

2500m 4 bar DN560 PN4 pipe 2 liters/day/tree x20 pumping stations														
	Cost HDPE = \$2,054,396 only applicable if pumping for 11 hours or more per day													
Flowrate 28,000 m3/day rate Hrs delivery	8	9	10	11	12	13	14	15	16	17	18	19	21	23
Rate of flow through 517.2 mm (m3/s)	0.972222222	0.864197531	0.777777778	0.707070707	0.648148148	0.598290598	0.555555556	0.518518519	0.486111111	0.45751634	0.432098765	0.409356725	0.37037037	0.338164251
Velocity (m/s) u =Q/A	4.63	4.11	3.70	3.37	3.08	2.85	2.64	2.47	2.31	2.18	2.06	1.95	1.76	1.61
Hydraulic diameter - d _n - (m)	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172	0.5172
Roughness of surface - k - (m)	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002	0.000002
Kinematic Viscosity - v - (m ² /s)	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001	0.000001
friction Coefficient λ	0.0095	0.0095	0.01	0.01	0.01	0.0105	0.0105	0.0105	0.0105	0.011	0.011	0.011	0.011	0.0115
Velocity (m/s)														
head (m) loss Darcy eq h=λ (l / dh) (u2 / 2g)	50.11	39.59	33.76	27.90	23.44	20.97	18.08	15.75	13.85	12.85	11.46	10.29	8.42	7.34
Renolds No. Re= u dh / v	2,393,100	2,127,200	1,914,480	1,740,436	1,595,400	1,472,677	1,367,486	1,276,320	1,196,550	1,126,165	1,063,600	1,007,621	911,657	832,383
Pressure Drop (Pa)	492,643	389,249	331,886	274,286	230,476	206,201	177,796	154,880	136,125	126,323	112,677	101,129	82,783	72,149
Pressure Drop (Bars)	4.93	3.89	3.32	2.74	2.30	2.06	1.78	1.55	1.36	1.26	1.13	1.01	0.83	0.72
Hydraulic Power KW	480	337	259	194	150	124	99	81	66	58	49	42	31	24
Total Cost \$0.09/kwh and elec. Pump eff 0.8%	\$8,645	\$6,831	\$5,824	\$4,813	\$4,045	\$3,619	\$3,120	\$2,718	\$2,389	\$2,217	\$1,977	\$1,775	\$1,453	\$1,266
7months watering cost	\$1,815,506	\$1,434,475	\$1,223,078	\$1,010,809	\$849,359	\$759,900	\$655,220	\$570,769	\$501,653	\$465,530	\$415,241	\$372,684	\$305,075	\$265,886
Total 3 year costs of pumping	\$5,446,518	\$4,303,424	\$3,669,235	\$3,032,427	\$2,548,076	\$2,279,699	\$1,965,661	\$1,712,308	\$1,504,959	\$1,396,590	\$1,245,724	\$1,118,053	\$915,225	\$797,658
Possible cost of Pump Stations	\$1,921,170	\$1,349,300	\$1,035,410	\$777,919	\$599,195	\$494,847	\$396,203	\$322,127	\$265,425	\$231,823	\$195,293	\$166,053	\$122,983	\$97,865
At pumping Stations a possible solar installation														
Solar anticipated Power requirements kW	600	422	324	243	187	155	124	101	83	72	61	52	38	31
Cost of Panels \$/Wp	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2	\$2
Total Wp	750	527	404	304	234	193	155	126	104	91	76	65	48	38
No. Of 300 kWp Panels	2,001	1,406	1,079	810	624	515	413	336	276	241	203	173	128	102
Cost of Panels \$	\$450,274	\$316,242	\$242,674	\$182,325	\$140,436	\$115,980	\$92,860	\$75,499	\$62,209	\$54,334	\$45,772	\$38,919	\$28,824	\$22,937
Cost of 1 inverter 24V 75kW	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000	\$15,000
No of Inverters	10.0	7.0	5.4	4.1	3.1	2.6	2.1	1.7	1.4	1.2	1.0	1.0	1.0	1.0
Total cost of Inverters \$	\$150,091	\$105,414	\$80,891	\$60,775	\$46,812	\$38,660	\$30,953	\$25,166	\$20,736	\$18,111	\$15,257	\$15,000	\$15,000	\$15,000
Area required m2	4,803	3,373	2,589	1,945	1,498	1,237	991	805	664	580	488	415	307	245
Framework costs	\$110,067	\$77,304	\$59,320	\$44,568	\$34,329	\$28,351	\$22,699	\$18,455	\$15,207	\$13,282	\$11,189	\$9,513	\$7,046	\$5,607
Wiring and Gyro etc	\$44,027	\$30,921	\$23,728	\$17,827	\$13,732	\$11,340	\$9,080	\$7,382	\$6,083	\$5,313	\$4,475	\$3,805	\$2,818	\$2,243
Costs for 1 solar installation	\$754,460	\$529,881	\$406,614	\$305,495	\$235,309	\$194,331	\$155,592	\$126,502	\$104,235	\$91,039	\$76,693	\$67,237	\$53,688	\$45,787
Cost of 20 installations	\$15,089,193	\$10,597,628	\$8,132,286	\$6,109,908	\$4,706,176	\$3,886,611	\$3,111,843	\$2,530,042	\$2,084,691	\$1,820,779	\$1,533,863	\$1,344,748	\$1,073,769	\$915,732
Backup power system Generator Kw		422	324	243	187	155	124	101	83	72	61	52	38	31
Fuel Cost 7 mths (0.3633 l/kWh @ \$0.6/l)		\$193,017	\$296,230	\$333,843	\$342,858	\$353,938	\$340,059	\$322,561	\$303,751	\$298,460	\$279,365	\$261,291	\$228,705	\$209,992
Total yearly running costs 1 year	\$0	\$193,017	\$296,230	\$333,843	\$342,858	\$353,938	\$340,059	\$322,561	\$303,751	\$298,460	\$279,365	\$261,291	\$228,705	\$209,992
Total running costs 4 years	\$0	\$772,066	\$1,184,918	\$1,335,370	\$1,371,431	\$1,415,751	\$1,360,237	\$1,290,243	\$1,215,003	\$1,193,838	\$1,117,461	\$1,045,164	\$914,818	\$839,969
Total Capital costs for Solar installation	\$17,010,364	\$11,946,928	\$9,167,696	\$6,887,827	\$5,305,371	\$4,381,458	\$3,508,045	\$2,852,170	\$2,350,115	\$2,052,602	\$1,729,155	\$1,510,800	\$1,196,752	\$1,013,597
Costs of project for pumping on main line 50km for 4	\$17,010,364	\$12,718,995	\$10,352,614	\$8,223,197	\$6,676,802	\$5,797,210	\$4,868,283	\$4,142,413	\$3,565,119	\$3,246,441	\$2,846,616	\$2,555,964	\$2,111,570	\$1,853,566
Total power requiremets maximum per hour kW	12691	9117	7155	5546	4429	3777	3160	2697	2343	2133	1905	1722	1453	1296
114 solar installations														
costs of 114 x 10 KWp solar panels	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000	\$2,280,000
Cost of 114 inverters	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000	\$342,000
Cost of 40Kw UPS	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000	\$570,000
Total power costs installation	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000	\$3,192,000
Total solar panels required 300Wp	18,809	14,341	11,889	9,877	8,481	7,666	6,895	6,317	5,874	5,611	5,326	5,097	4,761	4,565
Cost of 10 MW Solar panel plant	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000	\$ 20,000,000
Savings on solar costs by opening solar plant	\$7,053,429	\$5,378,028	\$4,458,429	\$3,704,060	\$3,180,454	\$2,874,747	\$2,585,750	\$2,368,733	\$2,202,612	\$2,104,170	\$1,997,147	\$1,911,482	\$1,785,302	\$1,711,713
Revenue to solar plant	\$4,232,057	\$3,226,817	\$2,675,057	\$2,222,436	\$1,908,272	\$1,724,848	\$1,551,450	\$1,421,240	\$1,321,567	\$1,262,502	\$1,198,288	\$1,146,889	\$1,071,181	\$1,027,028