SAIGON
WATER DISTRIBUTION PROJECT

CONTRACT NO. AID/vn-86

MONTHLY REPORT
NUMBER 12
MAY 31 , 1971

FOR

UNITED STATES
AGENCY FOR INTERNATIONAL DEVELOPMENT
AND
SAIGON METROPOLITAN WATER OFFICE
MINISTRY OF PUBLIC WORKS
REPUBLIC OF VIETNAM

MERRITT-CHAPMAN & SCOTT CORPORATION
MORRISON-KNUDSEN COMPANY, INC.
J. E. GREINER COMPANY, INC.
ENGINEERS

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SAIGON VIETNAM

AID - VN - 86

SUBMITTED BY :

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ENGINEERS
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June 15, 1971

United States Agency for
International Development
Mission to Vietnam

Saigon Metropolitan Water Office
Ministry of Public Works
Republic of Vietnam

SUBJECT: Monthly Report for May, 1971
Contract AID/VN-86

Gentlemen:

With the exception of pressure recordings, the testing and measuring of the distribution system are complete. Inventory of valves and hydrants will continue, as will verification and investigation of system components. And, of course, there will be a constant need for checking, verifying or uncovering information as the analyses of the system develops more alternatives and trade offs.

A notable achievement during May was the completion of the district measurement program. After the months of preparation the tests went as scheduled with no adverse effects other than isolated interruptions in service. The cooperation of the treatment plant and sector personnel was necessary and was received. We thank all those who were involved.

Respectfully submitted,

WILLIAM A. CHENEY
ACTING PROJECT MANAGER

TABLE OF CONTENTS

LIST OF TABLES			i
LIST OF FIGURES			ii
SECTION	I	- PROJECT DESCRIPTION	I
SECTION	II	- PROJECT HISTORY	2
SECTION	III	- PROGRESS, ENGINEERING	4
SECTION	IV	- PROGRESS, CONSTRUCTION	22
SECTION	V	- PROGRESS, PROCUREMENT	22
SECTION	VI	- SUMMARY DATA	23
SECTION	VII	- PERSONNEL	24
SECTION	VIII	- ENVIRONMENTAL WORK CONDITIONS	25

LIST OF TABLES

TABLE	1	- COMPLETE GEOPHONE SURVEY RESULTS	11
	2	- MAJOR UNDERGROUND LEAKS	12
	3	- WATER STUDY AREA #3 DATA	13
	4	- COMPILATION OF WATER STUDY DATA	15
	5	- TYPICAL COSTS, PIPE MATERIALS	17

LIST OF FIGURES

	Page
1 - Project Study Area	2
2 - Project Schedule	18
3 - Forecast/Progress Chart	19
4 - Number of valves inspected 6" & larger	20
5 - Location of Pitometer Districts	21
6 - Photograph of Pitometer Installation	6
7 - Photograph of Pipe Samples.	16

APPENDIX

Basic Hydraulic Studies on Standard Distribution Network Systems	1 - 4
Index to Figures	5
(Figures 1 - 16, Showing Pressures for Pipe Grids with a Range of Population Densities and a Minimum Fire flow.)	6 - 19

SECTION I

PROJECT DESCRIPTION

The objectives of the Saigon Water Distribution Project are as follows:

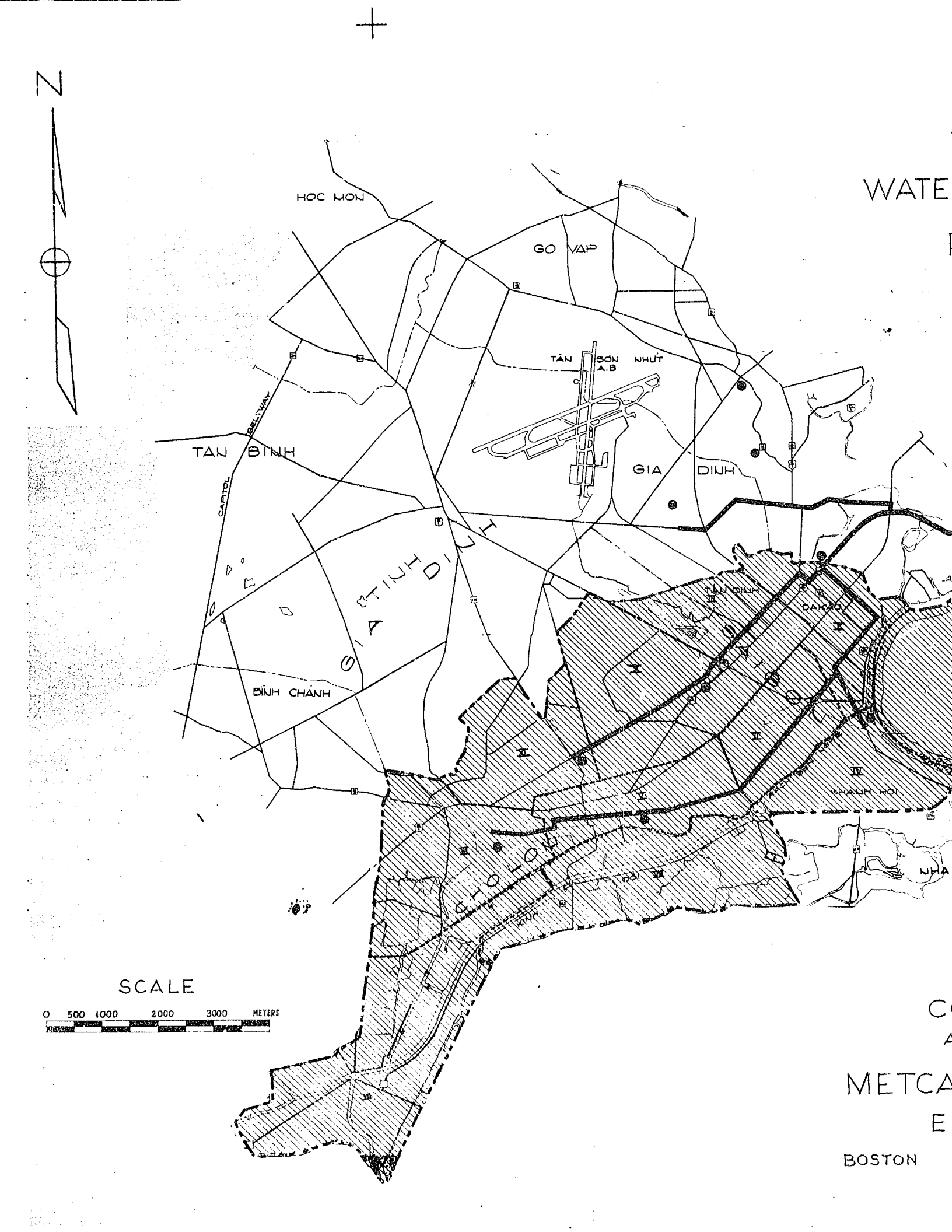
1. Examine the existing system to determine its physical condition and the extent it can meet current and foreseeable future demands.

2. Determine improvements or modifications to the existing system that should be made to upgrade the system to meet current or immediately foreseeable distribution demands.

3. Prepare a program for expansion of the Saigon metropolitan area water distribution system within the study area (Figure 1.) The program for expansion shall be keyed to implementation by increments that can be related to project time periods, GVN financial capacity, and engineering and construction considerations.

The major deficiencies in the existing network would be identified and a program of remedial action would be undertaken through a survey and inventory of the existing system, supplemented by a program of hydraulic measurement. The distribution network would then be analysed and recommendations made for an immediate program to achieve the greatest possible improvement with a relatively limited program of reinforcements and inter-connections.

The system would also be studied for determination of an improved system of primary and secondary mains to provide adequate distribution throughout the present water service area. A phased construction program would be recommended that would be related to increments of time and which would recognize the ultimate demands within the existing water service area.



WATE

C

A

METCA

E

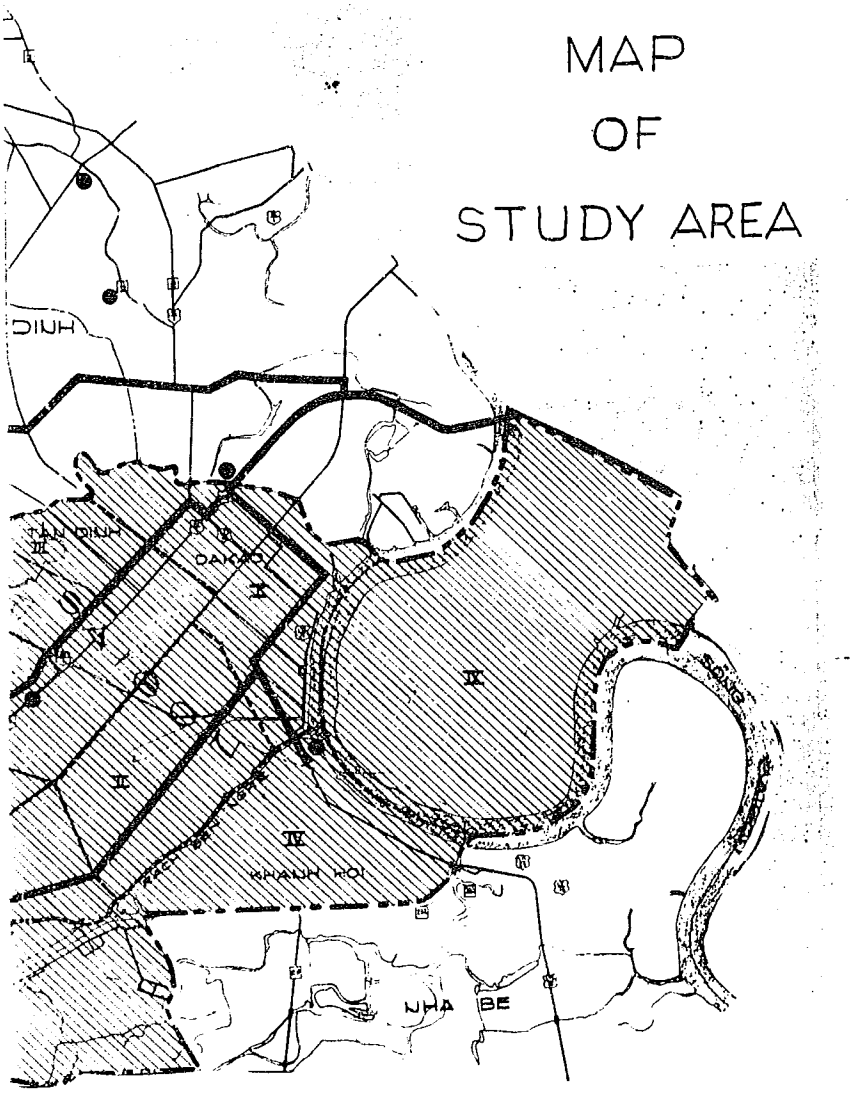
BOSTON

FIGURE 1

SAIGON

WATER DISTRIBUTION PROJECT

MAP OF STUDY AREA



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BOSTON SAIGON

JUNE 1970

SECTION II

PROJECT HISTORY

The Thu Duc water treatment plant began operations in June 1966. Pressure mains were completed in 1967 which were able to transport water to all of the metropolitan system in Gia Dinh and Saigon-Cholon.

By September of 1967 water production reached the capacity of the existing transmission system. Since that time expansion of the system has been undertaken only as pipe stock, connections and other supplies and materials became available. It readily became apparent that a hydraulic survey and investigation of the system were needed together with a plan for the replacement, reinforcement, and further expansion of the system.

Following discussions among personnel of the SMWO, USAID and AID/W, a scope of work was developed as a basis for discussion with interested consultants. The chronological order of events following the initial advertisement in the Commerce Business Daily for statements of interest by consultants in the summer of 1969 was as follows:

October 6, 1969	- Metcalf & Eddy, Inc. selected for negotiation.
April 15, 1970	- Effective date of contract.
May 15, 1970	- Personnel approved.
May 30, 1970	- Engineer's advance party arrived in Saigon to begin work.
October 20, 1970	- Meeting with Chief of City Public Works Office, the City Police, USAID and SMWO at the the SMWO Office to discuss work during curfew hours.
December 2, 1970	- Presentation of test procedures and work review with SMWO.
January 15, 1971	- Tenth anniversary celebration of the Saigon Metropolitan Water Office

SECTION III

PROGRESS ENGINEERING

Until the end of the first week in May, there was some doubt as to whether the district measurements could be made. Extra effort in locating alternae valves in several locations and the long awaited permission by the Prefecture for excavations at several other locations enabled the Contractor to make the flow measurements during the third week in May.

Considerable discussion led to the decision to work the field crews on 12 hour shifts during this testing period rather than hire additional people for short employment. To the credit of all concerned the tests were conducted as scheduled under normal operating pressures, at 30 meters for 24 hours and at 35 meters for 24 hours in two sequential test periods in Saigon and Cholon. That the maximum limit of the measurements was achieved is attested to by the statement that the treatment plant could not have sustained a 24 hour test at one meter higher pressure. The results of the program will be presented in the next month's report.

The appendix to this months report explains and includes examples of sample pipe sizing for various grid spacing within loops to reflect pressure drops which would result with a set fire flow coupled with the consumption of different population densities within the grids. This graphic example of the computer out-put demonstrates the range of alternatives it is possible to consider with the resultant effects.

During the reporting period, the pressure survey was continued. A number of readings to fill in those collected earlier for the various testing programs were taken. The readings serve to both complete the pressure gradients within the system as well as to confirm or check computer out-put.

The outline below follows that shown in Figure 2, "Project Schedule and Time Distribution" The percentage of completion is shown in Figure 3. It was called to our attention that the estimated time lag as shown in Section VI, "Summary Data", was less than that shown by projecting the completion curve in Figure 3. The reason for this is the "scatter" or the disparity between the average or curve line and the actual point on the line for any

given time. The actual planned completion for each month is shown numerically at the top of Figure 2 under each month's heading.

A. MAPPING

Work began on the system over lays which will be inked mylars. The entire system has been plotted in pencil on report size sheets and the final inking will go forward as parts of the system are finally verified.

The mapping of pertinent Gia Dinh system components is now complete except for the verification of certain valves. The growth of the system there has been quite remarkable.

B. SYSTEM INVENTORY

Roughly two weeks of the field crews effort was devoted exclusively to the district measurement program during the reporting period. This work took precedence over the inventory of the system facilities. Some progress was made as noted below.

Valves and Hydrants During the reporting period 41 valve locations were inspected and plotted. Nineteen hydrants simularly were inspected and located on the 1/500 system maps and the Contractor's 1/5000 master maps. It is expected that during the next report period the work of one field crew will be devoted exclusively to inventory work and two more crews will be added with the completion of the Pitometer work.

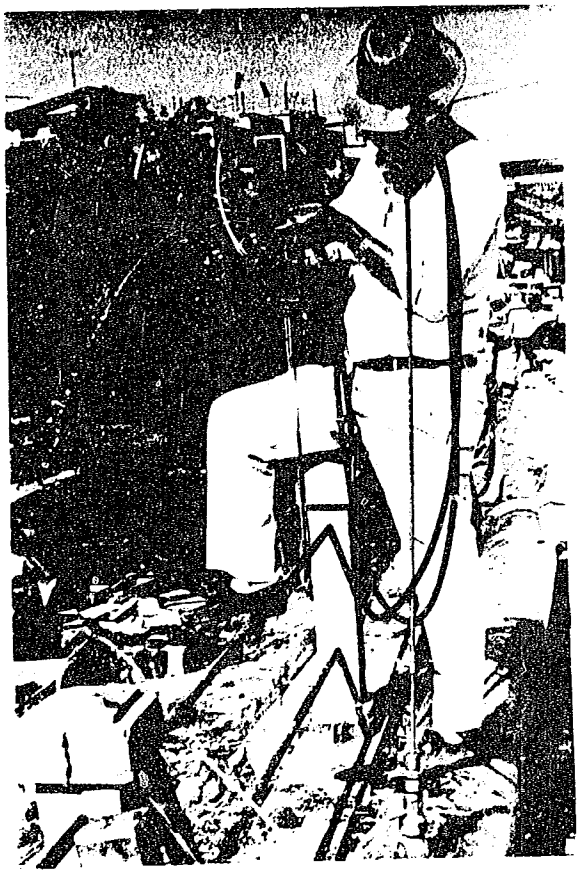
Pipe size verification continued with the inspection of excavations made by the various STC sector crews. Thirty-seven such inspections were made during the month.

C. HYDRAULIC MEASUREMENT PROGRAM

The tests and surveys for this program are largely concluded. The results of the complete leakage survey are shown in Table 1. The crews will continue checking until the middle of June as seems appropriate. The third water area study results are also shown (Table 3).

The pressure survey began again at the end of the reporting period and will carry on through June. The district measurements were run finally during the third week in May with the preparatory work taking up much of the first two weeks of the month.

Technicians taking simultaneous readings from pitometer and differential manometer during the test by the "hose" method.



Technician bleeding air from pitometer hoses in preparation for test.

Pipe condition test of 300 Ø mm line on Ben Van Don at the Cau Chong River Crossing.

Pressure Survey. Pressure recorders were placed by the crews during the last week in May. It is anticipated that about 50 more locations will be recorded before the end of this program in June.

Geophone Survey. The geophone coverage was completed for all of the system within the study area. The only work that continues is rechecks of underground leaks after repairs by STC.

District Measurements. Repair of 35 defective valves of the 80 required for the measurements took over 5 months. Also, 3/4" pitometers had to be designed and fabricated locally to allow gauging flow from existing 3/4" air relief corporations in the concrete trunk mains. Through perseverance it all was done and the measurements were completed in the last half of May at terminal station pressures of 30 and 35 meters respectively, for 24 hour periods. The results of the measurements will appear in the next monthly report.

Due to the unavoidable delays in making the measurements, their sole original purpose of assisting in locating water waste and leakage was after the fact. In the final outcome, however, a complete geophone survey of all the system instead of the originally planned survey in only those areas where district and sub-division measurements indicated the highest probability of leakage and waste, was accomplished. And the results of the geophone survey were excellent with an estimated 32,500 med leakage and waste from broken mains, services and fixtures located. In fact, this is approximately [illegible] to 10% of production originally established as a reasonable goal for a survey with a complete series of district and sub-division measurements. Such a survey for a city the size of Saigon would take more than a year even if system records, system facilities and the cooperation among those involved were ideal.

The preparations and results from these measurements will serve well future waste and leakage work. And they are more comprehensive then originally scoped in that the system was divided into a more definitive 9 districts instead of the originally planned 3 or 4. Also, measurements by this finer division are valuable for system design. (Figure 5 shows the district boundaries).

Water Studies. A brief summary of results from Study # 3 in Cholon, which was completed this report period, is shown in Figure 3. A comparative summary for all three studies is shown in Table 4. More complete information for all the studies will be included in the final report of the Pitometer Associates.

E. PLANNING STUDY

Water Use. The major effort for the month was the conversion of system water use data into node takeoffs for system simulation.

A Method was developed which utilized the data available on water use in the Districts and Phuongs of Saigon and Cholon together with land use studies, existing distribution system plans, and aerial photographs so as to simulate existing water use patterns.

A computer program was written to help in processing these data into the node takeoffs for the various system conditions. The program is to some extent self-checking; i. e., it identifies errors occurring in the disaggregation and assignment of water use in Phuong areas into node tributary aeras.

A sample of the data analysis computer printout will be presented in next months report.

Work has been started on the selection of criteria and bases for determining the 1980 water supply requirements. This projection will consider, in addition to increasing water use for an increasing population, the effect of increasing per capita water use in low pressure areas when improvements are made; extensions to provide service in heretofore unserved areas; consideration to serve military areas not currently served by SMWU; increasing industrial and organization water use; and reduction of unaccounted for water.

F. HYDRAULIC ANALYSIS

Model Verification The data collected on the pipes and nodes of the primary distribution system have been transferred onto punched cards. The punched card input was printed out, checked against the data sheets, and corrected where necessary.

The results of the pipe condition tests were further analyzed to develop a mathematical expression linking the Hazen-Williams C to the age and diameter of the unlined cast-iron pipes in the Saigon Water Distribution System.

The equation derived is:

$$C = F - M\,(\mathrm{Log}_{10}\,(0.15 + 0.14T) + 1)$$

Where C = Hazen-Williams Coefficient, T = the age of the pipe in years. F and M are constants for each pipe size, ranging between an F of 140 and an M of 37 for 150 mm pipe, to an F of 143 and an M of 33 for 500 mm pipe.

The results obtained from this will be used both in our system analysis and in economic evaluations between lined and unlined iron pipe.

G. SYSTEM PLANNING

Immediate Program An evaluation was made of the relative merits of the various plastic, metallic, and cement pipes based on relative costs (see Table 5) and suitability for specific elements of the distribution system. A preliminary draft of this evaluation has been written giving outline specifications. Recommendations are being formulated.

The following evaluations were initiated but not completed during the month:

1. A comparison between the carrying capacity of lined and unlined pipe using corrosion growth rate factors in unlined pipe experienced in the Saigon System to date.

2. A comparison of the cost and effectiveness of using the French flush-type hydrants vs U. S. post-type hydrants.

Development Module. An investigation was made of the potential for the initial use of 100 mm pipe. The case evaluated was that of a developing area of Gia-Dinh. The analysis was based on subsequent replacement of the 100 mm pipe when increased population density and the need for better fire protection require larger size pipe. Basic criteria were formulated, and cost effectiveness and economics were considered.

Cost Estimates. Additional cost data on water distribution system components were collected during the month. Preliminary tables and curves were prepared giving unit costs for various size and type of pipe.

H. Report

A first draft was written on the appendix section of the report on pipe condition tests which will present our results in detail.

Typing was completed on a separate report prepared by James E. Bogle, AIP, on "Four 2000 Population Projections for Republic of Vietnam and Saigon Metropolitan Area." This report will be printed and distributed during June.

TABLE 1, Geophone Survey, Total Leaks, Saigon Thuy Cuc

L E A K A G E - S O U R C E

District	Main	Service	Pub. Ft.	Hydrant	Valve	Total	% of Total
	(The Number is followed by the estimated loss in m3)						
1	20 - 10,098	12 - 328	4 - 8	0 - 0	1 - 2	37 - 10,436	6 - 32
2	52 - 3,257	21 - 638	21 - 687	5 - 144	5 - 12	104 - 4,738	17 - 15
3	13 - 319	12 - 337	22 - 331	3 - 20	2 - 7	52 - 1,014	8 - 3
4	35 - 887	15 - 264	16 - 356	1 - 1	2 - 8	68 - 1,516	11 - 5
5	27 - 1,610	19 - 248	17 - 340	8 - 177	4 - 21	75 - 2,396	12 - 7
6	41 - 1,928	4 - 144	17 - 512	2 - 10	0 - 0	64 - 2,594	11 - 8
7	5 - 12	2 - 50	8 - 119	0 - 0	1 - 1	16 - 182	3 - 0
8	27 - 1,162	18 - 302	7 - 113	0 - 0	1 - 1	53 - 1,579	9 - 5
9	S E R V E B Y P R I V A T E C O N T R A C T O R						
10	2 - 10	5 - 147	21 - 363	1 - 2	1 - 10	30 - 532	5 - 2
11	1 - 50	2 - 10	18 - 354	0 - 0	1 - 2	22 - 416	4 - 1
Gia Dinh	25 - 2,972	45 - 3,771	11 - 114	2 - 201	0 - 0	83 - 7,058	14 - 22
Total	248 - 22,305	155 - 6,239	162 - 3,297	22 - 555	18 - 64	604 - 32,461	
% of Total	41 - 69	25 - 19	27 - 10	4 - 2	3.0 - 0	100 - 100	100 - 100

TABLE 2, Major Underground Leaks Found During Geophone Survey, By Districts (23% of the leaks found with an estimated 82% of the water loss.)

District	Main	Service	Hydrant	Valve	Total
	(Number of Leaks Followed by Estimated Loss in m3)				
1	5 - 9040	5 - 295			10 - 9335
2	9 - 3075	8 - 550			17 - 3625
3	6 - 300	6 - 327			12 - 627
4	4 - 725	4 - 165			8 - 890
5	9 - 1570	5 - 220			14 - 1790
6	2 - 1750	2 - 135			4 - 1885
7		1 - 50			1 - 50
8	6 - 1125	5 - 250			11 - 1375
9	N O T	S U P P L I E D	B Y	S M W O	
10		3 - 140		1 - 10	4 - 150
11	1 - 50				1 - 50
Gia Dinh	13 - 2875	41 - 3740	1 - 200		55 - 6815
Total	55 - 20510	80 - 5872	1 - 200	1 - 10	137 - 26592

TABLE 3, WATER AREA STUDY

Water Study # 3, Cu Xa Phu Lam, Duong Hau Giang in Cholon

The area can be classified as a lower, middle income, residential area. There are thirty-four metered connections for thirty-nine properties. Two hundred and ninety-nine residents, or an average of 8.8 occupants per connection, consume water at an average of 127 liters per day.

With the line pressure on a typical day ranging from 1 meter (1800-1900) to 14 meters (0300-0400) water column, and with the house meters recording 100% of water flowing into the study area (by comparing with a calibrated master meter) consumption was as follows:

	Area Consumption in Cubic Meters.	Per Capita Consumption in Liters
24 Hour	38.2	127
Max. Hour (1800-1900)	63.6	212
Min. Hour (0300-0400)	7.5	37
% Max. Rate to Total	166%	166%
% Min. Rate to Total	20%	20%

Note that some rain water is collected and used for washing and cleaning purposes but the amount is not significant.

Statistics per connection are as follows:

Properties		1.15
Plumbing Fixtures		3.7
Taps	2.2	
Showers	0.3	
Bath Tubs	-	
Tank Toilets	0.2	
Non Tank Toilets	1.0	
Water Storage Capacity		0.72 m3
Ground	0.7	
Elevated	-	

Occupants 8.8

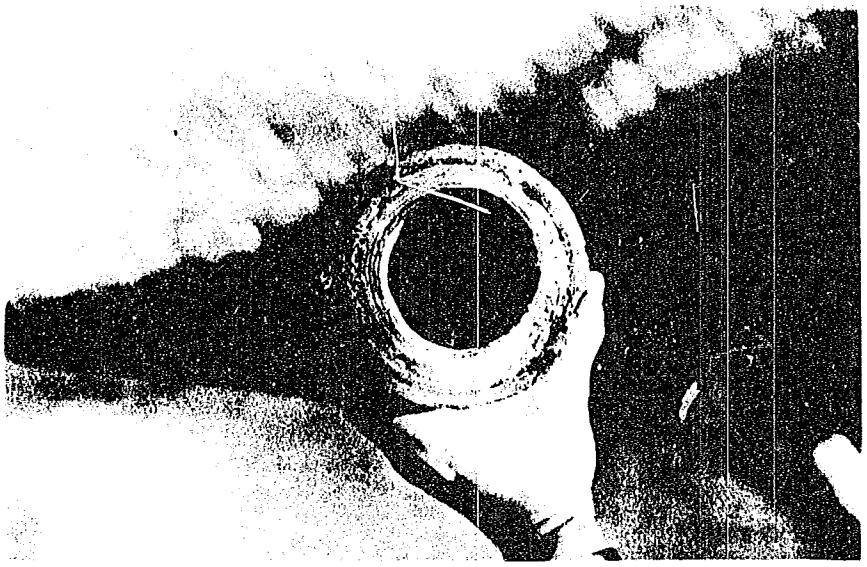
Adult	4.3
Child	4.5

Meter data is as follows:

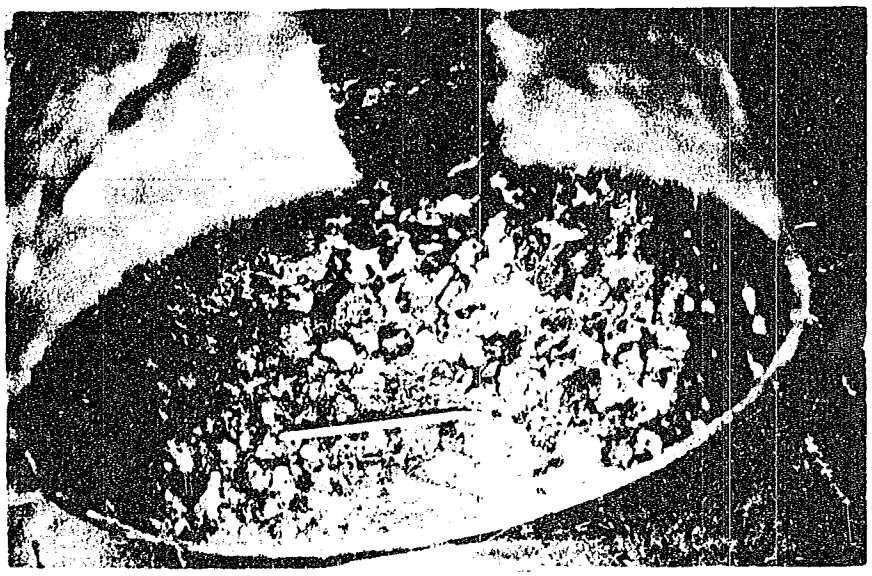
Number	Make	Origin	Type	Size
12	Doris	French	Velocity	15mm
12	Rockwell	US	Displacement	5.8"
10	Badger	US	"	"

TABLE 4, DATA SUMMARY FOR WATER STUDY AREAS

	Cholon	Saigon	Gia Dinh
Income Bracket	Low Middle	Middle	High Middle
Properties	39	17	36
Meter Connections	34	14	34
Occupants	299	125	233
Occupants per connection	8.8	9.0	6.9
Plumbing fixtures per connection	3.7	4.2	6.4
Water storage capacity per connection m3	0.7	0.8	0.7
Per capita consumption, after system leakage repaired.	124	140	150
Displacement meters	22	5	34
Velocity meters	12	9	0
Meters found stopped	0	1	2
Meter registration, as found	100%	85%	34%
Meter registration, after leakage repaired	-	-	87%
Meter registration, after stopped meters replaced.	-	95%	95%
Normal pressure range, meters water column.	1-14	10-22	14-22
Ratio max. hour to total consumption	1.66	2.50	1.50
Ratio min. hour to total consumption	0.20	0.10	0.18



100 Ø mm pipe sample from Cau Binh Tien in Cholon. The pipe was installed in 1924 and is heavily encrusted, up to 16 mm., with iron deposits from ground water wells.



500 mm Ø pipe sample from Govap collector line installed in 1925. This sample came from Vo Di Nguy & Chi Lang in Gia Dinh and shows tuberculation from low pH water.

TABLE 5, TYPICAL COSTS, PIPE MATERIALS

Type of Pipe	Class	Safety Factor	$ U. S. / Meter 200 mm.	400 mm.	600 mm.	1200 mm
PVC	Std. 160	2:1	8			
	Class 150	4:1	16			
Composite - PVC - Fiberglass	150	4:1	9			
Filled Fiberglass	100 psi.			23	36	
Polyethylene (high density)	80 psi.			60	160	
Cast Iron (coated & lined)	150 psi.		14	33		
Ductile Iron (coated & lined)	150 psi.		15	32		
Steel (coated & lined)	150 psi.				40	80
Asbestos Cement (coated)	100 psi.		8	20	42	
Reinforced Concrete prestressed (coated)	100 psi.				59	118

PROJECT SCHEDULE & TIME DIST

	% TOT. EFFORT	% COMP.	% JOB COMP.
SCHEDULED COMPLETION			
ACTUAL COMPLETION			
A			
MAPPING	21.0	81	16.9
1. SYSTEM MAPS (1:15,000)	1.5	100	1.5
2. SYSTEM WORKING MAPS	8.5	100	8.5
3. PLANNING MAPS	1.5	100	1.5
4. FINAL SYSTEM MAPS	4.0	20	0.8
5. FINAL PLANNING MAPS	1.0	100	1.0
6. SMWD SYS. MAP CORRECTIONS	4.5	80	3.6
B			
SYSTEM INVENTORY	11.0	78	8.6
1. VALVES	3.0	70	2.1
2. HYDRANTS	3.0	65	1.9
3. PIPING	4.0	90	3.6
4. CORROSION EFFECTS	1.0	100	1.0
C			
HYDRAULIC MEAS.	20.0	98	19.7
1. PIPE CONDITION TESTS	5.0	100	5.0
2. FLOW TESTS	5.0	100	5.0
3. PRESSURE SURVEY	1.0	90	0.9
4. GEOPHONE SURVEY	5.0	100	5.0
5. TRUNK MAIN SURVEY	2.0	100	2.0
6. DISTRICT MEASUREMENT	2.0	90	1.8
D			
PLANNING STUDY	7.0	86	6.0
1. DEMOGRAPHY	2.5	100	2.5
2. LAND USE	1.5	100	1.5
3. WATER USE	3.0	65	2.0
E			
FINANCIAL PROGRAM	3.0	10	0.3
F			
HYDRAULIC ANALYSIS	15.0	45	6.7
1. MODEL VERIFICATION	6.0	85	5.1
2. IMMEDIATE PROGRAM	5.0	25	1.2
3. LONG RANGE PROGRAM	4.0	10	0.4
G			
SYSTEM PLANNING	15.0	46	6.9
1. IMMEDIATE PROGRAM	4.0	40	1.6
2. DEVELOPMENT MODULE	4.0	85	3.4
3. COST ESTIMATES	2.0	30	0.6
4. LONG RANGE PROGRAM	5.0	25	1.3
H			
REPORT	8.0	8	0.6
1. TEXT	4.0	15	0.6
2. GRAPHICS	2.0		
3. CLIENT REVIEW			
4. REVISIONS & FINAL REPRODUCTION	2.0		
	100		65.7

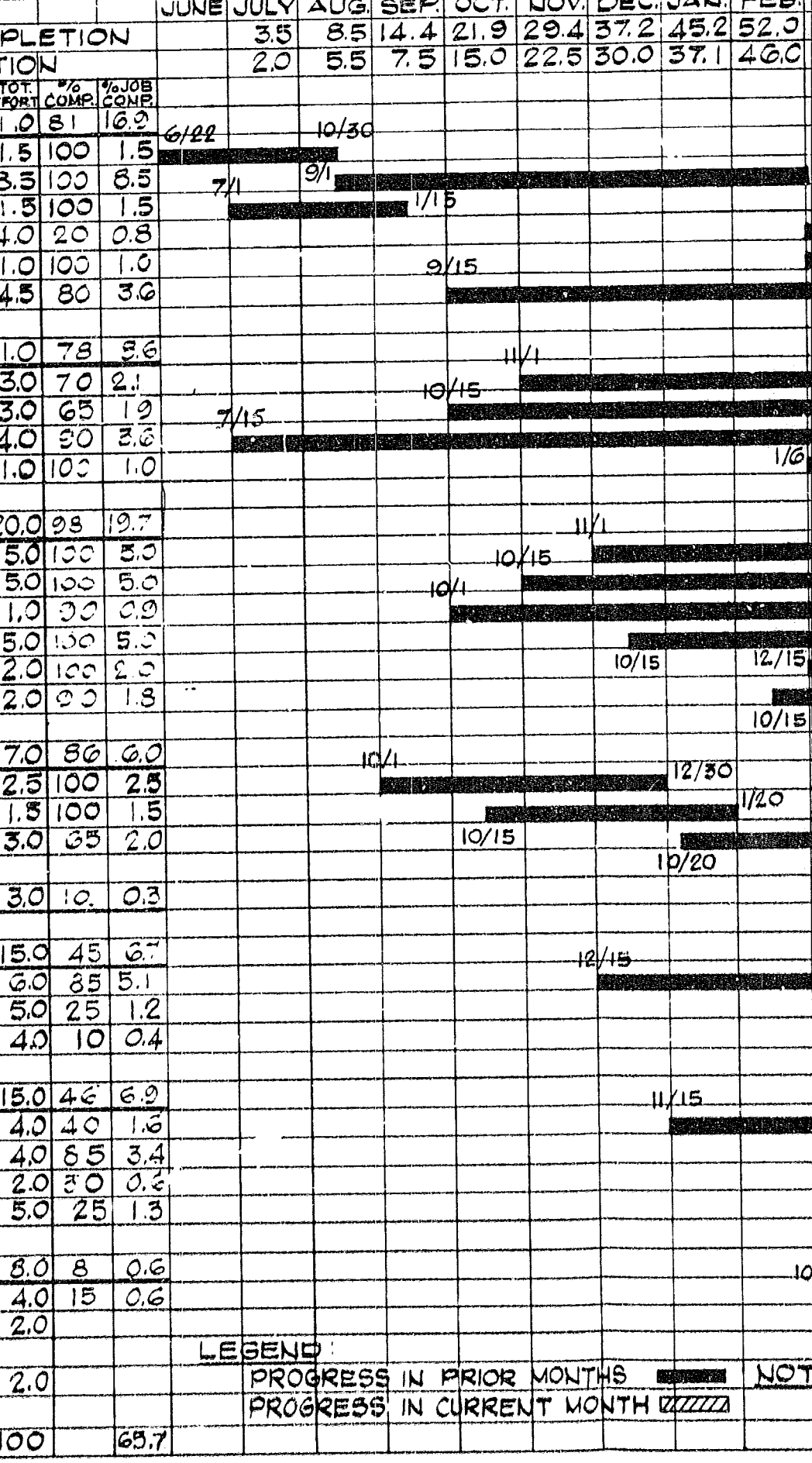
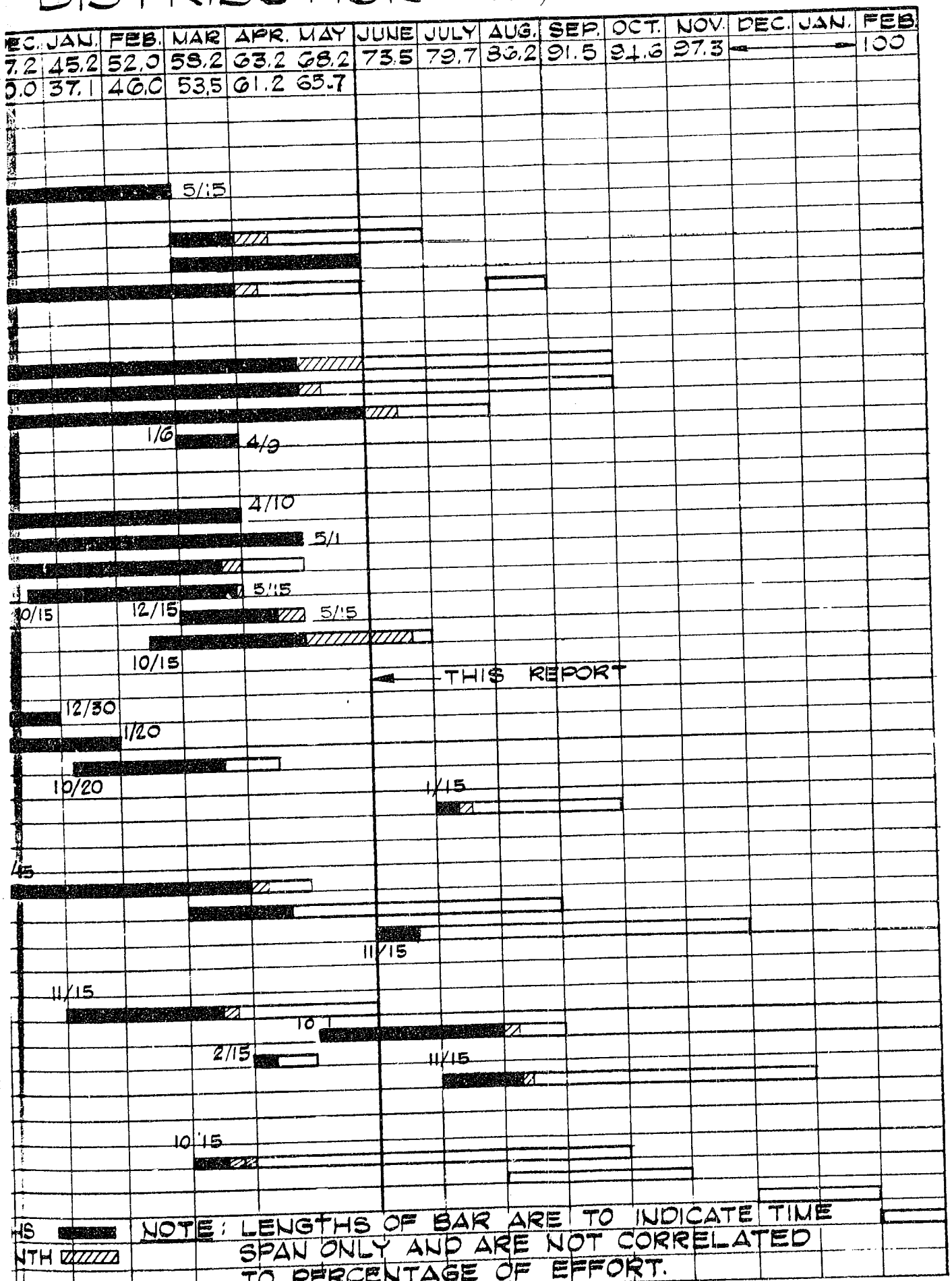


FIGURE 2

DISTRIBUTION AID/VN - 86



FORECAST/PROGRESS CHART AIB

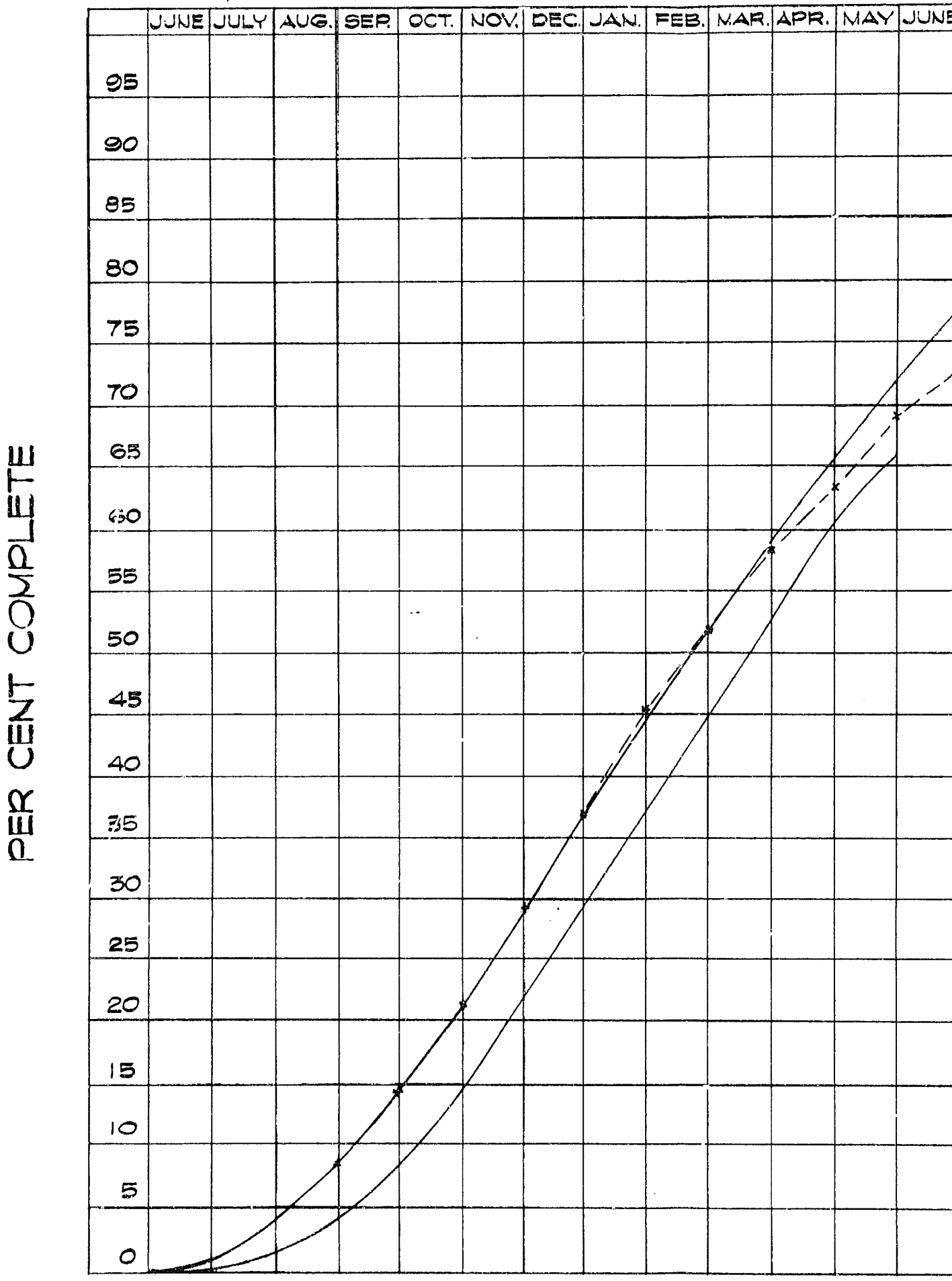
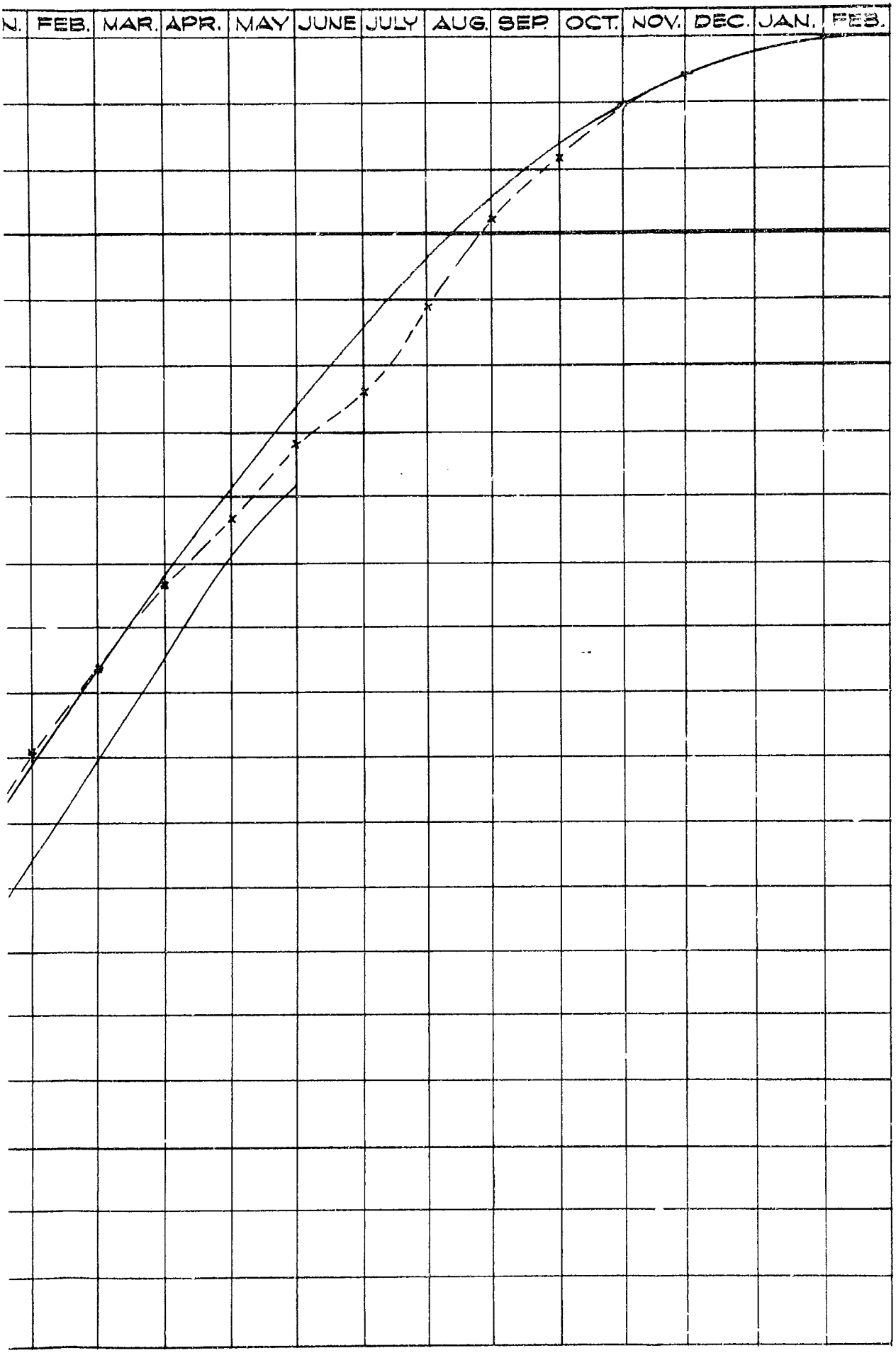


FIGURE 3

CHART AID/VN-86



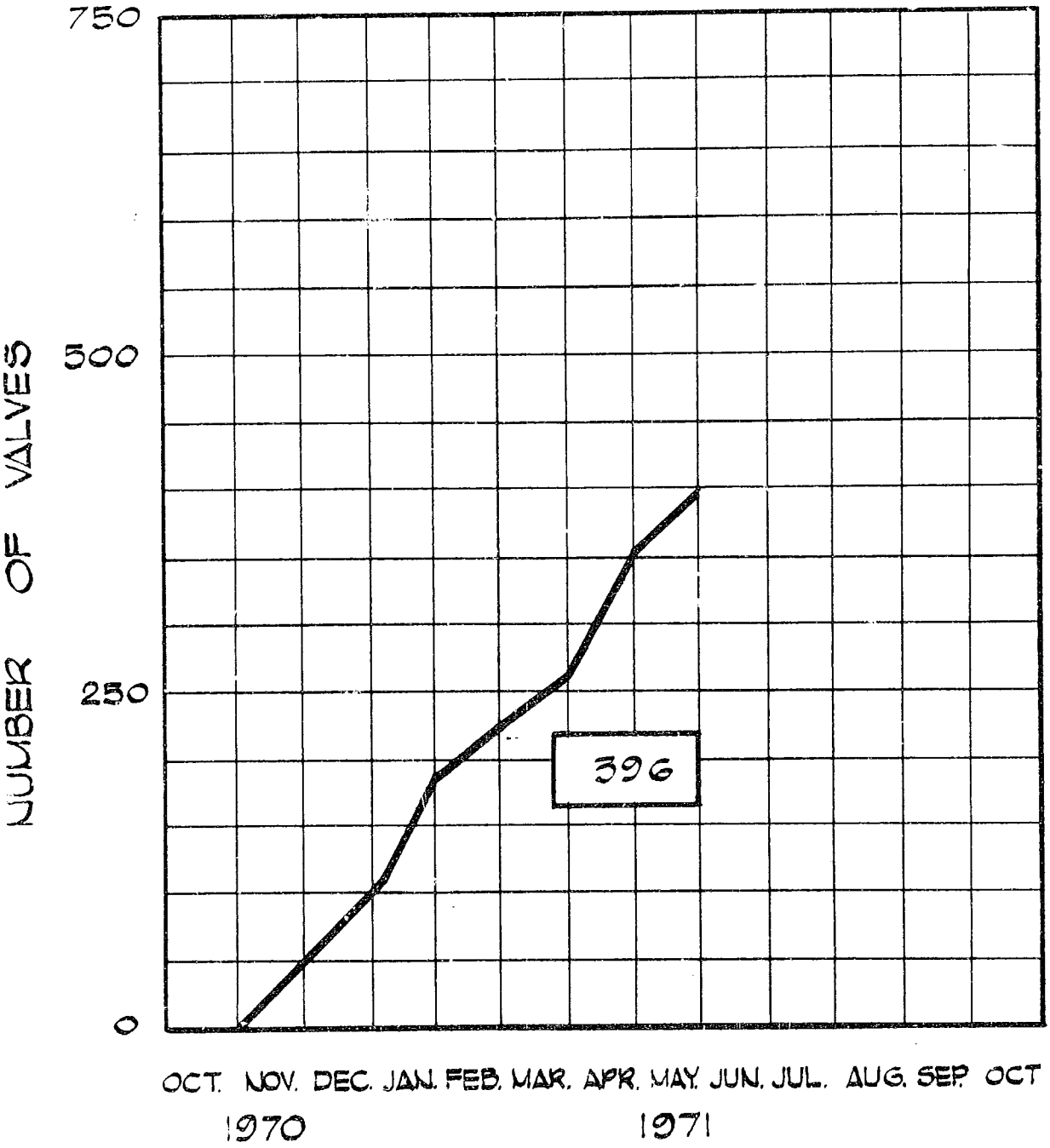
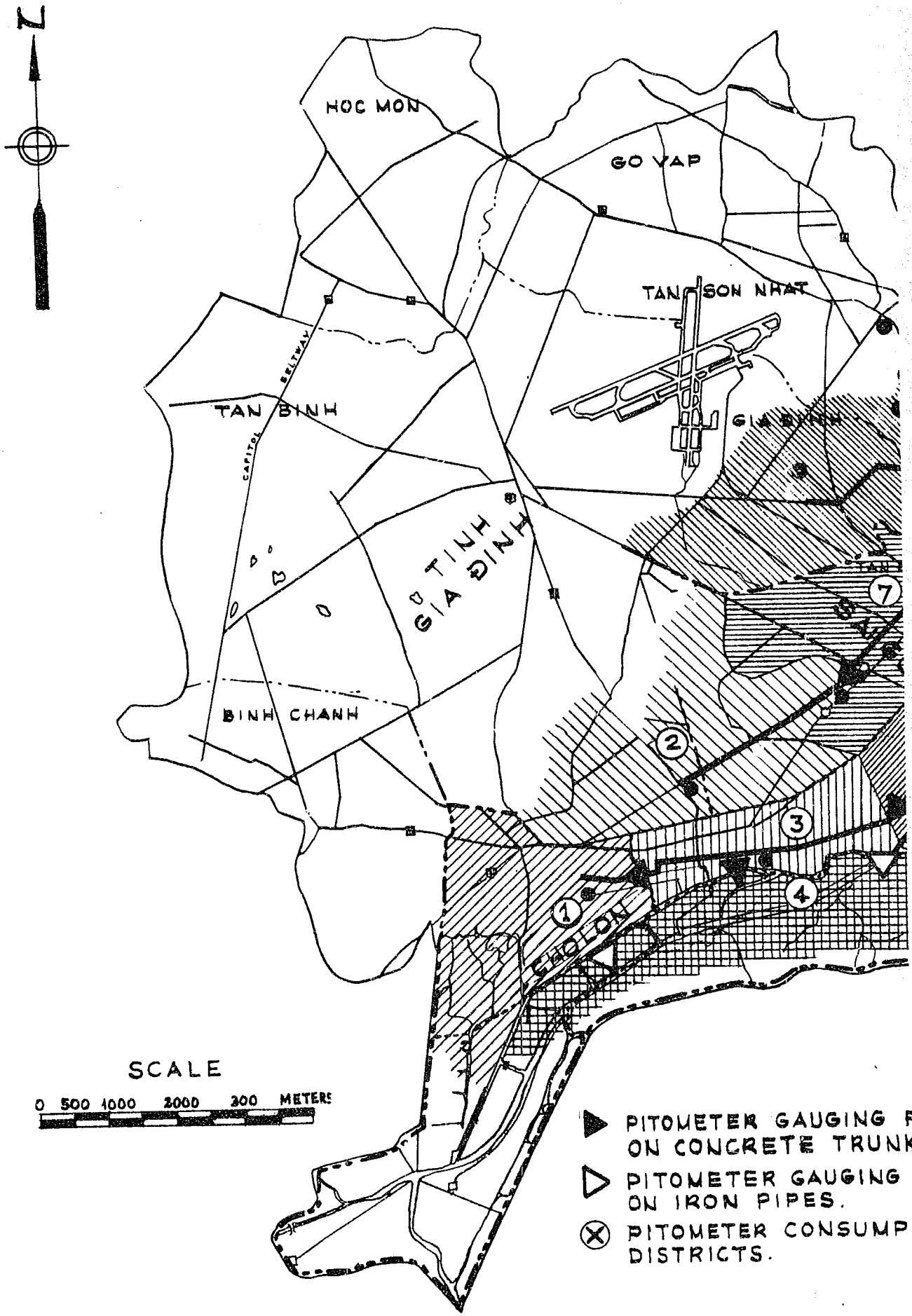


FIG. 4 NUMBER OF VALVES INSPECTED IN SAIGON CHOLON AND GIADINH PROVINCE


N
HOC MON
GO VAP
TAN SON NHAT
CAPITOL BELTWAY
TAN BINH
GIA BINH
TINH GIA DINH
BINH CHANH
1
2
3
4
5
6
7
SAIGON
SCALE
0 500 1000 2000 300 METERS
PITOMETER GAUGING F
ON CONCRETE TRUNK
PITOMETER GAUGING
ON IRON PIPES.
PITOMETER CONSUMP
DISTRICTS.

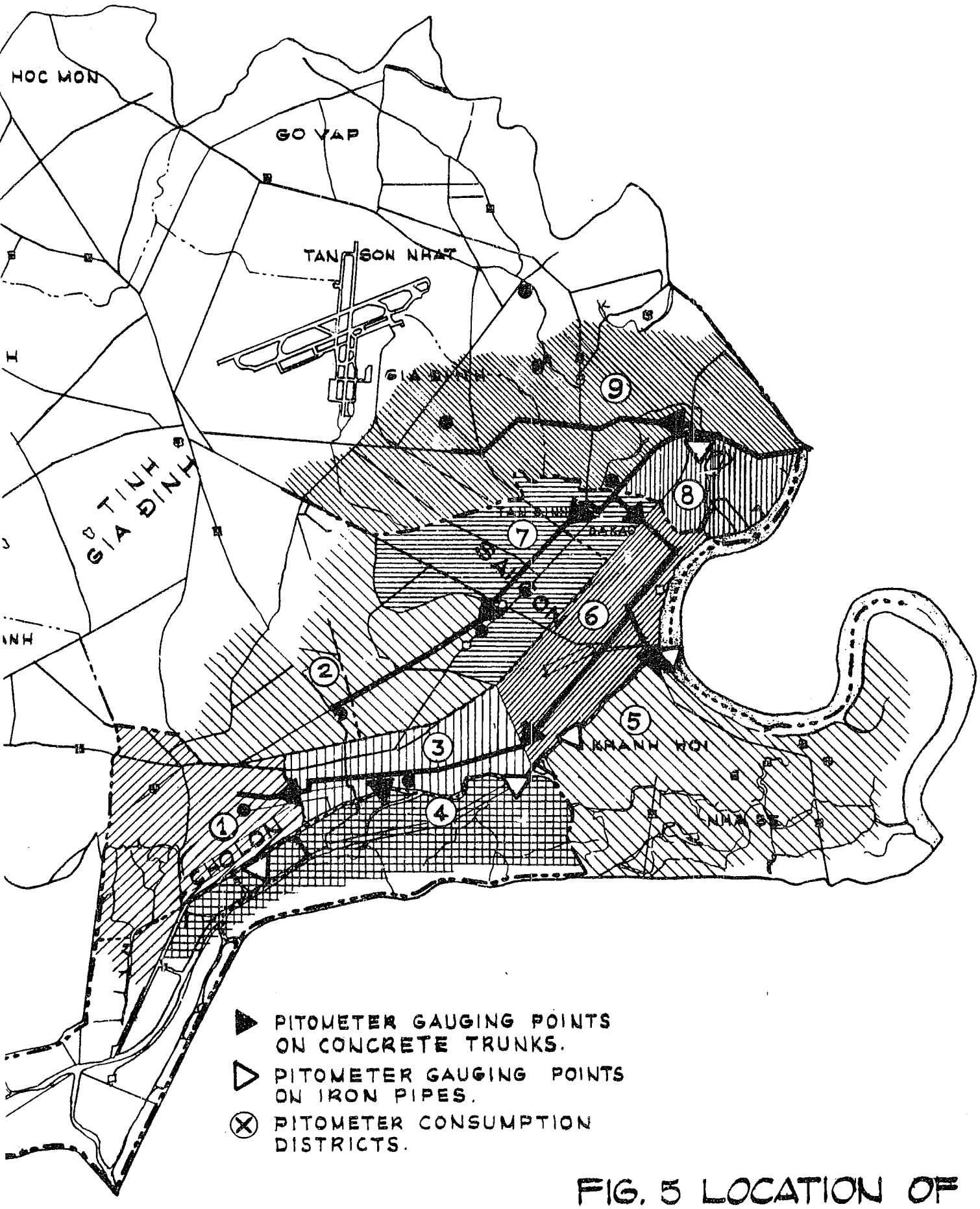


FIG. 5 LOCATION OF DISTRICT MEASUREMENTS

SECTION IV

PROGRESS, CONSTRUCTION

This project does not involve construction and no report is made under this section.

SECTION V

PROGRESS, PROCUREMENT

This project does not involve procurement and no report is made under this section.

SECTION VI

SUMMARY DATA

Contract Number	AID -vn- 86
Date of contract	4/12/70
Contract type	Cost Plus Fixed Fee
Contract estimate	
Dollars	588,209
Piasters	20,000,000
Additional expenditures since previous report	
Dollars	36,000
Piasters	1,120,740
Expenditures to data	
Dollars (5/23/71)	407,000
Piasters (5/16/71)	8,397,197
Contract completion date	March 1, 1972
Scheduled percentage complete	68.2
Anticipated completion date	March 1, 1972
Actual percentage complete	65.4
Time lag	About two weeks

SECTION VII

PERSONNEL

On May 31st, there were 35 Vietnamese on the Metcalf & Eddy Staff. This represented three less than were on the rolls at the end of the last reporting period. There were four Americans and one Third Country National for a total staff of 40.

During the month the following U.S. Staff were in Vietnam

WILLIAM A. CHENEY	Acting Project Manager & Data Collector
DONALD M. DEWART	Hydraulic Engineer
JAMES G. DOLAN	(Left May 10, 1971)
GEORGE W. MANN, Jr.	Field Engineer
WILLIAM SHEARSTON	(Left May 31, 1971)

Both Messrs. Dolan and Shearston have completed their work in Vietnam. Mr. Shearston's work as Office Manager will be carried on by Mr. Ernesto Gabriel who came to the project team from the Philippines.

During the reporting period the district measurement program was completed at a number of locations and consequent man power requirements were extraordinary. It was decided after discussions with the Project Representative that it would be more practical and economical to man shifts of 12 hours with men from the field crews than to hire extra crews for the measurement program. Though the pay rolls appear to have increased rather sharply, they will fall off proportionately during the following pay period. To the credit of the supervisory personnel and the field engineers as well as the crews themselves, there were no delays or extensions of the tests once they began.

It is anticipated that in the coming month that the Pitometer and Pressure Measurement Work will be concluded which will allow a further reduction in staff numbers.

SECTION VIII

ENVIRONMENTAL WORK CONDITIONS

No report is required under this section for this reporting period.

APPENDIX

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 3

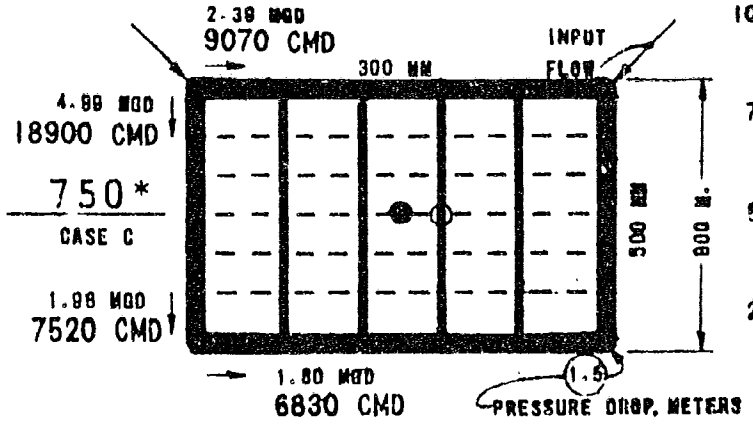
SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

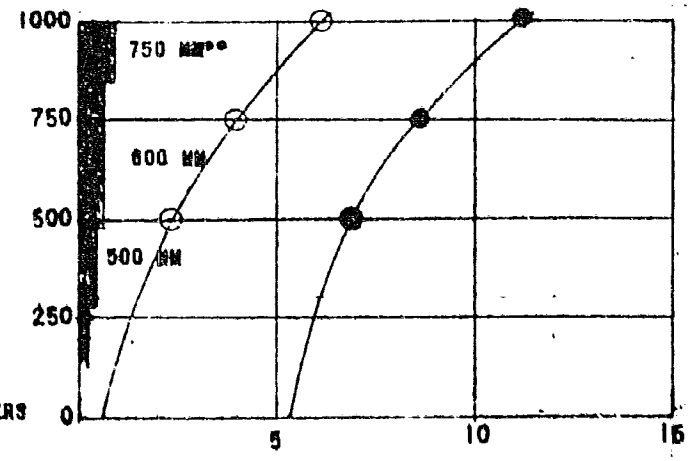
DETAIL USE SYSTEM FOR 500 - 750 ppha COMPUTED BY

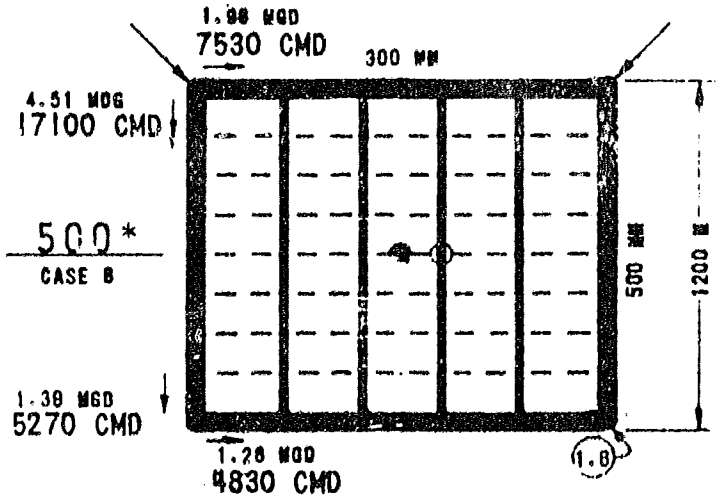
PIPE SIZES

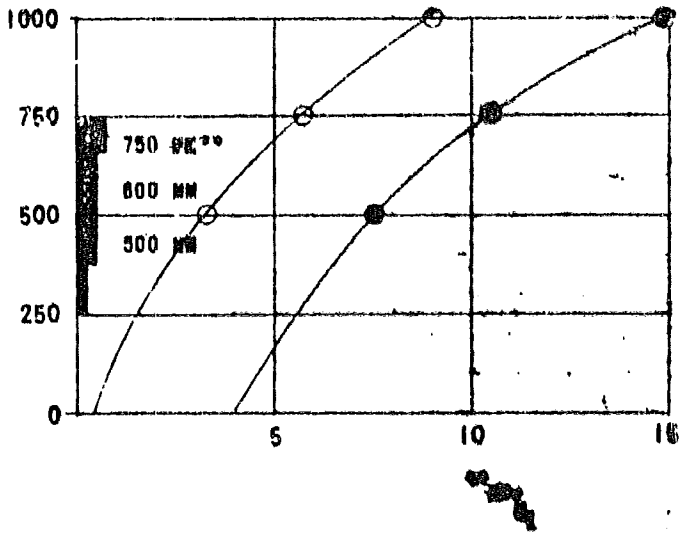
– – – – 150 MM ——— 250 MM ▬▬▬ OUTSIDE

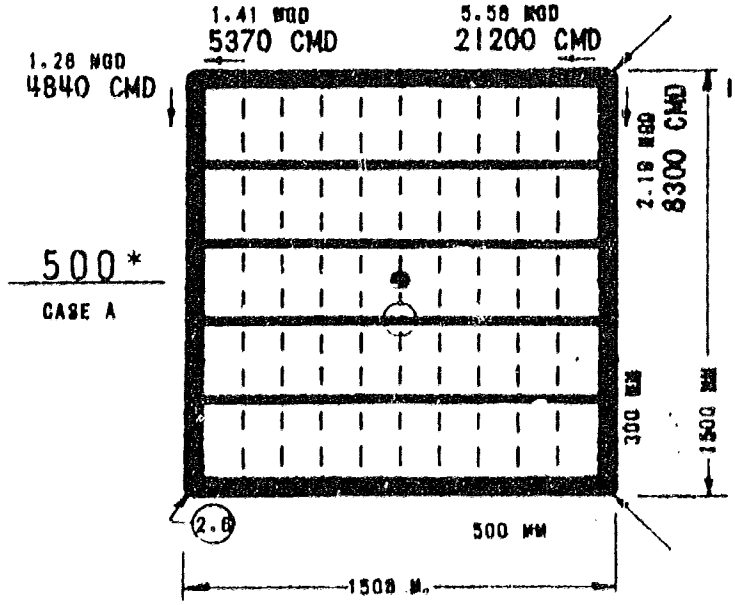
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW ● 63 LPS, C = 120

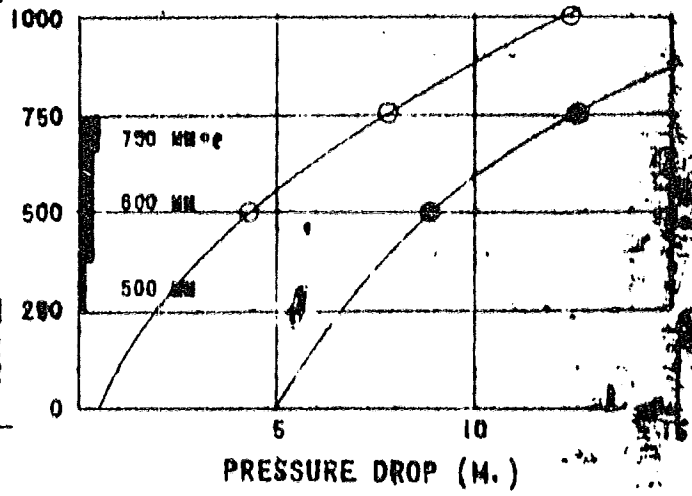












*ppha = PERSONS PER HECTARE

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION ADJACENT TO ● FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 4

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

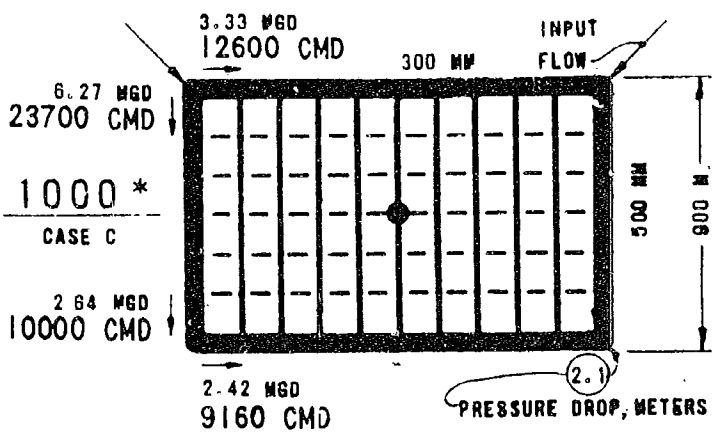
DETAIL USE SYSTEM FOR 500 - 1000 ppha COMPUTED BY

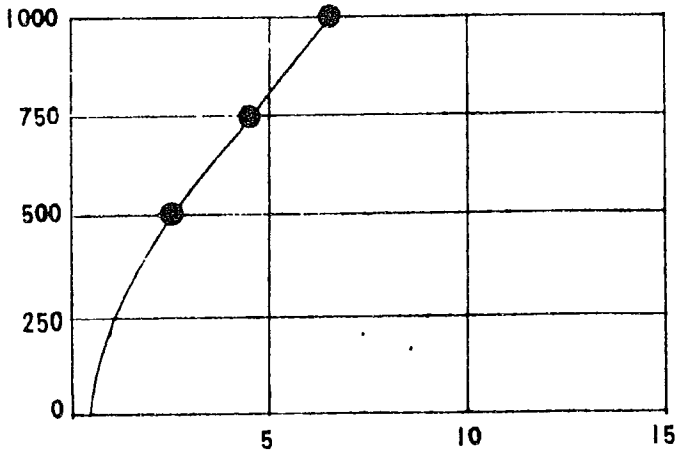
PIPE SIZES

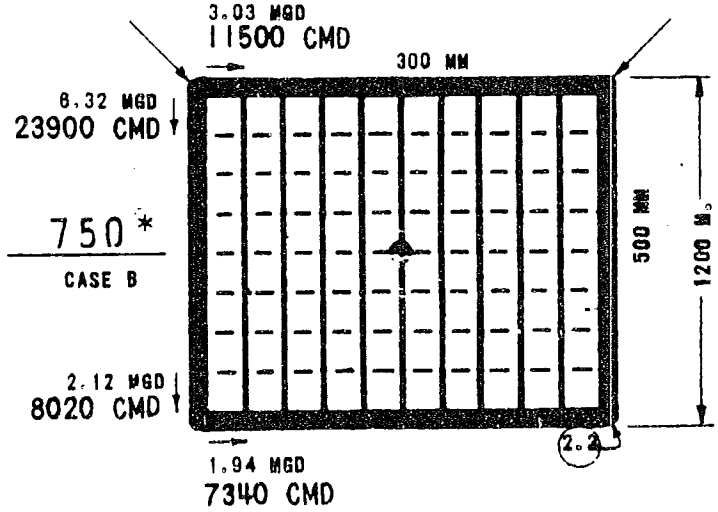
——— 200 MM ▬▬ OUTSIDE

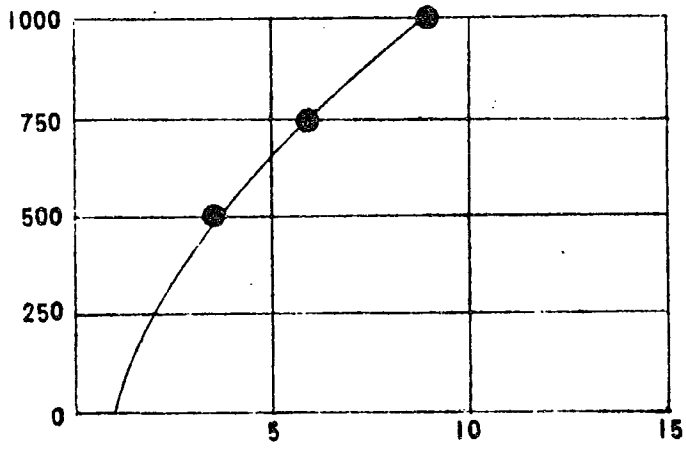
— — — 150 MM

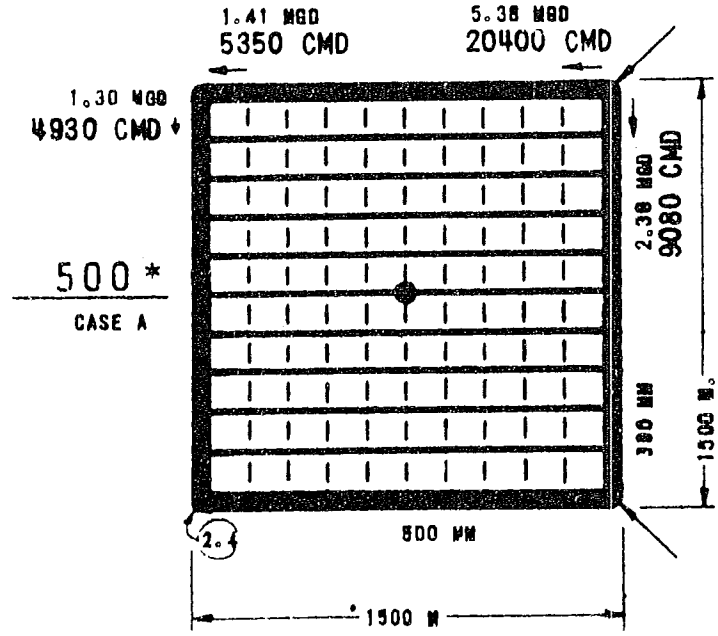
FLOWS BASE ON 400 LPCD, PLUS FIRE FLOW ● 63 LPS, C = 120

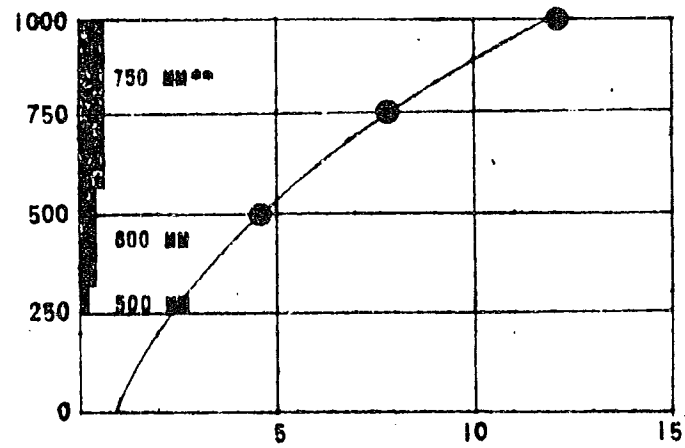












* ppha = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

PROJECT SAIGON WATER REPORT ACCT. NO. 9641 PAGE CASE 5

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

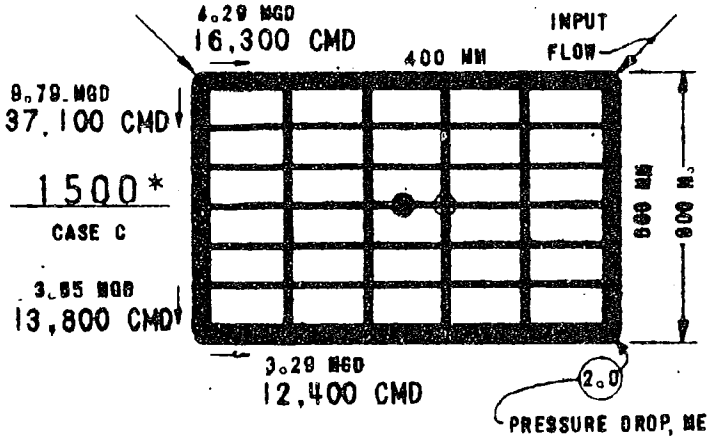
DETAIL USE SYSTEM FOR 1000 - 1500 ppha COMPUTED BY

PIPE SIZES

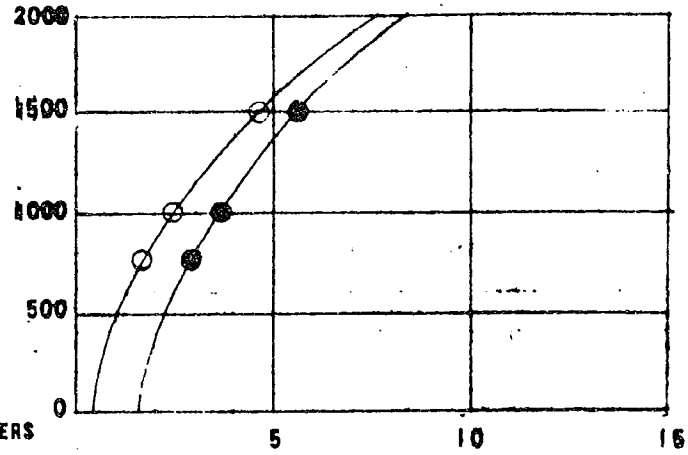
200 MM — OUTSIDE

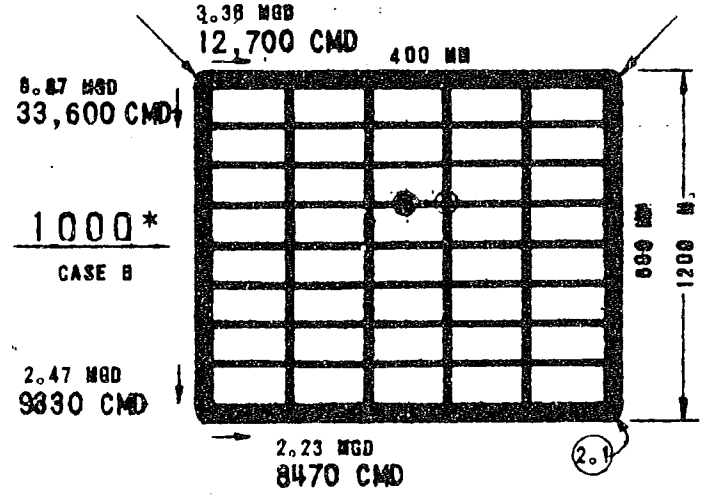
250 MM

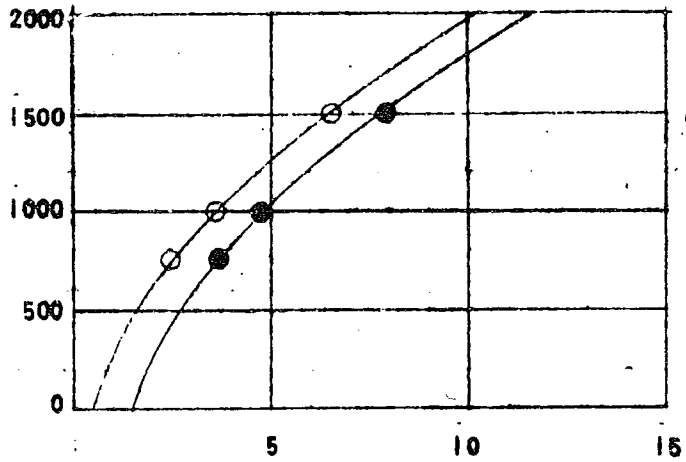
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW @ 63 LPS, C = 150

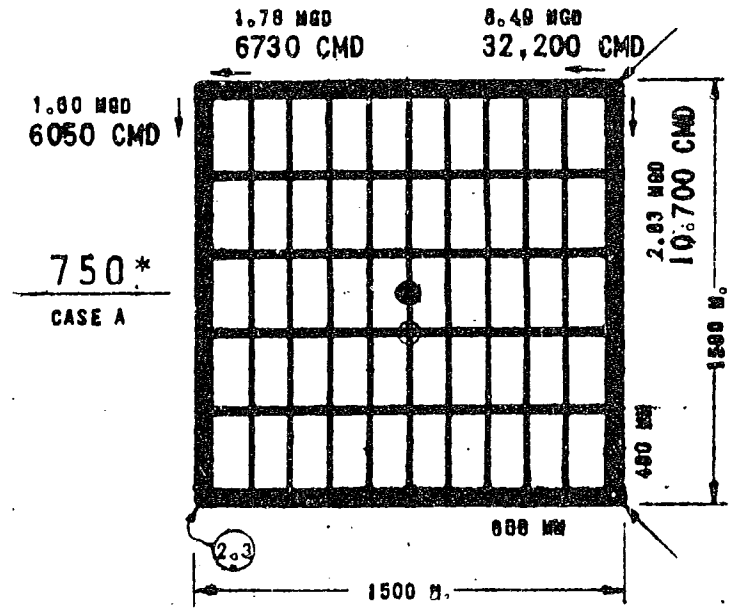


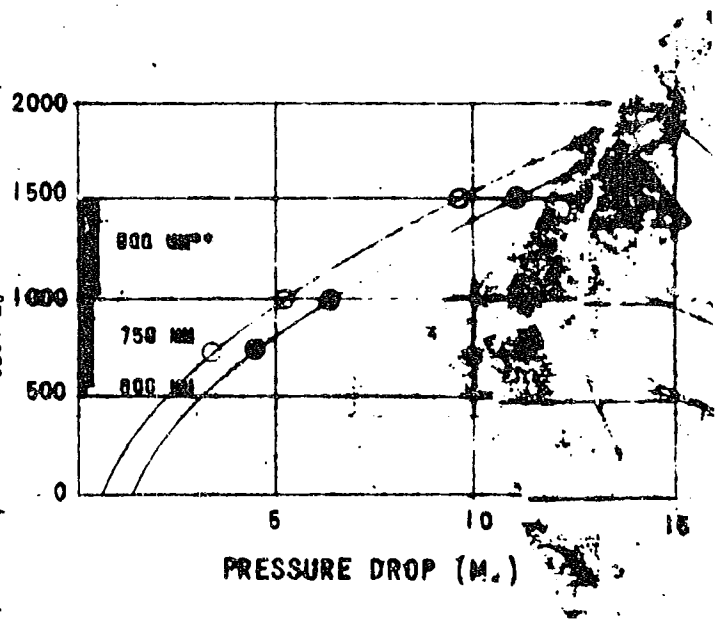
PRESSURE DROP, METERS











* ppha = PERSONS PER HECTARE

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION ADJACENT TO ● FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 6

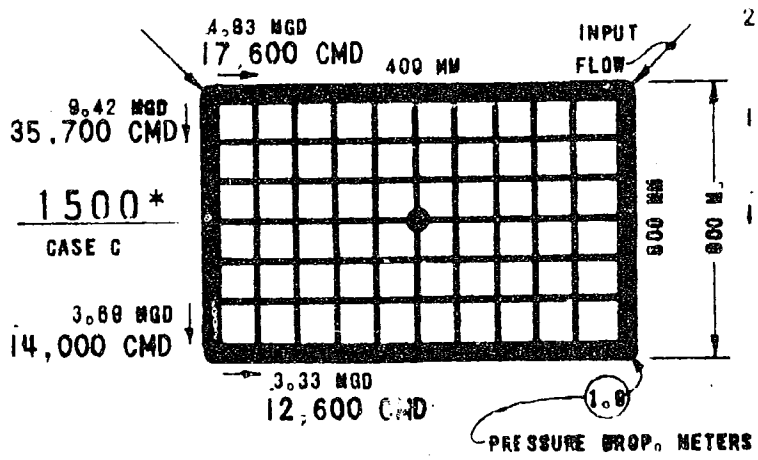
SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

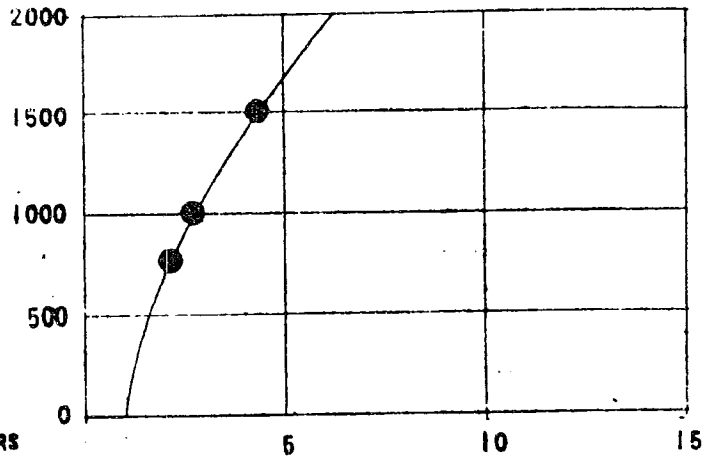
DETAIL USE SYSTEM FOR 1000 - 1500 ppha COMPUTED BY

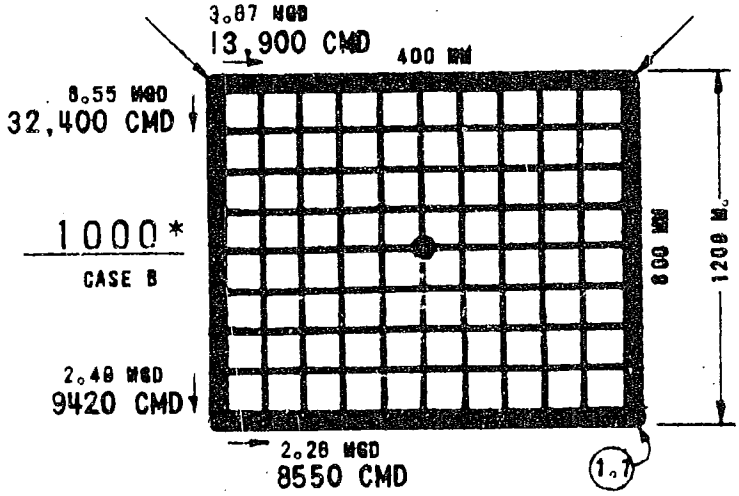
PIPE SIZES

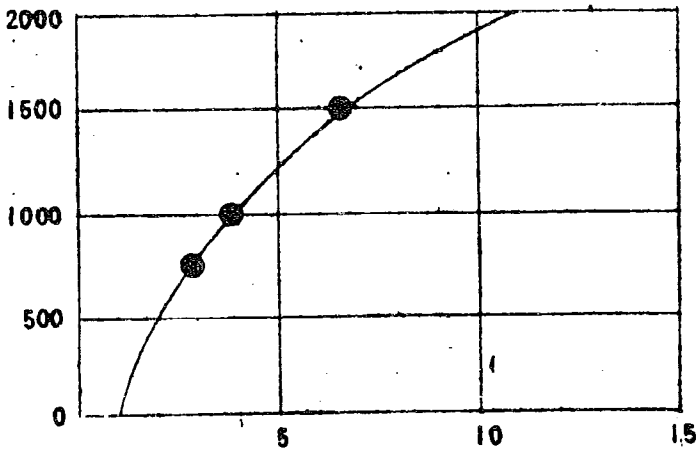
200 MM OUTSIDE

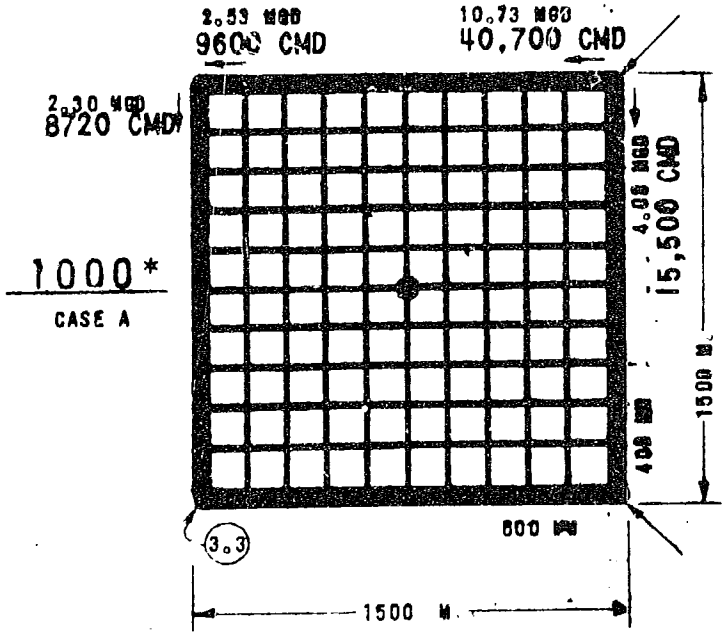
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW ● 63 LPS, C = 120

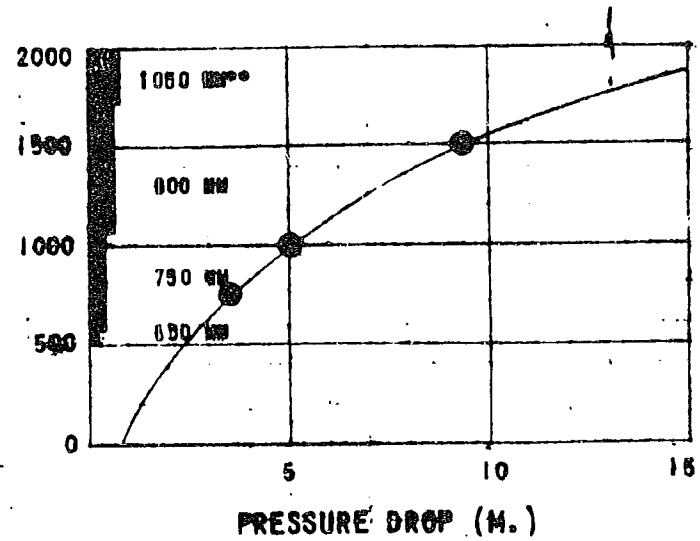












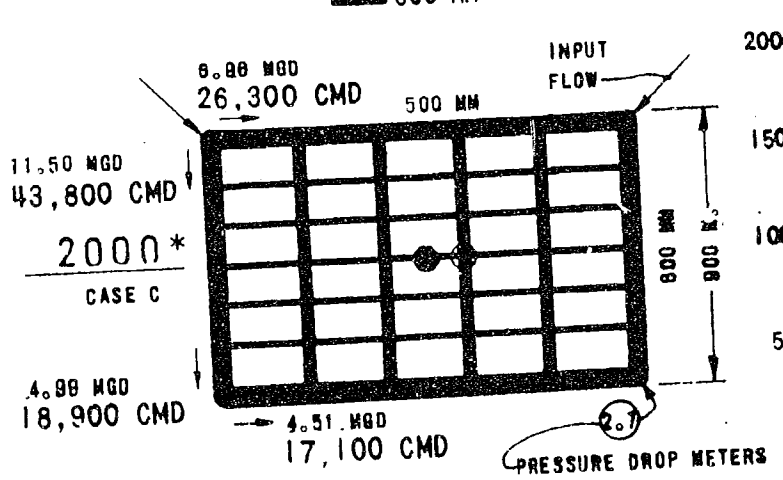
* ppha = PERSONS PER HECTARE

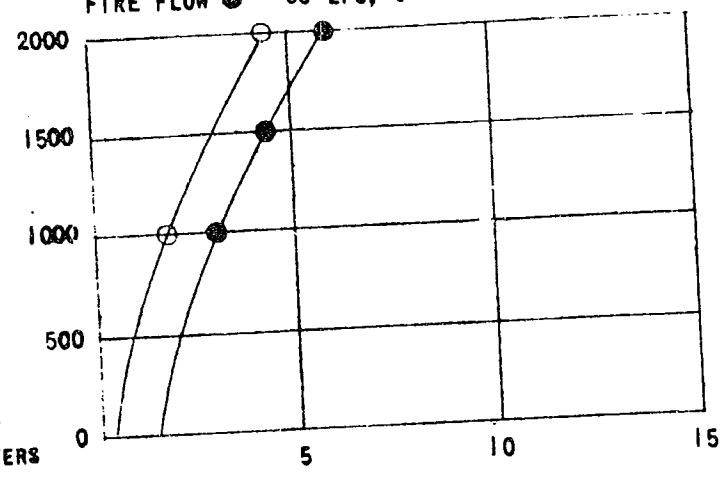
● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

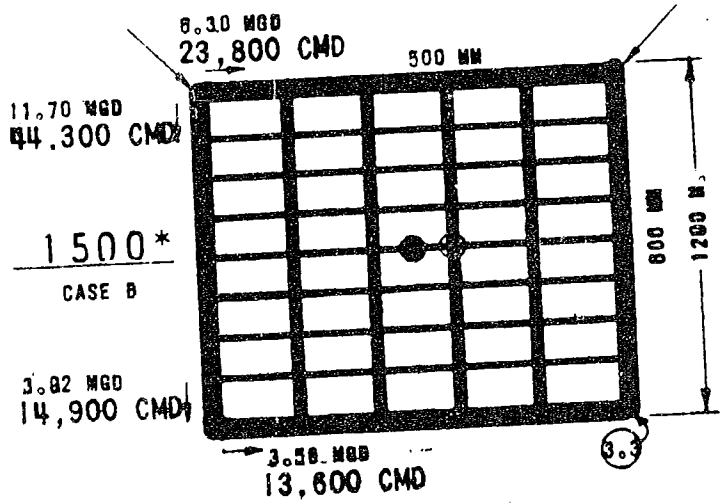
**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

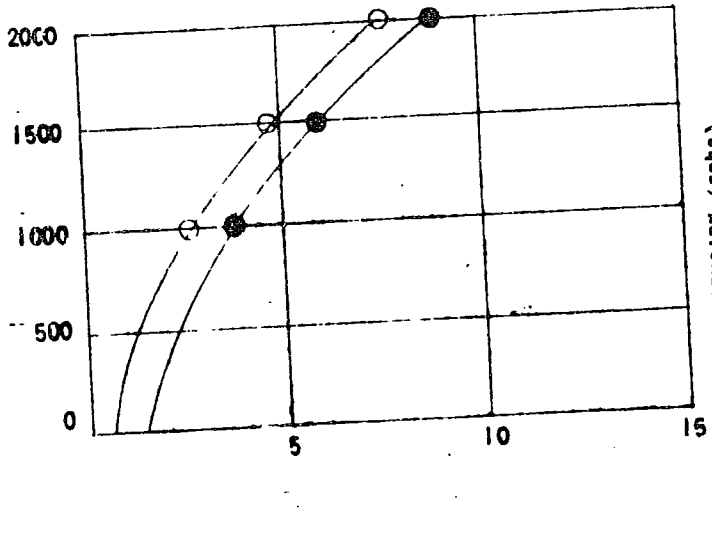
PIPE SIZES
200 MM
OUTSIDE
300 MM

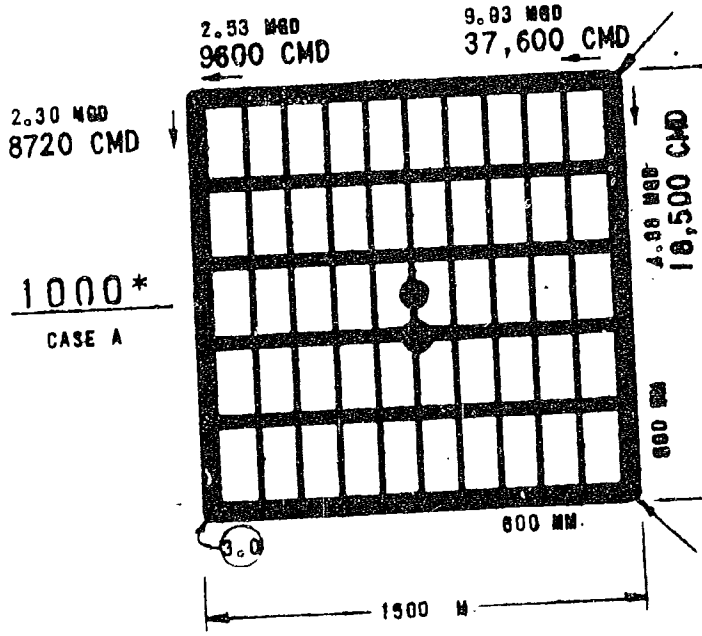
FLOWS BASED ON 400 LPCD, PLUS
FIRE FLOW ● 63 LPS, C = 120

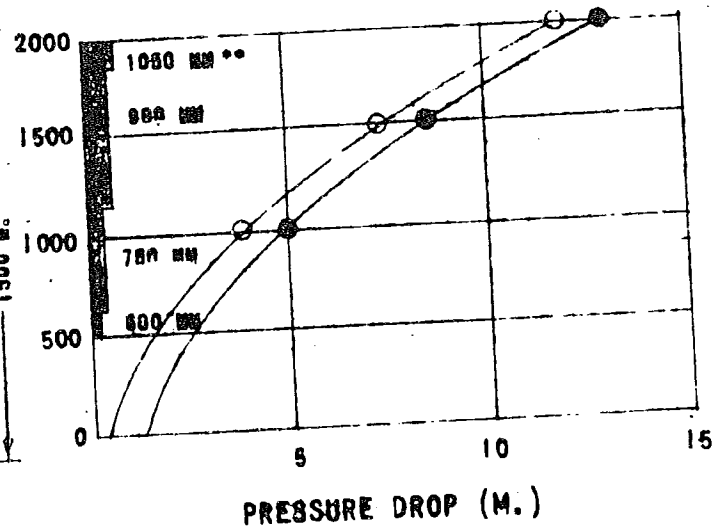












* ppha = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION ADJACENT TO ● FIRE FLOW

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

METCALF & EDDY, ENGINEERS

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 11

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

DETAIL USE SYSTEM FOR 250 - 500 ppha COMPUTED BY

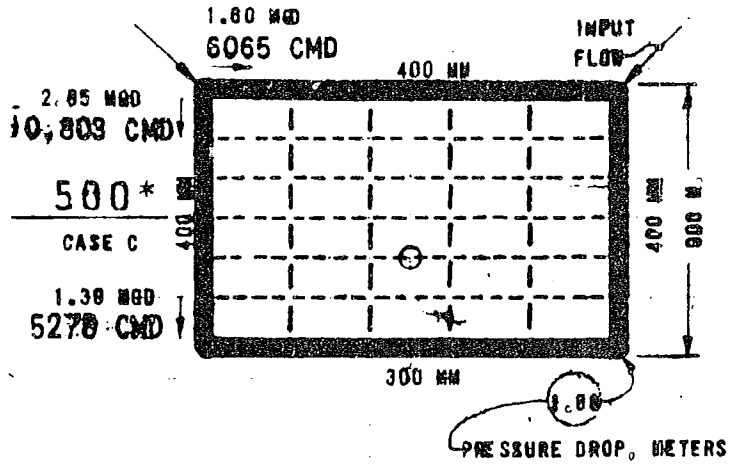
PIPE SIZES

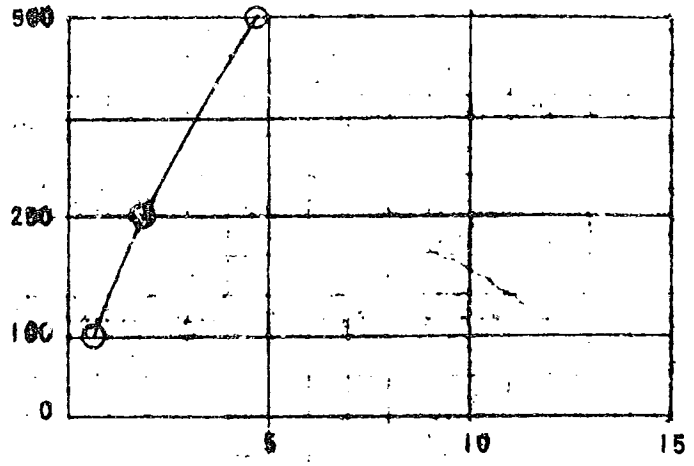
------ 100 MM

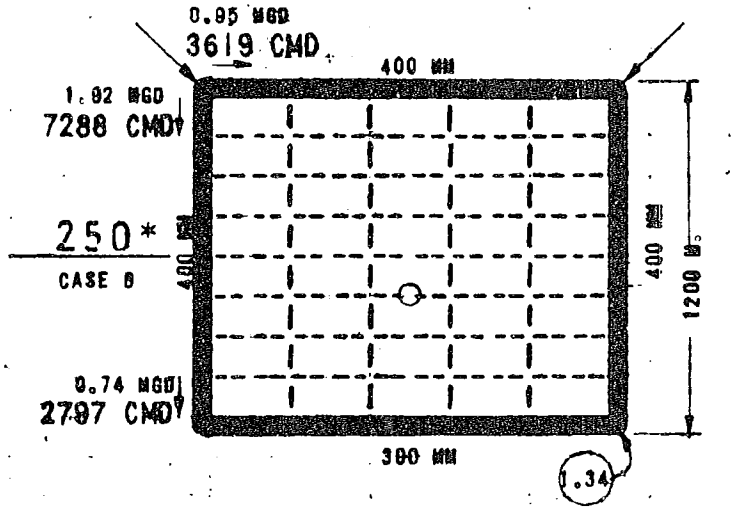
— — — 150 MM

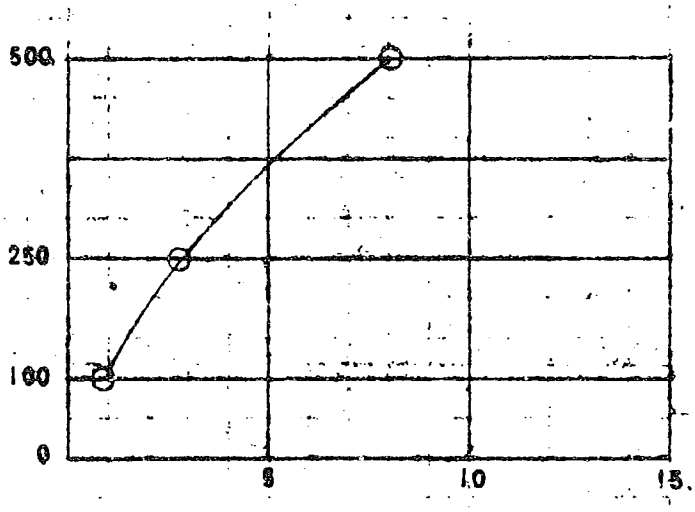
OUTSIDE

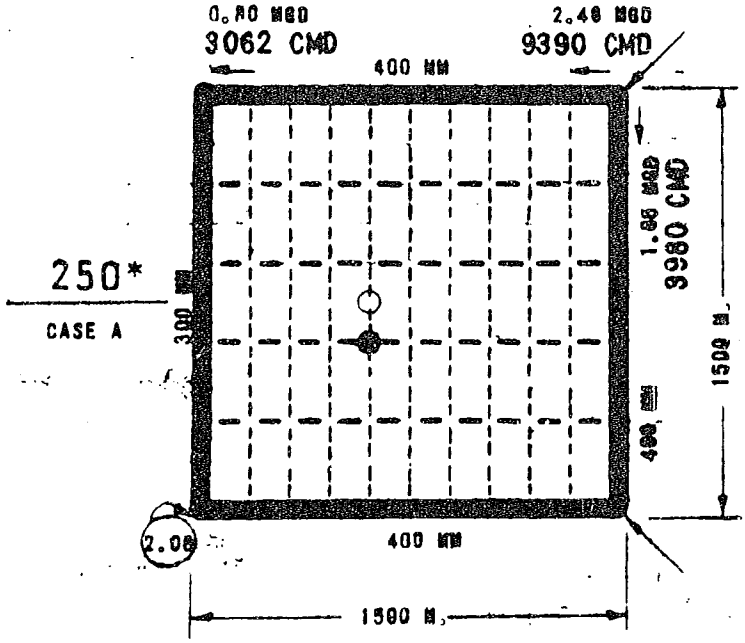
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW @ 32 LPS, C = 120

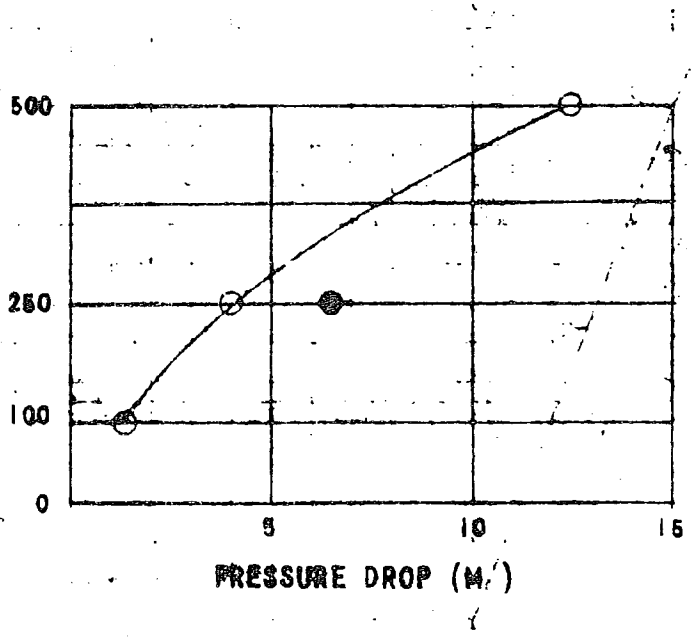












* ppha = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 32 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION WITH NO FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 12

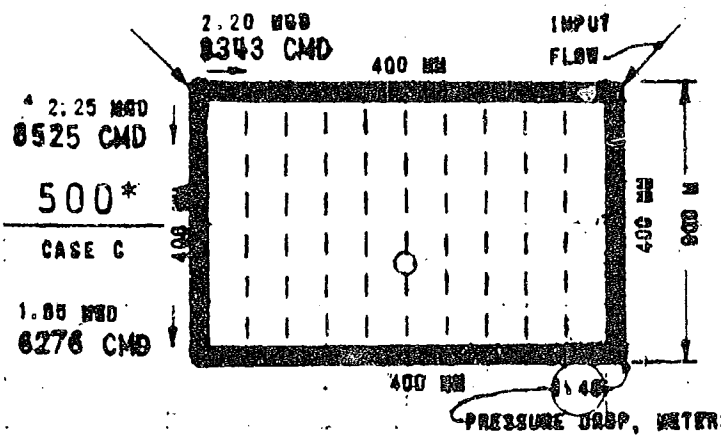
SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

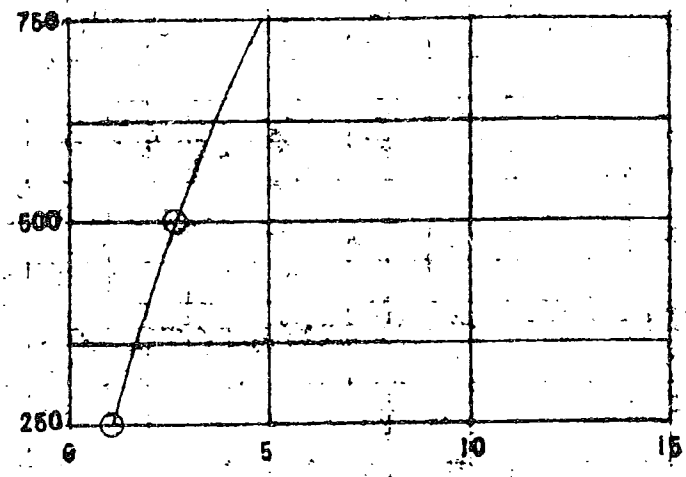
DETAIL USE SYSTEM FOR 250 - 750 pphe COMPUTED BY

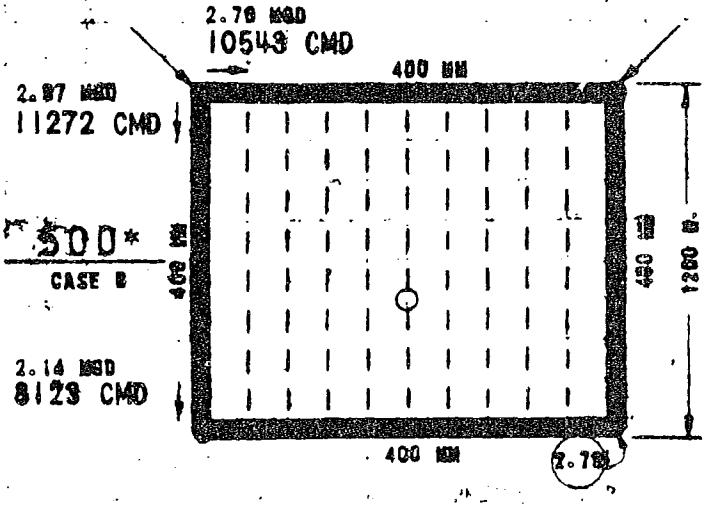
PIPE SIZES

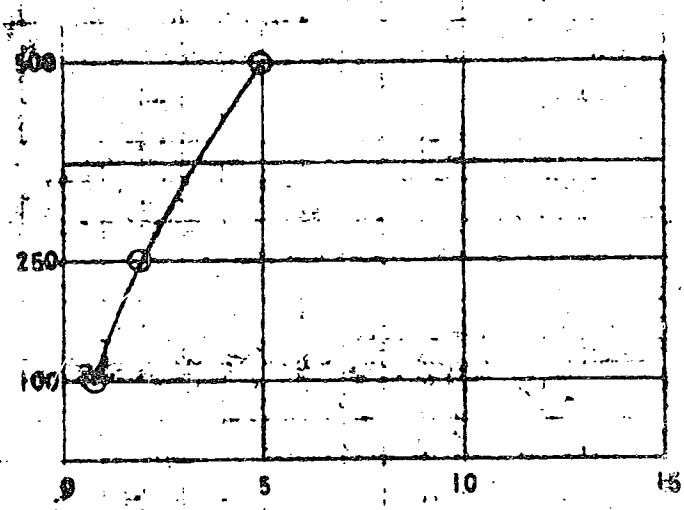
— — — 150 MM OUTSIDE

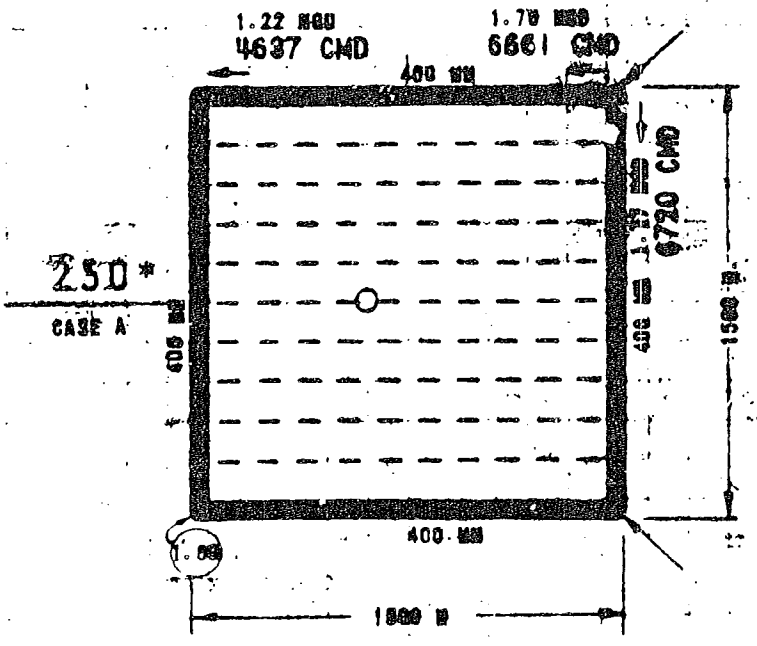
FLOWS BASED ON 400 LPCD,
WITH NO FIRE FLOW C = 120

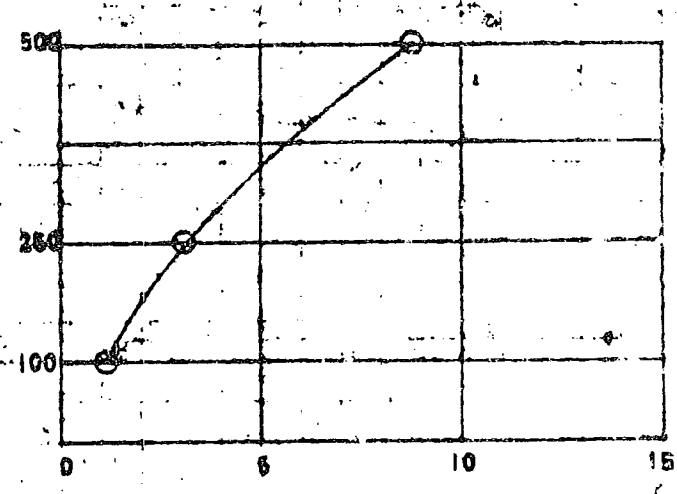












* pphe = PERSONS PER HECTARE

○ PRESSURE DROP LOCATION WITH NO FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. No. 9841 PAGE CASE 13

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

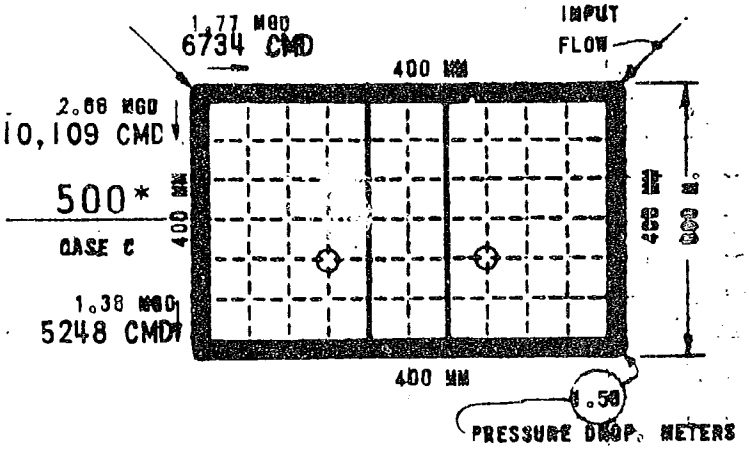
DETAIL USE SYSTEM FOR 250 - 750 pphe COMPUTED BY

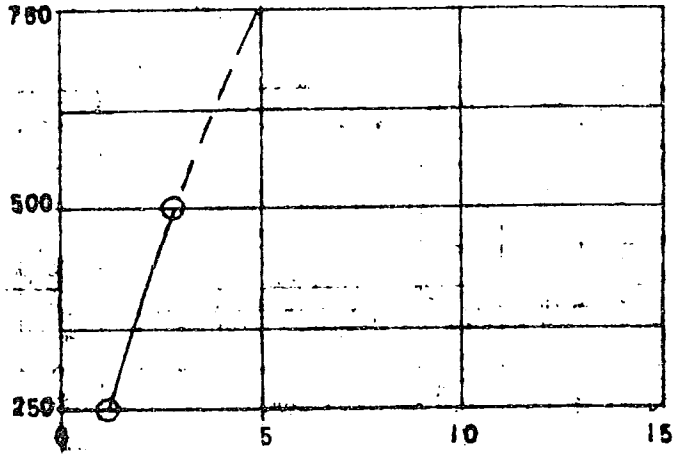
PIPE SIZES

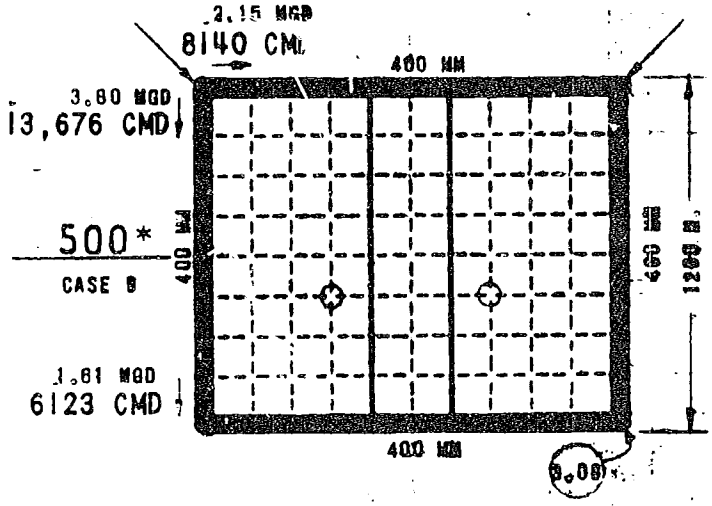
-----100 MM OUTSIDE

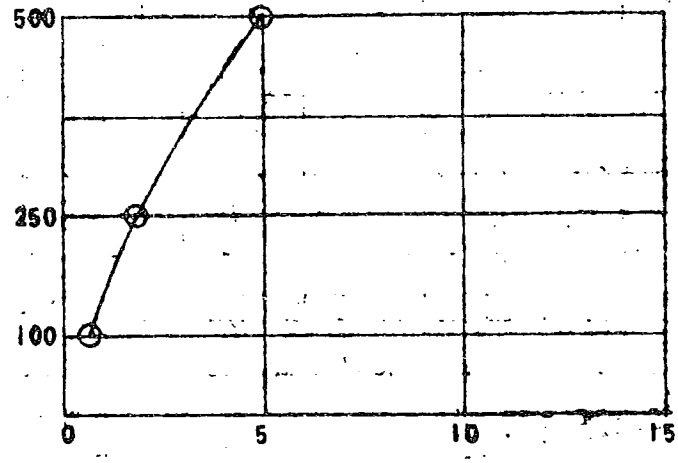
——— 200 MM

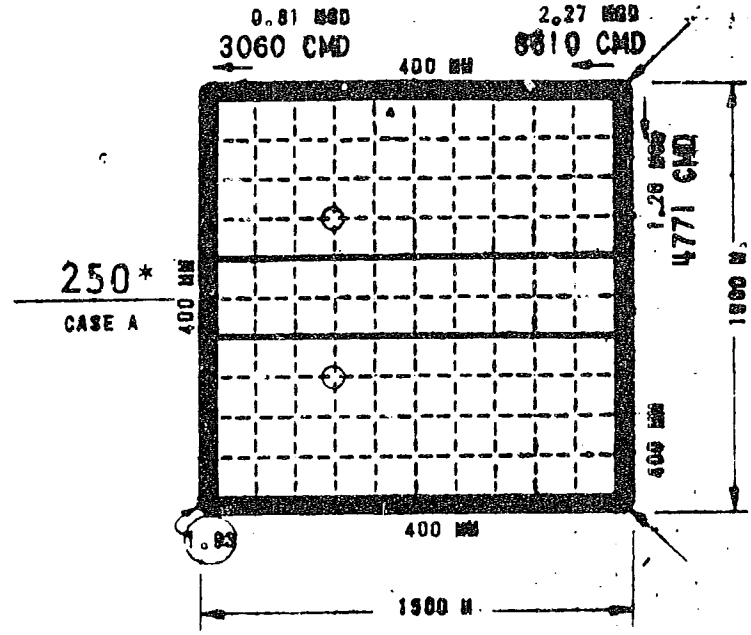
FLOWS BASED ON 400 LPCD, WITH NO FIRE FLOW. C = 120

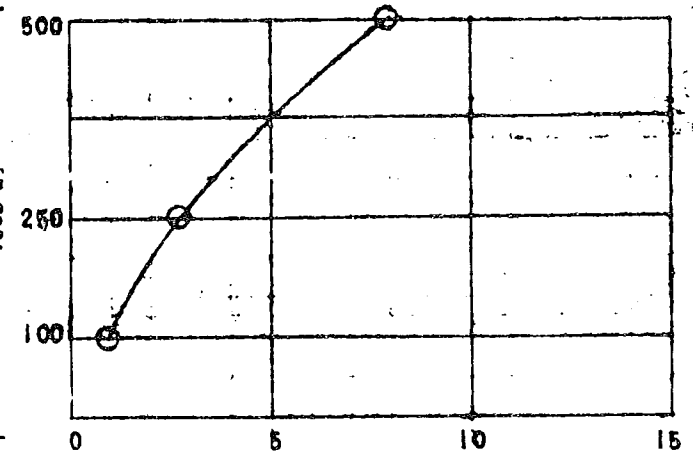












* pphe = PERSONS PER HECTARE

○ PRESSURE DROP LOCATION WITH NO FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. NO. 9841 PAGE CASE 14

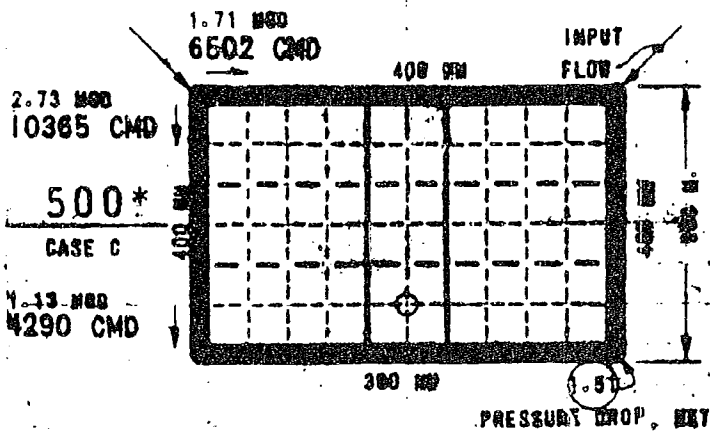
SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

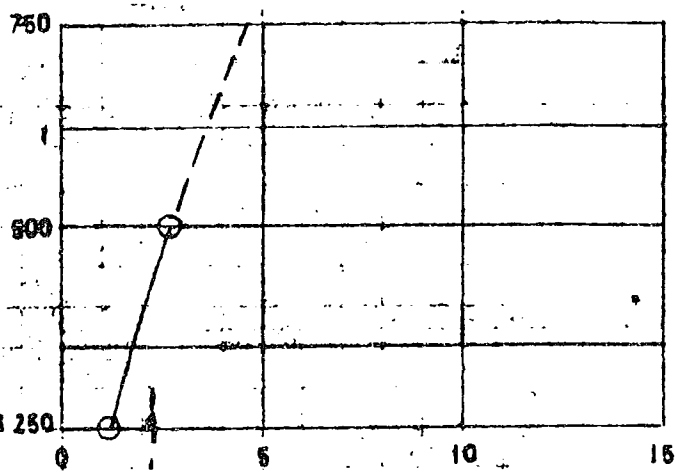
DETAIL USE SYSTEM FOR 250-500 pphe COMPUTED BY

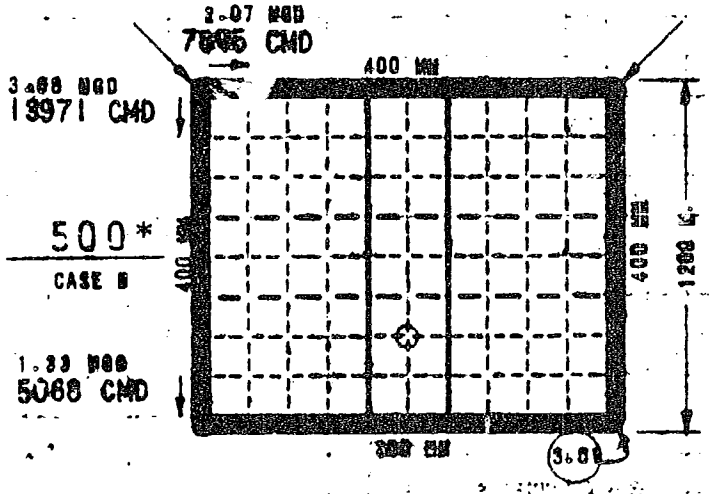
PIPE SIZES

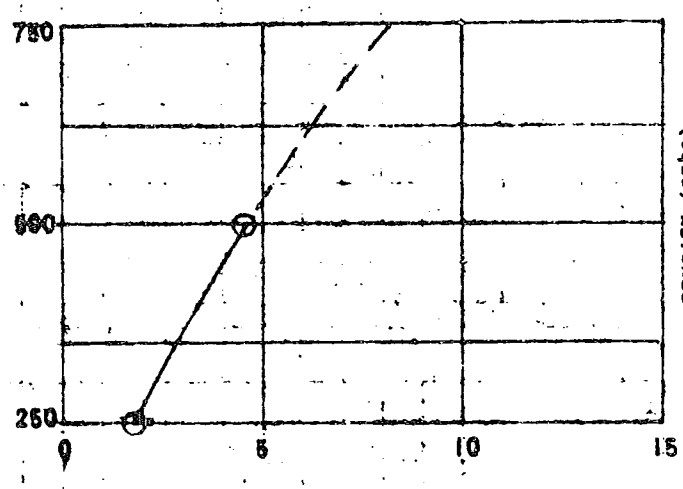
- - - - - 100 MM
— — — 150 MM
——— 200 MM
OUTSIDE

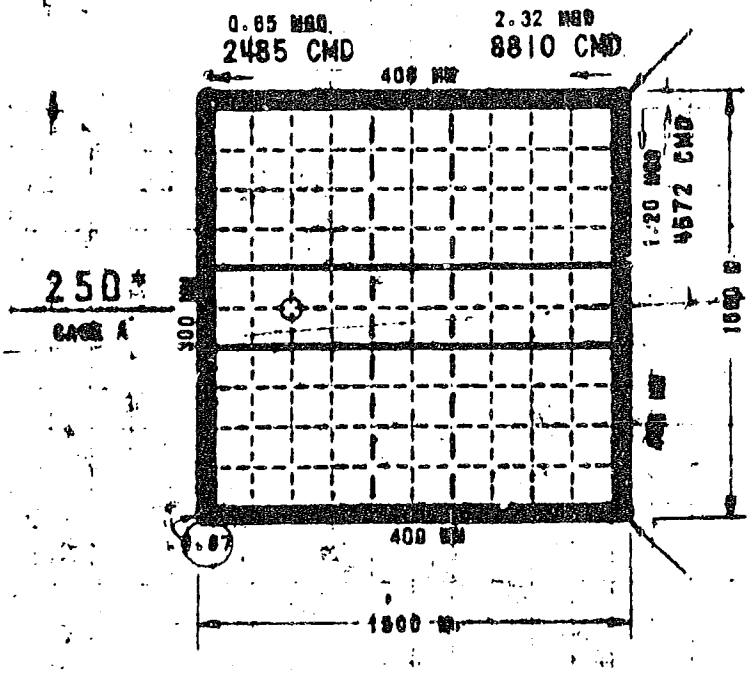
FLOWS BASED ON 400 LPCD, WITH NO FIRE FLOW , C = 120

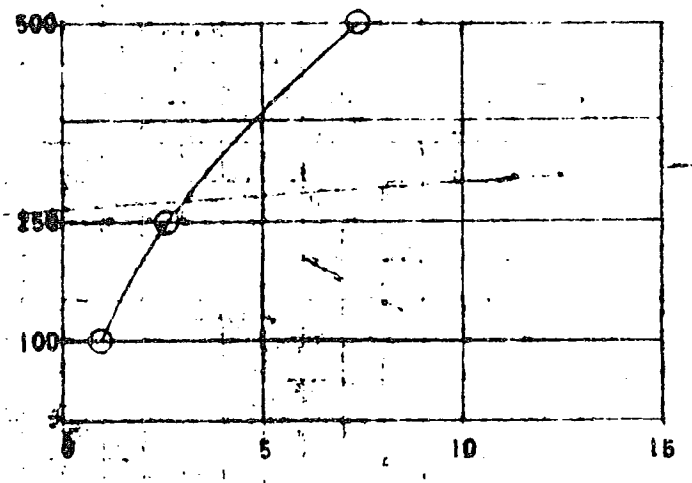












* pphe = PERSONS PER HECTARE

○ PRESSURE DROP-LOCATION WITH NO FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT. NO. 8841 PAGE CASE 15

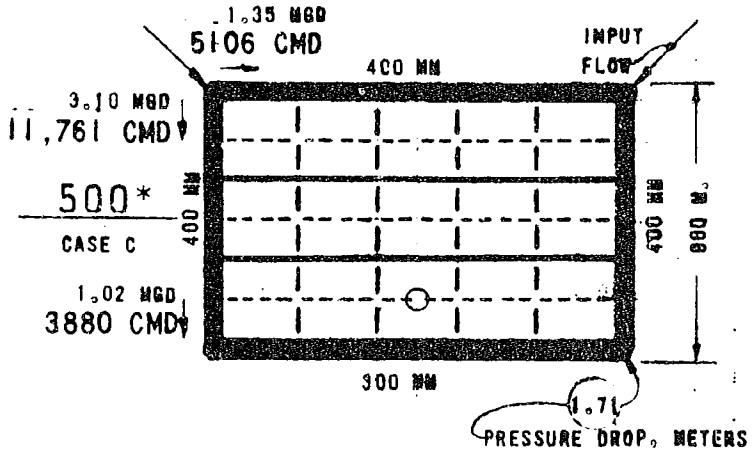
SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

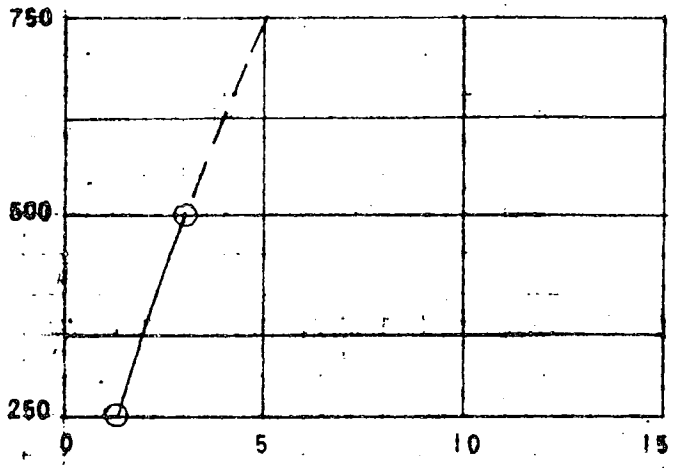
DETAIL USE SYSTEM FOR 250-750 [redacted] COMPUTED BY

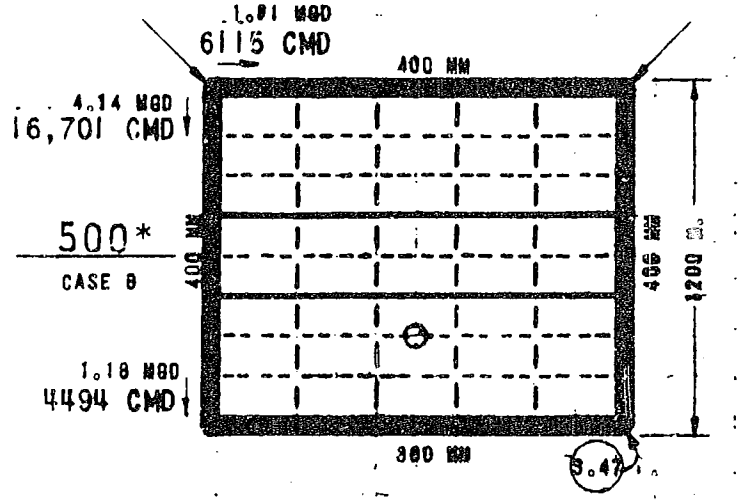
PIPE SIZES

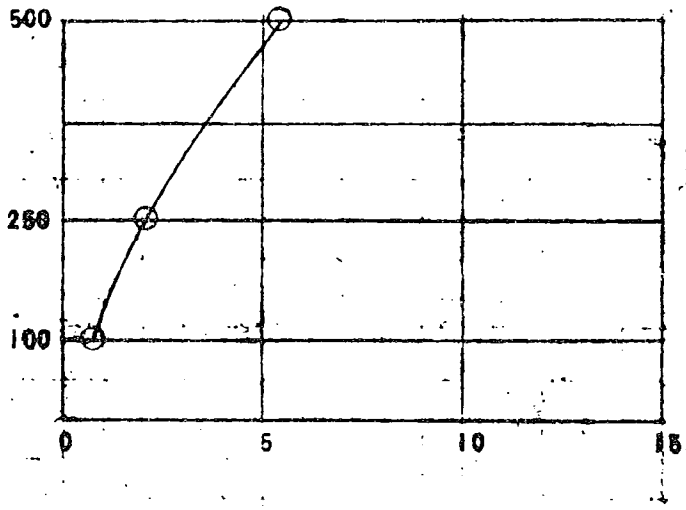
- - - - - - 100 MM
— — — 150 MM
——— 200 MM
OUTSIDE

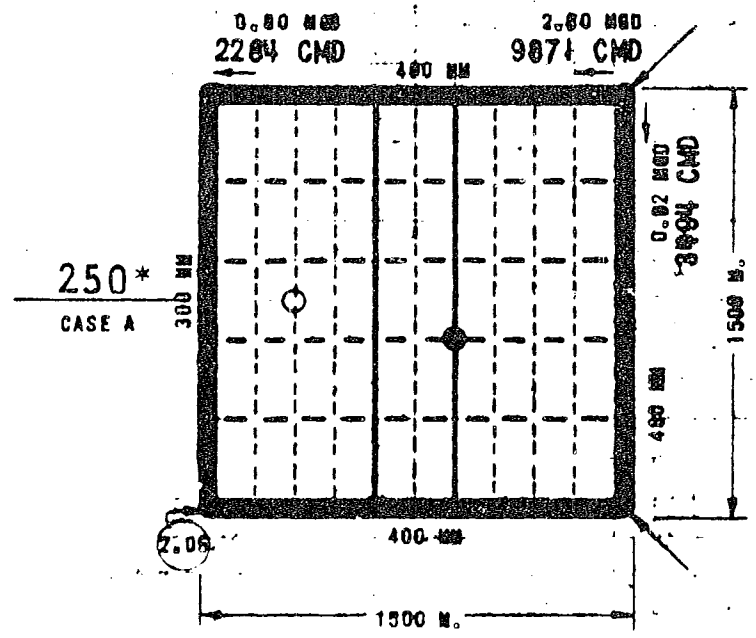
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW @ 63 LPS, C = 120

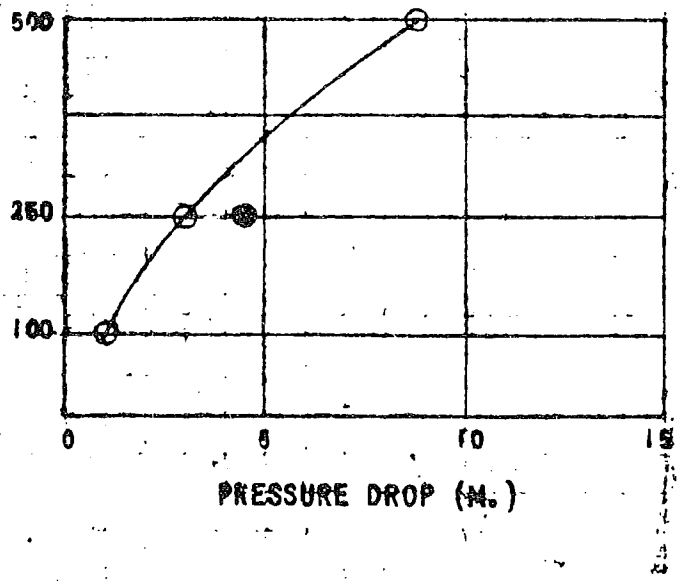












* pphe = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION WITH NO FIRE FLOW

PROJECT SAIGON WATER REPORT ACCT NO 9841 PAGE CASE 16

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE MARCH, 1971

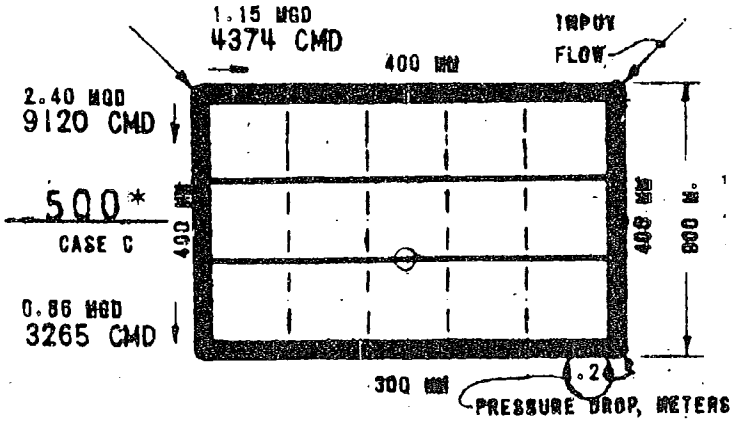
DETAIL USE SYSTEM FOR 250 - 750 pphe COMPUTED BY

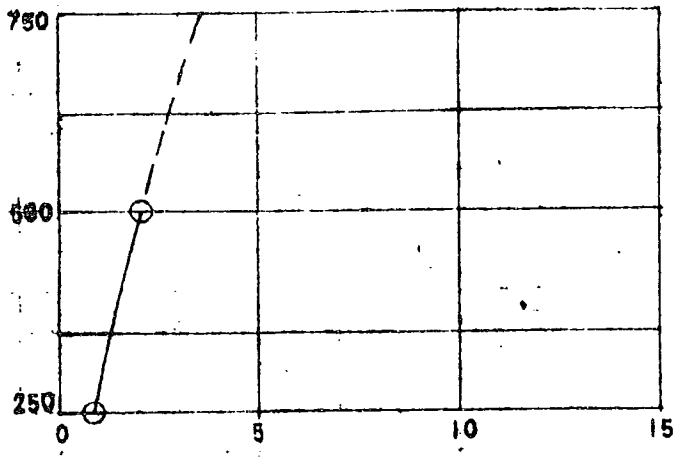
PIPE SIZES

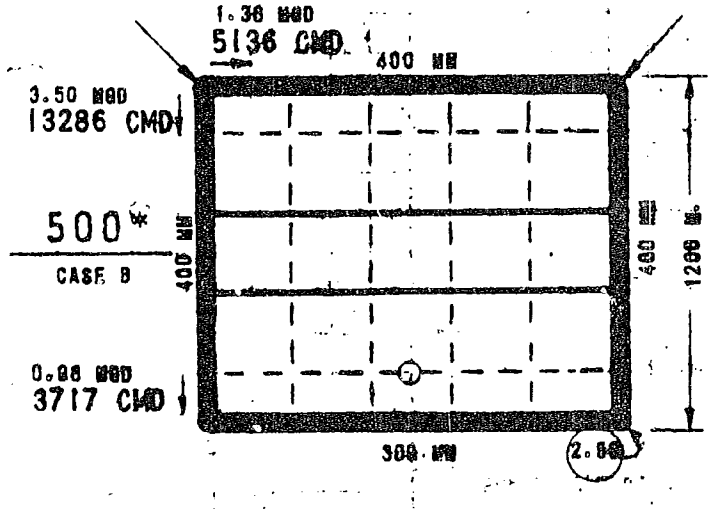
— — — 150 MM ■ OUTSIDE

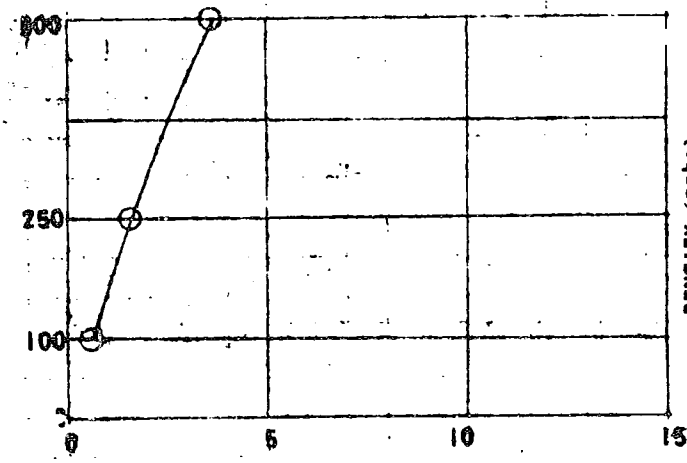
——— 200 MM

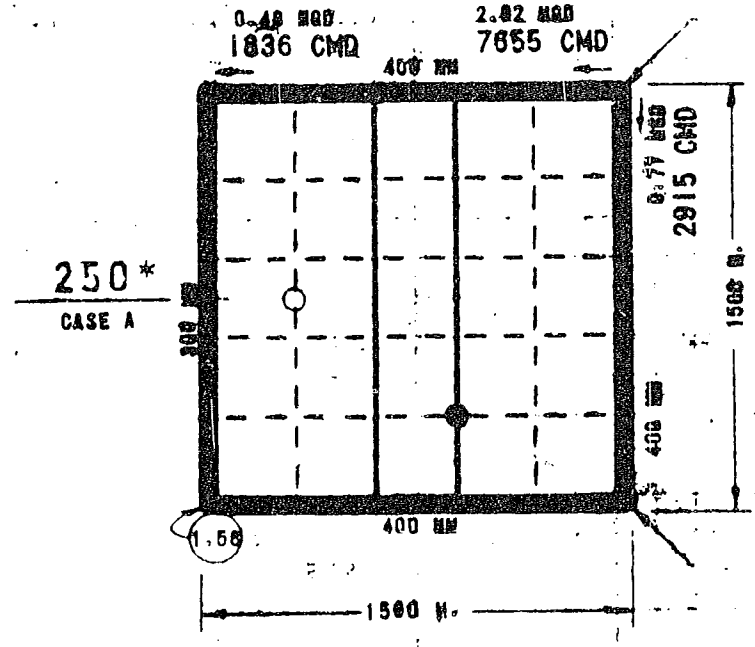
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW ● 63 LPS, C = 120

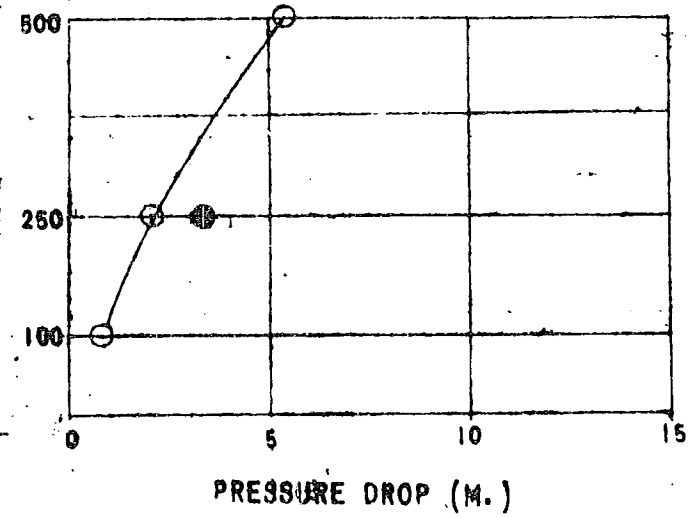












* [illegible] PER HECTARE

● [illegible] LOCATION WITH 63 LPS FIRE FLOW (1000 GPM.)

○ PRESSURE DROP LOCATION WITH NO FIRE FLOW

NONREPRODUCIBLE GRID FORM, 145

METCALF & EDDY, ENGINEERS

J-9841

BASIC HYDRAULIC STUDIES ON STANDARD DISTRIBUTION NETWORK SYSTEMS

Purpose

In order to provide guidance for the selection of suitable pipe sizes for the secondary distribution network in the Saigon system, a considerable number of grid patterns were investigated by computer analysis. The purpose of these studies was to determine efficient arrangements of suitable pipe sizes to provide for various population densities as well as, in most cases, a minimum fire flow of 63 liters per second.

The data presented are the results of basic hydraulic studies conducted to date and should not be regarded as recommendations. These results are subject to economic evaluation at a later date and to specific applications upon the existing system prior to establishing recommendations.

Basic Conditions

The basic module was taken as a square 1,500 meters by 1,500 meters surrounded by a primary grid loop. In addition, two other module sizes 1,500 by 1,200 meters and 1,500 by 900 meters were examined for the same internal piping pattern.

The internal block size was taken as 150 meters by 150 meters. Some studies, however, were made utilizing lines in every other street--that is, 300 meters on centers which might represent an initial development or the significant lines in an initial development or reinforcing

The group of Cases 11-16 was prepared to show possible initial developments that could later be reinforced and/or partially replaced to provide increased strength for additional population density or fire flow.

Case 11 is similar in pattern to Case 1 but utilizes 100-mm pipe in place of 150 mm, and 150-mm pipe in place of 200 mm. The results shown are primarily domestic demand only, exclusive of fire flow. This pattern could later be strengthened by the addition of either 150-or 200-mm lines between the 150-mm lines shown and by the replacement of the 100-mm lines by either 150- or 200-mm pipes, as might be necessary. The pressure drop shown with a fire flow is for 32 l.p.s, notthe 63 l.p.s used in other cases.

Case 12 utilizes 150-mm pipe in one direction only. This indicates the potential capacity of a system where the pipes in the other direction are extremely small initially and provides a system which can be reinforced by the construction of larger mains in the opposite direction as needed, of such sizes as projected future use may warrant, ranging from say 150 mm to 300 mm.

Case 13 presents a system utilizing 100-mm pipes except for two 200-mm pipes near the center in one direction only. This provides an initial system of relatively low strength but of adequate coverage with the objective of ultimately replacing as much of the 4-inch pipe system as may be needed to provide additional strength. Such replacements can occur gradually as demands increase in any part of the area.

Case 14 indicates the amount of increased strength over the Case 13 system by adding two 150-mm pipes in the opposite direction to the two 200-mm pipes.

Case 15 indicates a system with two 200-mm pipes near the center, but in the opposite direction to those in Case 14, together with 150-mm pipes 300 meters apart in the opposite direction. The 100-mm pipes every 150 meters parallel to the 200-mm pipes could ultimately be replaced. In addition, new mains of suitable size between the 150-mm pipes could be installed to reinforce this system.

Case 16 is a partial development pattern with pipes 300 meters apart in both directions. It includes two 200-mm pipes near the center similar to those in Case 15 and 150-mm pipes in the opposite direction also comparable to Case 15. The additional lines parallel to the 200-mm pipes are 150 mm so that future pipelines would be added in both directions as necessary to bring the system up to the desired ultimate strength.

Presentation of Results

Computer runs were made for each of three population densities generally assuming the fire flow would be taken at the weakest point in the grid system. The results of the computer analyses were plotted to show the relation between population density (persons per hectare), and the pressure drop at a critically low point in the network system.

Each case presents the results of these analyses for the three different size modules using the same internal pattern and pipe sizes. The plot of the system has been annotated to show the flow conditions in the external loop for a suitable population density.

List of figures showing pressures for pipe grids, etc. Page

Case 1 - 200 mm @ 300 m x 150 mm @ 150 m Grid 6

Case 2 - Addition of 150 mm pipe to Case 1. 7

Case 3 - Substitution of 250 mm pipe for 200 mm pipe 8

Case 4 - Addition of 200 mm pipe 9

Case 5 - Substitution of 200 mm pipe for 150 mm pipe 10

Case 6 - All 200 mm pipe grid 11

Case 7 - Substitution of 300 mm pipe for 250 mm pipe in case 5. 12

Case 8 - Substitution of 250 mm pipe in one direction only for every other 200 mm pipe in case 6. 13

Case 11 - 100 mm pipe @ 150 m x 150 mm pipe @ 300 m grid without fire flow 14

Case 12 - Loop utilizing 150 mm pipe in one direction only. 15

Case 13 - Loop utilizing 100 mm pipe in one direction only with 2 - 200 mm reinforcing lines 16

Case 14 - Case 13 reinforced with 2-150 mm pipe grids 17

Case 15 - Further reinforcement of Case 14 18

Case 16 - Possible Development Patterns 19

PROJECT SAIGON WATER REPORT ACCT. NO 9841 PAGE GRAPH 1

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

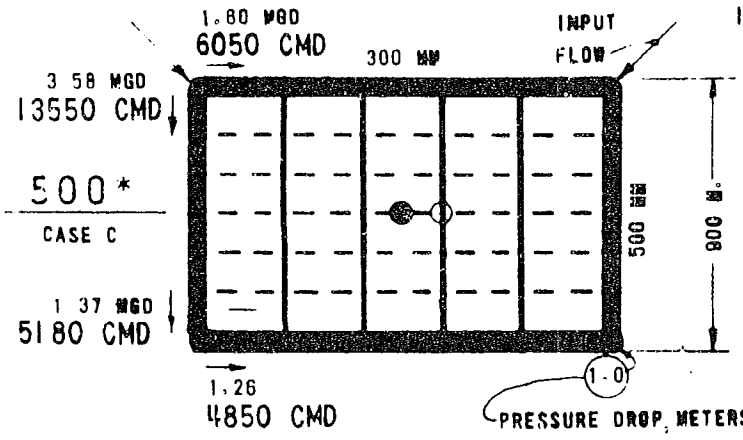
DETAIL USE SYSTEM FOR 250-500 ppha COMPUTED BY

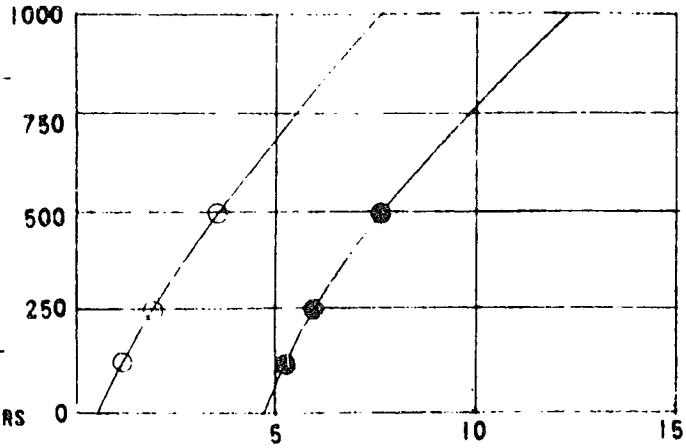
PIPE SIZES

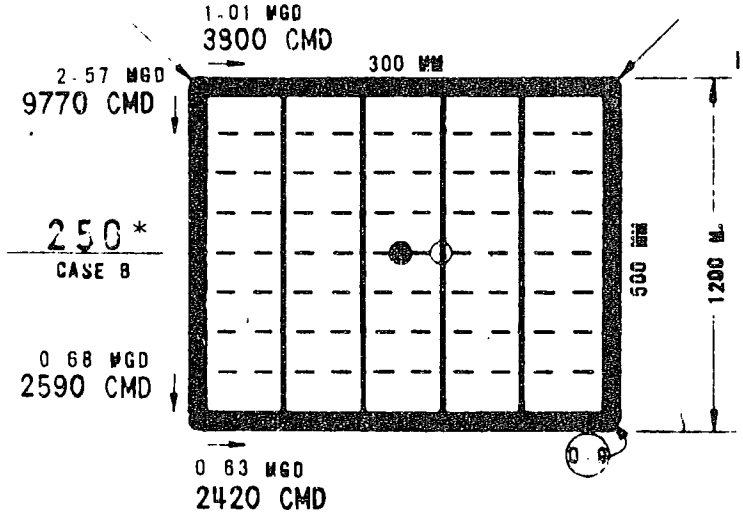
——— 200 MM OUTSIDE

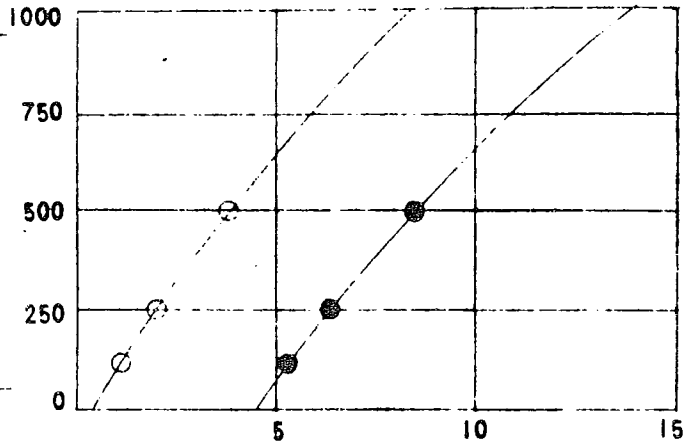
— — — 150 MM

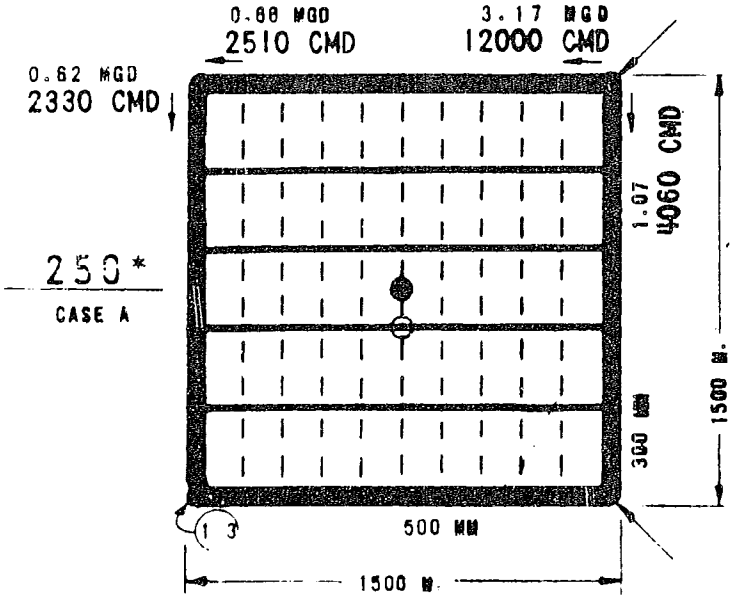
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW ● 63 LPS, C = 120

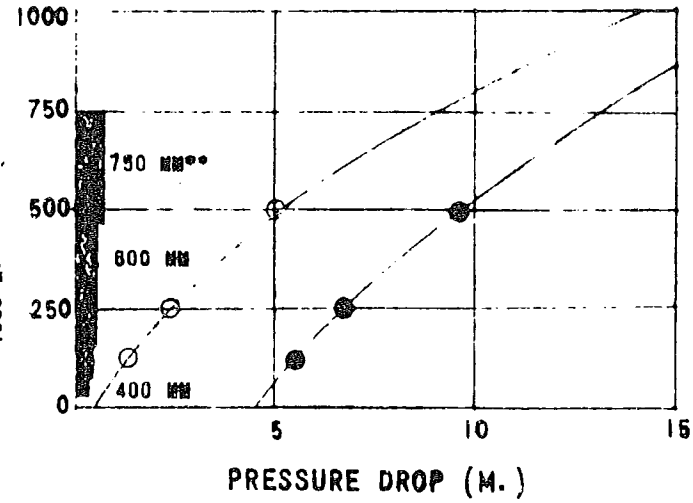












* ppha = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM.)

○ PRESSURE DROP LOCATION ADJACENT TO ● FIRE FLOW

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

NONREPRODUCIBLE GRID FORM 145

METCALF & EDDY, ENGINEERS

PROJECT SAIGON WATER REPORT ACCT NO 9641 PAGE CASE 2

SUBJECT STANDARD DISTRIBUTION NETWORK SYSTEMS DATE FEBRUARY, 1971

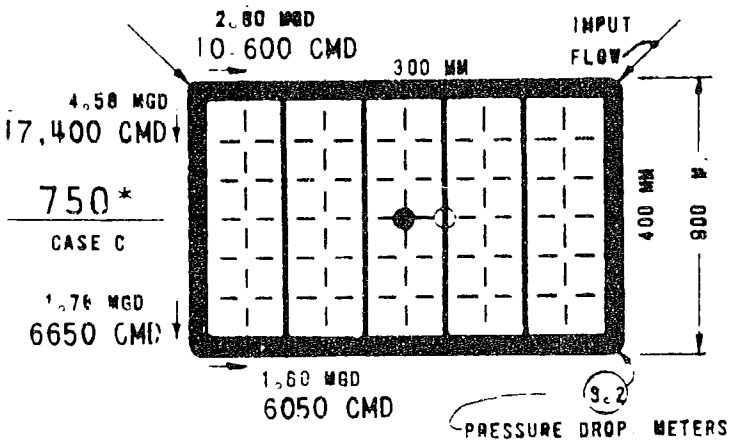
DETAIL USE SYSTEM FOR 250 - 750 ppha COMPUTED BY

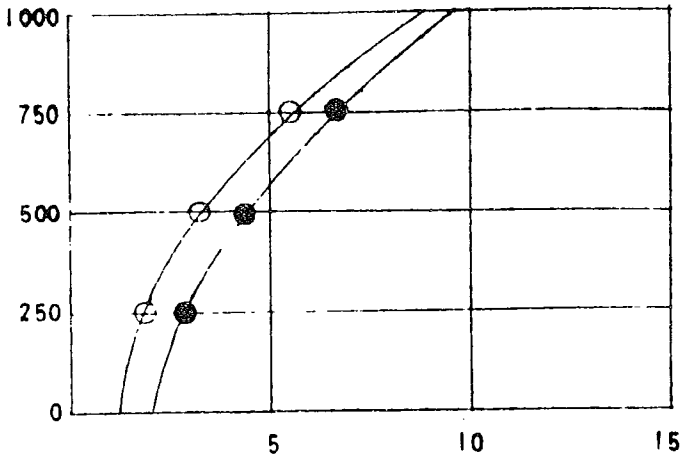
PIPE SIZES

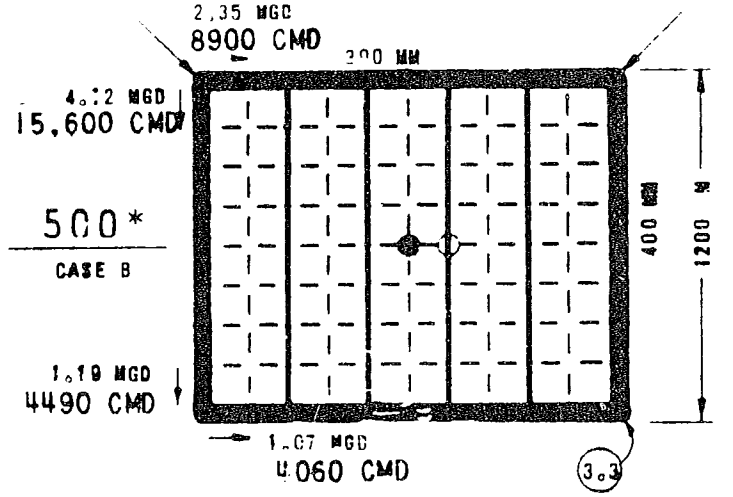
200 MM OUTSIDE

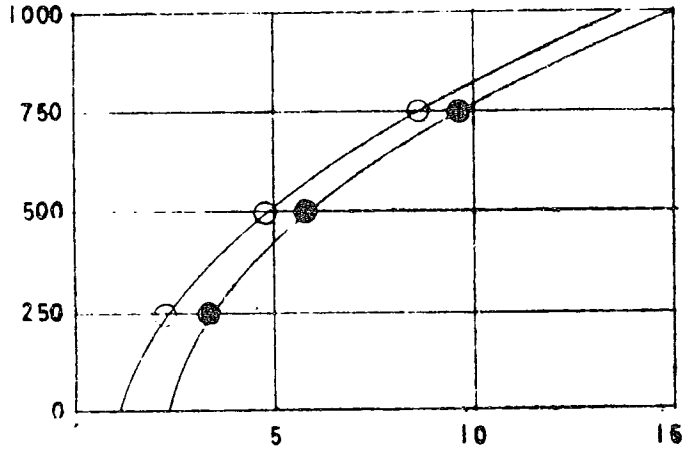
150 MM

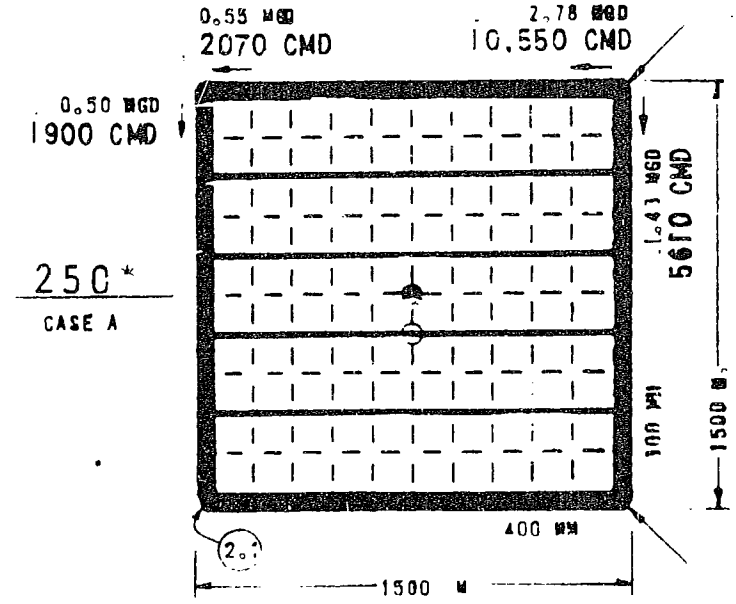
FLOWS BASED ON 400 LPCD, PLUS FIRE FLOW @ 63 LPS, C = 120

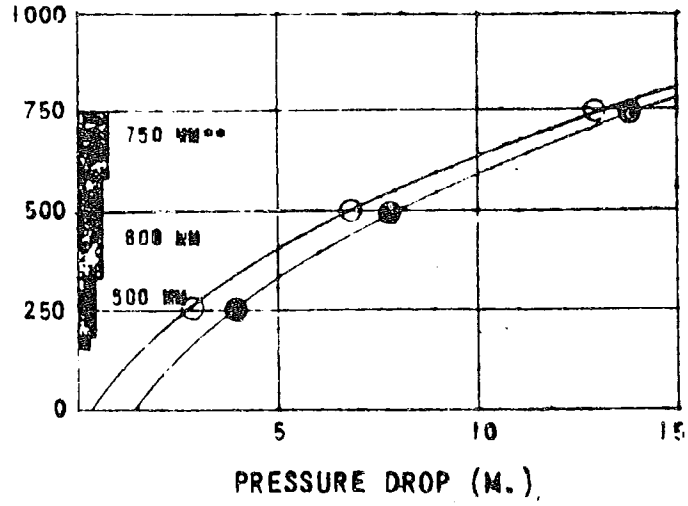












• ppha = PERSONS PER HECTARE

● PRESSURE DROP LOCATION WITH 63 LPS FIRE FLOW (1000 GPM)

○ PRESSURE DROP LOCATION ADJACENT TO ● FIRE FLOW

**SIZE OF OUTSIDE LINE SERVING ADJACENT LOOP

METCALF & EDDY, ENGINEERS

NONREPRODUCIBLE GRID FORM 145