4) Roofing Materials

As of March 1988, the civil engineering work of Gamair Clear Water Reservoir (with concrete-made walls, columns and bottom slab) is near completion. 7.0 meter span corrugated aluminum sheets are used to roof over it. Nearly similar structure and materials were used for the existing Mogren Treatment Plant and it was imitated. The quantity of the roofing materials is 3,500 sq. meters.

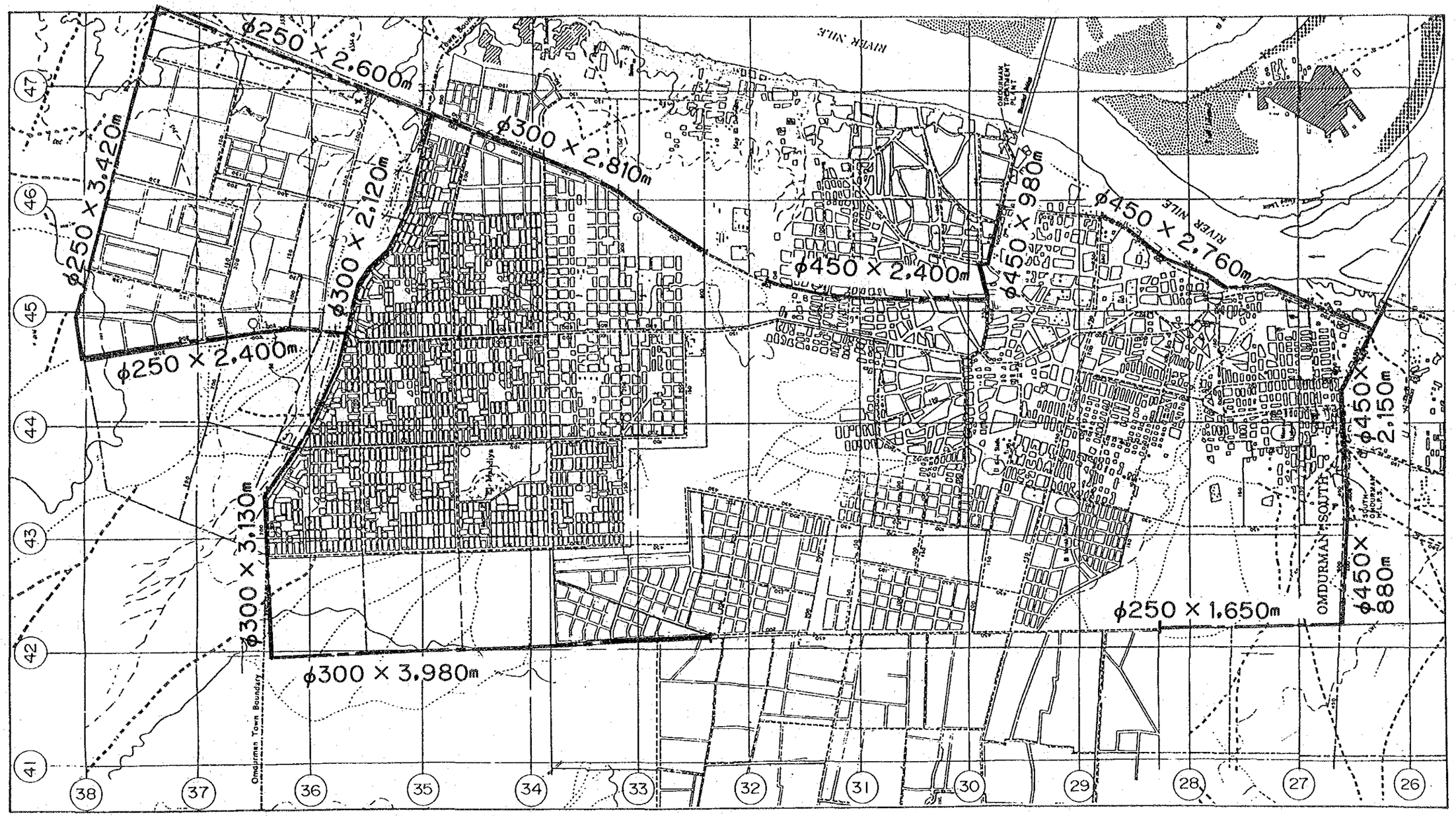
5) Related Equipment

For the maintenance of the pipelines, 4 sets of leakage detectors are planned to be provided.

5.4 Basic Design Drawings

The Basic Design Drawings are listed below :

Drawing-1	General Plan of Distribution Mains
Drawing-2	Key Map of Distribution Mains
Drawing-3	Plan of Distribution Mains (No. 1)
Drawing-4	Plan of Distribution Mains (No. 2)
Drawing-5	Plan of Distribution Mains (No. 3)
Drawing-6	Plan of Distribution Mains (No. 4)
Drawing-7	Plan of Distribution Mains (No. 5)
Drawing-8	Roofing Structure for Gamair Service Reservoir



SCALE

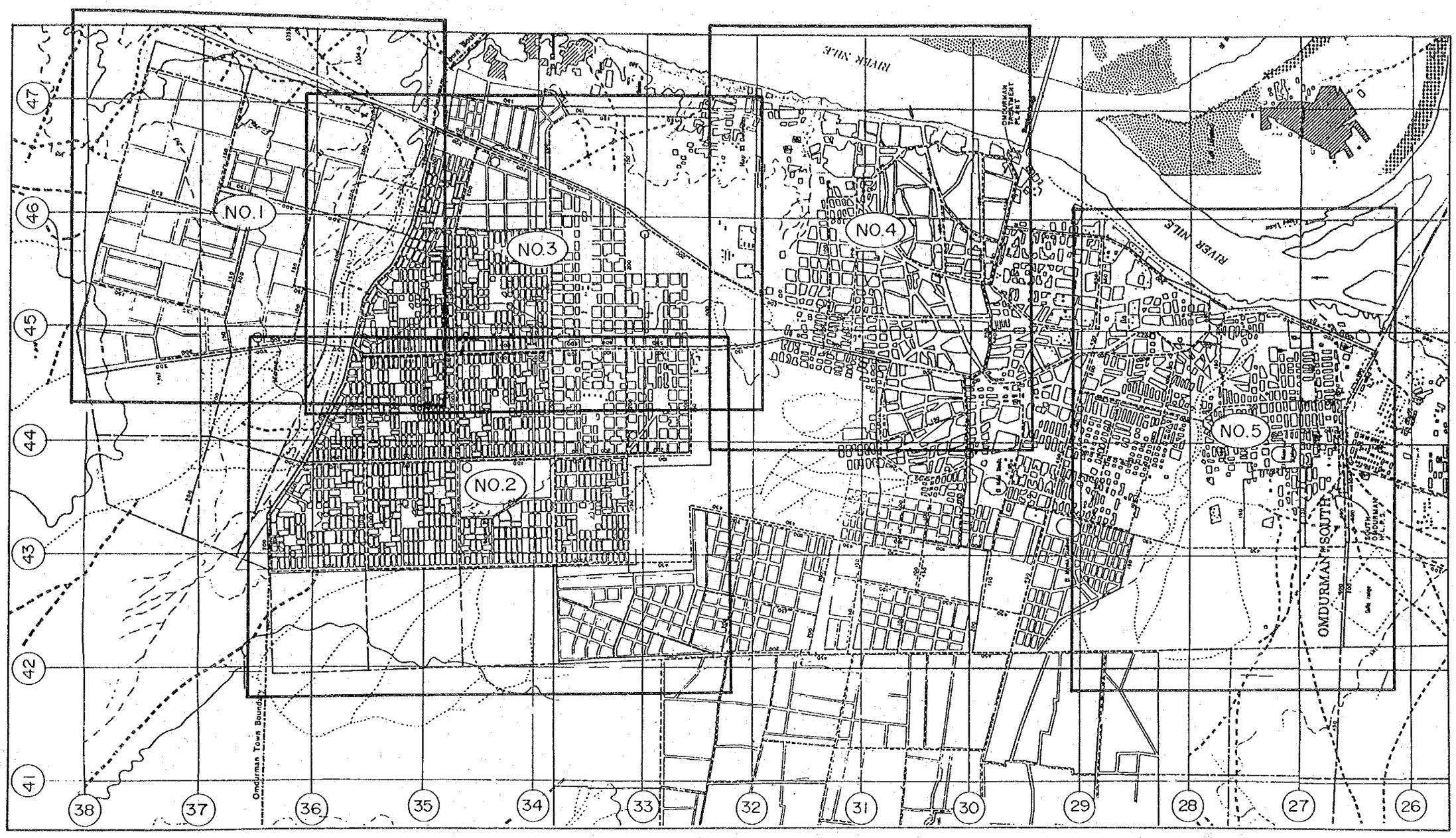
0 500m 1000m 1500m 2000m

LEGEND

PROPOSED PIPELINE

GENARAL PLAN
OF
DISTRIBUTION MAINS

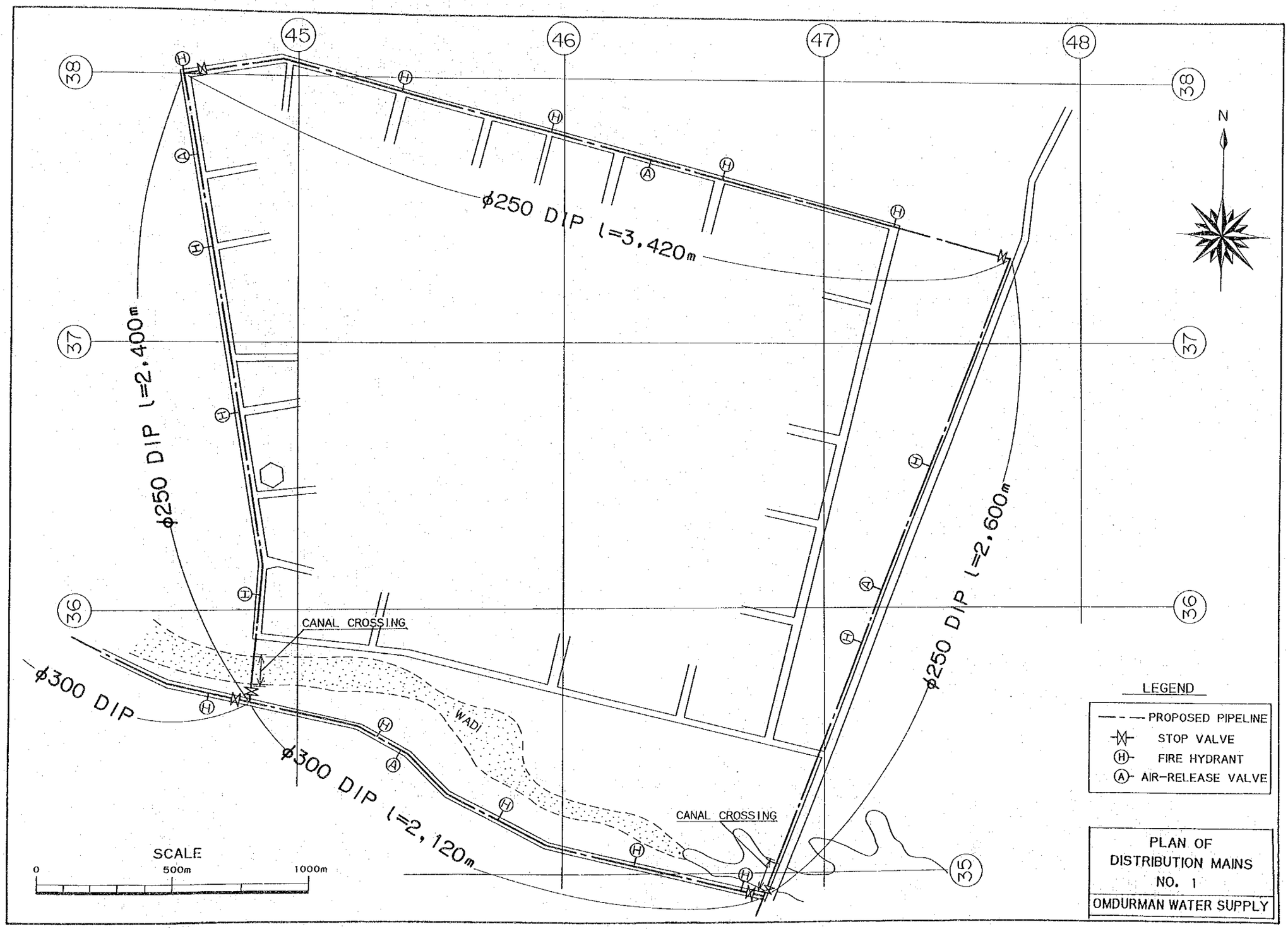
OMDURMAN WATER SUPPLY

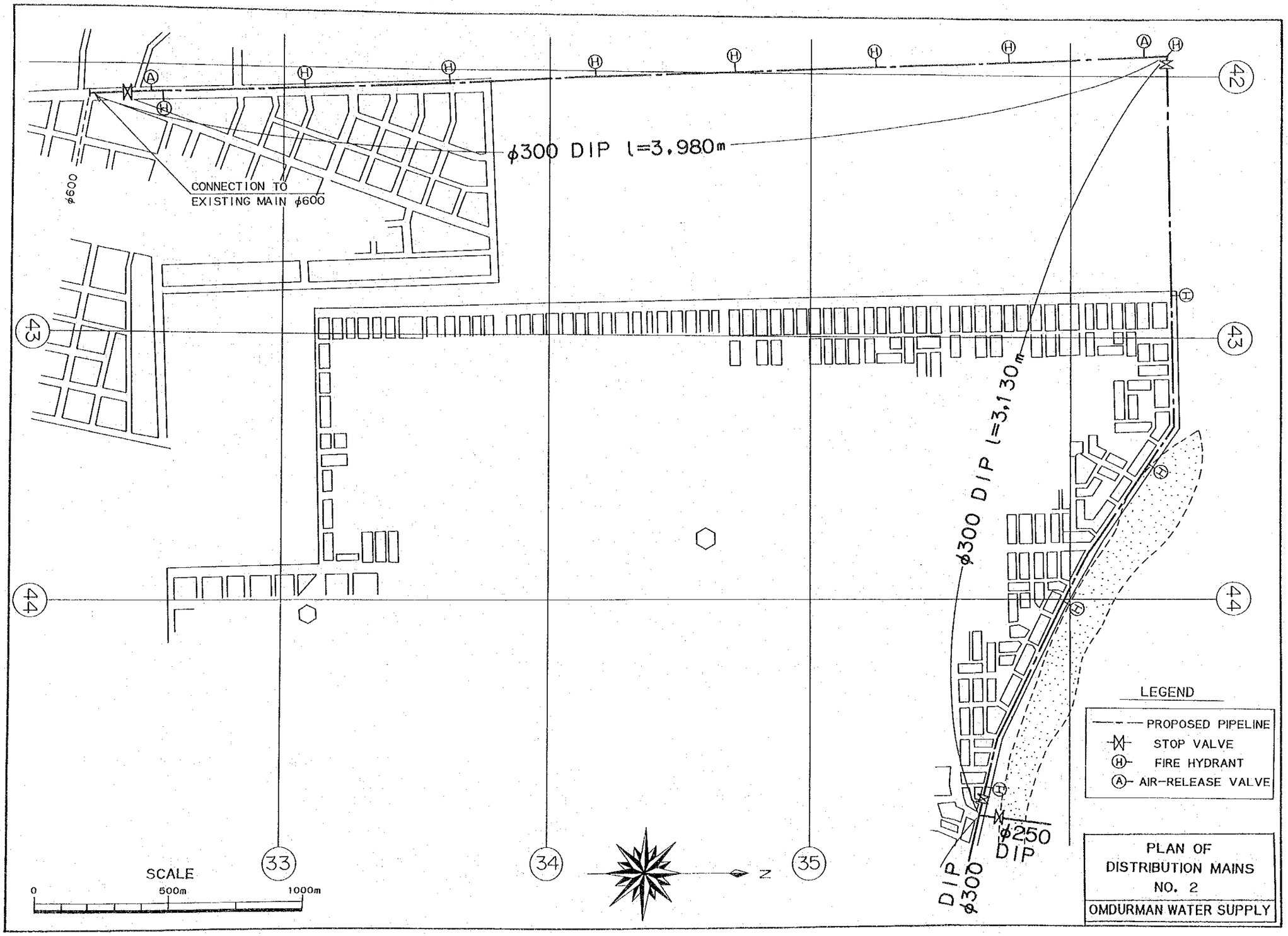


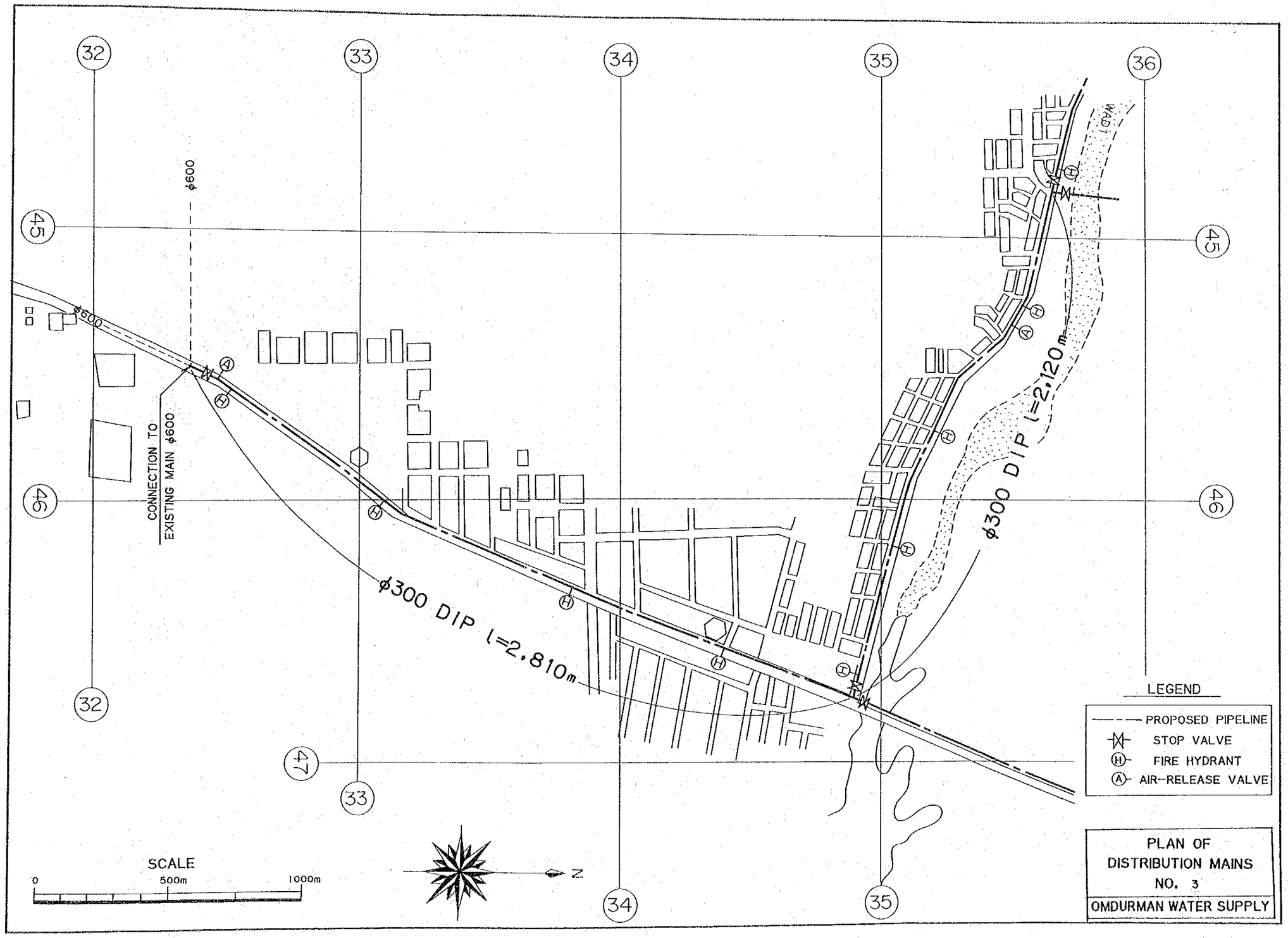
SCALE

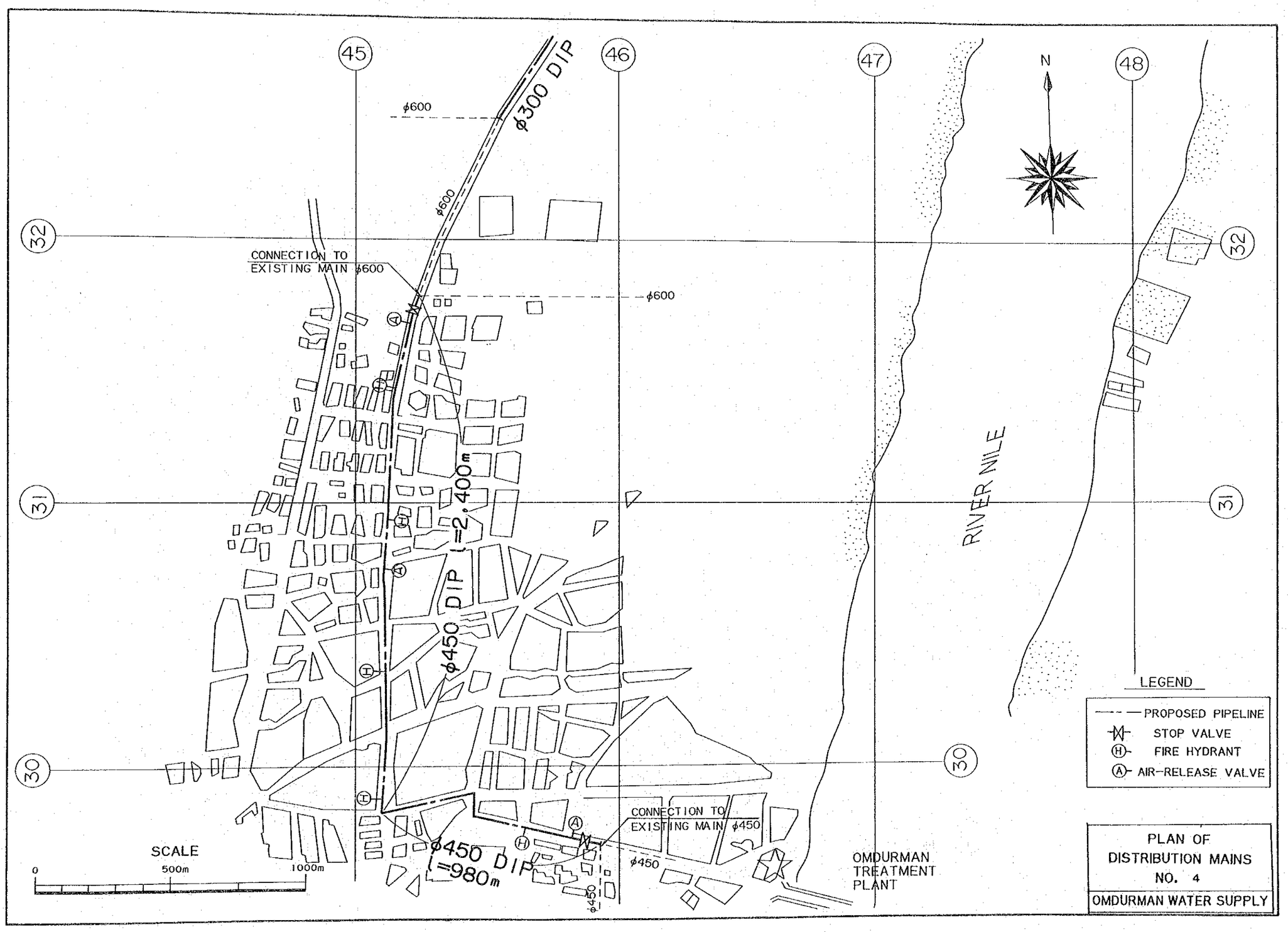
0 500m 1000m 1500m 2000m

KEY MAP
OF
DISTRIBUTION MAINS
OMDURMAN WATER SUPPLY


45
46
47
48
38
37
36
35
N
φ250 DIP l=3,420m
φ250 DIP l=2,400m
φ250 DIP l=2,600m
φ300 DIP
φ300 DIP l=2,120m
CANAL CROSSING
CANAL CROSSING
WADI
SCALE
0
500m
1000m
LEGEND
PROPOSED PIPELINE
STOP VALVE
FIRE HYDRANT
AIR-RELEASE VALVE
PLAN OF
DISTRIBUTION MAINS
NO. 1
OMDURMAN WATER SUPPLY


φ300 DIP l=3,980m
CONNECTION TO
EXISTING MAIN φ600
φ600
φ300 DIP l=3,130m
φ250
DIP
φ300
DIP
φ300
42
43
44
33
34
35
SCALE
0
500m
1000m
N
LEGEND
PROPOSED PIPELINE
STOP VALVE
FIRE HYDRANT
AIR-RELEASE VALVE
PLAN OF
DISTRIBUTION MAINS
NO. 2
OMDURMAN WATER SUPPLY


32
33
34
35
36
45
46
47
φ600
φ500
CONNECTION TO EXISTING MAIN φ600
φ300 DIP l=2,810m
φ300 DIP l=2,120m
WADI
SCALE
0
500m
1000m
N
LEGEND
PROPOSED PIPELINE
STOP VALVE
FIRE HYDRANT
AIR-RELEASE VALVE
PLAN OF DISTRIBUTION MAINS NO. 3
OMDURMAN WATER SUPPLY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46
47
48
32
31
30
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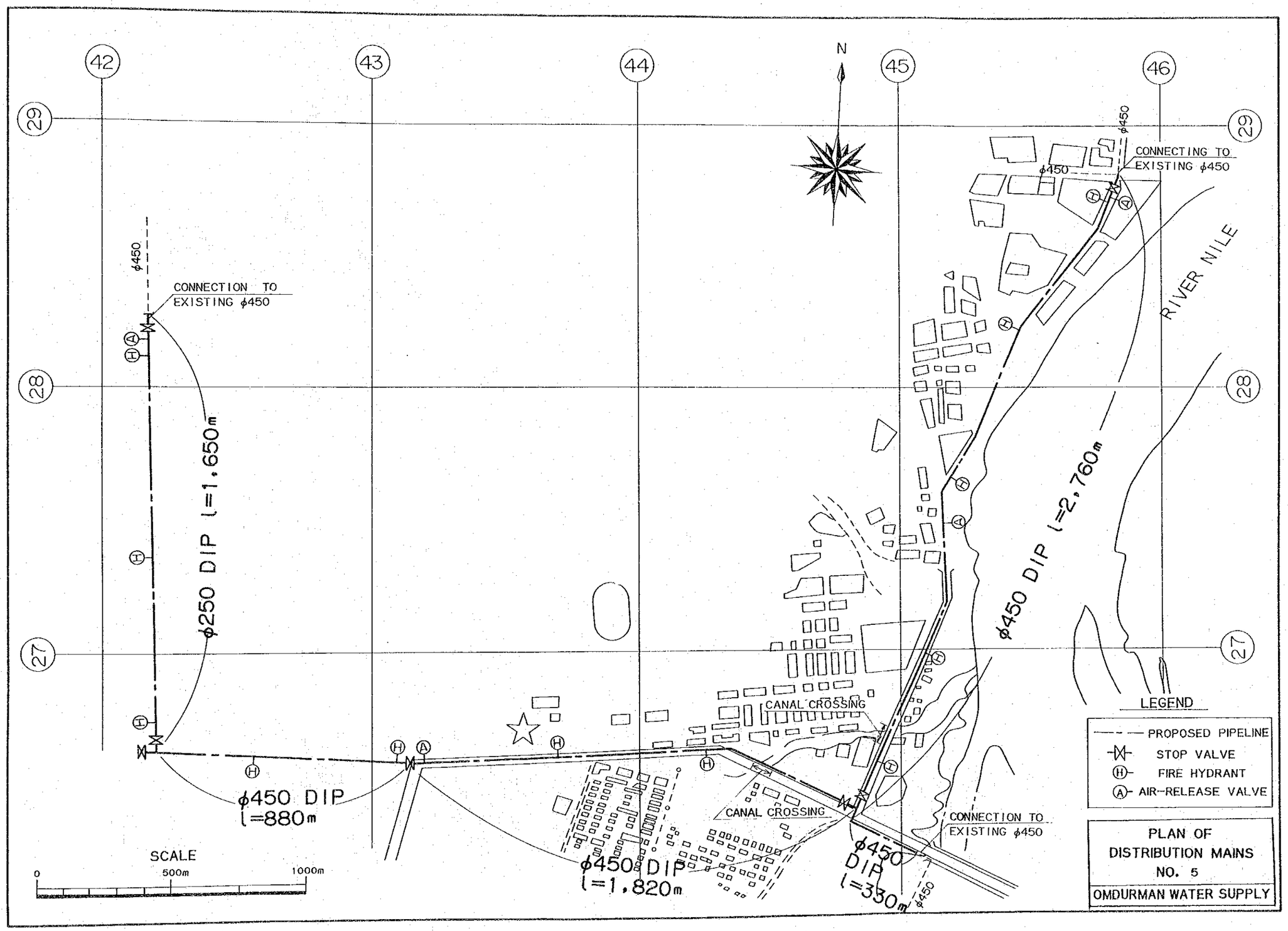
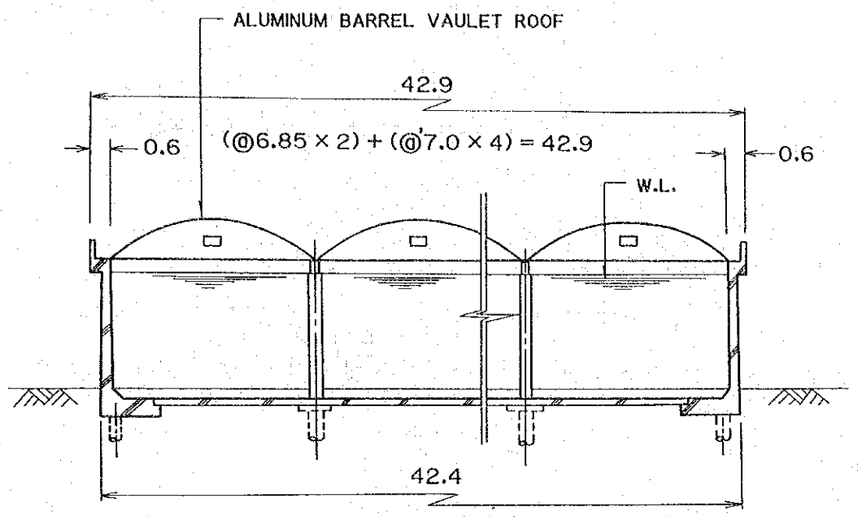
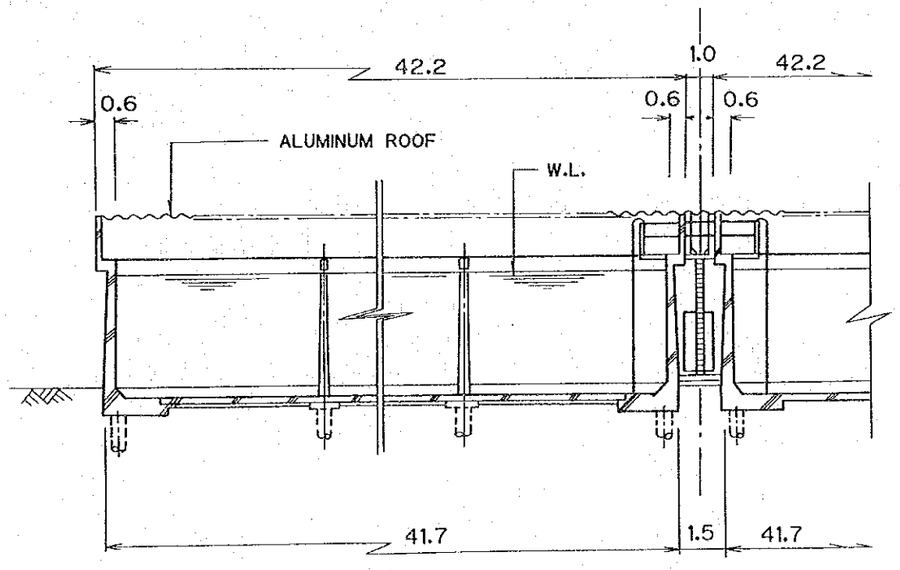
φ600
φ300 DIP
φ600
CONNECTION TO
EXISTING MAIN φ600
φ600
φ450 DIP
l=2,400m
φ450 DIP
l=980m
φ450
CONNECTION TO
EXISTING MAIN φ450
φ450
RIVER NILE
OMDURMAN
TREATMENT
PLANT
SCALE
0
500m
1000m
LEGEND
PROPOSED PIPELINE
STOP VALVE
FIRE HYDRANT
AIR-RELEASE VALVE
PLAN OF
DISTRIBUTION MAINS
NO. 4
OMDURMAN WATER SUPPLY


42
43
44
45
46
29
28
27
N
φ450
CONNECTING TO
EXISTING φ450
φ450
RIVER NILE
CONNECTION TO
EXISTING φ450
φ450 DIP
l=2,760m
φ450 DIP
l=1,650m
φ250 DIP l=1,
φ450 DIP
l=880m
CANAL CROSSING
CANAL CROSSING
φ450 DIP
l=1,820m
φ450
DIP
l=330m
φ450
CONNECTION TO
EXISTING φ450
SCALE
0
500m
1000m
LEGEND
PROPOSED PIPELINE
STOP VALVE
FIRE HYDRANT
AIR-RELEASE VALVE
PLAN OF
DISTRIBUTION MAINS
NO. 5
OMDURMAN WATER SUPPLY



SECTION "A"



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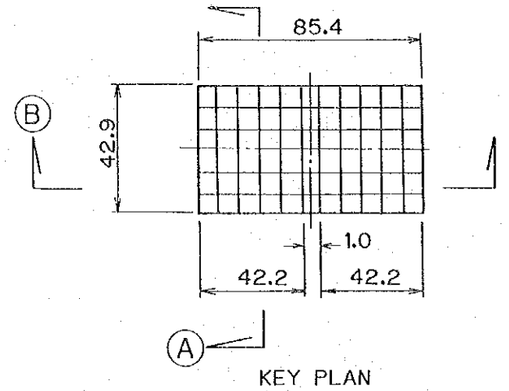
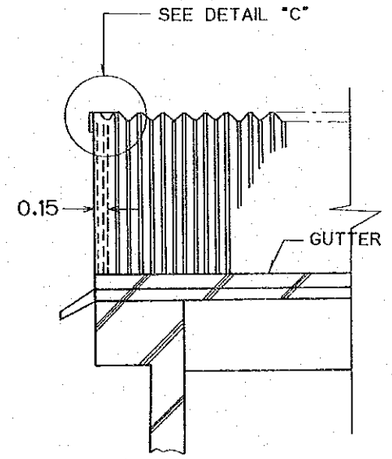
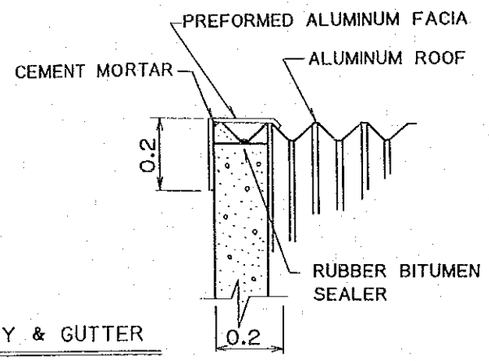


KEY PLAN

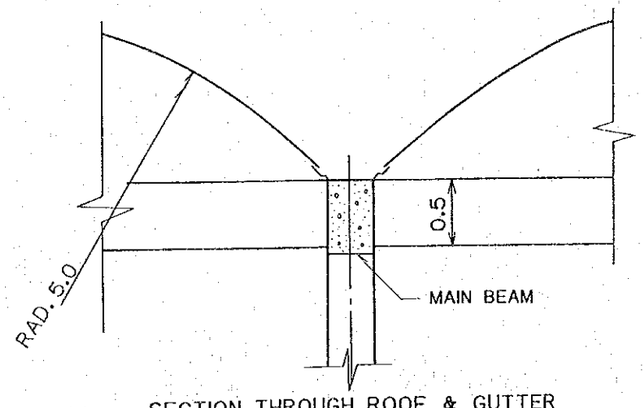
[TREATED WATER RESERVOIR]



DETAIL OF RAINWATER GULLEY & GUTTER



DETAIL "C"



SECTION THROUGH ROOF & GUTTER

ROOFING STRUCTURE
FOR
GAMAIR SERVICE RESERVOIR
OMDURMAN WATER SUPPLY

Chapter 6. ORGANIZATIONAL ARRANGEMENT FOR IMPLEMENTATION

6.1 Organizational Setup for Implementation

As described in Chapter 4, the executive agency of this Project is NUWC.

Construction machinery and materials are accepted by the Purchasing Section of Supplies Administration Department. Then, the machinery are transferred to the Operation and Maintenance Department and the materials to the Construction Section of the National Projects Management Department, for the use of pipelaying and related work. The part of pipelines laid by the Japanese side will be handed over to the Construction Section when completed. Omdurman Office will confirm the transferred quantity and level of workmanship before maintenance.

The Operation and Maintenance Department and the National Projects Management Department are organized to manage, operate and maintain existing equipment and facilities. For construction of new pipelines as well as operation and maintenance of equipment and facilities provided under the aid project, a corresponding organizational arrangement is necessary. In addition, for transfer of technology, responsible section(s) or department(s) and staff shall be assigned. Regarding leakage control, a new organizational group will have to be set up with appropriation of budget, because the involved work differ in nature from the existing department/sections' responsibilities.

After completion of the Project, technical management of the distribution pipelines in Omdurman area is placed under the control of Omdurman Office which, together with other four sections, is controlled by Director of the National Projects Management Department. The provided construction machinery will be managed, with regards to technical matters, by Director of the Operation and Maintenance Department and, regarding administrative aspects, by Director of the Management and Administration Department.

6.2 Share of Responsibility of Construction

Under the Japanese Grant Aid Project of providing machinery, materials and service, a part of pipelaying work of the distribution pipelines will be undertaken by Japanese contractor, while the Sudanese side will do remaining work.

1) Japanese Portion (length of pipelines : 20,300 m)

Awarding the whole work as a package to a Japanese contractor will be appropriate. The contractor will sub-contract local contractors.

The local contractors differ in size and field of speciality. Their participation in the Project will be provision of most of unskilled labor which is available locally. Payment will be made by the Japanese contractor.

2) Sudanese Portion (length of pipelines: 11,000m, Roofing of the reservoir)

The construction section of NUWC will undertake it. The expense will be born by the Sudanese side and its budget has been prepared.

This portion will be implemented using the provided machinery and operation technique learned from the Japanese side. Accordingly, the timing of the construction will be after the completion of Japanese portion.

Otherwise, this portion could be commenced without waiting the Japanese side's completion, for laying of small size pipe (250 mm) is possible, depending solely on manual labor. Necessary labor force could be managed under the direct employment of NUWC which has experienced many pipelaying work in similar way of management, as it retains about 6,200 laborers within the total 7,700 employees.

NUWC also has experiences of roofing at other plants (Mogren Treatment Plant in Khartoum, etc.) using same materials as provided under the Project. The size of previous work was also similar as this one. Upon consultation with NUWC, the arrangement was agreed.

6.3 Construction Plan

The Project includes two different parts, namely, provision of machinery and materials, and construction of pipelines. Accordingly, the construction plan is described in two headings.

1) Provision of Machinery and Materials

a) Pipe

All pipe materials of 31,300 m length is provided by the Japanese side. 20,300 meters of it is laid by Japanese side and the rest, 11,000 meters, is laid by the Sudanese side. The Japanese side transport the 11,000 meters pipe materials to the Omdurman pipe yard and the Sudanese side receives

them after checking the items and number and the Japanese side is relieved its responsibility.

b) Construction Machinery

Upon arrival of the construction machinery, the Japanese side checks the items and number and hand them over to the Sudanese side, on the paper of transfer. However, the Japanese contractor holds every right of using all of them without charge during the construction work by the Japanese side, as well as the responsibility of maintaining the machinery in good condition. After the completion, they will be transferred materially.

Parts of machinery worn or lost during the construction should be added, in advance, to the supply as spare parts.

c) Roofing Materials

The Sudanese side undertakes installation using the materials granted by the Japanese side. The materials are handed over to the Sudanese side at the stock yards prior to the installation by NUWC.

2) Construction

a) Detailed Design Works

Detailed design, tender documentation and tendering are conducted by the Japanese side. The Sudanese side has responsibility for surveying the pipe route roads which is necessary for the detailed design. The survey shall be completed by the end of July 1988 on the Sudanese side expense.

b) Construction Supervision

The Japanese side will supervise the Japanese portion of pipelaying work, namely of 20,300 m length. The Sudanese side will supervise the Sudanese portion which includes pipelaying work of 11,000 m length and roofing installation.

3) Procurement of Equipment and Materials

Eligible countries for supplying equipments and materials are limited to Japan and Sudan for this Project, except the following cases ;

- The required product is made only in a particular country.
- The required product is lower in price and better than or equal with Japanese product in quality obviously.
- A supplier's agent is in Japan to provide adequate service.

It is most likely that major machinery and materials are supplied from Japan, considering the above conditions. Aggregates such as sand, gravel, etc. are locally supplied. Roofing materials are imported from a producing country because they are not available in Japan.

Supply of major machinery and materials is described as follows :

a) Piping Materials and Construction Machinery

All of the piping materials such as cast iron pipe, valves and fire hydrants, of total length 31,300 meters and 450/350/250 size, and construction machinery (listed in the Table - 15) are Japanese products and supplied at the Japanese side expense.

The period for delivery is estimated at eight months, consisting of 3 months' manufacturing, 1 month's marine transportation and 4 months' local processing including custom clearance, unloading and inland transportation.

b) Roofing Materials

Roofing materials (corrugated aluminum, 3,500 m^2) are purchased from Europe at the Japanese side expense.

Note : This kind of material is not produced in Japan, as it is not needed in the market. In Japan, manufacturing is possible but cost is too high. In Europe (England), manufacturing factories exist and they have experienced supply to Khartoum Treatment Plant in the past.

c) Cement and Steel Reinforcing Bars

Cement and steel reinforcing bars of a limited quantity are required for special parts, like crossing of water channel bottom, of the pipelaying. As local factories producing cement and steel bars are suspending operation due to difficulty of raw materials' procurement, most of these materials have to depend on import, causing shortage in the market nevertheless. However, cement and steel bars for the Project can be procured locally, as the planned quantity is small.

Regarding the cost sharing, the Japanese side bears the cost of 20,300 meter length and the Sudanese side that of 11,000 meter length.

d) Sand, Gravel and Brick

These materials are locally available and the costs are shared by the Sudanese side, in similar manner as mentioned previously on cement and steel bars. As brick is abundant, cheap and easy for work, small structures

attached to the distribution pipelines are planned to be brick-made, as many as possible, at the design stage.

6.4 Implementation Schedule

Implementation of the Project starts at the Exchange of Notes by the both Governments of Japan and the Sudan, proceeds to detailed design, tendering, procurement and delivery of materials, etc. and further to construction. Each of the 1st and 2nd stages needs 8 months for manufacturing and transportation. Of the Japanese side's construction of 20,300 meter long pipelaying, the 1st and 2nd stage will require about 5 and 5 months respectively, totaling about 10 months. The Sudanese side's construction of 11,000 meter long pipelaying, following the Japanese side's, will take about 12 months more before completion, it is estimated.

Estimated Construction Period

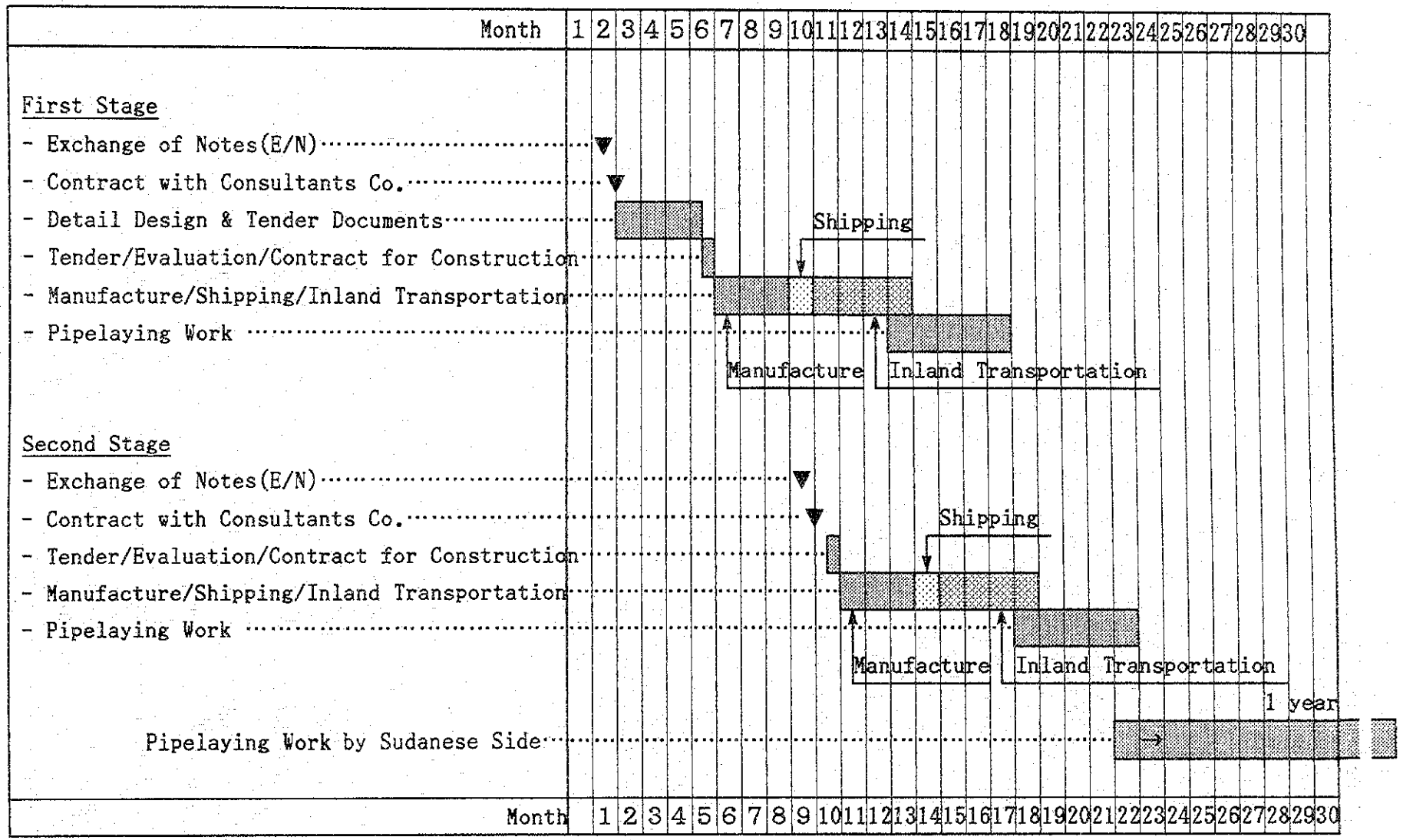
1) Japanese Side Construction Work

	1st Stage Work	2nd Stage Work
Pipelines Installed	: Ø450×8.3 km	Ø300×12.0 km
Estimated Progress Rate of Construction	: 1.9 km/month	2.7 km/month
Laying Work Period	: 8.3/1.9 = 4.3 months	12.0/2.7 = 4.5 months
Appurtenant Work Period	: 0.7 months	0.5 months
Construction Period	: 4.3+0.7=5.0 months	4.5+0.5=5.0 months
Total Construction Period	:	5.0+5.0 = 10.0 months

2) Sudanese Side Construction Work

Pipeline Installed	: Ø450~Ø250×11.0 km
Estimated Progress Rate of Construction	: 1.1 km/month
Laying Work Period	: 11.0/1.1 = 10.0 months
Appurtenant Work Period	: 2.0 months
Total Construction Period	: 10.0+2.0 = 12.0 months

Fig-9 IMPLEMENTATION SCHEDULE



6.5 Cost Estimation

Cost estimates for the Portion Implemented by Sudanese Side

Pipelaying Works	LS	700 thousand
Roofing Work	LS	30 thousand
Total	LS	730 thousand

Chapter 7. MAINTENANCE PLAN

7.1 Organization for Maintenance

NUWC is organized, as shown in Fig-5 of Chapter 4, by 10 departments of two distinct functions, administrative and operative, under the control of Director General. Involved in and relevant to this Project are 3 departments, the Supplies Administration Dept. to accept the delivered goods provided under the grant, the Engineering Management Dept. to manage the construction machinery and the National Projects Management Dept. to manage the construction work and subsequent maintenance.

The distribution pipelines provided under the grant project will be managed by Omdurman Office of the National Projects Management Dept. when completed. The pipelines will be ductile cast iron pipes, upon consideration of easiness of maintenance. When completed, the pipelines of this Project will cause far less occurrence of faults needing repair works, in comparison with existing asbestos cement pipelines. Consequently, strengthening the organization and/or reinforcing the staff number, specially for the pipelines will be unnecessary.

7.2 Maintenance Plan and Cost

Major work involved in the maintenance of distribution pipelines are detecting leaks and repairing them. Some leaks are detectable above ground and others are undetectable. Detectable leaks are easily found by patrolling pipelines and are repairable without difficulty. For detecting the above-ground undetectable leaks, the Project provides leakage detecting equipment. As detection and repair of leaks are peculiar work which require special technical skills, a new organization is deemed necessary. But, it will be formed by assigning some persons of NUWC's employees to staff of it without increasing the number of total employees.

Maintenance of pipelines management will be pictured in the following figure, Fig-10.

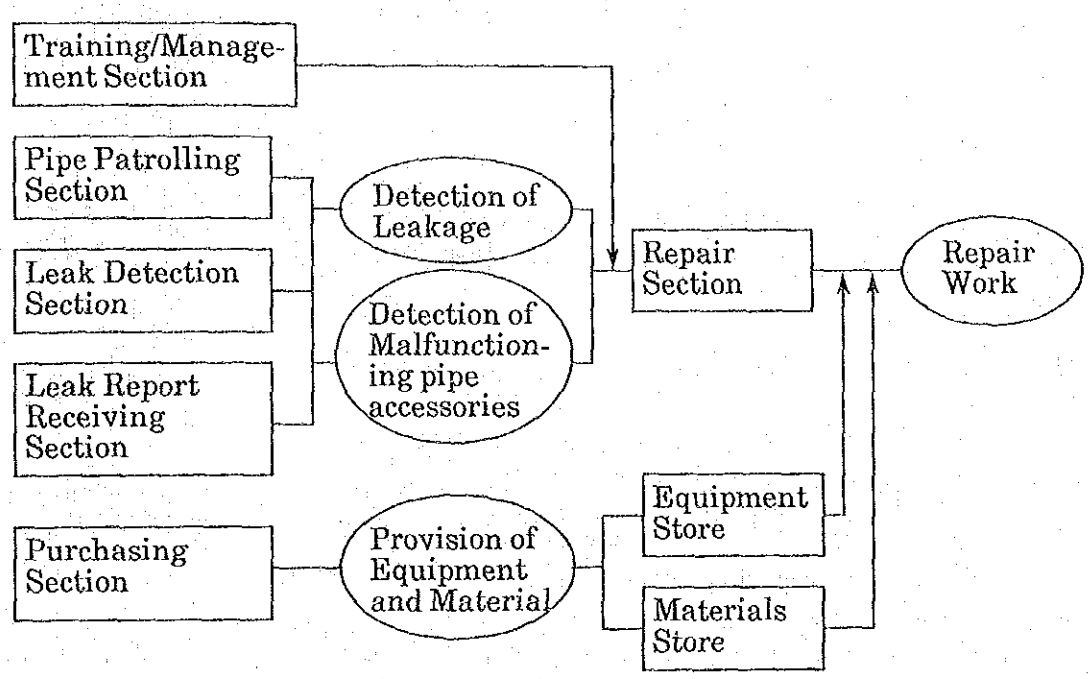


Fig-10 Flow Sheet of Pipeline Maintenance

Expenditure for repair and maintenance of the distribution facilities in the Metropolitan Khartoum area is, as shown in the table below, more or less than 1% of total expenditure (88/89 figure includes distribution pumps' repair). As described in the previous section of this report, the pipelines constructed under the Project will not cause substantial increase of maintenance cost after completion, as ductile cast iron pipes are used.

	1985/86	1986/87	1987/88
Repair & Maintenance Cost (A) (1,000 LS)	164	3,595	700
Total Expenditure (B) (1,000 LS)	13,953	50,000	57,500
A/B (%)	1.2	7.2	1.2

Chapter 8. PROJECT EVALUATION

8.1 Effect of the Project's Implementation

Quantitative evaluation of the social and economic effects resulting from the Project's implementation is difficult. However, some direct and indirect influences are discussed below.

1) Improvement of Water Supply System

a) Increase of Per Capita Water Supply

To meet increasing water demand in the Omdurman area, a plan to transmit 11,000 m^3/day from the Khartoum North Water Treatment Plant and make the total supply to the area 52,300 m^3/day is in progress. Upon completion of the plan, when the said supply is delivered to the area, it will raise the daily per capita supply from the present 60 ℓ to 80 ℓ on the average, or a 30% increase. Moreover, when the present loss of water due to leakage, believed to be 25%, is lowered by the utilization of leakage detecting equipment, the 80 ℓ/cpd supply may be improved further.

b) Expansion of Service Area

New distribution pipelines installed under the Project are expected to increase the service area to serve 655,000 consumers. Also, the residential areas where people are presently buying water from vendors, or are otherwise indirectly served, will be benefited. Thus, both the directly supplied and indirectly supplied areas will be expanded.

c) Increase of Service Pressure

By the improvement of the distribution network, service pressure and water flow will increase, and pressure of 15 meters or more will be maintained for the supply, as shown in Table - 14. Then, the individual booster pumps used presently will no longer be needed. Increase of the service pressure will also bring about the improvement of water quality, as increased internal pressure prevents the intrusion of polluted water from outside.

2) Indirect Improvement

a) Decrease of Water-Related Diseases

Improvement of the water supply, as is well known, will decrease the occurrence of not only water-related diseases but also of other contagious diseases like trachoma. Although such data is limited in the Metropolitan Area and Omdurman area, the occurrence of contagious diseases decreased

by 50% in Sharqiya Governorate in Egypt when per capita water supply increased by 50%, it was reported in 1984.

b) Decrease of Fire

The fire-fighting capability of the water supply system will increase remarkably by the installation of hydrants at 500 meter intervals under the Project. It will decrease the occurrence of fires as well as the amount of damage due to them.

c) Lessening of Toil for Women and Children

Water collecting has generally been considered the work of women and children, forcing them to carry water from distant places, where water distribution pipes are not provided. Completion of the Project will free them from such toil.

8.2 Appropriateness of the Project

1) Technical Aspects

NUWC has implemented much work to cope with the increasing water demand, making its own water supply improvement program on the basis of the Master Plan of the Metropolitan Area made in 1979, and modifying it in consideration of the changes since then. Twenty-four groundwater supply stations in the service area and partial installation of distribution pipelines are provided for, based on NUWC's own program.

As NUWC has experience in planning and executing the improvement of distribution pipelines, the organization is sufficiently capable of managing the pipelaying technology of ductile cast iron pipelines which is newly introduced under the Project. Larger sized pipes will be laid mainly by the Japanese side and transfer of the related technology will be accomplished through the work. NUWC will be able to undertake overall management involving the various technical know-how, based on the newly learned technology.

2) Administrative Aspect

Operation and maintenance of the systems have not necessarily been satisfactory, due to the shortage of spare parts and technical personnel resulting from an insufficient budgetary allotment for these matters.

To improve the above mentioned circumstances, provisions are made as described below :

- Shortage of materials for repair : Supply of appropriate amount of materials needed for repair
- Shortage of machinery for repair : Supply of equipment and machinery for construction
- Shortage of transportation capacity of construction/maintenance materials and equipment : Supply of 9 trucks
- Shortage of means of communication : Supply of one station wagon

Of the drinking water produced at the water treatment plants, 25% is said to be lost to leakage presently. To improve this situation, the following measures are taken :

- Supporting leakage detection work : Supply of 2 pumps for pressure tests
- Pinpointing leakage spots : Supply of 4 leakage detectors

The machinery and equipment are maintained by each department in charge of them and are expected to be used for efficient operation and maintenance of the systems. Successful utilization by the engineers and technicians is foreseen, after the technology is transferred to them by the Japanese side.

3) Economic Aspects

As discussed previously, the overall effect of the Project is not limited to the quantitative benefit of the additional 11,000 m^3/day supply to the area from the Khartoum North Water Treatment Plant. However, to make the matter simple, the economic effect will be calculated on the basis of the said additional water volume. Regarding the ratio of use of various types of consumption and the unit rate of the water tariff, the prevailing values throughout the Metropolitan Area are applied to the calculation.

Amount of Water Sold

Accounted - for Water : 11,000 m^3/day × 75% = 8,250 m^3/day (leakage ratio 25%)

Domestic Use : 8,250 m^3/day × 60% = 4,950 m^3/day (60% + 20% + 20%)

Commercial/Industrial Use : 8,250 m^3/day × 20% = 1,650 m^3/day

Public Use : 8,250 m^3/day × 20% = 1,650 m^3/day

Income (Annual)

From Domestic Use	:	4,950 m³/day × 30 days × 12 months × LS 1.0 = LS 1.8 million
From Commercial/ Industrial Use	:	1,650 m³/day × 30 days × 12 months × LS 1.4 = LS 0.8 million
From Public Use	:	1,650 m³/day × 30 days × 12 months × LS 1.4 = LS 0.6 million
		Total = LS 3.2 million

The budgetary expenditure for the entire municipal area in 1987/1988 is approx. LS 33.5 million as shown in the attached Appendix. Calculated proportionally on the basis of served population, the budgetary expenditure for the Omdurman area is estimated as follows :

LS 33.5 million × 38% = LS 12.7 million

As the increased supply is 11,000 m³/day, it equals 21% of the planned total consumption of the Omdurman area of 52,300 m³/day :

11,000/52,300 = 21%

The increased supply causes an increase of the budgetary expenditure. Assuming that the LS 12.7 million increases proportionally to the supply's increase, the budget increase will amount to LS 2.7 million :

12.7 × 21% = 2.7

This projected expenditure of LS 2.7 million is less than the estimated income of LS 3.2 million.

As the above results are made based on a few assumptions, a definite positive merit cannot be proved. Still, it suggests that the Project will possibly result in more revenue than expense and will be economically beneficial.

Chapter 9. CONCLUSION AND RECOMMENDATION

9.1 Conclusion

The water supply plan has been proposed to distribute treated water from four systems to the Omdurman area with a total supply capacity of 52,300 m^3/day, and parts of the plan are presently under implementation to cope with the rapidly increasing water demand in the area. The present Project is planned to supply water effectively by constructing a main pipe network to reinforce the distribution system.

After completion of the Project, a total of 52,300 m^3/day will be delivered to the served population of 655,000 in 1988, with an increased per capita supply of 80 liter per day. In addition to this, service pressure will be raised and pollution-inducing negative pressure will be prevented to maintain better water quality. The changes will contribute greatly to the people's public health by improving their living environment and reducing the incidence of disease. Also, damage and loss due to fire will be reduced by the provision of strategically located hydrants. Thus, overall environmental conditions will be improved effectively.

As described above, the Project's effectiveness is obvious and its implementation is urgently needed. Provision of the machinery and materials and transfer of the construction technology under the Japanese Grant Aid Program is appropriate and significant.

9.2 Recommendations

The Project is divided into two parts. The first part consisting of the installation of distribution pipelines undertaken by the Japanese side includes the provision of materials and installation, while the second part includes only the provision of materials which will be installed by the Sudanese side itself. The following considerations will be required in relation to the execution of the Grant Aid Project.

1) Management Organization of NUWC

   a) Establishment of an organization for management of the construction work

   Three departments of NUWC will be involved in the construction work implemented by the Sudanese side, using the pipe materials provided under the Project.

Supplies Administration Department	:	Control of storage and supply of pipe materials
Operation and Maintenance Department	:	Operation and maintenance of construction equipment
National Projects Management Department	:	Construction work and supervision

In the execution of the construction work, the three departments' functions will have to be inter-connected and it may cause inefficiency in the management of the work. To avoid such situations, the management procedures shall be clearly defined for smooth and stable execution of each department's responsibilities.

b) Budget allotment for procurement of spare parts

The quantity of spare parts and materials granted under the Project is limited and, for effective management of the facilities, a continuous and stable supply of them shall be secured. Preparation of a budget for the procurement is indispensable.

c) Preparation of distribution pipe ledger

After completion of the Project, the pipeline data shall be transcribed from the water works' records to a ledger for permanent preservation. Exact location and alignment of the pipelines shall be clearly filled in with drawings for use in future repair work. In the ledger, the following data shall be recorded: date of pipelaying, diameter, pipe material, length, manufacturing specifications, valve's location, location and structure of accessories and all other information necessary for operation and maintenance.

2) Matters Related to Construction

a) Earth covers of pipeline in trench

The pipelaying depth (earth cover depth) is standardized uniformly by NUWC and presently observed in construction, as shown below.

Nominal Size of Pipe	Earth Covers
Ø600mm~Ø250mm	1.50 m
Ø200mm	1.25 m
Ø150mm~Ø100mm	1.00 m

The above standard is prepared for cases in which asbestos cement pipes are laid in soft ground. For harder ground, the depth is to be determined reasonably and economically, upon consideration of existing conditions. NUWC is expected to revise the standard suit to pipe materials, road and traffic conditions and other factors. Improved, more flexible standards will help speed the progress of work and economize on construction.

b) Structure of reservoir

Presently NUWC makes it a practice to use aluminum corrugated sheets for roofing clear water reservoir and applies it in planning. However, the material seems to be unsuitable for the reasons of: 1) The poor heat insulation property of aluminum will raise the water temperature in the reservoir and cause the evaporation of chlorine which results in the material's corrosion. If the chlorine dosage is increased in future to maintain sufficient residual chlorine at the consumers' taps, corrosion may be accelerated due to evaporated residual chlorine. 2) The material is required to be imported using foreign currency. It is recommended that clear water reservoirs be made of reinforced concrete bought with domestic currency and covered by earth on the top slab for temperature control. Reinforced concrete reservoirs can be economical, due to the saving of foreign currency, and structurally stable, as the roof is built as an integrated member of the whole structure.

APPENDICES

Appendix - 1

Appendix - 2

Appendix - 3

Appendix -1

App 1.1 Organization of the Study Team

The JICA entrusted with the execution of the study from the Government of Japan has organized the Study Team with members as follows :

1.	Mr. Yoshikatsu NAKAMURA Team Leader	First Basic Design Study Division, Grant Aid Planning & Survey Department, JICA
2.	Mr. Hiroshi MACHIDA Water Supply Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
3.	Mr. Hideki YAMAZAKI Pipeline Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
4.	Mr. Masami OGURA Machinery and Material Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
5.	Mr. Takayuki NIIKURA Pipeline Planning and Cost Estimation	Overseas Services Department, Nihon Suido Consultants Co., Ltd.

App 1.2 ACTIVITIES OF THE STUDY TEAM

No.	Date(1988)	Activities
1	Mar19 (Sat)	Departure of Team members from Narita
2	Mar20 (Sun)	↓
3	Mar21 (Mon)	Arrival at Khartoum
4	Mar22 (Tue)	Visit to Japanese Embassy and Ministry of Finance and Economic Planning
5	Mar23 (Wed)	Visit to NUWC and arrangement of the Schedule
6	Mar24 (Thu)	Explanation and discussion on Inception Report at NUWC
7	Mar25 (Fri)	Study of the collected data (holiday)
8	Mar26 (Sat)	Field survey of pipelines(ϕ 250) in the northern part of Omdurman area
9	Mar27 (Sun)	Field survey of Gamair Pump Station and pipelines (ϕ 250) in Omdurman area
10	Mar28 (Mon)	Field survey of pipelines(ϕ 250) in the southern part of Omdurman area
11	Mar29 (Tue)	Field survey of Mogren Treatment Plant and the Intake Facilities
12	Mar30 (Wed)	Geological survey in Omdurman area
13	Mar31 (Thu)	Data collection and field survey of Treatment Plants
14	Apr 1 (Fri)	Study of the collected data (holiday)
15	Apr 2 (Sat)	Data collection at Omdurnan Office
16	Apr 3 (Sun)	Data collection at NUWC
17	Apr 4 (Mon)	Data collection at NUWC
18	Apr 5 (Tue)	Data collection / Arrival of the Team Leader to Khartoum
19	Apr 6 (Wed)	Internal meeting of the Study Team (National holiday)
20	Apr 7 (Thu)	Discussion at Ministry of Finance and Economic Planning, NUWC, and Japanese Embassy
21	Apr 8 (Fri)	Preparation of draft of Minutes of Discussions (holiday)
22	Apr 9 (Sat)	Meeting with Ministry of Finance and Economic Planning and NUWC
23	Apr10 (Sun)	Meeting on Minutes of Discussions
24	Apr11 (Mon)	Study of the collected data (holiday)
25	Apr12 (Tue)	Finalized Minutes of Discussions by Ministry of Finance and Economic Planning, NUWC, and Study Team
26	Apr13 (Wed)	Departure from Khartoum
27	Apr14 (Thu)	↓
28	Apr15 (Fri)	Arrival at Narita

App 1.3 Main Officers Discussed with the Study Team

Ministry of Finance and Economic Planning	Undersecretary	Mr. Omer Abdel Salem
	Director	Mr. Abdelhafiz Mohamed Ahmed
NUWC	Director General	Mr. Ismail Mohmound Ismail
	Director	Mr. Mohamed Hassan Ammar
	Director	Mr. Omer Abdin Mohamd
	Manager of Omdurman Area	Mr. Osman Haroun
	Staff of Omdurman Area	Mr. Hassan Mohd Khalafald
	Staff of Omdurman Area	Mr. Mohamed Mustafal Abed
Embassy of Japan	Ambassador	Mr. Hikaru Oka
	Counselor	Mr. Akihisa Tanaka
	First Secretary	Mr. Toshio Kaneko
	Second Secretary	Mr. Yoshihiko Sato

App 1.4 Minutes of Discussion

MINUTES OF DISCUSSIONS ON IMMEDIATE IMPROVEMENT PROJECT FOR OMDURMAN AREA WATER SUPPLY IN THE REPUBLIC OF THE SUDAN

In response to the request of the Government of the Republic of the Sudan, the Government of Japan decided to conduct a basic design study on the Immediate Improvement Project for Omdurman Area Water Supply and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to Sudan the study team headed by Mr. Yoshikatsu Nakamura, Officer, First Basic Design Study Div., Grant Aid Planning and Survey Dep., JICA from March 19 to April 15, 1988.

The team had a series of discussions on the Project with the officials concerned of the Government of the Sudan and conducted field survey in Omdurman and related areas.

As a result of the study, both parties agreed to recommend to their respective Government that the major points of understanding reached between them, as attached herewith, should be examined towards the realization of the Project.

Dated : April 10, 1988

Yoshikatsu Nakamura

Team Leader of Basic
Design Study Team,
Japan International
Cooperation Agency

Adam Ibrahim El Imam

Acting Undersecretary
for Planning, Ministry
of Finance and Economic Planning

Ismail Mahmoud Ismail

Director General,
National Urban Water
Corporation

MAJOR POINTS OF UNDERSTANDING

1. The objective of the project is to improve and to reinforce distribution systems in Omdurman area where the inhabitants are suffering from serious shortage of the water supply.

2. The site of the project is Omdurman area as a part of Khartoum as shown in Annex 1.

3. National Urban Water Corporation(NUWC) under the Ministry of Energy and Mining is responsible for the administration and the execution of the project.

4. Components of the project will be comprised of the followings :

   a) Supply of ductile iron pipes in the total length of about 31,200m, construction machinery, equipment, roofing and related materials necessary for the implementation of the work, as detailed in Annex 2.

   b) Implementation of the construction work of the main part of distribution mains by the Japanese side to cope with immediate necessity to supply water to the inhabitants in the areas where they suffer from the most serious shortage of the water supply (Annex 3).

5. The Sudanese side agreed to carry out the topographical survey for the project implementation and to send the survey results to the Japanese side by the end of July, 1988, as stated in Annex 4 in detail.

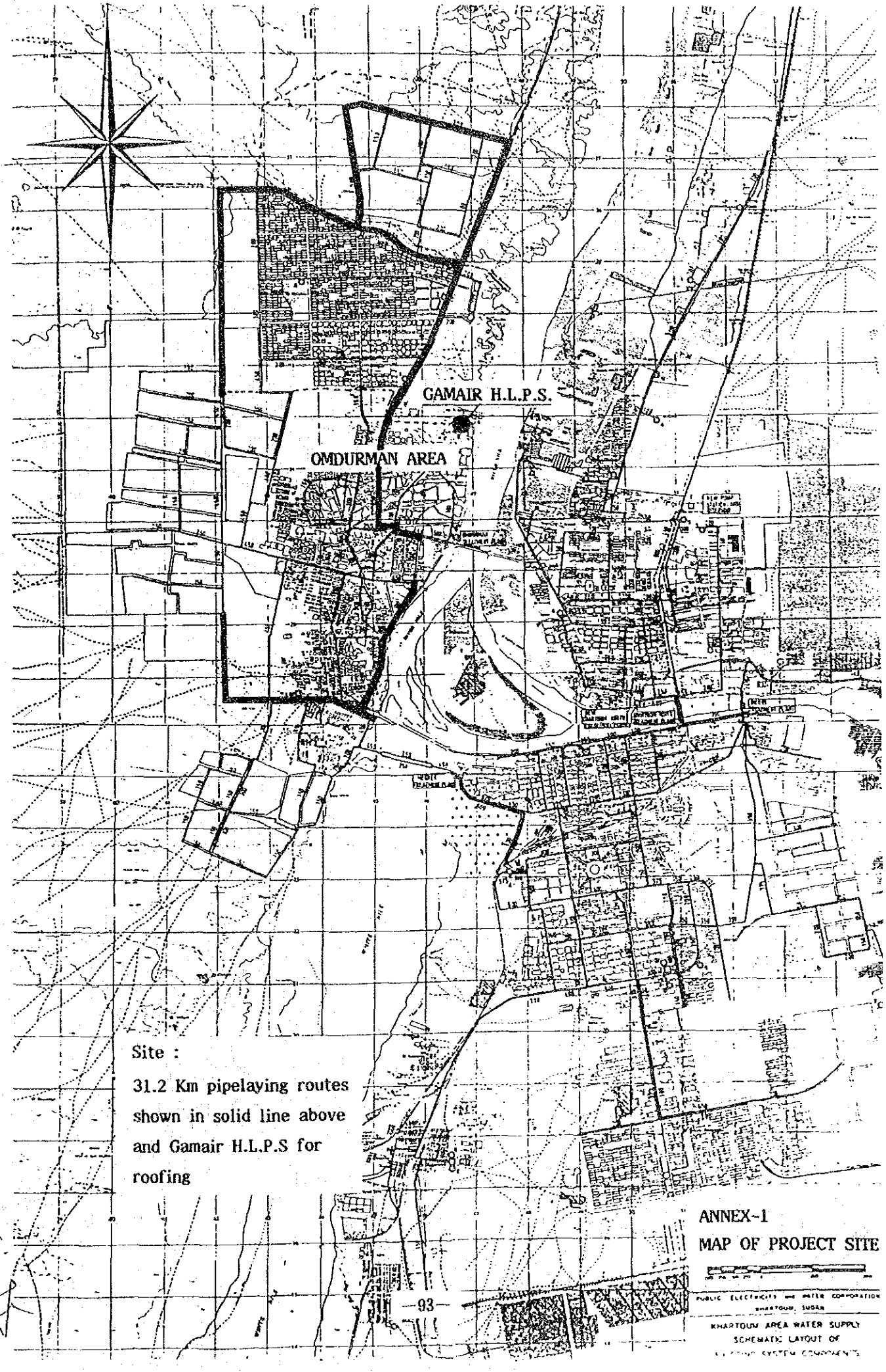
6. The Sudanese side agreed to provide the pipe storage yards in Omdurman area at least 2 sites of 1 ha each.

7. The Sudanese side understood the system of Japanese Grant Aid Program explained by the Team and confirmed the measures to be taken by the Sudanese side, as described in Annex 5.

8. The supplied construction machinery listed in Annex-2 shall be exclusively used for the pipelaying works carried out by the Japanese side, and the said machinery shall be handed over to the Sudanese side after completion of the Japanese works.

9. The Sudan side agreed to set up a particular implementation unit and to allocate the specific budget for expenses not borne by the Grant to carry out the project

10. The Final Report (10 copies in English) on the project will be submitted to the Sudanese side by August 1988.



Site :

31.2 Km pipelaying routes shown in solid line above and Gamair H.L.P.S for roofing

ANNEX-1

MAP OF PROJECT SITE

PUBLIC ELECTRICITY AND WATER CORPORATION
KHARTOUM, SUDAN

KHARTOUM AREA WATER SUPPLY
SCHEMATIC LAYOUT OF

ANNEX-2

LIST OF PIPES, ROOFING MATERIALS, AND CONSTRUCTION MACHINERY AND EQUIPMENT

1. Pipe Materials & Valves

A. Pipes

Pipe Dia.	Pipe Length
450 mm	9,170 m
300 mm	11,980 m
250 mm	10,070 m
Total	31,220 m

B. Valves,Fittings 1 lot

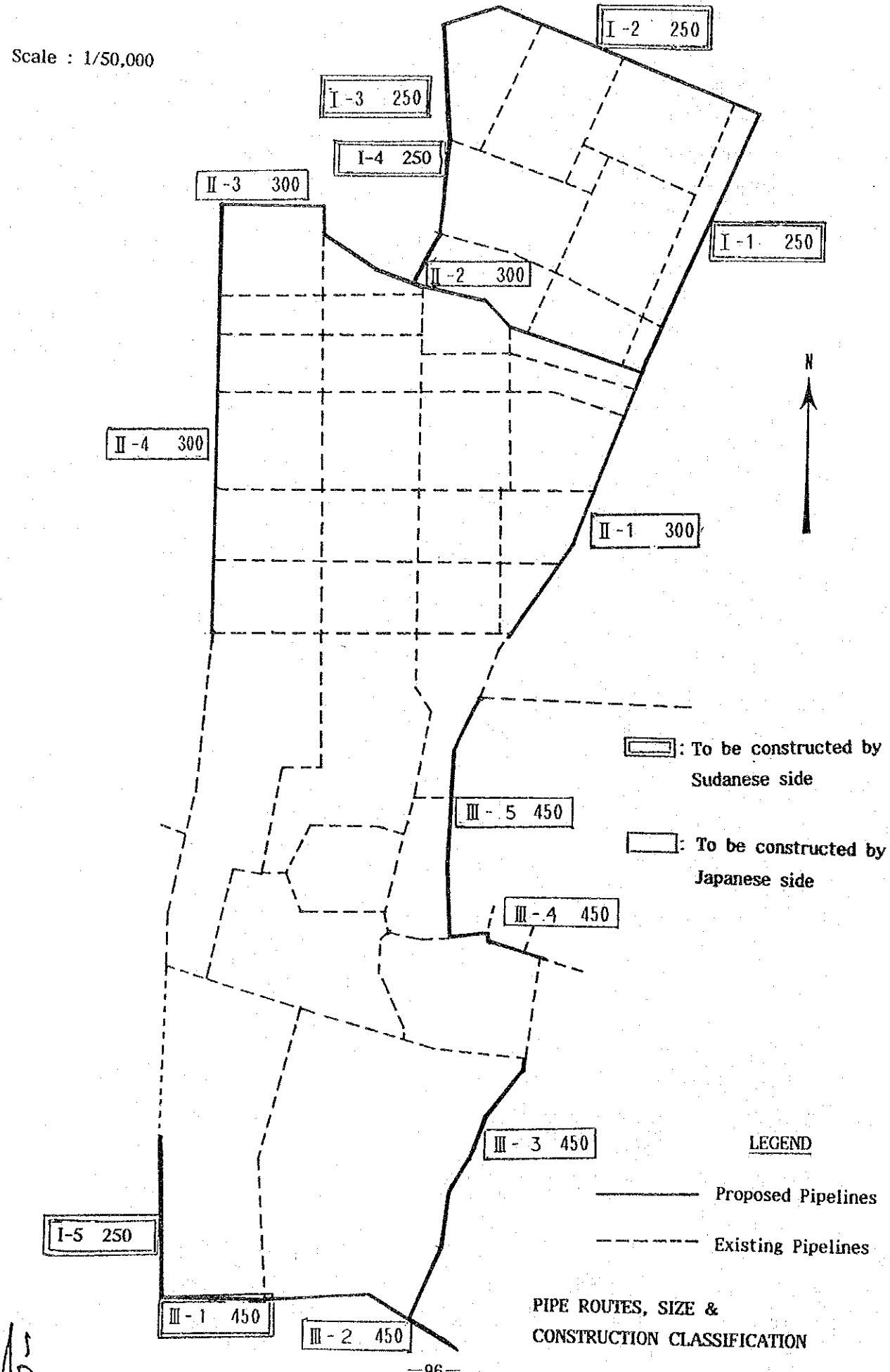
2. Roofing Materials

Corrugated Aluminum Sheet	3,500 sq.m

3. Construction Machinery & Equipment

Backhoe	0.6 cu.m	2 units
Hydraulic Breaker		2 units
Truck Crane	16 ton	1 unit
Truck Crane	10 ton	1 unit
Tractor Shovel	1.0 cu.m	2 units
Dump Truck	11 ton	2 units
Cargo Truck	8 ton	1 unit
Repair Truck (with hydraulic crane)	4 ton	2 units
Pickup	1 ton	4 units
Compressor	5 cu.m/min	2 sets
Concrete Cutter		1 set
Breaker		8 sets
Pipe Cutter		2 sets
Concrete Drill		2 sets
Station Wagon		1 unit

Test Pump for Water Pressure		2 sets
Sludge Pump		3 sets
Leakage Detector	Handy Type	4 sets
Spare Parts		1 lot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Ⅰ-2 250
Ⅰ-3 250
Ⅰ-4 250
Ⅱ-3 300
Ⅰ-1 250
Ⅱ-2 300
N
Ⅱ-4 300
Ⅱ-1 300
: To be constructed by Sudanese side
Ⅲ-5 450
: To be constructed by Japanese side
Ⅲ-4 450
Ⅲ-3 450
LEGEND
Proposed Pipelines
Existing Pipelines
I-5 250
Ⅲ-1 450
Ⅲ-2 450
PIPE ROUTES, SIZE & CONSTRUCTION CLASSIFICATION

ANNEX-3

LIST OF CONSTRUCTION WORKS

1. Pipelaying Works

Pipe Dia.	Pipe Length to be Constructed by Japanese Side	Pipe Length to be Constructed by Sudanese Side
450 mm	8,290 m	880 m
300 mm	11,980 m	———
250 mm	———	10,070 m
Total	20,270 m	10,950 m

2. Roofing Work

Work to be Constructed by Japanese Side	Work to be Constructed by Sudanese Side
———	3,500 sq.m (at Gamair High Lift Pumping Station)

ANNEX-4

DETAILS OF TOPOGRAPHIC SURVEY FOR PIPELAYING DESIGN

- Plan Scale : 1/3,000
  Sites : Pipe laying routes of 31.2 Km in distance x 30 m in width
- Longitudinal Profile for the above

- Spot Detailed Survey

Annex-5

UNDERTAKINGS TO BE TAKEN BY THE SUDANESE SIDE

1. To secure, clear and level the site for pipelaying prior to the work.

2. To bear commissions to the Japanese foreign exchange bank for banking service based upon the the Banking Arrangement.

3. To ensure prompt unloading procedure, tax exemption, customs clearance for the products purchased under the Grant at ports of disembarkation in Sudan. Arrangements for prompt internal transportation, to be paid under the Grant, shall be made for the products.

4. To exempt Japanese nationals from customs duties, income taxes and other fiscal levies which may be imposed in Sudan with respect to the supply of the products and services under the verified contracts.

5. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Sudan and stay therein for the performance of their work.

6. To maintain and use properly and effectively the distribution systems completed, equipment and materials purchased under the Grant.

7. To bear all the expenses other than those to be borne by the Grant, necessary for the completion of the distribution systems as well as for the transportation and the installation of the equipment and materials.

App 1.5 List of Collected Data

Informations and data collected during the basic study period are as follows:

Class. : Design Drawings (size : B0)
Source : NUWC
Contents : a) General Plan & Section, Treated Water Reservoir, El Gamair New Waterworks
b) Access Platform Roof Gutter and Rainwater Soakaway Detal, Treated Water Reservoir, El Gamair New Waterworks
c) Other detaile drawings of Gamair Treated Water Reservoir

Class. : Geographical Drawings
Source : Department of Survey, Ministry of Defence
Contents : a) Omdurman & Khartoum (scale : 1/100,000)
b) Omdurman Area (scale : 1/3,000)
c) Mahadia Area in Omdurman Area (scale : 1/5,000)

Class. : Unit Costs of Construction Works
Source : Contract Agreement of Construction Work, NUWC
Contents : Unit Costs of Construction Works of Treated Water Reservoir
(Cited from the recently contracted one with Egyptian constructors)
a) Unit cost of excavation and pipelaying
b) Construction unit cost of concrete structure
c) Unit cost of reinforcing steel bar working

Class. : Construction Standard
Source : Construcrion Depertment, NUWC
Contents : a) Excavation standard and earth of installed pipes
b) Standard of undergrand Fire Hydrant setting

Class. : General Information about Sudan
Source : NUWC Office
Contents : a) Sudan in Africa
b) Industrial Policies and Industrialization in the Sudan
c) The Southern Sudan

Class. : Pipe Drawings

Source : Omdurman Office, NUWC

Contents : Layout of proposed pipeline routes and existing pipelines

a) Pipeline routs Proposed in Master Plan(1979)

b) Existing pipelines

Class. : Technological calculation

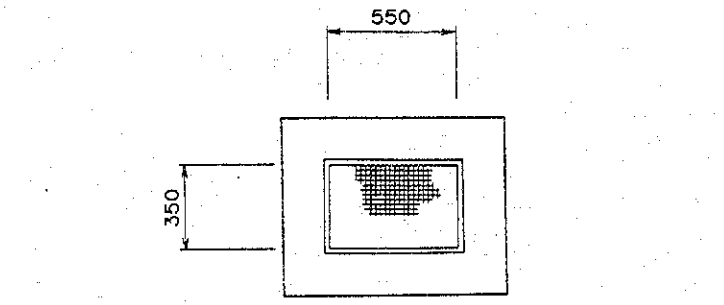
Source : Planning Department, NUWC

Contents : Data for pipe network analysis in Omdurman Area

Appendix -2

App 2.1 Detail Drawings of Basic Design

(1) STANDARD DESIGN OF PIPELAYING TRENCH AND AIR-RELEASE VALVE BOX
(2) STANDARD DESIGN OF CANAL CROSSING AND BLOWOFF PIPE
(3) STANDARD DESIGN OF STOP VALVE BOX AND FIRE HYDRANT BOX
(4) DETAIL OF PIPE FITTINGS No.1-1
(5) DETAIL OF PIPE FITTINGS No.1-2
(6) DETAIL OF PIPE FITTINGS No.1-3
(7) DETAIL OF PIPE FITTINGS No.1-4
(8) DETAIL OF PIPE FITTINGS No.2,3-1
(9) DETAIL OF PIPE FITTINGS No.2,3-2
(10) DETAIL OF PIPE FITTINGS No.2,3-3
(11) DETAIL OF PIPE FITTINGS No.2,3-4
(12) DETAIL OF PIPE FITTINGS No.4-1
(13) DETAIL OF PIPE FITTINGS No.4-2
(14) DETAIL OF PIPE FITTINGS No.4-3
(15) DETAIL OF PIPE FITTINGS No.4-4
(16) DETAIL OF PIPE FITTINGS No.5-1
(17) DETAIL OF PIPE FITTINGS No.5-2
(18) DETAIL OF PIPE FITTINGS No.5-3
(19) DETAIL OF PIPE FITTINGS No.5-4
(20) DETAIL OF PIPE FITTINGS No.5-5
(21) DETAIL OF PIPE FITTINGS No.5-6
(22) DETAIL OF PIPE FITTINGS No.5-7
(23) DETAIL OF PIPE FITTINGS No.5-8



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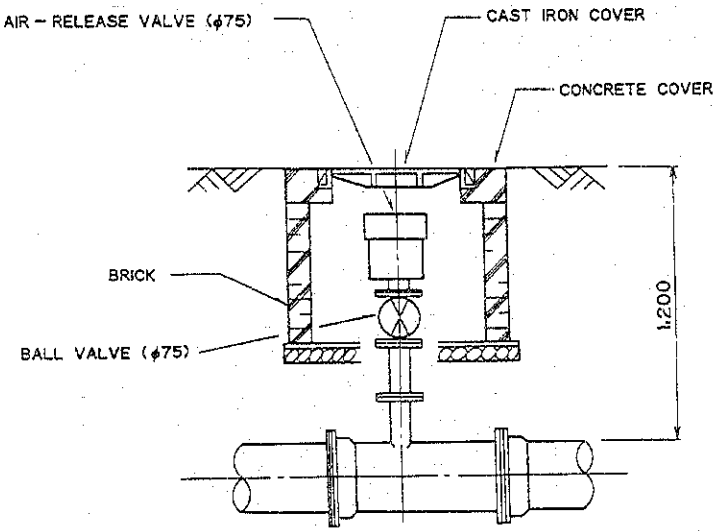

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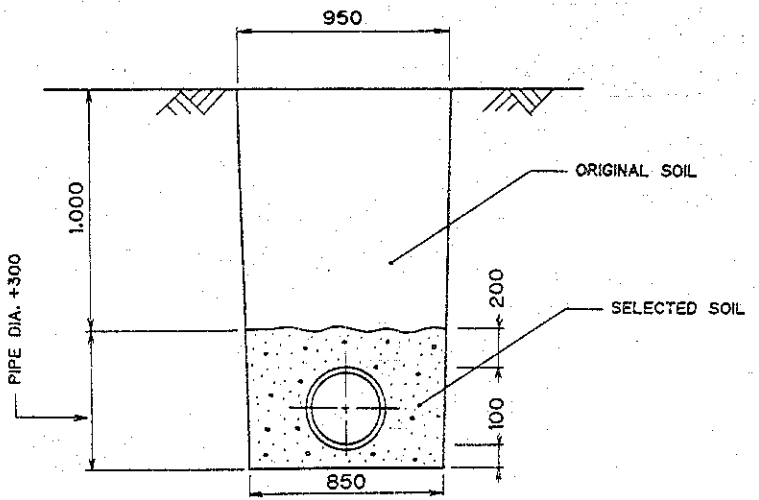

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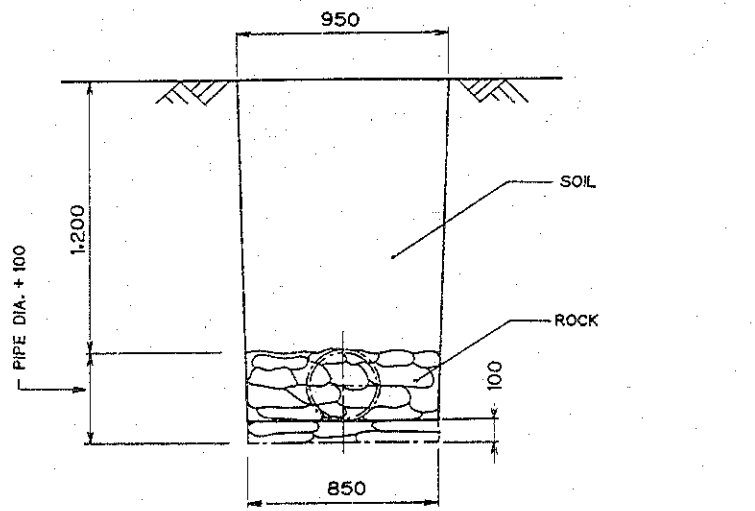

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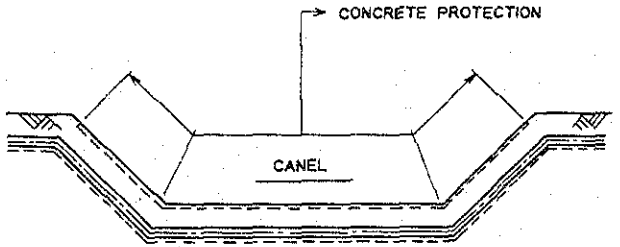
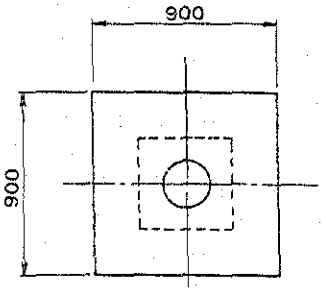
STANDARD DESIGN OF AIR-RELEASE VALVE BOX & PIPELAYING TRENCH

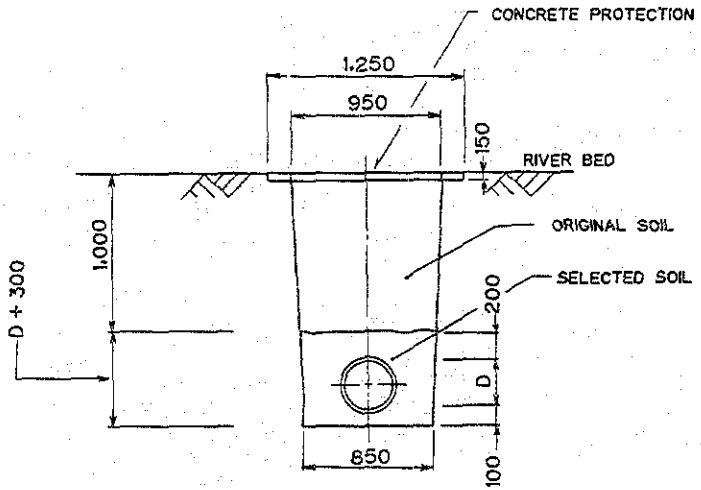
OMDURMAN WATER SUPPLY



LONGITUDINAL SECTION

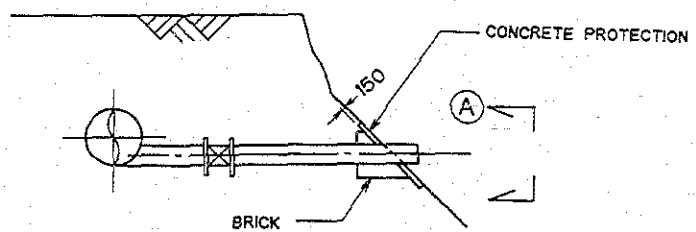


Ⓐ SECTION



CROSS SECTION

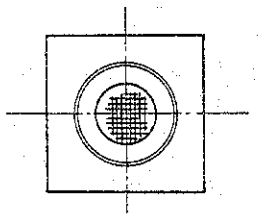
S= 1/30



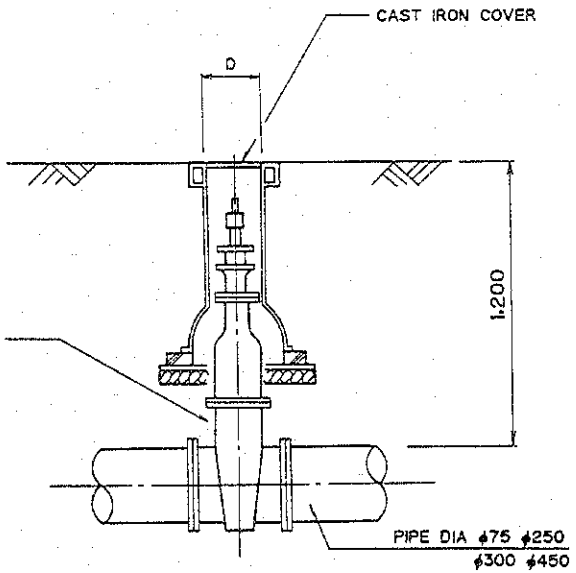
SECTION

STANDARD DESIGN
OF
CANAL CROSSING &
BLOWOFF PIPE

OMDURMAN WATER SUPPLY



PLAN



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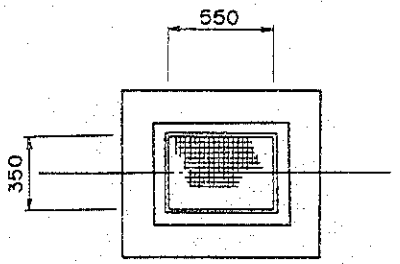

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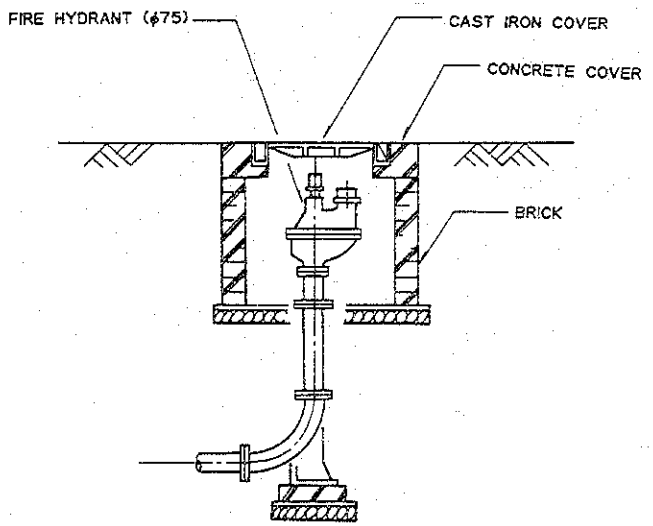


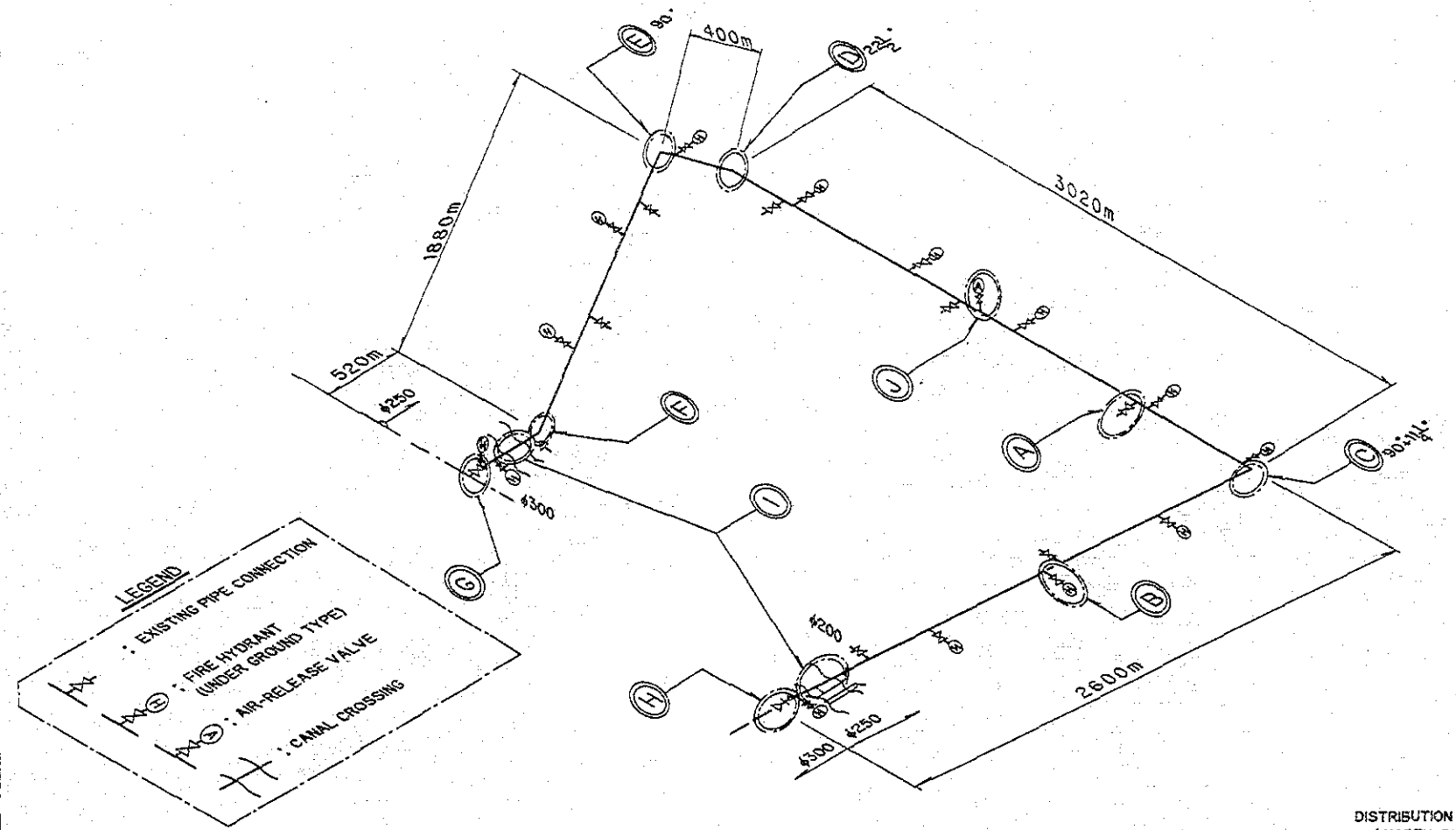
SECTION

S= 1/20

STANDARD DESIGN
OF
STOP VALVE BOX &
FIRE HYDRANT BOX

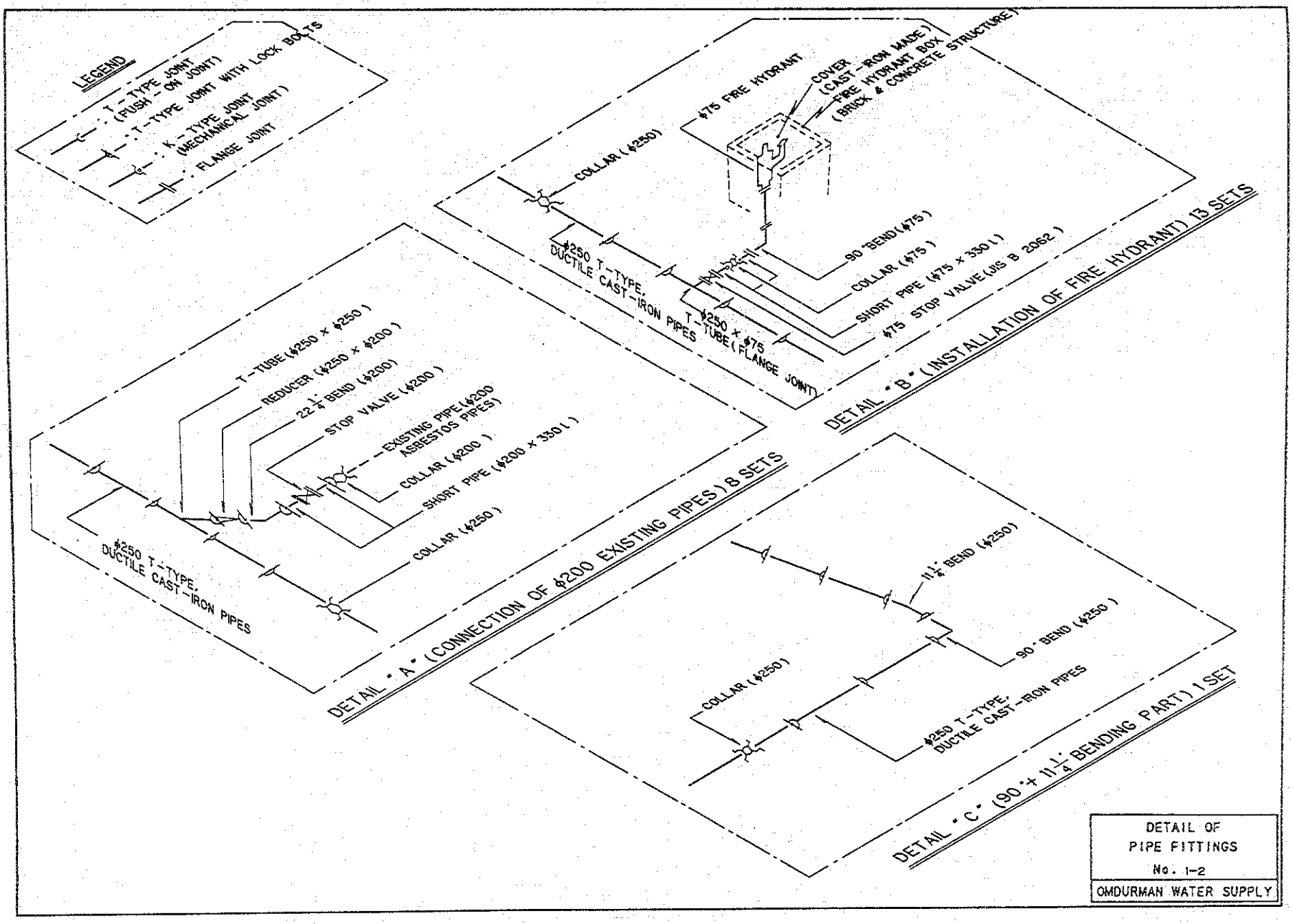
OMDURMAN WATER SUPPLY

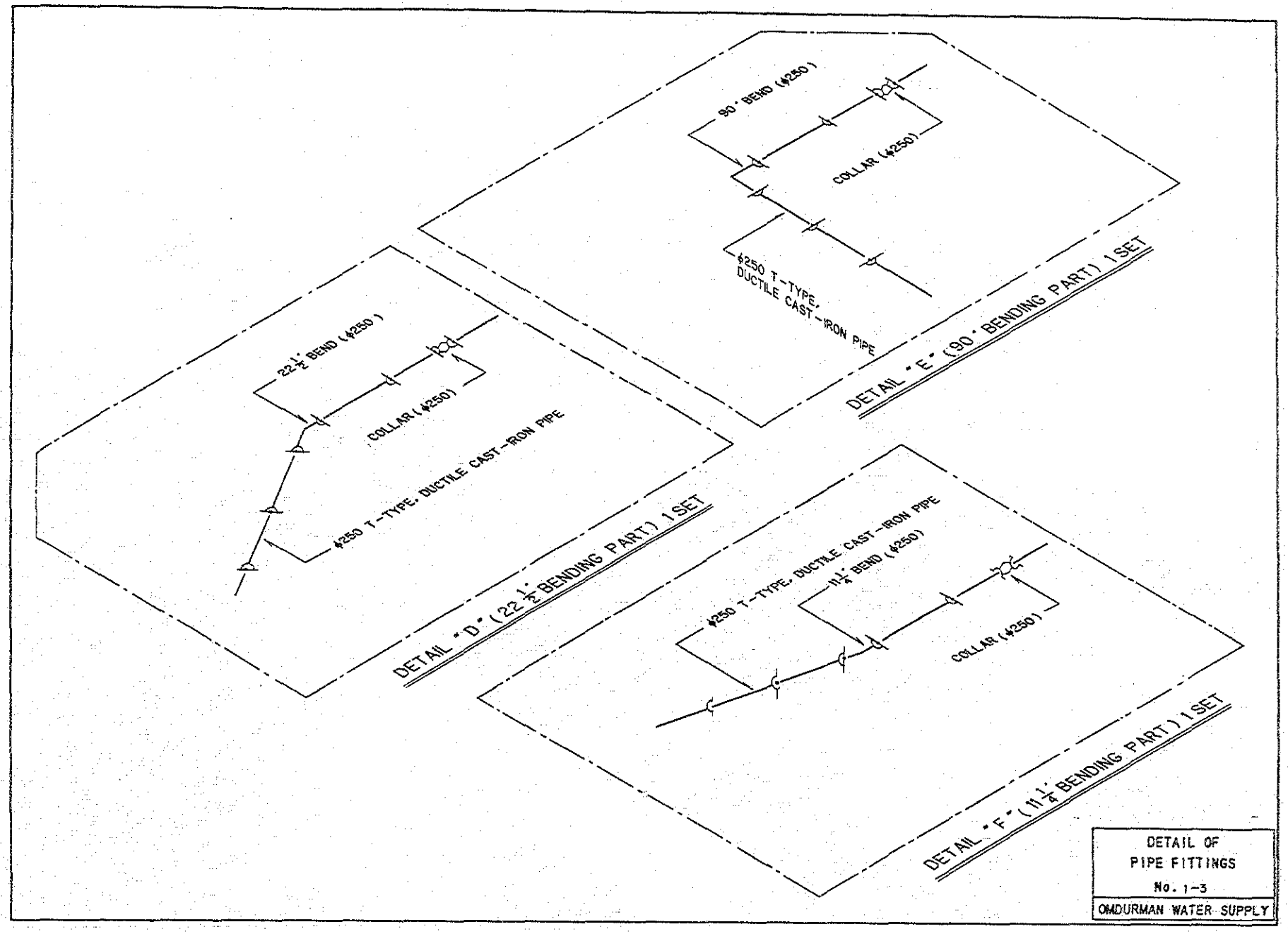
DISTRIBUTION MAINS NO.1
(NORTH BLOCK. ϕ250)

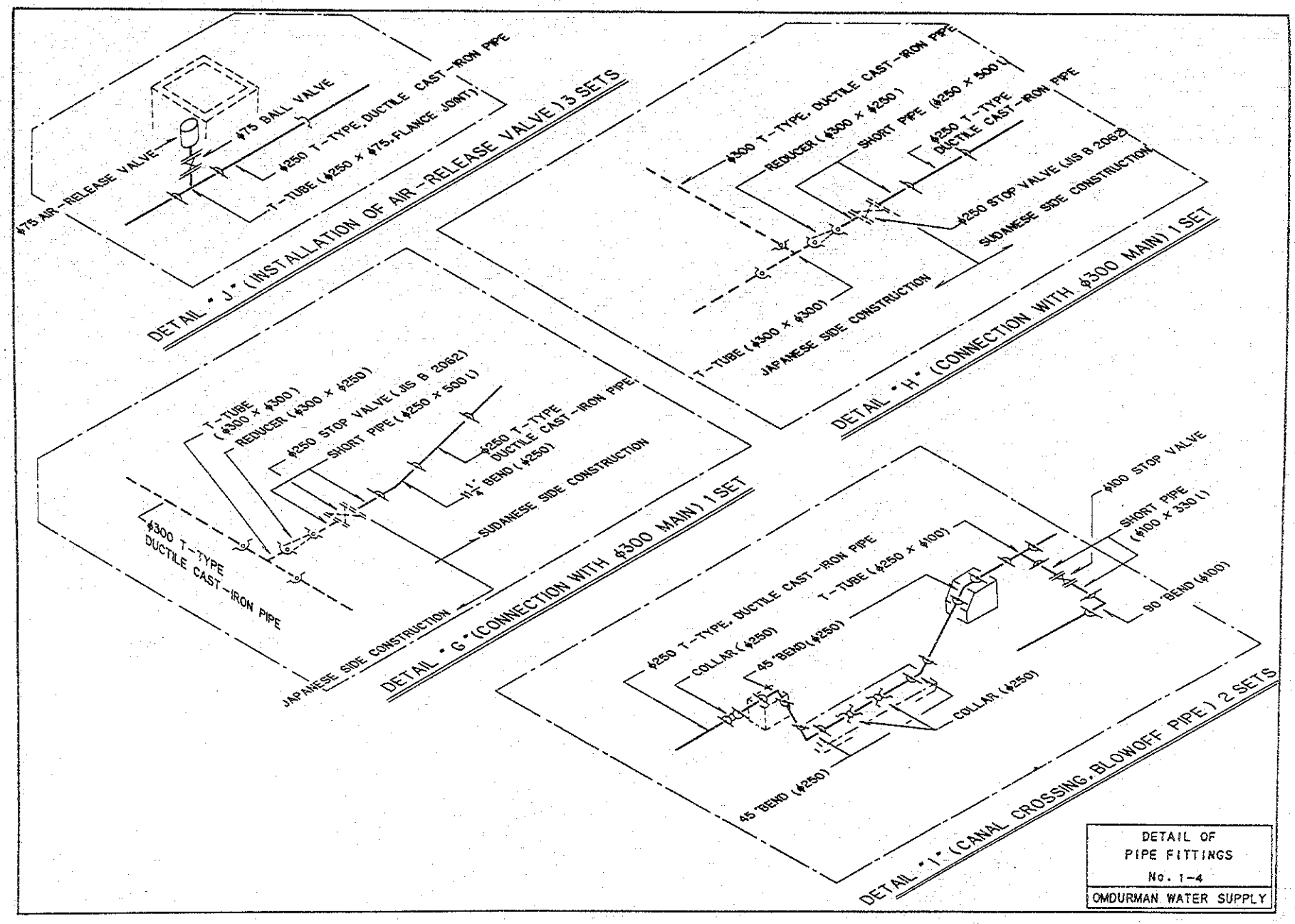


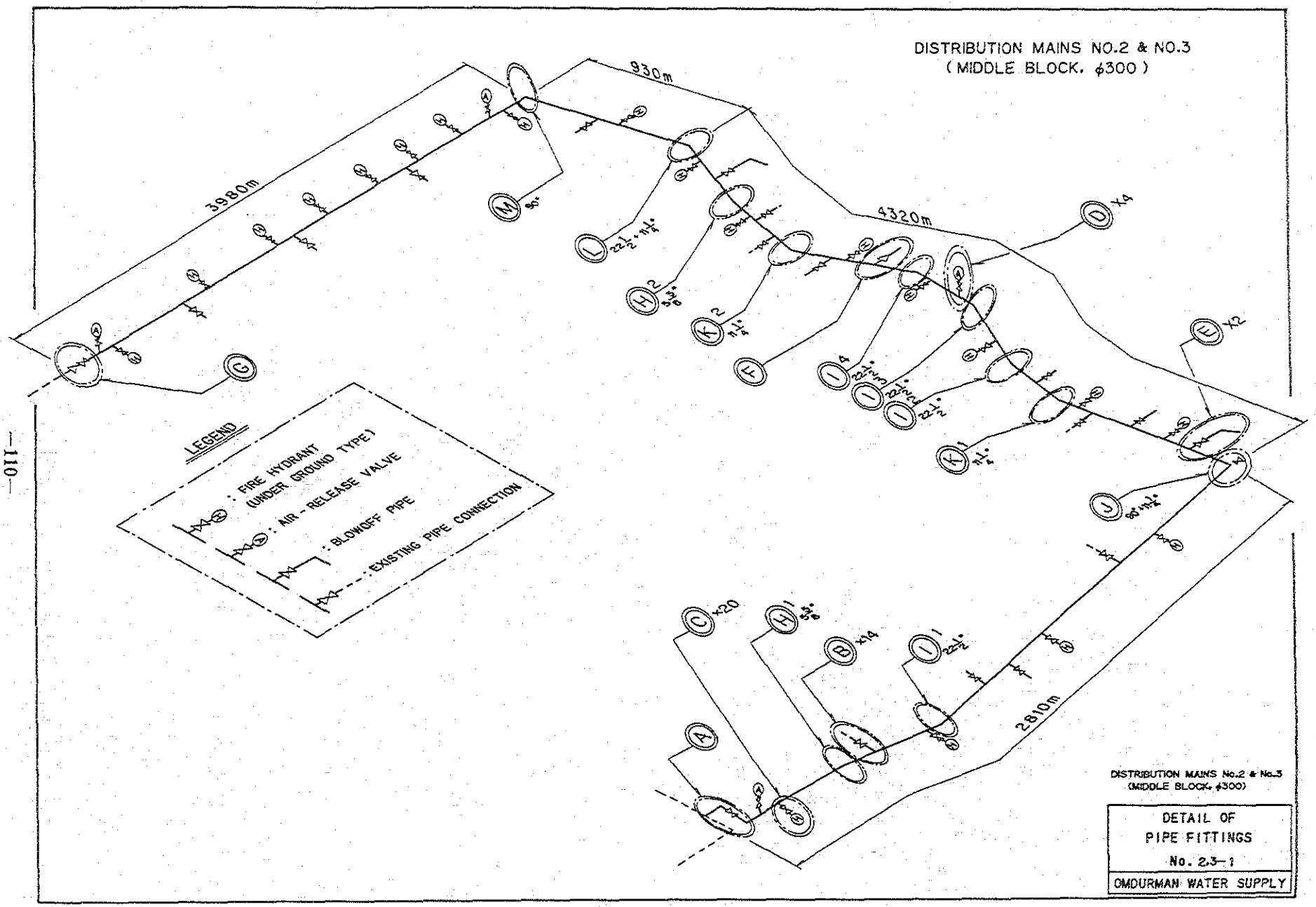
DISTRIBUTION MAINS No.1
(NORTH BLOCK.ϕ250)

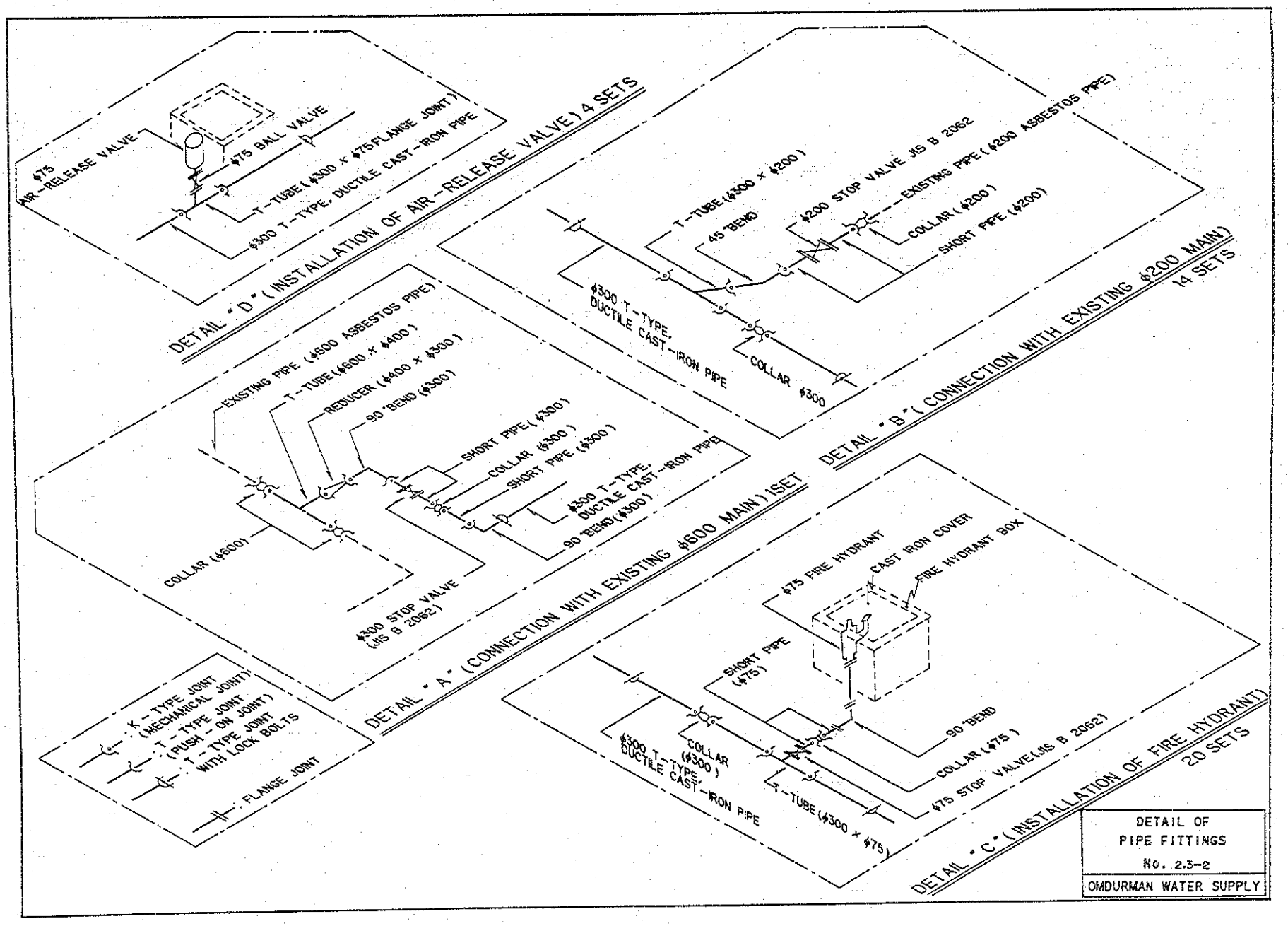
DETAIL OF PIPE FITTINGS
No.1-1
OMOURMAN WATER SUPPLY

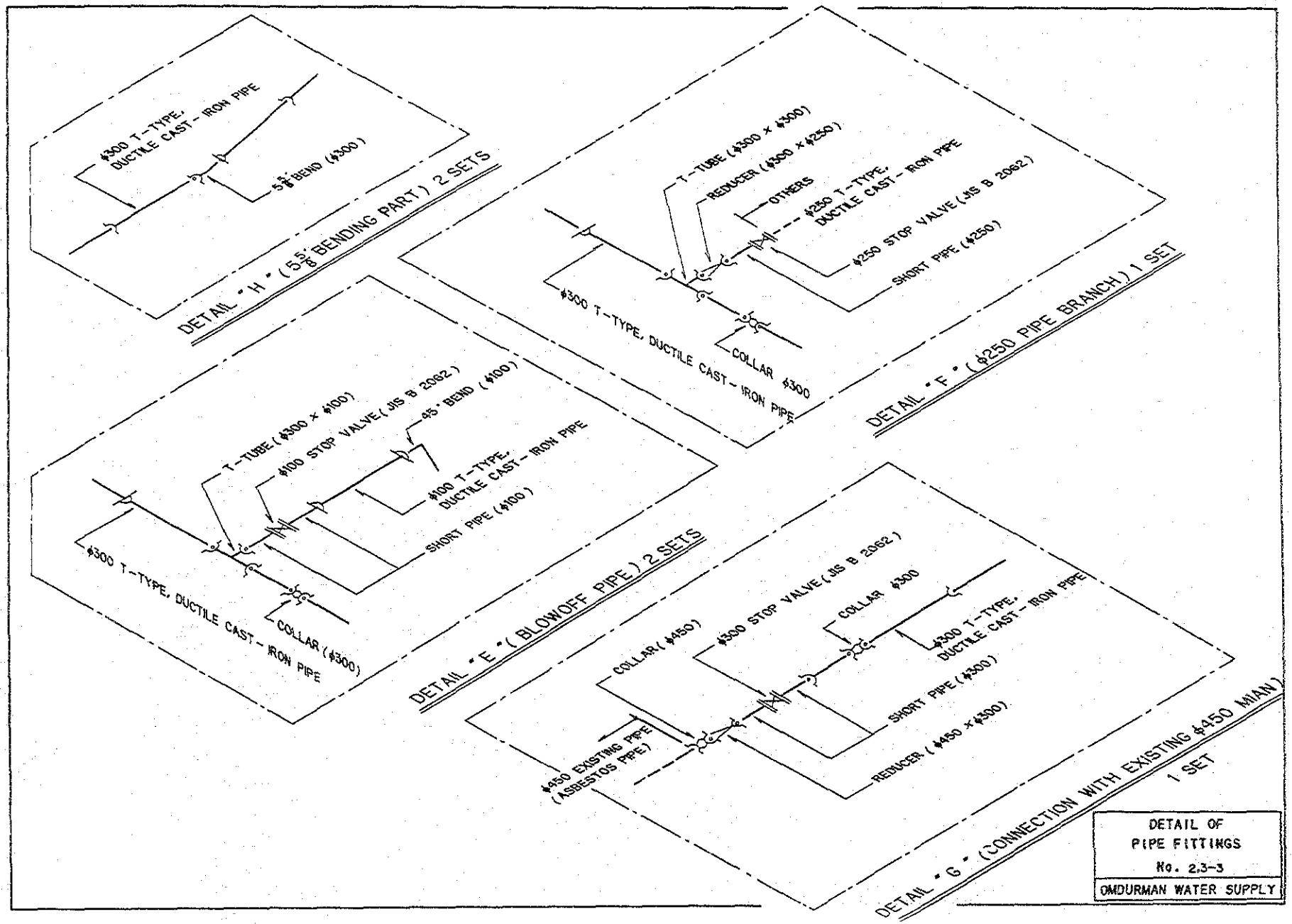

LEGEND
T-TYPE JOINT (PUSH-ON JOINT)
T-TYPE JOINT WITH LOCK BOLTS
K-TYPE JOINT (MECHANICAL JOINT)
FLANGE JOINT
DETAIL "A" (CONNECTION OF φ200 EXISTING PIPES) 8 SETS
T-TUBE (φ250 × φ250)
REDUCER (φ250 × φ200)
22½° BEND (φ200)
STOP VALVE (φ200)
EXISTING PIPE (φ200 ASBESTOS PIPES)
COLLAR (φ200)
SHORT PIPE (φ200 × 330ℓ)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST-IRON PIPES
DETAIL "B" (INSTALLATION OF FIRE HYDRANT) 13 SETS
φ75 FIRE HYDRANT
COVER (CAST-IRON MADE) FIRE HYDRANT BOX (BRICK & CONCRETE STRUCTURE)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST-IRON PIPES
T-TUBE (φ250 × φ75 FLANGE JOINT)
90° BEND (φ75)
COLLAR (φ75)
SHORT PIPE (φ75 × 330ℓ)
φ75 STOP VALVE (JIS B 2062)
DETAIL "C" (90° + 11¼° BENDING PART) 1 SET
11¼° BEND (φ250)
90° BEND (φ250)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST-IRON PIPES
DETAIL OF PIPE FITTINGS
No. 1-2
OMDURMAN WATER SUPPLY


90° BEND (φ250)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "E" (90° BENDING PART) 1 SET
22½° BEND (φ250)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "D" (22½° BENDING PART) 1 SET
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
11¼° BEND (φ250)
COLLAR (φ250)
DETAIL "F" (11¼° BENDING PART) 1 SET
DETAIL OF
PIPE FITTINGS
No. 1-3
OMDURMAN WATER SUPPLY


DETAIL " J " (INSTALLATION OF AIR-RELEASE VALVE) 3 SETS
φ75 AIR-RELEASE VALVE
φ75 BALL VALVE
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ250 × φ75, FLANGE JOINT)
DETAIL " H " (CONNECTION WITH φ300 MAIN) 1 SET
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
REDUCER (φ300 × φ250)
SHORT PIPE (φ250 × 500 L)
φ250 T-TYPE DUCTILE CAST-IRON PIPE
φ250 STOP VALVE (JIS B 2062)
SUDANESE SIDE CONSTRUCTION
T-TUBE (φ300 × φ300)
JAPANESE SIDE CONSTRUCTION
DETAIL " G " (CONNECTION WITH φ300 MAIN) 1 SET
T-TUBE (φ300 × φ300)
REDUCER (φ300 × φ250)
φ250 STOP VALVE (JIS B 2062)
SHORT PIPE (φ250 × 500 L)
φ250 T-TYPE DUCTILE CAST-IRON PIPE
11.1° BEND (φ250)
SUDANESE SIDE CONSTRUCTION
φ300 T-TYPE DUCTILE CAST-IRON PIPE
JAPANESE SIDE CONSTRUCTION
DETAIL " I " (CANAL CROSSING, BLOWOFF PIPE) 2 SETS
φ400 STOP VALVE
SHORT PIPE (φ100 × 330 L)
90° BEND (φ100)
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ250 × φ100)
COLLAR (φ250)
45° BEND (φ250)
COLLAR (φ250)
45° BEND (φ250)
DETAIL OF PIPE FITTINGS No. 1-4
OMDURMAN WATER SUPPLY


DISTRIBUTION MAINS NO.2 & NO.3
(MIDDLE BLOCK. φ300)
930m
3980m
4320m
2810m
LEGEND
: FIRE HYDRANT (UNDER GROUND TYPE)
: AIR - RELEASE VALVE
: BLOWOFF PIPE
: EXISTING PIPE CONNECTION
DISTRIBUTION MAINS No.2 & No.3 (MIDDLE BLOCK. φ300)
DETAIL OF PIPE FITTINGS
No. 2.3-1
OMDURMAN WATER SUPPLY

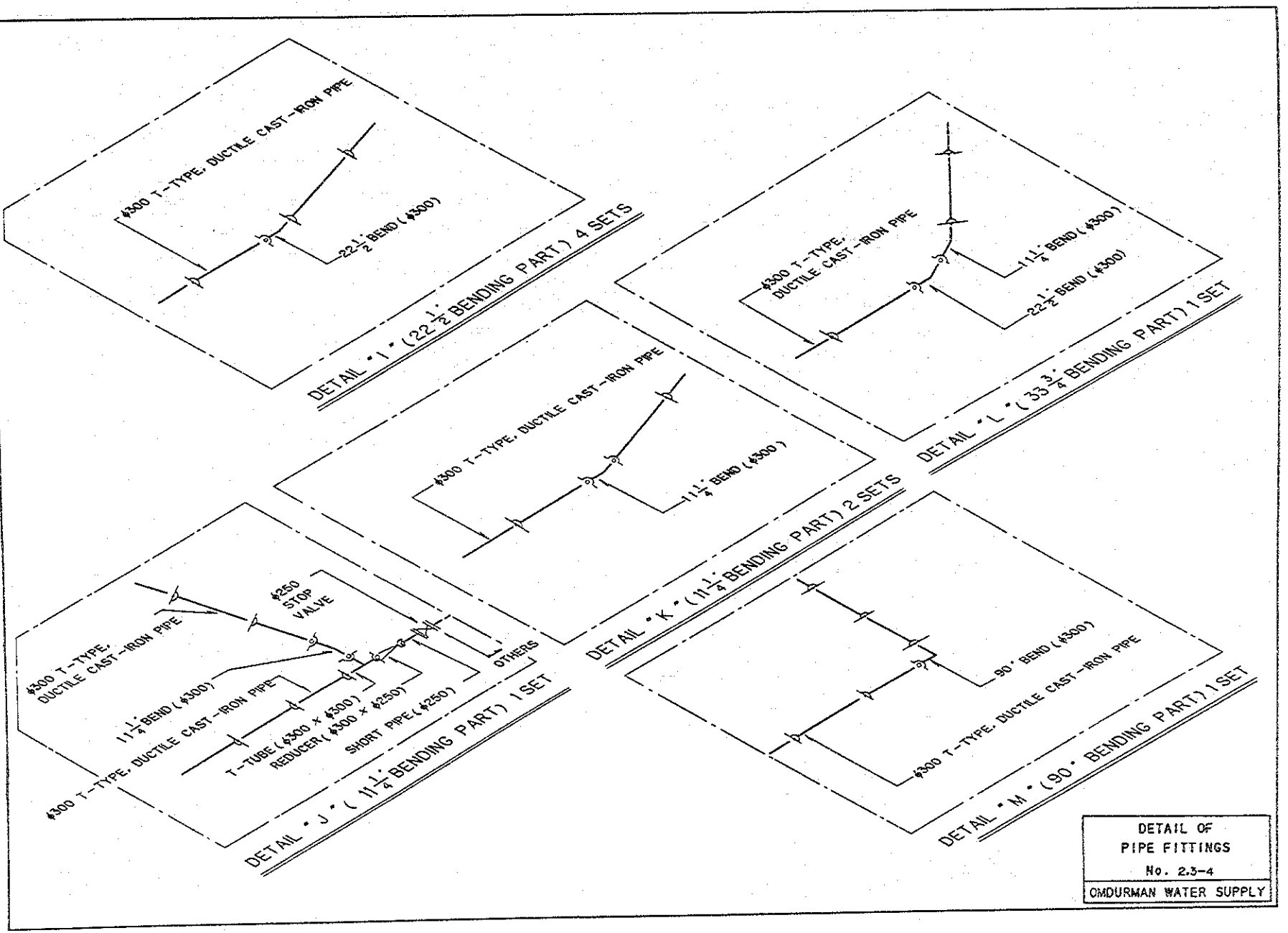

DETAIL "D" (INSTALLATION OF AIR-RELEASE VALVE) 4 SETS
φ75 AIR-RELEASE VALVE
φ75 BALL VALVE
T-TUBE (φ300 × φ75 FLANGE JOINT)
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "B" (CONNECTION WITH EXISTING φ200 MAIN) 14 SETS
T-TUBE (φ300 × φ200)
45° BEND
φ200 STOP VALVE JIS B 2062
EXISTING PIPE (φ200 ASBESTOS PIPE)
COLLAR (φ200)
SHORT PIPE (φ200)
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
COLLAR φ300
DETAIL "A" (CONNECTION WITH EXISTING φ600 MAIN) 1SET
EXISTING PIPE (φ600 ASBESTOS PIPE)
T-TUBE (φ600 × φ400)
REDUCER (φ400 × φ300)
90° BEND (φ300)
SHORT PIPE (φ300)
COLLAR (φ300)
SHORT PIPE (φ300)
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
90° BEND (φ300)
COLLAR (φ600)
φ300 STOP VALVE (JIS B 2062)
K-TYPE JOINT (MECHANICAL JOINT)
T-TYPE JOINT (PUSH-ON JOINT)
T-TYPE JOINT WITH LOCK BOLTS
FLANGE JOINT
DETAIL "C" (INSTALLATION OF FIRE HYDRANT) 20 SETS
φ75 FIRE HYDRANT
CAST IRON COVER
FIRE HYDRANT BOX
SHORT PIPE (φ75)
90° BEND
COLLAR (φ75)
φ75 STOP VALVE (JIS B 2062)
COLLAR (φ300)
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ300 × φ75)
DETAIL OF PIPE FITTINGS
No. 2.3-2
OMDURMAN WATER SUPPLY

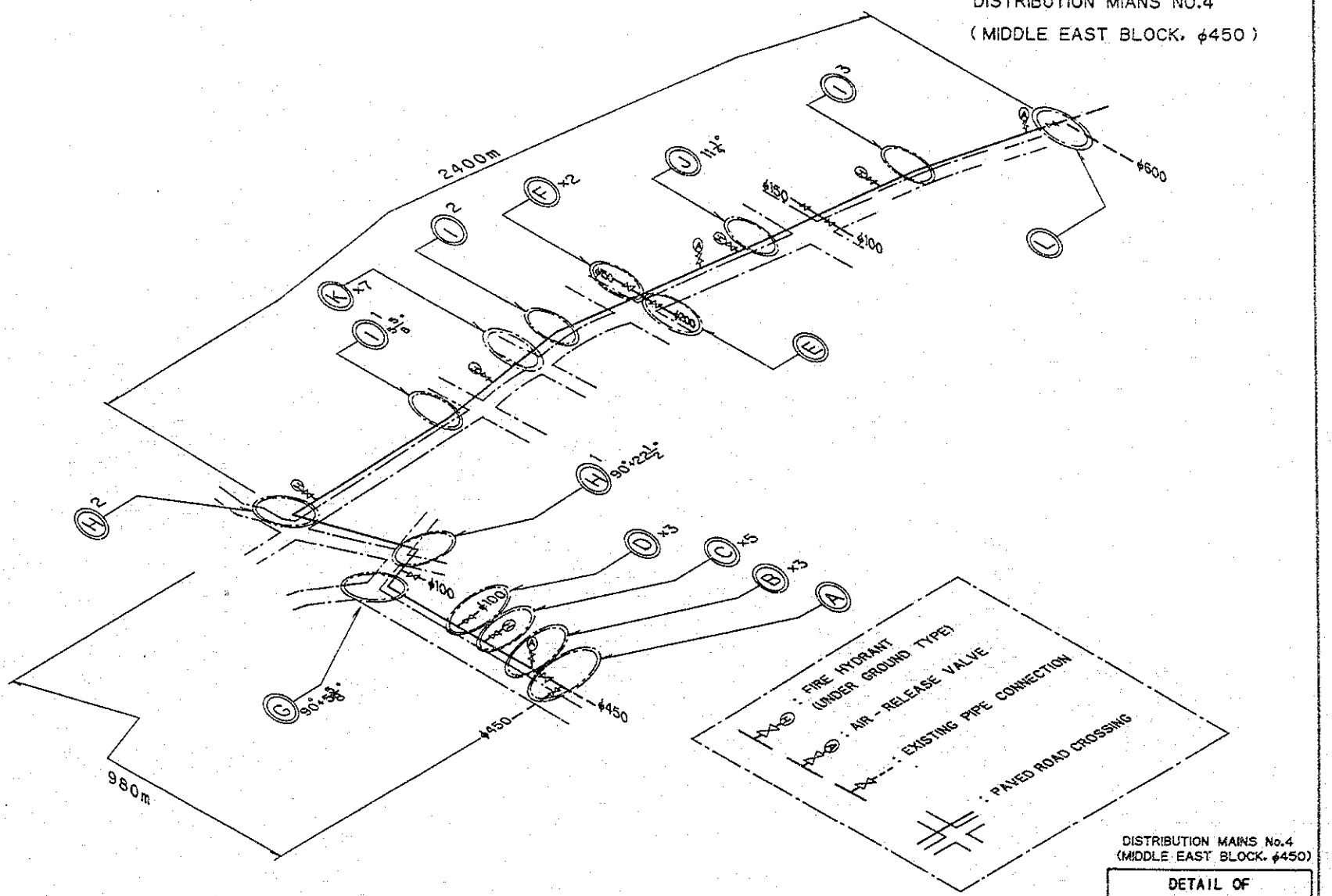


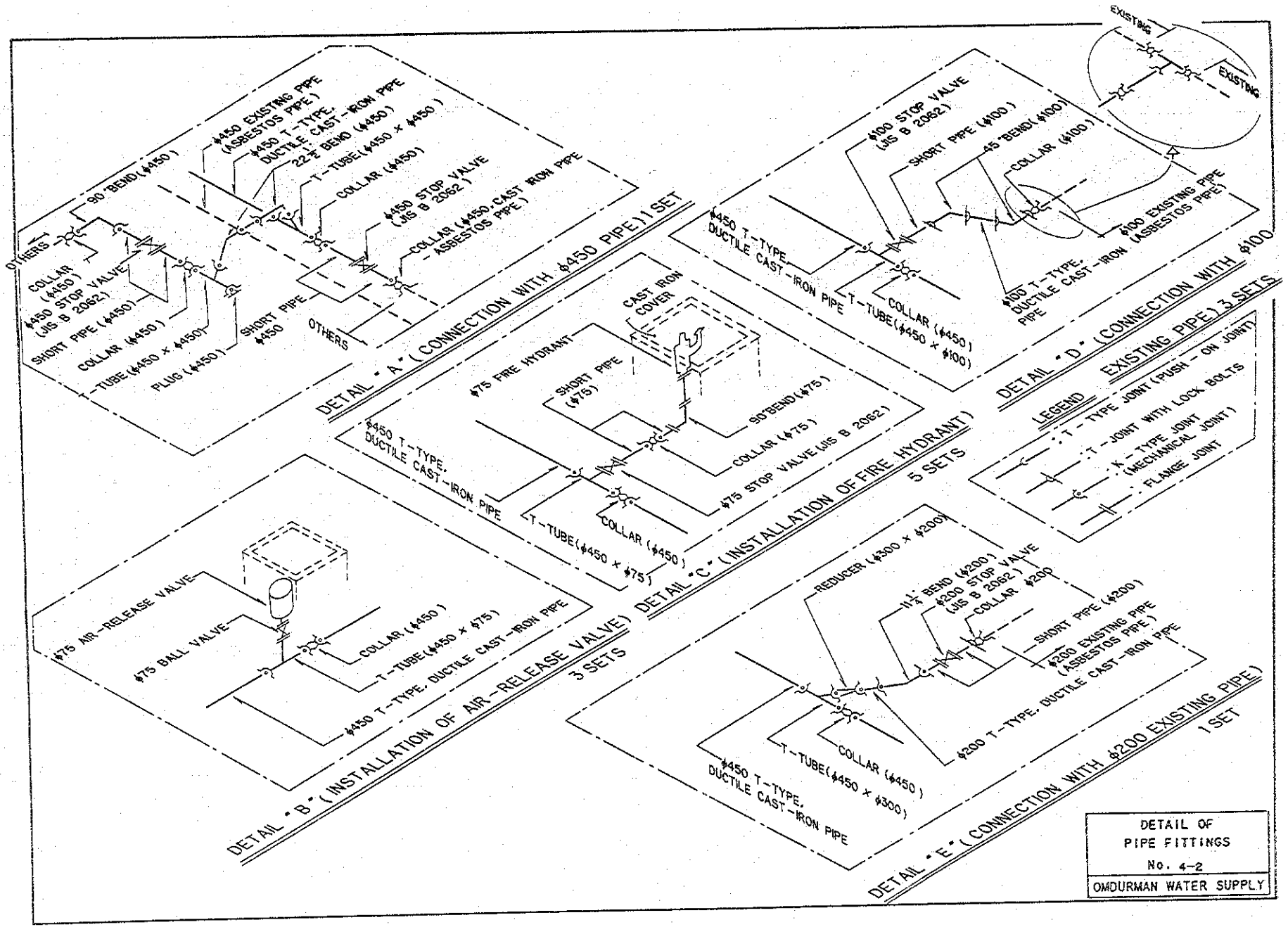
DETAIL OF PIPE FITTINGS

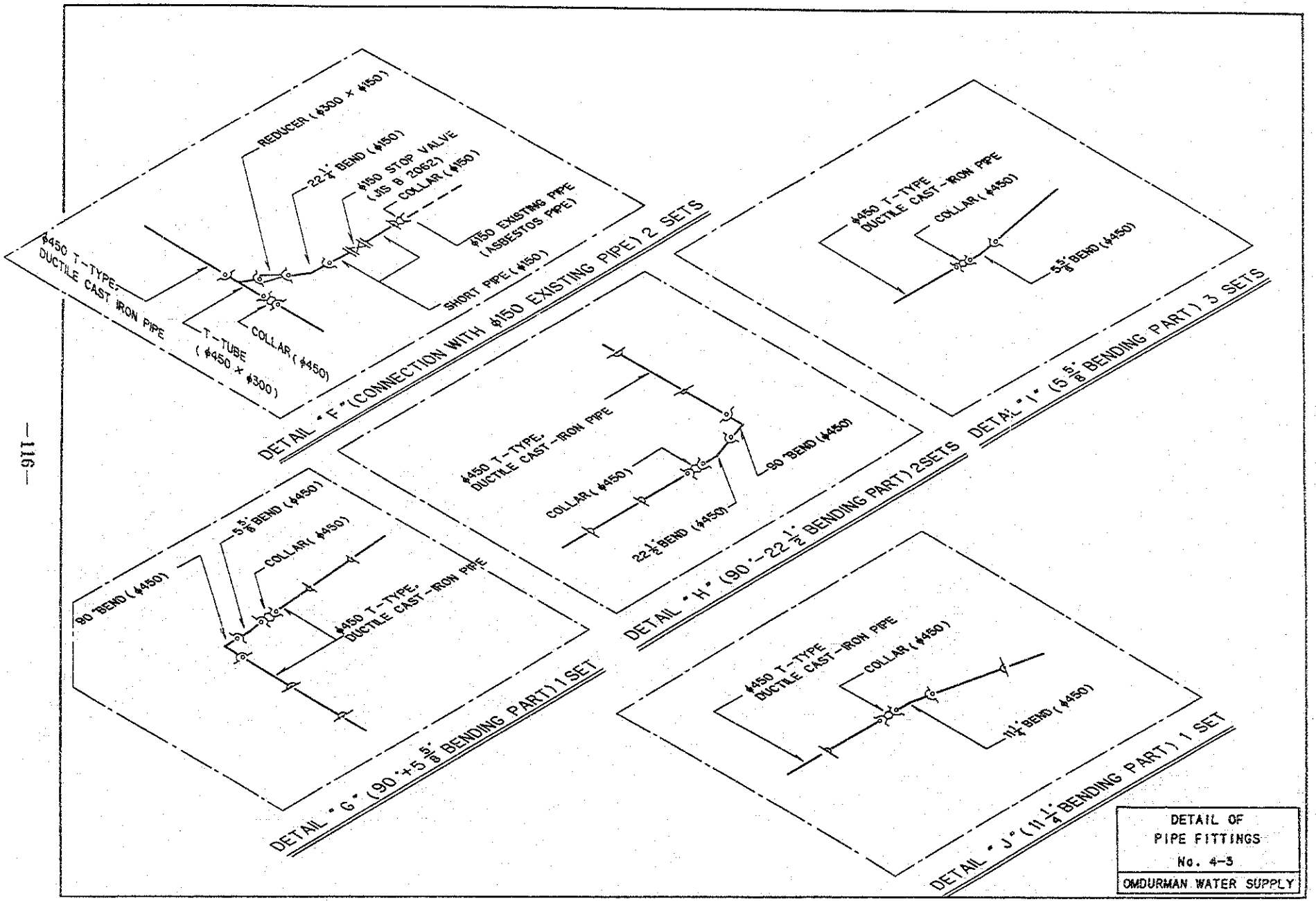
No. 2.3-3

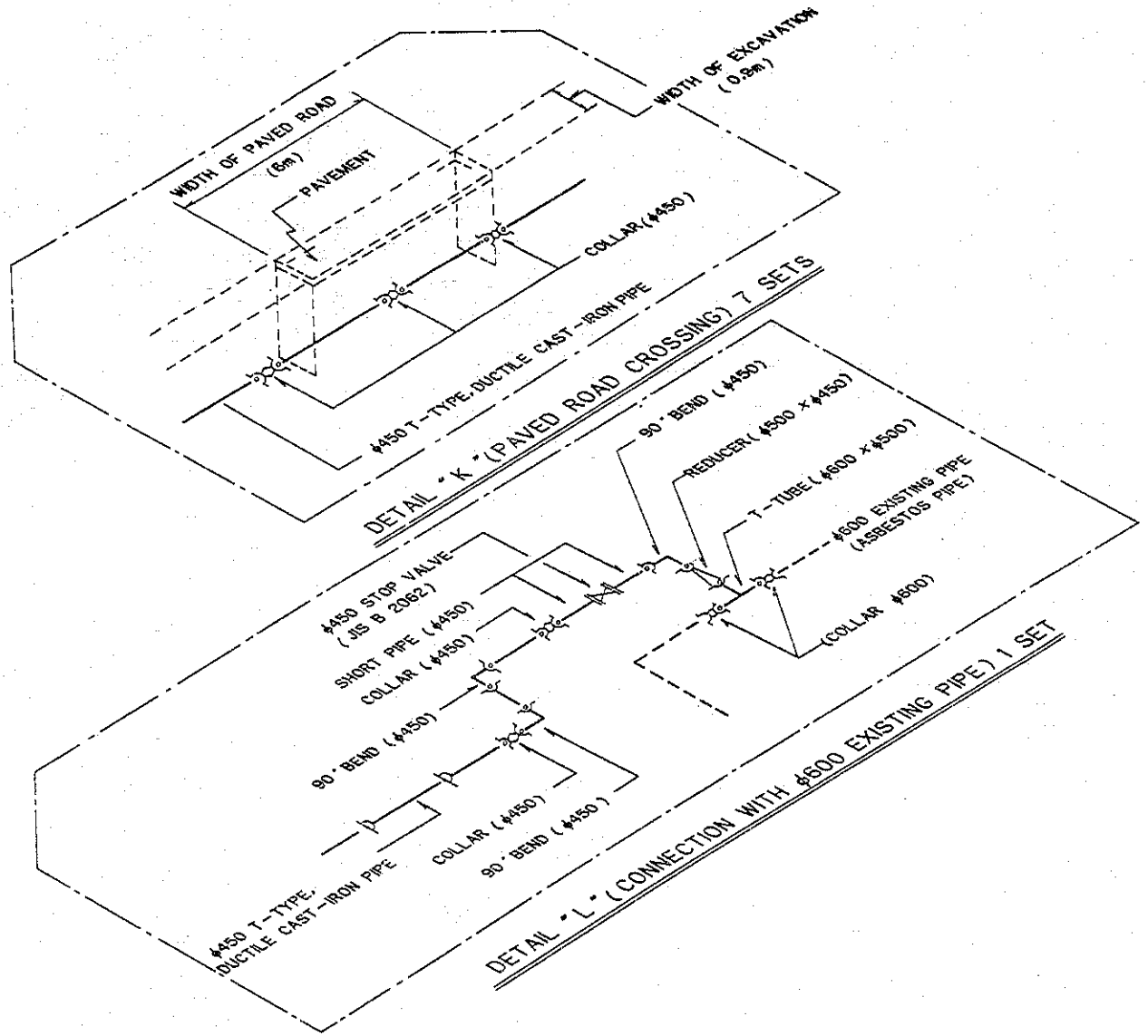
OMDURMAN WATER SUPPLY


φ300 T-TYPE, DUCTILE CAST-IRON PIPE
22 1/2° BEND (φ300)
DETAIL "I" (22 1/2° BENDING PART) 4 SETS
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
11 1/4° BEND (φ300)
DETAIL "K" (11 1/4° BENDING PART) 2 SETS
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
11 1/4° BEND (φ300)
22 1/2° BEND (φ300)
DETAIL "L" (33 3/4° BENDING PART) 1 SET
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
φ250 STOP VALVE
11 1/4° BEND (φ300)
T-TUBE (φ300 x φ300)
REDUCER (φ300 x φ250)
SHORT PIPE (φ250)
OTHERS
DETAIL "J" (11 1/4° BENDING PART) 1 SET
90° BEND (φ300)
φ300 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "M" (90° BENDING PART) 1 SET
DETAIL OF PIPE FITTINGS
No. 2.3-4
OMDURMAN WATER SUPPLY

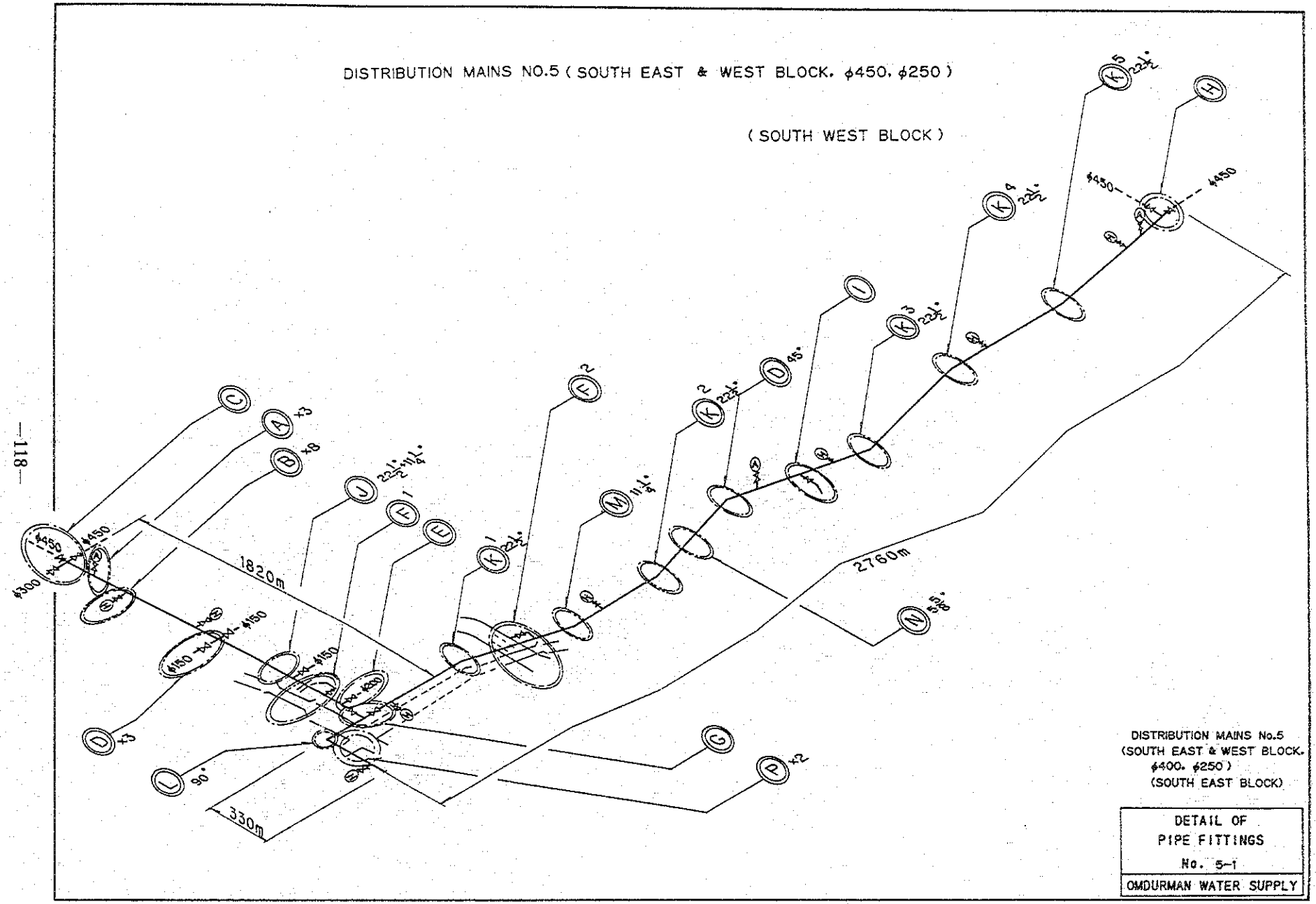

DISTRIBUTION MIANS NO.4
(MIDDLE EAST BLOCK, φ450)
2400m
980m
φ600
φ150
φ100
φ450
: FIRE HYDRANT (UNDER GROUND TYPE)
: AIR - RELEASE VALVE
: EXISTING PIPE CONNECTION
: PAVED ROAD CROSSING
DISTRIBUTION MAINS No.4
(MIDDLE EAST BLOCK, φ450)
DETAIL OF PIPE FITTINGS
No. 4-1
OMDURMAN WATER SUPPLY

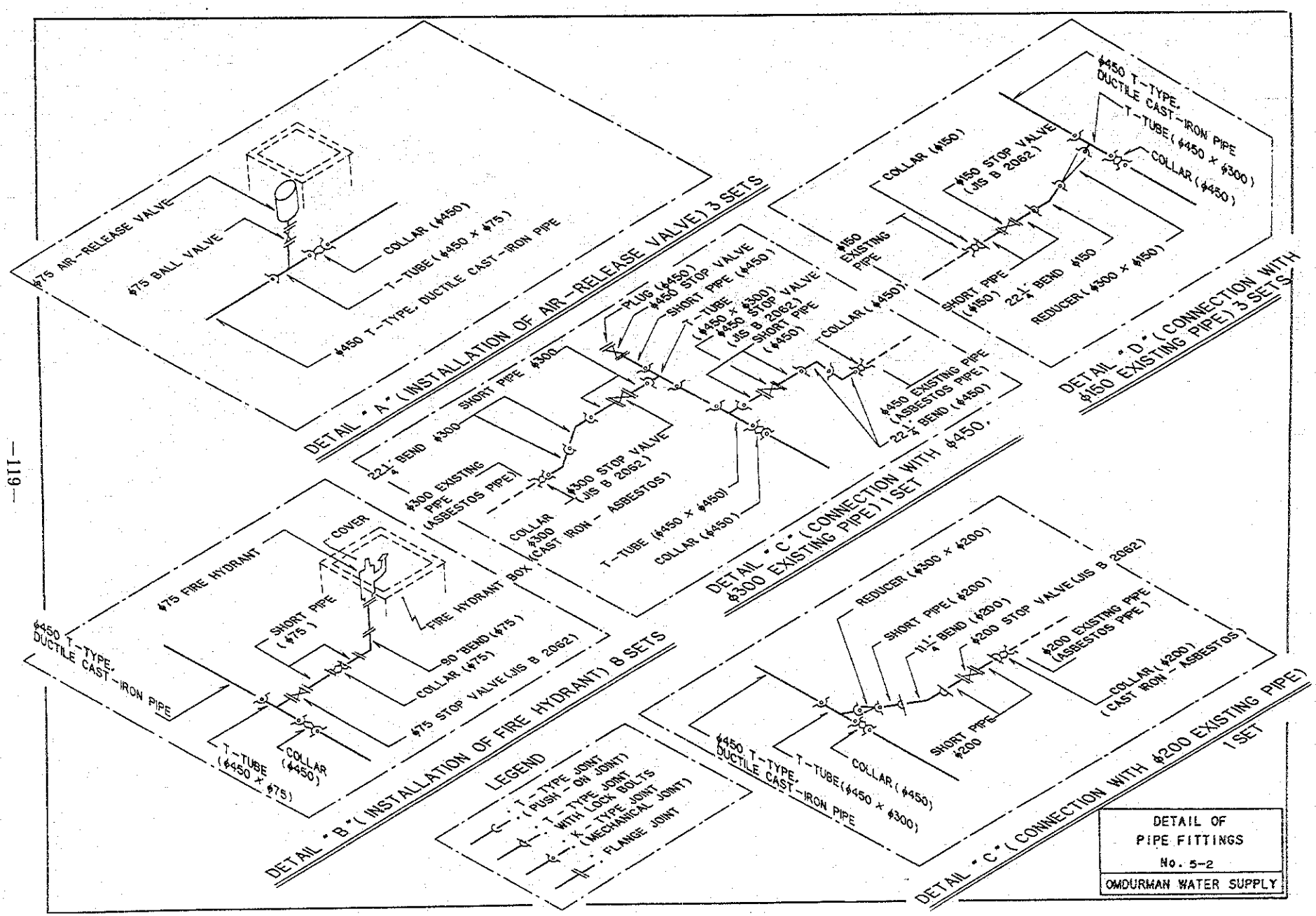

DETAIL "A" (CONNECTION WITH φ450 PIPE) 1 SET
DETAIL "B" (INSTALLATION OF AIR-RELEASE VALVE) 3 SETS
DETAIL "C" (INSTALLATION OF FIRE HYDRANT) 5 SETS
DETAIL "D" (CONNECTION WITH φ100 EXISTING PIPE) 3 SETS
DETAIL "E" (CONNECTION WITH φ200 EXISTING PIPE) 1 SET
LEGEND
T-TYPE JOINT (PUSH-ON JOINT)
T-JOINT WITH LOCK BOLTS
K-TYPE JOINT (MECHANICAL JOINT)
FLANGE JOINT
EXISTING
EXISTING
DETAIL OF PIPE FITTINGS
No. 4-2
OMDURMAN WATER SUPPLY

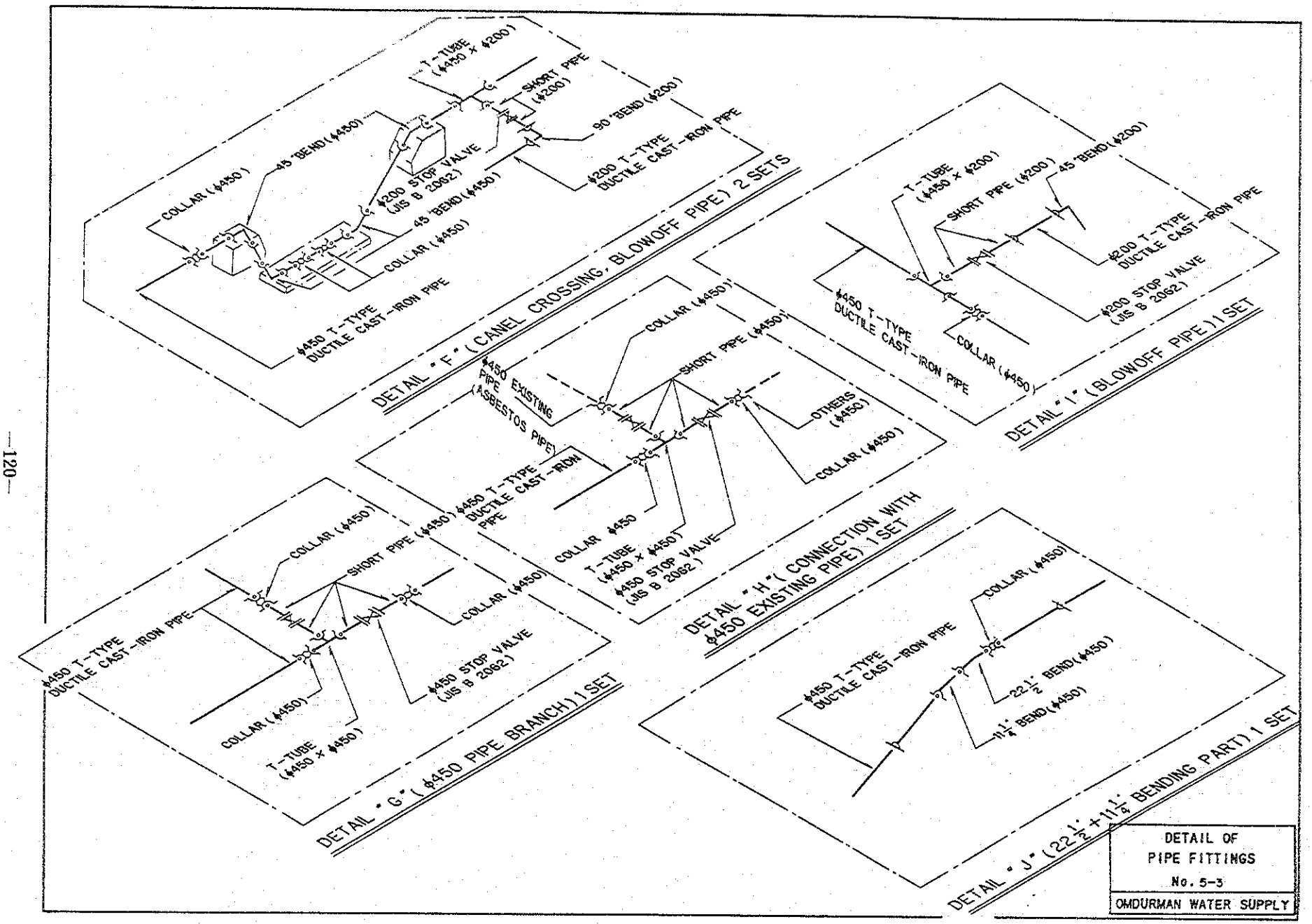

REDUCER (φ300 × φ150)
22½° BEND (φ150)
φ150 STOP VALVE (JIS B 2062)
COLLAR (φ150)
φ150 EXISTING PIPE (ASBESTOS PIPE)
SHORT PIPE (φ150)
φ450 T-TYPE DUCTILE CAST IRON PIPE
T-TUBE (φ450 × φ300)
COLLAR (φ450)
DETAIL "F" (CONNECTION WITH φ150 EXISTING PIPE) 2 SETS
φ450 T-TYPE DUCTILE CAST-IRON PIPE
COLLAR (φ450)
5.5° BEND (φ450)
DETAIL "I" (5 5.5° BENDING PART) 3 SETS
φ450 T-TYPE DUCTILE CAST-IRON PIPE
COLLAR (φ450)
22½° BEND (φ450)
90° BEND (φ450)
DETAIL "H" (90°-22½° BENDING PART) 2SETS
90° BEND (φ450)
5.5° BEND (φ450)
COLLAR (φ450)
φ450 T-TYPE DUCTILE CAST-IRON PIPE
DETAIL "G" (90°+5 5.5° BENDING PART) 1 SET
φ450 T-TYPE DUCTILE CAST-IRON PIPE
COLLAR (φ450)
11¼° BEND (φ450)
DETAIL "J" (11¼° BENDING PART) 1 SET
DETAIL OF PIPE FITTINGS No. 4-3
OMDURMAN WATER SUPPLY

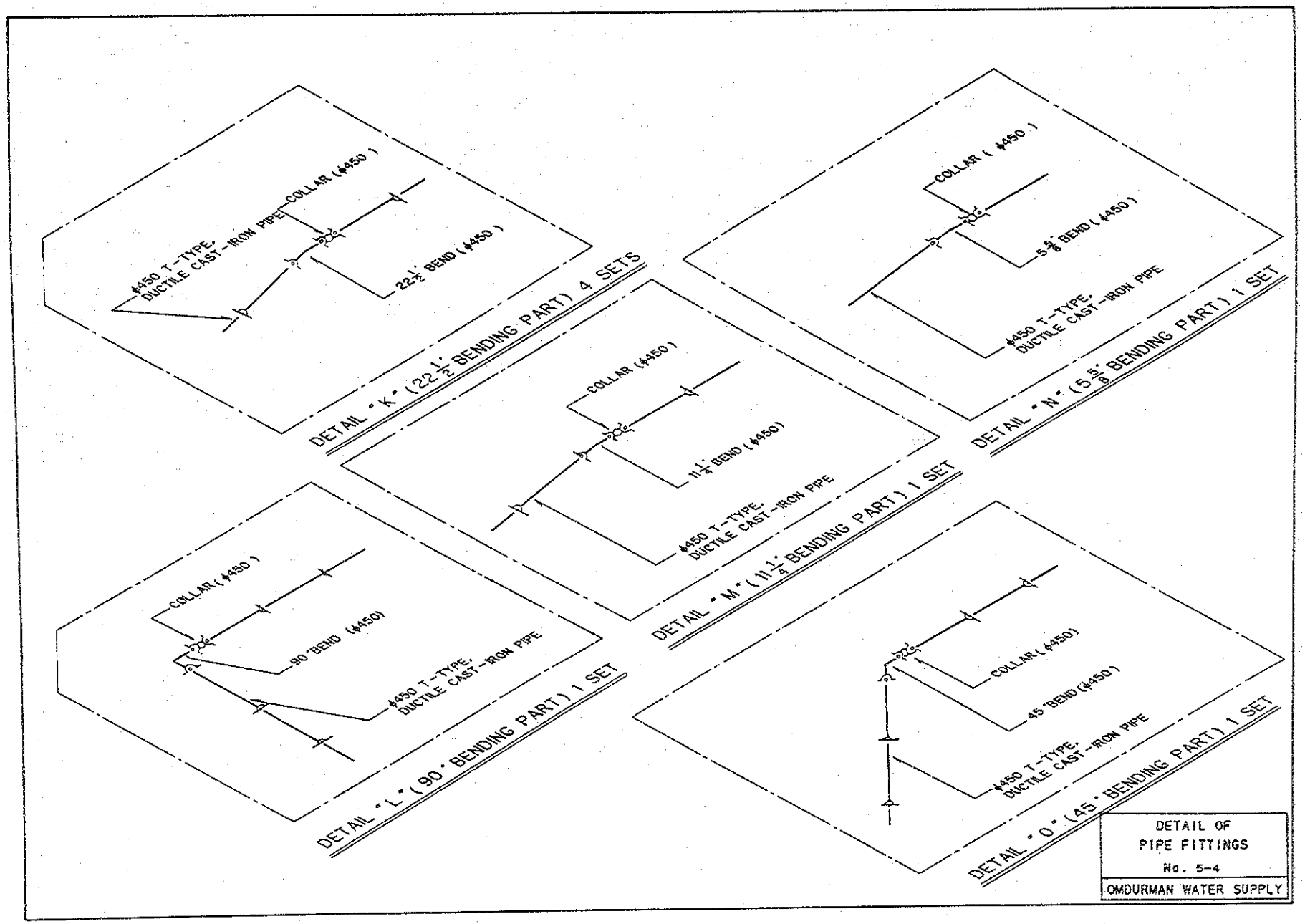


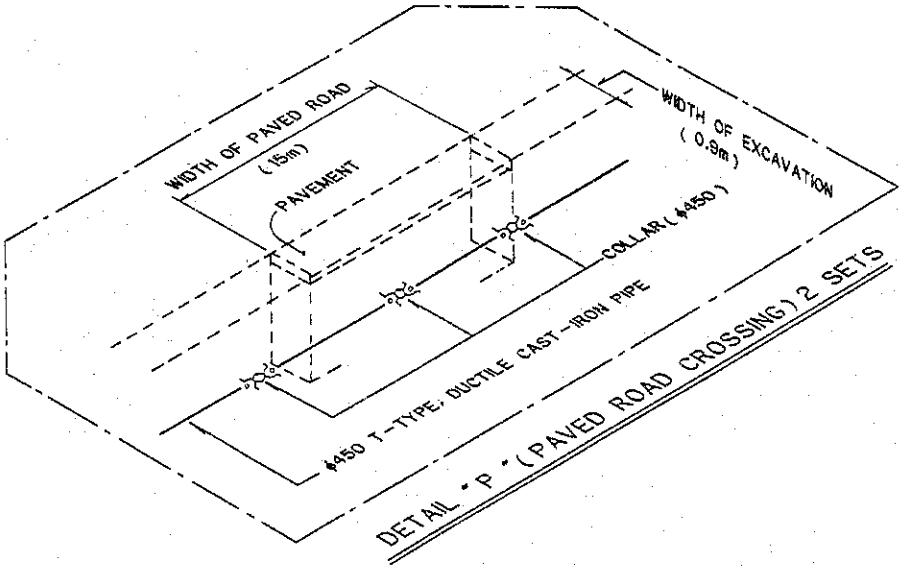
DETAIL OF PIPE FITTINGS
No. 4-4
OMDURMAN WATER SUPPLY


DISTRIBUTION MAINS NO.5 (SOUTH EAST & WEST BLOCK. φ450. φ250)
(SOUTH WEST BLOCK)
1820m
2760m
330m
DISTRIBUTION MAINS No.5
(SOUTH EAST & WEST BLOCK.
φ400. φ250)
(SOUTH EAST BLOCK)
DETAIL OF
PIPE FITTINGS
No. 5-1
OMDURMAN WATER SUPPLY


DETAIL "A" (INSTALLATION OF AIR-RELEASE VALVE) 3 SETS
φ75 AIR-RELEASE VALVE
φ75 BALL VALVE
COLLAR (φ450)
T-TUBE (φ450 × φ75)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "B" (INSTALLATION OF FIRE HYDRANT) 8 SETS
φ75 FIRE HYDRANT
COVER
FIRE HYDRANT BOX
SHORT PIPE (φ75)
90° BEND (φ75)
COLLAR (φ75)
φ75 STOP VALVE (JIS B 2062)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ450 × φ75)
COLLAR (φ450)
DETAIL "C" (CONNECTION WITH φ300 EXISTING PIPE) 1 SET
PLUG (φ450)
φ450 STOP VALVE
SHORT PIPE (φ450)
T-TUBE (φ450 × φ300) (JIS B 2062)
φ450 STOP VALVE
SHORT PIPE (φ450)
SHORT PIPE φ300
22½° BEND φ300
φ300 EXISTING PIPE (ASBESTOS PIPE)
φ300 STOP VALVE (JIS B 2062)
COLLAR φ300 (CAST IRON - ASBESTOS)
T-TUBE (φ450 × φ450)
COLLAR (φ450)
DETAIL "D" (CONNECTION WITH φ150 EXISTING PIPE) 3 SETS
φ150 EXISTING PIPE
COLLAR (φ150)
φ150 STOP VALVE (JIS B 2062)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ450 × φ300)
COLLAR (φ450)
COLLAR (φ450)
φ450 EXISTING PIPE (ASBESTOS PIPE)
22½° BEND (φ450)
SHORT PIPE (φ150)
22½° BEND φ150
REDUCER (φ300 × φ150)
DETAIL "C" (CONNECTION WITH φ200 EXISTING PIPE) 1 SET
REDUCER (φ300 × φ200)
SHORT PIPE (φ200)
11¼° BEND (φ200)
φ200 STOP VALVE (JIS B 2062)
φ200 EXISTING PIPE (ASBESTOS PIPE)
COLLAR (φ200) (CAST IRON - ASBESTOS)
SHORT PIPE φ200
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ450 × φ300)
COLLAR (φ450)
LEGEND
: T-TYPE JOINT (PUSH-ON JOINT)
: T-TYPE JOINT WITH LOCK BOLTS
: K-TYPE JOINT (MECHANICAL JOINT)
: FLANGE JOINT
DETAIL OF PIPE FITTINGS
No. 5-2
OMDURMAN WATER SUPPLY


DETAIL "F" (CANEL CROSSING, BLOWOFF PIPE) 2 SETS
COLLAR (φ450)
45° BEND (φ450)
T-TUBE (φ450 × φ200)
SHORT PIPE (φ200)
90° BEND (φ200)
φ200 STOP VALVE (JIS B 2062)
45° BEND (φ450)
COLLAR (φ450)
φ200 T-TYPE DUCTILE CAST-IRON PIPE
φ450 T-TYPE DUCTILE CAST-IRON PIPE
DETAIL "I" (BLOWOFF PIPE) 1 SET
T-TUBE (φ450 × φ200)
SHORT PIPE (φ200)
45° BEND (φ200)
φ200 T-TYPE DUCTILE CAST-IRON PIPE
φ200 STOP VALVE (JIS B 2062)
φ450 T-TYPE DUCTILE CAST-IRON PIPE
COLLAR (φ450)
DETAIL "H" (CONNECTION WITH φ450 EXISTING PIPE) 1 SET
COLLAR (φ450)
SHORT PIPE (φ450)
φ450 EXISTING PIPE (ASBESTOS PIPE)
OTHERS (φ450)
COLLAR (φ450)
φ450 T-TYPE DUCTILE CAST-IRON PIPE
COLLAR φ450
T-TUBE (φ450 × φ450)
φ450 STOP VALVE (JIS B 2062)
DETAIL "G" (φ450 PIPE BRANCH) 1 SET
COLLAR (φ450)
SHORT PIPE (φ450)
COLLAR (φ450)
φ450 T-TYPE DUCTILE CAST-IRON PIPE
φ450 STOP VALVE (JIS B 2062)
COLLAR (φ450)
T-TUBE (φ450 × φ450)
DETAIL "J" (22 1/2" + 11 1/4" BENDING PART) 1 SET
COLLAR (φ450)
φ450 T-TYPE DUCTILE CAST-IRON PIPE
22 1/2" BEND (φ450)
11 1/4" BEND (φ450)
DETAIL OF PIPE FITTINGS
No. 5-3
OMDURMAN WATER SUPPLY


φ450 T-TYPE, DUCTILE CAST-IRON PIPE
COLLAR (φ450)
22½° BEND (φ450)
DETAIL "K" (22½° BENDING PART) 4 SETS
COLLAR (φ450)
11¼° BEND (φ450)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "M" (11¼° BENDING PART) 1 SET
COLLAR (φ450)
5 5/8° BEND (φ450)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "N" (5 5/8° BENDING PART) 1 SET
COLLAR (φ450)
90° BEND (φ450)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "L" (90° BENDING PART) 1 SET
COLLAR (φ450)
45° BEND (φ450)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
DETAIL "O" (45° BENDING PART) 1 SET
DETAIL OF PIPE FITTINGS
No. 5-4
OMDURMAN WATER SUPPLY

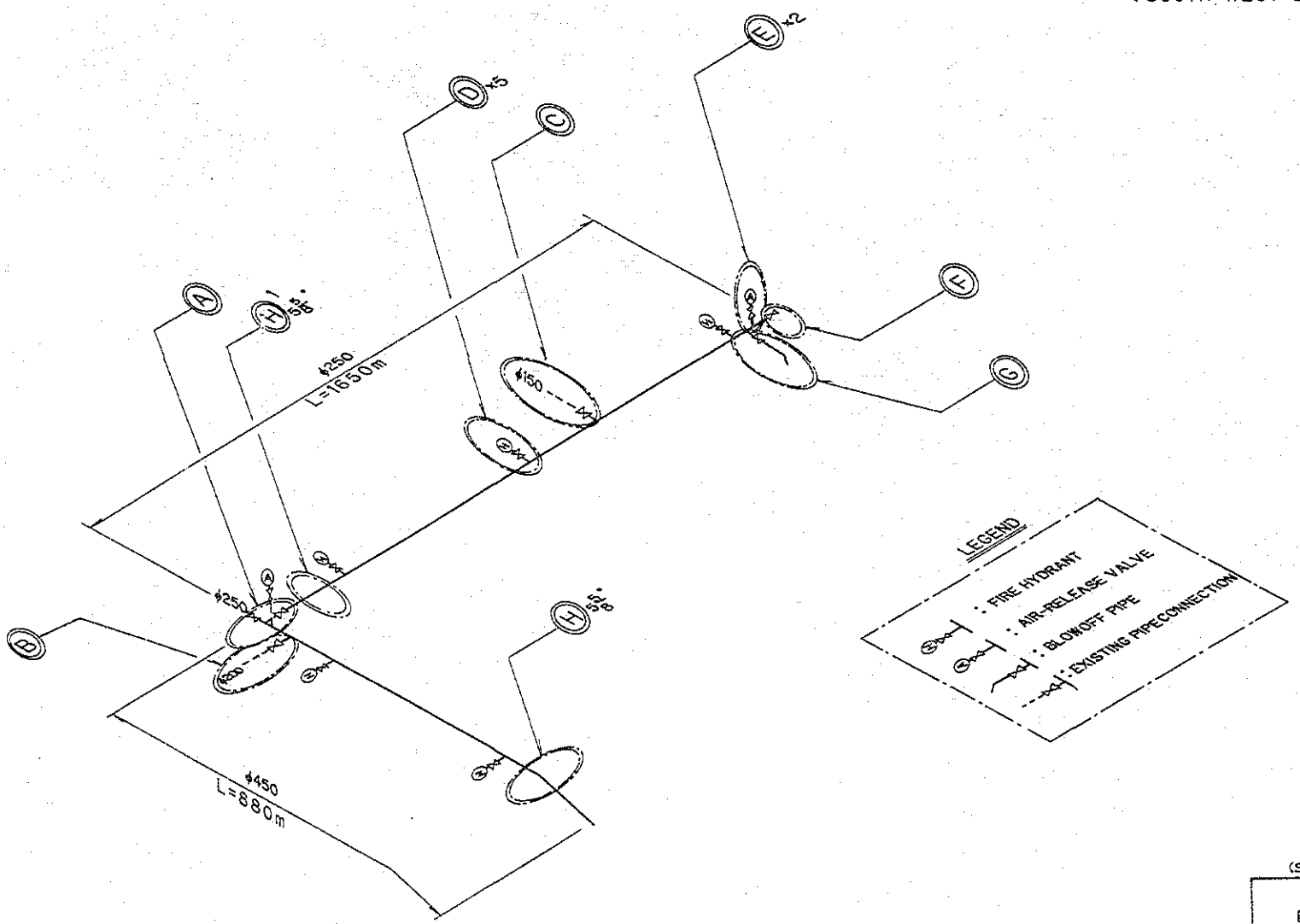


DETAIL "P" (PAVED ROAD CROSSING) 2 SETS

DETAIL OF PIPE FITTINGS
No. 5-5
OMDURMAN WATER SUPPLY

DISTRIBUTION MAINS NO.5 (SOUTH EAST & WEST BLOCK, φ450, φ250)

(SOUTH WEST BLOCK)

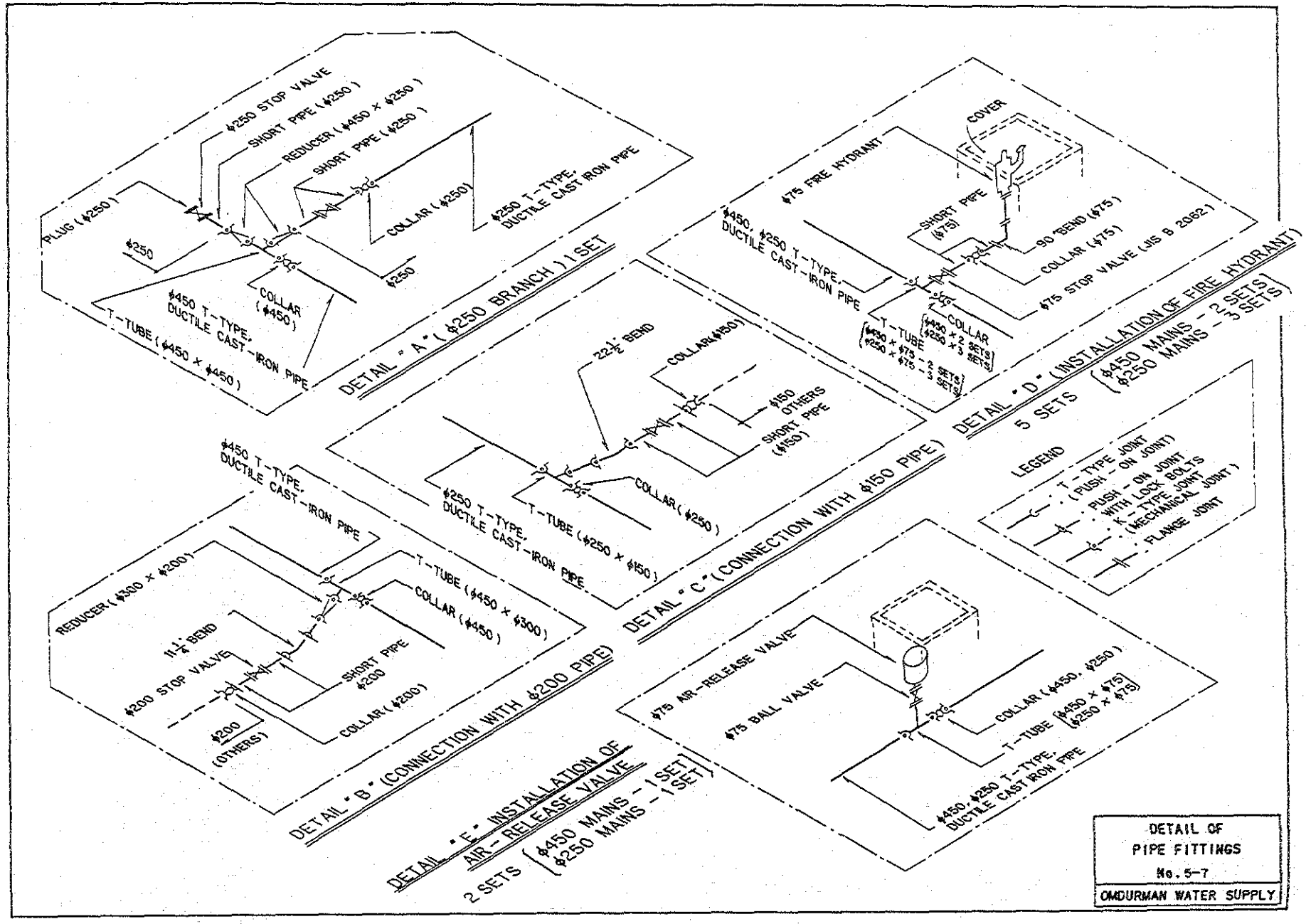


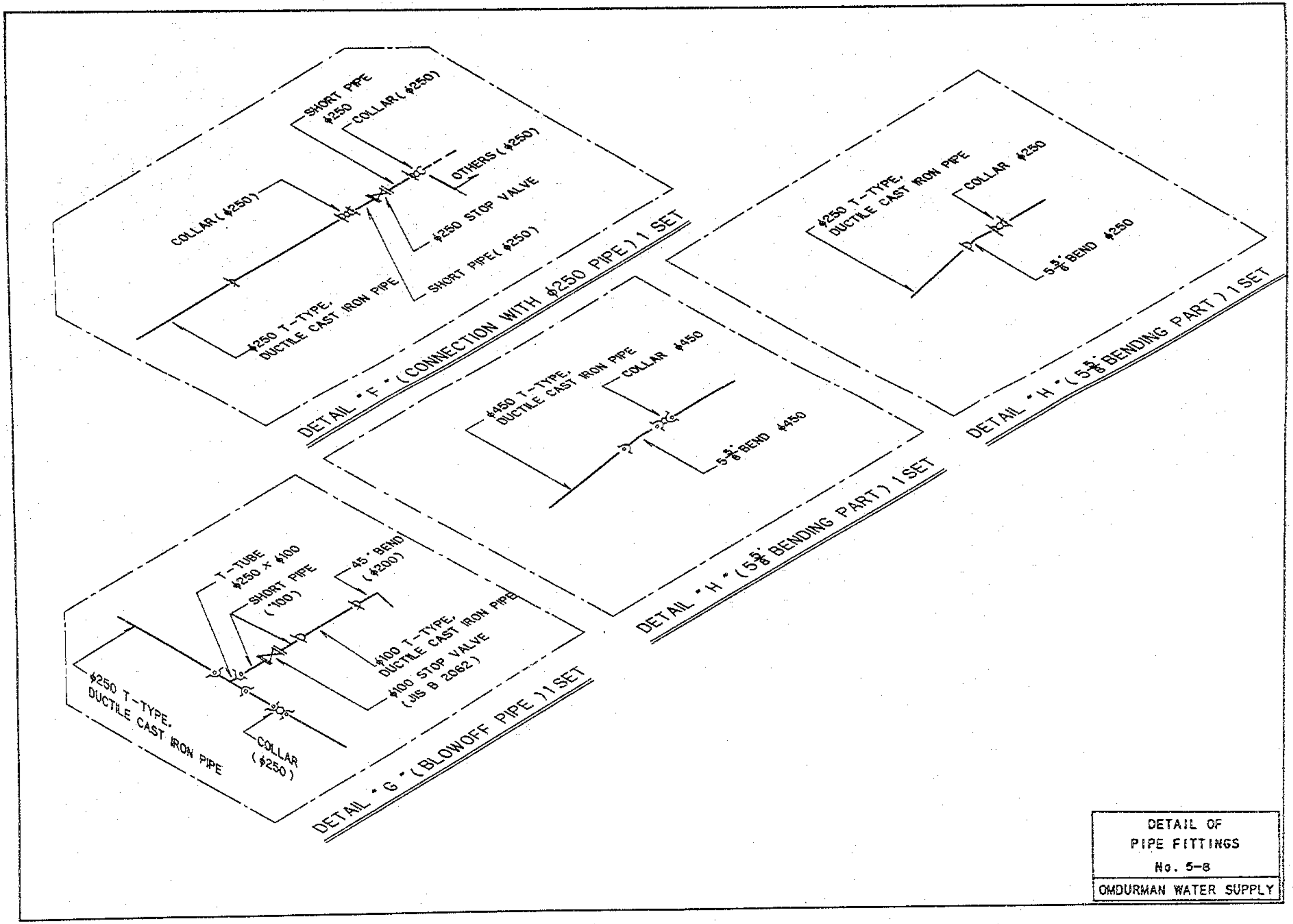
(SOUTH WEST BLOCK)

DETAIL OF
PIPE FITTINGS

No. 5-6

OMDURMAN WATER SUPPLY


PLUG (φ250)
φ250
φ250 STOP VALVE
SHORT PIPE (φ250)
REDUCER (φ450 × φ250)
SHORT PIPE (φ250)
COLLAR (φ250)
φ250 T-TYPE, DUCTILE CAST IRON PIPE
φ250
COLLAR (φ450)
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ450 × φ450)
DETAIL "A" (φ250 BRANCH) 1 SET
φ75 FIRE HYDRANT
COVER
SHORT PIPE (φ75)
90° BEND (φ75)
COLLAR (φ75)
φ75 STOP VALVE (JIS B 2062)
φ450, φ250 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ450 × φ75 - 2 SETS) (φ250 × φ75 - 3 SETS)
COLLAR (φ450 × 2 SETS) (φ250 × 3 SETS)
DETAIL "D" (INSTALLATION OF FIRE HYDRANT)
5 SETS (φ450 MAINS - 2 SETS) (φ250 MAINS - 3 SETS)
22½° BEND
COLLAR(φ150)
φ150 OTHERS
SHORT PIPE (φ150)
φ250 T-TYPE, DUCTILE CAST-IRON PIPE
T-TUBE (φ250 × φ150)
COLLAR (φ250)
DETAIL "C" (CONNECTION WITH φ150 PIPE)
LEGEND
T-TYPE JOINT (PUSH-ON JOINT)
PUSH-ON JOINT WITH LOCK BOLTS
K-TYPE JOINT (MECHANICAL JOINT)
FLANGE JOINT
φ450 T-TYPE, DUCTILE CAST-IRON PIPE
REDUCER (φ300 × φ200)
T-TUBE (φ450 × φ300)
COLLAR (φ450)
11¼° BEND
φ200 STOP VALVE
SHORT PIPE φ200
COLLAR (φ200)
φ200 (OTHERS)
DETAIL "B" (CONNECTION WITH φ200 PIPE)
φ75 AIR-RELEASE VALVE
φ75 BALL VALVE
COLLAR (φ450, φ250)
T-TUBE (φ450 × φ75) (φ250 × φ75)
φ450, φ250 T-TYPE, DUCTILE CAST IRON PIPE
DETAIL "E" INSTALLATION OF AIR-RELEASE VALVE
2 SETS (φ450 MAINS - 1 SET) (φ250 MAINS - 1 SET)
DETAIL OF PIPE FITTINGS
No. 5-7
OMDURMAN WATER SUPPLY


SHORT PIPE ϕ250
COLLAR(ϕ250)
COLLAR(ϕ250)
OTHERS(ϕ250)
ϕ250 STOP VALVE
SHORT PIPE(ϕ250)
ϕ250 T-TYPE, DUCTILE CAST IRON PIPE
DETAIL "F" (CONNECTION WITH ϕ250 PIPE) 1 SET
ϕ450 T-TYPE, DUCTILE CAST IRON PIPE
COLLAR ϕ450
5 5/8° BEND ϕ450
DETAIL "H" (5 5/8° BENDING PART) 1 SET
ϕ250 T-TYPE, DUCTILE CAST IRON PIPE
COLLAR ϕ250
5 5/8° BEND ϕ250
DETAIL "H" (5 5/8° BENDING PART) 1 SET
T-TUBE ϕ250 x ϕ100
SHORT PIPE (ϕ100)
45° BEND (ϕ200)
ϕ100 T-TYPE, DUCTILE CAST IRON PIPE
ϕ100 STOP VALVE (JIS B 2062)
ϕ250 T-TYPE, DUCTILE CAST IRON PIPE
COLLAR (ϕ250)
DETAIL "G" (BLOWOFF PIPE) 1 SET
DETAIL OF
PIPE FITTINGS
No. 5-8
OMDURMAN WATER SUPPLY

Appendix -3

App 3.1 NUWC Operating Budget for Khartoum

Balance Sheet

Water Charge

App 3.2 Comparison of Quantity of Material/Equipment

Analyses of Water Quality at Omdurman and Mogren Treatment Plant

Analyses of Water Quality at Omdurman Treatment Plant

App 3.1

Table- 1 NUWC OPERATING BUDGET FOR KHARTOUM (a)

(Unit : LS)

No.	Item	1985/86	1986/87	1987/88
I.	INCOME			
	1. Sales	12,576,273	48,000,000	55,000,000
	2. Other Income	1,376,938	2,000,000	2,000,000
	Total Income	13,953,211	50,000,000	57,000,000
II.	EXPENDITURE			
	1. Procuction Cost			
	1) Salaries & Wages	3,446,653	4,039,720	6,000,000
	2) Fuel & Power	1,285	1,408,350	800,000
	3) Operating Materials	812,219	2,400,870	1,500,000
	4) Repair & Maintenance	511,153	1,317,960	500,000
	5) Depreciation	2,787,825	2,848,095	516,710
	6) Other Expenses	289,778	540,090	3,475,000
	Total Production Cost	7,848,913	12,555,085	12,791,710
	2. Distrubution Cost			
	1) Salaries & Wages	3,874,698	2,109,630	4,000,000
	2) Fuel & Power	686,864	413,490	300,000
	3) Operating Materials	690,811	1,722,450	800,000
	4) Repair & Maintenance	164,146	3,595,480	700,000
	5) Depreciation	668,250	3,229,418	600,000
	6) Other Expenses	1,051,926	859,370	2,000,000
	Total Distribution Cost	7,136,695	11,929,898	8,400,000
	3. Administration Cost			
	1) Salaries & Wages	1,557,448	2,898,810	2,760,725
	2) Fuel & Power	3,161	583,710	200,000
	3) Operating Materials	13,878	1,215,716	200,000
	4) Repair & Maintenance	2,229,137	1,370,176	220,000
	5) Depreciation	3,161,145	682,700	1,000,000
	6) Other Expenses	389,531	1,472,220	400,000
	Total Administraion Cost	7,354,301	8,223,332	4,780,725

App 3.1

Table- 1 NUWC OPERATING BUDGET FOR KHARTOUM (b)

(Unit : LS)

No.	Item	1985/86	1986/87	1987/88
4.	Financial Charges			
	1) 5% Interest on Capital	5,913,163	5,614,522	7,507,000
	2) Audit Fees	9,966	540,000	3,000
	Total Financial Charges	5,935,129	6,166,522	7,510,000
	TOTAL OF EXPEN.	28,275,038	38,874,837	33,482,435
5.	Net Surplus for the Year	▲14,321,827	11,125,163	24,017,565
	TOTAL EXPENDITURE	13,953,211	50,000,000	57,500,000

App 3.1

Table- 2 BALANCE SHEET (a)

(Unit : LS)

No.	Liabilities	1983/84	1984/85	1985/86
1.	Capital Reserve Equity	19,435,675	19,435,675	19,435,675
2.	Capital Reserve Grant (Ministry of Finance)	18,605,652	21,319,801	30,447,636
3.	Revaluation Surplus	148,578,507	148,578,507	148,578,507
4.	Deficit for Previous Year (1)	▲ 14,926,764	▲ 25,271,111	▲ 23,971,603
5.	Devicit for Previous Year (2)	▲ 10,425,977	▲ 8,668,497	▲ 14,321,827
6.	Consumer Deposit	245,243	356,937	482,333
7.	Current Liabilities	6,449,546	10,702,404	6,418,072
8.	Pension & Benefit Reserve	291,164	312,160	449,464
9.	Accrued Charges	15,000	3,000	15,000
10.	Social Insurance	140,105	571,681	131,586
11.	5% Interest on Capital	25,649,566	25,541,867	40,863,573
	TOTAL LIABILITIES	194,057,717	192,882,424	208,528,461

Table- 2 BALANCE SHEET (b)

(Unit : LS)

No.	Assets	1983/84	1984/85	1985/86
1.	Fixed Assets	202,835,496	205,843,244	207,291,376
2.	Less Accumulated Debts	▲ 57,300,226	▲ 63,774,587	▲ 70,391,807
3.	Work in Progress	4,989,471	3,541,955	7,155,097
4.	Stock in Hand	3,923,703	5,768,804	3,166,435
5.	Material in Transit	7,894,763	1,000,000	7,341,645
6.	Costomer Account Receivable	10,132,373	17,601,492	19,545,934
7.	Less Provision for Bad Debts	▲ 198,769	▲ 206,769	▲ 216,738

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Table- 2 BALANCE SHEET (b)

(Unit : LS)

No.	Assets	1983/84	1984/85	1985/86
8.	Account Receivable Government	1,545,779	2,545,779	2,750,000
9.	Municipality Account	20,049	20,049	250,000
10.	Account Receivable Staff	70,513	70,513	20,049
11.	Sundry National Electricity Corporation	635,967	▲ 237,196	▲ 584,034
12.	Sundry Debts	453,600	1,205,235	1,896,612
13.	Staff Welfare Fund	31,862	53,862	170,802
14.	Prepayment	6,926	6,926	6,926
15.	Balance at Bank	718,033	1,137,581	1,863,692
16.	Correct Account with Areas	18,154,175	18,154,170	21,481,705
17.	Rural administration	144,002	151,336	235,453
18.	French Loan	—	—	2,719,674
19.	Indian Loan	—	—	3,825,640
	TOTAL ASSETS	194,057,717	192,882,424	208,528,461

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Water Charge

As of Jan.1987

1) Forth & Third Class Area (1/2 in. Connection)

0	-	15 m3	LS 10.00
15	-	Extra	LS 0.75/m3

2) Second Class Area (3/4 in. Connection)

0	-	15 m3	LS 15.00
15	-	50 m3	LS 0.75/m3
50	-	Extra	LS 1.00/m3

3) First Class Area (1 in. Connection)

0	-	15 m3	LS 20.00
15	-	Extra	LS 1.00/m3

4) Industrial & Commercial

0	-	50 m3	LS 65.00
50	-	Extra	LS 1.50/m3

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Table - 3 Comparison of Quantity of Material/Equipment

Item	Description	Requested Quantity	Evaluated Quantity
1. Grant Material/Equipment			
a) Ductile Cast Iron Pipe	φ 250mm	8,500 m	10,070 m
Ductile Cast Iron Pipe	φ 300mm	12,000 m *	12,040 m
Ductile Cast Iron Pipe	φ 450mm	8,500 m	9,170 m
Joints, Fittings, Valves and Others		1 L.S.	1 L.S.
b)Construction Machinery			
Backhoe	(0.6 m³)	2 units	2 units
Hydraulic Breaker		—	2 units
Truck Crane	(16 ton)	1 unit	1 unit
Truck Crane	(10 ton)	2 units	1 unit
Tractor Shovel	(1.0 m³)	—	2 units
Dump Truck	(11 ton)	2 units	2 units
Cargo Truck	(8 ton)	2 units	1 unit
Repair Truck with Hydraulic Crane	(4 ton)	—	2 units
Car for Reparing work	(2 ton)	3 units	—
Pickup	(1 ton truck)	4 units	4 units
Station Wagon		2 units	1 unit
Compressor	(5.0 m³/min)	4 sets	2 sets
Concrete Cutter		—	1 set
Breaker	(Breaker 4sets/unit)	2 units	2 units
Pipe Cutter		10 sets	2 sets
Concrete Drill		—	2 sets
Test Pump for Water Pressure		5 sets	2 sets
Sludge Pump		6 sets	3 sets
Spare parts		1 L.S.	1 L.S.
c) Roofing Materials			
Aluminum Corrugate Type Roofings		12,000 m²	3,500 m²
d) Related Equipment			
Leakage Detector		4 sets	4 sets
PVC Pipe Welder		2 sets	—
Wireless Telephone(Portable type)		1 L.S.	—
Flow Meter	(φ 600～φ 400)	3 sets	—

Item	Description	Requested Quantity	Evaluated Quantity
2. Construction Works			
a) Distribution Pipelaying Works		Main portion	ϕ 450～ϕ 300 ×20.3km
b) Technical Training		Training for Constructin Machinery Operation	Training for Constructin Machinery Operation and Maintenance
			Training for Pipe Installa -tion Works and Testings

Note * : The figure shows the accepted length at the Preliminary Study stage.

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Table - 4 ANALYSES OF WATER QUALITY AT OMDURMAN AND MOGREN TREATMENT PLANT

		OMDURMAN TREATMENT PLANT						MOGREN TRESTMRNT PLANT		
		RAW WATER			TAP WATER			RAW WATER		
		Jul 6 1982	Aug16 1982	Jan22 1983	Jul 1982	Aug 1982	Jan 1983	JUl 14 1982	Aug12 1982	Jan13 1983
Appearance		Muddy	Muddy	Opal.	Clear	Clear	Clear	Muddy	Muddy	Opal.
Turbidity	F.T.U.	40	200	42	24	42	7.5	760	1086	24
Colour Hazen Unit	UNIT	375	150	120	—	—	—	50	100	45
Odour		Nil	Nil	Nil	Nil	Nil	Nil	Earthy	Earthy	Nil
Temperature when sample tested	℃	33	27	35	32	31	20	28	30	18
pH Value		8.1	8.2	8.3	6.55	6.78	7.14	8.5	8.1	8.3
Electric Conductivity	μ S/cm	200	160	150	—	—	—	130	180	150
Total Hardness as $CaCo_3$	mg/ℓ	50	60	60	80	244	60	85	80	90
Permanent Hardness	mg/ℓ	Nil	Nil	Nil	20	164	Nil	15	5	Nil
Methyl Orange Alkalinity as $CaCo_3$	mg/ℓ	110	80	130	60	80	65	70	75	100
Calcium as Ca	mg/ℓ	10.00	14.8	14.90	24	22	16	18	24	25.2
Magnesium as Mg	mg/ℓ	6.00	5.52	8.38	6	44.16	4.8	9.60	4.80	6.48
Silicate as SiO_2	mg/ℓ	18	4	20	—	—	—	16	16	12
Sulphate as SO_4	mg/ℓ	19	9	27.60	28.8	42.42	14.4	38.40	24	19.2
Chloride as Cl	mg/ℓ	16	13	18	19	14	14	18	17	20
Iron as Fe	mg/ℓ	Nil	Nil	Nil	Nil	Nil	Nil	0.04	0.06	0.20
Nitrite as N	mg/ℓ	0.02	Nil	Nil	0.007	Nil	Nil	0.006	0.001	Nil
Ammoniacal Ammonia as NH_3	mg/ℓ	0.415	0.060	0.020	Trace	Nil	0.040	0.060	0.232	0.032
Albuminoid Ammonia as NH_3	mg/ℓ	0.376	0.100	0.200	0.404	0.016	0.380	0.172	0.512	0.448
Fluoride as F	mg/ℓ	0.5	0.4	0.5	—	—	—	0.45	0.4	—
Solid in suspension at 105℃	mg/ℓ	400	200	100	—	—	—	600	1000	50
Total Dissolved Solid dried at 180℃	mg/ℓ	—	—	—	100	410	150	—	—	—

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Table - 5 ANALYSES OF WATER QUALITY AT OMDURMAN TREATMENT PLANT

Month : Aug, 1985

Day	pH Value of water			TURBIDITY(F.T.U.)			CHLORINE Residual mg/ℓ	SOLID in Suspension mg/ℓ
	Raw	Filter	Tap	Raw	Filter	Tap		
1	—	—	—	—	—	—	—	—
2	8.1	6.7	6.7	2200	12	12	0.2	3200
3	8.1	6.5	6.6	1280	12	23	0.2	2200
4	—	—	—	—	—	—	—	—
5	—	—	—	—	—	—	—	—
6	8.1	5.9	6.5	1360	10	36	0.15	2800
7	—	—	—	—	—	—	—	—
8	—	—	—	—	—	—	—	—
9	8.1	6.7	6.9	1200	17	32	TRACE	2600
10	—	—	—	—	—	—	—	—
11	8.1	5.66	6.7	1185	7.0	18	0.1	1600
12	8.1	6.7	6.5	1080	45	19	0.1	1600
13	8.1	5.8	6.3	880	10	18	0.1	1000
14	—	—	—	—	—	—	—	—
15	8.1	5.8	6.7	800	16	18	0.15	—
16	—	—	—	—	—	—	—	—
17	8.1	6.1	6.5	1040	7.5	18	0.3	—
18	—	—	—	—	—	—	—	—
19	8.1	6.9	6.1	1540	4.7	22	0.15	4000
20	8.1	6.9	7.1	1460	4.2	5.4	0.4	2400
21	—	—	—	—	—	—	—	—
22	8.1	5.9	6.7	1440	5.3	21	0.25	3200
23	8.1	6.1	6.7	1300	8.4	19	0.15	3200
24	8.3	6.3	6.7	760	16	15	0.3	1600
25	8.3	6.1	6.7	500	8.1	18	0.15	—
26	8.3	6.1	6.7	650	11	16	0.1	1200
27	8.3	6.1	6.7	560	10	11	TRACE	—
28	—	—	—	—	—	—	—	—
29	—	—	—	—	—	—	—	—
30	8.3	6.3	6.5	630	9.2	14	0.15	—

Remarks : Examined at CENTRAL LABORATORY, MOGREN TREATMENT PLANT