161 350	162 350	127 700	140 050	134 450
TOTAL	1 061 450	1 085 450	1 027 800	1 040 150	1 034 550
Estimated foreign share	76 %	76 %	78 %	76 %	77 %
MAIN CHARACTERISTICS					
. Earth work (m^3)	4 300 000	4 600 000	2 000 000	900 000	2 000 000
. Dredging (m^3)	4 800 000	4 800 000	4 500 000	4 800 000	4 800 000
. Concrete (m^3)		175 000			
. Piping (outside battery limit)* (t)	11 800	12 400	11 600	7 800	11 100
. Roads (km)	16.2	22.1	23.2	15.8	18.8
. Railways (km)	10.55	14.7	15.7	9.25	14.7
. Estimated work-hours (European conditions)		19 400 000			

* *Excluding product pipeline*

10. PRELIMINARY IMPLEMENTATION SCHEDULE

A preliminary schedule of implementation has been worked out and is presented in figure 10.1

It has been established using European conditions and has to be adapted to Vietnamese conditions in a further stage.



ANNEES
-2 -1 +1 +2 +3 +4 +5
-12 -9 -6 -3 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60
PORT
ETUDE DU SITE
ETUDE DU PORT
EQUIPEMENTS SITE
CHANTIER
PORT TEMPORAIRE
RAFFINERIE
ETUDES
EQUIPEMENTS SITE
GENIE CIVIL
MONTAGE
DEMARRAGE
ENGRAIS
ETUDES
EQUIPEMENTS SITE
GENIE CIVIL
MONTAGE
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EQUIPEMENTS SITE
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2 PREMIERS GROUPES
2 PREMIERS GROUPES

FIGURE 10.1

APPENDIX I

REQUISITION FOR SOIL SURVEY

1. Topographical survey
2. Borings, testings and laboratory works

1. TOPOGRAPHICAL SURVEY FOR THE COMPLEX SITE

The present requisition defines the services, supplies and works to be done in accordance with BEICIP drawing entitled "DELIMITATION OF TOPOGRAPHICAL SURVEY AREA N° 78060.A.100" and with the standard STD 1700-30-02 "MARKERS" and the following descriptions :

1. TOPOGRAPHIC SURVEYS

Topographic survey will be made on site located to the West of NGHI-SON ISLAND in the TINH GIA DISTRICT - THANH HOA PROVINCE - and marked by letters A. B. C. D...

a) Plot surveys made on a 50m grid, see note 1, localized within letters as designated by BEICIP drawing.

b) Survey covering all details concerning this area such as :
roads, paths, canals or various ditches, vegetation, land under cultivation, etc...

c) Draughting a map-scale 1/2000, see note 2, to show all the above details so as the position of the drill holes, n° 1-2-3 plus one hole per 10.000 square metres.

NOTE 1 *: Grid of 50m for flat and uncovered soil*
Grid of 25m for very wooded and uneven soil

NOTE 2 *: 1/5000 if the area is very large*

2. WORKS AND SUPPLIERS

Supply and installation of the marks at drilling spots designed by letters A, B, C, ...

3. PARTICULAR REQUIREMENTS

All levels measurements will be given with reference to the lowest level water (C-used on the VIETNAM marine maps).

4. DRAWINGS & DOCUMENTS

The contractor will provide the following documents :

- Costs for topographical surveys
- Costs for the markers
- Costs for all the drawings
- Schedule for carrying out : design, works and suppliers

2. BORINGS, TESTINGS AND LABORATORY WORKS FOR THE SITE

The present requisition defines services and works to be done in accordance with the descriptions made below :

1. Drilling
2. Sampling and shipment of samples
3. Testing
4. Laboratory study and analysis
5. Documents to be provided.

1. DRILLINGS

Holes shall be drilled on spots indicated on drawing entitled "DELIMITATION OF TOPOGRAPHICAL SURVEY AREA n° 78060.A-100" and localized on the ground by surveyor's stakes - average depth of the boring will be 30 metres.

2. SAMPLING AND SHIPMENT OF SAMPLES

a) SAMPLING

Disturbed samples will be taken from all borings at every 1.5m maximum or at every structure change of the soil.

Undisturbed samples will be taken at 3m intervals or at each structure of the soil.

Samples should permit the reconstitution of the stratification. Consequently, each sample shall bear the following information :

- Date when sample was taken
- Boring number
- Depth in relation to ground level - one sample of phreatic water will be taken in each boring.

b) *SHIPMENT OF UNDISTURBED SAMPLES*

Undisturbed samples shall be enclosed in metallic or plastic shells, under paraffin and sealed.

Packing shall be such that the samples are not disturbed by vibrations during the transport.

On the arrival at the soil laboratory the shell shall be mechanically opened.

3. "IN SITU" TESTING

The "In Situ Testing" shall be made by dynamic penetrometer at each drilling spot.

These testings should permit a continuous representation of the peak strength and lateral fiction.

They will be carried on up the good soil.

These testings will be made for each boring. Other testings will be requested if necessary.

These "In situ" testing will include the diagrams of the penetration tests with description of the characteristics of the apparatus used.

4. LABORATORY STUDY AND ANALYSIS

a) *IDENTIFICATION TESTINGS*

From the disturbed soil samples, the following identification tests shall be made :

- Apparent density
- Natural moisture content
- Dry density

- Specific weight
- Atterberg limits and sand equivalent
- Particle size distribution.

b) RESULTS FROM MECHANICAL TEST

From the undisturbed soil samples, the following mechanical tests shall be made :

- Quick undrained triaxial compression test allowing angle of friction and cohesion
- Oedometric tests (compressibility and consolidation tests).

c) CHEMICAL ANALYSIS OF THE WATER

- pH value
- Water soluble sulphates expressed as SO_3.

5. DOCUMENTS TO BE PROVIDED

1. BORING LOG BOOK comprising the following indications :
   - Level of ground level at the boring spot and level of the different layers encountered.
   - Description of various layers crossed
   - Diameter of drilling tubes used
   - Level at which the disturbed and undisturbed samples were taken
   - Level of the water table and the different water levels encountered, if any.

This log book must also include the following indications :

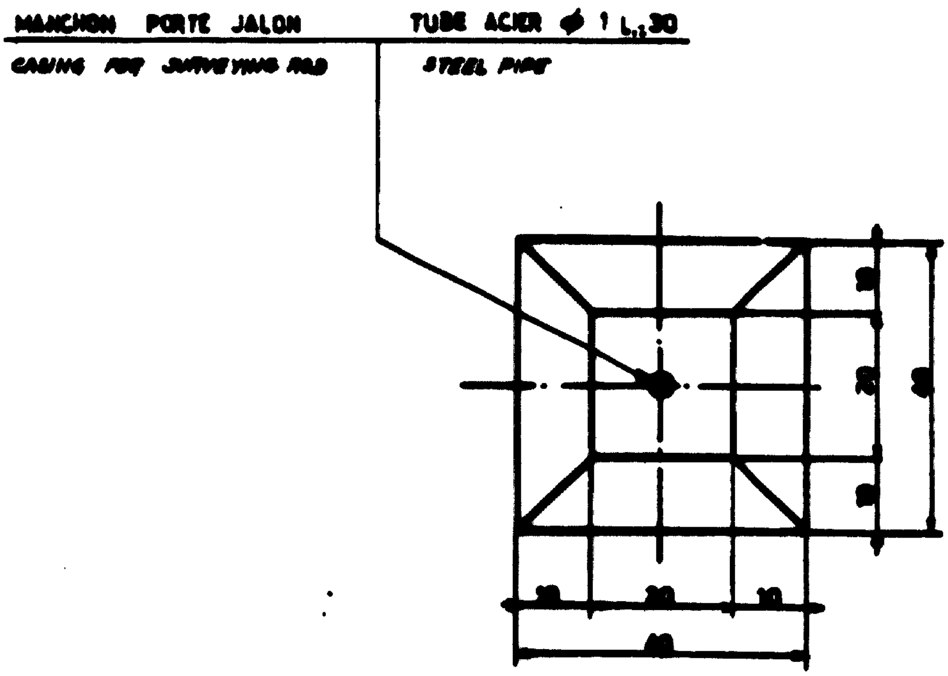
- level at which the bore water is lost
- pressure of the artesian water
- water level after sinking the boring, measured in the morning, at the beginning of the shift.

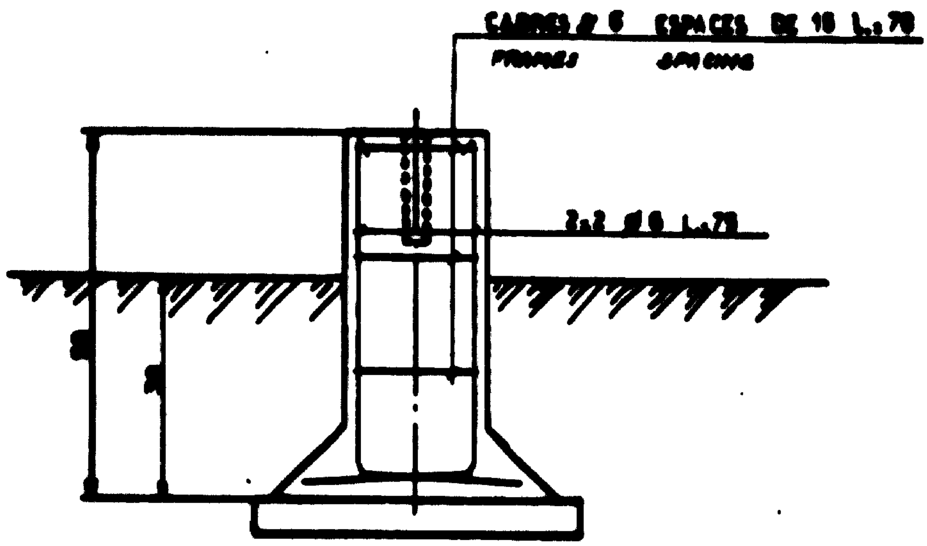
Examination of the site

- Determination of geological characteristics of the site
- General information concerning the design of roads and the basic principles used for similar construction already existing in the area
- Type of cement to be used depending on the corrosiveness of the water in contact with the foundations
- Variation in level of ground water table
- Back fill materials from the site. Examination ad to the possibility of using materials from the site for back filling will be proceeded.

2. FINAL REPORT

At the completion of the soil exploration, investigation, a final report supported by all data allowing the calculation of the soil bearing capacity. This report will also include bore log and geologic profiles.





- Toutes dimensions sont exprimées en cm. sauf les ϕ d'armatures qui sont en mm.
- *All the measures are given in centimeters except ϕ of reinforcing bars which are given in millimeters.*

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APPENDIX 2

REQUISITION FOR MARINE SURVEY

1. Oceanographic survey
2. Topographical survey
3. Borings, testings and laboratory works

The present requisition covers :

- Collect of physical information allowing to study the possible lay out of a deep-sea harbour close to NGHI SON Island.

- Definition of services, work and supplies to be furnished to perform the topographical surveys and the borings, testings and laboratory works.

A part of these measures and works have already been performed on the site. The present requisition gives a complete scope of work to be undertaken.

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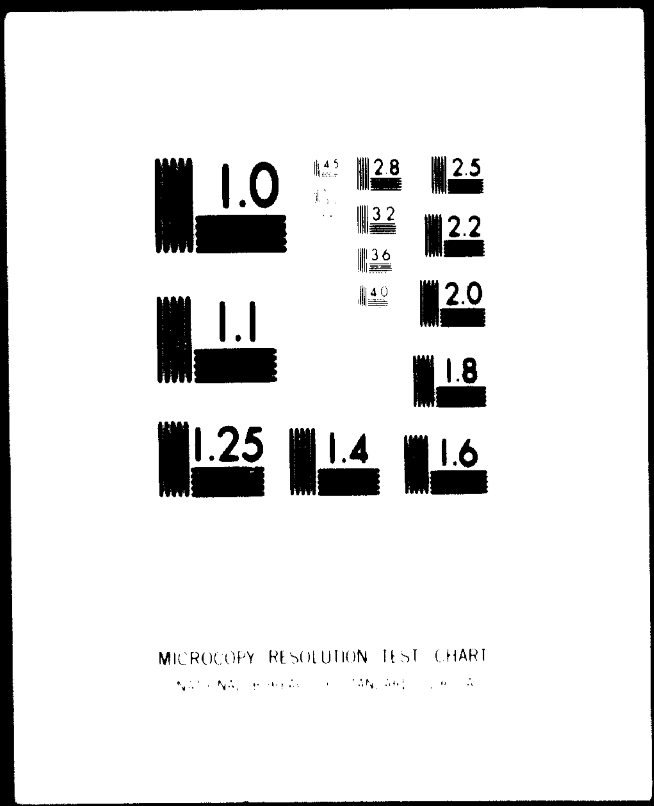

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1. OCEANOGRAPHICAL SURVEY

- **SWELL**

Swell observation and measures will be carried out by competent firms. They could be finished off if necessary by local data observed over a period as long as possible.

- **WINDS**

A compass-card has to be established taking into account local data available. Additional measures could be carried out on the highest points of the site.

- **TIDES**

A tide diary has to be established considering the already collected information and completed by local data.

- **MARINE CURRENTS**

Current measures will be made where will be installed the future facilities (entry, access, channel, etc..). Several measures will be carried out spread over fifteen days including low and high tides. Eight or ten assays will necessarily be made at different depth : one 2 metres above the sea bottom, one 4 metres below the surface and one in the interval when possible.

• SALINITY

Report will be established in accordance with available data and completed by local checking.

2. MARINE TOPOGRAPHICAL SURVEYS

The present requisition covers :

- The execution of the marine topographical surveys
- Localization of bore holes.

1. TOPOGRAPHICAL SUNVEYS

Geophysical and bathymetric surveys shall be made offshore to the North and the South of NGHI-SON Island in the TINH GIA district and in THAN HOA COUNTRY.

SERVICES TO BE PROVIDED

- Sea bed to be surveyed in the demarcated area :

  1. To the North by letters ABCD
  2. To the South by letters EFGH

  (see BEICIP drawing n° 78060.A.020).

  These surveys will be made on a 25m grid origin point :

  - axis AB to the North, width of area about 2.5 km, average length 5km
  - axis HG to the South, width of area about 3 km, average length 5 km.

  If necessary the areas will be widened up to favourable sea bed.

  A means of continuous recording of the sea bed could be used.

- Localization of possible underwater obstacles such as rocky bank, wrecks, etc..

- Execution of drawing on the scale of 1/10.000 showing :

  - bottom contour line in the area

  - position of possible obstacles

  - position of bore holes located by N°1 to 11 on the North Site and N° 20 to 39 on the South Site.

- Marking of channel

  Determination of the most favourable approach in the two cases either North harbour or South harbour.

2. LOCALIZATION OF BORE HOLES

Works to be executed are as follows :

- Supply of stationary buoys with anchoring appurtenances (each buoy shall be fitted with a reflective part allowing its localization at night).

- Buovs laying at locations shown on the 1/10 000 scale drawing.

3. LOCATION OF ACCESS CHANNEL

Works to be executed are :
Determination of the most favourable access channel in either case, North port or South port.

4. DRAWINGS AND DOCUMENTS

Documents to be provided :

- With the offer
  - price covering the topographical surveys
  - price covering the supply of buoys
  - price covering the buovs laying
  - price covering the execution of drawing
  - schedule for end of study and buoys laying.

- At the completion of the contract :
  - reproducibles plus 2 copies of each drawing (including buovs drawings scale 1/10 000.
  - drawing of buoys
  - two draught of each drawing.

3. BORINGS, TESTING AND LABORATORY WORKS FOR THE OFFSHORE SITE

The present requisition defines services and works to be done in accordance with the descriptions made below :

1. Drilling
2. Sampling and shipment of samples
3. Testing
4. Laboratory study and analysis
5. Documents to be provided.

1. DRILLINGS

Holes shall be drilled on spots indicated on drawing n° 78060.A-020 (from 1 to 11 on the North site and from 20 to 39 on the South site), and localized on the sea by buoys. Average depth of the boring will be more or less 30 metres according to soil characteristics.

2. SAMPLING AND SHIPMENT OF SAMPLES

a) Sampling

Disturbed samples will be taken from all borings at every 1.5m maximum or at every structure change of the soil.

Undisturbed samples will be taken at 3m intervals or at each structure change of the soil.

Samples should permit the reconstitution of the stratification. Consequently, each sample shall bear the following information :

- date when sample was taken
- boring number
- depth in relation to 0,00 of boring. Samples water will be taken in each future area warf or quay for laboratory analysis.

b) ***Shipment of undisturbed samples***

Undistrubed samples shall be enclosed in metallic or plastic shells, under paraffin and sealed.

Packing shall be such that the samples are not distrubed by vibrations during the transport.

On the arrival at the soil laboratory the shell shall be mechanically opened.

3. "IN SITU" TESTING

The "In situ testing" shall be made by dynamic penetrometer at each drilling spot.

These testings should permit a continuous representation of the peak strength and lateral fiction.

They will be carried on up to the good soil.

These testings will be made for each boring. Other testings will be requested if necessary.

These "In situ" testing will include the diagrams of the penetration tests with description of the characteristics of the apparatus used.

4. LABORATORY STUDY AND ANALYSIS

a) ***Identification testings***

From the disturbed soil samples, the following identification tests shall be made :

- Apparent density
- Natural moisture content
- Dry density
- Specific weight
- Atterberg limits and sand equivalent
- Particle size distribution.

b) *Results from mechanical tests*

From the undisturbed soil samples, the following mechanical tests shall be made :

- Quick undrained triaxial compression test
- Test allowing the determination of the allowing angle of friction and cohesion
- Oedometric tests (compressibility and consolidation tests).

c) *Chemical analysis of the water in the bore hole*

- pH value
- Water soluble sulphates expressed as SO_3

5. DOCUMENTS TO BE PROVIDED

- *Boring log book* comprising the following indications :
  - First boring level compared with the LLWS and level of the different layers encountered
  - Description of various layers crossed
  - Diameter of drilling tubes used
  - Level at which the disturbed and undisturbed samples were taken.

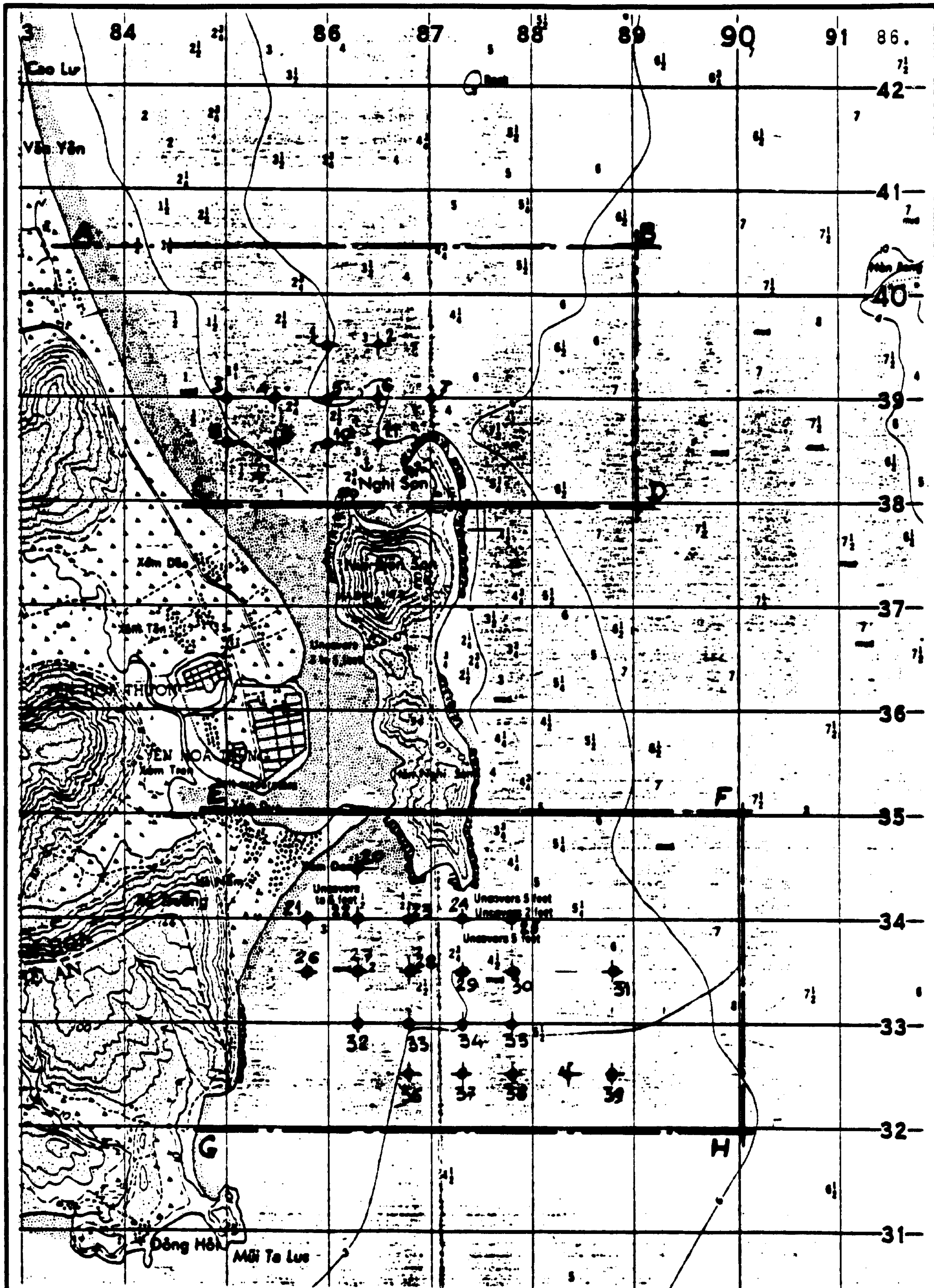
- *Final report*

  At the completion of the soil exploration, investigation, a final report supported by all data allowing the calculation of the soil bearing capacity.

  This report will also include bore log and geologic profiles.

Analysis and general information

General guidance for the choice of various principles of foundation to be applied depending on the nature of the construction, with the anticipated settling factor for the main constructions.



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PETRO VIET NAM

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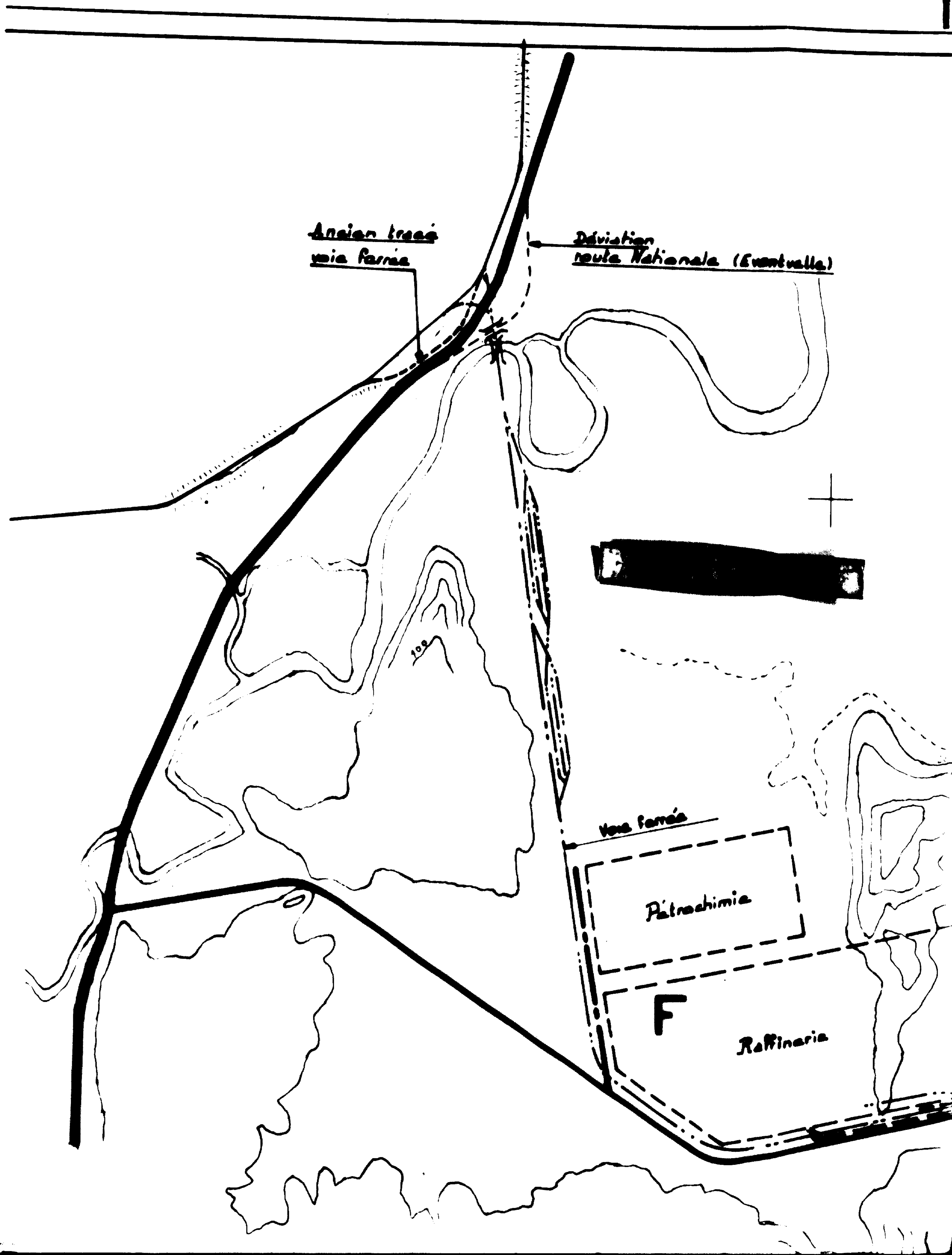

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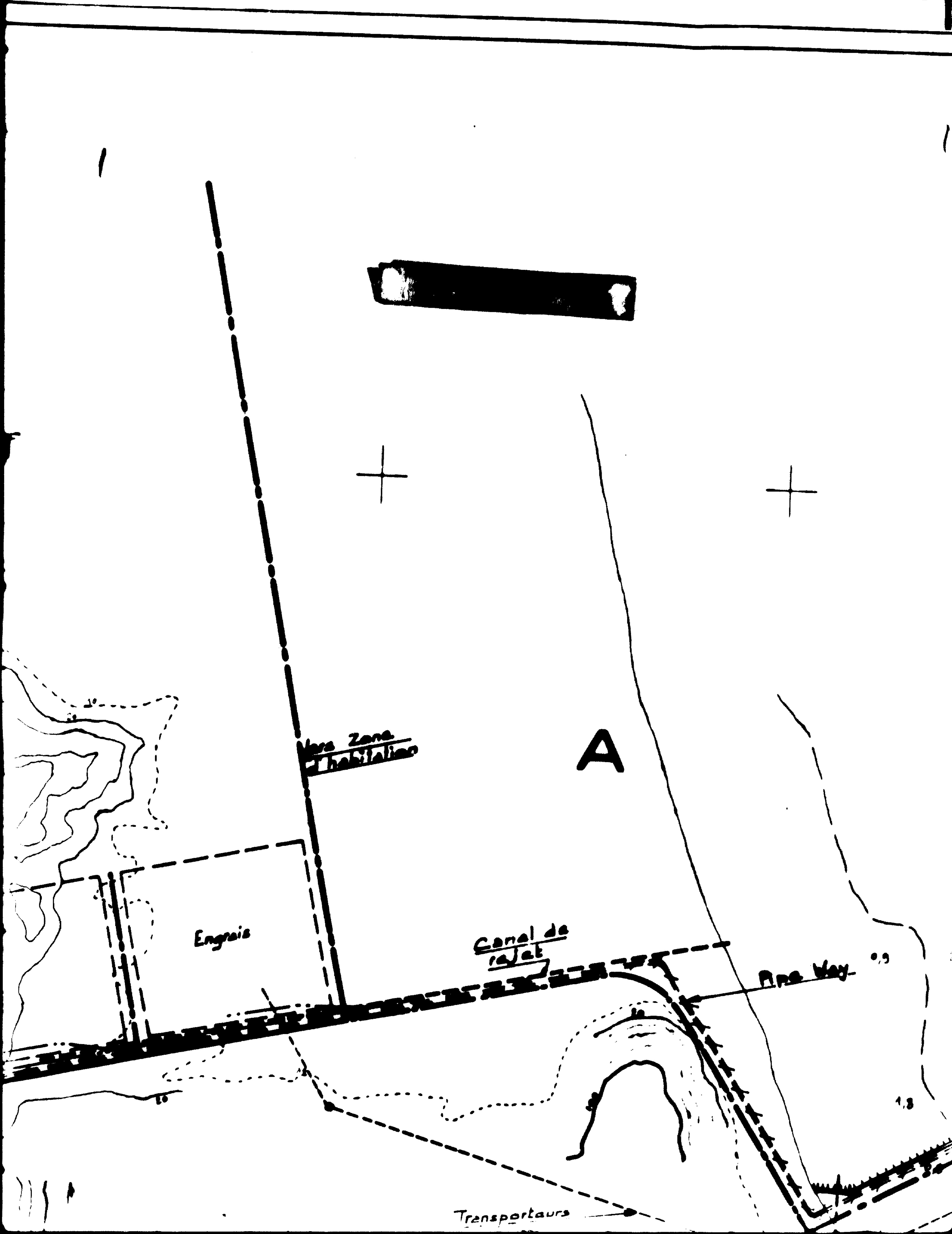
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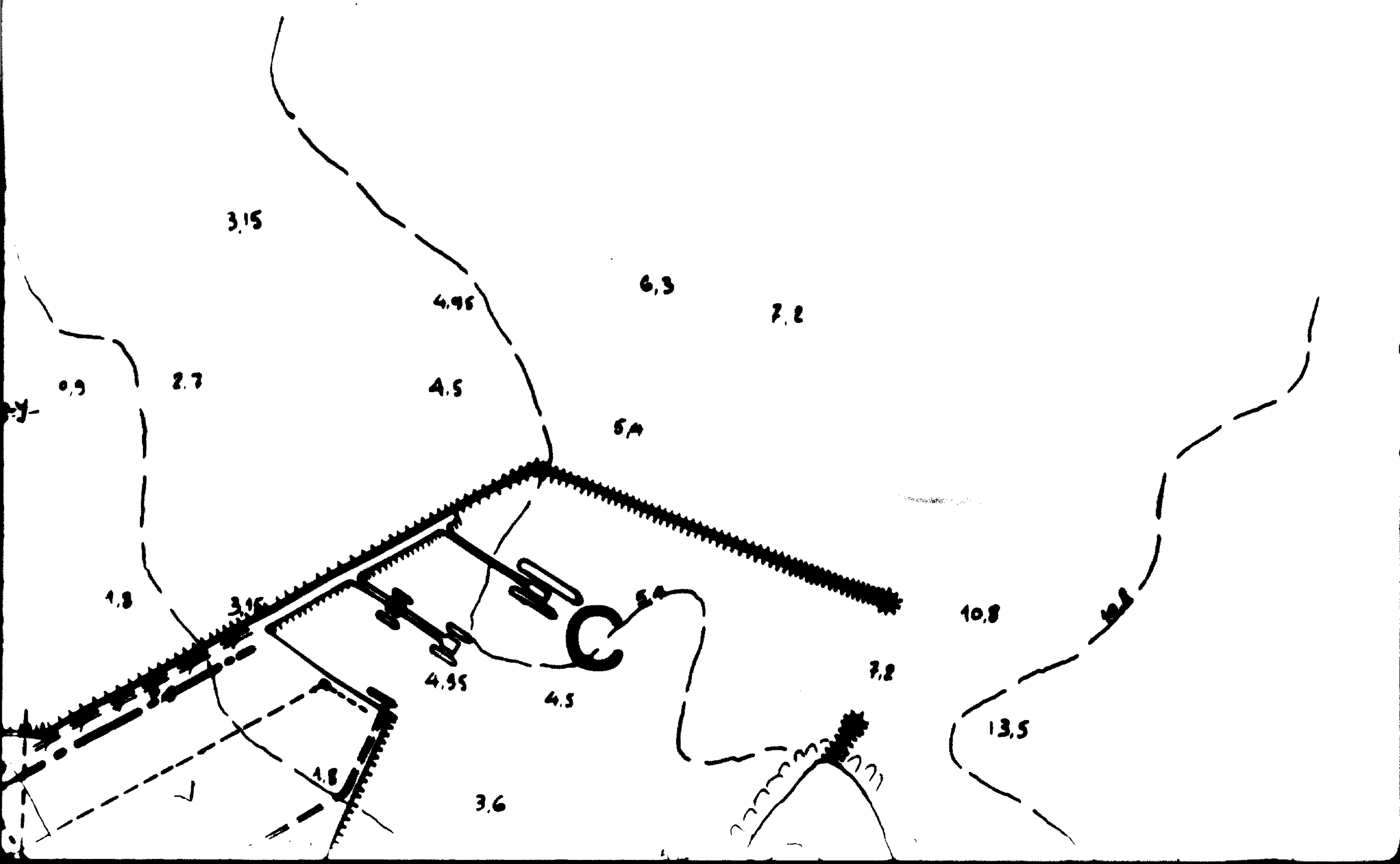

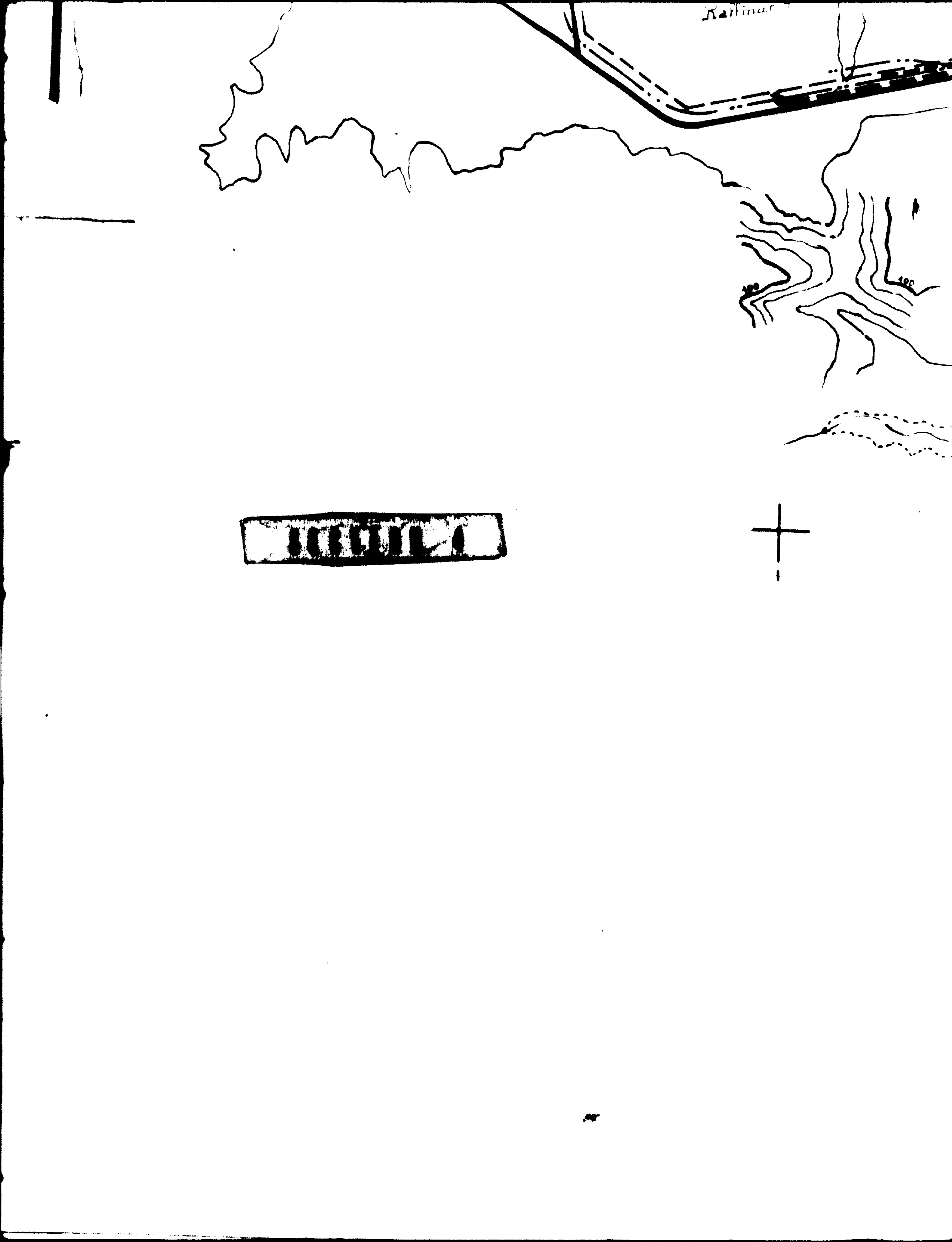
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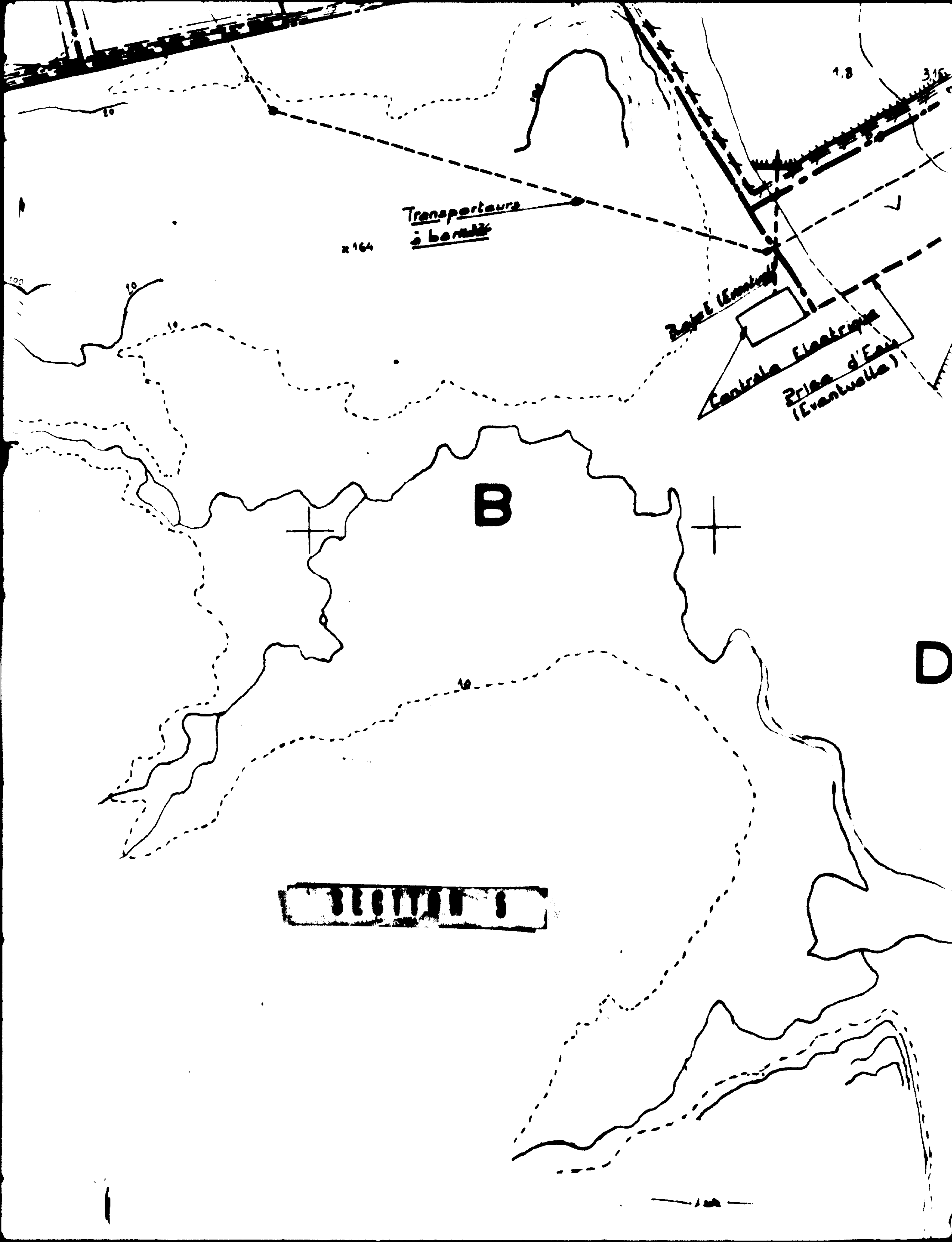
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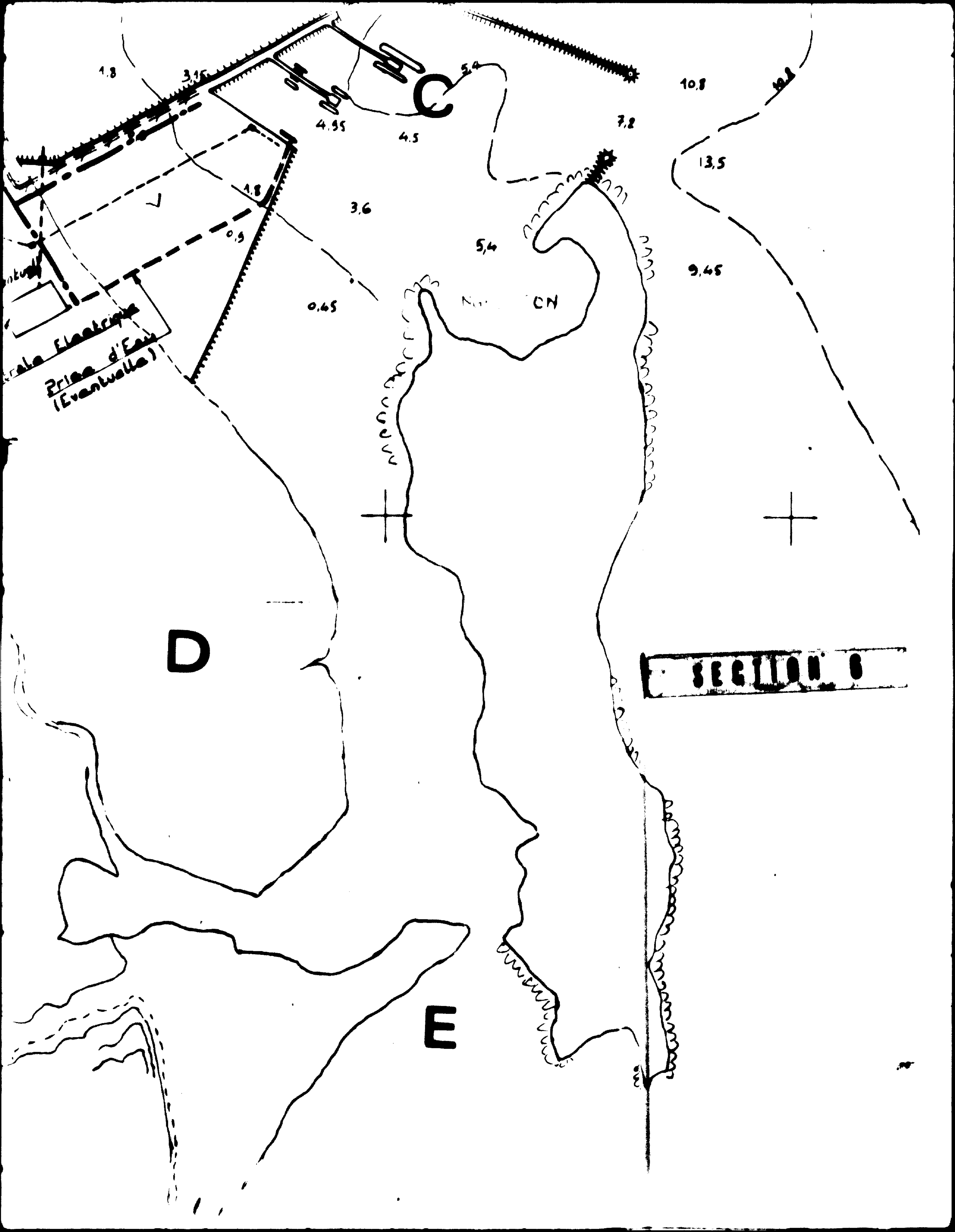
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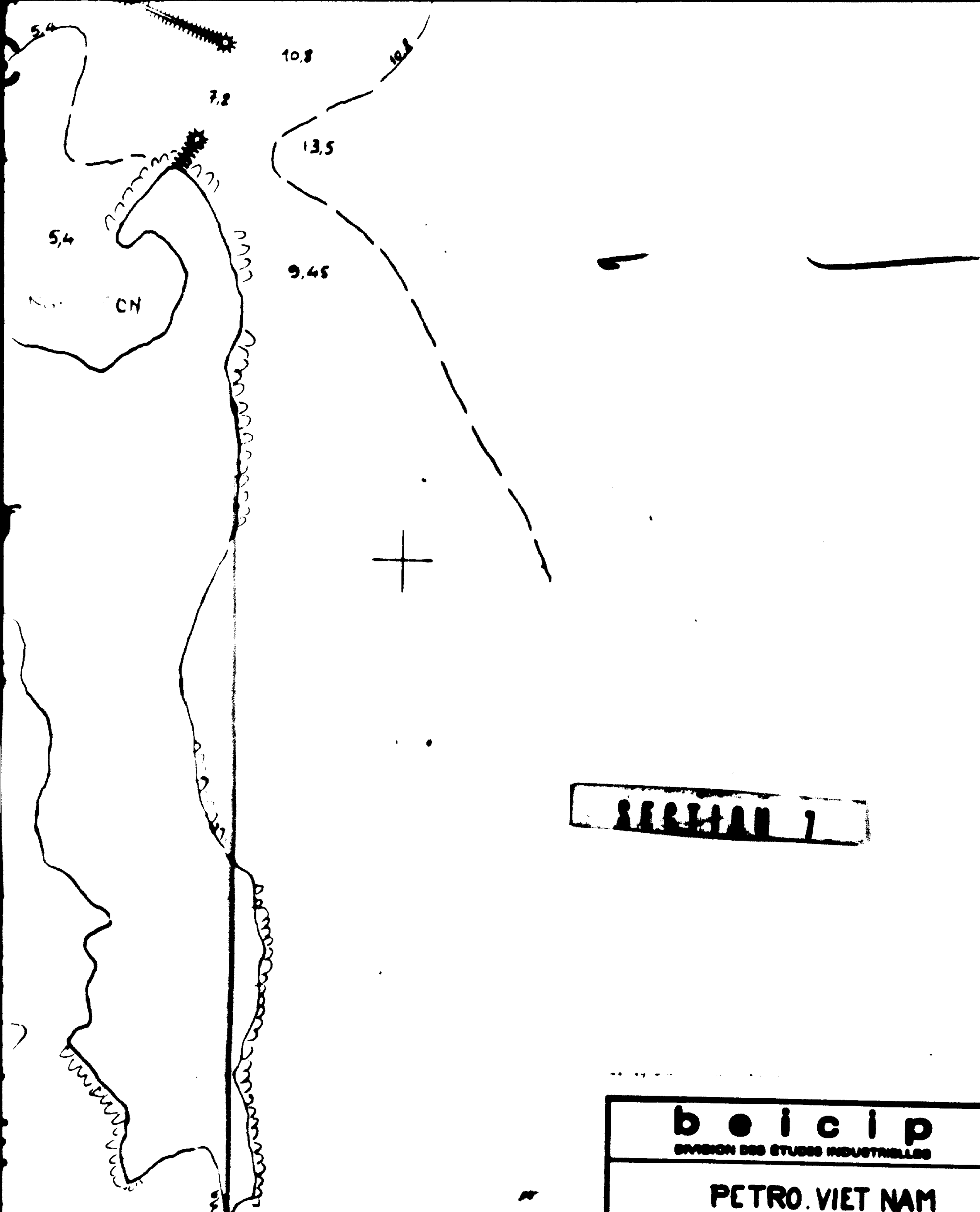

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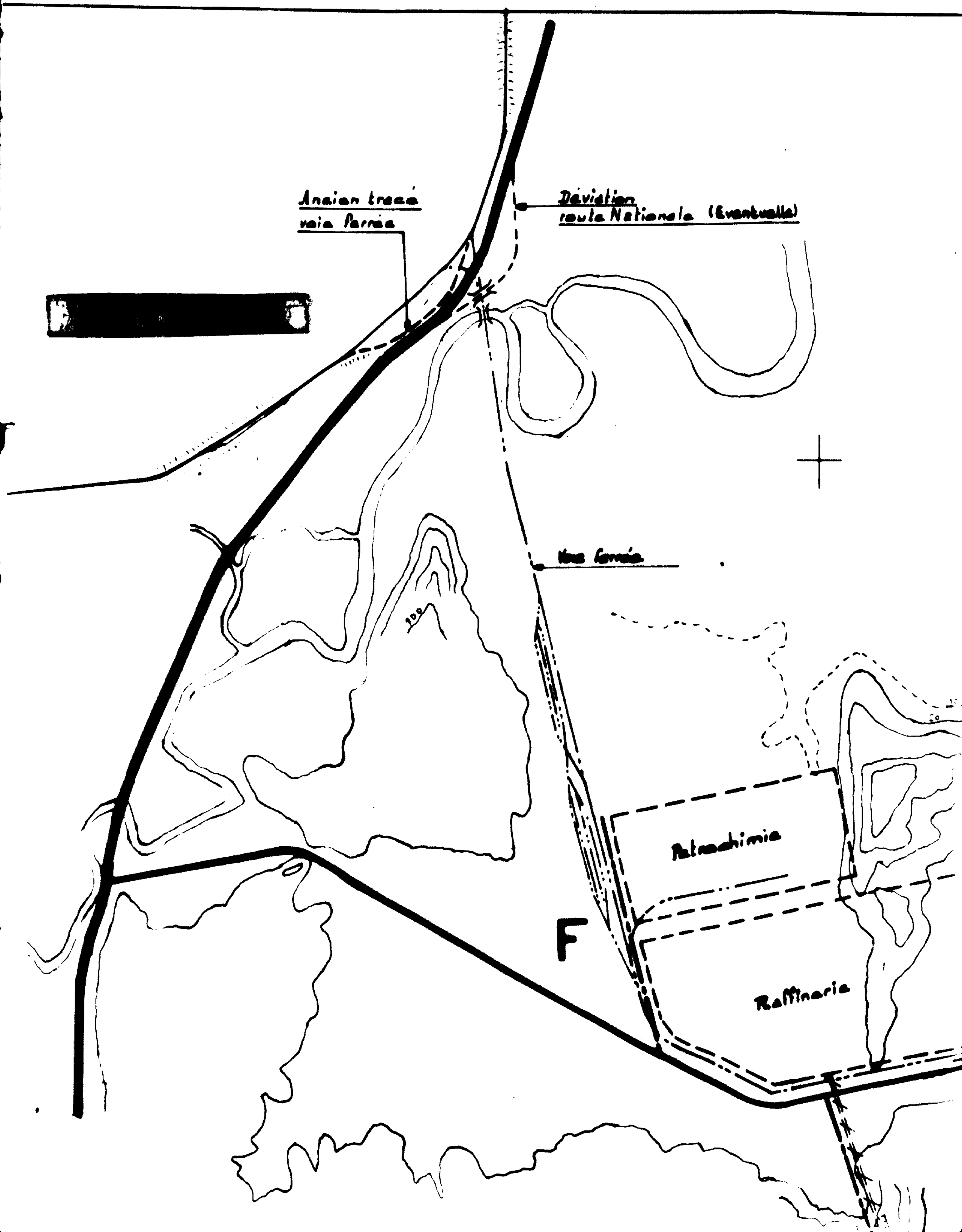
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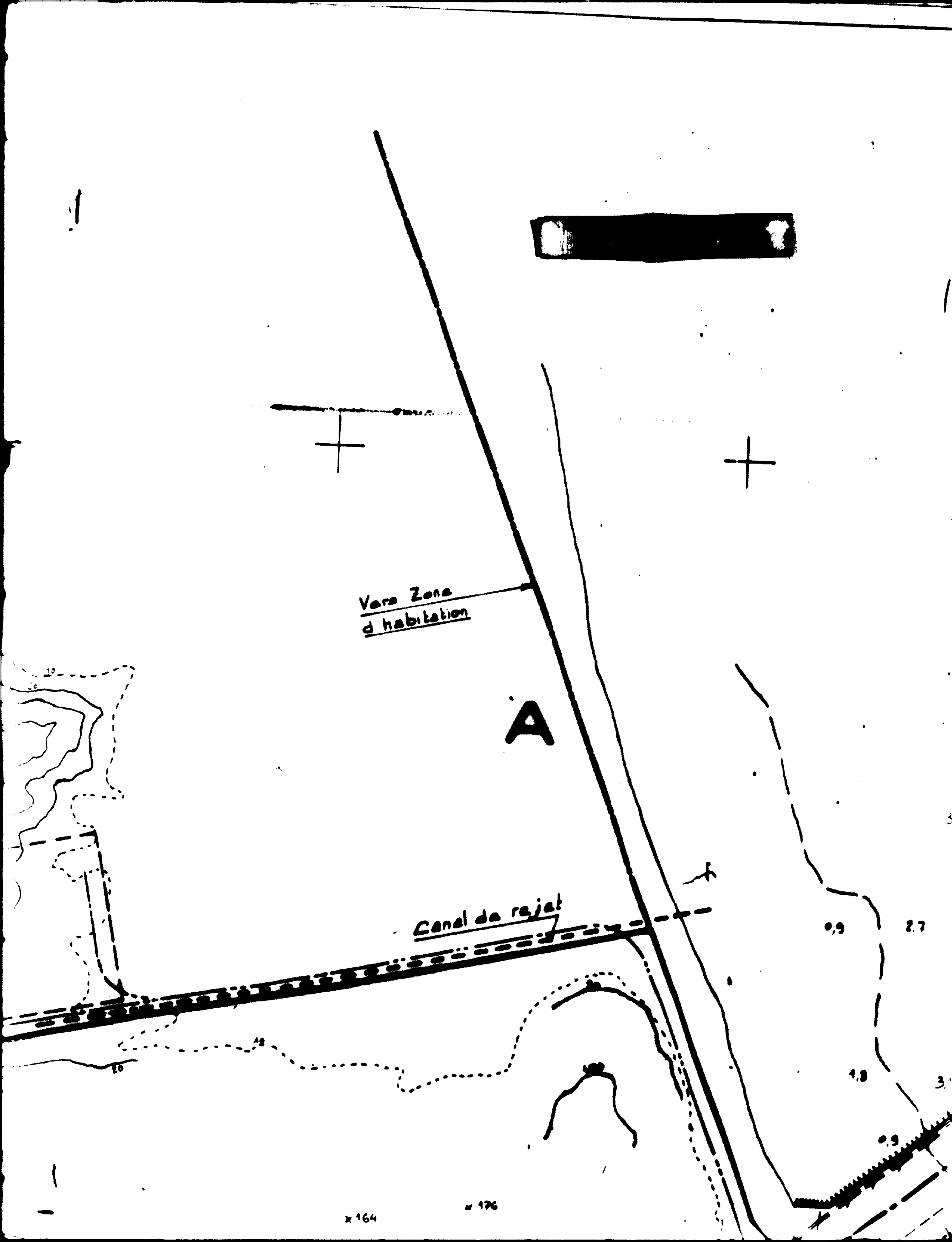
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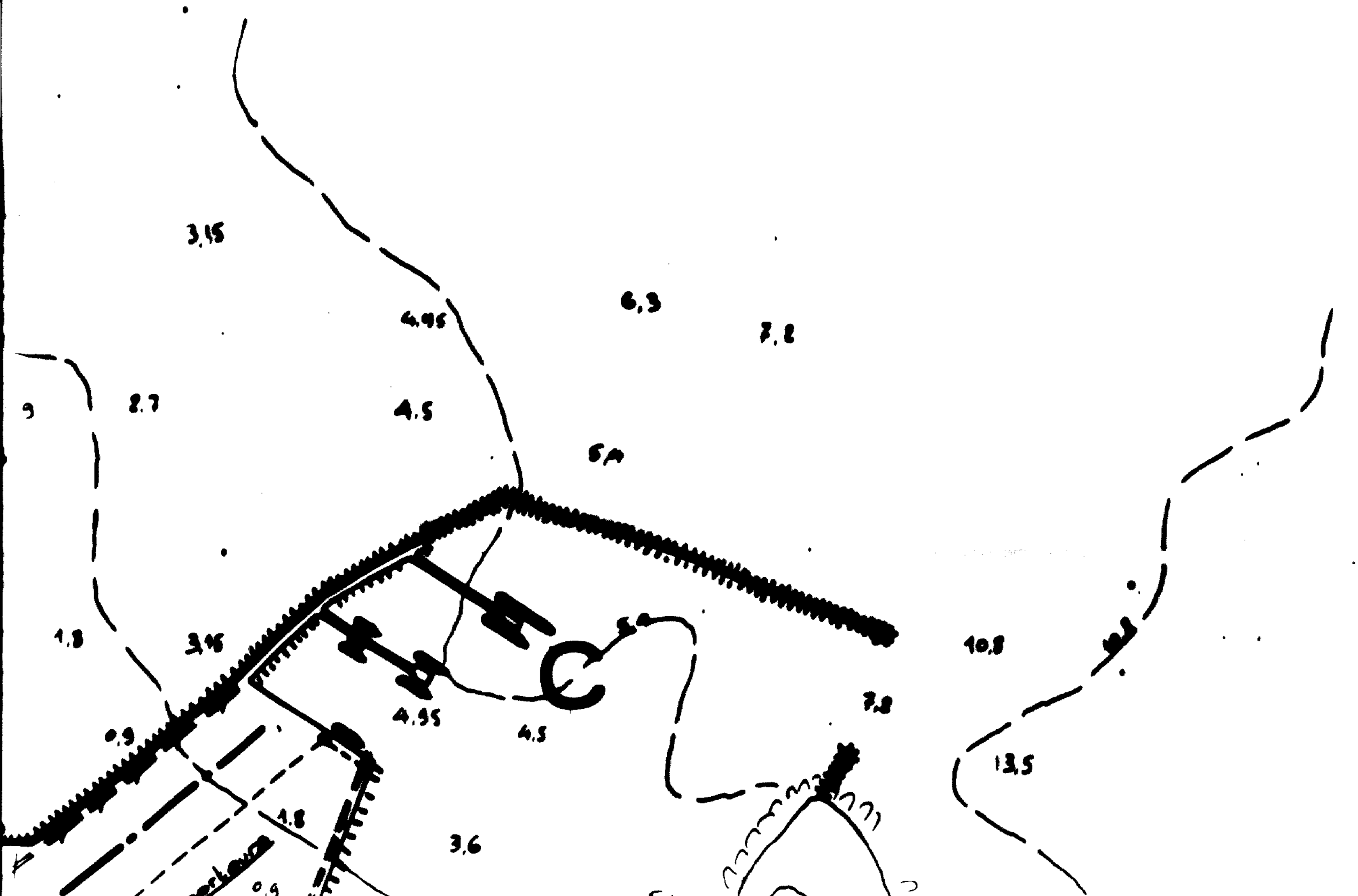

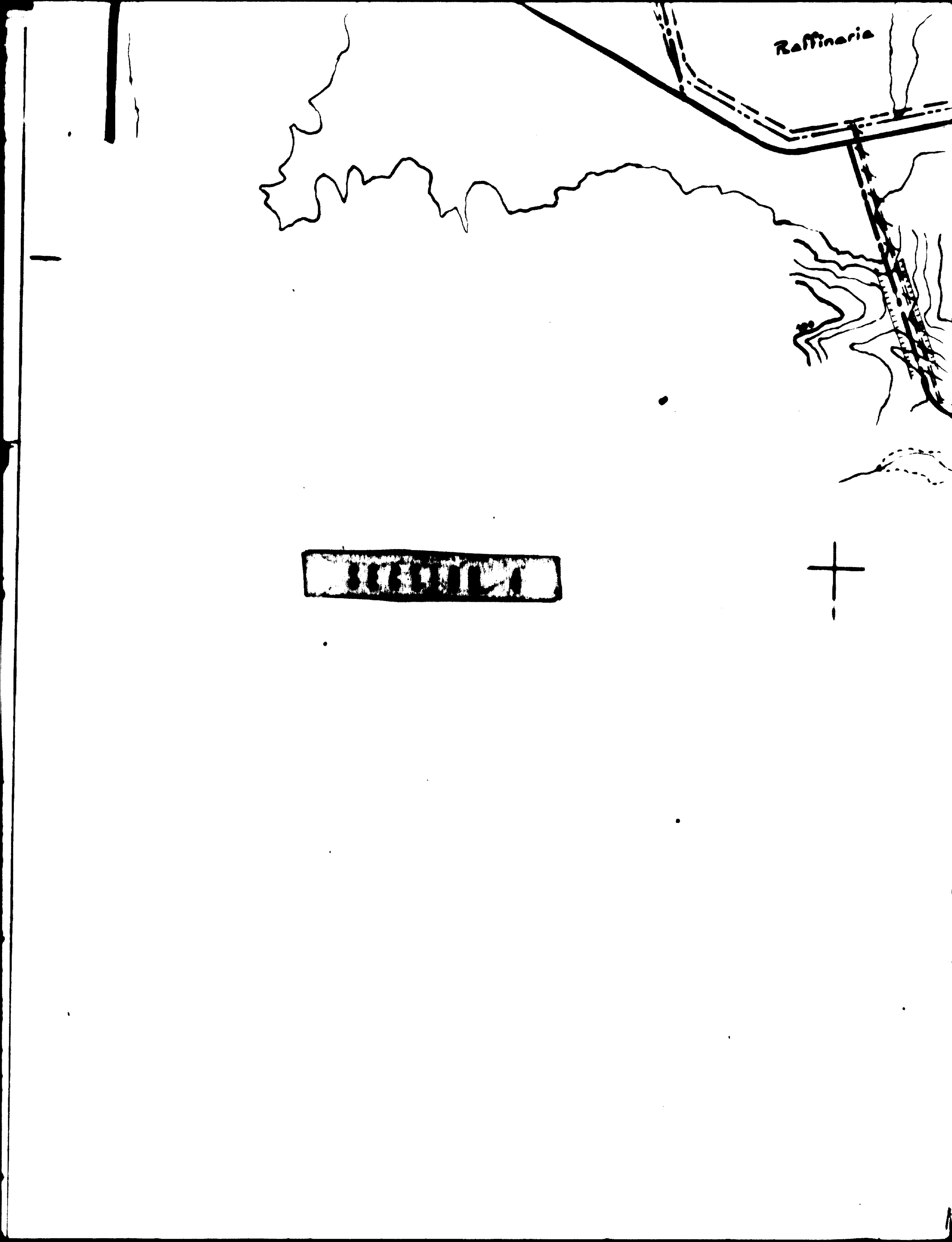
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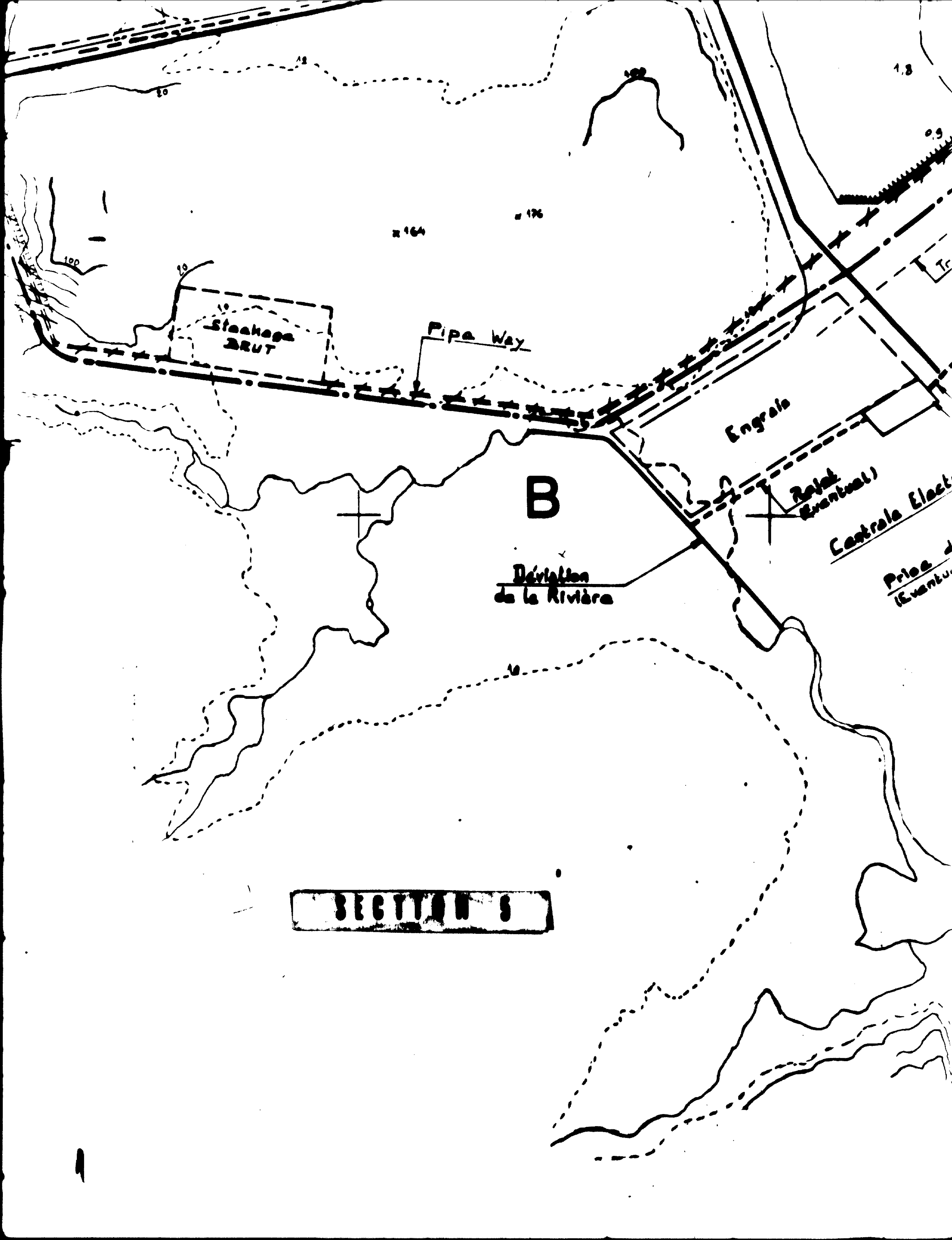
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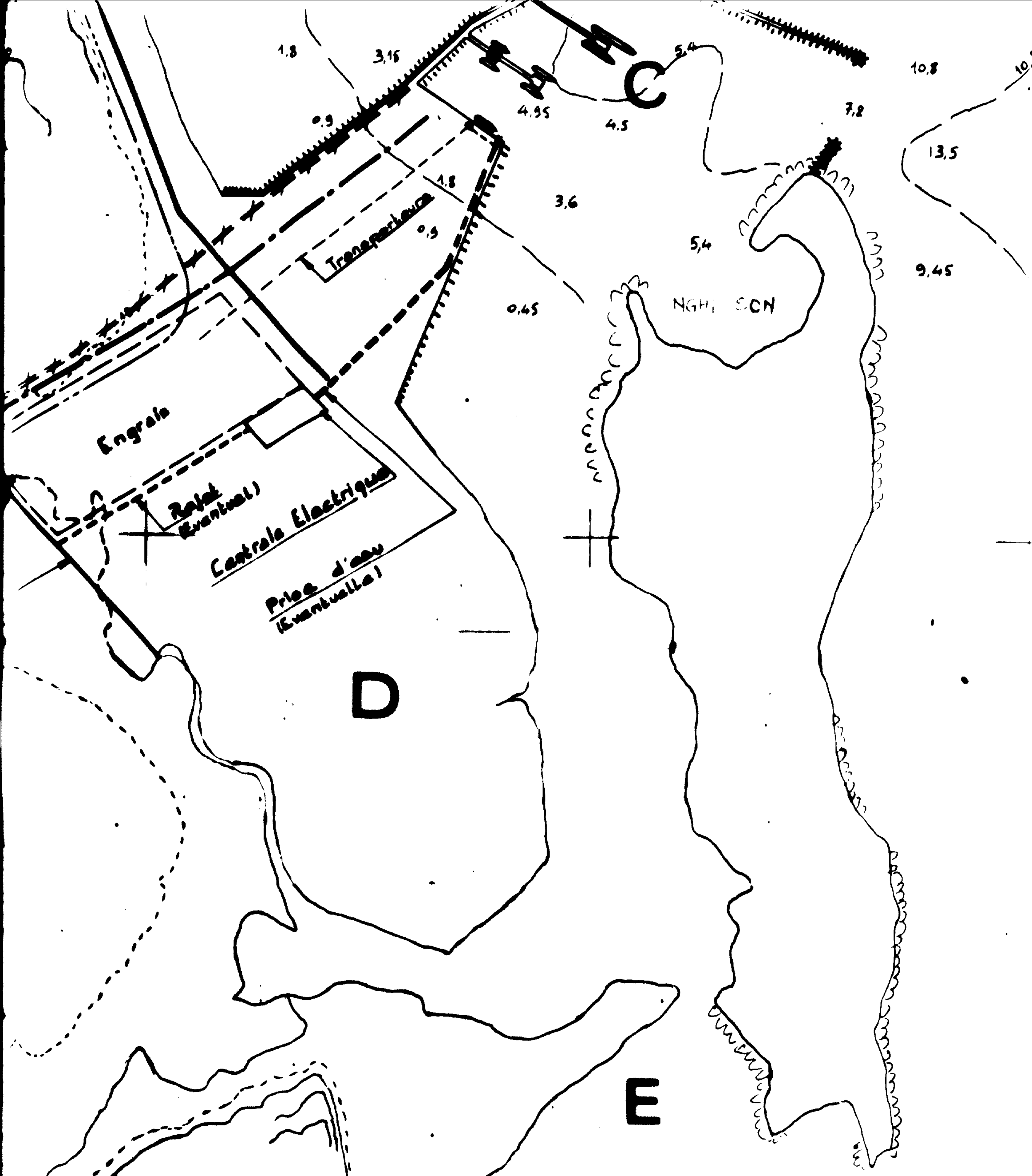
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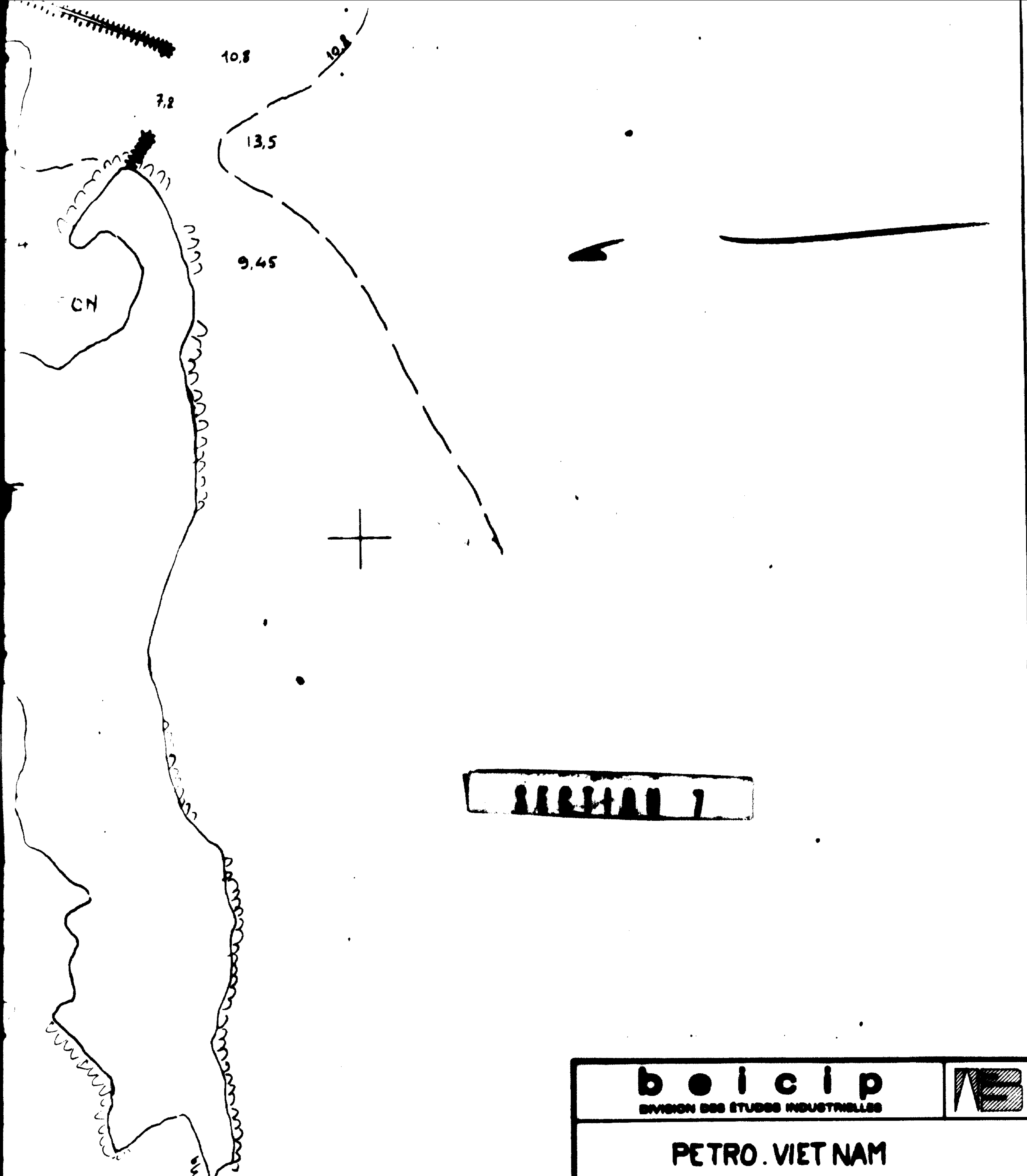

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IMPLANTATION D'UN COMPLEXE INDUSTRIALO-PORTUAIRE

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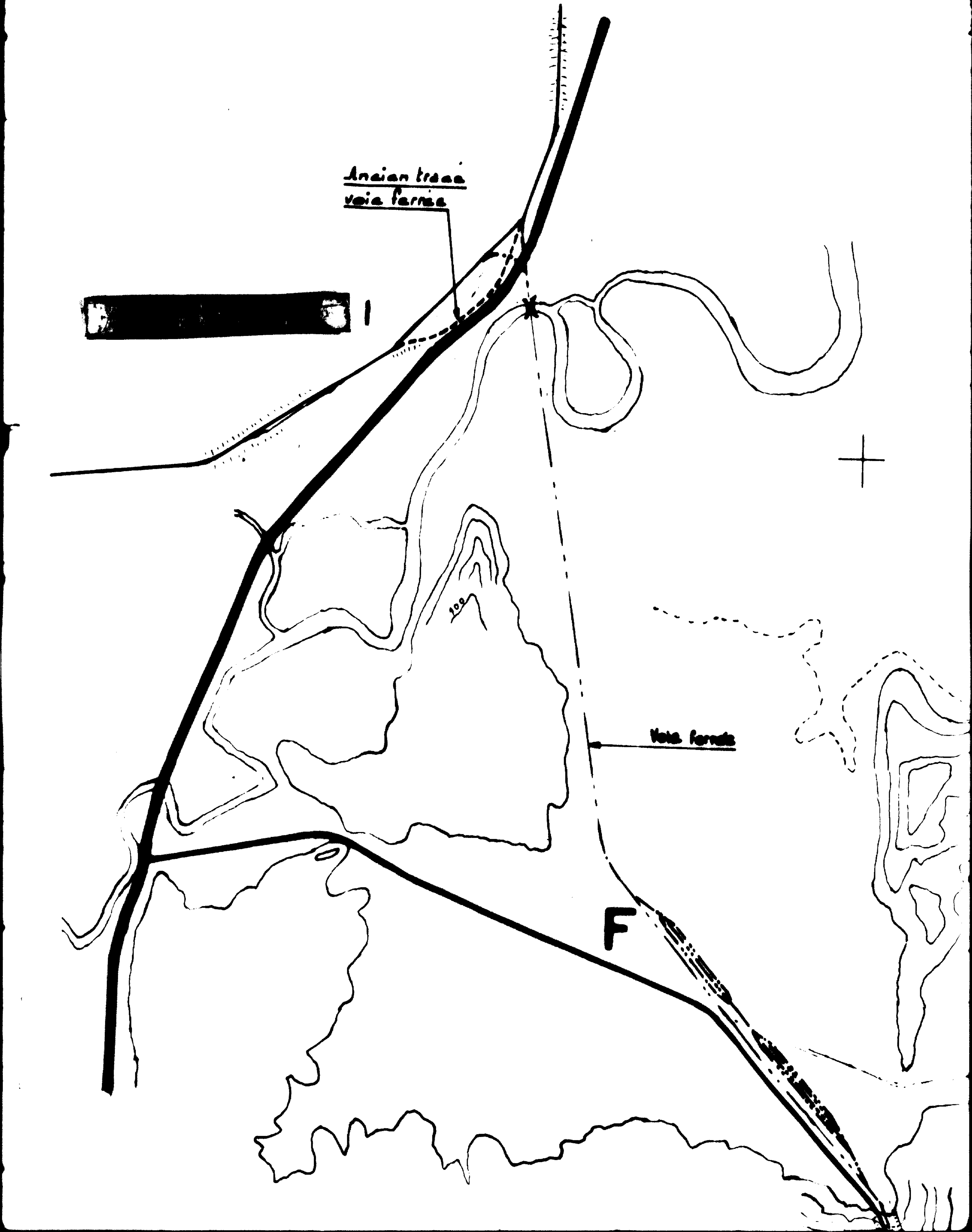

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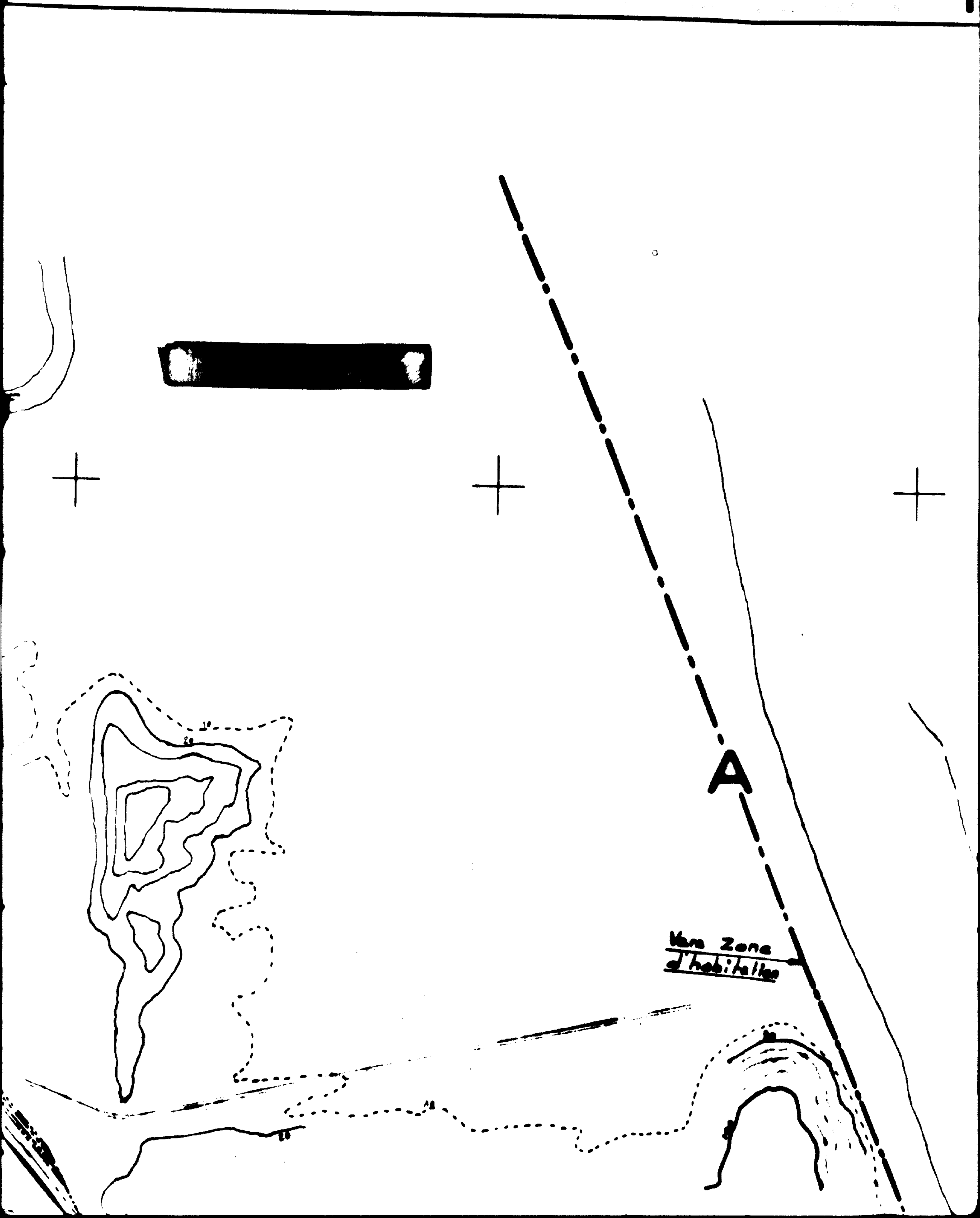
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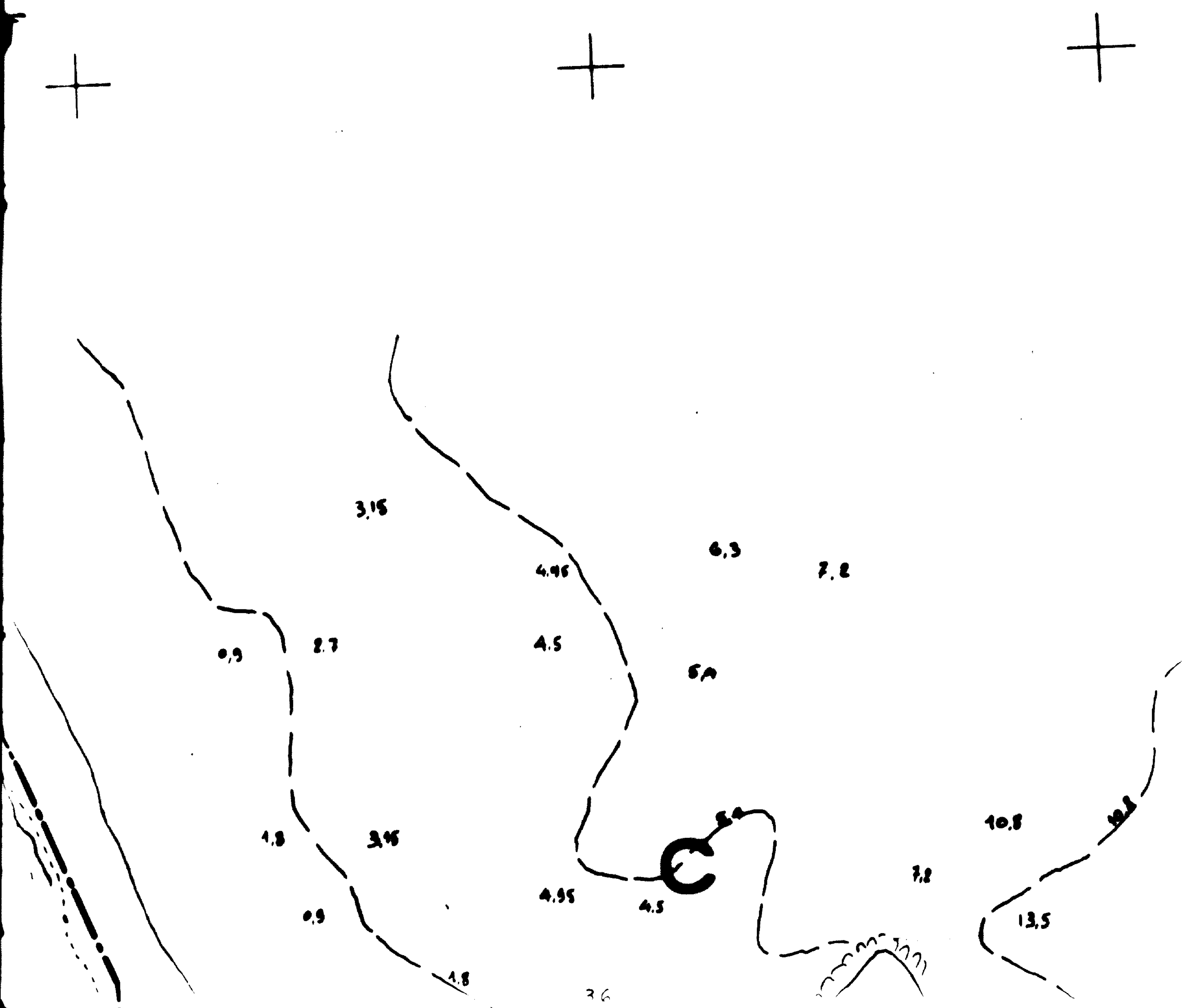

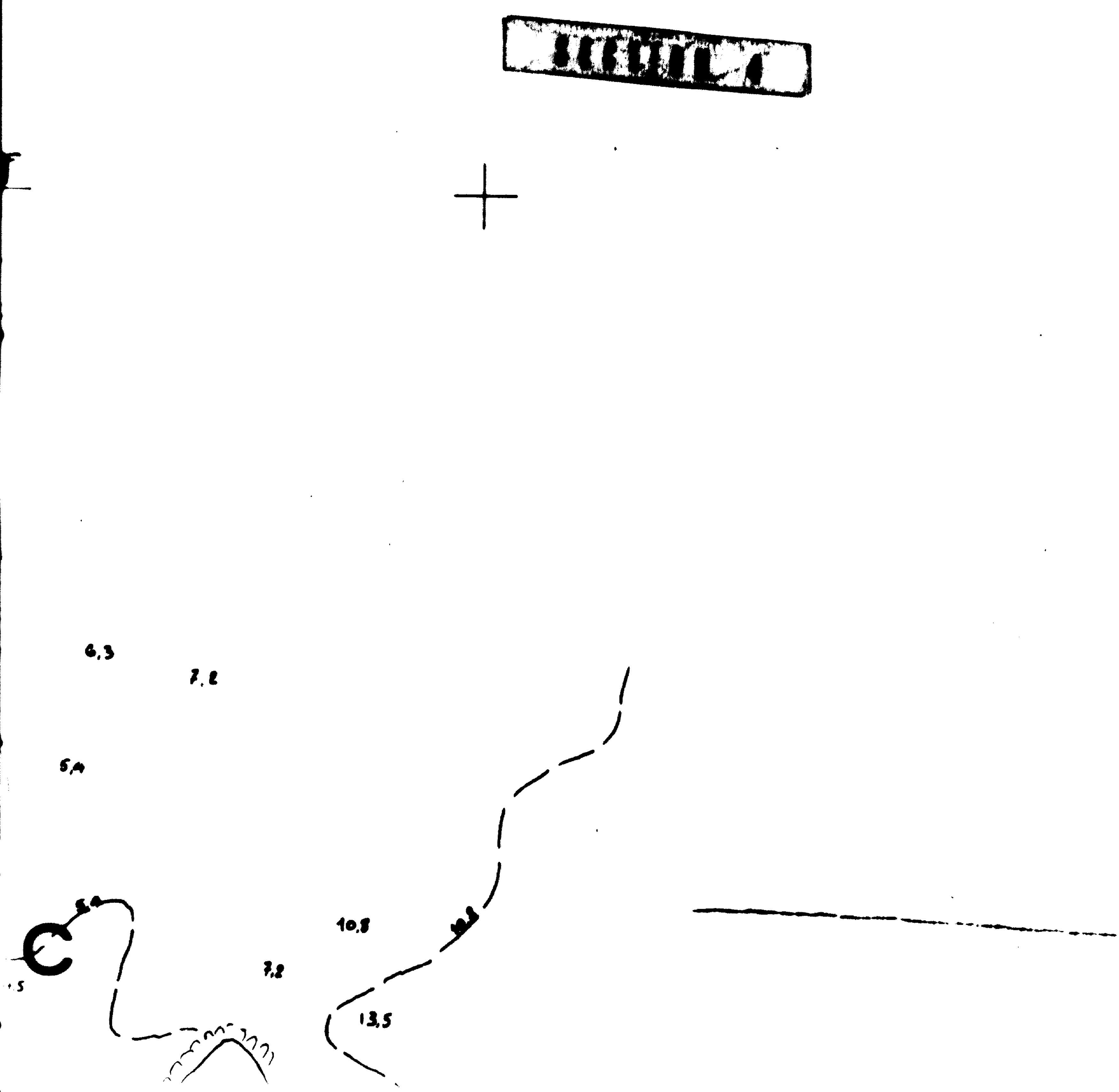
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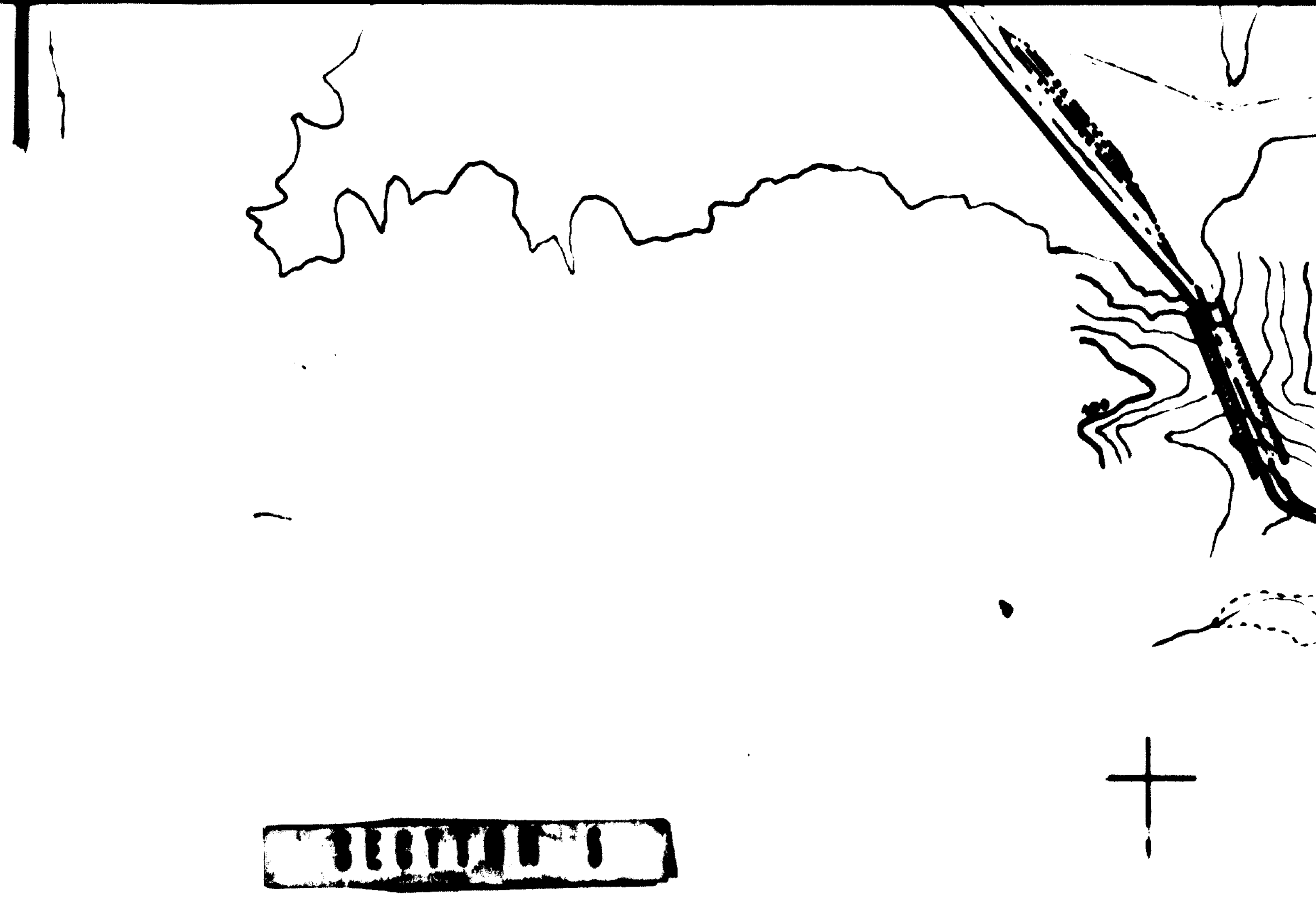
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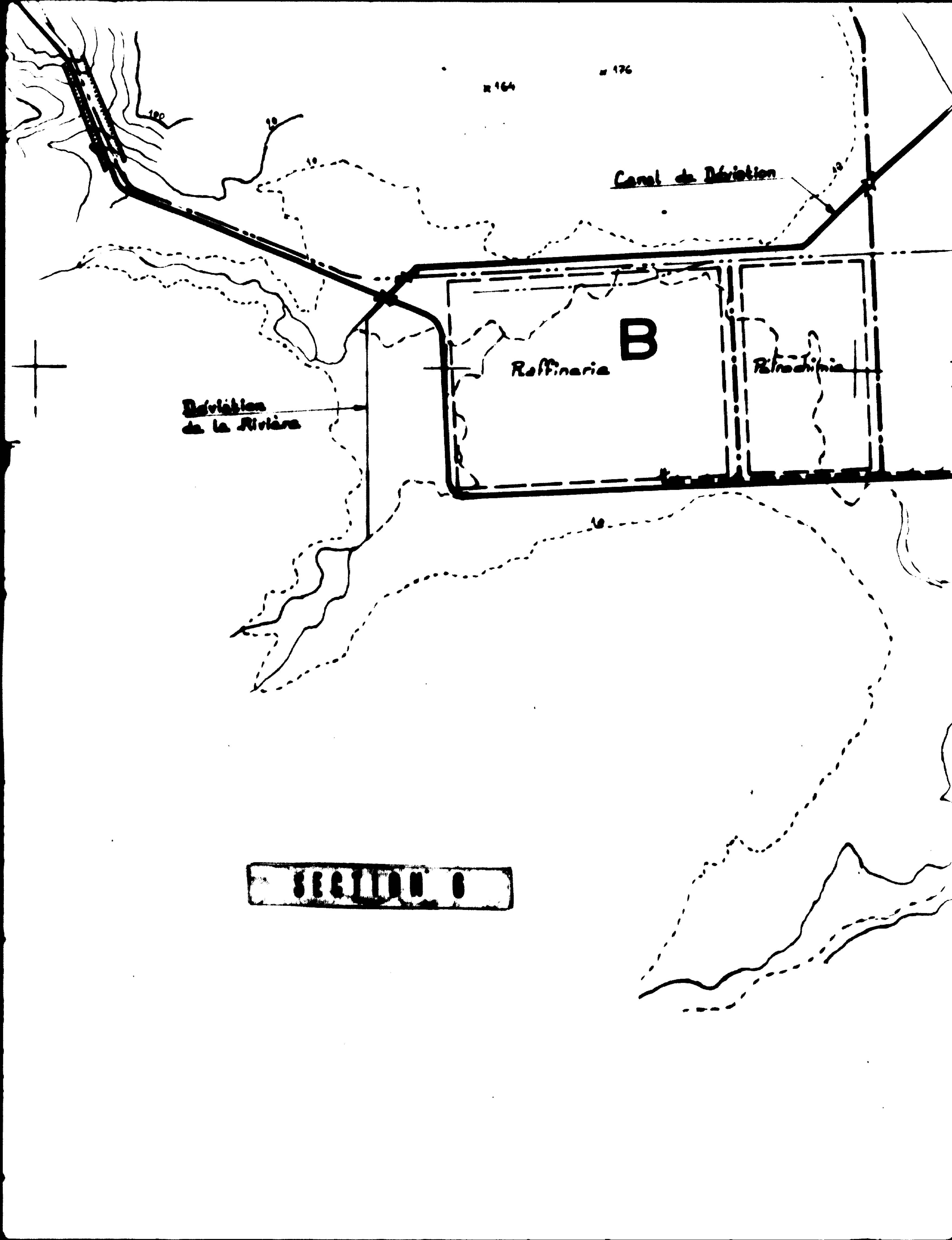

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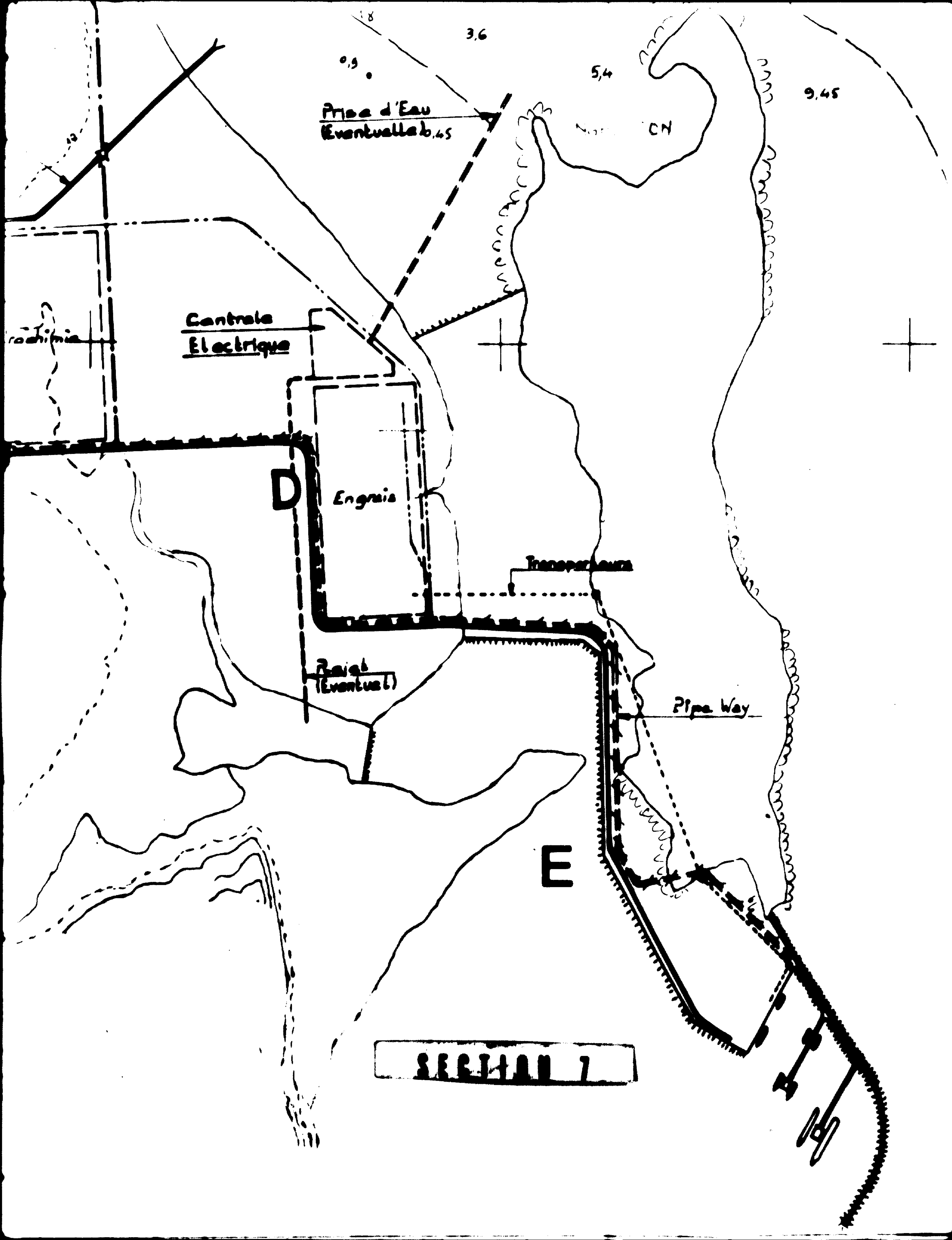

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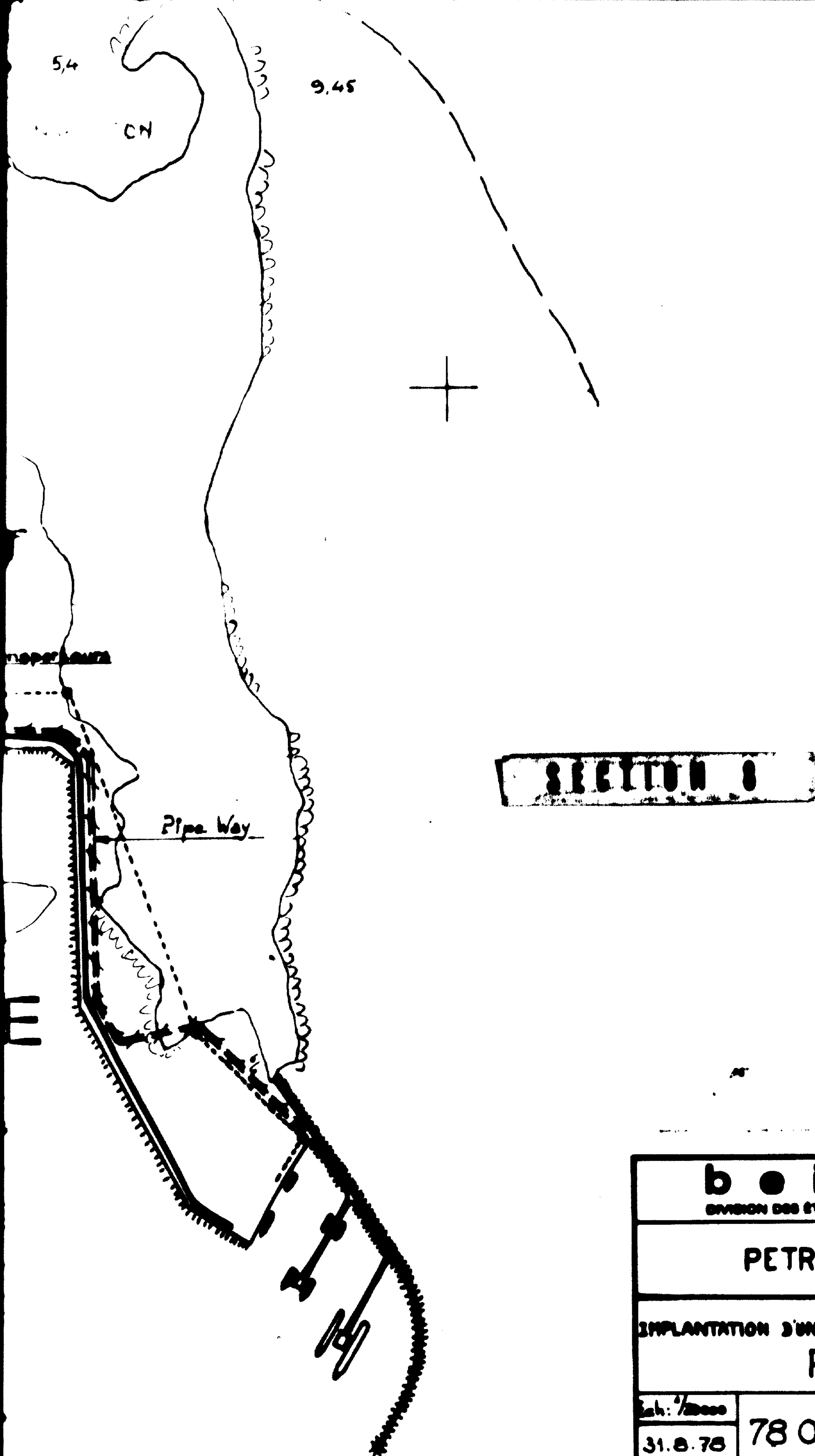

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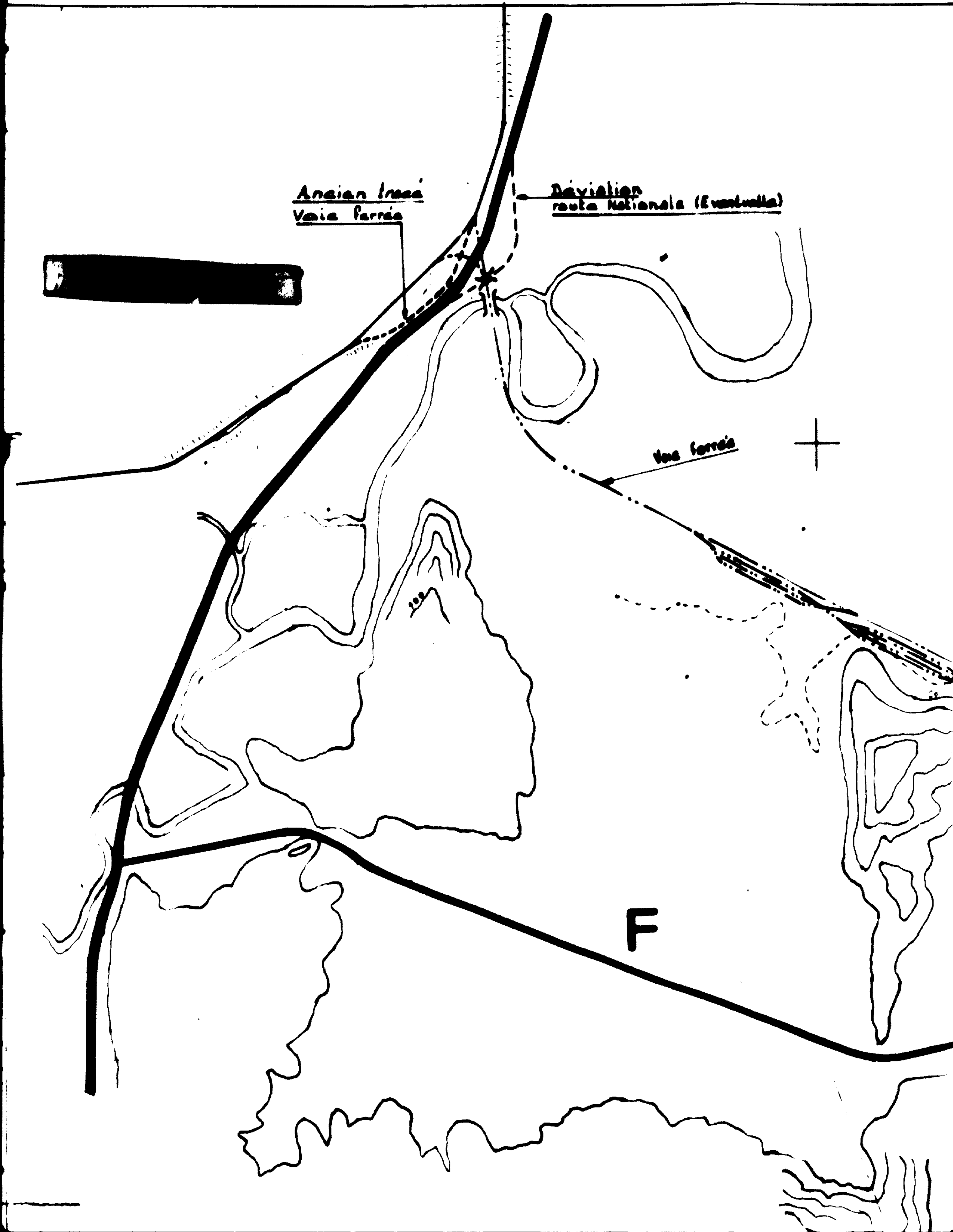
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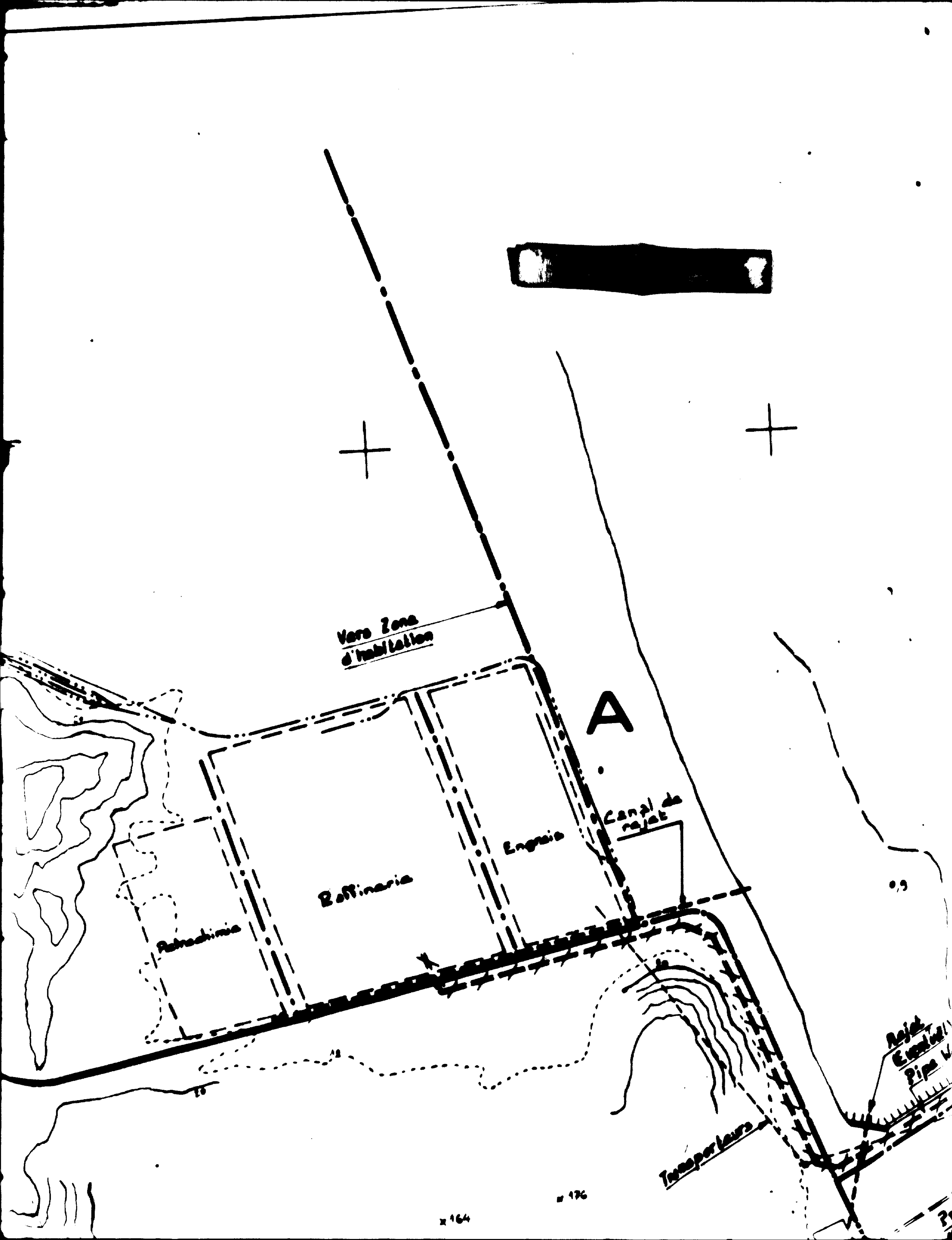
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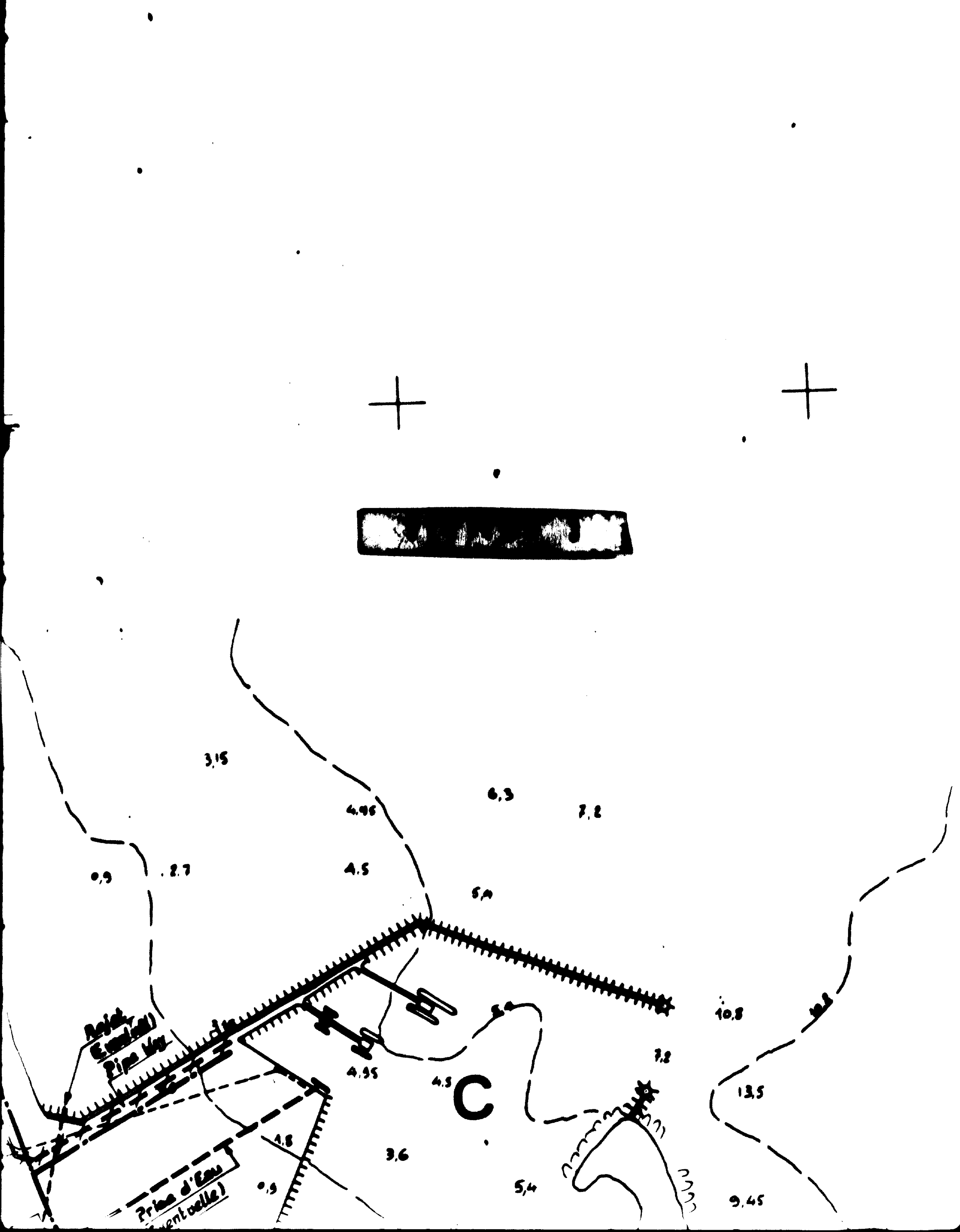

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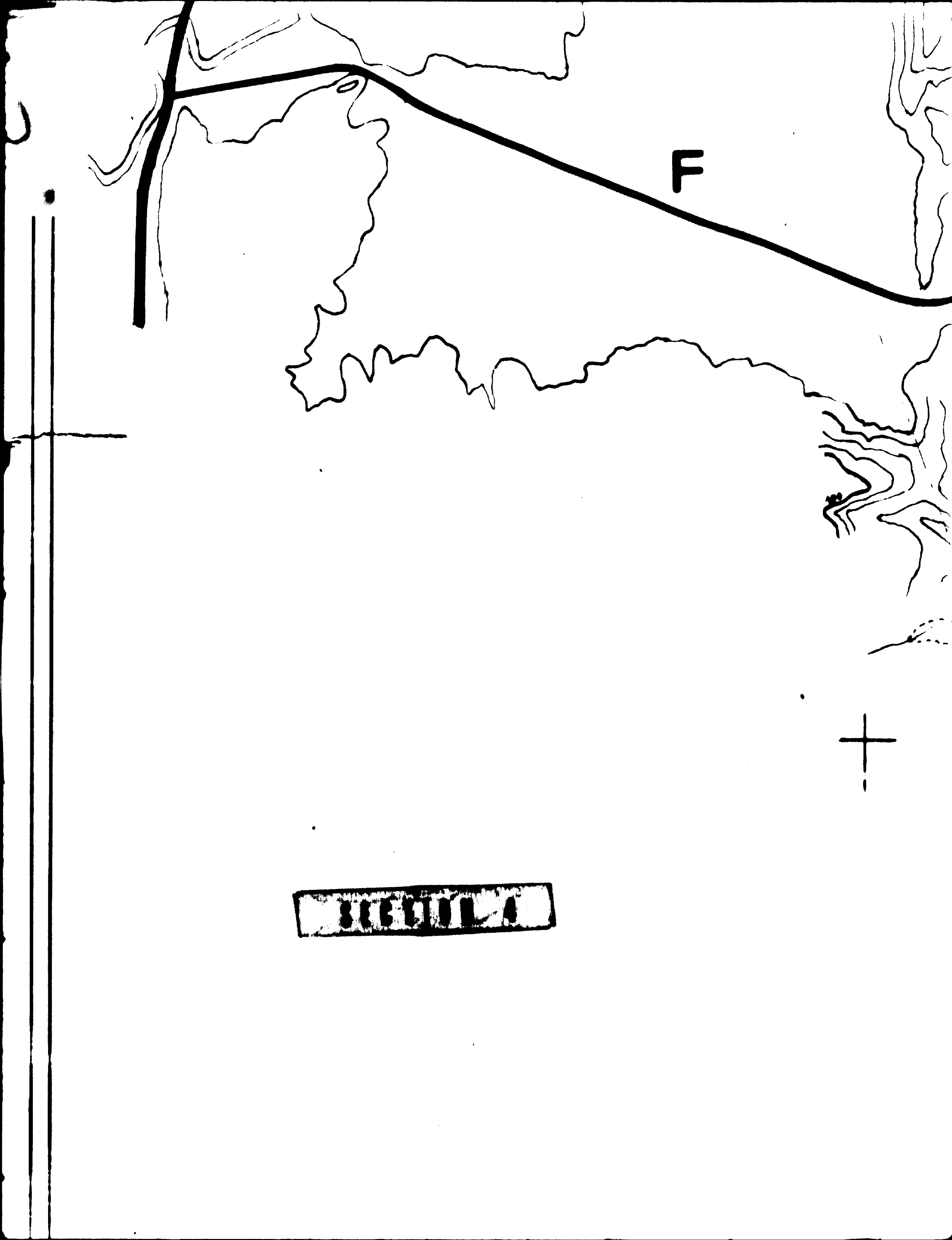
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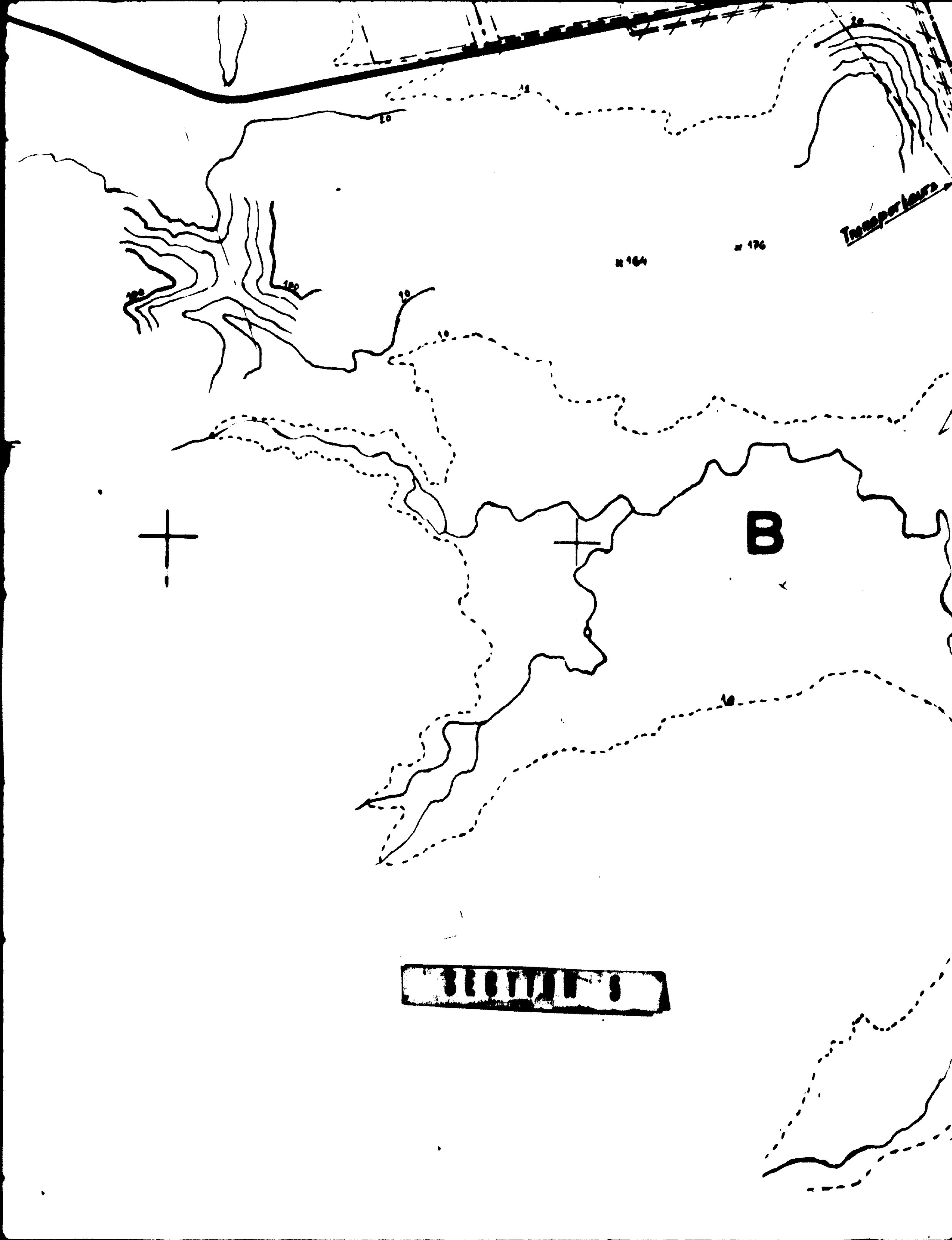
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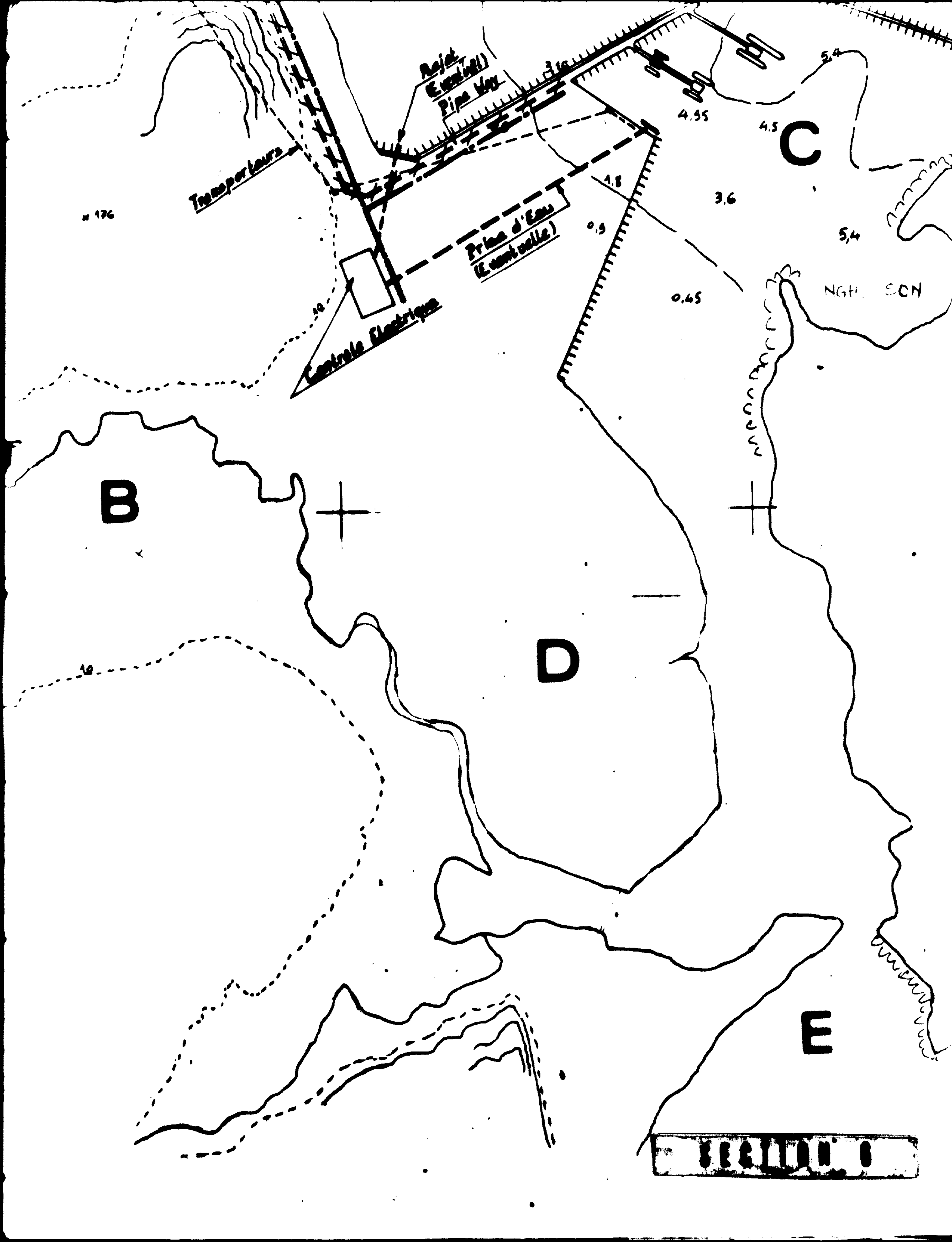
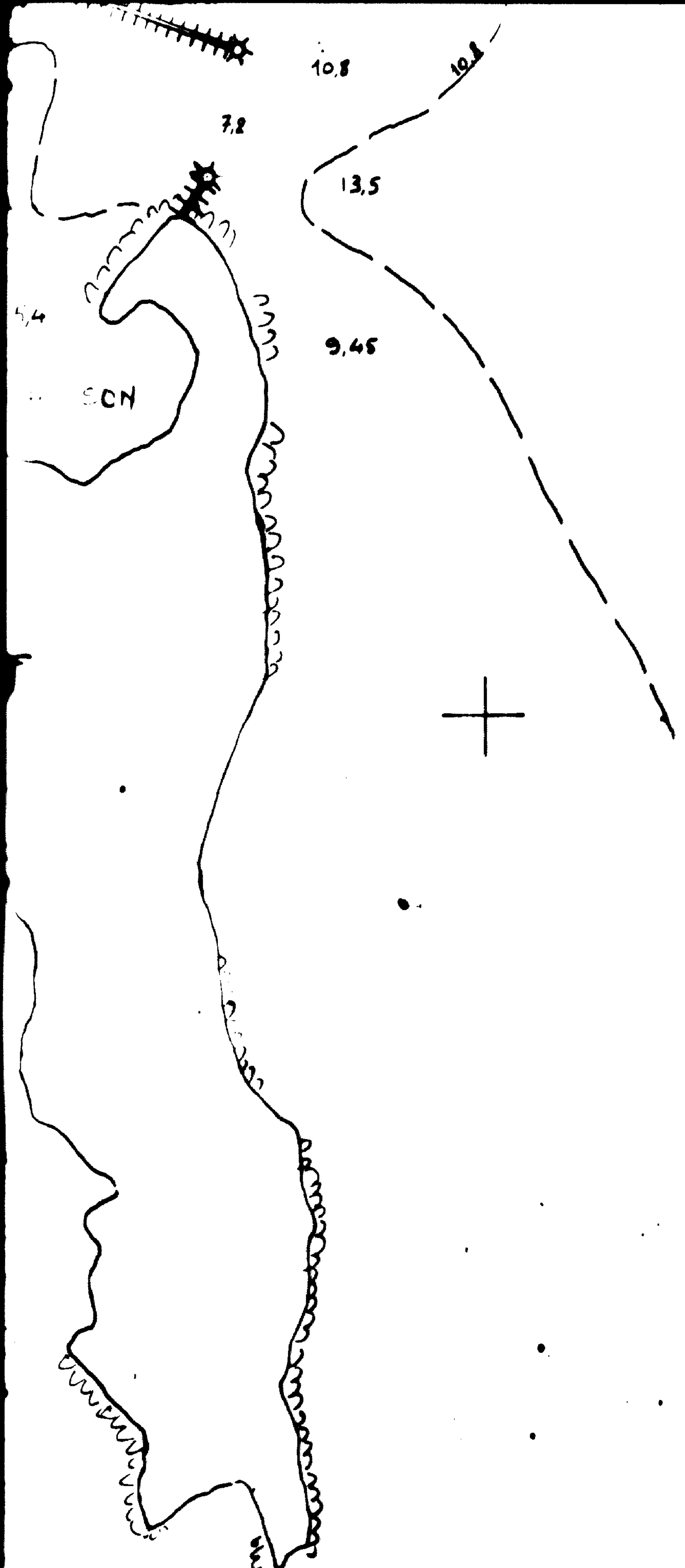
164
176



Rejet (Eventuel)
Pipe Way
Transporteurs
Prise d'Eau (Eventuelle)
Centrale Electrique
x 176
10
4.95
4.5
5,4
C
1.8
3,6
0,9
5,4
0,45
NGH SON
B
D
10
E



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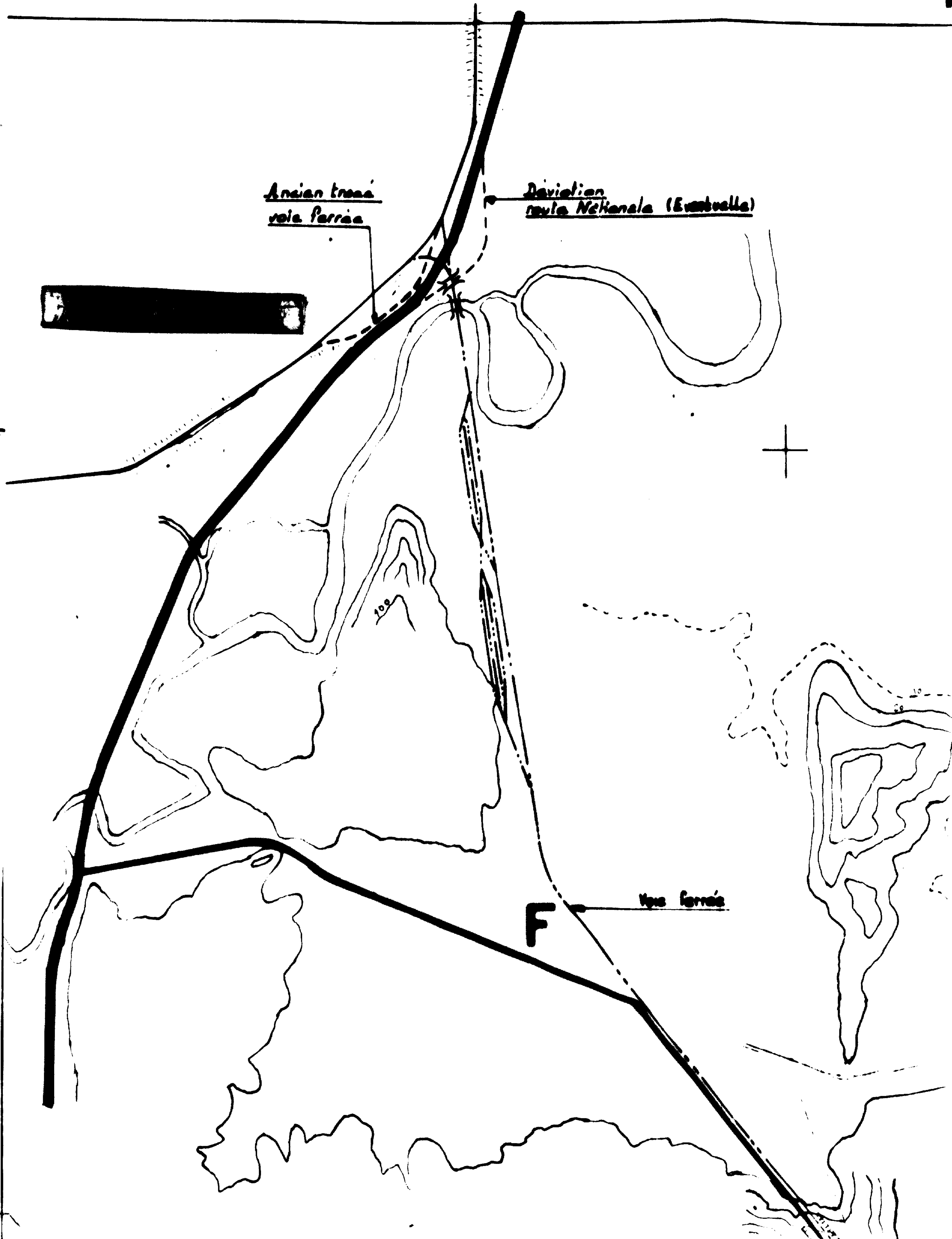
DIVISION DES ÉTUDES INDUSTRIELLES

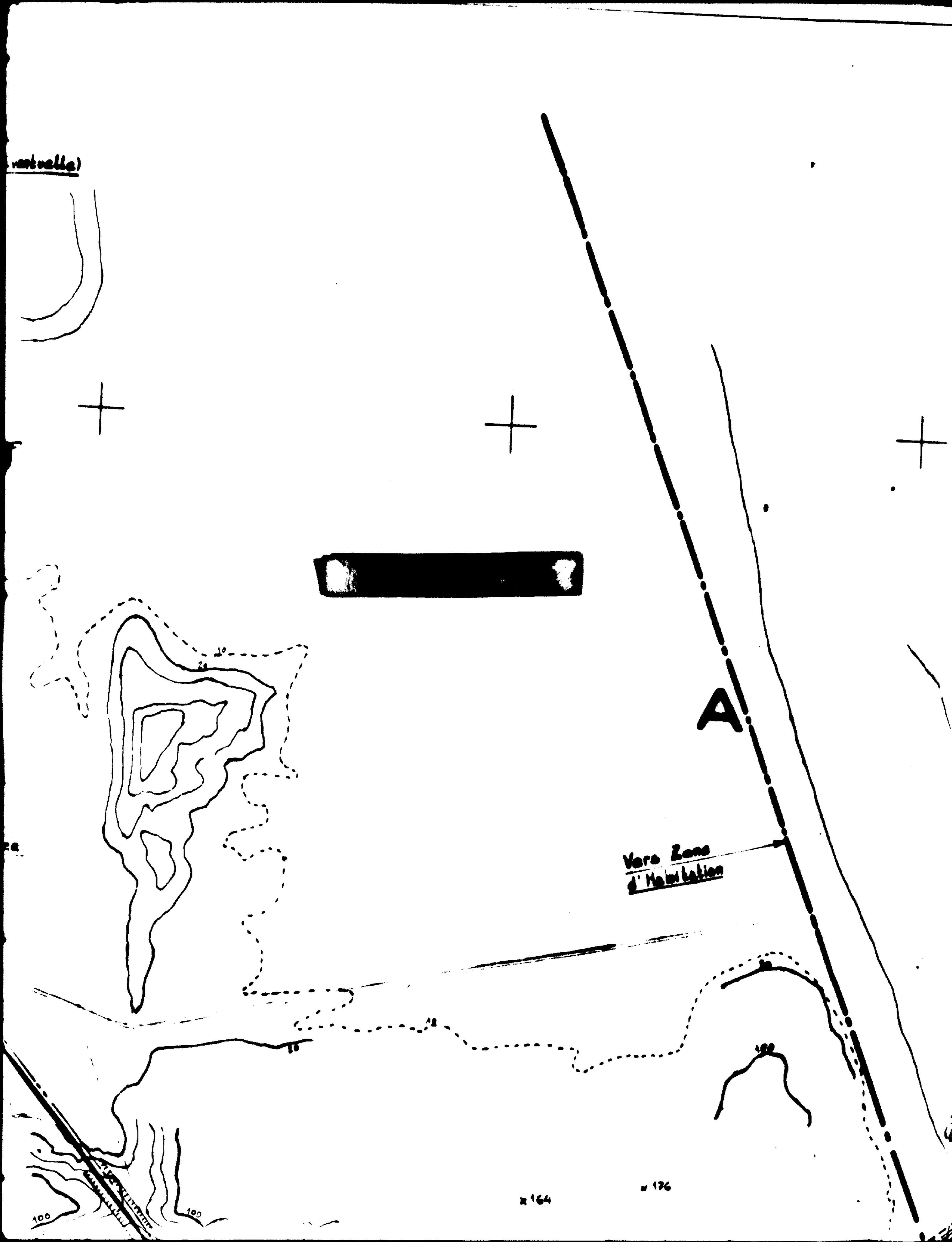
PETRO . VIET NAM

IMPLANTATION D'UN COMPLEXE INDUSTRIALO-PORTUAIRE

Projet N°4

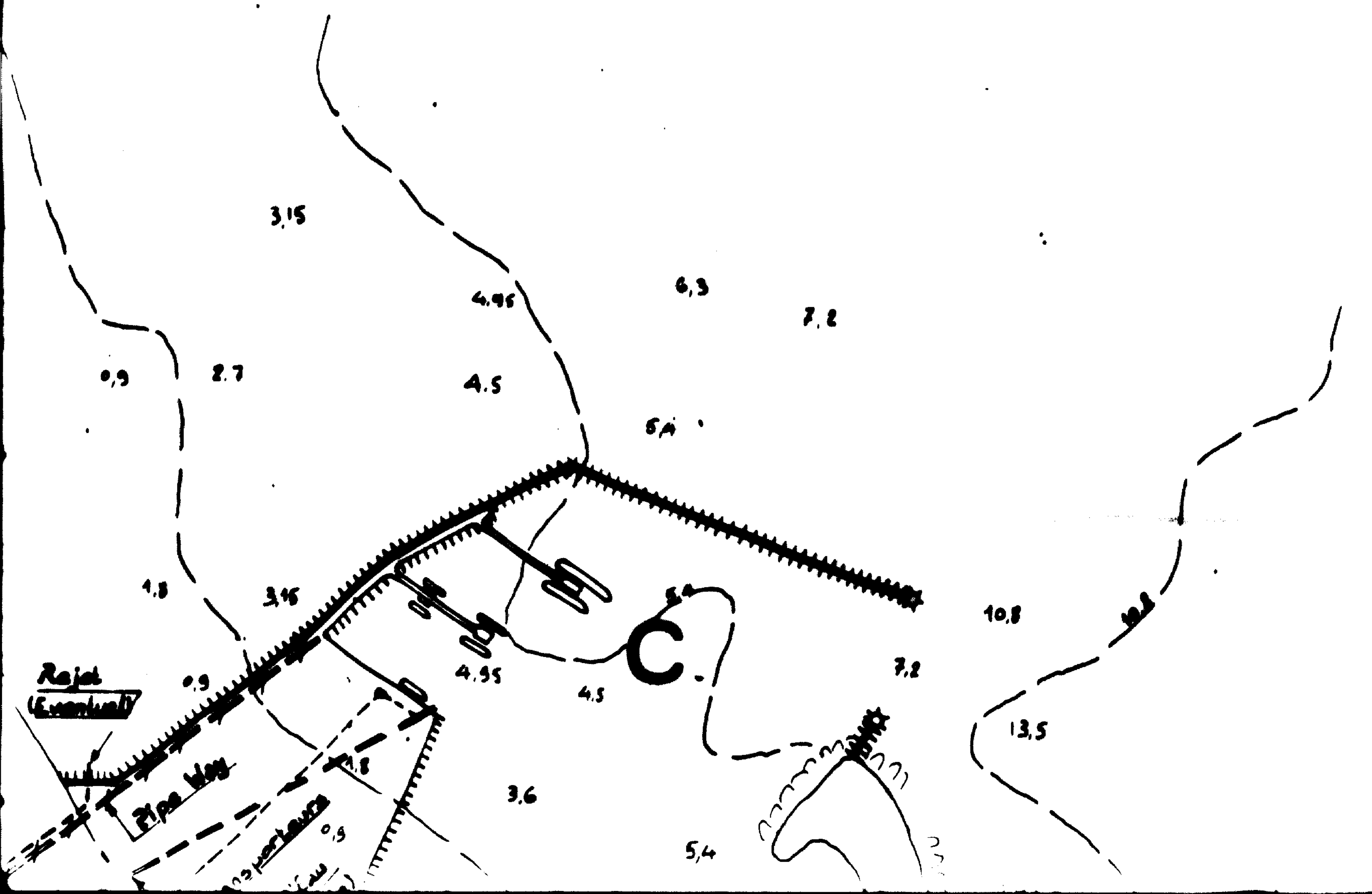
Ech: 1/20000	78060 . A . 004	REV. 0
31.8.78		


Ancien tracé
voie ferrée
Déviation
route Nationale (Eventuelle)
[redacted]
100
F
Voie ferrée



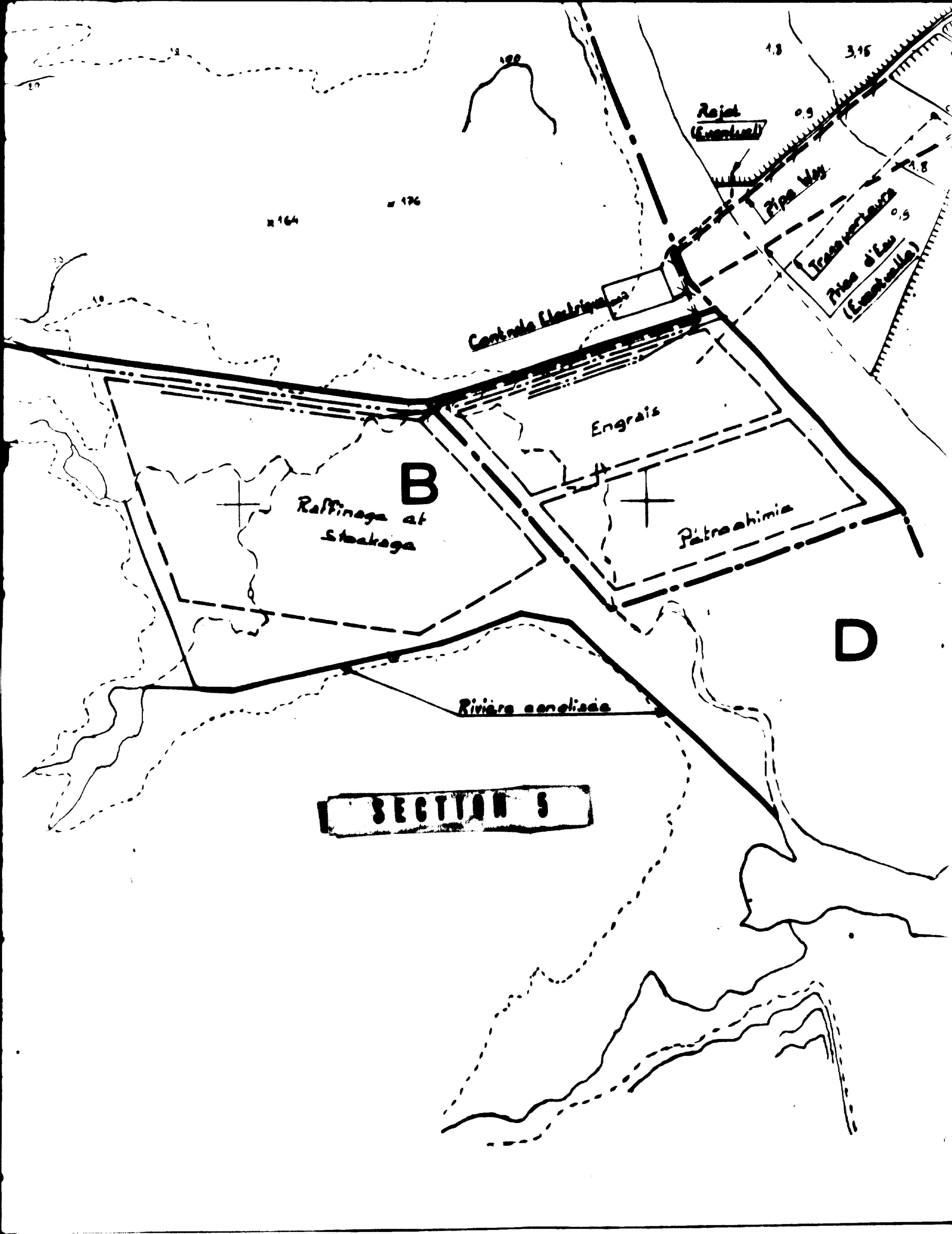
ventuelle)
[redacted]
A
Vers Zone
d'Habitation
x 164
x 176
100
100

[redacted]

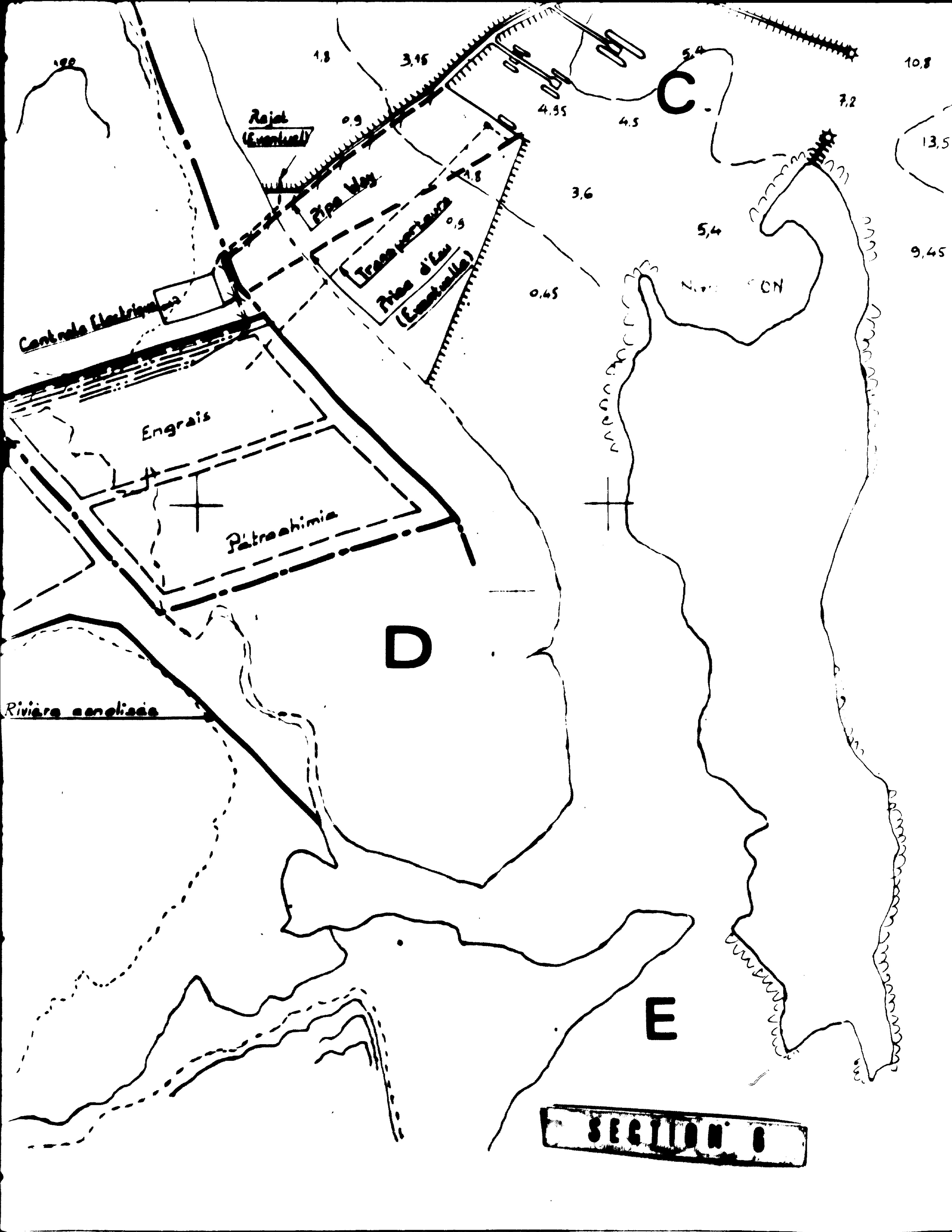


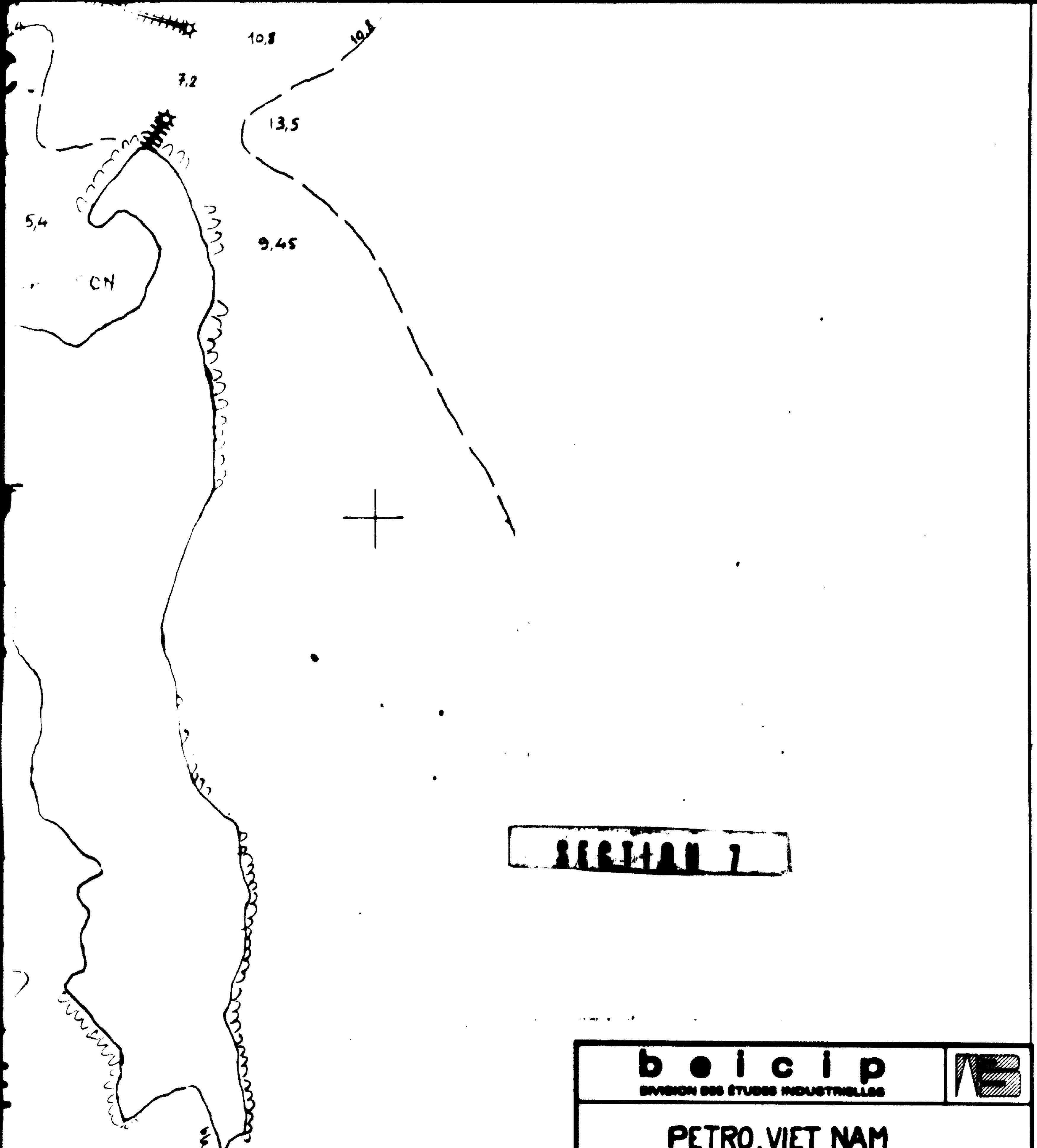
3,15
4,95
6,3
7,2
0,9
2,7
4,5
1,8
3,15
Rajet
0,9
Pipe Way
4,95
4,5
C
7,2
10,8
13,5
1,8
3,6
0,9
5,4


100
100



Rejet
(Eventuel)
1,8
3,15
0,9
1,8
0,5
Pipe Way
Transporteurs
Prise d'Eau
(Eventuelle)
Centrale Electrique
x 164
x 176
Engrais
B
Raffinage et
Stockage
Pétrochimie
D
Rivière canalisée
SECTION 5


1,8
3,15
5,4
10,8
C
7,2
13,5
0,9
4,95
4,5
Rejet (Eventuel)
Pipe Way
1,8
3,6
5,4
9,45
Transporteurs
0,9
Prise d'Eau (Eventuelle)
0,45
Centrale Electrique
Engrais
Pétrochimie
D
Rivière canalisée
E
SECTION



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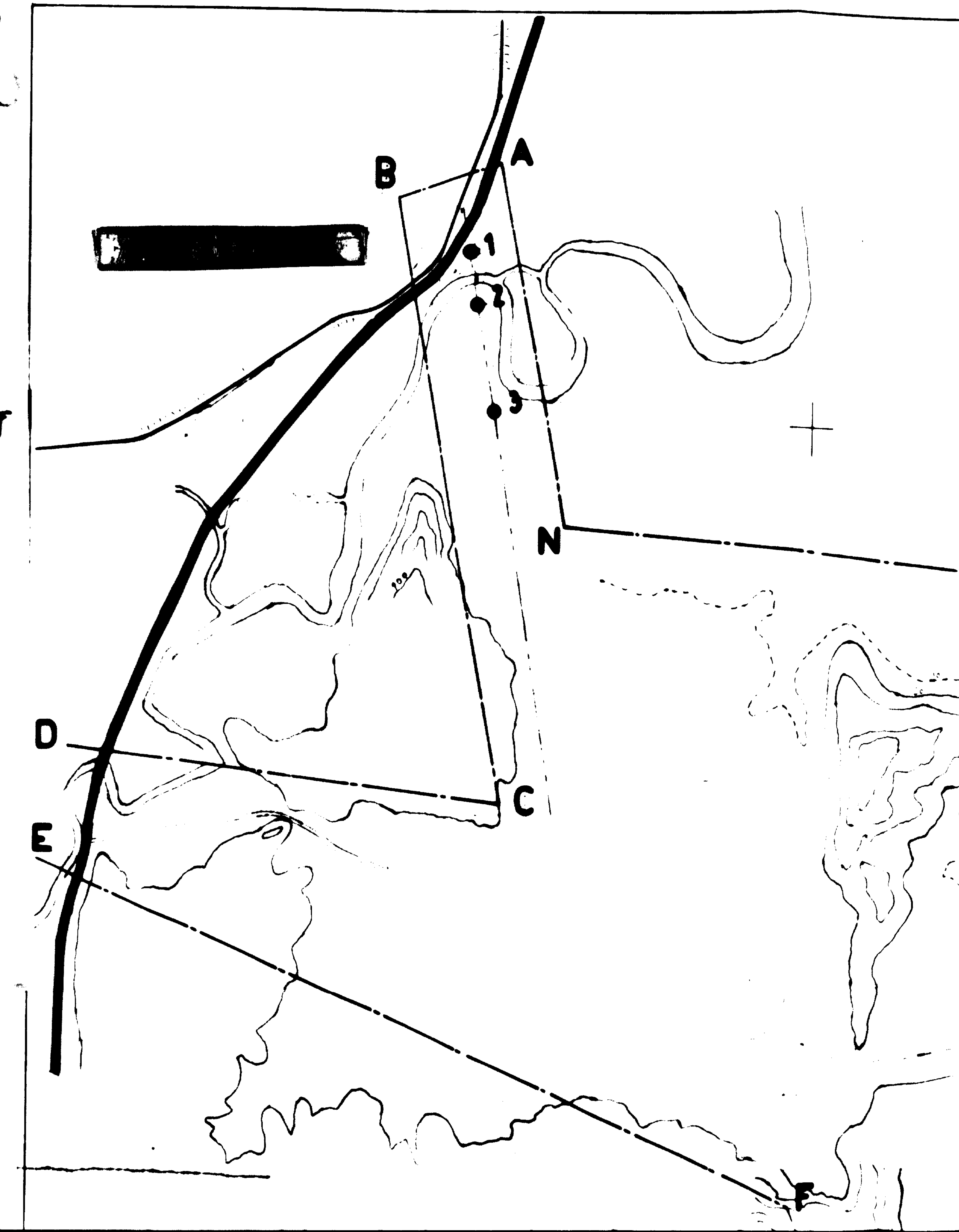
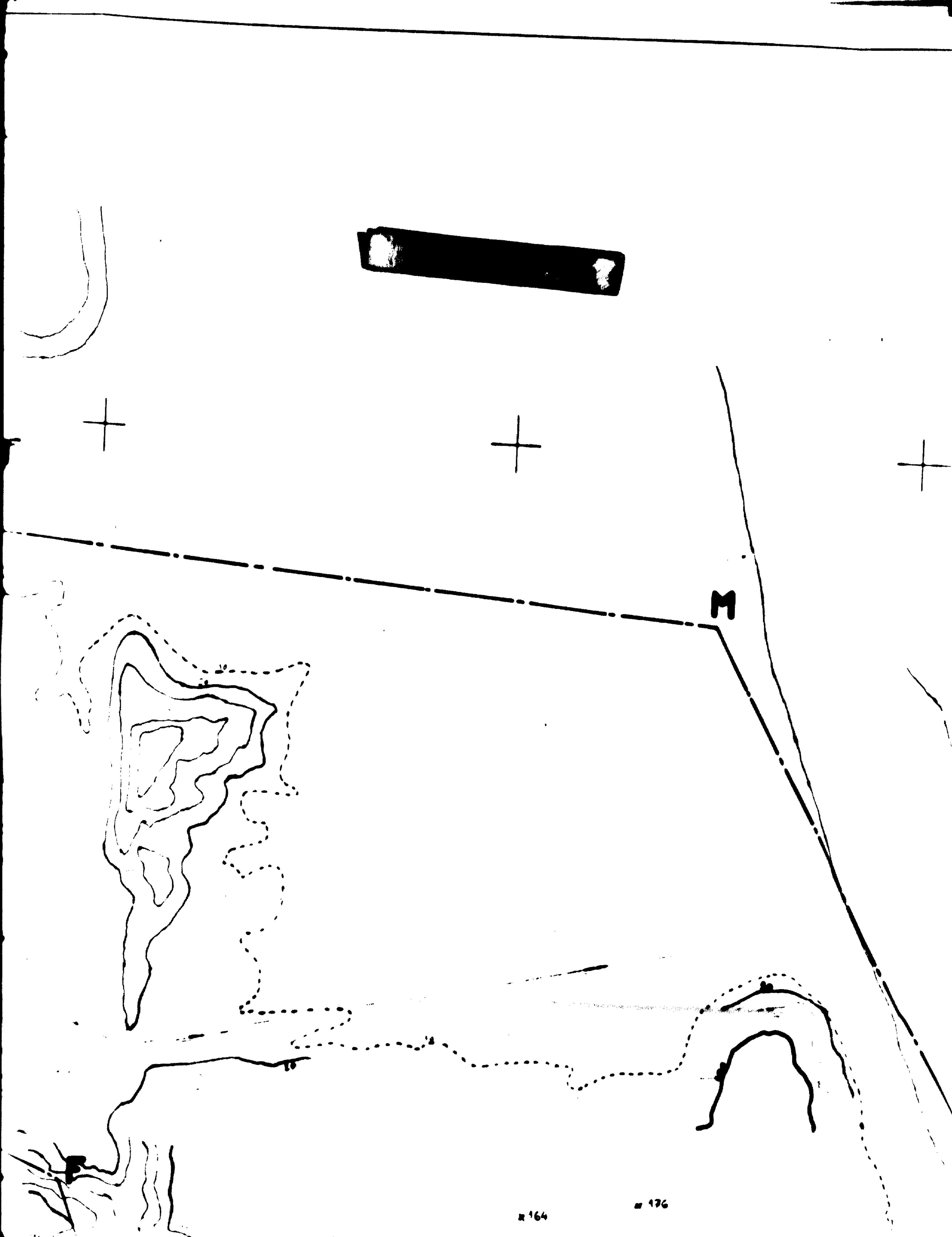
PETRO. VIET NAM

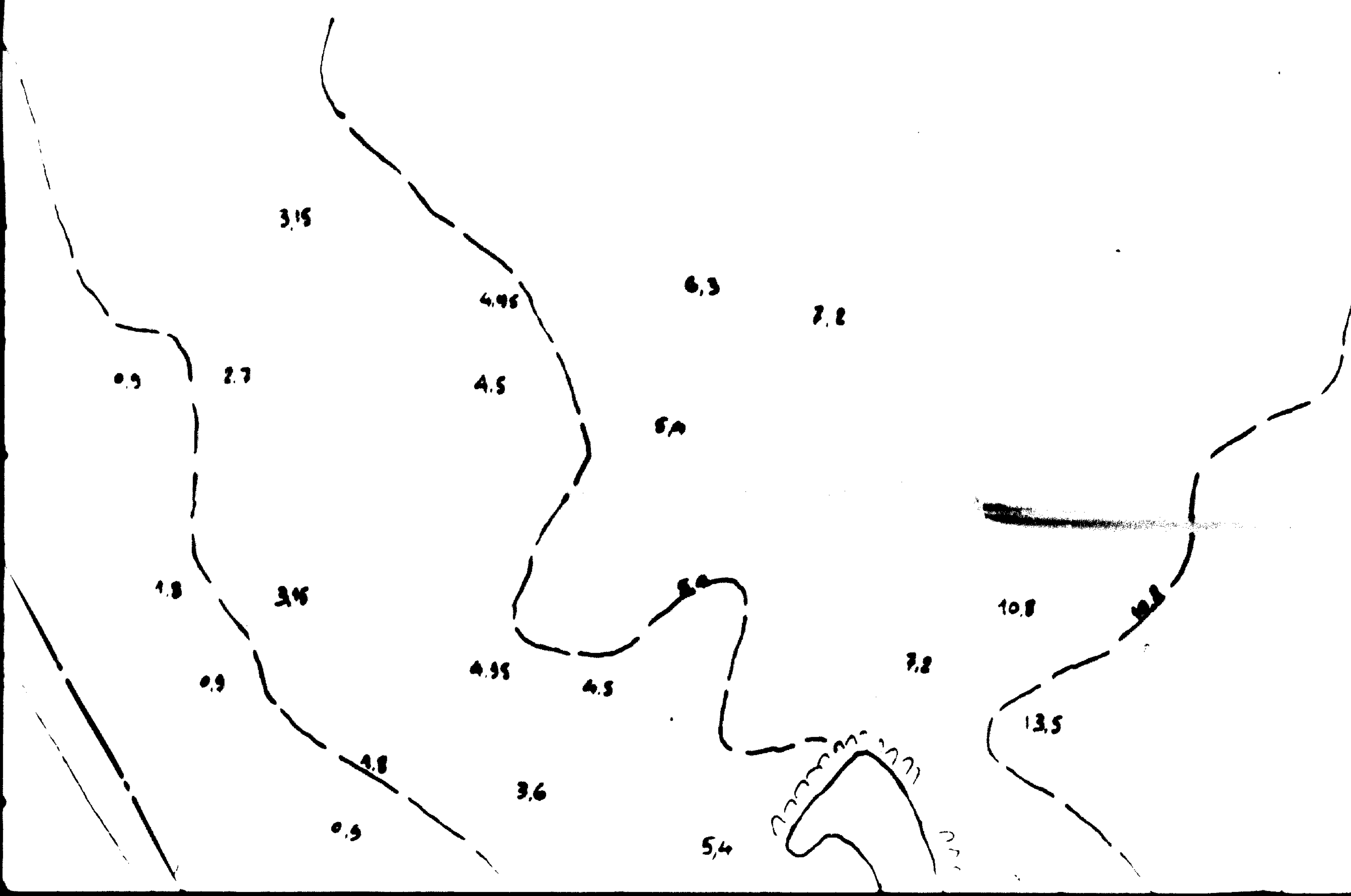
IMPLANTATION D'UN COMPLEXE INDUSTRIALO-PORTUAIRE
Projet N°5

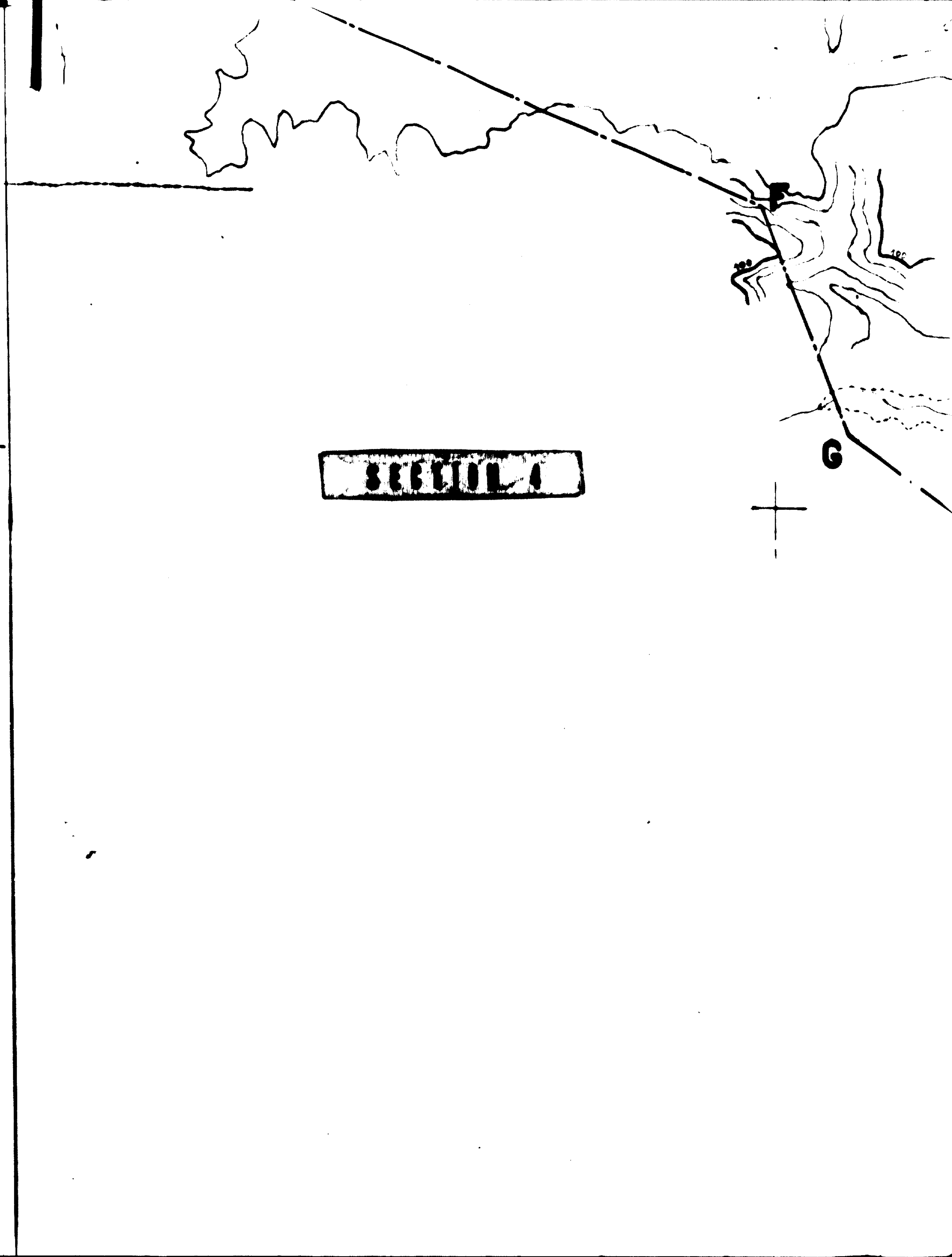
Ech: 1/20.000	78060 A.005	REV.
31.8.78		0

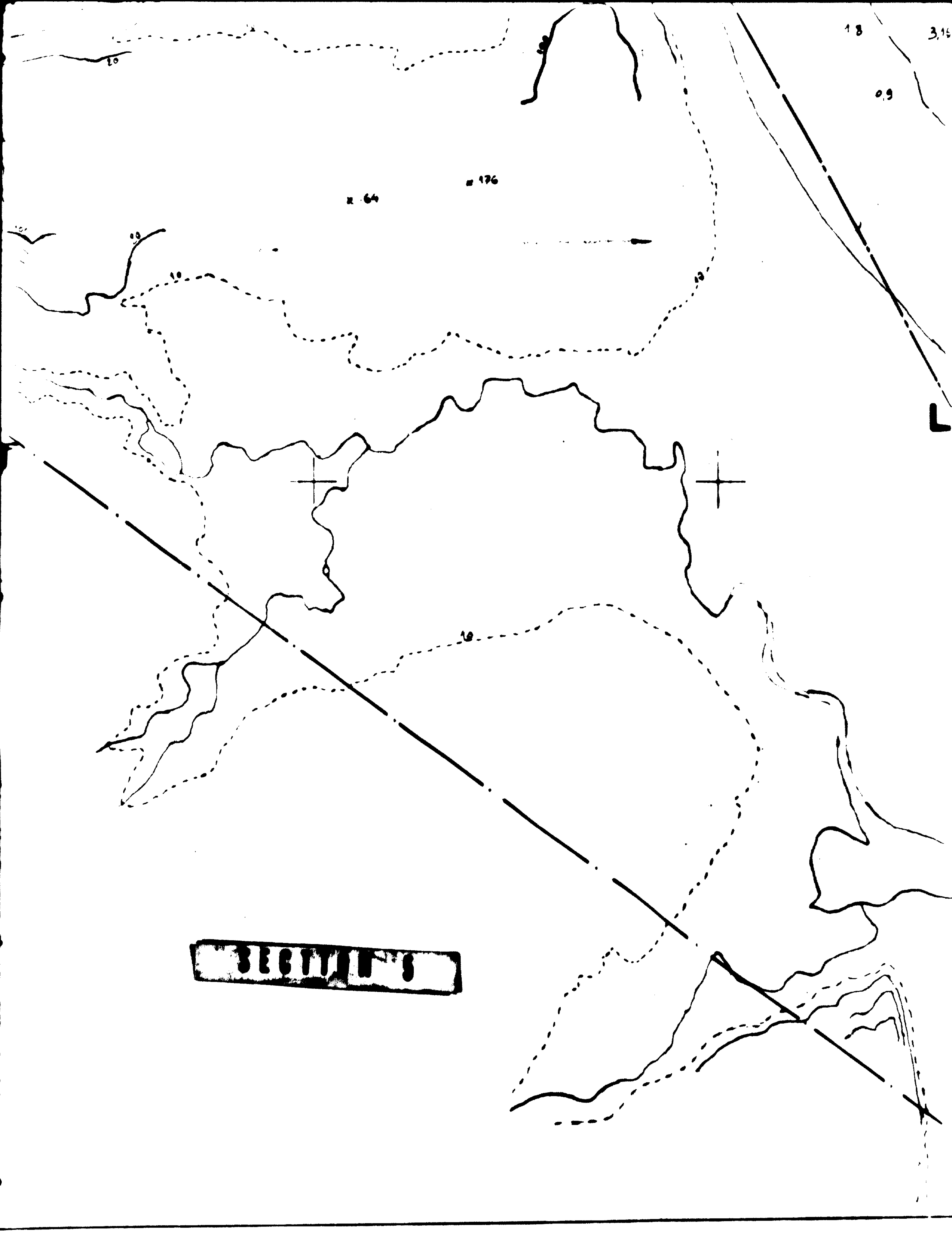

[redacted]
A
B
1
2
3
N
D
C
E
F

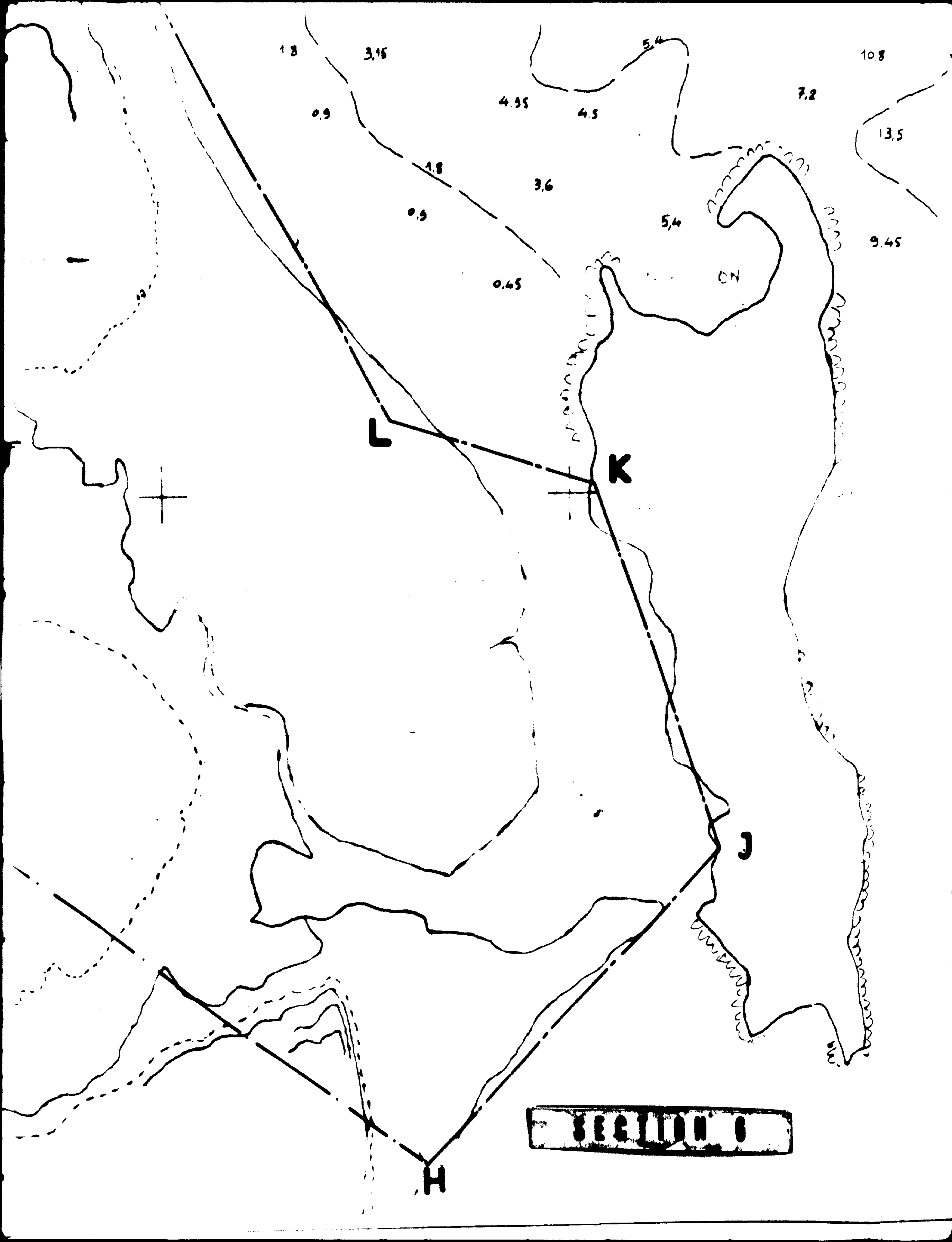

M
10
164
176

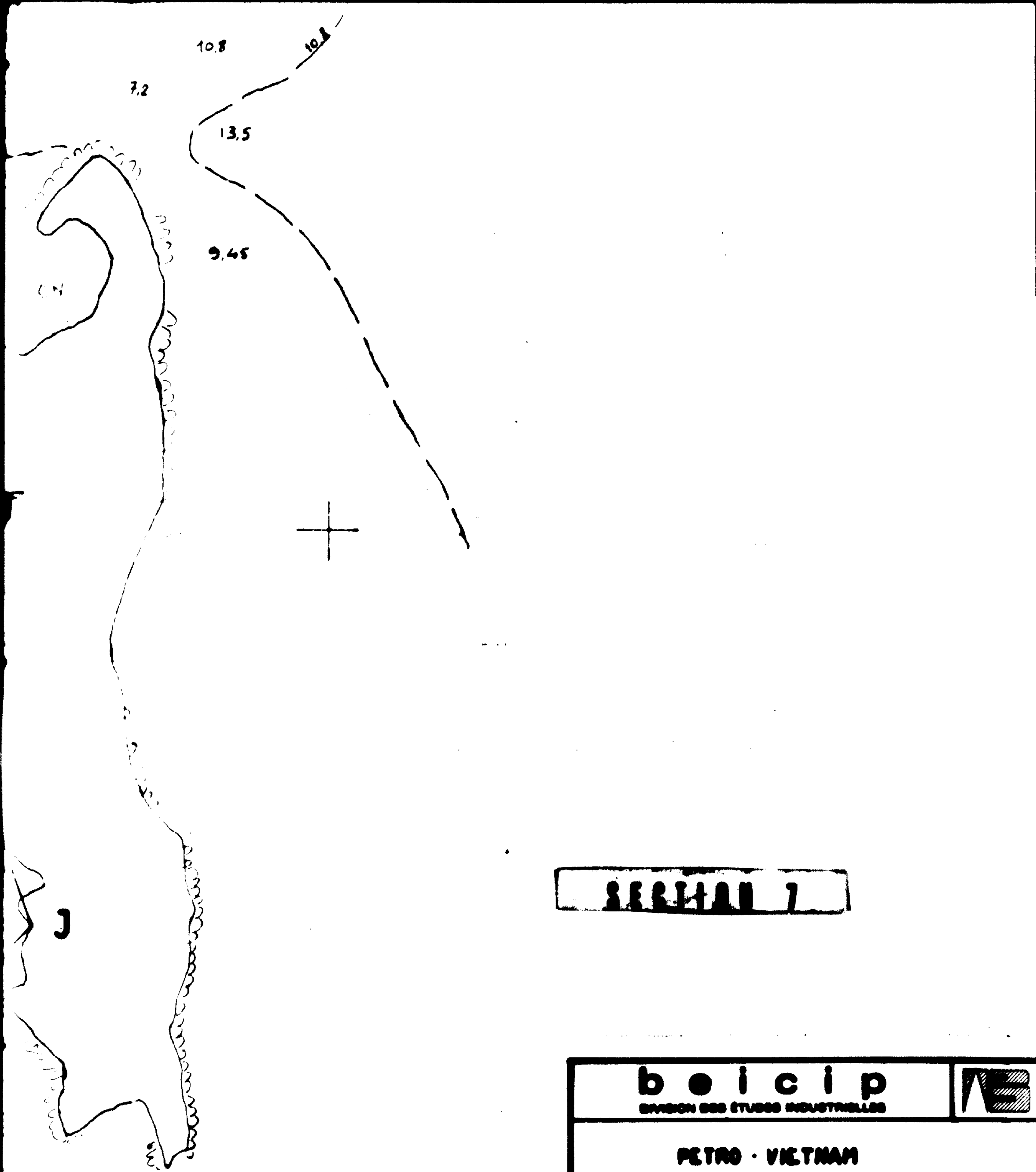
[redacted]




SECTION 4
G


20
10
x 64
x 176
1.8
0.9
L


1.8
3,16
5.4
10.8
0.9
4.35
4.5
7.2
13,5
1.8
3,6
0,9
5,4
9.45
0.45
L
K
J
H
SECTION 6



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DIVISION DES ÉTUDES INDUSTRIELLES

PETRO · VIETNAM

DÉLIMITATION DE LA ZONE DES RELEVÉS TOPOGRAPHIQUES

DELIMITATION OF TOPOGRAPHICAL SURVEY AREA

SCALE: 1/	78.060 · A · 100	REV.
19 . 10 . 78		0

[illegible]

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