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PRELIMINARY DESIGN REPORT

PVC DRAINAGE PIPE PRODUCTION FACILITY
UPPER EGYPT DRAINAGE II PROJECT
ARAB REPUBLIC OF EGYPT

Prepared for
The Egyptian Public Authority for Drainage Projects
and the
United States Agency for International Development

Prepared by
STV, INC.
Pottstown, Pennsylvania

Contract No. AID/otr-C-1452

12 May 1977

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Attention: Mr. Thomas A. Sterner
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Reference: PVC Drainage Pipe Production Facility
Upper Egypt Drainage Project II
Arab Republic of Egypt

Contract No.: AID/otr-C-1452

Subject: Preliminary Design Report

Our Project No.: 13-4173

Gentlemen:

Enclosed, herewith, are three (3) copies of the Preliminary Design Report fulfilling the first phase of our contractual agreement for this project. The report defines all the stages of implementing a production facility for the manufacture of plastic drainage pipe.

We wish to express our gratitude to the Egyptian Public Authority for Drainage Projects, the Cairo Mission of the Agency for International Development and the World Bank for their assistance in making our stay in Egypt both productive and enjoyable.

We are pleased to be of service to you, and if you have any questions or comments, please do not hesitate to contact our office.

Very truly yours,

STV, Inc.

Thomas F. Hagerty

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PVC DRAINAGE PIPE PRODUCTION FACILITY
UPPER EGYPT DRAINAGE II PROJECT
ARAB REPUBLIC OF EGYPT

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PROJECT REQUIREMENT

The Egyptian Public Authority for Drainage Projects (EPADP) in conjunction with United States Agency for International Development (USAID) requires a preliminary project report formulating the requirements for the production of plastic drainage pipe in order to drain 500,000 feedans of agricultural land by 1982. This report analyzes the required number of production lines, plant locations, equipment, operations and management, personnel training, scheduling and estimated costs for the execution of this project.

TECHNICAL DESIGN CRITERIA

The following technical design criteria formulate the basic parameters for the production of the PVC drainage pipe for Upper Egypt Drainage II Project, Arab Republic of Egypt. This criteria is based on project meetings with representatives of the United States Agency for International Development (USAID) and the Egyptian Public Authority for Drainage Projects (EPADP) and the World Bank Report No. 1111-EGT.

Technical Design Criteria

- The area of lands to be implemented with drainage pipe is 500,000 feddans and is identified on the reference map generated by the EPADP "Fig. 16 - Upper Egypt Drainage Project".
- Approximately 100 meters of PVC drainage pipe is required for each feddan. This equates to about 50,000 km of PVC drainage pipe for the project.
- The drainage pipe is to be nominal 80 mm outside diameter. The drainage pipe will be thin walled, corrugated, perforated and flexible.
- The PVC drainage pipe production rate is based on the following revised EPADP implementation schedule:

1977	1978	1979	1980	1981	TOTAL
10,000	70,000	140,000	140,000	140,000	500,000 Feddans

- No fittings are required for connection to the cement pipe collectors or interconnecting between laterals.

The production facilities, raw material and final product logistics, and the estimated costs are based on these criteria.

RECOMMENDATIONS AND CONCLUSIONS

This Preliminary Design Report for the PVC Drainage Pipe Production Facility, Upper Egypt Drainage II has reaffirmed the pre-planning for this project. The financing requirements are within the original budget of $31,000,000 U.S. Dollars, and in accordance with the implementation schedule proposed by the EPADP.

- Final Product Design.

The final product shall be flexible, corrugated, perforated, thin wall polyvinyl chloride (PVC) drainage pipe. The pipe shall have a nominal 80 mm outside diameter and the coil length of pipe shall be 100 meters. The perforations shall be 0.9 to 2.0 mm wide by a maximum of 5.0 mm long and represent a minimum inlet area of 10.0 square centimeters per meter of pipe.

The raw material shall be purchased from the U.S. as precompounded PVC having a cell classification of 12454-B in accordance with ASTM D1784.

- Plant Location Analysis

The combination of a least cost analysis, site surveys, and intangible factors was the basis for determining the optimum number of plants and their respective locations. Three drainage pipe production plants have been determined to best fit the requirements of this project with the first location at Qena in the southern section, the second at Asyut in the central section and the third plant at Beni Suef in the northern section of Upper Egypt.

The actual plant site locations within the cities were proposed by EPADP. The sites were inspected and found to have the necessary support facilities, i.e., availability of utilities, access, etc.

The use of mobile plants was investigated and determined to be not practical for this project. The mobile plants are susceptible to malfunction due to the constant relocation and start-up. The logistics of raw material supply, personnel and communication also tend to make mobile plants undesirable.

- Production Facilities.

The selection of production equipment required to fulfill the demands of the Upper Egypt Drainage II Project is based on attaining a total of 5,000 operating hours per year with extrusion speeds of 10 meters per minute. This necessitates six extrusion lines to produce the 50,000 kilometers of required pipe.

All equipment pertaining to the production, testing, and handling of the drainage pipe shall be of U.S. manufacture and of identical design to facilitate training and spare parts inventory.

The real estate required for each of the three plants is approximately 12,000 square meters (2.8 feddans) having nominal dimensions of 120 m by 100 m. EDADP will acquire the necessary land.

Each plant will house two extrusion lines and all the required ancillary services. The nominal size of the building is 42 m by 30 m with a ceiling height of 5 m. The type of building can be either the traditional concrete and masonry construction or a steel frame building.

The manufacture of PVC drainage pipe presents no major environmental or health hazards. Basic safety precautions, as with all industrial plants, must be implemented, i.e., safety training, electrical safeguards, etc.

- Project Schedule

The major milestones for the completion of the project are:

July 1977	Issue IFB
October 1977	Sign Contract
April 1978	Full Production Plant No. 1 (Qena)
September 1978	Full Production Plant No. 2 (Asyut)
January 1979	Full Production Plant No. 3 (Beni Suef)
April 1983	Completion of Project

- Project Cost Estimate

The total project cost is estimated at $28,200,000 in foreign exchange costs and LE 4,500,000 in local currency costs.

The breakdown of these totals are shown in the Cost Summary.

- Contractual Agreement Analysis

It is recommended that one contractor be utilized to furnish and start-up the six lines of extrusion equipment. This contractor would also train the personnel and provide technical assistance thru the first year of operation.

Subsequent contracts would be let annually to supply the compounded PVC resin. All contracts would be fixed price.

- Prequalification of Bidders

The basic prerequisites for a qualified bidder is previous experience in the operation of a plastics extrusion plant or in the manufacture of plastic extrusion machinery.

- Operations Management

The expatriate labor required for the operations portion of this project consists of one Management Specialist and one Production Specialists. Production Specialists will transfer from plant to plant as each one becomes operative. These expatriates can be withdrawn after the capabilities of the local staff are proven.

- Transportation

The project equipment shall be shipped sea freight to the port of Alexandria and by truck to the plant sites.

The PVC raw material shall be shipped sea freight in palletized bags. The bags should be plastic-covered paper bags or plastic bags and weigh about 25 kilograms each. The raw material should be trucked to the plants but could also be delivered by rail or barge. A minimum of 30 days supply should be inventoried at each plant.

The distribution of the finished drain pipe should be by road. Each truck or tractor trailer should be capable of transporting about eight (8) kilometers of pipe.

PROJECT IMPLEMENTATION

PVC DRAINAGE PIPE

COST SUMMARY

ITEM	COST US DOLLARS	COST EGYPTIAN POUNDS
Production Equipment	$ 2,366,000	LE 36,000
Plant Construction	114,000	551,000
Raw Materials	17,815,000	176,000
Operational Cost	217,000	1,914,000
Overhead Cost	66,000	493,000
Contractor's Profit	194,000	300,000
Sub Total	$ 20,772,000	LE 3,470,000
Contingencies		
Physical Project	444,000	481,000
Raw Materials	1,781,000	-
Price	4,154,000	693,000
TOTAL PROJECT COST	$ 27,151,000	LE 4,644,000

ABBREVIATIONS

ARE	-	Arab Republic of Egypt
ASTM	-	American Society for Testing and Materials
EPADP	-	Egyptian Public Authority for Drainage Projects
GOE	-	Government of Egypt
GNP	-	Gross National Product
IBRD	-	International Bank for Reconstruction and Development
IDA	-	International Development Association
NPC	-	National Plastic Company
USAID	-	Agency for International Development

°C	-	degrees centigrade
cm	-	centimeter
fed	-	feddan (1 fed = 1.04 acre)
hr	-	hour
kg	-	kilogram (1 kg = 2.2 pounds)
km	-	kilometer
KVA	-	kilovolt ampere
kw	-	kilowatt
m	-	meter (1 m = 3.28 feet)
min	-	minute
mm	-	millimeter
PE	-	polyethylene
PVC	-	polyvinyl chloride
rpm	-	revolutions per minute
sec	-	second
ton	-	long ton (2240 pounds, 1016 kg)
m ton	-	metric ton (2205 pounds, 1000 kg)

1. INTRODUCTION

1.1 Background

1.1.1 The Need for Drainage

Prior to the completion of the Aswan Dam in 1970, the Nile overflowed its banks each year during August and September and then receded. The flooding left the land moist enough for crop growth and also served to flush out the salts which had accumulated in the soil. After the river receded the groundwater level dropped to two meters or more below the surface. That drop was assisted by the natural removal of moisture from the soil by growing plants and, in some locations, by the use of small tubewells used to permit perennial irrigation.

The completion of the Aswan High Dam has enabled nearly all farmers to irrigate their land throughout the year using water brought in through an extensive system of canals. However, the absence of adequate drainage facilities to complement the increased use of irrigation water has resulted in a gradual build-up of the groundwater level to the point that waterlogging has become a problem in wide areas. Seepage of water from irrigated plots and fields situated at higher levels than adjacent land adds to the waterlogging problem in fields at lower elevations. Since water is now supplied through the canal system throughout the year, the many small tubewells are no longer used. The drawdown of groundwater thus no longer occurs. The situation is further aggravated by widespread over irrigation, fostered by lack of attention to water management and lack of financial incentives to water conservation.

The drainage program is designed to reduce the waterlogging by providing adequate drainage in the most seriously affected areas in Upper Egypt.

Salinity problems associated with high groundwater levels are also evident in the waterlogged areas of Upper Egypt. Salts rising with the water as a result of capillary action are deposited on the surface, and after flood irrigation ceased to be the practice, are no longer flushed out. As a result, there are by now 12,000 feddans of agricultural land which had to be taken out of production. Proper drainage and better irrigation practices should, in combination, prevent further salination of the land and, over time, reduce its effects in the already affected areas.

1.2 Program Description

The Government of Egypt has requested assistance from the Agency for International Development (USAID) and the IDA/IBRD to finance a third drainage program. The proposed program, titled "Upper Egypt Drainage II", includes 500,000 feddans of land in Upper Egypt, located in the six governorates of Beni Suef, El Minya, Sohag, Asyut, Qena and Aswan. The basic elements of the drainage systems proposed to be installed are buried plastic pipe laterals, approximately 80 mm in diameter, that feed into larger (250 to 500 cm) buried cement pipe collectors; the collectors are in turn connected to open drains that carry the water back to the Nile by gravity flow or where the topography does not permit this, by pumping.

The program differs from previous efforts, in that plastic drainage pipe will be used instead of cement pipe, and the installation will be performed by foreign contractors. This is expected to result in a sub-

stantial acceleration of construction compared to previous efforts.

USAID will finance that portion of the program associated with the purchase and installation of the machinery to manufacture plastic drainage pipe, the initial operation of these plants, and the importation of the plastic resin to manufacture all of the plastic drainage piping required to implement the 500,000 feddans of the Upper Egypt Drainage II Project.

2.0 FINAL PRODUCT DESIGN

2.1 General

Corrugated, perforated, plastic drainage pipe has been identified in a report by the World Bank Reference Report No. 1111-EGT as having distinct cost and time advantages over the presently used cement drainage pipe. Although the World Bank refers to the plastic drainage pipe as being produced from PVC this assumption must be justified and it is technically considered in this section.

2.2 Selection of Type of Resin

The two primary thermoplastic materials used for the manufacture of corrugated, perforated, drainage pipe are polyvinyl chloride (PVC) and polyethylene (PE). Both of these materials are readily available from numerous suppliers in the U.S. and worldwide, and are economically similar.

Neither type of resin presents any major problem for selection of equipment or for the manufacture of plastic pipe. The following technical considerations provide a basis for the selection of the raw material for the manufacture of drainage pipe.

- PVC smooth wall pipe and PVC electrical conduit are presently being extruded in Egypt. Although also familiar with the extrusion of PE, the predominance of the experience in Egypt is with PVC.
- The PE extrusion process can be restarted more readily than the PVC process after a power outage. However, the Equipment Manufacturers have provided for such occurrences in the design of their machinery and the pipe producers have standard operating procedures to

minimize equipment down time. Power outages can be expected on an average of two to three times weekly and ranging from five minutes to two hours in duration. The time required to restart the extrusion machine will be about two hours per machine.

- PVC drainage pipe for this project would be white. This is the color formed by the normal compounding of ingredients. This would increase the reflectivity of the pipe thus reducing the surface temperature of the pipe. PE pipe is normally black which increases the absorbance of sunlight thus increasing the surface temperature of the pipe.
- PVC is more rigid at elevated temperatures than PE due to its higher tensile strength. PVC exhibits the same strength at 77°C as PE does at 60°C.
- PVC is preferred by the EPADP because of their concern that PE is prone to rodent infestation.

In addition to the advantages of PVC drainage pipe as listed above, the EPADP and the representatives of National Plastics feel more confident both in the manufacture and use of PVC for drainage pipe. For the Upper Egypt Drainage II Project, PVC corrugated, perforated, drainage pipe is therefore recommended.

2.3 Technical Specifications for Flexible Corrugated Perforated Polyvinyl Chloride (PVC) Drainage Pipe

2.3.1 Scope

This specification defines the requirements and test methods for materials, marking, dimensions, workmanship, impact resistance, pipe stiffness, perforation, minimum bending radius and extrusion quality for flexible, corrugated, PVC drainage pipe.

- It defines the nominal size of 80 mm only.
- Pipe produced to this standard shall be installed in accordance with EPADP standards for installation of plastic drainage pipe.

2.3.2 Applicable Documents

The documents referenced below become part of this specification.

American Society for Testing and Materials (ASTM)

ASTM D1784	Rigid Poly (Vinyl Chloride) Compound and Chlorinated Poly (Vinyl Chloride) Compounds.
ASTM D2122	Determining Dimensions of Thermoplastic Pipe and Fittings.
ASTM D2152	Quality of Extruded Poly (Vinyl Chloride) Pipe by Acetone Immersion.
ASTM D2412	External Loading Properties of Plastic Pipe by Parallel Plate Loading.
ASTM D2444	Impact Resistance of Thermoplastic Pipe and Fittings by Means of a TUP (Falling Weight).

2.3.3 Materials

The pipe shall be made of white PVC compound having a cell classification of 12454-B in accordance with ASTM D1784 where:

1 = PVC Homopolymer

2 = Impact Strength (IZOD) of 34.7 J/m (0.65 ft. lbf/in)

4 = Tensile Strength of 48.3 M Pa (7000 psi)

5 = Modulus of Elasticity in Tension of 2758 M Pa (400,000 psi)

4 = Deflection Temperature Under Load 70°C (158°F)

B = Chemical Resistance

Clean rework material, generated from the manufacturer's own production, may be used provided that the pipe produced meets all requirements of this specification. Rework material is defined as off-grade drainage pipe which can be recycled to the process. This procedure is only utilized for non-pressure rated pipe and presents a method of minimizing losses.

2.3.4 Workmanship

The pipe shall be homogeneous throughout and free of foreign inclusions, cracks, splits, and obstructions to flow or any other visible defects. The pipe shall be uniform in color, opacity, density and other physical properties.

2.3.5 Dimensions

The nominal diameter shall be the outside diameter and shall be 80 mm.

The inside diameter shall be 70 mm.

The tolerance on the specified outside and inside diameters shall be ±3% when measured in accordance with ASTM D2122.

The standard length of pipe per coil shall be 100m ±1%. Each coil shall be approximately 54 cm in width by 150 cm outside diameter.

The perforations shall be cleanly cut or drilled and be uniformly spaced in 4 to 6 rows along the length and around the circumference of the pipe. The perforations shall be located in the valleys of the corrugations. The dimensions of perforations shall be 0.9 mm to 2.0 mm in width and a maximum of 5.0 mm in length.

The total inlet area of perforations shall be not less than 10

square centimeters per 1 meter of pipe as per the requirements of the EPADP.

The minimum wall thickness of the pipe at any point along the corrugations shall be 0.5 mm.

2.3.6 Impact Resistance

Pipe specimens from production shall sustain a 1 kilogram rounded weight allowed to drop from a height of 1 meter without damage when tested at room temperature in accordance with ASTM D2444.

2.3.7 Pipe Stiffness

Pipe specimens from production shall exhibit a minimum pipe stiffness of 0.5 Kg/cm^2 at 5% minimum deflection when tested in accordance with ASTM D2412.

2.3.8 Extrusion Quality

Pipe specimens from production shall not flake or disintegrate when immersed in anhydrous acetone for 20 minutes in accordance with ASTM D2152.

2.3.9 Minimum Bending Radius

Pipe from production at room temperature must withstand bending to a minimum diameter of 37 cm without cracking or other visible damage.

2.3.10 Marking

Each coil of pipe produced shall bear a tag indicating the day, month, year and plant location of manufacture as well as a mark of acceptance by the Quality Control Inspector.

2.3.11 Test Report

The following tests and dimensional checks shall be completed

daily at each plant for each production line and the results recorded and retained for a period of one year:

Date

Plant

Production Line

Dimensions

(a) Outside Diameter

(b) Inside Diameter

(c) Coil Length

(d) Coil Weight

(e) Perforation/Inlet Area Per Meter

(f) Minimum Wall Thickness

Workmanship

Impact Resistance

Pipe Stiffness

Extrusion Quality

Minimum Bending Radius

Description of Failures

2.4 Polyvinyl Chloride (PVC) Compounding

PVC is available in two basic forms; virgin or compounded. The compounded PVC is an intimate blend of virgin PVC with a variety of additives. These additives include titanium dioxide for stability and color, polyethylene or beeswax for lubrication, antioxidants, ultra-violet inhibitors and plasticizers. PVC drainage pipe is produced from compounded PVC. Compounding is a complicated procedure and at the present

time there is no facility in Egypt to compound PVC. The exact mixture of raw materials must be weighed and blended in a high impact type blender. The blender power consumption is high and periodic maintenance is required. In addition to the mixing equipment, there are many raw materials which must be ordered, shipped, inventoried, and stored and without all of the heretofore mentioned ingredients the production of PVC drainage pipe would cease. To avoid the high probability of down time due to compounding failures or the unavailability of any of the raw materials it is recommended that compounded PVC be imported for the entire project.

3.0 TRANSPORTATION

3.1 Project Equipment Shipping

The project equipment for the manufacture of PVC plastic drainage pipe can either be shipped via sea freight to the Port of Alexandria or air freight to Cairo. The new project schedule could be met if the equipment is shipped via air freight however, if it is determined that the schedule is slipping then it is more economical to ship via sea freight. Both the port and the airport have the capability of receiving the equipment from the viewpoint of material handling, however, it is recommended that a local expediter be employed to process the equipment through the import procedures. The expediter should visually inspect the condition of the crates and retain any damaged crates for inspection of the equipment by the supervisor for equipment installation. If damaged, the expediter shall, at the direction of the supervisor, initiate claim procedures. The equipment shall be shipped via truck to the plant site where final inspection and equipment acceptance will be performed.

3.2 Raw Material Shipping

3.2.1 General

PVC compound is shipped by U.S. manufacturers via several standard methods; bulk shipments, 1000 kg palletized containers, or palletized plastic covered paper bags. The selected type of packaging is determined by analyzing several factors such as the port capabilities, local transportation and inplant material handling.

3.2.2 Port of Alexandria - Capabilities

The Port of Alexandria has the material handling capability of

off-loading pallet loads of plastic-covered paper bags or 1000 kg palletized containers. The port is not equipped at the present time for bulk handling of any commodity except grain.

As dictated by the USAID contract the raw material must be shipped via a U.S. carrier. To alleviate the excessive waiting time prevalent at the port, agreements between the United States and A.R.E. allow the U.S. carriers priority berthing. All shipments of raw materials should be received by an expediter in order to clear the shipment through the port in the minimum amount of time, since there are minimal facilities for storage at the port.

3.3 Packaging of Raw Material

The most efficient form of packaging from the overall considerations of port facilities, local transport and in-plant material handling is plastic-covered paper bags. National Plastics receives the majority of their feed stock in this manner and finds it reduces the in-transit losses. Bagged materials are handled manually thus minimizing the requirement for material handling equipment such as storage silos, pneumatic conveying systems, etc. At the present time, the standard procedure at the port is to depalletize the loads for local transport. The packaging of the PVC raw material is therefore recommended to be plastic-covered paper or plastic bags ranging in weight from 20 to 30 kilograms.

3.4 Raw Material Shipment Size

It is recommended that a minimum of 30 days and a maximum of 90 days supply of raw material be inventoried at each plant. In the year of greatest usage approximately 5,250,000 kg of raw material will be required.

Since U.S. shipping companies are to be utilized for the sea transportation, it is necessary that the shipment size at least meet their minimum inducements. This would normally be about 450,000 kilograms of PVC unless they had other cargo also destined for Alexandria in which case they would accept a smaller shipment. At this rate, i.e., 450,000 kg per shipment, one shipment would be required each month in the greatest usage year. This shipment would be immediately transferred to trucks and distributed in pro-rated quantities to the plants to maintain their proper inventory levels. This size shipment would be a reasonable order from the U.S. supplier's standpoint and would not overburden the local transport system in Egypt.

National Plastics Company has the capability to transport the raw material from the port of entry to the respective plant sites, and NPC has agreed with the EPADP to assume full responsibility for the delivery of the raw materials.

For those years with lesser raw materials requirements, it is suggested that this order size be retained but that the spacing be increased to always maintain the 30 days minimum supply. It is anticipated that the time involved, from the ordering of the raw material until it is received at each plant, is ninety days.

3.5 Finished Product Shipment

The shipping of the PVC drainage pipe is the responsibility of the EPADP. This responsibility includes furnishing, with the assistance of the World Bank, transport vehicles, providing drivers and performing the logistics of the distribution. It is imperative that the individual plant manager coordinate operations with the distribution managers to assure

proper production schedules. The transport vehicles should be capable of carrying at least eight (8) km of PVC drainage pipe which necessitates high volume low tonnage type vehicles.

3.6 Transportation, Duties, Taxes, Etc.

Import duties, taxes, agency fees and other local currency costs associated with the importation of equipment and resins, like other local costs, will be financed by the borrower, EPADP, under the terms of the Loan Agreement with USAID.

4.0 PLANT LOCATION ANALYSIS

4.1 Economic Considerations

One of the primary considerations in locating the drainage pipe production plants is to arrive at a least cost combination of plant sizes and locations, other factors being equal, in relation to the areas where drainage pipe is required under the Upper Egypt Drainage II Project. Areas to be implemented with drainage pipe, over the five-year period, extend from just north of Giza nearly to Aswan. The schedule of lands to be implemented with drainage pipe is given in Table 4-1.

4.2 Number of Plants

The least cost analysis compares plans involving the construction of one, two, three, or four plants. The one and two-plant solutions were found to cost about the same, and both solutions were more cost effective than either the three or four-plant solution when all major cost factors that are likely to vary with size and location were considered. The results of this analysis are shown in Table 4-2. Other less significant cost considerations such as requirements for local labor will undoubtedly increase the spread between the one or two-plant solution and those involving more plants, as would time-discounting of early capital costs against later pipe distribution costs. These refinements were not pursued since the cost spread for the one or two-plant alternatives is already significant. Two plants are recommended as determined from the least cost analysis, however, additional factors must be considered before the final recommendation for the number of plants is established.

TABLE 4-1

SCHEDULE OF AGRICULTURAL LANDS TO BE IMPLEMENTED WITH DRAINAGE PIPE

	AREA	1977	1978	1979	1980	1981	TOTAL
1.	El Rahawy	-	-	-	10,000	10,000	20,000
2.	El Masanda (Giza)	-	-	-	5,000	5,000	10,000
3.	El Masanda (Beni Suef)	-	-	-	10,000	10,000	20,000
4.	Koshesha	-	-	-	10,000	10,000	20,000
5.	Musay Aaref	2,000	5,000	-	-	-	7,000
6.	El Hakamna	8,000	-	-	-	-	8,000
7.	Ehnasia	-	-	-	15,000	15,000	30,000
8.	Tabhar & El Agamein	-	-	-	3,000	3,000	6,000
9.	El Shahat	-	-	-	5,000	7,000	12,000
10.	Greaf	-	-	-	-	5,000	5,000
11.	Zenket	-	-	-	3,000	3,000	6,000
12.	El Husan	-	-	-	-	2,000	2,000
13.	Rouss	-	-	-	-	9,000	9,000
14.	Abu Raheb	-	-	-	5,000	5,500	10,500
15.	Beni Mazar	-	-	-	10,000	17,000	27,000
16.	Minshat El Dahab	-	-	-	11,100	18,500	29,600
17.	Kabkab	-	-	-	18,000	20,000	38,000
18.	Abu Gabal	-	8,000	8,000	2,000	-	18,000
19.	El Kussia	-	5,000	8,000	1,400	-	14,400
20.	El Badary	-	10,000	13,500	5,500	-	29,000
21.	Tahta	-	3,000	3,000	-	-	6,000
22.	Akmin	-	-	17,000	8,000	-	25,000
23.	Sohag	-	6,000	15,000	5,000	-	26,000
24.	El Baliana	-	-	6,600	2,000	-	8,600
25.	Abutist	-	-	11,400	3,000	-	14,400
26.	Hamad	-	-	23,000	5,000	-	28,000
27.	Kift	-	9,000	8,500	-	-	17,500
28.	Hegaza	-	9,000	7,000	3,000	-	19,000
29.	Armant	-	5,000	5,000	-	-	10,000
30.	Komeir	-	5,000	5,000	-	-	10,000
31.	El Sebaeia	-	-	7,200	-	-	7,200
32.	Komombo	-	4,000	1,800	-	-	5,800
	TOTAL FEDDANS	10,000	69,000	140,000	140,000	140,000	499,000

TABLE 4-2

LEAST COST ANALYSIS

	Plan 1 One Plant	Plan 2 Two Plants	Plan 3 Three Plants	Plan 4 Four Plants
Pipe Production Equipment	$1,932,000	$ 1,948,000	$ 2,101,000	$ 2,145,000
Support Equipment	85,000	102,000	130,000	170,000
Spare Parts	150,000	200,000	225,000	300,000
Equipment Maintenance 3%	61,000	62,000	67,000	70,000
Building Construction	930,000	1,231,000	1,492,000	1,960,000
Building Maintenance 1.5%	14,000	18,000	22,000	30,000
Expatriate Technicians	188,000	250,000	272,000	312,000
Pipe Distribution	456,000	241,000	172,000	1/
	$ 3,816,000	$ 4,052,000	$ 4,481,000	$ 4,987,000

Note:

1/ Pipe distribution costs have not been calculated for Plan 4 since the other costs make this the most costly alternative.

4.3 Selection of Plant Sites

The next step in the analysis is to select the locations for the plants. Several major cities and towns suitable as a plant site are present in the Nile Valley namely: El Giza, Beni Suef, El Minya, Asyut, Sohag, Qena, Luxor and Aswan. Other smaller villages in the valley have been excluded from consideration since each plant requires support services usually available only in larger towns, such as electrical power, water, telephone, vehicle service, garages, etc. This analysis also studies the intangible factors for determination of plant location - factors such as availability of labor, personnel housing, public transportation, etc.

The locations of the bridges across the River Nile were also factored into the study. However, it was determined that the bridge locations were not significant to the final plant site selection. In the northern sectors, i.e. Beni Suef and El Minya there is no bridge but the lands to be drained are all on the west side of the river as is the city and main road. Thus the plant would be located on the west side. In the southern sectors - Asyut, Sohag, and Qena where lands on both sides of the River Nile will be implemented with drain pipe, the plant sites will be located in close proximity to the bridge.

Since Giza and Aswan lie at the extreme ends of the drainage area and the location of a plant near either city would increase pipe distribution costs significantly, both cities were eliminated. Luxor also was eliminated from contention by inspection of the EPADP implementation map since only a few areas of effected land lies south

of the city, and there are no bridges located in Luxor, necessitating backtracking by the delivery vehicles.

Four combinations of plant locations were tentatively selected and investigated for Plan Two. They were El Minya/Sohag, Beni Suef/Sohag, El Minya/Qena, and Beni Suef/Qena. These combinations were tested for total truck kilometers for the delivery of the drainage pipe. The factors for determining the combination of the best two plant locations are related by the following equations:

$$\frac{\text{No. of Feddans}}{\text{Implemented Area}} \times \frac{\text{Amount of Pipe}}{\text{Feddan}} \div \frac{\text{Amount of Pipe}}{\text{Truck}}$$

$$= \frac{\text{No. of Truck Loads}}{\text{Implemented Area}}$$

By calculating the number of truck loads per implemented area it follows:

$$\frac{\text{No. of Truck Loads}}{\text{Implemented Area}} \times \text{Round trip distance to pipe plant}$$

$$= \text{Total truck distance}$$

Each plant location combination is calculated for each implemented area then summated. The least total truck distance represents the least cost plant location combination. The analysis can be extended to three plant locations and would yield Qena, Asyut and Beni Suef for the plant locations. The results of these calculations are given in Table 4-3.

Sohag, although located centrally in the southern section of the drainage area and thereby requiring the least truck transportation, as

TABLE 4-3

TOTAL TRUCK KILOMETERS FOR DELIVERY OF DRAINAGE PIPE FOR TWO AND THREE PLANTS

AREA	FEDDANS	PLANT LOCATIONS: BENI SUEF/ASYUT/QENA DISTANCE TO PLANT KM	BENI SUEF/ASYUT/QENA TRUCK KM (1000's)	EL MINYA/QENA DISTANCE TO PLANT KM	EL MINYA/QENA TRUCK KM (1000's)	BENI SUEF/QENA DISTANCE TO PLANT KM	BENI SUEF/QENA TRUCK KM (1000's)
1 EL RAHAWY	20,000	135 (B.S.)	67.5	210	105.0	135	67.5
2 EL MASANDA 2/	10,000	65 (B.S.)	16.3	145	36.3	65	16.3
3 EL MASANDA 3/	20,000	40 (B.S.)	20.0	115	57.5	40	20.0
4 KOSHESHA	20,000	25 (B.S.)	12.5	100	50.0	25	12.5
5 MUSAY AAREF	7,000	10 (B.S.)	1.8	565 1/	98.9	565 1/	98.9
6 EL HAKAMNA	8,000	10 (B.S.)	2.0	550 1/	110.0	550 1/	110.0
7 EHNASIA	30,000	20 (B.S.)	15.0	65	48.8	10	10.0
8 TABHAR	6,000	60 (B.S.)	9.0	145	21.8	70	10.5
9 EL SHAHAT	12,000	50 (B.S.)	15.0	135	90.5	60	60.0
10 GREAF	5,000	45 (B.S.)	5.6	125	15.6	50	6.3
11 ZENKET	6,000	40 (B.S.)	6.0	120	18.0	45	6.8
12 EL HOSAN	2,000	55 (B.S.)	2.8	130	6.5	55	2.8
13 EL ROUSS	9,000	45 (B.S.)	10.1	120	27.0	45	10.1
14 ABU RAHEB	10,500	75 (B.S.)	19.7	0	0	75	19.7
15 BENI MAZAR	27,000	95 (B.S.)	64.1	15	10.3	90	60.8
16 MINSHAT EL DAHAB	29,600	165 (A.)	122.1	50	37.0	125	92.5
17 KABKAB	38,000	95 (A.)	66.5	115	109.3	190	180.5
18 ABU GABAL	18,000	75 (A.)	33.8	130	58.5	205	92.3
19 EL KUSSIA	14,400	60 (A.)	21.6	155	55.8	230	82.8
20 EL BADARY	29,000	30 (A.)	21.8	235	170.4	240	174.0
21 TAHTA	6,000	75 (A.)	11.3	195	29.3	195	29.3
22 AKMIM	25,000	90 (A.)	56.3	170	106.3	170	106.3
23 SOHAG	26,000	120 (Q.)	78.0	120	78.0	120	78.0
24 EL BALIANA	8,600	100 (Q.)	21.8	100	21.5	100	21.5
25 ABUTIST	14,400	75 (Q.)	27.0	80	28.8	30	28.8

TABLE 4-3

TOTAL TRUCK KILOMETERS FOR DELIVERY OF DRAINAGE PIPE FOR TWO AND THREE PLANTS

AREA	FEDDANS	PLANT LOCATIONS: BENI SUEF/ASYUT/QENA DISTANCE TO PLANT KM	BENI SUEF/ASYUT/QENA TRUCK KM (1000's)	EL MINYA/QENA DISTANCE TO PLANT KM	EL MINYA/QENA TRUCK KM (1000's)	BENI SUEF/QENA DISTANCE TO PLANT KM	BENI SUEF/QENA TRUCK KM (1000's)
26 HAMAD	28,000	30 (Q.)	13.9	30	21.0	30	21.0
27 KIFT	17,500	20 (Q.)	9.3	25	10.9	25	10.9
28 HEGAZA	19,000	30 (Q.)	14.3	30	14.3	30	14.3
29 ARMANT	10,000	80 (Q.)	20.0	75	18.8	75	18.8
30 KOMEIR	10,000	115 (Q.)	28.8	115	28.8	115	28.8
31 EL SEBAEIA	7,200	155 (Q.)	27.9	155	27.9	155	27.9
32 KOMOMBO	5,800	240 (Q.)	34.8	240	39.8	240	39.8
	499,000		876.6		1,496.7		1,559.7

1/ To be supplied from the southern plant, which is due on stream first.

2/ El Mazanda (Beni Suef).

3/ El Mazanda (Giza).

4/ (B.S.) - Beni Suef
(A) - Asyut
(Q) - Qena

indicated in Table 4-3, was also eliminated. This was because the town is smaller than say Qena and cannot provide the same quality of supporting services necessary to operate the drainage pipe plant and the difference in transportation costs is small in comparison to the total cost.

The remaining locations for Plan Two then are El Minya/Qena and Beni Suef/Qena. However, the final selection is based on other than least cost considerations since pipe distribution costs are nearly the same if one plant is located at Beni Suef or El Minya and the other at Qena.

4.4 Site Survey

4.4.1 General

The cities of El Minya, Qena, Beni Suef and Asyut were surveyed for possible plant locations. The actual sites within these cities were proposed by the EPADP. Several factors determined these selections: terrain, water and electric power supply, real estate availability, and highway access. The total land required for the plant is approximately 2.8 feddans (120 m by 100 m).

4.4.2 El Minya

El Minya has the capability of supporting a drainage pipe production plant. It is located approximately 250 km south of Cairo on the Cairo-Aswan road. The proposed site is about 2 km south of the center of the city on the main road. There is adequate water and power availability at the site. The site itself is lower than the road but visual inspection revealed the land to be suitable. One drawback of this site is the land is currently being utilized for agricultural purposes,

however, the EPADP stated that this is not a major factor and the site could be made available. The site for El Minya is shown on Figure 4-1.

4.4.3 Qena

Qena is a combination of an agricultural and industrial city. It is located approximately 550 km south of Cairo at the intersection of the Cairo-Aswan road with the Port Safaga road. The proposed site is located about 3 km east of the city on the Port Safaga road. The site is flat desert terrain with easy highway access, electrical power, and water supply. According to the EPADP the land is readily available. The site plan for Qena is shown on Figure 4-2.

4.4.4 Beni Suef

Beni Suef is located approximately 120 km south of Cairo on the Cairo-Aswan road. Beni Suef is the smallest of the four cities.

The proposed site is located about 2 km east of the center of the city away from the main transportation route. Water is available but the power distribution is only two phase power as opposed to the required three phase power. This site is located on agriculture land and is not quite as readily available. The location of the site is shown on Figure 4-3.

4.4.5 Asyut

Asyut is located approximately 400 km south of Cairo on the Cairo-Aswan road. The city is an agricultural center and has the largest university in Upper Egypt. The city is very capable of supporting a PVC Plastic Drainage Pipe production facility. A proposed site location, as shown on Figure 4-4, is located about 5 km north of

FIG.4-1

SITE LOCATION-EL MINYA

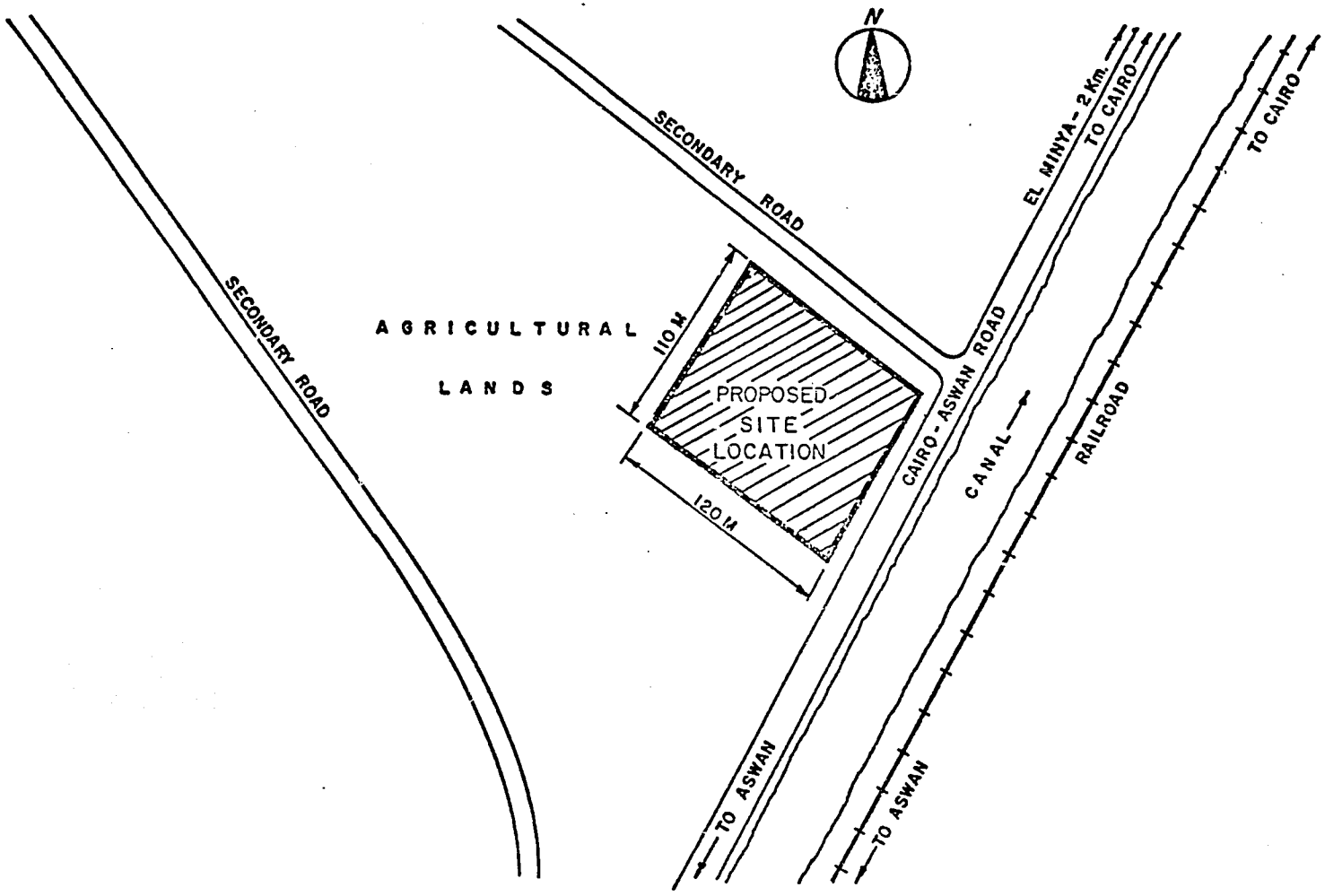


FIG 4-2

SITE LOCATION - QENA

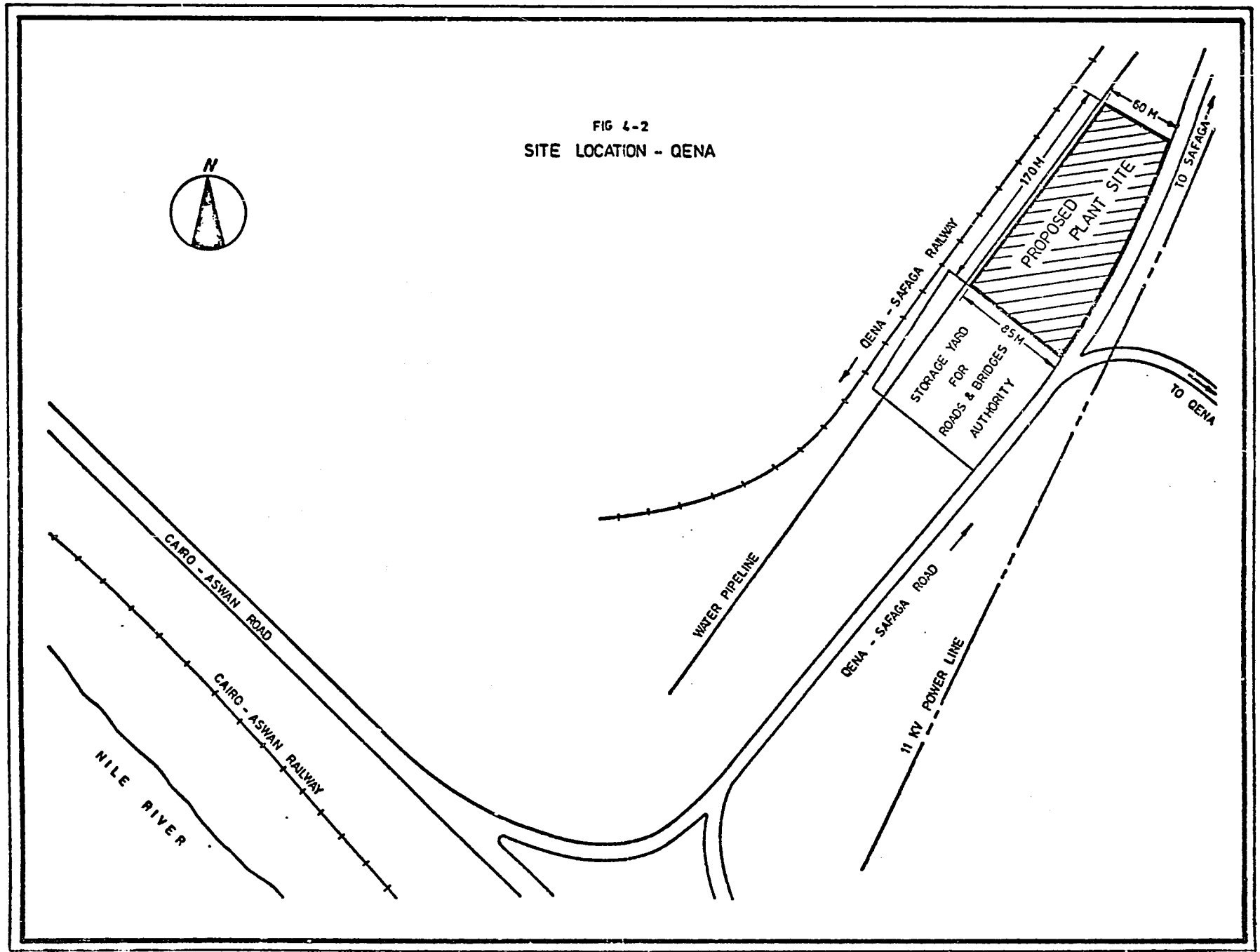


FIG. 4-3

SITE LOCATION - BENI SUEF

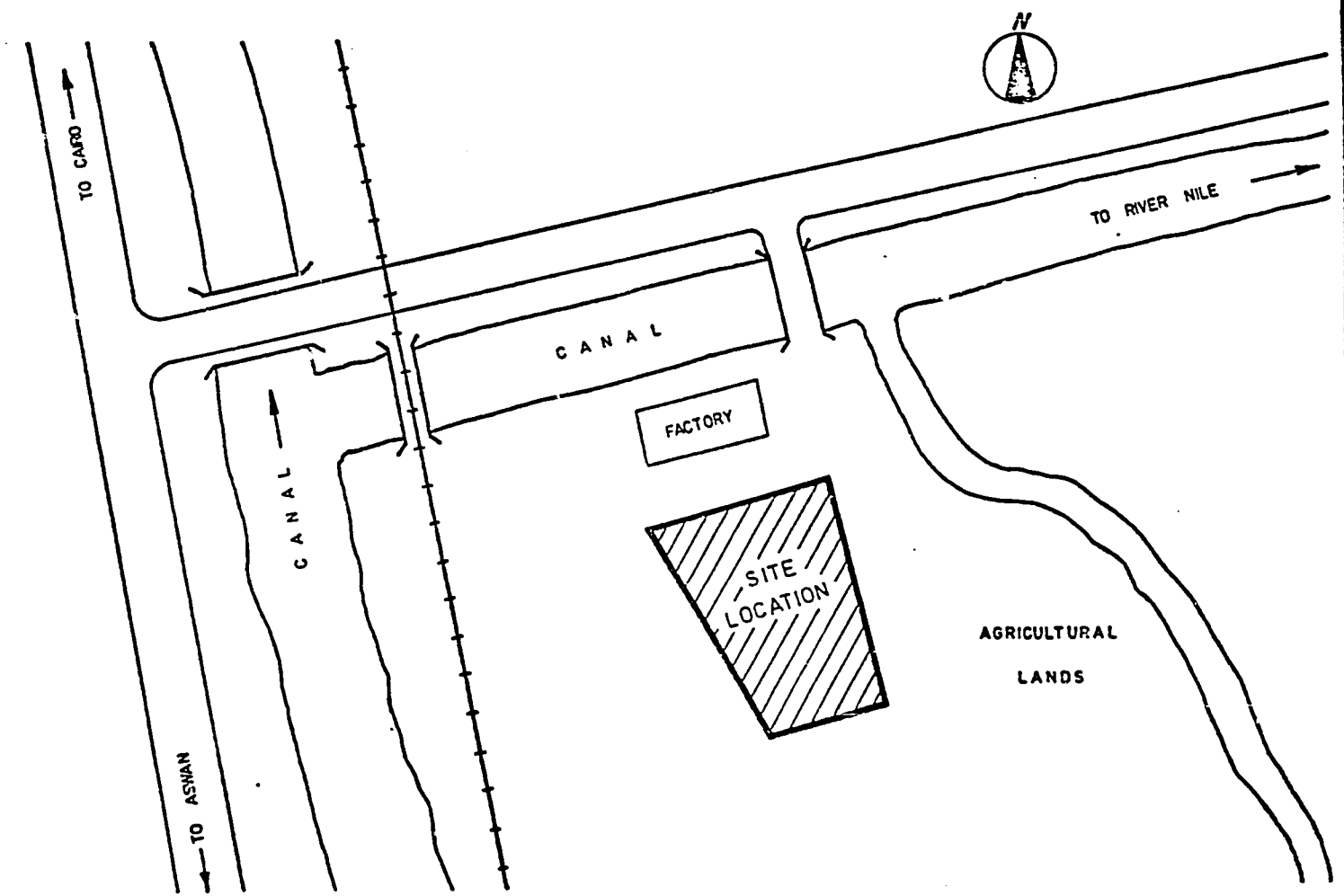
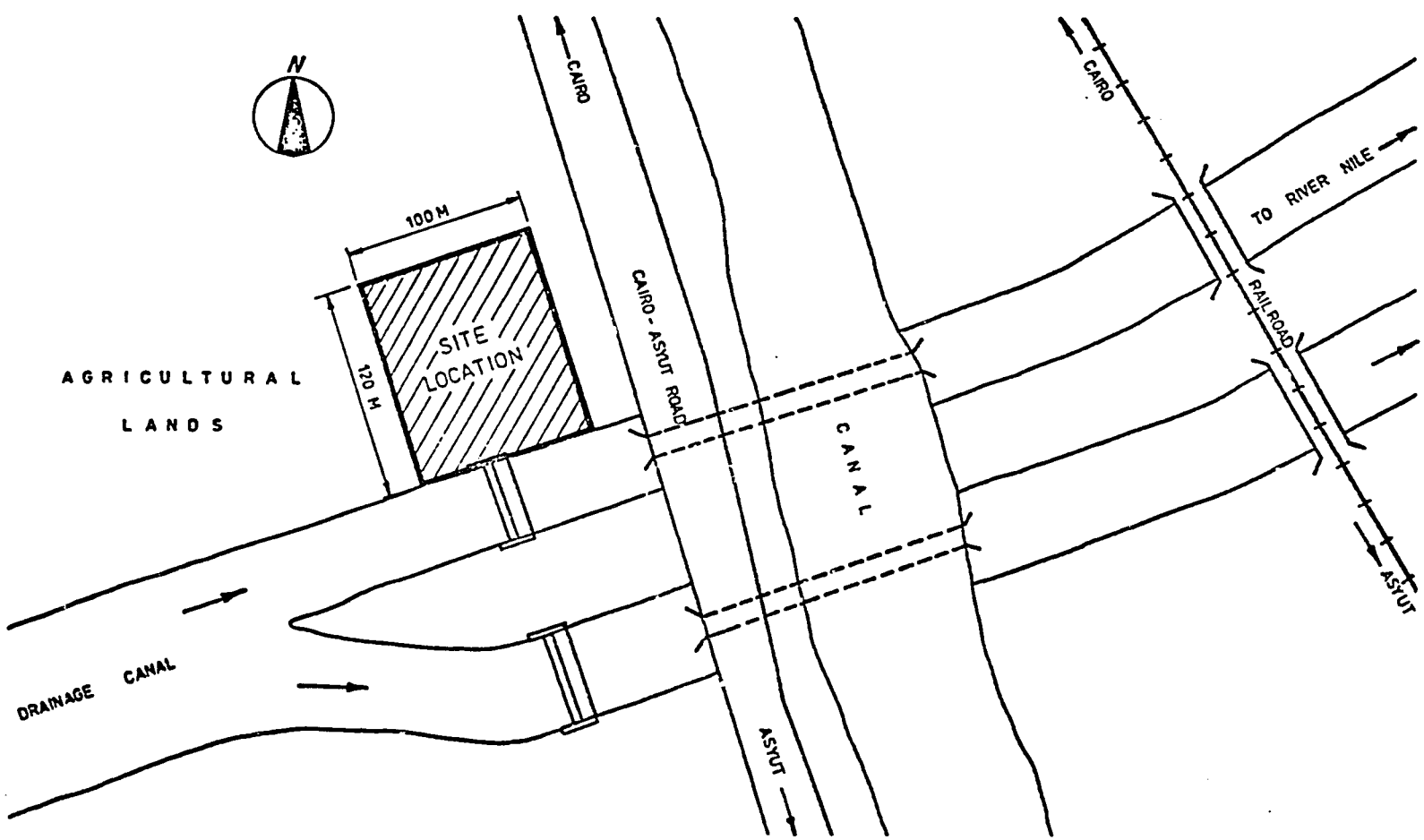


FIG. 4-4

SITE LOCATION - ASYUT



the city, on the Cairo-Aswan road. There is adequate water and power supply in the vicinity of the site and easy access to the main road. The site is currently being used for agricultural purposes, and the nearest demand for plastic drainage pipe is approximately 50 km in either direction.

4.4.6 Plant Site Selection

In summation, Asyut, located at the approximate centroid of the agricultural lands, is a prime location for a plant since it is decided to have three plants. However, in that the three-plant arrangement is considered effective then the cities Qena and Beni Suef are the only acceptable choices. Qena, Asyut and Beni Suef are best suited to supporting a plastic pipe plant because of their better infrastructure. Although the Least Cost Analysis indicates the two-plant location is the most economical solution, the EPADP has decided that other considerations such as the intangible value of the superior infrastructure of three plant locations outweigh the economical justification for two plants. The project area map indicating the plant locations is shown on Figure 4-5.

4.5 Implementation Schedule

EPADP plans to implement the five-year drainage program earlier in the southern portion and later in the northern portion with the exception of two small areas near Beni Suef. It is, therefore, recommended that the southern plant, e.e., the Qena plant, be erected first even though two of the parcels of land to be implemented are in the north. The pipe for these relatively small parcels would be trucked from Qena.

Assuming that the implementation plan is not changed and that presently projected schedules are met, the three recommended locations,

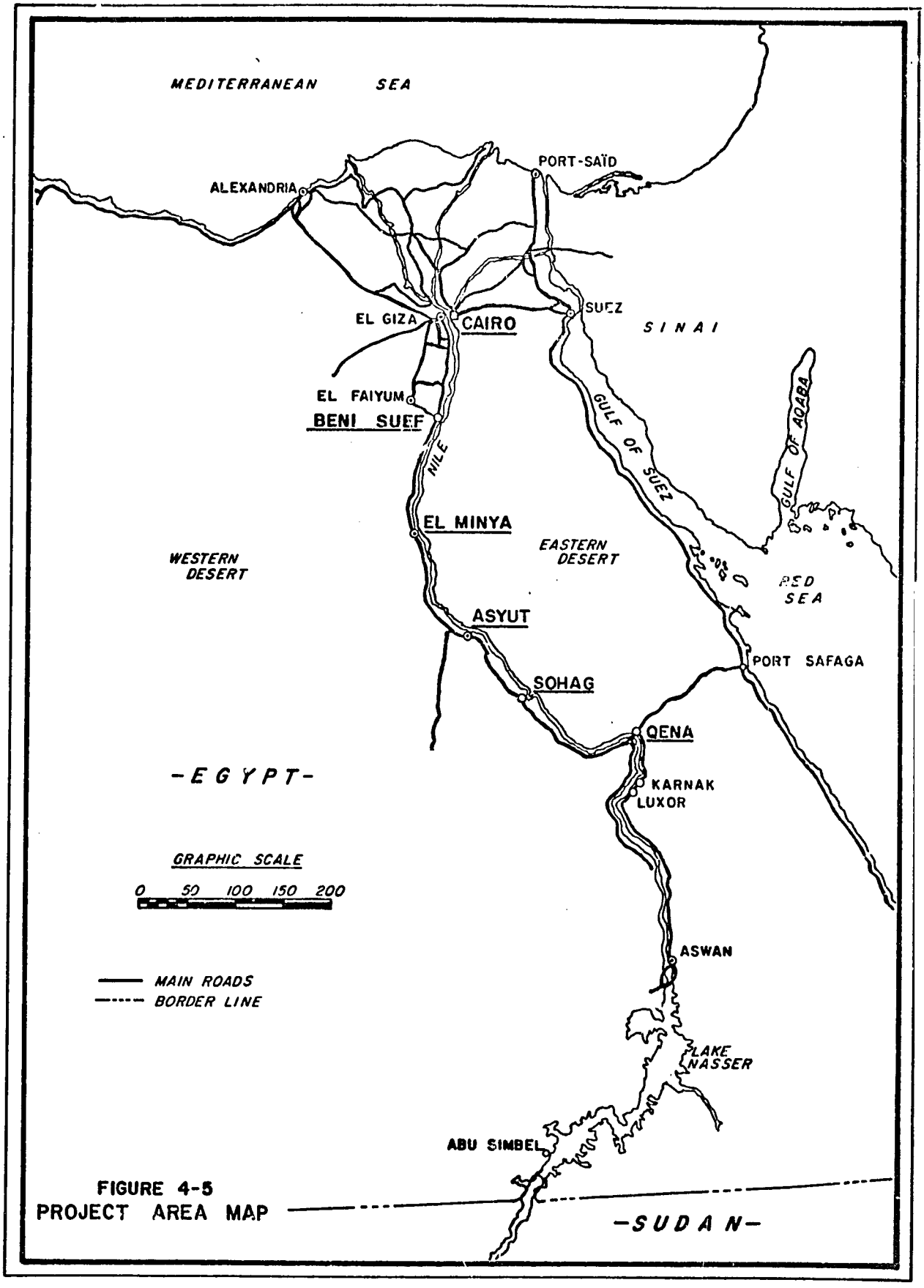


FIGURE 4-5
PROJECT AREA MAP

i.e. Beni Suef, Asyut, and Qena are preferable since they involve the minimum costs in cross shipping pipe from the southern plant to the northern portions of the area and vice versa. Some transshipment is anticipated particularly in the last two years of the program as the requirements in the south are fulfilled. Physical movement of one or more production lines, during the final two years, from the southern sector to the northern sector are indicated by conservative calculations of machine productivity. However, production at the northern and central plant may be sufficient to supply nearly all the pipe required with marginal shipments from the southern plant, if the full potential production of each line of equipment is realized as experience is gained by local staff. This decision to relocate machines should be made after experience has demonstrated the actual production potential. Although present plans do not show any requirement for drainage pipe in the southern portion of Upper Egypt during the fourth year, the excess pipe production facilities at the southern plant might be used for other than Upper Egypt Drainage II needs in addition to supplementing the needs in the northern portion of the project area.

4.6 Fixed Versus Mobile Plant

A relatively new development in the production of PVC drainage pipe is the use of completely mobile production plants. This method of manufacture has specific disadvantages and heretofore has not been very successful. The disadvantages concern logistics, operations, personnel, and economics.

The logistics of mobile plants is complicated by not only having

to assure a raw material supply at the proper time but also at the proper place. The lack of advanced communications would make satisfactory operation management difficult.

Extruders are high precision pieces of machinery with close tolerance parts. Such machinery frequently requires readjustment due to weather variations let alone changes in sitings due to the vibrations of travel. The qualified personnel who must follow the plant are required to live a semi-nomadic life to insure production of the pipe. Finally, the plants must be self-sustaining, that is, integral power supply, filtered water supply, personnel housing (above that required by the fixed plant location) which translates into increased equipment and their concomitant problems over the fixed plant location. If the requirements for pipe were concentrated in a certain area for a moderate length of time say four months then mobile plants might be more advantageous. With the pipe requirements spread rather uniformly up and down the River Nile in each of the years, fixed plants are better controlled from a management and operation viewpoint and are strongly recommended for this project.

5.0 PRODUCTION FACILITIES

5.1 Plastic Pipe Production Equipment

5.1.1 General

All equipment pertaining to the production, testing, and handling of the plastic pipe shall be of U.S. manufacture and of identical design to facilitate training and spare parts inventory. That is, all extruders shall be the same model by the same manufacturer. Similarly, all perforators, chillers, etc. shall be identical to each other.

5.1.2 Analysis of Equipment

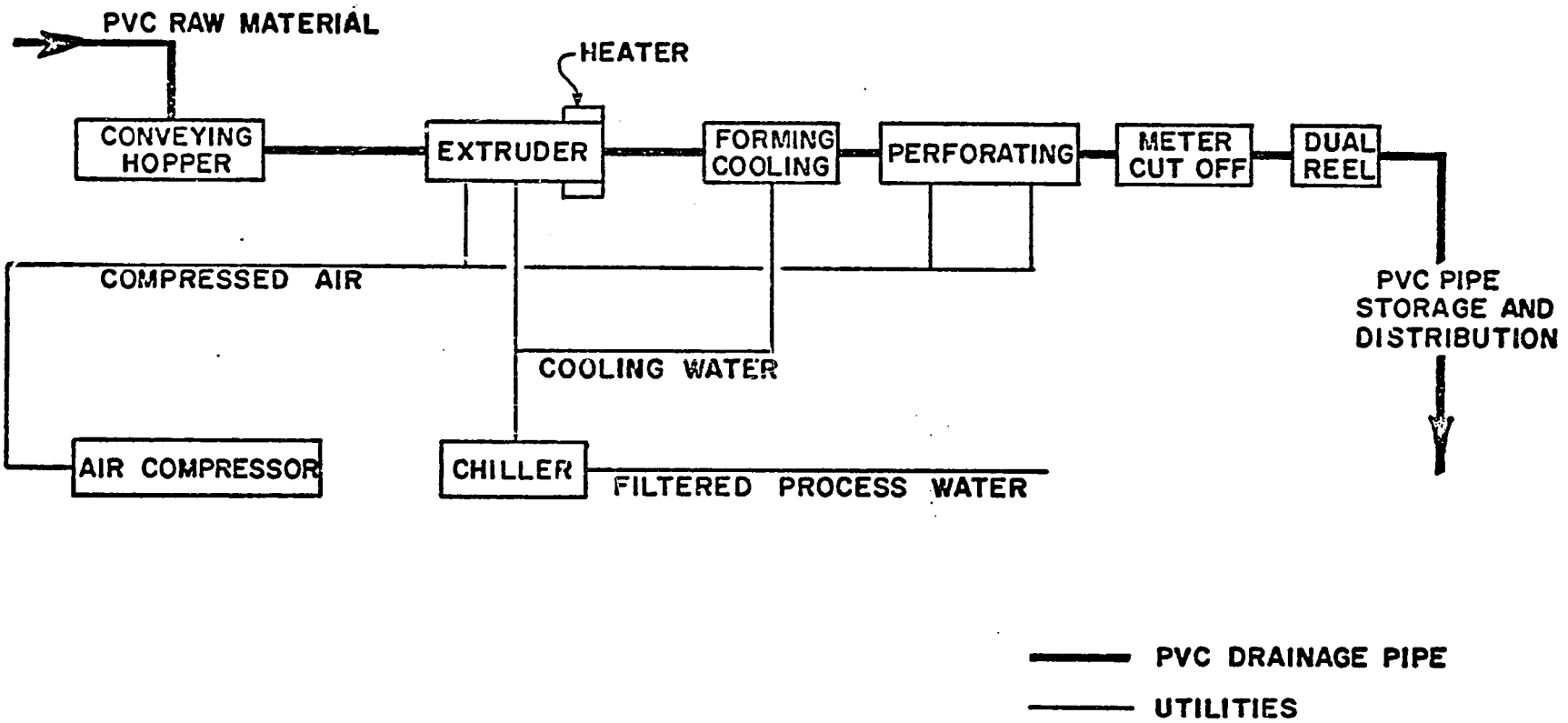
The flexible, corrugated, perforated PVC drainage pipe has a minimum allowable weight of 0.32 Kg/m. It is assumed that the average actual weight of the PVC drainage pipe will be 0.35 Kg/m which includes an 8-10% holdweight factor which is normal for this type operation to insure at least the minimum wall thickness throughout. A flow schematic of the extrusion line is shown on Figure 5-1.

Standard extrusion equipment to produce PVC drainage pipe is readily available. Typical extrusion machines for the production of 65 mm to 150 mm diameter drainage pipe are twin screw design capable of processing an average of about 180 kilograms of PVC compound per hour under prevailing conditions. This rate of producing pipe, that weighs 0.35 Kg/m will result in extrusion speeds, and down stream forming speeds, of approximately 10 meters per minute which is attainable and reasonable for this process.

Extrusion machines are designed to produce a definite range of pipe diameters. If the machine is too small the velocity of the molten

FIG. 5-1

FLOW SCHEMATIC - PVC DRAINAGE PIPE PRODUCTION



plastic through the die will be too high, yielding an inferior product, and if the machine is too large the residence time of the plastic in the extrusion barrel will be too long which results in an inefficient process.

5.1.3 Number of Extrusion Lines

In the later years of this project, when the greatest demand will exist for pipe i.e., 14,000 kilometers per year, the operation will probably have attained a state of refinement to the point that production will conservatively average five days per week, 20 hours per day, 50 weeks per year for a total of 5,000 hours per year. At an output of 180 Kg/hr, each extruder line can produce 900,000 kg of finished pipe per year, or

$$900{,}000 \text{ Kg/year} \div 0.35 \text{ Kg/m} = 2{,}570 \text{ Km/year/extruder.}$$

Since maximum annual requirements in the last year is 14,000 Km/year, then

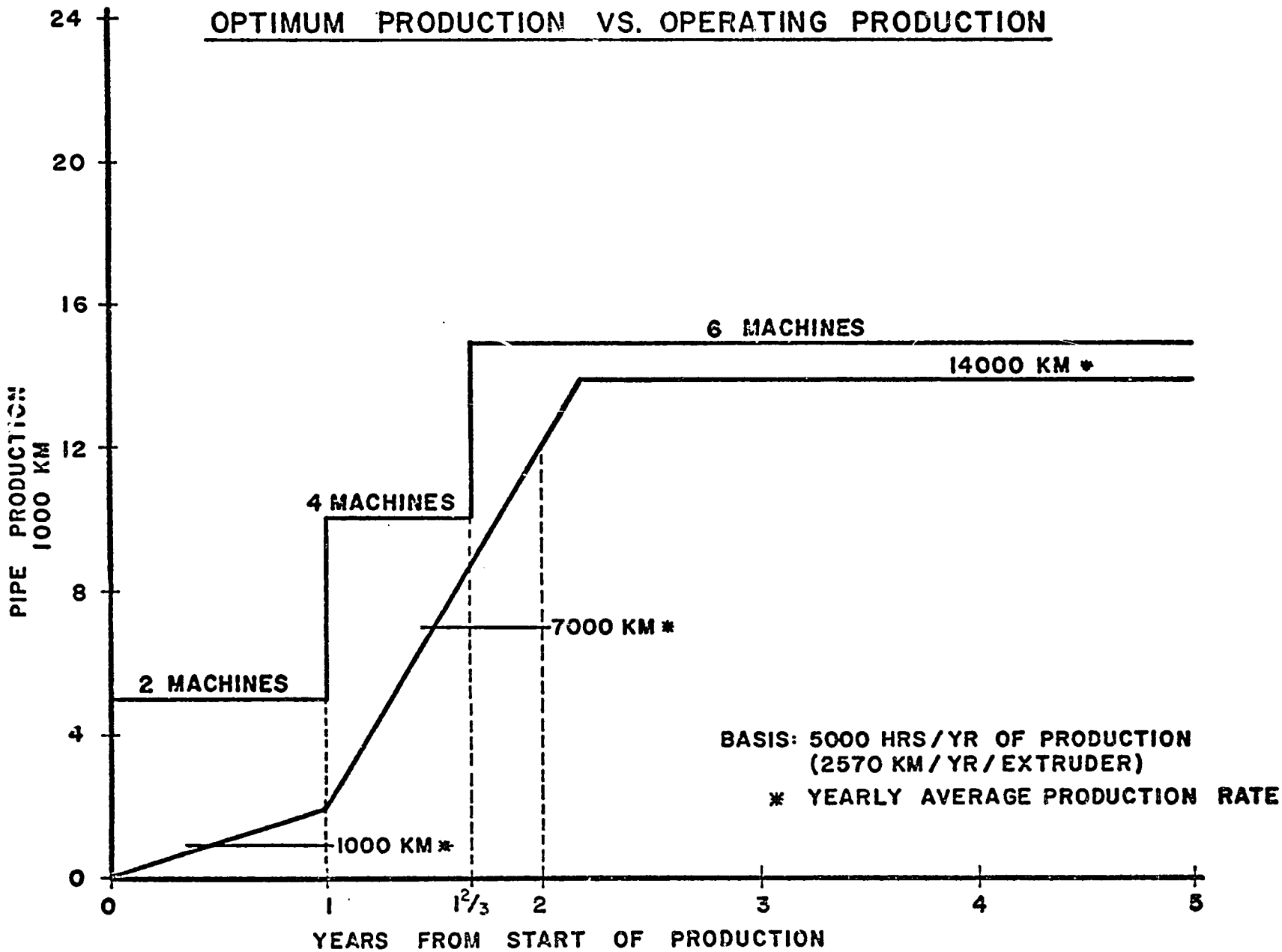
$$14{,}000 \text{ Km/year} \div 2{,}570 \text{ Km/year/extruder} = 5.4 \text{ extruders.}$$

It is therefore recommended that six extruder lines be the final number in operation to adequately cover these requirements and have a reserve for contingencies.

The relationship between the optimum production rate and the required production rate to meet the drainage pipe implementation schedule is shown on Figure 5-2. The optimum production rate was calculated on 5,000 hours/year operation based on 5 days/week, 50 weeks/year, 20 hours/day and a machine capability of 180 Kg/hr. It is evident that a conservative estimate of downtime was allotted not only for machinery problems but also for operations and related factors such as operator training, climate, lost time due to illness, holidays, etc. One extrusion

FIGURE 5-2

OPTIMUM PRODUCTION VS. OPERATING PRODUCTION



line is required to meet the first year production rate, however, the second extrusion line should be started concurrently with the first for training purposes. At the end of the first year the second plant should be started. Eight months later the third plant (machines 5 and 6) should be started permitting full production of 14,000 Km/yr to be reached and continued to completion of the program. This start-up requirement is shown on the project schedule.

5.1.3 Pipe Production Equipment

The equipment required for each of the six pipe extrusion lines will consist of the following:

- One integral motor, vacuum hopper loader with ratio (two tube) capability to handle virgin and regrind PVC compounds simultaneously, minimum capacity of 400 Kg/hr working through a 3 meter vertical rise and 3 meter horizontal distance from extruder to supply.
- One twin screw, single stage extruder, with minimum 50 horsepower motor, minimum 320 Kg/hr rated capacity when processing rigid PVC compounds (powder or pellet) and 10% metered regrind, including all necessary dose feeders, drives, barrels, screws, heating/cooling units, venting, control cabinet and full instrumentation controlling extruder and haul-off forming units.
- One extrusion head with a capacity for corrugated PVC pipes in diameters 65 mm to 100 mm.
- One extrusion die set for nominal size 80 mm diameter PVC corrugated pipe.

- One combination haul-off, forming and cooling unit with a capacity for 65 mm to 100 mm diameter pipes including necessary forming clamps to produce 80 mm diameter PVC corrugated pipe at line speeds up to 20 meters per minute.
- One perforating (slotting) machine with a capacity for 65 mm to 100 mm diameter pipes including necessary cutting knives to produce a minimum of 408 slots per meter in the corrugation valleys in size 80 mm diameter PVC pipe at line speeds up to 20 meters per minute.
- One meter counter with capacity for 65 mm to 100 mm pipes to measure the length of 80 mm PVC corrugated pipe in coil lengths of 50 to 150 meters at line speeds up to 20 meters per minute.
- One cut-off unit with a capacity for 65 mm to 100 mm pipes automatically actuated by the meter counter to cut off 80 mm PVC corrugated pipe at specified lengths of 50 to 150 meters.
- One dual reel machine, each reel having a capacity for up to 150 meters of 80 mm corrugated PVC pipe complete with meter counter and designed with 180 degrees rotation capability to facilitate removal of one full coil while a second is winding. It must accommodate line speeds up to 20 meters per minute without over stressing the corrugated pipe.

5.1.4 Spare Parts

Because of the inaccessibility of U.S. supply, it is recommended that each plant be supplied with spares of the following critical components:

- Three matched sets, barrel and screws, complete
- Three sets of heater bands, complete
- Three drive motors, complete
- One feed screw assembly with drive
- One integral motor vacuum hopper loader
- Three extrusion heads, complete
- Three die sets, 80 mm nominal size
- One set, screen and knives for granulator
- Three sets of forming clamps
- Three sets of slotting knives
- 15" Drill press, floor model, 1/2" chuck
- 1/2" Electric hand drill
- 1/4" Electric hand drill
- Portable power hack saw
- 8" Wheel bench grinder

Inventory level of other less critical spare parts are to be as recommended by the equipment manufacturers.

5.1.5 Quality Control Equipment

A quality control lab is required at each production facility. It is to be equipped to accomplish the following checks and tests of finished pipe:

(a) 0-25.4 mm micrometer for measuring wall thickness

(b) 150 mm caliper for measuring outside and inside diameter

(c) Measuring wheel and counter 0-1000 m for measuring pipe length

(d) Water inlet area meter (may be custom made depending upon slot configuration).

(e) 0-2 KG scale for weighing short lengths (1 meter)

(f) 0-100 KG scale for weighing coils

(g) Tup Impact Tester for checking impact resistance

(h) Compression testing machine for pipe stiffness

(i) Three stainless steel containers with covers for immersing pipe pieces for extrusion quality test.

(j) Miscellaneous equipment

(1) 0-60 minute timer

(2) 0-100°C immersion thermometer

(3) 0-25.4 mm dial indicator

(4) Direct reading certified hygrometer 0-100%

5.1.6 Ancillary Equipment

Each production line must be supplied with cooling water, compressed air and electric power as follows:

(a) Cooling Water - Air cooled condenser with a capacity of 27,000 kilocalories (107,100 BTU) per hour conveying 7.2 M^3/hr (32 GPM) at a pressure of 3.7 atmospheres for each extrusion line to supply chilled water at 4°C.

(b) Compressed Air - Capacity of 895 Liters (31.6 ft^3) per minute at a pressure of 10 atmospheres with a holding capacity of 300 Liters (10.6 ft^3). Power of 7.5 horsepower.

(c) Power - An estimated load of 322 KVA, 3 phase, 380 volts, 50 cycles will be encountered. A listing of equipment power requirements are as follows:

2 - Extruders, 50 HP each	100 KVA
2 - Extruder heaters, 33 KW each	66
2 - Haul-off and formers, 7.5 KW each	15
2 - Perforators, 2 HP (estimate) each	6
2 - Reelers, 2 HP each	6
1 - Air compressor, 10 HP	12
2 - Chillers, 20 HP each	42
2 - Sump pumps, 1-1/2 HP each	4
1 - Grinder, 5 HP	6
2 - Brine circulating pumps, 5 HP each	12
1 - Lighting load	33
1 - Repair area and miscellaneous	20
	322 KVA

As is evident from the above tabulation, a 300 KVA transformer is inadequate. The next U.S. standard size is 500 KVA. This size would not only handle the estimated load, but would provide ample capacity for frequency down rating (if unit were designed for 60 Hz), increased life, minimize voltage drop, larger latitude of variation in power factor and future addition of equipment.

A high voltage disconnect switch shall be provided to disconnect the plant from the incoming line. Switch gear and motor control equipment shall be provided in accordance with the National Electrical Code (U.S.). The transformer and the switch gear shall be in a controlled access area (preferably a room within the plant).

A standby power generator will not be provided because the installed cost of a 500 KVA unit is approximately $70,000 (including all automatic start and transfer equipment). The machine down time due to a power failure is approximately four hours which takes into consideration the 5000 hr/year operational production schedule.

(d) One granulator, mobile to accept up to 100 mm diameter PVC pipe in 2 m lengths and with a capacity to grind a minimum of 200 Kg/hr to 3 to 4 mm (1/8 inch) granules.

5.1.7 Mobile Equipment

Each plant shall be equipped with the following mobile equipment:

- Two pickup trucks for local deliveries, service, maintenance, etc., with four wheel drive.
- One fork lift truck with capacity to unload PVC raw material in bags on standard pallets; each pallet weighing 450 to 500 Kg. This fork lift truck should be equipped with a prong attachment and high mast to assist in loading the coils of finished pipe onto trucks or trailers for delivery.

5.2 Supporting Facilities

5.2.1 General

The supporting facilities necessary to complement the production units include real estate, buildings, storage, receiving and shipping areas. A typical plant arrangement is shown on Figure 5-3.

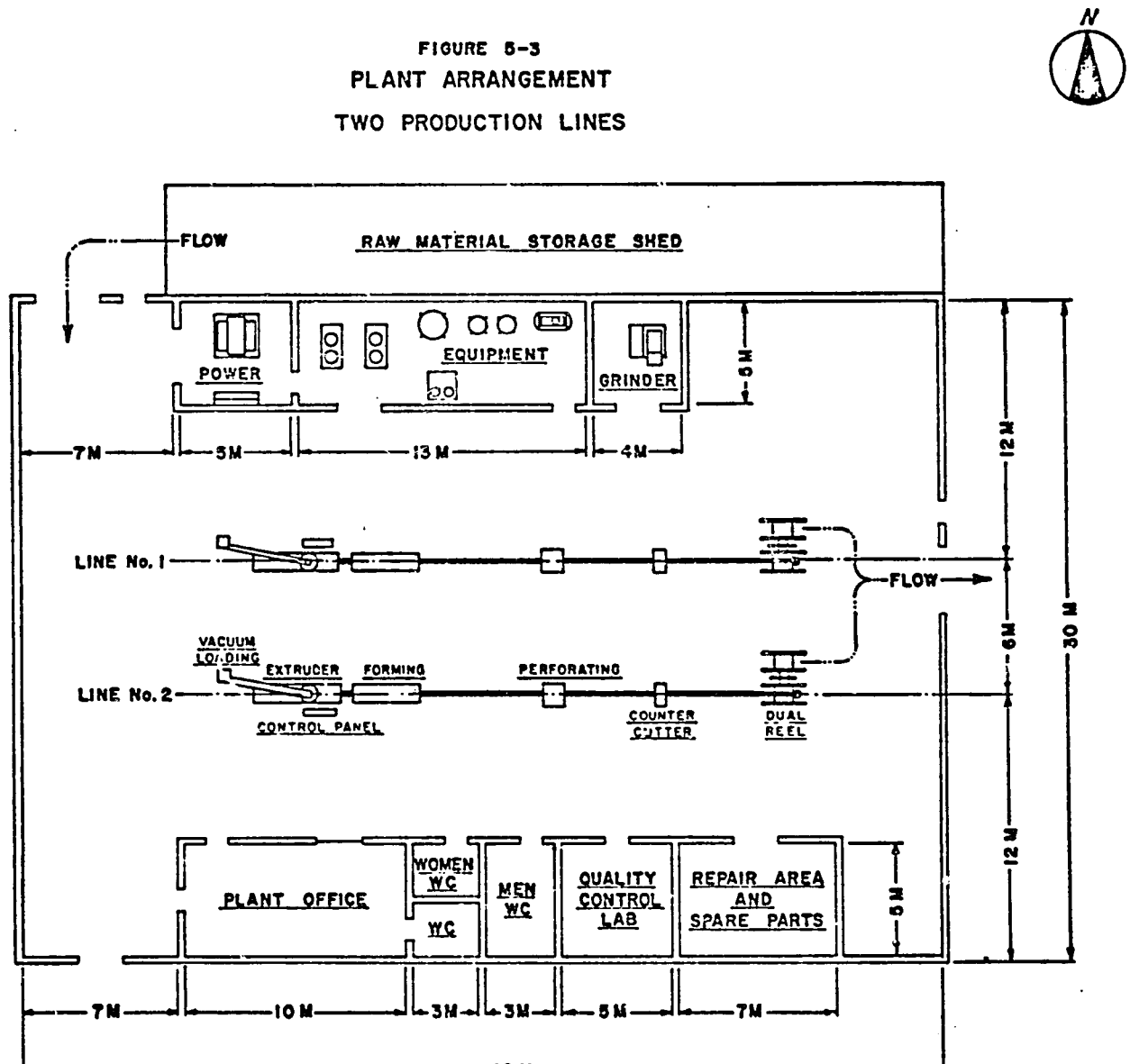
5.2.2 Real Estate Requirements

The real estate required for each of two plants is approximately

FIGURE 5-3

PLANT ARRANGEMENT

TWO PRODUCTION LINES



12,000 square meters (2.8 feddans) having nominal dimensions of 120 meters long by 100 meters wide. The Government of Egypt will furnish the real estate for the project as described in the Plant Location Analysis section. A general site arrangement is shown on Figure 5-4.

5.2.3 Site Preparation and Road Work

All site preparation, yard work, fencing, road work, etc. will be done by EPADP. The bidder will be responsible only for the process equipment and the ancillary equipment.

5.2.4 Building Requirements

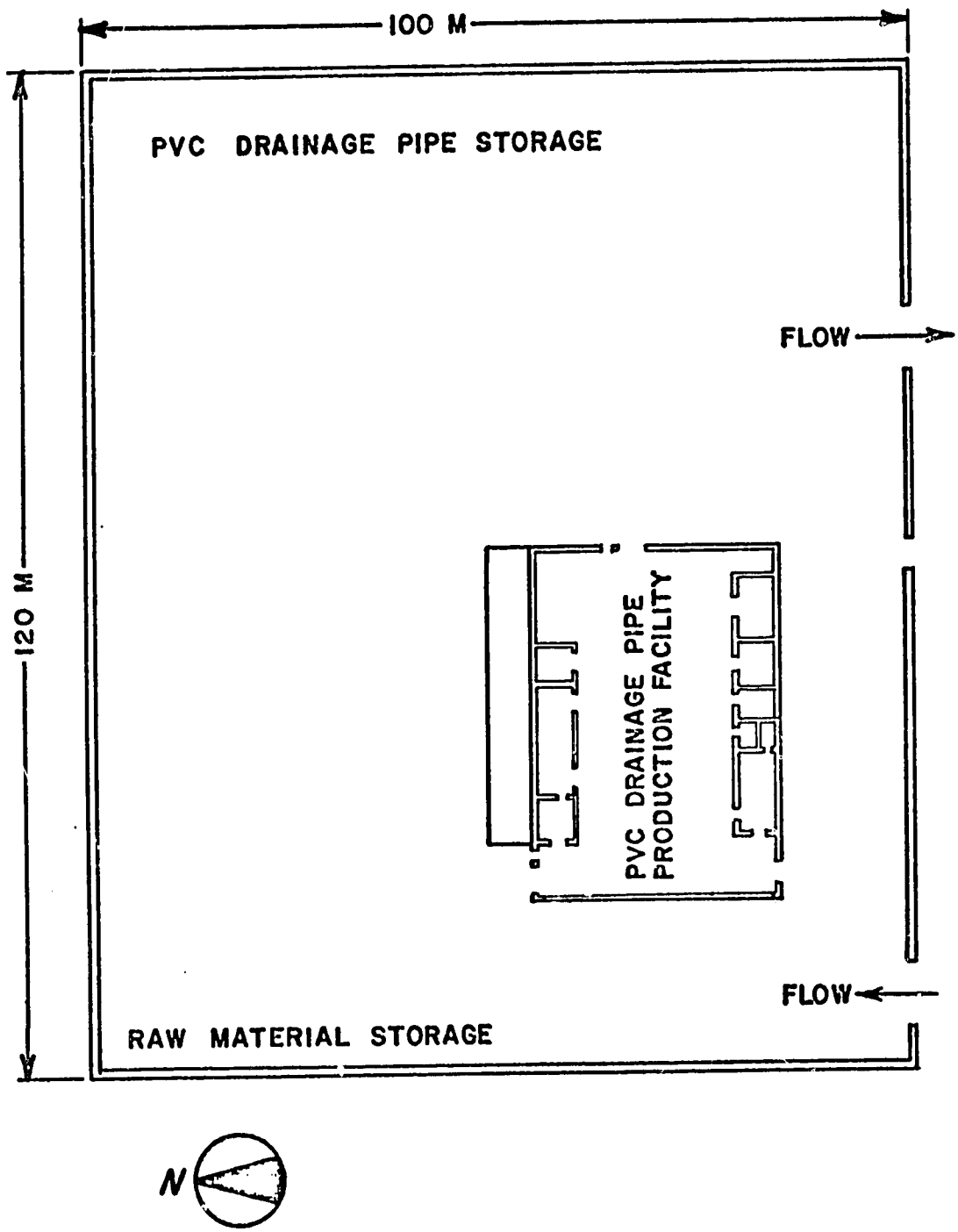
On the premise that each building will house two extrusion lines, the building required is approximately 1,260 square meters having nominal dimensions of 42 meters long by 30 meters wide and a ceiling height of 5 meters. The building will house the production equipment, shipping and receiving areas, office areas, quality control lab, and sanitary facilities.

5.2.5 Architectural/Structural

Two types of building construction are considered feasible for the project: traditional concrete and masonry construction and steel frame construction. The traditional construction consists of reinforced cast-in-place concrete columns and beams with brick fill walls and a poured concrete roof. The second type of building construction consists of a steel frame building with brick fill walls and corrugated asbestos sheet roof. The cost of these buildings is similar. The primary problem area for both types of construction is the availability of construction materials. A project priority determined by the GOE is required to obtain building materials. This required priority foreseeably could

FIGURE 5-4

GENERAL SITE ARRANGEMENT



delay the procurement of materials and the subsequent construction. Structural steel appears difficult to obtain in Egypt but it could be imported for this project.

A pre-fabricated type of building was also contemplated for feasibility but it was judged as not suitable for this project. The cost of this building is greater than the other types of construction due to the ocean shipping costs and contingency for damage. An estimated ten percent additional material would have to be purchased to compensate for the losses due to damage in transit. Also there is a lack of experienced erectors in Egypt and consequently expatriate constructors would add to the costs. Although the walls, roof and interior would be erected faster than with traditional construction methods, the total construction time would be shortened only slightly.

5.2.6 Heating and Ventilating

Gravity type roof ventilators are satisfactory for this installation for general ventilation requirements. An exhaust fan and duct system is required to exhaust the heat and gases from the extruders. Comfort heating is not required due to the climate of the locale.

5.2.7 Lighting

Incandescent lighting can be used for general purpose lighting. For areas requiring higher light intensities such as at the extrusion machines, office area, quality control lab, and the repair shop, fluorescent lighting should be used. Emergency lighting should be provided and be inspected and tested on a regular basis.

5.2.8 Water Supply

The city water supply is available at each of the designated

site locations. The water supply is adequate for the process water and potable water requirement. The process water and potable water must be segr ted by means of a back flow prevention device. This device will prevent back siphoning of contaminated process water into the potable water main in the event of a pressure loss.

5.2.9 Sanitary Facilities

The sanitary facilities shall be tied into the present disposal system in use at each city.

5.2.10 Finished Pipe Storage

Notwithstanding the higher ambient temperatures found in Egypt in comparison to those in the U.S., it is not considered necessary to construct covered storage sheds for the finished pipe. If, however, the implementation should fall behind the rate of pipe production such that pipe was to lay in the storage yard for more than six months even while utilizing a first-in first-out procedure, then some protection should be provided. This could consist of a tarpaulin supported above the coils of pipe or some other rudimentary system to keep the pipe out of the direct sunlight.

5.3 Environmental and Safety Aspects

5.3.1 Environmental and Health Impact

The manufacture of PVC drainage pipe presents no major environmental or health hazard. PVC drainage pipe is manufactured using compound PVC. PVC is produced by the polymerization reaction of vinyl chloride monomer (VCM). VCM is a known carcinogen and every precaution must be implemented to protect the processing personnel from inhaling

this chemical. The Threshold Limit Value, TLV, that is the maximum tolerable concentration of VCM is 1 ppm. The PVC polymerization reaction is conducted at high temperatures and most of the volatile VCM is removed. The polymerization reaction is the most dangerous step since raw VCM is highly toxic and extremely flammable. The polymerized PVC resin is then processed into powder or pellets. At this stage there is virtually no VCM present in the resin. The compounding step consists of reheating the pellets and intimately mixing other ingredients with the PVC in order to formulate a usable resin. This step eliminates the remaining VCM from the resin. The compound PVC is the form which is received in Egypt for the pipe production. When this material is reheated in the pipe extruder the chemical equilibrium constant, although extremely small, i.e., this indicates a very stable PVC molecule, will cause a slight reversing effect and subsequent release of VCM. This release of VCM has been analyzed and found to be well below the Threshold Limit Value for VCM. Consequently the Occupational Health and Safety Administration, OSHA, and the Environmental Protection Agency, EPA, have no regulations pertaining to the manufacture of PVC drainage pipe.

5.3.2 Occupational Health and Safety

There are no extraordinary health or safety hazards related to the manufacture of PVC drainage pipe, however, basic precautions and operator safety training must be implemented. The extruder machines should be provided with exhaust hoods and fans to remove any vapors formed and to cool the work area during the heating process. These fans can exhaust directly to the outside atmosphere with no deleterious effects

on the surroundings. In general, the basic safety precautions include machine guards on all rotating machinery, proper type of electrical safeguards and the supervision and safety training of the employees by the operations management. By adhering to these guidelines there are no foreseeable environmental or safety hazards.

6.0 OPERATIONS MANAGEMENT

6.1 General

The Organization Chart proposed for the operation of the pipe plant is shown on Figure 6-1. It is intended that after plant construction, the General Manager has single point responsibility for the production of the 50,000 kilometers of drainage piping required for the Upper Egypt Drainage II Project. This includes the ordering of raw materials, selection and training of personnel, manufacture of finished pipe according to the agreed implementation plan and the disbursement of funds to accomplish these objectives.

It is intended that the positions of General Manager and Plant Manager be filled by Egyptian Nationals. National Plastics has such individuals who have the required background and with proper training can operate the plants at the anticipated efficiency. It is necessary that those supervisory personnel, and the training personnel have a good command of the English language in reading, writing and speaking.

6.2 Training Requirements

The equipment suppliers shall furnish personnel to train the plant operators in all aspects of pipe production. This includes equipment installation, start-up, maintenance, troubleshooting, etc. It is anticipated that a two or three man team could be assigned to each plant in succession. This time would be adequate to properly train and assist in operations to attain the plant's full capacity.

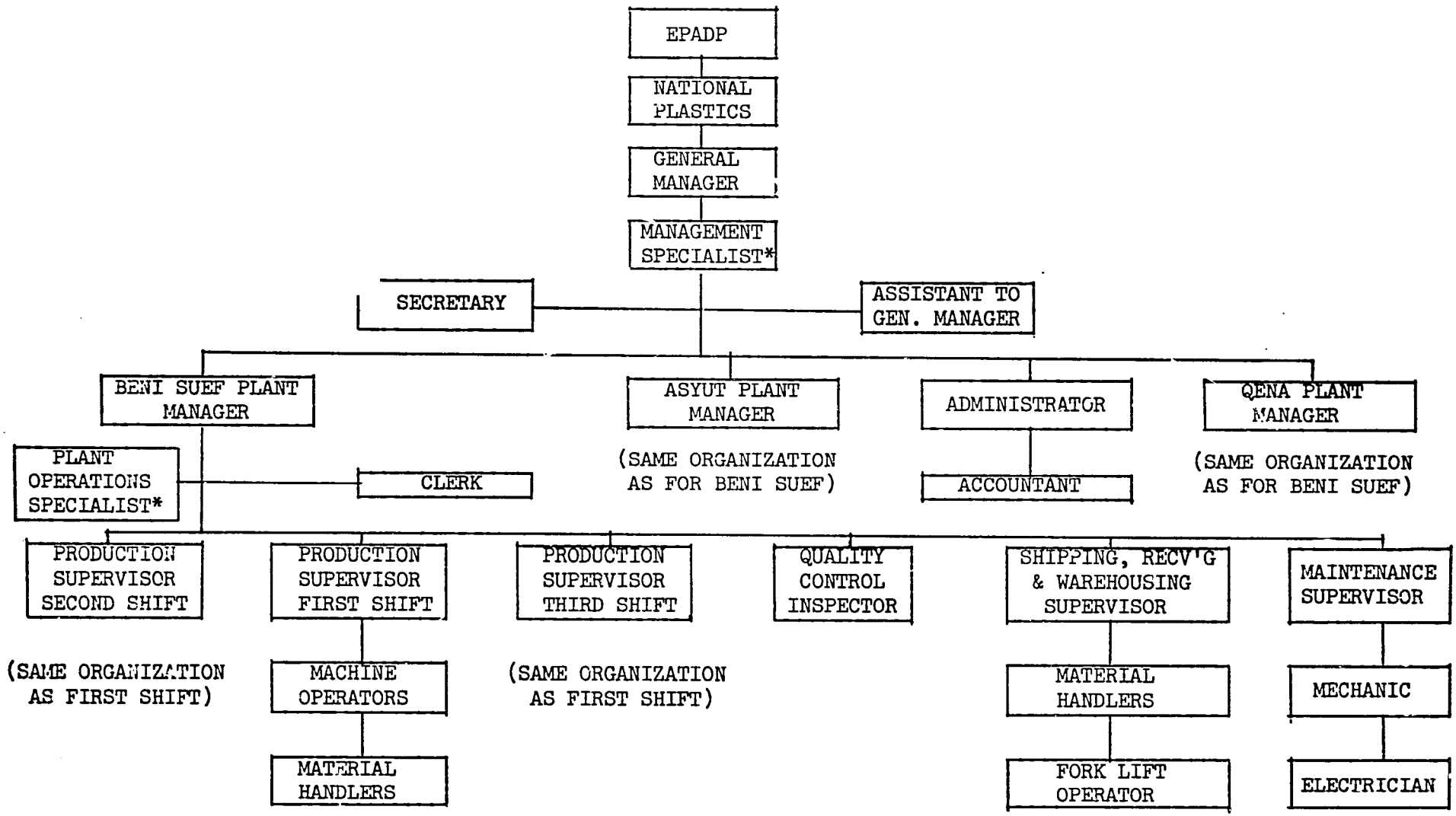
6.3 General Manager

It is recommended that the entire plastic drainage pipe project

FIGURE 6-1

ORGANIZATIONAL CHART

PLASTIC DRAIN PIPE PRODUCTION



* Expatriates

be under the direction of the General Manager. This individual should be an officer of the EPADP (or be so designated) with powers to act for the Authority in financial, legal, personnel and other decision requiring matters. He should be experienced in all matters of general management, be knowledgeable in the processing of plastics and the equipment involved, and be willing to accept and carry out this responsibility to the completion of the project. Everyone else involved with the project should be subordinate to this individual. He will have total responsibility for every phase of the operation.

The General Manager should be located in Cairo, in permanent offices, will full time administrative, secretarial and bookkeeping services. All records would be kept on file at the Cairo office and all disbursements made through this office.

Close liaison with the EPADP central office is critical to the success of the project. Proximity to the National Plastics Company would also be beneficial. Hence, the recommendation that the General Manager be located in Cairo.

6.4 Plant Manager

The Plant Manager should be experienced at plastic pipe extrusion and have had successfully performed all the duties and responsibilities required of administrative and logistics work.

6.5 Other Supervisory Personnel

All other supervisory personnel should be locally hired and trained in advance of completed operations through a three month program under the direction of the General and Plant Managers. Assistance should be provided

in this program by the equipment suppliers and raw material suppliers. Further assistance will be obtained from the experienced staff at National Plastics and will possibly be implemented through the Egyptian Drainage Authority Technical Training Centers.

6.6 Non-Supervisory Personnel

Non-supervisory personnel should be locally hired and trained on the job by each Plant Manager and his supervisory staff.

6.7 Quality Control Inspector

The Quality Control Inspector is responsible for checking the incoming raw material and performing all the tests of finished pipe. This position would be required on the day shift only, production from the second and third shifts would be held for inspection before being released to inventory on the following day. The greatest assistance in training this individual should be by the raw material supplier. He should report directly to the Plant Manager and operate independent of the production personnel.

6.8 Maintenance Supervisor

The Maintenance Supervisor is responsible for keeping all production equipment, mobile equipment, and ancillary equipment operational. He must have fundamental knowledge of the maintenance of mechanical and electrical equipment components. This position would be a day shift requirement only but he would be on call for critical breakdowns at other times. Training for this locally hired individual will come from the Plant Manager with assistance from equipment suppliers. This individual would also be responsible for local facilities maintenance such as sanitary and water systems.

6.9 Shipping, Receiving and Warehousing Supervisor

This individual would be responsible for receiving, unloading, storage and maintaining of proper inventory levels of raw material. He would also be responsible for storage, loading, and maintaining of proper inventory levels of finished pipe. This would be a day shift requirement only. This position requires the ability to manage material handlers and an understanding of safe handling of raw material and finished pipe. The storage yard should be set up on the first-in, first-out principle to lessen the effects of ultraviolet degradation of the pipe.

6.10 Production Supervisor

The Production Supervisor will be responsible for maintaining required pipe production. They will supervise all of the operating personnel and be responsible for all equipment, from regrinding of scrap to tagging of finished coils of pipe. Second in responsibility and ability to the Plant Manager, this position is normally the training ground for future Plant Managers. These individuals, one for each shift, must have good mechanical ability and will receive extensive training by all equipment suppliers in the proper operation of each component.

7.0 PROJECT SCHEDULE

7.1 General

The Project Schedule is presented by the Critical Path Method (CPM). The schedule covers all of the critical milestones associated with the manufacture of the PVC drainage pipe from the preparation of the preliminary project plan to the attainment of full production status including the hiring of personnel and the ordering of raw materials. The times allotted for the individual steps are considered to be the optimum attainable. The present schedule is illustrated on Figure 7-1.

7.2 Project Schedule

1. Start Preparation of Preliminary Design Report.
2. Start Preparation of Information for Bidders (IFB).
3. Completion of Preliminary Design Report.
4. Start Review of IFB by EPADP and USAID.
5. Complete Review of IFB by EPADP and USAID.
6. Condition Precedent - Completed.
7. Complete Preparation of IFB.
8. Issue IFB.
9. Start Building Design - Plant No. 1.
10. Order Construction Materials - Plant No. 1
11. Receive Proposals.
12. Complete Building Design - Plant No. 1.
13. Receive Construction Materials - Plant No. 1.
14. EPADP Selects Prime Contractor with USAID Approval.
15. Start Building Construction - Plant No. 1.

16. Sign Contract.

17. Start Building Design - Plant No. 2.

18. Letters of Commitment Established.

19. Order Building Construction Material - Plant No. 2.

20. Letters of Credit Established and Loan Disbursements Begin.

21. Expatriate Management Specialist Assigned to Egypt.

22. Order Pipe Production Equipment - Plants Nos. 1, 2 and 3.

23. Order Raw Material Shipment No. 1.

24. Complete Design of Plant No. 2.

25. Plant Operations Specialist Assigned to Plant No. 1.

26. Receive Construction Materials - Plant No. 2.

27. Start Building Design - Plant No. 3

28. Start Building Construction - Plant No. 2.

29. Hire Supervisory Personnel - Plant No. 1.

30. Receive Equipment and Start Installation of Equipment - Plant No. 1.

31. Complete Building Construction - Plant No. 1.

32. Order Construction Materials - Plant No. 3.

33. Hire and Train Local Unskilled Labor.

34. Receive Raw Material Shipment No. 1.

35. Complete Building Design - Plant No. 3.

36. Project Evaluation.

37. Complete Installation of Equipment - Plant No. 1.

38. Equipment Start-up - Plant No. 1.

39. Order Raw Material Shipment No. 2.

40. Receive Construction Materials - Plant No. 3.

41. Full Production - Plant No. 1.

42. Start Building Construction - Plant No. 3.

43. Plant Operation Specialist Assigned to Plant No. 2.

44. Receive Raw Material Shipment No. 2.

45. Hire and Train Supervisory Personnel - Plant No. 2.

46. Receive Equipment and Start Installation - Plant No. 2

47. Finish Building Construction - Plant No. 2.

48. Hire and Train Unskilled Labor.

49. Order Raw Material Shipment No. 3.

50. Complete Installation of Equipment - Plant No. 2.

51. Equipment Start-up - Plant No. 2.

52. Plant Operation Specialist Assigned to Plant No. 3.

53. Full Production - Plant No. 2.

54. Receive Raw Material Shipment No. 3.

55. Complete Building Construction - Plant No. 3.

56. Hire and Train Supervisory Personnel - Plant No. 3.

57. Receive Equipment and Start Installation - Plant No. 3.

58. Hire and Train Unskilled Labor.

59. Complete Installation of Equipment - Plant No. 3.

60. Equipment Start-up - Plant No. 3.

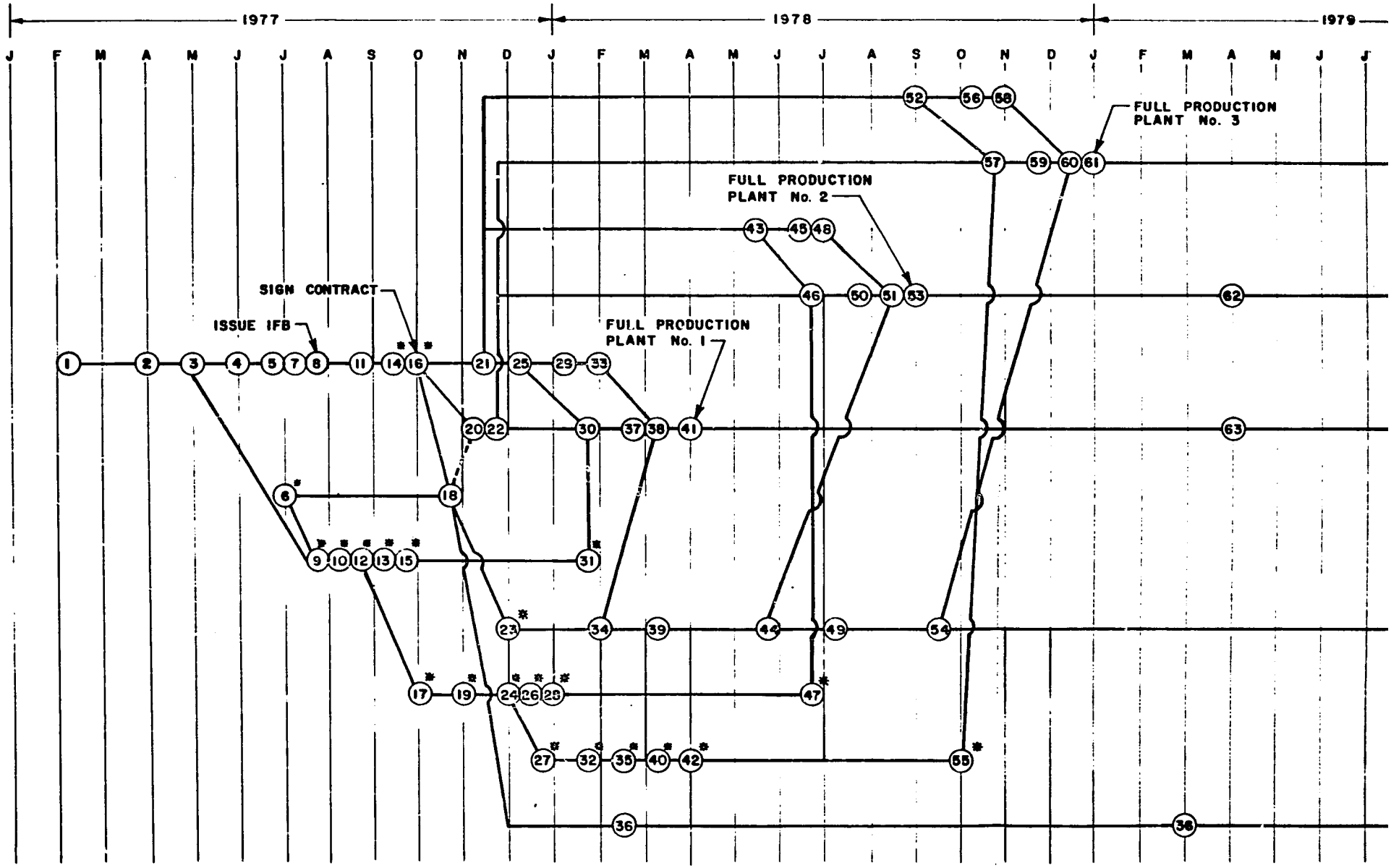
61. Full Production - Plant No. 3.

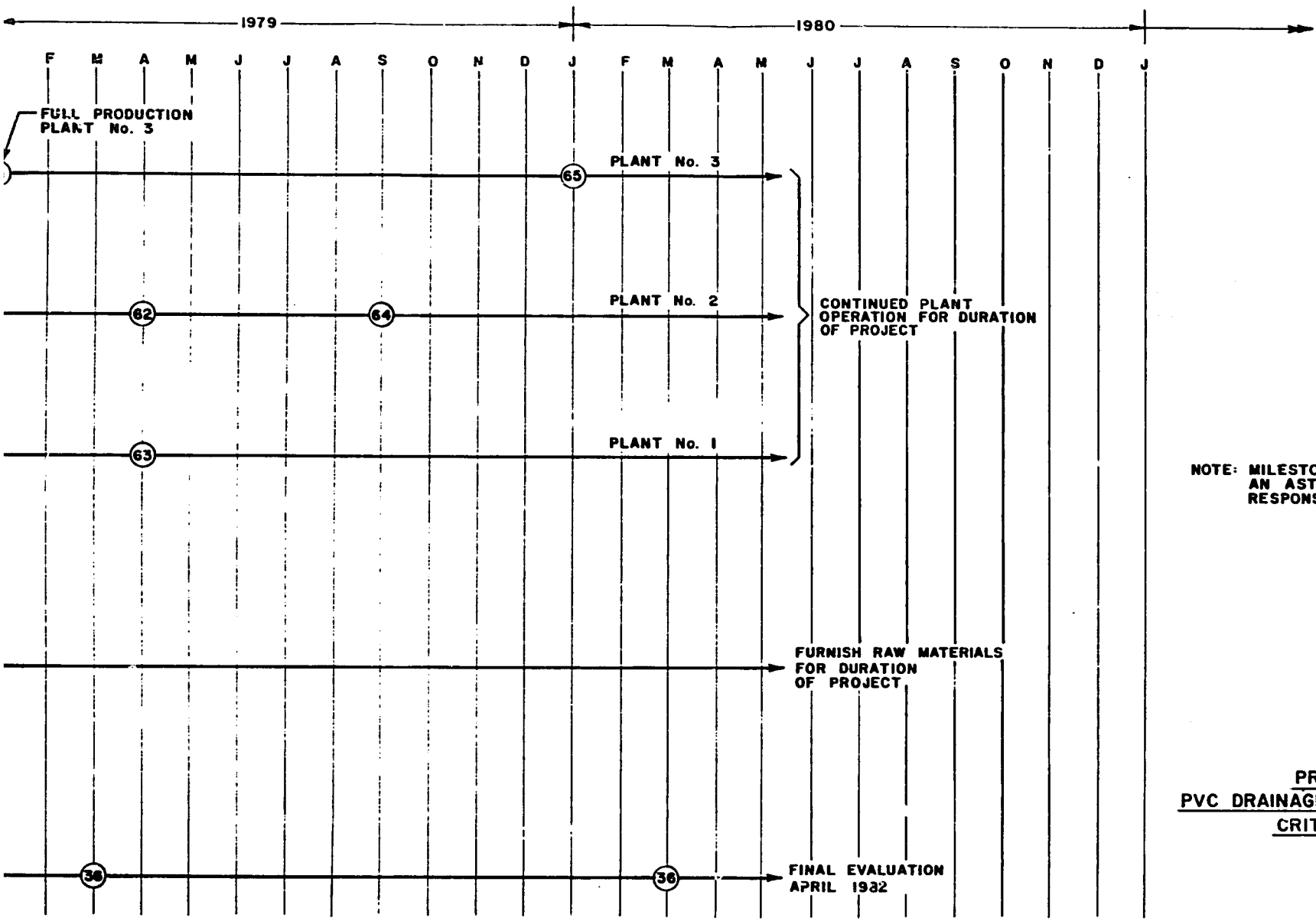
62. Evaluation of Plant No. 2 Productivity to Determine if Extruders from Plant No. 1 Should Be Relocated.

63. Evaluation for Withdrawal of Plant Operations Specialist - Plant No. 1.

64. Evaluation for Withdrawal of Plant Operations Specialist - Plant No. 2.

65. Evaluation for Withdrawal of Plant Operations Specialist - Plant No. 3.


1977
1978
1979
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J
SIGN CONTRACT
ISSUE IFB
FULL PRODUCTION PLANT No. 1
FULL PRODUCTION PLANT No. 2
FULL PRODUCTION PLANT No. 3



NOTE: MILESTONES MARKED WITH AN ASTERISK (*) ARE THE RESPONSIBILITY OF THE EPADP.

FIGURE 7-1

PROJECT SCHEDULE

PVC DRAINAGE PIPE PRODUCTION FACILIT

CRITICAL PATH CHART

8.0 CONTRACTUAL AGREEMENT ANALYSIS

8.1 Selection of Contract Type

The major components required for PVC drainage pipe manufacture for the implementation of the Upper Egypt Drainage II Project include furnishing, installing and the start-up of six lines of extrusion machinery, the training of machine operators and the procurement of about 17,600 tons of compounded PVC. These goods and services must be supplied by U.S. firms. Operation of each plant to meet targeted PVC drainage pipe requirements in their respective service areas will require an expatriate management specialist and operations specialist, local machine operators and staff, and other locally obtained support, such as transport, power, and other utilities.

There are several variations of contract arrangements that could be utilized in purchasing these services including dividing the project into the various types of services and goods and contracting separately for each. However, due to the size and nature of the project, only two alternatives seem appropriate. One arrangement would be for one contract to provide all goods and services; the other arrangement would be to separate out the supply of the PVC raw material.

It is recommended that the second method be utilized, i.e., one U.S. contractor be selected to supply and install the equipment, and to furnish technical and managerial specialist, and a separate contract be let on a yearly basis to PVC resin producers for the supply of raw materials. This procedure eliminates the need for incorporating an escalation factor into the bids.

The construction of the building and the associated civil work is to be accomplished by the EPADP. With the EPADP having overall project

responsibility and National Plastics Company having pipe production responsibility, the continuity of implementation, simplicity of coordination and management is assured.

Another consideration in separating out the raw material supply is one of bidder response. Discussions with PVC resin producers and equipment manufacturers in the U.S. indicate a greater interest in bidding only their own speciality.

Under this alternative, procurement of the compounded PVC feedstock would be contracted separately on a yearly basis. The offering price of such materials under five year future contracting will assuredly involve price escalation for later deliveries under any form of contracting. Direct annual procurement contracts by EPADP would increase coordination needs, however, if computed on a timely basis should present no problem, and these annual contracts would decrease forward-contracting price increments associated with uncertainty.

It is suggested that the contracts for the project be prepared as follows:

A. Equipment and Service Contract

- Supply of six extrusion lines complete with ancillary equipment
- Provide the stipulated managerial and operations specialist to assist the start-up and operation for each plant.

B. Raw Material Contract

- Furnish the required amount of compounded PVC to the Port of Alexandria, ARE.

The raw material contract would be rebid on a yearly basis.

8.2 EPADP Responsibilities

The EPADP will be responsible for implementation of the program and it will carry out that responsibility in accordance with USAID

regulations by contracting with a U.S. firm to furnish, install, and start-up the PVC pipe manufacturing equipment. The EPADP will obtain the required land for the plant sites, make site improvements, construct the buildings, connect the utilities, and handle all the interface with the other governmental agencies as required. These would probably include the Ministry of Housing and Reconstruction, the Ministry of Transportation, the Ministry of Industry and the Ministry of Agriculture. The Government of Egypt through the EPADP will provide the necessary local currency to carry out the project.

The arrangement between EPADP and National Plastics Company (NPC) should be such that the overall project responsibility of the EPADP is not altered. NPC will assume the responsibility for the manufacture of the PVC drainage pipe and the delivery of the PVC raw material from the Port of Alexandria to the respective plant sites. It is suggested that they be technical advisors to EPADP in all matters concerning the manufacture of the PVC pipe. They could also supply some of the intermediate level supervisory personnel with the probability that they would eventually take over the plant operation. They could also provide non-supervisory personnel to the project such as machine operators. Another area where NPC would be particulary valuable would be in supplying machine shop services as required.

9.0 PREQUALIFICATION OF BIDDERS

9.1 General

It is anticipated that an advertisement of an invitation for bids for the supply, erection, and start up of the extruding machinery will elicit responses from varied U.S. organizations but most will probably be from the following groups:

a) Plastic Pipe Manufacturers

b) Plastics Machinery Manufacturers

c) Engineers and Constructors

It is recommended that any firm to be considered qualified have either recent experience in operating a plastic extrusion manufacturing facility or be a bona fide extrusion machinery manufacturer.

The day to day operation of the plants in Egypt is going to be a particularly important aspect of the project. Experience in the extrusion of pipe, conduit, or other profiles is considered important to the success of this project. Firms presently engaged in the manufacture of plastic pipe or other profiles would therefore be generally considered qualified. These firms are familiar with the purchase of machinery and materials and the specifying of entire plant facilities. Due to the high transportation costs of finished products in the U.S. extrusion industry, it is common for U.S. firms to have multi-plant organizations. These firms therefore have personnel familiar with setting up and operating such plants even some with overseas experience which would be advantageous.

Manufacturers of pipe extrusion machinery will be particularly interested in bidding on this project. Although the supply and erection of machinery is one of the more straight forward aspects of the entire project, it will be the most important portion of the U.S. Contractor's

responsibility. Therefore, plastic extrusion machinery manufacturers should be considered qualified.

For a plant in the U.S. it is common practice for an Engineer and Constructor to assemble the expertise to design and build an extrusion plant. In this particular project where the civil works will be accomplished by the EPADP with the assistance of local contractors, there does not appear to be any advantage for U.S. engineering or construction firm to be the prime contractor. They could prequalify only if they have recently designed and built a plastic extrusion plant or have a joint venture partner who has.

Responses from an invitation for bids for the supply of the compounded PVC resin should only be solicited or accepted from bona fide PVC resin producers or custom compounders.

10.0 PROJECT COST ESTIMATE

10.1 General

The project cost estimate presented below contains all the elements for the production of the drainage pipe. It includes the foreign exchange costs and local currency costs for production equipment, plant construction, raw material, operations and management and both the foreign and local overhead and contractor's profit. The contingencies are divided into two sub-sections i.e. physical which includes the plant and raw materials and price. The Project Cost Estimate is presented in Table 10-1. The costs are given in U.S. Dollar costs and Egyptian Pound costs. The backup data is given at the end of this section.

10.2 Explanatory Notes

10.2.1 Production Equipment

The production equipment is itemized into the units of required machinery. The unit prices reflect the costs of the equipment for purchase in 1977. All production equipment will be supplied from the U.S. and is shown as predominantly a foreign exchange cost. The Egyptian Pound portion is for local transportation costs.

10.2.2 Plant Construction

The site acquisitions, site improvements, and building construction are most expeditiously handled by the EPADP. These costs are shown as Egyptian Pound costs.

10.2.3 Raw Material

The cost of the raw material includes the price of the basic resin, plus compounding, special handling, packaging, freight and

TABLE 10-1

PROJECT COST ESTIMATE

COST SUMMARY

ITEM	COST US DOLLARS (IN THOUSANDS) 1977	1978	1979	1980	1981	TOTAL	COST EGYPTIAN POUNDS (IN THOUSANDS) 1977	1978	1979	1980	1981	TOTAL
Production Equipment	$2,366	-	-	-	-	$ 2,366	LE 36	-	-	-	-	LE 36
Plant Construction	38	76	-	-	-	114	184	367	-	-	-	551
Raw Materials	293	2,156	4,743	5,174	5,449	17,815	4	25	48	49	50	176
Operational Cost	50	100	67	-	-	217	118	381	453	481	481	1,914
Overhead Cost	18	35	13	-	-	66	60	150	91	96	96	493
Contractor's Profit	173	15	6	-	-	194	40	90	54	58	58	300
SUB TOTAL	2,938	2,382	4,829	5,174	5,449	20,772	442	1,013	646	684	685	3,470
Contingencies												
Physical												
Project	397	34	13	-	-	444	64	144	87	93	93	481
Raw Materials	29	216	474	517	545	1,781	-	-	-	-	-	-
Price	587	476	966	1,035	1,090	4,154	88	202	129	137	137	693
TOTAL PROJECT COST	$3,951	3,108	6,282	6,726	7,084	$27,151	LE 594	1,359	862	914	915	LE 4,644

TABLE 10-1

PROJECT COST ESTIMATE

PRODUCTION EQUIPMENT	QUANTITY	UNIT COST	US DOLLAR COST (IN THOUSANDS)	EGYPTIAN POUND COST (IN THOUSANDS)
Pipe Extruder	6	$ 165	$ 990	-
Vacuum Hoppers Loaders	6	5	30	-
Extruder Head	6	17	102	-
Extrusion Die Set	6	5	30	-
Haul-off, Forming, Cooling Unit	6	28	168	-
Perforator	6	17	102	-
Meter Counter	6	2.5	15	-
Cutting Unit	6	8	48	-
Dual Reel	6	17	102	-
PVC Reclaimer-Grinder	3	20	60	-
Air Compressor	3	12	36	-
Water Chiller	6	7	42	-
Fork Lift	3	25	75	-
Quality Control Equipment	3	6	18	-
Office Equipment	-	27	27	LE 11
Spare Parts	-	225	225	-
Transformer	3	12	36	-
Miscellaneous Equipment	-	40	40	15
SUB TOTAL EQUIPMENT			$ 2,146	LE 26
Freight and Insurance (See Note 3)			220	10
TOTAL PRODUCTION EQUIPMENT			$ 2,366	LE 36

Notes:

1. All equipment shall be purchased in 1977 to assure identical units and to avoid schedule delays for long lead items.

2. Escalation of equipment costs is included in unit prices.

3. Freight costs are based on air freight charges.

TABLE 10-1 (Continued)

PROJECT COST ESTIMATE

	US DOLLAR COST (IN THOUSANDS)						EGYPTIAN POUND COST (IN THOUSANDS)					
RAW MATERIAL COSTS	1977	1978	1979	1980	1981	TOTAL	1977	1978	1979	1980	1981	TOTAL
PVC Raw Material To Alexandria	$ 293	2,156	4,743	5,174	5,449	$17,815	-	-	-	-	-	-
Local Transport	-	-	-	-	-	-	LE 4	25	48	49	50	LE 176
TOTAL RAW MATERIAL	$ 293	2,156	4,743	5,174	5,449	$17,815	LE 4	25	48	49	50	LE 176
OPERATIONAL COSTS												
Expatriate Technicians	50	100	67	-	-	217	5	10	7	-	-	22
Egyptian Staff	-	-	-	-	-	-	20	70	100	115	115	420
Administration	-	-	-	-	-	-	3	7	12	12	12	46
Electric Power	-	-	-	-	-	-	90	260	300	320	320	1,290
Equipment Maintenance @ 3% of Equipment	-	-	-	-	-	-	-	28	28	28	28	112
Building Maintenance @ 1.5% of Building	-	-	-	-	-	-	-	6	6	6	6	24
TOTAL OPERATIONAL COST	$ 50	100	67	-	-	$ 217	LE 118	381	453	481	481	LE 1,914

TABLE 10-1 (Continued)

PROJECT COST ESTIMATE

PLANT CONSTRUCTION	QUANTITY	UNIT COST	US DOLLAR COST (IN THOUSANDS) 1977	1978	TOTAL	EGYPTIAN POUND COST (IN THOUSANDS) 1977	1978	TOTAL
Site Acquisition	3/2.8 Fed	LE 2,000	-	-	-	LE 6	11	LE 17
Site Preparation	-	LE 4,000	-	-	-	4	8	12
Production Building	3/1260 m^2	LE 70	-	-	-	88	176	264
Storage Shed	3/ 175 m^2	LE 40	-	-	-	7	14	21
Plant Office	3/ 50 m^2	LE 100	-	-	-	5	10	15
Quality Control Lab	3/ 25 m^2	LE 100	-	-	-	2.5	5	7.5
Repair Shop	3/ 50 m^2	LE 100	-	-	-	5	10	15
Power Connection	3	LE 35,000	-	-	-	35	70	105
Water Connection	3	LE 3,500	-	-	-	3.5	7	10.5
Sewer Connection	3	LE 2,000	-	-	-	2	4	6
Security Fence	3	LE 6,000	-	-	-	6	12	18
Engineering and Supervision			$ 30	60	$ 90	10	22	32
Equipment Installation			8	16	24	10	18	28
TOTAL - PLANT CONSTRUCTION			$ 38	76	$ 114	LE 184	367	LE 551

TABLE 10-1 (Continued)

PROJECT COST ESTIMATE

	US DOLLAR COST (IN THOUSANDS)					EGYPTIAN POUND COST (IN THOUSANDS)					
OVERHEAD COST	1977	1978	1979	1980	TOTAL	1977	1978	1979	1980	1981	TOTAL
20% Total Cost Excluding Raw Materials & Equipment	$ 18	35	13	-	$ 66	$ 60	150	91	96	96	LE 493
CONTRACTOR'S PROFIT											
7% Total Cost Excluding Raw Material	173	15	6	-	194	40	90	54	58	58	300

escalation over the duration of the project. All these costs are considered to be U.S. Dollar costs except for the local transportation from Alexandria to the plant.

10.2.4 Operational Costs

The U.S. Dollar costs are based on 80% of the total cost of the expatriates based on 4.33 man years of work effort.

10.2.5 Overhead Cost and Contractor's Profit

The overhead and contractor's profit are based on current U.S. practices, i.e., 20% overhead rate and 7% profit. Local contractor profit was included in the estimate assuming the subcontract for the plant construction is let to a private sector company.

10.2.6 Contingencies

The contingencies were divided into two subsections, i.e., physical contingencies and price contingencies. Also, they were calculated for both foreign currency and local currency. The physical contingency was calculated as 15% of total project costs excluding raw materials and 10% for raw materials less local transport costs. The price contingency was calculated at 20% of total project cost.

10.3 Analysis of Cost Estimate

Several major factors affect the expenditures of funds for the project. All the production equipment will be purchased in the first year (1977) hence a large capital expenditure. In the second year, the costs drop off during the construction and plant start-up phases. The costs for the third and fourth years of the project reflect full pipe production and implementation. The fifth year is also a full production year, however,

the raw materials will have been purchased in the preceding year. The fourth and fifth year cost data also reflect a withdrawal of foreign labor.

10.4 Back-Up Calculations

10.4.1 Raw Material Costs

The actual cost of compounded PVC will escalate in accordance with the Chemical Process Industries Price Index for plastics as published by the McGraw-Hill in Chemical Engineering. The following costs are estimated PVC costs over the next five years.

TABLE 10-2

COMPOUNDED PVC

ESTIMATED COST

	1977	1978	1979	1980	1981
BASE PRICE (1977)	$ 0.55	0.55	0.55	0.55	0.55
EXCALATION PVC	-	0.044	0.088	0.154	0.22
COMPOUNDING	0.110	0.110	0.121	0.132	0.132
PACKAGING	0.022	0.022	0.033	0.044	0.044
SPECIAL HANDLING	0.022	0.022	0.022	0.022	0.022
FREIGHT TO ALEXANDRIA	0.132	0.132	0.154	0.154	0.154
TOTAL PVC COST (KG)	$ 0.836	0.88	0.968	1.056	1.112

NOTES:
1. Costs are given in U.S. Dollars per Kilogram of PVC.
2. Price information is referred to 1977.
3. Costs represent shipment from U.S. plant to the Port of Alexandria.

WEIGHT OF PVC PIPE PER FEDDAN

$$\frac{0.35 \text{ Kg of Pipe}}{\text{Meter of Pipe}} \times \frac{100 \text{ Meters of Pipe}}{\text{Feddan}} = \frac{35 \text{ Kg of Pipe}}{\text{Feddan}}$$

COST OF RAW MATERIAL PER YEAR

1977

$$10{,}000 \text{ Fed} \times \frac{35 \text{ Kg}}{\text{Fed}} \times \frac{\$0.836}{\text{Kg}} = \$\ 293{,}000$$

1978

$$70{,}000 \text{ Fed} \times \frac{35 \text{ Kg}}{\text{Fed}} \times \frac{\$0.88}{\text{Kg}} = \$\ 2{,}156{,}000$$

1979

$$140{,}000 \text{ Fed} \times \frac{35 \text{ Kg}}{\text{Fed}} \times \frac{\$0.968}{\text{Kg}} = \$\ 4{,}743{,}000$$

1980

$$140{,}000 \text{ Fed} \times \frac{35 \text{ Kg}}{\text{Fed}} \times \frac{\$1.056}{\text{Kg}} = \$\ 5{,}174{,}000$$

1981

$$140{,}000 \text{ Fed} \times \frac{35 \text{ Kg}}{\text{Fed}} \times \frac{\$1.112}{\text{Kg}} = \$\ 5{,}449{,}000$$

TOTAL RAW MATERIAL COST $ 17,815,000

10.4.2 Overhead, Contractor's Profit, and Contingencies - Foreign Currency

10.4.2.1 Overhead Costs - Foreign Currency

20% of total cost (excluding cost of raw materials and equipment)

$ 331,000 x 0.20 = $ 66,200

10.4.2.2 Contractor's Profit - Foreign Currency

7% of total cost (excluding cost of raw material including overhead)

$ 2,763,200 x 0.07 = $ 193,400

10.4.2.3 Contingencies - Foreign Currency

Physical - 15% on total project excluding cost of raw materials

$ 2,956,600 x 0.15 = $ 443,500

- 10% Raw Materials

$17,815,000 x 0.10 = $ 1,781,500

Price - 20% on total project cost

$20,771,600 x 0.20 = $ 4,154,300

10.4.3 Overhead, Contractor's Profit, and Contingencies - Local Currency

10.4.3.1 Overhead Cost - Local Currency

LE 2,465,000 x 0.20 = LE 493,000

10.4.3.2 Contractor's Profit

10% total project cost (excluding raw materials)

LE 2,994,000 x 0.10 = LE 299,400

10.4.3.3 Contingencies

Physical - 15% total project cost

LE 3,203,500 x 0.15 = LE 481,000

Price - 20% of total project cost

LE 3,469,000 x 0.20 = LE 694,000

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