Water Supply Engineering
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture-46
Water Losses in Water Distribution System

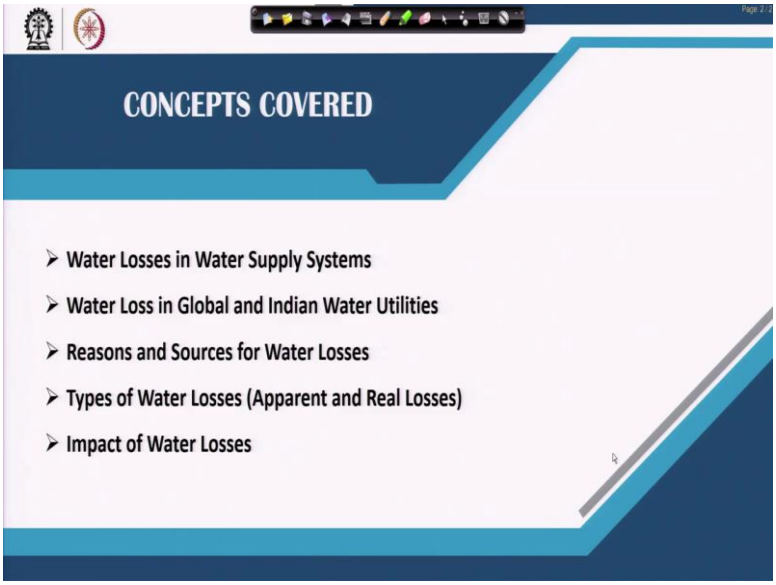
Hi friends and welcome back so we are now in the 9th week of this course water supply engineering. And so far we have discussed about various components of a water distribution system we started with the estimation of the demand then we discussed about the water abstraction or water intake. We did talk about the storage system, we talked about the water treatment or water purification techniques and in the last week we discussed about the water distribution system.

Now in relation to the water distribution system when we feed water to a distribution system our goal or intent is to supply water to the consumers. But in process some amount I am saying some but this sum is actually quite significant. So, in fact significant amount of water is lost within the distribution system. So, if we are producing say 100 unit of water the consumer and consumer does not get that 100 unit of water it may get 60 units 60 unit.

At times just 50 unit so almost like 30 to 50% of water global average would be somewhere around 30 in fact. The best systems have less losses whereas quite a few systems actually have loss losses in the order of 50%. So, substantial amount of water does not reach consumer and is lost somewhere in the distribution system. So, we are going to discuss these concepts like what is water losses what where what are the various sources where the water gets lost.

So, this is what basically and what are in fact we will talk about the estimation and control of the water losses as well. So, this is what we are going to discuss in this particular week and we will start this lecture on the basics of the water losses.

(Refer Slide Time: 02:15)



So, practically like the water losses occur in the system we will talk about some statistics on the global and Indian scenario of the water loss in the water distribution systems. We will discuss about the reasons for the water losses we will talk about the sources of water losses we will talk about the different types of water losses generally apparent in real losses as they are categorized and we will discuss about the impact of water losses as well.

(Refer Slide Time: 02:45)

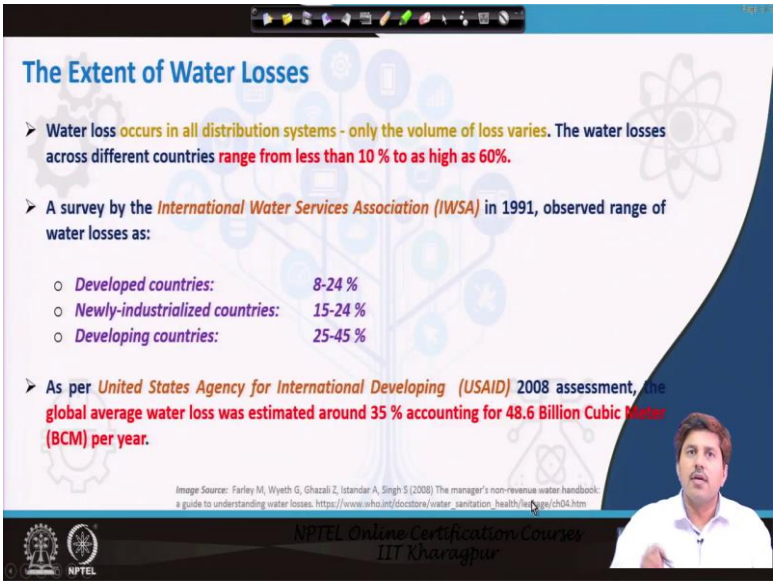
So, in water supply system which basically intends to supply treated water to the consumer generally through a pipe network in most cases in fact through a pipe network however as just we were discussing that all of the water that is pumped to the supply network does not reach to the target end consumers. And some water is lost within this supply system itself. Now where this water lost this water can be lost through leakages in the pipe generally like

the bigger pipe mains where the water flows under pressure may have very huge quantity of water might leak from there.

So substantial quantity of water might leak there, these leakages might originate from the cracks from the pipe burst from the like or through the joints. Then water may lost through the overflows particularly in the storage system. So, our storage reservoirs or ESR might actually lead to the water loss. It may lost from the consumer and also like through the taps fittings, water fittings so that can also be another source of loss. Now water loss is the water which is produced but does not reach to the target consumer.

Water which we have produced but we are not able to supply that to the target customer target consumer that portion of water is considered as loss and that what typically we refer as water loss. Now water loss is a global problem and there is no water distribution system anywhere which is having absolutely no water loss. So, there is no absolutely no system with zero water loss.

(Refer Slide Time: 04:38)



However if we look at the extent of water losses so we see the numbers vary in a very wide range. The water loss occurs in all distribution system but as we were just saying the%age or the numbers or the volume of water loss actually varies. So, in the different countries this water loss may range from less than 10% so there are utilities which have water losses in fact in the range of around 5% and it goes as high as 60% or even like some cases even higher than 60%.

So, that is basically substantial amount of water might actually get lost 60% water loss means if you are producing 100 unit just 60 unit is lost and you are just getting 40 units of water. Now producing water requires huge amount of efforts as just we have been discussing it needs basically the abstraction or the intake of water then you will be treating that water purifying that water storing pumping that water.

So lot of energy lot of effort lot of say financial resources are involved in production of water and if after producing 100 units we are barely able to use say 40, 50, 60 units and our say 50 to 40 to 50 units are going to water losses. Then it is basically puts a huge burden on the water utilities. Survey by International Water Service Association in our as back as 1991 has estimated that in the developed countries losses range typically around 8 to 24% in newly in industrialised countries it is between 15 to 24% typically.

And in developing countries it is 25 to 45% there are underdeveloped countries as well where the water losses is even higher. Further as per the USAID 2008 assessment the global average water loss is estimated around 35% which accounts for 48.6 billion, cubic metre water per year. So, that is a huge amount of water close to 50 billion cubic metre of water is lost in one year which is almost 1/3 in fact a little more than 1/3 if you see the average number as 35. So it is in fact more than 1/3 of the water which is produced is lost. So, that is the extent of losses.

(Refer Slide Time: 07:19)

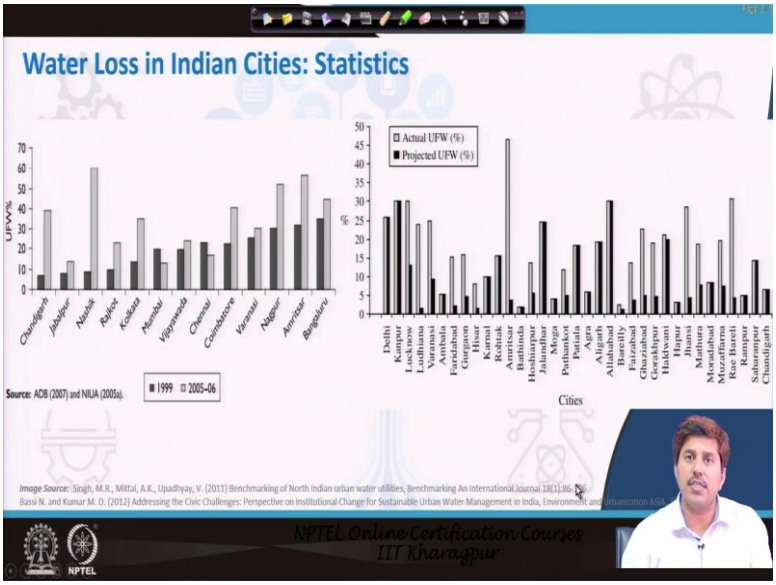
Now if you see the losses happening in the different places different countries so this is kind of example this is from OECD so here you can see that Neitherland, Amsterdam has water

losses in the order of just 4%, Cologne Germany 7%, New York City in USA 7% but again within like country also so Phonics USA 8% and many places even in the U.S. losses are as high as 30% or that range. So, if you see the Mexico; so Mexico City has losses of around 44% and in Mexico itself this particular city has losses of around 14%.

In UK there are losses around 24%, 22% so that way like we can see that there are various range of losses happening. If you see a countrywide average of the European countries so Germany is fairly well in terms of water losses less than 5%. Denmark around 10% whereas the countries like Bulgaria has of order around 50% water losses. Hungary around 35% Slovenia around 40% Italy around 30% Sweden a little less than 20% Spain little more than 20%. You can average water losses are little more than 20%.

So that way like we can see again within a country like let us say these this is data for the Canada. So, this is the Environmental Canada data now within the different cities in Canada water losses ranged from 22% to just 7.5%.

(Refer Slide Time: 09:21)

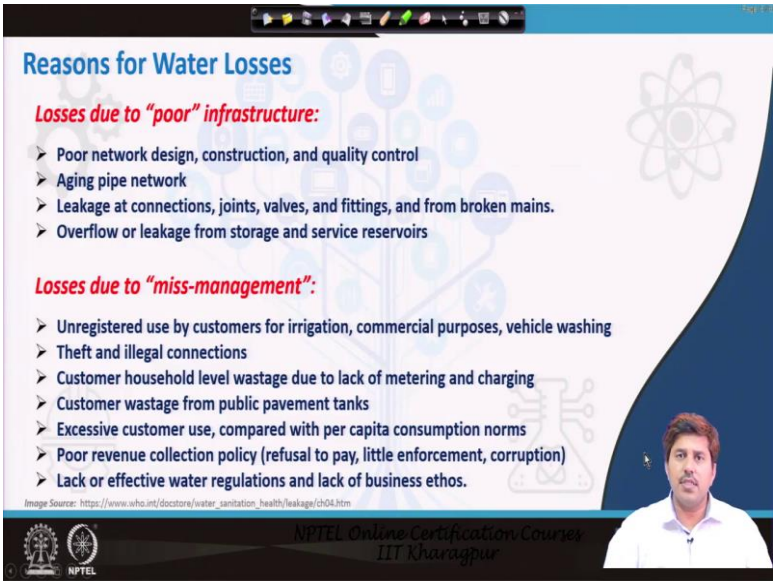


So, there could be huge variation in the water losses across utilities across countries if we see what our losses in Indian cities various Indian cities again there are different estimates available. As per the Asian Development Bank study which is in like done in the 2005-06 if you see water losses in Chandigarh it is close to 40% then Jabalpur it is less. Nasik it is as high as 60%, Kolkata again around 40%, Rajkot more than 20%, Mumbai, Vijayawada, Chennai they are fairly better in comparison.

Coimbatore high losses, Amritsar very high losses, Bengaluru more than 40%, Nagpur again more than 40% water losses though that is a old data of 5, 6. Another study done in 2012 for different cities, so, here you can see that water losses like many places it is actually in the range of around 25% to somewhere between 15 to 25% many places fall in that range. Few even exceeding so Delhi, Kanpur, Lucknow water losses are high.

Ludhiana again of the same order, Amritsar very high water losses around 50%, Raebareli Jhansi, Allahabad are the cities with higher water losses. If you see on a better side so like Ambala, Hisar then Bhatinda, Moga, Hopur, Rampur so, there are various cities Faizabad these are Bareilly so these are city with lesser water losses.

(Refer Slide Time: 11:09)



Now again this data also is from certain sources and numbers are not fixed they are just estimated during a short term studies whereas because particularly in Indian conditions we do not have water metering. We do not do not have robust water metering citywide. So, estimation of water losses itself is a big challenge. So, we will talk about that in some later class. So, now we have been discussing about water losses and the you see that there is huge extent of losses takes place in the distribution system.

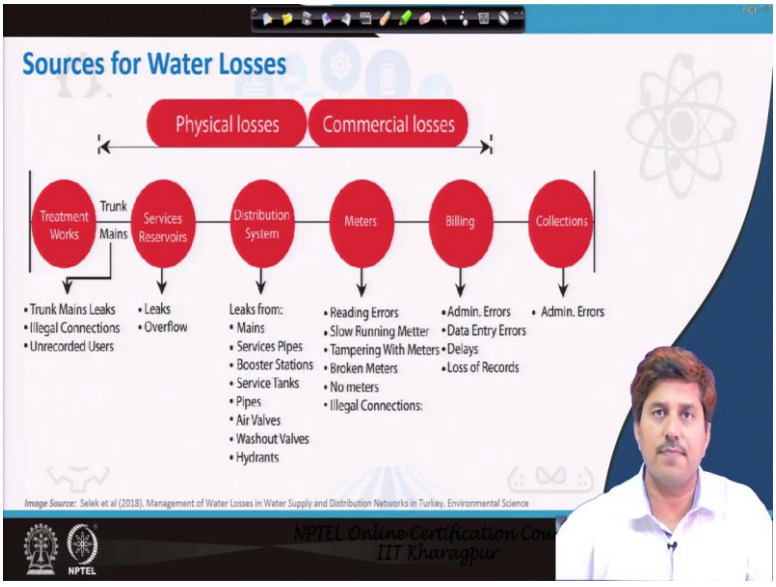
But why this losses take place so what are the reason for these water losses where does that water go? So, water loss actually is either due to poor infrastructure. So, poor infrastructure means poor network design construction, quality control, aging pipe network leakage at connection joint wall fitting then broken mains or overflow or leakage from storage and service reservoirs. So, these could be like reasons for like having poor infrastructure.

If your reservoir is the floating wall in the reservoir is not working well you will see overflow taking place from the reservoir. If your walls of reservoir or floor of reservoir is not leak proof you might see water leaking from there you might see water leaking from various connection joint was this very common actually in Indian cities. If you go across water mains some places you will see that there is; it is broken and water is leaking from there.

So this is a pretty common thing here then losses could be because of mismanagement also it is not necessarily always due to poor infrastructure or always due to this kind of leakages it could be because of mismanagement. Mismanagement include like there might be unregistered users, tapping for irrigation, commercial purpose or vehicle washing there might be theft and illegal connections.

There might be household level wastage there might be like wastage from public pavement tanks. Then excessive uses by the end-users which increases the per-capita demand or it is much higher than the per capita norms. What it could be basically lack of effective water regulation and lack of business ethos. It could be revenue collection policy issues so like there are various other this kind of factors also lead to water losses.

(Refer Slide Time: 13:48)



Now if you see the sources of water losses so water losses could be like coming as a physical losses or could be coming as a commercial losses. So, if you see in like detail wise so physical losses where the water is basically getting lost physically through the poor

infrastructure as just we were discussing. So, it can loss through the trunk or main lines so that is basically through leakage, through illegal connections, through unrecorded users.

It could loss through these service reservoirs through leakage through overflow it could loss from the distribution system. So, can there leak can be from mains leak and me from service pie from booster stations, from service tanks, from distribution pipes, from air balls, from washout walls, from fire hydrants. So, there could be like n number of places from where water can leak. There could be commercial losses which are more so related to the management and this may not essentially be the physical losses.

So water might not actually be getting lost but in the record of utility it might be entered as a loss that would be because of reading errors. So, if your pump is faulty let us say your pump is sending one meter cube of water and just reading it as say 0.9 meter cube. So, if you have supplied to a household 20 meter cube of water your system will just record 18 meter cube of water so that means 2 meter cube water is lost in the record of utility.

Although that is not actual loss because the total water has been delivered is 20 but in the record of utility what water like the household has got 18 meter cube of water, so in the record of utility 2 meter cube of water has lost which is in fact has been delivered to the end consumer but because of metering and accuracy it cannot be read that way. So, slow running meter there is possibility with tampering with meter like bypassing lines or those kind of thing broken meters no meters or illegal connections.

Then there could be error in the billing data entry errors delays loss of record can also lead to the water loss and administrative errors can also lead to the commercial losses.

(Refer Slide Time: 16:27)

So, based on these sources typically water losses are categorized into two major categories that are real water losses and apparent water losses. So, these are same as just we were discussing so real losses are also known as physical losses so the physical losses is amount of water which is lost through the physical means. Actually lost through the physical means so you have a pipe you have some wall some place there crack is happening and water is leaking from there, water is getting lost from there.

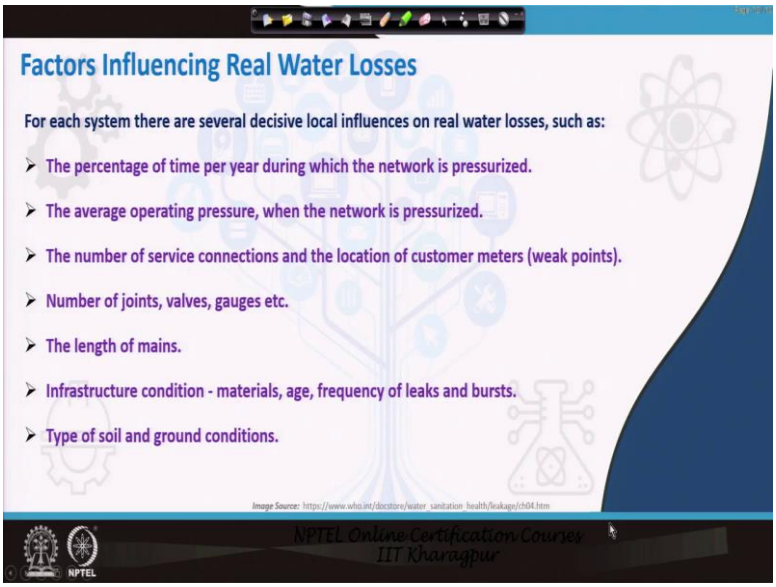
So that is actually a real loss and in U.S. up to 30% of supplied water actually gets lost for example so this loss will happen as just we were discussing it can happen because of leakage or overflow in the system components it can be because of pipe busting because of leaking joints fitting service pipes and connections it can be because of seepage through the reservoir walls or overflow due to the float wall failures.

So this could these things could lead to the real losses in the system which is actually a physical loss and water is actually getting lost. The other type of loss is known as the apparent loss. So, apparent loss is the common term used in the water industry however many people refer it to as non physical losses, management losses or some people refer it as a commercial losses as well. So, apparent loss means it is actually the water has not lost physically it is not lost physically.

But it is recorded as a loss in the utility recorder just we were giving example so this could be basically error in the recording or data handling errors or metering inaccuracies or theft of

water or kind of unauthorized consumptions. So, we will talk about this apparent losses in more detail in the next class.

(Refer Slide Time: 18:15)



Though but so these are the two major cases the real losses and apparent losses. Now as you you would understand that real losses are the one which is actually the water is getting lost from the system. In physical terms so what influences these real losses there are variety of factors which plays a very decisive role which have a decisive local influence on the real water losses. And these factors could be like the percentage of time per year during which the network is pressurized.

Because the pipe burst, cracks or leakage through fluid fittings largely depends on the pressure in the pipe line. If the pressure if the average operating pressure which is the next point is high then there is a high chances of these kind of leakages appearing. And even if a leak has appeared water is running with a low pressure the amount of water that will be lost is less whereas if the pressure is very high the amount of water lost through that particular leak or burst is going to be very high.

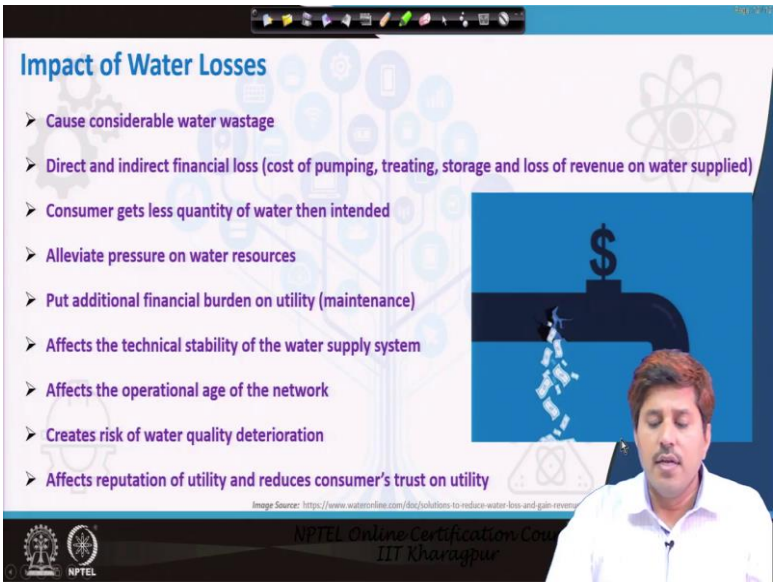
If you have a crack here and if you are running water at say 10 meter head the amount lost with respect to same crack and if you are running water at 20 meter head so amount of water lost here is going to be much more as opposed to the other case when the pressure is low. So, what is the average operating pressure when the network is pressurized also plays a very important role in kind of in setting up the quantity of the real water losses.

Again the number of service connections and the location of the customer meters because these are the weak points. If you have a say branch pipe going on and then there are service connections going from say every place so these points essentially are the weaker points from where water loss might take place. So, how many of such weak points are there or consumer meters points. So, anywhere basically where you put join for all gauges so these are all weak points in the network which are susceptible to kind of open and water might loss from these places from the joints.

So how many of such joints are there in the network is again a very important factor. Then the length of mains, what is the length of means the larger the length the difficult is the maintenance and more chances of the losses. Infrastructure conditions what is the material of the pipe line what is the age of the infrastructure frequency of leaks and burst and then type of soil and ground condition also.

Because what kind of reinforcement has given while laying the pipe lines what is the bearing capacity of the soil many time uneven settlement of the earth like you may have a very good pipeline laid but if there is an uneven settlement of earth that also might kind of some it might cause some tilt in the pipeline and may result in the cracks or breakage of the or burst of the pipeline's pipe systems. So, these are the reasons generally for the real water losses.

(Refer Slide Time: 21:44)



Now if we see how these water losses impact so there are there are like various disadvantages of having water losses in the system obviously that will be there. But these includes that water losses can cause considerable water wastage. So, that is the first point very

straightforward. If water is getting lost from the system you are actually losing water, so there is a lot of water wastage which is the very important point and then there are direct and indirect financial loss.

Why direct and indirect financial loss because for producing unit amount of water it requires lot of cost there is a cost of pumping, cost of treating water, cost of storage all this happens. So, there is a cost involved in basically producing that water which is getting lost so indirectly basically it is a financial loss or you can say directly also because it is a loss of revenue on water supplied. So, if you are able to supply that water if you prevent the loss and supply that water so you are going to generate some revenue possibly on that water.

So if you are losing that water you are straight forward losing revenue. So, that way there is a direct as well as indirect financial loss which is there with water losses in a return with the water losses. Then when the water is getting lost consumer gets the less quantity of water than intended. It further elevate pressure on the water resources because if a community is to supply a 100 units of water and utility is having 40% water loss.

So if you withdraw 100 unit of water you will be able to just supply 60 because 40% will get lost. So, in order to meet the demand you probably need to withdraw more amount of water you need to withdraw more amount of water you need to withdraw say one 160, 170 units of water so that even after 40y% loss you can you can still supply the 100 unit of water which is the demand from the community all right.

So that way you need to withdraw more water from the resources and when you withdraw more water from the resources it will increase pressure on the water resources. It also put additional financial burden on the utility because you need to maintain that losses and you need to produce more amount of water. So, there is of course additional financial burden on the utility. It affects the tech stability of the water supply system the systems which are having more losses specifically the real losses physical losses.

So that means this infrastructure is not good so it might not basically be remain technically stable for a long period of time with cracks leaks appearing system overhauling and system maintenance is basically required. So, the technical stability of the supply system also

affected with these losses and leakages it affects the operational age of the network it creates the risk of water quality deterioration this is again a very important point.

The losses because if say you are having a pressurized pipeline system you have put in treated water which is going to say to the consumer end. The water quality which you are feeding in the in the pipeline is going to presumably remain similar by the time it is delivered to the consumer but what happens if you end up developing say some crack over here if you have developed the crack over here and say water is getting lost from this point.

Now once there is an opening there is a possibility of contaminant entering also in the pipeline. There is a possibility of contaminant entering in the pipeline and that could deteriorate the water quality. So, a system which is pressurized and is watertight has much, much less chances of recontamination then a system where there is a lot of cracks and bursts are there. Because it provides an opening through which the contaminant might enter into the into the system again.

So, that creates a risk of water quality deterioration. And lastly it affects the reputation of utility as well because if you are having a utility which is maintaining its water supply system in a much better way there is no leakages there is no water loss there is no pipe burst. So, you kind of utility can gain trust of the consumers that yes the system is being well managed. Whereas if you see lot of like water losses you see like reservoirs are overflowing water is leaking through facets.

Water is there are mains which are broken at several places so then you lose trust on the utility that the management of the utility is not that great it is rather poor management of the utility. So, these are the major impacts of water losses that happen on the system. So, with this we will end this particular class here and in next class we will start discussing more about the estimation of water losses.

And how we use the concept of water balance or water auditing for measuring the water losses and also we will talk about the; we will talk about the performance indicators that are helpful in getting an idea of the water loss from a water supply system. So, thank you for joining see you in the next class.