Groundwater Hydrology and Management
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Week - 8
Lecture 3
Drilling wells

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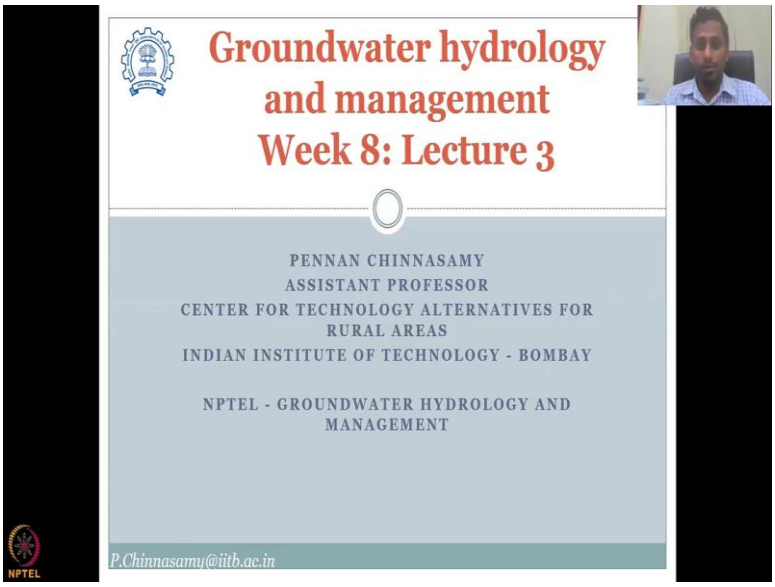

Hello everyone, welcome to NPTEL course on Groundwater Hydrology and Management. This is week 8, lecture 3. In this week, we are looking at the different types of wells, how they are constructed and the different types and uses of wells. What we will be doing today is that we look into a more deep aquifer wells. In the initial other classes, we looked at wells that are most commonly used in India in terms of dug wells where a manual labor is needed.

And then we looked at the drive wells, where you have to hit on the top of a drive point, which goes in and accesses the water. In today's lecture, we will look on more about the driving plus water jet methods and more importantly, we will look at the drilling methods where a bore hole is drilled into the ground by the use of heavy machinery.

So, before that, I hope you had access to the book PDF book that I shared in the last lectures. Most of the notes are from that also. However, the other books I use I have already been given in the syllabus. In the drive point, and also while you are making the wells there is lot of debris which forms.

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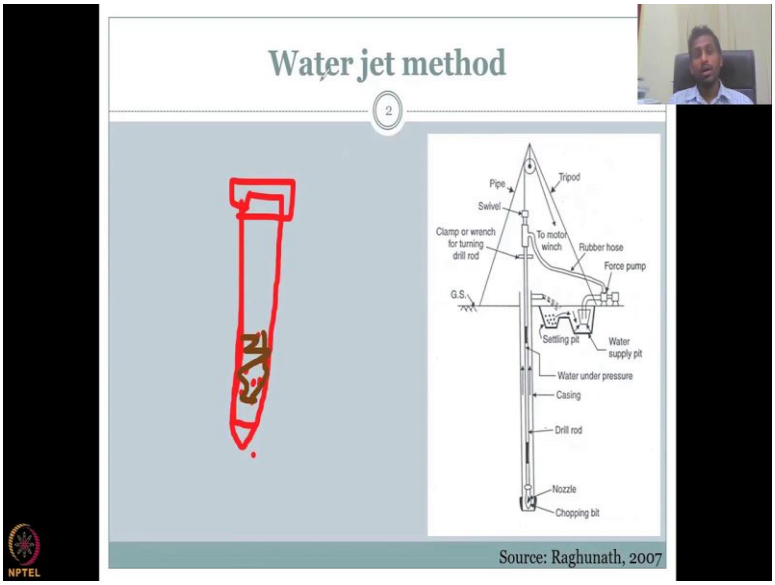

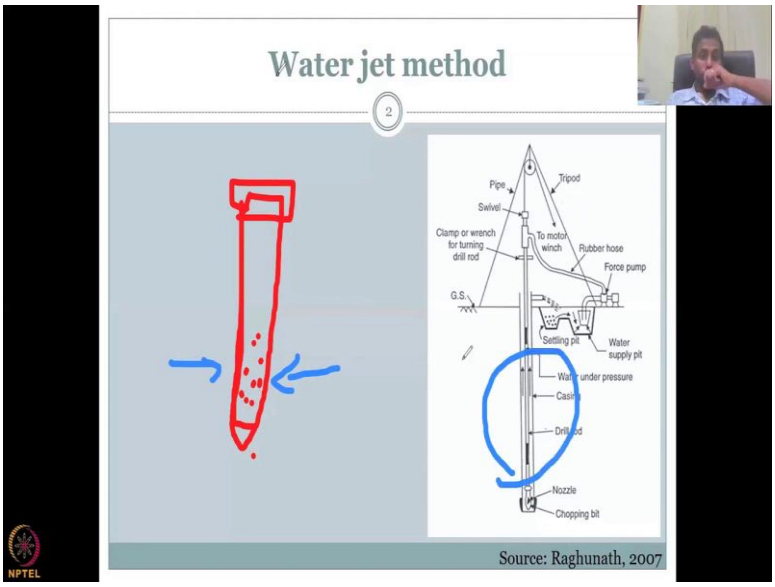

I showed an image last time where there is a lot of rocks, sand, soil that can be inside the well, you will have to constantly pull it out. And some people use pulley method and some people if it is big enough, they go and take it through trolleys and stuff or JCPs come and that then the big bulldozers, excavators they come and take the soil out.

But what do you do when the well is so small and the particles are very minute which means it does not accumulate that fast but however if it accumulates it just stops the drilling process, the drill bits break or the drill bits go into the screens of the well and the well does not work. Digging a well inside is different but if the well is fully clogged then it is a waste.

I will show you an example, you have a drive point where you have hit the well hard and it has gone in. On the top you have a point, so when you hit and goes in it is fine and then here

you have all the screen, the well is screened till that end, what happens is if this is clogged which is with all these debris and surface clogging, then water cannot here flow in you are wasting the well and this debris has to be taken out often so that your well is working properly.

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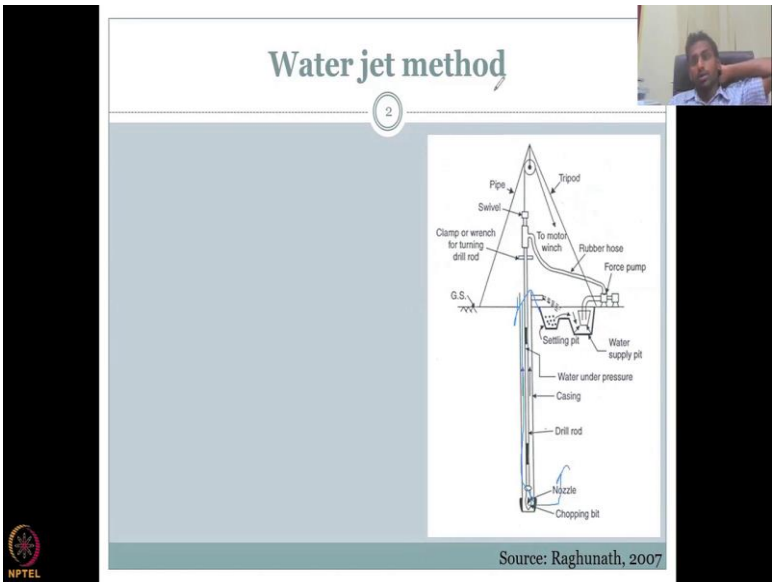

So, let us see how this works. In this method, you have a well dug it is dug by using a drill, a small motor which is being pushed and then you also have a mechanism to push water, you flush water and then you pull out the debris. So, as I show you the water is under pressure in the tube. While the water is under pressure it comes and as it hits the nozzle, the water comes out in a very high pressure manner. So, for example I draw a water is here, all this area is water and water comes out through the tube with the debris because water comes out of the nozzle with high pressure.

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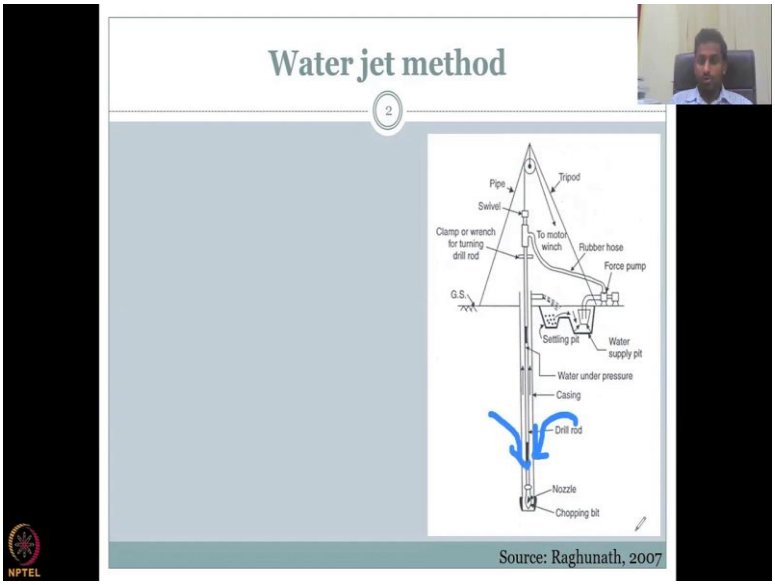

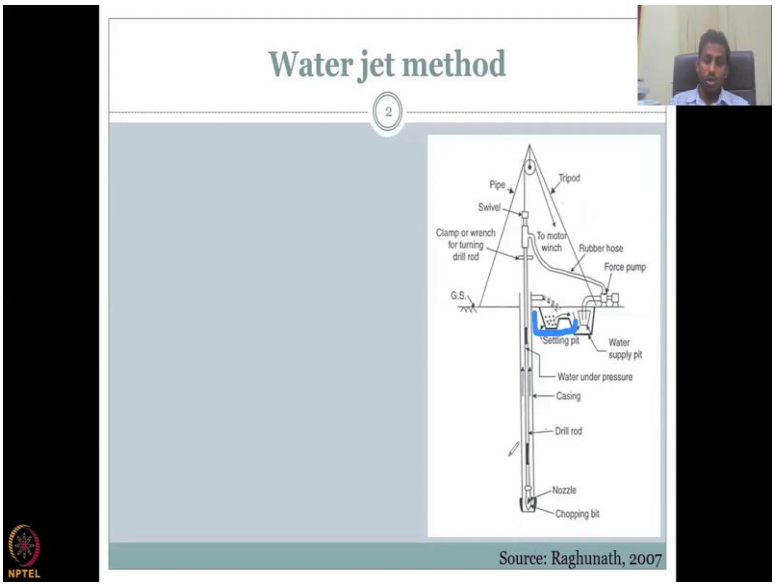

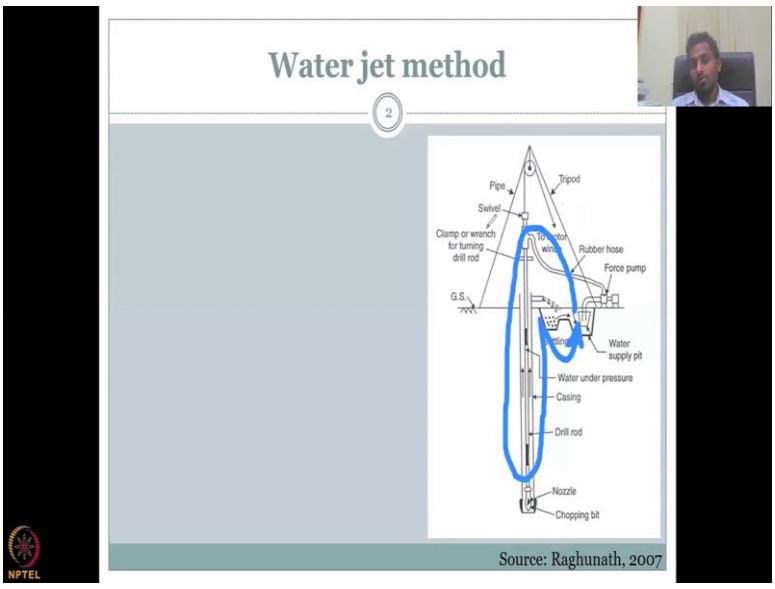

So, all we need to do is to make sure we understand that we have water, we keep on drilling, but if the debris is not coming, the debris is not coming out, that means there is no water so you keep on drilling, but by the time you keep on drilling, the soil particles, the rocks here can collapse into the well. So, to prevent that, what we do is we use this water jet method to push water into the well inject water into the well and take out the debris. So, the debris comes out. And your settling point is here where you a settling pit on point where the water with the debris comes and all the sand, silt and all the rock materials lay down.

Then you take the water out, which is again siphoned back into, so it is like a cyclic work where you have the water taken, pushed into the system, and then it comes back out and then goes back into the same pond or a pit where you take water and push it again. So, it is not a full volume of water that you have to give to this pump, you can keep on pushing water, the same water can be used as long as you filter it or take out the debris for which we are doing this work.

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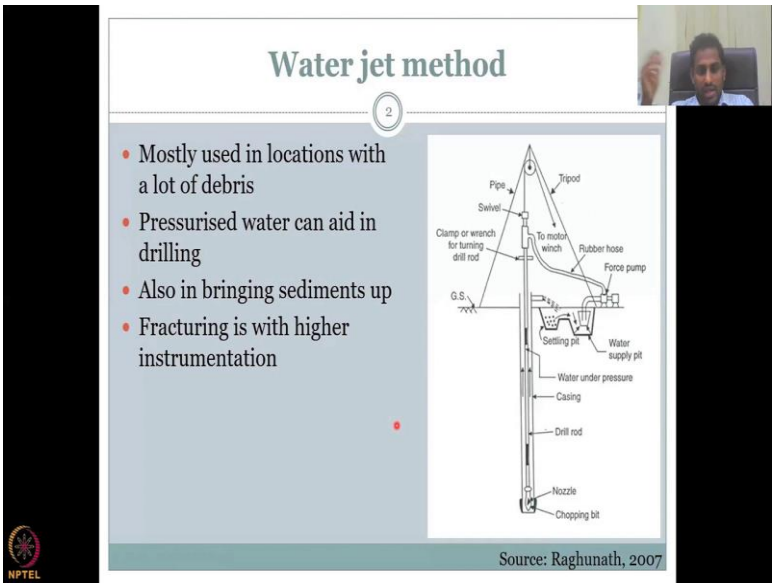

So, this method is kind of expensive, but it is needed in some locations, mostly in locations with a lot of debris. And as I showed you in the geo hydrology map, a location which has a lot of rocks, hard rocks, there, this method is very, very useful, you will have to constantly pour water to take out the debris. Pressurized water can aid in drilling also, it is not only to remove the debris, but also the water along with the spinning drill can help in breaking the particles faster.

So, think there is a drill which is spinning. So, if there is water also hitting hard, water and the drill aid together, so they mix well together and they break the drills, please Google some videos on that you will be seeing it. We cannot use those materials on NPTEL because of copyright issues, so I cannot put them here for your reference. But if you just Google type it in YouTube or any other video channel, you can find this pressurize water driven which can be of help.

Also in bringing sediments up as I said all the debris can also be brought up, so two things can be achieved by just sending a pressurized water. All you have to do is have a pump, the pump would take the water and then there is a motor which pushes the water at a very high pressure and this can also go and this length can be adjusted using a pulley system.

Fracturing is with higher instrumentation. So, this is the same concept they use in fracturing which is deep deep in the bedrock or near the bedrock region where gases are kept or they are captured. The gases are captured or locked into the rocks because of rock formation sometimes there is big gas in and the gas does not come out and these are hydrocarbons or gases that can be used for fuel, and to break those kinds of rocks people use fracturing techniques to break the rock and expose the or release the gas which is being caught by a suction pump into tanks. There also fracturing is done by using water.

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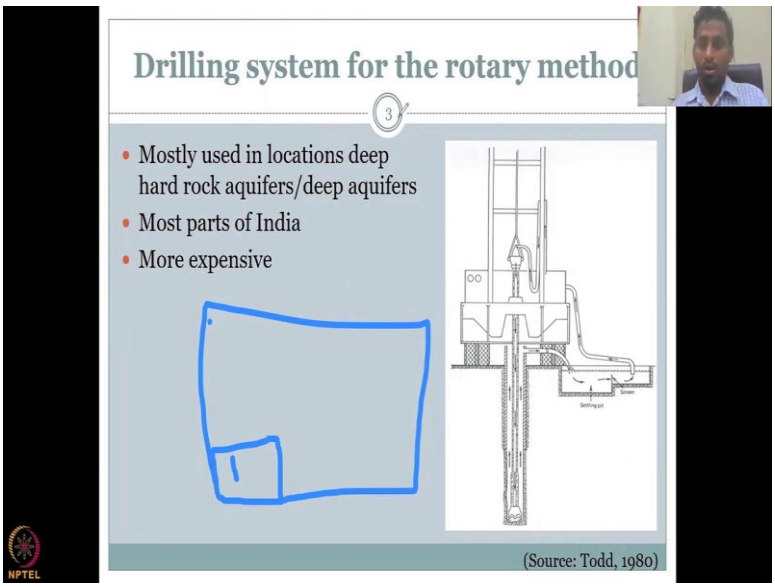

So, now we come to the most abundant type of well in India, which is the tube wells and most importantly the tube wells which are at a deep aquifer level. These go at least a couple of meters down if not hundreds, it is 300 feet below the ground. And what happens is there is

no way you can dig that kind of wells. You need to have a meter machine that can push an auger into it and auger is kind of a drilling device or you have to have a truck for example here you can see a truck where it is lifting a rotator or the drill bit up and down based on the depth which is needed. Here also there is water which comes out.

So, when you see a video of a bore hole being made, you will see that water is gushing out from the bottom of the well. And that happens because pressurized water is sent it is called hydraulics like a lot of water which is being pushed in and the pressure aids in breaking the rock and also bringing the sediments up. So, here you could see the water is pushing and the sediments come up. But most importantly what do you see is the drilling system for rotary method wherein mostly it is used in the hard rock aquifers or deep aquifers which consist most of your or contributes to the most of the aquifer system in India.

Initially these trucks were very expensive to get one to your location. So, they would charge 1 lakh because the truck is big and it has to go through different parts to come to your location. And then you drill it. You could see these trucks standing in the highway because anyone can call. They do not go home for some days, they just wait for a call and then they go into the bore wells especially during the rabi season. They are also asked to deepen the well sometimes.

So, it is not only for making new wells, but also to deepen or flush out another well. It is as I said in most parts of India and it is the most expensive method of the methods, the volume of water may be much lesser compared to a dug well. However, these wells are preferred because of the small size. Think about it you have a piece of land, you have a piece of land and to make a dug well you have to contribute 10 percent of the land or say 5 percent of the land.

However, for a bore drilling system, you can just have a small point comparatively on a land and that one well location can cater as much as water as your dug well. And in some cases depending on the depth, depending on the water connectivity, it can be more or less in terms of if the aquifer, confined aquifer is small.

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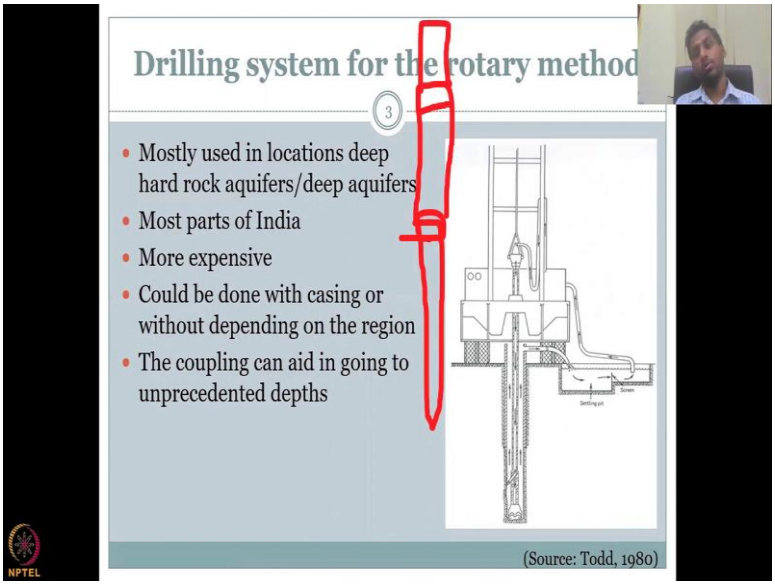

So, what you see here is it is more expensive and could be done with casing or without depending on the region. Normally, casing cannot go to such depths, think about the expenses for tubes to put that deep, you have to put meters of the meters of well tube so this one is what I am talking about the casing. So, mostly it is done without the casing. But it depends on the region, if the region requires that the casing is put so that they prevent the sediments from collapsing in you have to put.

Normally what happens is you have casing only to a particular depth. And then after that it is nothing, it is just drill and then it takes it out. And then you have your well ready. So, you have to understand that even though it is an expensive method, the other accessories would also add to the cost, thereby making it unsustainable for farmers. And now why there is a lot of farm loans that farmers take for these wells, especially from loan shops where they take too much of interest and then the farmer does not get enough profit. So, they end up in depth.

What you saw in the drive point? In the drive point, what we saw is there is a coupling of wells. So, you have a drive, and then you couple it to another length. And you can keep on adding the length based on the depth you want to go for the well.

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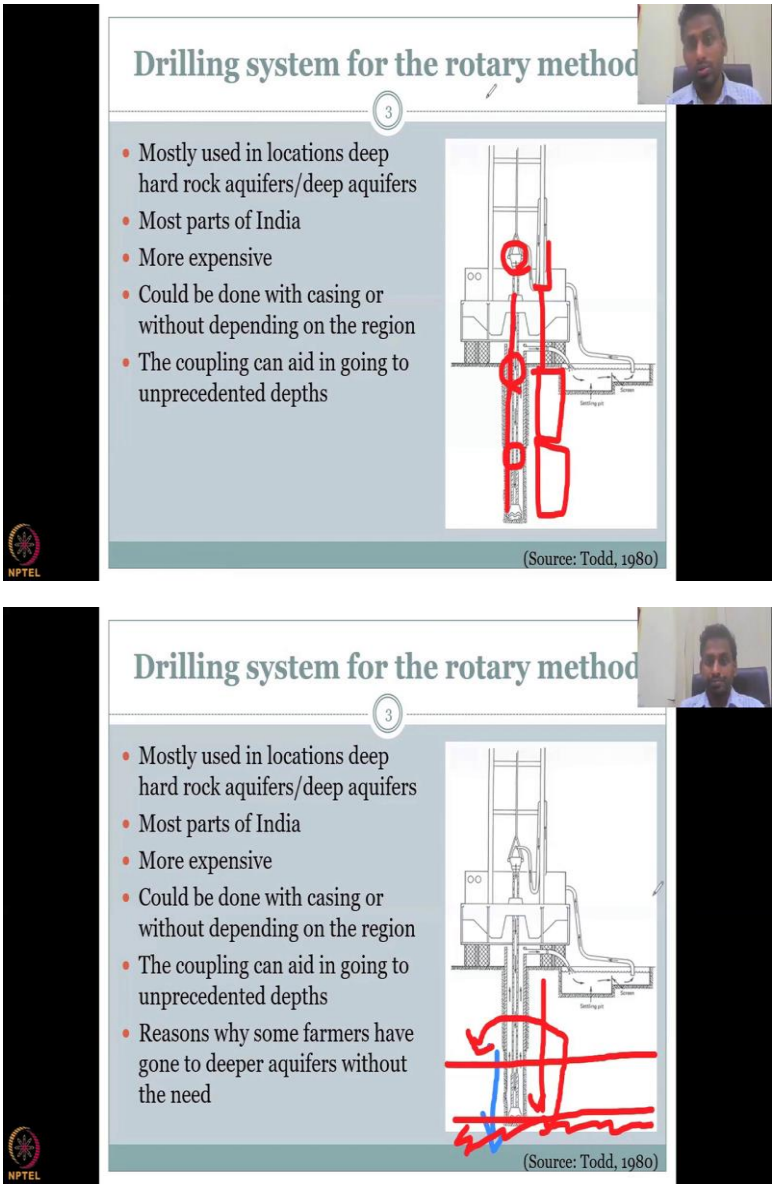

So, same way here, you can add depth by coupling at regular intervals the pipe, which actually drills, you just take it out, but when you started for example, the drill, which goes in is just this depth, and then you add another coupling to it, another coupling, another coupling and so that is how 3, 4, 5 tubes would be kept always as 10, 15 tubes that are kept it is like a steel pipe, which is connected to the drill and then it goes in and rotates.

So, this is the part which rotates, it rotates and then the whole body of the drill rotates. What I am trying to say is that drill body is not one length, it can be increased by coupling and that is how easy it is comparatively to drill deeper depths. So, with this ease what do people do? What do farmers do? Farmers have gone deeper to aquifers without the need. What am I

saying here is for example you are getting water at this level. For example, you are getting water at this level. Still, the farmer says Oh, you are here.

All I have to pay is just extra diesel for putting it much lower. So, they just go deeper and deeper and deeper. Bringing the law of this whole truck and the machine to that place is the expensive part, running it is not expensive. So, what they do normally is they just bring the guy and as when the water hits, as soon as they know when the water hits, they do some calculations and say okay, you want this depth or you want to go much deeper, they just have to pay some extra and the farmer goes deeper. I have seen a lot of people who complained that the water was good.

But I was so jealous that I went down much deeper so that I will have more groundwater, but then I opened the confined aquifer and it was so salty that all the water became salty. So, think about it this was a non-permeable rock and this is where I said you should have stopped with the drill if you had good water, but some people what they do, they just go further down and go to this aquifer underneath which is salty water. Now, when you build this, this water because of pressure will come up and mix with the unconfined or the other confined aquifer thereby making the all the water salty, I will do it again just for your clarity.

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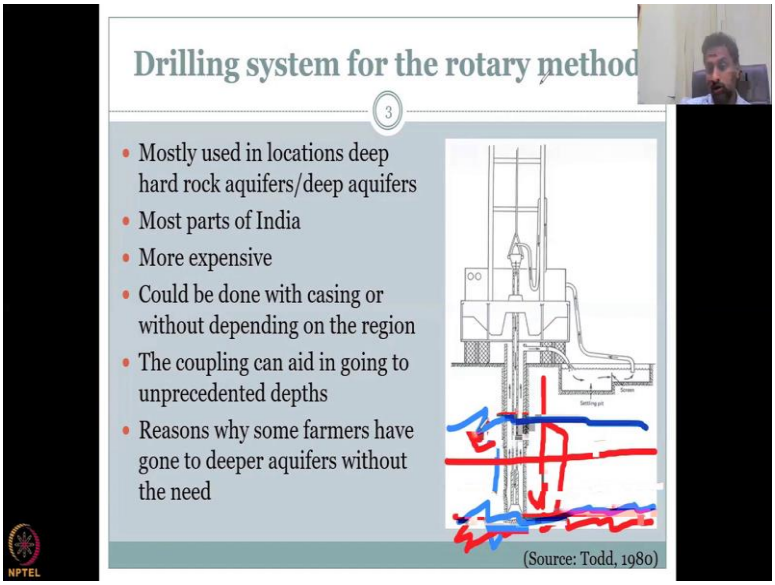

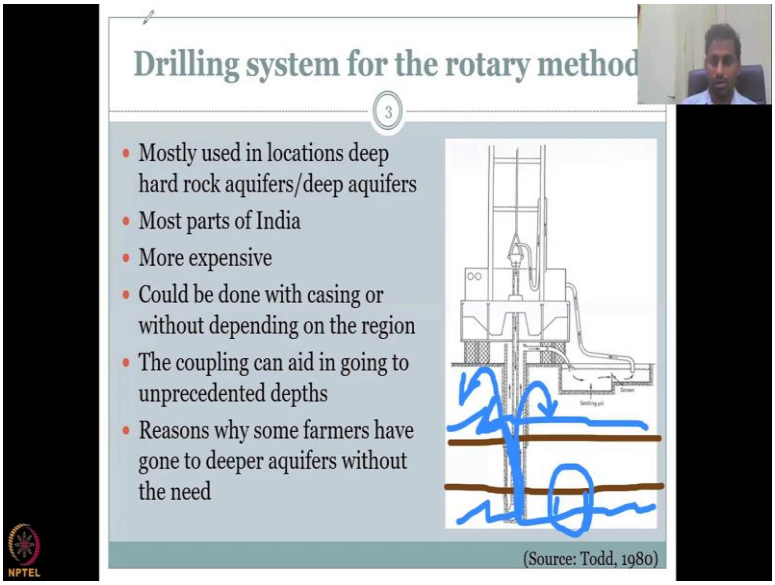

So, this was the initial point where the good water was there and it was separated by another water using a non-permeable layer or aquiter, aquito we call them and then there is another aquiter, aquito and then there is water. So, water is present both in this region and this region. So, if you know that the water is good and it is enough by the depth or thickness of the water level, you should have stopped but what normally people some farmers do is they keep on drilling and expose this water.

Once you expose this water because there is no casing you see there is no casing then this water would rise and mix into this water there is no casing and this water would come down. So, there is a mix of water and this water which is more salty, naturally it is more salty as you go down the profile, now makes all the water salty. There is no cleaning of this aquifer anymore. You have depleted it. You have made the connections between the aquifers and now it is full of salt, you need to do something to reduce a salt, all you have to do is take the water up, purify it and then use it for agriculture or drinking which is not very profitable to the farmers. That is why you see in cities you have a lot of ROs which are taking this salt and then removing the salt, filtering it out and then giving you drinking water.

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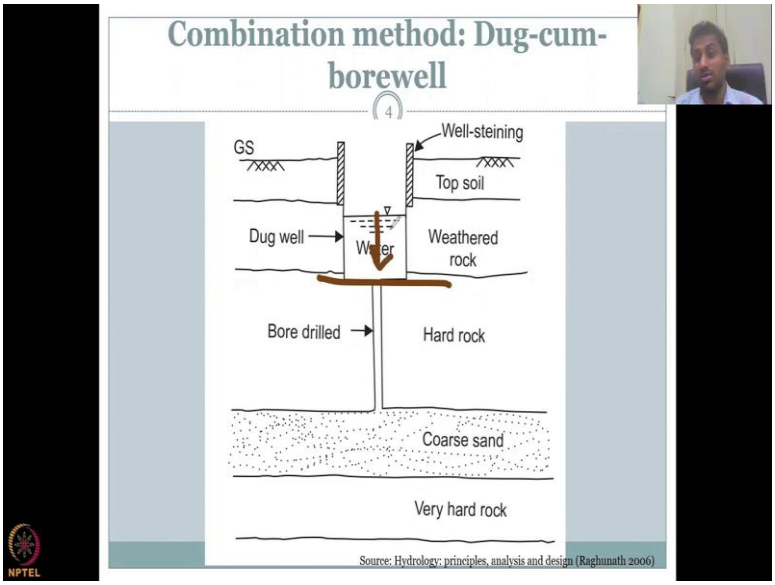

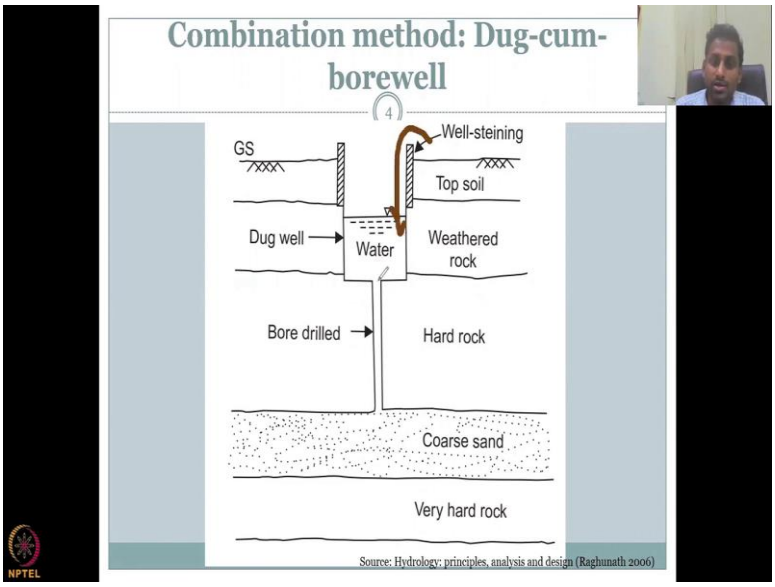

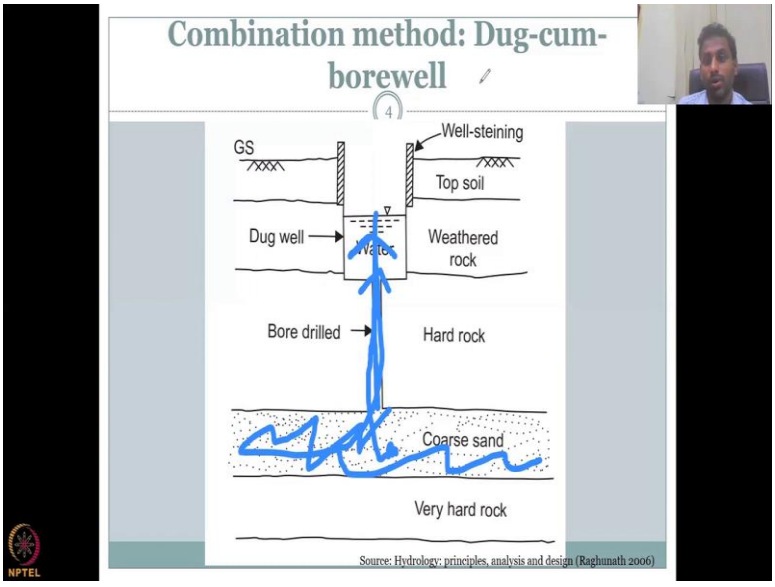

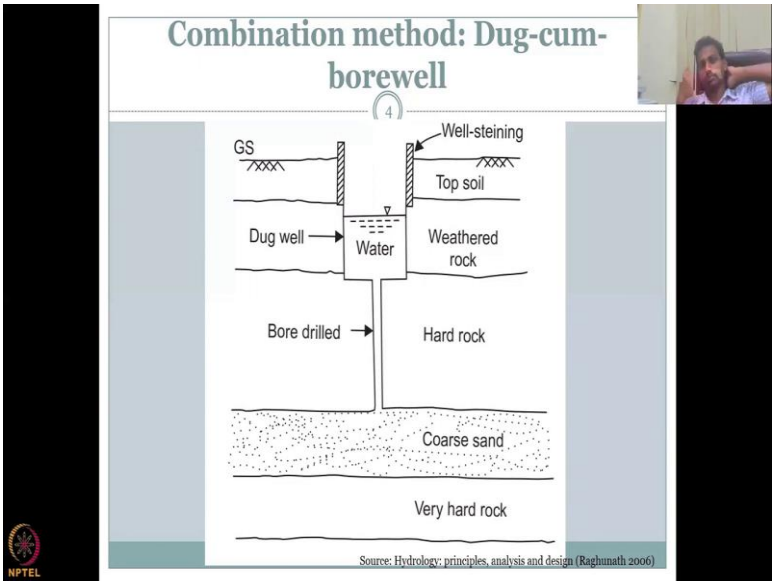

Let us move on. So, this system is of good use in the Indian network at least to get the wells done, but how deep you should go should be very calculated. So, we have seen the three types, we have seen the dug well, the drive well and the drilling method. Now, there is also something called a combination which is called a dug-cum-borewell. So, which means you dig first you make the first well which is a dug well until here you do a dug well and then after that you go down into the dug well and then you drive your second well.

So, initially you would stop here in the normal scenario for dug well you would stop here, but then once this water level has gone down, once this water is not enough, what farmers do is inside the well they will get inside the well and they start drilling another well. Here you cannot bring your JCP or your truck into it. So, this has to be mostly a drive point well which we saw in today's example also. So, then you dig deeper so that you come to this hard rock aquifer or this aquifer which is going to give water.

So, now when you make this connection when you make this pipe through the pipe connection through your well driving point, then this water would go up and mix with the dug well, both ways? So, if this goes down in the bottom, the high water can come down or if the water here is more, initially it is more so you can go up. And also depending on the pressure difference and also you can put your pump ahead here, where you want to pump from if it can be here or here based on the water level.

So, here is where how you could convert a dug well into a borewell. So, always bore is for deep aquifers it is much much deeper and the width is smaller whereas dug well it is in the shallow aquifer and it is much bigger. So, here you have a ground surface GS and then you

have the well on lining on the both sides. Then you have a dug well which has water table, but then it is very small. So, you need extra water and you made this connection. So, this is also done and it is not as bad as your deep deep bore wells.

However, caution has to be here because you are also connecting a shallow aquifer and a deep aquifer for water and the deep aquifer may not be as good as your shallow aquifer in terms of salt levels.

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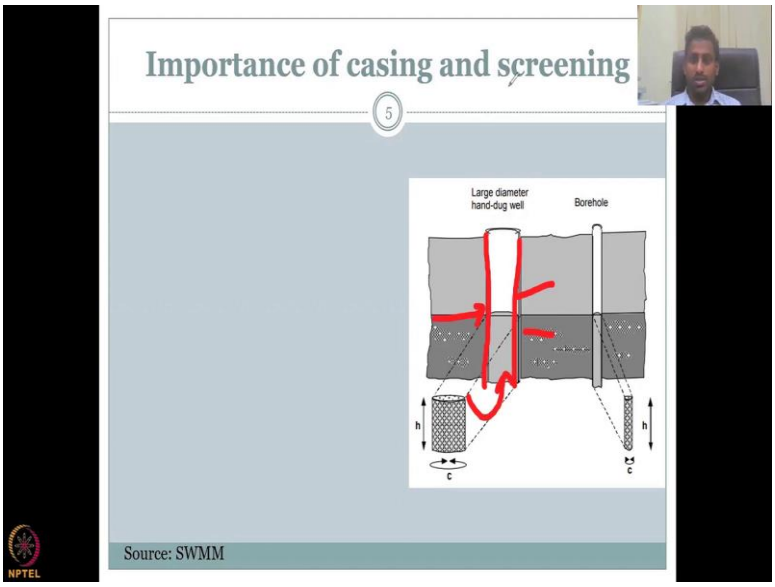

So, we have talked about salt levels, we have talked about the methods that are used for taking the debris out, etc. What is important is also the casing part. The casing is the side of the well that you make so that the debris does not fall in. So, the debris is major major impact of causing factor for your groundwater wells and the performance of the well. So, it is important to make sure that the casing and the screening are understood. So, the casing is what is put on the sides of your walls of the well so that your debris does not move. So, this rock and other things do not move.

However, you want the water to move. So, there is small spaces where water can move or water can move from down up. The other part is your screening as I said the screen is where actual water can move into the well. So, these are arranged in particular fashion like a matrix and then nodes are placed. It has a particular geometry not random geometry. So, that maximum water comes. If you do not do this well.

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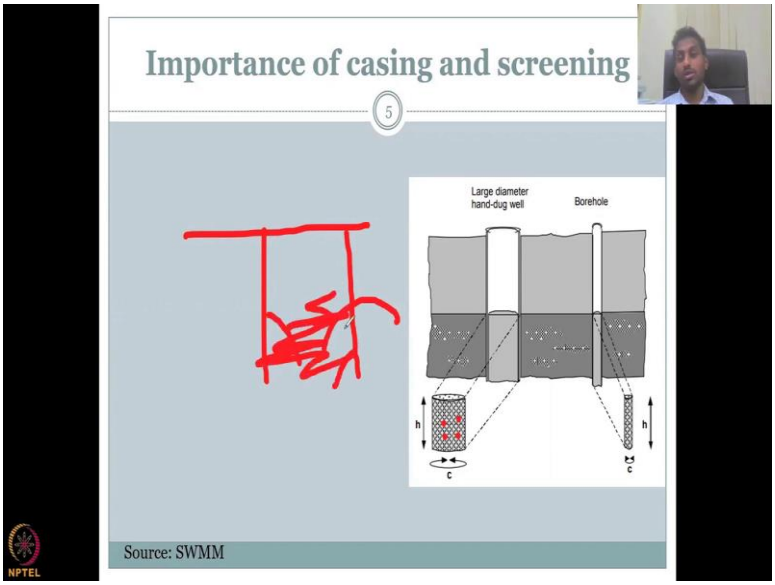

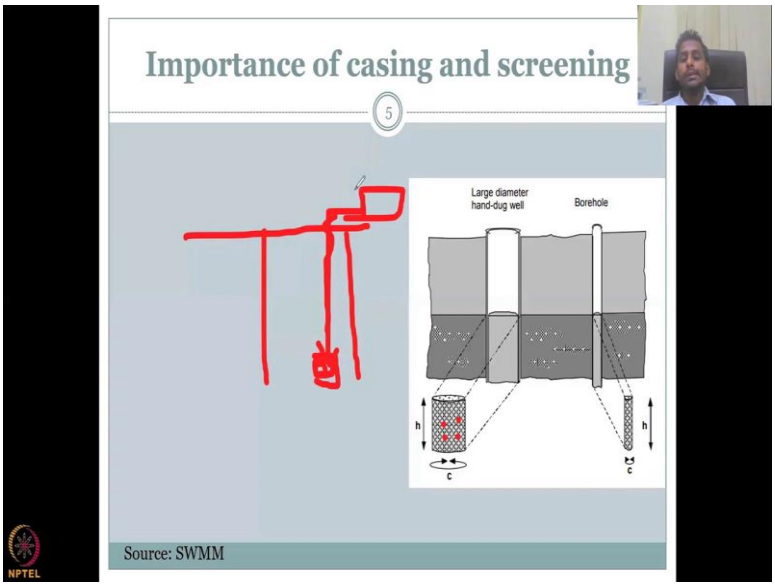

For example, I have a land and I just dig a well, water just comes in, what happens is all the sediments also come in and in due course of time, you will have a lot of sediments here rather than water. More importantly, your pump is on the top, but the suction opening is down this is a suction opening where water moves in. If there is debris, this whole pipe gets clogged and water does not move you have to change the pipe. Sometimes you have a nozzle or the mouth of the tube, where the water goes that is clogged because of these sediments and rocks.

More importantly these can also go into your machinery and impact your pump depending on the pump style, there are pumps which do not get affected at all, but there are many pumps which get affected.

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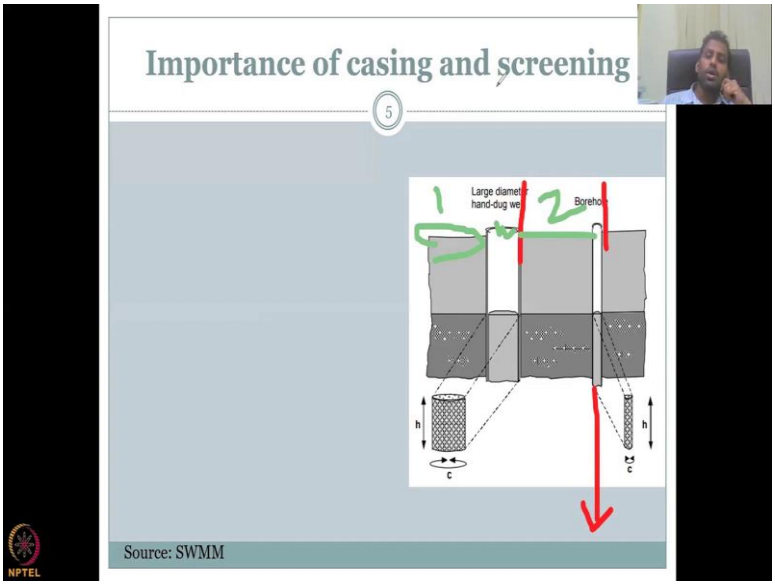

So, for all this there is a need to reduce the debris that was going into the pumping by putting a screening. The screen also prevents or slows down the recharge water. So, it is not a win win situation. Some of the water is also lost because you have to get water to go through these small holes which is slow. So, there are two types you have the borewell which is going into a deep aquifer and then you have the large a hand dug well which is the smaller aquifers. Just for this image you can see both are the same depth, but mostly this will be way way below, the opening and other things.

The circumference, the size of the well is also of much importance in the dug well and the bore. So, this is why I said like let us take this is the land and this is the land for these two wells. So, now you have compromised on this land for growing crops because you cannot grow crops here. Whereas in the second, this is the first and the second. The first is run to using your dug well, however, as I said you have crop only this area you are losing a very small fraction of the area when compared to a land with just dug well, sorry with just borewell. You can see that the land loss is much less compared to this like maybe 4 times, 5 times the width of a bore well you could say.

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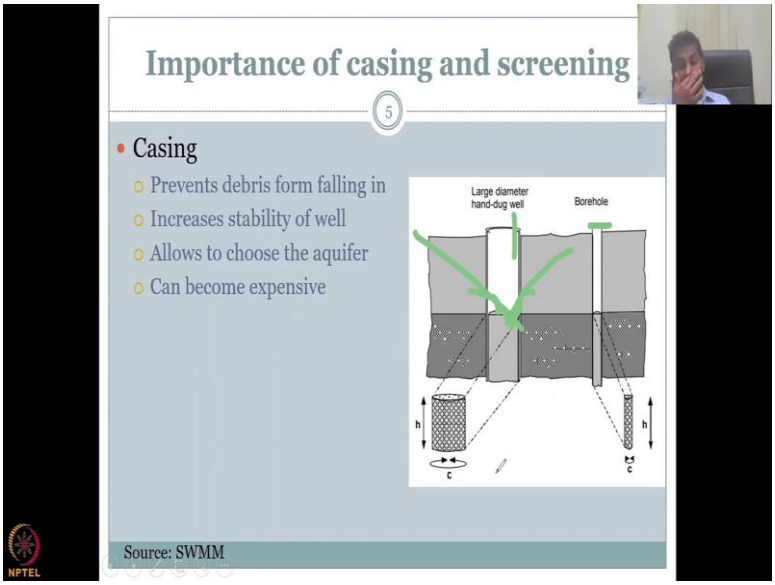

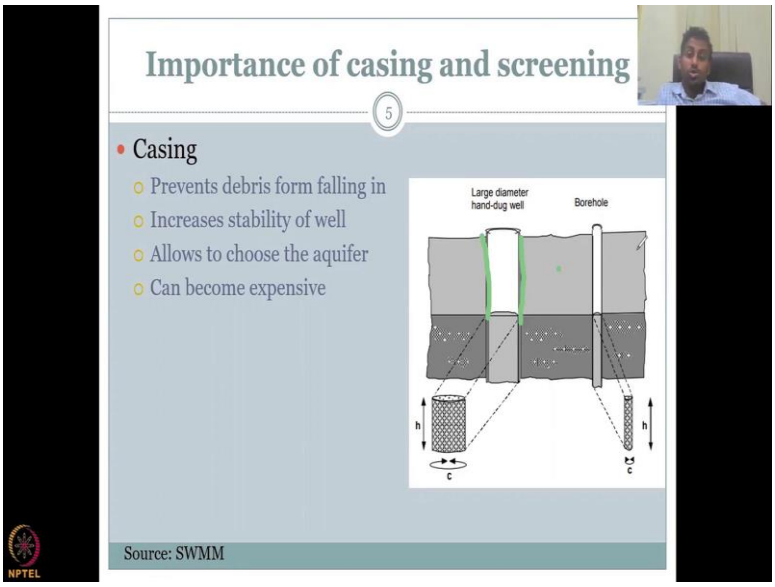

More importantly it is needed because most these lands the small formats are already small and you do not have space to lose more land for water, maintenance all these things this is more maintenance. You have to cover it, you have to make sure nothing falls into it, it is too big people get those wash things in it or bath, etcetera thereby polluting the water whereas here is just closed. Nothing can pollute and other things you just close the top, cement or something and whenever you have to change them the nose of the tube or the pump then you take it out. So, let us get into the specifics of this.

Casing, the casing prevents debris from falling in into the well. It increases stability of the well, because slowly when these particles move suppose your particles are moving slowly

one by one it is moving then at one point there will be a landslide kind of an effect, but all these soil moves into the well, it is called collapse of the well, the well collapse can happen.

But in this case, since you are preventing the movement, you are making strong boundaries. So, there is no even a small amount of soil movement. So, that is where the stability is kept. Now, why would these move? The soil it depends on the water movement and also the disturbances which occur on the site. It is not an earthquake, but soil does move when because your well is there, water is moving so, there is a movement of soil also, allows to choose the aquifer. This is another interesting part which I showed in the previous example.

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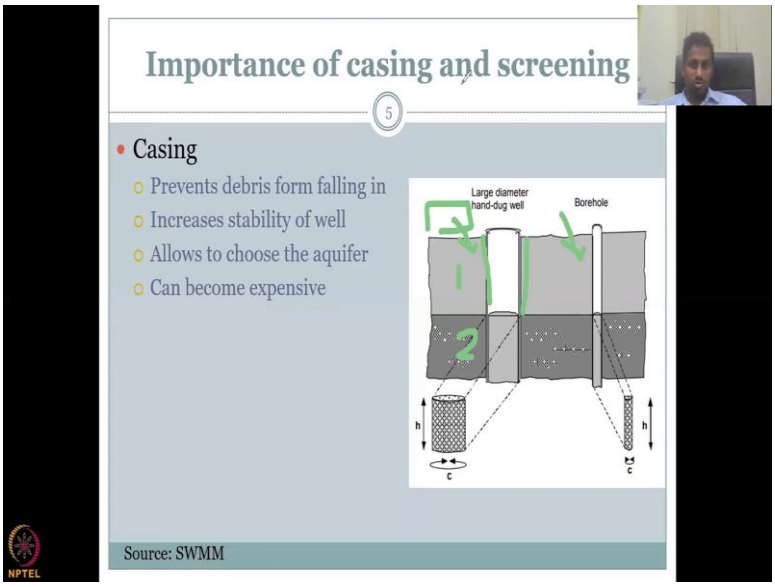

This casing, the casing allows you to choose the water, for example this first water, second water or first aquifer and second aquifer, you do not want the first aquifer maybe there is a industry which is polluting water in it. You do not want the first aquifer. So, what do you do you chase the top layer and only open the well by bottom layer where a good water comes in the deeper good water and it can become expensive as how much depth you go in the profile.

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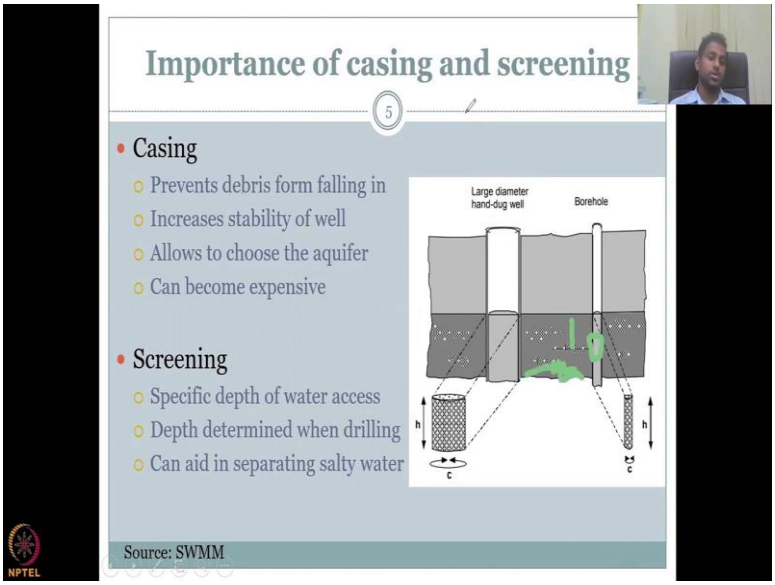

Now, let us look at screening. Screening also allows you to get into the specific depth of water access, the screening depth is determined well drilling. So, where you put the screen is also very determinantal of the water available. For example, some people would put even though this whole water is the same water. They will put the screen here just to make sure that the top water comes in from the aquifer I do not want to put it down because if the water table falls down then the all the sand, silt, clay or the sediments will also come in.

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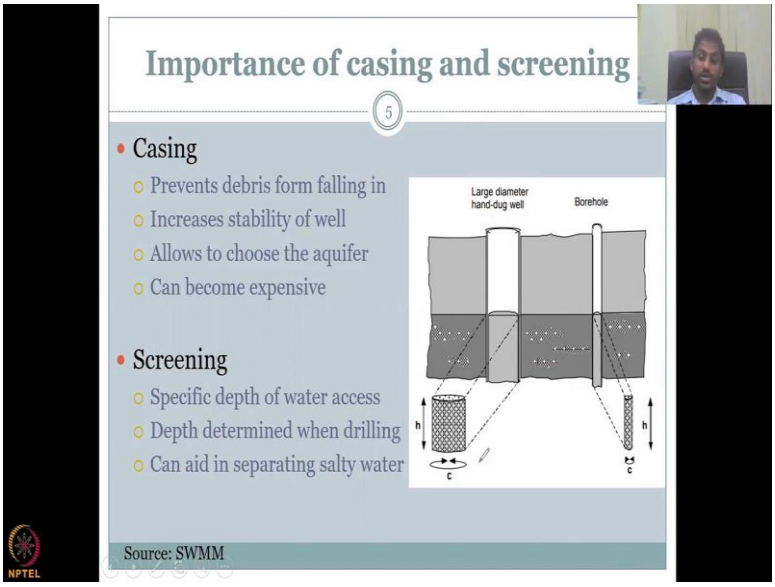

So, you can pick and choose the specific depth of water access even within an aquifer. They determine when drilling because while you drill while this debris comes out I showed in the previous slide also the debris will come out as and when you put pressurized water or you can

take the sample at every depth. So, when you analyze the sample you understand that some rocks are not good which means the water will also be not good, too salty, too much with micro nutrients or ores you do not want that.

So, you have to wait till you replace it or you go to a different depth. Can aid in separating salty water also same like casing your screening can also aid in reducing the salt content that the minerals that go into the well because it has a filter or a very small holes. So, I think we have covered most of the different types of wells where the wells are to be placed and the type also covers the access to the aquifers what type of aquifers there are, how much money you have also depends on how you spend and what type of well you can get.

So, a dug well is much cheaper compared to a borewell in terms of the machinery, but the overall cost and time if you want time, then the borehole is very, very cheap because you just call the guy, he will come in a day, the morning he we will start and by afternoon you have the water ready, you have the well ready, he will go. Whereas the dug well takes a long long time. So, if that aspect it is expensive dug wells, you can look at some studies which I have done a comparative analysis of these two wells. But more importantly, the friendly nature to the aquifer is better in the dug well compared to the borewell.

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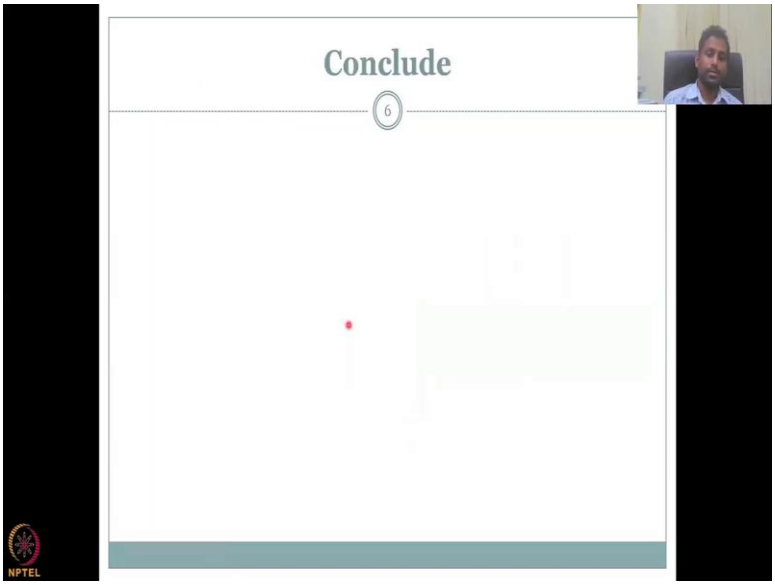

With this I would stop here on the third lecture. In the fourth lecture, we will look at the wells have been established now, how do you take water out? It is through the pumps, we will look at different pumps, why they are used, how they are used and what are the alternatives. I will see you in the next class. Thank you.