WASH FIELD REPORT NO. 211

REHABILITATION STUDIES OF THE KISMAYO, SOMALIA WATER SUPPLY FACILITIES

Prepared for the USAID Mission to Somalia
under WASH Activity No. 318

by

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FEASIBILITY STUDY OF

REHABILITATION OF KISMAYO

WATER SUPPLY FACILITIES

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EXECUTIVE SUMMARY

During the period of March 15 through March 22, 1987 a team of WASH consultants conducted a field evaluation of the water treatment plant which serves the Town of Kismayo, Somalia. The Kismayo water treatment plant is operated by the Kismayo Water Agency. The treatment process train consists of intake and low lift pumping, chemical injection, pretreatment, sedimentation, filtration and high lift pumping.

The plant has been in operation since 1970 and has experienced operational problems since start-up. The problems can be categorized into three major areas:

1. Problems associated with lack of funds for proper maintenance and purchase of water treatment chemicals and spare parts.

2. Problems associated with the misapplication of certain water treatment technology to this East Africa setting.

3. Problems associated with high solids loadings from the Jubba River.

The objective of this WASH report was to advise USAID/SOMALIA on the immediate actions which should be taken to correct design and operating deficiencies at the water treatment and transmission facilities. To achieve this objective the WASH team reviewed each unit process to determine if each process could be renovated and upgraded or should be replaced.

A complete replacement of the entire facility was not considered a feasible option because:

1. The existing process train of coagulation sedimentation, filtration and chlorination is appropriate for the water quality of the supply system.

2. The major treatment structures (i.e., sedimentation basins, filters, clearwell) are in good condition.

The option of replacing the two major process steps (pretreatment and filtration) with a packaged, predesigned, factory assembled unit was considered and rejected. Most package units would increase the complexity of operation and maintenance and would require a larger lead time for manufacture.

Based on the field evaluation, findings and recommendations have been provided to upgrade certain unit processes; to complete additional improvements which will simplify the operation of other unit processes; and to correct design deficiencies throughout the plant.

The focus of the evaluation has been to upgrade the facility to deliver its approximate existing pumping capacity (6.06 ML/day). During the design of the improvements, a detailed hydraulic evaluation of the facility and the transmission main should be undertaken to determine its maximum hydraulic capacity. This is necessary because of the apparent potential for growth in the Kismayo area.

A brief review of the existing transmission main to the Town of Kismayo indicated that there are two sites where visible leakage is occurring from the pipeline. The WASH team recommends that the two visible leaks be corrected and that additional evaluations of the transmission pipeline and distribution mains within the Town of Kismayo be undertaken to quantify leakage that may not be visible.

Finally, the long term success of this renovation project is dependent upon the training of plant personnel in the operation and maintenance of the facility. It is the recommendation of the WASH team that during the start-up phase, a one month training program be undertaken.

CHAPTER 1

INTRODUCTION AND WATER QUALITY

1.1 Background

The Kismayo water treatment plant, transmission line, storage reservoir and distribution system were designed and constructed by the U.S. Corps of Engineers during the period 1966 to 1969 and the facilities were placed into operation in 1970. The plant has been operated by the Kismayo Water Agency (KWA) since then.

The treatment processes consist of: river intake and low lift pump facilities, chemical injection, pretreatment, sedimentation, filtration and high lift pumping. Settled sludge and filter backwash are returned to the river. The site plan and plant process flow diagram are shown in Figures 1.1 and 1.2.

After the plant was placed into operation, immediate major operational problems occurred due to the extremely large quantities of suspended solids in the River water. The flocculation and, sedimentation facilities were generating sludge loadings that could not be handled by the designed and constructed sludge handling facilities.

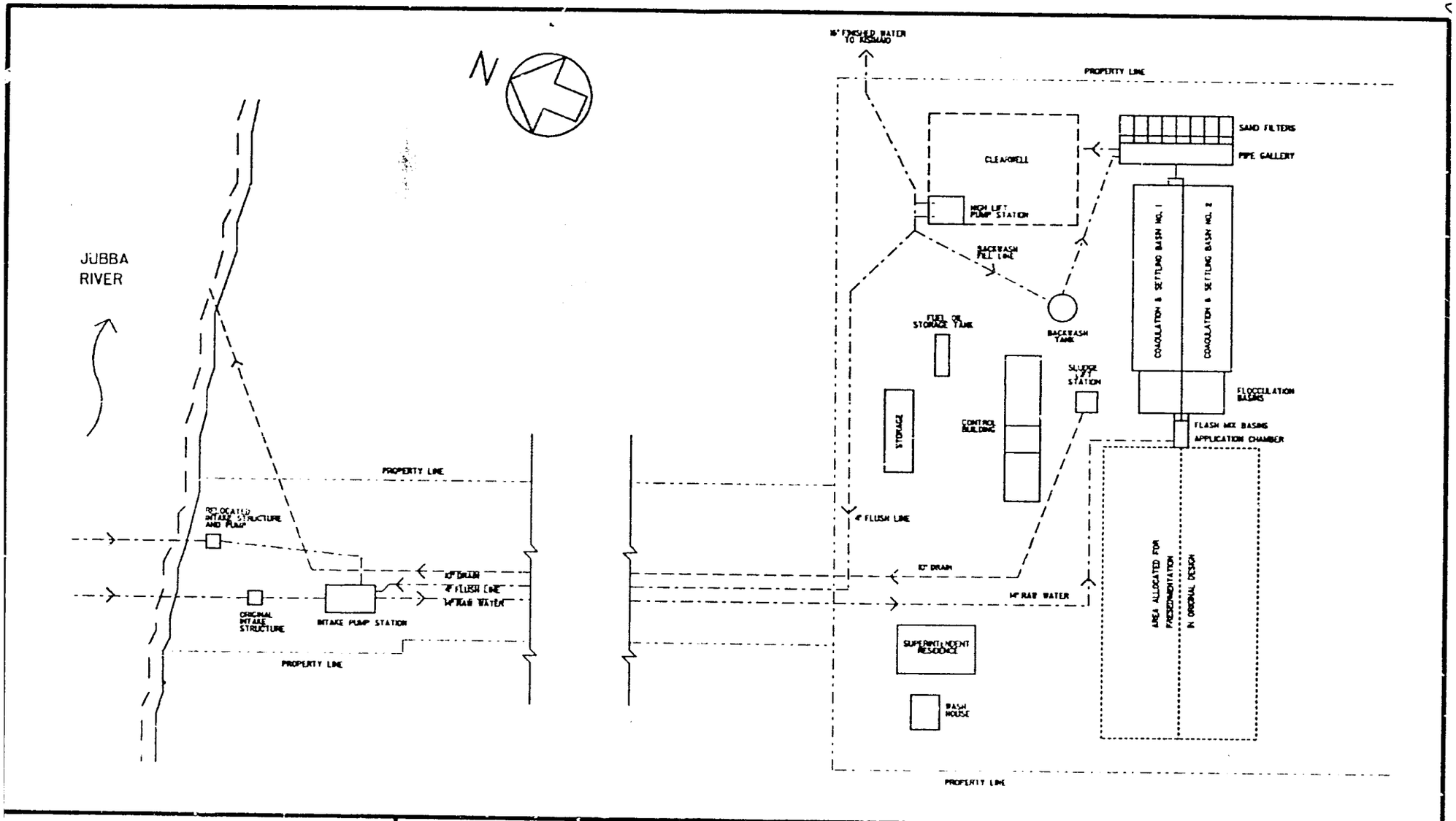
The other major factor contributing to operational problems and system failures was the lack of adequate spare parts, tools, service equipment, and training, to provide the required servicing and maintenance. Although the resulting operational problems were not manifested as quickly as those related to the sludge situation, over a few years time equipment started to fail because of the lack of ability and funding to provide proper operation and maintenance.

It has also been reported by several sources that the lack of currency to purchase chemicals required in the treatment process contributed to the inability of the KWA to treat water.

The resulting inability to operate the plant as intended, particularly the sedimentation and filtration processes, forced the plant operation to be essentially that of pumping untreated Jubba River water into Kismayo. This continues to be the practice.

Electric motors, pumps switchgear, chemical pumps, diesel engines were all severely affected by this absence of maintenance. In 1979 the electrically driven low lift pumps were replaced with one new diesel driven pump. A new intake was also provided at the same time. The pumps were replaced because of the inability to keep the two 125 kva diesel generator units in continuous operation. The intake was replaced due to clogging of the screen.

In 1983 the diesel engines for the two high lift pumps were replaced with Cummins diesel engines under assistance from USAID.



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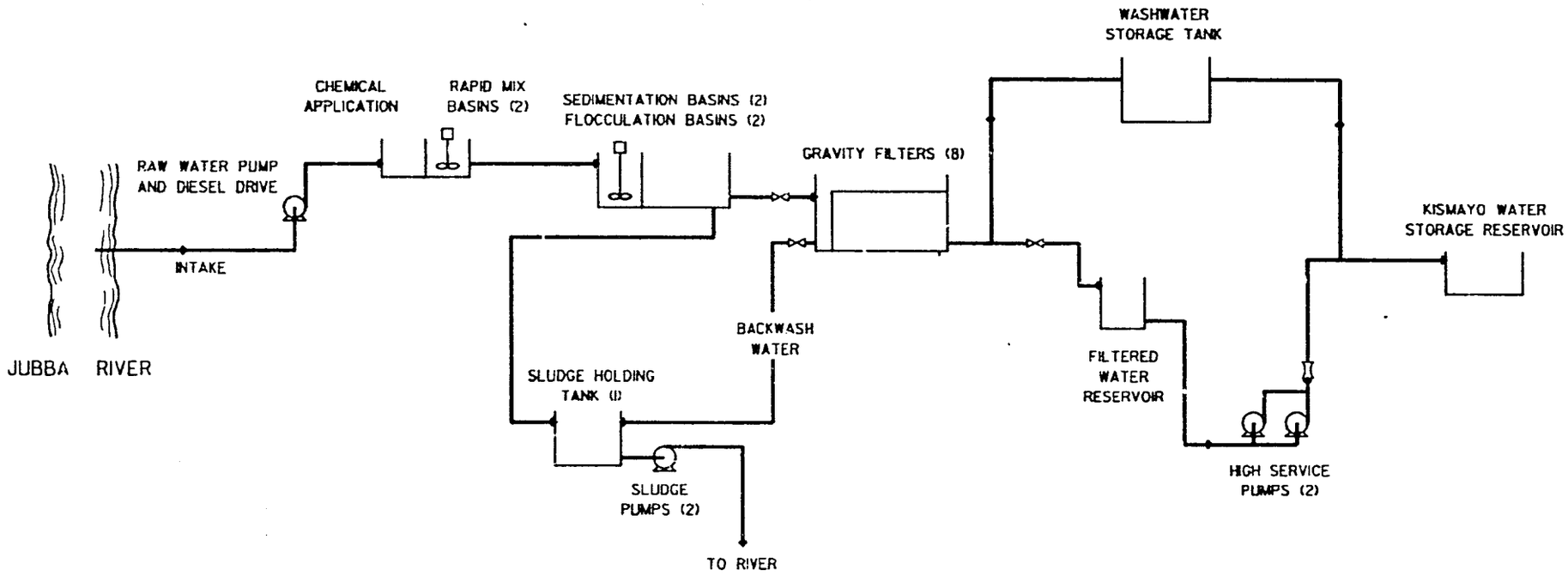
KISMAYO WATER AGENCY
WATER TREATMENT PLANT

SITE PLAN

SHEET NO.
1.1



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KISMAYO WATER AGENCY
WATER TREATMENT PLANT

PROCESS FLOW SCHEMATIC

SHEET NO.
1.2

In summary, the plant only operated in a satisfactory manner for a brief period early in 1970 and has served only as a source of untreated raw water for the last 15 to 16 years. The fact that the KWA has been able to achieve this continuing service is directly attributable to the significant and innovative efforts of Mr. Hersi Abdi Saddad, General Manager of the Kismayo Water Agency.

The descriptions of existing conditions that follow for each component of the water treatment process are based on a review of available drawings and three days of on-site field investigations and interviews during the week of March 15, 1987. The descriptions present a summary of the WASH team interpretations of the intended method of operations based on the facilities as designed and constructed and describe the current operating status.

1.2 Water Quality

The source of supply for the KWA water treatment plant is the Jubba River. USAID has funded a number of studies in the Jubba River Valley under the Jubba Development Analytical Studies (JUDAS) project. A part of that project, the Jubba Environmental and Socioeconomic Studies (JESS) included in the collection of water quality data. (See JESS Consultancy Report on Water Quality and Public Health Engineering prepared by Associates in Rural Development, Inc. and dated November 20, 1986).

Water quality was sampled in the irrigation zone at Jilib, Kamsuma, Ararac, Yontoy and Gob: and in the reservoir zone at Luuq, Borduba and Boardheers. Field measurements were made of PH, chlorides, dissolved oxygen, carbon dioxide, hardness and alkalinity. The oxygen, carbon dioxide and alkalinity field measurements were discarded due to interference with high turbidity.

In addition to the field analyses, larger samples were taken to NUS laboratory in Mogadishu for analyses. A summary range of expected water quality and a map of the Jubba River Valley in Somalia is included in Appendix A.

1.3 Objectives

The objectives of this report and the site visit by the WASH team and this report were to advise USAID/SOMALIA on immediate actions to correct design and operating efficiencies at the Kismayo water treatment and transmission facilities by completing studies leading to a recommended program of rehabilitation or replacement.

The following chapters summarize the findings of the WASH team. Those unit processes that the WASH team identified as requiring upgrading and additional improvements which in the opinion of the WASH team are required for the proper operation of the plant are discussed.

CHAPTER 2

INTAKE AND LOW PUMP FACILITIES

2.1 Existing Condition

The original intake and low lift pumping system consists of an intake pipe and strainer, intake structure, pump house and untreated water discharge main. The intake and screen extends about 24 meters into the river from the intake structure. The centerline elevation of the original intake is 1.2 meters.

The original structure houses a 24-inch intake and a 4-inch flush line to allow the intake to be flushed with water. The structure (Figure 2.1) is located along the river side of an existing dike.

The original design had two horizontal centrifugal pumps each rated at 6.06 cubic meters per minute and 18.3 meters total dynamic head. The original pumps were driven by electric motors supplied by two 125 kva diesel driven generators (Figure 2.2) located at the water treatment plant site. The pumps discharge into a 14-inch ACP untreated water discharge main which delivers water to the chemical applications chamber.

The pumps are housed in a 9 meter by 4.4 meter reinforced concrete block structure which is located about 13 meters from the river. The centerline elevation of the pumps is 3.9 m. Existing ground elevation is about 4.5. There is no air handling or dehumidification equipment in the building.

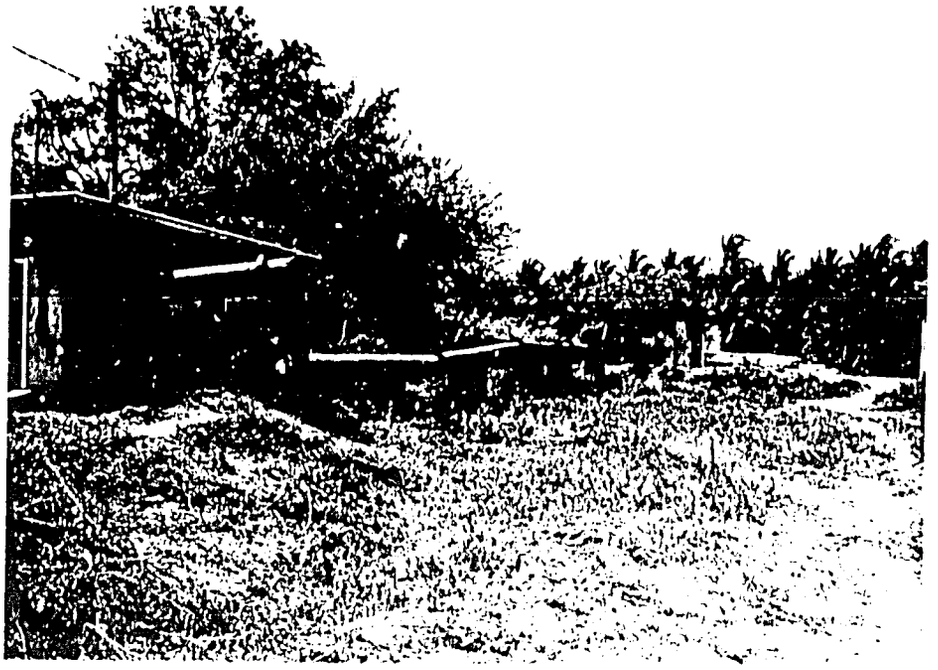
It has been reported that bottom sediments clogged the intake screen after several years of operation. Flushing, if attempted, was not successful and the intake was abandoned about 1979. The present intake is a 14-inch main. It was indicated that the end of the intake was about 2 meters above the bottom of the river.

During a visit by others to the site in December, 1983, it was reported that the original pump house was flooded. By that time KWA had modified the intake pumping arrangement by installing a single irrigation pump driven by a diesel engine, both manufactured in East Germany (Figure 2.3 and 2.4).

The pump and engine are installed on ground level at the top of the river embankment. There are no spare parts, no operating instructions, and no information on pump capacity. However, measurements were made of the flow over a V-notch weir during the WASH team visit that indicated a discharge of approximately 7 cubic meters per minute.

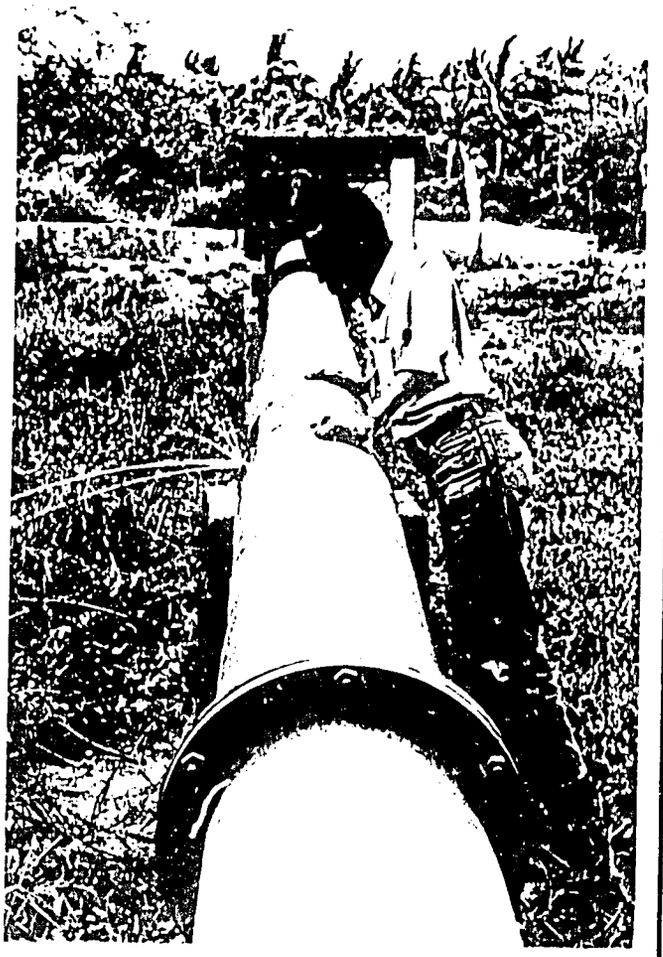
FIG. 2.1 ORIGINAL LOW LIFT PUMP STATION

FIG. 2.2 DIESEL DRIVEN GENERATORS

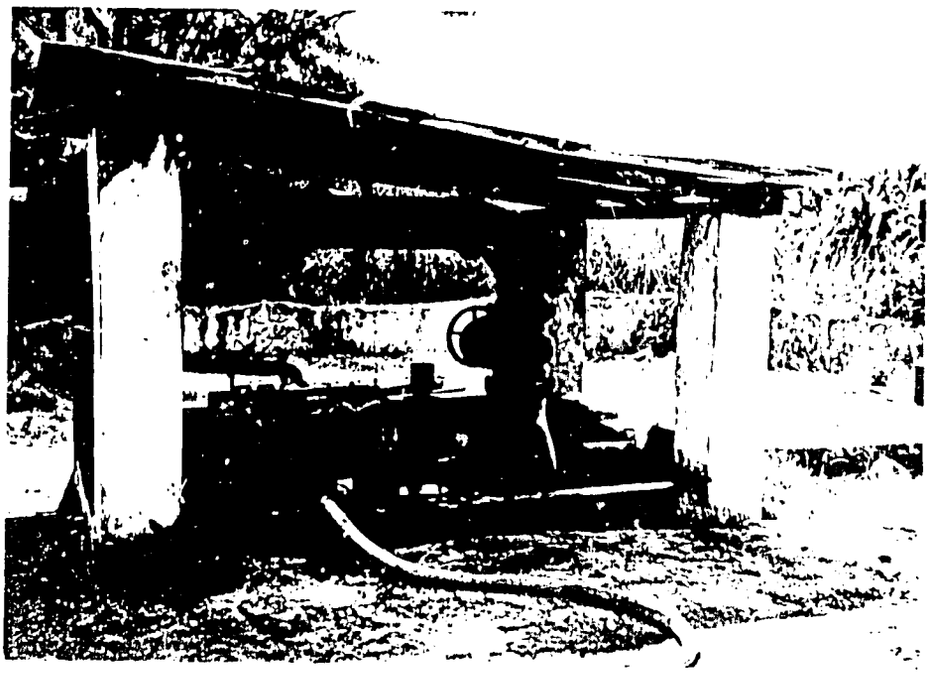


NEW WATER MAIN FROM LOW LIFT PUMP TO
– EXISTING ACP DISCHARGE MAIN. ORIGINAL –
PUMP HOUSE AT LEFT

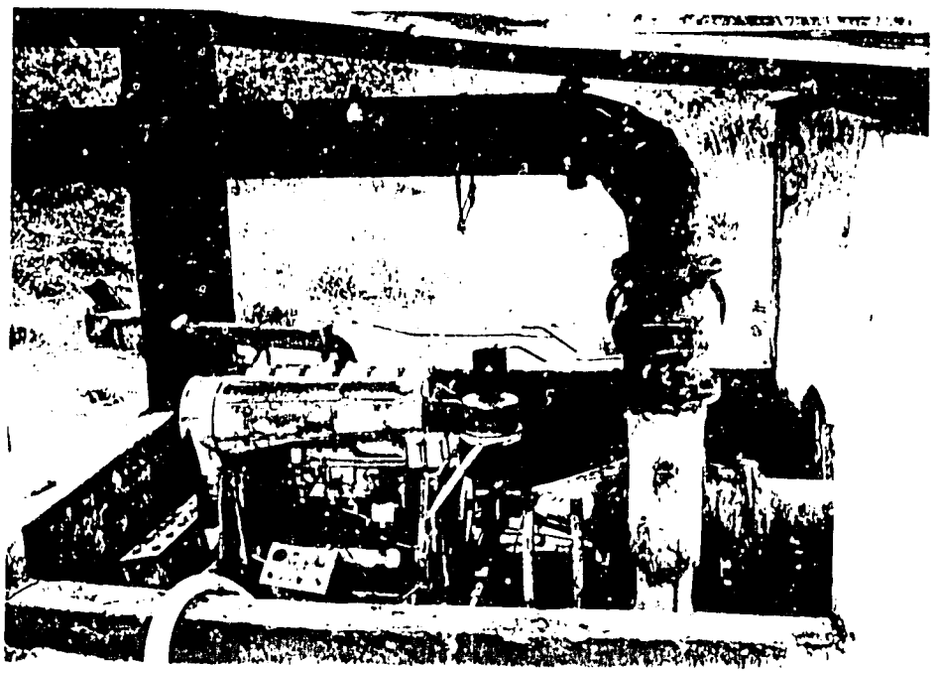
– NOTE LEAK IN EXISTING INTAKE LINE –



– FIG. 2.3 NEW INTAKE PUMP STATION –
AND PIPELINE



LOW LIFT PUMP AND ENGINE. NOTE SUMP PUMP DISCHARGE LINE WHICH IS USED TO DEWATER THE PIT



NOTE BATTERY ON FLOOR OF THE PUMP PIT

FIG. 2.4 LOW LIFT PUMP AND DIESEL DRIVE

2.2 Alternatives

There are three alternatives to upgrade the raw water intake and pump station. They are:

1. Rehabilitate the existing pump station.
2. Modify the existing pump station.
3. Construct a new pump station.

Rehabilitating the existing pump station includes removing and replacing the two existing pumps and electric motors, rehabilitating all valves and adding a sump pump. The rehabilitated station would employ a diesel driven generator as a source of power for the electric motors. The generator would be located in the generator room of the existing control building. The advantage of this alternative is that it utilizes the existing pump station. The disadvantage of this alternative is that it continues to rely on the original concept of a diesel driven generator. If the generator malfunctions, the intake pumps will not function.

Modifying the original pump station would include removing the existing two pumps and motors and replacing them with one new pump with a diesel drive, replacing interior piping and valves as required, rehabilitating existing valves which will remain in service and adding a sump pump to the pump station. This option eliminates the need for a generator but requires extensive modification to the existing structure which was not sized to accommodate diesel drives. A intermediate floor would have to be constructed to raise the diesel above existing grade and the station is only large enough to accomodate a single pump and diesel.

Alternative 1 would use the existing East German intake, pump and diesel drive for standby purposes because the existing pump station would house two new pumps and motors. Alternative 2 would utilize the existing East German intake as a standby while the East German pump and drive would function as the second pump.

Both the original and new untreated water pumps are located at an elevation that has experienced minor flooding during high river stages. The original design plans indicate a maximum flood stage of 4.5. However, due to the lack of historical data, it can not be assumed that higher flood stages will not occur. Whichever alternative is selected, additional flood control measures should be considered.

Under Alternative 3, a new pump station would be constructed between the existing pump station and intake structure. The pump station would be equipped with two diesel driven pump with the diesels located above anticipated flood levels. This alternative would utilize the existing East German intake for standby purposes.

2.3 Recommendation

It is the recommendation of the WASH team that a new pump station be constructed. All new work can be completed without interference with day-to-day operaton of the plant and the cost for the new station is approximately the same as the cost to modify the existing station.

CHAPTER 3

PRETREATMENT ISSUES

3.1 Existing Condition

The pretreatment process train consists of an application chamber, two flash mix basins, and two flocculation basins. Untreated water is pumped from the intake to the application chamber where chemicals, if available, are added.

The plant is equipped to feed four chemicals: line, aluminum sulfate, soda ash and chlorine. Solutions of all chemicals applied in the application chamber - chlorine, alum and soda ash are injected using chemical pumps and 1-inch wrought iron feed lines. Lime is delivered by gravity in a elevated lime solution trough (Figure 3.1). The trough is a 6-inch steel pipe with flushing ports spaced along the length from the chemical room to the application chamber. The rate of flow to the chamber and control of chemical pumps is designed to be based on operation of a flow switch located on the untreated water influent to the application chamber. The chamber is a "U" shaped rectangle 0.75 m wide by 7.85 meters long with a design water depth of 1.45 meters.

From the application chamber water flows through 14-inch openings in a common wall to the flash mix chamber. The flash mix chamber can be isolated from the application chamber by means of 14-inch shear gates. As far as can be determined the shear gate valves are not operable.

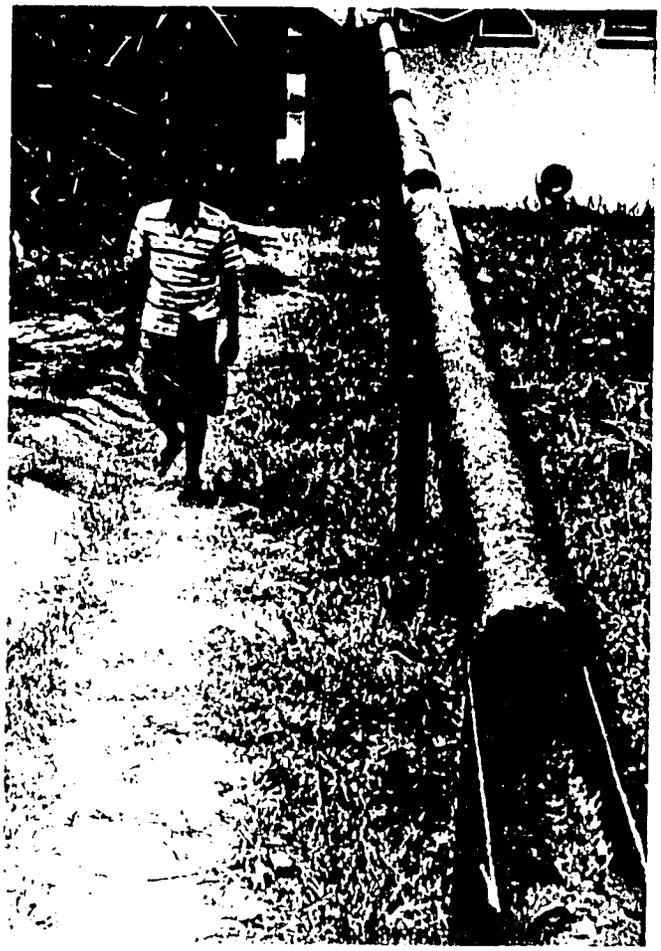
Each flash mix chamber (Fig. 3.2) is 1.45 meters square with a total depth of 2.01 meters and a design water depth of 1.25 meters. Water enters the flocculation basins via flow over weirs located in a common wall with the flocculator basin.

Each flash mix chamber is equipped with a Model 116-RELD-22 flash mixer. The mixer is a vertical turbine with a 0.8 meter carbon steel blade powered by a 2 Hp motor.

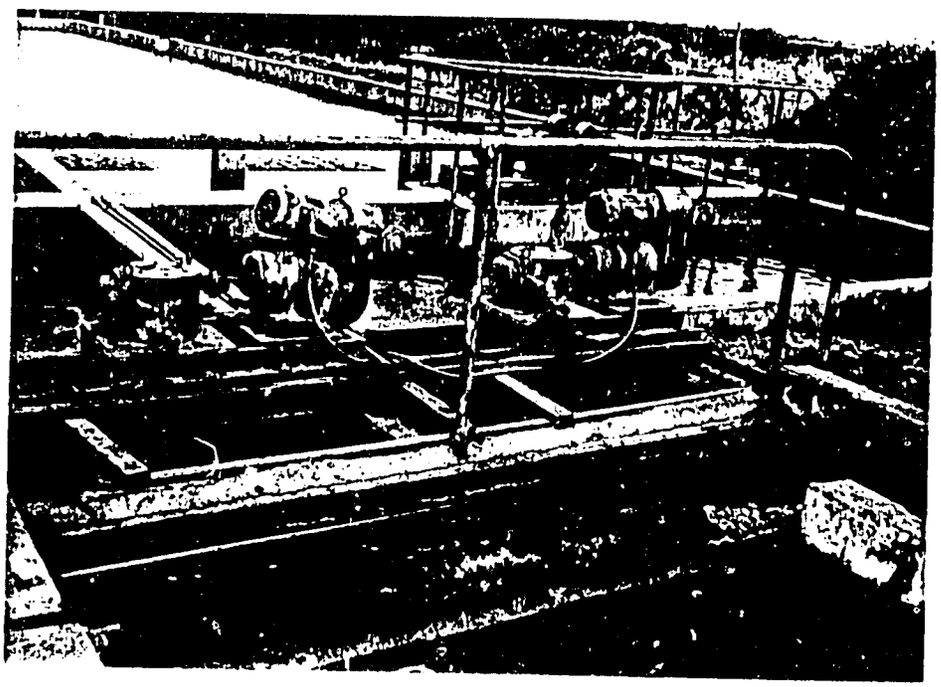
Each flocculator basin is 6.75 meters square with a total depth of 4.97 meters and a design water depth of 3.97 meters. Water enters the sedimentation basins by flowing over weirs located along the common wall between the flocculation basins and the coagulation basins. The basins are equipped with a rotating paddle frame which supports vertically mounted redwood paddle blades. The frame is driven by a 5 HP V-belt drive motor.

Both the flash mixers and the flocculators were manufactured by Dorr Oliver Inc., Stamford, Connecticut, USA.

In the late 1970's KWA was no longer able to operate the twin 125 KVA diesel generators which supplied power to the flash mixers, flocculators and all electric motors in the plant. It is our understanding that the motors on the flash mixers and flocculators have not been operated since then.

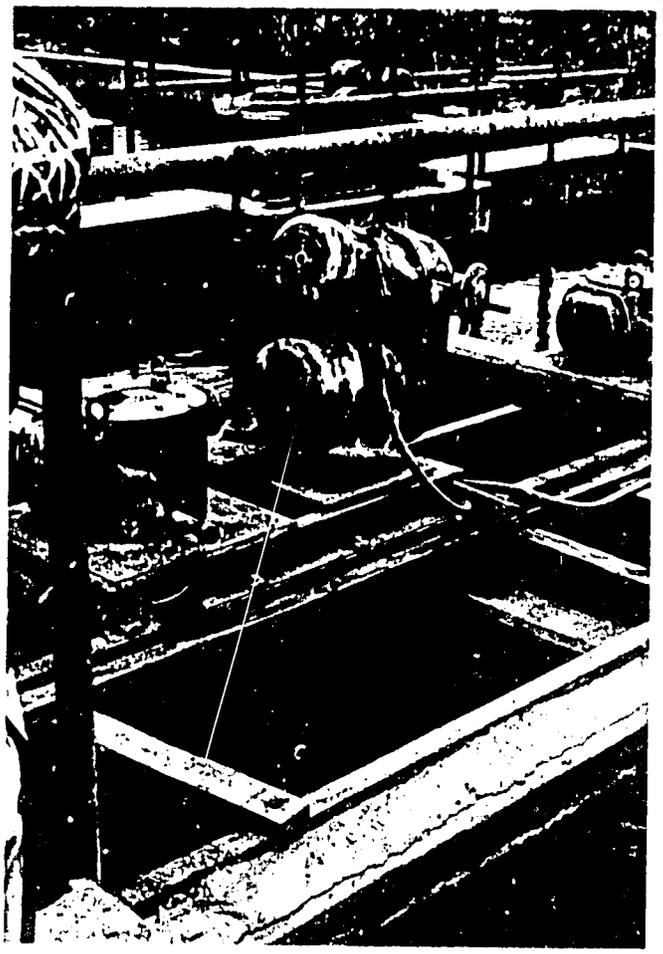


LIME SOLUTION TROUGH FROM CHEMICAL MIX TANKS



LIME SOLUTION TROUGH AND SECTION OF CHEMICAL APPLICATION CHAMBER

FIG. 3.1 CHEMICAL APPLICATION AND RAPID MIX CHAMBERS



ONE OF TWO FLASH MIXERS WITH THE MOTOR PARTIALLY DETACHED FROM THE RIGHT ANGLE DRIVE

WEIR CONTROLLING FLOW TO THE SEDIMENTATION BASINS FROM THE FLOCCULATION BASINS

FIG. 3.2 FLOCCULATION BASINS

3.2 Alternatives

The original design anticipated the need for presedimentation of Jubba River water by allocating space for future basins. Alternative materials for use in the basins include portland cement or bituminous concrete lining.

Either material may be appropriate pending further site investigation.

There are two alternatives to upgrade the flash mix and flocculation basins. They are:

1. Rehabilitate the existing pretreatment units.

2. Modify the pretreatment process.

Rehabilitating the existing pretreatment equipment includes removing and replacing the flash mixers and flocculators. The advantage of this alternative is that it is a simple replacement of equipment that KWA has operated in the past. The disadvantage is that the existing mechanical equipment requires regular maintenance and spare parts and relies on diesel driven generators for power. If the generator malfunctions, the mixers and flocculators will not function.

Modifying the pretreatment process includes installing a parshall flume between the presedimentation basins and the chemical application channel, removing the flash mixers and flocculators and installing baffle walls in the flocculation basins. This option eliminates maintenance of complicated mechanical equipment and the need for a generator. However, it requires the construction of a hydraulic mixing device and static mixers within the existing basins. Alternative 2 is an application of simpler technology. Under either alternative the inlet control to the sedimentation basins will have to be modified by construction of a new wall with discharge ports. The ports will prevent short circuiting of the flow within the sedimentation basins.

3.3 Recommendation

It is recommendation that the periodic high silt load in the river water to be removed by installing two presedimentation basins ahead of the chemical application basin. It appears that the original design anticipated the need for presedimentation. The original design drawings show an area on the site where space had been allocated for presedimentation basins.

The basins will be equipped with a weir structure at each end to control flow and water level. Raw water will be pumped to the presedimentation basins. Silt removal would be done using a backhoe or manually loading a truck which could be backed into one end of the basins.

Overflow from the basins will pass over a weir and into a parshal flume where chemicals will be added. The hydraulic drop would provide mixing and eliminate the need for flash mixers.

The WASH team recommends that the chemical application chamber be modified, the flash mixers and flocculators be removed and the flash mix basins and flocculation basins be modified. Pretreated water will flow to the sedimentation basins through a wall with equally spaced ports.

These improvements will eliminate the need for electric motors to drive the flash mixers and flocculators, which will also reduce the size of electrical generating equipment. There is an additional benefit that there is less mechanical equipment to maintain.

CHAPTER 4

CHEMICAL SYSTEMS

4.1 Existing Condition

The KWA water treatment plant was designed and constructed to feed four chemicals: lime, aluminum sulfate (alum), soda ash, and chlorine.

Chlorine is used for disinfection and can be fed at two locations: the application chamber, and after filtration. The first application point is intended to reduce the bacterial load on the filters; the seconds application point is final chlorination with contact time in the clearwell.

Chlorine is supplied in pressurized gas cylinders which delivered chlorine to two BIF Model 854 chlorinizers, each capable of feeding 182 kg per day of chlorine gas. Concentrated chlorine solution is pumped by two Aurora booster pumps to the injection points.

The existing chlorine feed room is shown in Figure 4.1. It is our understanding that the chlorine feed system functioned for two or three years and has not been used since.

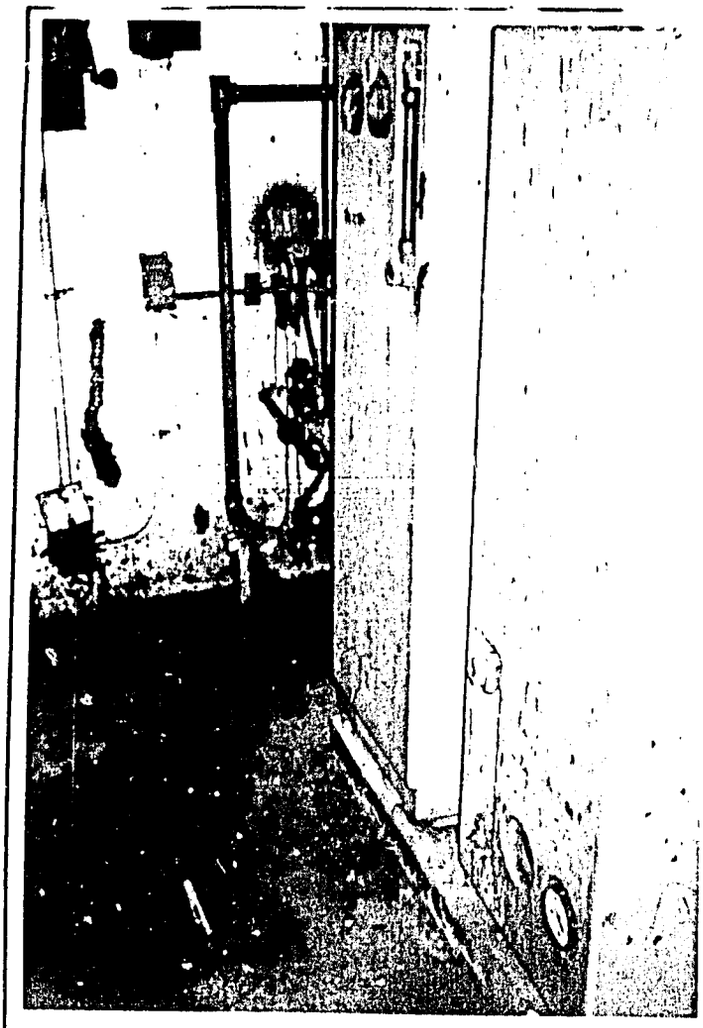
Alum is used as a coagulant aid in the sedimentation process. The design provided for delivery in dry form and for mixing with water into two cubic meter polyethylene storage tanks. Each tank is equipped with a 3/4 Hp propeller mixer. There is no equipment available to load the alum tank which is 180 cm high and located on an angle iron support. The design provided for alum feed to the application chamber with a BIF Model 1730 Simplex Adust-O-Feeder.

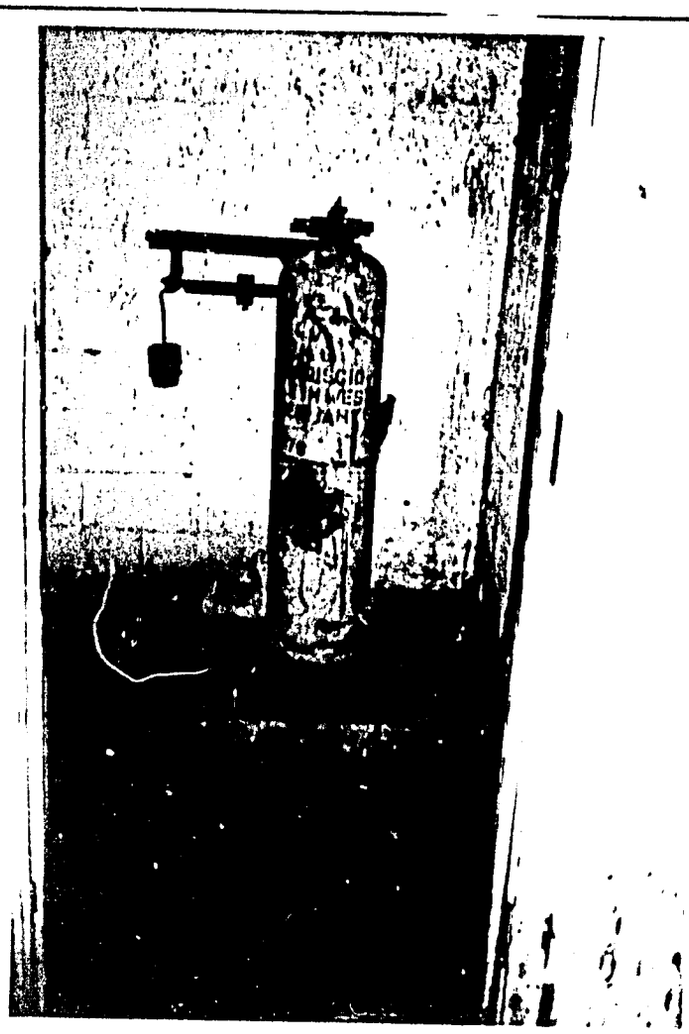
The alum tanks (Figure 4.2) are severely deteriorated. The mixers and chemical feed equipment have not been used since the late 1970's.

Soda ash was to be used with lime to raise the ph and soften the water thereby assisting in the coagulation process. Both chemicals were delivered in dry form and mixed in water. Each chemical was intended to be mixed and polyethylene storage tanks equipped with 3/4 Hp propeller mixers. The lime tank has a capacity of 525 gallons and is of the same dimensions as the alum tanks.

The soda ash tank has a capacity of 350 gallons and is 1.22 meters high. The lime and soda ash tanks (Figure 4.3) are severely deteriorated. The mixers and chemical feed equipment have not been used since the late 1970's.

Similar to the alum tanks, the design and constructed facilities did not include equipment to load the soda ash and lime tanks. The chemical facilities are not located in an area where the chemicals can be easily handled and the equipment can be maintained.





NOTE DISCONNECTED PIPING
AND UNCOVERED
ELECTRICAL JUNCTION BOX

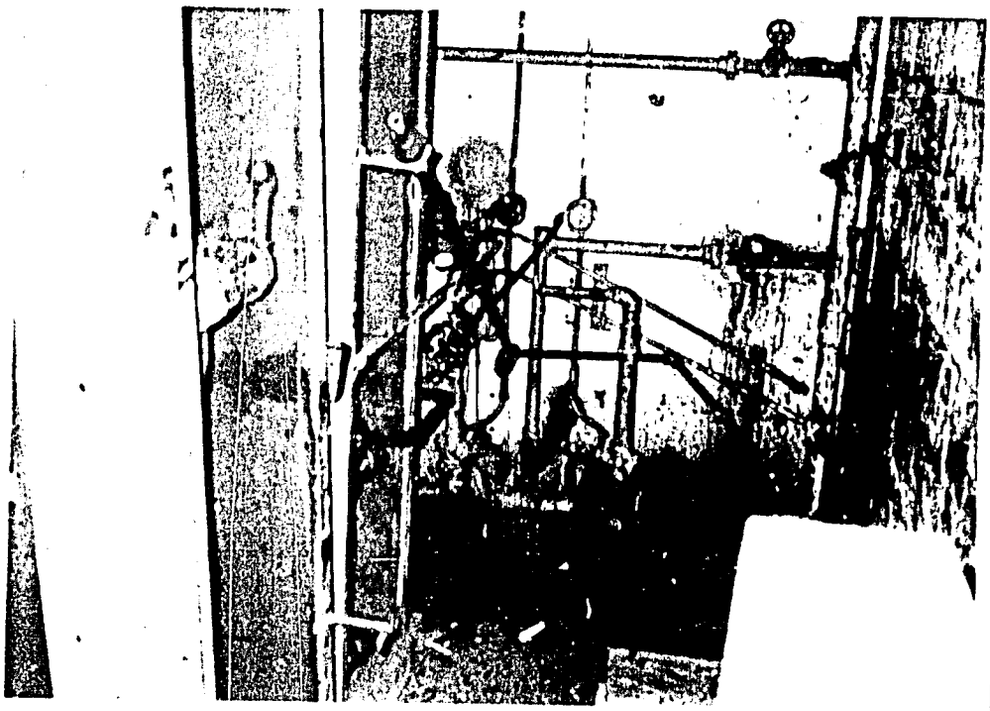
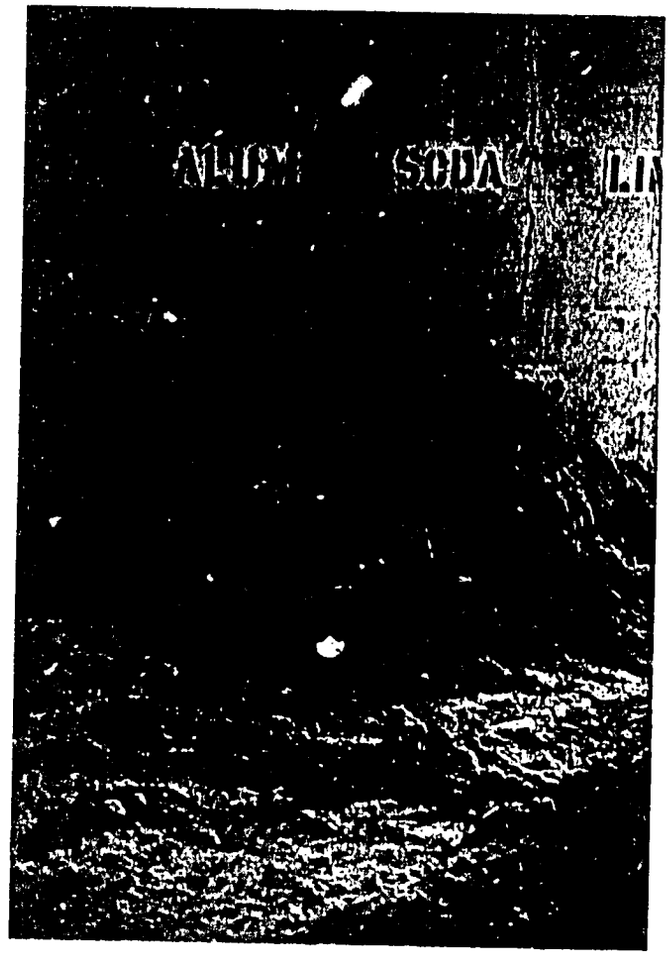


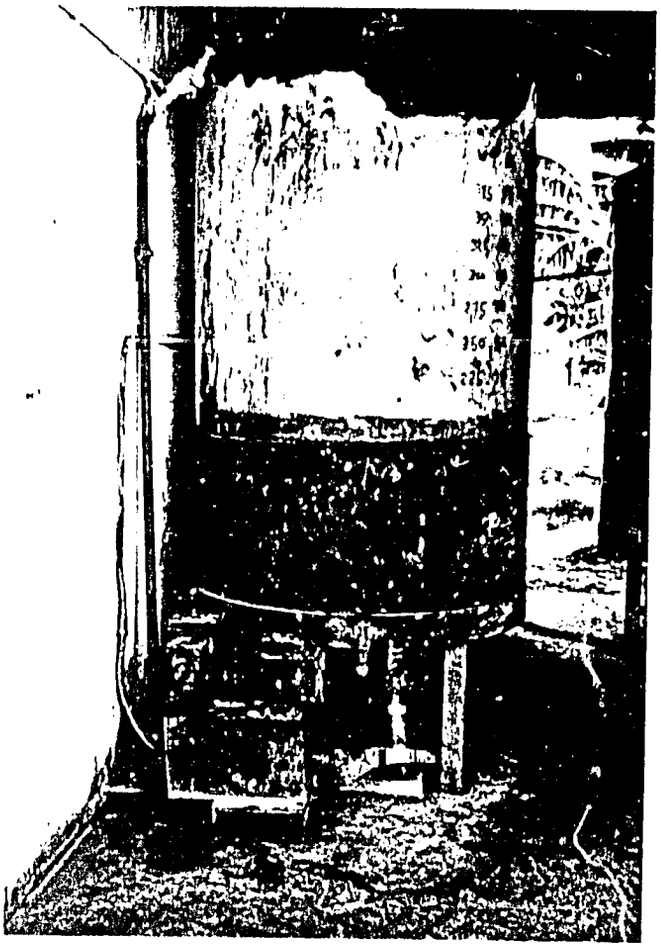
FIG. 4.1 CHLORINE FEED ROOM

NOTE LACK OF FACILITIES TO LOAD CHEMICALS INTO TANKS FOR MIXING



DRY CHEMICAL STORAGE AREA. NOTE NO BAGGED STORAGE

FIG. 4.2 ALUM TANKS AND CHEMICAL STORAGE AREA



SCREEN USED FOR SIFTING CHEMICAL BY HAND

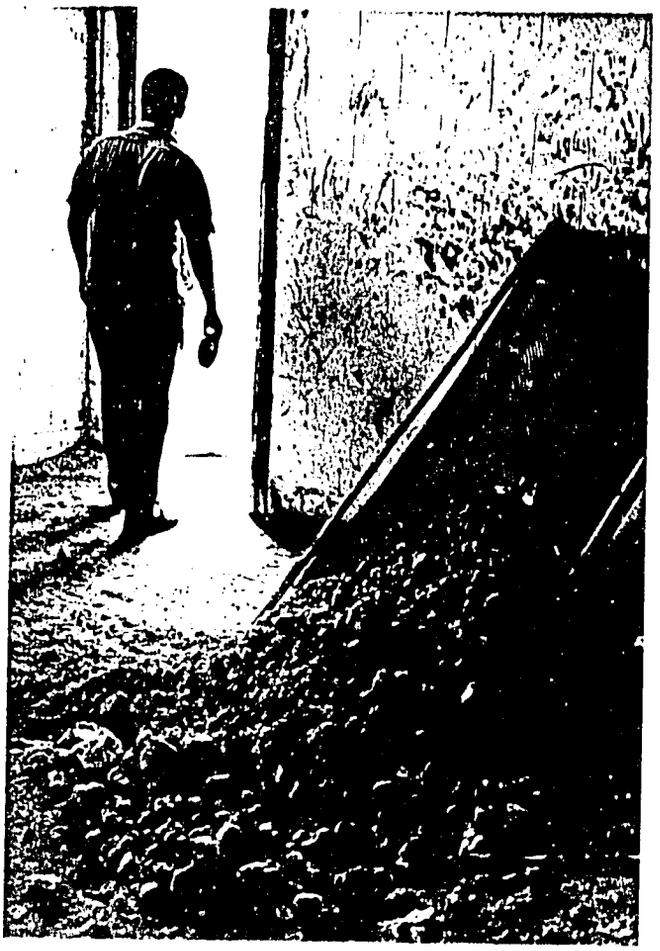


FIG. 4.3 LIME TANK AND CHEMICAL STORAGE ROOM

4.2 Alternatives

There are two alternatives to upgrade the chemical feed systems. They are:

1. Replace the existing chemical feed equipment and add a stairway to allow the chemical tanks to be loaded.

2. Construct a new chemical feed building between the presedimentation basins and the chemical application chamber.

Alternative 1 is a simple replacement of equipment KWA has operated in the past. The disadvantages include:

1. Chemical equipment was not properly located in the original design.

2. There are no means to handle and store bagged chemicals.

3. The system must rely on diesel driven generator units for power.

Alternative 2 includes new storage tanks, manual mixers and a gravity feed system for alum, lime and soda ash. The storage tanks and feed systems will be located on an elevated floor to allow for gravity feed of chemicals into a parshall flume. The lower level below the tanks can be used for storage. A manual hoist will be provided to lift the bagged chemicals to the upper level.

Existing chlorination equipment will be replaced with wall mounted units operated by water pressure provided by the high lift pumps. New chlorination equipment will be located in the existing control building. This will eliminate the need for the chlorinators and pumps in the original design.

4.3 Recommendation

The WASH team recommends alternative 2. It is an application of simpler technology and corrects original design deficiencies. It also eliminates the reliance on a generator to provide power for chemical feed.

CHAPTER 5

SEDIMENTATION

5.1 Existing Condition

It has been reported by others that the Jubba River is a highly turbid, slow moving watercourse. The heaviest silt load is reputedly in the bottom portion of the river cross-section. This condition is aggravated during periods when the river receives heavy runoff. (Approximate elevation 1.2 m).

Installation drawings indicate that the original intake was located within the zone of highest turbidity where the silt load was the highest. When the new low lift pump facility was installed, a new intake at a higher elevation (approximate elevation 3.0 m) was installed.

The existing sedimentation basins (Figure 5.1) are 8.5 meters wide and 34.7 meters long. The basins have a total depth of 4.27 meters and a design water depth of 3.66 meters. Each basin contains 19.3 linear feet of weir plates to control overflow from the basin. The floor of the basin slopes back to the inlet at a slope of 0.5 percent. There is no sludge collection mechanism in the sedimentation tanks.

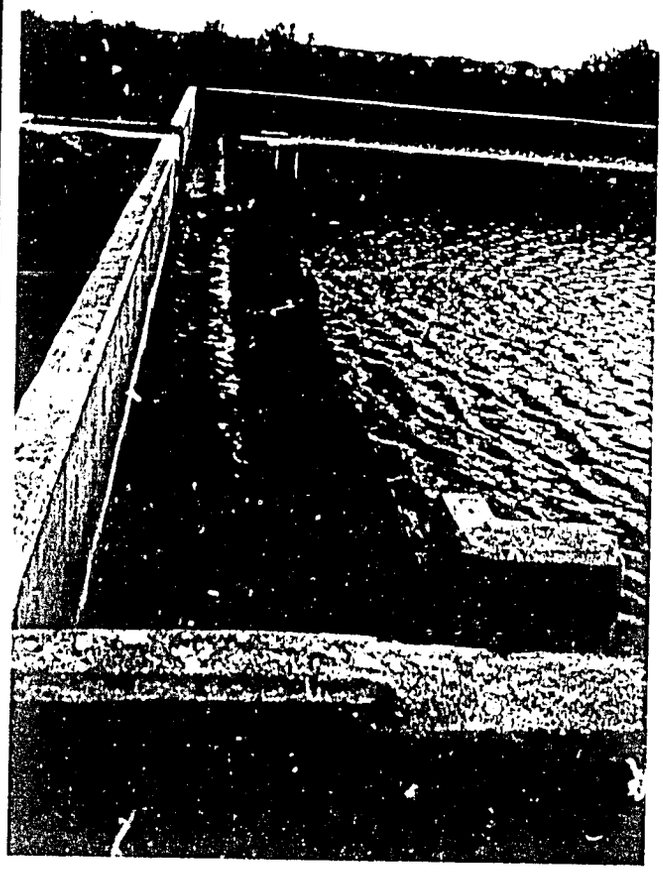
Operating instructions indicate that the operation should establish a cleaning schedule based on the time required to build up a silt depth of 18-inches in one sedimentation basin. It was intended that sludge be drawn off by a 6-inch drain located in the west (inlet) corner of each basin. Each drain line runs to a common sludge collection sump which is described in Section 6.

It appears that due to a heavier than anticipated silt load and/or operator inattentiveness, solids accumulate to a much greater depth than intended by the designer. This concentrates the sludge within the sedimentation basin and makes sludge removal more difficult. Sludge volume and concentration require that each basin be taken out-of-service for cleaning.

The method of sludge removal consists of removing one basin from service and manually shoveling sludge over the basin walls. It has been reported that one basin is cleaned on an average of once every four months. Since there is no method of removing sludge from the site, the usual disposal area is in the immediate vicinity of the sedimentation basins. (Figure 5.2).

5.2 Alternatives

Since the anticipated silt load is high, it is recommended that pre-sedimentation units be installed in the treatment process ahead of the chemical application basin. In addition to pre-sedimentation, there are two alternative improvements:



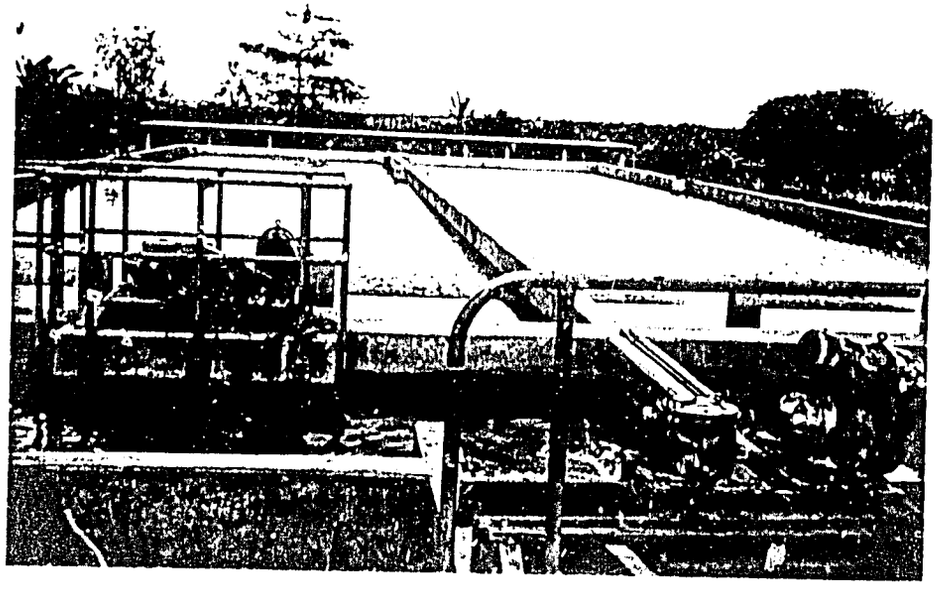


FIG. 5.1 EXISTING SEDIMENTATION BASINS

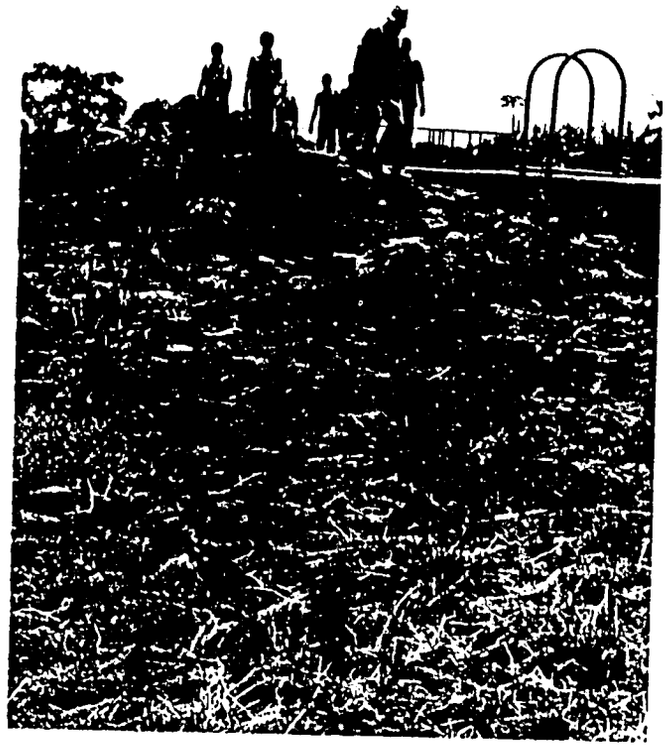


FIG. 5.2 SLUDGE DISPOSAL AREA ADJACENT TO SEDIMENTATION TANKS

1.0 Install mechanical sludge collection in the sedimentation basins.

2.0 Modify the interior of the basins to direct sludge to sludge draw-off pipes placed in the bottom of the sedimentation basins.

There are no advantages to Alternative 1. It is a more complicated technology. It requires an electric generator to drive the equipment and the system is more difficult to maintain.

Alternative 2 consists of perforated PVC pipe and valves and a sludge collection trough in parallel with each sedimentation basin. Sludge can be drawn from each basin using the valves. The operator can observe the concentration of the sludge. There is little mechanical equipment to maintain and the system uses no electric power.

Under either alternative the inlet wall to the sedimentation basins should also be modified to improve flow characteristics and prevent short circuiting. The sludge that has been disposed adjacent to the sedimentation basins should be removed and/or regraded. The existing wooden V-notch weir should be rehabilitated.

5.3 Recommendation

The WASH team recommends Alternative 2.

CHAPTER 6

SLUDGE HANDLING

6.1 Existing Condition

There are four process sidestreams that are piped to a central sludge pumping facility. They are: flocculation basin drains (two 8-inch lines), sedimentation basin drains (two 8-inch lines), filter backwash (one 10-inch line), a filter to waste drain (one 4-inch line), and the overflow from the septic tank that serves the superintendent's residence and the administration building (8-inch). The sludge holding facility is approximately 31.5 meters square and 6 meters deep (Figure 6.1). The wet well is designed to have a maximum storage of 3,225 cubic meters. The wet well appears to be of sufficient volume to process the anticipated sludge loads, if pretreatment basins are installed before sedimentation.

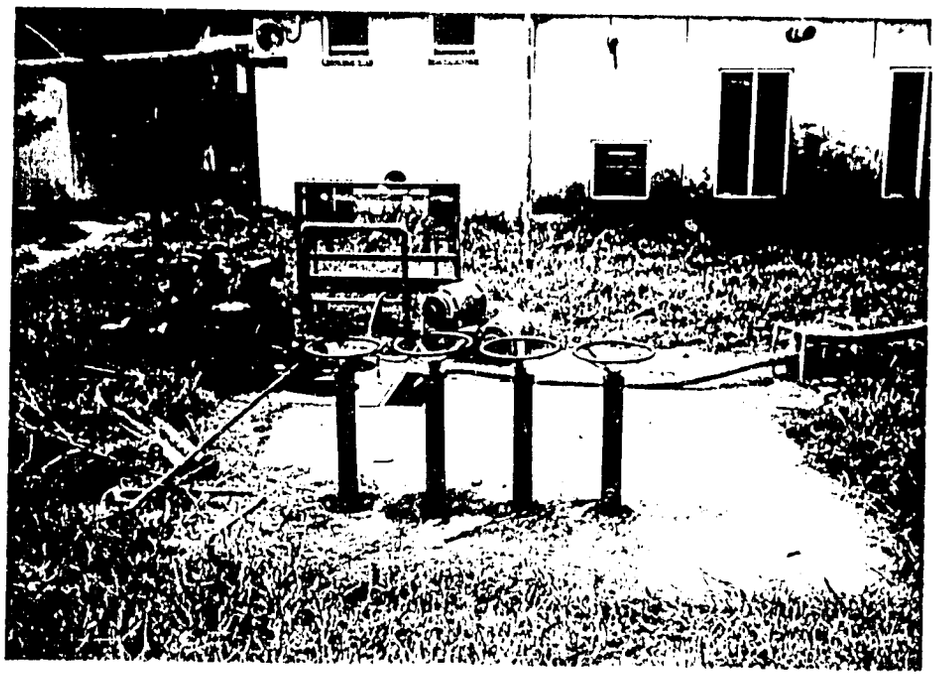
The original design provided space for two non-clog sump pumps (Figure 6.2) each to have a capacity of 2.27 cubic meters per minute at a TDH of 12.2 meters. The pumps were designed to be powered by 10 Hp electric motors. Sludge was to be disposed by pumping to the Jubba River below the intake. As previously described, the sludge pumping facilities failed shortly after the plant was placed into operation and the pumps have been removed from the site. Factors that may have contributed to failure include:

- Higher than anticipated sludge concentrations.
- Lack of generators capability to power the electric motors.
- A plugged river discharge line.

6.2 Recommendation

There are no disposal alternatives to the Jubba River other than concentrating the sludge in lagoons for removal by earth moving equipment. This is not considered feasible since alum sludge is hydrophilic and is best dewatered by freeze drying or mechanical separation. If water conservation is a consideration in the future, the backwash water may be recycled by pumping to the pre-sedimentation basins to reduce sludge volume.

It is the WASH team recommendation that the existing sludge handling facilities be rehabilitated. The proposed work includes removing and replacing the sludge pumps and motors, cleaning the influent lines to the sludge pumping wet well and cleaning the pump discharge to the river. The pumps could be powered by diesel drives as an alternate to electric motors driven by a generator. The diesel drive alternative is preferred.



NOTE VERTICAL PUMPS HAVE BEEN DISCONNECTED FROM DISCHARGE LINES (HOLDING TANK BELOW)

VALVES DRAIN FLOCCULATION BASINS (2) AND SEDIMENTATION BASINS (2)

FIG. 6.1 SLUDGE HOLDING TANK

FIG. 6.2 SLUDGE PUMPS

CHAPTER 7

FILTRATION

7.1 Existing Condition

There are eight filters at the KWA water treatment plant. Each filter is 2.55 meters wide and 4.25 meters long. The filters contain 0.75 m of sand intended to have an effective size between 0.4 and 0.55 mm (Figure 7.1).

The sand is supported by 0.3 m of gravel which is divided into four layers. The gravel is supported by Leopold clay tile block underdrains. Figure 7.2 shows the sand, gravel and clay tile which were exposed during the visit to the plant on March 17 to March 20.

Each filter contains two backwash water troughs which run the length of the filter. The troughs are constructed of reinforced concrete and are 0.5 meters above the water surface. Within the filter gallery there are four pipe manifolds: untreated water, treated water, backwash waste. Each filter can be individually backwashed.

There are six manually operated gate valves for each filter. The valves were not operated during the visit. There is a 8-inch BIF Model RCE filter rate of flow controller on each filter. The rate of flow controllers do not appear to be operable.

Each filter is equipped with gage glasses to measure loss of head across the filters. None of the gage glasses were able to be used to measure loss of head due to the need for the lines to be flushed. There is a 10-inch BIF Model RCE backwash rate of flow controller on the backwash influent line. It is not operable. Figure 7.3 shows the pipe gallery and the 10-inch backwash rate of flow controller.

7.2 Recommendation

It is the recommendation of the WASH team that the existing filters be rehabilitated and modified. The proposed work includes installing orifice plates on the filter influent lines, removing the rate controllers, installing a weir box in the clearwell to control water level, removing the backwash water flow control valve, rehabilitating gate valves, removing and replacing filter media, and cleaning and repairing filter bottoms.

These modifications will simplify the filtration and backwash process by eliminating the rate controllers and the need to measure loss of head across the filter bed. The modifications also make maximum use of the existing facilities at minimum cost.

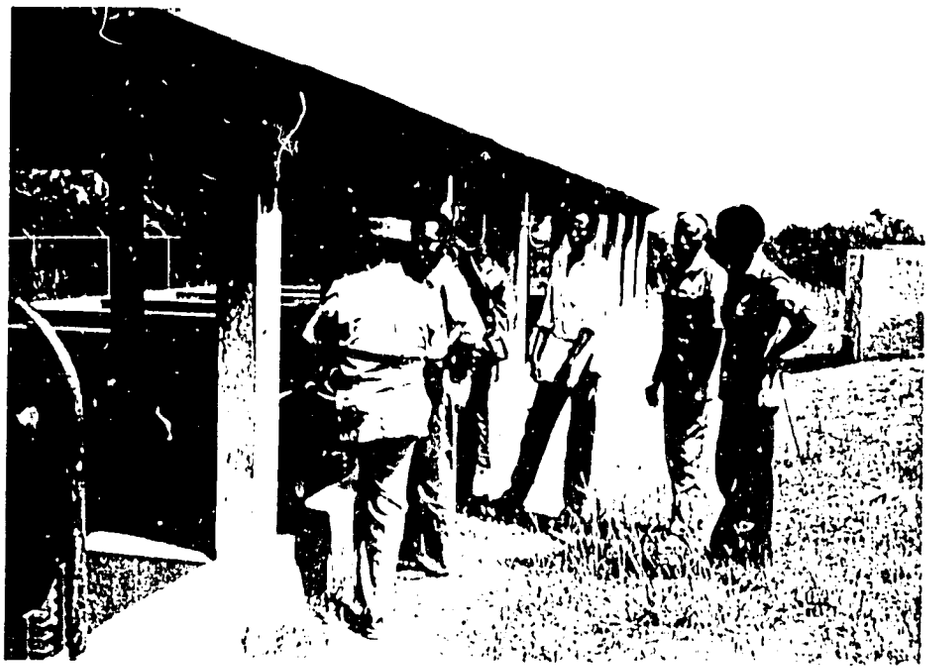
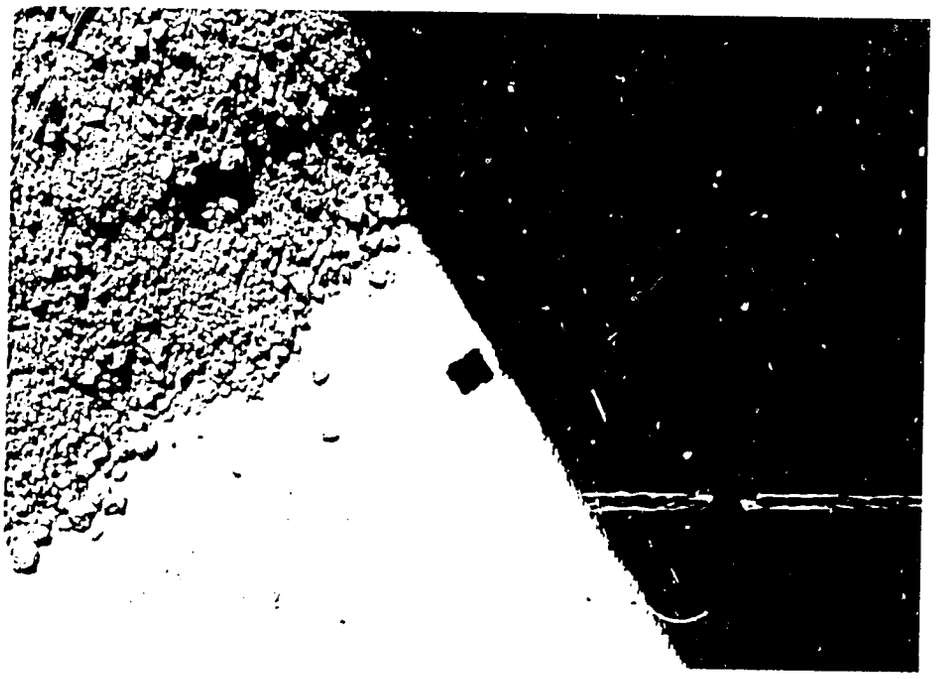


FIG. 7.1 FILTERS AND COVERED PIPE GALLERY



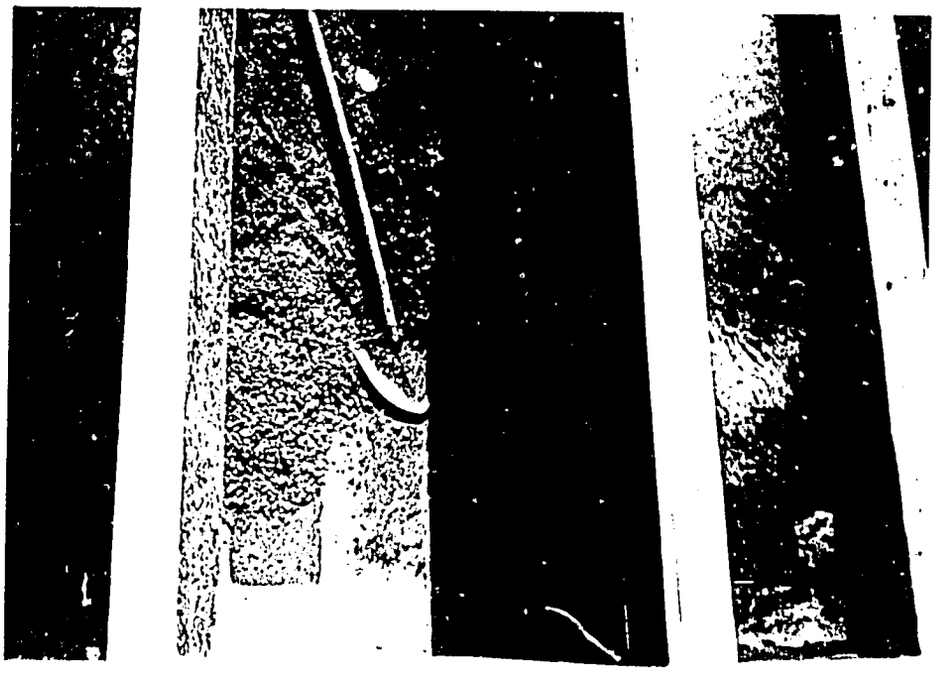
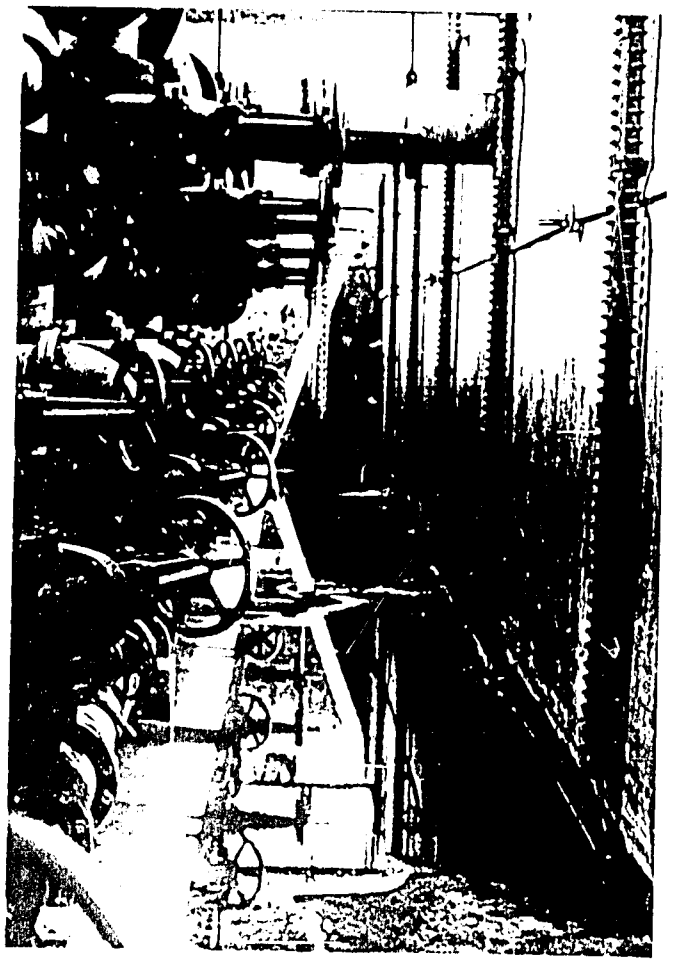


FIG. 7.2 FILTER BOX WITH EXPOSED CLAY TILE UNDERDRAIN



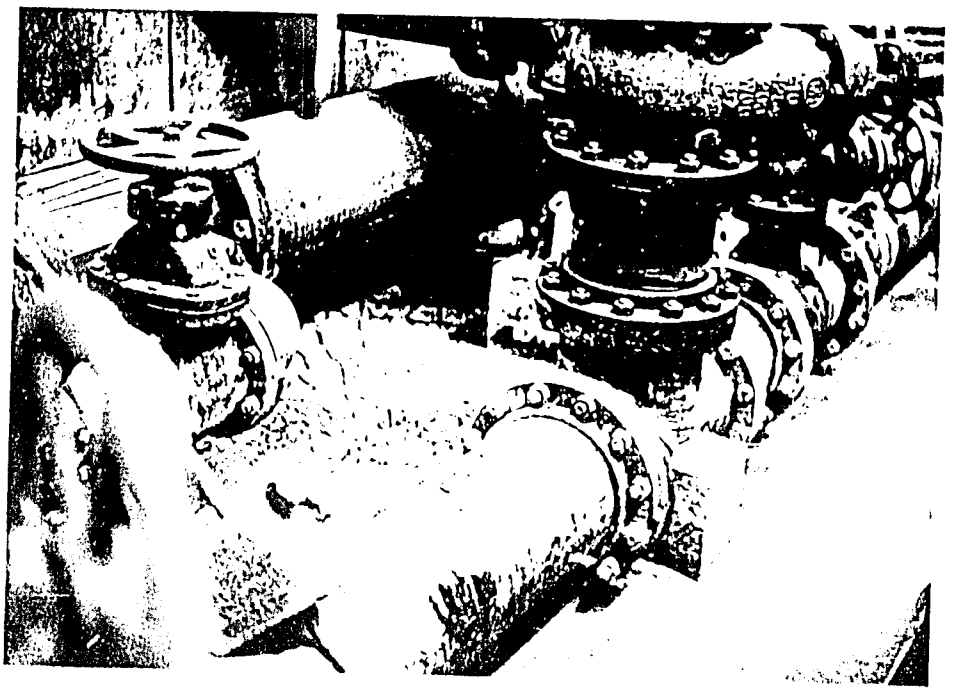


FIG. 7.3 PIPE GALLERY AND BACKWASH RATE CONTROLLER

CHAPTER 8

HIGH LIFT PUMP FACILITIES

8.1 Existing Condition

The existing facilities consist of the following:

- Two Cummins diesel engines furnished by Kirloskar of India in 1983. These units replace the original diesel engines of 210 Hp.

- Two deep well vertical turbine pumps with right angle gear drives. 1600 gpm, 520 ft. head at 1800 rpm.

The original pumps continue to operate without any apparent difficulties. The original diesel engines became inoperable with the lack of spare parts, proper tools for maintenance, and the complete lack of funding for servicing and maintenance. That same condition now exists with the Cummin diesels and a proposal is being considered for replacement of both the pumps and diesel engines.

8.2 Alternatives

There are two alternatives:

1. Overhaul existing diesel engines and pumps.

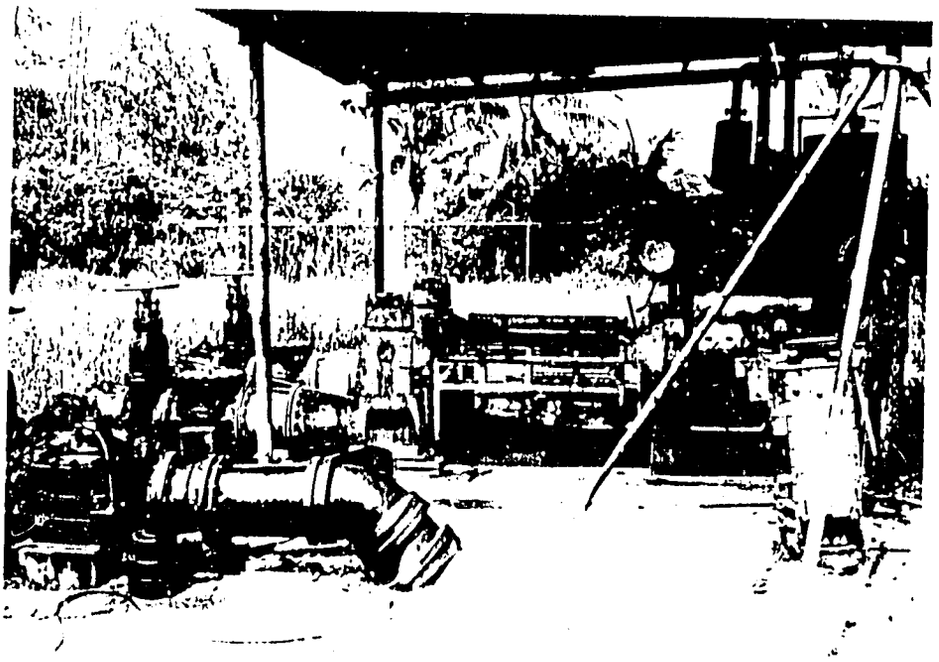
2. Furnish and install two new deep well turbine pumps and diesel drives, having the same specifications as the original equipment.

Alternative 1 can be rejected on the basis that the cost for rehabilitation of the units approaches the cost for replacement. This is based on preliminary cost estimates prepared by George A. Fuller who is the contractor currently working on the Kismayo port project

Alternative 2 is preferred based on reliability and relative costs, however, it is considered essential to provide an extensive inventory of spare parts, tools and lubricants; along with adequate training of local operator in order to assure long term reliable and dependable operation.

8.3 Recommendation

The WASH team recommends alternative 2.



NOTE POOL OF DIESEL WASTE IN YARD
ADJACENT TO HIGH LIFT PUMPS

FIG. 8.1 HIGH LIFT PUMP FACILITIES

CHAPTER 9

TRANSMISSION LINE

9.1 Existing Condition

The transmission line consists of approximately 32 km of 16 inch diameter asbestos cement pipe and includes the following on-line structures:

Description	Number
MH "A" 16" gate valve with vacuum relief valve	6
MH "B" 16" gate valve with blow off	3
MH "C" 16" and 12" gate valves	1
MH "D" vacuum relief valve	8
MH "E" 16" gate valve	8
MH "F" 4" stub-in valve	7
MH "G" blow off valve	8
Meter MH 6" gate valve and 6" meter	1
Total	42

The entire route along the transmission line was traveled six times during the field visit to Kismayo and major problems with leakage were not visible. Problems were being experienced in the reach of line that goes cross country from approximately km 10 to km 16 (starting from Kismayo and going towards the WTP) (Figure 9.1). It was reported that leakage was at a valve structure and that a crew would be immediately assigned to repair the installation. Although poorly equipped from the standpoint of equipment, tools and repair components, the Kismayo Water Agency under Mr. Hersi has done a commendable job in coping with such situations.

In addition there was a leak in the vicinity of the pipeline structure No. 7 located approximately at km 20. Failure at this location has continued to occur since the original construction and is most likely related to differential settlement based on unfavorable bearing conditions. The situation is probably aggravated because of the close proximity to the road way. The ACP has repeatedly fractured and efforts are being made to replace the pipe in this area with cast iron or ductile iron pipe.

Based on the general suitability and characteristics of the ACP transmission line and the conditions noted in the field, it is our opinion that replacement of the existing pipeline is not a viable consideration based on available information.

9.2 Recommendation

It is recommended that as soon as the repairs have been completed at the two known and visible points of leakage that quantification of losses be undertaken by temporarily isolating the transmission line from the high lift pumping facilities to the ground storage reservoir located on a hill in Kismayo. This will require the closing off approximately 8 connections and particularly closing of the 12 inch gate valve located on the 16 inch diameter pipeline structure approximately 1 km from the storage reservoir. Since the present mode of operation is to draw down the clear well after closing down the rest of the plant facilities, measured clear well withdrawal could be compared with the quantity delivered to the reservoir. It would also be desirable to have pressure gauges installed along the pipeline at various points.

If this check for pipeline condition and leakage is not successful, it would be necessary to consider the measurement of flow velocities along the pipeline using pitometer equipment. This would require the importation of tapping equipment, corporation stops, and pitometer rods and accessories. Following the arrival and clearance of the equipment we would recommend that a specialist in leakage detection be selected (perhaps using IQC or WASH procedures) for such a study. It is estimated that it would take at least 3 to 4 weeks to select test locations, expose the pipeline, insert corporation stops, perform the required measurements, interpret the results and prepare a report. It is recommended that this procedure be employed only if it is truly impossible to achieve the isolation of the transmission line required to perform the direct measurement of production from the high lift pumps versus delivery to reservoir.

CHAPTER 10

MISCELLANEOUS

10.1 Electrical System

The electrical wiring system at the KWA plant has not been in operation since the 125 kva diesel generator sets were removed from service in the late 1970's. There were several instances where electrical box covers were removed and wires were spliced with no data on connections. There is no operating dehumidification equipment and the original intake pump station was reported to have been flooded. As a result all of the existing wiring cannot be considered to be of any value.

It is the recommendation of the WASH team that all wiring required as part of the process recommendation discussed earlier be new installation

10.2 Backwash Water Storage Tank

The backwash water storage tank is bolted steel construction. The tank exterior appears to be in good condition with limited rust at the joints. The wooden walkway is in poor condition and can not support any loads. The walkway should be replaced.

10.3 Control Building

The control building requires general cleaning and painting, storage shelves, and new laboratory equipment. Two new diesel driven generators may be required to power the sludge pumps and electric lights. The units should be approximately 30 K.W.

CHAPTER 11

OPERATION AND MAINTENANCE

11.1 The original plant and subsequent modifications receive little or no maintenance due to a number of factors:

- Lack of redundant equipment to allow down-time for service and maintenance
- Lack of spare parts and lubricants
- Lack of tools and equipment to perform maintenance and servicing
- Lack of funds to facilitate the purchase of equipment and supplies manufactured outside of Somalia
- Lack of training during the construction of the original plant
- Lack of detailed operation and maintenance manuals

Any rehabilitation project, if it is to be a long term success, must consider all of the above items in the planning and design phases. It is the opinion of the WASH team that new stores of spare parts and chemicals be provided and that operation and maintenance manuals and training be provided upon completion of the plant improvements.

CHAPTER 12

SUMMARY OF RECOMMENDED PROGRAM

12.0 Description

12.1 RAW WATER INTAKE AND PUMP STATION

Construct New Pump Station

- o Clean existing river intake and raise intake elevation.
- o Construct new pump station between exist. pump station and intake structure. Pump station to be equipped with two diesel-driven pumps. Diesels to be located above flood level.
- o Utilize existing East German intake for standby purposes.

12.2 PRESEDIMENTATION BASINS

Construct New Basins

- o Construct two parallel, lined presedimentation basins. Each basin would be approximately 45m long, 13m wide and 4m depth. Basins will have weirs at each end to control flow and water level. Silt removal will be manual.

12.3 PRETREATMENT UNITS

Modify Pretreatment Units

- o Install a parshall flume between the presedimentation basins and the application channel of the pretreatment units to act as a static mixer. Chemicals (alum, soda ash, and lime) will be introduced at this point in the treatment process.
- o Remove flash mixers and flocculators.
- o Install baffle walls in flocculation basins to provide for tapered static flocculation, (addition of buffle walls may require that height of side walls in flash mix and flocculation be increased because of additional head losses.)

12.4 SEDIMENTATION

Modify Existing Basins

- o Install a new wall with ports at head end of the sedimentation basins to prevent short-circuiting.
- o Install manual sludge draw-off pipes in sedimentation basins. Sludge to be piped to lift station.

12.5 CHEMICAL SYSTEMS

Construct New Chemical Feed Facilities

- Construct a new building for the chemical feed facilities between the new presedimentation basins and the pretreatment basins. The building will consist of the following:

  a) New storage tanks, mixers and feed systems for alum, lime and soda ash.
  b) Storage tanks and feed systems to be located on an elevated floor to allow for gravity feed of chemicals into parshall flume.
  c) Lower level below tanks may be used for storage of bags of dry chemicals.
  d) Manual hoist to be provided to lift bags of chemicals from lower level to chemical storage tanks on upper level.

- Replace all existing chlorination equipment in existing chlorination room with wall mounted units operated by water pressure.

12.6 SLUDGE HANDLING

Rehabilitate Existing Facilities

- Remove and replace sludge pumps and motors.
- Clean all influent lines to lift station.
- Clean the discharge line to the river.

12.7 FILTERS

Rehabilitate and Modify Existing Filters

- Install orifice plates on the filter influent lines to control maximum rate of flow to each filter.
- Remove rate controllers from filter effluent lines.
- Install a weir box in clearwell to control water level in filters. Set weir at level of top of filter media plus headloss through clean bed.
- Remove flow control valves on backwash water lines and replace with orifice plates to control flow.
- Rehabilitate gate alves.
- Remove and replace filter media.
- Clean and repair filter bottoms.

12.8 HIGH LIFT PUMPING FACILITIES

Replace Existing Equipment

- Remove and replace exiting turbine pumps and diesel drives.

12.9 TRANSMISSION LINE

- o Repair visible leaks.
- o Quantify leakage.

12.10 MISCELLANEOUS

- o Repaint interior of control building. Add shelving to former chemical storage room for storage of spare parts and equipment.
- o Remove and replace all electrical wiring and equipment.
- o Remove overflow pipe from septic tank to lift station and install new subsurface disposal system for sanitary wastes.
- o Replace elevated tank walkway.
- o Check and rehabilitate all valves and controls.
- o General clean-up of site including diesel spills.
- o Furnish and install new laboratory equipment.
- o Remove the existing 15kw and two 100kw diesel generators and replace with two-30kw diesel generators.

12.11 OPERATION AND MAINTENANCE

- o Furnish spare parts, tools, lubricants, seals, bearings, service equipment, etc. to assure proper operation and maintenance. (Generous inventory for all equipment under adequate protection).

- o Provide a minimum of one month start-up and training assistance plus follow-up inspection/training visits at six month intervals.

- o Provide an operation and maintenance manual which details the following for each treatment process:

  - Function description and design data.

  - Process considerations.

  - Modes of operation.

  - Equipment controls.

  - Safety considerations.

12.13 ESTIMATED COSTS

CHAPTER 13

IMPLEMENTATION OPTIONS

13.1 Construction Services

Assumptions

- It is considered essential that there only be a single contracting entity that will be fully responsible for all services including the furnishing and installing of equipment, construction, and rehabilitation work.

- Work will be funded by USAID, therefore U.S. consultants and contractors will be involved; or U.S. firms with host country firms; unless selected free world countries (AID Geographic Code 941) are allowed to submit qualifications and proposals.

- Selection of contractor (either using conventional design and construct or turnkey procedures)

  a) Open competition among U.S. contractors.

  b) Open competition among U.S. firms and from 941 countries, if permitted.

13.2 Discussion

A number of U.S. contractors have on-going work in Somalia or have recently worked in Somalia including J.A. Jones, George A. Fuller, and Turnkey. Although the total estimated cost of the recommended rehabilitation of the water treatment facilities is $2,100,000, it is anticipated that a number of responsive bids would be received. This is, of course, highly dependent on timing as it related to prospective bidder's on-going or projected work in Africa and the Near East. There would be a definite interest on the part of international contractors based in Kenya, if 941 countries are to be allowed.

13.3 Design and Supervision Services

Assumptions

- Required engineering services could be provided through the WASH project, and IQC contractor, or through competitive selection of a consultant. Because of time constraints related to the emergency need for water supply improvements it may be necessary to consider WASH or IQC procedures.

- Design effort is relatively straight forward based on maximizing the utilization of existing structures that are in excellent condition. In addition, no suitable alternative raw water intake location is available and the existing site is a given. The engineering design services could be completed in less than four months.

- Because of the long-term involved, it may not be appropriate to consider WASH or IQC procedures for services during construction. WASH and IQC procedures could be considered for the recommended training of local operators.

13.4 Selection of Consultant

- Competitive selection of consultant for detailed design, preparation of contract documents, bid review, assistance in contract award.

- Competitive selection of consultant for preparation of the terms of reference and performance documents for Turnkey contract, evaluation of Turnkey proposals, assistance in contract award.

13.5 Discussion

No problem would be anticipated in receiving responsive proposals for the required engineering services, either for the detailed design and services during construction; or the preparation of the required documents for a Turnkey (design plus construction) contract.

Figure No.13-1 compares the anticipated schedule for rehabilitation using the conventional design and construct procedures with that of Turnkey procedures. The number of agreements required for design, construction, and services during construction would be the same, as noted below;

<u>Conventional Design and Construct Procedures</u>

1. Contract for detailed engineering design, preparation of contract documents, bidding and award assistance, and services during construction

2. Construction contract

3. Contract for services during construction

Turnkey Procedures

1. Contract for preparation

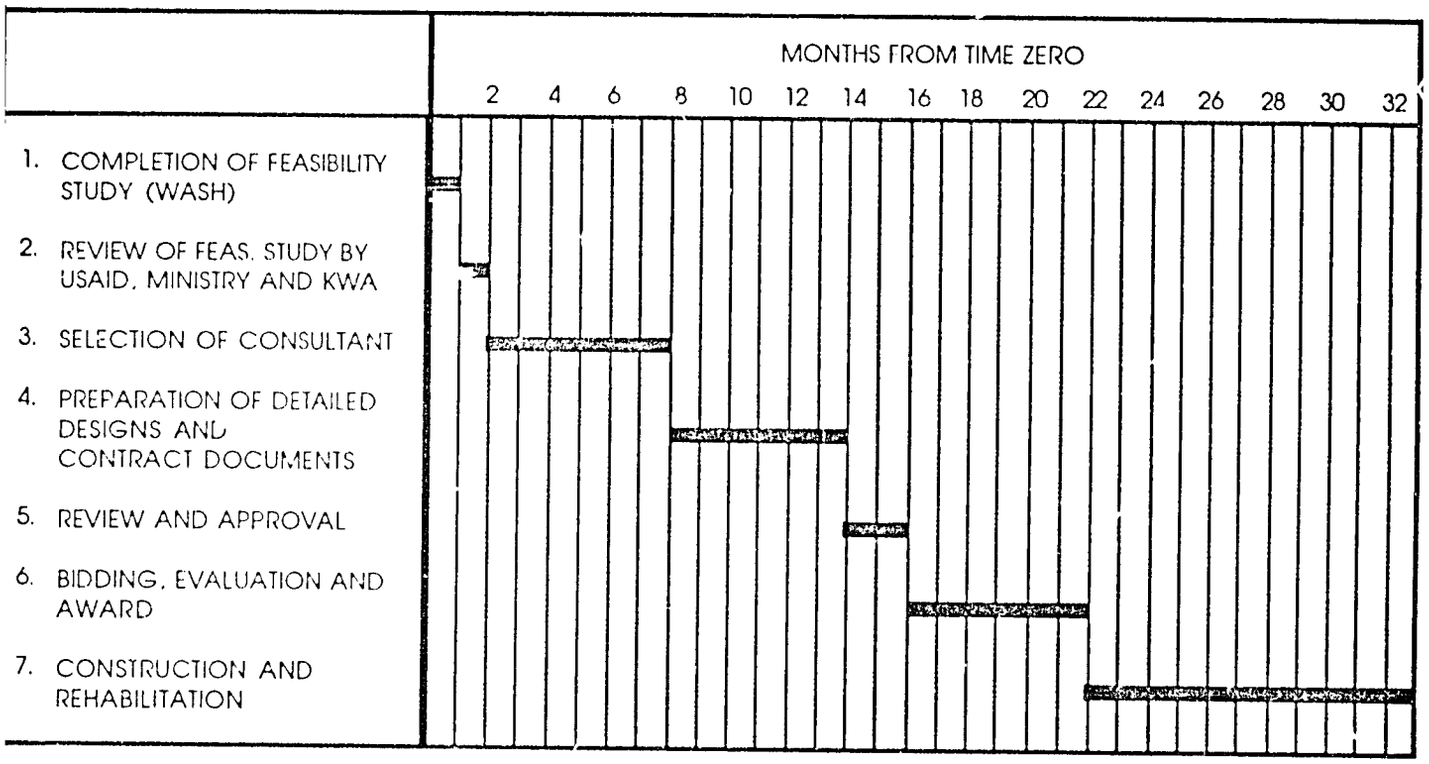
2. Contract for detailed design and construction

3. Contract for services during construction

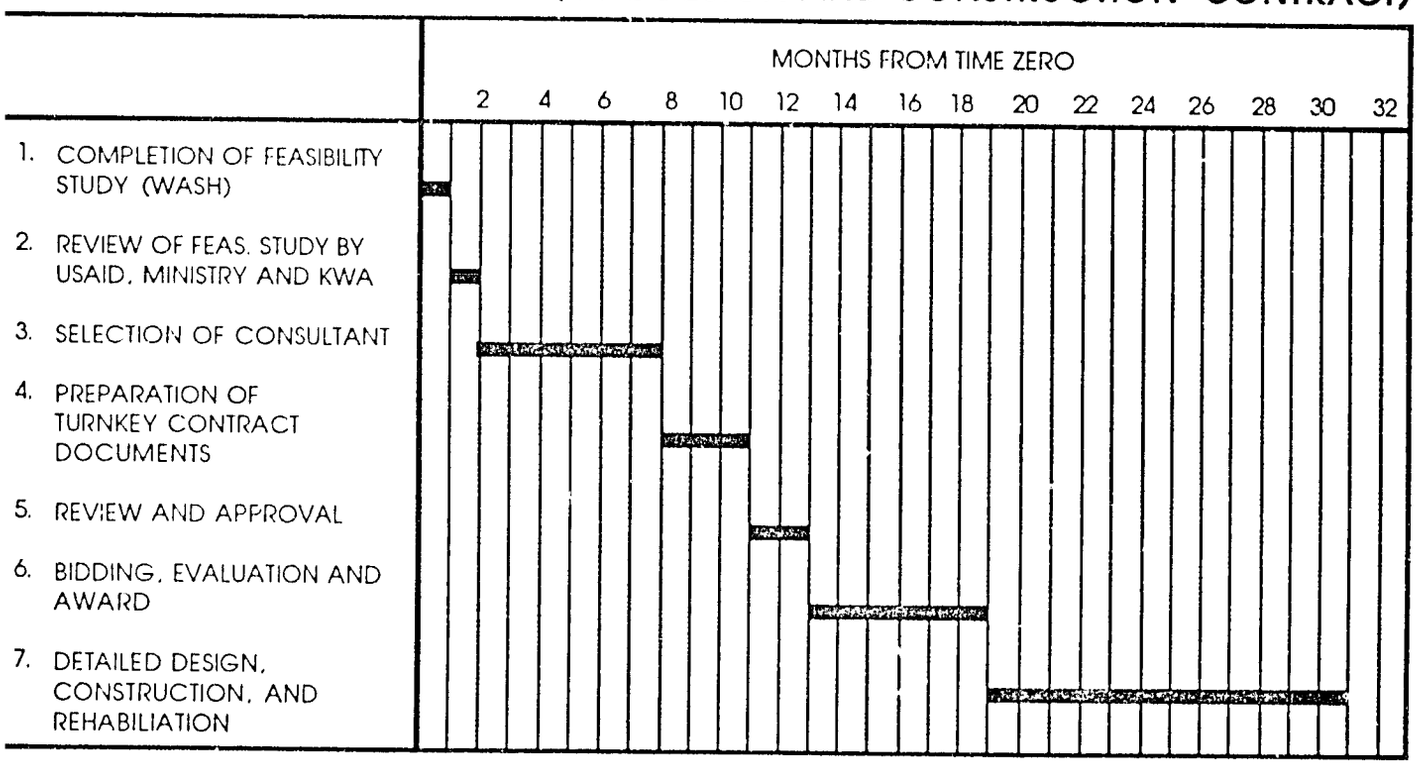
Because of the nature and location of the work to be performed, the proposed procedures are essentially equal from the view of overview requirements to be placed on AID and the schedule for completion. The turnkey procedures might save a few months time if delivery of equipment and materials can be expedited by using performance specifications and early procurement. The conventional design and construct procedures can provide a stronger mechanism for quality control because of separate design and construction responsibilities, and also provide AID with technical assistance during the bidding and award procedures.

FIGURE 13-1

ANTICIPATED SCHEDULE FOR REHABILITATION OF KWA-WTP USING CONVENTIONAL DESIGN AND CONSTRUCT PROCEDURES



ANTICIPATED SCHEDULE FOR REHABILITATION OF KWA-WTP USING TURNKEY PROCEDURES (ONE DESIGN AND CONSTRUCTION CONTRACT)



CHAPTER 14

ESTIMATED COST OF RECOMMENDED PROGRAM

14.1 Estimated Construction Cost

The estimated construction cost of the recommended program is $2,100,000. The estimate is based upon the work being completed by U.S. Contractor using U.S. products. The anticipated construction period is January 1, 1988 through December 31, 1988.

The estimate is summarized as follows:

Low Lift Pump Station (new)	$ 250,000.
Presedimentation Basins (new)	400,000.
Chemical Building (new)	175,000.
Existing Flocculation and Sedimentation (rehabilitation)	175,000.
Filters (rehabilitation)	75,000.
Sludge pumping (rehabilitation)	75,000.
Control Building (rehabilitation)	150,000.
High Lift Pump Station (rehabilitation)	200,000.
Electrical (rehabilitation)	150,000.
Miscellaneous	150,000.
Subtotal	$1,800,000.
15% Contingency	300,000.
Total	$2,100,000.

14.2 Estimated Cost of Services During Design

The estimated cost of engineering services during design is $250,000. The cost is summarized as follows:

Labor	$236,000.
Travel	8,500.
Per Diem	3,000.
Other Direct Costs	2,500.
Total	$250,000.

The labor costs for design have been developed from an estimated number of detailed drawings, to be prepared. The drawings include site plans, civil, mechanical, structural archietectural and electrical sheets, along with specific features and details for the rehabilitation of existing facilities.

14.3 Effect of Turnkey Procedures on Estimated Costs

The engineering costs for preparation of the performance documents for turnkey procedures would be less than that for preparing the detailed design drawings, however, the design costs would be added to the work of the turnkey contractor and increase the contractors costs. For the purposes of this feasibility study it has been assumed that the total cost for engineering and construction will be approximately the same whether conventional design or turnkey procedures are employed.

14.4 Estimated cost of Services During Construction

The following is a preliminary estimate of the costs for services during construction, start-up and training.

Resident Services

Bid Evaluation and Resident Engineer - Say 15 person months		$ 150,000.
Home Office Support	allow	10,000.
Travel and Per Diem	allow	20,000.
		$ 180,000.
	Contingencies	10,000.
	Total Resident Services	$ 190,000.

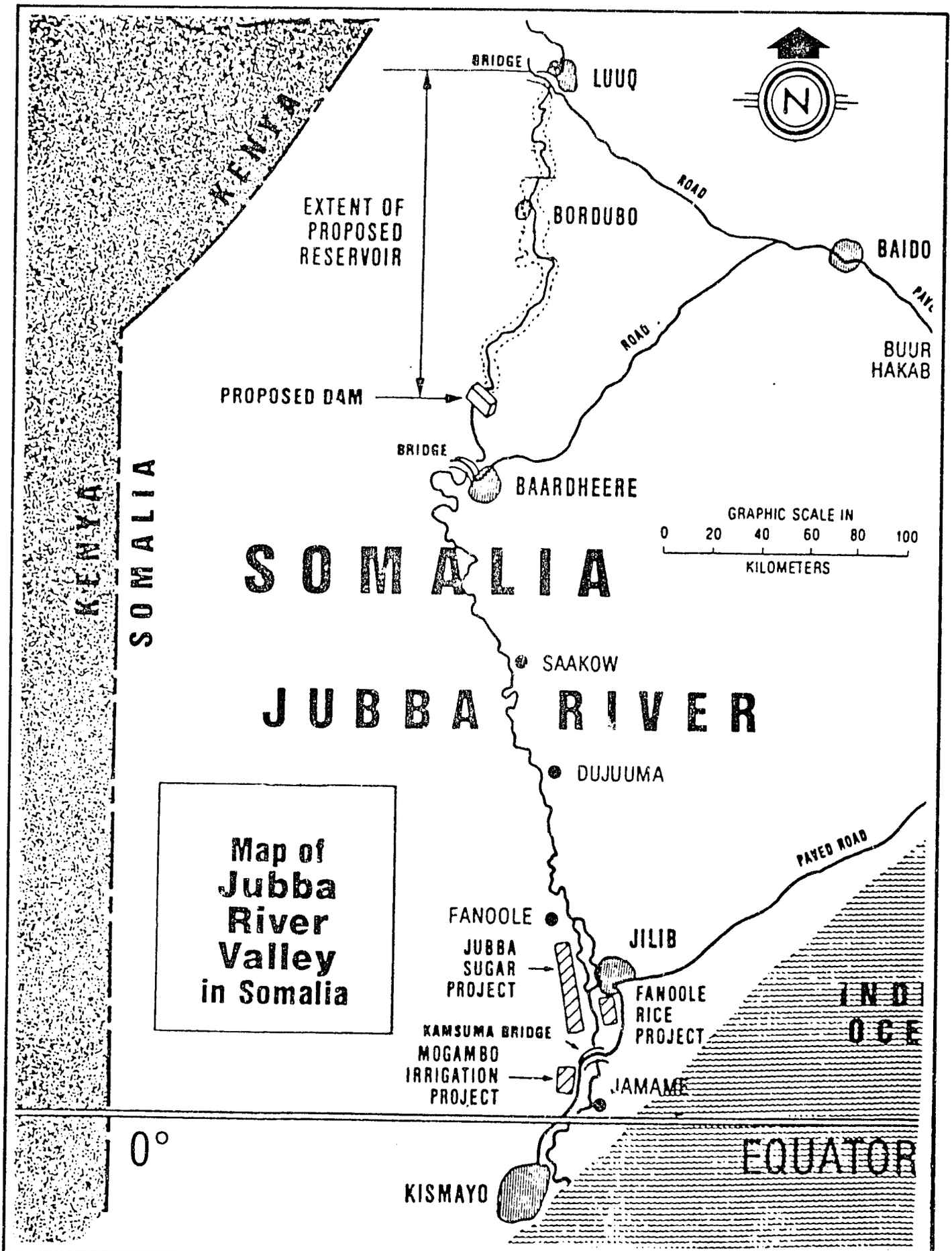
Start-Up & Training

Senior Engineer -	Say 4 person months	$ 45,000.
Travel and Per Diem -	allow	10,000.
	Subtotal	$ 55,000.
	Contingencies	5,000
	Total Start-Up & Training	$ 60,000.
	Total Services During Construction	$ 250,000.

The above preliminary estimates should be reviewed and adjusted aas required upon completion of the design phase.

APPENDIX A

SUMMARY OF JUBBA RIVER WATER QUALITY DATA



REHABILITATION OF THE
KISMAYO WATER SUPPLY FACILITIES

WASH PROJECT NO. 318

MARCH 1987

18

Data Check

Ranges to be expected for data on water quality.

parameter	minimum	maximum	normal range
pH	5.0	9.0	7.5-8.5
temperature	20	35	25-30
conductivity	100	5000*	200-3000
salinity %	0	40*	0-1
Secchi depth cm	0	500	1-200
in mg/l:			
chlorides	1	19,000*	1-500
sulfates as SO_4	1	200	1-50
nitrates as N	0.1	20	1-5
phosphates as P	0.001	5	0.1-1
calcium	1	200	10-100
sodium	1	500	1-100
magnesium	1	100	1-20
total diss. solids	1	5000	10-1000
suspend. solids	1	5000	10-300
color	1	20	2-5
turbidity	1	500	1-200
settleable solids in ml/l	0	10	0.1-2
Arsenic mg/l	0	0.05	0-0.01
Boron mg/l	0.1	4	0.7-2
Selenium mg/l	0.001	0.02	0.001-0.005

*ocean

APPENDIX B

KISMAYO WATER AGENCY

LIST OF 1970 INSTALLATION DRAWINGS

Kismayo Water Supply System 1970 Installation
Design Drawings.

INDEX OF DRAWINGS

Control Building

- Electrical & Mechanical Layout	# SOM-SK-166 by Overseas African Construction Corpn (OACC)
- Utilities, plumbing and chem.equipment	# 26-04-02 sht. 33M2 by USACE
- Architectural	# 26-04-02 sht. 30A2 by USACE
- Operation and Maintenance	SOM.SK.254.OM by O.A.C.C.
- Electrical Plan	# 26-04-02 sht. by USACE
- Mechanical, fuel oil system	# 26-04-02 sht. 32M1 by USACE
- Electrical Layout in power room	SOM.SK. 16A by O.A.C.C.

Flocculation

Details of Dorrco flocculator	# 03D13843. by Dorr Oliver
Civil Coagulation and settling basin, plan, section and details	# 26-04-02 sht. 11C11 by USACE

Superintendants Residence

Electrical: Residence and Intake pump plans and schedules	# 26-04-02 sht. 3763 by

Clear Water Transmission

Locations of Additional Stubb-offs	# C-7 -(Shows Main Route & photographs) # C-2 (Shows Main from TP to Road).
Schedule/Details of chamber & fittings	#SOM SK - 152 by O.A.C.C.

Raw Water Intake

RW intake structure, plan, sections and details	# 26-04-02, Sht. 4C4 by USACE
Piping layout - intake structure	# SOM SK-154 by O.A.C.C.
River intake study	# C-12 by O.A.C.C.

Raw Water Intake Pump House

Electrical installation	# E-513 by O.A.C.C.
Civil-intake pumps, plan, section and details	# 26-04-02, Sht. 5C5 by USACE.
Architectural intake pump house	# 26-04-02, Sht. 31A3 by USACE.
Piping Layout	# SOM-SK-168 by O.A.C.C.

Treatment Plant - Layout/General

Electrical Distribution	# 26-04-02, Sht. 35E1
General layout plan, details and utilities	# 26-04-02, Sht. 1C1
Civil General utilities and layout	# 26-04-02, Sht. 3C3
Civil Grading and drainage	# 26-04-02, Sht. 2C2

Gravity Filters and Backwash System

Backwash tank - layout and piping	# SOM-SK-169 by O.A.C.C.
Glazed fire clay filter Bottom	# 699791 by F.B.Leopold Co. Inc.
Service Gallery piping	# 03D 13654 by Dorr Oliver
Rapid sand filters and service Gallery piping	# 26-04-02. Sht. 9C9
Rapid sand filters and service Gallery piping	# 26-04-02. Sht. 8C8

Lift Station

Civil and Electrical	# 26-04-02 Sht. 7CE7 by USACE

Clear Water Pumping

Civil high lift pumps	# 26-04-02 Sht. 6CE6 by USACE

Distribution System

Semi-schematic layout of pipe system	#KX-1/86 by KAMPIHL

APPENDIX C

SCHEDULE AND CONTACTS OF WASH TEAM

15 MARCH TO 25 MARCH 1987

SCHEDULE AND CONTACTS

15 March 87 Nairobi to Mogadishu-KQ 430 (approximately one hour behind schedule). Met by USAID expediter and overnight at USAID guesthouse.

16 March 87 USAID:

Dan Vincent	Engineer
Abdul Kadir	Engineer
Hussain	Engineer

Alice Butler-Short USAID Management Officer (Arrangemeets for ID, accomodation exchange, medical care, check-in forms, and commissary)

Sally Patton USAID project manager for the JESS project

Associates in Rural Development (ARD) - Providing technical assistance and management of the Jubba Environmental and Socioeconomic Studies (JESS)

Dr. Gus Tillman Chief of Party

AGRAR-UND Hydrotechnik GMBH, Essen, Germany German consulting engineering firm provideing technical assistance to the Ministry of Minerals and Water Resources, primarily on the JESS project, and funded by GTZ.

_____ Hydrologist

17 March 87 Mogidushu to Kismayo by road. Approximately 7 hrs. Overnight and the camp facilities of ROICC and George A. Fuller, contractor.

Charles Crockett	ROICC
Warren Buser	Parsons Brinckerhoff
John Scanlon	George A. Fuller
Robert Smith	NAVFAC

18 March 87 Kismayo Water Agency

Hersi Abdi Saddad	General Manager
Ahmed Ibrahim Maclim	Deputy General Manager

Field visit to treament plant, transmission line, and storage facilites

19 March 87 Ali Farah Warsma Foreman of construction under OICC during the

period 1966 to 1969
(Had excellent recall of
conditions that existed
and events during
construction)

Field vists of facilities confirming as built conditions, photographs, interviews

20 March 87 Kismayo to Mogadishu by road. Arrived at USAID guest house at approximaately 1830. Attempted to make arrangements to have film developed for presentation to USAID on Sunday 22 Mardh. Not auccessful, because of continuing poser outages no one would guarantee delivery.

21 March 87 USAID guesthouse - preparine draft report

22 March 87 USAID - Briefing and discussion of draft report

Dan Vincent	Engineer
Lou Cohen	Mission Director
Dale Pfeiffer	Deputy Mission Director

Based on results todate and discussions it was agreed that the WASH team should depart to Narobi on 22 March, if possible, in order to obtain improved cost information regarding equipment, chemicals, filter media that would be available in Kenya.

INFORMATION OBTAINED DURING STOP IN NAIROBI, KENYA
23 MARCH 1983

Individuals Contacted

Fred Guymont	REDSO Engineer
M.A.K. Khan	Howard Humphreys Consulting Engineers - Technical Director
Mr. Ndiambo	General Manager of the Water & Sewerage Department Nairobi City Commission
Jeremiah N Otiano	Gaulke & Roberts Ltd. Sales Representative
Tom Finch	Gaulke & Roberts Ltd. Sales representative

Names and addresses of companies

Gaulke & Roberts Ltd.	Kitui Road P.O. Box 30340, Nairobi Tel. 554044 Pumps and diesel driven generator set
Sheets Hospital	Bruce House, Standard Street P.O. Box 30158, Nairobi Tel. 22140 Telex 22181
[illegible] Ltd.	Supplier of chlorine Mai Avenue. P.O. Box 30669, Nairobi Tel. 22198
Magadi Soda Co. Ltd.	Supplier of soda ash Box 1, Magadi Tel. Magadi 1
Industrial Distributors (T) Ltd.	Kampala Road Industrial Area P.O. Box 44577, Nairobi Tel. 540188
Kilindini Direct Ltd.	Fare Road Box 40820 Nairobi

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Tel. 5080006
Supplier of filter sand

Burd. Civil Engineers — Mombasa Road
Box 66207, Nairobi
Tel. 822820
Contractors and supplier of
filter sand

Cost Information

Caterpillar 55 kva generator set — KSh 320,000 with
35 % duty included

KSh 40,000 to ship from
Mombasa to Kismayo

400 kva generator set installed at Nairobi water plant
1984 costs

KSh 1,200,000
Drive 1,002,000
Switchgear 130,000
Installation 70,000

Pump and motor [illegible] TDH

1/2 Hp Cat.2304
Drive Jet 500,000
Pump [illegible] 50,000
KSh 20% installation
KSh 10% escalation

Pump and motor [illegible] TDH
Drive KSh 150,000
Pump - As above

Best Available Document

-84-

APPENDIX D

REFERENCES

REFERENCES

Agrar- und Hydrotechnik GMBH. Advisory Assistance to the Ministry of Juba Valley Development. Hydrology of the Juba River Main Report-Annexes 1-4. Essen, Germany, 1985

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Associates in Rural Development. JESS Interim Report on Impacts on Gender Planning and the Proposed Rehabilitation Dam. Burlington, Vermont, November 1986

Bonetti, Francesco and International. Report on Cost of Borehole water and Shallow Wells. Somalia, December, 1987

Bonetti refugee Water Project Report to Ministry Water Works and Irrigation for the Refugee Water Supply. Mogadishu, Somalia, September 1987

[illegible] Report of the Engineer to Government of March 8 to 11, 1911. [illegible] March, 1911

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APPENDIX E

GEORGE A FULLER CO.

WATER TREATMENT PLANT

DESCRIPTION OF PACKAGE WATER
TREATMENT PLANT

GEORGE A. FULLER CONSTRUCTION CAMP

KISMAYO, SOMALIA

During the field visit to Kismayo, the WASH team visited the water filtration plant used by the George A. Fuller Company (GAFCO) to treat water supplied by the KWA distribution system. GAFCO uses treated water for domestic purposes in the camp and for construction of the port facilities.

The plant is a package unit of Austrian manufacture. It has a treatment capacity of 5 cubic meters per hour and currently operates 10 to 12 hours per day. The treatment process consists of chemical coagulation, sedimentation, and pressure filtration. Backwash water and sludge are wasted on site.

The plant operator indicated that the following chemicals are used in the treatment process:

Chemical	Daily Usage (1)	Approximate Dosage (2)
Sodium [illegible]	2 kg	27 mg/l
[illegible]	10 kg	133 mg/l
Fe [illegible]	40 grams	0.5 mg/l
[illegible]		1 mg/l

(1) reported by operator

(2) based on 75 cubic meters per day.

The plant has been in operation for about 15 months.

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APPENDIX F

KISMAYO WATER AGENCY

SUMMARY OF PHYSICAL FEATURES

AT

KISMAYO WATER TREATMENT PLANT

KISMAYO WATER AGENCY
SUMMARY OF
WATER TREATMENT PLANT
PHYSICAL FEATURES

PRINCIPAL PLANT FEATURES

Surface water supply-Jubba River
Raw water pumping from the Jubba River
Chemical application
Rapid mix
Flocculation
Sedimentation
Rapid sand filtration
Chemical feed and storage
Finish water storage reservoir
Backwashwater storage reservoir
High lift pumps

PLANT CAPACITY

Average flow (assumed to be the capacity of the high lift pump) 6.06 m3/m
Ultimate capacity (Two high lift pumps) 12.12 m3/m

PLANT EQUIPMENT

[illegible] existing equipment and modified pump station arrangements:

Number of pumps	1
Type of pump	Horizontal centrifugal
Type of intake screen	Line shaft pipe with screen

Chemical coagulation basin

Number of units	1
Size of basin	U-shaped
Width	0.75m (average)
Length	7.65m (average)
Average water depth	1.45m
Volume	0.84m3
Detention time	
at average flow	1.4 minutes
at ultimate flow	42 seconds

Rapid mix

Number of units	2
Size of basin	
Width	1.45m
Length	1.45m
Average water depth	1.25m
Volume of each unit	2.53m3
Detention time at	

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65

average flow	0.43minutes
ultimate flow	13 sec

Flocculation

Number of units	2
Size of basin	
Width	6.75m
Length	6.75m
Average water depth	3.97m
Volume of each unit	180.90m3
Detention time	
at design flow	30 minutes
at ultimate flow	15 minutes

Sedimentation

Number of units	2
Size of basin	
Width	8.5m
Length	34.7m
Average water depth	3.66m
Volume of each basin	1079.5m3
Total volume	2159.0m3
Detention time	
at average flow	6 hours
at ultimate flow	3 hours

Filters

Number of units	2
Size of filter	
Width	2.55m
Length	4.25m
Surface area	10.84m2
Filtration rate	
at 1.25 MGD flow rate	0.07m/minute
1500 gpm	1.72 gpm/ft2

High Lift pumps

Number of units	2
Rated capacity (1500 gpm @ 520 ft)	8.05 m3 @ 158.5m
Type	vertical turbine
Power	Diesel engine driven

Finished water storage

Total capacity (22 x 27 x 0.9 assumed)	535 m3
Detention time at average flow	98 minutes

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APPENDIX G

INFORMATION OBTAINED BY WASH TEAM

DURING STOP IN NAIROBI, KENYA

MARCH 23, 1987

REFER TO

FICHE

2 OF 3

FOR

FIGURE(S):

Figure 9.1

REFER TO

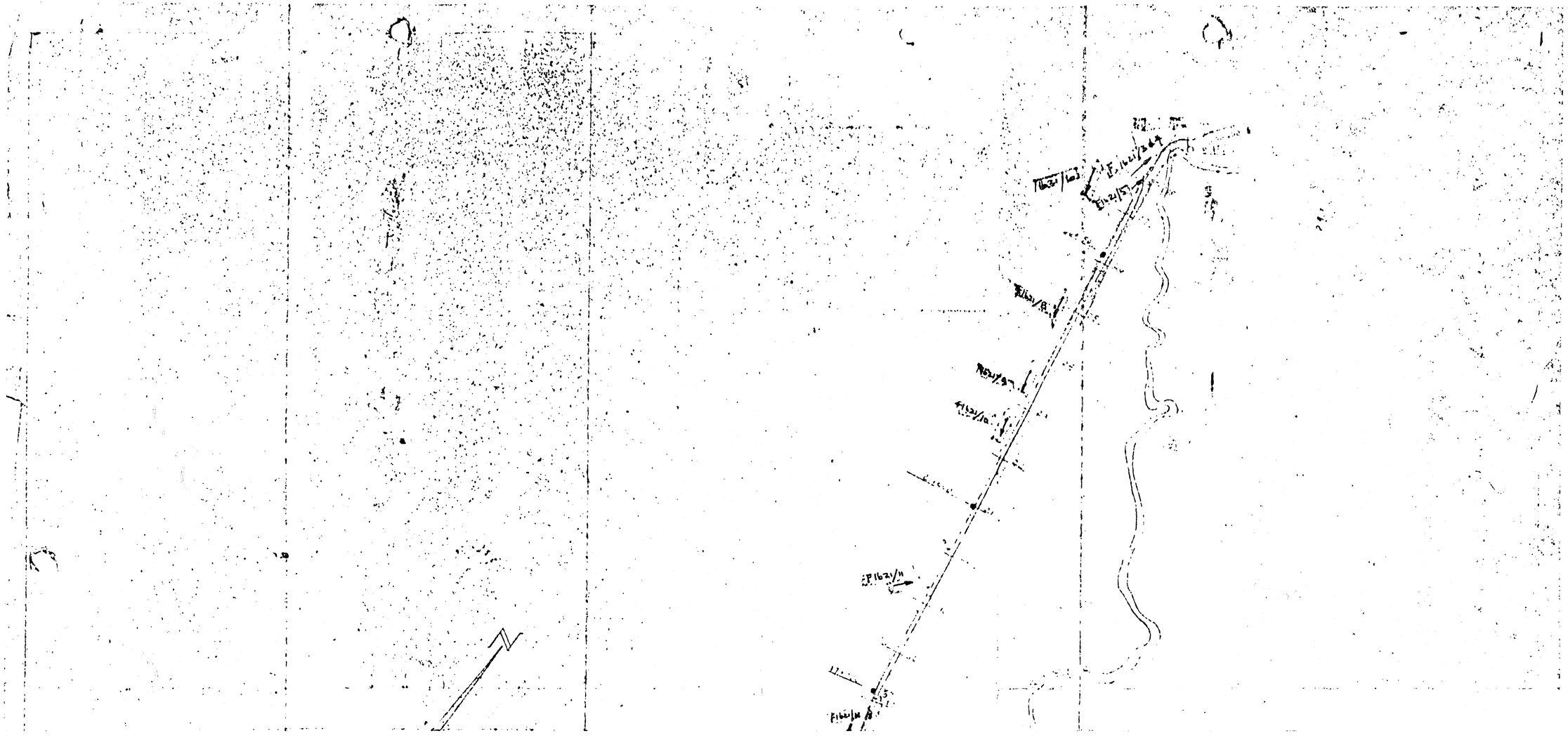
FICHE

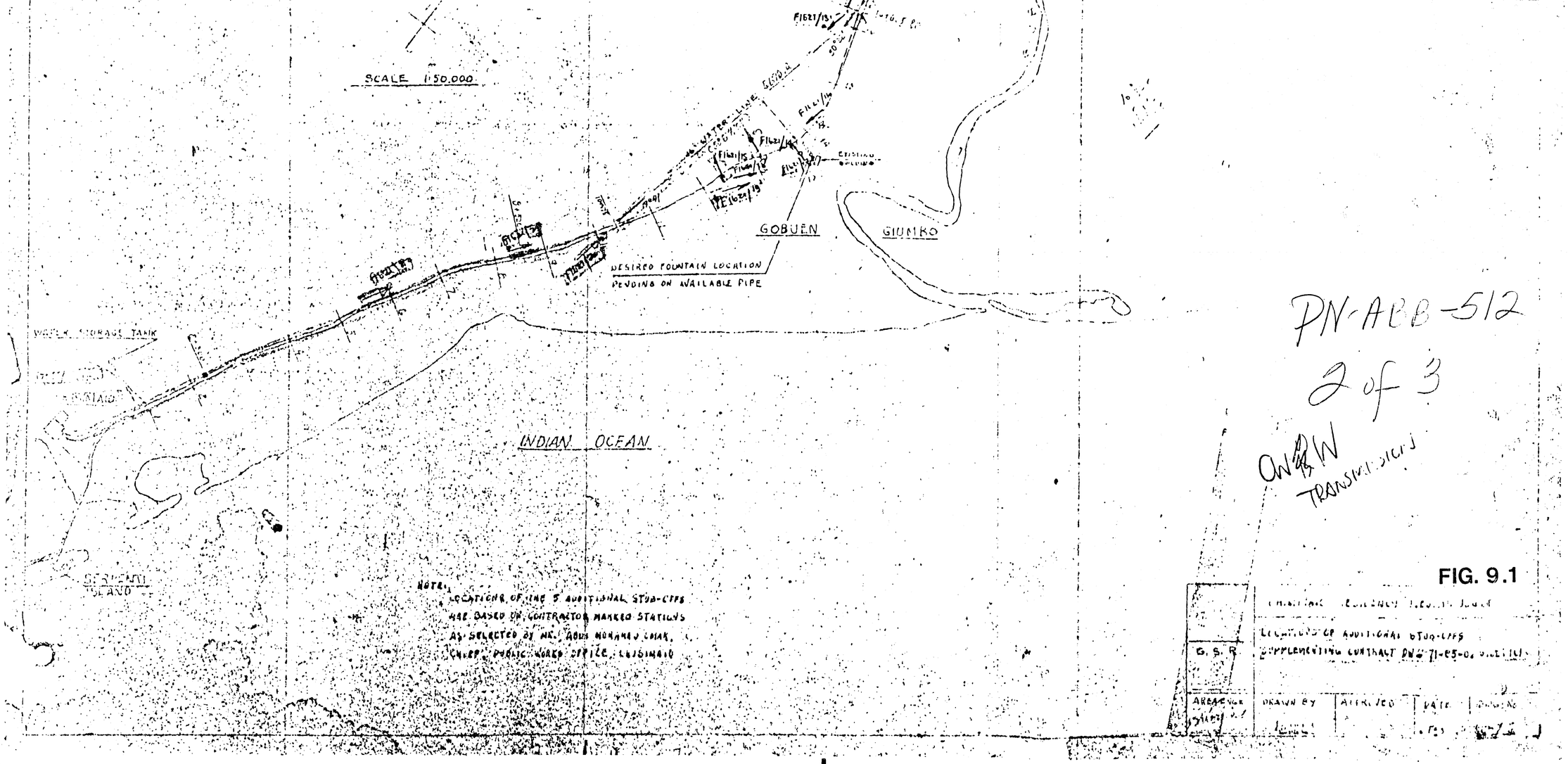
3 OF 3

FOR

FIGURE(S):

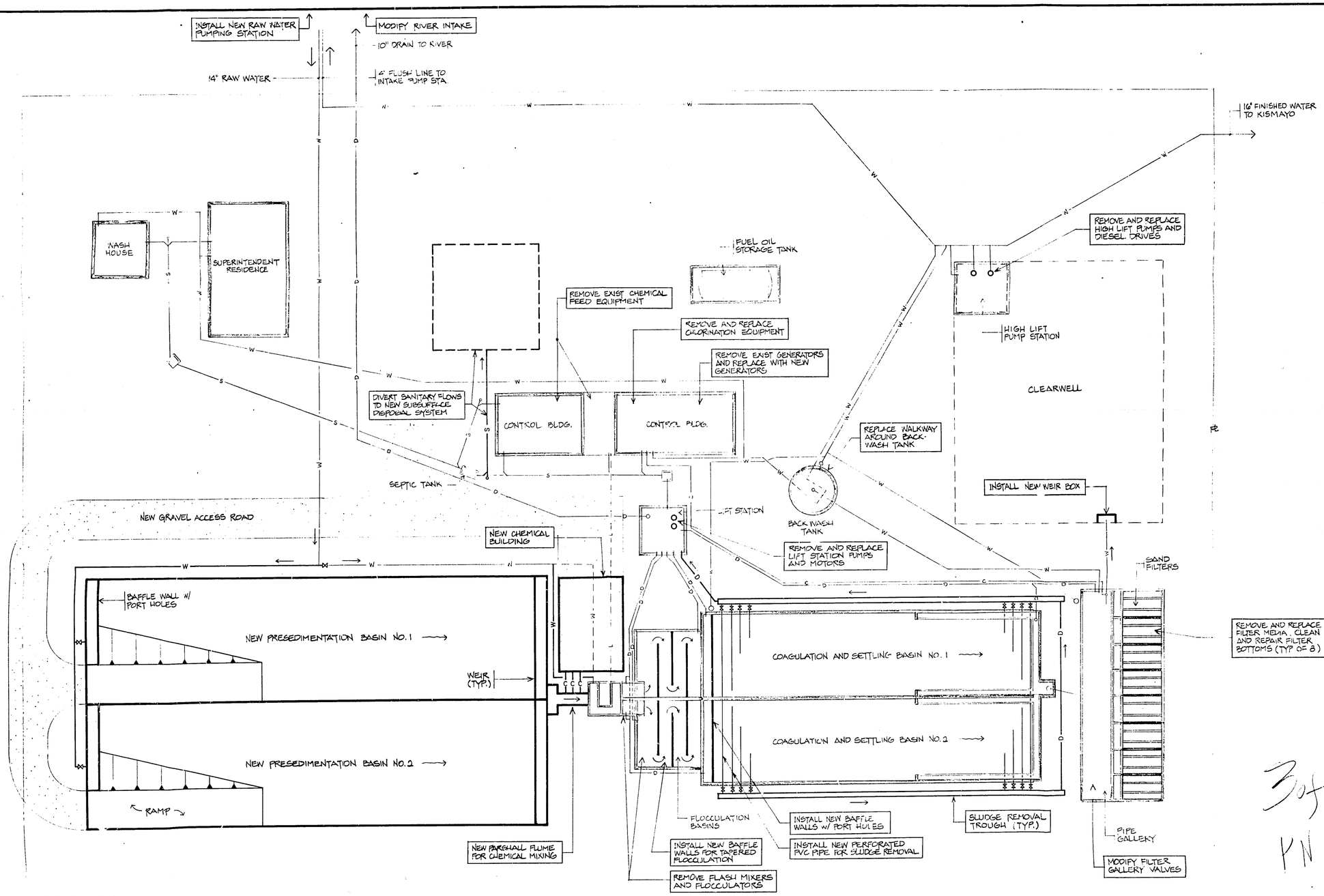
Site Plan


F1621/10
F1621/11
F1621/14



PN-ABB-512
2 of 3
ON BW
TRANSPARENCIES

FIG. 9.1



3 of 3
PN HCE-512

MISCELLANEOUS IMPROVEMENTS

- REMOVE AND REPLACE ALL ELECTRICAL WIRING AND EQUIPMENT
- FLUSH AND CLEAN ALL DRAIN LINES
- CHECK AND REHABILITATE ALL VALVES AND EQUIPMENT TO REMAIN IN SERVICE

PLAN
1:200

Date	Ch'k'd.	Revision

Designed by: J.F.F.
Drawn by: J.W.P.
Checked by: J.F.F.
Approved by: F.J.H.
Date: MAY 1987
Scale: AS NOTED

KISMAYO WATER AGENCY
WATER TREATMENT PLANT

SITE PLAN
RECOMMENDED IMPROVEMENTS

CAMP DRESSER & McKEE INC.
One Center Plaza
Boston, Massachusetts 02108
CDM
environmental engineers, scientists, planners, & management consultants

SHEET NO. 12.1

PROJECT MANAGER Approved by: Date:
PROJECT ENGINEER Approved by: Date:
PLUMBING Approved by: Date:
HVAC Approved by: Date:
INSTRUMENTATION Approved by: Date:
ELECTRICAL Approved by: Date:
STRUCTURAL Approved by: Date:
ARCHITECTURAL Approved by: Date: