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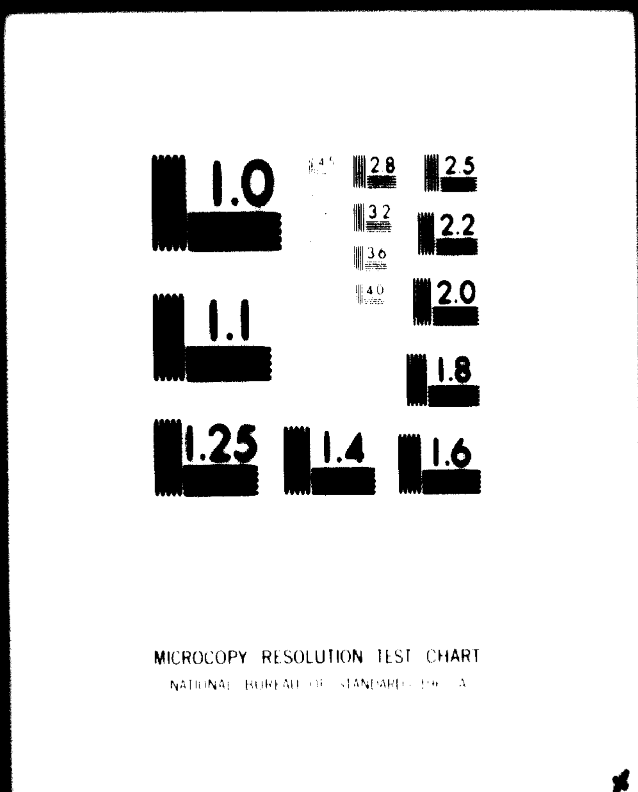

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STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA - DIREZIONE LAVORI
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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

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PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

STUDIO TECNICO INGEGNERIA

PROGETTAZIONE COORDINATA - DIREZIONE LAVORI

VIALE REGINA MARGHERITA 278 ROMA (ITALIA)

PART: Iª

INDEX OF PARAGRAPHS

P A R T - I

		Page
I-1	INTRODUCTION	1
I-2	MECHANISATION OF SALT PRODUCTION AND TREATMENT OPERATIONS	2
	I-2-1 Salt gathering	2
	I-2-2 Description of the machine	3
	I-2-3 Estimated cost of the salt gathering machine	5
	I-2-4 Transportation of the salt from the treatment installation (washing and purifying)	5
	I-2-5 Estimated cost of the salt transportation	6
	I-2-6 Salt treatment: washing and purifying	6
	I-2-7 Description of the operating washing installation	8
	I-2-8 Description of the washing and purifying installation	9
	I-2-9 Estimated cost of the washing and purifying installation	11
	I-2-10 Salt accumulation	12
	I-2-11 Estimated cost of the installation for the salt accumulation	13
I-3	COST FOR THE MANAGEMENT AND AMORTMENT OF THE COLLECTING AND PURIFYING OPERATIONS, AND FOR THE ACCUMULATION OF THE PRODUCT, FOR A YEARLY PRODUCTION OF 50,000 TONS.	14
	I-3-1 Amortment of the invested capital for machinary	14
	I-3-2 Amortment of the invested capital for constructions	14
	I-3-3 Total amortment	15

Page

I-3-4 Maintenance 15
I-3-5 Cost of man power 15
I-3-6 Energy consumption 16
I-3-7 Cost for a gathered, depurated and accumulated ton of salt 17
I-3-8 Consideration on the cost of gathering and accumulating operations of salt 17

I-4 SYSTEM OF LOADING SALT ON BOATS 19

I-4-1 Cost of the embarking system 22
I-4-2 Amortment of the invested capital 22
I-4-3 Man power 22
I-4-4 Cost for maintenance 23
I-4-5 Cost of energy 23
I-4-6 Cost for ton. of gathered salt and loaded aboard 24
I-4-7 Consideration on the loading operations on vessels 24

I-5 CONCLUSION 25

I-6 PRODUCTION OF ALIMENTARY SALT PACKS 26

I-6-1 Amortments 28
I-6-2 Maintenance 28
I-6-3 Staff 29
I-6-4 Energy 29
I-6-5 Conditioning materials 30
I-6-6 Lowering of work 30
I-6-7 Cost 30

I-7 PROPOSAL FOR A GENERAL RECONSTRUCTION OF ADEN SALTERN 31

P A R T - II

		Page
II-1	INTRODUCTION	34
II-2	PRESENT SITUATION OF WORLD' SALT MARKET	35
	II-2-1 Sodium chloride (NaCl)	35
	II-2-2 Rock or mine salt	35
	II-2-3 Sea salt	36
	II-2-4 Salt production processes	37
	II-2-5 Extraction from mines	37
	II-2-6 Mine salt solution and artificial evaporating	37
	II-2-7 Solar evaporating	38
	II-2-8 Rock salt mines and sea saltern	39
	II-2-9 Uses for sodium chloride and its derivatives	40
II-3	WORLD' SALT PRODUCTION FROM 1910 UPTO PRESENT TIMES	42
II-4	PRESUMED AVERAGE CONSUMPTIONS ACCORDING TO INDUSTRIALIZATION LEVEL	53
	II-4-1 Provision for salt demand and offer for the next years according to foreseeable consumption and production	54
	II-4-2 Provision difficulty	54
	II-4-3 World population and its increase from 1970 to 2000	55
II-5	RELATIONS BETWEEN POPULATION, PRODUCTION AND WORLD SALT CONSUMPTION	58
	II-5 1 Provision for the world salt produ-ction according to the relation produ-ction/world population	60
	II-5-2 Provisions for the world salt consu-mption according to the relation ave-rage consumption/world population	61

		Page
	II-5-3 Prevision for the world salt consumption according to different directing elements	62
	II-5-4 Development of world chemical industry	63
II-6	FORESEEABLE ABSORPTION MARKETS FOR ADEN SALT WITH REFERENCES TO EXISTING OR FORECAST SALTERNS IN THE MAIN COUNTRIES	67
	II-6-1 Asia	68
	II-6-2 Africa	80
FINAL CONSIDERATIONS		86

DRAWING INDEX

DWG 783/1		MAP OF EXISTING SALTERN
" "	2	PICKING - LOADING MACHINE
" "	3	LAYOUT OF HYDRAULIC CIRCUIT OF PICKING AND LOADING MACHINE
" "	4	LAYOUT OF WASHING AND ACCUMULATION INSTALLATION
" "	5	WASHING AND PURIFYING INSTALLATION DETAILS
" "	6	WASHING AND PURIFYING INSTALLATION SECTION B-B
" "	7	SALT ACCUMULATION INSTALLATION
" "	8	GENERAL MAP OF ACCUMULATION AND LOADING STATION AREAS
" "	9	SALT LOADING APPARATUS
" "	10	CONDITIONING SALT INSTALLATION
" "	11	MAP OF PROPOSED SALTERN

I-1 INTRODUCTION

It is necessary to point out that no mechanisation of salterns like those presently cultivated at the still functioning Aden saltern or of others that might be constructed with the same dimensions and with the same criteria, is possible.

The machinery proposed here for optimum production of salt are graded according to the UNIDO established formulae, for an initial production of 50,000 tons. of salt per year. This production is to be extracted from an experimental saltern to be set up in the zone denominated "Caltex".

It is necessary to emphasize that mechanisation is possible for producting quantities considerably higher than that mentioned above; in the present case the machinery envisaged is graded for minimum production. Even so they will be capable in carrying out the gathering operations of the above quantities (50,000 tons. per annum) in approximately 2 months of the year, remaining idle for the 10 months.

From the above data we deduce that the gathering with the same equipment can be carried on a saltern 10 times larger and more, by employing a larger number of work shifts.

In any case when constructing any experimental saltern the crystallisers must have minimum dimensions of 100,000 square meters, if machinery is to be used correctly. The pans must be boarded on at least one of its four sides by a road negotiable by trucks and the network of channels must be reduced to the minimum and be laid out judiciously, so that too many obstacles preventing the passage of gathering machinery from one pan to another are not created.

The treatment and gathering operations of salt, not including the phases of production have been estimated in this manner:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

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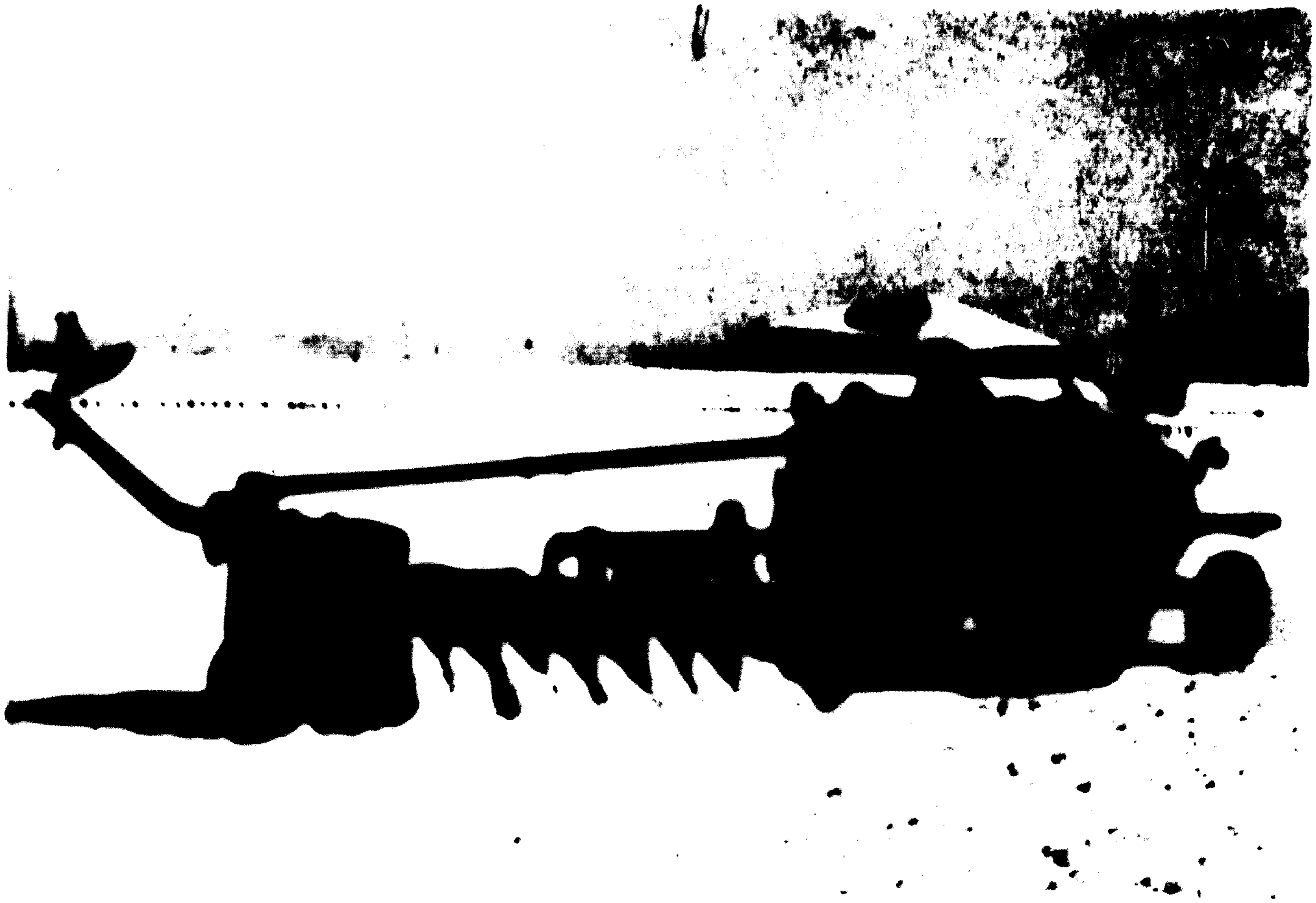

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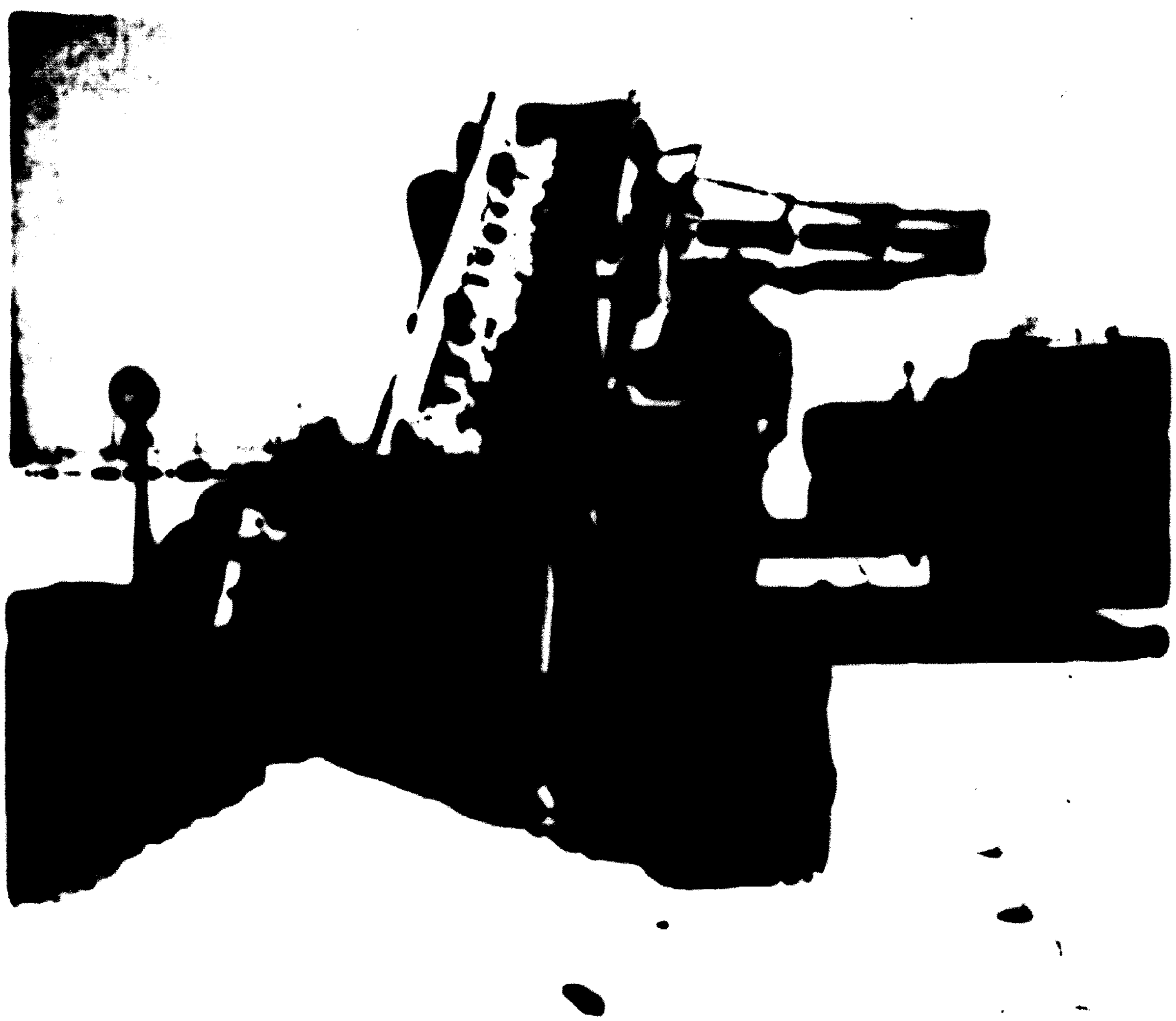

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Photo n° 2

Completed the shattering operation, the gathering machine will enter into the basin (photo n° 1-b). The gathering machine more suitable for Aden saltern is the one represented in drawing n° 2. This machine is widely used in the American salt pans of the Morton Salt company, in the Mexicans, Argentines, Tunisians and where ever large thickness of salt are to be gathered and low rain falls are present. This enables to maintain entact, once formed, the salt bottom of the basin. Though remaining basically similar in the various locations of use, these machines change is constructing details; there is no doubt that the best ones are those used by the American Morton Salt Company.

This machine gathers the shattered salt crust, and loads it directly on the trucks, which later load it on the sides of the basin, as clearly shown in photo n° 2.

I-2-2 Description of the machine

These machines have gathering potentiality which vary from 200 to 500 tons. per hour. In our case we will choose the smallest, the 200 per hour unit. It consists of; (see schematic drawing number 2).

a) a solid track van with a four meter inter axel and track width large enough to be supported on the bottom of the basin with a unitary load not exceeding 500 grams per sq. cm., with a motor solely used for tracktion of approximately 70 hp.:

b) a blade with a width of 3,50 meters similar to that of a Bulldozzer. At the central portion of the blade, for 1,20 meter width, is derived for the transporter equiped with a side way scraper, the heigth of the blade is controlled by hydraulic pistons;

c) two convergents screw conveyors placed on the extremites of the blade, having a length of about one meter each and width of 80 cm., with a spiral band of 15 cm. in width, rotating at a speed of one revolution per second. These provide pushing of the salt from the blade to the transporter equiped with central shovel dredgers;

d) transporter equiped with central shovel dredgers having a length of 1,50 meter with sectiones shovel of about 1.2 x 0.2 sq. meters and having a maximum capacity not exceeding 250 tons. per hour. This transporter is sloped at an approximately angle of 45° and receives the movement from the hydraulic motor which drives the screw conveyors, having its motor axel in one compact piece;

e) conveying band with rubber band equiped with special openings for steep climbs. The length of the band is about 6 meters and the width 90 cm., with a maximum capacity not exceeding 250 tons. per hour; the belt has a slope of about 40°. This band is driven by a hydraulic motor placed on the superior extremity;

f) a transporter with a swivel horizontal band, having approximate length of 3 meters 50 cm. and a width of 70cm. maximum capacity not exceeding 250 tons. per hour for the loading of the trucks. Driven by a hydraulic engine placed at the end of the band and working in series with one of the preceeding band;

g) a Deisel motor of about 80 hp placed on the rear of the track van , drives, with the two power gears, two hydraulic pumps. The first of about 50 hp which sends oil under pressure to the hydraulic motor which in turn activates the screw conveyors and the shovel dredger transporter and the other of abour 30 hp which sends oil under pressure to the two hydraulic motors which work in series with the two conveyor bands The functioning pressure for the pumps should be approximately of a hundred and fifty atms.

From the machine described above you have a picture which shows it in action and a general schematic design which can be used by the building company to present its relative offering.

The hydraulic system for the transmission for the various movements is only hinted, since these transmissions can be realized both mechanically or electrically. Our experience made us choose, from machines used in salt pans, because of particular corrosive surroundings, the hydraulic transmission.

An orientative scheme of the hydraulic installation can be seen in drawing number 3.

I-2-3 Estimated cost of the salt gathering machine

The cost of the machine used in Aden should be approximately of \$ 60,000; that of the tractor is about \$ 6,000 and that of the plough is about \$ 1,000 so that the cost of the whole collecting apparatus should be of \$ 67,000 with a ten year amortment of the capital.

I-2-4 Transportation of the salt from the gathering machine to the treatment installation (washing and purifying)

For this operation, dump trucks with a dead weigth of 15 tons. and very low pressure tires, are used. Presuming the accumulation of salt in point C of drawing number 1 and a medium transport of 1 kilometer, one can foresee the number of trucks needed:

- loading time $\frac{15 \times 60}{200}$ = approximately 5 minutes
- unloading time = approximately 3 minutes
- distance with load at 20 Km. per hour = $= \frac{60}{20} = 3$ minutes

- distance without load at 30 Km. per hour = $= \frac{60}{30} = 2$ minutes

Following this data, the time required for a truck to do the entire journey is:
5 + 3 + 3 + 2 = 13 min.
since in 13 minutes the quantity of transported salt is:

$$\frac{200 \times 13}{60} = 43 \text{ tons.}$$

therefore the number of trucks need will be $\frac{43}{15} = 3$

plus one in reserve, so 4 trucks of 15 tons. of dead weight are estimated.

I-2-5 Estimated cost of the salt transportation

The cost of truck like the ones used in Aden is of about $ 24,000 so the total cost for the means of transportation is presumed to be of $ 96,000 with a 10 year amortment of the capital.

I-2-6 Salt Treatment: washing and purifying

To obtain a salt free from physical and chemical impurities, relying only on the purificating installations is not quite enough, one must operate properly on the production and gathering of salt. A good rule to follow consist of introducing water with a density of 25.6 - 25.7 Bè in the crystallisers, that's after sedimented into the basins immediately preceeding the crystalliser pans, a portion of the salt.

This first salt is very rich of calcium sulfate, and with this method, that is sedimenting out of the basins the highest portion of these impurities, one will have a product with a very low sulfate percentage.

Naturally when in the basins preceeding the crystallisser pans enough salt will be deposited, one could proceed in melting it, to put into water at 10 ÷ 14 Bè drawn before these basins, water that later will be utilized in the production process.

This water brings in solution only sodium chloride since calcium sulfate has a very slow and difficult solubility.

To avoid a non-tolerable quantity of magnesium and potassium it will be wise not to make the water density in the basins exceed 28.5 Bè since after this density is surpassed there are noticeable percipitation of potassium salts other than magnesium chloride and magnesium sulfate.

To obtain this is is necessary, since sea water is of 3.7 Bè, to have saltern ratios of at least 1:9, that is, for every square meter of crystallisser pans at least 9 square meters of evaporation basins. It is advisable to release in the sea a part of the basin water which has reached 28.5 Bè (unless one wants to use this water for the extraction of bromide); the entity of this released water should be equal to one thirtyth of the sea water volume put in the salt pans.

Besides this proposed gathering system, grants for what above mentioned, the absence of physical impurities in the product.

We are firmly convinced, after the ana lysis of a sea water sample collected in Aden, that the sole use of the above mentioned precautions, if followed by a well qualified chemist, one can guarantee purity of the product of 98 - 99% of NaCl on a hydrate, even so we propose washing and purifying installations, also requested from the UNIDO.

I-2-7 Description of the operating washing installation (see attached schematic drawing number 4)

The washing of salt will take place with water having a 25 - 26 Bè, coming from the evaporating zone and inserted by an adequate piping system in the bucket elevators draught basin at water level.

The quantity of needed water in the installation is equal to that of the treated salt.

All the exhausted water will flow out from the flush weir placed in back of the spiral wheels.

It will be wise to set up an emergency weir in corrispondence to the bucket elevators draught basin, this weir will have to be 10 cm. higher than those of the spiral wheels.

The water coming from the washing installation by the small canals drawn on the side of the concrete basins, on which all the weirs converge, will be drawn by gravity in a canal placed on the ground and through it will reach, always by the force of gravity, the clarifying basins. These basins are built by banking an area of about 1,000 square meters near the installation, they will operate with a water level of about 50 cm.; their scope is to enable the exhausted water to settle, by a slow movement, all the parts which carry in suspension, and especially the calcium sulfate crystals.

A electrical pump will provide to send back to the installation clarified water.

The water into clarifying basins, must be partially and periodically substituted with water having 25 Bè coming from the evaporating zone, so that the washing water will never surpass 26 Bè always resulting saturated compared to the sodium clorate but not to the potassium and magnesium salts, for this reason the potassium and magnesium salts during the washing operations, pass in a good percentage in solution into the washing water.

This operation requires a continuous and careful check by a well qualified chemist.

As mentioned already, clearified water in the basins and brough back to a lower degree of magnesium salts by the above mentioned operation, come from a special pump sent back to the installation to repeat another washing cycle.

Another wash will be done by fresh water or sea water by a concentrated series of sprays directly to the bucket elevators in the last steep part, located above water level. The quantity of this water will have to be about 5% of the quantity of treated salt.

I-2-8 <u>Description of the washing and purifying installation</u>

It is composed of: (see drawing n° 5 - 6)

a) a concrete collecting hopper placed on a ground floor, and of such dimension to accomodate the unloading of a 15 ton. dead weight truck. The bottom of this hopper has an opening of about 2 meters in length and an adjustable width to supply the extraction band located underneath it, with a capacity of 200 tons. per hour;

b) an extracting band having a width of 90 cm., length of about 15 mt. and sloped at approximately 20°, with a speed such that it may have a maximum capacity not exceeding 250 tons. per hour. This band conveyor is used to transport salt from the unloading hopper to the washing installation.
The motion will be given to it by a 40 hp electric motor water tight type and exteriorly ventilated. All the conveyor structure will be made of adeguately resistent steel;

c) a two way loading hopper, with the possibility of completely or partially excluding one of the two disharges, to subdivide the load of salt between the two washing units. This hopper will be built of stainless steel 18/8;

d) two washing spiral wheel working in parallel together having a length of 10 meter, diameter about 1 mt., steps egual to the diameter, 5° sloped from the orizontal, spirals having a width of about 15 cm., rotating velocity of 1 turn per minute, built completely of steel of adequate resistance. It will be required to have two lateral supports and a few intermediate ones, the commanding stock will be in the rear and will consist, for each of its spiral wheels from a motor reducing gear of about 24 hp, 380 volts, 50 cycles.
This electric motor should be water tight and exteriorley ventilated. (It would be advisable that this motor reducing gear on its slow transmission has the same speed of the spiral wheels in order to directly match it on the ax of the spiral wheel, as it is unadvisable to use a chain transmission in the proximity of salt water). The two spiral wheels will be located in steel shells which will have in the inferior terminal part a controlled weir of about 2 m. in width and of adjustable height for the discharge of the exhausted washing water.
The two spiral wheels with shells are located in a single basin of concrete as shown in the attached schematic drawing.
On the sides of this basin, small canals are drawn, which put in communication the weir of the exhausted washing water with the clarifying basins of water itself;

e) two bucket elevators with buckets bored (with holes of 5 mm. in diameter distant from each other, about 1 cm) with a sloped side of about 30° and a length of 3 m. which dredge the salt unloaded from the spiral wheels from appropriate concrete basins of a particular shape, and a side of 12 ml. in length which provides the draining of the washed salt; the slope of this second part of bucket elevators is of about 15° from the horizontal. The width of the bucket elevators is of about 1.80 ml. with the bucket width of 1.20 ml. Sectionized view of the bucket as indicated in the attached drawing, traction chains with section adequate to the strain, guide roller type, constructed with steel of adequate strength, steel particularly resistant for the chain links and of the nylon bushing. Driving wheels and back gear of cast iron with a diameter of about 1 meter. Driving group (one for each bucket elevator) built in front with a water tight electric motor externally ventilated of 35 hp, 380 volts, 50 cycles and reducing gears with a ratio to give the bucket elevators a speed of 0.20 ml. per second;

f) exhaust hopper of the bucket elevator in an iron plate with an extracting band underneath, having a length of mt.; width 70 mm. and a speed such that it may have a maximum capacity not exceeding 250 tons. per hour, 12 hp motor reducing gear, 380 volts, 50 cycles, run by a water tight electric motor;

g) one propeller pump with a vertical ax having a rate of flow of 250 mc. per hour and a static head of about 8 meters, with an iron cast body and bronze or stainless steel impeller. Water tight motor directly driving. This pump is used to send the washing water from the decantation basins to the installation.

I-2-9 Estimated cost of the washing and purifying installation

The cost of this installation can be distributed in the following manner:

a) buildings and decantation basins $ 17,000

b) purifying installations including the electric installation in low tension (380 volts) and the pump for the washing water circulation and including everything mentioned above, all placed in Aden $ 115,000

A 25 year amortment of the building and decantation basins, and a 10 year amortment of the installations.

I-2-10 Salt accumulation

The installation which will provide this operation is composed of: (see attached drawing n° 7)

a) a conveyor band which joins the washing installation exhaust band with the effective heaper. This band which has a length of about 40 ml. and a slope of about 10° such that it will raise the salt till the height of the hopper of the heaping band.
Its width is of about 0.90 ml. and it will have a velocity which will guarantee a maximum capacity of 250 tons. per hour.
Its movement will be conferred from a water tight motor of about 30 HP exteriorly ventilated, 380 V 50 Cycles and idoneous reducer;

b) a mobile support tower placed on rails with a turning platform. This tower built with profile steels, has the superior portion composed of a turning platform on which it is installed a steel dolphin of about 15 ml. high. The rotation of this platform is operated from a 5 HP gear reducing motor connected on a spur wheel which is working in series to a rim gear having a diameter of about 7 ml. being one piece with the turning platform;

c) a conveyor band with a slope of about 15°, length of about 40 ml. sustained, as clearly showed in drawing n° 7, by the above described steel dolphin.

A ten horse power electric winch enables to change the slope of this band till lowering it completely horizontal position for big maintenance works; this winch is placed on the platform.

This band is 0.90 ml. wide and has a velocity which will guarantee a maximum capacity of 250 tons. per hour. It is operated from an electric motor with its relative reducer exactly the same as the precedent band.

Its construction is in profile steel, and has two small lateral service gangways so that the workers can do normal maintenance operations.

It would be advisable to set the bands motor and relative reducers, in the middle of the band near the point of grip of the structures' band by the wire rope which unites it to the steel dolphin.

This band is capable of doing a cumulus 20 ml. high even though it is sufficient to accumulate 70,000 tons. of salt per year, the tower should remain fixed in a spot, so that the cumulus will take a bean shape, as indicated in drawing n. . It is advisable to buy this apparatus built on 4 train rails, so that in case of an expansion of the saltern the same apparatus may be used for the formation of two parallel cumulus as long as one wishes with the only displacement of the apparatus on rails and the interposition of mobile bands between the washing exhaust band and the first accumulating band.

I-2-11 Estimated cost of the installation for the salt accumulation

The cost of this installation can be divided in this manner: construction and rails for supporting the tower $ 17,000; full electric installation in low tension and everything mentioned above, all placed in Aden $ 142,000.
A 25 year amortment of the constructions, and a 10 year amortmen of the installations.

I-3 COST FOR THE MANAGMENT AND AMORTMENT OF THE COLLECTING AND PURIFYING OPERATIONS, AND FOR THE ACCUMULATION OF THE PRODUCT, FOR A YEARLY PRODUCTION OF 50,000 TONS.

I-3-1 Amortment of the invested capital for machinery

The capital to invest is the following: capital with an estimated 10 years amortment

n° 1 collecting machine	$ 60,000
n° 1 50 hp tractor	$ 6,000
n° 1 four furrow plough	$ 1,000
n° 4 dumping truck	$ 96,000
n° 1 washing and purifying installation	$ 11[illegible],000
n° 1 accumulating installation	$ 1[illegible]2,000
Total	$ [illegible]12,000

Considering a 7% interest on the capital, one derives to an amortment coefficient of 0.142378 therefore the relative annual amortment quote is of $ 60,000

I-3-2 Amortment of the invested capital for constructions

An estimated 25 year amortment of the capital; of constructions and of earth moving works

for the washing installation	$ 17,000
constructions for the base of the accumulator	$ 17,000
Total	$ 34,000

Considering the 7% interest on the capital, one derives to an amortment coefficient of 0.085811, therefore the relative annual quote will be of: $ 2,920

I-3-3 Total amortment

Total amortment of annual quote \$ 62,920, incidence of the amortment quote on the cost of salt:

62,920:50,000 = \$ 1.25 per ton

I-3-4 Maintenance

It is estimated a maintenance quote of [illegible]% for the machinery and of 2% for the constructions and in the soil, therefore the annual expense for the maintenace will be of:

\$ 21,680

incidence of the maintenance quote on the cost of salt:

\$ 21,680:50,000 = \$ 0.435

I-3-5 Cost of man power

For the superintendance on the gathering operations, washing and accumulation, the following staff will be needed:

- n° 2 control technicians (1 engineer and 1 chemist)
- n° 1 plough driver (specialized workmen)
- n° 2 collecting machine drivers (specialized workmen)
- n° 4 truck drivers (specialized workmen)
- n° 2 drivers for the washing installation (specialized workmen)
- n° 2 drivers for the accumulating installation (specialized workmen)
- n° 1 installation chief (technical expert)
- n° 4 general services (normal workmen)

Having the following hour salaries:

- technicians and installation chief	\$/hour	0.67
- specialised workmen	"	0.50
- normal workmen	"	0.33

And bringing in mind that to collect 200 tons/hour of salt with the above mentioned staff, one will need:

- 3	hours of technician	$	2.00
- 11	hours of specialized workmen	$	5.50
- 4	hours of normal workman	$	1.32
	Total	$	8.82

the incidence of the man power quote on the salt will be of:

$ 8.82 : 200 = $ 0,0441 per ton

I-3-6 Energy consumption

The necessity of power is subdivided between electric energy and the use of oil by the diesel motors of the self-moving means of transportation.

In the following means of transportation a diesel motor's power is used:

- gathering machine	150 H.P.
- tractors	50 H.P.
- trucks	280 H.P.
Total	480 H.P.

which will have a use about 100 Kg. of oil per hour at a price of $ 0.042 per Kg. for a total of $ 4.20.

To this we have to add $ 0.84 an hour for the use of lubricant oils.

The electric power described in the various installations is approximately the following:

- washing installation	KW 130
- accumulation installation	KW 70
Total	KW 200

which have a use of 200 KW per hour at a price of $ 0.017 per hour gives a total of $ 3.40 per hour, so in one hour all the functional installations will give a total energy expense of $ 8.44.

The incidence of energy on the total salt price will be:

$ 8.44 : 200 = $ 0.0422 per ton.

I-3-7 Cost for a gathered, depurated and accumulated ton of salt

- for amortment		$ 1.2300
- for maintenance		$ 0.4950
- for man power		$ 0.0441
- for energy		$ 0.0422
	Total	$ 1.8113

I-3-8 Consideration on the cost of gathering and accumulating operations of salt

The cost of these operations seems quite high, especially in the amortment and maintenance sections. The fact is, that it is not possible to lower oneself the use of decisively lower machines potentiality, because their cost would be slightly lower, because if we should use the same number of workers for their functioning, it would be very hard to deminish the total cost.

But one most consider as well, that in an ideal zone like that of Aden Salt Production, it would be advisable since one has to try the mechanization of salt, the use of machines that after having been tried and found the generousity of them, could augment the rate of production without changing them.

The 50,000 tons., yearly, proposed for mechanizing the operations of gathering and accumulating are a very low quantity and we think that in the world, productions of this sort are not considered, because one must sell on a competitive exportation level in the world market.

The proposed operations, even though it limits the day to eight hours of work (one shift) they would complete their work in:

$$\frac{50{,}000}{200 \times 8} = \text{about 30 work days}$$

It is obvious, since Aden's climate consents to work on the gathering of salt throughout the whole year, that those apparatus would be sufficient for a production 10 times as large, limiting the work to eight hours a day, and even 20 times as large if increasing work to two of eight hours each, that is 16 hours a day.

In the first case the cost of the operations, of man power and energy consumption remain untouched, the total expense would be lowered to $ 0.25 per ton., and the second case as low as $ 0.17 per ton.

Naturally, one has to consider for such a small production in the above analysis, we didn't include any spare machines, because even for a few days of repair their would be no dammage done; but in the case of continuous work, it will be indispensable to have a certain amount of spare machines and motors, estimated around 20% of the capital.

Also the quote of maintenance for machines that work almost every day should increase, while one should go more prudent deciding upon the time of amortment, even though some say that the machines get worn out more when they do not work than when they do.

It would also be necessary, if the work would increase, to employ equiped workshops and workers skilled enough to conduct fast and good repairs.

In any case we can say, thinking of all the previous considerations, for a saltern of 500 to 600,000 tons, the gathering, depurating and accumulating process, could be easily done for $ 0.50 per ton. While for production of millions of tons per year, this cost could be lowered to about $ 0.33 per ton.

I-4 System of Loading Salt on Boats

When point C is decided to be the accumulating point of salt (see drawing n° 8) the nearest point with depth high enough for the embarkment is point D. Up to 400 ml. one can reach it with a good paved road already existent and good for trucks.

The last piece of 370 ml. which divides the end of the road from the embarkment point D, will be passed with two conveyor bands having a length of about 185 ml. each and placed in series.

At the end of these bands, the loading station which will lay on the standard, will be built.

The bands, being in low bottom water where they are layed, could be rested on stone dam embankment having a width large enough to enable, next to the band, a small pathway for the inspection of the band itself. If the foreseen dam embankment could involve the normal currents of the bay, it could be replaced by a light iron sectioned landing-stage with wooded trampling; the cost of this pathway should be equal to that of the stone dam embankment.

It is foreseen a 200 tons. per hour capacity for the bands increasing till 4 or 500 if the power of the motors and of the band speed is doubled, and by the replacement of the rubber band by another idoneus to support this new pull. The loading station will be built with a loading structure having a high and length adequate for the load of the 20,000 to 30,000 ton. ships.

Consequently, the loading of the vessels should be done in the following manner:

Two excavators having a loading potentiality of 100 to 150 tons. per hour will provide to load the salt from the cumulus on the trucks.

These trucks, will cover the whole distance already exsisting and indicated in drawing n° 8 . The length of this distance is of about 3 Km.;
foreseeing for the trucks incharge of the loading of salt:

loading time	8 min.
unloading time	2 min.
time required to cover the distance at 50 Km. per hour	7 min.
Total time required for 1 trip	17 min.

in one hour every truck will transport:

$$\frac{15 \times 60}{17} = 52 \text{ tons.}$$

Consequently, the same trucks that provide the transportation of salt from the basins to the depurating installation, could be utilized for the transport from the cumulus to the proximity of the boat; naturally when the boat will have to be loaded the gathering operations will have to stop.

Always considering the system for the requested 50,000 tons., this does not present any difficulty, because as we have already seen the gathering operations take place only for 30 working days a year. In the same way, even if one intends to send out all the 50,000 tons produced, the loading operations will interest only 30 working days a year.

The trucks will deposit their salt in the hopper indicated with letter in drawing n° 9.

This concrete hopper will have a capacity large enough to receive at least one whole load truck, it will be placed on ground floor and on the bottom it will have an opening of about 2 ml. in length and an adjustable width so that it may feed the band conveyor which starts there, with a capacity of 200 tons. per hour.

The hopper's salt will be transported to the loading installation by the two above mentioned conveyor bands each having a length of 185 ml. These bands will be horizontal, will lay on stone dead banks or on sectioned landing-stage, will have a width of 0,90 ml. and they will be separately driven by an electric motor-reducer of about 30 HP with water proof exteriorly ventilated motor, 50 [illegible]. The speed will be great enough to assure a maximum capacity of 250 tons per hour. The second of these two bands will have the last part upwardly sloped in order to unload in the hopper of loading device of the vessels.

The loading device will be composed of a turning plate on a [illegible]° angle; on this plate, and being part of it, there will be a yard having a height of about 10 ml., which will hold by the means of wire ropes the real loading band having a length of about 1[illegible] ml. The height of the plate and the length of the band are fixed and idoneous to the vessels load having a capacity of 20 to 30,000 tons., if one has to load vessels of lower tonnage you will move the position of the vessel. The rotation of the plate will be secured by a [illegible] HP motor reducer with ring gear having a diameter of about [illegible] ml. The loading band will have a width of 0,90 ml., will be driven by a 20 HP motor reducer and it will have a speed enough to secure the maximum capacity of 250 tons. per hour. A 10 HP motor winch, placed on the turning plate, will allow to raise and lower the loading band according to the height of the vessels' hold and to raise completely when it is not at work. Drawing n. 9 shown all this apparatus.

I-4-1 Cost of the embarking system

The necessary expense needed for all the apparatus for the loading of salt from the cumuls to the vessel is the following:

- n. 2 excavators with a capacity of 100 to 150 tons. per hour	$ 84,000
- n. 2 conveyor bands complete with hoppers and low tension electric installation	$ 92,000
- support of the conveyor bands	$ 18,000
- base support for the loading apparatus	$ 67,000
- loading apparatus complete with low tension installation	$ 67,000
Total	$ 328,000

I-4-2 Amortment of the invested capital

For the mechanic part equal to $ 243,000 we foresee a 10 year amortment.

For the remaining $ 85,000 a 25 year amortment.

So, the annual quote of amortment, foreseeing a 7% interest on the capital, will be of:

The part to amortize in 10 years
0.142378 x $ 243,000 = $ 35,000

The part to amortize in 25 years
0.085811 x $ 85,000 = $ 7,250

Total amortment quote $ 42,250

I-4-3 Man Power

The cost of man power for the performance of the above mentioned operations is the following:

- n. 3 excavator drivers (skilled workman)
- n. 4 truck drivers " "
- n. 2 superintendant for the functioning of the conveyor bands " "
- n. 2 in charge of the functioning of the loading apparatus " "
- n. 2 in charge of the various servi ces (normal workman)
- n. 1 control technician (diploed mechanical eng.)

Knowing the hour pay, already adopted for the gathering of salt operations, the hour expense of the workers will be of:

- technician	n. 1 hour	$ 0,67
- specialized workmen	n. 11 hours	$ 5,30
- normal workman	n. 2 hours	$ 0,66
Total hourly expense for the workers		$ 6,63

I-4-4 Cost for maintenance

We foresee as we did before, a maintenance quote of 5% for the machinery and of 2% for the manufactured goods.

So the yearly maintenance expense will be of:

243,000 x 0,05 + 85,000 x 0,02 = $ 13,850

I-4-5 Cost of energy

Generated power by the diesel motors

- n. 4 trucks	200 HP
- n. 2 excavators	180 HP
Total	460 HP

For this power we estimate an hourly use of naphta: 160 Kg. x $ 0.042/Kg. =	$ 6.72
plus $ 1.34 lubrificant oils	$ 1.34

Installed electric power

Conveyor bands	KW 90
Loading apparatus	KW 25
Total	KW 115

Which has an hourly use of 115 KW per hour x $/KWh 0.017 = $ 1.955
so the total hourly expense for energy will be of $ 10.015

I-[illegible]-6 Cost for ton. of gathered salt and loaded aboard

Incidence of amortment $ 42,250 : 50,000	=	$/tons	0.84
Incidence of maintenance $ 13,850 : 50,000	=	$/tons	0.277
Incidence of man power $ 6.38 : 200	=	$/tons	0.034
Incidence of energy $ 10.015 : 200	=	$/tons	0.017
Total		$/ton	1.168

I-[illegible]-7 Considerations on the loading operations on vessels

The proposed loading system was chosen for from the various possible it resulted the most economic and simplest one. It enables the use of the same trucks used for only 30 days a year in the gathering operations and it also enables to load product which arrives from other working saltern in the zone.

Also, with about the double of the expense, can be easily brought to a potentiality of about 500 tons. per hour as mentioned before in the technical dealing.

The cost of the loading operations seems very high because of the modest quantity of salt to embark which leaves the installation inactive for a good part of the year.

This same installation, if potentiated, could serve a saltern with a production of 500 to 600,000 tons. per year, it is true that this would double the cost of the installation, but the incidence of the amortment quotes would decre ase of about one fifth, that is the incidence of man power and of energy would remain untouched while the cost of the loading operations would decrease to:

- Incidence of amortment	$/ton	0.166
- " " maintenance	"	0.055
- " " man power	"	0.034
- " " energy	"	0.050
Total	$/ton	0.305

I-5 CONCLUSION

Saying that 0.335 $ is the cost for one ton. of marine salt in the crystalliser pans (for working salterns in zones like that of Aden, this should be the maximum cost) we can conclude that for a saltern limited to a production of 50,000 tons. per year, with the proposed apparatus in the attached study, the salt can be placed aboard the vessels at the prize of:

- cost of salt in the crystalliser pans	$ 0.335 per ton.
- cost for the gathering, washing and accumulating	$ 1.771 per ton.
- cost for loading operations	$ 1.168 per ton.
Total cost aboard	$ 3.274 per ton.

Always on the net of the expenses of administrations and of the profits, but they should not exceed 20%.

If the saltern' production will be enlarged to 500.000 ÷ 600.000 ton. year, the salt can be placed aboard the vessels at the prize of:

- cost of salt in the crystalliser pans	$ 0.335 per ton.
- cost for the gathering, washing and accumulating	$ 0.50 per ton.
- cost for loading operations	$ 0.305 per ton.
Total cost aboard	$ 1.140

Always on the net of the expenses of administrations and of the profit, but they should not exceed 20%.

This last price is exceptionally competitive, because of the high quality of the salt.

The economic balance above mentioned would notevely increase if the production would be brought to one million tons.

I-6 PRODUCTION OF ALIMENTARY SALT PACKS

From raw marine salt it is possible with simple operations to draw alimentary salts to put in packs. Submitting the salt to a preceeding grinding it is possible to obtain about 50% fine salt and the rest coarse salt.

In the attached drawing n. 10 it is schematically described an installation for a 5 tons per hour production of alimentary salt, manufactured in cardboard boxes of 1/2 Kg., of which 2.5 tons. fine salt and the rest coarse salt.

The various machines like those numerated on the scheme and their cost is reported as follows:

1) Ball mill having a capacity of 5 tons. per hour	$	25,000
2) Basins for blending salt and water in a 6 to 1 ratio	$	5,000
3) Pump for the raising of water salt mixture with channel impeller having a capacity of 35 mc. per hour	$	4,200
4) Concrete basins for the decantation and elimination of magnesium by NaOH of the water arriving from the instal lation and to reinsert it in the cycle. Surface of 500 square meters and 1 meter 50 cm. in length	$	8,500
5) Cyclone for the reduction of the water mixture quantity until about 15%		850
6) Continuous pushing centrifugal having a capacity of 5 tons. per hour an exit salt humidity of 3%	$	50,000
7) Fluid bed dryer having a capacity of 5 tons. per hour, functioning by a hot air current for the drying of fine salt till 0.2% of humidity to make it ideneus for the packing	$	34,000
8) Stove for the production of hot air with heat exchanger having a potentiality of 18,000 mc. per hour of 150°C air, necessary for the drying of salt, including the immission fan and the oil burner	$	25,000
9) Cyclone for the separation of salt powder brought along from the drying air, including the aspiration fan of 20,000 mc. per hour and mechanical unloading with pockets	$	3,400
10) Vibrating screen for the separation of fine and coarse salts by a net with meshes of 1 mm.	$	12,000

11) n. 2 silos in stainless steel having sizes large enough to contain 8 hours of installation product, serving as a bag for the conditioning machines $ 10,000

12) n. 2 manufacturing machines, one for fine salts and the other for coarse salt, idoneous to condition the salt in cardboard boxes of 1/2 Kg. each having a capacity of 2.5 tons of dry salt $ 58,500

Bands bucket chains and pipings for the internal movement of salt estimated $ 34,000

Industrial buildings idoneous to enclose the installation, including the low tension electric installation, having a volume of about 16,000 mc. $ 160,000

Necessary total expense $ [illegible]30,450

I-6-1 Amortments

We foresee a 10 year amortment for the installations and a 25 year amortment for the constructions.

Consequently the annual amortment quote, foreseeing a 7% interest on the capital, will be of:

170,000 x 0.085811 + 260,450 x 0.109795 =

$ 43,600

I-6-2 Maintenance

We foresee a 10% yearly expense for the installations and a 2% for the constructions. Consequently the amortment quote will be of:

170,000 x 0.02 + 260,450 x 0.10 =

$ 29,445

1-6-3 Conditioning [illegible]

The conditioning will take place (as already mentioned) in cardboard boxes of 1/2 Kg. and every 10 boxes will be packed in an undulated cardboard carton [illegible] the transportation [illegible]. For every ton of salt: 2,000 boxes, 20 undulated cartons of cardboard and 1 [illegible] of vinyl [illegible].

- [illegible] cardboard box printed in two colors 0.005
- An undulated cardboard carton 0.005
- A [illegible] of vinyl [illegible] 1.660
- So that the [illegible] of conditioning material [illegible] ton of salt is:
- Boxes 2,000 x 0.005 10.00
- Cartons 20 x 0.005 [illegible].25
- [illegible] 1 x 1.66 1.66

1-6- [illegible]

In this type of installation we have a [illegible] of about 10%, due for the humidity lost by salt, for the salt powder wasted in the cyclones, and for the periodicals additions of sweet water in the clarification basins for partially renewing the washing water.

1-6-7 Cost

The foregoing installation is for a production of 10,000 tons, per year of conditioned salt. It represents a unity of production, if one wants to increase the production he should add in parallel one or more identical units.

The total cost for a conditioned ton of salt will be of:

- Raw salt 1.100 Kg.	$ 2.30
- Amortment $ [illegible]3,600 : 10,000	$ 4.36
- Maintenance $ 29,4[illegible] : 10,000	$ 2.94
- Staff $ 7.[illegible]1 : [illegible]	$ 1.48
- Energy	$ 0.75
- Conditioning materials	$ 15.91
Cost for one ton. of conditioned salt	$ 27.74

This cost is for salt placed in the factory storage and it is net of the general expenses and the profit which the company decides on.

I-7 PROPOSAL FOR A GENERAL RECONSTRUCTION OF ADEN SALTERN

As said in the introduction of this study, we will show in her generalities, the possibility of realizing in Aden zone a saltern of considerable potentiality.

After the survey done in Aden and the acquisition of the meteorogical data of the zone, one can to the following technical observations of general character.

1) From the test of the meteorogical data we can easily say that the zone could have an annual salt production of about 36 Kg. per square meter of utilized area, with an annual production per square meter of crystalliser pans 380 Kg.

2) The area which adapts itself most easily for a saltern, including the working saltern, those which are abandoned and those which can be gotten from the lagoon, could add up to more than 1,600 hectares with a production which could be about 600,000 tons. per year.

3) The chemical impurities of the produced salt can be eliminated almost completely, without expensive washing or depurating installations, adopting for the salt pans a ratio, evaporating zone crystalliser zone, much larger than the present work of Aden saltern (about 5 to 6), so that the crystallization could be limited to the gathered salt during the interval of density in which the least amount of chemical impurities are present.

4) The physical impurities (soil, sand, etc.) could be totally eliminated using the gathering system of salt on salt.
In alla world salterns, where during the course of the year there is a period is not long enough, that the rain to passe the evaporation, the bottons of the crystallisers are formed by a compact salt layer, created in the first year of manufacturing with a definite loss of product.
The adoption of this system brings three great advantages: the no - need refined bottons of basins in the time of construction (very expensive operation), the guarantee of having a product without physical impurities, this is because the gathering machines will never come in direct contact with the soil; the possibility of having basins bottons able to support the weight of modern gathering machines and of trucks which transport the salt out of the basins, independently from the nature of the soil.

5) The loading expenses could be greatly decreased, by changing the position for the production of salt, to a place nearer the loading zone.
The Eastern part of the saltern, denominated "CALTEX" would be the most idoneous for this pourpose.

Even though leaving the present study, this company permits itself to advise, for an yearly production of 600,000 tons., a lay out of new the saltern, schematically indicated in drawing n. 11, where A is the place were sea water comes in, B the production zone of salt, C the accumulating zone and D the loading zone.

The zone indicated with n. 1 is under sea level, it has an extension of 700 hectars and it can be flooded without use of pumps, by water gates or weir a height which would let the water enter only in high tide, but not let it exit during low tide. It will consist of the first evaporating zone.

By the means of an adequate pumping station, the water which will have covered by gravity all the basins in which the evaporating zone n. 1 was subdivided, will be piked up in a higher position, and will flood the second evaporating zone. This second zone has an area of about 400 hectars and also covers about all the area of the old "Italian" saltern.

By a second pumping, the water will pass from the second evaporating zone to the third which includes about all the presently operating ones. Naturally this zone, of about 250 hectars, will have to be flattened and change the construction concept of the pans. From the third evaporating zone, with a pump ad piping system, the water will be transferred in the purposely ampliated zone, denominated "CALTEX", zone number four.

This zone, will in part built the fourth evaporating zone of about 300 hectars, and in part, for 180 hectars, the crystalliser zone.

For the passage of water from the fourth evaporating zone to the crystalliser, a third pick up of water will be needed, this will be done by another pumping station.

A salt pan concevied in this manner could produce about 600,000 tons. of salt per year, which would be very pure.

PART: IIª

STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA 279 ROMA ITALIA

II-1 INTRODUCTION

The technical and economical initiative related to the rise of the Aden salt industry by the renewal of the already existing installations, the creation of new basins and gathering organization, the treatment and transport of the product based on a mechanised criteria, cannot be disjoined from the present world situation of the salt market.

All the development of the industry is necessarily conditioned from a series of founded and decisive choices which can be only decided upon, after a thorough discussion with the responsible government officials, the eventual financiers of the initiative as well as the international commercial operator in this sector.

In the enclosed study, we have followed the directives contained in the agreed program, namely the development of mechanization for the increasing production, increase the quality of salt and decrease the cost of production in the general picture and particularly in the production output of [illegible],000 tons. of salt per year.

Due to the topographical and climatical conditions particularly favorable in Aden salt productive zone, the requested plan presently limited to a production of [illegible],000 tons. per year, should be intended exclusively as a pilot production, in order to allow in the next phase, in the near future, the increment of production towards a bigger quantity, as to be competitively inserted, the new Aden salt pans, in the commercial world market.

As seen in the present studys, and as foreseen in the performed marketing report study of salt, the tendency of the operators is towards increasing installations and the decreasing of cost, of transportation through the use of cargo ships with a tonnage greater than 100,000 tons.

Naturally we cannot exclude nor undervaluate the possibility of selling the product in small stocks, but with this solution, the geographical position of this salt pan will be unfavorable to the selling outputs due to the high cost of transportation.

Therefore, in the following study, we will give a broad outline of the present salt production on a world wide scale and the foreseen demand of this product in relation to two fundamental factors: the increasing demand of the industrialized countries which buy salt, and the increasing population.

Before examining the present situation of world' salt production and its consumption levels in various Countries, according to their economic development degree, it seems necessary to premise some mentions about salt in general.

II-2 PRESENT SITUATION OF WORLD' SALT MARKET

II-2-1 Sodium Chloride (NaCl)

Sodium chloride (NaCl) called also simply salt is notoriously important for direct use as well as for the manufacturing of chemical products wich contain chloride and sodium, and this because in natural state there is few other sodium containing compounds.

In nature salt can be found

- at solid state: like mine salt (or rock salt)
- at liquid state: into sea water and some springs (sea salt)

II-2-2 Rock or mine salt

Mine salt deposits, which are one of the main salt sources for industry, have been constituted by the evaporation of original brackish water ponds.

Mine salt can be found in gemma and in more or less deep stratus as well as in superficial deposits.

The deep deposits derive from sea water evaporation in closed ponds; the superficial deposits much less importance than the first ones, derive from continental water evaporation in desertic areas or from the evaporation of salt lakes.

Mine salt deposits are accompained by gypsum and anhydrite and are enclosed between clayish rocks, scarcely permeable to underground waters.

II-2-3 Sea salt

Besides its presence into some spring waters, salt at solution state, is found above all into sea water. In this water the sodium chloride content differ scarcely in large Oceans, where it exists at 3,5%, while it presents important differences in small basins (0,7% in the Baltic Sea; 1,8% in the Black Sea; 3,8% in the Mediterranean; 3,9% in the Red Sea).

In the interior seas, deprived of important affluents, the salt content may ascend up to very high values. Dead Sea, in example, together with great quantities of other salt, contains about 20% of sodium chloride.

Even rivers are generally pouring into the important salt quantities. So, in example, it is calculated that the Rio Grande, with its numerous affluents, pours into the Gulf of Mexixo 5 tons/minute of salt.

II-2- Salt production processes

Sodium chloride production is obtained mainly by three methods:

1 - extraction of rock salt from mines;

2 - evaporation of natural solution (salty water springs) or of those coming from mine salt dig solution, by the means of heat obtained from combustion.

3 - sea water or some salt lakes evaporation by the means of solar hent or, in cold Countries, throu gh water congealment.

II-2-[illegible] Extraction from mines

Salt mine exploitation consists in opening galleries into saline deposits with interposition of few supports left in the rocks, in order to bring solid salt to the surface.

Mine salt deposits exploitation, which require excavation works, is convenient only where salt exists in large quantities with little impurities. Impurity degree differs from deposit to deposit and even into the same deposit from point to point. The purest salt is usually found in the middle of the stratus vertical section, and the less pure one, on the edges.

II-2-6 Mine salt solution and artificial evaporation

To utilise less pure mine salt, extraction by solution and artificial evaporation process are combined.

In this case the underground deposit is reached, drilling wells in the same ways used to drill water, oil or methane wells.

When the well is opened two coaxial pipes are inserted in it and pure water is poured into the deposit along one of the pipes: water dissolves salt, while the so obtained brine is brought to the surface through the second pipe, by the means of compressed air or centrifugal pumps.

The brine coming from the wells is saturated, or almost, and in general relatively pure. Further it is evaporated in basins, whose bottom is fitted with steam runned pipe coils. With water evaporation, produced by steam heat, a crystalline salt mass is formed on the brine surface, and further deposits upon the bottom of the basins where, at regular intervals, hydraulic action rakes withdraw and depose it upon a sloping plate to dry. Then the product is washed dried and calibrated.

Refined salt, also called vacuum salt, is produced instead in large vacuum evaporators, usually vertical.

II-2-7 Solar evaporation

In high enough temperature Countries salt is obtained in so called salterns by the evaporation of sea water or interior lakes through the action of solar heat and wind.

To get salt, sea water is introduced in series of basins (evaporating basins) where it deposes its salt in suspension as well as the less soluble salts, such as calcium carbonate and gypsum. Further, the water is brought into concentrating basins (salt gathering basins), where, sun and wind originated evaporation starts the crystallised salt deposit and then, whenever the solution has reached a high concentration degree, another quantity of sodium chloride mixed with magnesium sulphate is deposited.

At last water is returned to the sea or even used (mother waters) to extract other salts (potassium bromide and iodide, potassium and magnesium chloride).

The so obtained salt is then collected in large heaps and exposed to rainfalls which remove magnesium salts.

In cold Countries like Norway and Siberia, sea water concentration is obtained by congealment and further evaporation, by the means of artificial heating.

II-2-8 <u>Rock salt mines and sea salterns</u>

Enormous rock salt deposits, belonging to one or another of the foresaid types, are widely spread in various parts of the terrestrial crust.

In the United States, the largest deposit, whose extension has been estimated to be about 290.000 square Kms, is the salt mine of Luann. It has been localised by drillings, up to 3.000 meters deep, in West Alabama, Central Mississippi, in Arkansas, North and South Alabama and the North-East of Texas.

Another deposit, about 160.000 square Kms wide exist in Kansas, Colorado, Oklahoma, Texas and New Mexico. Salt is found at different depths, included between 100 and more than 300 meters.

A third deposit, about 110.000 square Kms is located between the States of New York, Peunsylvania Ohio, Virginia, Michigan, South Ontario.

Minor importance salt mines are located in other areas of the United States and in particular in the Great Utah plain, Nevada, Colorado, Arizona, California, New Mexico and in confining States.

Large superficial rock salt deposits are located even in Argentine, Mexico, the Far East, China, Russia and West Europe. Among these the more important ones are, Stassfurt in Saxony (Germany), exploited for potassium salts extraction and Wielicska (Poland), which - according to experts - is by itself sufficient to cover world requirements for several centuries.

In Italy rock salt deposits are located in the province of Pisa (Volterra), the Cosensa area (Lungro) and the Southern extend of Sicily where they reach a wide surface and important depth (Agrigento).

Sodium chloride production obtained by solar evaporation of brackish waters is performed instead in many Countries of the world, above all through sea saltern production.

In the United States 95% of the solar evaporation salt production, occurs in California along San Francisco's beaches, Monterey, San Diego and Long Beach.

Other sea salterns are in operation, construction, or enlargement in Greece (Missolongi), Turkey, Tunisia, Spain, West Africa, Mexico, Argentine, South Africa, East Africa, Red Sea (Eritrea , Ceylon, Australia, India, China, etc.

In Italy exists important sea salterns in Puglia (Margherita di Savoia) Sicily (province of Trapani and Ragusa), Sardinia (province of Cagliari) and others of minor importance in Romagna (Cervia).

II-2-9 Uses for sodium chloride and its derivatives

Sodium chloride uses can be devided in alimentary and industrial ones.

Almost one third of the world sodium chloride production is destined to alimentary uses, because salt is an essential element for human organic functions.

Besides its domestic alimentary use, salt is utilised for vegetables, fish and meat preservation, cheese, butter, oleomargarine preparation and for alimentary canned food etc. Salt is even used for animal feeding.

In medicine sodium chloride is used, among others, to prevent insulations, prepare blood isotonic solutions to be used in hypodermoclisis, etc.

More than half the sodium chloride production is used to prepare chemical substances: metallic sodium, sodium carbonate, caustic soda, chlorine, hydrochloridric acid, hypochlorites, chlorates, sodium sulphate and hyposulphite, etc. Between industrial uses it should be mentioned, skin tanning, water depuration, regeneration of sodium permutite and zeolite, brine preparation in refrigeration plants and refrigerating mixtures with ice, preparation of synthetic rubber, uses in metallurgic, ceramic and soap industries.

It is known that, salt components such as chlorine (Cl) and sodium (Na) are never found free in the nature. Therefore not only sodium chloride, but also its separate components [illegible] [illegible] [illegible] [illegible] [illegible]

Chlorine itself [illegible] the most important [illegible] halogens and has remarkable [illegible] and [illegible] properties, for which [illegible] [illegible] range of industrial uses. In [illegible] [illegible] used to [illegible] [illegible], fabrics and paper, to manufacture [illegible] of [illegible] compounds such as hypochlorites, and [illegible] [illegible] to [illegible] [illegible] [illegible] [illegible], [illegible] and the [illegible] halogens [illegible] and [illegible] [illegible] [illegible] [illegible].

An important chlorine [illegible] [illegible] [illegible] [illegible] [illegible] commercially called [illegible] [illegible]. [illegible] [illegible] used in numerous industries, [illegible] [illegible], manufacture of [illegible] chlorides and the [illegible] [illegible]. [illegible] and nitric acid [illegible], [illegible] as [illegible] [illegible], [illegible] [illegible] chlorine [illegible] [illegible] [illegible] and [illegible] used to [illegible] solve platinum and gold.

The hypochlorites [illegible] [illegible] [illegible] [illegible] [illegible] purpose [illegible], [illegible] [illegible], [illegible] as [illegible] and [illegible]. [illegible] [illegible], [illegible] [illegible] [illegible] [illegible] [illegible]. [illegible] [illegible] [illegible] potassium chlorate [illegible] [illegible] [illegible] [illegible] [illegible], explosives and [illegible] [illegible] [illegible], [illegible] [illegible], as antiseptic and [illegible] [illegible].

Equally important [illegible] the other [illegible] [illegible], [illegible], [illegible] [illegible] the [illegible] [illegible] [illegible] [illegible] [illegible], like chlorine, [illegible] [illegible] found [illegible] [illegible] the [illegible]. [illegible] [illegible] [illegible] [illegible] [illegible] be particularly noted [illegible] [illegible] [illegible] and [illegible] [illegible]. [illegible] [illegible] [illegible] of [illegible] [illegible] [illegible] [illegible] [illegible] is obtained [illegible], [illegible] [illegible] chloride [illegible] [illegible] [illegible]. It is used to manufacture artificial [illegible] [illegible], [illegible], [illegible] [illegible] and for general [illegible] [illegible].

[illegible] [illegible] [illegible] [illegible] [illegible] [illegible] is found in nature [illegible] [illegible] [illegible] [illegible] [illegible] [illegible], at [illegible] [illegible], it [illegible] the [illegible] [illegible] [illegible] which appears under the [illegible] of [illegible], [illegible] other, as the [illegible] of [illegible] [illegible] [illegible] [illegible] as upon [illegible]'s acid leads. It is widely used in numerous industries, such as soap, paper, and color ones etc.

Sodium and chlorine are also used, the first in chemical fertilizers production and the second in plastic materials and synthetic resins manufacturing.

It is to underline at last that sea water concentrated for sodium chloride extraction, when it has reached 30° Bé (mother waters) and is drained from salt gathering basins, contains yet about [illegible] grs of sodium chloride, [illegible] grs magnesium chloride, [illegible] grs potassium chloride and [illegible] grs magnesium sulphate per liter.

In various cases, from mother waters are extracted the foresaid salts as well as bromine and other minor ones, which are destined to some industrial works and to chemico-pharmaceutical products manufacturing.

1.3 - WORLD' SALT PRODUCTION FROM 1910 UNTIL PRESENT TIME

World' salt production has been continually increasing in this century, not only because of the population increase, but above all, by the fact of the impressive development of chemical industry.

In 1910 salt production was estimated to be about [illegible] million tons; in [illegible] about [illegible] million and in [illegible] it reached almost [illegible] million. In 1950 it was about [illegible] million from which one third in the United States. At present time, according to rather reliable estimates, even if precise data are missing for some countries, this production must be superior to [illegible] million tons/year (Estimate for [illegible]: [illegible],[illegible],000 tons - Yearbook U.N. [illegible])

We have reported in the following tables, production data, gathering from various international sources and for different periods of time. These data are not always comparable between themselves, because of the foresaid changes and limitations, nevertheless they can be used, even being incomplete and partially heterogeneous, to provide an enough indicative picture of world' salt production situation.

Hereafter can be found some data extr   for the [illegible]-[illegible] period, with reference to the main producing States (Giua - Industrial chemistry treaty - Vol. III):

Mondial salt production 1927-1957

(in thousands tons)

Countries	1927	1937	1947	1948	1956	1957
Germania	3.558	4.458	—	1.912 (1)	3.581	3.587
Russia	2.426	4.400	—	—	—	—
Inghilterra	2.075	3.115	3.130	—	5.068	5.064
Francia	1.951	2.339	—	2.644	3.261	3.307
Italia	1.051	1.556	1.680	—	1.867	1.839
Spagna	979	820	834	—	1.029	1.352
Polonia	498	643	—	725	—	—
Romania	328	325	—	—	—	—
Cecoslovacchia	122	182	9	—	—	—
Grecia	104	100	—	52	—	—
Olanda	38	133	—	250	—	—
Svizzera	78	82	—	100	119	131
Jugoslavia	63	59	111	—	144	148
Bulgaria	52	53	—	—	—	—
Portogallo	50	74	69	—	—	—
Total Europe	13.409	18.339	—	17.000	—	—

(1) = Bizona

Mondial salt production 1927-1957

(in thousands tons)

Paesi (Countries)	1927	1937	1947	1948	1956	1957
Cina	1.971	3.000	--	2.267	--	--
India	1.638	1.880	--	2.254	3.225	3.670
Giappone	619	600	--	194	671	869
Total Asia	5.640	7.700	--	7.000	--	--
Egitto	223	227	--	360	530	416
Total Africa	720	1.000	--	700	--	--
U.S.A.	6.866	8.354	14.800	--	21.968	21.640
Canada	244	416	672	--	1.445	1.597
Argentina	153	254	--	--	375	--
Brasile	350	710	--	781	798	799
Total America	7.900	10.200	--	18.000	--	--
Australia	126	128	--	--	416	439
Total mondial	27.900	36.901	--	43.000	--	--

(The totals indicated in the tables are not, generaly, the sums of the single items because the latter ones in many cases are presumed).

A more reliable statistic prospect of world' malt production for the 1948/1964 period has been extracted from the 1965 Statistical Yearbook of the United Nations. This prospect concerns the greatest number of Countries, where statistics exist. Classifications reported in the prospect are those used in national statistic and are not homogenised in this report.

Mondial salt production 1948-1964

(in thousands tons)

Countries	1948	1956	1957	1958	1959	1960	1961	1962	1963	1964
AFRICA										
Algeria	73.0	103.4	116.7	132.6	127.6	140.0	131.0 (1)	131.0 (1)	130.0 (1)	—
Angola	63.4	81.5	52.3	69.1	69.2	57.8	66.8	60.4	68.6	81.1
Canarie	—	17.7	15.1	15.1	13.1	11.5	14.1	14.0	17.9	18.0
Isole del Capo Verde	13.6	22.0	19.7	7.8	20.3	23.8	23.9 (5)	26.9	29.1	34.0
Congo Rep.Dem.	—	0.5	0.3	0.5	0.6	—	0.6	0.6	0.3	0.2
Etiopia	—	149	177	166	140	157	151	198	255	263
Kenya	16.8	22.2 (1)	23.0	19.0	19.6	22.3	22.9	18.9	17.0	26.7
Libia	7.1	17.0	17.0	14.0	15.0	12.8	12.0	15.0	18.5	12.5
Maurizio	3.4	3.5	3.8	3.9	3.8	4.3	4.0	3.9	4.2	4.4
Marocco	40.0	28.0	52.0	61.0	33.8	30.3	21.2	27.6	37.3	60.7
Mozambico	10.1	12.4	18.0	21.9 (3)	18.6	29.0	—	—	—	—
Senegal	—	63.0	61.0	70.9	69.5	49.6	43.4	48.2	60.0	56.1
Sud Africa (6)	153	172	146	219	237	235	208	255	198	300
Africa Sud Est	14.9	79.2	66.2	64.4	50.3	72.3	55.6	75.6	64.7	98.8
Sudan	36.8	54.2	53.4	54.0	53.9	54.0	53.1	57.9	37.0	60.3
Tanzania (3)	11.6	28.0	25.6	29.8	31.1	34.8	33.4	30.3	33.9	32.6
Tunisia (5)	105	135	148	161	151	114	161	170	351	214
Uganda	3.0	9.0	9.7	10.1	8.9	5.0	6.6	3.2	3.1	2.9
Rep.Arabe Unita	126	530	416	403	383	522	517	337	392	675

Countries	1948	1956	1957	1958	1959	1960	1961	1962	1963	1964
ASIA										
Aden	275	252	201	158	178	130	78	79	73	91
Afganistan (8)	—	22.6	22.1	25.6	27.5	25.9	22.8	31.0	32.9	—
Birmania	43.4	86.6	115.9	110.7	111.6	148.2	124.2	154.4	160.7	127.3
Cambogia	—	23.7	30.0	64.0	49.5	37.1	53.5	—	—	—
Ceylon	78.6	108.3	81.7	17.4	28.8	57.0	33.9	36.9	21.9	45.3
Cina (continentale)	—	4 940	8 277	10 400	11 040	12 900	11 000	10 000	10 500	11 000
Cina (Taiwan)	376	329	387	444	430	453	435	595	626	602
Cipro	—	4.6	6.5	5.1	5.4	—	2.1	5.8	7.0	—
India	2 301	3 241	3 670	4 232	3 178	3 436	3 481	3 886	4 544	4 647
Indonesia	—	109	347	235	315	198	447	304	304	(1)304
Iran (8)	—	(5)280	(5)300	(5)132	133	130	145	246	345	—
Iraq (9)	(5) 13.3	20.0	22.4	26.4	36.8	36.1	38.0	38.1	30.6	—
Israele (9)(10)	5.0	26.0	31.6	33.7	34.0	37.2	44.1	45.0	51.6	—
Giappone	893	671	869	1 085	1 170	834	849	879	747	893
Giordania	—	10.1	10.1	10.9	15.7	12.3	16.5	33.5	17.7	20.0
Rep. di Corea	90	197	369	436	390	399	122	388	230	386
Libano	—	12	12	12	13	(1) 12	(1)17	(1)16	(1)19	(1) 20
Pakistan	281	393	459	360	288	431	389	449	455	382
Filippine	117.5	63.6	116.1	139.6	174.5	94.7	93.3	95.7	70.1	46.6
Isole Ryukyu	—	5	3	3	5	3	4	4	4	5
Siria	20.3	32.7	33.8	17.0	8.0	9.5	7.4	17.9	14.9	17.9
Thailandia	—	248	263	427	459	335	194	258	(1)266	(1) —
Turchia	266	378	421	488	491	445	483	447	398	355
Rep. Viet-Nam	(11) 65	60	80	62	116	144	100	193	128	90

NOTES:

1) Source: U.S. Bureau of Mines
2) Export
3) Sales (Senegal, starting from 1956)
4) Twelve months expiring the 30th September of the indicated year
5) Source: *Statistical Summary of the Mineral Industry* (London)
6) Twelve months expiring during the indicated year
7) Data extracted from taxes paid for salt selling
8) Year starting from 21st March of the indicated year
9) Twelve months starting from 1st April of the indicated year
10) Government recognized plants production
11) North Vietnam included
12) Including Syria
13) Ukrainian data are included in those for USSR
14) Before 1950, Saar excluded

Mondial salt production 1966 & 1967

A S I A

		1966		1967	
	(A)	(B)		(C)	
• Birmania (4)	(132.000)	132.000	(?)	134.000	
• Ceylon	(65.000)	--		76.000	
• Cina	(13.000.000)	13.000.000	(?)	13.000.000	
• Taiwan	(411.000)	411.000		518.000	
• Cipro	(4.000)	4.000		7.000	
• Corea del Sud	(393.000)	393.000		612.000	
• Corea del Nord	--	--		550.000	
• Filippine	(183.000)	142.000		116.000	
• Giappone	(870.000)	850.000		985.000	
• Giordania	--	13.000		12.000	
• India	(4.521.000)	4.508.000		4.489.000	
• Indonesia	(215.000)	250.000	(?)	100.000	
• Iran	(225.000)	225.000	(?)	245.000	
• Iraq	(60.000)	--		41.000	
• Israele	--	55.000	(?)	57.000	
• Libano	(25.000)	--		25.000	
• Mongolia	(8.000)	--		8.000	
• Pakistan	(469.000)	509.000		696.000	
• Siria	(11.800	--		19.600	
• Thailandia	(188.000)	200.000	(?)	110.000	
• Turchia	(492.000)	285.000		637.300	
• Vietnam del Sud	(88.000)	160.000	(?)	87.000	(1966)
• Vietnam del Nord	(150.000)	--		150.000	(1966)
• Yemen	(100.000)	--		100.000	(1966)
• Yemen Meridionale	(72.000)	--		72.000	
		21.137.000		22.843.900	

Mondial salt production 1966 & 1967

AFRICA

		(A)	1966 (B)	1967 (C)
- Algeria		(116.000)	116.000	117.000
- Angola		(61.000)	61.000	78.000
- Ciad		(10.000)	—	10.000
- Congo Kinshasa		—	1.000 (1)	—
- R.A.U. Egitto		(627.000)	627.000	584.000
- Etiopia		(188.000)	188.000	202.000
- Ghana		(34.000)	36.000	36.000
- Kenya		(32.000)	32.000	24.910
- Libia		(8.000)	—	25.000
- Madagascar		—	456.000 (?)	—
- Mali		—	—	—
- Marocco		(39.000	39.000	21.000
- Mauritania		—	—	1.002
- Nigeria		—	1.000 (-)	—
- Niger		—	—	—
- Rep. Sudafricana		(315.000)	--	-
- Senegal		—	—	—
- Africa del SW (=Namibia)		(124.000)	124.000	80.000
- Somalia	(5)	(33.000)	—	—
- Sudan		(43.000)	—	56.000
- Tanzania		(37.000)	41.000	40.000
- Tunisia		(305.000)	328.000	257.000
- Uganda		(6.000)	2.000	5.000
-Isole Capo Verde		(31.000)	—	30.000
- Mosambico		(30)	—	20
			2.366.000	1.875.938

MONDIAL SALT PRODUCTION 1966 & 1967

OCEANIA & AUSTRALIA

	1966		1967
	(A)	(B)	(C)
- Australia	(665.000)	665.000 (?)	714.000
- Nuova Zelanda	(36.000)	36.000	56.000
		701.000	770.000

RECAPITULATION

	1966	1967
- Europa	42.831.000	43.322.579
- Asia	21.137.000	22.346.900
- Africa	2.366.000	1.875.932
- America Sett, e centrale	40.245.000	45.240.000
- America Meridion.	2.696.000	2.328.000
- Oceania	701.000	770.000
	109.976.000	115.383.411
Totale mondial valuation	111.190.000	116.000.000 (?)

(A) 1967 National statistics
(B) 1966 Statistical Yearbook
(C) 1968 National statistics
(1) Rock-salt 196[illegible]
(2) Sea-salt
(3) 1966 Data
(4) 1965 Data
(5) 1962 Data
(6) Of them 9,1[illegible]4,000 tons of rock-salt
(7) In 1965 117,000 tons.

Salt mondial production

in thousands of tons

1948 - 1960

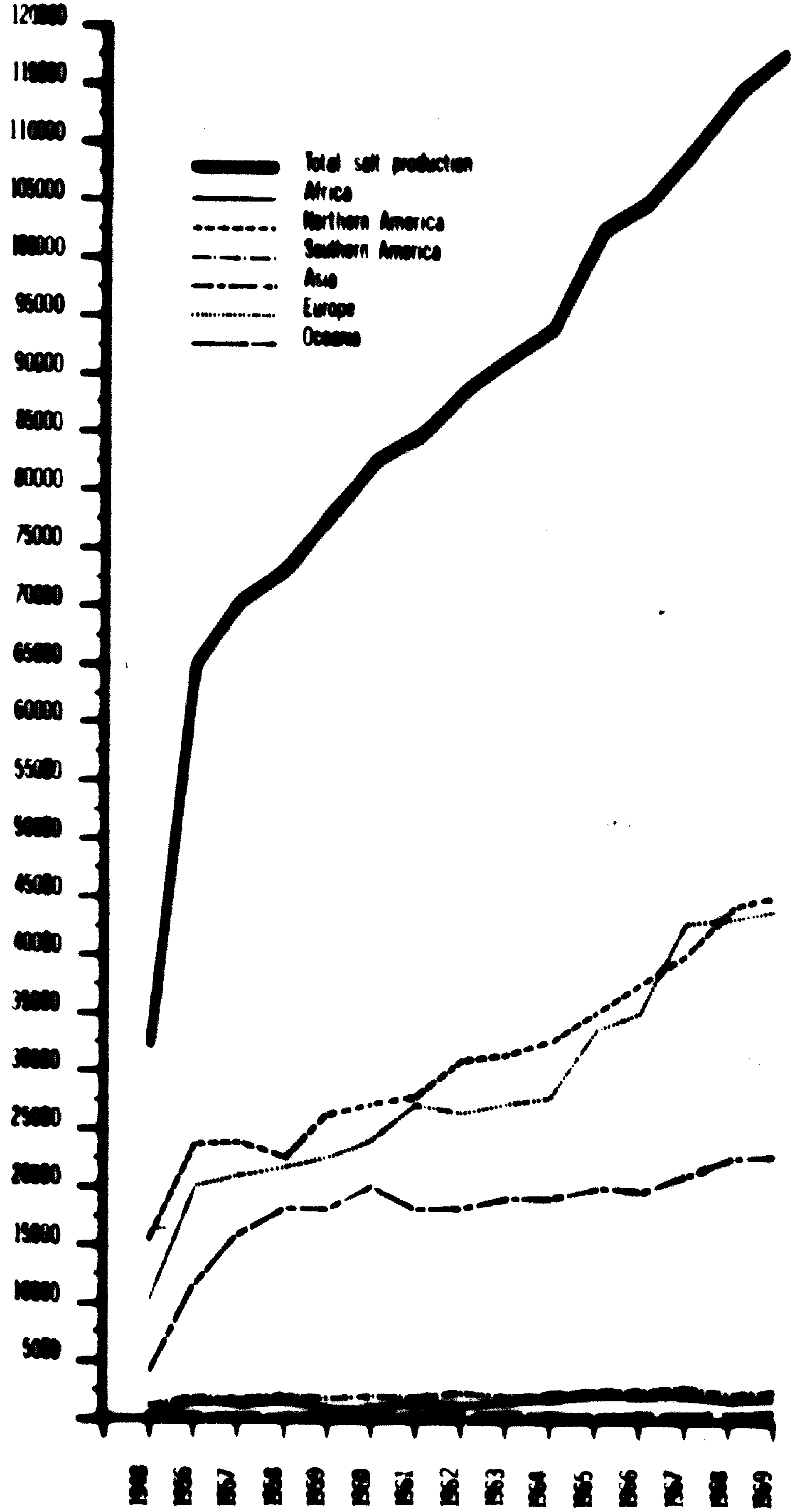
continents	1948 (1)	1956 (1)	1957 (1)	1958 (1)	1959 (1)	1960 (1)
Africa	677,7	1.527,6	1.420,8	1.523,1	1.101,6	1.105,7
America Sett.	15.731,8	23.751,2	23.864,8	22.523,9	26.356,5	27.229,3
America Mer.	1.368,7	1.591,9	1.684,6	2.052,0	1.889,9	2.051,0
Asia	4.225,1	11.513,2	16.128,2	18.924,4	18.697,8	20.308,0
Europa	10.368,0	20.335,3	21.128,2	21.802,5	22.574,4	24.795,4
Oceania	249,0	426,6	445,4	443,8	495,6	488,3
	32.396,2	65.145,8	70.772,0	73.469,7	77.615,8	82.680,7

1961 - 1967

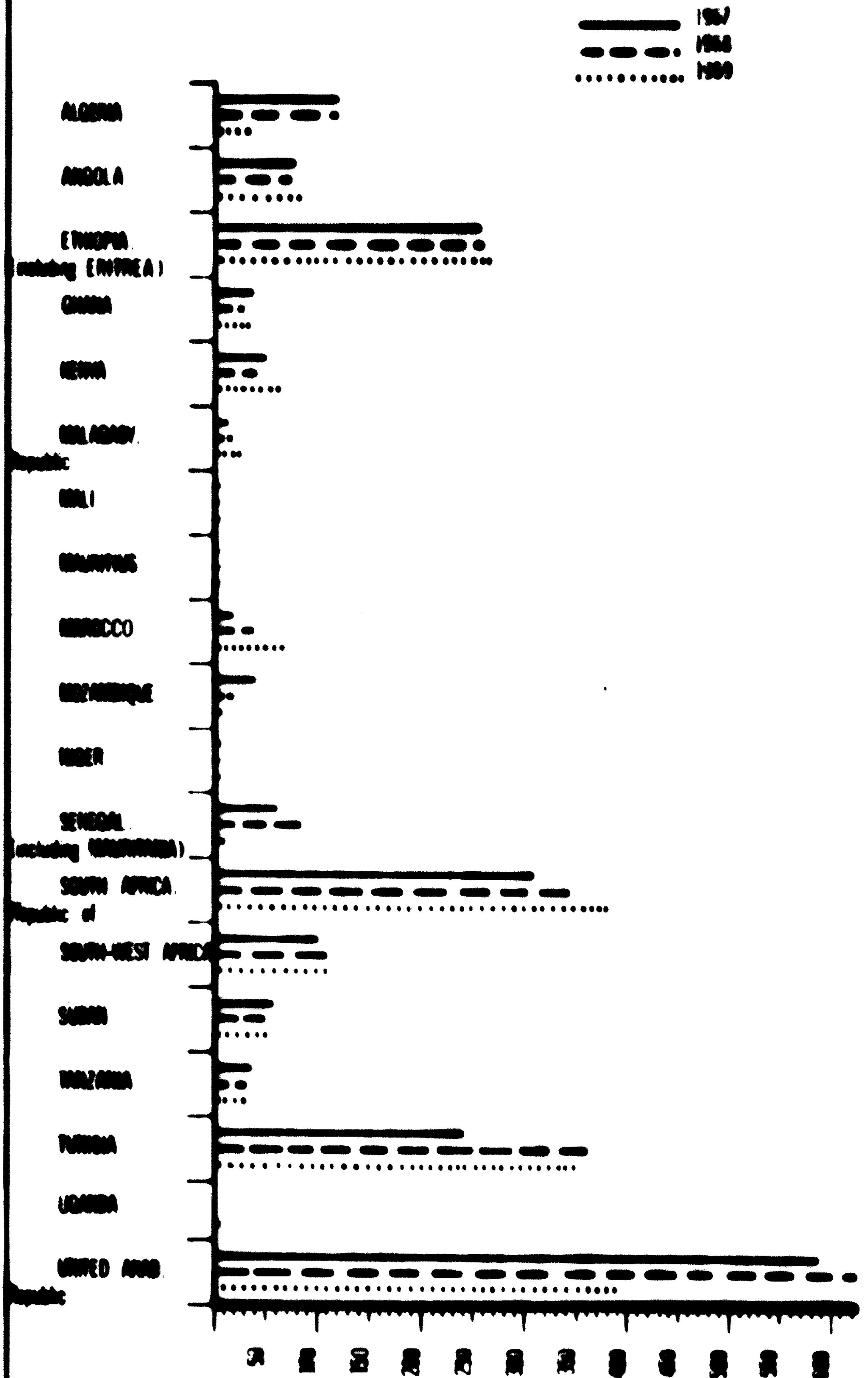
Continents	1961 (1)	1962 (1)	1963 (1)	1964 (1)	1966	1967
Africa	1.525,6	1.473,5	1.717,6	1.940,3	2.366,0	1.875,9
America Sett.	27.76[illegible],8	31.072,8	31.507,1	32.494,2	40.245,0	44.240,0
America Mer.	1.947,1	2.418,4	1.895,6	1.912,9	2.696,0	2.328,0
Asia	18.179,8	18.202,3	19.046,4	19.032,1	21.137,0	22.843,9
Europa	27.217,0	26.577,9	27.394,9	27.968,0	42.831,0	43.322,6
Oceania	522,1	554,0	602,2	571,7	701,0	770,0
	84.633,4	88.847,9	91.723,8	94.012,2	109.976,0	115.380,4
					(2) 111.190,0	116.000,0

(1) (Metric Tons)
(2) (Mondial valuation)

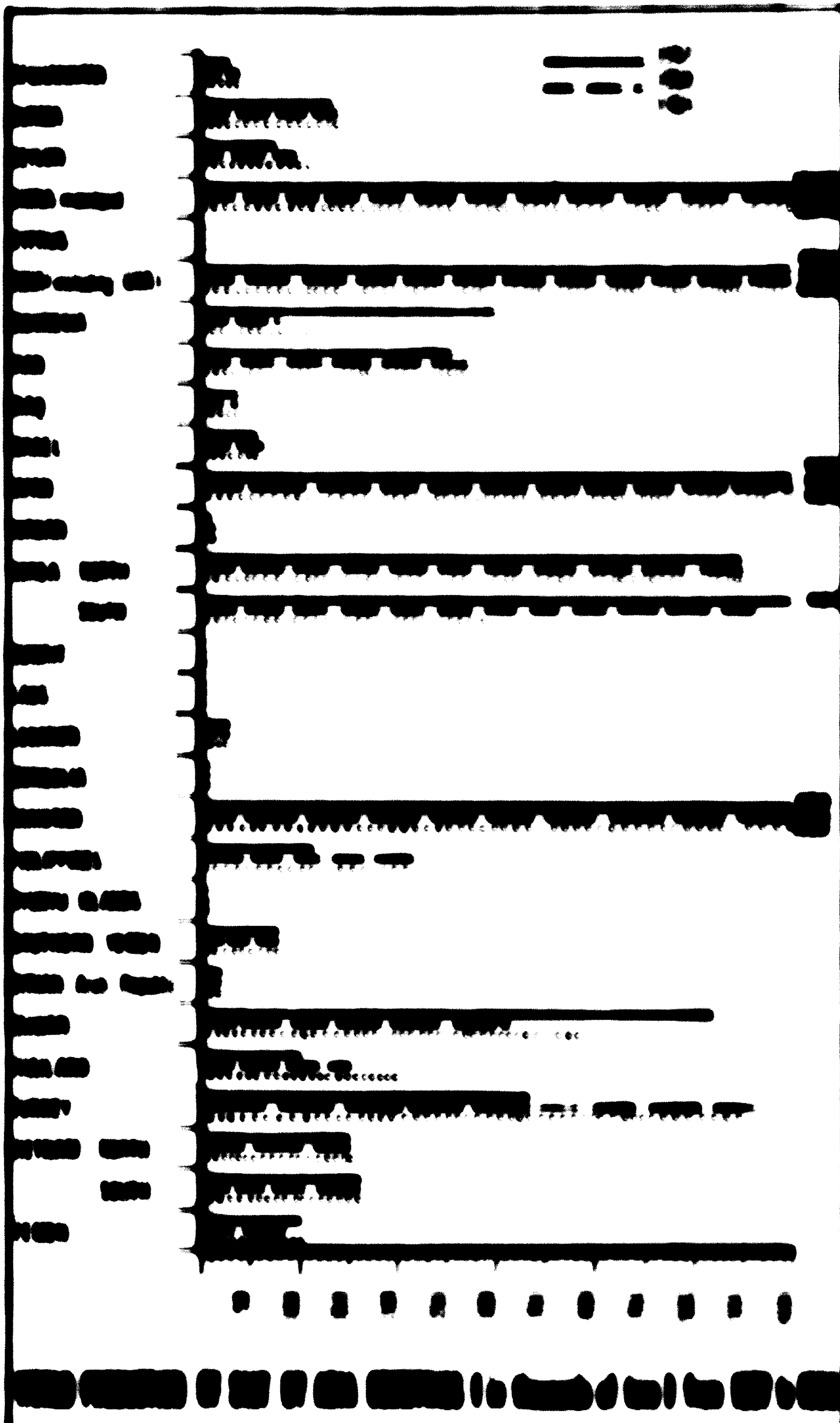
In the following tables is schematically showed the mondial situation of salt production and that for AFRICA and [illegible] COUNTRIES.



120000
115000
110000
105000
100000
95000
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
Total salt production
Africa
Northern America
Southern America
Asia
Europe
Oceania


ALGERIA
ANGOLA
ETHIOPIA
(including ERITREA)
GHANA
KENYA
MALAGASY
Republic
MALI
MAURITIUS
MOROCCO
MOZAMBIQUE
NIGER
SENEGAL
(including MAURITANIA)
SOUTH AFRICA
Republic of
SOUTH-WEST AFRICA
SUDAN
TANZANIA
TUNISIA
UGANDA
UNITED ARAB
Republic

[illegible]



19. **<u>Presumed average consumptions according to industrialization level.</u>**

It is well known that presumed average consumptions differ highly according to the industrialization level of every Country.

It must be considered that alimentary salt consumption for each inhabitant of economically developed Countries can be estimated from 6 to 8 Kg/year (Giua - Tratt. Chim. ind. Vol. 2).

In general - according to data given by Dr. Guidi, General Director of Italian State Monopolies, during a meeting of experts held in Rome and promoted by UNIDO (25-28th October, 1968) - annual average salt consumption in the world, <u>for alimentary uses only</u>, seems to stabilize around 7 Kg/year.

Yet in the four African Regions (North Africa, West Africa, Central Africa and East Africa), as it appears from a report elaborated from the UNECA (United Nations Economic Commission for Africa), yearly average consumption for alimentary use should be between 4,5 and 4,8 Kg/inhabitant. However, in the forecasting of salt production and consumption in Africa, in the next ten years, UNECA, cautiously, has taken an average index of 5 Kg. inhabitant/year.

Before the exceptional development of chemical industry, the <u>total salt consumption</u> (for alimentary and industrial use) could have been estimated in the different Countries between 10 and 15 Kg/year.

At present times, in Countries starting their industrialization phase, total salt consumption can be estimated between 10/20 and 40/50 Kg.

In industrialized Countries, consumption average between 50 and 100 Kgs/year. In Italy, as example, from 1951 pro-capite salt consumption, because of the industrial development of the Country, has assumed a constant increase of about 150.000 tons/year and has already reached 70 Kgs/year.

In France, Germany and England this consumption is keeping around 100 Kgs/year.

Pro-capite consumptions instead in highly industrialized Countries is nowadays included between 100 and 200 Kgs/year and is destined to increase in the future. In the United States in fact, consumption has reached 200 Kgs/year/inhabitant, with a trend toward a future increase.

I.2. Provision for salt demand and offer for the next years according to foreseeable consumption and production.

I.2.1 Provision difficulty - I.2.2. World population and its increase from 1970 to 2000 - I.2.3. Relations between population, product and world salt consumption - I.2.4 Provision for the world salt production according to the relation production/world population - I.2.5 Provision for the world salt consumption according to the relation average consumption/world population - I.2.6 Provision for the world salt consumption according to different directing elements - I.2.7. Development of world chemical industry - I.2.8. Foreseeable absorbtion for Asian salt with indications about existing or foreseen salterns in the main producing Countries - I.2.8.1. Asia - I.2.8.2. Africa - I.2.9. . Final considerations.

I.2.1. Provision difficulty

To foresee with a good approximation salt demand and offer on international market during the next years is rather difficult, because:

a - in some cases production and consumption data are completely missing;
b - or they are scarcely and incompletely issued with important delays;
c - or else there is a lack of important informations about capacity, time of realisation and starting of operations for new salterns or the enlargement of already existing ones.

Vice versa, to formulate forecasts with a certain degree of availability it is necessary to dispose of the greatest possible quantity of data related to:

1 - pro-capite consumption in the various geographical areas according to their economic development degree;

2 - average annual increase index concerning the population of each area;

3 - average annual increase index about production, concerning the effective increase of previous year and the eventual work starting of new plants as well as the enlargement of existing ones;

4 - economic development of each Country and the volume of productive investments realized in the Country;

5 - industrialization of the same Countries, with particular attention to chemical industry expansion.

Since the foresaid elements are only partly available, we have tried to limit the present survey to some fundamental data related to population increase and the variations of the demand compared to consumption increase. These data have been estimated considering the elementary average substance aspect or have been referred, for some geographical areas and Countries, to overall industrial and commercial purposes.

The period of time considered for the forecasts is 1970/1980, with indications of some rough prospects even for the 1970/2000 period. The deducted data can be considered rather orientative, even with all the continuous limitations reserves previously indicated.

II.-3 - World population and its increase from 1970 to 2000

In June 1966 the world population was amounting up to 3.348.427.000 persons. In June 1967 the same population was estimated to have increased up to 3.412.385.000 units, with the increase in one year of 63.958.000 units.

From the estimations referred to 1966 and '67 the consistency of world population was so distributed in each Continent.

World population distributed in Continents for 1966-1967

Annual increase average coefficient: 1958-66=1,8%; 1963-67=1,9%

Continents	June 1966	Density ab/Kmq.	June 1967	Density ab/Kmq.
- Africa	320.173.000	(10,6)	329.771.000	(11)
- Asia	1.913.661.000	(43,4)	1.951.561.000	(44)
- Oceania (Austral.)	19.299.000	(2,2)	19.695.000	(2,2)
- Europe	628.74[illegible].000	(59,7)	633.774.000	(60,2)
- Northern & Centr.America	296.2[illegible]1.000	(12,2)	301.133.000	(12,2)
- Southern "	170.3[illegible]2.000	(9,6)	176.451.000	(9,9)
	3.348.427.000	(22,4)	3.412.385.000	(23)

According to the previous indications, annual increase average coefficient of the world population has been estimated of 1,8% for the 1958/ 66 period and of 1,9% for the 1963/67 period.

From 1968 and with great approximation up to 2000 the foresaid coefficient has been estimated to have an average of about 2%.

Therefore in 1980, according to the last indicated coefficient, the world population should reach a total of 4.414.283.856 units, with an increase of more 1 billion inhabitants respect to 1967.

It is moreover possible to notice that, consequently to approximative estimates, as reliable as they can be, world population in the year 2000 should exceed widely 6,5 billion units, which is to say, that it will be more than the double of the present one.

Probable average increase of world population for 1967/2000

Annual average increase coefficient:
1958-1966 = 1,8% 1963-1967 = 1,9% 1968-2000 = 2,0%

Period			Total average increase	Annual average increase
	1966	—	3.348.427.000	—
June	67	—	3.412.385.000	63.958.000
"	68	(stima)	3.480.632.700	68.247.700
"	69	"	3.550.245.354	69.612.654
"	70	"	3.621.250.261	71.004.907
"	1971	"	3.693.675.266	72.425.005
"	72	"	3.767.548.771	73.873.505
"	73	"	3.842.899.746	75.350.975
"	74	"	3.919.757.740	76.857.994
"	75	"	3.998.152.894	78.395.154
"	1976	"	4.078.115.951	79.963.057
"	77	"	4.159.678.270	81.562.319
"	78	"	4.242.871.835	83.193.565
"	79	"	4.327.729.271	84.857.436
"	80	"	4.414.283.856	86.554.585
"	1981	"	4.502.569.533	88.285.677
"	82	"	4.592.620.923	90.051.390
"	83	"	4.684.473.341	91.852.418
"	84	"	4.778.162.807	93.689.466
"	85	"	4.873.726.063	95.563.256
"	1986	"	4.971.200.584	97.474.521
"	87	"	5.070.624.595	99.424.011
"	88	"	5.172.037.086	101.412.491
"	89	"	5.275.477.827	103.440.741
"	90	"	5.380.987.383	105.509.556
"	1991	"	5.488.607.130	107.619.747
"	92	"	5.598.379.272	109.772.142
"	93	"	5.710.346.857	111.967.585
"	94	"	5.824.553.79[illegible]	114.206.937
"	95	"	5.941.044.869	116.491.075
"	1996	"	6.059.865.766	118.820.897
"	97	"	6.181.063.081	121.197.315
"	98	"	6.304.684.342	123.621.261
"	99	"	6.430.770.028	126.093.686
"	2000	"	6.559.393.509	128.619.560

VII-5

Relations between population, production and world salt consumption

To dispose of some preliminary directing elements, concerning the salt production and consumption in the next years, we have elaborated the statistic data related to 1966, which are among the most recent ones in our possession integrated and compared with different sources.

From the foresaid elaboration it has been drawn up - with reference to the various geographical areas - the following values and relations, which, with adequate adaptations, can be further useful for next years forecastings.

Values of salt production and consumption in 1966

Continents	Population	Global salt production (Tons)	Presumed average alimentary cons. (Tons) (1)	Presumed average industrial cons. (Tons) (2)
- Africa	320.173.000	2.366.000	1.600.865	765.135
- Asia	1.913.661.000	21.137.000	9.568.305	11.568.695
- Oceania e Australia	19.299.000	701.000	96.495	604.505
- Europe	628.741.000	42.831.000	3.143.705	39.687.295
- Northern and Central America	296.211.000	40.245.000	1.481.055	38.763.945
- Southern America	170.342.000	2.696.000	851.710	1.844.290
	3.348.427.000	109.976.000	16.742.135	93.233.865
		111.190.000 (3)		94.447.865 (3)

(1) - Calculated on the base of presumed minimum alimentary consumption of Kgs 5/pro-capite

(2) - Including exports, usual supply and occasional stocks

(3) - Data without integrated estimations & compared to various sources.

[illegible]

Continents	Relation production/ population	(1) Rel. [illegible] consumption [illegible]	(2) Rel. industry [illegible]	(3) [illegible] production	(3) [illegible] consumption [illegible]
Africa	[illegible]		9,1	[illegible]	[illegible]
Asia	[illegible]		[illegible]	[illegible]	[illegible]
Oceania Australia	[illegible]		[illegible]	[illegible]	[illegible]
Europe	[illegible]		63,1	[illegible]	[illegible]
America Sett. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
America world.	[illegible]		[illegible]	[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	[illegible] (3)	[illegible]	[illegible] (3)	[illegible] (3)	[illegible] (3)

(1) - Calculated on base of the [illegible] century consumption [illegible]

(2) - Including exports, [illegible] and [illegible] stocks

(3) - Data without integrated estimations and compared to various sources

II-5-1 **Provision for the world salt production according to the relation production/world population**

In 1966/1967 period the relation production/world population was about Kgs 33,5/33,8 for each inhabitant.

In this period infact the world salt produ ction has been estimated to 111 million tons in 1966 and to more than 115 million tons in 1967. During the same time world population has reached respectively 3.348.427.000 and 3.412.385.000 units.

If we consider - as already previously said - that world population should increase between 1967 and 1980 of more than 1 billion inhabitants and if, for mere simplification, the relation between production and population of Kgs 33,5/in habitant was considered unchanged, it would derive that within 1980 world salt global production should increase of more than 33 million tons per year.

Equally, roughly and with exclusive referen ce to the natural world population increase, excluding, always for mere simplification, whatever variation of the present economic and industrial development parameters, it could be considered that before 2000 world global salt production should indicatively increase of more than 100 million tons/year, as it can be deducted from the following table.

Provision for world global average salt production according to world population increase for the period 1967-2000
(relation production/population = Kgs 33,5/inhabitant/year)

Years	Presumed world population	Presumed global salt production (Tons)
1967	3.412.385.000	114.314.897,5
1970	3.621.250.261	121.311.883,7
1975	3.998.152.894	133.938.121,9
1980	4.414.283.856	147.878.509,2
1985	4.873.726.063	163.269.834,1
1990	5.380.987.383	180.263.077,3
1995	5.941.044.869	199.025.003,1
2000	6.559.393.588	219.729.685,1

In substance, according to the data hereover, in 2000 the world global salt production should reach 219.729.685,1 tons and therefore increase of 105.414.787,6 tons in comparison to 1967 production, equal to 114.314.897,5 tons.

II-5-2 Provisions for the world salt consumption according to the relation average consumption/world population.

We must keep in mind that world salt production development is directly related to world salt consumption development.

And infact sodium chloride disponibility in the nature can be estimated as almost illimitated. It has already been said that, according to expert statements, the single rock-salt deposit of Wieliska in Poland could suffice for some centuries to cover the whole world requirement.

It seems therefore reasonable to admit that world salt production increase with the demand of this product.

In economic terms it derives therefore that the relation production/world population can be considered very similar to the average consumption/world population one Especially if consumption is considered globally (which means from both alimentary and industrial sides), and if in the expression "average consumption" are included, besides the incidence of effective consumption, even those of occasional stocks and usual supplies, excluding every differentation between geographical areas at various industrialization degree.

From the comparison between the foresaid relations it can be deducted that world salt demand and offer tend generally toward a constant balance which, even if instable, should increase.

At last, according to what has been said up to now, we should reach the provision that world average salt consumption should increase before 1980 of about 30 million tons and before 2000 of about 100 million tons per year. Continuously the foresaid forecasts could be any way decreased of [illegible] and therefore the presumed world salt consumption should register an increase of 18/22 million tons/year respect to 1967 and consumption in year 2000 an increase of 60/90 million tons/year respect to 1967.

II-3-) **Forecasts for the world salt consumption according to different forecasting elements**

The forecast world salt consumption may be anyway deducted even from various other elements than those deriving from the relation production/world population.

As far as alimentary use salt is concerned, consumption increase could be foreseen according to the minimum relation of Kgs. 5/pro-capite, in function of the presumable world population increase.

In 1966 such a consumption was of about 16.742.135 tons/year. In 1970 it should ascend up to 18.106.625,3 tons; in 1975 up to 19.990.764,4 tons; in 1980 up to 22.071.419,2 tons and in 2000 up to 32.796.967,9 tons/year.

Industrial use salt presented in 1966 a presumed average consumption of 93.233.865 tons (or 94.447.865 tons according to various valutations). According to a relation average industrial consumption/population calculated in 20,2 Kgs pro-capite/year, which for more simplification, can be considered as conventionally unchanged, it will be deducted that in 1970 such consumption should rise up to 102.119.257,2 tons/year; in 1979 up to 112.482.804,7 tons/year in 1980 up to 124.482.804,7 and in 2000 up to 184.974.890,1 tons/year.

At last, even according to various forecast elements (presumed pro-capite index for alimentary use Kgs 5 and 20,2 for industrial use) the world global average salt consumption trend should present the following increase in the following year.

Years	Alimentary consumpt. (Tons)	Industrial cons. (Tons)(1)	Global consumpt. (Tons) (1)
1966	16.762.135	93.233.865	109.976.000
(1966) (2)	(--)	(94.447.865)	(111.190.000)
1970	18.106.625	102.119.257,2	120.225.882,2
1975	19.990.764,4	112.747.911,6	132.738.676
1980	22.071.419,2	124.482.804,7	146.554.223,9
2000	32.796.967,9	184.974.890,1	217.771.857

(1) - Including exports, supplies and stocks

(2) - Presumed valutation, including data missing in official statistics.

[illegible] - Development of world chemical industry

In the previous paragraphs it has been considered the further trend of the presumed world salt production and consumption essentially in relation with population increase.

Anyway it cannot be neglected that this trend will be conditionned not only by the natural increase of world population, but also by the economic and industrial development of each Country and in particular by the expansion of chemical industry. It is well known, infact, that sodium chloride components are becoming always more required in the chemico-organic sector as well as in the inorganic one.

It is to observe that an accurate valutation of world chemical production is practically impossible due to the lack of homogeneous data about all the countries as well as because countries possessing a chemical industry are now very numerous.

Some of them, even important, as China, do not provide data. Others and among them different Eastern Europe Countries or those from developing areas, are publishing data scarcely controlled.

Anyhow - according to indications from the Financial Times (January, 1969) - world chemical production should be estimated, in value terms, [illegible] billion dollars.

In particular, according to estimates obtained from presently available elements (UNO statistics, producting Countries data, OCDE, EEC, [illegible], etc.), we have been able to draw up the following table about chemical production value in some of the main countries or areas, in billion dollars [illegible].

Chemical production value in the world main countries during the period of 1964-68

Countries	1964	1965	1966	1967	1968
Western Europe	27.900	30.450	33.200	35.800	39.330
USA	33.600	36.000	40.100	41.900	45.380
URSS	n.c.	n.c.	n.c.	12.500	13.550
Japan	4.720	5.500	6.300	8.350	10.100
Canada	1.660	1.770	2.000	2.180	2.620
France	5.050	5.540	5.950	6.950	7.570
Western Germany	6.900	7.680	8.150	9.300	10.950
Italy	3.930	4.520	5.230	5.650	6.290
Belgium	750	880	970	1.040	1.180
Holland	1.050	1.320	1.530	1.970	2.450
Switzerland	n.c.	800	860	1.300	1.420
England	5.980	6.380	6.600	7.210	7.550

In 1968 the chemical industry has maintained its prevailing sector character of the overall economic development systems (Chemical Week, January 1969).

In the following table, we have reported a prospect related to the chemical industry development rate in the main Countries or World areas, elaborated by the National Association of Italian Chemical Industry, with data supplied by the OCDE and the sectorial technical press.

<u>Chemical production development in the main</u>

<u>World Countries for the 1964/68 period</u>

Countries or World areas	Development average rate 1958-68 (%)	'64 (%)	1965 (%)	1966 (%)	1967 (%)	1968 (%)
- Western Europe	10,8	11,0	14,0	8,8	8,5	10,6
- United States	8,5	14,1	10,2	7,5	4,7	8,3
- URSS	8,0	6,1	9,4	8,9	8,9	8,4
- Japan	16,9	13,3	14,9	21,4	20,1	16,0
- Canada	7,0	6,8	7,2	9,1	5,2	7,3
- France	11,5	14,3	18,1	11,2	12,4	8,8
- Western Germany	14,6	20,2	18,4	8,7	7,9	18,1
- Italy	9,9	8,2	9,1	16,0	7,9	11,4
- Belgium	9,1	17,5	9,1	9,1	8,8	13,5
- Holland	13,2	8,4	8,6	13,9	14,1	24,5
- Switzerland	15,8	n.c.	14,2	8,6	30,1	10,2
- England	6,7	7,7	9,6	6,4	8,2	6,2

There is instead in the following table the trend of the relations, which has been confirmed in the main Countries for 1967/68, between industrial production development rate in general and the chemical production development rate.

Compared development of the [illegible] production of the chemical production in the main industrialized Countries (years 1957 - 1964)

Countries	Average rate of the total industrial production (%)	Average rate of the chemical production (%)
- United States	4.5	8.3
- Japan	13.6	10.0
- Canada	5.2	7.3
- Western Germany	12.1	10.1
- England	4.5	6.8
- France	3.5	8.0
- Italy	6.2	11.4
- URSS	n.d.	8.4
- Holland	10.9	24.9
- Belgium	6.0	13.3
- Switzerland	8.9	10.2

From the preceding data, the chemical industry positions are appearing for every important Country, not only relatively, but also absolutely. Yet the expansive rush of this industry tends to slow down gradually even keeping the supremacy respect to the average of the other manufacturing industries. In some Countries however, as Japan, it still reached exceptional development points.

On this subject it seems interesting to sum up the chemical investments average compared to the total of the investments for 1963-1964 for the following Countries, excluding the single "social investments"

Chemical investments upon the total of investments
(average 1963 - 64 in %)

United States	11.60
Western Germany	10.09
Japan	20.15
France	7.95
Italy	12.50
Belgium	9.90
Holland	14.29
England	13.70

The European Economic Commission of the United Nations has dedicated lately an interesting study to chemical products market, indicating trends and prospectives.

According to this study, chemical products utilization will extend in the future to always increasing sectors. In European Countries, the industries of constructions, public works, automobiles and leather will use always more chemical products. In consequence the chemical industry expansion rate in its whole should make a certain progress because, among others, of chlorine and synthetic ammonia increase.

Among the main changes, that will materialise during next year in the organic and inorganic chemical sectors, we must underline a larger ethylene utilization especially for vynil chloride production; an increase of concentrated fertilizers production and an increase of chlorine demand according to the caustic soda one in highly industrialized Countries.

It remains to underline moreover that some years ago, the main part of European chemical industries were using raw materials available "in loco" and at particularly advantageous prices. The great increase of the demand has provoqued a lack of traditional raw materials and has determined the recourse to other raw materials available "in loco" or in the international markets with similar prices.

II-6 Foreseeable absorption markets for [illegible] salt with indications to existing or foreseen relations in the main Countries.

In general, as long as salt procurement is concerned it must be kept in mind that many Countries, except for temporary conjunctures due to lesser wants of balance between demand and offer of the product, will be presumably autosufficient in the future.

In fact, it is known that especially European and American Countries possess enormous sea salt potential resources and chiefly rock-salt, which will allow to satisfy gradually the demand deriving from an increasing interior consumption.

Undoubtedly even African and Asiatic Countries could count upon important natural potential resouces.

Yet their scarce industrialisation, the limited modernisation and mechanisation of the plants, the minor organisation of their production and selling corporations suppose that in many of these Countries the adaptation of production to consumption increase will be slower.

It is why it must be kept in mind that the seasonable realisation of the n w [illegible] saltern, with modern criterious and mainly mechanised equipment, as well as with an adequate industrial and commercial organisation, should consent to [illegible] salt a favourable penetration into international markets.

Substantially the main absorbtion area of the produced salt should be constituted by the Asiatic and African Countries markets, especially those bordering the Indian Ocean and some of the Pacific Ocean ones. Undoubtedly however the market which could present the major placement possibility seems to be Japan.

In the following pages we will present a fast panorama of the foreseeable production and consumption possibilities for Asia, [illegible] with reference to some of the main Countries of each continent and to the foreseen or existing salterns for salt production increase in each of them.

II-4-1 [illegible]

First of all in what Asia is concerned in general, there is to consider that this Continent should reach in 1980 a population of 2.770.816.127 inhabitants with an increase of 857.155.127 units compared to 1966 situation. This appears in the following table in which is indicated the probable asiatic population increase from 1966 to 1980.

Average probable increase of Asiatic population from 1966 to 1980

(annual average increase coefficient = 2,73%)

(P e r i o d)			Global average increase (foreseen)	Annual average increase (foreseen)
	1966	(est.)	1,913.661.000	--
June	1967	"	1.951.561.000	37.900.000
"	1968	"	2.004.837.615	53.276.615
"	1969	"	2.059.569.682	54.732.067
"	1970	"	2.115.795.934	56.226.252
"	1971	"	2.173.557.163	57.761.229
"	1972	"	2.232.895.273	59.338.110
"	1973	"	2.293.851.314	60.956.041
"	1974	"	2.356.473.509	62.622.195
"	1975	"	2.420.807.290	64.333.781
"	1976	"	2.486.895.329	66.088.039
"	1977	"	2,554.787.571	67.892.242
"	1978	"	2,624.533.278	69.745.707
"	1979	"	2,697.183.030	72.649.752
"	1980	"	2,770.816.127	73.633.097

From the foresaid data it can be roughly presumed that in 1980, in Asia, if a population consistency equal to 2.770.816.127 units is reached, unit alimentary consumption (calculated on the minimum base of 5 Kgs pro-capite) should ascend up to 13.854.063 tons and industrial consumption including exports and stocks (calculated on the base of 7 Kgs. pro-capite) should increase up to tons. 19.395.712.

Consequently overall consumption should result in 1980 equal to 33.250.505 tons.

To this however should be added a further higher overall consumption share, related in particular to Japan, because of its high industrial development and the foreseeable increase of its population. In fact, in 1980, Japan should have more than 111 millions inhabitants (annual average increase rate of about 1%) and an overall consumption presumably oscillating between 8,8 and 11,1 millions tons if at that time the Country have reached a pro-capite average overall consumption included between 80 and 100 Kgs.

Obviously from the foresaid consumption values (8,8 - 11,1 millions tons) it must be anyhow detracted the figure of 1.333.000, representing the Japanese consumption share already calculated in the whole presumed asiatic global consumption (33.250.276 tons) on the base of the global average consumption of Kgs 12 pro-capite. Therefore the Japanese global consumption should register a special additive requirement, included between 6.668.000 and 9.768.000 tons.

At last, adding to the 33.250.505 tons unit overall consumption in Asia, foreseen for 1980, the foresaid Japanese additive requirement estimated between 6.668.000 and 9.768.000 tons, we obtain a presumed overall total consumption rising up to [illegible] and [illegible] tons, as summarized in the following table.

Forecast of salt consumption in Asia in 1980

	1966		1980
- Population (1)	1,9[illegible],661,000		2,779,[illegible]
	(presumed average data)		
	tons	tons	tons
- Asiatic average alimentary consumption (2)	9,568,305	13,854,090	13,954,080
- Asiatic average industrial consumption (3)	11,481,966	19,395,712	19,395,712
- Overall Asiatic average consumpt.	21,050,271	33,249,792	33,249,792
- Overall Japanese average of additional requirement (according to Asiatic overall average consumption)	(4) 3,861,000	(5) 6,468,000	(6) 9,828,000
- Overall Asiatic average consumption (including Japanese additional requirement)	24,911,271	39,717,792	43,077,792
- Overall Asiatic presumed increase compared to 1966 (including the Japanese additional requirement)		14,806,521	18,166,521

(1) - Valuated according to annual average increase coefficient

(2) - Calculated according to the minimum average index of 5 Kgs pro-capite

(3) - Calculated according to the average index Kgs pro-capite for 1966 and 7 Kgs for 1980

(4) - Calculated according to the average index Kgs 50 pro-capite

(5) - " " " " " " Kgs.80 "

(6) - " " " " " " Kgs 100 "

From the preceding data, it is deducted that, in 1980, average overall consumption in Asia could present an increase eventually varying between 14.[illegible] and 1[illegible].1 millions tons compared to 196[illegible] figures.

As it has already been said, however, peculiar consideration should be reserved to some asiatic countries and [illegible] essentially to Japan.

- JAPAN - The [illegible] Monopoly Corporation, which controls salt production and market, subdivides the requirement of the country in two main items: soda industries and general industries. Among the latter ones is included [illegible] the alimentary use purposes.

In 1[illegible] [illegible] industries have consumed [illegible],000 tons, [illegible], but the requirement is clearly increasing [illegible] 19[illegible] it has been foreseen [illegible],11[illegible],000 tons, [illegible] for 1[illegible] [illegible] tons, and for 1971 [illegible] tons, [illegible] about one million and half tons more than 1[illegible]. For generic industries instead, [illegible] increases. In fact, [illegible] 1,[illegible] tons, were consumed in 196[illegible], [illegible] 1[illegible], 1[illegible], 1[illegible] has been foreseen respectively [illegible] 1,[illegible], 1,[illegible] and 1,4[illegible].

As [illegible] national production, which was in 19[illegible] of about [illegible] tons, and to satisfy its requirements, Japan is compelled to import salt from about 20 countries. Until now the main providers are Mexico, [illegible], [illegible], Australia, India, [illegible] countries of the [illegible].

In 19[illegible] [illegible] import was of about [illegible].2 millions tons, and in 1[illegible], [illegible] millions tons, from which however 1[illegible] imported directly by the Monopoly, while the remaining [illegible] were acquired abroad by the Japanese [illegible] industrial groups.

Japanese natural conditions and the configuration of its [illegible], do not allow salt collection through natural [illegible] in salt gathering basins in such a way that the main Japanese production is made of an intere[illegible] certainly not modern procedure of [illegible] means. In fact, upon special ma[illegible], [illegible] several [illegible] rows constituted with short [illegible], salt water is poured and then evaporated. With this process there is a 300 tons, org duction of salt for every hectare of gathering surface. In 1968 with reed evaporation it has been collected about 700,000 tons. But such a management is so expensive that in 1969 it is foreseen that production would be reduced to about [illegible]00,000 tons.

Two other processes are also used in Japan. The evaporation in factories and the "Ion-Exchange Membrane" (electrolysis). The first has produced 120,000 tons only in 1968 and the second [illegible] tons. However, in 1968 this latter process, even if we do not still possess statistics about it, could have given 200,000 tons of salt, without [illegible] hopes to further many increases.

It must be observed that the whole Japanese production is destined to alimentary use and therefore the industrial sector must depend on foreign markets.

About this subject it is necessary to outline that Japan foresees to import for the next years large salt quantities (about [illegible],000,000 tons/year) from Australian salterns, in which Japanese companies have made important investments.

This provision may constitute an evident preoccupation for the introduction of Nafun salt into the Japanese market.

However, as already said, it must be considered that Japan is a Country of very intensive and increasing industrialization and still presented in 1968 an average pro-capite salt overall consumption inferior to 60 Kgs/year/inhabitant. This index however is enough below the Italian one (70 Kgs) and very inferior to the consumption of the more industrialized European Countries (Great Britain, France, West Germany - 100 Kgs).

Obviously Japan, which has a 101,090,000 inhabitants (June 1968 estimate) and has consumed during the same year about 5,090,000 tons of salt (for alimentary and industrial use) from which 5,170,000 tons imported and 920,000 tons produced "in loco", should reach and surpass in the next years the consumption of [illegible],000,000 tons/year (100 Kgs year/inhabitant). This level could be presumably reached before 6/8 years, considering that, already between 1968 and 1971 Japanese average consumption increase should be around 460,000 tons/year.

Consequently in these next ten years Japan, considering that its local production would not surpass, due to the foresaid limitative environment conditions, one million tons/year, will need an annual import of about 8/9 millions tons of salt. Even if Japan imports in the future about 5.000.000 tons/year from Australia, its market should still present an additional absorbtion capacity of about 3/4 millions tons/year.

At present in Japan the production cost of common salt is about 12.000 yens/ton (33 dollars) and the product is retailed, for alimentary use, at 18.000 yens.

The import prices are oscillating, according to provenience Countries, from a minimum 9,20 dollars/ton to a maximum 14,10 dollars/ton.

Lately imported salt has been sold to industries at the price of 15.000 yens for quantities inferior to 15 tons and at 13.200 yens quantities superior to the former one.

About the quality of the salt acquired abroad by Japan, the Mexican product is of excellent quality (99%), the Australian one is considered as good (98-99%), but instead salt imported from India is estimated to be poor (94%).

Concerning shipping, it has been noticed that at present various tonnage ships are still used, according to origin Countries of the product. From the Red Sea, for instance, shipping is made with 10/12.000 tons ships; from Australia with 18/20.000 ton ships; from Mexico instead with units of about 130.000 tons.

Obviously this trend to "gigantism" of the ships will extend further on for the requirement of shipping costs. However it has been considered that for several more years the kind of ship, used by various Countries for salt shipping, will be limited to units between 5.000 and 20/25.000 tons.

Among Asiatic Countries having a large salt production and export toward Japan, there is to consider first of all India and Red China.

INDIA - From 1963 Indian salt production (which had a 498.704.000 population in June 1967 with an annual average increase co fficient, for the 1963-67 period, equal to 2,5%) has been oscillating around 4,5 millions tons/year. 76% of this production is obtained from sea water.

The consumption is divided approximately in 60% for alimentation, 30% for industry and 10% for export.

However Indian salt purity is in average poor (94-95%) as it has been often noted in the product exported toward Japan and production is very fractionned in thousands of small salterns.

Infact, from the 5.076 salterns registered from the Salt Commissioner of India, 5.022 are of small dimension and produce less than 10.000 metric tons of salt per year. These salterns are located along the East and West coast of the Country, in the States of Andhra Pradesh, Madras and Maharashtra. However the salt is extracted even from interior lakes in Rajasthan and Gujarat and from rock-salt deposits of the Himashal Pradesh.

Salt produced in the region of Gujarat is exported in Japan, East Africa and South West Asia, while salt produced along the South East coast close to Tuticorin and Madras is exported toward Ceylon.

In the last years, Indian chemical industry has presented an increasing development, as it can be deduced among others from the production increase of caustic soda, hypochloridric acid, soda ashes and plastic materials.

Trend of some Indian Chemical products from 1965 to 1968
(in tons)

	1965	1966	1967	1968
- Caustic Soda	--	229.200	246.000	306.000
- Hypochloridric acid	9.000	29.000	32.100	--
- Soda ashes	322.000	349.700	355.800	--
- Plastic materials and resins	39.240	39.360	47.711	--

There is to notice about Indian salterns that they usually have almost absolute equipments and machineries. However Indian government intends to [illegible] the existing salt [illegible], as well as to install new ones, which, if fully worked will produce [illegible],5 million tons/year, i. e. the double of the present production.

By recent [illegible] it seems that the production during 19[illegible] has been of [illegible],[illegible] millions tons. (Industrial Mineral Review [illegible]) and that the export was only 100,000 tons/year due to poor harbour installation.

CHINESE POPULAR REPUBLIC - In the end of 19[illegible] the Chinese population was estimated to be of 646,530,000 inhabitants. In June 19[illegible] it ascended up to 720 million and in June 19[illegible] [illegible]. The annual increase coefficient is considered equal to 1,[illegible]%.

From 19[illegible] Chinese salt production - which is extracted among others also from the large salterns of the [illegible] in the North - has presented the following trend (estimations from the U.S. Bureau of Mines and from various other sources).

- 1957	metric tons.		[illegible],277,000
- 195[illegible]	"	"	10,[illegible],000
- 1959	"	"	11,[illegible],000
- 1960	"	"	12,900,000
- 1961	"	"	11,000,000
- 1962	"	"	10,000,000
- 1963	"	"	10,[illegible],000
- 1964	"	"	11,000,000
- 1965	"	"	--
- 1966	"	"	13,[illegible]00,000
- 1967	"	"	11,000,000

Chinese salt production, formed in its 4/5 by sea salt, is in great part absorbed by alimentary consumption and the industrialisation of the Country. Another share is exported, mainly toward Japan.

Although if precise and up to date data do not exist about Chinese chemical industry, it is known that there is factories in Harbin, Kirin, Changchun, Fushun, Anshan, Fenki, Dairen, Tiensin, Taiyuan, Taiman, Lanchow, Loyang, Nanking, Shanghai, Chungking, Canton etc. Among others, caustic soda (270.000 tons in 1958), soda ashes (640.000 tons in 1958) chemical fertilizers (4.900.000 tons in 1969), are produced. Fertilizers and soda are produced especially in the important centers of Dairen and Kaifeng.

In the provinces of Kirin, Liaoning, Hopeh and Kwangtung there is among other in activity modern factories of artificial textiles, synthetic rubber and plastic materials. New plants for the production of the latter product have started working in Shanghai, Nankin, Tientsin, Hsinchong, Fuchow.

There is not final and reliable information about the modernizing of existing plants and construction of new ones. Anyhow, according to sources of various origin, it should be kept in mind that during the next ten years Chinese salt production should reach about 15.000.000 tons/year.

Among the other Countries bordering the Indian and Pacific Oceans and for whose there is some data related to salt production it is necessary to consider first of all, Pakistan, Northern Vietnam, Burma, Philippines, Thailand, Indonesia, Southern Vietnam, Iraq and Mongolia.

In these Countries, in 1967, production had the following trend:

- Pakistan	tons	695.000	
- Northern Vietnam	"	190.000	(1966)
- Burma	"	134.000	
- Philippines	"	116.000	
- Thailand	"	110.000	
- Indonesia	"	100.000	
- Southern Vietnam	"	87.000	
- Iraq	"	41.000	
- Mongolia	"	8.000	
	tons	1.342.000	

It must be noticed that for each Country, the foresaid 1967 quantities do not express their maximum productive potential level. In fact the production trend in each of these Countries has shown in these last years important oscillations. It is however clear that temporary conjunctures, due to climatic, social and political factors, could create from time to time, in many of these Countries, favourable occasions for the sale of Aden salt.

From approximate estimates related to each of the foresaid Countries concerning the consistency of their population and economic development, it would appear that in 1967 these Countries have had a total salt consumption, for alimentary and industrial use, of more than 3 million tons. Therefore, in 1967, their interior production should have been inferior to their production of about 1,8/2 million tons with consequently the necessity to cover their requirement with imports from abroad.

It is necessary to observe moreover, that there is some other Asiatic Countries, such as Saudi Arabia, Bhutan, Cambodia, Laos, Malaysia, Nepal, Oman and Singapore for which, even if we do not have statistic data about their salt production and consumption, as well as about salt trend with foreign Countries, it is presumable that they have a sodium chloride annual consumption of a certain importance.

According to presumptive elements, drawn up from the population consistency and economic development of each Country of this second group Countries, it should be concluded that in 1967 their consumption should have been of about 350/380.000 tons. This requirement should be therefore added to the foresaid 1,8/2 million ones, for the same period of time and concerning the first group Countries. Consequently it should be calculated that, in 1967, Asiatic consumption should have surpassed of about 3,3 million tons the interior production of these Countries.

Obviously this situation cannot be taken into account as a reliable appreciation for the future, because the situation of the foresaid Countries appears considerably oscillating as well as because it is known that in many Asiatic Countries are foreseen, in a near future, enlargement of existing installations or construction of new production plants. So, for istance, in Ceylon, where the Elephant pass, Puttalam, Palavi and Hambantota salterns have produced 75.000 tons. of salt in 1966 and 76.000 tons. in 1967, the production will be increased to reach more than 200 thousand tons, when will be realized the foreseen modernizations and infrastructural enlargements.

Another foreseeable production increase should come from Indian salt pans. This production, as we underlined in the paragraph concerning this Country, should rise up to about 6 million tons/year. Equally Indonesian salt production, which is a State monopoly, should increase of about 100.000 tons. its present potential, consequently to the foreseen realisation of new salt pans [illegible] by the Indonesian government.

Concerning the Chinese Popular Republic, its productive potential should increase of about 2 millions tons respect to its present constancy. An eventual increase of about [illegible].000 tons, should be registered also for Taiwan. In this Country, producing yearly from [illegible] to [illegible].000 tons. of salt, in preceding years one quarter of the production was destined to national consumption and the remaining to export. In these [illegible] years however, according to the increasing interior demand, but also to a gradual development of the [illegible] chemical industry, the product is [illegible] limited quantities and consequently there is in project the enlargement of the present salt pans.

Anyway, independently from the foreseen productive increases, due to the infrastructure expansion of each country, there is to keep in mind that, in the next years, because of the natural demographic increase and economic development of the whole Asiatic Continent, it will be possible to sell on this market important salt quantities.

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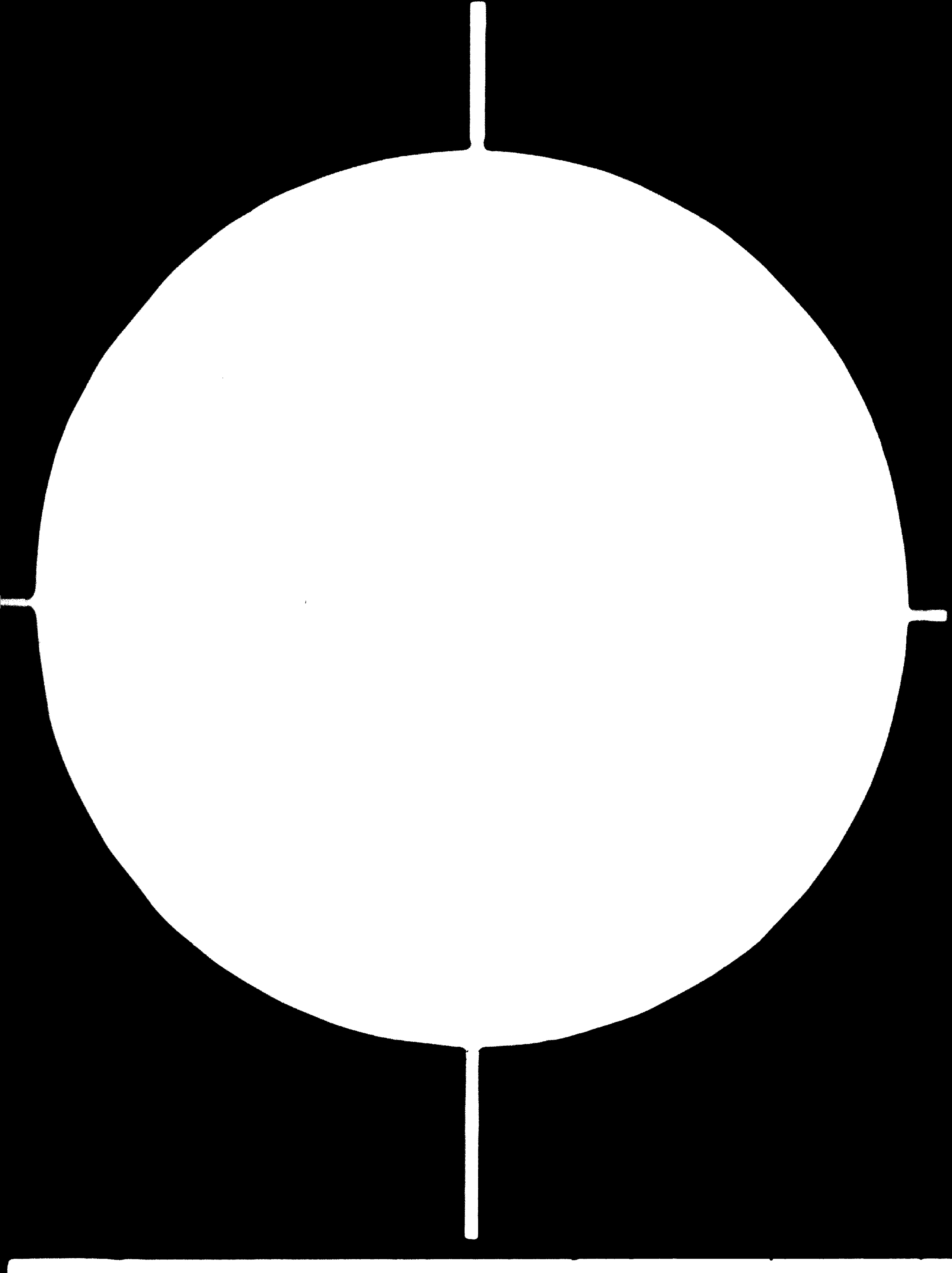
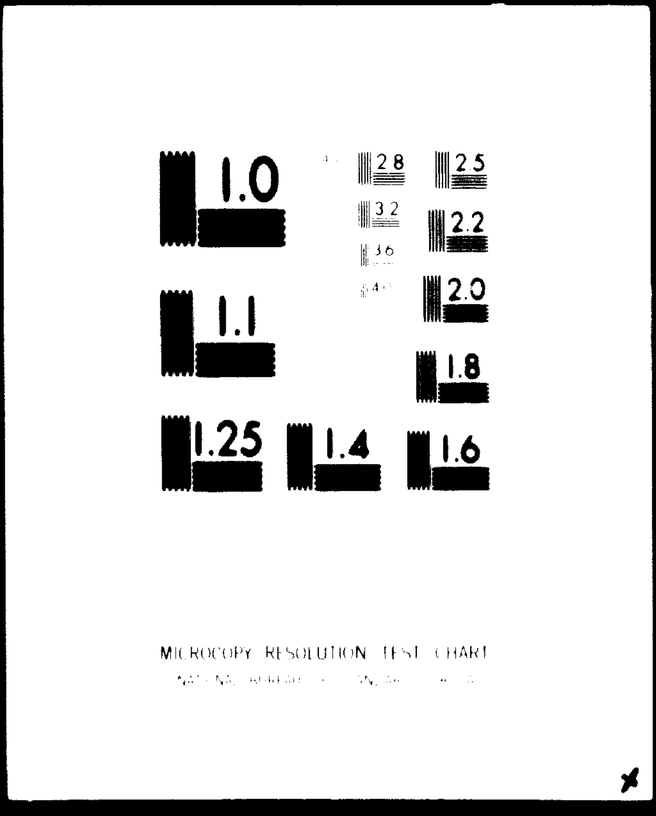


2 OF 2

03647



24x

D

II-6-2 AFRICA

According to a document of the United Nations Economic Commission for Africa (UNECA), enclosed into the documents published in occasion of the foresaid International Experts Meeting, held in Rome (25-29/4/1968) on the initiative of U.N.I.D.O., overall African salt production in 1980 should ascend to 4.001.000 tons.

Alimentary use consumption, calculated according to 5 Kgs pro-capite, should be about 2.020.000 tons in 1980. Consumption for other uses than the alimentary one should reach instead 774.000 tons. Overall consumption (alimentary and industrial uses) should be therefore of 2.794.000 tons.

In the following table Africa is subdivided into 4 regions (Northern, Western, Eastern and Southern) each one with its own production and consumption data.

From these data it appear that in the 1970-1980 decade Northern Africa should be able to export yearly between 750.000 and 1.400.000 tons. Vice versa in the same period Western Africa should have a salt import of 15/30.000 tons; Central Africa 80/146.000 tons; Eastern Africa between 1.000 and 85.88.000 tons.

In any case, independently of the U.N.E.C.A. forecasts, other observations about future developments of salt consumption in Africa Countries are appearing, which are related to population increase in the Continent for the 1970-1980 decade and to the presumable average salt consumption index for alimentary and overall use.

We have reported in another following table the African population increase according to the average annual increase coefficient estimated to be about 2,36% in the foresaid decade.

Forecast for salt production and consumption in the four African Sub-regions

	(Production) (1.000 tons)				(Consum.) (1.000 tons)				Export or Import			
	1965	1970	1975	1980	1965	1970	1975	1980	1965	1970	1975	1980
Northern Africa	1.048	1.430	1.942	2.519	488	653	835	1.062	560	777	1.107	1.457
- Algeria	135	180	240	320	75	103	137	183	60	77	103	137
- Libia	6	8	11	16	—	8	11	16	6	-	-	-
- Marrocco	38	52	71	98	34	52	71	98	4	-	-	-
- Sudan	60	90	110	135	60	73	89	108	-	17	21	27
- Tunisia	315	400	510	650	32	84	107	137	283	316	403	513
- Rep.Araba Unita	494	700	1.000	1.300	287	333	420	520	207	367	580	780
Western Africa	90	415	675	900	324	448	669	916	-234	-33	6	-16
- Ghana	31	100	150	200	35	48	66	91	- 4	52	84	109
- Guinea	3	15	25	50	16	21	76	85	- 13	- 6	-51	- 35
- Nigeria	-	200	300	400	145	213	312	459	-145	-13	-12	- 59
- Senegal	56	100	150	150	35	42	51	62	21	58	99	88
- Togo	-	-	50	100	11	15	19	24	- 11	-15	31	76
Central Africa	-	-	-	-	59	82	111	146	- 59	-82	-111	-146
Oriental Africa	296	360	496	582	262	361	502	670	34	- 1	- 6	- 88

Forecast for salt production and consumption in the four African Sub-regions

	(Production)(1.000 tons)				(Consum.)(1.000 tons)				(1.000 tonn.)			
	1965	1970	1975	1980	1965	1970	1975	1980	1965	1970	1975	1980
- **Etiopia**	236	250	350	400	81	95	140	175	129	155	210	225
- **Kenya**	31	40	60	80	37	52	77	103	- 6	-12	-17	-23
- **Magadascar**	15	50	60	70	15	25	31	54	-	25	29	16
- **Maurizio**	4	5	6	7	4	5	6	7	-	-	-	-
- **Rep.Unita di Tanzania**	10	15	20	25	26	49	64	85	-16	-34	-44	-60
Sub-regions (Total	1.434	2.205	3.113	4.001	1.093	1.544	2.117	2.794	341	661	994	1.207
					1.360	1.550	1.770	2.020				

- **Sub-regions (Total concerning a 5 Kgs pro-capite requirement for alimentary uses)**

Presumable average increase of African population for the 1967-1980 period

(average annual increase coefficient = 2,36%)

Period			Overall average increase (foreseen)	Annual average increase (foreseen)
Giugno	1967	(stima)	329.771.000	--
June	1968	"	337.553.595	7.782.595
"	1969	"	345.519.860	7.966.265
"	1970	"	353.674.129	8.154.269
"	1971	"	362.021.838	8.347.709
"	1972	"	370.555.553	8.533.715
"	1973	"	379.100.664	8.545.111
"	1974	"	388.050.439	8.949.775
"	1975	"	397.208.429	9.157.990
"	1976	"	406.582.558	9.374.119
"	1977	"	416.177.906	9.595.348
"	1978	"	425.769.704	9.591.798
"	1979	"	435.817.869	10.048.165
"	1980	"	446.102.869	10.285.000

Overall increase foreseen for the 1967/1980 period 116.331.869

Therefore if for the foresaid period, the foreseen average salt consumption in Africa were calculated according to the conventional average population increase (2,36%) as well as to the differentiated average consumption indexes (5,7 and 10 Kgs pro-capite), it will appear the following foreseen average consumptions:

Year	Overall population (unit)	Average consumption Index (Kgs/inhabit.)	Average consumption foreseen (Tons)
1970	353.674.129	5	1.768.370,6
"	353.674.129	7	2.475.718,9
1975	397.208.439	5	1.986.052
"	397.208.439	7	2.780.459
1980	446.102.869	5	2.230.514,3
"	446.102.869	7	3.122.720
"	446.102.869	10	4.461.028

The foresaid data appear somewhat superior to U.N.E.C.A. ones. About this it must be noticed however that the U.N.E.C.A. report does not indicate average population increase in the next ten years.

In our opinion the increase average coefficient of 2,36%, adopted for the 1967-1980 period, can be considered, cautiously, as reliable and therefore the average salt consumption could reach in Africa for 1975 1.986.042 tons (U.N.E.C.A. 1.770.000 tons) with index of 5 Kgs/pro-capite for alimentary use and 2.780.459 tons with index of 7 Kgs for overall use (alimentary and industrial). In 1980 the figures could respectively increase to 2.230.514,3 tons (U.N.E.C.A. 2.020.000 tons) and 3.122.720 (according to the 5 Kgs/inhabitant alimentary index and the overall 7 Kgs/inhabitant one.

If it was possible to use a higher overall index (10 Kgs/inhabitant) at least for the end of the next decade (1980), due to a beginning industrial take off in the African Continent, consumption should presumably reach a 4.561.028 tons level, while production should be likely of about 4.000.000 tons.

In any case, one must pay attention, particularly, to Eastern and Central Africa regions for the future sale of Aden salt.

According to U.N.E.C.A. forecasts, in these regions, in 1980, it should be registered a total consumption of about 816.000 tons, while production should rise to an overall average of 582.000 tons. It will remain therefore an unsatisfied demand of almost 234.000 tons. Yet if this demand was established, in our opinion and always with cautions appreciations, with slightly superior consumption indexes than those indicated by U.N.E.C.A., it should oscillate between 300/400.000 tons.

About the forecasts, according to future enlargement and new infrastructural constructions in the different African Countries, it must be kept in mind what has been stated by the United Nations Economic Commission for Africa.

According to the foresaid report, salt production expansion in Northern Africa is more easily foreseeable than the expansion of the other regions, as Northern Africa has much more favourable work conditions. Especially Algeria, Tunisia and the United Arab Republic, which are the Countries with a higher productive possibilities.

In Western Africa conditions are little satisfactory for a solar salt production, because of the damp climate and the sea water low concentration, much diluted by the great rivers flow. Nevertheless in some Countries, like Ghana, Guinea, Senegal and Togo, there is some possibilities of sodium chloride production.

Improvements could be made not only on the saltern mechanizations field, but also in the transportation and portual capacity one. In Nigeria it exist the possibility to develop salt production, using vacuum evaporation.

About Central Africa, the working of the new plant for potassium carbonate production of Congo-Brazzaville, should turn this sub-region to be normally autosufficient for sodium chloride production. About this subject it must be considered that, according to a 1966 study of the

European Economic Community the working of the Holle potassium deposits (about 60 Kms North-East of Pointe-Noire) by the "Compagnis des Potasses" of Congo, whose factories were at that time already in construction, should allow the annual extraction of 500/600.000 tons. of rock salt, which having a scarce use in the interior chemical industry should be thus mainly exported.

In eastern Africa - always according to the U.N.E.C.A. report - whatever the salt production increase could be if exports toward Japan were maintained and developed, there will be still few regions, in which conditions are really favourable for the implementation of new salterns. The Red Sea area, from the water saltness point of view, the climate and the altogether topography would appear very much adapted for solar salt production and would deserve, according to the Commission, a special survey about its productive possibilities expansion. It must be observed that in the foresaid report only Ethiopia is mentioned, which is very favoured for the installation of new plants, especially from the transportation and portual capacities point of view.

FINAL CONSIDERATIONS

The production of the future Aden saltern, according to the preceeding considerations, should find sale possibilities on:

1° - the Japanese market, which should be normally in position to absorb always 3/4 million tons, even when there will be a salt production increase in the Indian and Pacific Ocean region due to the working of the new salterns or the enlargement of the old ones;

2° - some Asiatic Countries markets, which might need of some quantities, even fractional and rather small, until they would not be in condition to be autosufficient due to the modernization of the old salterns or the constru ction of new ones;

3° - some East and Central African Countries, until these also would not become autosufficient due to the foresaid motives;

4° - other world markets, usually for special conjunctural circumnstance and, in particular, due to favourable sea transportation contracts, that should consent in some cases exceptional sea freight, allowing to bring the salt to its destination at extremely competitive prices.

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

MAP OF EXISTING SALTERN

prog N°	781
dis N°	1
all N°	
scale	1:50'000
dis	Rodolfo [illegible]
contr	
appr	[illegible]
data	10-5-'72

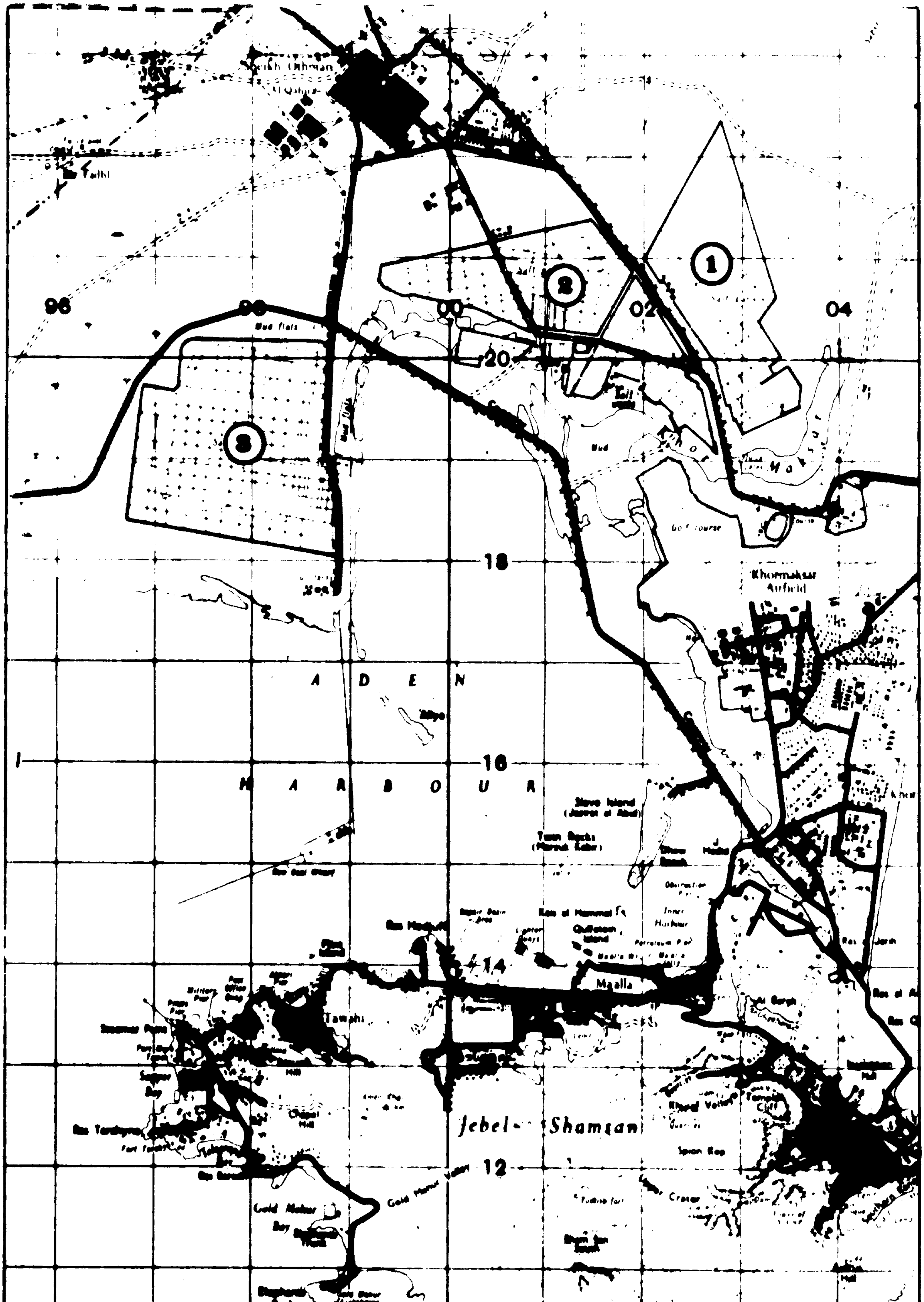
STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

L E G E N D

(1) Italian saltern

(2) Indo-Aden saltern

(3) -Caltex- saltern



96
98
00
02
04
1
2
3
Mud flats
20
18
16
14
12
10
Golf course
Khormaksar Airfield
A D E N
H A R B O U R
Slave Island
(Jazirat al Abid)
Twin Rocks
Inner Harbour
Maalla
Tawahi
Jebel Shamsan
Gold Mohur Valley
Gold Mohur Bay
Conquest Bay

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

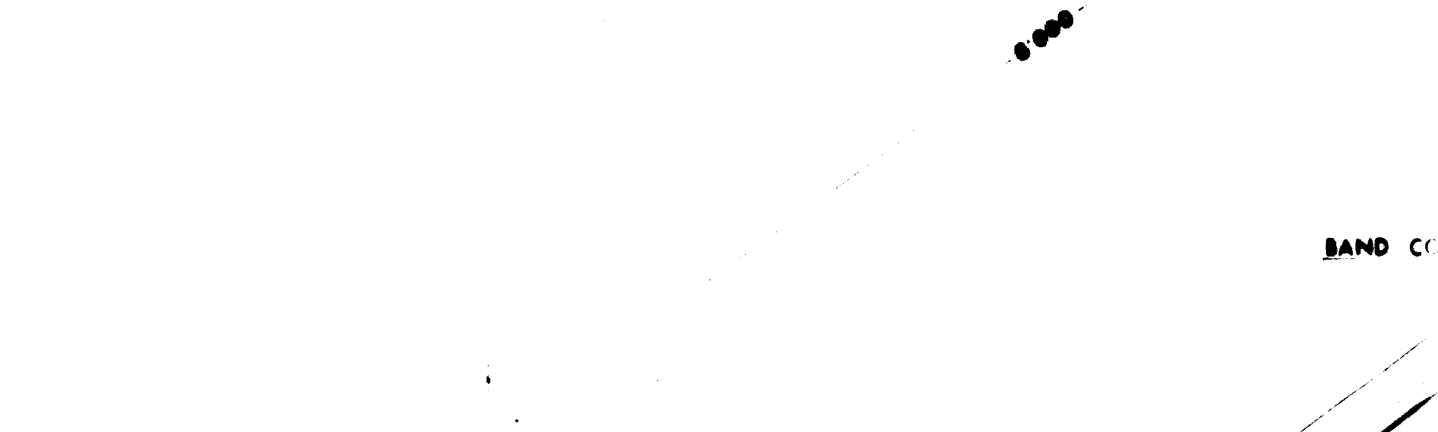
PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

PICKING-LOADING MACHINE

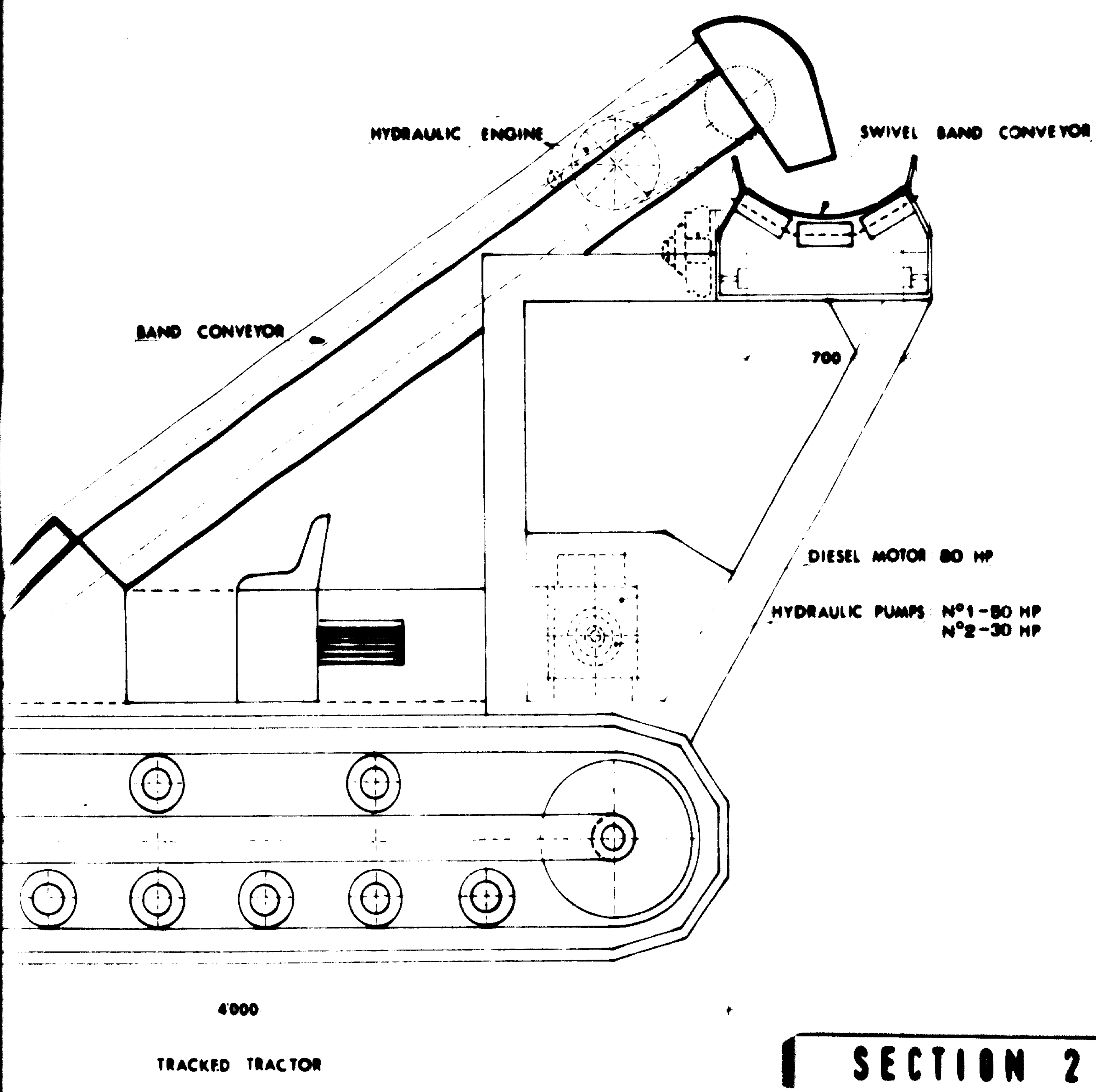
prog N°	708
dis N	2
all N°	
scala	1:25
dis	[illegible]
contr	
app	[illegible]
data	10-5-'78

S.T.I.
STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

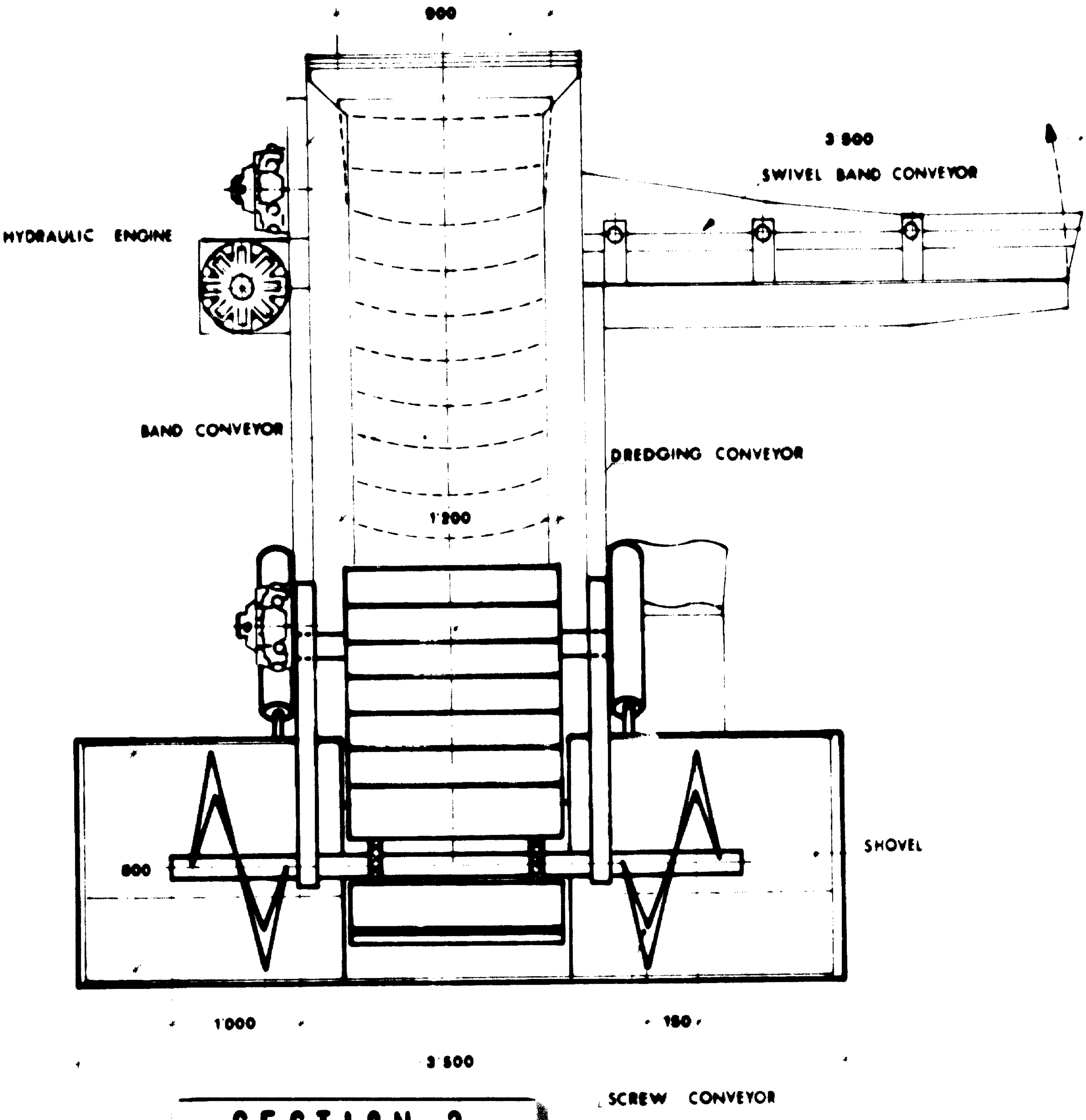


HYDRAULIC ENGINE
BAND C
SCREW CONVEYOR
SHOVEL
DREDGING CONVEYOR
TRACK

SECTION 1


HYDRAULIC ENGINE
SWIVEL BAND CONVEYOR
BAND CONVEYOR
700
DIESEL MOTOR 80 HP
HYDRAULIC PUMPS N°1-50 HP
N°2-30 HP
4000
TRACKED TRACTOR

SECTION 2


900
3 500
SWIVEL BAND CONVEYOR
HYDRAULIC ENGINE
BAND CONVEYOR
DREDGING CONVEYOR
1 200
SHOVEL
800
1 000
150
3 500
SCREW CONVEYOR

SECTION 3

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

LAYOUT OF HYDRAULIC CIRCUIT OF PICKING AND LOADING MACHINE

prog N°	788
dis N°	3
all N°	
scale	no scale
dis	
contr	
appr	
date	10-5-'72

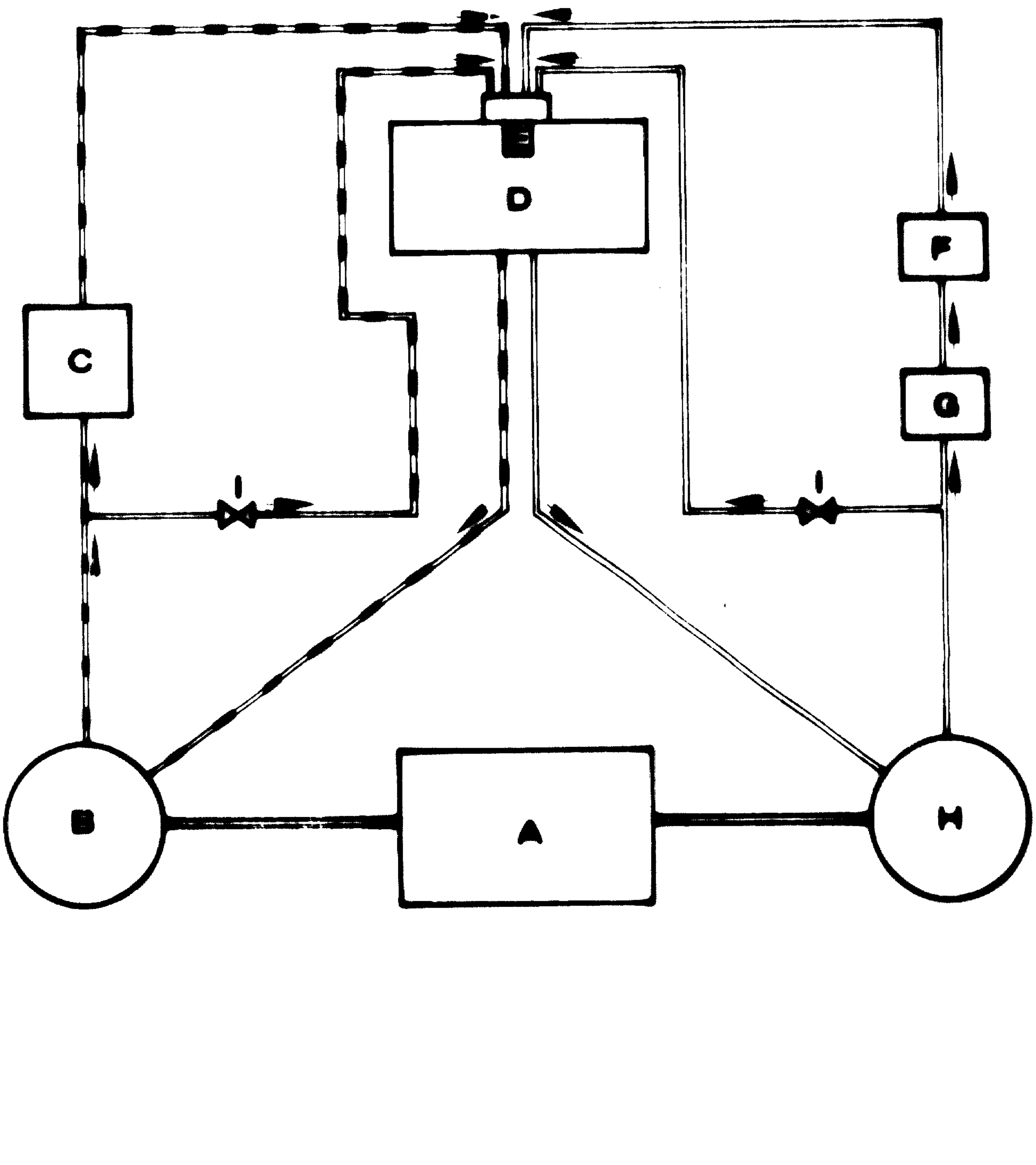
STUDIO TECNICO INGEGNERIA

PROGETTAZIONE COORDINATA - DIREZIONE LAVORI

VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

L E G E N D

	Oil line for dredging and screw conveyors
	Oil line for band conveyors
A	Diesel motor 80 HP
B	Hydraulic pump 50 HP
C	Hydraulic engine for dredging conveyor and screw conveyor
D	Oil tank
E	Oil filter
F	Hydraulic engine for band conveyor
G	Hydraulic engine for band conveyor
H	Hydraulic pump 30 HP
I	Expansion valve



E
D
C
F
G
I
I
B
A
H

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

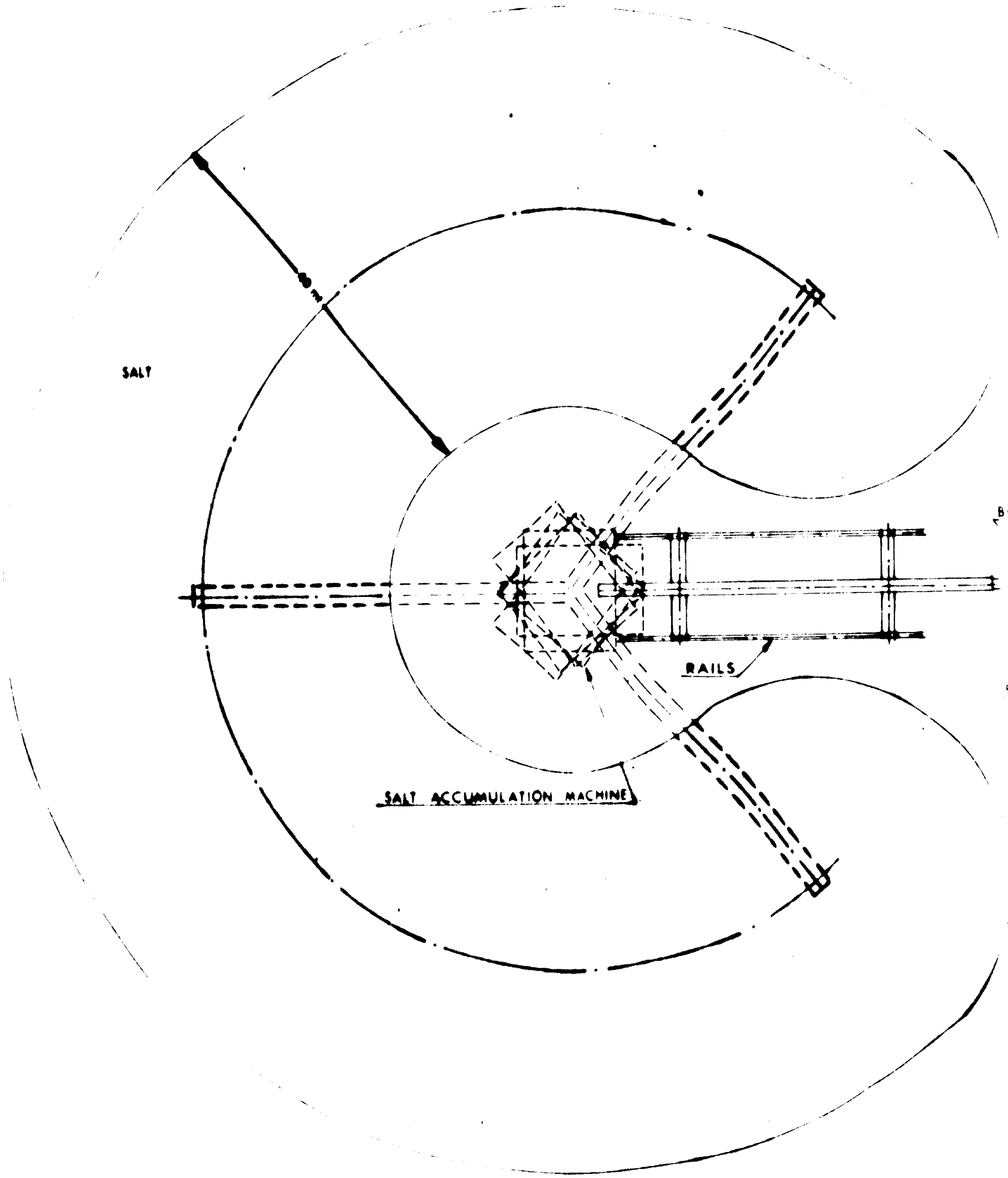
PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

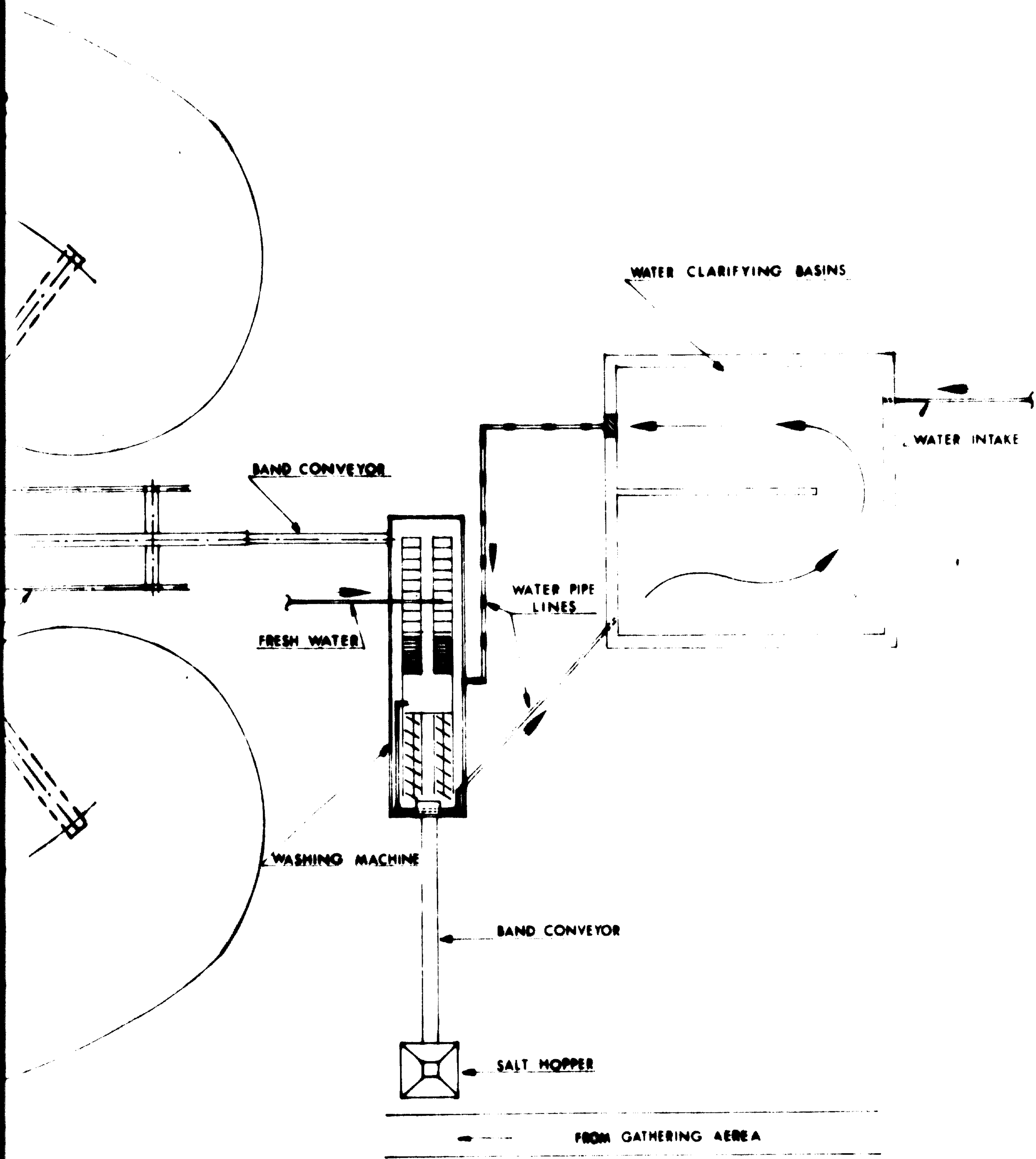
LAYOUT OF WASHING AND ACCUMULATION INSTALLATIONS

prog. N!	788
dis N!	4
all N!	
scala	1:500
dis	[illegible]
contr	
appr	[illegible]
data	10-5-'72

STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA, 878 - ROMA (ITALIA)



SECTION 1



WATER CLARIFYING BASINS
WATER INTAKE
BAND CONVEYOR
WATER PIPE LINES
FRESH WATER
WASHING MACHINE
BAND CONVEYOR
SALT HOPPER
FROM GATHERING AEREA

SECTION 2

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

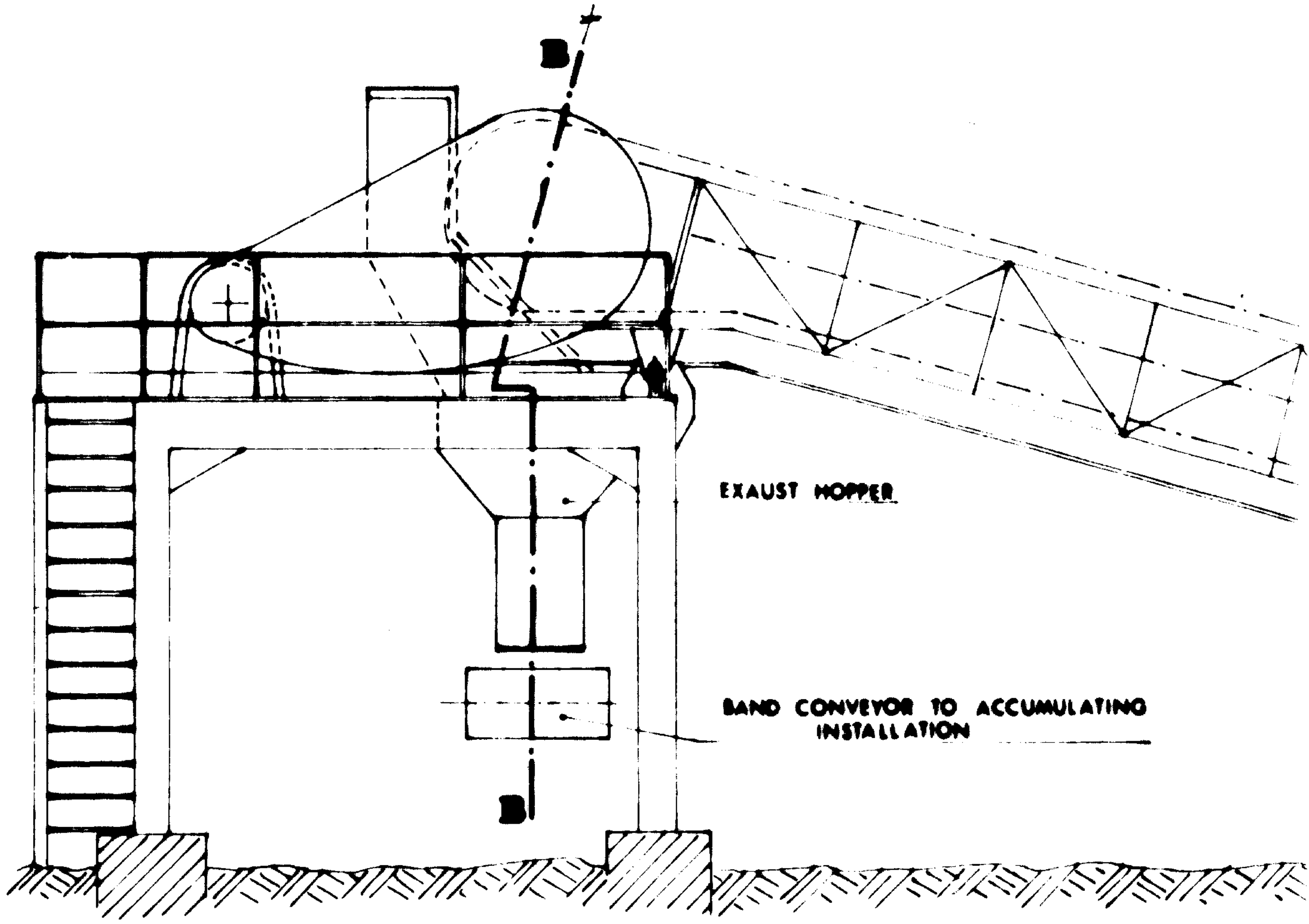
PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

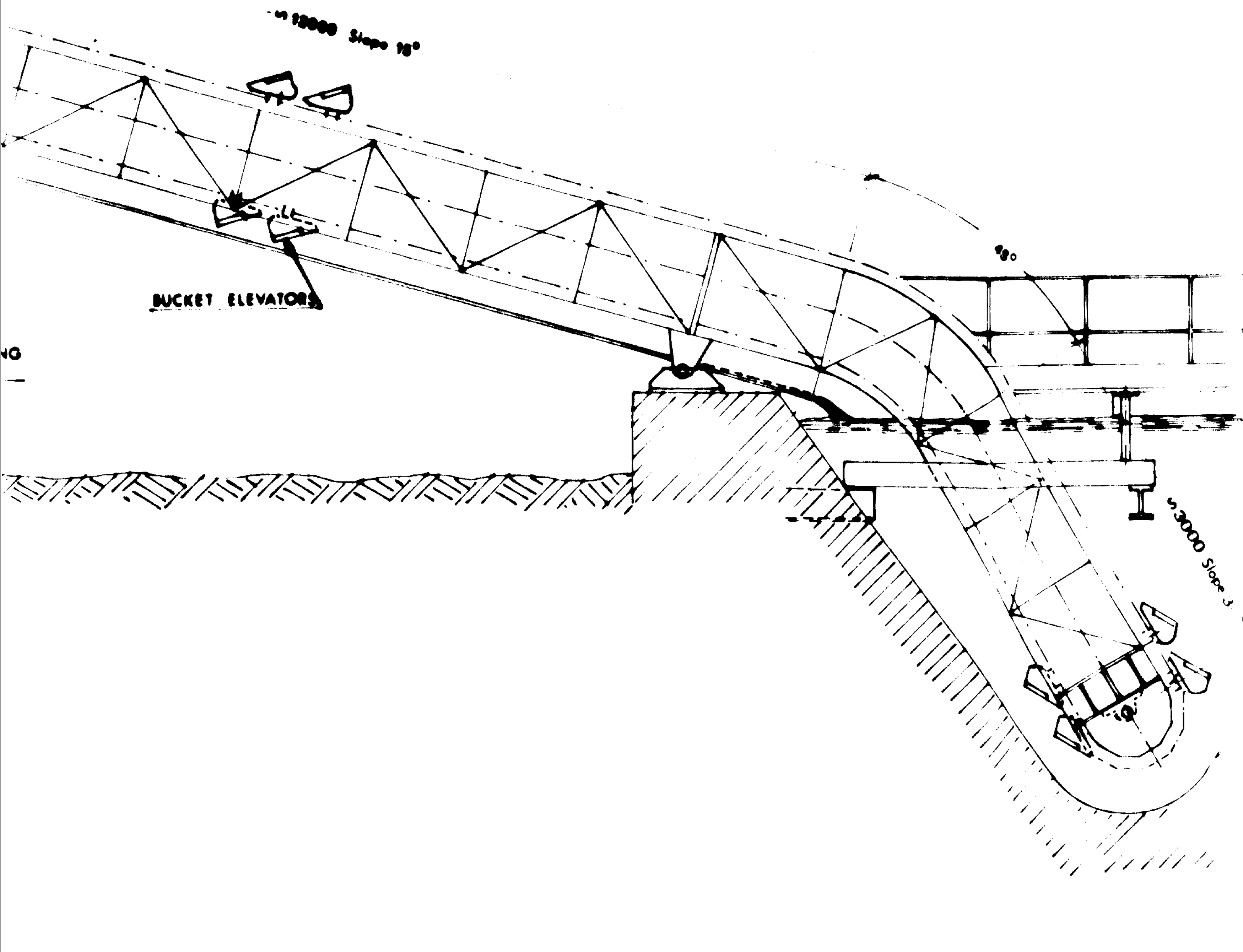
WASHING AND PURIFYING INSTALLATION DETAILS

prog Nº	788
dis Nº	5
all Nº	
scala	1:50
dis.	Rodolfo Mancini
contr	
appr	Augusto Tolu
data	10-5-'72

STI
STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

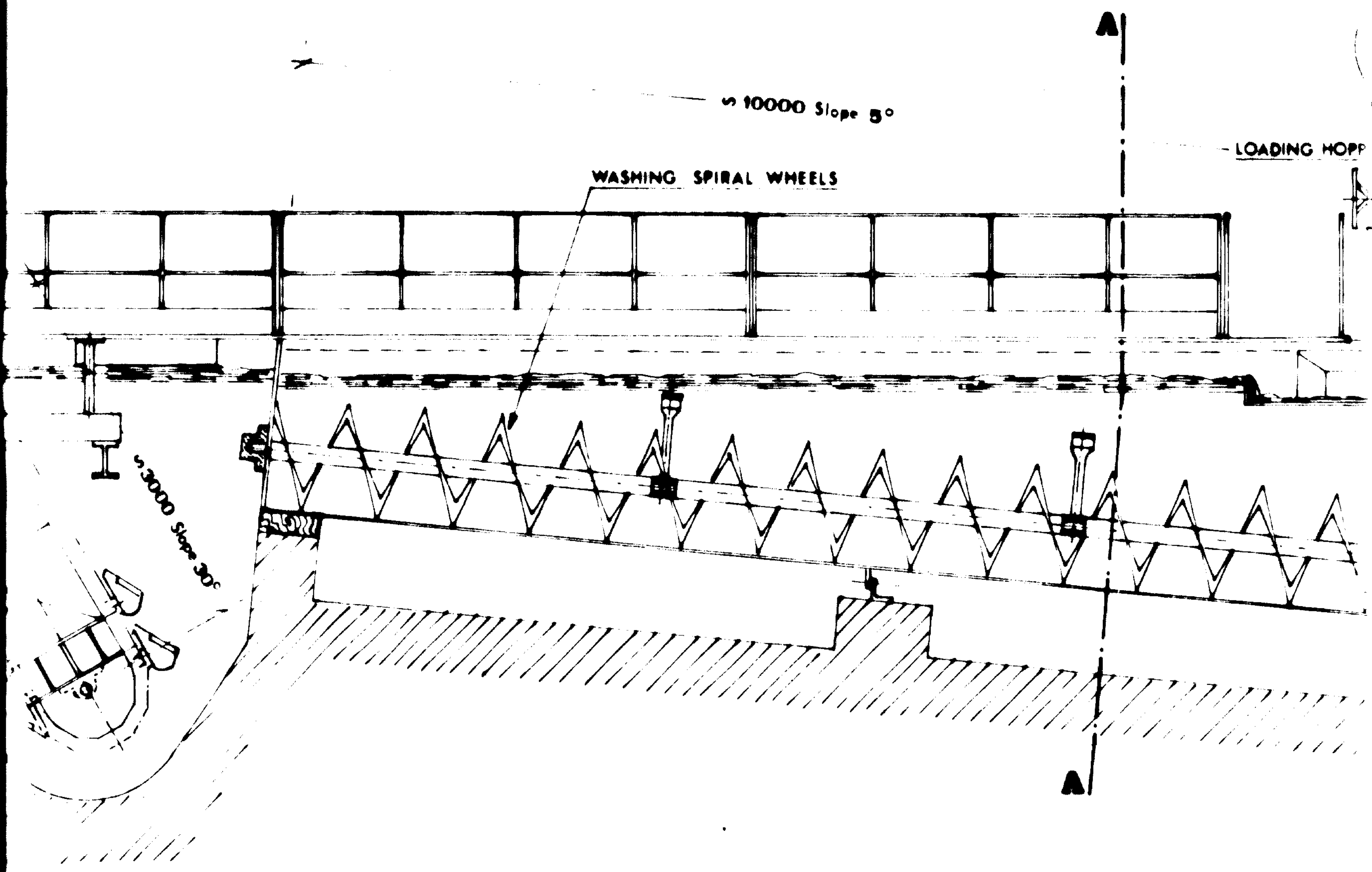

B
EXAUST HOPPER
BAND CONVEVOR TO ACCUMULATING INSTALLATION
B

SECTION 1



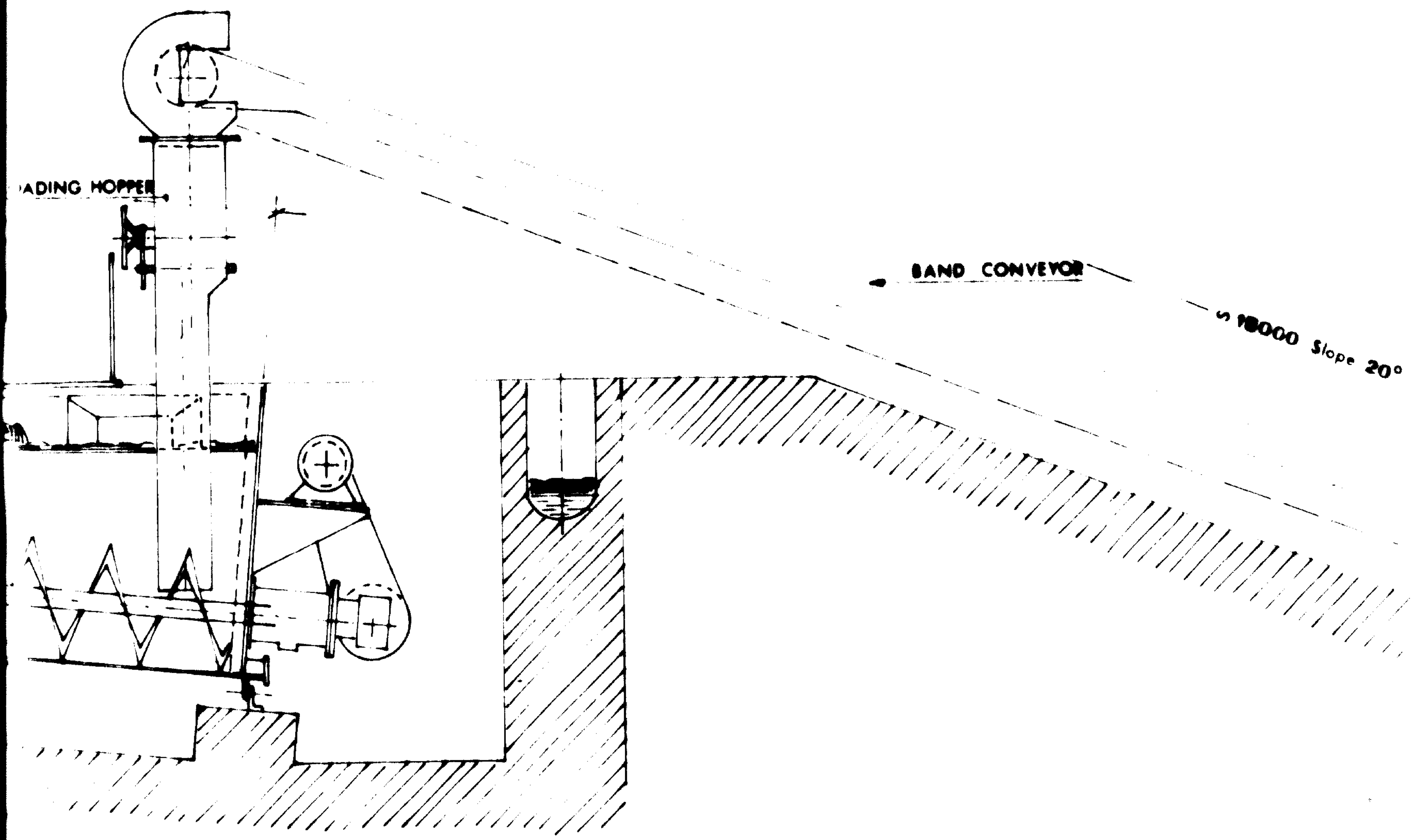
SECTION 2

I

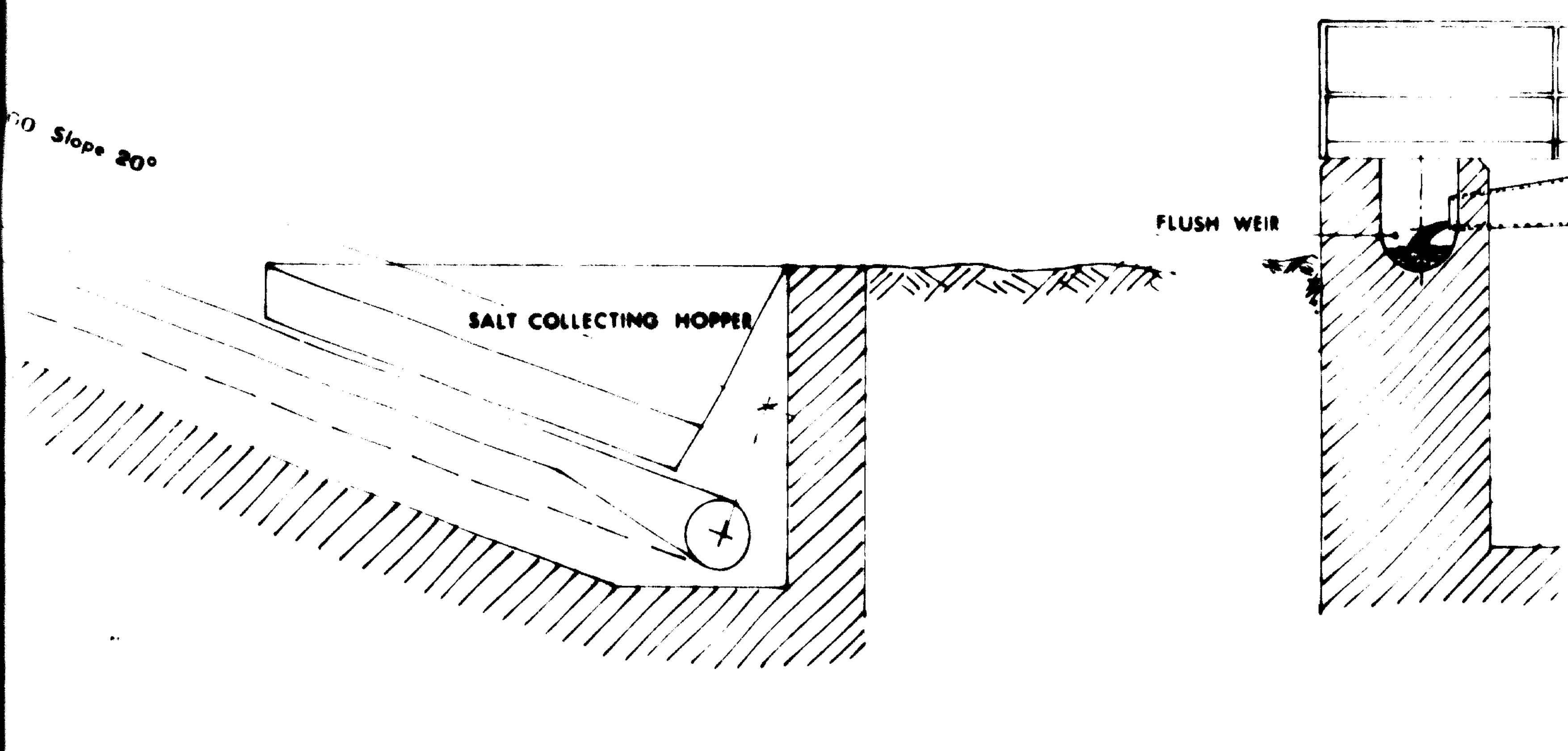


Longitudinal section

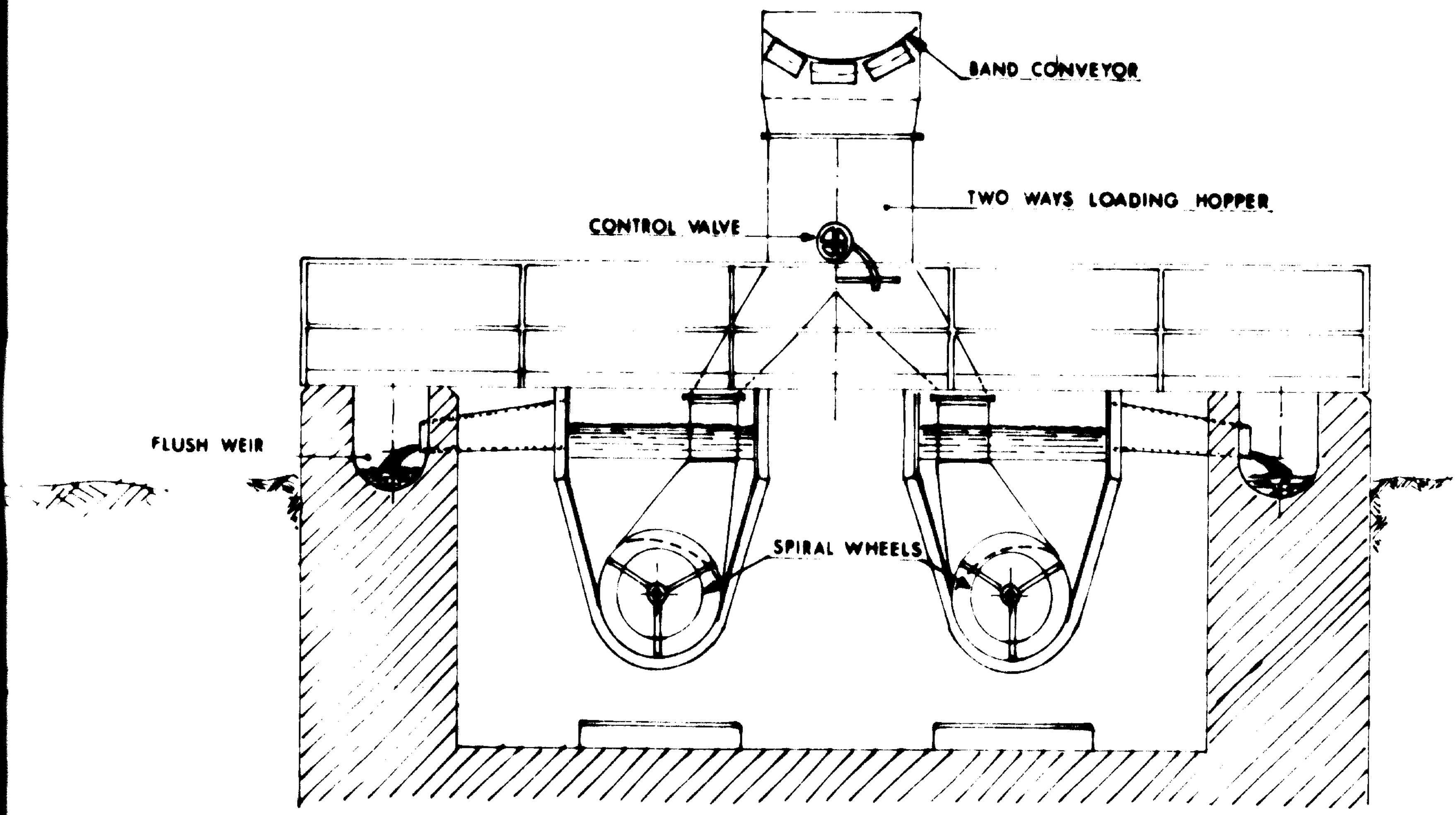
SECTION 3



SECTION 4



SECTION 5



Section A-A

Note: For section B-B see drawing n° 6

SECTION 6

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

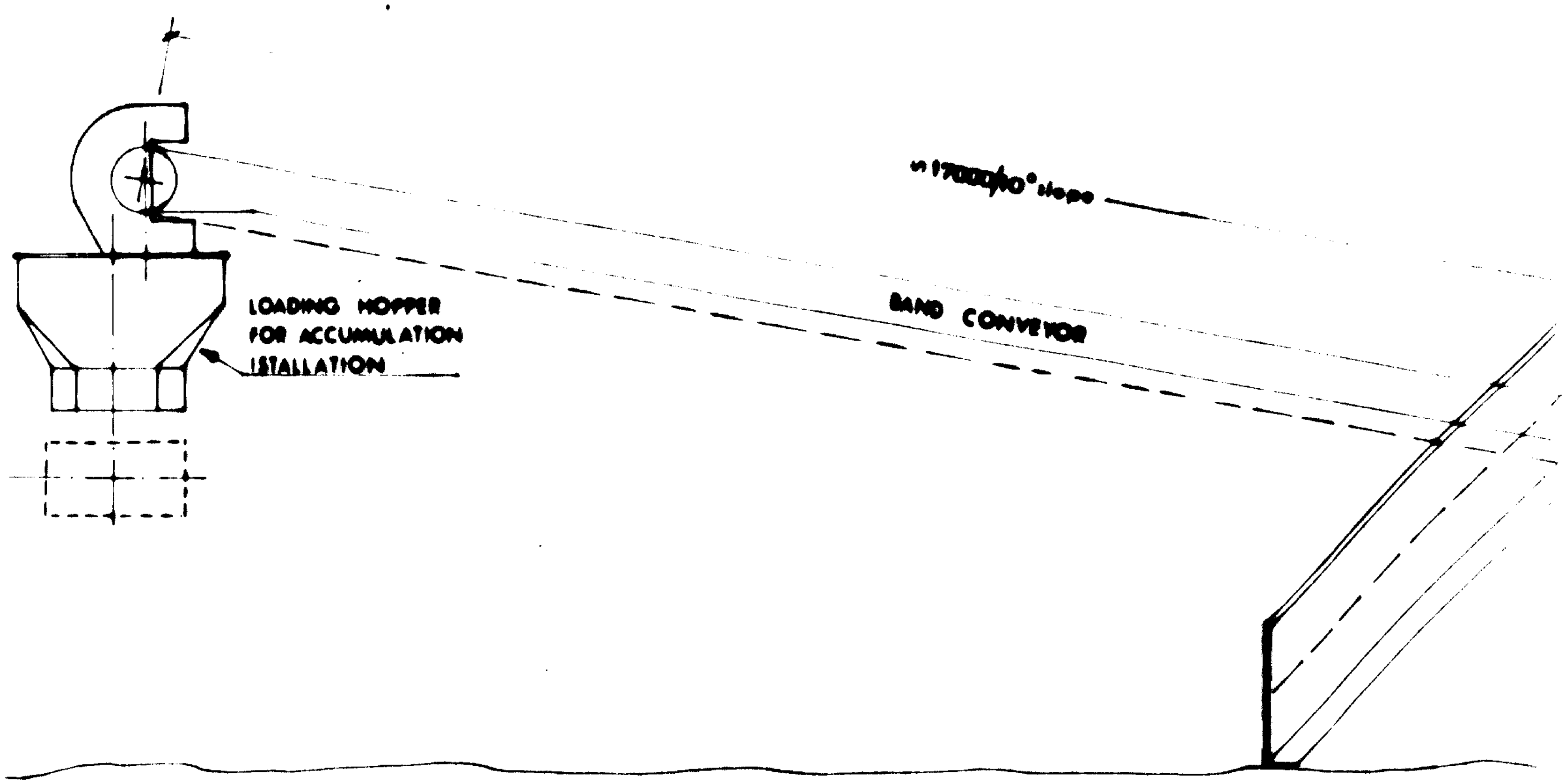
TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

WASHING AND PURIFYING INSTALLATION

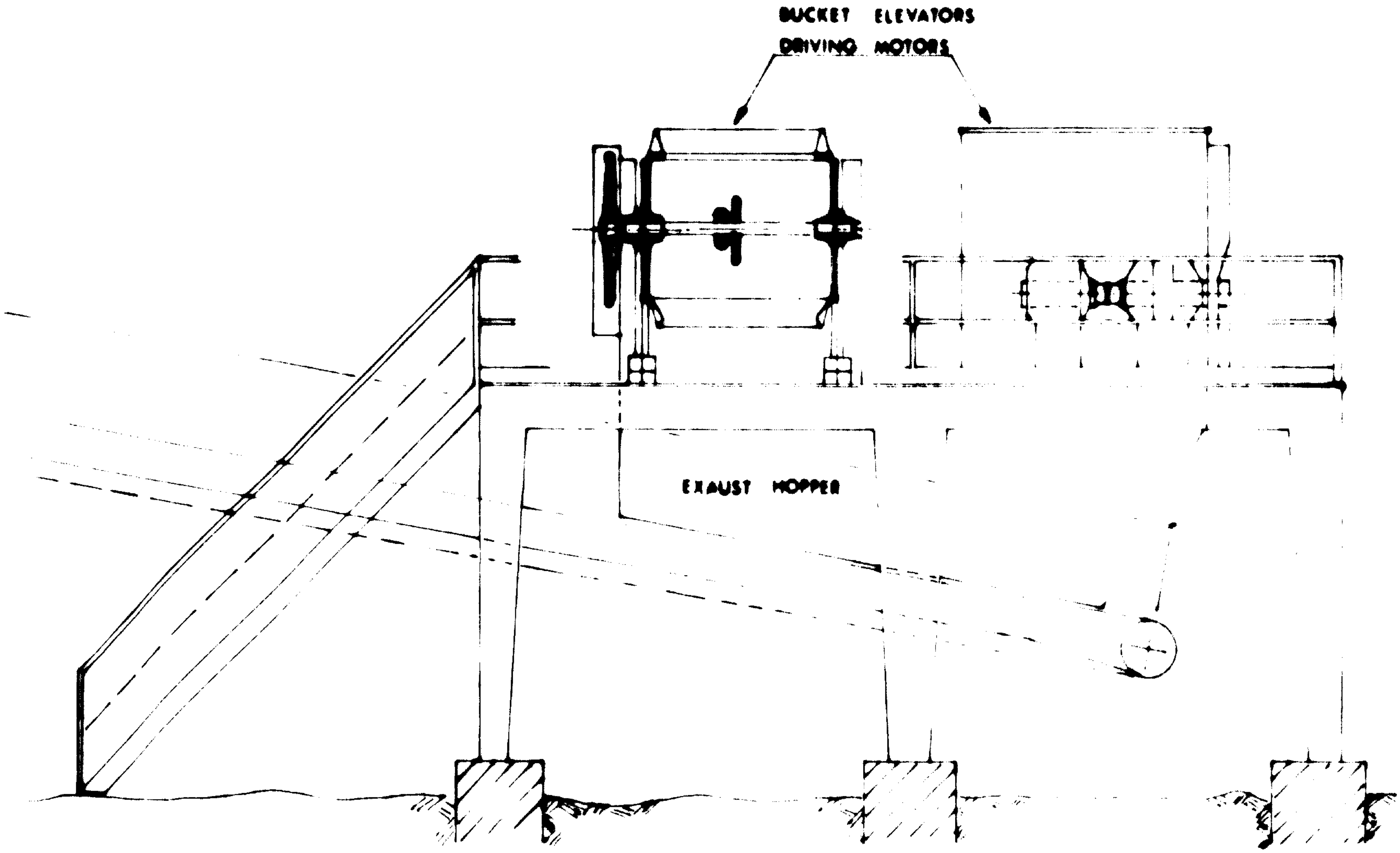
SECTION B-B

prog. N°	788
dis N°	6
all. N°	
scala	1:50
dis.	Rodolfo Mancini
contr	
appr	ing. paolo [illegible]
data	10-5-'72

STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA, 278 – ROMA (ITALIA)


17000/10° slope
BAND CONVEYOR
LOADING HOPPER
FOR ACCUMULATION
ISTALLATION

SECTION 1



SECTION 2

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

SALT ACCUMULATION INSTALLATION

prog N° 788

dis N° 7

all. N°

scala as shown

dis: Rodolfo Mancini

contr

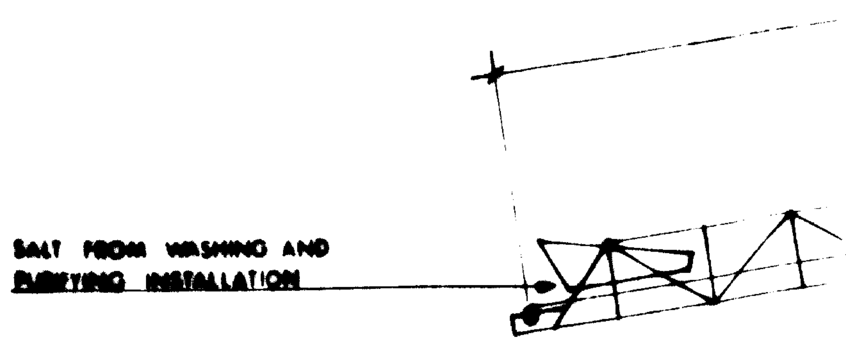
appr: [illegible]

data 10-5-'78

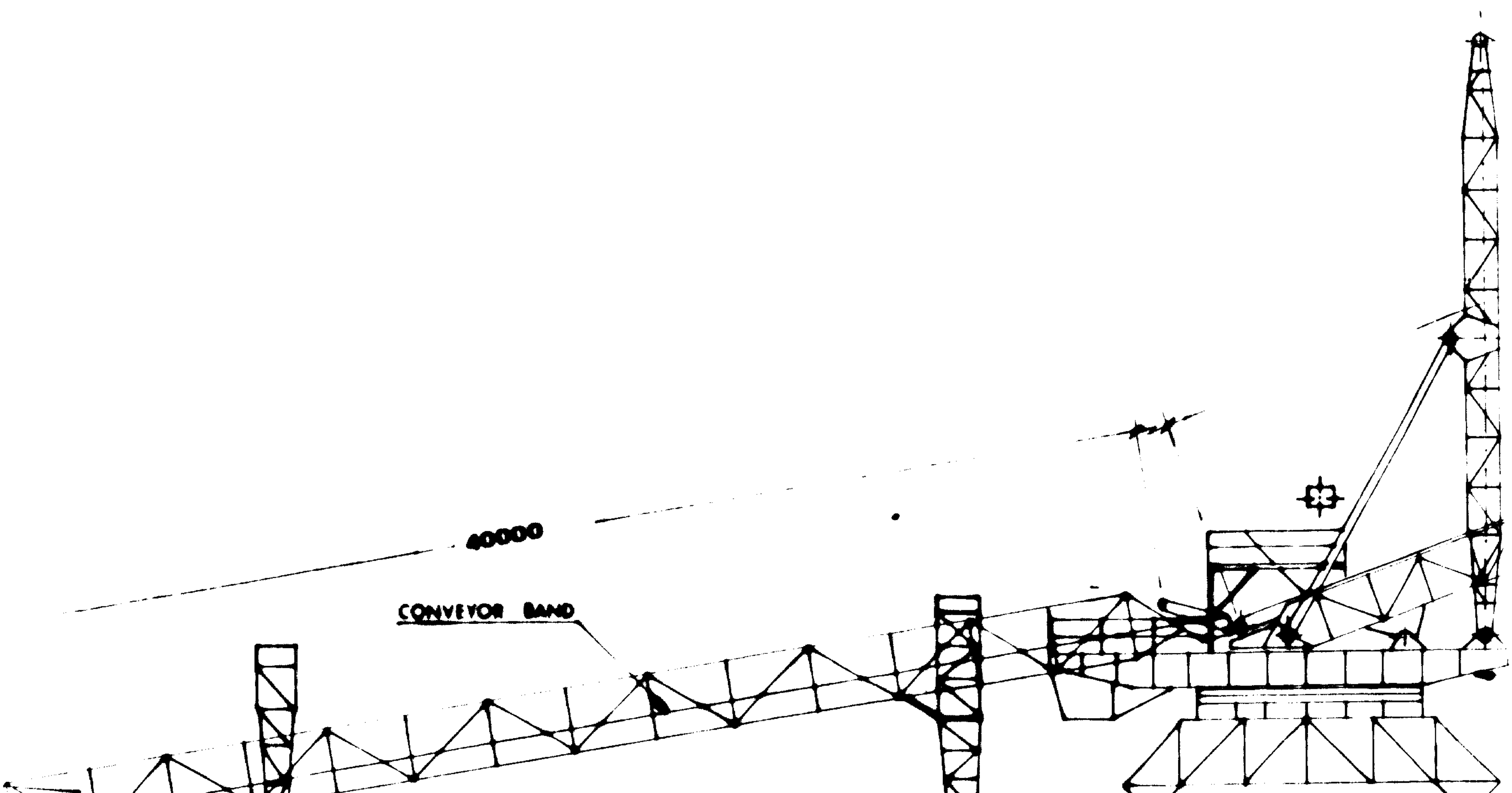
STUDIO TECNICO INGEGNERIA

PROGETTAZIONE COORDINATA-DIREZIONE LAVORI

VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

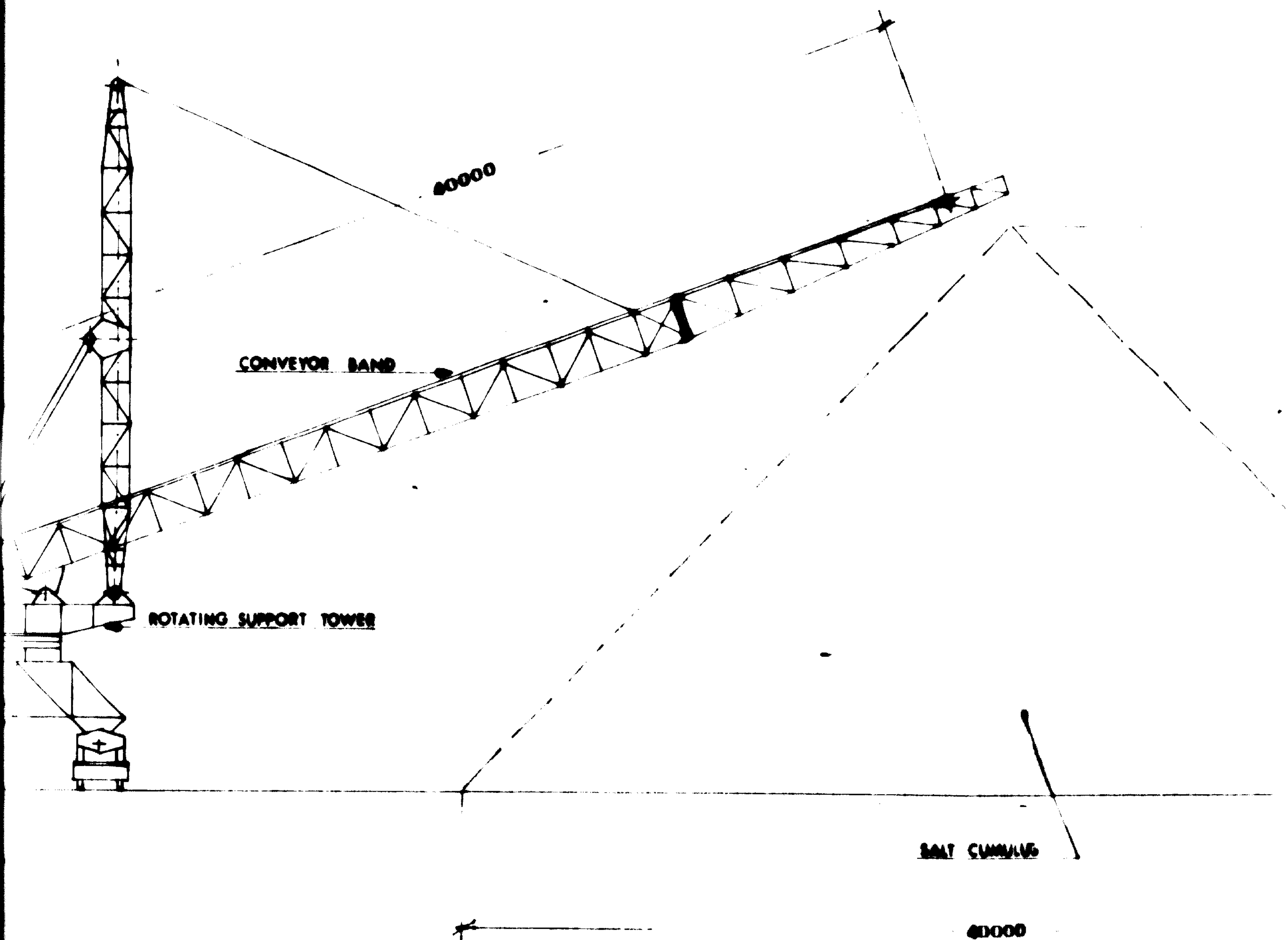


SECTION 1



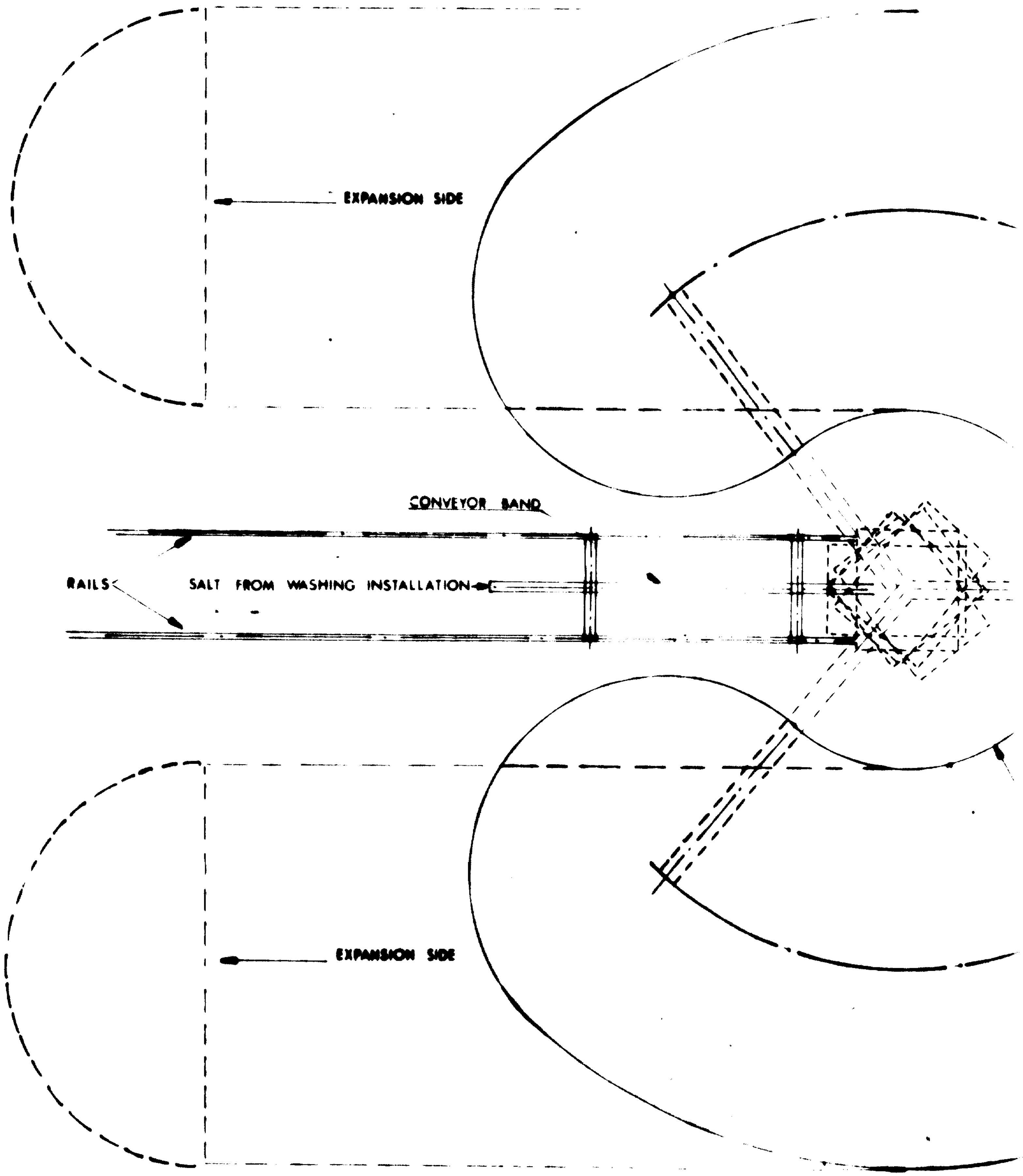
Scale 1:200

SECTION 2


40000
CONVEYOR BAND
ROTATING SUPPORT TOWER
SALT CUMULUS
40000

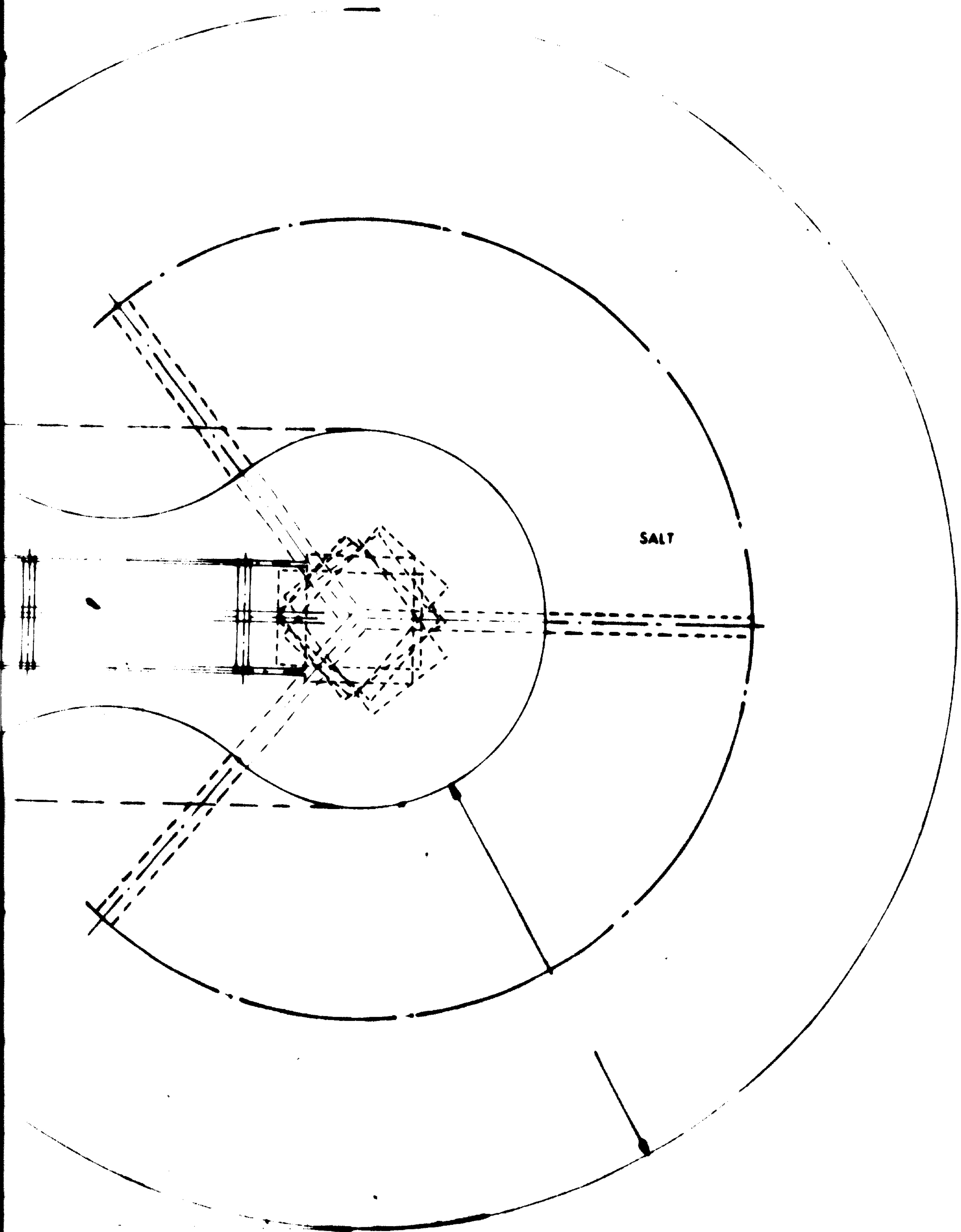
SECTION 3

SECTION 4



SECTION 5

Scale 1:500



SECTION 6

Scale 1:500

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

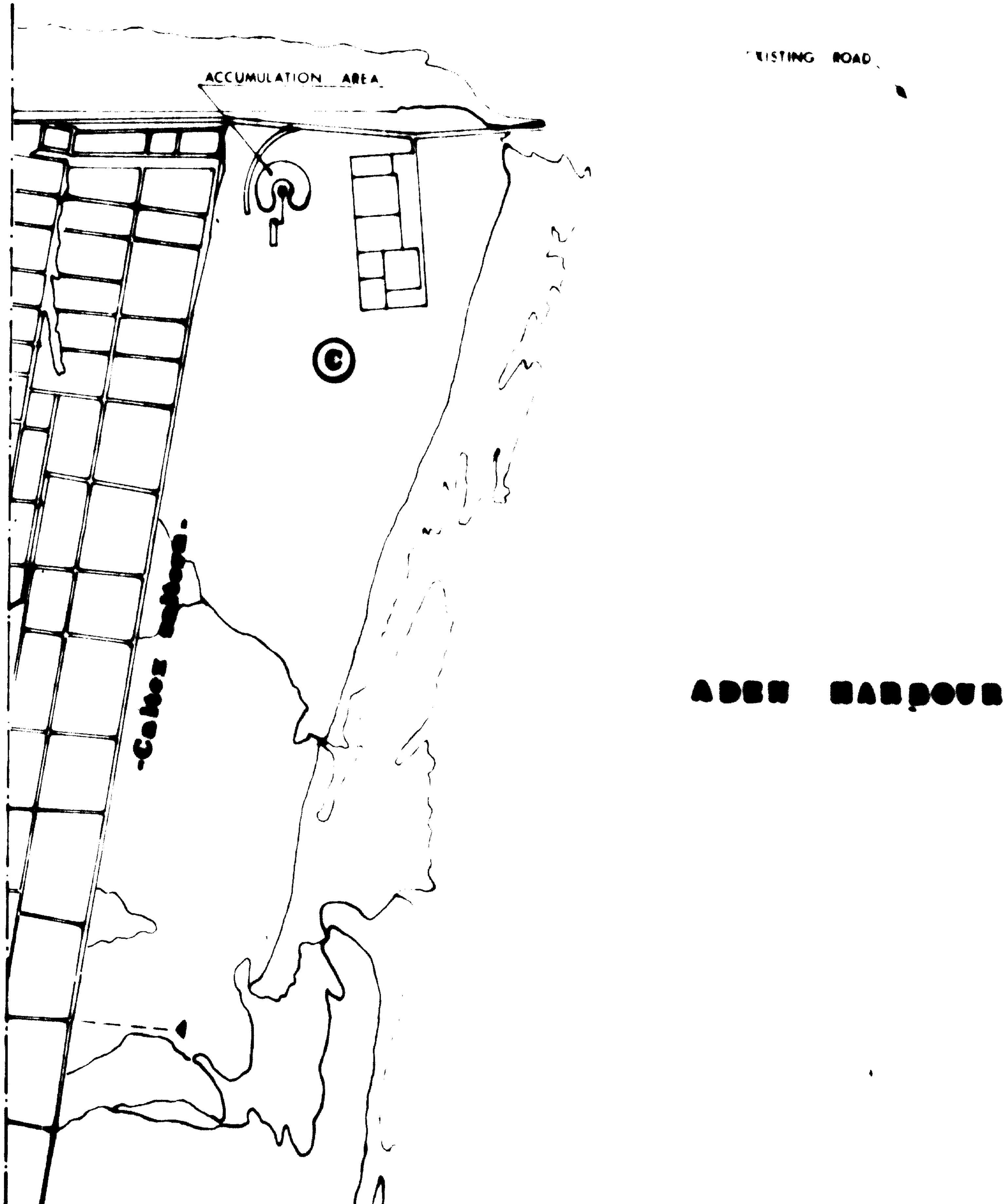
TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

GENERAL MAP OF ACCUMULATION AND LOADING STATION AREAS

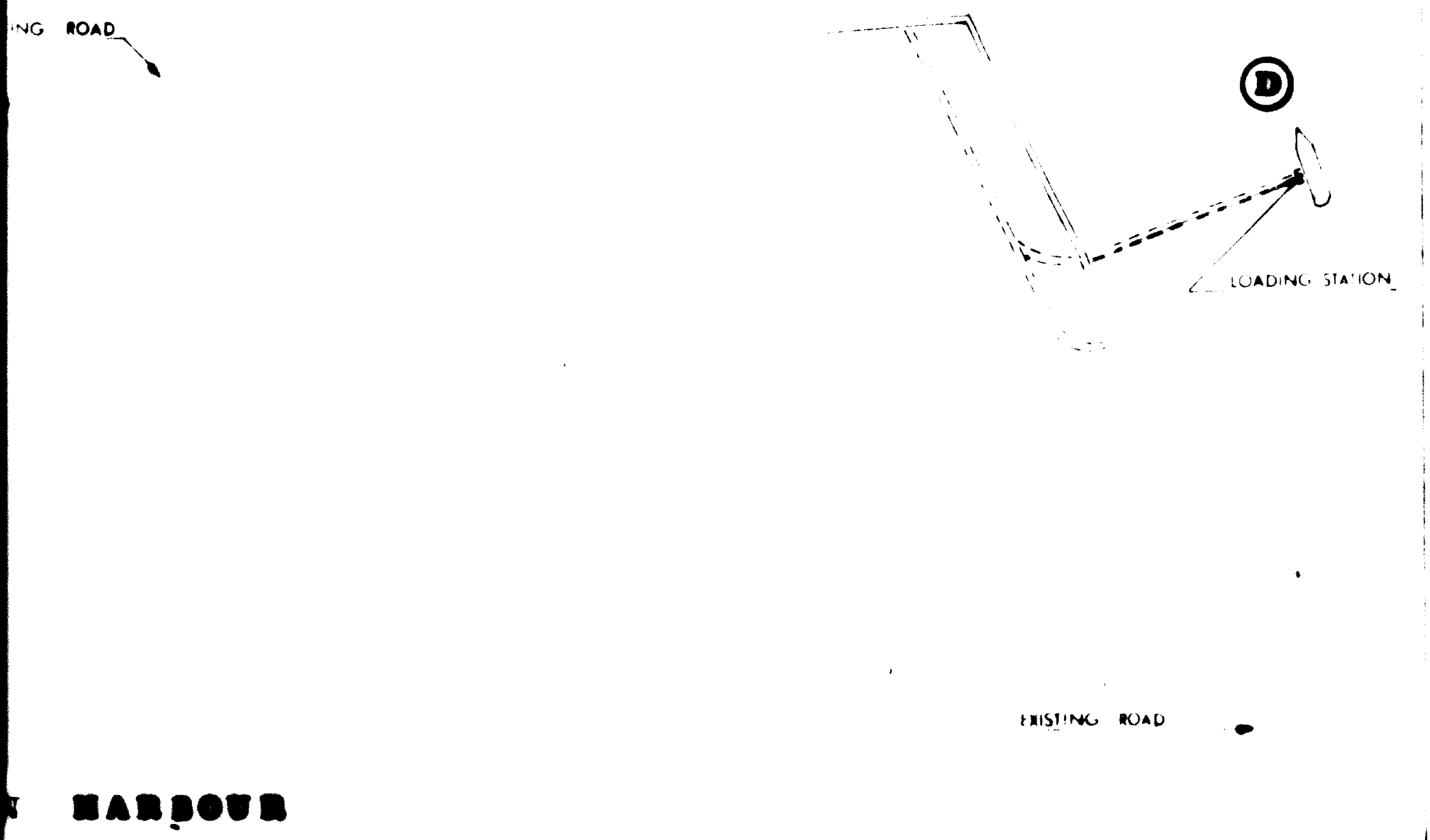
prog. N°	783
dis. N°	8
all. N°	
scala	1:10000
dis.	
contr.	
appr.	
data	10 5 '72

STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA - DIREZIONE LAVORI
VIALE REGINA MARGHERITA 278 ROMA (ITALIA)

L E G E N D



SECTION 1



Note: For details of -D- zone see drawing n° 9 and for -C- zone see drawing n°7

SECTION 2

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

SALT LOADING APPARATUS

prog. N° 788

dis. N° 9

all. N°

scala 1:100

dis. Rodolfo Mancini

contr.

esec.

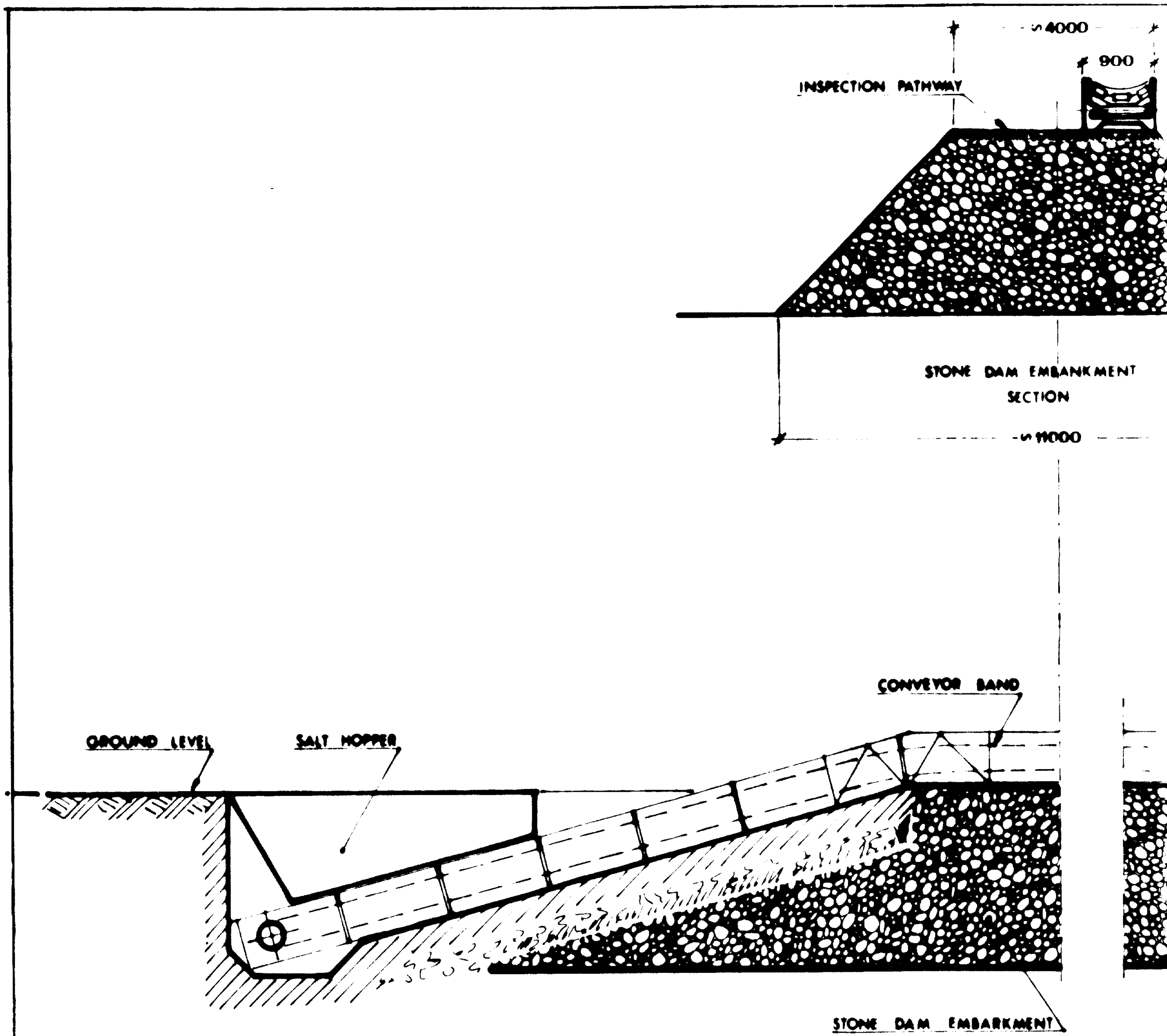
data 10-5-'73

STI

STUDIO TECNICO INGEGNERIA

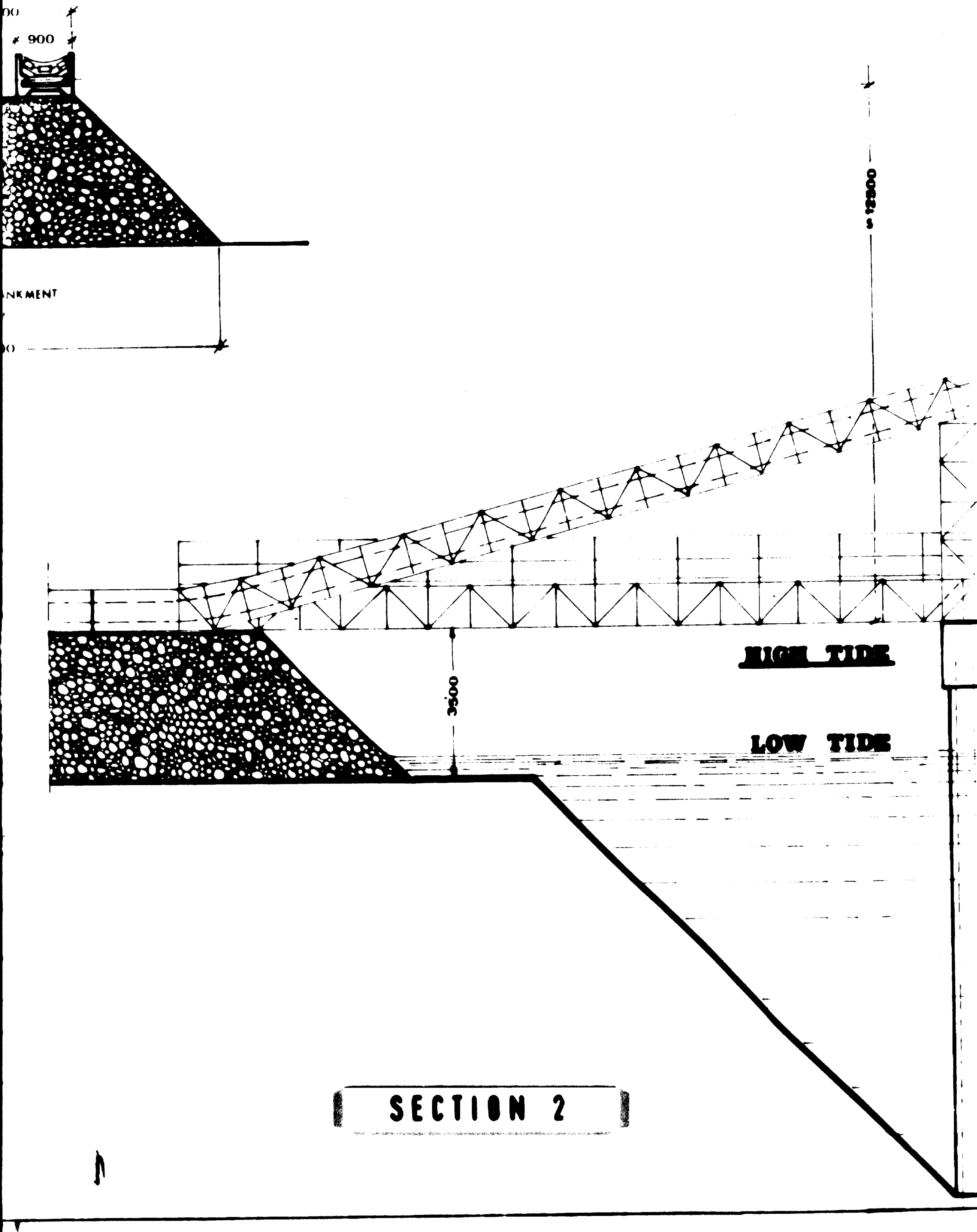
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI

VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

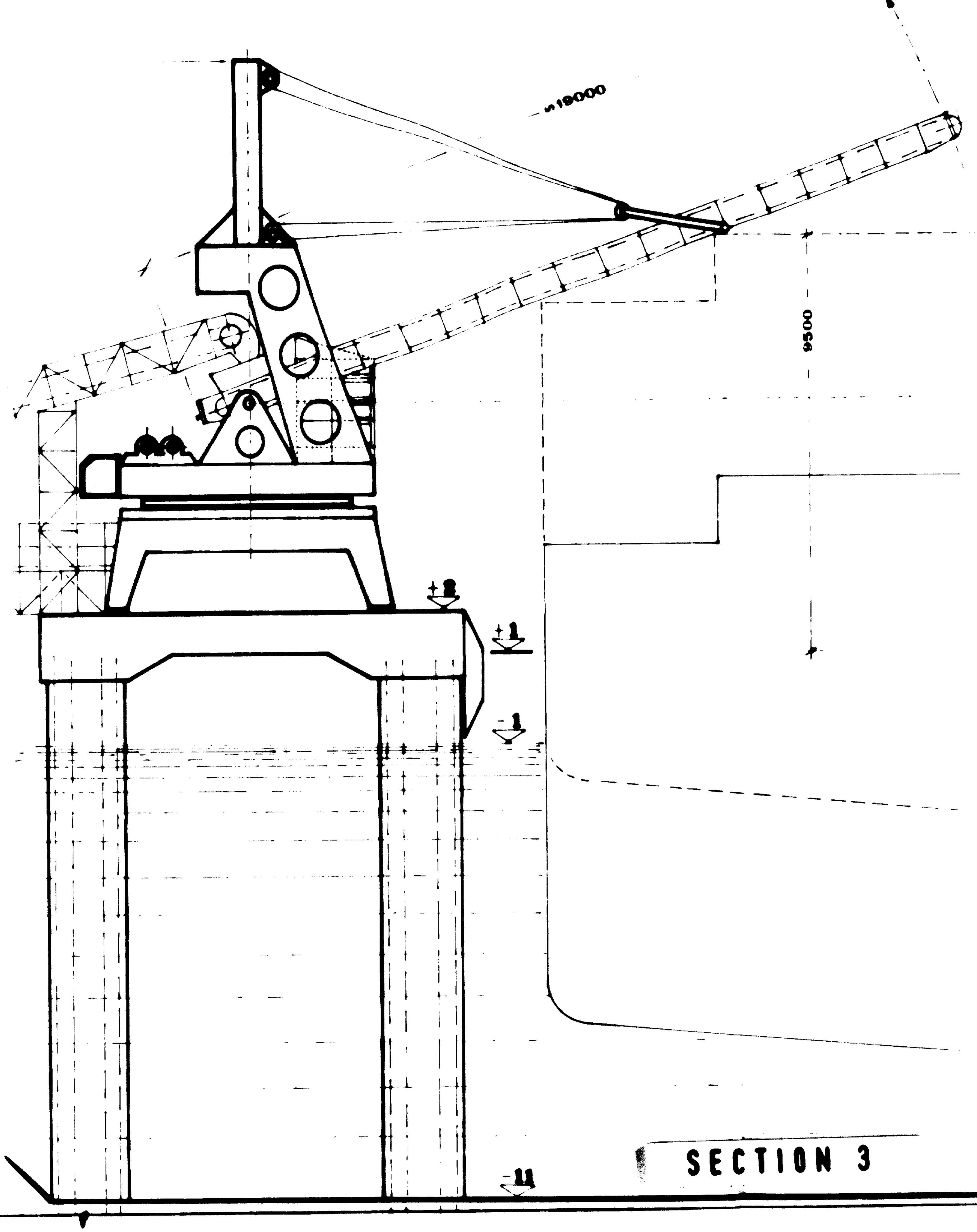


~4000
900
INSPECTION PATHWAY
STONE DAM EMBANKMENT
SECTION
~11000
CONVEYOR BAND
GROUND LEVEL
SALT HOPPER
STONE DAM EMBARKMENT

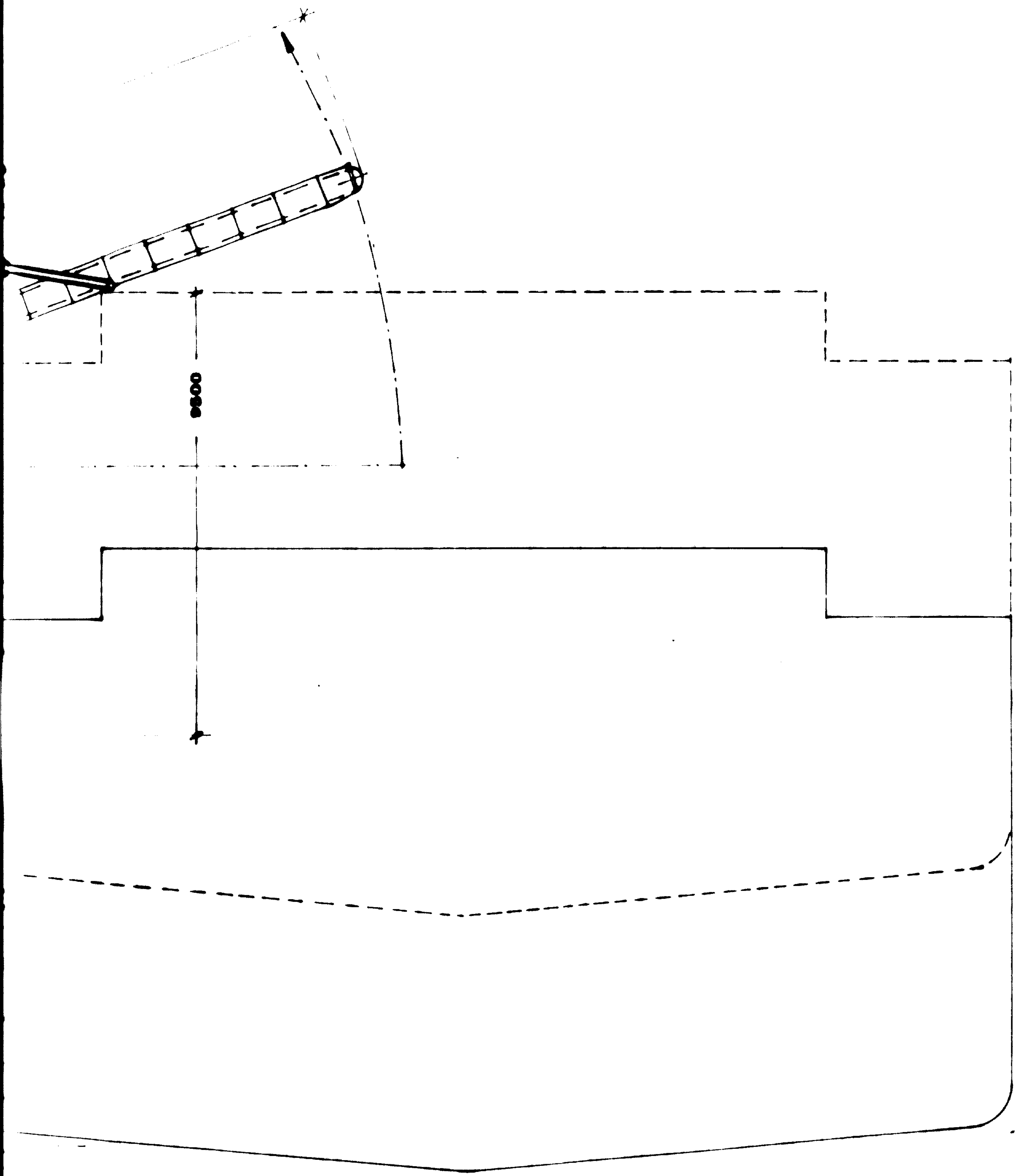
SECTION 1



SECTION 2



SECTION 3



SECTION 4

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

CONDITIONING SALT INSTALLATION

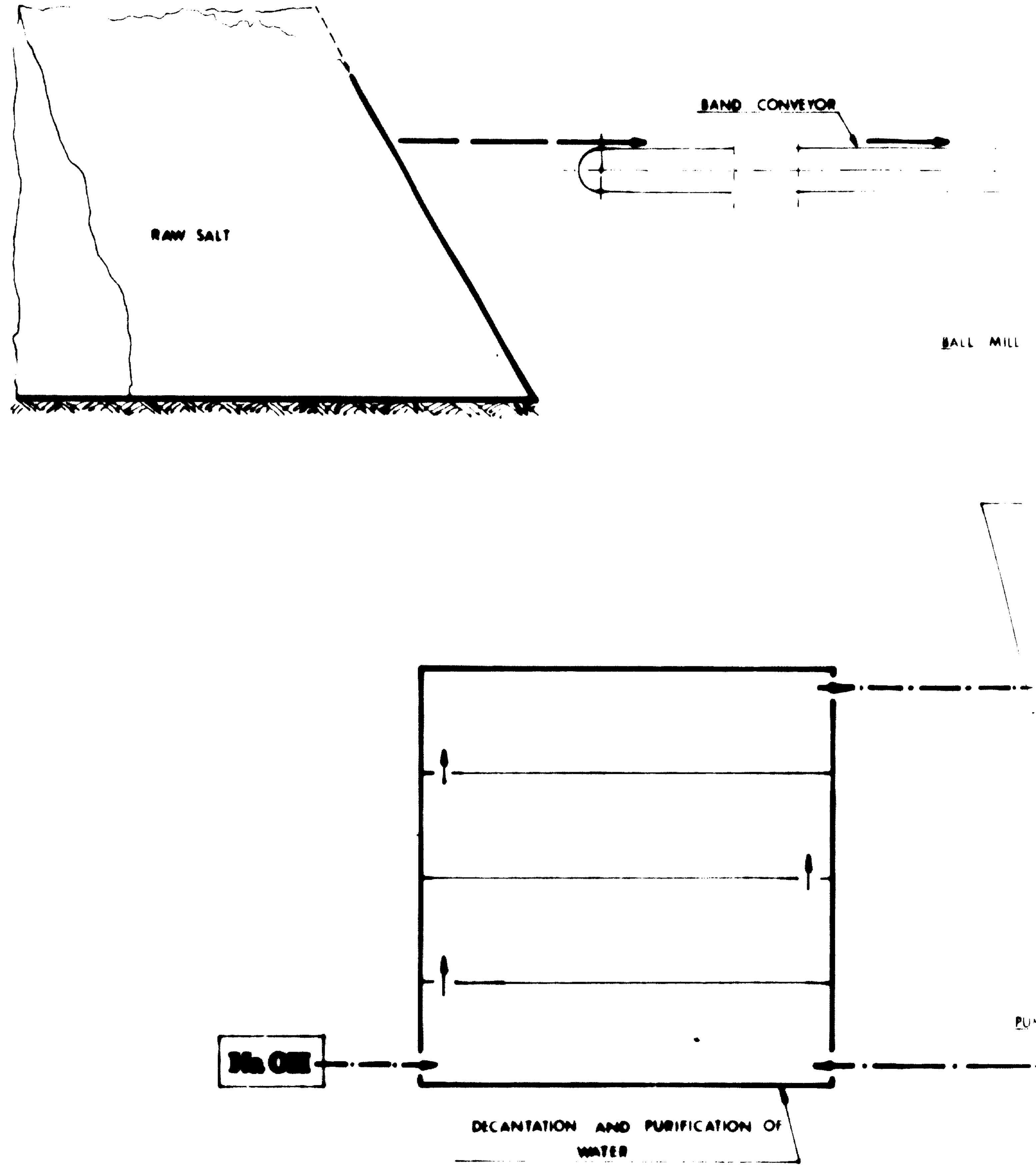
prog N°	708
dis N°	10
all N°	
scale	no scale
dis	
contr	
appr	
data	10 5 '72

[illegible]

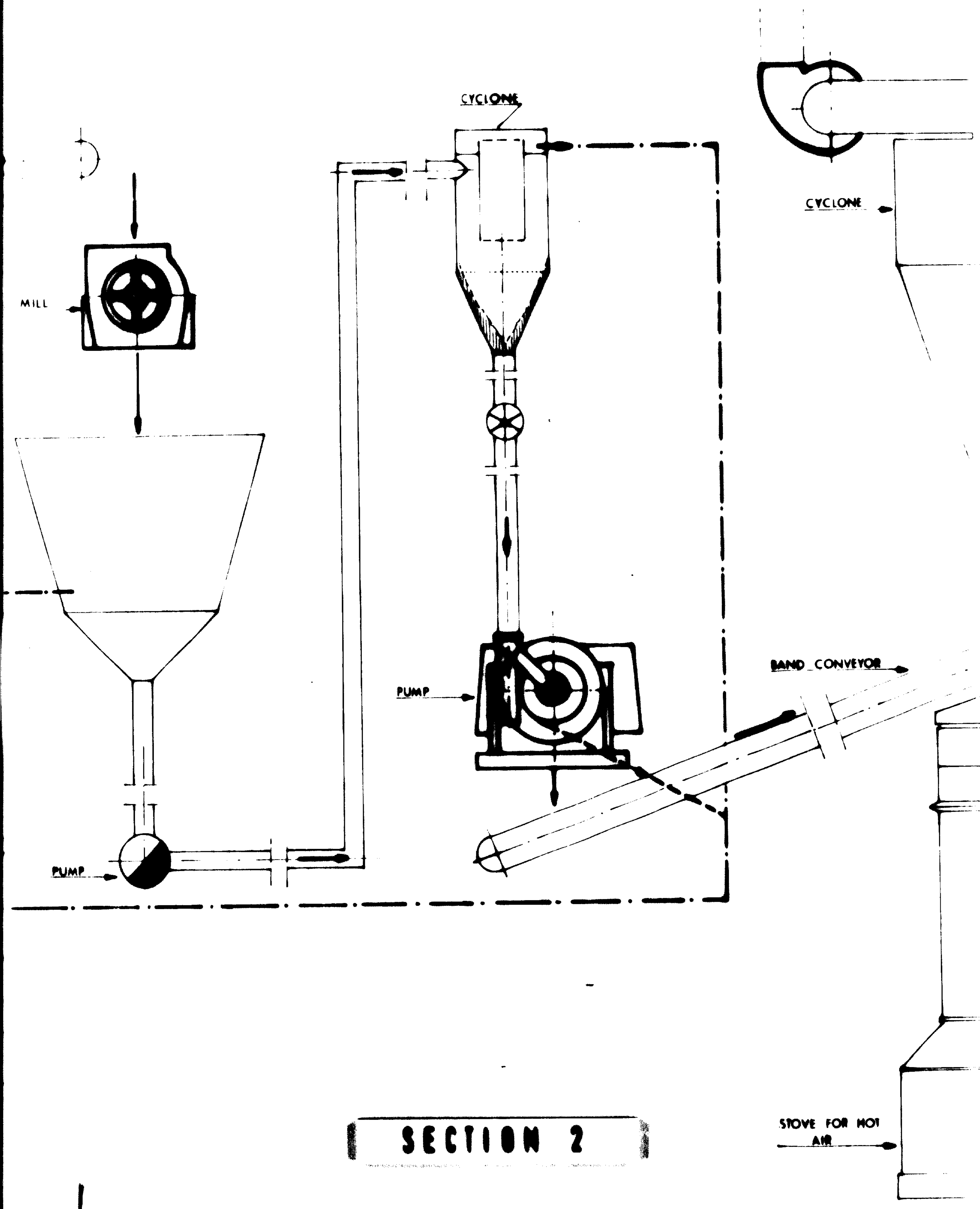
STUDIO TECNICO INGEGNERIA

PROGETTAZIONE COORDINATA-DIREZIONE LAVORI

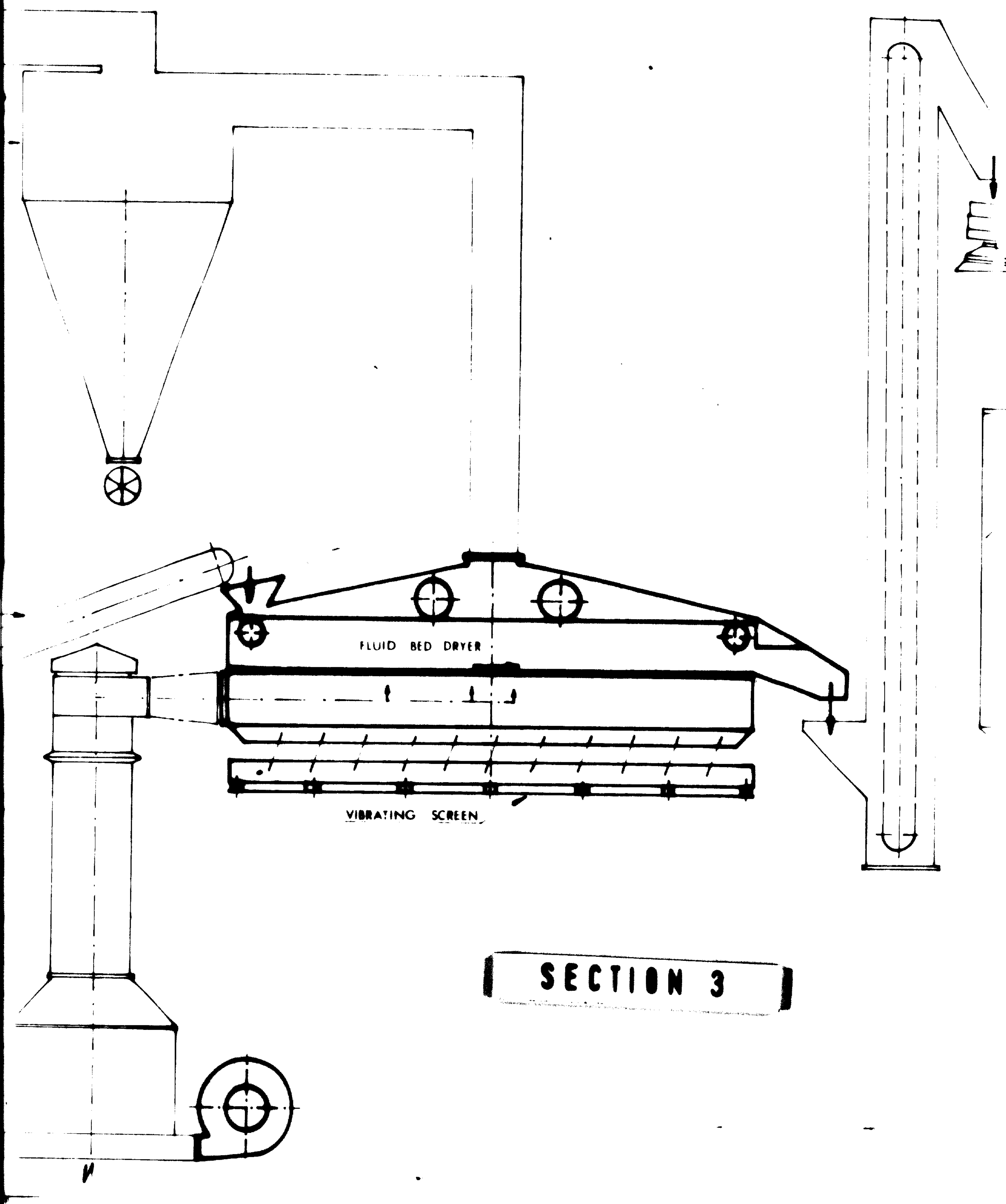
VIALE REGINA MARGHERITA 278 ROMA (ITALIA)


RAW SALT
BAND CONVEYOR
BALL MILL
Na OH
DECANTATION AND PURIFICATION OF WATER

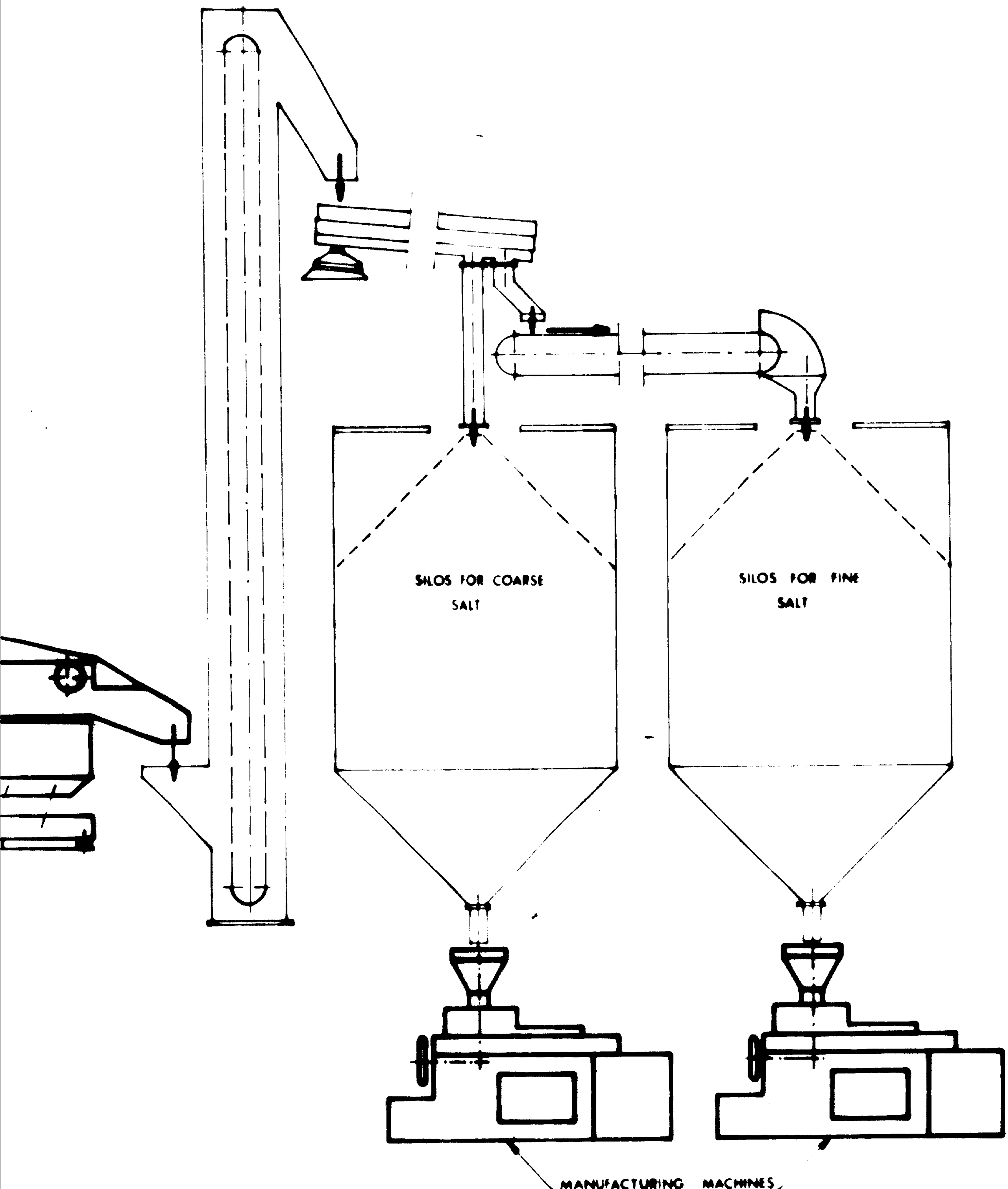
SECTION 1


CYCLONE
CYCLONE
MILL
PUMP
BAND CONVEYOR
PUMP
STOVE FOR HOT AIR

SECTION 2



SECTION 3


SILOS FOR COARSE
SALT
SILOS FOR FINE
SALT
MANUFACTURING MACHINES

SECTION 4

UNITED NATIONS

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

VIENNA

PEOPLE'S DEMOCRATIC REPUBLIC OF YEMEN

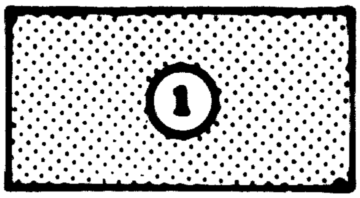
TECHNO-ECONOMIC AND MARKET STUDY FOR SOLAR SALT PRODUCTION

MAP OF PROPOSED SALTERN

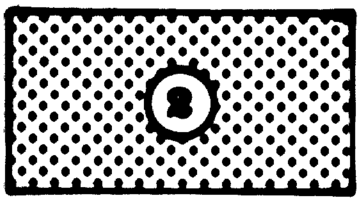
prog N°	783
dis N°	11
all N°	
scale	1:50000
dis	Rodolfo Mancini
contr	
appr	
data	10-5-'72

STI
STUDIO TECNICO INGEGNERIA
PROGETTAZIONE COORDINATA-DIREZIONE LAVORI
VIALE REGINA MARGHERITA 278 - ROMA (ITALIA)

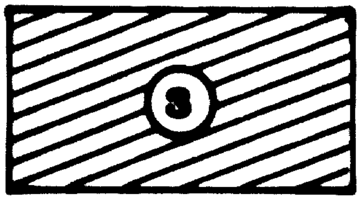
L E G E N D



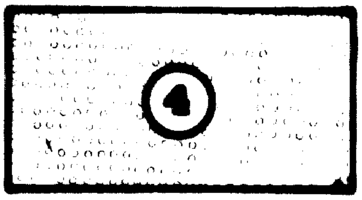
I° Evaporation zone



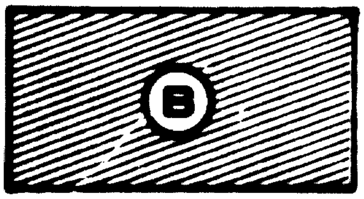
II° Evaporation zone



III° Evaporation zone



IV° Evaporation zone

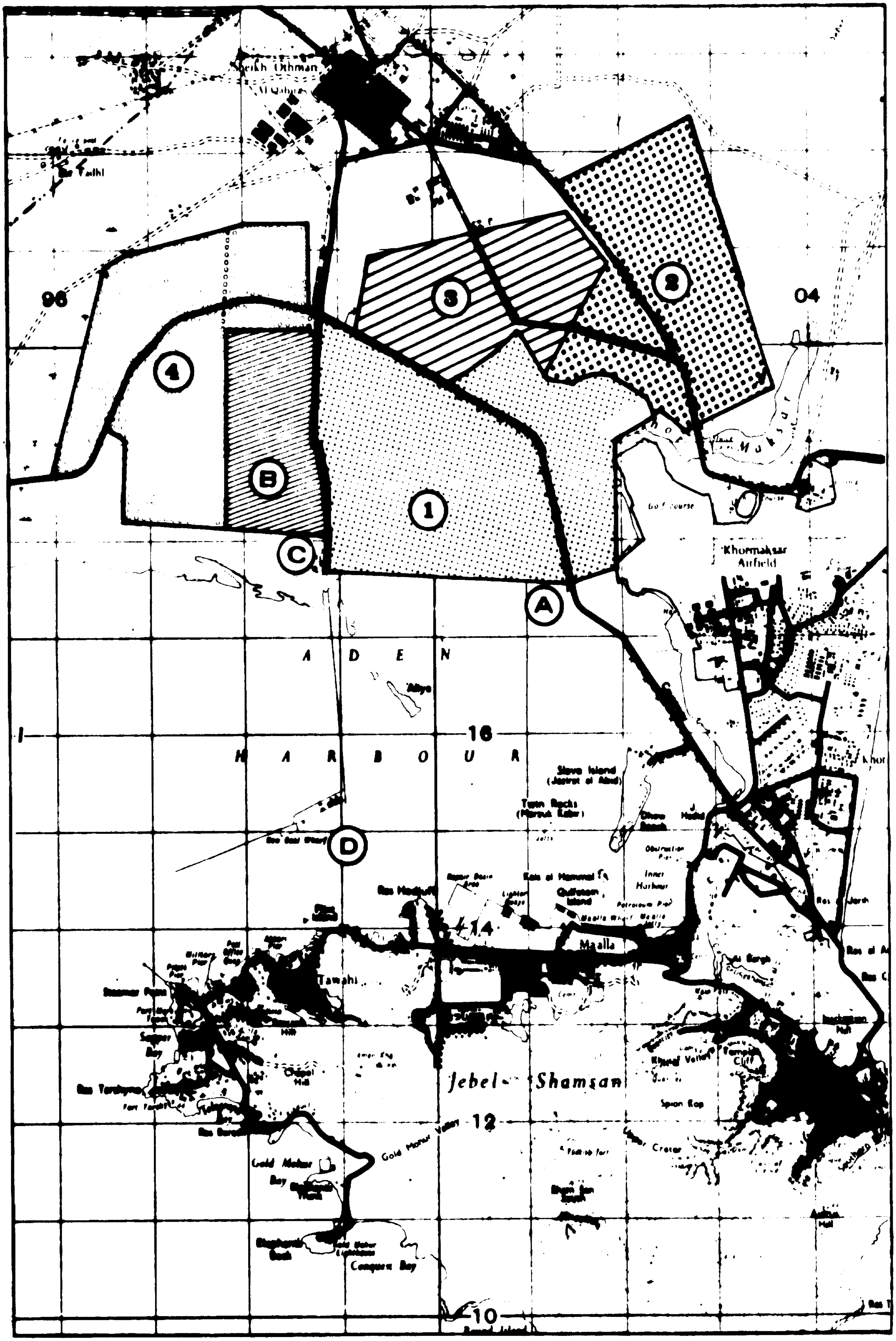


Crystallisers zone

(A) Water intake

(C) Gathering area

(D) Embarking area


Sheikh Othman
96
04
4
B
1
2
3
C
A
D
Khormaksar Airfield
Golf Course
A D E N
H A R B O U R
16
Slave Island (Jazirat al Abid)
Ras al Hammal
Maalla
Tawahi
Jebel Shamsan
12
Gold Mohur Valley
Gold Mohur Bay
Conquest Bay
Ras Tarshyne
10

B-560

81.08.25