The per capita water demand, classified by income levels of consumer and the served population corresponding each income level are listed in Table 5-1 and the potential water demand classified by uses is shown in Table 5-2. The above tables are prepared based on the data from "Khartoum Area Water Supply Project, 1977" by the World Bank and the NUWC's forecast.

As seen in Table 5-2, the present supply satisfies only 55 % of the potential demand. Under the Project, 62,400 m^3/day will be supplied additionally from the Khartoum South DPS and it will increase the supply greatly 91 % of the lowly set water demand.

Table 5-1 Water Demand by Income Level

Level		Demand (liters/person/day)	Population
Residential	1st Class	300	75,000
	2nd Class	200	100,000
	3rd Class	80	250,000
	4th Class	25	75,000
	Others	10	100,000
	Total		600,000

Table 5-2 Water Demand by Use

Uses	Demand (m^3/day)
Domestic	65,000
Others (public, commercial and industrial)	33,000
Unaccounted-for	53,000
Total	151,000

5.2.3 Planned Facilities, Machines and Materials

a) Distribution Pipelines (200-700 mm in diameter, 25.7 km long)

Such factors as physical strength, durability, workability, corrosion resistance, marketability and economy of various materials will be comparatively studied for selecting the pipe material, based on Japan Industrial Standard and Japan Water Works Association Standard.

b) Construction Machines (2 backhoes, 1 pickup truck)

Size of construction works, construction period, economy and durability of various types and specifications will be comparatively studied for selecting the construction machine.

c) Roofing Materials for Reservoir (3,600 m^2)

Design conditions of the structure of the existing reservoir, physical strength, durability, workability, economy and marketability of various materials and specifications will be comparatively studied for selecting the roofing materials.

d) Building Materials for Warehouse (1,000 m^2)

Physical strength, durability, workability, economy and marketability of various materials and specifications will be comparatively studied for selecting the building materials.

5.3 Basic Plan

5.3.1 Distribution Pipelines Plan

a) Pipeline Routes and Length

Field reconnaissance, test excavation and other surveys have been made for studying the pipeline route proposed by the Sudanese side. Further, the situation of land use, existing distribution pipelines and distribution of population have been put into consideration in drafting the pipeline plan shown in Fig.5-1, which has been discussed with the Sudanese side and agreed on.

b) Pipeline Planning

Based on the present situation of land use, the water demands by use have been allocated to the districts in the area. To prepare a most appropriate plan, computed by the running distribution pipelines network analysis program, various factors for pipeline planning have been figured, as shown in Fig. 5-2, on the basis of such items as the district-wise water demand, the conditions of the distribution pipelines including the existing ones and newly installed ones under the Project, and the water supply from the Mogren and Burri WTP's and the Khartoum South DPS.

The network computation will be based on the following conditions:

Method	: Hardy-Cross Method
Flow formula	: Hazen-Williams formula
Roughness Coefficient	: C=120 for new and C=100-70 for old pipes
Maximum Hour Peak Factor	: 1.2
Required Service Pressure	: 10 meters water head

The computation results and the pressure contour lines are shown in Table 5-3 and Fig. 5-3 respectively.

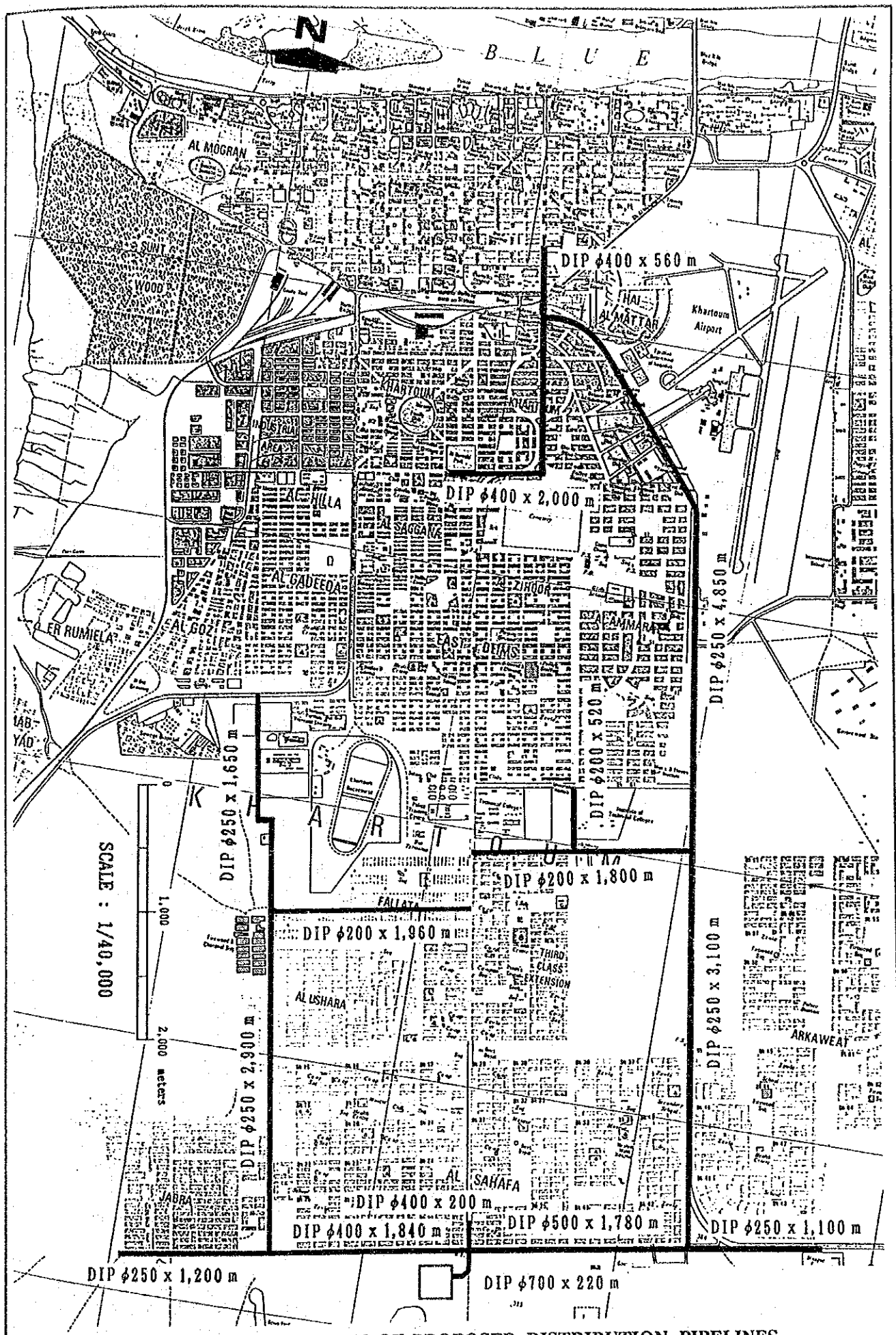


Fig.- 5.1 GENERAL PLAN OF PROPOSED DISTRIBUTION PIPELINES

Fig.- 5.2 SKELTON OF NETWORK ANALYSIS FOR KHARTOUM DISTRIBUTION PIPELINES

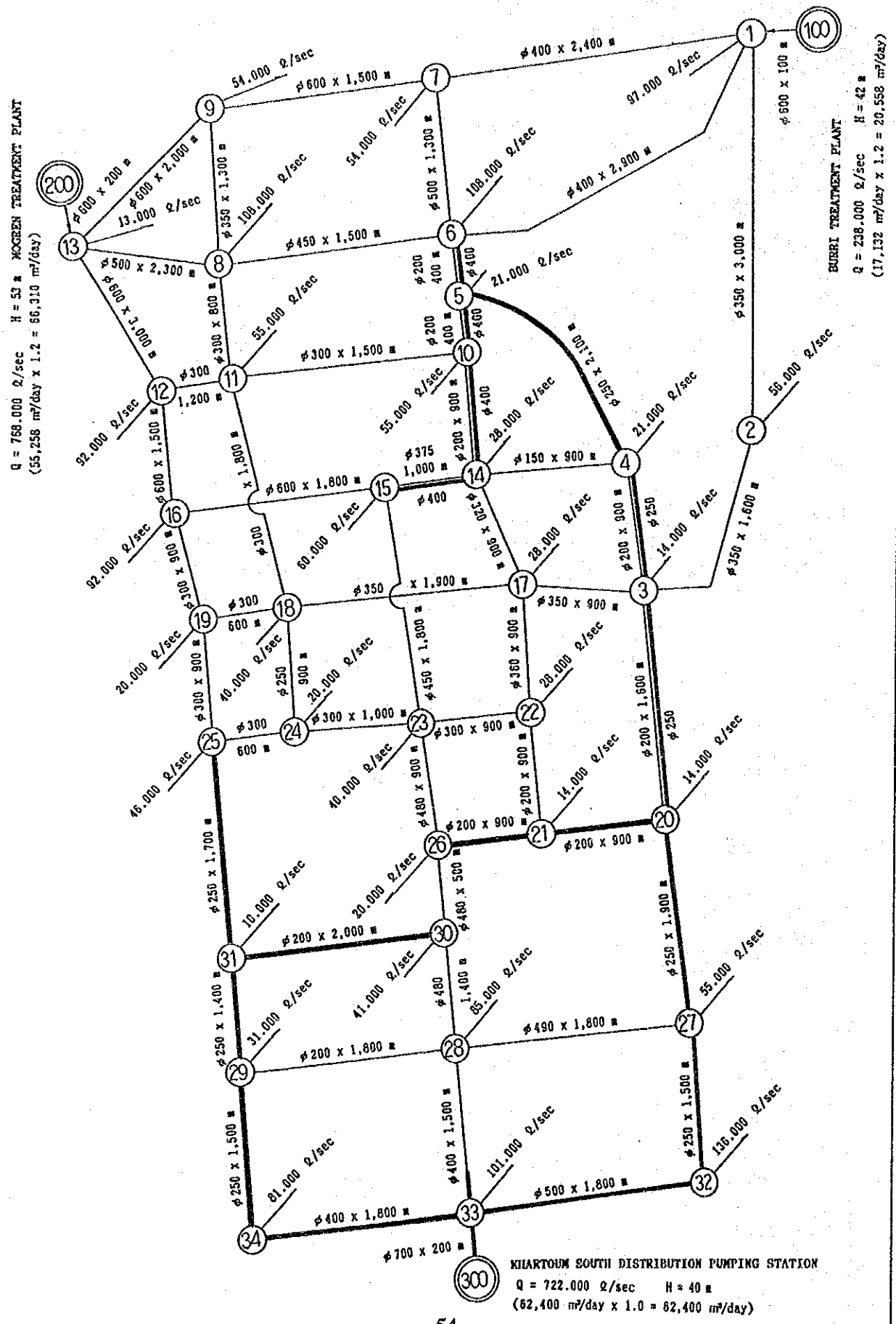
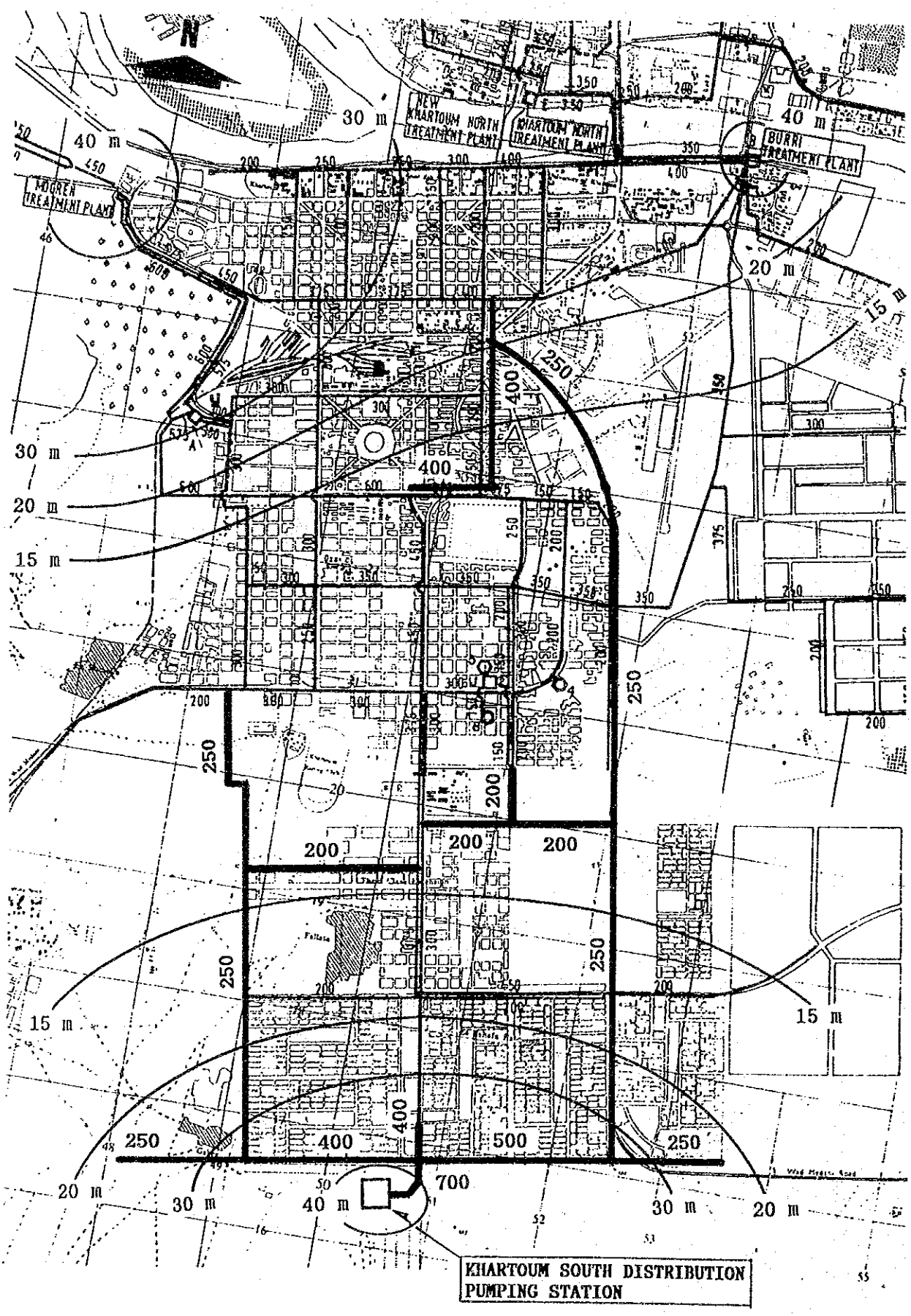


TABLE - 5.3 NETWORK ANALYSIS FOR DISTRIBUTION PIPELINES IN KHARTOUM AREA

Node - Node	Type	D (mm)	L (m)	C	R (%)	Q (l/sec)	V (m/sec)	i (‰)	dH (m)	Hb/r (m)	H (m)	GL (m)	He (m)
100 - 1	0	600	100	70	70	238.000	1.718	19.770	1.98	0.00	420.25	380.00	40.25
200 - 13	0	600	200	80	80	778.000	4.299	72.103	14.42	0.00	417.58	380.00	37.58
300 - 33	1	700	200	120	100	722.000	1.876	4.723	0.94	0.00	422.00	383.00	39.00
1 - 2	0	350	3000	80	80	59.661	0.969	8.603	25.81	0.00	394.45	381.00	13.45
2 - 3	0	350	1600	80	80	3.661	0.059	0.049	0.08	0.00	394.37	381.00	13.37
3 - 4	0	200	900	90	90	3.822	0.150	0.369	0.33	0.00	394.37	381.00	13.37
3 - 4	1	250	900	120	100	12.101	0.247	0.369	0.33	0.00	394.37	381.00	13.37
4 - 5	1	250	2100	120	100	34.074	0.694	2.503	5.26	0.00	394.70	381.00	13.70
5 - 6	0	200	400	80	80	14.294	0.711	9.338	3.74	0.00	399.96	380.00	19.96
5 - 6	1	400	400	120	100	239.224	1.904	9.338	3.74	0.00	399.96	380.00	19.96
6 - 1	0	400	2900	70	70	41.835	0.679	5.712	16.56	0.00	403.69	380.00	23.69
6 - 7	1	500	1300	120	100	243.640	1.241	3.259	4.24	0.00	403.69	380.00	23.69
7 - 1	0	400	2400	70	70	39.503	0.642	5.137	12.33	0.00	407.93	380.00	27.93
6 - 8	1	450	1500	120	100	76.043	0.478	0.631	0.95	0.00	403.69	380.00	23.69
8 - 9	1	350	1300	120	100	110.012	1.143	4.252	5.53	0.00	404.64	380.00	24.64
9 - 7	1	600	1500	120	100	258.137	0.913	1.492	2.24	0.00	407.93	380.00	27.93
5 - 10	0	200	400	80	80	11.189	0.556	5.936	2.37	0.00	397.58	380.00	17.58
5 - 10	1	400	400	120	100	187.256	1.490	5.936	2.37	0.00	397.58	380.00	17.58
10 - 11	0	300	1500	80	80	16.064	0.355	1.609	2.41	0.00	395.17	380.00	15.17
11 - 8	0	300	800	80	80	47.248	1.044	11.838	9.47	0.00	395.17	380.00	15.17
11 - 12	0	300	1200	80	80	12.589	0.278	1.025	1.23	0.00	395.17	380.00	15.17
12 - 13	0	600	3000	80	80	221.572	1.224	7.061	21.83	0.00	396.40	380.00	16.40
13 - 8	0	500	2300	80	80	121.279	0.965	5.627	12.94	0.00	404.64	380.00	24.64
10 - 14	0	200	900	90	90	10.695	0.420	2.474	2.23	0.00	395.35	381.00	14.35
10 - 14	1	400	900	120	100	116.686	0.929	2.474	2.23	0.00	395.35	381.00	14.35
14 - 15	0	375	1000	90	90	22.051	0.243	0.426	0.43	0.00	394.93	381.00	13.93
14 - 15	1	400	1000	120	100	45.099	0.359	0.426	0.43	0.00	394.93	381.00	13.93
15 - 16	0	600	1800	90	90	3.483	0.015	0.001	0.00	0.00	394.93	381.00	13.93
16 - 12	0	600	1500	90	90	116.983	0.511	0.982	1.47	0.00	394.93	381.00	13.93
3 - 17	0	350	900	90	90	19.942	0.248	0.476	0.43	0.00	393.94	381.00	12.94
17 - 14	0	320	900	90	90	29.381	0.445	1.573	1.42	0.00	393.94	381.00	12.94
14 - 4	0	150	900	90	90	2.850	0.185	0.729	0.66	0.00	394.70	381.00	13.70
17 - 18	0	350	1900	90	90	19.973	0.248	0.477	0.91	0.00	393.03	381.00	12.03
18 - 11	0	300	1800	90	90	20.901	0.365	1.186	2.14	0.00	393.03	381.00	12.03
18 - 19	0	300	600	90	90	0.832	0.015	0.003	0.00	0.00	393.03	381.00	12.03
19 - 16	0	300	900	90	90	28.467	0.497	2.101	1.89	0.00	393.03	381.00	12.03
3 - 20	0	200	1600	100	100	4.545	0.145	0.250	0.40	0.00	394.37	381.00	13.37
3 - 20	1	250	1600	120	100	9.813	0.200	0.250	0.40	0.00	394.37	381.00	13.37
20 - 21	1	200	900	120	100	7.150	0.228	0.413	0.37	0.00	394.40	382.00	12.40
21 - 22	0	200	900	100	100	6.683	0.213	0.511	0.46	0.00	393.94	381.00	12.94
22 - 17	0	360	900	90	90	1.351	0.017	0.003	0.00	0.00	393.94	381.00	12.94
22 - 23	0	300	900	90	90	19.967	0.349	1.090	0.98	0.00	393.94	381.00	12.94
23 - 15	0	450	1800	90	90	3.666	0.028	0.006	0.01	0.00	394.92	381.00	13.92
23 - 24	0	300	1000	90	90	27.013	0.472	1.907	1.91	0.00	393.01	381.00	12.01
24 - 18	0	250	900	90	90	1.706	0.041	0.025	0.02	0.00	393.01	381.00	12.01
24 - 25	0	300	600	90	90	8.719	0.152	0.235	0.14	0.00	392.87	381.00	11.87
25 - 19	0	300	900	90	90	7.634	0.133	0.184	0.17	0.00	392.87	381.00	11.87
21 - 26	1	200	900	120	100	13.533	0.431	1.345	1.21	0.00	394.40	382.00	12.40
26 - 23	0	480	900	100	100	83.314	0.460	0.765	0.69	0.00	394.92	381.00	13.92
20 - 27	1	250	1900	120	100	35.507	0.723	2.702	5.13	0.00	394.77	382.00	12.77
27 - 28	0	490	1800	100	100	12.268	0.065	0.020	0.04	0.00	399.90	382.00	17.90
28 - 30	0	480	1400	100	100	160.812	0.889	2.583	3.62	0.00	396.32	382.00	14.32
28 - 29	0	200	1800	100	100	3.228	0.103	0.133	0.24	0.00	399.94	382.00	17.94
29 - 31	1	250	1400	120	100	36.681	0.747	2.869	4.02	0.00	396.16	382.00	14.16
30 - 31	1	200	2000	120	100	2.965	0.094	0.081	0.16	0.00	396.16	382.00	14.16
31 - 25	1	250	1700	120	100	29.647	0.604	1.935	3.29	0.00	392.87	381.00	11.87
27 - 32	1	250	1500	120	100	78.239	1.594	11.651	17.48	0.00	399.90	382.00	17.90
32 - 33	1	500	1800	120	100	214.239	1.091	2.569	4.62	0.00	417.38	383.00	34.38
33 - 34	1	400	1800	120	100	151.909	1.209	4.031	7.26	0.00	414.74	383.00	31.74
34 - 29	1	250	1500	120	100	70.909	1.445	9.713	14.57	0.00	400.18	382.00	18.18
13 - 9	1	600	2000	120	100	422.149	1.493	3.707	7.41	0.00	410.17	380.00	30.17
30 - 26	0	480	500	100	100	116.846	0.646	1.430	0.72	0.00	395.61	382.00	13.61
33 - 28	0	400	1500	100	100	254.852	2.028	14.710	22.06	0.00	399.94	382.00	17.94

Type 0 : Existing pipeline
Type 1 : Proposed pipeline
D : Diameter of pipeline
L : Length of pipeline
Q : Flow rate
C : Coefficient of velocity (Hazen & Williams's Fomula)
V : Velocity
i : Hydraulic gradient
dH : Loss of water head
Hb/r : Booster-pumped pressure
H : Dynamic water level above sea level
GL : Ground elevation above sea level
He : Effective service pressure
R : Discount rate for pipe diameter

Fig.- 5.3 PLANNED SERVICE PRESSURE CONTOUR LINE IN KHARTOUM AREA



c) Pipe Material

The pipe material requested by the Sudanese side was ductile iron pipe (DIP) and it is judged to be reasonable technically. For the reasoning, a comparative discussion will be made hereinafter, comparing DIP used most widely for waterworks with steel pipe (SP), asbestos cement pipe (ACP) and polyvinyl chloride pipe (PVC).

1) Physical Strength

Regarding physical strength, ACP and PVC are far lower than DIP and SP. Though ACP is used widely in the Sudan, production has been stopped in Japan. In the 1950's and 1960's, it was popular in Japan because of the low prices, but accidents due to the physical weakness have happened frequently. A theory suspecting asbestos, the material of the pipe, as a cancer precursor has led to restriction of use of ACP for new plans and eventually to suspension of the production.

2) Durability

DIP and SP are superior in durability and resistivity against weathering. Comparatively, PVC is downgraded under direct sunlight and weak against heat. ACP is less resistive against impact by rough handling through transportation and installation at site.

3) Workability

Leakage is caused mostly by poor workmanship in pipe joints. In case of DIP, ACP and PVC, pipe-joining is easy and needs less skill. With SP, however, skill in on-the-site welding of pipe is needed definitely. In addition, preparation of special equipment and materials is required.

4) Resistivity against Corrosion

For both inside and outside of DIP, ACP and PVC, the resistance to corrosion is high. But, rust crust by corrosion tends to form inside in SP, to cause reduction of effective sectional area for water flow and generation of red water.

5) Marketability and Economy

DIP and SP are high in applicability and marketability, and pipes of 200-700 mm in diameter are easily available, though prices are relatively high. PVC, though relatively low in price, has a limitation in diameter size. JWWA specifies, for example, its sizes to be 150 mm or below for water supply. ACP is not produced in Japan anymore.

6) Easiness of Branching Connection

For DIP, tees or split tees can facilitate branching a house connection and saddle is not needed. For PVC and ACP, a saddle is used for protecting drilled pipe wall, preventing pipe's break and facilitating joining of pipes for connection, which however increases connection cost.

By the reasons mentioned above, DIP is selected for the material of the pipelines to be implemented under the Project. SP is relatively less expensive as to the material cost, but needs welding for the joint which makes the cost higher in total.

d) Design Criteria

1) Class and Standard of Pipe

The pipe material shall be Ductile Iron Pipe for Waterworks (JIS G 5526, 5527). Regarding joint type, T type for all straight pipes and fittings of 250 mm and below 250 mm, K type for fittings of 300 mm and above 300 mm and T type joint are specified. Third class pipe (wall thickness thinner than First and Second class, use for lower pressure) is selected, upon consideration of pipe burying depth (1.3 m), surcharge load (500 kg/m^2) and internal water pressure (4.5 kg/cm^2).

2) Pipe Burying Depth

Considering geological conditions, volume of road traffic and workability, the pipe burying depth (from road surface to the top of pipe) is specified at 1.3 meters in minimum. The standard cross section of earth work is shown in the basic design drawings of Appendix 2. Earth for backfilling should not contain any pieces of rock.

3) Protection of Fittings

At branches, joints and bends in a pipeline, internal water pressure causes an imbalance of horizontal and vertical forces. The imbalance displaces and slips off the pipe, causing leakage. Protective means to prevent slip-off of pipe are needed at those fittings normally. As cement is difficult to be procured in the Sudan, special joints made of ductile iron are used for the protection at fittings where necessary. The special joints are used at the both ends of tees, bends of 22 1/2 degrees and above, gate valves and reducers.

4) Valves and Hydrants

At the strategic points of the pipeline, gate valves, air valves and blow-off valves of JIS Standards will be installed. Fire hydrants for fire fighting shall be located at about every 500-meter

interval, according to the NUWC criteria. The hydrant is of 75 mm single mouth type underground and facilitates coupling with fire hose, the mouth will be shaped to comply with the British Standard. Details are shown in the basic design drawings in Appendix 2.

The outline of the distribution pipelines based on the above criteria is shown in Fig. 5-4.

5.3.2 Machines and Materials Plan

a) Construction Machines

As stated in Section 4.3.4, out of the total length of 770 km of distribution pipelines in the Khartoum Area, the length of pipe materials of ACP amounts to 680 km, 90 % of the total length. As it is generally reported that ACP is weak in its physical strength and durability comparing to the other materials, the ratio of occurrence of breakage of the pipeline and leakage is higher. In that sense, the NUWC needs careful attention to take preventive as well as remedial measures in the way of maintenance of the pipeline. The construction machines procured under the current Project will contribute greatly to repairs and maintenance works of the existing distribution system made of ACP, after it is connected with the new distribution pipelines to be constructed under the present Project. For prompt and expeditious repairs, efficient work is required in order to complete such work with a minimum suspension of water supply, and for that purpose, it is important to use suitable construction machines to conduct effective construction. The following construction machines have been selected:

(1) Backhoe (0.6 – 0.7 m^3) : 1 unit

The machine will be used for construction spots of pipeline routes with an excavation trench of one meter or more wide. Generally it is used for the excavation of pipe routes of distribution pipes of 450 mm or more in diameter in case of ACP and or a work site where a larger space is available and where underground obstructions are ignorable or their locations can be recognized. The machine will be, therefore, used for excavation and loading of earth, and be superior in mobility and stability in running over uneven ground, and be good for speedy transportation between sites, and have such other superior characters as easiness of checkup because of simple structure, small size and light weight and easily operable hydrostatic drive, 4-wheel drive (4WD) type with front and rear double tires.

(2) Backhoe (with blade, 0.35 m^3) : 1 unit

The machine will be used for construction spots of pipeline routes with an excavation trench of less than one meter wide. Generally it is used for the excavation of distribution pipes routes of less than 450 mm in case of ACP or where traffic is heavy and space is small

and works are enforced to be implemented within limited spaces, and where there exists underground obstruction, requiring careful excavation. The machine will be used for excavation, loading and backfilling of earth, and be superior in mobility and stability in running over uneven ground, and be good for speedy transportation between sites, and have such other superior characters as easy handling at narrow sites because of small circling radius in front and rear, easiness of checkup because of simple structure, small size and light weight and easily operable hydrostatic drive, 4-wheel drive (4WD) type with front and rear double tires.

(3) Pickup (double cabin) : 1 unit

This machine will be used for transporting staff members, materials and equipment, superior in mobility and stability in running over uneven ground, and be of a 4-wheel drive (4WD) type.

The above three machines can be used for future extension works of distribution pipelines after completion of the Project, while the machines procured by this Project will be used for pipelaying work of the Project.

b) Roofing Materials for Reservoir

Two reservoirs of reinforced concrete (walls, columns and base) located at the Khartoum South DPS are planned to be completed by the end of this year. For their roofing, metal (zinc-coated steel, PVC-coated steel, stainless, aluminum, copper or other) plate as well as reinforced concrete are conceivable. As the use of light-weight metal is prerequisite condition for the design of the roof, similarly to existing other materials, the use of reinforced concrete has been deleted from the list of candidate materials. Corrugated aluminum plate has been selected after a comparative study of physical strength, durability, workability, economy and possibility of common use with other existing reservoirs (Mogren and Gamail: both similarly structured and using corrugated aluminum plate). The required quantity will be 3,600 m^2 in total.

This material is not standardized in Japan. Though production may be technically possible, custom making in Japan will be obviously costly. United Kingdom (U.K.) product, which have been previously delivered and interchangeable for the material and spare parts now being used, is therefore selected.

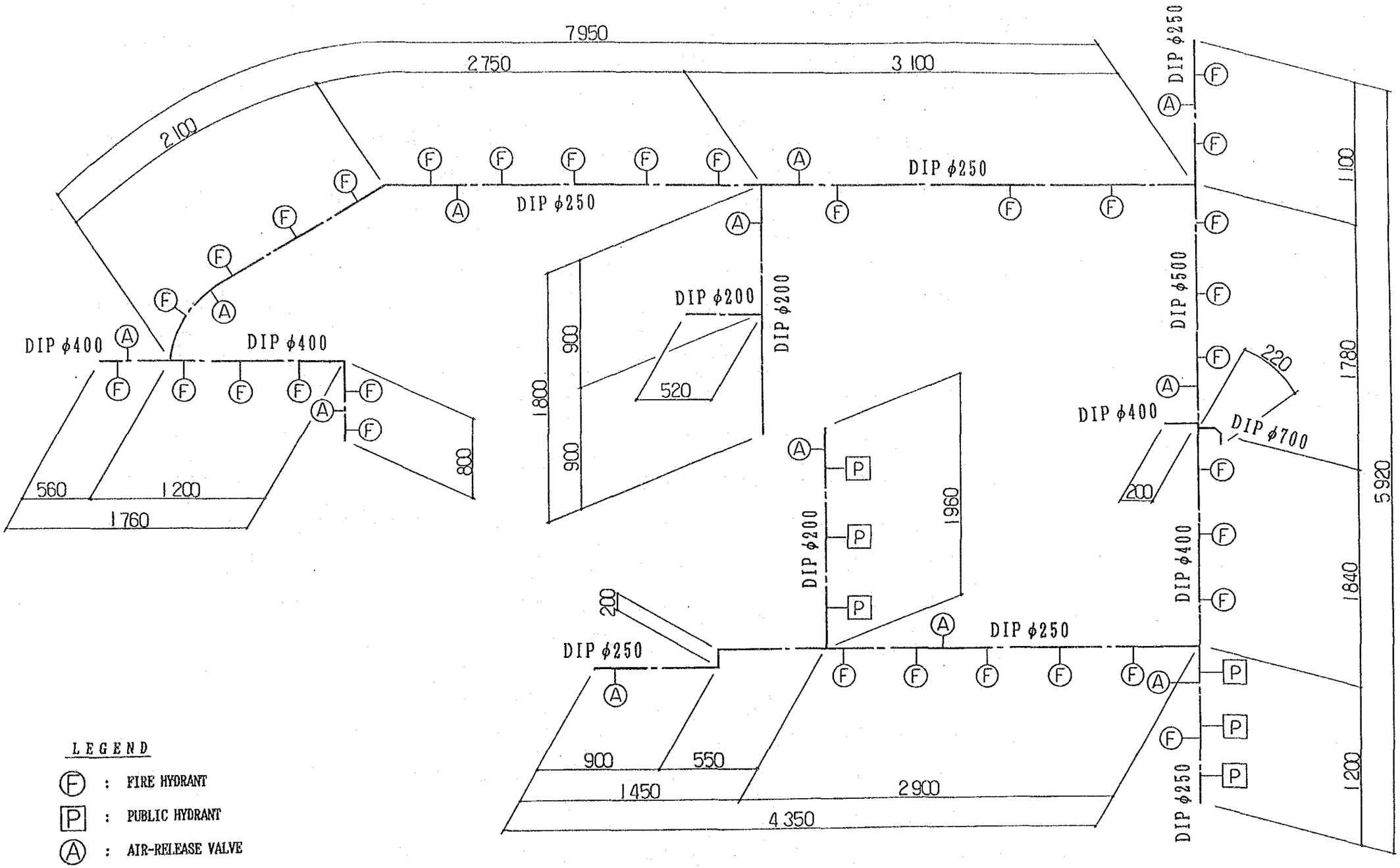


Fig.– 5.4 DETAILED PLAN OF PROPOSED DISTRIBUTION PIPELINES

c) Building Materials for Warehouse

The warehouse will be used to store NUWC's waterworks materials including gate valves, air valves, fire hydrants, pipe joints materials, various spare parts of construction machines, etc. Prefabricated building materials for package type building will be selected in the design. Physical strength, durability, workability, economy are comparatively studied and consequently, colored steel plates for roof and wall and formed steel for beams and columns will be selected for the package type building. Necessary quantity will be for 1,000 m^2 floor space.

5.3.3 Basic Design Drawings

Basic design drawings for the Project are presented in Appendix 2.

5.4 Construction Execution Plan

5.4.1 Principles of Executing Construction

The executing agency of the Sudanese side is the NUWC under the Ministry of Energy and Industry. After the Exchange of Notes (E/N) was agreed upon between the Japanese and Sudanese governments, Japanese consultant will contract a consultancy service for preparing detailed design drawings and tender documents with the Sudanese government. Based on the documents, the Sudanese government, assisted by Japanese consultant, will put the Project out to tender for general competitive bidding by the tenderers holding Japanese judicial status, to select a contractor. The Sudanese Government and the contractor selected by bidding will conclude a contract agreement. The construction is commenced then.

Based on the contract, the Japanese contractor will start construction after bringing in construction machines and materials, transported by sea and land, into the construction site. The pipelaying works will be carried out by local sub-contractors and laborers employed by the Japanese contractor, under appropriate guidance and supervision of the Japanese contractor, using two backhoes and a pickup truck, procured by the Project, in addition to the construction machines brought in on rental basis.

Regarding the executive setup of the agency, the Construction Section, the National Projects Management Department of the NUWC will be assigned to the execution, throughout the construction stage. After completion, the contractor will run pre-determined tests and, when no abnormality is recognized, the administration of the completed pipelines will be transferred from the Section to the Khartoum Area Office under the Section for future maintenance. Construction machines and vehicles procured by the Project will be repaired and inspected by the contractor after

the construction and handed over to the Machinery Section, the Operation and Maintenance Department, for further use. The roofing materials for reservoir and building materials for warehouse provided by the Project will be confirmed of acceptance by the Purchasing Section, the Supplies Administration Department and then, they will be installed and fabricated under management of the Construction Section, the National Projects Management Department.

5.4.2 Considerations in Executing Construction

a) Construction Market

Public works in the Sudan are at present generally carried out directly under public management or on a contract basis, or by combination of the two. The construction market is open to international participation, and, for example, MISR of Egypt is constructing the Khartoum South DPS and Daeu Co. of Korea is working on the pavement works of 500 km distance, a part of 1,000 km long road between Port Sudan and Khartoum. As construction contractors can start business only by reporting to the responsible agencies. It is not easy to evaluate the capability of contractors in their workability and fund-raising. Regarding technical workability for general construction, the local contractors' capabilities are at a manageable level.

b) Materials and Labor Cost

Shortage of construction materials like cement and iron bars has been acute since August 1990 and the prices have hiked rapidly. As the price hike is unsteady, a general rule is that quotation of materials can be valid only for the date of quotation. The situation hinders right estimation of construction cost. When a construction project needs sizable volume of materials, procuring goods of same brand and quality in the Sudanese market is extremely difficult. However, locally-produced sand, gravel and brick are procurable easily.

Rapid rise of living cost is accelerating the hike of the wage of construction workers, including engineers. No information regarding the wage increases has been published, but employers are paying fairly reasonable wage to workers, depending on necessity of skilled labors. Paying "incentive" allowance in addition to basic wage has been practiced generally.

It is reported that supply of light oil required for construction machines is in serious shortage in the country. Considering the situation, tremendous effort may be needed to obtain the required amount of light oil for such machines locally. In case supply of the local oil falls in difficult situation, special consideration including its provision externally would be necessary in order to attain the expected progress of the present Project as intended.

5.4.3 Construction Management Plan

The retained consultant shall carry out the detailed design and prepare the tender documents, as soon as possible after the Exchange of Notes. The consultant, based on them, assist the Sudanese government in tendering and selecting a Japanese contractor. During the construction stage, the consultant is to guide the contractor to exert its full capability. The scope of works in the detailed design and construction management is as follows:

a) Detailed Design

(1) Detailed design of pipelaying works of the distribution pipelines
(2) Specifications of the machines and materials to be procured
(3) Tendering

b) Construction Management

(1) Assistance of tendering and contracting
(2) Examination of drawings of machines and materials, proposed by the contractor
(3) Examination of construction plan proposed by the contractor
(4) Understanding progress of the works
(5) Solving technical problems related to the works
(6) Inspection of the quality and quantity of the completed works
(7) Attending tests
(8) Inspection and testing of the completed facilities
(9) Preparation of the monthly reports and completion report

For managing construction, assignment of a project manager and a pipeline engineer is proposed. Actually, except for a very busy period such as an inspection stage, continuous stationing of the pipeline engineer will be sufficient for the construction management.

5.4.4 Procurement Plan

a) Japanese Share of the Work

The machines and materials procured under the Project, except for the roofing materials procured in the third country, are to be procured in Japan within the planned period. Cranes, trucks and other machines for unloading and transporting the machines and materials to be procured under this project will be prepared locally. Regarding transportation from Port Sudan, the disembarkation port, to Khartoum, a detailed plan is to be prepared for discussion with the relevant agencies of the Sudan, as it is needed for shortening the transportation period.

b) Sudanese Share of the Work

All construction materials needed for the Sudanese portion of the work (installation of the roofing of the reservoirs and fabrication of the warehouse) are available locally.

5.4.5 Implementation Schedule

The Project, subject to the requirements of Japan's grant aid scheme, will be implemented in two phases. Commenced by signing of the E/N between the Japanese and the Sudanese Governments, the stages of implementation will imply: detailed design including preparation of drawings and tender documents; tendering and evaluation of bidding; contracting of the construction work; manufacturing of machines and materials; transportation of machines and materials by sea and land, and pipelaying and construction work. The whole implementation schedule is shown in Fig.5-5. The reservoir roofing and warehouse building materials will be scheduled to be procured in the first phase.

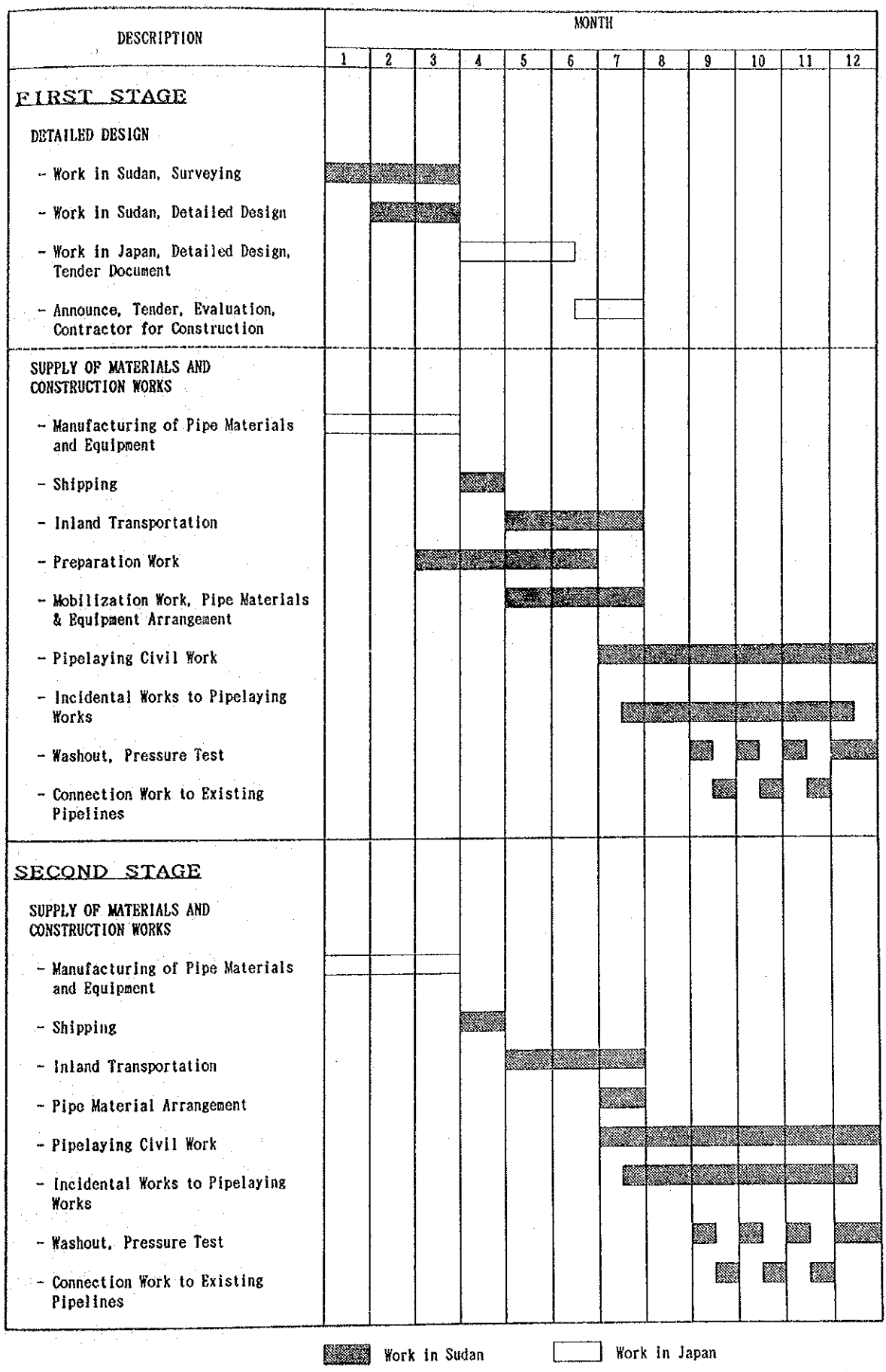
The total period from the contract to the completion will be 12 months for first and second phase each. The periods for manufacturing, marine transportation and inland transportation are estimated at three, one and three months respectively. The field construction period will be 6 months as shown in Table 5-4.

Table 5-4 Schedule for Pipelaying

Item	Phase I	Phase II
a) Pipelaying Work	Ø 400 mm, 2.56 km Ø 250 mm, 7.95 km	Ø 700 mm, 0.22 km Ø 500 mm, 1.78 km Ø 400 mm, 2.04 km Ø 250 mm, 6.85 km Ø 200 mm, 4.28 km
Total	10.51 km	15.17 km
b) Progress Scheduled for Pipelaying	2.2 km/month	2.9 km/month
c) Period Required for Pipelaying	4.8 months	5.2 months
d) Period Required for Flushing, Connection *	1.2 months	0.8 months
e) Construction Period	6 months	6 months
f) Total Period	12 months	

Note : * includes pressure test, disinfection and connection with existing pipes.

Fig.- 5.5 IMPLEMENTATION SCHEDULE



5.5 Scope of Work

The Scope of Work of the Project and the portions implemented by the Japanese side and the Sudanese side are shown in the following table.

Table 5-5 Scope of Work

Item	Supply of Materials and Equipment (by Japanese Side)	Construction Work (by Japanese)	Construction Work (by Sudanese)
1. Distribution Pipelaying Work	Ø 700/500/400/250/200 mm Total Length : 25.7 km	Pipelaying Ø 700/500/400 /250/200 mm Total Length : 25.7 km	-
2. Construction Machinery	1 Backhoe(0.6 – 0.7 m^3) 1 Backhoe(0.35 m^3) 1 Pickup Truck	-	-
3. Roofing Work	Corrugated Aluminum, with auxiliaries : 3,600 m^2	-	Installation : 3,600 m^2
4. Warehouse Work	Building Materials, Prefabricated Colored Steel with installation parts and auxiliaries : 1,000 m^2	-	Construction Work : 1,000 m^2

Estimated cost for the portion implemented by Sudanese side is as follows.
(Refer to Appendix 4.)

1) Installation Work of Roofing Materials : LS 390 thousand
2) Construction of Warehouse : LS 1,870 thousand

Total estimated cost born by the Sudanese side : LS 2,260 thousand

CHAPTER 6 BENEFITS AND CONCLUSIONS

6.1 Benefits of the Project

Direct and indirect benefits of the Project on various social and economic aspects are described below.

6.1.1 Direct Benefits

a) Increase in Water Served

To meet the rapidly increasing water demand of the Khartoum, the Khartoum North WTP, after completion of construction, will transmit a part (62,400 m^3/day) of its treated water to the Khartoum South DPS, which will distribute water to the Khartoum Area.

As the result, the Khartoum Area will receive water increased by 75 %. This increased supply of water will contribute to the improvement of demand-supply conditions remarkably in its southern part and to the enhancement of the water supply level throughout the Khartoum Area. Since the number of consumers in the Khartoum Area is estimated at about 600,000, average gross per capita water consumption will increase by 110 liters/day. This means the per capita water consumption of the Area will increase to 250 liters/day upon completion of the Project (140 liters/day at present), and this increase of water supply is expected to support social and economic activities of the Khartoum Area.

b) Increase in Population Served

It is expected that the Project will also increase the number of consumers. They will receive water from the distribution pipes newly installed under this Project, particularly through the public hydrants set up along the highway running east-to-west in the southern part of the Khartoum Area.

c) Increase in Water Pressure

Thanks to the improvement of distribution networks planned by this Project, water pressure, in addition to water supply quantity, will be increased throughout the service area as shown in Table 5-3. This increase of water supply pressure will necessarily prevent negative pressures in the distribution system, and thus prevent the infiltration of wastewater into the pipes. As a result, the Project will improve water quality of the system.

6.1.2 Indirect Benefits

a) Decrease of Epidemic Diseases

Expansion of water supply is known to be effective to decrease not only water-borne epidemic diseases but also other type of diseases such as trachoma. This is widely known as Mills-Reincke phenomenon, which is the coincidence between the improvement in the quality of water supply and a lowering in the death rate in a community from diseases not thought to be directly waterborne. It has actually been reported that a decrease of waterborne diseases has been brought about as an effect of the increase of per capita water consumption, although accurate data concerning the rate of epidemic diseases to the extension of water supply in the Metropolitan Area or the Khartoum Area is not available.

b) Decreases of Fire Losses

This project will make it possible to maintain enough water supply pressure as well as quantity, and help curtail the amount of fire losses.

c) Effect to Social and Economic Activities

The improvement of water supply conditions is expected to give favorable effects to social and economic activities of the Khartoum Area, especially to its southern part where water supply conditions are critical at present. The Khartoum Area at its northern part is a center of commercial, institutional and educational activities. Governmental offices and universities are located in this area, and at its western part, the important industrial estate is located. The Project therefore will contribute not only to social stability and improvement of welfare, but also to acceleration of the economic activities for the Metropolitan Area by supplying potable water to citizens and industrial water to factories in good quality and quantity.

6.2 Conclusions and Recommendations

6.2.1 Suitability of the Project

Based on the programs proposed in the Khartoum Area Water Supply Project (Master Plan) established in 1979, the NUWC has hitherto drafted necessary improvement plans and carried them out to solve the rapidly increasing water demands.

The Project is required to be implemented in line with the above Master Plan to improve water

supply conditions, especially in the southern part of the Khartoum Area. The Project will thus keep pace with the construction of the Khartoum North WTP, the Khartoum South DPS and the treated water transmission pipeline which connect these facilities.

The NUWC, as the executing agency, has implemented a number of projects to improve water supply in the Metropolitan Area and other local cities, with the technical and economical assistance by foreign countries including Japanese Government grant aid for the Omdurman Area Water Supply Project. On top of these experience, the NUWC has received the intensive guidance in both administrative and technical aspects during the course of the project implementation.

Judging from the above experiences, the NUWC will be well qualified in technical and administrative aspects to conduct this Project and to maintain the completed facilities.

a) Operation and Maintenance

The maintenance and administration of equipment and facilities of the NUWC are not necessarily effective nor satisfactory due to the shortage of spare parts and administrative engineers. Taking these conditions into account and for better management, the following measures are planned in this Project.

For lack of necessary pipe repairing machinery
: Procurement of construction machinery

For lack of transportation and communication media
: Procurement of a pickup truck

For shortage of spare parts for construction machinery
: Procurement of necessary spare parts

For shortage of storing places : Procurement of warehouse materials

For lack of repair shops : Procurement of warehouse materials

The above machinery and materials to be procured will be administered by respective departments concerned of the NUWC and be used for effective management and administration. The engineers and technicians engaging in management and administration will be given on-the-job training while the Project is being executed. It is judged therefore that the equipment procured will be utilized and managed effectively by the NUWC.

b) Financial Aspects

Besides the direct and indirect benefits mentioned in previous section, the treated water of 62,400 m^3/day in day-maximum capacity (54,000 m^3/day: day-average capacity) will be supplied from the Khartoum North WTP to the project area. The financial effects of the water supplied to

the Areas will be considered as follows. The rate of accounted for water is assumed to be 65%, and the percentages of water uses and their unit prices assumed to be the same as those of the total average of the metropolitan areas.

Under the above assumptions, 65% of 54,000 m^3/day (day-average) of water transmitted from the Khartoum North WTP will be effective. Revenue accrued from the water will be estimated in the following as the proportions of water are 65 %, 20 % and 15 % for domestic, commercial and industrial, and public uses respectively.

Accounted for water :

Total	: 54,000 m^3/day	x	65%	=	35,100 m^3/day
Domestic	: 35,100 m^3/day	x	65%	=	22,800 m^3/day
Commercial & Industrial	: 35,100 m^3/day	x	20%	=	7,000 m^3/day
(Public	: 35,100 m^3/day	x	15%	=	5,300 m^3/day)

Water rate applicable

Domestic	: 22,800 m^3/day x 30 day x 12 months x LS 2.5 = LS 20.5 million
Commercial & Industrial	: 7,000 m^3/day x 30 day x 12 months x LS 8.0 = LS 20.2 million
Total	LS 40.7 million

The total budget expenditure of the Metropolitan Area for fiscal 1990/91 is, as shown in Table 4-1, LS 105 million. The equivalent amount of budget expenditure payable to the Khartoum Area can be calculated with the populations proportions. The following is a result of calculation with the population proportion of the Khartoum Area assumed at 31 %.

Assumed annual expenditure for the Khartoum Area : LS 105.4 x 31% = LS 32.7 million

In this connection, we have to calculate the portion of the expenditure corresponding to the water supply of 54,000 m^3/day (daily average) to be newly introduced by this Project. The rate of this water volume to the average water supply of 83,000 m^3/day is assumed to be about 65%. On the assumption that expenditure varies in proportion of the supply of produced water, the expenditure corresponding to the water supply to be newly introduced by this project is calculated as follows.

Expenditure for water supply to be newly introduced : LS 32.7 x 65% = LS 21.3 million

This amount of expenditure for the increase of water, i.e., LS 21.3 million is less than the assumed revenue of LS 40.7 million from the water to be introduced by the Project. This assumption indicates that the revenue to be introduced by the project will be more than the incremental expenditure, demonstrating the feasibility of the Project.

6.2.2 Recommendations

The Sudanese Government is required to facilitate the implementation of the on-going projects which include the Khartoum North WTP, which is scheduled to be completed at the end of 1992, and the Khartoum South DPS, which is scheduled to be completed in October 1991, and the transmission pipelines to connect with the above facilities to realize the effect of the installation of the distribution pipelines under this Project. Especially the construction of transmission pipeline is urgent. This Project will be required to be given a top priority for implementation among other planned national projects as expressed in the letter by the NUWC (See Appendix 1). With regard to the transmission pipeline between the above WTP and DPS, a part of pipe materials (SP, diameter 600 mm, Length: 4.5 km and diameter 500 mm, Length: 2.5 km) are already in the storage yard in Khartoum.

The following considerations are required to be paid to the maintenance and administration of the equipment introduced by the Project and also to the post-Project planning.

a) Record Keeping

Upon completion of the Project, information on distribution pipelines shall be recorded and kept for future maintenance. These information, based on the as-built drawings, will include pipeline maps indicating detailed pipeline alignment of them and necessary data such as date of installation, diameters, materials, length, location of valves and other appurtenances with their locations and structures.

b) Training of NUWC Staff Members

Training of the staff members is one of the important tasks for the NUWC. The technical ability of the senior staff members is found to be at a considerably high level. Large differences are seen between the levels of the senior and junior staff members. In the aspects of operation and maintenance of the existing facilities, for example, it is observed that subordinated staff does not necessarily comply with the senior staff's instructions. Training of middle class and technical staff members is essential to efficient operation of water supply. Training for these staff members must be planned and executed carefully and systematically.

c) Allocation of Necessary Budgets for Procurement of Spare Parts

Periodical procurement of spare parts is essential to efficient operation of the facilities. Priority should be placed in allocating budgets needed for such procurement. The following spare parts or spare units and tools are considered necessary to maintain the facilities for sound operation.

i) Spare Parts for Pipelines

- pipe for repair
- pipe cutter
- joints and couplings
- gland packings and rings for valves
- packings for pipe joint

ii) Spare Parts for WTP and Pump Station

- treatment facilities; drive units of mixers, solenoid valves for desludging of clariflocculator, and control apparatus or valves for filter
- chemical dosage equipment; mixers for chemical solution, chemical feeding apparatus or pumps
- pumps and mechanical equipment; impellers, packings, gaskets, bearings, seals, etc. and tools for maintenance
- electric equipment and instrumentation; breakers, relays, switches, meters (watt-hour, ampere, volt), water level meters, transmitter for flow meters, indicators, recorders, signal bulbs, alarm and tools for maintenance
- water quality analysis, color comparemeter, glass wares, chemicals and regents

d) Review of Water Supply Master Plan

As more than ten years have passed since the establishment of the existing Master Plan, it is required to be revised to meet the present situation. Revision will be made by paying attention to all related aspects to remold it into a new long-term master plan. New treatment plants and pipelines will be planned and constructed in compliance with the master plan thus established.

APPENDICES

Appendix - 1

App 1.1 Organization of the Study Team
App 1.2 Field Activities of the Study Team
App 1.3 Main Officials Discussed with the Study Team
App 1.4 Minutes of Discussions
App 1.5 List of Collected Data
App 1.6 Letter of NUWC

Appendix - 2

App 2.1 Basic Design Drawings

Appendix - 3

App 3.1 NUWC Operation Budget for Khartoum
App 3.2 NUWC Balance Sheet
App 3.3 NUWC Water Charges
App 3.4 Analyses of Raw and Treated Water Qualities

Appendix - 4

App 4.1 Cost Estimate for Construction Work by Sudanese Side

Appendix - 1

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. Akihiko MORITA Team Leader	Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs
2.	Mr. Hiroshi MACHIDA Water Supply Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
3.	Mr. Takayuki NIIKURA Pipeline Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
4.	Mr. Kazuhisa KOSAKA Machinery and Material Planning	Overseas Services Department, Nihon Suido Consultants Co., Ltd.
5.	Mr. Masami OGURA Cost Estimation	Overseas Services Department, Nihon Suido Consultants Co., Ltd.

App 1.2 Field Activities of the Study Team

No.	Date (1991)	Activity
1	Apr 17 (Wed)	Departure of Team members from Narita
2	Apr 18 (Thu)	Arrival at Khartoum
3	Apr 19 (Fri)	Field Reconnaissance
4	Apr 20 (Sat)	Visit to JICA and meeting Visit to NUWC
5	Apr 21 (Sun)	Visit to Japanese Embassy Arrangement of the schedule at NUWC
6	Apr 22 (Mon)	Explanation and discussion of Inception Report at NUWC
7	Apr 23 (Tue)	Discussion of Inception Report Field Reconnaissance
8	Apr 24 (Wed)	Discussion at Ministry of Finance and Economic Planning (MFEP) Finalized Minutes of Discussion with Ministry of Finance and Economic Planning, NUWC
9	Apr 25 (Thu)	Team Leader departure From Khartoum Data collection at NUWC
10	Apr 26 (Fri)	Field Reconnaissance of pipelines
11	Apr 27 (Sat)	Data collection at Khartoum Office
12	Apr 28 (Sun)	Data collection at MFEP, NUWC
13	Apr 29 (Mon)	Data collection at Department of Statistics Field Reconnaissance of pipelines
14	Apr 30 (Tue)	Data collection at Khartoum Office Field Reconnaissance of pipelines
15	May 1 (Wed)	Data collection at MFEP,NUWC Arrangement of the survey schedule
16	May 2 (Thu)	Field Reconnaissance of pipelines Arrangement of the Surveying schedule and working schedule
17	May 3 (Fri)	Field Reconnaissance of pipelines and Surveying Data collection at NUWC
18	May 4 (Sat)	Field Reconnaissance of pipelines and Surveying Study and analysis of the collected data
19	May 5 (Sun)	Field Reconnaissance of pipelines and Surveying
20	May 6 (Mon)	Field Reconnaissance of pipelines and Surveying Data collection at Department of Statistics
21	May 7 (Tue)	Field Reconnaissance of pipelines and Surveying Data collection at MFEP, NUWC
22	May 8 (Wed)	Field Reconnaissance of pipelines and Surveying Data collection at Khartoum Office
23	May 9 (Thu)	Field Reconnaissance of pipelines and Surveying Data collection at Department of Statistics
24	May 10 (Fri)	Field Reconnaissance of pipelines and Surveying Study and analysis of the collected data
25	May 11 (Sat)	Field Reconnaissance of pipelines and Surveying Data collection at MFEP, NUWC
26	May 12 (Sun)	Field Reconnaissance of pipelines and Surveying Data collection at Khartoum Office
27	May 13 (Mon)	Study of the collected data
28	May 14 (Tue)	Departure from Khartoum
29	May 15 (Wed)	↓
30	May 16 (Thu)	Arrival Narita

App 1.3 Main Officials Discussed with the Study Team

Ministry of Finance and Economic Planning	Undersecretary	Mr. Mohamed Kheir Eitubear
	Secretary	Mr. Osman H.M. Elamin
	Director	Mr. Hshim Mohamed Zain
NUWC	Director General	Mr. Farouk El Tayeb
	Director	Mr. Sidding El Mustafa
	Director	Mr. Mohamed Hassan Ammar
	Staff of Planning Section	Mr. Burahan Ahmed El M.
Embassy of Japan	Ambassador	Mr. Daizan Araki
	First Secretary	Mr. Masaru Dekiba
JICA Sudan Office	President Representative of Sudan Office	Mr. Masao Tsujioka
	Coordinator	Mr. Tomoyuki Sudoh

App 1.4 Minutes of Discussions

MINUTES OF DISCUSSIONS
THE BASIC DESIGN STUDY ON THE IMMEDIATE IMPROVEMENT PROJECT FOR KHARTOUM AREA DISTRIBUTION SYSTEM OF GREATER KHARTOUM METROPOLITAN WATER SUPPLY SYSTEM 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 THE KHARTOUM AREA DISTRIBUTION SYSTEM (hereinafter referred to as "the Project"), and the Japan International Cooperation Agency (JICA) sent the study team, headed by Mr. Akihiko Morita, Grant Aid Division, Economic Cooperation Bureau, Ministry of Foreign Affairs, from April 17th to May 16th, 1991.

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

As a result of the discussions and field survey, both parties confirmed the main items described on the attached sheets. The team will proceed to the works and prepare the Basic Design Study Report.

Khartoum, 24 April 1991

Mr. Akihiko Morita
Team Leader of
Basic Design Study Team,
JICA

Mr. Siddig El Abbas
Mustafa
Director of National
Projects, NUWC

Mr. Hashim Mohamed Zain
Assistant Undersecretary
Project Loans & Grants, MFEP

ATTACHMENT

1. Objective

The objective of the project is to provide access to basic water supply through the improved and reinforced distribution pipeline system from the present water production facilities, which are also capable to distribute increased production from the Khartoum North Treatment Plant through Khartoum South High Lift Pumping Station (which construction works are in progress and are scheduled to complete in 1992) in the southern part of the Khartoum area, and further to improve living standard of the inhabitants in the served area.

2. Project Areas

The project areas are Khartoum area as a part of the Greater Khartoum Metropolitan as shown in Attached Sheet.

3. Executing Agency

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

4. Necessary Items for the Realization of the Project Requested by the Government of the Sudan

After discussion with the Basic Design Study Team, the following items were judged necessary for the realization of the project.

(1) Construction Works (Distribution pipeline installation works)

To supply ductile iron pipes in total length of about 25.2 km including pipes, fittings, appurtenances and valves and to construct

distribution pipelines by utilizing these materials supplied as follows:

Ø500	x	1.7 km
Ø400	x	4.6 km
Ø250	x	15.8 km
Ø200	x	3.1 km
Total length		25.2 km

(2) Supply of Machinery and Materials;

a) To supply Construction Machinery with adequate amount of spare parts

- Backhoe (0.6-0.7 m^3) : 1 unit
- Backhoe (with blade, 0.35 m^3) : 1 unit
- Pick-up (double cabin) : 1 unit

b) To supply Roofing Materials for Reservoir (at Khartoum South High Lift Pumping Station)
Aluminium Roofing Sheets : 3,600 m^2

c) To supply Materials for total space of storage warehouse of : 1,000 m^2

(3) Provision of consulting services for implementation of the Project:

To provide services for Detail Design and construction supervision for construction period of the distribution pipeline system.

However, the final components of the Project may differ from the above items, if it is judged necessary after further studies in Japan.

5. Grant Aid System Extended by the Government of Japan

(1) The Government of the Sudan has fully understood the system of

Japanese Grant Aid explained by the Team.

(2) The Government of Sudan will take necessary measures described in Annex 2 for smooth implementation of the Project, on condition that the Grant Aid Assistance by the Government of Japan is extended to the Project.

6. Schedule of the Study

Based on the Minutes of Discussion and technical examination of the study results, JICA will complete the Final Report and send it to the Government of the Sudan on September, 1991.

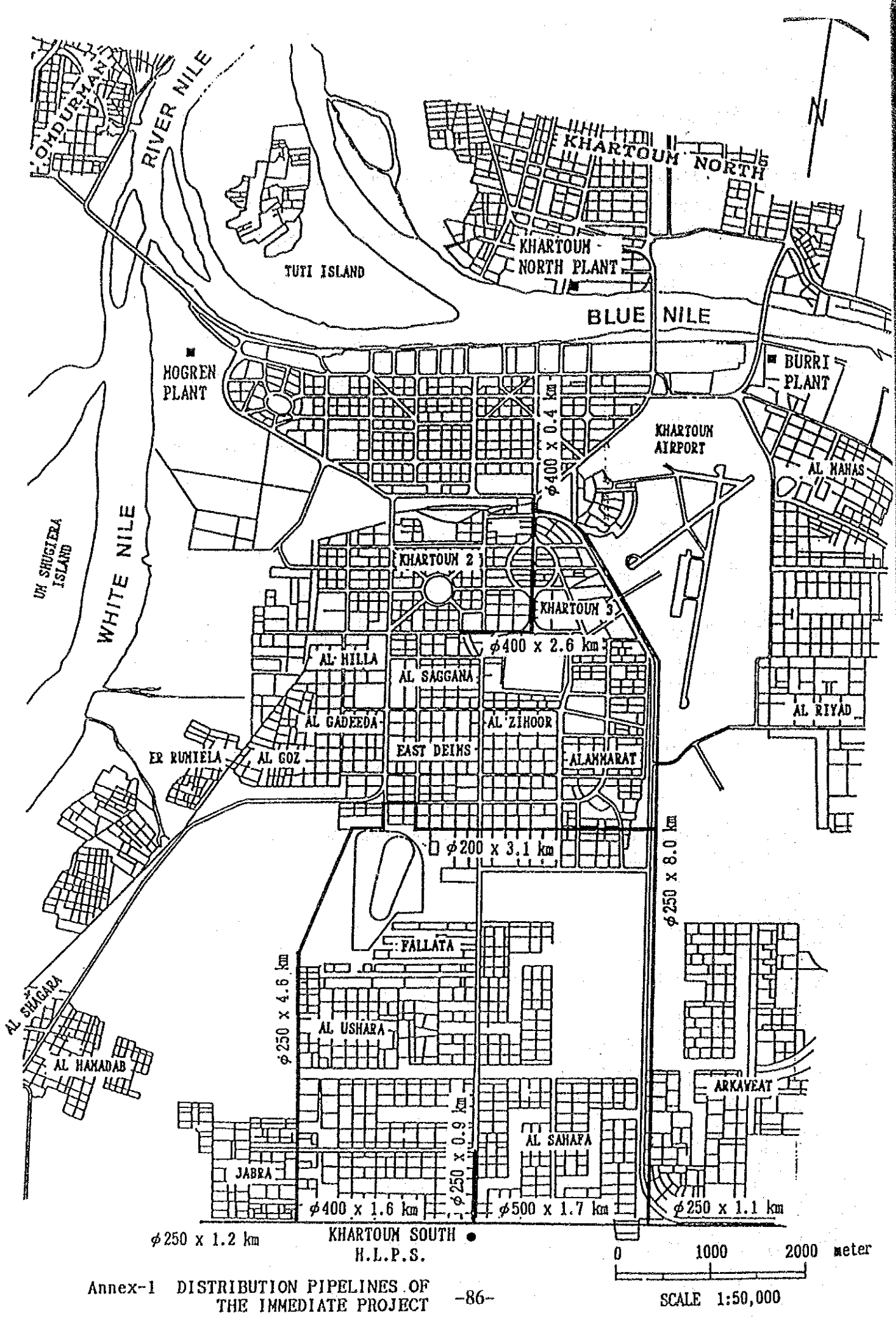
7. Schedule of the Construction Works

NUWC agreed to complete all of the works stated below until the described period, and NUWC committed themselves to completing the works as follows :

(1) Khartoum North Treatment Plant construction works (Stage III & IV - 108,000 m^3/day) will be completed until the end of 1992.

(2) Transmission Pipeline installation works (Ø600-Ø700 x 13.8 km) will be completed until February 1992.

(3) Khartoum South High-Lift Pumping Station construction works will be completed until October 1991.



Annex-1 DISTRIBUTION PIPELINES OF THE IMMEDIATE PROJECT

Annex-2

UNDERTAKINGS TO BE TAKEN BY THE SUDANESE SIDE

1. To secure, clear and level the site for pipe laying prior to the works, where the site is occupied illegally.

2. 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 shall be assisted for the Project execution.

3. To exempt the 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.

4. To offer Japanese nationals whose services may be required in connection with the supply of the products and the services under the contract such adequate supports as may be necessary for their entry into Sudan and stay therein for the performance of the their works.

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

6. To bear all the expenses necessary, other than those covered by the Grant, necessary for the present Project.

7. The Sudanese side agree to provide the pipe storage yards for the construction works in the Khartoum area in at least two (2) sites of each one (1) ha in size.

8. The Sudanese side will install the roofing materials supplied by Japanese side for reservoirs at the Khartoum South High Lift Pumping Station.

9. The Sudanese side will utilize the storage materials supplied by

Japanese side and construct storage/warehouse at the premises of Khartoum South High Lift Puming Station.

10. The supplied construction machinery shown in the item 4-(2)-a) above shall be exclusively used for the distribution pipeline installation works carried out by the Japanese side, and the said machinery shall be handed over to the Sudanese side after the completion of the construction works.

11. The Sudanese side agreed to set up a particular implementation unit and to allocate specific budget for expenses, not borned by the Grant, to carry out the Project.

12. The Sudanese side promised that the necessary license for importing enough fuel shall be given to the Japanese side, as stated in the attached Annex-5.

    All customs, duties and taxes originating from the import shall be borne by the Sudanese side.

Annex-3 COPY OF THE LETTER FROM NUWC

بسم الله الرحمن الرحيم

Republic of the Sudan

جمهورية السودان

الهيئة القومية لمياه المدن

NATIONAL URBAN WATER CORPORATION

Our Ref bl/A/3814/98

Your Ref. _____

Date 22.4.1991

اشارتنا _____

اشارتكم _____

التاريخ _____

NATIONAL URBAN WATER CORPORATION
22 APR 1991
HEAD QUARTERS

Japan International Cooperation Agency
Att. Mr. Akihiko Morita
Team Leader,
Basic Design Study Team

Dear Sirs,

We herewith confirm that the following works related to the Immediate Improvement Project for Khartoum Area Distribution System shall be completed by the periods mentioned below.

1) Khartoum North Treatment Plant construction works (Stage III& IV - 108,000 m^3/day) will be completed by the end of 1992.

2) Transmission Pipeline installation works (Ø700-Ø600 x13.8 km) will be completed by February 1992.

3) Khartoum South High-Lift Pumping Station Construction works will be completed by October 1991.

We appreciate your consideration and actions you may take.

Sincerely your's

Siddig El Abbas Mustafa
Director of National
Projects, NUWC

Nagwa*

١٢ب ـ شارع الجمهورية ص.ب ٣١٠ الخرطوم تلغرافيا: مياه الخرطوم تلكس ٢٢٢٣٠ الخرطوم تلفونات ٨٠٧٨٧/ ٨١٣٤٠

13 P. Gamhuria Avenue. P.O Box 310 Khartoum, Telg. Water Khartoum, Telex: 22230 Nuwc Tele: 80787/ 81340

Annex-4 COPY OF THE LETTER FROM MFEP

جمهورية السودان
THE REPUBLIC OF THE SUDAN
وزارة المالية والتخطيط الاقتصادي
Ministry of Finance and Economic Planning
ECONOMIC PLANNING
P.O. Box 2092, KHARTOUM
Cable : (EIMAR)
TELEX : 324
Tel. 77004
التخطيط الاقتصادي
ص.ب ٢٠٩٢ ـ الخرطوم
تلغرافيا : (اعمار)
تلكس : ٣٢٤
تليفون : ٧٧٠٠٤

Khartoum : .....
Ref : .....
Date: 22.4.1991

الخرطوم في : .....
الاشارة : .....
المرفق : .....

Japan International Cooperation Agency
Att. Mr. Akihiko Morita
Team Leader,
Basic Design Study Team

Dear Sirs,

We herewith confirm that all necessary arrangements consisting of local and foreign currencies shall be carried out to make them complete the following works by the periods mentioned below:-

1) Khartoum North Treatment Plant construction works (Stage III & IV - 108,000 m^3/day) will be completed by the end of 1992.

2) Transmission Pipeline installation works (Ø700-Ø600x13.8 km) will be completed by February 1992.

3) Khartoum South High Lift Pumping Station construction works will be completed by October 1991.

We appreciate your consideration and actions you may take.

Sincerely your's,

Kamal Idris Kambalawy
Head of water section

Annex-5 COPY OF THE LETTER FROM MES&M

جمهورية السودان
وزارة الطاقة والتعدين
Republic of the Sudan
Ministry of Energy and Mining

المؤسسة العامة للبترول
General Petroleum Corporation.

Japan International Corporation Agency

Att: Mr. Akihiko Morika

Team Leader

Basic design system team.

Sub: Supply of Fuel and Lubricants for the construction works of immediate improvement for Khartoum area distribution system

We hereby confirm that G.P.C. has no objection to approve the import licence necessary for importation of fuels and lubricants needed for the above project.

Sincerely yours,

Hamad EL Neel A/Gadir

For/ G.M. G.P.C.

Copy to:.

Director of National Projects N.U.W.C

تليفونات: ٧٩١٨٨ - ٧٩٢٦٦ - ٧٩١٩٢ - ٧٦٦٠٩ تلكس ٢٢٦٣٨ جيبتكو - تلغرافيا: بترسودان صندوق بريد: ٢٩٨١ الخرطوم
Tel: 79188, 79366 75893, 76709. Tlx. 22438 GEPETCO Kan Cable PETROSUDAN P.O. Box 2986, Khartoum Sudan

App 1.5 List of Collected Data

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

Category : Design Drawings

Source : NUWC

Contents : Dwgs. related to Khartoum South High Lift Pump Station

1) Structural Dwg. of Treated Water Reservoir
(KH. S. W. W. 15) S=1/25~1/10
EL GAMEIR NEW WATER WORKS, TREATED WATER RESERVOIR

2) Structural Dwg. of Treated Water Reservoir
(KH. S. W. W. 1) S=1/100
EL GAMEIR NEW WATER WORKS, TREATED WATER RESERVOIR

3) General Plan of Khartoum South High Lift Pump Station
(KH. SOUTH W/W. GENERAL SITE PLAN), S=1/500

4) Structural Dwg. of Water Tower, (KH. S. W.W. 26), S=1/50
WATER TOWER DETAIL

Category : Design Drawings

Source : NUWC

Contents : Dwgs. related to Rehabilitation of Central Khartoum Water Supply

1) EXISTING PIPES &VALVES LAYOUT

2) PLANS (Which shows location of Conn. point with Ø400mm DCIP)

3) OTHER DETAILS, Such as Plan of Conn. point, Detailed Pipe Arrangement, Profit of Conn. Point, etc.

Category : MAP

Source : Department of Survey, Ministry of Defense

Contents : Plan of Khartoum Area S=1/5,000

Category : Report on Socioeconomics

Source : Go. of Sudan (Min. of Finance and Economic Planning)

Contents : THE FOUR YEAR SALVATION RECOVERY AND DEVELOPMENT PROGRAMME. 1988 / 89 - 1991 / 92
Report on Recent Economic Development, Medium - Term Development Framework, Macro Economic Projections on Government Recurrent Budget & Balance of Payment, etc.

Category : Report on Socio economics

Source : Go. of Sudan (Min of Finance and Economic Planning)

Contents : BANK OF SUDAN (30TH) ANNUAL REPORT
Summary of Developments in the Sudan in 1989 and the Outlook for the future, National Income, Agricultural & Industrial Production, Government Finance, Economic Development Plans and Projects, Foreign Trade, etc.

Category : Report on Socioeconomic

Source : The Economic Intelligent Unit Ltd.

Contents : Sudan, Country Profile 1990 - 1991
Annual Survey of Political and Economic Background.

Category : DEVELOPMENT OF PRICE INDICES (TABLE)

Source : Min. of Finance & Economic Planning

Contents : Table which shows the development of average price indices for high and low income groups from year 1980 through 1989.

Category : COST OF LIVING INDEX IN KHARTOUM AREA 1988 - 1990 (TABLE)

Source : Min. of Finance & Economic Planning

Contents : Table which shows the cost of living index for higher, medium & lower salaried groups in the KHARTOUM AREA from year 1988 through 1990

App 1.6 Letter of NUWC

بسم الله الرحمن الرحيم

Republic of the Sudan

جمهورية السودان

الهيئة القومية لمياه المدن

NATIONAL URBAN WATER CORPORATION

NATIONAL URBAN WATER CORPORATION
12 MAY 1991
HEAD QUARTERS

Our Ref 13/12/6/3008
Your Ref. _____
Date 9.5.1991

_____ اشارتنا
_____ اشارتكم
_____ التاريخ

Japan International Cooperation Agency

Att: Mr. Akihiks Morita

Dear Sirs,

Re:- Transmission Pipeline System
between Khartoum North Treatment &
Khartoum South High-Lift Pump Station
in Sahafa

It is our great pleasure to inform you that, concerning the captioned transmission pipeline system, it was confirmed by Ministries concerned that all arrangements of pipe materials & implementation works shall finaly be realized as the highest priority project among other national projects under the assurance of the full supports from Ministry of Finance and Economic Planning together with Ministry of Energy and Mining.

We, therefore, confirm that the said Transmission Pipeline System is to be completed by the end of 1992 calender year as scheduled with all endevours of Ministries concerned .

We appreciate your consideration and arrangement.

Sincerely Your's

Farouk Eltyeb Ali Sawi
Director General NUWC.

CC:

Minister of Finance

Minister of Energy & Mining

١٢ب ـ شارع الجمهورية ص.ب ٣١٠ الخرطوم تلغرافيا: مياه الخرطوم تلكس ٢٢٢٣٠ الخرطوم تلفونات ٨١٣٤٠/٨٠٧٨٧

13 B, Gamhuria Avenue. P.O Box 310 Khartoum, Telg. Water Khartoum, Telex: 22230 Nuwc Tele: 80787/ 81340

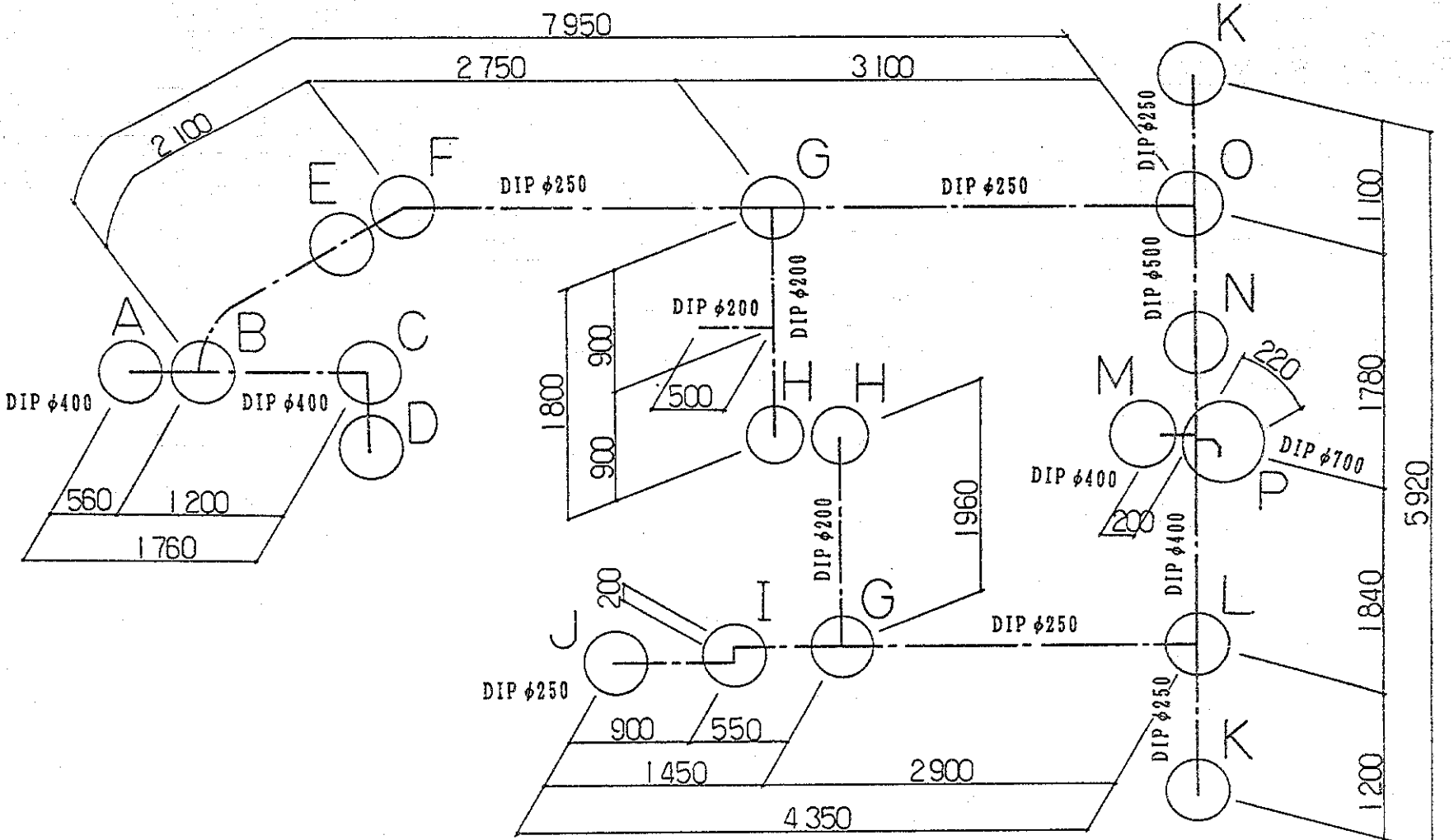
Appendix-2

App 2.1 Basic Design Drawings

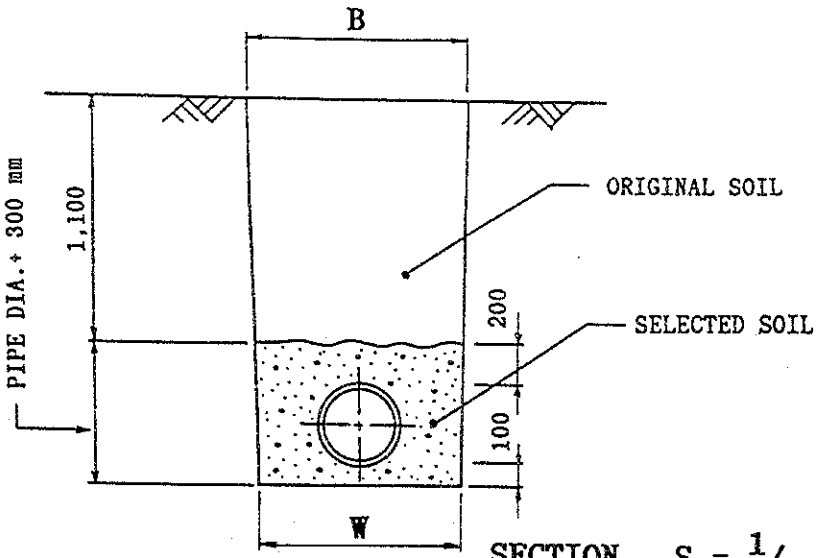
Appendix-2

App 2.1 Basic Design Drawings

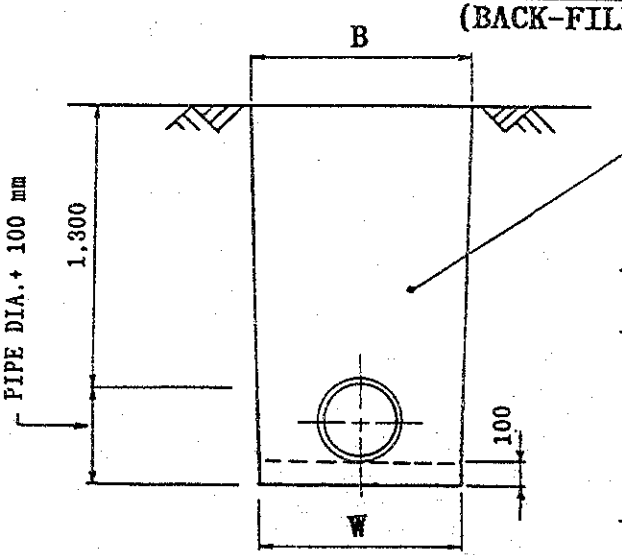
No. 1 Key Map, Distribution Pipelines
No. 2 Standard Design of Air-Release Valve Box & Pipeline Trench
No. 3 Standard Design of Stop Valve Box & Fire Hydrant Box
No. 4 Standard Design of Public Hydrant
No. 5 Standard Detail of Roofing Structure
No. 6 Standard Detail of Warehouse
No. 7 Detail of Pipe Fittings
No. 8 Detail of Pipe Fittings
No. 9 Detail of Pipe Fittings
No.10 Detail of Pipe Fittings
No.11 Detail of Pipe Fittings
No.12 Detail of Pipe Fittings
No.13 Detail of Pipe Fittings
No.14 Detail of Pipe Fittings
No.15 Detail of Pipe Fittings
No.16 Detail of Pipe Fittings



KEY MAP
DISTRIBUTION PIPELINES
DRAWING NO. 1
KHARTOUM WATER SUPPLY



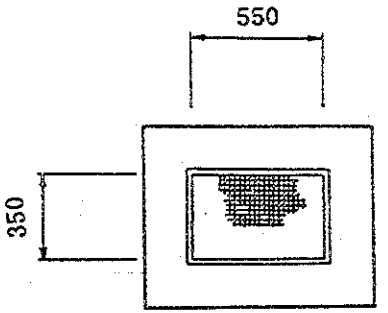
SECTION (BACK-FILL) S = 1/30



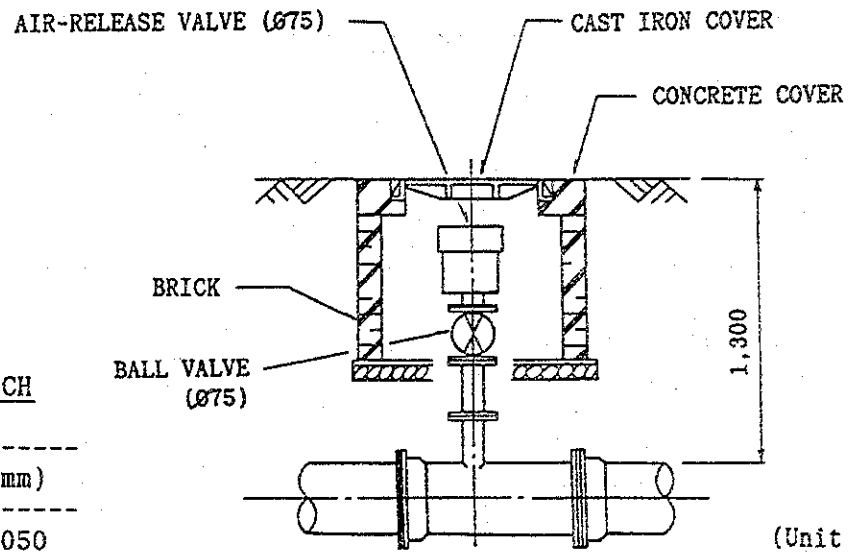
SECTION (EXCAVATION) S = 1/30

DIMENSION OF TRENCH

D(mm)	B(mm)	W(mm)
200	1,150	1,050
250	1,150	1,050
400	1,423	1,250
500	1,433	1,250
700	1,803	1,600



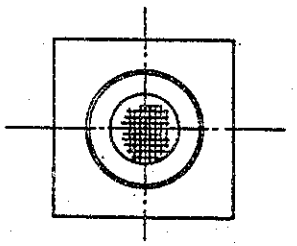
PLAN S = 1/30



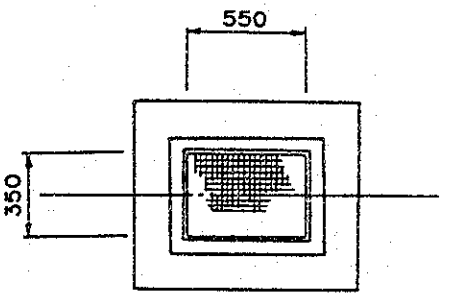
(Unit : mm)

SECTION S = 1/30

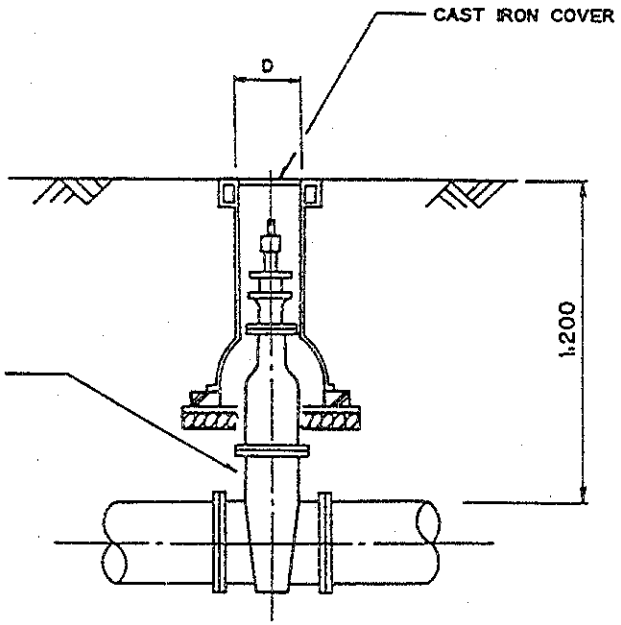
STANDARD DESIGN OF AIR-RELEASE VALVE BOX & PIPELAYING TRENCH
DRAWING NO. 2
KHARTOUM WATER SUPPLY



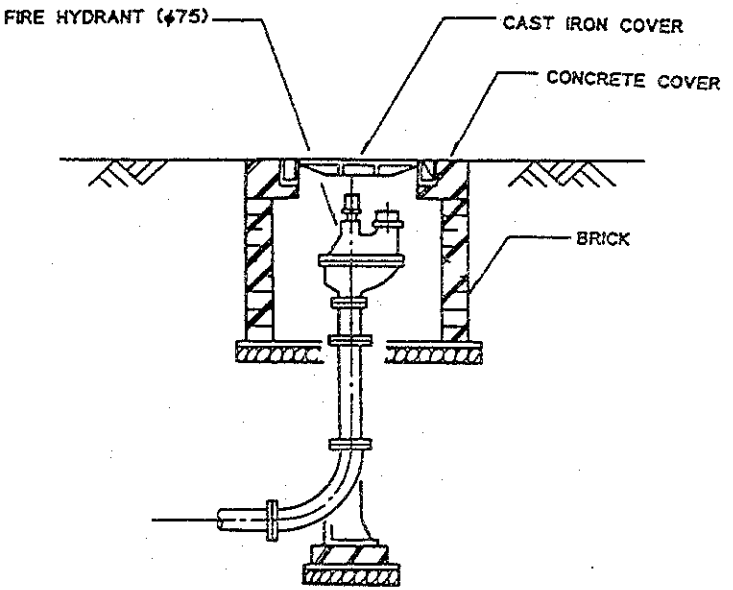
PLAN



PLAN



SECTION S = $^{1}/_{30}$

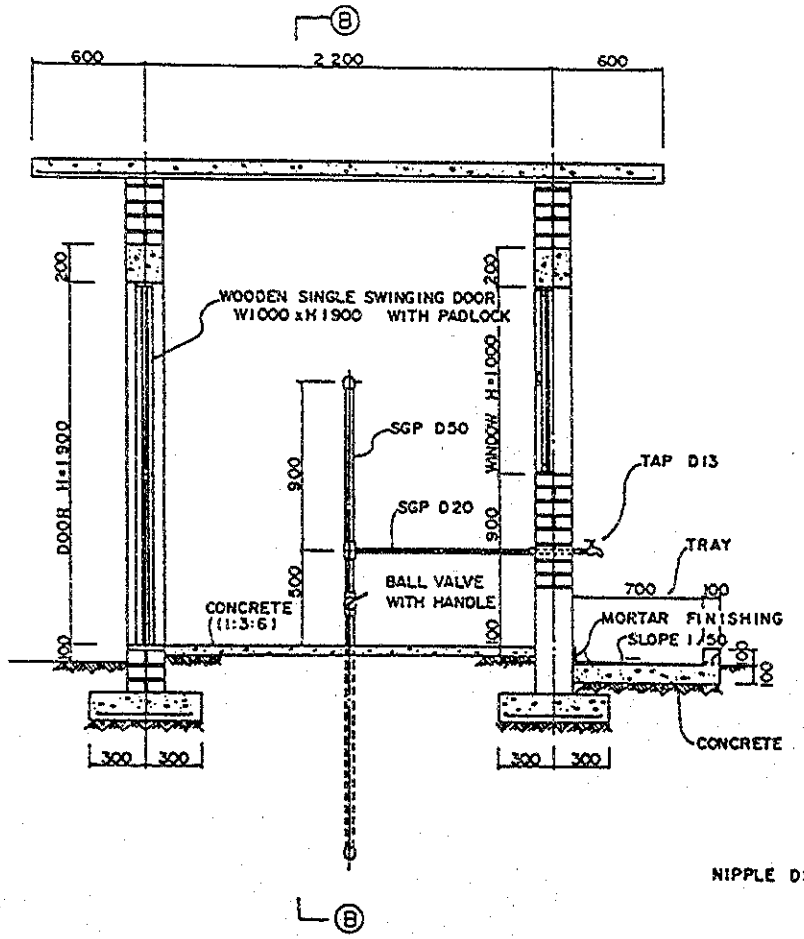


SECTION

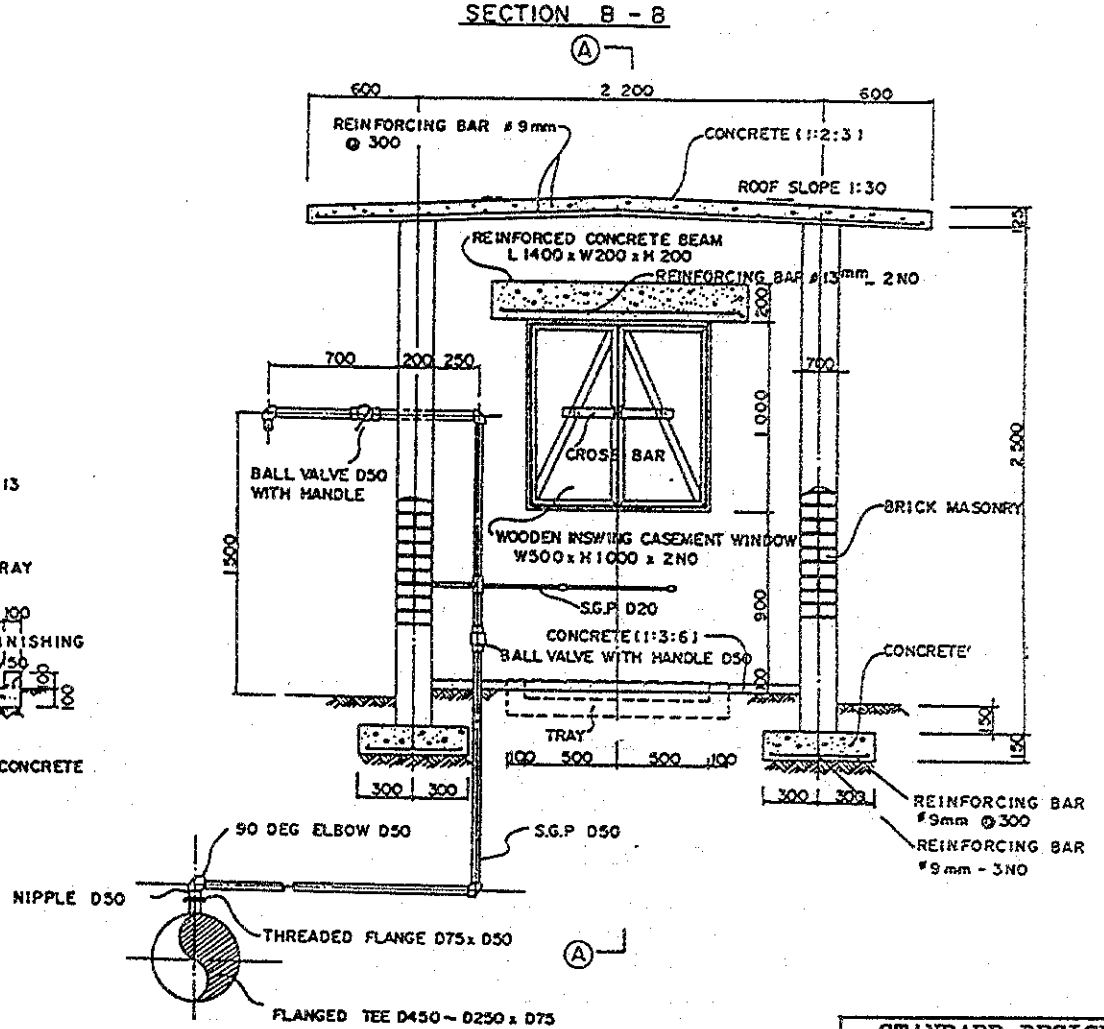
S = $^{1}/_{30}$

STANDARD DESIGN OF STOP VALVE BOX & FIRE HYDRANT BOX
DRAWING NO. 3
KHARTOUM WATER SUPPLY

SECTION A - A

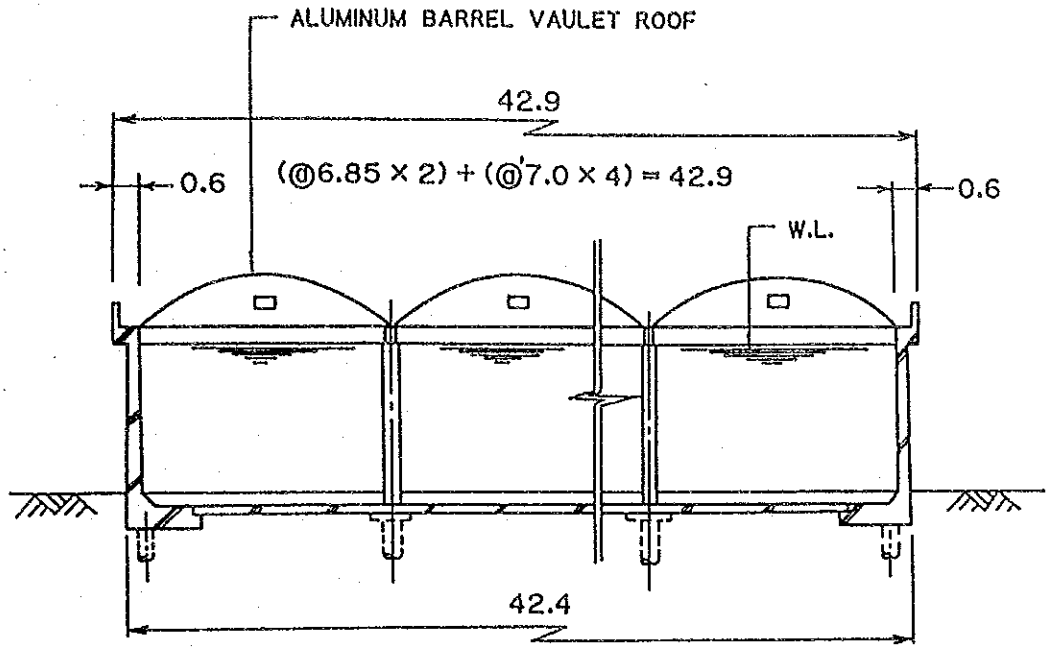


SECTION B - B

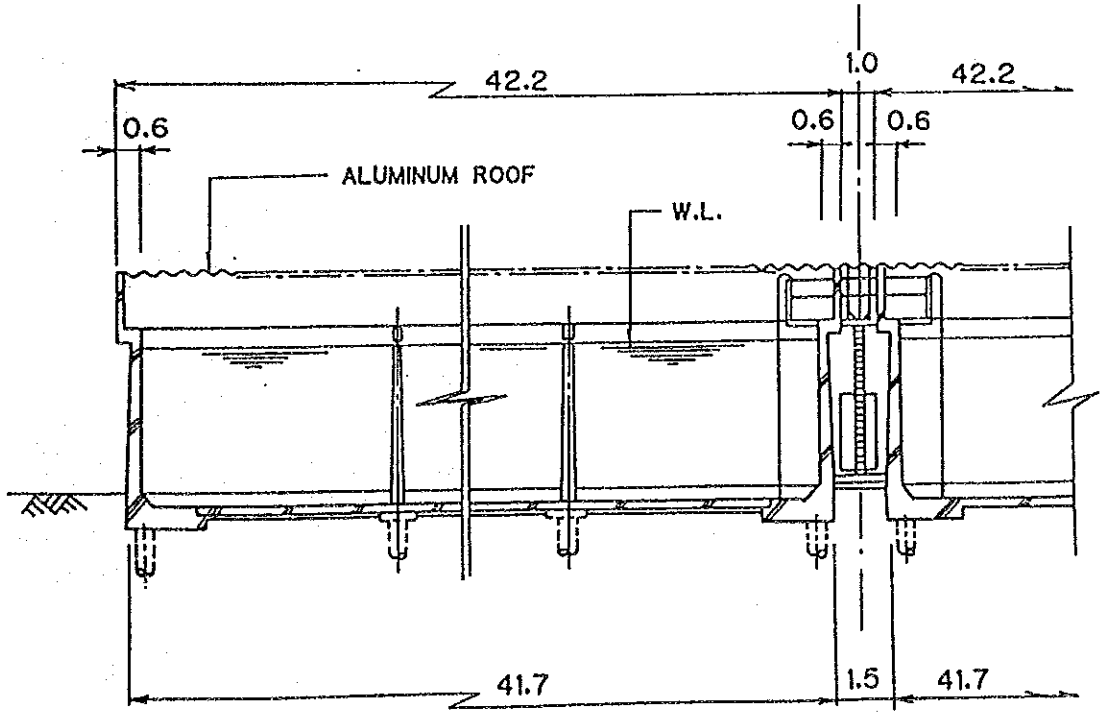


STANDARD DESIGN OF PUBLIC HYDRANT
DRAWING NO. 4
KHARTOUM WATER SUPPLY

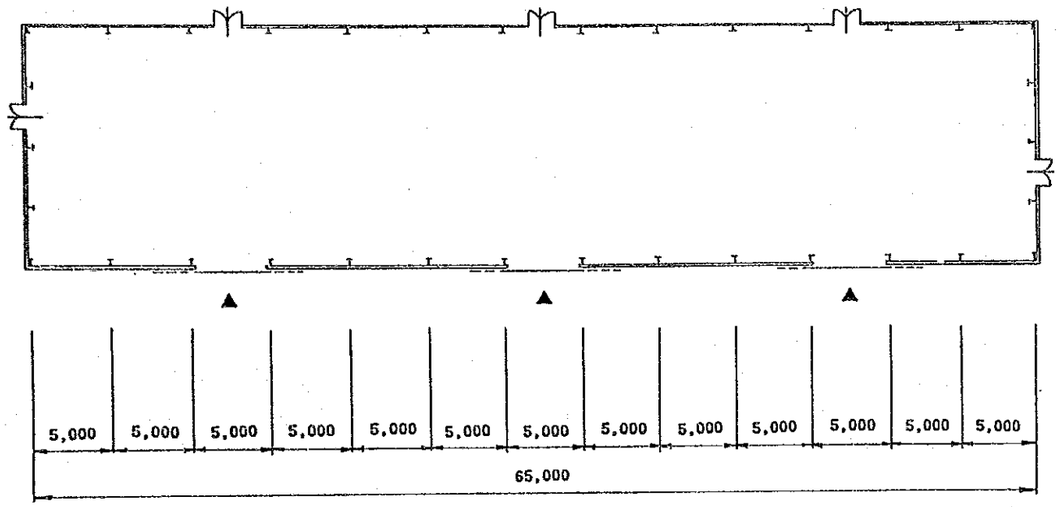
STANDARD DETAIL OF ROOFING STRUCTURE DRAWING NO. 5
KHARTOUM WATER SUPPLY



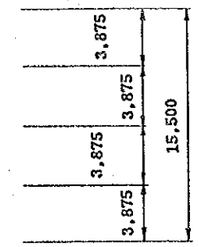
SECTION "A"

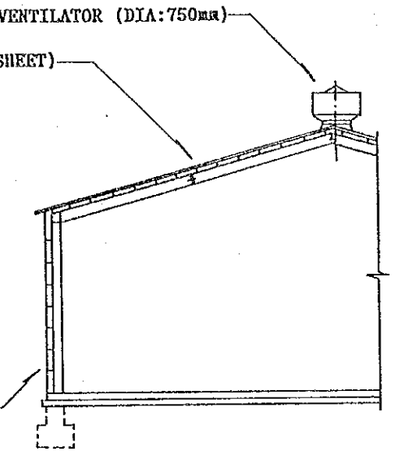


SECTION "B"

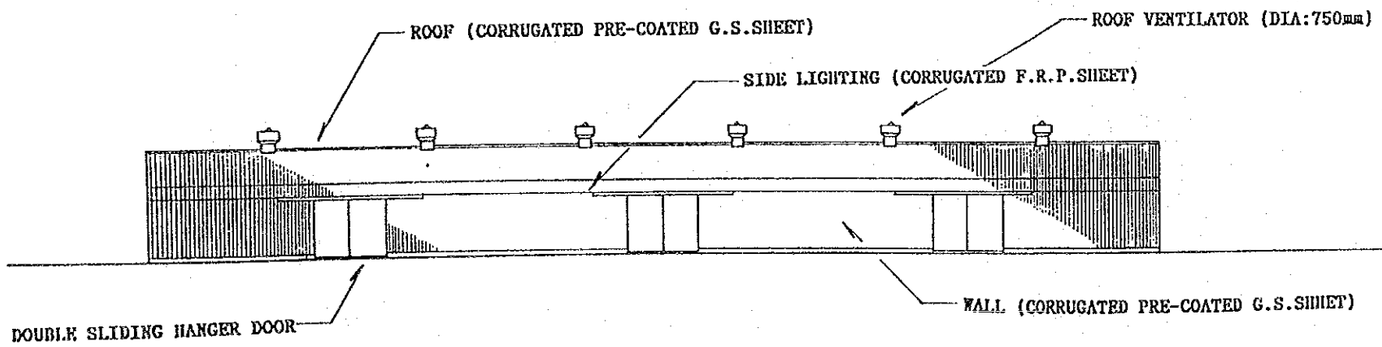


FLOOR PLAN

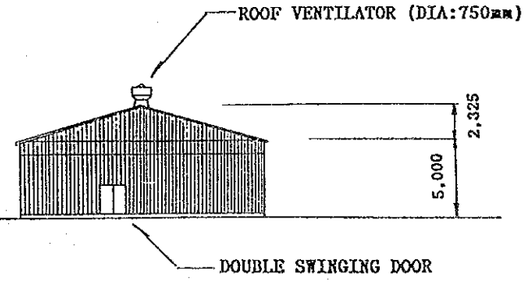




SECTION

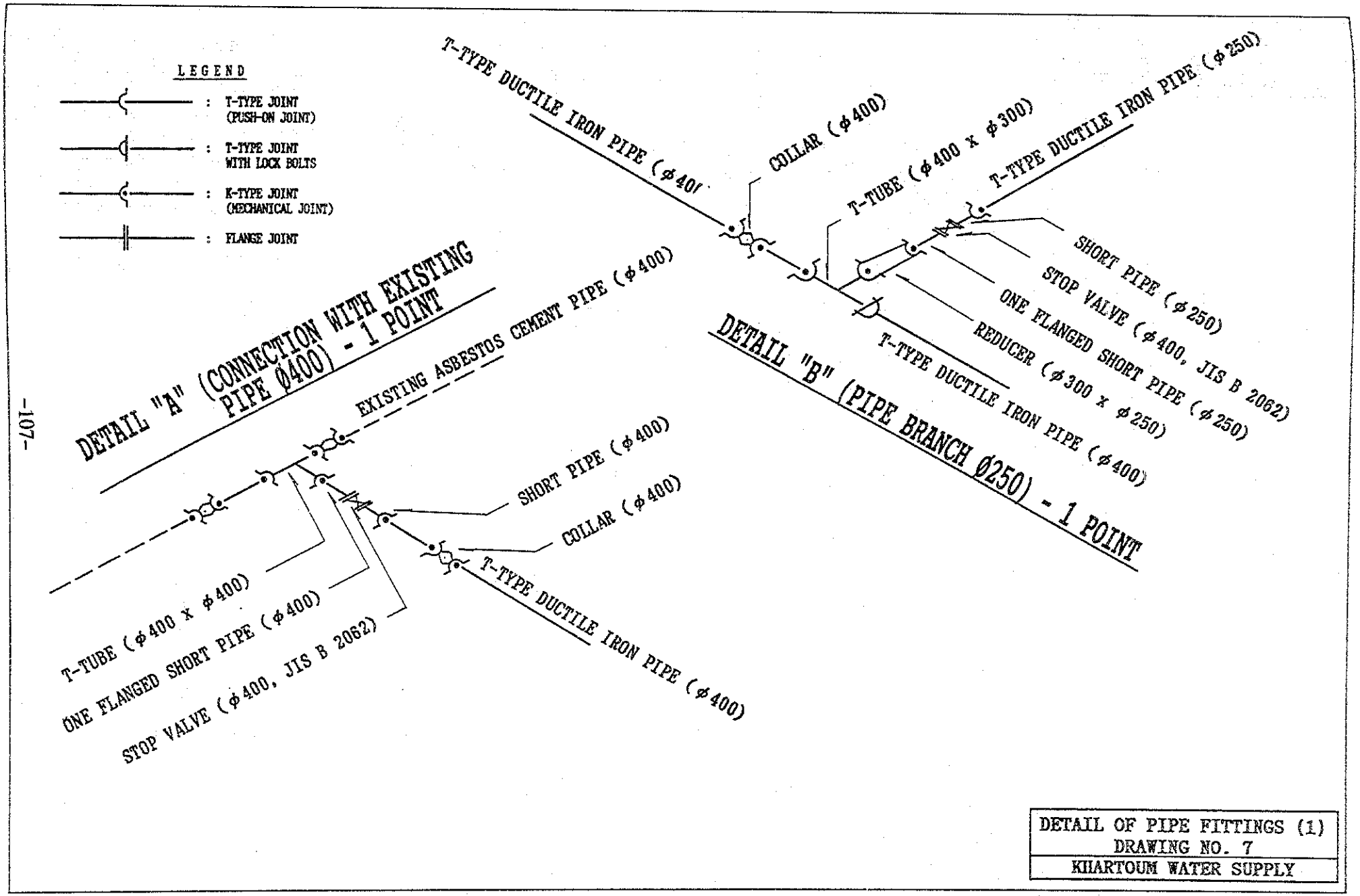


ELEVATION

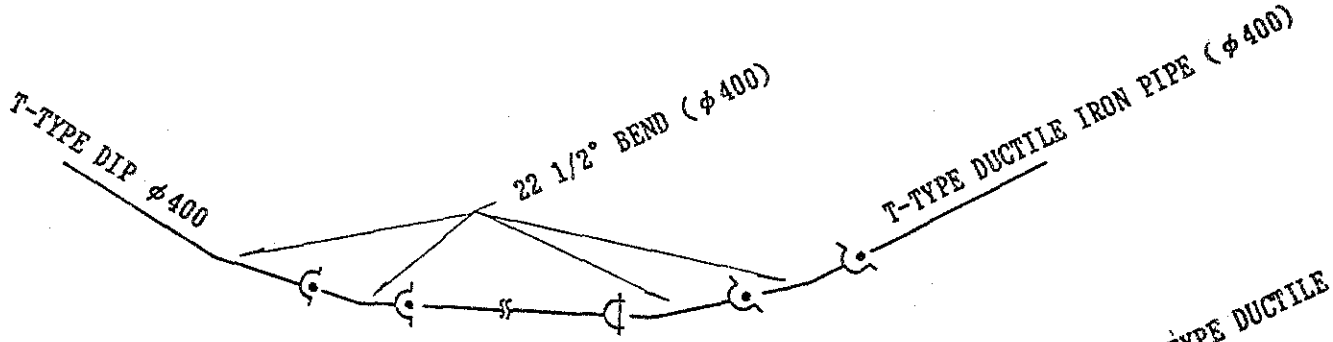


ELEVATION

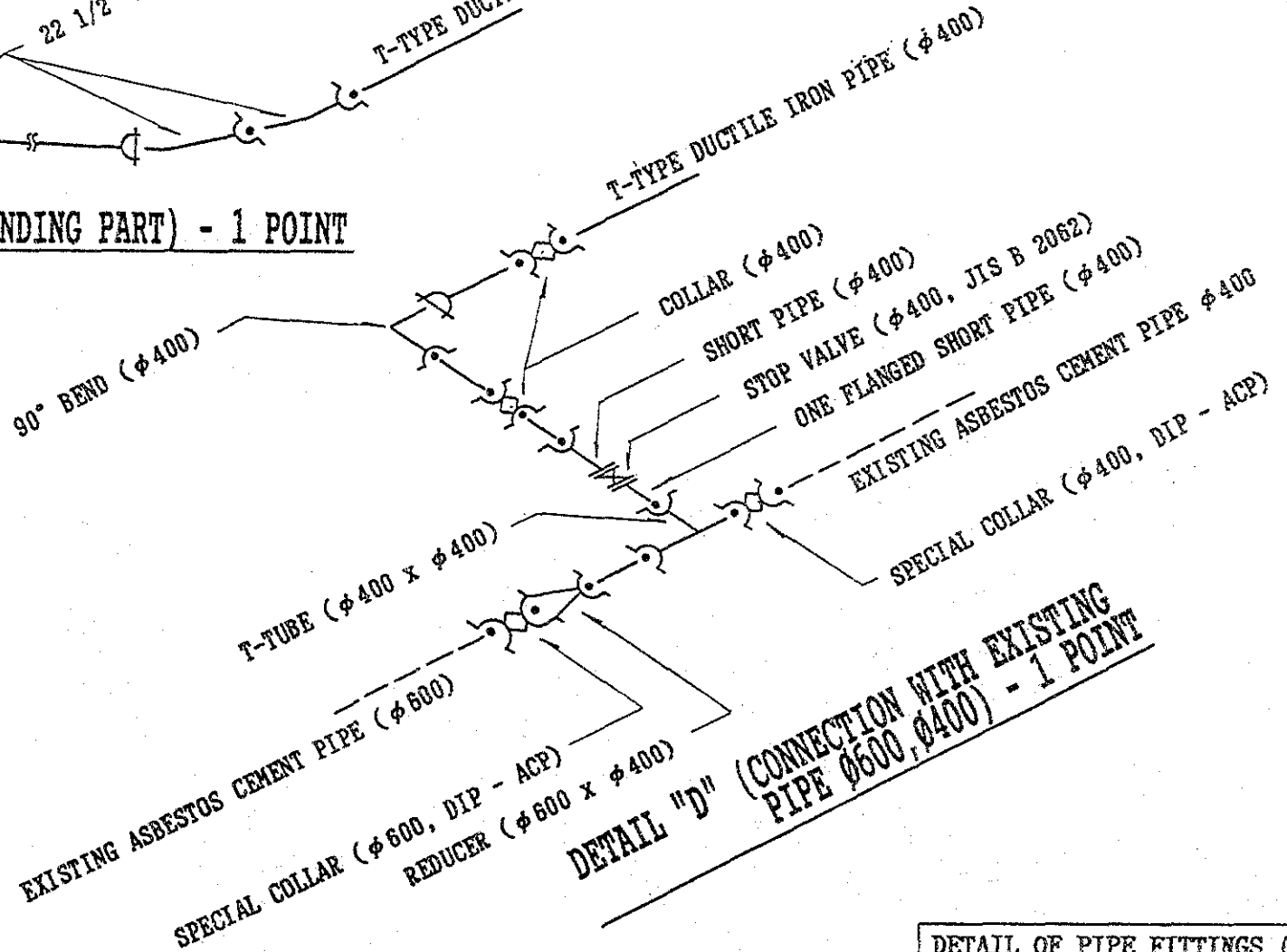
STANDARD DETAIL OF WAREHOUSE
DRAWING NO. 6
KHARTOUM WATER SUPPLY



DETAIL OF PIPE FITTINGS (1)
DRAWING NO. 7
KHARTOUM WATER SUPPLY



DETAIL "C" (22 1/2° BENDING PART) - 1 POINT

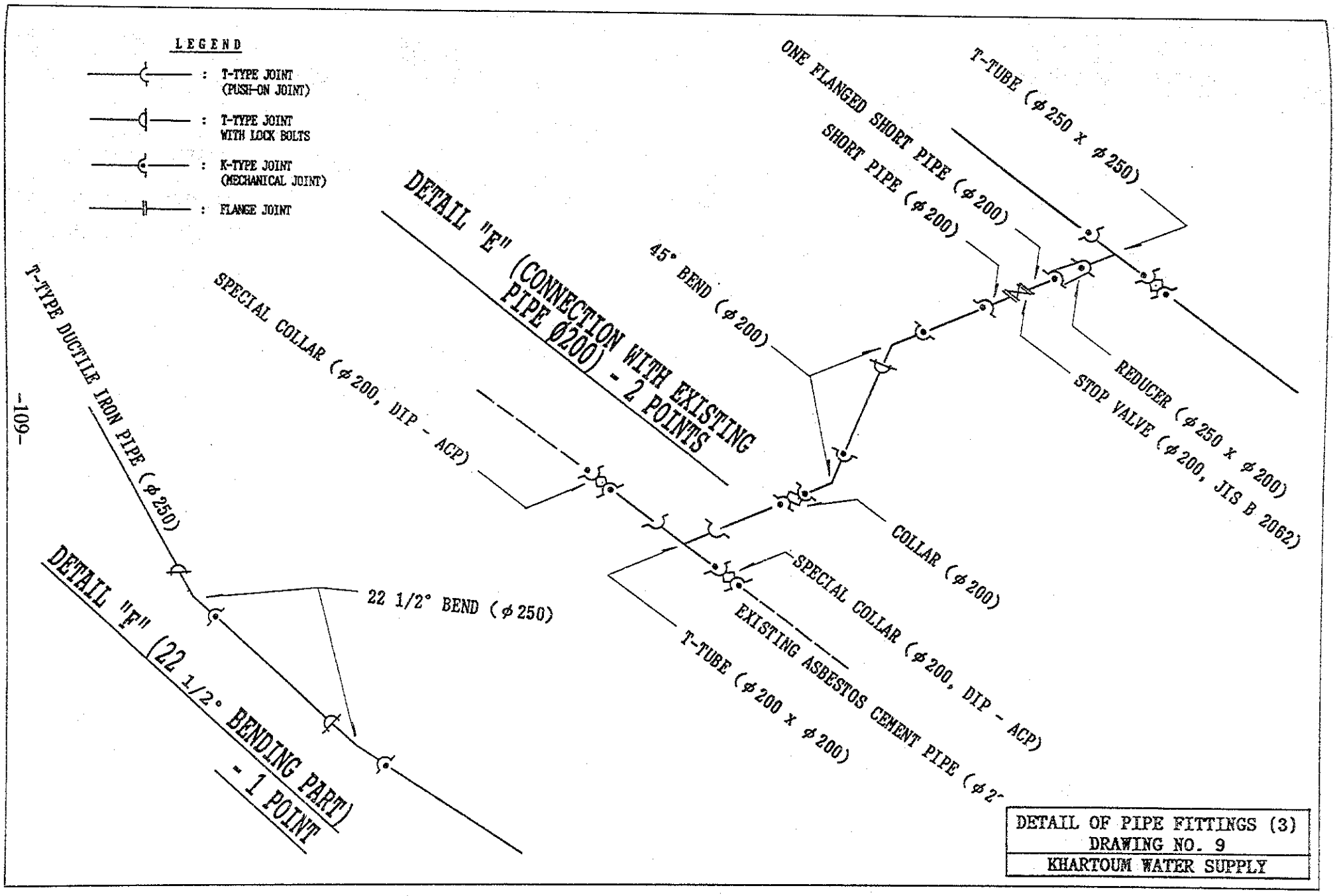


DETAIL "D" (CONNECTION WITH EXISTING PIPE Ø600,Ø400) - 1 POINT

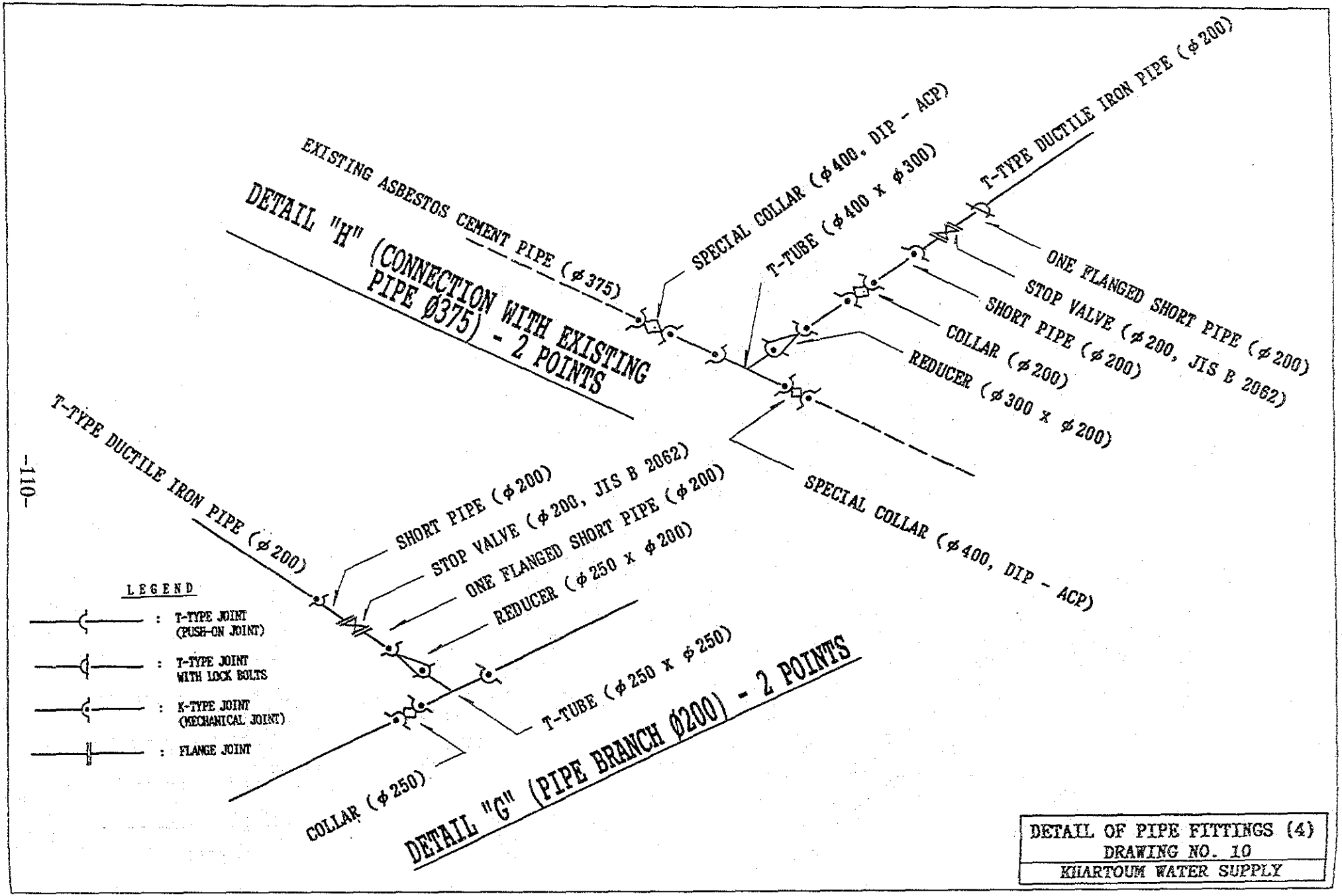
LEGEND

- : T-TYPE JOINT (PUSH-ON JOINT)
- : T-TYPE JOINT WITH LOCK BOLTS
- : K-TYPE JOINT (MECHANICAL JOINT)
- : FLANGE JOINT

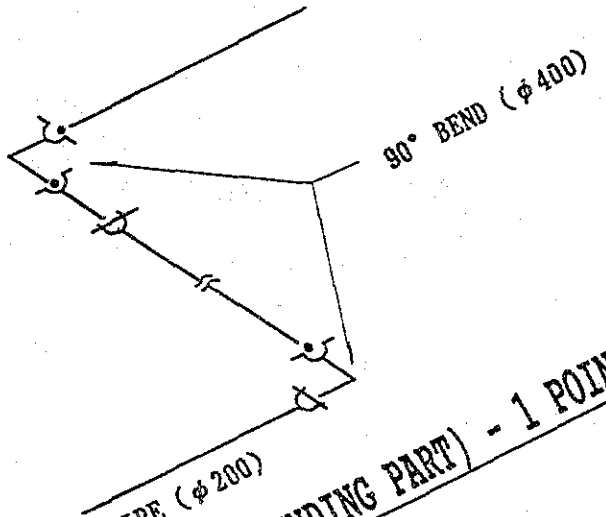
DETAIL OF PIPE FITTINGS (2)
DRAWING NO. 8
KHARTOUM WATER SUPPLY



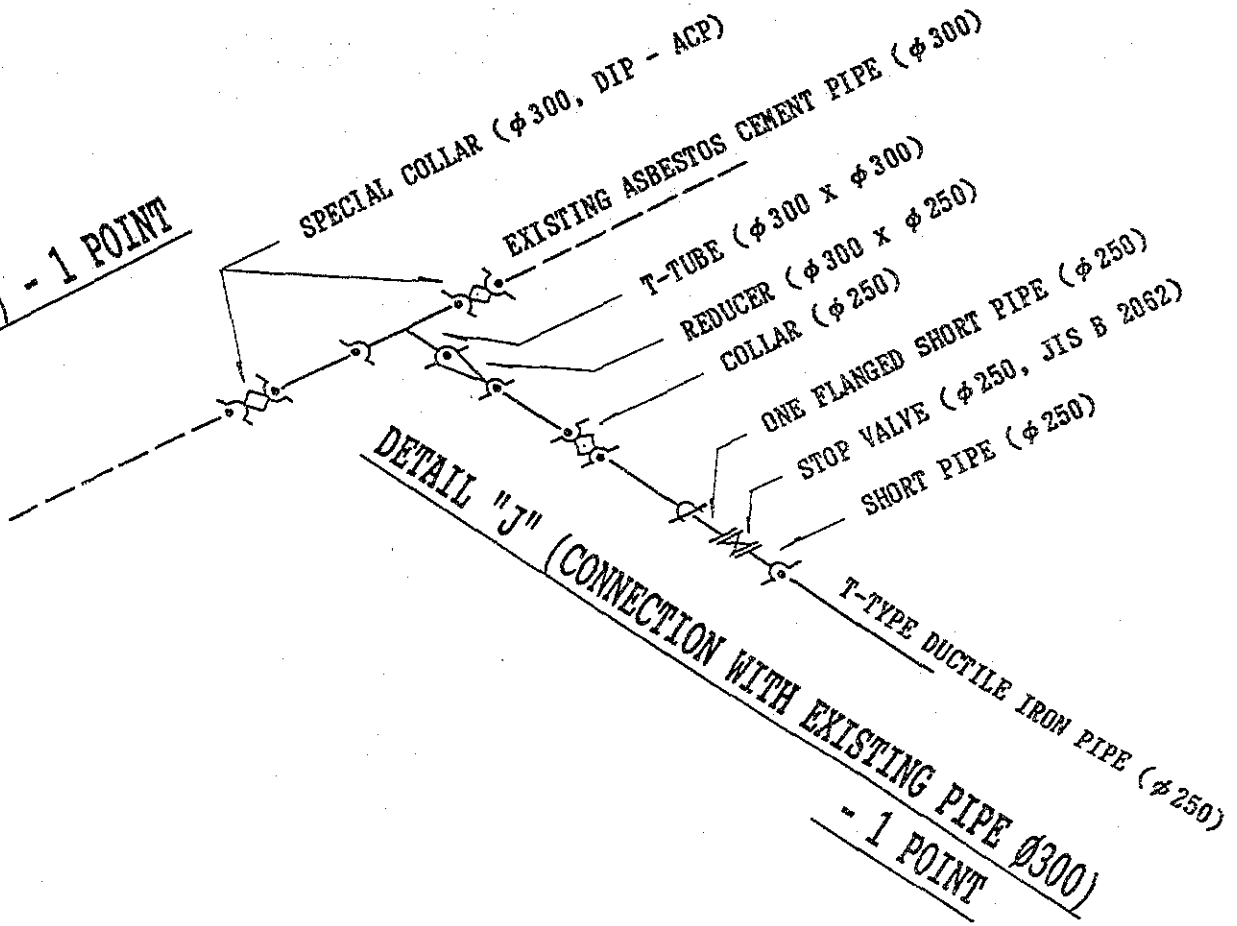
DETAIL OF PIPE FITTINGS (3)
DRAWING NO. 9
KHARTOUM WATER SUPPLY



DETAIL OF PIPE FITTINGS (4)
DRAWING NO. 10
KHARTOUM WATER SUPPLY



DETAIL "I" (90° BENDING PART) - 1 POINT

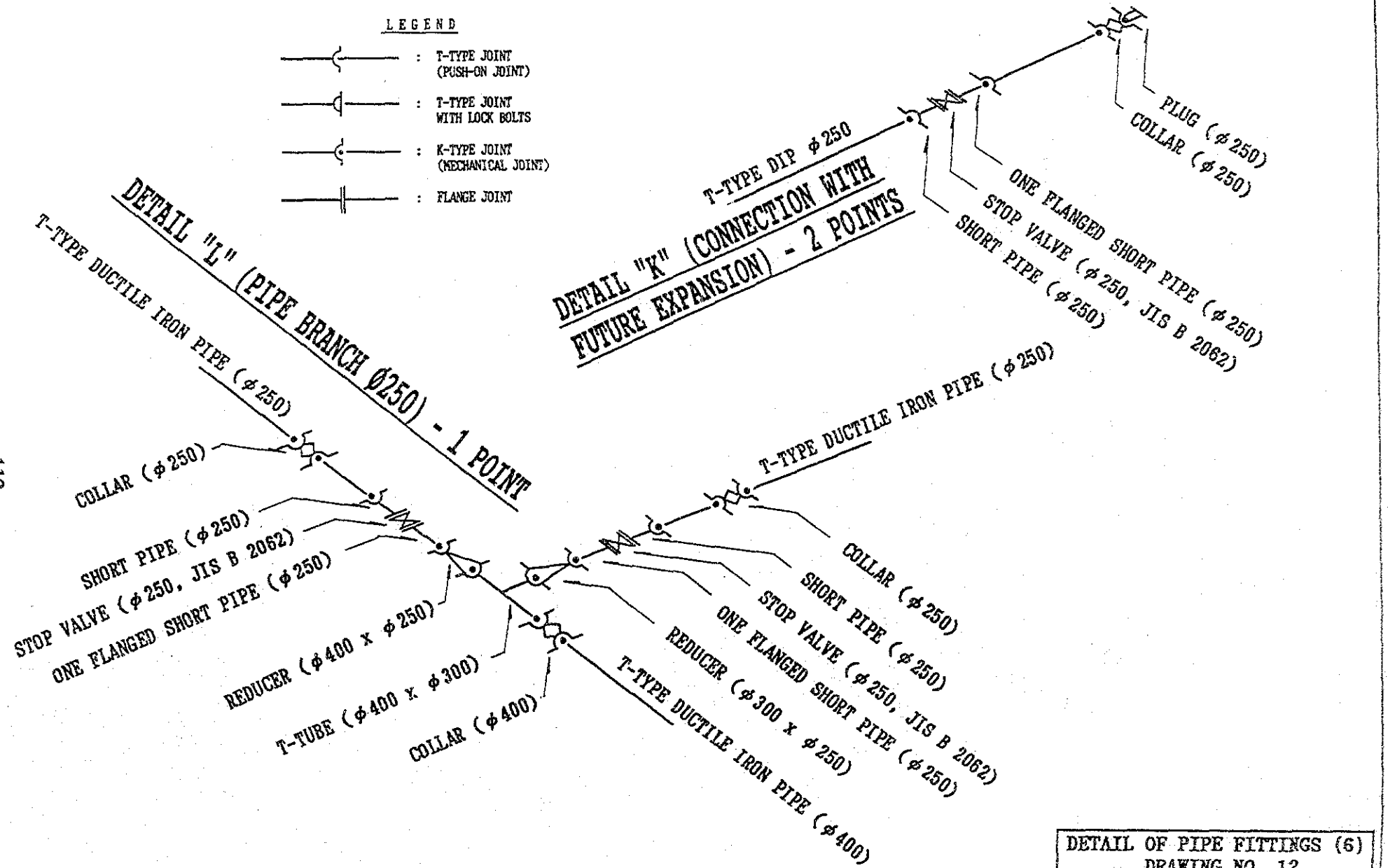


DETAIL "J" (CONNECTION WITH EXISTING PIPE Ø300) - 1 POINT

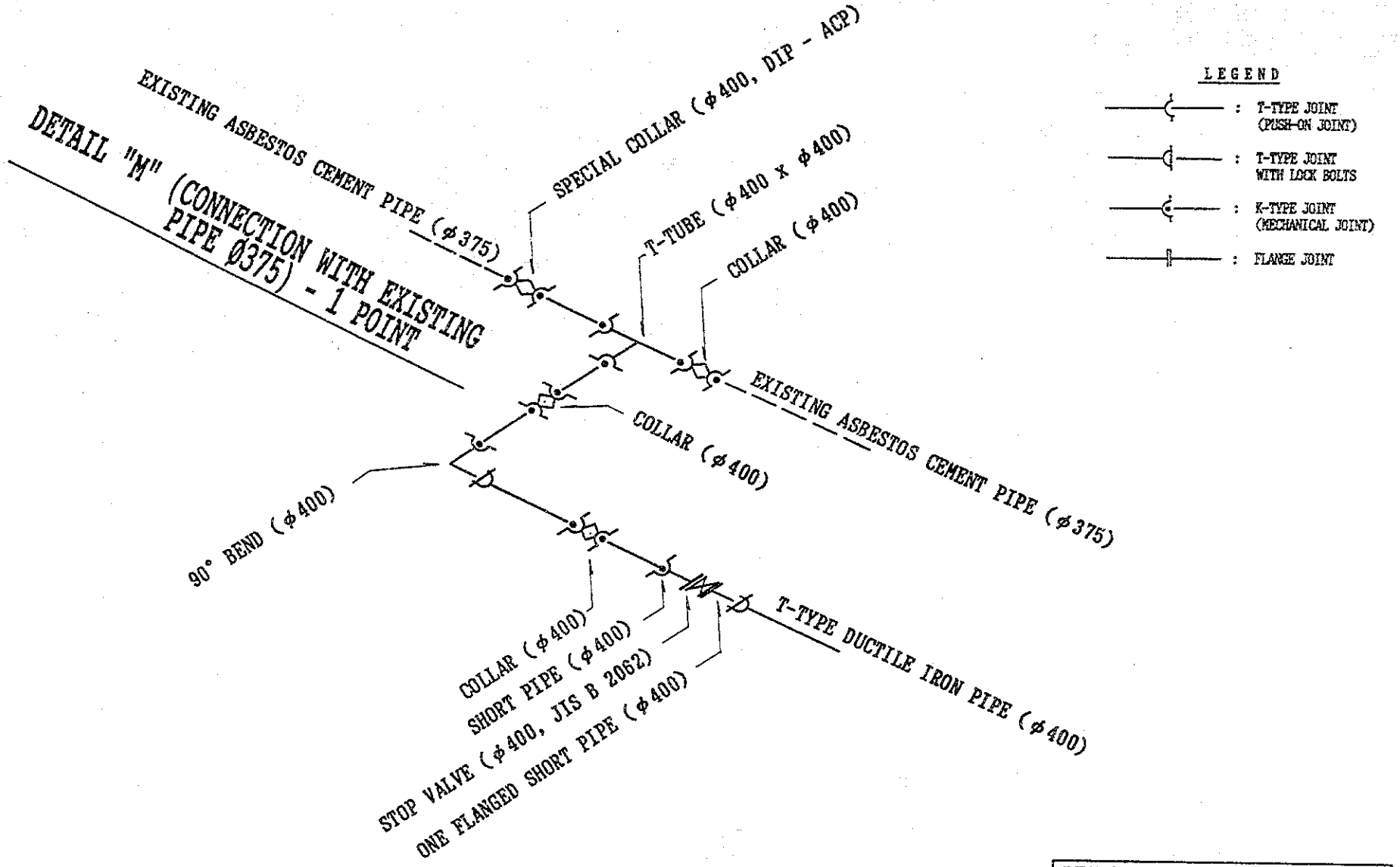
LEGEND

- : T-TYPE JOINT (PUSH-ON JOINT)
- : T-TYPE JOINT WITH LOCK BOLTS
- : K-TYPE JOINT (MECHANICAL JOINT)
- : FLANGE JOINT

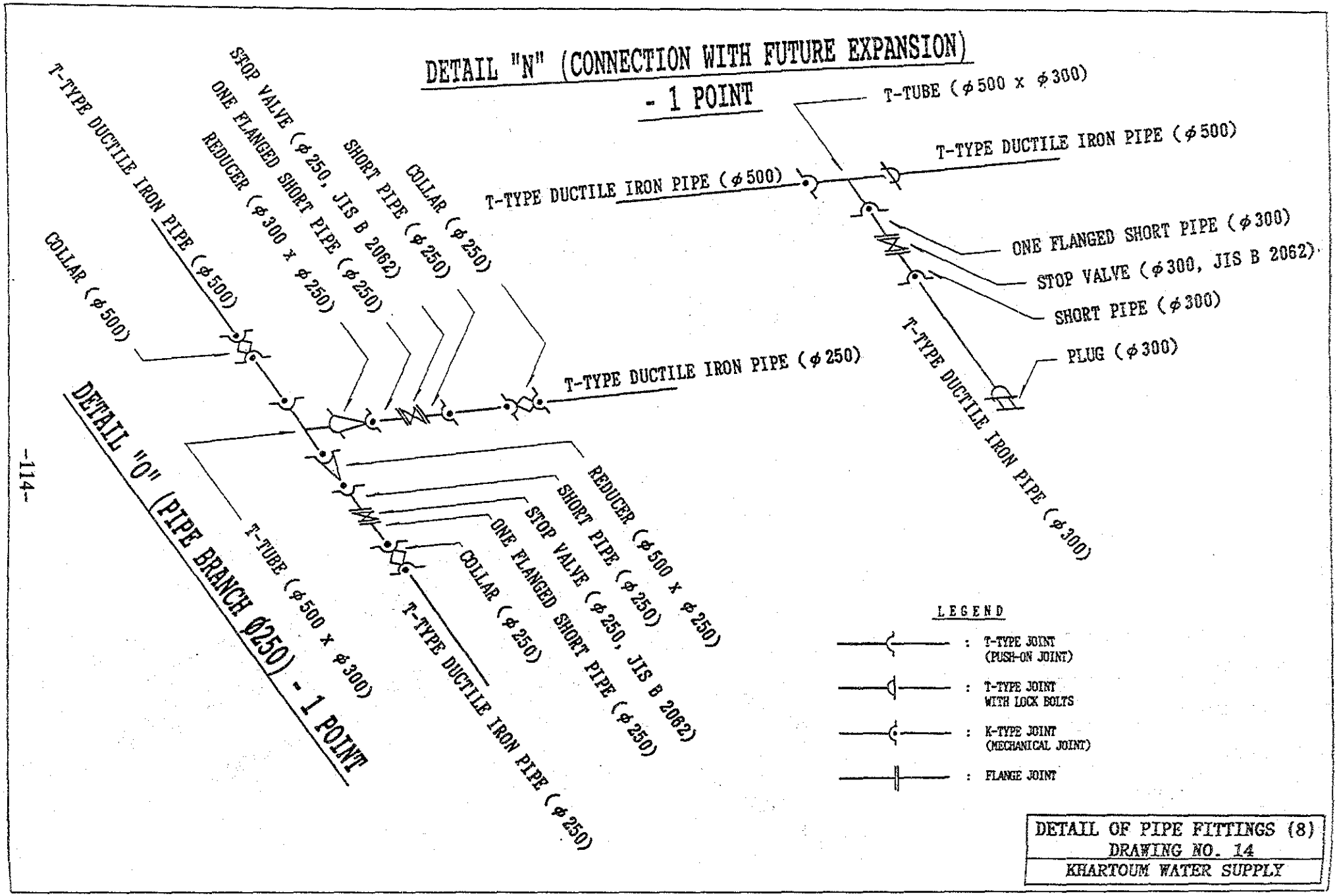
DETAIL OF PIPE FITTINGS (5)
DRAWING NO. 11
KHARTOUM WATER SUPPLY



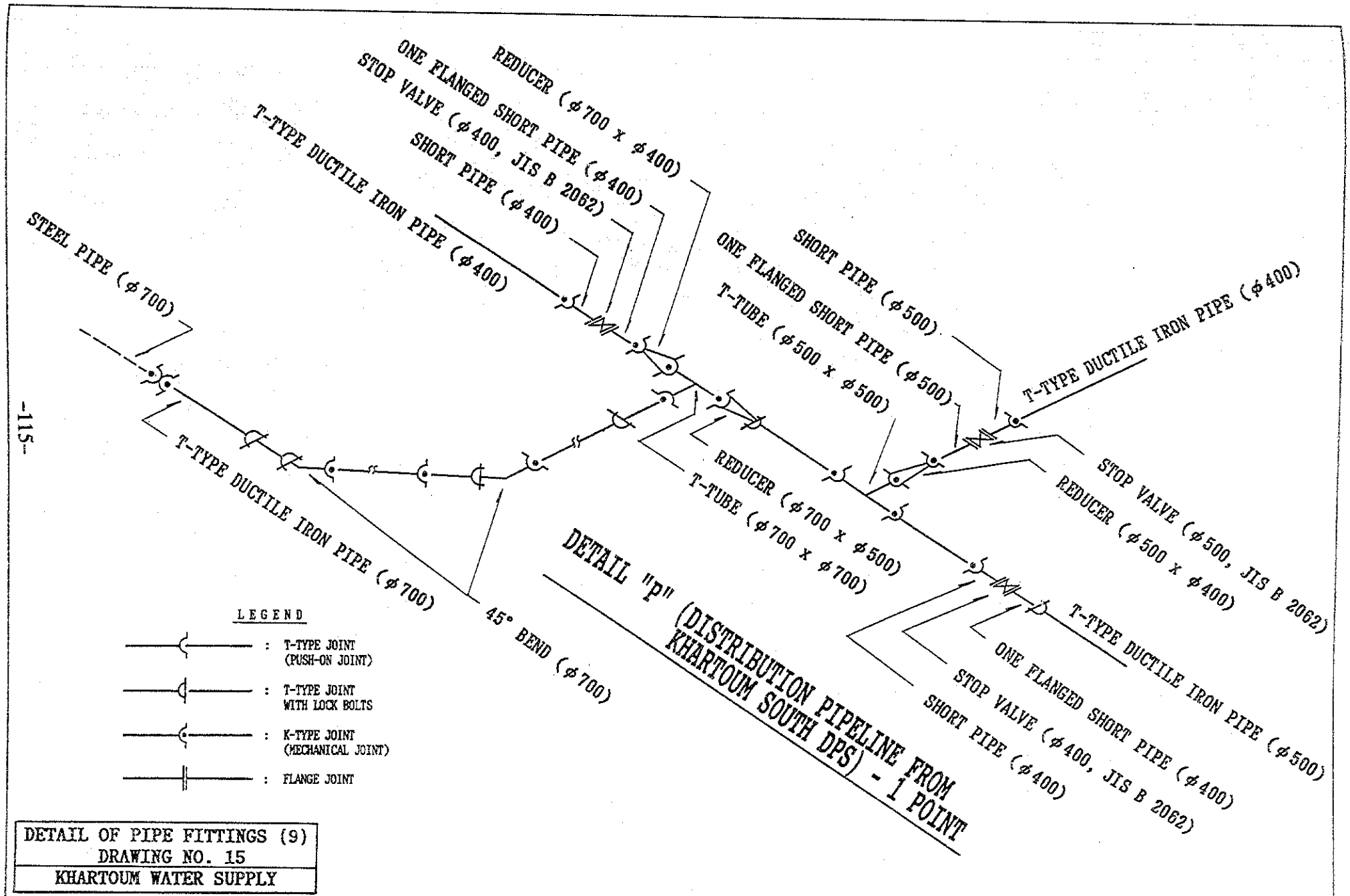
DETAIL OF PIPE FITTINGS (6)
DRAWING NO. 12
KHARTOUM WATER SUPPLY



DETAIL OF PIPE FITTINGS (7)
DRAWING NO. 13
KHARTOUM WATER SUPPLY

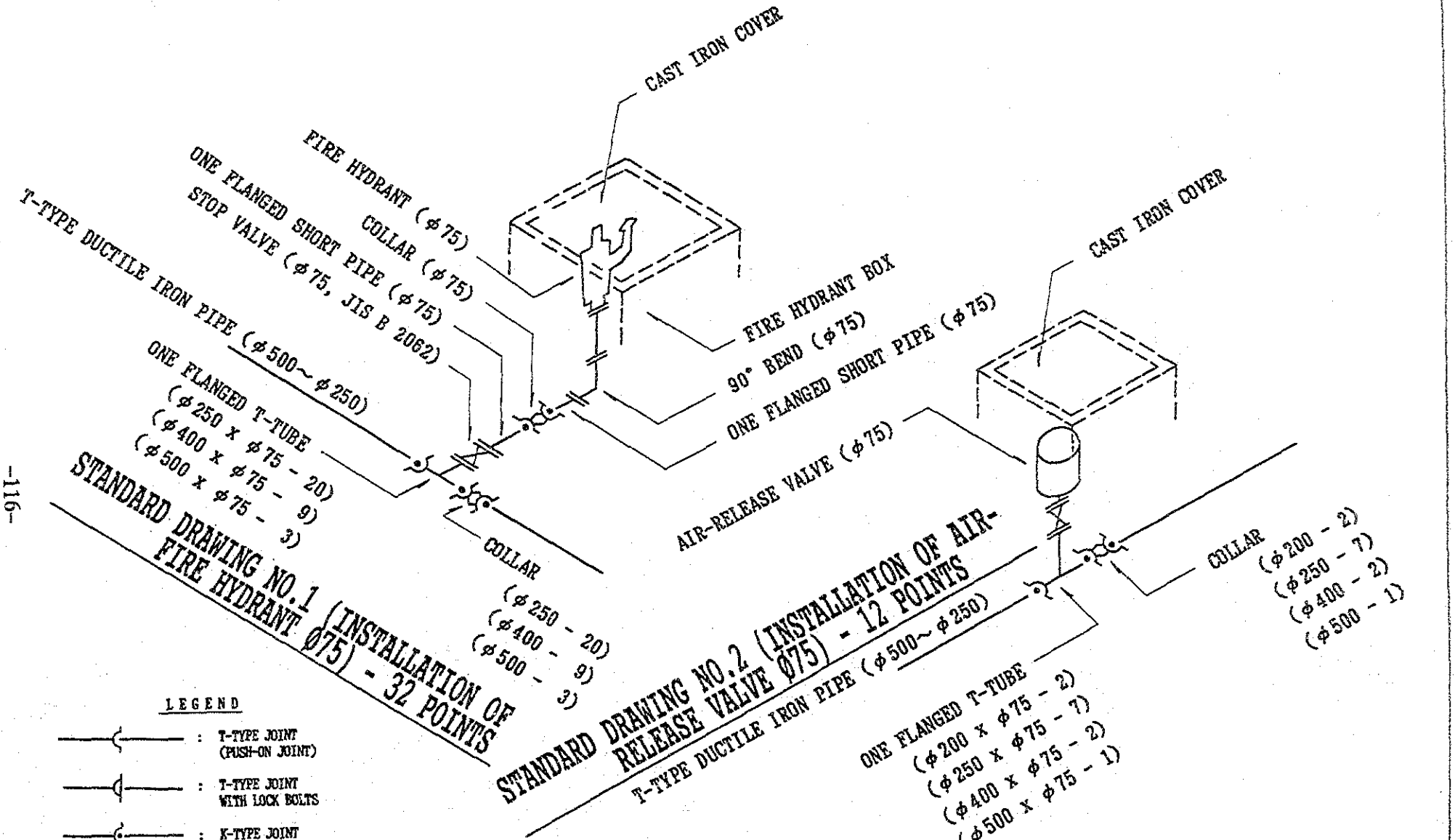


DETAIL OF PIPE FITTINGS (8)
DRAWING NO. 14
KHARTOUM WATER SUPPLY



DETAIL "P" (DISTRIBUTION PIPELINE FROM KHARTOUM SOUTH DPS) - 1 POINT

DETAIL OF PIPE FITTINGS (9)
DRAWING NO. 15
KHARTOUM WATER SUPPLY



DETAIL OF PIPE FITTINGS (10)
DRAWING NO. 16
KHARTOUM WATER SUPPLY

Appendix-3

Table 1 NUWC OPERATION BUDGET FOR KHARTOUM (a)

(Unit : £S)

No.	ITEM	1988/89	1989/90	1990/1991
Ⅰ.	INCOME			
1.	Sales	36,795,047	92,738,395	215,202,000
2.	Other Income	1,414,886	3,314,811	3,500,000
	TOTAL INCOME	38,209,933	96,053,206	218,702,000
Ⅱ.	EXPENDITURE			
1.	Production Cost			
1)	Salaries & Wages	7,098,410	8,539,518	10,539,518
2)	Fuel & Power	393,361	456,096	1,000,000
3)	Operating Materials	315,893	2,485,710	19,400,000
4)	Repair & Maintenance	3,362,363	2,815,866	2,500,000
5)	Depreciation	8,776,593	10,289,610	3,500,000
6)	Other Expenses	1,624,911	1,677,460	1,300,000
	Total Production Cost	21,571,531	26,264,260	38,239,518
2.	Distribution Cost			
1)	Salaries & Wages	10,353,504	8,299,442	10,298,442
2)	Fuel & Power	324,284	205,481	1,000,000
3)	Operating Materials	111,784	607,607	15,000,000
4)	Repair & Maintenance	2,321,315	9,187,384	3,500,000
5)	Depreciation	11,006,005	12,583,110	4,000,000
6)	Other Expenses	4,523,794	2,229,417	1,200,000
	Total Distribution Cost	28,640,686	33,112,441	34,998,442
3.	Administration Cost			
1)	Salaries & Wages	6,812,542	14,468,370	15,902,675
2)	Fuel & Power	243,957	1,052,188	1,527,500
3)	Operating Materials	47,612	981,604	600,000
4)	Repair & Maintenance	803,653	1,060,484	700,000
5)	Depreciation	2,191,151	2,842,531	2,240,000
6)	Other Expenses	2,311,496	6,739,167	577,000
	Total Administration Cost	12,410,411	27,144,344	21,547,175
4.	Financial Charge			
1)	5% Interest on Capital	9,920,686	11,735,523	10,000,000
2)	Audit Fees	12,000	12,000	30,000
	Bad Dets	35,979	43,385	600,000
	Total Financial Charge	9,968,665	11,790,908	10,630,000
	TOTAL OF EXPEN	72,591,293	98,311,953	105,415,135
5.	Net Surplus for the Year	▲34,381,360	▲2,258,747	113,286,865
	TOTAL EXPENDITURE	38,209,933	96,053,206	218,702,000

App 3.2 NUWC Balance Sheet

Table - 2 BALANCE SHEET (a)

(Unit : £S)

No.	Assets	1986 / 87	1987/88	1988/1989
1.	Capital Reserve Equity	19,435,675	19,435,675	19,435,675
2.	Capital Reserve Grant (Ministry of Finance)	63,246,703	68,483,262	147,269,121
3.	Revaluation surplus	217,202,471	245,578,163	277,223,904
4.	Deficit for Previous Year (1)	(57,439,495)	(56,318,877)	(76,975,199)
5.	Deficit for Previous Year (2)	(7,879,382)	(11,556,321)	(34,381,360)
6.	Consumer Deposit	626,803	805,458	981,667
7.	Current Liabilities	1,166,263	536,620	129,760
8.	Pension & Benefit Reserve	435,964	464,773	534,574
9.	Grant for Areas	18,460,322	18,460,322	18,460,322
10.	Social Insurance	576,675	915,164	1,146,411
11.	5% Interest on Capital	46,371,124	55,441,213	65,361,900
12.	Ministry of Finance Loan			8,000,000
13.	Arab Fund			3,247,043
14.	Bank of Sudan Loan		9,828,354	12,391,530
15.	Cash at Bank		(414,177)	
	TOTAL LIABILITIES	302,203,123	351,659,629	442,825,348

Table - 2 BALANCE SHEET (b)

(Unit : £S)

No.	Assets	1986 / 87	1987/88	1988/1989
1.	Fixed Assets	283,756,908	316,457,419	359,971,183
2.	Less Accumulated Debts	(100,205,825)	(119,233,319)	(141,207,068)
3.	Work in Progress	3,065,709	3,072,251	8,354,070
4.	Stock in Hand	12,047,203	21,841,625	31,539,174
5.	Material in Transit	2,022,548	7,616,420	16,373,662
6.	Customer Account Receivable	39,451,326	53,805,583	65,738,878
7.	Less Provision for Bat Debts	(273,208)	(358,942)	(394,921)
8.	Account Receivable Government	6,144,274	7,658,021	8,959,752
9.	Municipality Account	20,049	20,049	20,049
10.	Account Receivable Staff	168,382	234,133	266,087
11.	Sundry National Electricity Corporation	307,936	294,899	285,213
12.	Sundry Debts	188,896	20,122	580,474
13.	Staff Welfare Fund	196,587	264,953	278,777
14.	Prepayment Egyptian Loan	-	10,725,359	9,637,646
15.	Balance at Bank	12,201,321	-	4,634,769
16.	Correct Account with Areas	39,083,980	47,949,487	76,522,528
17.	Rural Administration	53,046	-	-
18.	French Loan	521,330	-	-
19.	Indian Loan	3,452,661	538,339	538,339
20.	Suspense with Bank of Sudan	-	753,230	-
21.	Payment in Adviser	-	-	726,736
	TOTAL ASSETS	302,203,123	351,659,629	442,825,348

App 3.3 NUWC Water Charges

WATER CHARGE

As of Nov., 1989

1)	Forth & Third Class Area (1/2 in. Connection)		
	0-15m^3	LS	30
	15-Extra	LS	2.5/m^3
2)	Second Class Area (3/4 in. Connection)		
	0-15m^3	LS	40
	15-Extra	LS	2.5/m^3
3)	First Class Area (1 in. Connection)		
	0-15m^3	LS	50
	15-Extra	LS	2.5/m^3
4)	Industrial & Commercial		
	0-50m^3	LS	300
	50-Extra	LS	8/m^3
5)	Stand Pipe (Kiosk)	LS	5/m^3

App 3.4 Analyses of Raw and Treated Water Qualities

Table—1.1 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - KHARTOUM NORTH (RAW WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Muddy	Turbid	Turbid	Opal	Opal	Opal	Turbid	Turbid	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30.5	28	31	27	22	22	22	27	31	37	32
pH Value		8.5	8.5	8.3	8.7	8.3	8.7	8.3	8.3	8.3	8.5	8.5	8.7
Dionic Reading (E.C.)		-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness As CaCO3	mg/l	110	90	75	70	80	75	105	105	90	90	100	105
Methyl Orange Alkalinity As CaCO3	mg/l	103	90	90	80	55	95	135	135	105	120	120	100
Phcnolphthalein Alkalinity	mg/l	-	20	-	8	5	-	5	5	8	9	7	10
Permanent Hardness	mg/l	5	Nil	Nil	Nil	25	Nil	Nil	Nil	Nil	Nil	Nil	5
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	15	10	Nil	20	30	30	15	30	20	Nil
Calcium As Ca	mg/l	36	32	26	20	26	24.0	30	30	30	28	30	26
Magnesium As Mg	mg/l	4.8	2.4	2.4	5.8	3.6	3.6	7.2	7.2	3.6	4.8	6.0	9.6
Silica As SiO2	mg/l	11	20	5	5	12	5	12	12	8	-	15	10
Sulphate As SO4	mg/l	48	9.6	14.4	19.2	24	36.48	43.25	43.25	28.8	23.8	33.6	38.4
Chloride As Cl	mg/l	12	6	12	6	15	8	19	19	13	10	8	9
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	0.26	0.060	0.060	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	6	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	7800	1700	400	180	200	40	10	10	5.0	20	20	80
Total Dissolved solid at 180℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-

Remarks : Examined at CENTRAL LABORATORY, MOGREN TREATMENT PLANT

Table—1.2 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - KHARTOUM NORTH NEW(TAP WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Turbid	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30	28	31	27	22	27	24	27	31	37	32
pH Value		6.1	6.7	6.9	7.3	7.1	7.1	7.3	7.1	7.3	7.3	7.3	7.5
Dionic Reading (E.C.)		690	615	225	225	195	180	165	280	255	195	220	210
Total Hardness As CaCO3	mg/l	165	130	75	75	75	205	100	250	95	130	100	105
Methyl Orange Alkalinity As CaCO3	mg/l	135	60	80	65	75	75	105	110	95	130	115	90
Phcnolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Permanent Hardness	mg/l	130	70	Nil	10	Nil	Nil	Nil	Nil	Nil	Nil	Nil	15
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	5	Nil	Nil	Nil	Nil	Nil	Nil	35	15	Nil
Calcium As Ca	mg/l	60	40	24	20.8	24	26	26	32	30	30	32	26
Magnesium As Mg	mg/l	9.6	7.2	3.6	5.52	3.0	2.4	9.6	7.2	4.8	4.8	4.8	9.6
Silica As SiO2	mg/l	11	18	7	11	11	5	7	11	14	-	12	10
Sulphate As SO4	mg/l	105.6	72	24	14.4	24	38.4	38.4	48	33.6	33.6	38.4	43.2
Chloride As Cl	mg/l	21	13	15	16	15	13	12	20	15	8	8	8
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Trace	Nil	Nil	Trace	Nil	Nil	Nil	Nil	Nil	Nil	0.0003
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	Trace	Trace	0.040	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved solid at 180℃	mg/l	460	410	150	150	130	120	110	190	170	130	140	140

Table—2.1 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - BURRI (RAW WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Muddy	Turbid	Turbid	Opal	Opal	Opal	Turbid	Turbid	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30.5	28	31	27	22	27	22	27	31	37	32
pH Value		8.5	8.5	8.3	8.7	8.3	8.7	8.7	8.3	8.3	8.5	8.5	8.7
Dionic.Reading (E.C.)		-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness As CaCO3	mg/l	110	95	85	70	80	80	95	110	90	90	100	105
Methyl Orange Alkalinity As CaCO3	mg/l	105	100	90	80	95	95	120	120	105	130	115	105
Phcnolphthalein Alkalinity	mg/l	-	20	-	8	7	-	15	5	5	5	5	10
Permanent Hardness	mg/l	5	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Excess Alkalinity As CaCO3	mg/l	Nil	5	5	10	15	15	25	10	15	40	15	Nil
Calcium As Ca	mg/l	36	34	26	20	24	26	26	34	30	28	30	26
Magnesium As Mg	mg/l	4.8	2.4	4.8	4.8	4.8	3.6	7.2	6.0	3.6	4.8	6.0	9.6
Silica As SiO2	mg/l	11	18	5	5	12	5	12	50	11.0	10	17	15
Sulphate As SO4	mg/l	48	14.4	24	9.6	24	43.2	43.2	43.25	28.8	19.2	33.6	48
Chloride As Cl	mg/l	12	4	10	6	18	8	7	15	16	8	10	12
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Trace	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	0.014	Trace	0.0040	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	7800	2000	600	160	60	40	10	10	Nil	20	20	7
Total Dissolved solid at 180℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-

Table—2.2 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - BURRI (TAP WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Turbid	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30	28	31	27	22	27	24	27	31	37	32
pH Value		6.9	6.7	6.5	6.7	6.7	7.3	7.3	7.1	7.1	7.3	7.3	7.3
Dionic Reading (E.C.)		420	540	300	60	150	240	255	280	255	220	220	225
Total Hardness As CaCO3	mg/l	135	135	80	75	75	80	100	100	90	95	95	110
Methyl Orange Alkalinity As CaCO3	mg/l	85	55	80	55	60	85	105	115	95	140	120	100
Phcnolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Permanent Hardness	mg/l	50	80	Nil	20	20	15	Nil	Nil	Nil	Nil	Nil	10
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	Nil	Nil	Nil	5	35	45	45	45	25	Nil
Calcium As Ca	mg/l	48	44	26	20.8	26	24	30	36	30	28	30	32
Magnesium As Mg	mg/l	3.6	6	3.6	5.52	2.4	4.8	6.0	2.4	3.6	6.0	4.8	7.2
Silica As SiO2	mg/l	11	14	5	7	13	5	11	9.0	14	-	15	15
Sulphate As SO4	mg/l	72	76.8	24	13.4	28.8	43.2	38.4	43.25	19.2	19.2	38.4	43.2
Chloride As Cl	mg/l	16	13	18	12	20	8	7	19	12	10	10	8
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Trace	Nil	Nil	Trace	Nil	Nil	Nil	Nil	Nil	Nil	0.0012
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	0.012	Trace	0.030	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	-	-	-	-		-	-	-	-	-	-	-
Total Dissolved solid at 180℃	mg/l	280	360	200	200	160	160						

Table—3.1 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - MOGREN (RAW WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Muddy	Turbid	Turbid	Opal	Opal	Opal	Turbid	Turbid	Opal	Opal	Opal	Opal
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	
Temperature when sample tested ℃		29.5	30.5	28	31	27	21	27	22	27	30	37	32
pH Value		8.3	8.7	8.3	8.3	8.3	8.1	8.7	8.3	8.5	8.5	8.5	8.5
Dionic Reading (E.C.)		-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness As CaCO3	mg/l	110	130	85	75	45	50	60	55	60	65	60	65
Methyl Orange Alkalinity As CaCO3	mg/l	110	115	90	80	90	85	90	110	100	145	160	130
Phcnolphthalein Alkalinity	mg/l	-	25	-	5	5	Nil	15	7	8	10	5	20
Permanent Hardness	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	5	5	45	35	30	55	40	80	105	65
Calcium As Ca	mg/l	34	38	22	20	10	14	10.0	14	20	14	16	14.0
Magnesium As Mg	mg/l	6.0	8.4	4.8	6	4.8	4.0	8.4	2.0	2.4	7.2	6.0	7.2
Silica As SiO2	mg/l	11	18	5	7	15	19	12	8.0	13	17	11	6.0
Sulphate As SO4	mg/l	43.2	57.6	28.8	19.2	6.72	4.8	24	9.6	13.2	9.6	9.6	13
Chloride As Cl	mg/l	13	14	15	8	12	10	8	20	12	12	12	13
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Nil	Nil	Nil	Trace	Nil	Nil	Nil	Nil	Nil	0.012	Trace
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	0.019	Trace	0.080	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	9400	4250	450	180	180	80	80	80	80	180	100	180
Total Dissolved solid at 180℃	mg/l	-	-	-	-	-	-	-	-	-	-		-

Table—3.2 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - MOGREN (TAP WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Turbid	Opal	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30	28	31	27	21	27	24	27	30	37	32
pH Value		6.7	6.7	6.7	6.9	6.9	6.7	6.9	6.9	7.3	7.1	7.1	6.9
Dionic Reading (E.C.)		420	465	285	285	300	285	200	270	270	255	270	270
Total Hardness As CaCO3	mg/l	125	150	85	85	60	50	55	55	65	65	60	65
Methyl Orange Alkalinity As CaCO3	mg/l	100	80	60	63	70	55	65	75	90	120	135	105
Phenolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Permanent Hardness	mg/l	25	70	25	22	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	Nil	Nil	20	5	10.0	20	25	55	75	40
Calcium As Ca	mg/l	42	52	28	25.6	12	14.0	10.0	14	18.0	14	10.8	14.0
Magnesium As Mg	mg/l	4.8	4.8	2.6	5.04	4.8	3.6	7.2	4.8	4.8	7.2	7.92	7.2
Silica As SiO2	mg/l	13	16	11	8	12	5	14	8.0	11	17	8	15
Sulphate As SO4	mg/l	57.6	86.4	28.8	38.4	9.6	4.8	19.2	9.6	20	19.2	9.6	19.2
Chloride As Cl	mg/l	13	12	20	17	12	12	9	15	10	12	13	13
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Nil	Nil	Nil	Nil	0.006	Trace	0.040	Nil	Nil	Nil	Nil
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Trace	Nil	Nil	Trace	Nil	Nil	Nil	Trace
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved solid at 180℃	mg/l	280	310	190	140	200	190	130	-	180	180	180	180

Table—4.1 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - OMDURMAN (RAW WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Muddy	Turbid	Turbid	Opal	Opal	Opal	Turbid	Turbid	Opal	Opal	Opal	Opal
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30.5	28	81	27	22	27	22	27	31	37	32
pH Value		8.5	8.3	8.5	8.9	8.3	8.3	8.7	8.3	8.3	8.5	8.5	8.5
Dionic Reading (E.C.)		-	-	-	-	-	-	-	-	-	-	-	-
Total Hardness As CaCO3	mg/l	105	80	60	50	50	50	50	50	60	60	65	70
Methyl Orange Alkalinity As CaCO3	mg/l	115	95	100	82	90	90	90	100	115	120	160	130
Phcnolphthalein Alkalinity	mg/l	15	15	-	12	-	-	15	5	8	10	15	10
Permanent Hardness	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Excess Alkalinity As CaCO3	mg/l	10	15	40	32	40	40	40	45	60	60	105	60
Calcium As Ca	mg/l	30	24	14	40	12.0	14	8.0	12	14	12	16	14
Magnesium As Mg	mg/l	7.2	4.8	6.0	6.0	4.8	3.6	7.2	6	6.0	7.2	6.0	3.4
Silica As SiO2	mg/l	15	18	5	11	11	5	15	10	8	-	11	16
Sulphate As SO4	mg/l	40.0	4.8	4.8	9.6	9.6	24	9.6	9.6	9.6	4.8	9.6	9.6
Chloride As Cl	mg/l	22	10	20	5	13	13	7	15	13	10	12	12
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Nil	Nil	Nil	Trace	Trace	Trace	Trace	Nil	Nil	Nil	Nil
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	Trace	Trace	0.070	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	7100	700	400	120	140	140	180	40	120	100	100	200
Total Dissolved solid at 180℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-

Table—4.2 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

YEAR 89/1990 LOCATION: - OMDURMAN (TAP WATER)

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Turbid	Clear	Clear	Clear	Opal	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30	28	31	27	22	27	24	27	31	37	32
pH Value		6.7	6.5	6.7	6.9	6.5	6.7	8.7	6.9	6.9	7.3	7.1	7.1
Dionic-Reading (E.C.)		450	345	255	250	165	210	270	270	255	180	360	255
Total Hardness As CaCO3	mg/l	155	110	70	60	50	50	60	80	80	80	85	80
Methyl Orange Alkalinity As CaCO3	mg/l	60	55	60	55	75	65	90	85	90	130	115	95
Phcnolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Permanent Hardness	mg/l	95	55	10	5	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	Nil	Nil	25	15	40	15	30	60	30	15
Calcium As Ca	mg/l	48	34	20	128	12	14	8.0	14	18	20	26	20
Magnesium As Mg	mg/l	8.4	6.0	4.8	6.72	4.8	3.6	7.2	6.0	3.6	7.2	4.8	7.2
Silica As SiO2	mg/l	13	20	9	7	11	5	15	10	13	-	14	8.0
Sulphate As SO4	mg/l	91.2	62.4	19.2	19.2	11.52	28.8	9.6	14.2	11.52	19.2	28.8	28.8
Chloride As Cl	mg/l	21	13	18	15	18	15	7	19	21	12	10	12
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	0.0014
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	Trace	Trace	0.080	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved solid at 180℃	mg/l	300	280	170	140	110	140	180	170	170	120	240	170

Table—5 RESULTS OF EXCAMINATION OF SAMPLE OF WATER

LOCATION: - KHARTOUM NORTH (TREATED WATER)

YEAR 89/1990

DETIALS OF ANALYSIS		Jul. 1989	Aug.	Sep.	Oct.	Nov.	Dec.	Jan. 1990	Feb.	Mar.	Apr.	May.	June.
Appearance		Turbid	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Turbity (F.T.U.)		-	-	-	-	-	-	-	-	-	-	-	-
Colour Hazen Unit		-	-	-	-	-	-	-	-	-	-	-	-
Temperature when sample tested ℃		29.5	30	28	31	27	22	27	24	27	31	37	32
pH Value		6.5	6.7	6.3	6.9	7.1	7.1	7.5	7.3	7.1	7.3	7.3	7.1
Dionic Reading (E.C.)		600	570	255	230	150	150	270	270	300	180	195	255
Total Hardness As CaCO3	mg/l	165	140	80	75	75	75	105	100	95	100	100	105
Methyl Orange Alkalinity As CaCO3	mg/l	45	60	50	63	75	80	110	110	90	125	115	95
Phcnolphthalein Alkalinity	mg/l	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Permanent Hardness	mg/l	120	80	30	12	Nil	Nil	Nil	Nil	5	Nil	Nil	10
Excess Alkalinity As CaCO3	mg/l	Nil	Nil	Nil	Nil	Nil	5	5	10	Nil	25	15	Nil
Calcium As Ca	mg/l	52	42	26	20	24	26	32	32	32	28	32	26
Magnesium As Mg	mg/l	8.4	8.4	3.6	6	3.6	2.4	6.0	408	3.6	7.2	4.8	9.6
Silica As SiO2	mg/l	11	14	7	7	11	15	9	12	18	-	16	15
Sulphate As SO4	mg/l	100.8	86.4	33.6	24	24	38.4	48	31.62	38.4	38.4	38.4	43.2
Chloride As Cl	mg/l	21	13	15	16	13	13	7	20	12	10	10	8
Iron As Fe	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrate A N	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Nitrite As N	mg/l	Nil	Trace	Nil	Nil	Trace	Nil	Nil	Nil	Nil	Nil	Nil	0.0003
Ammonical Ammonia As NH3	mg/l	Nil	Nil	Nil	Nil	Nil	Trace	Trace	0.030	Nil	Nil	Nil	Nil
Albuminoid Ammonia As NH3	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Fluoride As F	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Solid In Suspension dried at 105℃	mg/l	-	-	-	-	-	-	-	-	-	-	-	-
Total Dissolved solid at 180℃	mg/l	800	380	160	160	100	100	180	180	200	120	130	170

Appendix - 4

App 4.1 Cost Estimate for Construction Work by Sudanese Side

Appendix - 4

App 4.1 Cost Estimate for Construction Work by Sudanese Side

1. Roofing Work for Reservoirs

Construction Period: 81 days (estimated)

a)	Labor Cost	lump sum	LS	296,000
b)	Crane	charges for 60 days	LS	90,000
C)	Miscellaneous	1% of labor cost	LS	3,000
	TOTAL		LS	389,000
			(LS	390,000)

2. Warehouse Work

a)	Civil Work (Earth Work, Foundation Work, Concrete Work)	lump sum	LS	1,712,000
b)	Fabrication of steel beam, etc.	lump sum	LS	84,000
c)	Installation of materials for walls and roof	lump sum	LS	45,000
d)	Crane	charges for 18 days	LS	27,000
	TOTAL		LS	1,868,000
			(LS	1,870,000)

TOTAL (Item 1 + Item 2)		LS	2,257,000
		(LS	2,260,000)