Environmental Engineering - II

Design Project of Housing Scheme

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SUBMITTED TO:

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Project Aim:

- To be able to design Sewage System until Completion.

SOME BASIC TERMS

Sewage: It is the Liquid Waste of Wastewater produced as a result of water use.

Sewer: It is a Pipe or Conduit for carrying sewage. It is generally closed and flow takes place under gravity.

Sewerage: it is a comprehensive term. This term is applied to the Art Of the collection of wastewater and conveying it to the point of final disposal with or without treatment.

SOURCES OF WASTEWATER

1. Domestic It is waste water from residential buildings, offices, other buildings and institutions etc.

2. Industrial It is liquid waste from industrial processes like dying, paper making, fertilizers, chemicals, leather etc.

3. Storm water It include surface run off generated by rainfalls and street wash.

TYPES OF SEWERS

1. **Sanitary Sewer:** Sewer which carries sanitary sewage i.e., wastewater originating from a municipality including domestic and industrial wastewater.
2. **Storm Sewer:** It carries storm sewage including surface run off and street washes.
3. **Combined Sewer:** It carries domestic, industrial and storm sewage.

4. House Sewer: is a pipe conveying wastewater from

an individual structure to a common sewer or some

other point of disposal.

TYPES OF SEWERAGE SYSTEMS

1. **Separate System** If storm water is carried separately from domestic and industrial waste, the system is called separate system.

When favored

I) There is an immediate need for collection of sanitary sewage but not for storm sewage.

II) Where sanitary sewage need treatment but storm water does not

2. Combined System: A system in which sewer carry both sanitary as well as storm sewage.

When favored

I) When combined sewage can be disposed off with out treatment

II) When both need treatment

III) When streets are narrow and two separate sewers cannot be laid.

3. Partially Combined: If some portion of storm or surface run off (from roofs, roads, open spaces etc) is allowed to be carried along with sanitary sewage, the system is known as partially combined system.

Note: In urban areas, mostly, partially combined system is used.

Infiltration

The water enters sewer through poor joints, cracked pipes and walls and covers of manholes. Infiltration is almost non-existent in dry weather but it will increase during rainy season.

Infiltration rates $\leq$ 45 lit /km of sewer/day/mm dia (E.W. Steel)

WASA: 225 mm – 610 mm, Infiltration = 5 % of Av. Sewage flow.

> 610 mm, Infiltration = 10 % of Av. Sewage flow.

SEWAGE FLOW / QUANTITY

Sanitary and industrial sewage is derived from water supply, so it has a relationship with amount of water consumption. Generally 80–90% of water consumption is taken as sewage flow.

Variation In Sewage Flow

Like water supply, sewage flow varies from time to time. Since sewers must be able to accommodate the max flow the variation in sewage flow need to be studied.

Generally, following formula is used to estimate the rates (Peak Factor) of max. to average flow, where p is the population in thousands.

$$\frac{Q_{\max}}{Q_{av}} = M = 1 + \frac{14}{4 + \sqrt{p}} \quad (E.W\ Steel)$$

DESIGN PERIODS

1. Collection Works: Period of design is "Indefinite" as the system is designed to case for the maximum development of the area.

2. Disposal Works: Design period is usually 10 years. Rates of flow required are: average daily, peak and minimum flow rates, including infiltration.

3. Treatment Works: Design period is 15 to 20 years flow rates required are average and peak.

INVERT LEVEL

It is the level of the invert of the sewer pipe

Invert: Inverted Arch

Invert Level = G.L– Cover over pipe– thickness of Pipe– dia of pipe.

Steps For Design Of Sewer

1. Preliminary Investigations
2. Design consideration/Formulation of design criteria
3. Actual Design
4. Preparation of drawings and BOQ
5. Subsequent modifications.

PRELIMINARY INVESTIGATION

If map of the area is not already available, the first step is to carry out survey to draw a map of the project area.

Different details are marked on the map like

- Streets
- Railway lines
- Streams
- Location of under ground utilities like gas, water mains etc.
- Establish BENCH MARKS through out the area and make contour profiles.
- Soil conditions should be investigated for the type of structure, location of water table, presence of any underground rock etc.
- Collection of rainfall and run off data.
- Study of natural slopes of the area and selection of a suitable disposal point.

DESIGN CONSIDERATIONS/FORMULATION OF DESIGN CRITERIA

Design Flow

Sanitary Sewer = Peak Sewage flow + Infilt + Industrial flow

Partially Combined = 2 × (Peak sewage flow) + Infilt + Industrial Flow

(WASA CRITERIA)

Design Equation

Sewers are designed on the basis of open channel flow.

V = (Manning's Formula)

Where

V= velocity, m/sec

R= hydraulic mean depth = $\frac{Area}{wetted\ perimeter}$

= D/4, when pipe is flowing full or ½ full

S=slope of sewer

n=Co-efficient of roughness for pipe (0.012 for R.C.C pipes)

Minimum Velocities

Min velocities also called self cleansing velocities must be maintained in sewers to avoid deposition of suspended solids and subsequent choking of sewers.

Sanitary sewers = 0.6 m/sec [organic particle sp. gs = 1.61]

Storm sewers = 1 m/sec [inorganic particle sp. gs = 2.65]

Partially combined = 0.7 m/sec.

Maximum Velocities

2.4 m/sec (E.W Steel)

A limit on higher velocity is imposed due to abrasive character of solids in wastewater

Scraping or wearing away.

Min. Sewer Size

225 mm is taken as min sever size. [WASA, PHED]

why: choaking takes place with bigger size particles/substances which are usually thrown into sewer through manholes etc.

[Examples: shrubs, bricks etc].

Min Cover:

1m is taken as min cover over sewers to avoid damage from live loads coming on sewers.

Manholes

Purpose

- Cleaning
- Inspection
- House connections

Where provided

1. At every change in direction
2. Where two different dia pipes are to be connected.

Spacing

225 mm – 350 mm spacing 100 m

460 mm – 760 mm spacing 120 m [WASA]

> 760 mm spacing 150 m

Note For plots, one manhole be provided for 2 plots

viii) **Qd/Qf Ratios**

WASA recommend the Qd/Qf ratios in order to provide air space in the upper portion of sewers for ventilation purpose. Qd represent design flow and Qf is flow when sewer is flowing full.

Sewer Size	**Ratio (Qd/Qf)**
225 – 380 mm	0.7
460 – 1220 mm	0.75
1370 mm and larger	0.8

1) **DESIGN OF SEWER**

By design of sewer, we mean the following two things

1. To find Size of sewer

Q = AV is used to find size

1. To find required Slope to maintain a minimum velocity in sewers.

V = Is used to find slope.

PREPARATION OF DRAWING AND BOQ

Typical drawings include

- Sewer joints
- Manholes
- Disposal station
- Sewer profiles or L – sections

SUBSEQUENT MODIFICATIONS

Mostly done due to some unforeseen incident, to accommodate some additional demand/requirement of the client etc.

SEWERS FLOWING PARTIALLY FULL

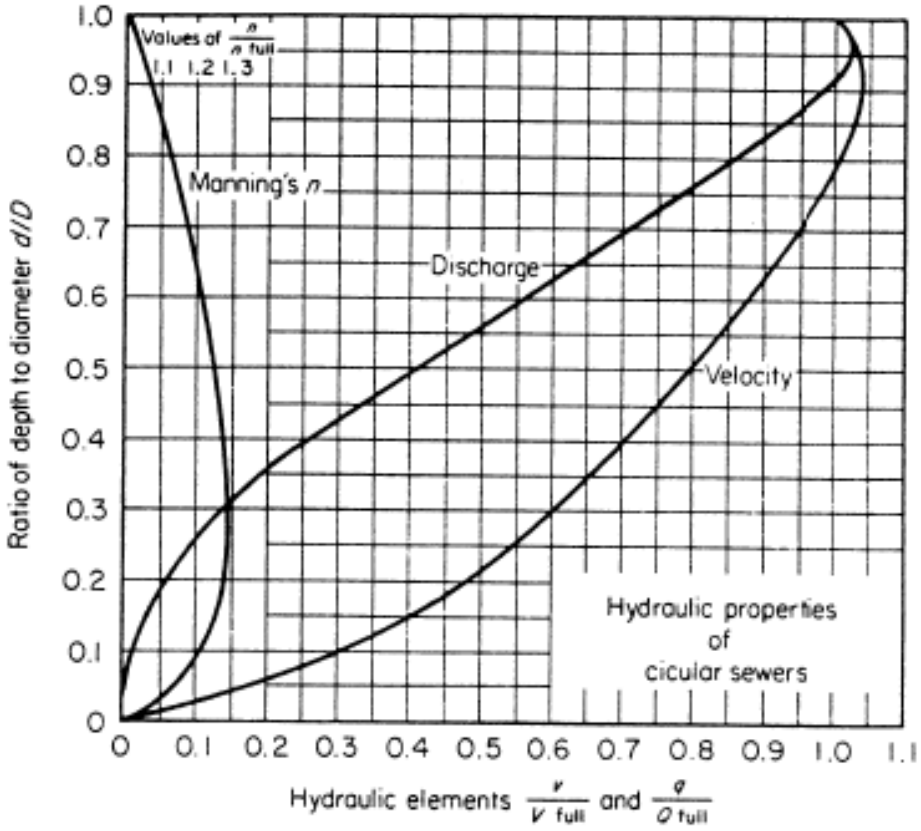
It is necessary to determine velocity and depth of sewage in a pipe when it is flowing only partially full. For this, use of the GRAPH will allow quick computation of the hydraulic elements of partially filled circular sewer.

For using this graph, it is necessary to find first the conditions when a sewer is flowing full. Then by calculating the ratio of any two known hydraulic elements, the others can be found.

Significance Of Partial Flow Study

Conditions during partial flow, must frequently be determined in combined / partially combined sewers due to the following reasons.

- To investigate velocities during dry weather flow to determine possibilities of deposits occurring in pipes.
- Knowledge of depth of flow is of value in designing sewer inter sections.



Sewer diameter(in)	Sewer diameter(mm)	Minimum slope
6	150	0.0043
8	200	0.0033
10	255	0.0025
12	310	0.0019
15	380	0.0014
18	460	0.0011
21	530	0.00092
24	610	0.00077

225mm, 310mm, 380mm, 460mm, 530mm, 610mm, 690mm, 760mm, 840mm, 915mm, 990mm, 1070mm and 1220mm are the commercial diameters.

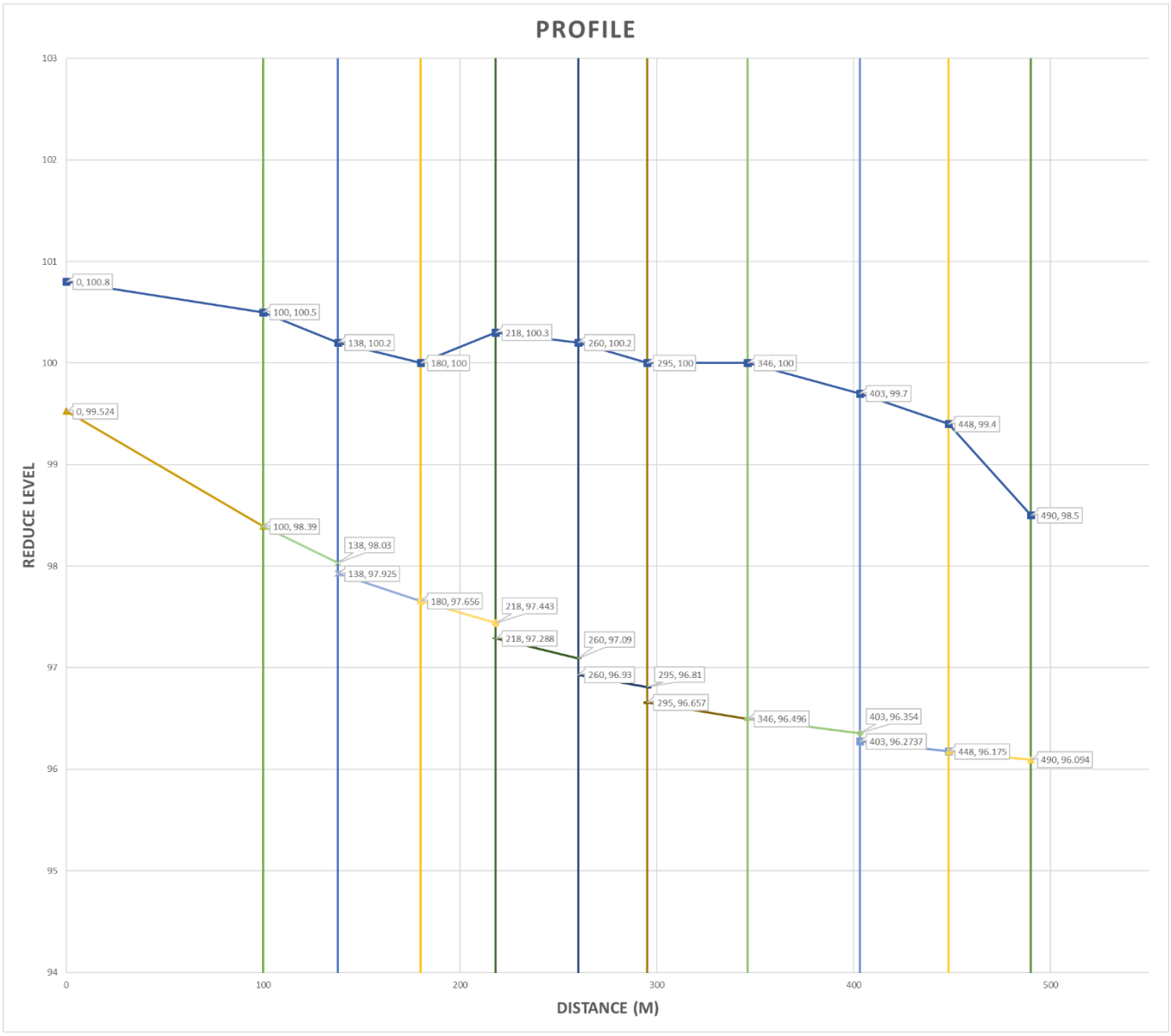
Sr#	Pipeline	Distance (m)	Houses	Appartment	Flats	Population	Σ Population (houses, appartments, flats)	A.w.c (houses, flats, appartments)	Sewage per capita	Q average (Houses, flats, appartments)	M	Q peak (houses, appart, flats)
1	M1-M2	100	30	0	0	300	300	272	244.8	73.44	4.078463961	299.5223933
2	M2-M4	38	6	0	0	60	360	272	244.8	88.128	4.043478261	356.3436522
3	M3-M4	98	22	0	0	220	220	272	244.8	53.856	4.132662734	222.5686842
4	M4-M6	42	8	0	0	80	660	272	244.8	161.568	3.909149037	631.5933917
5	M5-M6	98	21	0	0	210	210	272	244.8	51.408	4.14024028	212.8414723
6	M6-M8	38	5	0	0	50	920	272	244.8	225.216	3.823055155	861.0131897
7	M7-M8	9	3	0	0	30	30	272	244.8	7.344	4.354735684	31.98117886
8	M9-M10	18	3	0	1	530	530	272	244.8	129.744	3.961076028	513.9258482
9	M10-M11	117	28	0	0	280	810	272	244.8	198.288	3.857142857	764.8251429
10	M8-M11	42	0	0	0	0	950	272	244.8	232.56	3.814251689	887.0423728
11	M12-M13	15	3	0	0	30	30	272	244.8	7.344	4.354735684	31.98117886
12	M13-M14	118	24	0	0	240	270	272	244.8	66.096	4.097608812	270.835552
13	M11-M14	35	0	0	0	0	1760	272	244.8	430.848	3.628293622	1563.24305
14	M15-M16	22	3	0	1	530	530	272	244.8	129.744	3.961076028	513.9258482
15	M16-M17	118	21	0	0	210	740	272	244.8	181.152	3.880520618	702.9640709
16	M14-M17	51	3	0	0	30	2060	272	244.8	504.288	3.575769001	1803.217398
17	M18-M19	26	2	0	1	520	520	272	244.8	127.296	3.965404162	504.7800882
18	M19-M20	118	11	1	0	910	1430	272	244.8	350.064	3.694470485	1293.301116
19	M17-M20	57	6	0	0	60	2860	272	244.8	700.128	3.45995827	2422.413663
20	M20-M21	45	4	0	0	40	4330	272	244.8	1059.984	3.302303953	3500.389354
21	M21-M22	42	2	0	0	20	4350	272	244.8	1064.88	3.300487978	3514.623638
22	M23-M24	93	15	1	0	950	950	272	244.8	232.56	3.814251689	887.0423728
23	M24-M26	67	0	0	0	0	950	272	244.8	232.56	3.814251689	887.0423728
24	M25-M26	68	11	0	0	110	110	272	244.8	26.928	4.232015437	113.9597117
25	M26-M27	173	35	0	0	350	1410	272	244.8	345.168	3.698829409	1276.717549
26	M27-M29	49	0	1	0	800	2210	272	244.8	541.008	3.551668147	1921.480881
27	M28-M29	161	21	0	0	210	210	272	244.8	51.408	4.14024028	212.8414723
28	M29-M22	14	0	0	0	0	2420	272	244.8	592.416	3.519964001	2085.282994
29	M22-M30	16	0	0	0	0	6770	272	244.8	1657.296	3.120594461	5171.748717

Sr#	Pipeline	School	Dispensary	Grave Yard	Park	Population	Σ Population (miscellaneous)	A.W.C (miscellaneous)	Sewage per capita	Q average (miscellaneous)	M	Q peak (miscellaneous)	Comercial area (m^2)	Q average (comercial area)	M	Qpeak (miscellaneous)	Total Qaverage
1	M1-M2	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	73.44
2	M2-M4	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	88.128
3	M3-M4	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	53.856
4	M4-M6	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	161.568
5	M5-M6	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	51.408
6	M6-M8	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	225.216
7	M7-M8	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	7.344
8	M9-M10	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	129.744
9	M10-M11	0	1	0	0	20	20	50	45	0.9	4.380481916	3.942433724	0	0	2	0	199.188
10	M8-M11	1	0	0	0	200	200	50	45	9	4.148038586	37.33234728	0	0	2	0	241.56
11	M12-M13	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	7.344
12	M13-M14	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	66.096
13	M11-M14	0	0	0	1	20	240	50	45	10.8	4.118110959	44.47559836	0	0	2	0	441.648
14	M15-M16	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	129.744
15	M16-M17	0	0	0	0	0	0	50	45	0	4.5	0	168	11.06784	2	22.13568	192.21984
16	M14-M17	0	0	0	0	0	240	50	45	10.8	4.118110959	44.47559836	0	0	2	0	515.088
17	M18-M19	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	127.296
18	M19-M20	0	0	0	0	0	0	50	45	0	4.5	0	144	9.48672	2	18.97344	359.55072
19	M17-M20	0	0	0	0	0	240	50	45	10.8	4.118110959	44.47559836	168	11.06784	2	22.13568	721.99584
20	M20-M21	0	0	0	0	0	240	50	45	10.8	4.118110959	44.47559836	144	9.48672	2	18.97344	1080.27072
21	M21-M22	0	0	0	0	0	240	50	45	10.8	4.118110959	44.47559836	0	0	2	0	1075.68
22	M23-M24	0	0	1	0	10	10	50	45	0.45	4.414634146	1.986585366	0	0	2	0	233.01
23	M24-M26	0	0	0	1	20	30	50	45	1.35	4.354735684	5.878893173	0	0	2	0	233.91
24	M25-M26	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	26.928
25	M26-M27	0	0	0	0	0	30	50	45	1.35	4.354735684	5.878893173	0	0	2	0	346.518
26	M27-M29	0	0	0	0	0	30	50	45	1.35	4.354735684	5.878893173	0	0	2	0	542.358
27	M28-M29	0	0	0	0	0	0	50	45	0	4.5	0	0	0	2	0	51.408
28	M29-M22	0	0	0	0	0	30	50	45	1.35	4.354735684	5.878893173	0	0	2	0	593.766
29	M22-M30	0	0	0	0	0	270	50	45	12.15	4.097608812	49.78594706	0	0	2	0	1669.446

Sr#	Pipeline	Total Q peak	Qd (m^3/day)	Qd (m^3/sec)	V (m/sec)	Diameter (m)	Diameter (mm)	Commercial Diameter (mm)	Commercial Diameter (m)
1	M1-M2	299.5223933	599.0447867	0.006933389	0.7	0.1123282	112.32823	225	0.225
2	M2-M4	356.3436522	712.6873043	0.008248696	0.7	0.1225205	122.52051	225	0.225
3	M3-M4	222.5686842	445.1373684	0.005152053	0.7	0.0968292	96.829192	225	0.225
4	M4-M6	631.5933917	1263.186783	0.014620217	0.7	0.1631147	163.11469	225	0.225
5	M5-M6	212.8414723	425.6829447	0.004926886	0.7	0.0946896	94.689627	225	0.225
6	M6-M8	861.0131897	1722.026379	0.019930861	0.7	0.1904492	190.44921	225	0.225
7	M7-M8	31.98117886	63.96235772	0.000740305	0.7	0.0367047	36.704686	225	0.225
8	M9-M10	513.9258482	1027.851696	0.011896432	0.7	0.1471379	147.13788	225	0.225
9	M10-M11	768.7675766	1537.535153	0.017795546	0.7	0.1799583	179.95827	225	0.225
10	M8-M11	924.37472	1848.74944	0.021397563	0.7	0.1973324	197.33236	380	0.38
11	M12-M13	31.98117886	63.96235772	0.000740305	0.7	0.0367047	36.704686	225	0.225
12	M13-M14	270.835552	541.671104	0.006269341	0.7	0.1068137	106.81374	225	0.225
13	M11-M14	1607.718649	3215.437297	0.037215709	0.7	0.2602431	260.24315	380	0.38
14	M15-M16	513.9258482	1027.851696	0.011896432	0.7	0.1471379	147.13788	225	0.225
15	M16-M17	725.0997509	1452.41307	0.016810336	0.7	0.1749059	174.90586	225	0.225
16	M14-M17	1847.692996	3695.385992	0.042770671	0.7	0.2789904	278.99035	380	0.38
17	M18-M19	504.7800882	1009.560176	0.011684724	0.7	0.1458228	145.82278	225	0.225
18	M19-M20	1312.274556	2626.446455	0.030398686	0.7	0.2352034	235.20338	380	0.38
19	M17-M20	2489.024942	4980.263452	0.057641938	0.7	0.323881	323.88098	380	0.38
20	M20-M21	3563.838392	7129.574128	0.082518219	0.7	0.3875173	387.51728	460	0.46
21	M21-M22	3559.099236	7118.198472	0.082386556	0.7	0.387208	387.208	460	0.46
22	M23-M24	889.0289581	1778.057916	0.020579374	0.7	0.1935228	193.52284	225	0.225
23	M24-M26	892.9212659	1785.842532	0.020669474	0.7	0.193946	193.94602	225	0.225
24	M25-M26	113.9597117	227.9194234	0.002637956	0.7	0.0692867	69.286711	225	0.225
25	M26-M27	1282.596443	2565.192885	0.029689732	0.7	0.2324445	232.44451	380	0.38
26	M27-M29	1927.359774	3854.719549	0.04461481	0.7	0.2849415	284.94148	380	0.38
27	M28-M29	212.8414723	425.6829447	0.004926886	0.7	0.0946896	94.689627	225	0.225
28	M29-M22	2091.161887	4182.323774	0.048406525	0.7	0.2968029	296.80288	380	0.38
29	M22-M30	5221.534664	10443.06933	0.120868858	0.7	0.4690006	469.00056	530	0.53

		According to Commercial Diameter						According to Dry weather condition										
Sr#	Pipeline	V full (not ok)	V full (Satisfied) (m/sec)	Q full (m^3/sec)	Qd/Qfull (m^3/sec)	Va/ Vfull	Va	Qd mean (m^3/sec)	v full (m/sec)	V full (Satisfied) (m/sec)	Q full (m^3/sec)	Qd mean/ Q full (m^3/sec)	Va/ Vfull	Va	S (m/sec)	Fall	Upper Invert Level	Down Invert Level
1	M1-M2	0.7	1.2	0.04768875	0.145388351	0.6	0.72	0.003466694	1.2	1.2	0.04768875	0.072694176	0.52	0.624	0.0112915	1.129152	99.524	98.3948478
2	M2-M4	0.7	1.1	0.043714688	0.188693918	0.65	0.715	0.004124348	1.1	1.1	0.043714688	0.094346959	0.56	0.616	0.009488	0.360545	98.3948478	98.0343032
3	M3-M4	0.7	1.3	0.051662813	0.099724592	0.56	0.728	0.002576026	1.3	1.3	0.051662813	0.049862296	0.56	0.728	0.0132519	1.298682	99.224	97.9253181
4	M4-M6	0.7	0.9	0.035766563	0.408767753	0.8	0.72	0.007310109	0.9	0.9	0.035766563	0.204383877	0.67	0.603	0.0063515	0.266762	97.9253181	97.6585559
5	M5-M6	0.7	1.3	0.051662813	0.095366197	0.55	0.715	0.002463443	1.3	1.35	0.053649844	0.045917058	0.45	0.6075	0.0142908	1.400502	99.524	98.1234984
6	M6-M8	0.7	0.8	0.0317925	0.626904486	0.91	0.728	0.00996543	0.8	0.85	0.033779531	0.295013876	0.74	0.629	0.0056654	0.215284	97.6585559	97.4432721
7	M7-M8	0.7	2.4	0.0953775	0.007761842	0.3	0.72	0.000370153	2.4	2.4	0.0953775	0.003880921	0.39	0.936	0.0451661	0.406495	99.024	98.6175052
8	M9-M10	0.7	1	0.039740625	0.299351902	0.72	0.72	0.005948216	1	1	0.039740625	0.149675951	0.62	0.62	0.0078413	0.141144	99.124	98.982856
9	M10-M11	0.7	0.8	0.0317925	0.559740371	0.89	0.712	0.008897773	0.8	0.85	0.033779531	0.263407234	0.71	0.6035	0.0056654	0.662848	98.982856	98.3200083
10	M8-M11	0.7	1.1	0.1246894	0.171606913	0.64	0.704	0.010698781	1.1	1.1	0.1246894	0.085803456	0.55	0.605	0.0047174	0.198133	97.2883	97.0901671
11	M12-M13	0.7	2.4	0.0953775	0.007761842	0.3	0.72	0.000370153	2.4	2.4	0.0953775	0.003880921	0.39	0.936	0.0451661	0.67491	99.124	98.4465087
12	M13-M14	0.7	1.3	0.051662813	0.121351146	0.56	0.728	0.003134671	1.3	1.3	0.051662813	0.060675573	0.47	0.611	0.0132519	1.563719	98.4465087	96.8827897
13	M11-M14	0.7	0.9	0.1020186	0.364793376	0.78	0.702	0.018607855	0.9	0.95	0.1076863	0.172796862	0.64	0.608	0.0035186	0.123151	96.9352	96.8120492
14	M15-M16	0.7	0.95	0.037753594	0.315107265	0.74	0.703	0.005948216	0.95	1	0.039740625	0.149675951	0.62	0.62	0.0078413	0.172509	98.924	98.7514906
15	M16-M17	0.7	0.8	0.0317925	0.528751638	0.88	0.704	0.008392358	0.8	0.8	0.0317925	0.263972894	0.75	0.6	0.0050185	0.592178	98.7514906	98.159313
16	M14-M17	0.7	0.85	0.0963509	0.443905259	0.83	0.7055	0.021385336	0.85	0.9	0.1020186	0.209621928	0.67	0.603	0.003158	0.161056	96.657	96.4959439
17	M18-M19	0.7	1	0.039740625	0.294024673	0.72	0.72	0.005842362	1	1	0.039740625	0.147012336	0.62	0.62	0.0078413	0.203875	98.224	98.0201253
18	M19-M20	0.7	1	0.113354	0.268174796	0.71	0.71	0.015188363	1	1	0.113354	0.133990533	0.61	0.61	0.0038987	0.460049	97.8651	97.4050512
19	M17-M20	0.7	0.75	0.0850155	0.67801681	0.95	0.7125	0.028808159	0.75	0.8	0.0906832	0.317679119	0.75	0.6	0.0024952	0.142225	96.4959439	96.3537187
20	M20-M21	0.7	0.75	0.1245795	0.662373979	0.94	0.705	0.04124813	0.75	0.85	0.1411901	0.292146047	0.72	0.612	0.0021834	0.098252	96.2737	96.1754483
21	M21-M22	0.7	0.75	0.1245795	0.661317122	0.94	0.705	0.041193278	0.75	0.8	0.1328848	0.309992401	0.75	0.6	0.0019341	0.08123	96.1754483	96.0942179
22	M23-M24	0.7	0.75	0.029805469	0.690456312	0.95	0.7125	0.010289687	0.75	0.8	0.0317925	0.323651396	0.75	0.6	0.0050185	0.466716	99.224	98.757837
23	M24-M26	0.7	0.75	0.029805469	0.693479238	0.94	0.705	0.010334737	0.75	0.8	0.0317925	0.325068393	0.75	0.6	0.0050185	0.336236	98.757837	98.4210473
24	M25-M26	0.7	1.6	0.063585	0.041487085	0.45	0.72	0.001318978	1.6	1.7	0.067559063	0.019523334	0.36	0.612	0.0226615	1.540979	99.224	97.6830209
25	M26-M27	0.7	1	0.113354	0.261920466	0.72	0.72	0.014844866	1	1.1	0.1246894	0.119054757	0.56	0.616	0.0047174	0.816119	97.5282	96.7119012
26	M27-M29	0.7	0.85	0.0963509	0.463045074	0.83	0.7055	0.022307405	0.85	0.9	0.1020186	0.218660174	0.67	0.603	0.003158	0.15474	96.7119012	96.5571611
27	M28-M29	0.7	1.3	0.051662813	0.095366197	0.55	0.715	0.002463443	1.3	1.3	0.051662813	0.047683098	0.47	0.611	0.0132519	2.133549	98.224	96.0904512
28	M29-M22	0.7	0.85	0.0963509	0.502398267	0.85	0.7225	0.024203263	0.85	0.85	0.0963509	0.251199133	0.71	0.6035	0.0028168	0.039436	95.9355	95.8960645
29	M22-M30	0.7	0.75	0.165379875	0.730855904	0.96	0.72	0.060434429	0.75	0.8	0.1764052	0.342588705	0.76	0.608	0.0016012	0.025619	95.7461	95.7204808

Sr.	Pipleline	Distance	Total Distance	Upper Invert Level	Down Invert Level	NSL
1	M1-M2	100	0	99.524	98.39	100.8
2	M2-M4	38	100	98.39	98.03	100.5
3	M4-M6	42	138	97.925	97.658	100.2
4	M6-M8	38	180	97.656	97.443	100
5	M8-M11	42	218	97.288	97.09	100.3
6	M11-M14	35	260	96.93	96.81	100.2
7	M14-M17	51	295	96.657	96.496	100
8	M17-M20	57	346	96.496	96.354	100
9	M20-M21	45	403	96.2737	96.175	99.7
10	M21-M22	42	448	96.175	96.094	99.4
11	M22-M30	16	490	95.75	95.72	98.5



Bill of Quantity (BOQ)

Pipeline	Diameter	Diameter	Measurements(m)			1 NSL	2 NSL	Mean of NSL	U I/L	D I/L	Mean	Excavation Quantity	Excavation Quantity	Excation Rate	Manhole (m)				NO of Manhole	Total Volumn	manhole price	Bedding	Bedding Volume	Bedding Volume	Bedding rate	Pipe length	Pipe price	Back filling Volume	Back Filling Rate
	mm	inch	length	Width	Depth	m	m	m	m	m	m	m^3	ft^3	RS	Area	Area	Depth	Volume(m3)		m3	Rs	Class	m3	ft3	RS	Ft	per running foot	ft3	Rs
M1-M2	225	8.9	100	0.6375	1.690576	100.8	100.5	100.65	99.524	98.39485	98.95942	107.774	3806.004	79926.078	0.2374625	1.227183594	1.840576112	1.021573441	9	9.194	495000					328.08399	154199.4753	3299.45993	36294.05921
M2-M4	225	8.9	38	0.6375	2.135425	100.5	100.2	100.35	98.39485	98.0343	98.21458	51.731	1826.848	38363.798	0.2374625	1.227183594	2.285424513	1.5674841	3	4.702	165000					124.6719162	58595.80061	1634.36088	17977.96971
M3-M4	225	8.9	98	0.6375	1.775341	100.5	100.2	100.35	99.224	97.92532	98.57466	110.914	3916.899	82254.870	0.2374625	1.227183594	1.925340942	1.12559545	6	6.754	330000					321.5223102	151115.4858	3420.48565	37625.34213
M4-M6	225	8.9	42	0.6375	2.308063	100.2	100	100.1	97.92532	97.65856	97.79194	61.798	2182.385	45830.091	0.2374625	1.227183594	2.458062991	1.779343208	3	5.338	165000					137.7952758	64763.77963	1969.63691	21666.006
M5-M6	225	8.9	98	0.6375	1.576251	100.8	100	100.4	99.524	98.1235	98.82375	98.476	3477.650	73030.651	0.2374625	1.227183594	1.726250809	0.881275304	6	5.288	330000					321.5223102	151115.4858	2981.23714	32793.60856
M6-M8	225	8.9	38	0.6375	2.599086	100	100.3	100.15	97.65856	97.44327	97.55091	62.963	2223.508	46693.672	0.2374625	1.227183594	2.749086022	2.136481897	3	6.409	165000					124.6719162	58595.80061	2031.02153	22341.23688
M7-M8	225	8.9	9	0.6375	1.479247	100.3	100.3	100.3	99.024	98.61751	98.82075	8.487	299.721	6294.150	0.2374625	1.227183594	1.6292474	0.762234313	2	1.524	110000					29.5275591	13877.95278	254.132495	2795.45744
M9-M10	225	8.9	18	0.6375	1.346572	100.4	100.4	100.4	99.124	98.98286	99.05343	15.452	545.678	11459.241	0.2374625	1.227183594	1.496572014	0.599417255	3	1.798	165000					59.0551182	27755.90555	454.500274	4999.503018
M10-M11	225	8.9	117	0.6375	1.648568	100.4	100.2	100.3	98.98286	98.32001	98.65143	122.963	4342.373	91189.842	0.2374625	1.227183594	1.798567849	0.970021589	8	7.760	440000					383.8582683	180413.3861	3749.71719	41246.88904
M8-M11	380	15.0	42	0.87	3.060766	100.3	100.2	100.25	97.2883	97.09017	97.18923	111.840	3949.599	82941.583	0.2374625	1.227183594	3.210766441	2.703048533	2	5.406	110000	Class B bedding	27.960	987.400	29621.99395	137.7952758	64763.77963	3459.24891	38051.73801
M12-M13	225	8.9	15	0.6375	1.614746	100.4	100.4	100.4	99.124	98.44651	98.78525	15.441	545.293	11451.152	0.2374625	1.227183594	1.764745667	0.928515563	2	1.857	110000					49.2125985	23129.9213	469.311362	5162.424979
M13-M14	225	8.9	118	0.6375	2.635351	100.4	100.2	100.3	98.44651	96.88279	97.66465	198.244	7000.917	147019.257	0.2374625	1.227183594	2.785350836	2.180985482	8	17.448	440000					387.1391082	181955.3809	6403.1953	70435.14833
M11-M14	380	15.0	35	0.87	3.376375	100.3	100.2	100.25	96.9352	96.81205	96.87362	102.811	3630.716	76245.042	0.2374625	1.227183594	3.526375388	3.090358654	2	6.181	110000	Class B bedding	25.703	907.679	27230.37221	114.8293965	53969.81636	3222.09106	35443.00163
M15-M16	225	8.9	22	0.6375	1.462255	100.4	100.2	100.3	98.924	98.75149	98.83775	20.508	724.236	15208.959	0.2374625	1.227183594	1.612254684	0.74138113	3	2.224	165000					72.1784778	33923.88457	612.796488	6740.761373
M16-M17	225	8.9	118	0.6375	1.494598	100.2	99.7	99.95	98.75149	98.15931	98.4554	112.431	3970.461	83379.681	0.2374625	1.227183594	1.644598173	0.781072529	6	4.686	330000					387.1391082	181955.3809	3372.73933	37100.1326
M14-M17	380	15.0	51	0.87	3.273528	100	99.7	99.85	96.657	96.49594	96.57647	145.246	5129.320	107715.718	0.2374625	1.227183594	3.423528034	2.964146069	3	8.892	165000	Class B bedding	36.312	1282.330	38469.89918	167.3228349	78641.7324	4533.89455	49872.84
M18-M19	225	8.9	26	0.6375	1.727937	100.2	99.5	99.85	98.224	98.02013	98.12206	28.641	1011.430	21240.030	0.2374625	1.227183594	1.877937354	1.067422543	3	3.202	165000					85.3018374	40091.86358	879.728592	9677.014507
M19-M20	380	15.0	118	0.87	1.864924	99.5	99.5	99.5	97.8651	97.40505	97.63508	191.453	6761.081	141982.912	0.2374625	1.227183594	2.014924401	1.235530801	7	8.649	385000					387.1391082	181955.3809	5383.44023	59217.84249
M17-M20	380	15.0	57	0.87	3.175169	99.7	99.5	99.6	96.49594	96.35372	96.42483	157.457	5560.517	116770.865	0.2374625	1.227183594	3.325168697	2.843441104	5	14.217	275000	Class B bedding	39.364	1390.129	41703.8805	187.0078743	87893.70092	4895.04201	53845.46216
M20-M21	460	18.1	45	0.99	3.225426	99.5	99.4	99.45	96.2737	96.17545	96.22457	149.693	5074.451	106563.470	0.2374625	1.227183594	3.375425836	2.905115841	4	11.620	220000	Class B bedding	35.923	1268.613	38058.38224	147.6377955	69389.76389	4350.74887	47858.23754
M21-M22	460	18.1	42	0.99	2.815167	99.4	98.5	98.95	96.17545	96.09422	96.13483	117.055	4133.738	86808.493	0.2374625	1.227183594	2.965166896	2.4016528	2	4.803	110000					137.7952758	64763.77963	3458.28248	38041.1073
M23-M24	225	8.9	93	0.6375	1.659358	100.5	100.8	100.65	99.224	98.75728	98.99064	98.379	3474.222	72958.660	0.2374625	1.227183594	1.809358126	0.983263241	9	8.849	495000					305.1181107	143405.512	3003.13619	33034.49807
M24-M26	225	8.9	67	0.6375	1.910834	100.8	100.2	100.5	98.75728	98.42105	98.58917	81.617	2882.255	60527.348	0.2374625	1.227183594	2.060834473	1.291870887	3	3.876	165000					219.8162733	103313.6485	2542.87032	27971.57357
M25-M26	225	8.9	68	0.6375	1.29649	99.3	100.2	99.75	99.224	97.68302	98.45351	56.203	1984.780	41680.384	0.2374625	1.227183594	1.446489566	0.537956897	4	2.152	220000					223.0971132	104855.6432	1640.33042	18043.63465
M26-M27	380	15.0	173	0.87	2.730039	100.2	99.5	99.85	97.52802	96.7119	97.11996	410.898	14510.707	304724.838	0.2374625	1.227183594	2.880039389	2.297185721	11	25.269	605000					567.5853027	266765.0923	12490.9304	137400.2345
M27-M29	380	15.0	49	0.87	2.565469	99.5	98.9	99.2	96.7119	96.55716	96.63453	109.366	3862.214	81106.501	0.2374625	1.227183594	2.715468851	2.095227456	2	4.190	110000					160.7611551	75557.7429	3290.13899	36191.5289
M28-M29	225	8.9	161	0.6375	1.942774	99.3	98.9	99.1	98.224	96.09045	97.15723	199.402	7041.784	147877.474	0.2374625	1.227183594	2.092774405	1.331067048	10	13.311	550000					528.2152239	248261.1552	6226.24899	68488.73885
M29-M22	380	15.0	14	0.87	2.784218	98.9	98.5	98.7	95.9355	95.89606	95.91578	33.912	1197.581	25149.194	0.2374625	1.227183594	2.93421777	2.36367254	2	4.727	110000					45.9317586	21587.92654	1034.13058	11375.43643
M22-M30	530	20.9	16	1.095	2.51671	98.5	98	98.25	95.7461	95.72048	95.73329	44.093	1557.118	32699.476	0.2374625	1.227183594	2.666709598	2.035390901	1	2.035	55000					52.4934384	24671.91605	1229.20066	13521.20721
Total														2239093.431	Total				132	Sum			165.262	Total Price	175084.5281	T.Price pipe	2911286.094	Total Price	1015212.635