Water Supply Engineering
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Lecture - 13
Surface Water Intakes Systems

Hello friends and welcome back. So we are in to the discussion on water intakes. And in the last couple of lectures for this week, we did talk about what are the various water sources available for water supply projects and what are the various types of intake. So we did discuss about the various types of intake and we will go into more in depth analysis of surface water intake systems in this particular class.

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So what we are going to cover in this class is the different type of intake systems; river, canal, lake and reservoir intake systems that we have and as in the previous lecture we did talk about that based on the water inside the intake structure we have two types of intake wet and dry intake systems. So we will discuss about those wet and dry intake systems as well.

And then we will talk about movable intake structures. And then some other features like single well or twin well intakes and then we will talk about the trash racks which are used for protecting the entry of large debris, tree branches and ice and those kind of thing into the intake. So this is what we are going to cover in this particular lecture.

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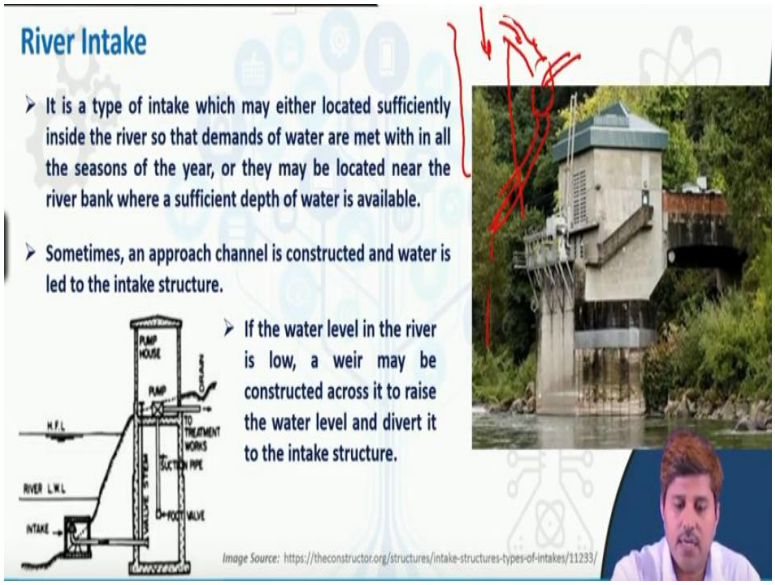

So as we discussed that, depending on this source water whether it is river or canal or reservoir or lake we may have different type of intake structures. So for the systems which are typically installed for abstracting or withdrawing water from the rivers are generally referred as river intake systems. Now this river intake is actually a system which can be located sufficiently inside the river okay or at the bank of the river.

Now how it is located depends on the nature of river itself. If there is adequate water available on the banks it is preferred to locate the structure on the bank itself. However, in many case the river banks are quite shallow so it may actually be located sufficiently inside the river where adequate water depth is available. Many times if we do not want to disturb the river, a approach channel is constructed.

So we may have actually say this is our river following. Now we may have a approach channel. We can, if this is the direction of flow, so in the upstream we can have a channel from where we can withdraw water in this channel, make a barrage in this channel and then install our intake structure in this channel and let that water, extra water go back into the river.

So an approach channel might be constructed and we may use such approach channel for the abstraction of water from the river. The water level in the river, if it is low in the river also we may at times construct a weir or a barrage kind of thing so that water level is raised and then we can divert that water towards our intake system. So systems are simple as like we discussed earlier the submerged and exposed structure.

So it is usually exposed kind of system. We may have kind of pipe going into the river and then water entering into this intake system and through a pipe it comes to a well which is usually a jack-well, at times other type of systems may also be used. And then from here water is pumped to the treatment facility. So this is a simple river intake system.

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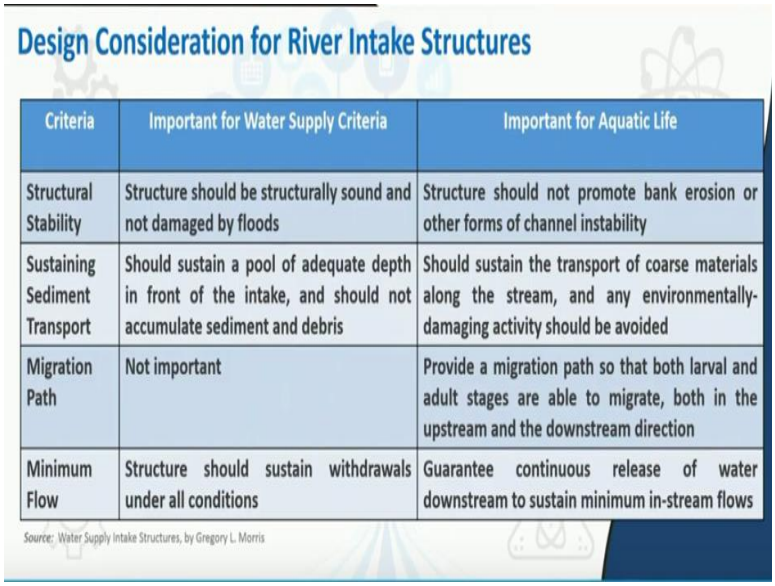

There are as the most cases the water is withdrawn from river for public water supply of the large projects. Generally if there is no suitable lake and then lake also has a capacity. If you continuously withdraw water from the lake and there is no replenishment, the level will fall which is not advisable. Whereas river takes the water to the sea. So if we can tap some water and utilize it, it is good from that perspective.

So in many places the intake systems are constructed on the rivers and when we are going to have a intake system on the river we have to see several criterias okay which we need to consider while designing the intake system. Now these criteria may be important from water supply perspective and at times may be important from aquatic life perspective as well. So we will have to see like structural stability of the intake.

So the structure should be kind of sound enough so that it does not get damaged by the floods if the floods are occurring in the river. Whereas, the structure should not promote the erosion because if it say promote the erosion then natural habitat of the

river aquatic systems will get distorted. So it should not kind of promote erosion or channel instability. So that is important from aquatic life perspective.

Similarly, it should provide adequate depth in front of the intake so that water can be withdrawn and it should not accumulate sediments and debris at the intake because then there is likely chances of clogging or these things entering into the river. Even if it is not entering we are protecting it is say, but if it gets accumulated over there, so capacity of the channel will reduce there.

So it should not accumulate sediments and debris in front of the intake that is important from the intake perspective, working of the intake perspective. Whereas from aquatic life perspective, it should not basically interrupt the sediment transport. So transport of sediment and coarse materials should take naturally around the course of the stream, the way it usually takes okay.

And any kind of environmental damaging activity should be completely avoided. Then the migration path perspective, it is not important for the water supply criteria whether there is a migration path or not, but from ecosystem perspective, it should be basically provide the safe migration path to the larva and adult phases and other type of systems which are there in the river so that they can actually migrate in both upstream and downstream as they would do in a natural system.

And there is a minimum flow criteria. So the structure should sustain the withdrawal under all condition. It should basically be at a, it should get the adequate depth of the water and adequate quantity of water so that it can withdraw the necessary amount of water as per the demand estimated under all conditions. But at the same time, it should guarantee the minimum in stream flow as well.

It is not that we withdraw all the water and do not leave anything in the river. So that is going to hamper the aquatic life of the system. So it has to be kind of take care of that as well.

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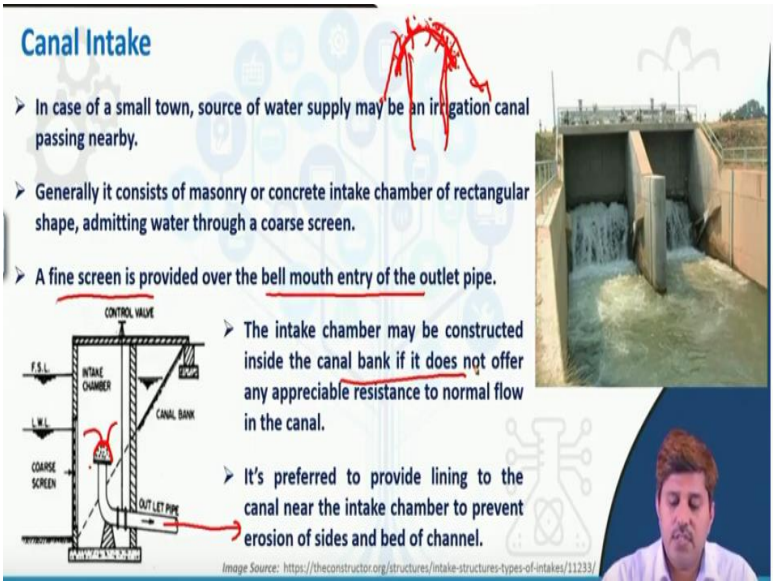

So these are some of the design criterias which one should follow while designing a river intake. Then for canal purpose, canal intakes are good for the small towns okay. Usually canals are not that big to support the water demand of larger cities, okay. So large cities usually rely either on the big rivers or lakes or groundwater systems, but for small towns canal may be a source of water supply, okay.

It will generally be a masonry or concrete structure. Then we can make a intake chamber generally of rectangular shape or trapezoidal shape and that admits water through a coarse screen okay. A fine screen is also provided over the bell mouth entry. So generally the canals like the, if say this is our main pipe which is going to take away the water.

So the entry in this pipe is basically protected through a bell mouth. This kind of system is provided and we call this bell mouth because it resembles a typical bell which we use in the temples and those places. So it is a bell mouth entry and then there are small pores. A screen is provided and water enters through these screens into this pipe.

The bell mouth is usually provided because it does not sustain anything on that. So if there is some part is because we are having actually a screen over there okay a very fine screen which is provided on the bell mouth entry. So if there is any entrapment it does not accumulate here. Because of this bell like structure of this it actually slides

down in the water so that the clogging, chances of clogging is not there due to its bell like structure, bell mouth like structure.

The chamber may be constructed inside the bank if it does not offer any appreciable resistance to the normal flow of the canal okay or another important perspective is we should provide lining near the intake chamber in the canal, so that the erosion and those kinds of things are prevented from the canal.

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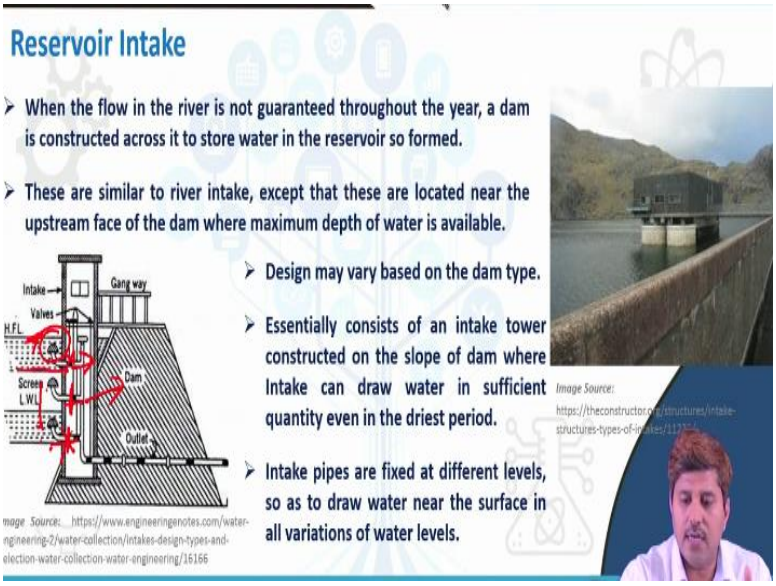

Then the reservoir intake is actually again a similar system which is used for withdrawing water from the reservoir okay particularly when the rivers the flow in the rivers is not adequate enough to guarantee supply throughout the year. So a dam or barrage may be constructed across it that stores the water in the reservoir, okay. So like if we have a river like structure we can actually construct a dam.

And this dam stores the adequate amount of water and that water may be then withdrawn for the purpose of meeting the water demands. This would be generally similar to the river intake except that these are located near the upstream face of the dam okay where the maximum depth is available. The design of these systems may vary based on the damn type okay. There are various options available.

It essentially typically consist a intake tower which is constructed on the slope of the dam where the intake can draw the water in the desired quantities okay, even in the driest period. And because for that reason, we have generally the water, the intake

pipe fixed at different levels as you can see here, okay. So it will be fixed at different levels so that it can draw water near the surface at all variation levels.

Why it is important to draw water near the surface because in dams water depth is quite high, and the water near the surface is relatively of better quality as the water in the subsurface, like not subsurface in fact, water at the deeper levels. The water at the deeper levels may have high level of sediment because the silting takes place.

So the silt concentration at the top will be less and as you go towards the depth, you may see high silt concentration. So silt level may be high. The oxygen transfer is low, so the water may develop anoxic or anaerobic zone at the greater depth if the depth of the reservoir is very high. So that is why the drawing water from very deep levels is generally not advised. But we may still have entry ports at different level.

So when the water is at say high flood level, we can close this and this port and allow this to withdraw water. When the level falls let us say level is somewhere here, then, of course, this will not get the water so we can close this and allow this to work by closing this and if it is the lowest level as in like none of the upper ports are getting water.

So we can allow, we can open the lower one and allow the water to enter through this port. So that way we can ensure the adequate amount of water entry into our intake system.

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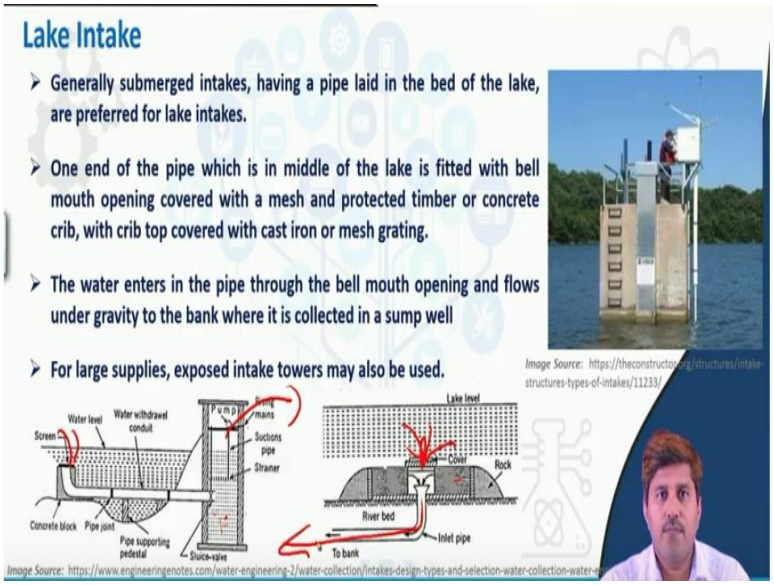

So another type is the lake intake which is generally submerged intake okay and we discussed the submerged and exposed intake in the previous lecture. Submerged intake usually will have in the lakes like we may have a pipe connecting through the lake at some places and then through a screen water enters into this pipe and then it goes to a well from where the water can be pumped and sent, okay.

The withdrawal conduit may be actually laid at the bottom of the lake okay. Then other type is that again like we discussed in the previous class that rock filled or timber crib kind of structures may be provided. So we may have rock and then kind of bed and through a cover water enters in here and then through this it actually goes to the another intake chamber or jack-well from where it can be pumped.

Or it can be pumped directly from the lake itself, okay. So what are typically enters in the pipe through bell mouth opening here also and flow usually takes place under gravity where it is collected into a sump-well like this and then from sump-well it will be pumped, okay.

For large lakes and if the target city size is also pretty large, so we may go for the exposed intake towers as well instead of going for completely submerged intakes which is generally preferred in the lakes.

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Now these were the different types based on the source, but again whether there is a water inside the intake tower or not again we can classify them as wet intake towers or dry intake towers, okay. Both of these are widely used and generally for large water supply projects from rivers or reservoirs where basically large change in water levels is often seen.

Both of them have great control openings which are typically known as ports and these ports provide water at various level in , in the basically concrete tower which is meant for collecting the flow and then connect that to the withdrawal conduit. If entry ports are submerged at all levels, there is no problem of any clogging or damaged by the debris.

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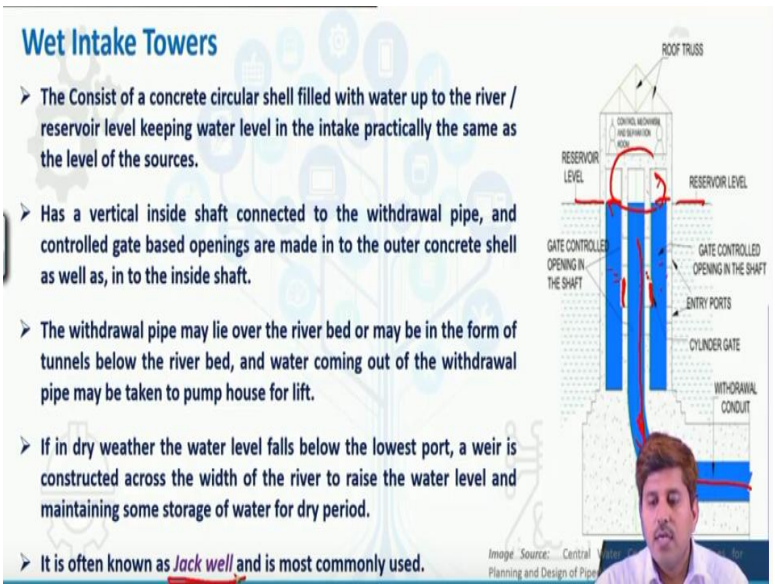

But many times under low flow condition when entry ports are not submerged so as just we were discussing in case of the reservoir intake the multiple ports are there and entry may be taken from different ports. So it is basically the same type of structures like wet intake tower or dry intake towers which are typically used in case of rivers or reservoirs, when they serve as a water source, okay.

Now the wet intake tower and dry intake tower the difference is the availability of water inside the tower. So for say in wet intake towers, we generally have a circular concrete cell, okay. So you can see that these are all circular concrete cells. This is our withdrawal conduit and then withdrawal conduit is basically enclosed by a circular concrete cell.

So this is basically our main withdrawal conduit okay that withdraws the water and across this conduit, across this pipe, there is a circular cell like this one that you see here. So this is actually encasing the entire conduit and this is usually filled with the water. This is usually filled with the water and one other important point is the level of water in this in the basically circular encasing channel is equal to the level of water in the reservoir or river.

So it usually consist a concrete cell which is filled with the water up to the reservoir level or river level okay. Then it has a vertical shaft which connects it to the withdrawal pipe. So this is your withdrawal conduit and this vertical shaft will connect it to the withdrawal pipe and there will be gates which will be basically controlling entry of water in all these channels, in all these basically shafts, okay?

The withdrawal pipe may lie over the riverbed or maybe in the form of tunnels below the riverbed and the water which comes out of withdrawal conduit is usually basically be sent to the treatment facility by pumping it okay. In dry weather case, the level may fall below the lowest port. And in that case, we may go for a construction of weir as discussed earlier.

This type of structure is one of the most commonly used structure and typically known as jack well. So jack wells are generally the wet intake tower kind of wells, okay. The point here is that this is our main withdrawal channel and this is encased by

the water surrounding and the water level here and here is same. So there is no extra thrust or extra pressure on the main intake conduit which is the difference when we see the dry intake towers.

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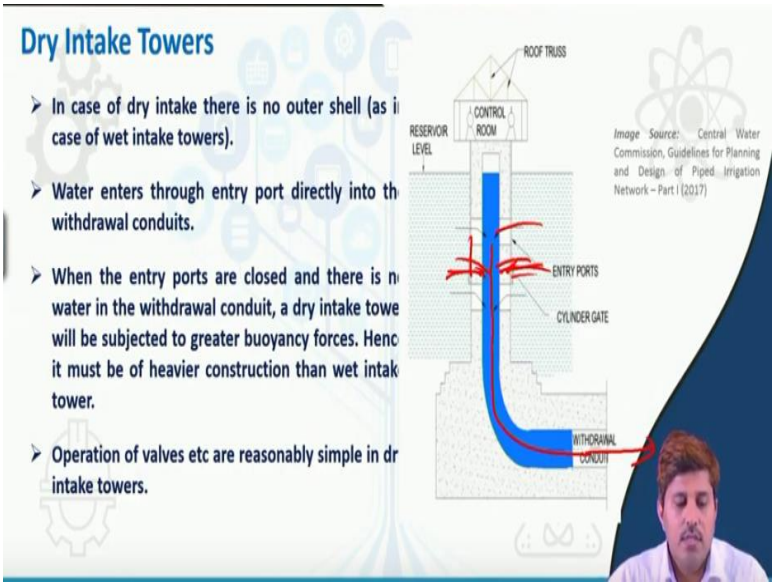

In the dry intake towers what happens that there is no outer cell. So as there is no outer cell we just have a basically concrete case and then there is a through entry ports water enter here and this eventually connects to the withdrawal conduit. So on outside it looks okay. We have water here in this and then we can have this like through entry ports and through this screens water enters directly in the withdraw conduit and then it is taken away.

The when basically entry ports are closed, there is no water in the withdrawal conduit, okay. So that is the basically disadvantage over here that when we are not operating these and these entry ports are say closed. So in that case when the entry ports get closed and thus there would not be any water in the withdrawal conduit and then the entire structure would be sub, because when there is no water, it will be just air in here and the entire structure will be subjected to the greater buoyancy forces.

And to kind of encounter this or to ensure the sustainability of these structure, they must be constructed with more reinforcement and has to have a heavier construction than the wet intake tower. So the kind of concrete and these things which is filled, must be heavier in order to counter that buoyancy force. The operation of valves etc.

are relatively easier here as there would not be much of water outside that way and it is simple, just one pipe.

So operation and control is far more easier whereas in wet intake tower you have the encasing where there is water surrounded. So even if the withdrawal conduit does not have water you have water surrounding pipes, the kind of pressure is not, the buoyancy force is not that much. So this is the dry intake towers.

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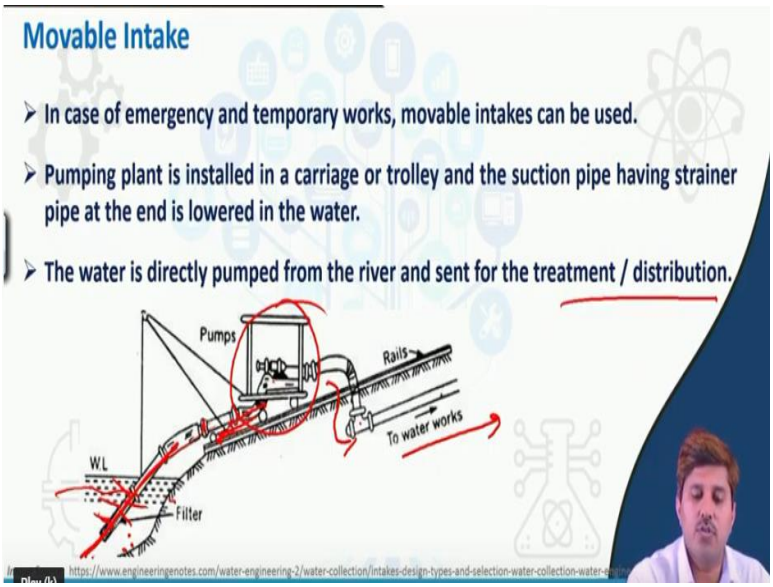

Now there are movable intakes also used at times which is specifically in case of emergency or when there is some temporary work going on okay temporary requirement of water is there at some place. So then movable intakes are used. So these are basically simple pumping plants which are installed in a carrier or trolley, okay and inside systems there would be a suction pipe, okay.

So if say this is our intake, it will eventually have a suction pipe and on the other end it will have a delivery pipe. So there will be strainer and we can use this, we can put this suction pipe into a water body or from where we want to pump water and then we can pump this water through suction so it will suck this water and of course it is going to enter through a screen.

So the water will be pumped here and then it will be delivered to basically a waterworks or wherever it is needed. So the water is directly pumped from the river or

lake or reservoir and it can be sent for the treatment and, subsequent treatment and distribution purpose.

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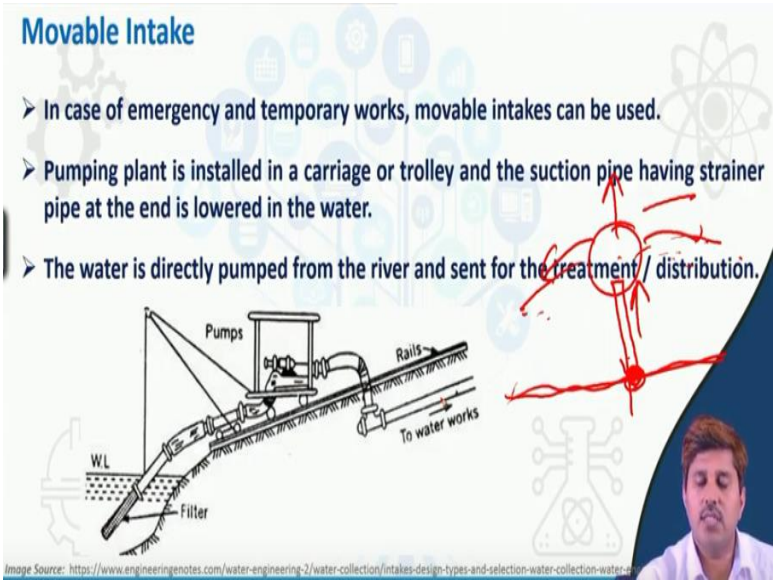

There are floating intake also. So floating intake maybe like it is not that movable. We may have a site fixed, okay. So let us say if this is my river or reservoir, okay. This is bank of river or reservoir. So we may have kind of intake system which may be thrust based okay and this have a ability to move in here, move in here. So we can basically, it is hinged at one point. At this particular point it may be hinged.

But then it has a facility to move here or there and then collect water from the different portions or it may actually be extended also at times in the, go further along the width of the river or in the towards the center of the river or reservoir. So depending on water level, one side hinge and then basically it has ability to float within this. Depending on the water level it can be adjusted. So this kind of intake may also be used at times.

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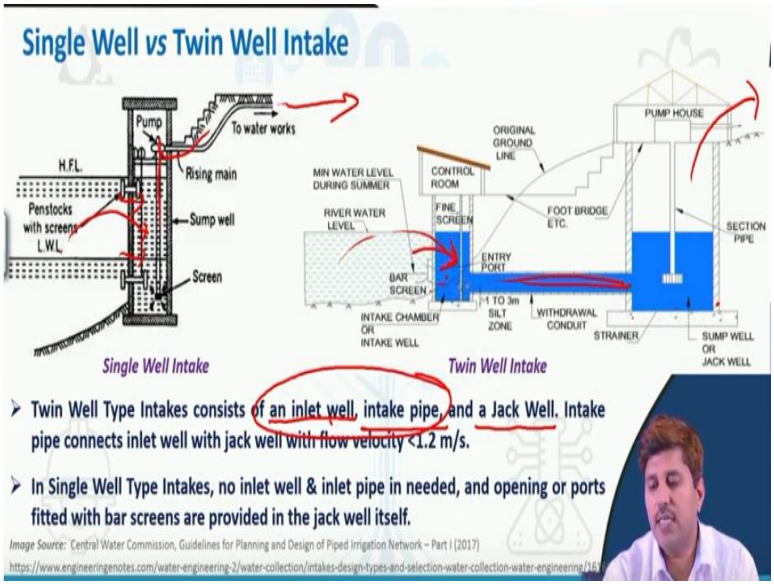

Then there are single well versus twin well intake systems. The single well intakes are the systems as just we have been discussing one single well so we will have basically water directly entering into our sump well or jack well or whatever we are providing and then from here we can pump water and send it to water works. Whereas in twin well systems, there are three components.

There would be an inlet well, then a intake pipe or this is also known as inlet pipe, so inlet pipe or intake pipe and usually a jack well okay. So what happens here that the water first enters through a screen into the inlet well which is your entry port. Entry port is inlet well, and then from inlet well there would be basically a intake pipe or inlet pipe which will eventually connect it to the jack well.

And from jack well then it will be pumped to the treatment facility or next stage treatment facility. So that is the difference here. Water directly enters to the well from where it is pumped and here we have an additional intake systems so there would be a intake well and intake pipe. So intake well will have water from the source and then intake pipe will connect it to the jack well so the water reaches jack well through this mechanism in the twin well intake systems.

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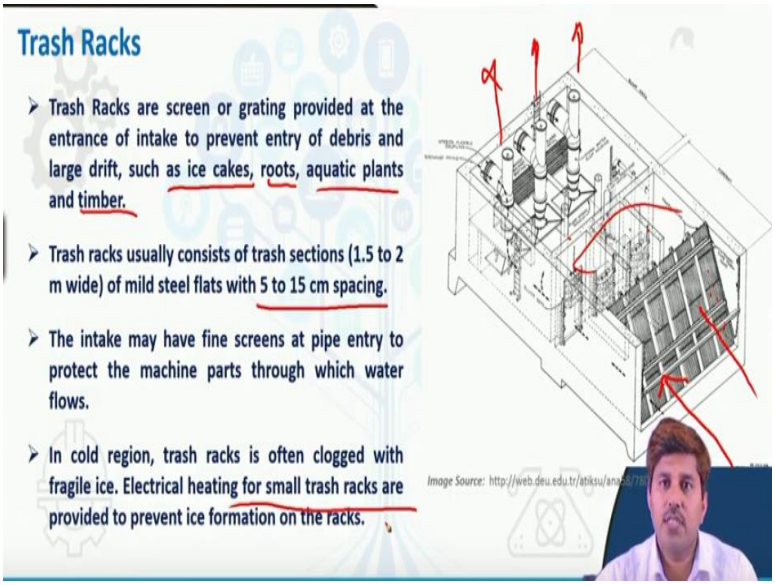

Then there are trash racks. So trash racks are generally screens and or maybe a grating provided at the entrance of the intake to prevent entry of debris in the channel. So as you can see here, from this point forwards, we are having basically pumping and other stuff over here. So pumping and these things will be done through pumps.

But for making water available to these pump house or to these suction chamber if this is the direction of flow from the river, the water enters and it first goes through these trash racks. The role of the trash rack is to prevent entry of the debris and the larger drift. So like there might be ice coming into the, big ice cakes trying to enter into the system or roots or aquatic plants, many time timber pieces.

So a lot of things actually are there in the river and particularly in Indian condition when rivers are not that clean. So when you try to pump water from river or when you try to take the river into your sump well, so when water enters into that, it has to be basically generally it is advisable to put a trash rack so that water passes to this and these things does not enter into your well, okay.

Then it typically consists 1.5 to 2 meter wide sections which are made of mild steel flats and generally 5 to 15 cm spacing is preferred. Later on we may have fine screens at well at the pipe entry like we were just discussing the bell mouth intake or those kind of thing as well. So at some places like in, in fact in majority of the cases we have to have a fine screen also so that it can basically remove the finer particles

before water enters to the machine parts from where it will be pumped and flowed, okay.

So in order to protect the machines or the various machine parts from the abrasion and these kind of effects, the fine screens are used for that purpose. But trash racks are generally the coarse screens to prevent the entry of the larger debris and larger particles. Other important path is that in colder regions okay many times we see that because these are racks and then water will be there.

And in a colder climate, these are iron, so temperature is quite down and then freezing might take place in the racks itself. So if the water freezes on the racks itself, it will form a fragile ice and it will prevent the entry of water through these racks. So in order to prevent this electrical heating systems also provided in some cases, particularly in the colder climates, countries with pretty cold climate.

So electrical heating for small racks may be provided to prevent the ice formation on these racks. So in the morning, when we tend to start the pumping, we may first put on electrical heater so that if any ice is formed there, it gets melted and we get kind of water entering into the system for pumping purpose.

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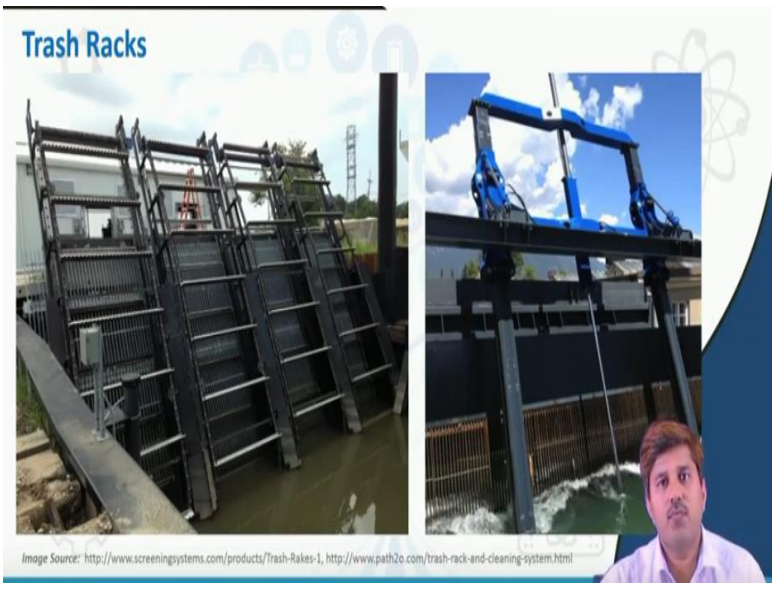

These are some of the examples of trash racks. So this is how typically it looks like okay. The water would be entering through these racks, so that the larger particle or tree branches, then various other stuff, larger stuff gets screened out and does not

enter into our well from where we are going to pump the water. So these are some of the some of the systems which are used for withdrawing water from the surface water systems as we discussed.

In the next class we will be talking about withdrawal of water from the groundwater system. So as we discussed earlier also, mentioned earlier also that usually the wells are used for pumping, for bringing groundwater into the well and then from there it can be pumped in. So we will be discussing the groundwater withdrawal aspects in the next class. So see you there and thank you for joining.