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FEASIBILITY OF WATER REUSE

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ABSTRACT

Though water reuse is being practiced in India for irrigation purpose, the detailed guidelines or framework for formal implementation of the same is completely lacking. The importance of water reuse is gaining acceptance rapidly but the full potential is yet not utilized. For implementation of water reuse in India attainment of economic feasibility is of prime importance. In present study Internal Rate of Return for a pipe line to carry reuse water is calculated based on data collected for Chhani Sewage Treatment Plant Area, Vadodara. The Internal Rate of Return obtained at 81.46% is good indicator of possibility of successful implementation of reuse projects for treated sewage, reducing pollution and stress on fresh water resource.

Keywords: Water reuse, Feasibility, Water Pricing, Distribution networks

INTRODUCTION

The issue of water availability does not seem to sensitize a layman regarding alarming conditions prevailing at present as one is enjoying water supply sufficient enough for daily consumption in most of the class I and class II cities in India. Whereas the scenario is quite different in many under developed and developing parts of India facing moderate to severe water stress.

Not only in India but all over the world one third of the total population lives in the areas under water stress. Total available usable water on earth is constant since millions of years as the same water changes forms continuously and being used and reused millions of times as part of hydrologic cycle. While population growth has been observed since quite long, in the last three centuries population of the world had grown exponentially and particularly increased more than three fold in last 90 years(Daigger, 2007). The increased industrial and agricultural needs have created water stress in several regions all over the world. Water reuse is being adopted as sustainable practice in developed and highly water scarce areas since last four decades at municipal scale (Leverenz et al., 2011).

In India at least water supply sector is showing acceptable performance as 91% population is having access to drinking water in class I and class II cities. But in sanitation sector the capacity exists to treat only12000 MLD sewage out of 38000 MLD sewage generated in class I and class II cities, causing 70% of generated sewage to be disposed in unsafe manner

in natural water bodies (CPHEEO, 2005). Further the practice of using this untreated or partially treated wastewater is prevalent in India posing severe health hazard and deterioration of soil characteristics (Mekala et al., 2008)

Further considering nutrient value of treated wastewater, study for coastal towns and cities has showed that wastewater worth Rs. 1091.20 million are discharged in to the coastal waters(CPCB 2009). Thus if unplanned and unofficial reuse of wastewater can be converted to planned and official reuse it can open the way to utilize the nutrient value of the sewage and create possibility to sell water to industries. The revenue thus generated can be utilized to construct much needed infrastructure in sanitation sector.

An experimental data collection and study has been conducted to understand feasibility of water reuse.

METHODOLOGY

Data for Chhani Sewage Treatment Plant Area were collected fromVadodara Mahanagar Seva Sadan and the case study of Chhani Sewage Treatment Plant (STP) was considered to evaluate feasibility of reuse and based on field data design of reclaimed water distribution network was carried out.

After studying the Chhani area where this treatment plant is located with the help of Google Earth and Google Maps and considering other local conditions it was found that a water reuse supply network from the Chhani STP to Gujarat State Fertilizers Corporation (GSFC) and / or Gujarat Alkalis and Chemicals Limited (GACL) can be designed as shown in Fig. 2 to 4. Table 1 gives the distances between Chhani STP and GACL and GSFC along various routes .

Table 1. Distances from Chhani STP to GSFC and GACL along various routes

Route No	From Chhani STP to Reuse Customer, kms	Customer Name	Nodes
1	3.3	GSFC	23
2	4.28	GSFC	30
3	11.4	GACL	63
4	9.55	GACL	51

The Distances shown in Table 1 were obtained from Google Earth as shown in figures (Fig. 2 ~ 4) and the nodes and the layouts of the pipes were determined with the help of EPANET (Fig. 5). The Route No. 2 to GSFC is selected because GSFC hasdemand of 63.4 MLD and thoughthe route is 0.98 km longer than the shortest route, it serves the purpose to supply reclaimed water to the near by farms.

The design of pipe network along route 2 for distribution of treated sewage is carried out using EPANET (Fig. 5) and friction headloss is calculated using Darcy-Weisbach equation using Churchill's equation for determining friction factor and Hazen-Williams equation and given in Table 2.

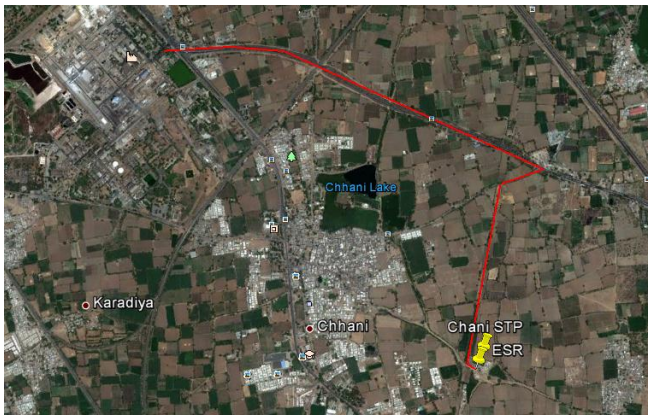

Figure 1: Lay out of the pipeline

The Chhani STP can produce 21.0 MLDof reusable water. As the demand of GSFC is more than the produce and 320 ha of farms cultivating banana are along the route 2 , the demand is not limiting factor for consideration of revenue.

The project is financially viable only when the cost of project is less than the revenue generated within reasonable time and the investment could be recovered well in advance before end of service life for facilities. Cost is the total expenditure incurred in form of goods and services whether fixed or variable, annual or single time opportunity cost or out of pocket cost. The cost of various items are obtained from the schedule of rates used by Gujarat Water Supply and Sanitation Board (GWSSB) . The calculation of material cost, labour cost and cost for lowering, laying and jointing of pipes etc. is given in detail in Table 3. The rate of reclaimed water to be supplied to agricultural and industrial uses is fixed at present rate of fresh water charged by Sardar Sarovar Narmada Nigam Limited (SSNNL) for water supply to agriculture and industries vide their circular no. CAD – 2005 – 53 – 80 - Part I- canals and SSNL/1103/15/VOMACEL/Part II respectively.

As the internal rate of return method considers different time period of various options and not only covers capital recovery but also calculates rate of return in future considering both interest rate and inflation rate, it is preferable for evaluating long term public works projects.

For cost analysis, sinking fund was calculated using Modified Accelerated Cost Recovery System (MACRS) method (IRS publication, 2012). The cost of project as obtained from Table 3 is considered to be availed by means of loan. So, every month not only depriciation amount to be put aside but principle amount repayment to bank in installations is also required to be considered. The interest payble on balance amount after paying installments to the bank is to be deducted for finding out net cash flow. Same way interest to be received on depriciation amount deposited in bank for safe keeping is to be added to calculate net cash flow. The cost of operation and maintenance as 5%, insurance as 0.75% of total capital cost and operator's salary as per prevailing rates and guidelines given in Manual on Water Supply and Treatment (CPHEEO, 2013) are considered. The cost for power consumption is calculted by using power charges as provided in Madhya Gujarat Vij Company Limited tariff schedule and pumping data.

The value for Internal Rate of Return is obtained using Eq. 1 and solving by trial and error mehtod.

$$ICO = \frac{CF_1}{(1+IRR)^1} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + \ldots\ldots + \frac{CF_n}{(1+IRR)^n} \quad \text{Eq. (1)}$$

Where,

CF = Cash inflow- Net cash outflow

Cash inflow = total income + interest on depriciation amount deposited in bank @ 8%

Cash outflow = depreciation + repayment of capital cost + interest @ 12% + operation & maintenance cost @ 5 % + insurance @ 0.75 % operator's salory

Net cash outflow = cash outflow – repayment of capital cost

ICO = Initial Cash outflow

IRR =Internal rate of return

n = Number of years

RESULTS AND ANALYSIS

The design of pipe network along route 2 for distribution of treated sewage is carried out using EPANET(Fig. 5) and friction headloss is calculated using Darcy-Weisbach equation using Churchill's equation for determining friction factor and Hazen-Williams equation and given in Table 2.

As shown in Table 2 comparison of output from EPANET (Fig. 5) using Darcy-Weisbach and Hazen-Williams equations is done with manual calculations done by Churchil's equation. It was found that Darcy – Weisbach equation yields better results for friction head loss calculations compared to Hazen – Williams equation which is not dimensionally balanced. The output from EPANET using Darcy-Weisbach equations shows exact matching with manual calculations done using Churchil's equation which is proved to be having very good accuracy of ± 0.45% and applicable to all flow regimes.

The results of economic analysis are tabulated in Tables 3 and 4. The Internal Rate of Return obtained at the value of 81.46% should be considered as highly appriciable. Any international organization like Asian Development Bank, World Bank etc. considers the project as feasible if IRR increases than 11%. Thus, for present case study the value of IRR obtained justifies the implementation of project and indicates very good chances of revenue generation. In this analysis as the demand of GSFC is much more than produce and farms are available in abundance, the demand is not limiting factor for consideration of revenue.

CONCLUSIONS

The result of this study shows that the output from EPANET using Darcy-Weisbach Equation exactly matches with friction head loss calculation done manually with Churchil's equation and there is definitely an opportunity in sanitation sector to improve cost recovery and revenue generation. If water reuse with proper control can be implemented, revenue generation can be achieved as add-on benefit to sustainable development. There is an urgent

need to conduct number of such studies to evaluate feasibility in different scenarios and develop a model which can evaluate feasibility of water reuse for any town or city in India based on local data.

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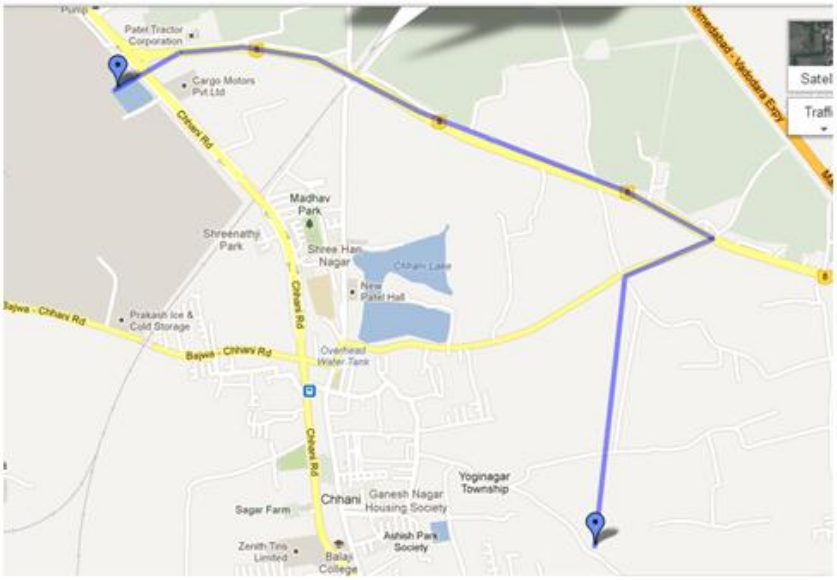

Figure 2. Chhani STP to GSFC Route 1

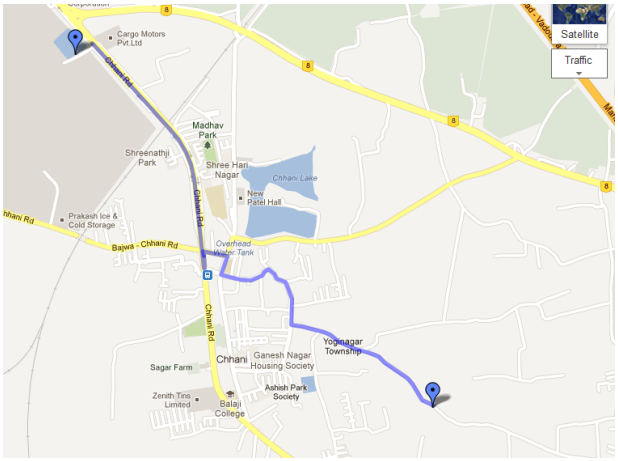

Figure 3. Chhani STP to GSFC Route 2

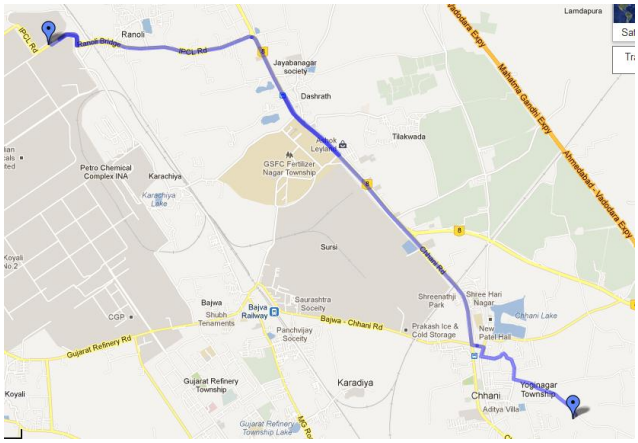

Figure 3. Chhani STP to GACL Route 1

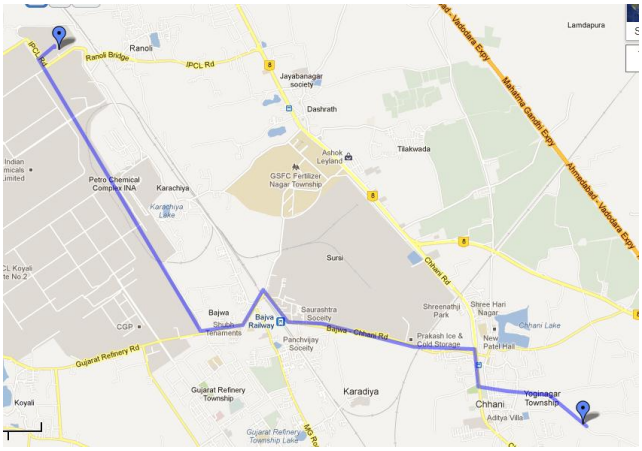

Figure 4. Chhani STP to GACL Route 2

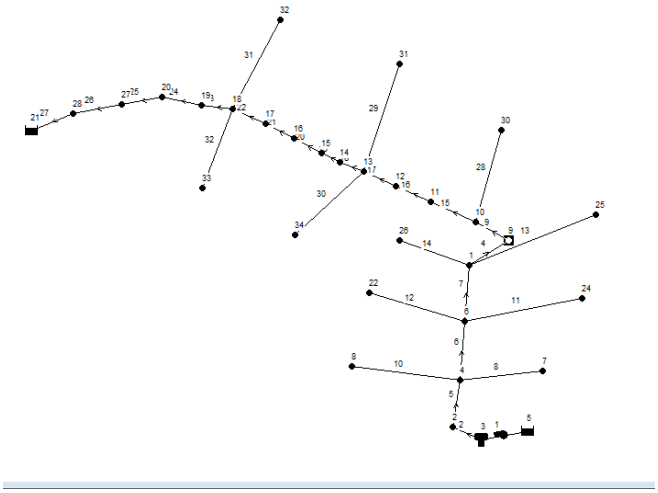

Table 2. Comparaison of output from EPANET using Darcy- Weisbatch and Hazen-Williams equation with manual calculation results using Churchil's equation

EPANET OUTPUT								MANUAL CALCULATION	
Link ID	Length	Diameter	Flow	Friction Factor	Friction Factor	Head Loss by Hazen-Wiliams	Head Loss by Darcy-Weisbach	Head Loss by Churchill Equation	
	Meter	Mili Meter	Cubic Meter per Hour	ƒ by Hazen-Williams	ƒ by Darcy-Weisbach	Meter	Meter	Head Loss in Meter	ƒ BY CHURCHIL
Pipe 9	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 15	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 16	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 17	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 18	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 19	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 20	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 21	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 22	215	500	1351.14	0.027	0.02	2.163	1.606	1.605	0.02
Pipe 23	190	500	1351.14	0.027	0.02	1.911	1.419	1.418	0.02
Pipe 24	190	500	1351.14	0.027	0.02	1.911	1.419	1.418	0.02
Pipe 28	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 29	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 30	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 31	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 32	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 2	64	500	1351.14	0.027	0.02	0.644	0.478	0.478	0.02
Pipe 4	300	500	1351.14	0.027	0.02	3.018	2.241	2.240	0.02
Pipe 5	415	500	1351.14	0.027	0.02	4.175	3.100	3.098	0.02
Pipe 6	415	500	1351.14	0.027	0.02	4.175	3.100	3.098	0.02
Pipe 7	415	500	1351.14	0.027	0.02	4.175	3.100	3.098	0.02
Pipe 8	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 10	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 11	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 12	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 13	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 14	400	200	0	0	0	0.000	0.000	0.000	0.00
Pipe 25	225	500	1351.14	0.027	0.02	2.264	1.681	1.680	0.02
Pipe 26	225	500	1351.14	0.027	0.02	2.264	1.681	1.680	0.02
Pipe 27	100	500	1351.14	0.027	0.02	1.006	0.747	0.747	0.02
Total Length	8874					45.008	33.421	33.400	
Continuous length	4249	TOTAL HEAD LOSS TO BE CONSIDERED				45.01	33.42	33.40	

Table 3 Cost derivation using GWSSB Schedule of Rates (SOR)

COST ESTIMATION FOR DI PIPE ASSEMBLY															
Link ID	Length	Diameter	pipe material		Pipe specials material			Work	Labour Charges Excavation		Labour Charges L, L & J		Labour Charges Refilling	
	m	mm	Unit price (per m)	Cost	No. of Specials	Unit price	Cost	Excavation in CuM	Unit price (per m)	Cost	Unit price (per m)	Cost	Unit price (per m)	Cost
Pipe 9	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 15	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 16	215	500	6069	1304835	0	16100	0	387	71	15265	269	104103	16	6192
Pipe 17	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 18	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 19	215	500	6069	1304835	2	16100	32200	387	71	15265	269	104103	16	6192
Pipe 20	215	500	6069	1304835	2	16100	32200	387	71	15265	269	104103	16	6192
Pipe 21	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 22	215	500	6069	1304835	1	16100	16100	387	71	15265	269	104103	16	6192
Pipe 23	190	500	6069	1153110	1	16100	16100	342	71	13490	269	91998	16	5472
Pipe 24	190	500	6069	1153110	1	16100	16100	342	71	13490	269	91998	16	5472
Pipe 28	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 29	400	200	1704	681600	1	6930	6930	720	71	28400	84	60480	16	11520
Pipe 30	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 31	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 32	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 2	64	500	6069	388416	2	16100	32200	115.2	71	4544	269	30988.8	16	1843.2
Pipe 4	300	500	6069	1820700	2	16100	32200	540	71	21300	269	145260	16	8640
Pipe 5	415	500	6069	2518635	2	16100	32200	747	71	29465	269	200943	16	11952
Pipe 6	415	500	6069	2518635	2	16100	32200	747	71	29465	269	200943	16	11952
Pipe 7	415	500	6069	2518635	2	16100	32200	747	71	29465	269	200943	16	11952
Pipe 8	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 10	400	200	6069	2427600	1	6930	6930	720	71	28400	84	60480	16	11520
Pipe 11	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 12	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 13	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 14	400	200	1704	681600	2	6930	13860	720	71	28400	84	60480	16	11520
Pipe 25	225	500	6069	1365525	2	16100	32200	405	71	15975	269	108945	16	6480
Pipe 26	225	500	6069	1365525	2	16100	32200	405	71	15975	269	108945	16	6480
Pipe 27	100	500	6069	606900	2	16100	32200	180	71	7100	269	48420	16	2880
Total Length in M	8874	Total cost		36396306			589400			630054		2831590.8		255571.2

Length in M for main ne	4249														
Miscellaneous Items		Unit	Rate												
Bedding for pipes	1064.88	Cum	44	46854.72											
Fixing charge for specials of 500mm	30	Nos.	2500	75000											
Fixing charge for specials of 200mm	18	Nos.	600	10800											
				132655											
Cost of specials.															
141	16100	(Weight 141 kg * 115 Rs./ Kg)													
64	6930	(Weight 141 kg * 110 Rs./ Kg)													

TOTAL COST OF MATERIAL AND LABOUR Rs./-	40702922
Additional for miscellaneous items Rs./-	130000
Conractor's Profit Rs./-	6124938.3
Contingency Rs./-	312747
TOTAL COST OF PIPELINE WORKS Rs./-	47270607.2
COST OF PUMPING UNIT Rs./-	8000000
COST OF ESR Rs./-	12000000
FINAL CAPITAL COST OF PROJECT Rs./-	67270607
Say	6.73 Crores

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Table 4 Calculation of Internal Rate of Return

Sr No	Particulars	AMOUNT IN RS.											AMOUNT IN RS.													
			1ST YEAR	2ND YEAR	3RD YEAR	4TH YEAR	5TH YEAR	6TH YEAR	7TH YEAR	8TH YEAR	9TH YEAR	10TH YEAR	11th YEAR	12th YEAR	13th YEAR	14th YEAR	15th YEAR	16th YEAR	17th YEAR	18th YEAR	19th YEAR	20th YEAR	21st YEAR	22nd YEAR	23rd YEAR	24th YEAR	25th YEAR
1	CAPITAL COST	67300000																								
2	FIXED COST																									
2.1.1	Rate of depriciation for first half as per MACRS			3.75	7.219	6.677	6.177	5.713	5.285	4.888	4.522	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	2.231	0	0	0
2.1.2	Rate of depriciation for second half as per MACRS		3.75	7.219	6.677	6.177	5.713	5.285	4.888	4.522	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	4.462	4.461	2.231	0	0	0	0
2.2.1	Depriciation for 1st Half		0	1261875	2429193.5	2246810.5	2078560.5	1922424.5	1778402.5	1644812	1521653	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	750731.5	0	0	0
2.2.2	Depriciation for 2nd half		1261875	2429193.5	2246810.5	2078560.5	1922424.5	1778402.5	1644812	1521653	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	1501463	1501126.5	750731.5	0	0	0	0
2.3	Total Depriciation		1261875	3691069	4676004	4325371	4000985	3700827	3423215	3166465	3023116	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	2251858	750732	0	0	0
2.4	Amount of Repayment		1261875	3691068.5	4676004	4325371	4000985	3700827	3423214.5	3166465	3023116	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	3002590	2251858	750732	0	0	0
2.5.1	Balance Capital for 1st half		67300000	64776250	59917863	55424242	51267121	47422272	43865467	40575843	37532537	34529611	31527358	28524432	25522179	22519253	19517000	16514074	13511821	10508895	7506642	4503716	1501463	0	0	0	0
2.5.2	Balance Capital for 2nd half		66038125	62347057	57671053	53345682	49344697	45643870	42220655	39054190	36031074	33028485	30025895	27023306	24020716	21018127	18015537	15012948	12010358	9007769	6005179	3002590	750732	0	0	0	0
2.6.1	Interest for 1st half		40380	38866	35951	33255	30760	28453	26319	24346	22520	20718	18916	17115	15313	13512	11710	9908	8107	6305	4504	2702	901	0	0	0	0
2.6.2	Interest for 2nd half		39623	37408	34603	32007	29607	27386	25332	23433	21619	19817	18016	16214	14412	12611	10809	9008	7206	5405	3603	1802	450	0	0	0	0
2.7	Total Interest to be paid		80003	76274	70553	65262	60367	55840	51652	47778	44138	40535	36932	33329	29726	26122	22520	18916	15313	11710	8107	4504	1351	0	0	0	0
2.8.1	Interest obtainable 1st half		0	100950	194335	179745	166285	153794	142272	131585	121732	120117	120090	120117	120090	120117	120090	120117	120090	120117	120090	120117	120090	60059	0	0	0
2.8.2	Interest obtainable 2nd half		100950	194335	179745	166285	153794	142272	131585	121732	120117	120090	120117	120090	120117	120090	120117	120090	120117	120090	120117	120090	60059	0	0	0	0
2.9	Total Interest to be received on depriciation money		100950	295285	374080	346030	320079	296066	273857	253317	241849	240207	240207	240207	240207	240207	240207	240207	240207	240207	240207	240207	180149	60059	0	0	0
2.10	Insurance		504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750	504750
2.11	Maintanence & Repairs		2019000	2019000	2019000	2019000	2019000	2019000	2019000	2019000	2019000	2019000	2692000	2692000	2692000	2692000	2692000	2692000	3365000	3365000	3365000	3365000	3365000	4038000	4038000	4038000	4038000
2.12	Energy cost		605000	605000	611050	617161	623332	629565	635861	642220	648642	655128	661680	668296	674979	681729	688546	695432	702386	709410	716504	723669	730906	738215	745597	753053	760584
2.13	Operator's salory		15000	16500	18150	19965	21962	24158	26573	29231	32154	35369	38906	42797	47076	51784	56962	62659	68925	75817	83399	91739	100912	111004	122104	134315	147746
2.14	Other charges		336500	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055	360055
3	CASH OUTFLOW		4485628	6912592	7899507	7551508	7230396	6934140	6661051	6409443	6271800	6257372	6936857	6943761	6951121	6958975	6967368	6976346	7658964	7669277	7680350	7692251	6954778	6142700	5410451	5430118	5451080
4	**NET CASH OUTFLOW**		**4384678**	**6617307**	**7525427**	**7205479**	**6910317**	**6638074**	**6387194**	**6156126**	**6029951**	**6017165**	**6696650**	**6703554**	**6710914**	**6718768**	**6727161**	**6736139**	**7418756**	**7429069**	**7440142**	**7452044**	**6774629**	**6082642**	**5410451**	**5430118**	**5451080**
6	INCOME																										
a	Selling price Rs./KL		13.41	14.75	16.23	17.85	19.63	21.60	23.76	26.13	28.75	31.62	34.78	38.26	42.09	46.29	50.92	56.02	61.62	67.78	74.56	82.01	90.22	99.24	109.16	120.08	132.08
b	Total selled water in KL to Industry		3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600	3885600
c	Income from produce		52105896	57316486	63048134	69352948	76288242	83917067	92308773	101539651	111693616	122862977	135149275	148664202	163530623	179883685	197872053	217659259	239425185	263367703	289704473	318674921	350542413	385596654	424156319	466571951	513229146
d	Selling price Rs./ha		3444.00	3702.30	3979.97	4278.47	4599.36	4944.31	5315.13	5713.77	6142.30	6602.97	7098.19	7630.56	8202.85	8818.06	9479.42	10190.37	10954.65	11776.25	12659.47	13608.93	14629.60	15726.82	16906.33	18174.31	19537.38
e	Total ha irrigated by reclaimed water		320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320	320
f	Income from produce		1102080	1184736	1273591	1369111	1471794	1582178	1700842	1828405	1965535	2112950	2271422	2441778	2624912	2821780	3033414	3260920	3505489	3768400	4051030	4354857	4681472	5032582	5410026	5815778	6251961
7	CASH INFLOW		53207976	58501222	64321725	70722058	77760036	85499245	94009615	103368055	113659151	124975928	137420697	151105981	166155534	182705465	200905467	220920178	242930673	267136103	293755503	323029778	355223884	390629236	429566345	472387729	519481107
8	**NET CASH FLOW**	**-67300000**	48823298	51883915	56796298	63516579	70849719	78861171	87622421	97211929	107629200	118958763	130724047	144402427	159444620	175986697	194178306	214184039	235511917	259707034	286315361	315577734	348449255	384546594	424155894	466957611	514030028
9	**INTERNAL RATE OF RETURN**		**81.45%**																								

Irrigation Depth for banana by surface irrigation **18 cm** **Water requirement per watering per ha** **1800 m3/ha/watering** **No. of watering needed** **30 Nos.** **Water requirement per year per ha** **54000 m3/ha/year**

Rate of water **328 Rs/ha/watering** **Total cost of water per ha per year** **9840 Rs./ha/year** **Rate of water in Rs,** **9840 For surface irrigation per ha** **Rate of water in Rs. 35% of surface irrigation** **3444 For drip irrigation per ha**