WATER PERFORMANCE

Water consumption calculations for both base case and efficient case scenarios have been performed (with same assumptions), however, only efficient case scenario calculations will be shown here in the interest of brevity. Per capita per day water use in a residential building for base case is 135L whereas that for efficient case is 95L (source- water performance module). For our educational building, bathing (30% of total use) and washing (20%) needn't be considered, hence the per capita per day consumption reduces to 47.5L, which is based on a 24 hour occupancy of the facility by a person, and we assume that all of this water is used in the 16 hours for which the person is awake. We further assume that a person spends about 3 hours per day in the SLC. Hence the per head per day domestic use of water in the SLC will be 47.5*(3/16) = 8.91 L, whose usage wise breakdown is shown below, with the percentages of all other uses doubled to add up to 100% as the rest 50% use needn't be accounted for (source of percentages- module).

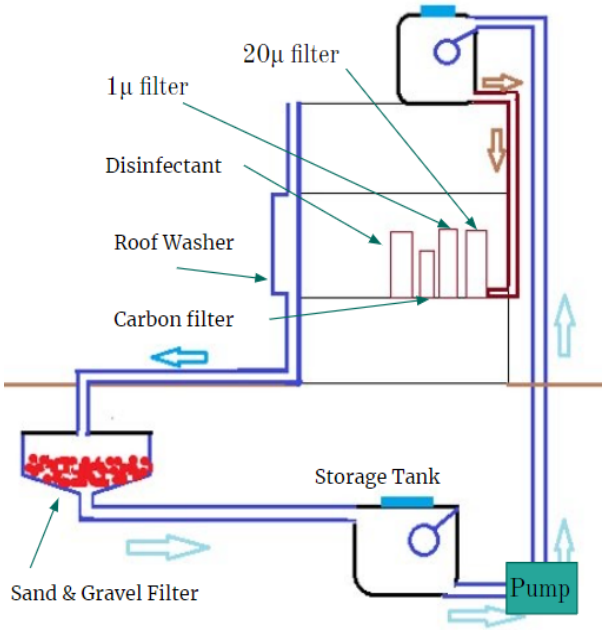
Activity	% Use	Use (L)	% Greywater	% Blackwater	Greywater (L)	Blackwater (L)
Drinking	8%	0.7125	0%	100%	0	0.7125
Cooking	6%	0.534375	0%	100%	0	0.534375
Toilet	34%	3.028125	0%	100%	0	3.028125
Cleaning SAC	16%	1.425	100%	0%	1.425	0
Washing Utensil	32%	2.85	100%	0%	2.85	0
Others	4%	0.35625	50%	50%	0.178125	0.178125
Total	100%	8.90625			4.453125	4.453125

We assume that 500 people will use the facility daily, and 36% of the total use (34% for toilet + 0.5*4% for others) can be taken care of by non-potable water. The irrigation area is 583m² and water requirement is 1L/m² (1.7L/m² for base case: from module) which too can be taken care of by non-potable water. Efficiency of the greywater treatment system is 75% (module) and that of the blackwater treatment system is 40% (underestimated assumption due to high impurity levels). Ropar's annual rainfall data has been taken from here. The roof and hardscape areas have a runoff coefficient of 0.85, and their areas are 952m² and 2483.9m² respectively. Using these assumptions and data, month wise water cycle calculations for the entire year are shown below.

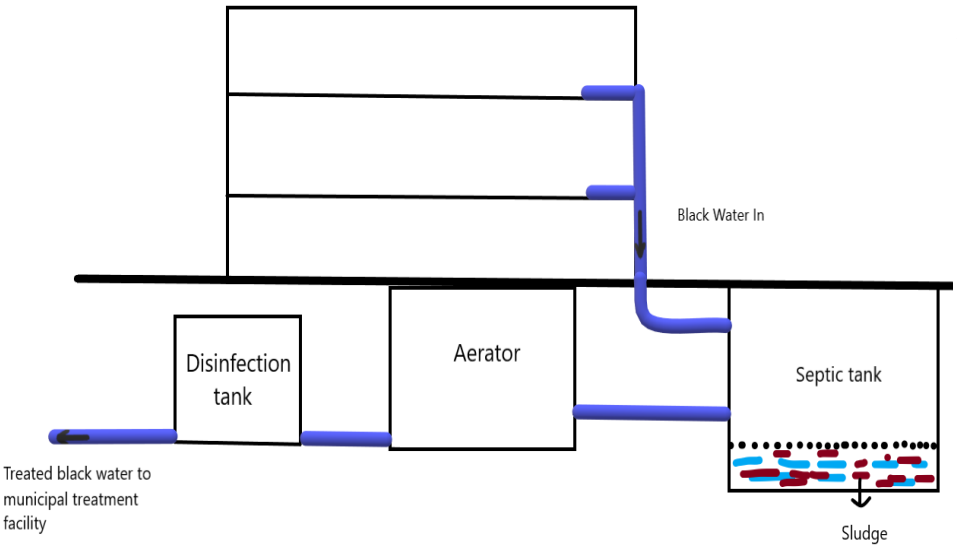
Month	Days	Seasonal Irrigation Factor (%)	Irrigation Use (L)	Occupant Use (L)	Greywater (L)	Blackwater (L)	Freshwater Needed for Occupant Use (L)	Non-Potable Water Needed for Occupant Use (L)	Recycled Greywater (L)	Treated Blackwater Sent to Municipal Treatment Plant (L)	Rainfall (mm)	Effective Rainfall (mm)	Water Harvested from Roof (L)	Water Harvested from Hardscape (L)	Surplus (-)/ Deficit (+) of Recycled Greywater (L)	Surplus (+)/ Deficit (-) of Greywater + Hardscape Harvested Water (L)	Surplus (-)/ Deficit (+) of Roof Harvested Water (L)
Jul	31	20%	3614.6	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	219	214	173168.8	451821.4100	1543.8969	450277.5131	-84818.80
Aug	31	20%	3614.6	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	249.9	244.9	198173.08	517061.0435	1543.8969	515517.1466	-109823.08
Sep	30	35%	6121.5	133593.75	66796.875	66796.875	85500	48093.7500	50097.6563	26718.7500	95.1	90.1	72908.92	190229.4815	4117.5938	186111.8878	12591.08
Oct	31	55%	9940.15	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	5.3	0.3	242.76	633.3945	7869.4469	-7236.0524	88107.24
Nov	30	50%	8745	133593.75	66796.875	66796.875	85500	48093.7500	50097.6563	26718.7500	4.7	0	0	0.0000	6741.0938	-6741.0938	85500.00
Dec	31	35%	6325.55	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	11.6	6.6	5340.72	13934.6790	4254.8469	9679.8321	83009.28
Jan	31	25%	4518.25	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	25.6	20.6	16669.52	43493.0890	2447.5469	41045.5421	71680.48
Feb	28.25	25%	4117.4375	125800.7813	62900.39063	62900.39063	80512.5	45288.2813	47175.2930	25160.1563	34.2	29.2	23628.64	61650.3980	2230.4258	59419.9722	56883.86
Mar	31	40%	7229.2	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	29.9	24.9	20149.08	52571.7435	5158.4969	47413.2466	68200.92
Apr	30	100%	17490	133593.750	66796.875	66796.875	85500	48093.7500	50097.6563	26718.7500	21.2	16.2	13109.04	34203.3030	15486.0938	18717.2093	72390.96
May	31	100%	18073	138046.875	69023.4375	69023.4375	88350	49696.8750	51767.5781	27609.3750	20.7	15.7	12704.44	33147.6455	16002.2969	17145.3486	75645.56
Jun	30	70%	12243	133593.75	66796.875	66796.875	85500	48093.7500	50097.6563	26718.7500	53.7	48.7	39408.04	102821.0405	10239.0938	92581.9468	46091.96
Total	**365.25**		102032.2875	1626503.9063	**813251.9531**	**813251.9531**	**1040962.5**	**585541.4063**	609938.9648	325300.7813	**770.9**	**711.2**	575503.04	1501567.2280	**77634.7289**	**1423932.4991**	**465459.46**

Using calculation data for both cases, we see that by using low flow fixtures and efficient irrigation practices, occupant use and irrigation use reduce from 2311347.6563 litres annually to 1626503.9063 annually (reduction of 29.63%) and 173454.8888 litres annually to 102032.2875 litres annually (reduction of 41.18%) respectively.
Annual consumption (red) = 1,02,032.2875 + 16,26,503.9063 = **17,28,536.1938L**
Annual use of alternative water and water returned to source/offset (green) = 6,09,938.9648 + 3,25,300.7813 + 5,75,503.04 + 15,01,567.2280 = **30,12,310.0141L**
Hence we achieve **net positive water performance** by a whopping **12,83,773.8203L**.

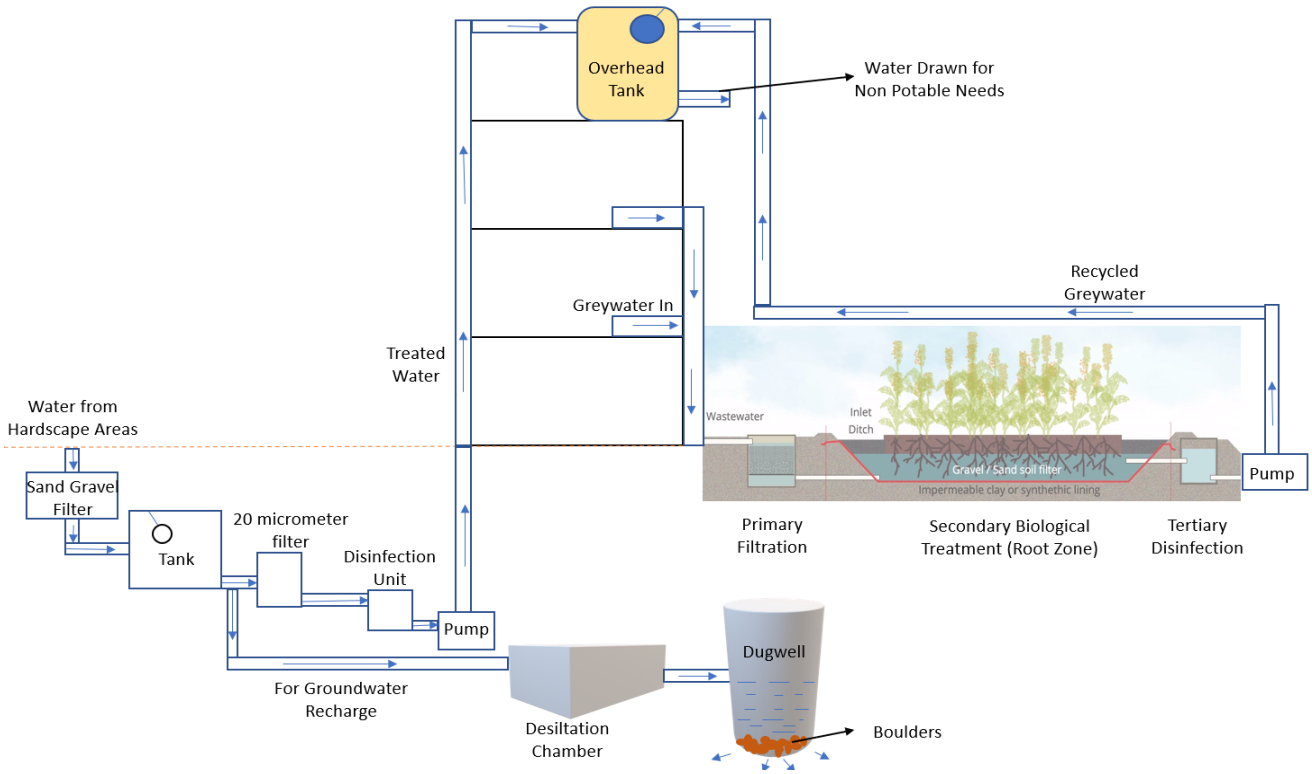
The water cycle will be explained using hand-drawn plumbing diagrams.



This is the rooftop rainwater harvesting system. The rainwater falling on the roof flows down through a pipe and undergoes some primary
filtration on its way to the tank. The water is allowed to settle in the tank and then pumped to an overhead tank from which it is drawn for use. It undergoes further treatment like micro filtration and disinfection near its point of use, making it potable. Overflow mechanisms like balloon systems and valves, and a first flush diverter have also been provided.



This is the blackwater treatment system. Blackwater from sources such as toilets and kitchen sinks is sent to a septic tank. After allowing this primary treatment to take place for sufficient time, the water is sent to an aerator for aerobic degradation of pollutants and finally disinfected before sending it to a municipal treatment facility.



This diagram shows the greywater treatment system and hardscape water harvesting system. Greywater from sources such as faucets undergoes primary filtration through a sand gravel filter and is then sent to a root zone water treatment system where it remains for 3 days. Post this, it is disinfected and pumped to an overhead tank. Water harvested from hardscape areas passes through a sand gravel filter and is allowed to settle in a tank, post which it undergoes micro filtration and disinfection before being pumped to the previously mentioned overhead tank. Water is then drawn from it for non potable uses. Excess harvested water is passed through a desiltation chamber and a dugwell before being discharged into the ground.

The treated blackwater (325300.7813L) is sent to the municipal treatment facility. After doing the calculations we realised that recycled greywater isn't enough to meet the non potable water needs (deficit of 77634.7289L). This is where water collected from hardscape areas can be used post treatment. Still, there are a couple of months where the recycled greywater + hardscape harvested water isn't enough and in such cases, surplus from previous months can be tapped into. The excess unused water from these sources (1423932.4991L) is used to raise the underground water table (it is permitted to do so in Ropar- confirmed by Dr. Sagar Rohidas Chavan, department of civil engineering IIT Ropar) or if required, can be sent to other buildings on the institute campus for non potable uses. Also, municipal water supply (465459.46L) equal to roof harvested water deficit is required to meet the freshwater consumption.