Municipal Solid Waste Management
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Lecture - 33
Site Selection and Types of Landfill

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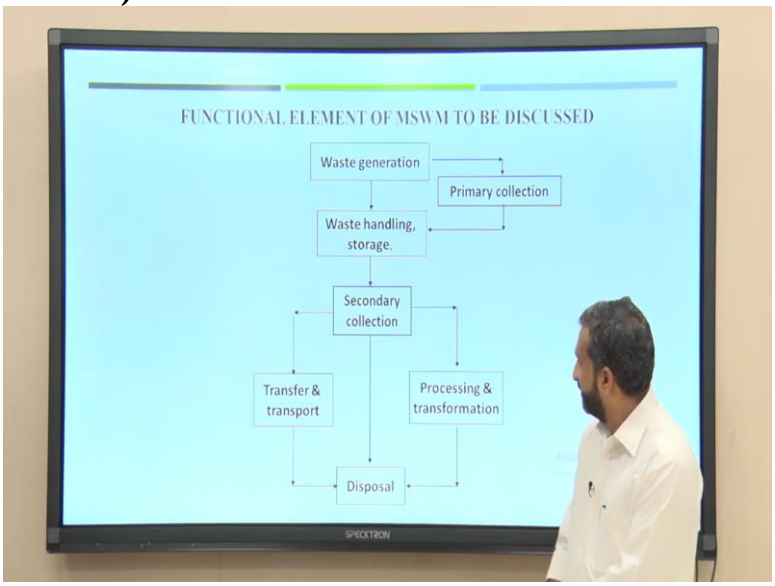

Hello, students so, today we will start a new module, disposal of solid waste. And this is our last functional element, our 6th functional element of municipal solid waste management. Today we will talk about site selection and types of landfill. So, before going for site selection, we need to understand what were the issues regarding disposal of solid waste? And I personally believe that disposal is one of the most important functional elements and therefore, important.

But I think before going for disposal or landfilling, we need to really look upon the treatment processes like in the previous modules we talked about waste to energy or incineration process or biological treatment, if suppose, those treatments are not possible for such kind of waste, I think only that kind of waste should go to the disposal site. But, normally you know, in India, there is no proper treatment process available and most of the treatment processes like composting is available in a centralized location that is very close to the disposal site.

So, it is a mixed kind of waste used to come before Swachh Bharat mission and still I think there are many cities that are not able to segregate the waste at source. So, entire mixed waste is coming to the disposal site and even though they have the composting plants; but they are

not able to run properly because it is not segregated and are able to produce good quality of product. So, finally, entire waste will go to the disposal site.

So, if you consider that specially for the Indian conditions or most of the developing countries like in Asia or Africa, this disposal has become the most important facility for municipal solid waste management. But suppose, if you have the proper treatment process available, so, you need not look upon the disposal one only such kind of waste which is not recyclable, which is not combustible, which is not biological treatable waste only that kind of waste will come to the disposal site.

So, you need not look upon whatever issues are normally coming through the disposal site. In those cases, we need not go for those kinds of problems in the disposal sites.

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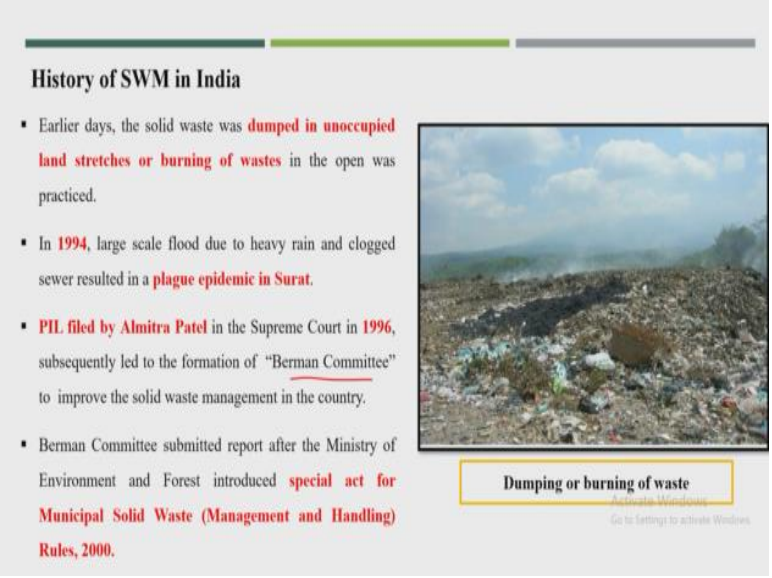

So, if you start with some history about solid waste management in India, the entire waste is normally used to go to the disposal site. And even before the solid waste management rule in 2000, I think the entire waste used to go to the disposal site, there was no treatment facility earlier. So, and in the disposal site also, the burning of waste was I think most of the locations or most of the city because the volume was increasing year by year the volume was increasing.

So, what local corporations used to do, they will burn out the dry material. And you see in the dumpsites, I think if you visit the dumpsites or disposal sites, you will see the plastic or paper mostly onto the top area, why because density is very low. So, these kinds of waste and more

density like kitchen waste or biological waste will be in the bottom and then there will be degradation. And on top, you will find a lot of dry matter.

And that is why the most of the corporation they will start the burning of such kind of waste. And that was the practice actually in most of the dumping locations. In 1994 the large-scale flood due to heavy rain and also the human health because of plague in Surat was found and because of that I think is a madam Almitra Patel who submitted the 1 PIL to the Supreme Court. And because of that, these Berman committee has been come up and they submitted 1 report and based on that, the rule has been modified and called municipal solid waste management handling rule 2000.

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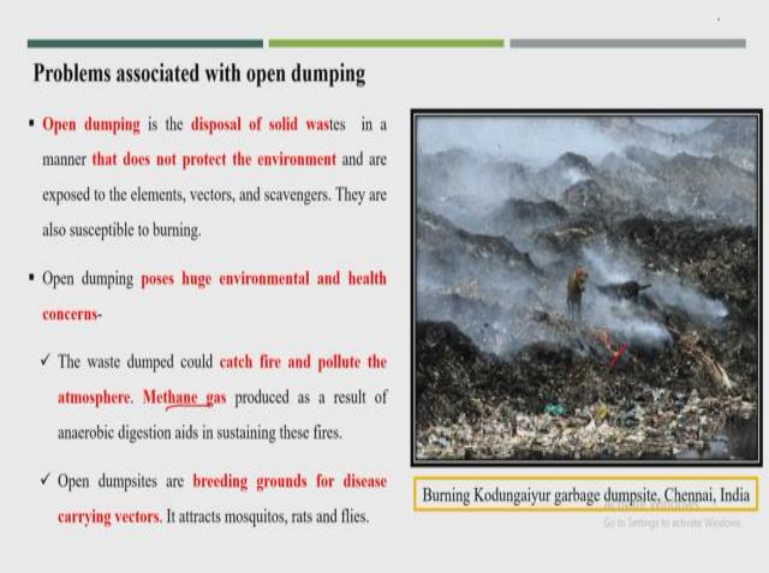

But again, the problem was, I think, although the rule was available, there was no financial support for the treatment processes of MSW because collection itself is a very costly process and whatever the finance was available with the local authority or with the ULB's, they normally used to 90, 95% finance they used to require for the collection only and even for having a proper sanitary landfill in the city is a very costly process.

And also if you want to have the treatment process the finance was not available. So, the problem actually with the association with the open dumping, see in the photograph the burning in one of the locations, one of the dumpsites in Chennai and there are a lot of health concerned because of the burning of these ones. So, a lot of polluted gases even I think we do not have the proper data of that, but pm production that particular matter production also is possible by having the burning of the waste.

Apart from that even this methane gas is also producing during the anaerobic digestion of this entire waste, mixed waste. So, this was one of the important issues was with the dump sites and also the breeding grounds for disease-carrying vectors, that was another problem, it attracts the rat flies.

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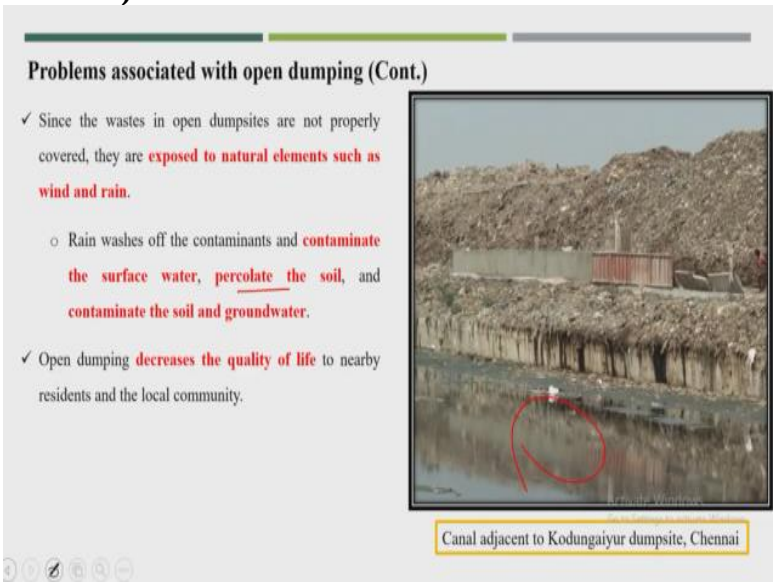

Now, another problem apart from the air pollution problem is the leachate production, you see here this is the dumpsites and this is the leachate is produced because of rain or because of anaerobic degradation of biodegradable matter. So, since the waste is opened, downsides or not properly covered, they used to expose with the wind and rain and this rain washed off the contaminants and these contaminants to the surface water and even percolate the soil and contaminate the soil and groundwater.

This is the, I think this is one of the locations normally we never talked about when you talk about pollutant sources. So, in water treatment also, if you study that, they will talk about there are 2 types of pollutants one is a point source, other is a nonpoint source. So in point source, this could be one of the points sources for the pollution of not only the surface water, and also the groundwater also because this leachate can percolate to the aquifer also in the ground.

And now this is the problem because whatever the or water is getting produce from these kinds of waste that will be washed off these kinds of waste and which will how not only the solids will come up, but also a lot of metals will also come with the leachate and this is the

major problem with such kind of leachate, it will how the organic contaminants like you can say that the purity 5 sometimes goes to 50,000 milligrams per liter.

But also I think I am not worried much about the purity value because that can be measured because of the organic particles in the leachate but it contains a lot of metals. And once these metals will reach the aquifer in the ground, how we will be able to treat that is very difficult and see and once. Not only the metal but whatever the pollutants will reach the aquifer, which is one of the best sources for drinking water.

Now, once it is getting contaminated, who can treat that is very difficult and this is one problem other problem wherever the nearby any surface sources available, maybe some pond is available nearby or somewhere water whatever the water is available because of washing of that particular waste also will reach to the surface sources now, that will also get contamination.

Now, apart from the air pollution, this is also one of the important pollutants from the dump sites and also the open dumping decreased the quality of life nearby residents and local community obviously, I think wherever I think you finalize the location of such kind of open dumping, I think nobody like that and their life also, the quality of life also will be very, very low.

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Now, , I think we were talking about the open dumping. Now, this is 1 important word called landfill. And please remember that, when I was saying open dumping, the is simple dumping,

and when you are saying landfilling is a properly designed landfill, the land will be filled properly, by and we know that there are 2 major issues you understood now, the one is air pollution.

So, the polluted air should not come out, and the second is the polluted water or that leachate, leachate should not come out that we will call is a landfill or sanitary landfill. So, if both the issues are getting considered properly get them collect and treated. We can call that a sanitary landfill. So, landfilling is the process by which residual solid waste is placed in the land or landfill.

And landfilling including monitoring of the incoming waste placement, compaction of waste, and installation of landfill environmental monitoring and control facility. So it is not only the just, just go waste and dump it, it will have the monitoring of incoming waste stream, placement, compaction properly covering of entire material so that the rainwater should not be entered into the waste and also, the environmental monitoring and control facilities are available.

So there are 2 types of landfills one is a sanitary landfill, there is an engineered facility for the disposal of MSW you can see here, I think this is what it looks like. And you saw the earlier photographs of dumping and next is the secured landfill. Now, this is for the MSW and secured landfill for the hazardous waste. So, you can see this is what the properly secured landfill, in India, such kind of landfill is very difficult to find and who do not do such kind of the landfilling, but now, thanks to the Swachh Bharat mission the number of cities like Indore and other cities has come up with these kinds of facilities.

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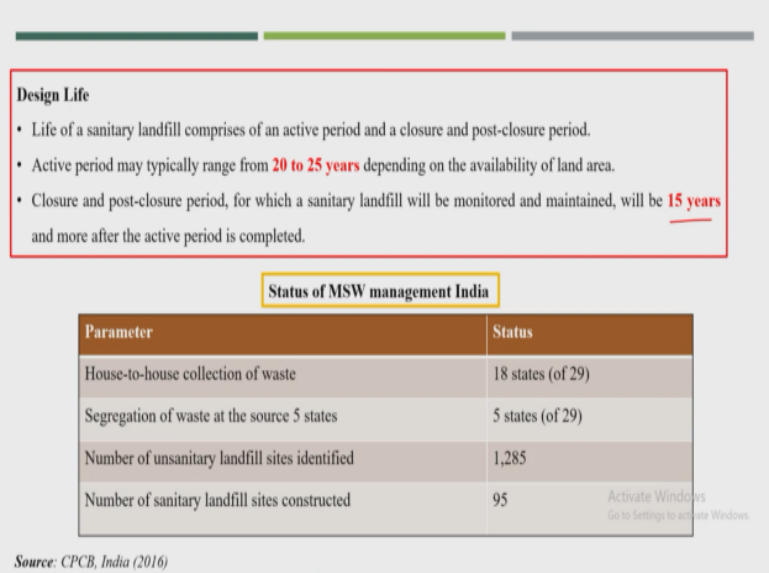

Design Life

- Life of a sanitary landfill comprises of an active period and a closure and post-closure period.
- Active period may typically range from **20 to 25 years** depending on the availability of land area.
- Closure and post-closure period, for which a sanitary landfill will be monitored and maintained, will be **15 years** and more after the active period is completed.

Status of MSW management India

Parameter	Status
House-to-house collection of waste	18 states (of 29)
Segregation of waste at the source 5 states	5 states (of 29)
Number of unsanitary landfill sites identified	1,285
Number of sanitary landfill sites constructed	95

Source: CPCB, India (2016)

So, what is the design life for the sanitary landfill? Normally, it includes the active period and closure and post-closure period. So and normally these active periods typically 20 to 25 years and the closure and post-closure period that also will be around 15 years. So it is not only that you just landfill the waste and then you forget no, no again you have to there is the closure and post-closure period also has to be there means up to that 15 years the monitoring will be there.

So monitoring, of polluted gas in the local area and monitoring of groundwater and surface water for 15 years and until that there should not be any kind of facility in near to those locations is not like you are planning for to make that particular location like a park. No, no, up to 15 years until the monitoring will not get over post-closure monitoring. You cannot have any other facility in that particular area. Now if you see the status of MSW in India, so the house to house collection is available is only in the 18 state out of 29.

Segregation of waste at source in only 5 states that is another problem and number of unsanitary landfill site identified see is a simple dumpsites, but now is good I think we have sanitary landfill has been constructed and Swachh Bharat mission. Now, why I think this table I had put it here because if you do not have house-to-house collection system means you do not have proper segregation.

And if you do not have house-to-house collection system and do not have segregation it source means is very difficult to have the sanitary landfill in the final location and your maximum waste or your entire mixed waste will reach the landfill area.

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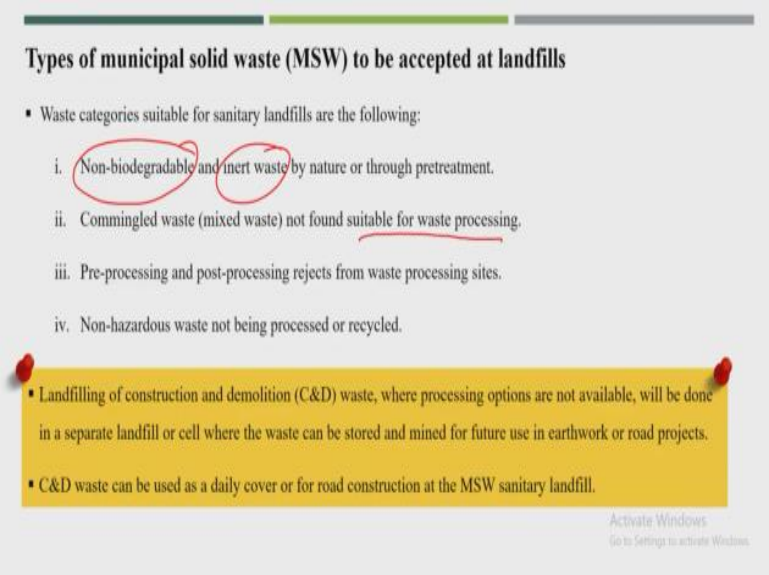

So, the type of municipal solid waste to be accepted at the landfill so, the waste category is suitable for sanitary landfill are as following you see here I put it there are 4 kinds of waste should come to the landfill area. The first is non-biodegradable and inert waste by nature or through pretreatment. So, this is what whatever is non-biodegradable or inert waste that will come to the disposal site or landfill site, the commingled waste mixed waste not found suitable for waste processing.

And next is pre-processing and post-processing rejects from the waste processing unit. So, there also is possible that from composting facility even from anaerobically digested if you are not able to produce compost out of that; that can also get disposed into the landfill area and even from the recycling that entire material is not 100% is not recyclable. So, whatever the rejects will come out that will come to the landfill area and non-hazardous waste not being processed or recycled, that is the last point.

Now, here you please remember this, I think I talked about there are 2 major issues in the landfill area. One is the polluted air and the second is leachate. Now, see that what kind of waste will produce the polluted gases and what kind of waste are producing leachate? Now is a major concentration or major components are by biodegradable matter suppose the waste because this biological waste is mixed into the dry material or commingled waste is reaching to the disposal site.

So, obviously, these biodegradable matter will get degrade under the anaerobic condition because of that gases polluted gases will produce because of leachate will produce and now suppose you have the house to house collections facility having the segregation facility and your entire biodegradable matter is going to the biological treatment facility either composting or anaerobic digestion.

Now, you tell me that the remaining that dry waste is reaching the disposal site, do you think that it will produce the polluted gas, paper, plastic will get will produce those polluted gases or it will produce the leachate? No, it is not possible and even though see it is already shared here now, the biological waste you removed out has been going to this composting facility or biogas facility.

Now, whatever the dry matter are there, paper is recyclable, plastic is recyclable, metal is recyclable, glass is recyclable, that also you will be able to segregate beforehand. Now, whatever is remained which is not recyclable, not biodegradable or there will be inert material from street sweeping waste, there are huge quantities getting produced. So, these wastes only should go to the landfill area.

Now, do you think that from non-biodegradable matter, non-recyclable matter, or inert matter whether the polluted gas will produce or whether leachate will produce out of that? No, but is not that you need not design the landfill for that. But you see that whatever the quantity is reaching right now and once you have the proper biological treatment facility proper recycling facility, you think that you are only that 20% or 30% material will reach to the disposal facility.

And there also you need not too much worry about the gas production, you need not too much worry about the leachate production, although you have to design properly, because you never know and you never know the what kind of pollutants will get generated, because in India, 3 months, 6 months rain, because of that could be possible that so, whatever the washed water is coming out from the disposal site can have the metal concentrations also into that or can produce some other gases, not only the methane.

But other gases could be also possible. Now, these one more one, the landfilling of construction demolition waste that C and D waste were processing options are not available

will be done at separate landfill or cell, where the waste can be stored and mined for future using earthwork or road project. So though even the C and D waste, because its density is very high, should not be added into the same kind of landfill or in the landfills also, if you have different locations only you get it stored.

Maybe it is I think that kind of waste here is useful for the other reason can be used as a construction material. So in this course, there is a very special module where we will talk about special waste. So special waste means, the construction demolition waste (C&D) which I shall include in 1 special lecture and another lecture will be on e-waste and biomedical waste that will be just brief information about those kinds of waste, such as, how to treat and how to dispose them.

And also, thus C&D waste can be used as a daily cover or for road construction at the MSW sanitary landfill that kind of utilization, we can do it of the C and D waste. So, again one more time, I am telling that in the disposal normally, what kind of waste should reach to the disposal site which should not be biodegradable, which should not be recyclable, only non-biodegradable, non-recyclable, inert material or whatever the rejects will come up rejects from the treatment facilities like from the composting facility, biogas facility if you have recycling facility or if you have incineration facility from that rejects will come to the disposal site.

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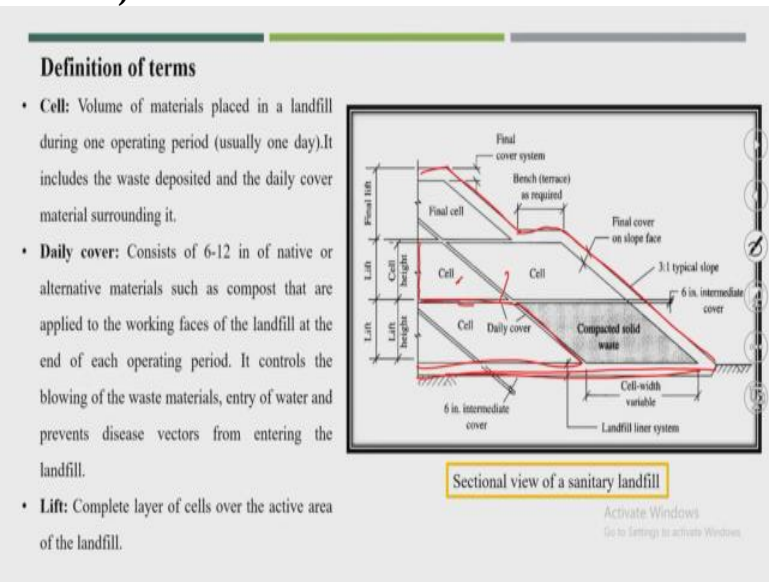

So, now, if you define the different terms, this is the 1 sectional view of the sanitary landfill. So, and you see here different words I wrote it, which I am going to explain here. So, the first

is cell. So, you see here cells, there are different cells. So, here I think this is the cross-sectional of the landfill area, this is the top area of the landfill and this is the ground. So, , what is cell? This is the volume of material placed in a landfill during the 1 operating period usually 1 day.

So, cell means whatever amount of waste is getting disposed in a day that we called as a cell. And it includes the waste deposited and the daily cover material surrounding it. So, you see here, so, I think, this is the 1-day waste is disposed off. And in here you see this is the daily cover. So it has to be covered properly. So, what is daily cover these consist of 6 to 12 inches of native soil or alternate materials such as compost that is applied to the working phase of the landfill at the end of each operating period.

It controls the knob blowing of the waste material entry into the water and prevents disease vectors from entering the landfill location. So, normally because these landfills are excavated landfills, you have to excavate the soil to get more volume. So whatever the excavated soil that is a native soil that we can use as a daily cover. I suppose that native soil is not good to utilize for daily cover, you can use the compost also in especially in America in the USA, they are using daily cover compost they are using for the daily cover.

Because they do not use that compost as fertilizer in the agriculture area. Now, lift is the complete layer of cell or the active area of the landfill, so, whatever the height or height of the cell that normally called as lift or how much is the depth of that particular cell.

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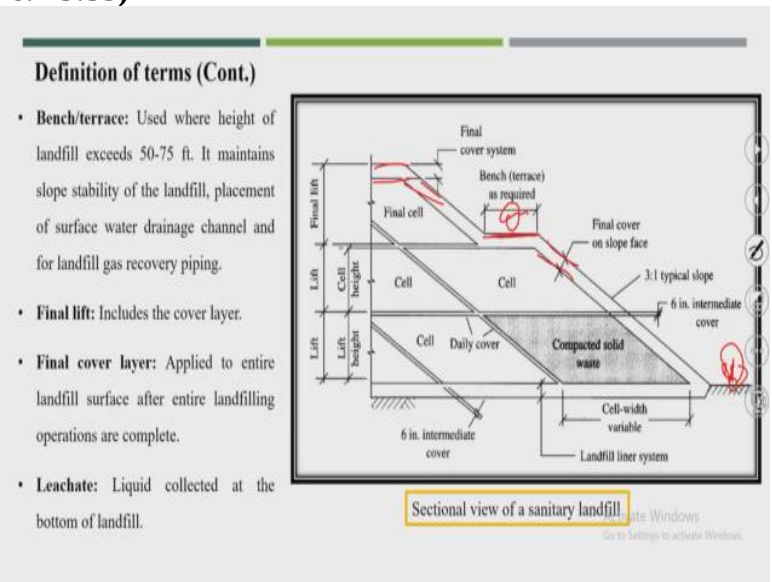

Now, next is the bench or terrace you can see this is the bench. So use where the height of the landfill exceeds 50 to 75 feet it maintains the ability of the stroke of landfill placement of surface water drainage channel and for landfill gas recovery piping. Now, whatever the activities are planned in the landfill area, you cannot do it onto the bottom area, we have to reach in such location where the monitoring system also we can install even the piping for the gas collection, leachate collection has to be put it into the entire the landfill area.

So, you will be required that bench area also required, the final lifts include the cover layer. So, this is the final cover layer applied to the entire landfilling operations are complete. So, this is the final cover these are onto the top of the entire waste material. Now, the leachate liquid is collected at the bottom of the landfill. So, this leachate I think still if we have the proper final cover also and daily cover still some kind of water will reach into the material and also in during degradation water will get produced. So, once there is an excess amount of water is getting generated that will come out in the form of leachate.

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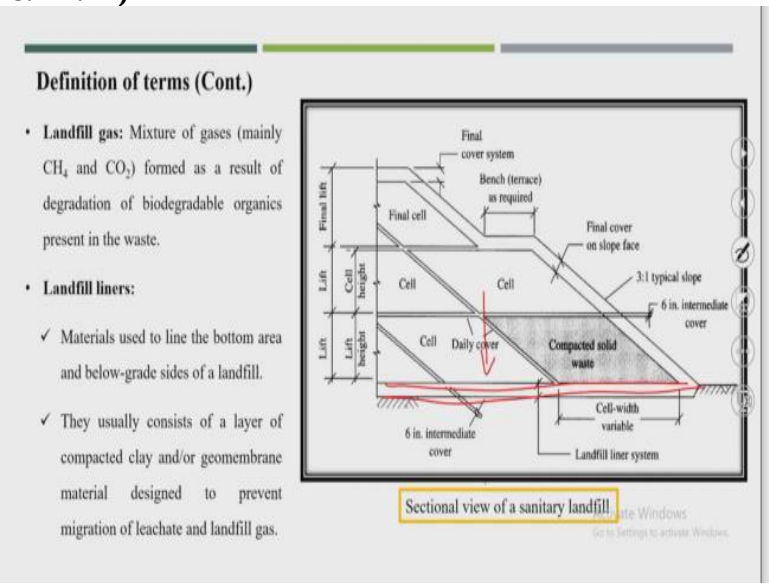

Now the landfill gas that is a mixture of gases mostly the gases will be the methane and carbon dioxide why because of this entire degradation in the anaerobic condition. So, these 2 are the major gases and now the landfill liner, this is the landfill use to line the bottom area and below-grade sides of the landfill so this is the liner. Now, this the what is the advantages of the liner so whatever the leachate is getting generated should not percolate to the soil so that leachate will not go or will not percolate into the soil if we have the proper landfill liner.

And by putting some kind of piping we can collect that particular leachate. So, they usually consist of a layer of compacted clay or geomembrane material designed to prevent the mitigation of leachate and landfill gas.

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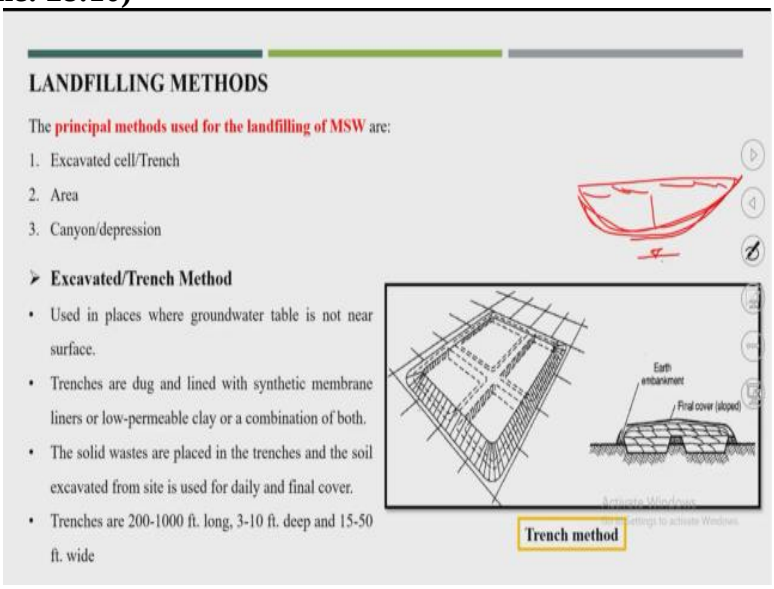

Now the landfilling methods, so, there are 3 major methods of landfilling, or we can call as a there are 3 types of landfills. First is the excavated cell or trench method. Next is the area method and the third is canyon or depression method. So, first is an excavated or trench method, this is the most popular method of landfilling. So, this name just you can understand is excavated.

So, or trench, though it is a time to time is an excavated will get particular volume or the excavation we can plan based on the requirement of the cell that is daily wastes reaching to the disposal site based on that we can excavate and whatever the soil is coming out that can be used as in daily cover. So, the excavated method is used to place where the groundwater table is not near the surface. So, this is one very important point for the landfilling one.

Now, you see here, suppose, this is the so, suppose, here is the, your groundwater table and this is the maximum water table, specially in the rainy season. Check that what is the depth of the water table? So, now, if you find the maximum one we can go for the excavation like in this case, like until that excavation we can do so that you can put proper liner so that the leachate should not reach into the water and the trenches are dug in line with synthetic membrane liner, or low permeable clay or combination of both.

So, the trenches could be 200 to 1000 feet long, 3 to 10 feet deep and 15 to 50 feet wide. So by trenching, we can dispose the waste. So and because of that, we will also get huge amounts of volume to dispose the waste.

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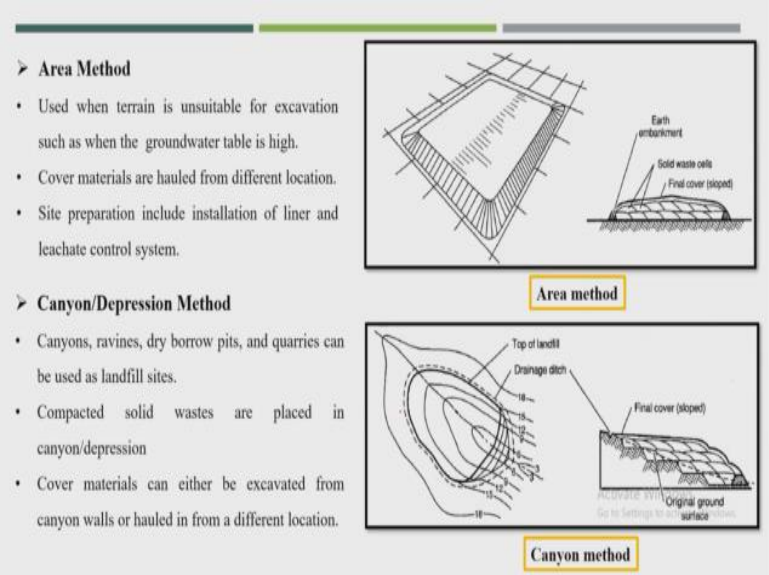

Now, next is the area method. So used when the terrain is unsuitable for excavation, such as when the groundwater table is high. Now, in the same example, suppose this is our surface and now the water table is somewhere here. Now, in this case, suppose if you go for excavated cell method or trench method, so, if you go for excavation like this, so, obviously, your entire disposal site will be in the flooded area, so, it is very difficult to dispose the waste into such cases.

So, in this case, rather than the excavation, you can put the liner onto the top of the surface and there we can dispose the waste like this. So, that is called the area method. So, the cover material is hauled from the different location sites now, here, in this case, your cover material will not or daily cover we will not get it in the same location. And a similar way this is the area method means that at the top of the earth's surface only we are disposing of the waste. So, next is the canyon or depression method.

This normally this method mostly will utilize in the hilly area where you will not find the plain area where you cannot go for excavation and you do not find a proper surface area where we can dispose of the waste. So, in that case, we can use the canyon or depression method. So, the compacted solid wastes are placed in the canyon or depression. So, as you see here, this is a hilly area. Now we are disposing of the waste like this in the depression.

So, this is these are the cells. So likewise or there are 2 hills also suppose like the this is there such kind of location. So, these particular areas we can utilize for the disposal of waste that is a canyon area can be used for the disposal. So in India, because I think this kind of method is very important in especially in the northeast part of India, especially in Nagaland, Meghalaya, were difficult to find the plain surface. So in I think this kind of method can be utilized in certain locations.

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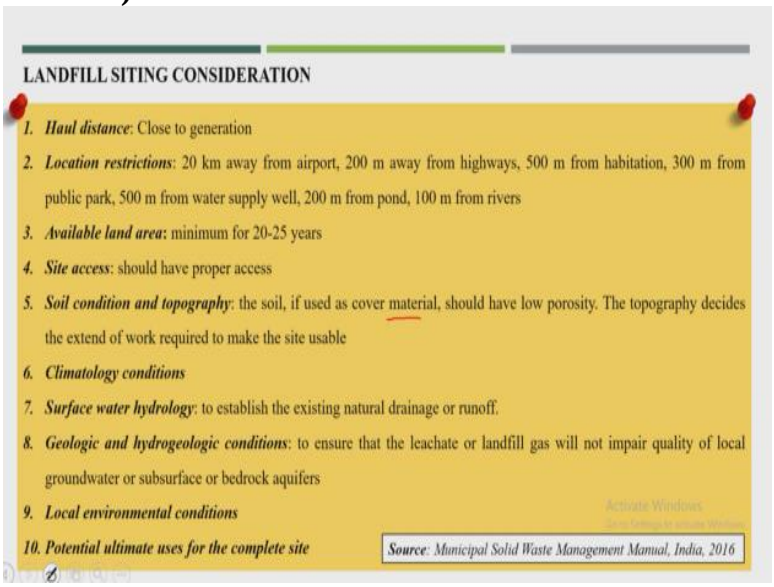

Next is the landfill siting consideration. So now these are the few important points are given in our solid waste management manual 2016 so we will go one by one. So first is the haul distance close to the generation. So obviously, if the haul distance is far away, then your collection cost will be more location restrictions are 20 kilometers away from the airport, 200 meters away from the highways, 500 meters away from the habitations habitation means wherever are the local residents are residing, 300 meters from the public park.

500 meters from water supply well and 200 meters from pond, 100 meters from rivers, this is the most important site restrictions. But in India, finding a location for a landfill is very, very difficult. So, many locations many cities if you go there they are finding the locations very close to the pond area, because pond you will get the large volume they need not have the excavations also.

So, because of that a lot of pollutions are coming up available land area minimum for 20 to 25 year means you will be required a large volume of the waste or large surface area of that

particular surface area is required. So, that you will be able to dispose the waste for 20 to 25 years but I think this is also not normally get discussed in the local authority. So many times we have seen that by 6 years, 7 years or before 10 years.

They are not able to dispose of the waste in such a location and after 10 years they are planning for another location for the disposal of waste that is not the proper way, site access should have the proper access. Obviously, I think this is very close to the highways. So, that it should be easily reachable soil condition topography the soil is used as a cover material should have low porosity, the topography decides the extent of work required to make the site usable.

So, this is also 1 important consideration because that soil will be used as a cover material also, the topography also needs to know that particular one. So, how much excavation needs to be done in the particular area based on that we can finalize by knowing the topography of the particular area, climatological conditions mean, you see that how the climatological conditions like if there is a huge rain or in a particular area or there is a longer rain for 6 months, 7 months where I think disposal is very, very difficult to design in such area surface.

Water hydrology to establish existing natural drainage or runoff you also have to be looked upon the local surface area hydrology need to know that wherever I think some reservoir is available nearby or should not be very close or also need to know the drainage if suppose there will be some kind of leachate will come out from that. So, from which or which particular location that the leachate will reach without knowing the drainage is very difficult to get aware.

Geological, hydrogeological conditions to ensure that leachate or landfill gas will not impair the quality of local groundwater, subsurface or bedrock aquifers that also need to be known. So, the porosity, void ratio that has to know into the local geological conditions also need to be known, local environmental condition potential ultimate uses for the complete site these also the 1 important point once you finish the 20, 25 years for the disposal of waste and 15 years for the monitoring water what could be the potential use of that particular location after 30 or 35 years of operation of that particular landfill.

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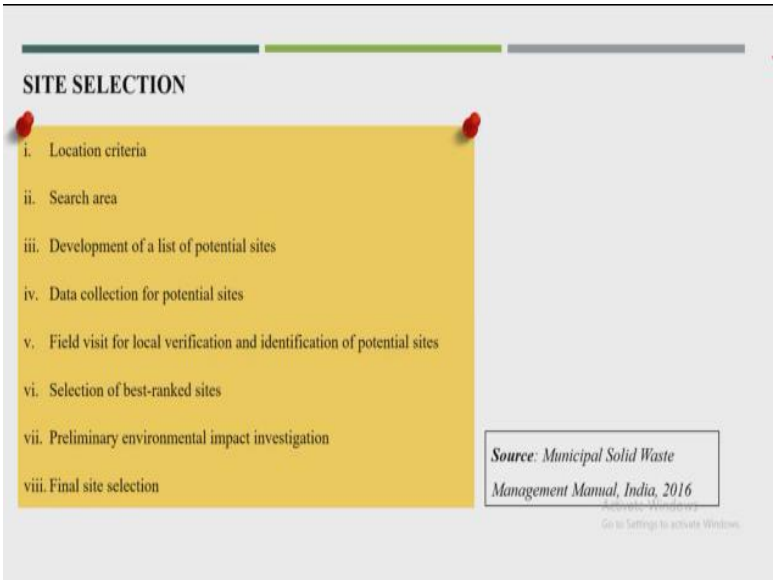

Now, when you talk about site selections, so, we have to have these 8 particular data are required to finalize the site selection. The first is the location criteria on what particular category or criteria you selected that particular site, search area development of the list of potential sites, data collections for potential sites, field visit for local verification, identification of the potential site, selection of best-ranked sites, preliminary environmental impact investigation and final site selection.

So, I think when you go for site selection, first, you look upon the location criteria what should be your criteria or what kind of waste you are planning to dispose of in that particular area after that, identify the different potential sites, you list out that collect the data. Once you collect the data, go for the field visits, do the verification particularly and then you rank the different locations by the numbers and then after once you rank that take the top 3 or 4 locations and go for preliminary environmental impact investigation.

So, these investigations mean I think atleast you check the groundwater quality in that particular area or surface water quality try to go for air quality analysis in that particular area. And finally, I think whichever will find the best in environmental impact investigation, you fix that particular location as a landfill site.

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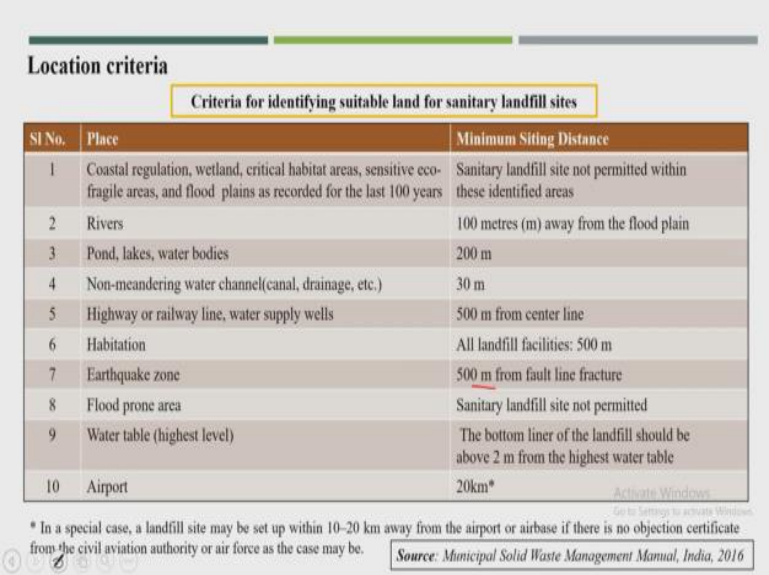

Location criteria

Criteria for identifying suitable land for sanitary landfill sites

Sl No.	Place	Minimum Siting Distance
1	Coastal regulation, wetland, critical habitat areas, sensitive eco-fragile areas, and flood plains as recorded for the last 100 years	Sanitary landfill site not permitted within these identified areas
2	Rivers	100 metres (m) away from the flood plain
3	Pond, lakes, water bodies	200 m
4	Non-meandering water channel(canal, drainage, etc.)	30 m
5	Highway or railway line, water supply wells	500 m from center line
6	Habitation	All landfill facilities: 500 m
7	Earthquake zone	500 m from fault line fracture
8	Flood prone area	Sanitary landfill site not permitted
9	Water table (highest level)	The bottom liner of the landfill should be above 2 m from the highest water table
10	Airport	20km*

* In a special case, a landfill site may be set up within 10–20 km away from the airport or airbase if there is no objection certificate from the civil aviation authority or air force as the case may be.

Source: Municipal Solid Waste Management Manual, India, 2016

This is the specially 1 special table has been given. I think based on them, for the criteria for identifying suitable land for sanitary sites. So you see here the location in the 1 part is location is given and minimum sighting distance. You see here the wetland area, critical habitat area, any eco fragile area floodplains which are recorded for the last 100 years. You cannot permit the sanitary landfill.

But now you see in I think you see in Guwahati in the northeast is the biggest city, the top city of northeast they finalize the location into the floodplains is very close to the 1 eco fragile area and that is just close, I think close means I do not think so, is a 10 meters or 20-meter distance is close to the eco fragile area in that location is a floodplain is already flooded area such location the river should be 100 meters away from a pond, I think already I told land here another one like an earthquake zone.

So, it should be 500 meters from the fault line fracture and habitations also see the habitation whatever the habitation should not be close to the landfill area and flood-prone area the sanitary landfill is not permitted and water table checks the water table every time the bottom liner of the landfill should be about 2 meters from the highest water table. See that the water table checks from time to time how water tables are changing in the location and the airport.

This is the important criteria that 20 kilometers away from the airports. And in special cases, landfill site may be set up within 10 to 20 kilometers away from the airport or airways if there is no objection, no objection certificate from the civil aviation authority or airforce as the case

may be, but I think is good to how as far as from the airport because a lot of flies, vectors are attracted into the disposal site, which is having the problem with the airport operations.

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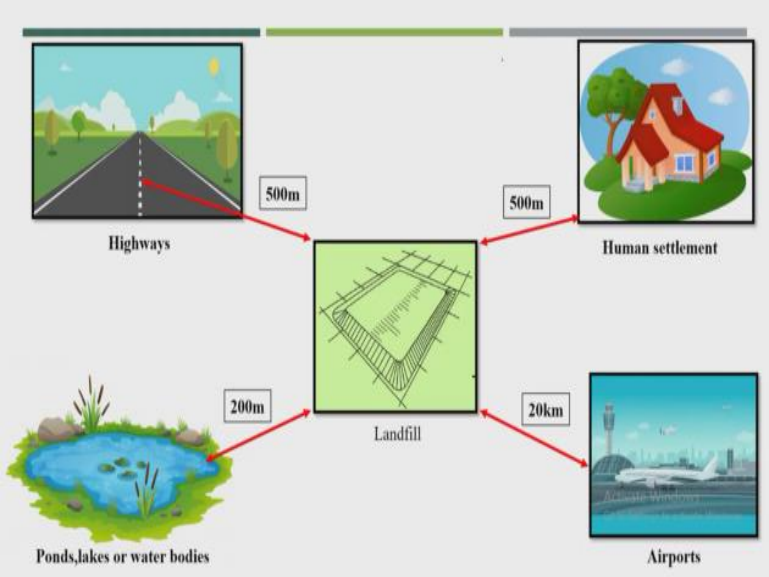

Now, this is also a similar kind of slide which I shared that wherever the landfill should be away from the highways, human settlements, the pond, lakes or water bodies and airports 20 kilometers, so, I think these are the important criteria for the site selections.

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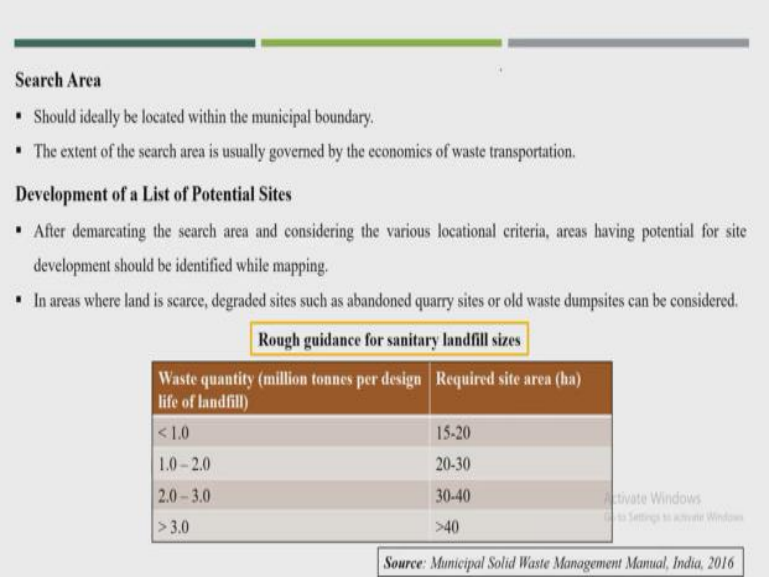

Now, the search area should ideally be located within the municipal boundary the extent of the search area is usually governed by the economics of the waste transportation. So, search area means I think the important factor you consider that is a haul distance, a haul distance should not be that more. So that it should be economical transportation should be economical. Now, the third point is the development of the list of the potential site.

After demarcating the search area considered the various location criteria areas having potential for site development should be identified while mapping in areas where land is scarce degraded sites such as abundant query sites, old dump sites can be considered even the mines area closed mines also can be utilized because already excavated one. So, that particular area also we can select and there are rough guidelines for sanitary landfill sizes because that area is very important while finalizing the potential sites.

So, the waste quantity if it is less than 1 million tonnes per day will help put the required site area 15 to 20 hectares. So likewise, for different quantities, simple guidelines have been as to given how much area will be required. This is for 20 to 25 years of operation of the landfill.

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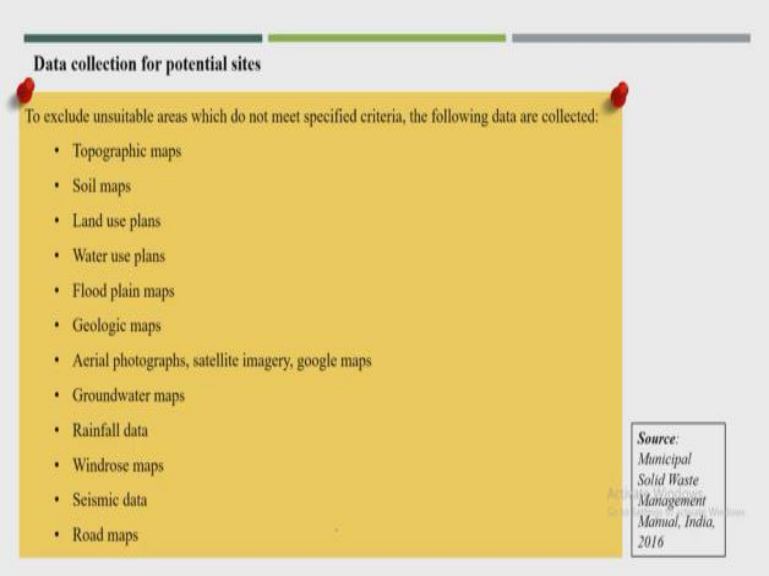

Now the data collections so what kind of data has to be collect in that potential sites, topographic maps, soil maps, land use plan, water use plan, floodplain map, geological map, aerial photograph, groundwater map, rainfall data, windrose map, seismic data, roadmaps these data need to be collected for the all potential site and important which I found that the groundwater map, rainfall data this is the important one, even roadmaps also is very important to reach to that particular locations.

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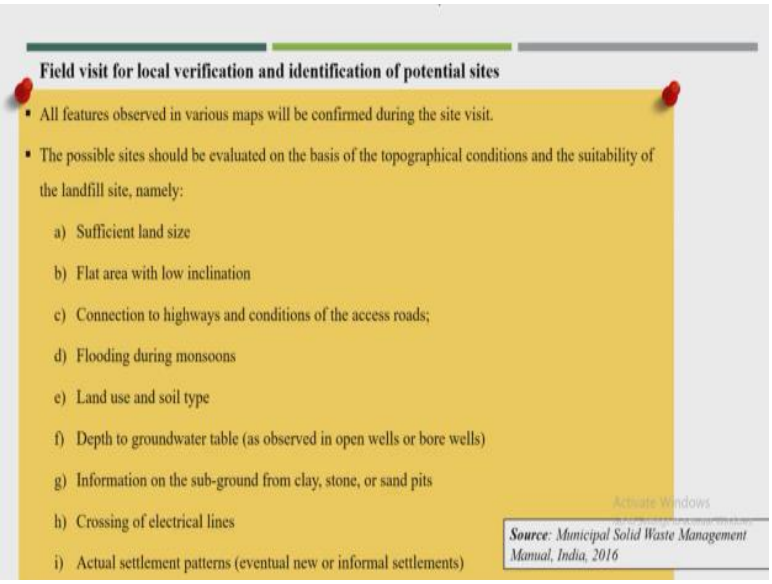

Then the field visit, the personal visit for verification of that particular site, local verification identification of that particular site. So, what are the different points that have to be looked upon into that, that is a sufficient land size, flat area with the low inclination, connection to highway and condition of the access roads, flooding during monsoon land use and soil type depth to the groundwater table, information on the sub-ground from clay, stones, sandpits, a crossing of electrical lines actual settlement pattern that has to be checked.

And along with that also some I think the local verification is again the very important one because by visiting a particular location you can see that what kind of roads, are available? What kind of inclinations you can check you can also take some equipments with you and can collect some data, which data you are not getting are secondary rather than secondary data, primary data you can collect in that particular location, even this depth of groundwater table normally these we cannot do by local verification, but maybe somewhere you will collect the water somewhere and can check where is the groundwater table.

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Now, the next point is selection of best-rank sites. The selection of the most appropriate site based on the there is one index has been given in this municipal solid waste manual that causes site sensitivity index has given and that also guidelines is given by central pollution control board. Normally you do it on to that and the identified sites are ranked on the basis of identified criteria for the preliminary environmental impact.

Now, once these rank these sites sensitivity index is nothing but the, whatever the points we have discussed the by a local verification and some data collection, you put it some numbers onto that. So, out of 10 out of 5 and find that rank the different sites onto that and once ranking has been given, you go for preliminary invite impact investigation. So, what are those preliminary environmental impact investigations; 2 or 3 sites may be chosen that the top-ranked sites for preliminary investigation, the impact of the sanitary landfill will be assessed.

And potentially quantified according to the national rules under local conditions. I think here I believe that especially you do for water monitoring and air monitoring in that particular locations. Maybe I think that data if you are able to collect for last 6 months, are those data's are available from last 20 years, 30 years data and you check that what kind of changes in that particular data and can think about if suppose some leachate will get released from the landfill area what kind of pollutions could be possible in that particular locations.

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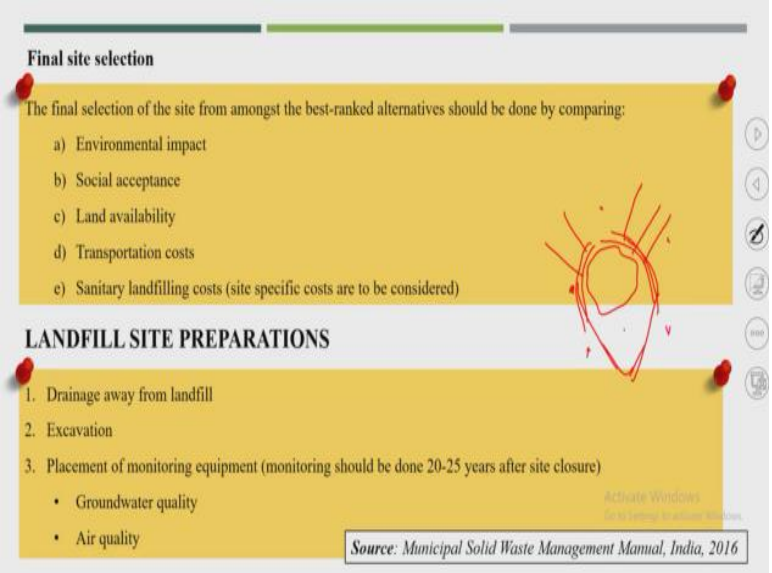

Now, the final site selections so, the final site selections among the best rank alternatives should be done by comparing the environmental impacts, social acceptance, land availability, transportation costs, and sanitary landfill costs. Now, this is the last and most important criteria, these 5 criteria if whatever the locations or whatever the ranked has been given, I think you finalize based on these 5 points.

The environmental impact should be low as far as low social acceptance should be as good as good land availability should be very high or as good as possible transportation costs as low as possible and the sanitary landfill cost that also as low as possible. That kind of location you can finalize for landfill area. Now, the last is landfill site preparation. So, I think before placing the waste into the landfill area, again that site has to be prepared properly.

So, the first is that drainage away from the landfill that is the important role suppose some location now, suppose this particular location you finalize for the disposal area. So, the first task has to do the whatever the drainage because obviously, this area is normally a low lying area, you are finalizing because they, in that case, your excavation will be not that high. So, that that cost you can reduce.

So, because of that, these kinds of water in this area nearby these fall sides during runoff, the water will enter into that particular location. So, for that, you need to create the drainage away. So, suppose you create some particular drains in the periphery or the disposal site. So, whatever the water will come out, that will not go to the disposal site and through the drainage, it will go away that kind of facility has to be created.

Now, next is the excavation. So, obviously, you have to create that particular volume whatever is required as per the design criteria of 20 to 25 years and how much amount of getting generated. There also you need one more important data from the city in yearly how the increase in the total quantity that also needs to be looked upon. And then finally, placement of monitoring equipments, like groundwater quality and air quality.

So, this is the location, so, here nearby somewhere here, here, here somewhere, you can finalize the monitoring stations for both the cases the groundwater quality also and air quality also has to be checked properly. So, this is the important point for site preparations. So, normally, the local authorities, who are not following these kinds of criteria are given properly the ranking of different potential locations final the impacts of the entire landfilling.

But I think is good now and because it is already the manuals has given the particular task his way is getting given now. So, now, the local authorities or corporation can go through these kinds of criteria and finalize 1 particular location, which can be run for 20 to 25 years for disposal of waste so, thank you.