Paper No. 499

# Comprehensive sewerage & drainage scheme

*BY*

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# COMPREHENSIVE SEWERAGE & DRAINAGE SCHEME MULTAN

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## 1. HISTORICAL DEVELOPMENT OF MULTAN CITY

The city of Multan can be regarded as one of the oldest cities of Pakistan. Like other cities of Punjab e.g. Lahore, the city was founded on the bank of river Ravi which later on abandoned its course and joined the Chenab near Abdul Hakim. Its citadel was built with a fortification wall having six gates. Inside along the wall a road is now constructed known as "Ooper Alung" meaning walk way at high level in the local language. Outside the wall is a circular road which used to be a moat filled with water in olden times. Gates were provided with draw bridges on this moat. The gates at Lohari and Daulat near the old fort (Qila Qasim Bagh) have been completely destroyed. our gates namely bohar, Haram Pak and Delhi are intact. The city is ancient and is said to have existed before Birth of Christ. From a study of levels (P.S. Plate-I) of the old city and Fort it can be seen that old city was planned and built much above the highest flood level since its existance. It indicates the fore-sight and intelligence of the planners. There are two mausoleums of Saints Shah Rukan-e-Alam and Hazrat Bahauddin Zikria built at higher levels than the old city inside the fortification of Qilla Qasim Bagh. During a heated discussion on the comprehensive Sewerage System of Multan built by M.D.A.; it was argued by a local journalist that the system had failed and needed to be enquired upon. He was asked by the autther to substantiate his conclusion. He said that the sewer built along the road can not command the sewerage of his house. The journalist was told by the author that system built by M.D.A. is 24 feet deep at the outfall and about 4-feet underground water table at the Disposal Station. It had cost Rs.14.5 Crores. His house should have been built in consultation with M.D.A. The journalist was not satisfied with the explanation. Following is the extract of the dialogue recorded between the journalist and the author :-

The Journalist. My house along the road cannot be connected to the sewer laid along this road.

The Author. Did you consult M.D.A. Engineers before fixing level of plinth of your house?

The Journalist. It was not necessary for me. I am not a subordinate of M.D.A.

The Author. Sir, at least you should have sought guidance from Mazar of Hazrat Shah Rukne Alam at the Fort.

The Journalist. What do you mean by this?

The Author. Sir, I mean the level of your house plinth should have been at least at the level of first step of the Mazar.

The journalist after this dialogue never came to M.D.A. Office. The General level of old city and the Fort is 430-40 as against highest flood level of Chenab recorded during the flood of 1976 at 412. The general level of Circular Road just out-side Bahar Gate near Shaheen market is 380-85. No problem of flooding or stagnation of sewerage is reported in the old city which is served by open surface drains on both sides of the paved streets. However, just outside the walled city on circular road, there are problems of stagnation of waste water and flooding after heavy rainfall. The other parts of the city are developed on

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the flood plain of the river made of fine clay deposited upto 15-25 feet over sand. The clay deposit is good for making bricks and it has been mined at several places to its entire depth in building the city. Thus one can find big depressions all over the city, most of which are abandoned kiln sites. katchi Abadies have been built in these depressions probably on account of very low price of their land. These abadies present, the most difficult problem of waste water disposal especially after a heavy rain-fall. Some of them are developed below the inverts of trunk sewers running by their sides along the roads so that in event of a rainfall or breakdown of electricity; sewage back flows into them. The civil station and the cantonment are built on flat plain at general ground elevation of 390. It was threatened to be flooded in 1976 when the level of Chanab at Bosan bund reached the dangour mark of 412. The Army took over control of flood protective bunds at Bosan and at Sher Shah bridge. The right marginal bund of railway cum road bridge over Chanab was dynamited to save the city and cantonment. The development outside walled city inspite of this threat continues unabated. Bahauddin Zikria University new Campus is built 2.5 miles from Bosan bund. Similarly is Gulgasht extensioon. The highest flood level recorded in 1976 was 412 i.e. 15 feet above general ground level of Gulgasht and Multan University New Campus. During July, 1978, unprecedented rains fell inside and in the outskirts of the city. Run-off exceeding 200 cusecs was built in catchment of 250 square miles extending upto tulamba and Abdul Hakim. It flowed in the abandoned course of Durana-Langana inundation canal. The natural water course of this channel has been blocked due to construction of Pak-Arab fertilizer factory and the Piran Ghaib thermal Power station. The Run-off, therefore, was forced to follow the course of L.M.Q. road towards the city and ultimately it found its way into the depressions near Shah Shams Mazar. The other depressions around the city were also filled upto 25 feet deep water. Two children were drowned near Bohar Gate in the depression of Nallah Wali Mohammad whose bed is blocked and built up with double storeyed houses. Emergency was declared in the city warranting visit of President of Pakistan. M.D.A. Engineers were directed to replan their comprehensive sewerage scheme under execution so as to include additional low lying areas to avoid accidents like the one of bohar Gate. Irrigation engineers were directed to prepare scheme for interception and diversion of run-off away from the habitation of city. The comprehensive Sewerage scheme has accordingly been modified. The scheme for interception of run-off has ben planned by Irrigation Department. From the description & events mentioned one can visualize the nature of development of the city and its problem of sewerage and drainage. The city except for the old walled portion is like a bowl as compared to its surroundings. The river (Chenab) flowing West is at a higher elevation than most of the city areas. The only possible course of drainage is by pumping waste water and disposing into river. With this basic evaluation of the problem its solution was sought through implementation of comprehensive Sewerage and Drainage scheme Multan.

## 2. FEASIBILITY STUDIES AND MASTER PLAN OF CITY SEWERAGE AND DRAINAGE.

The problem of city sewerage and drainage was studied in great detail by general Advisory Services (GAS) for Public Health Engineering Department (PHED) in 1968-69 and a report was published. The GAS for PHED during their tenure 1964-69 had also conducted studies and published Master Plan Reports for Water Supply & Sewerage & Drainage of Major cities of West pakistan i.e.Rawalpindi, Jhelum, Sialkot, Gujranwala, Sheikhupura, Quetta, Murree, Sukkur, Nawabshah and Hydrabad. They have implemented watersupply schemes in 8 - demonstration cities of Gujranwala, Sheikhupura, Multan, Rawalpindi, Nawabshah, Quetta and Hydrabad. The GAS also published design criteria for Municipal Water Supply in West Pakistan. The city of Multan was selected by the GAS for implementation of Phase-I of Urban water supply scheme Multan under a Master Plan of water supply prepared for the population projected to 1990. The Master Plan for sewerage and Drainage for Multan was also prepared for a prospective population of 13 lacs by 1990. It covered the Municipal Area of 1980. The criteria of design provided for Waste water flows comprised of peak hour domestic sewage, infilteration, Industrial waste and storm water.

## 3. DESCRIPTION OF COMPREHENSIVE SEWERAGE DRAINAGE SCHEME MULTAN

According to this plan, Phase-I of the scheme provided for construction of 43 miles of trunk sewers ranging from size of 12" to 72". Under the second phase, lateral sewers were proposed to be constructed to command areas and abadies served on the trunk sewers of Phase-I. The aggregate length of trunk and lateral sewers constructed upto date is 150 miles in the city. This system is connected to three Main Disposal Stations at Surej Miani, old Shujabad road and Vehari Road. Surej Miani Station is served by one intermediate station at Chungi No.9. Vehari Road station is served by another intermediate Station at Kiri Jamandan. The system commanded at Surej Miani station is the largest. The out-fall sewer terminating at Suraj Miani is 72 inches and it is laid 2 to 4 feet under ground water at maximum depth of 24 feet below natural surface. The disposal station at Surej Miani comprizes of seven vertical electric driven sewage pumps having aggregate discharge capacity of 94 cusecs. There are seven pumps each driven with vertical 3-phase electric motors of 100-150 BHP. Two of these are wound rotar type with slip rings connected to motor speed control gears. The others are the squirrel cage motors with star-Delta Starters. The station is equipped with a 250 KVA Diesel Electric generator capable of supplying electric energy to at-least two pumps during emergency. The station is connected directly to 11-KV grid of WAPDA with a step down 750-KVA transformer with high and low tension control panels. The electric sub station is also constructed by MDA. The other two main stations at old Shujabad and Vehari Road are each built on 60" outfall sewers having total installed capacity of 56 cusecs each. The intermediate pumping station at Chungi No.9 is built on 60" sewer is designed to serve part of old city and new Developments along L.M.Q. and Bosan roads. Each of the remaining four Disposal Stations have stand bye Diesel Electric Generator and Electric Sub stations of 250 K.V.A. All the equipoment of electrric sub-stations are made in Pakistan. The aggregate installed capacity of these stations is 294 cusecs as per detail given in the table below:-

**TABLE SHOWING CAPACITIES OF DISPOSAL STATIONS.**

| Sl. No. | Name of Station | Maximum size of sewer reaching disposal station in inches. | Capacity of sewer running full (Cusecs) | Installed capacity of pumps at the Station |
|---|---|---|---|---|
| 1. | Surej Miani. | 72" | 71" | 90 |
| 2. | Chungi No.9 | 60" | 50 | 56 |
| 3. | Old Shujabad Road. | 60" | 50 | 56 |
| 4. | Kiri Jamandan | 42" | 24 | 36 |
| 5. | Vehari Road | 60" | 50 | 56 |
| | | | Total | 294 |

The effluent from Surej Miani station is carried through a force main comprising of 3 lines of 24" Asbestos Cement Pressure pipes which are made to cross Shujabad canal and discharge into a sump where it is carried in an earthen channel of one mile length upto Akbar flood protective bund. The channel is crossed with its full supply level coincident with highest flood level of 412 at Akbar Bund and is carried upto River Chenab. Most of the effluent, however, is utilized for broad irrigation in the flood plain of the river during dry season. The effluent from old Shujabad Road Disposal Station at present is

utilized for broad irrigation through a mile long sewage channel constructed for this purpose.

The effluents from Vehari Road Disposal Station and old Shujabad Road Disposal Stations are, however, proposed ultimately to be disposed off into a proposed channel for interception of run-off generated outside the city leading upto Chanab River. The capacity of this proposed channel is 200 cusecs. Its ultimate length is proposed to be 25 miles, from Pajkhua Rest house upto Chanab River. Only primary treatment is given to sewage at the disposal stations comprising of screening and grit removal. 43 miles of trunk sewers of size 12" to 72" and five disposal stations of 294 cusec aggregate capacity described form the basic infrastructure for the city to intercept lateral and branch sewers to be constructed under the Master Plan. These are proposed to be constructed in four parts of the comprehensive scheme known as Phase-II (Lateral sewers) Under each part approximately 50 miles of lateral and branch sewers will be constructed and intercepted into the trunk sewers constructed under Phase-I of the scheme. The trunks and Disposal stations has cost Rs.14.50 crores. The laterals and branches are to cost Rs.12 crores. Extension to trunk sewers is also planned and is being implemented at cost of 3 crores. The sewerage system continues to be operated successfully with the help of Imported danish Made Sewer cleaning equipment.

## 4. PROBLEMS OF FACED DURING CONSTRUCTION.

The system of sewerage involved construction of following crossings:-

1) Main line Pakistan Railway at 4 - places.
2) Main Shujabad canal (800 cusecs).
3) Nau Bahar Canal.
4) Existing large trunk sewers in operation (P.S.Plate 3).

The crossing under-neath railway track were sanctioned by Pakistan Railway Authorities without allowing cutting of embankment carrying railway track. These crossing were made by horizental drilling and driving steel pipe casing while rail traffic continued under caution. Crossing of Shujabad canal (800 cusecs) was only permitted during closure of seven days and it was completed by working on 24 hours basis. Nau bahar canal is proposed to be crossed without closure, because its full section is in embankment. This will be done by drilling two piles in running canal, and by constructing a bridge on these piles. At two places crossing of existing trunk sewers in operation were made by driving steel casing pipes without affecting the flows of existing sewers. The main problems during such crossing were that existing brick masonry sewers were non-reinforced. They commanded major portion of old city areas. Their flows could not be diverted or obstructed during crossing. The sewers to be crossed were large egg shaped brick sewers of 40" x 60" and 36" x 54" egg sections running full. The crossing were made at 18-20 feet below bed of existing sewers. (P.S. Plate-6).

The sewer along L.M.Q. Road inside the city was constructed of 66" dia when Multan Bye-pass road was under construction. The road carried heavy traffic between Karachi and Lahore. It was diverted along Shah Shamas and Hafiz Jamal Road, creating traffic jams at Mumtazabad Railway level crossing. The trench after completion of sewer was filled with sand before relaying carpet, because there was no time available for compaction of refilled earth. For carpetting L.M.Q. and other city affected roads a carpetting plant was arranged from Lahore Municipal Corporation which included batch mixer and paver with a fleet of 15 dumper trucks. At many places continuous divertion of sewage was made for periods extending upto a year during construction of deep sewers involving their dismantlements. The trenches of sewers involved maintenance of existing water supply, Sui-gas and telephone lines which were often damaged and repaired at heavy cost and inconvenience to public.

At places where sewers were constructed in sandy strata, in narrow streets, in close proximity of buildings, timbering made to protect sides and avoid caving had to be left inside trenches. This was necessary for safety of life and property of citizens. The trenches dug as deep as 24 feet below ground with timbering upto full depth presented a night mare for the citizens, in event of a rainfall, who trembled with the fear of a house collapse. Fortunately no house collapse occured in a total length of 1.50 miles of such constructions having been completed successfully.

The soil of Multan (Multani Matti) is treacherous. It is similar to black cotton soil of Indo-Pak sub-continent. It is very hard to excavate when dry, and flows like water when wet. Restoration of roads surfaces over such a soil presented a serious problem after refilling of sewer trenches. The only possible solution sought was to refill the trenches with sand. ECNEC was convinced with difficulty on this account during consideration of 2nd Revised cost estimate of the Comprehensive Sewerage Scheme Multan Phase-I. Concreting under waterwas done at depths exceeding 12-15 feet underwater for making bottoms of wells of Disposal Stations leak proof. For this purpose cement sand slurry of 1:1 ratio was injected into coarse aggregate under pressure. The method is described in the paper already published in the proceedings of the Engineering Congress. The paper was written by Syed Irshad Hussain, Executive Engineer, Public Health Engineer Division Lahore and published under Sl.No.298 in the proceedings Vlume XXXVII-1952, entitled "Sub-aqueous construction methods adopted during the execution of the Lahore Sewerage Scheme".

## 5. PROBLEMS OF OPERATION AND MAINTENANCE AND RECOMMENDATIONS FOR OPTIMUM USE OF THE SYSTEM.

The sewer men have been trained to go down manholes as deep as 24 feet below ground. Oxygen masks and breathing apparatus are being used by the sewermen inside the manholes. Fatal accidents, however, have occurred on two occasions, in which a man died without oxygen mask and breathing apparatus having put on. On another occasion a 7-years old girl fell into a manhole without its cover. The accident took place on a 42" sewer. Blockades in the sewer system are often experienced. This is because of lack of proper solid waste management in the city. According to opinion of an expert on solid waste management; any Environmental Health Project is bound to fail without an effective solid waste collection and disposal system. Much can be improved if animals in the city are rehabilitated outside. Animal driven vehicles need to be replaced by Auto Mobiles and the dry system of laterines need replacement by the water borne system of sewerage employing flush toilets for private and public use. These are essentially needed, otherwise, in the city to ensure proper disposal of human excreta. An awareness with deep sense of hygiene needs to be created in the public. This awareness if created under a health Education Program will result into saving on curative measures like hospitalization and use of drugs. Any expenditure thus incurred on this account will soon be repaid in the form of saving of hospital and drug expenses. Enforcement of Building code which has recently been published by the Federal Ministry of Housing and supplied to all Provinces is another essential environmental health program so far neglected by Municipal authorities. Without its enforcement the sewer system cannot be efficiently operated. Use of ash, sand or grit in washing utensils are wrong habits of public, detrimental to efficient operation of sewer system. Introduction of hot water supply for kitchens, and use of detergents is the correct alternative for these wrong habits. The interceptions of surface drains into underground sewer system is another cause of accumulation of garbage and silt in the sewers. Their interceptions without gratings and silt excluders can cause blockades of sewers. Inspite of all these problems the sewer system at Multan built by PHE and MDA Engineers is made to work. The torture if not the capability of Engineers responsible for its design, construction and operation under the conditions described can be visualized. Engineers in this country are faced with the problem of building up their image in the society. The sewerage system at Multan built and operated by Engineers of this country is one example of hard

and devoted work, worth recognition.

## 6. CONCLUSION

The system provided for the city of Multan under the Comprehensive Sewerage Scheme is made to work despite difficulties and problems. It is the only system feasible for the city under its peculiar development. The country of Holland is built below sea level and is protected with dykes. On similar account city of Multan can be protected with bunds all around and drained with the deep underground system-off course utilizing electric power. It is matter of sensitivity analysis, if the cost of operation of the sewer system is cheaper or to build cities above highest flood level as did our fore-fathers. However, nothing can be done for cities already built for considerations other than cost.

## LIST OF PLATES

1. Hypothetical X-Sections of Multan city Showing elevation of Fort - Old city - Surej Miani Disposal Station - Akbar flood protective Bank - HFL - 1976

2. Plan and section of specially large junction manhole at Chungi No.9 Disposal Station.

3. Cross-section of Surej Miani disposal Station.

4. Plan of Surej Miani Disposal Station.

5. X-Section of timbering left in trench of 36" sewer in Kiri Jamandan Area.

6. Plan and X-Section of crossing of trunk sewers (Non-reinforced)

PLATE - I

# HYPOTHETICAL X-SECTIONS OF MULTAN CITY SHOWING ELEVATION OF FORT-OLD CITY - SUREJ MIANI DISPOSAL STATION- AKBAR FLOOD PROTECTIVE BAND H.F.L - 1976

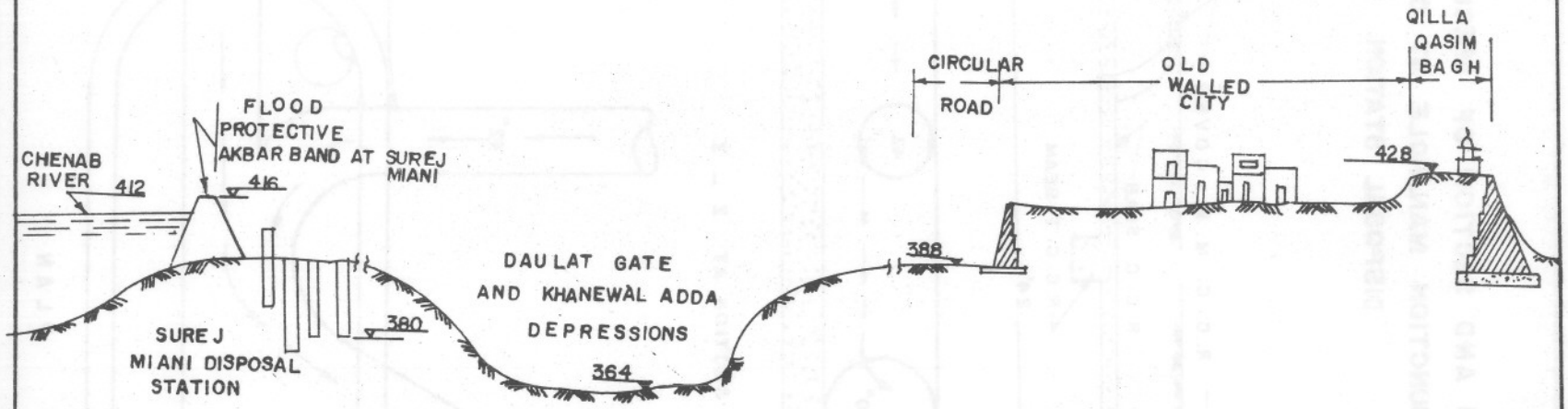


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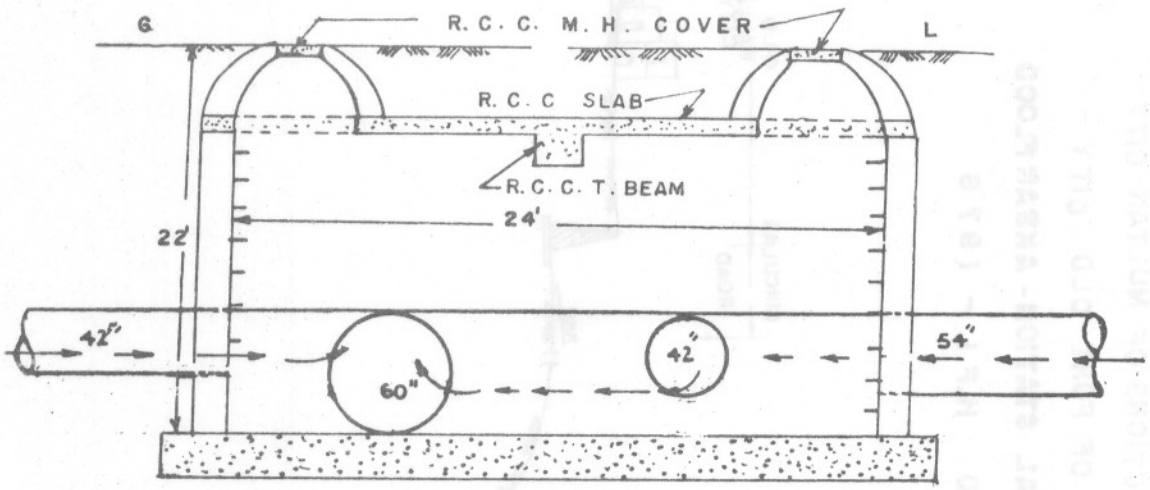
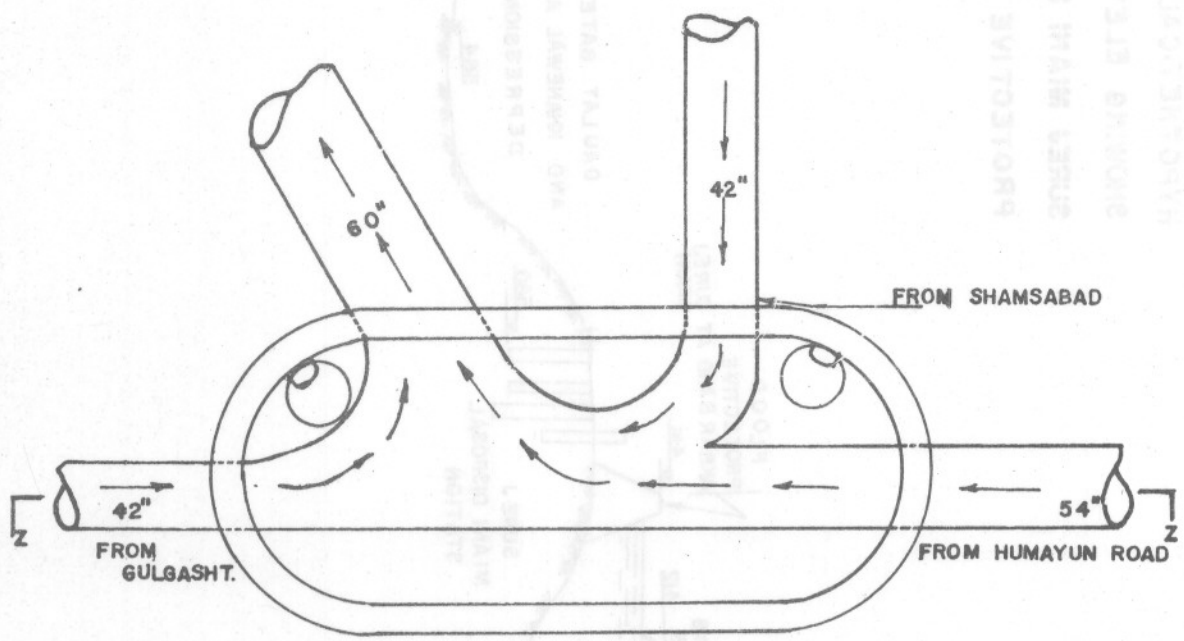
PLATE _ 2

# PLAN AND SECTION OF SPECIALLY LARGE JUNCTION MAN_HOLE AT CHUNGI NO 9 DISPOSAL STATION.




X _ SECTION AT Z _ Z

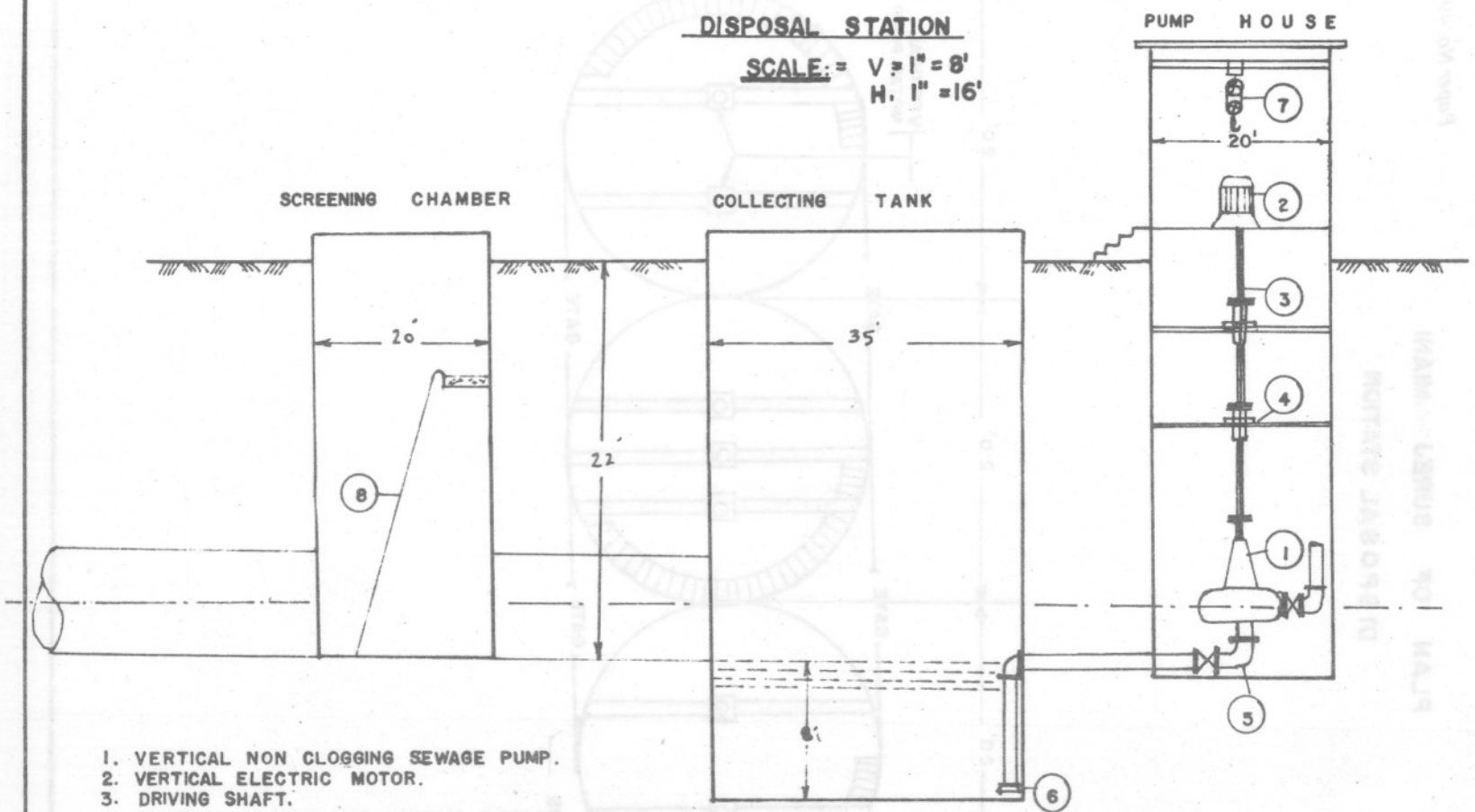



PLAN

PLATE_3

# CROSS SECTION OF SUREJ MIANI DISPOSAL STATION

SCALE:= V = 1" = 8'
H. 1" = 16'




1. VERTICAL NON CLOGGING SEWAGE PUMP.
2. VERTICAL ELECTRIC MOTOR.
3. DRIVING SHAFT.
4. PLUMMER BLOCKS & SUPPORING GIRDER.
5. SUCTION BEND.
6. BELL MOUTH.
7. CHAIN PULLEY BLOCK.
8. BAR SCREEN.

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PLATE_4.

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# PLAN OF SUREJ MIANI DISPOSAL STATION

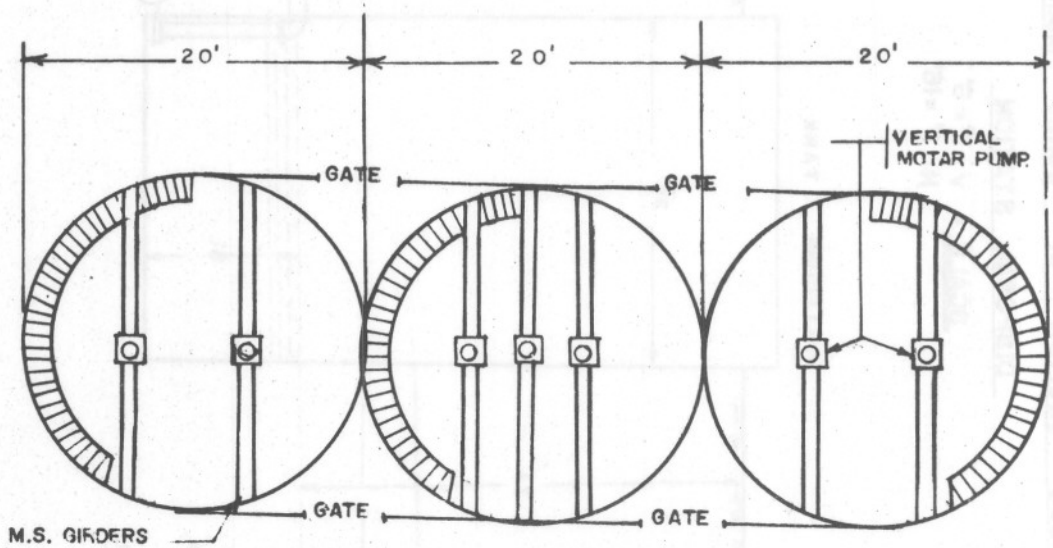

PLATE _ 5

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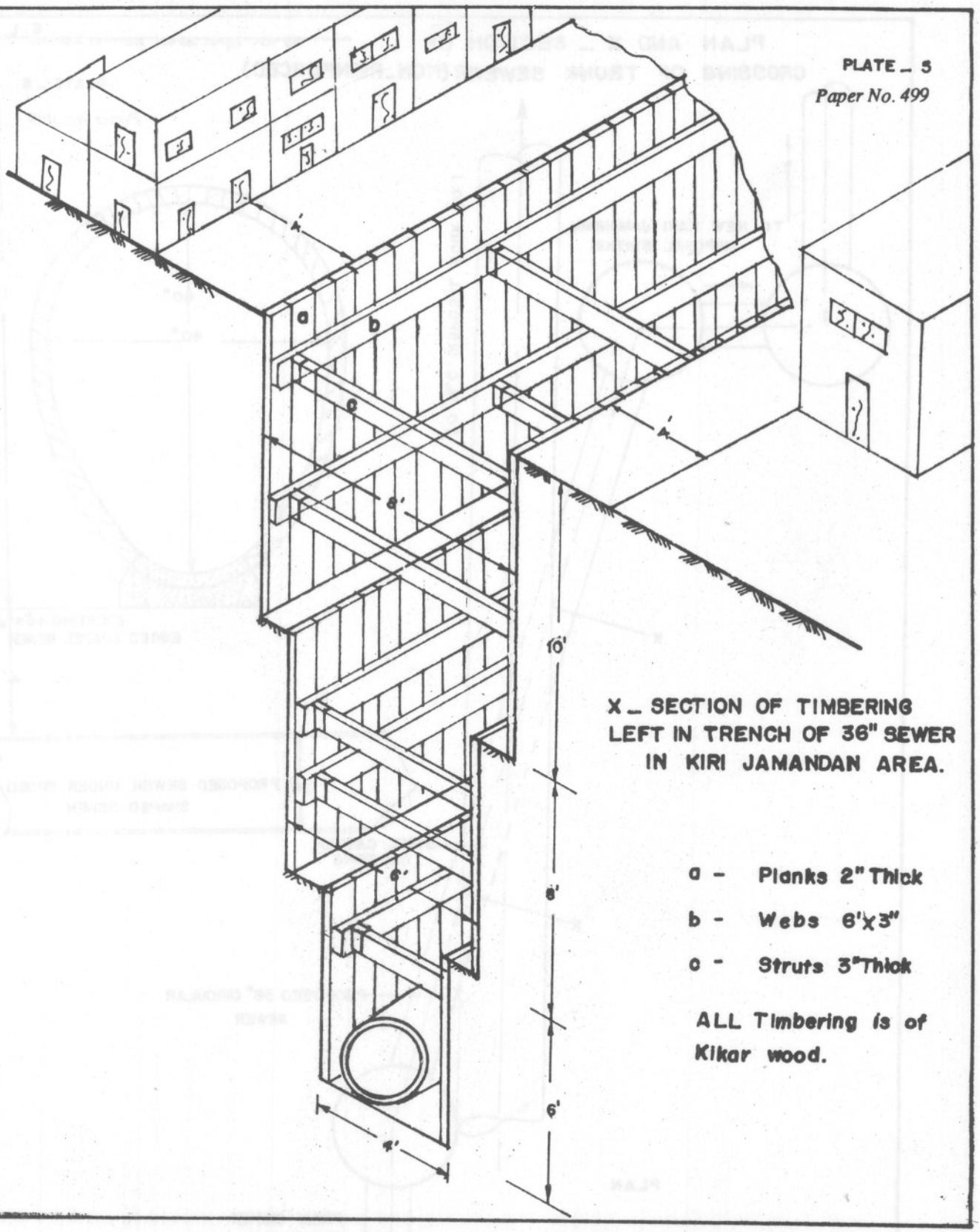


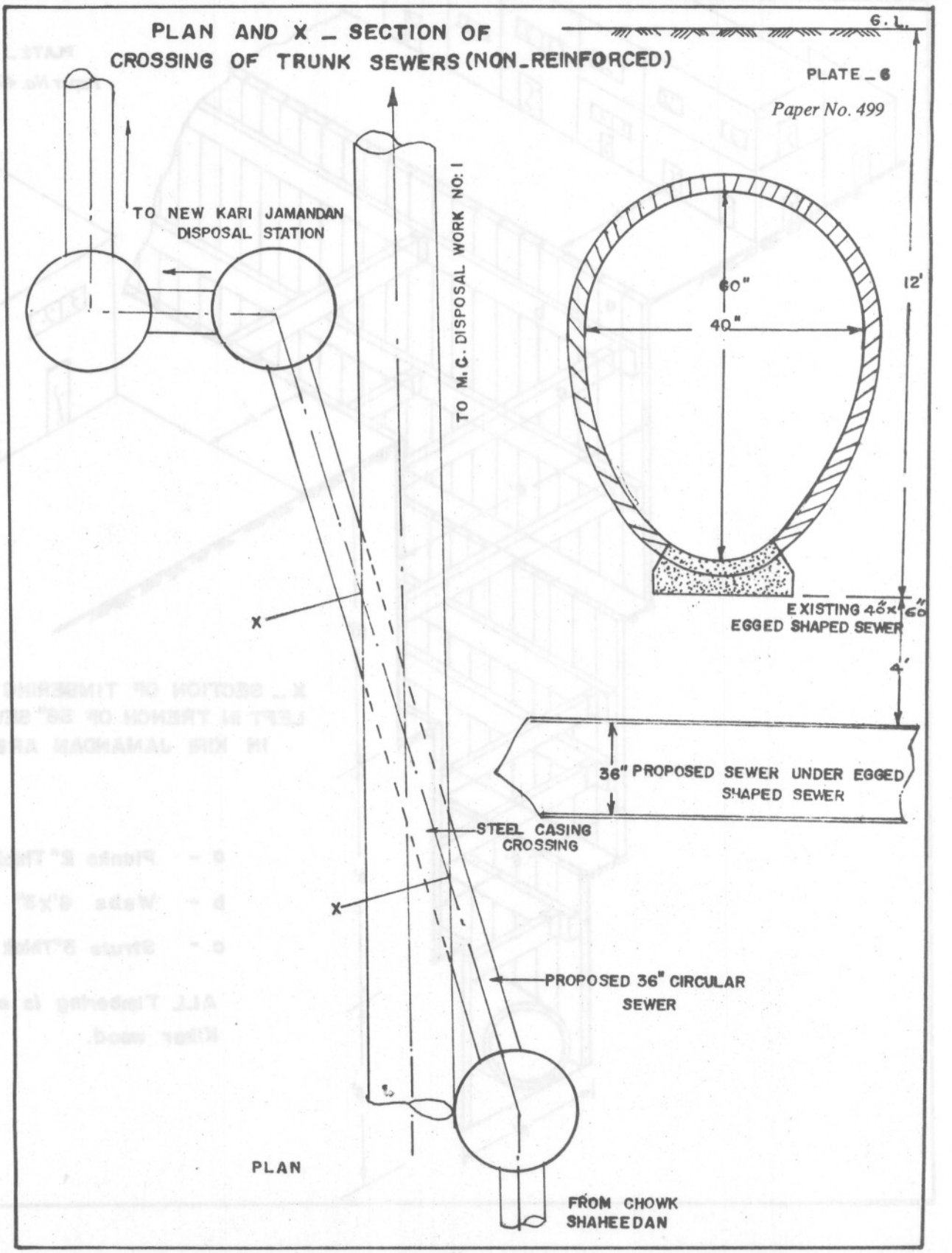

X _ SECTION OF TIMBERING LEFT IN TRENCH OF 36" SEWER IN KIRI JAMANDAN AREA.

a - Planks 2" Thick

b - Webs 6"x3"

c - Struts 3"Thick

ALL Timbering is of Kikar wood.


PLAN AND X _ SECTION OF
CROSSING OF TRUNK SEWERS (NON_REINFORCED)
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G. L.
TO NEW KARI JAMANDAN
DISPOSAL STATION
TO M.C. DISPOSAL WORK NO: I
60"
40"
12'
EXISTING 40"x60"
EGGED SHAPED SEWER
4'
36" PROPOSED SEWER UNDER EGGED
SHAPED SEWER
STEEL CASING
CROSSING
X
X
PROPOSED 36" CIRCULAR
SEWER
PLAN
FROM CHOWK
SHAHEEDAN