Sustainable Architecture

Prof. Avlokita Agrawal
Department of Architecture and Planning
Indian Institute of Technology, Roorkee

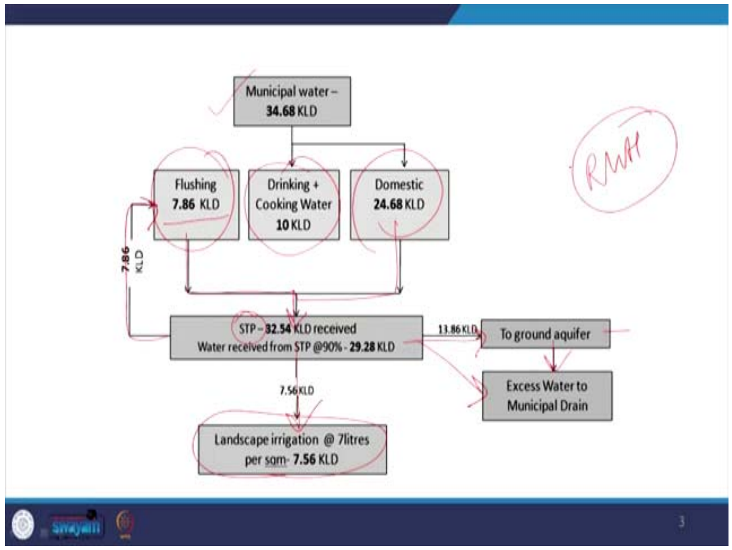
Lecture – 30
Water Conservation - V

Welcome to this last lecture of this week of lectures for this online ongoing course on Sustainable Architecture, where we have been discussing about Water Conservation, the different strategies, the different methods and the different components of this water conservation and water management. So, we have seen all the components so far, we have seen how to reduce the water consumption, we have seen how to capture the rain water and we have also seen how to treat the water. Now the point comes how much do we do it.

So, how much of the rain water should be collected, should we collect it at all, how much of the waste water should be treated and is required back into the system. So, we will today we will look at the summarizing and quantification of these numbers for a sample building. So, we will look at a case study which we have also been covering as part of the previous lectures and we will see how we will do it.

So, when we are talking about this water balance chart essentially which takes into account all these water consumption, rainwater harvesting, the sewage treatment plant, the municipal supply even the water which is used for gardening and irrigation. So, all of that put together in one simplified calculation format is what a water balance chart is.

(Refer Slide Time: 01:58)

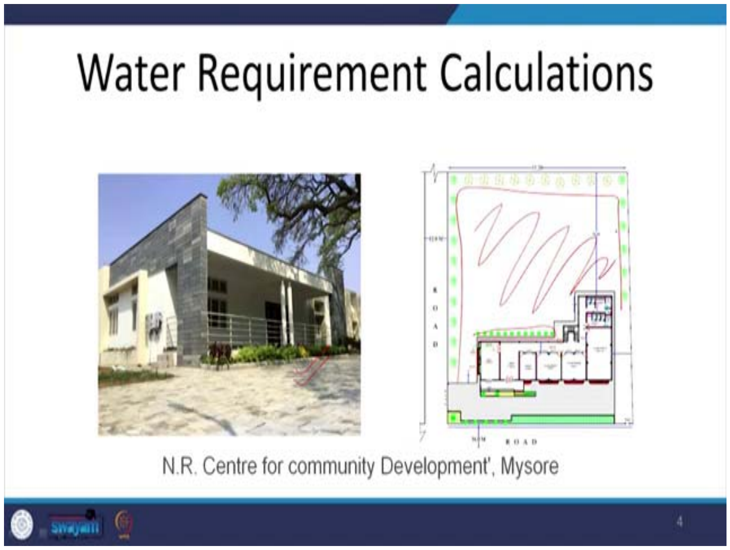


So, this is the sample water balance chart for some building which is not what we will be taking, but usually what we will have? We will have the municipal water supply. So, we will have the municipal water supply from where the water is coming. This water which is coming will be used for different purposes. So, flushing is a ~~non portable~~non-potable use, drinking and cooking water is a po~~r~~table used and domestic water supply is also a po~~r~~table water use. Now out of these flushing and the domestic uses.

They result in the sewage the grey water waste water generation which can be taken into an STP and the amount which is required for ~~non portable~~non-potable water may then be taken back and all the excess maybe through ground aquifer recharge system may be taken to the ground aquifer or it may have to be discharged to the municipal drain which is not a good strategy, but it may be required, part of it may also be required for the landscape irrigation.

So, every building every side would have a different water balance chart. Now here the rainwater harvesting is missing. So, whether there is some rainwater harvesting happening or not is not clear here.

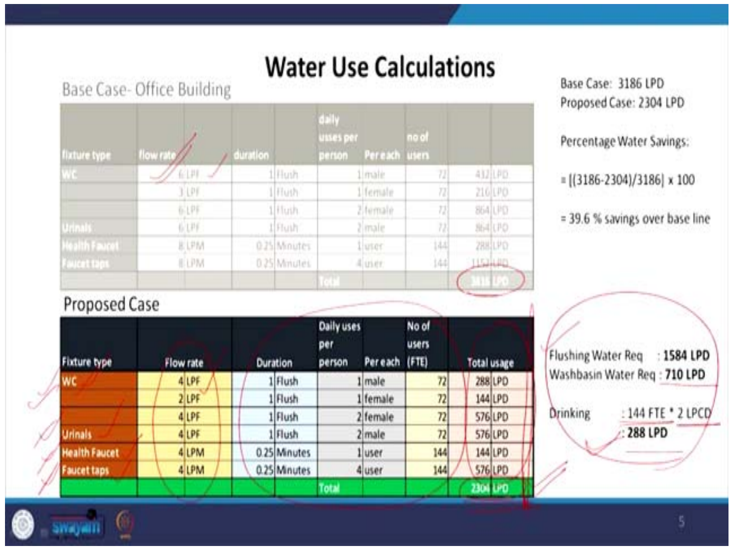
(Refer Slide Time: 03:19)



However, when we are looking at a detailed water balance chart rainwater harvesting and all these components will essentially be there. So, let us look at this example which is actually a center a school which is for community development in Mysore, this is the real case. So, this is the site and this is the small building of which is seen here. There are shrubs in the front and little bit behind and then there are trees all around and this entire area is maintained as green.

So, this is what the site essentially is. If you remember when we were doing the base case calculations and the water use reduction calculations from the base case to the proposed case this was the calculation chart that we had used.

(Refer Slide Time: 04:20)

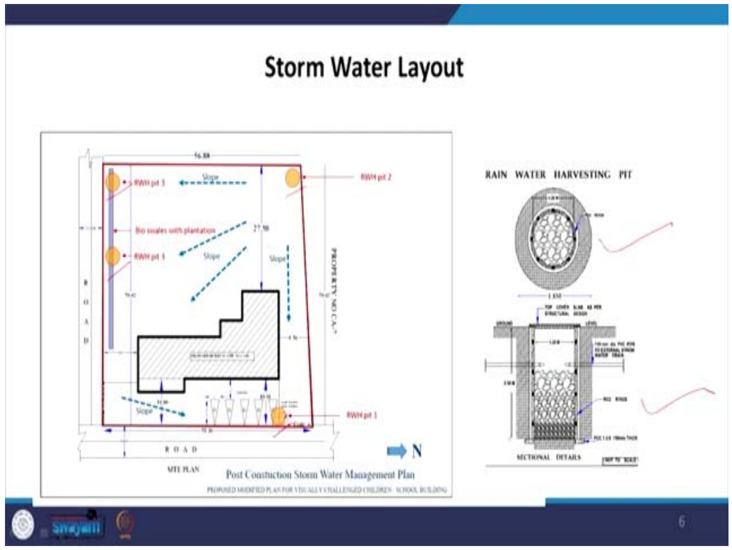


So, based upon the total FTE for this particular community centre, we calculated for different types of uses, for example, WC, Urinals, Health Faucet and Faucet taps and based upon their rate of flow which was amended from the base case values. So, in base case we had a 6 liter per flush for WC while the improved fixture which was selected for this particular building had a 4 liter per fixture and the daily users and number of FTEs remained the same and we calculated the total usage which was 2304 liter per day total.

Now, this water consumption is further divided into flushing water requirement which is for WC and Urinals then wash basin requirement which includes Health Faucet and Faucet taps because that is also the portable water and in addition to this particular calculation and this demand we also have drinking water which has been taken as 2 liter per capita per day and multiplying it by total FTE.

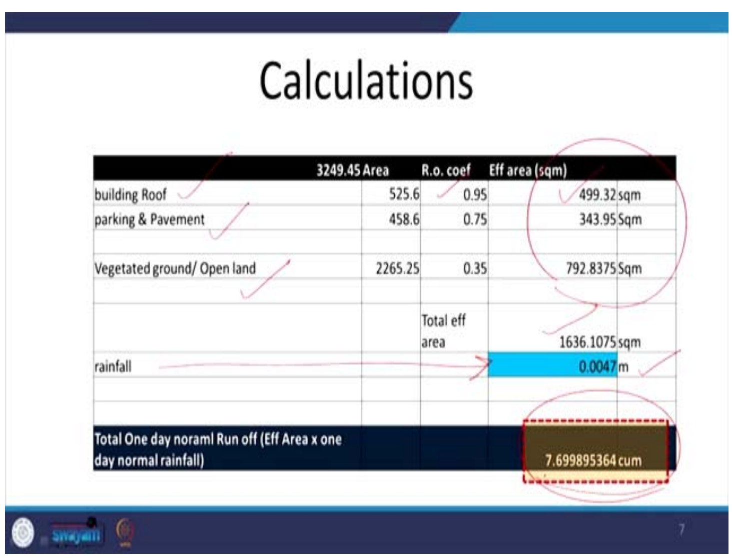
So, we get 288 liter per day. So, this is the total water requirement which we were we have already calculated where the actual one originally as per the base calculations was this one. So, the first thing that you would do is calculate FTE and once we have calculated FTE, we will calculate the reduced water demand on the basis of this improvised selection of these fixtures.

(Refer Slide Time: 06:06)



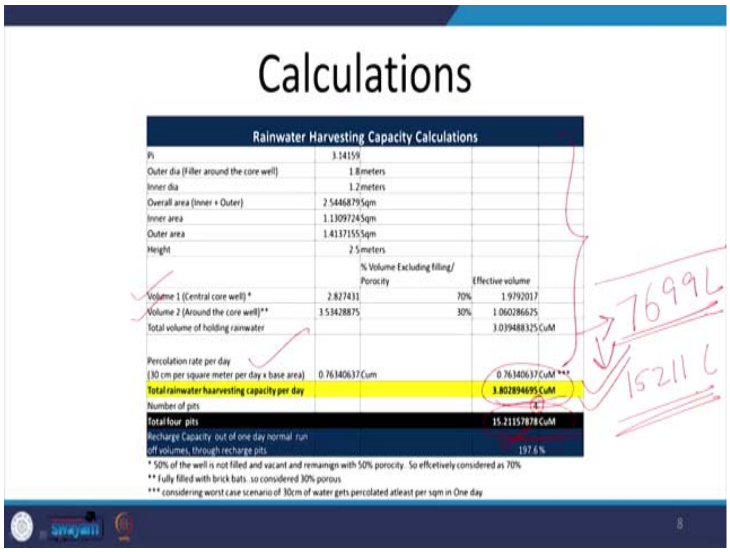
So, this is how we will first do the water calculations to establish the demand that the first point. The second was the storm water layout. So, we go back to the site. If you remember this picture this particular plan site plan you would remember that this was the same case where we had 4 rainwater harvesting pits, we had identified a design, we also took the calculations the diameter, the sizes, depth and we calculated the volume of rainwater which can be captured using these and held using these recharge pits.

(Refer Slide Time: 06:44)



So, if you look if you remember the calculation chart, we calculated the total building roof area and the effective area based on the run off coefficients for parking and pavement, for the vegetated open land. And we calculated that this is the total effective area, the rainfall which we calculated as the average daily in meters and we calculated the total amount of rainfall which per day which will be available. So, we are talking about 7699 liters of rain water be available.

(Refer Slide Time: 07:30)

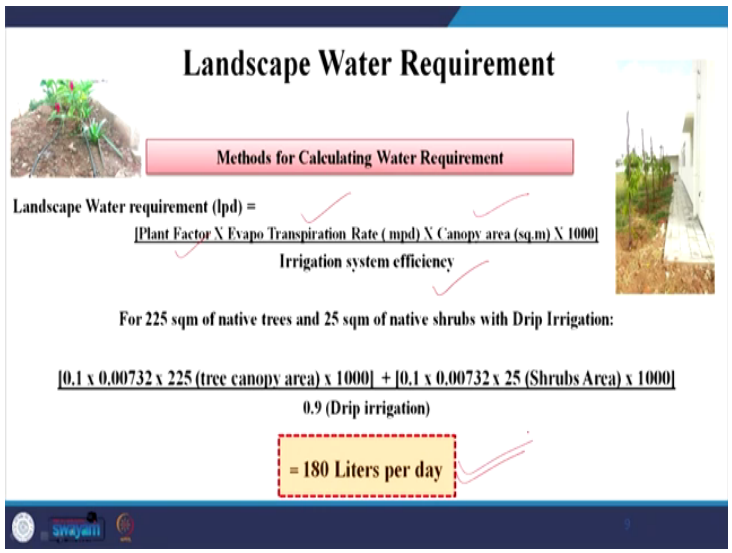


Now, to capture that to hold that we considered a design and on the basis of this design, the amount of water which can be held by the inner core and then by the outer core and the amount of water which will be percolated through the base of it. We calculate the total amount of water which can be harvested using one pit one recharge pit multiplied by the number of pits which were provided on the site and so, we calculated the total rainwater which can be harvested using these 4 pits which was 15211 liters per day that was the average.

So, these calculations are base on an average per day calculation which we have calculated. So, here now we also have the amount of rainwater which can be harvested. As you look at this here we talking about 15211 as compared to 7699 liter of rainwater which is actually going to come on an average. So, we are over sizing it. Now, when we were over sizing it we assumed that this is since this is only the average per day that is going to be received.

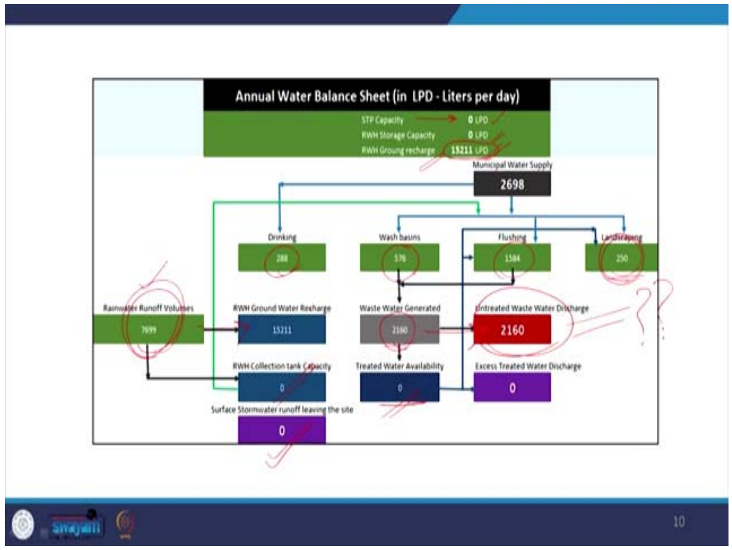
So, any excess which may happen with may occur when the peaks are there. So, during the time of peak rainfall, this system this design will be able to accommodate any peak rainfall as well. However, when we are looking at the water balance chart we will see whether it is advisable to do that whether it is an optimized solution or not to over design, so, much because each pit requires a lot of resources material resources to be constructed it requires capital cost it requires labor. So, whether it is an optimize solution or not can be very easily seen with the help of our water balance diagram.

(Refer Slide Time: 09:30)



The last one was this landscape water requirement. You remember this equation where we were considering the plant factor the evapotranspiration rate, the canopy area the irrigation system efficiency and on the bases of the total vegetated area that is available. So, total irrigation water requirement landscape water requirement can be calculated which in this case is 180 liters per day.

(Refer Slide Time: 09:58)



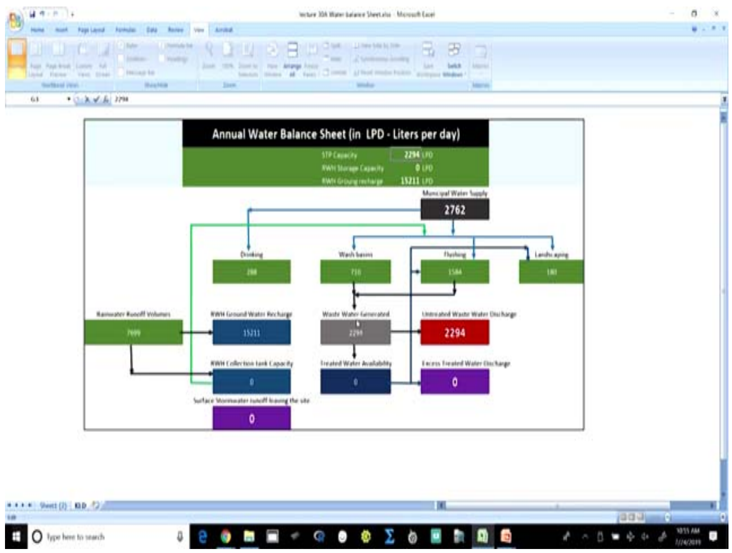
Now, we come to this water balance chart. So, if we are looking at this water balance chart, let us establish all these different components on this chart. We identify drinking water requirement as 288 liters per day, the washbasins again where the portable water is required as 576 liters per day, the flushing requirement 1584 and the landscaping requirement is 250, we calculated it to be 180, but we are taking it to be 250 here then we also know the rainwater runoff volume which 7699 liters per day as an average.

Now, we do not know whether this rainwater runoff will be recharged to the ground or will be collected in the tank as of now because we have the recharge pits with us we have assumed that this is the volume of these recharge pits and this is the amount of water which is going to be recharged to the ground. For now the rainwater storage capacity is not changed, it is 0, there is no storage and there was no STP which is installed. In the absence of rainwater storage capacity rainwater storage and STP we can see that all the rain water which will be available on the site cannot be reached to the ground with the help of this ground recharge.

There is 0 surface runoff living, the site which is very good which is ideal what we should be doing, there is no rain water storage. Now, this rain water can actually go back to supply for wash basins flushing and landscaping. Here out of this from the wash basins and flushing, the waste water which is generated is this much which is a sum total of flushing and wash basins. So, this water if there is an STP, the water would be treated, in the absence of an STP capacity here which is 0 no water is being treated.

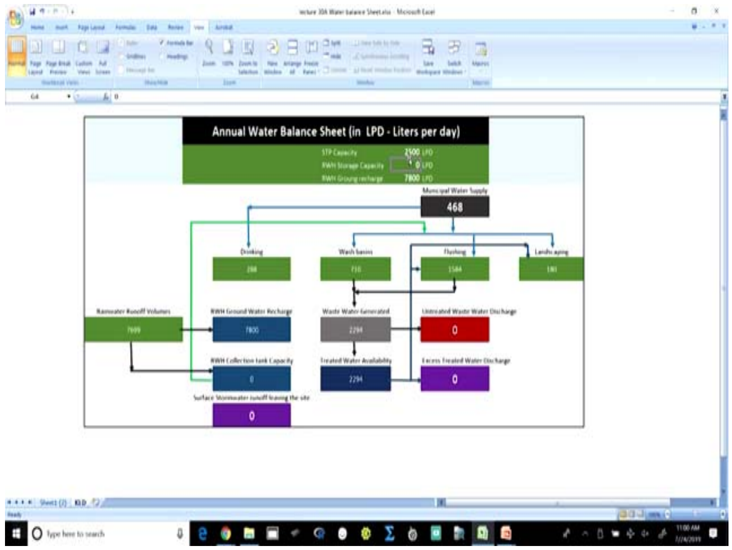
So, this untreated waste water all of it is actually going into the sewer municipal sewer. So, this is the untreated waste water discharge which in this particular sheet water balance diagram is the problem area. So, we need to solve this. Let us see how we can solve this one.

(Refer Slide Time: 12:33)



So, here we can modify the numbers. Let us see what strategy let us first of all see if we can add an STP plant. So, suppose we add an STP plant which is the same number as that which is the same amount as the total wastewater generated and slightly more than that.

(Refer Slide Time: 12:57)



So, in future if the number of occupants are increased, so, here if we make a 2500, the STP capacity liter per day. So, that will be the treatment capacity of STP. We see that complete treated the complete waste water which is generated is treated using the STP. Now, this treated wastewater would go back to be used in flushing and landscaping. So, we're using the treated water treated wastewater to go back to flushing and landscaping.

So, 100 percent of this water will actually be used for flushing and landscaping and there will be no access treated water which will be discharged and there will be 0 untreated wastewater discharge. Here it is it appears to be a very ideal scenario where there is no surface storm water runoff leaving the site there is no excess treated water discharge, there is no untreated waste water discharge. However, if we look at this number, so, we have a run off volume here and we have a run off rainwater harvesting groundwater recharge capacity, this is quite high.

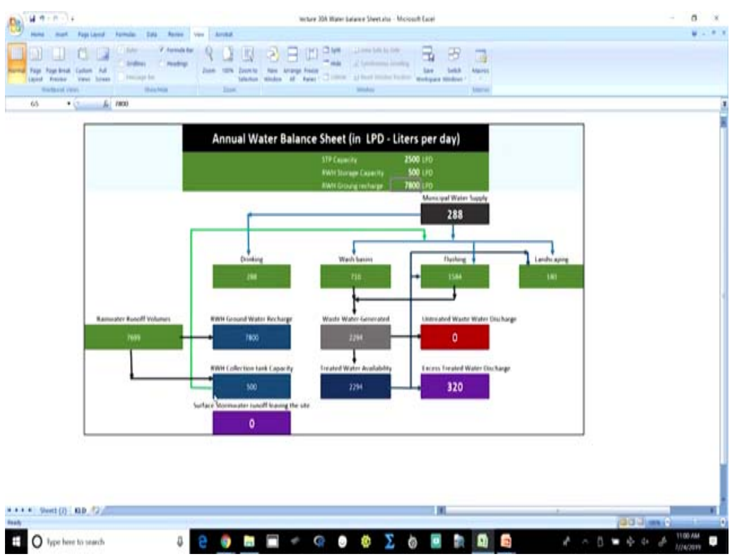
So, if you remember we had used 4 recharge pits, instead of 4 recharge pits suppose we make only 3 recharge pits there. So, if we reduce this by one forth, so, approximately taking around 11000 liters per day as the ground recharge capacity, we have reduced the number of recharge pits to 3 and still we see that we are way above the average run off which will be received per day.

If we reduced at to only 2 reducing it to further by making it only 2, so, around 7005 7800 liters per day. We see that we will still be able to recharge on an average all the rainwater which will be received except for the peak days. So, here we still have 0 untreated waste water being discharged, we have 0 excess treated water being discharge and we also have 0 surface storm water runoff which is leading the site. However, this is an average daily calculation.

So, if we look at the requirement from a peak rainfall day a point of view we may have to increase its slightly only to look at those far and few in between kind of scenarios. So, we have to make a judicious choice looking at the climatic data, the rain fall data for previous years that for how many days is the peak rainfall happening and will for how much time for how many days will there be storm water surface runoff.

So, based on that the groundwater recharge capacity for rainwater harvesting has to be designed. Now, here we see that the municipal water supply will be required only for providing the drinking water and part of the wash basins which is here. Suppose I also add little bit of rainwater collection capacity, if I add around 500 rainwater storage capacity, we see that this water will go to my washbasins flushing and landscaping.

(Refer Slide Time: 17:08)



The municipal water supply is reduced from 488 to 288, but there is an excess treated water discharge as well. So, we actually do not required the rainwater collection tank capacity and we have to make a choice weather taking 200 liters per day from municipality is a good proposition or making a rainwater harvesting collection tank, storage tanks of 500 liters is a good option.

So, we have to weigh these options and then decide upon the optimized solutions for the given site. This is what a balanced chart is and we have to make the optimized use of resources to use the material resources in the best manner to use a site and water all together in combination to result in an optimized solution. So, that was all about water conservation. See you next week with the new series of lectures as part of this course on sustainable architecture.

Thank you for being with us, see you again.