

**TABLE- 3**  
**TABLE SHOWING COMPARATIVE STATEMENT OF OVERALL COST STRUCTURE OF PUMPING MAIN**

S.No.	Pipe Size (mm)	Total Head		Thickness of pipe (mm)	Rates of pipe (Rs)	Cost of <b>2500</b> m pipe line (Rs in lakh)	1st stage flow		
		1st stage flow (m)	2nd stage flow (m)				Cost of pumpsets (Rs in lakh)	Annual cost energy charges (Rs in lakh)	Energy charges capitalised (Rs in lakh)
1	2	3	4	5	6	7	8	9	10
1	500	125.35	161.19	9	8145	203.63	284.03	1159.07	7687.97
2	600	70.55	85.46	9.9	10596	264.90	159.85	652.31	4326.67
3	700	50.10	57.21	10.8	13737	343.43	113.52	463.27	3072.81
4	800	41.29	45.02	11.7	16896	422.40	93.55	381.75	2532.12
5	1000	34.85	36.12	10	17269	431.73	78.95	322.20	2137.10
6	1200	32.89	33.42	10	18753	468.83	74.53	304.13	2017.27

Pipe Size (mm)	1st stage flow	2nd stage flow			Initial capital investment for pump sets and annual energy charges (Rs in lakh)	Grand Total of capitalised cost for 30 years (Rs in lakh)
	Total capitalised cost (Rs in lakh)	Cost of pumpsets (Rs in lakh)	Annual cost of energy charges (Rs in lakh)	Energy charges capitalised (Rs in lakh)		
11	12	13	14	15	16	17
500	8175.62	436.69	3627.36	24059.89	4186.18	12361.80
600	4751.42	231.51	1923.08	12755.56	2219.34	6970.76
700	3529.76	154.98	1287.33	8538.71	1485.65	5015.40
800	3048.07	121.97	1013.18	6720.32	1169.27	4217.34
1000	2647.78	97.86	812.89	5391.84	938.12	3585.90
1200	2560.63	90.55	752.14	4988.85	868.01	<b>3428.64</b>

The Economical diameter of pumping main is **1200** mm

**TABLE- 1**  
**TABLE SHOWING VELOCITY AND LOSS OF HEAD FOR DIFFERENT PIPE SIZES**

S.No.	Pipe size	Frictional losses per 1000 m		Velocity		Total head for <b>2500</b> m pipe lengths including <b>30</b> m of static head and <b>1.5</b> m residual head					
		for 1 <sup>st</sup> stage flow	for 2 <sup>nd</sup> stage flow	for 1 <sup>st</sup> stage flow	for 2 <sup>nd</sup> stage flow	1 <sup>st</sup> stage flow			2 <sup>nd</sup> stage flow		
						Frictional losses	Other losses	Total Head-H <sub>1</sub>	Frictional losses	Other losses	Total Head-H <sub>2</sub>
		(mm)			(m/sec.)	(m/sec.)	0	(m)	(m)	(m)	(m)
1	500	34.129	47.161	5.659	6.766	85.32	8.53	125.35	117.90	11.79	161.19
2	600	14.199	19.621	3.930	4.699	35.50	3.55	70.55	49.05	4.91	85.46
3	700	6.765	9.348	2.887	3.452	16.91	1.69	50.10	23.37	2.34	57.21
4	800	3.559	4.918	2.210	2.643	8.90	0.89	41.29	12.29	1.23	45.02
5	1000	1.217	1.681	1.415	1.691	3.04	0.30	34.85	4.20	0.42	36.12
6	1200	0.506	0.699	0.982	1.175	1.27	0.13	32.89	1.75	0.17	33.42

**TABLE- 2**  
**TABLE SHOWING KILOWATTS REQUIRED AND COST OF PUMPSETS FOR DIFFERENT PIPE SIZES**

S.No.	Pipe Size	1 <sup>st</sup> stage flow				2 <sup>nd</sup> stage flow			
		Total Head H <sub>1</sub>	Kilowatt/Horse power required including <b>100 %</b> standby	Cost of pump sets	Total Head H <sub>2</sub>	Kilowatt/Horse power required including <b>100 %</b> standby	Cost of pump sets		
		(m)	(kw)	(H.P.)	(Rs in Lakh)	(m)	(kw)	(H.P.)	(Rs in Lakh)
1	500	125.35	4369.62	5859.80	284.03	161.19	6718	9009	436.69
2	600	70.55	2459.16	3297.80	159.85	85.46	3562	4776	231.51
3	700	50.10	1746.50	2342.10	113.52	57.21	2384	3197	154.98
4	800	41.29	1439.19	1930.00	93.55	45.02	1877	2516	121.97
5	1000	34.85	1214.67	1628.90	78.95	36.12	1506	2019	97.86
6	1200	32.89	1146.56	1537.60	74.53	33.42	1393	1868	90.55

**DESIGN FOR ECONOMICAL SIZE OF PUMPING MAIN**

From:	<b>SPS at Kamed</b>
To:	<b>STP at Surasa</b>

(As per Modified Hazen Williams Formula)  
**Sewage Force Main/pumping main**

**DETAILS OF PIPES**

Diameter (mm)	Material Class	THICKNESS (mm)	CR	Rate / m (Rs)
<b>500</b>	<b>DI k9</b>	<b>9</b>	<b>1.00</b>	<b>8145</b>
<b>600</b>	<b>DI k9</b>	<b>9.9</b>	<b>1.00</b>	<b>10596</b>
<b>700</b>	<b>DI k9</b>	<b>10.8</b>	<b>1.00</b>	<b>13737</b>
<b>800</b>	<b>DI k9</b>	<b>11.7</b>	<b>1.00</b>	<b>16896</b>
<b>1000</b>	<b>MS Pipe</b>	<b>10</b>	<b>1.00</b>	<b>17269</b>
<b>1200</b>	<b>MS Pipe</b>	<b>10</b>	<b>1.00</b>	<b>18753</b>

	Year	Discharge	
1 <b>Water requirement -</b>			
a Initial	<b>2020</b>	<b>74.00</b>	mld
b Intermediate	<b>2035</b>	<b>92.00</b>	mld
c Ultimate	<b>2050</b>	<b>110.00</b>	mld
2 Length of pumping main	L	<b>2500</b>	m
3 Static head for pump	h	<b>30</b>	m
4 Design period	T	<b>30</b>	years
5 Combined efficiency of pump set	e	<b>75</b>	%
6 Cost of pumping unit	Rs/kW	<b>6500</b>	Rs
7 Rate of interest	r	<b>12.5</b>	%
8 Life of electric motor and pump	n	<b>15</b>	years
9 Hours of pumping	t	<b>23</b>	hrs
10 Specific gravity of liquid	g	<b>1.2</b>	
11 Energy charges	Rs/kWh	<b>7</b>	Rs
12 Residual head at delivery end	Rh	<b>1.5</b>	
13 Standby pump sets required		<b>100</b>	%

**SOLUTION :-**

	1 <sup>st</sup> 15 years	2 <sup>nd</sup> 15 years
1 Discharge at installation	74 mld	92 mld
2 Discharge at the end of 15 years	92 mld	110 mld
3 Average discharge	83 mld	101 mld
4 Hours of pumping for discharge after 15 yrs	23 hrs	23 hrs
5 Average hours of pumping for av. discharge	20.75 hrs	21.12 hrs
6 KW required at comb. efficiency of pump set	17.429 *H <sub>1</sub>	20.839 *H <sub>2</sub>