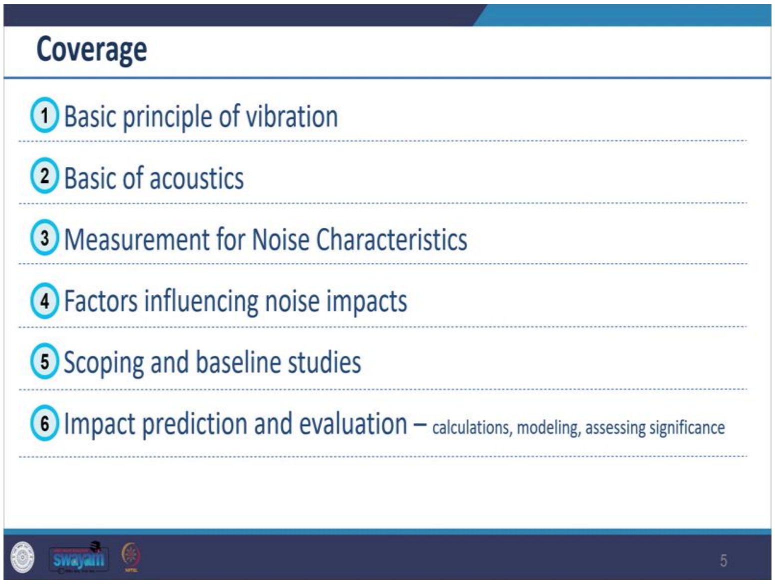
Environmental Impact Assessment
Professor Harshit Sosan Lakra
Department of Architecture and Planning
Indian Institute of Technology Roorkee
Lecture 44
EIA Methods – Noise

Welcome to this course Environmental Impact Assessment. And today, we are going to look at EIA methods in the domain of noise. In tIne will be looking at the concept, scoping, and baseline study.

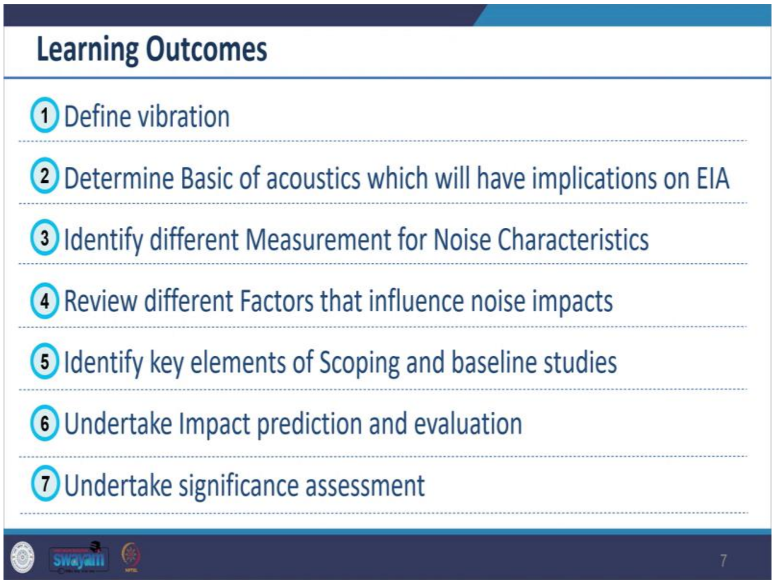
(Refer Slide Time: 00:44)



So, accordingly, our coverage will include, like we will first look at some of the basic principles of vibration, we will look at the basics of acoustics, and then we will see how measurements are done for various noise characteristics. Then we will look at factors influencing noise impacts like how is the impact and how it varies depending on what factors.

Then we will look at scoping and baseline studies, how are they done when we deal with noise impact, how we do impact prediction how we undertake evaluation, what kind of calculations are done what modelings are available, and how we assess the significance of any impact.

(Refer Slide Time: 02:09)



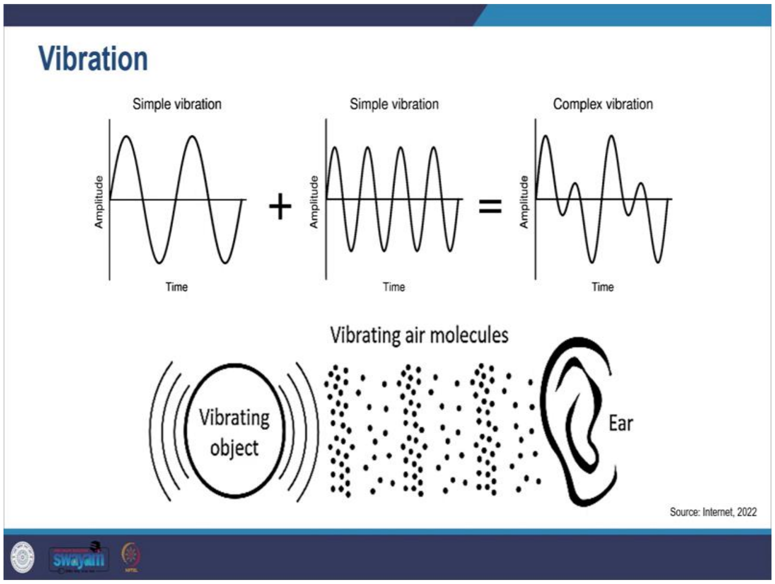
So, the learning outcomes expected from you after completion of the session is that you have to define certain terms related to it, like vibration and frequency, sound and so on, what is noise, and so on. Then you have to determine the basics of acoustics which will have implications for EIA. You would be required to identify different measurements for noise characteristics, you should be able to review different factors that influence noise impacts.

And you should be able to identify key elements of what you do within scoping and baseline studies. And then you should be able to undertake impact prediction and evaluation, at least understand the theories behind it. You should be able to decide which calculations to use, and what modeling to use, and then you should be able to undertake significance assessment as well.

So, the basic course book for this is ours, what we are following is Therivel and Wood's book on methods. So, we are constantly referring to that. So, when we consider noise, we see that almost all the projects have a noise impact. And noise during construction may be due to activities such as, like you might be doing land clearance, you might be doing construction the piling work, and then the frequent transportation that takes place in and around the site. So, all that leads to noise.

And we have seen much of this noise-related legislation, we have also seen certain environmental conditions also related to that. So, today we will just focus on some of the limited definitions and then how we undertake scoping, baseline, and impact prediction and assessment. So, noise is a major and growing form of pollution, and we have already seen WHO guidelines on that.

(Refer Slide Time: 03:56)

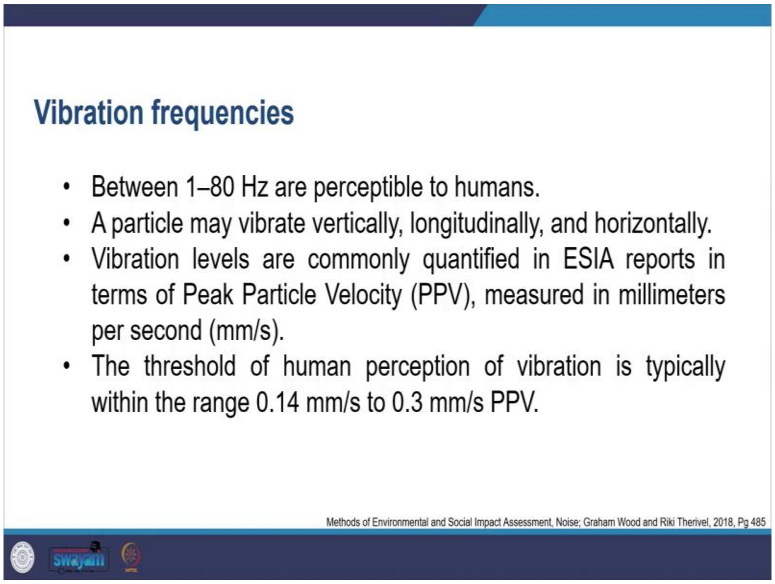


Now, look at the basic principle of vibration. So, what is vibration? Vibration is vibration refers to the oscillation of an object about a reference point. So, with like what kind, what number of oscillations per second is happening, and that is given in the form of frequency of vibration.

So, there is a difference in how vibration and sound are experienced or sensed by humans. And where we see that sound is like detected by hearing, we hear this sound, whereas the vibration is felt, felt as it is transmitted through the structure, the solid structure directly to the human body.

So, something that is coming from what we are receiving from the ear and then something which we are receiving or feeling at the entire body. So, vibration can occasionally occur at a single frequency, and then it is also usually seen at several different frequencies.

(Refer Slide Time: 05:09)



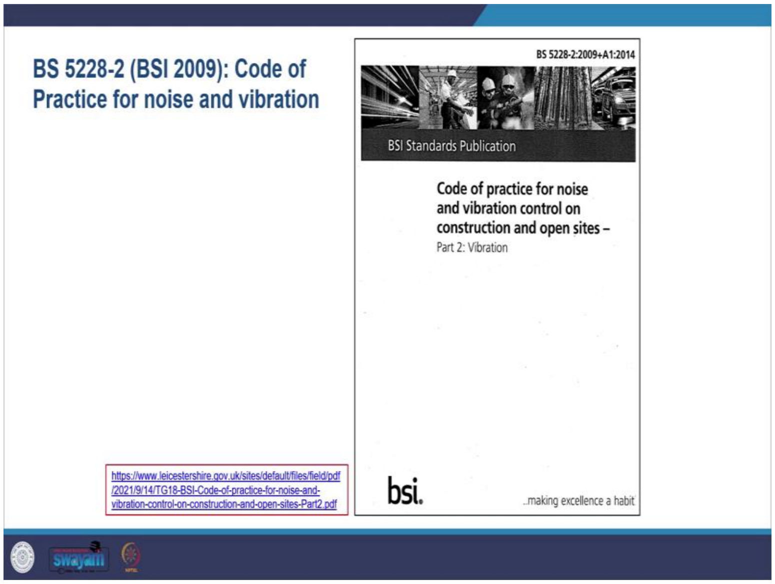
So, vibration frequency, frequencies between 1 to 80 hertz are perceptible to humans, we perceive that, and then the particle may vibrate vertically, longitudinally, and horizontally as well. And it is all, it involves, it often it is like a combination of all these three vertical, horizontal, longitudinal.

And it is, in general, what we see in EIA is that it is quantified, this vibration is quantified and it is given in terms of peak particle velocity PPV. It is measured in millimeters per second, mms, is given mm by s is given. So, that is how you refer to the EIA report.

If you look at the threshold of human perception of vibration, it ranges from 14 mm by s to 0.3 mm by s peak particle velocity, PPV. So, usually, you see that road traffic, and railways are the common sources of vibrations. If you have lived, ever lived next to the roads you might realize when heavy vehicles move, how you feel the vibration, or living nearer to the railway track. So, you would have a sense of what vibration is like.

So, usually, you do not get complaints from many of the vibration projects, but it is, usually when you get, the vibration where the complaints are usually raised are mostly concerned with vibration transferred through air.

(Refer Slide Time: 07:07)

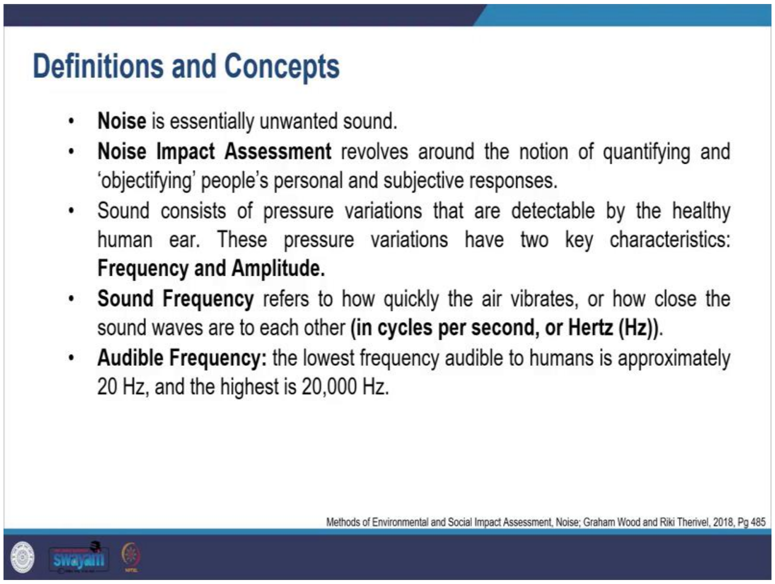


Then you can also find standards like BS 5228-2 standard which also indicates various construction activities and, which activities cause vibration. And these can be referred to there. So, looking at what is noise, what is the fundamental concept behind noise? So, noise is something where there is an unwanted sound. So, the unwanted sound is said to be noise.

So, the key point here is that what is unwanted can be very subjective. So, key, the key understanding here, when we define noise, is that it is very subjective to how people respond to it, and irrespective of the objective reality, like what is the actual intensity of the sound, irrespective of how people respond to that particular sound is what makes noise.

So, the physical level of noise does not, is not like the measurement of noise. It will vary with how each one receives it. So, for that matter you might be in a, among the concert, so what kind of noise level is there where you are close to the airport, what is good for you, many would be happy next to the rock band whereas the neighbors around the band going on might be unhappy with the same level of sound. So, we need to understand these differences.

(Refer Slide Time: 08:54)



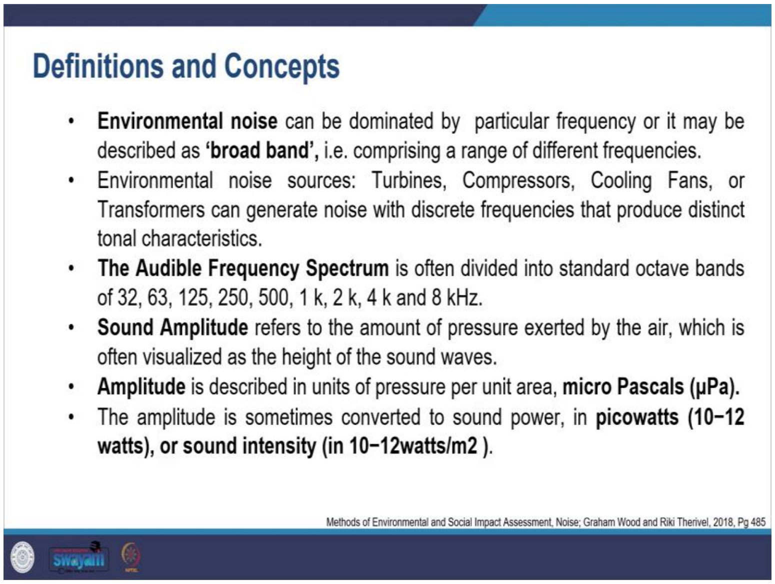
And then when we do undertake noise impact assessments, we look into quantifying and having a very objective understanding of how people are going to respond to that particular sound. So, we try to understand or when we say objectify that means having consistency across all the receivers and then giving a quantity of value to that response.

So, if you look at sound, sound consists of pressure variations that are detectable by the healthy human ear. So, the sound is set to be the pressure variation that we can hear. These pressure variations have like, you see that they have two main characteristics. One is frequency and another is amplitude.

So, sound frequency refers to how quickly the air vibrates, or how close the sound waves are to each other. So, in cycles per second which is also set like hertz. So, you see that sound frequency, how quickly the air vibrates in any particular sound. So, frequency is felt subjectively as the pitch of the sound. So, frequency is subjectively felt as the pitch of a sound.

So, you when you feel it, it is more of a pitch of the sound. And lowest frequency which is audible to humans is approximately 20 hertz. So, we can hear that, and the highest is 20,000 hertz.

(Refer Slide Time: 10:36)



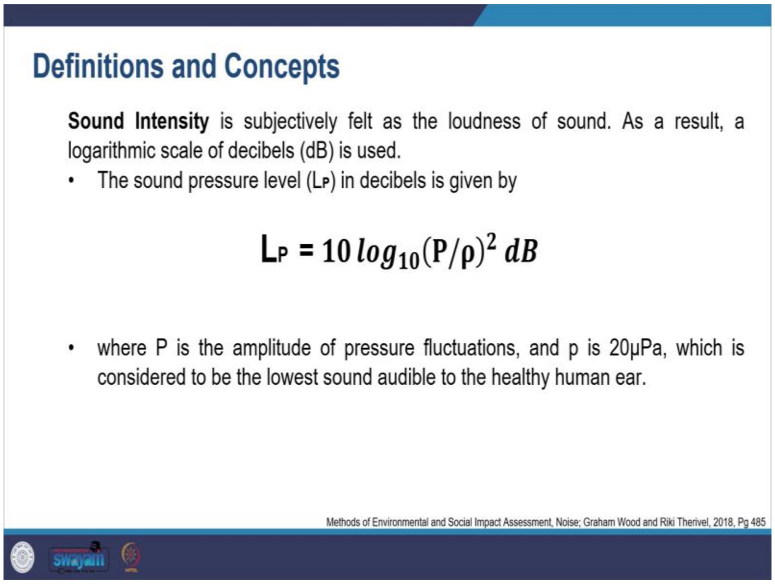
When we talk about environmental noise, it is mainly about particular frequencies or certain broadband. It comprises of range of sounds of different frequencies. So, in the environment, if you see, you might have like industrial area, you might have turbines, you might have a compressor, you might have fans, huge fans, and you might have transformers and all these things which might all add up and may give the sound of different frequency, and all add up. So, that would be the environmental noise.

And that would also lead to the total noise, how do you work out the total noise? So, the total noise is usually more, like you get a, you are aware of total noise more in any situation. And when you, the total noise exceeds, you are, you make note of that and you get irritated or annoyed by that context. So, there are range of frequencies, how these things are worked out, and you have sound level meters which can really capture a sound of different frequencies and also give you information of on environmental noise.

So, when we talk about sound amplitude then we majorly refer to the amount of pressure. So, when we are saying sound amplitude, we are referring to the amount of pressure, which is exerted by the ear, which is often visualized as the height of the sound waves. So, amplitude is described in units of pressure, per unit area micro Pascals. So, that is how you refer to it. So, sound amplitude, where you capture it by the amount of pressure, and it is indicated by micro Pascals.

So, the amplitude is sometimes converted to sound power. So, another term that you will many times come across standards is sound power which is in picowatts, 10 to 12 watts, or sound intensity which is like 10 to 12 watts per meter square. So, you would also see amplitude.

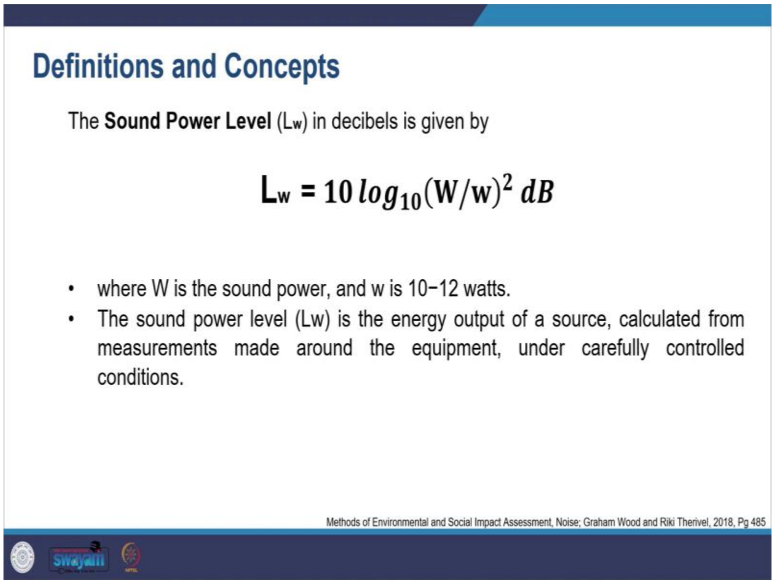
(Refer Slide Time: 13:34)



So, sound intensity is subjectively felt. So, it is like, it depends on the receiver. And it is like said as the loudness of the sound, how loud it is. And so it is indicated in the form of a logarithmic scale of decibels, you indicate in log decibel. That is how it is represented, sound intensity.

You also have a sound pressure level which is L p in decibels. It is given by, as you can see L p equals 10 logs of, you can see this, P capital P by lower p square decibels. So, here, you see that P is the amplitude of the pressure. So, we talked about the amplitude of the pressure fluctuation that happens, and small p is the micro Pascals, 20 micro Pascals. And 20, we take this number 20 because it is considered the lowest sound audible to the healthy human ear. So, the sound intensity level can also be described.

(Refer Slide Time: 14:34)



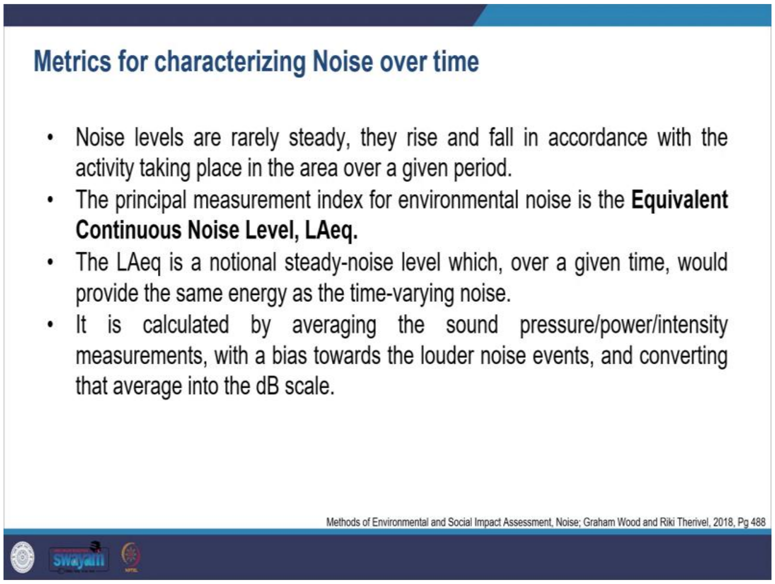
You can describe it as sound power where you indicate it by W, w and it is indicated as 10 to 12 watts. So, sound power level which is like L W is the energy output of a source. So, how much energy is coming out from the source, is calculated from measurements made around the equipment. So, wherever the equipment is placed, the source is there. So, you measure around that carefully in a very controlled condition.

So, usually, how do you get these values? So, you the manufacturers of the equipment, usually provide these L W, sound power levels. So, that is provided to you. So, you can use this information to assess these noise impacts and to undertake these noise impact calculations. So, there are certain frequencies for which the human ears are much more sensitive, like 1 kilohertz, 2 kilohertz, and 4 kilohertz, octave, and much less sensitive at the lower audible frequency.

So, if you see most of the sound analysis that is done in EIA, your major focus is on the loudness experienced by the people, the receivers. And more than actual, what is the physical magnitude of the sound? So, how the receiver responds is key to the EIA process. You also have a waiting curve which is used to give a single-figure index. So, there is an index also which is developed for this purpose which takes into consideration how the sensitivity of the human ear is, the range of sensitivity which is there.

So, looking at how it is measured, the characteristic is where you characterize noise over time. So, if you think of noise, noise is never steady, it is not very, uniform across. So, whenever this noise happens, it rises and falls, and it also depends on the activity that is taking place in an area. So, there might be a siren that might go up and down, there might be a bang that happens. So, there is a variation in the intensity. And it would vary with the time, it would vary with intensity.

(Refer Slide Time: 17:07)

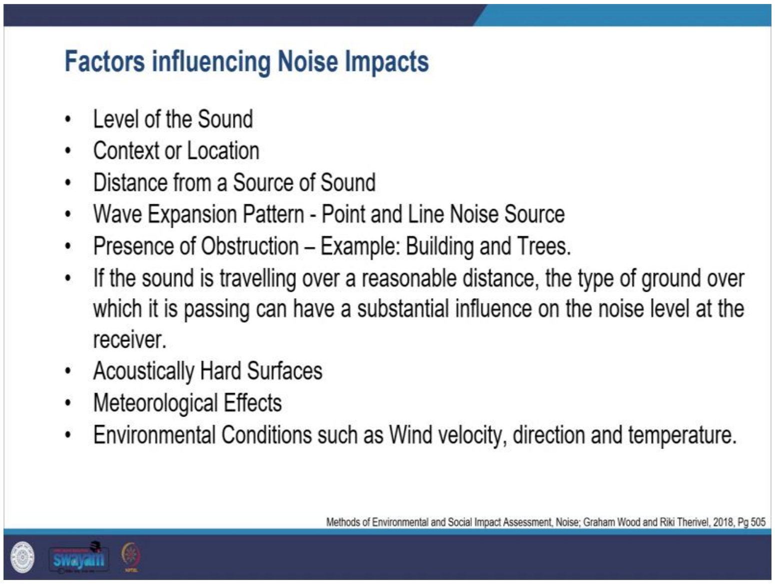


The key measurement index that is used for the environmental noise is Equivalent Continuous Noise Level. So, this LAeq is a national steady-noise level, a steady-noise level which is a consistent noise level that over a given time would provide the same energy at the same varying noise.

So, it is calculated by averaging the sign sound pressure or power or the intensity measurements. So, you average that out with them, with certain assumptions that, you will have more biases towards the louder noise events, and converting the average into decibel scale. So, you would take more towards the louder noise side, and then you would average it into a decibel scale here.

So, for most environmental noise meter indexes, you can read directly, and you have this LAeq which has been provided, mostly provided. And the benefit of this is that it takes into account the energy and the duration of noise events. And it is said to be a very reasonable indicator of like how people respond to noise. It has been acceptable for a wide range of sources as well.

(Refer Slide Time: 18:49)



Now, looking at the factors influencing noise impact. So, looking at what are the factors that influence the noise impact, there are physical factors that influence how much effect a sound will have upon a potentially affected receptor. So, what is the amount of sound? And the level of other sound, which are also affected by the receptor. So, what is the intensity of the sound, the original sound, and then what are the other sounds that might affect the cumulative impact that it would have over the receptor?

So, one is the physical factor of the sound, and then the other sounds are present in a place. And then also depends on the context. For example, a person coming from a rural background who has lesser, like less exposure to the hustle and bustle of the urban area would have lesser tolerance compared to somebody coming from a very noisy place, an urban area. So, that way, context also varies and you would see that the OECD has recommended different noise levels for the urban context and the rural areas.

So, another factor you see is that with the increasing distance from the source of sound, from wherever this sound is coming, as the distance increases level of noise from the source decreases. So, the level of noise will decrease as the distance increases. So, the way the sound will reduce or essentially accentuate would depend on, how the dispersion of energy is happening in which form it is happening, and the geometry of dispersion of that particular energy.

So, as the distance increases in which form it is spreading and then how far it is going, it would all determine the strength of the sound. Further, we see that you will also have different ways the wave expands. Like there might be variations in the expansion pattern of the waves. So, if you have a point noise source then the sound would go in the form of a sphere in the increasing radius. So, the radius will go on increase. Then the sound will decrease in this scale of 6 decibels in the sound pressure as the reduction of 6 decibels will happen with every doubling of this distance.

So, likewise, you will also see a variation in the expansion pattern. For when the source of sound noise is linear, line source, if you see like, you have roads and railway track which we talked about, so if that kind of source is there so that the wave pattern would be again different. And there would be the reduction would be 3 decibels per doubling of the distance. So, the reduction is less in the case of the linear source.

So, now, also the other factor that would influence is the presence of obstruction. So, what kind of obstructions are there in the way of noise? So, whether the propagation path from where the noise is traveling are there any obstructions or not? So, the obstruction could be a large building, there could be a wall, there could be a fence or there could be a mound which is obstructing, the line of movement of this noise. So, it would also depend on that. Usually, it is said that trees do not work as an effective barrier, so they do not stop the noise movement.

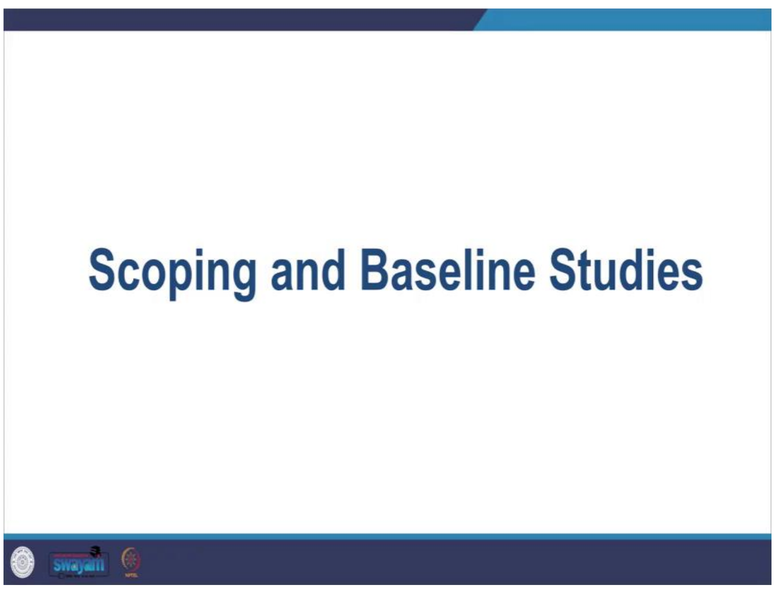
Other, you also see that what kind of ground surface is there, would also affect how the noise is traveling. And depending on how hard is the surface, if it is acting as a reflector then this noise may further increase or if it is acting as an observer, observing material like soft grounds where you can have crops, grasslands, and so on, so then it would absorb and it would reduce the intensity of this sound. There would, apart from, these effects, even the climatological effects would also play a role in how the noise travels.

So, one needs to look at the meteorological data as well, how things will affect. So, usually, it is seen that whenever the temperature increases, the sound waves tend to go more towards the ground level, and then we feel the elevated noise. So, we feel increased noise. So, during summertime, even when there is quiet you would have more perception of noise. Further, we see that wind speed and direction can also affect the noise level.

(Refer Slide Time: 24:20)

There are guidelines. IFC provides the IFC Performance Standard International Benchmark for Environmental and Social Risk Management. And you can look at Ps 1, 2, 3, and 6 for these guidelines and we have already seen some of the guidelines in a legislative time also, as well as you would also see these CPCB guidelines which are provided. So, that was the first key conceptual understanding.

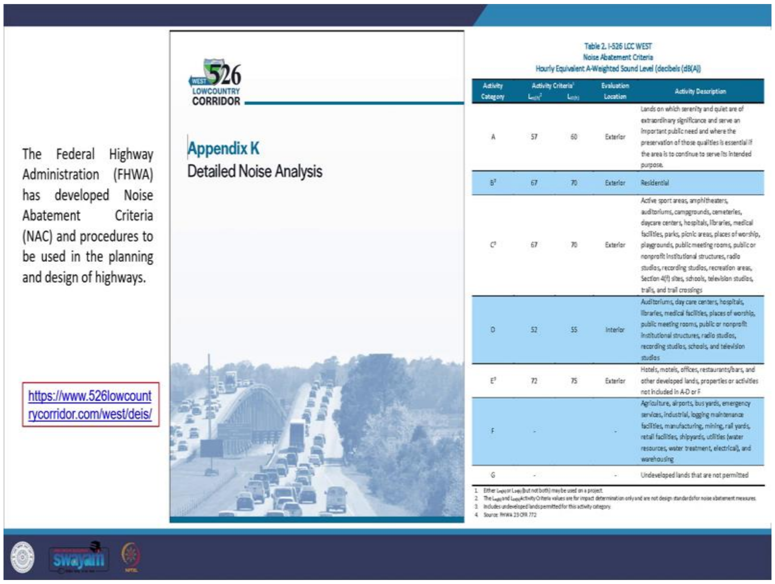
(Refer Slide Time: 24:54)



Now, moving to the second part, we see the scoping and baseline studies. So, looking at the scoping and baseline studies, how do we undertake that? So, when dealing with noise what do we do at the scoping state? So, usually, we identify the, what are the potential sources of noise, from where you need to identify, from where all the noise will come in your study area.

You need to identify who all are going to receive those sounds, who will be the receptors of those sounds, who are the people, and what are the sources likely to be affected because of the kind of development which you are going to undertake there. So, further, apart from receptors apart from the source of noise, you also look at the areas from where you are going to monitor the data. So, where you will monitor, where you will place the equipment, and regularly monitor the noise level in, your study area.

(Refer Slide Time: 25:59)



You are also required to check the national and international guidelines that are available for your study area and your subject domain. So, you need to refer to that as well in the scoping stage. So, here in the image you can see this case study, we will be referring to the line source. We are looking at the corridor transportation project here. I will be sharing the link for this, will be sharing this file with you.

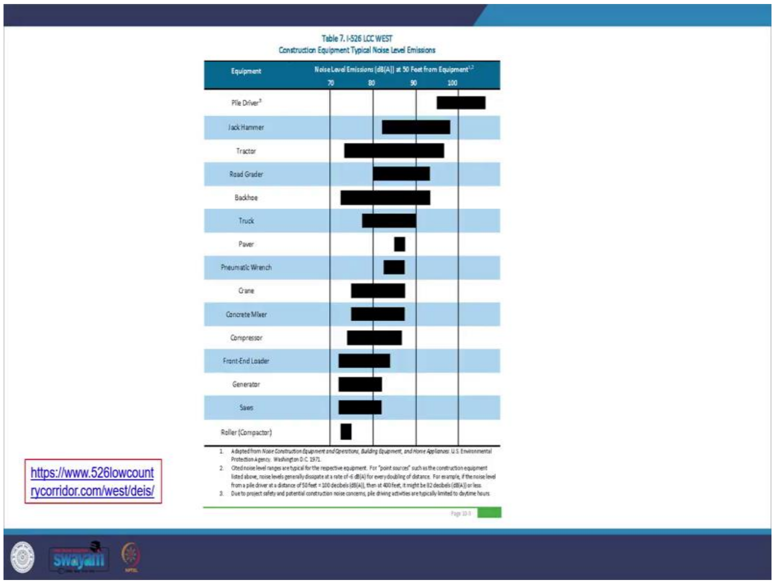
So, the Federal Highway Administration has developed a noise abatement criteria, NSC. So, in this particular study, you will see that they are using this reference and within this reference, they would be placing all their study findings impact and assessment. So, you can see different categories and activity criteria and you may pay attention to the unit they are using and then evaluation, location, where they are going to evaluate the exterior of the interior, and then what kind of activity has been happening there.

So, at the baseline study level, we identify what information is already there. So, you need not collect all the information, so what information is already there you can take it as a secondary data source. And then what data you need to collect, collection of any on-site data. So, you need to judicially decide upon the locations from where you are going to collect the data. One also needs to take care of what kind of changes will happen in the baseline condition in the future and because of your project. So, that also needs to be taken into consideration.

You need to identify potential sources of noise and you need to undertake a very detailed project analysis. You have to undertake, this project analysis has to take, has to be taken on-site in your project area as well as offsite, wherever the recipients would be. So, that also had to be taken. Then you have to take it at every stage of the project like during the construction stage, operational stage, and decommissioning stage.

So, you need to determine the characteristic of the noise source, so what is the characteristic of it, whether, when we say the characteristic, whether it is continuous or it is coming immediately, so what kind of noise source is that, at what time does it come, what is the duration and what is the tonal characteristic of that noise and all those parameters have to be seen.

(Refer to Slide Time: 28:46)

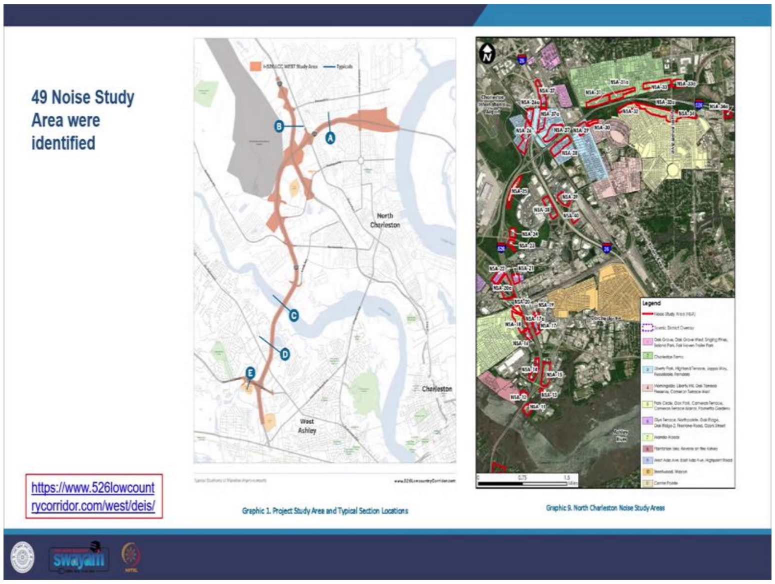


So, in the example here you can see, from the same case we have picked up, so you can see a construction equipment type typically noise level emissions. So, here they have taken during the construction phase depending on what kind of equipment. You can see the pile driver, jackhammer, tractor, road grader, back hole truck, and so on, and then look at the noise level which they have created here from 70 to 100 on a decibel scale, you can see here. So, that is how they are presenting their information.

You see that during the scoping stage, you each source of impact, you need to consider and you need to make judgments like what needs to be done. So, you need to determine what kind of detailed assessment would be required and then, and where you can work out without detailed assessments. You also need to decide what will be the significant impact beforehand so that you do not invest in studying unnecessary details that will not have a significant impact.

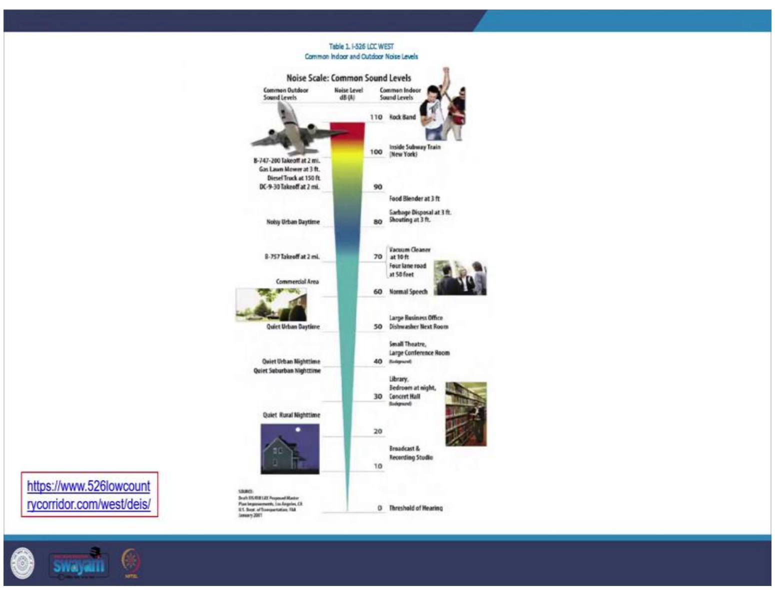
So, this and whatever you are deciding, what areas to be covered, what not to be covered, you need to explain your decision, and you need to justify why you are covering some areas and not covering others.

(Refer Slide Time: 30:12)



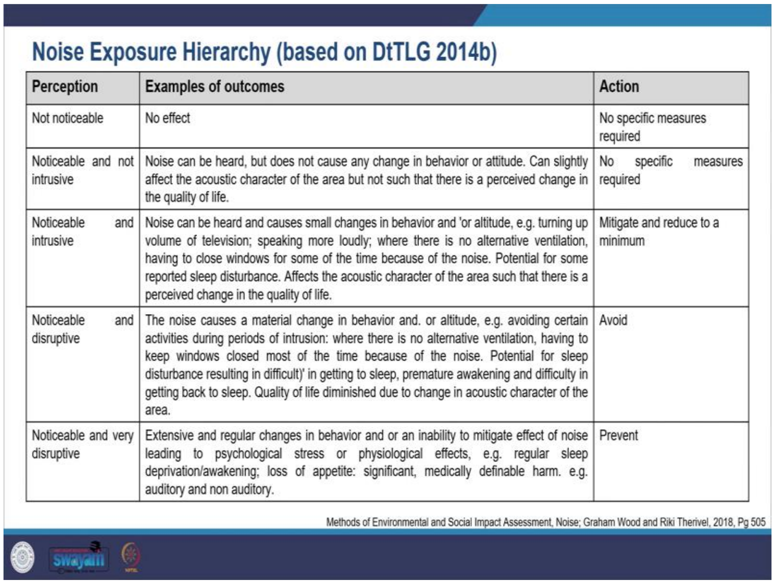
So, here from the same case of the low country corridor, you can see here that is the project area, in the center you can see. And you can see on the right-hand side, all the 49 noise study areas which are identified. So, you see how intensive those areas have been identified, and you can see all those marked in the red box, so that shows the noise study area. So, that, they have picked up here. And they have, in the report, this I have taken from any EIA reports, so they have also mentioned the noise scale.

(Refer Slide Time: 30:52)



Also, here you can see common indoor and outdoor noise levels. You can see on the left-hand side all common outdoor sound levels and then common indoor sound levels, and then how, starting from the threshold of hearing at the bottom.

(Refer Slide Time: 31:07)



Noise Exposure Hierarchy (based on DtTLG 2014b)

Perception	Examples of outcomes	Action
Not noticeable	No effect	No specific measures required
Noticeable and not intrusive	Noise can be heard, but does not cause any change in behavior or attitude. Can slightly affect the acoustic character of the area but not such that there is a perceived change in the quality of life.	No specific measures required
Noticeable and intrusive	Noise can be heard and causes small changes in behavior and 'or altitude, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a perceived change in the quality of life.	Mitigate and reduce to a minimum
Noticeable and disruptive	The noise causes a material change in behavior and. or altitude, e.g. avoiding certain activities during periods of intrusion: where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficult)' in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Avoid
Noticeable and very disruptive	Extensive and regular changes in behavior and or an inability to mitigate effect of noise leading to psychological stress or physiological effects, e.g. regular sleep deprivation/awakening; loss of appetite: significant, medically definable harm. e.g. auditory and non auditory.	Prevent

Methods of Environmental and Social Impact Assessment, Noise; Graham Wood and Riki Therivel, 2018, Pg 505

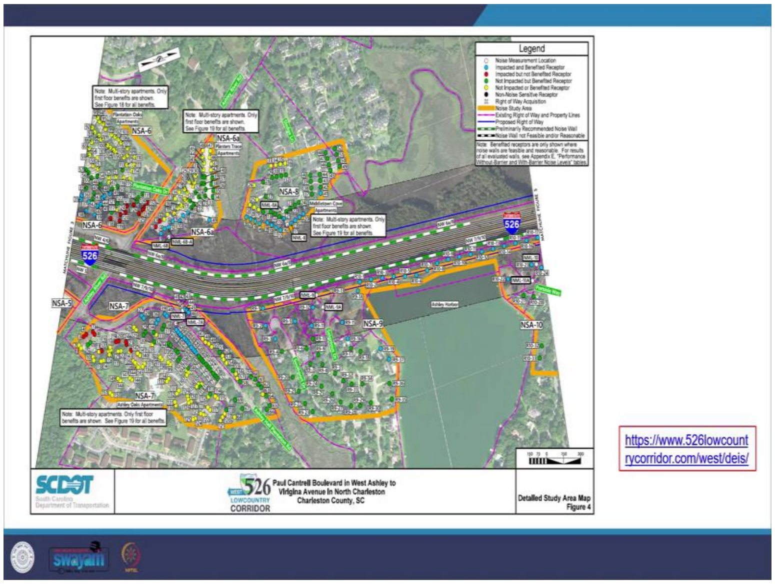
And then you also have the noise exposure hierarchy. So, you also undertake, to see what are the noticeable noises or not noticeable which will not have an impact. So, all those kinds of judgments you would be making in your scoping stage itself. So, there might be some sounds that are noticeable but not intrusive, there is no complaint about it, so there is no specific measurement required.

Then you might have noticeable and intrusive, so they, which can be mitigated, and then you will have noticeable and destructive which you need to avoid, and then noticeable and very destructive which you need to prevent. So, such kind of judgments, you have to make. The key important point in all these assessments, what you will be doing is to understand the receptors.

And for that, you might have to prepare, you can also prepare a map to identify noise receptors in the areas. And receptors can vary. So, you can have different kinds of receptors, you can have residents, you can have people working in the area or coming, visiting the surrounding areas. You also need to identify particular land uses or activities that are happening in there that are noise-sensitive.

For that for example, it could be studios, recording studios, you can have schools, you can have hospitals, libraries, worship spaces, churches, or things like that. So, then, those will be very sensitive to the noise. So, you need to take care of that.

(Refer Slide Time: 32:48)



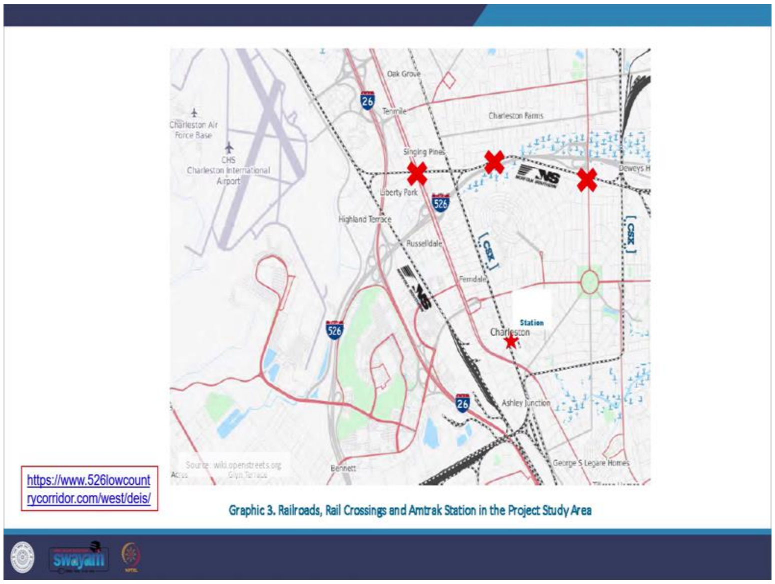
And here in the image, you can see how intensive they have made the map or all the points noted here. If you look at the legend, noise measurement locations of where or all the noise measurements have been done, at which locations the measurements have been done, and then the blue color circle you can see impacted and benefited receptors, which have a positive impact.

And then you see the red color circle, impacted but not benefited receptor, and so then you see the green color not impacted but benefited receptors. And then non-noise-sensitive receptors. So, you can see how the receptors are there, right of the acquisition, and all those areas and demarcations are there. The brown color lines, and polygons which you can see are the noise study areas.

So, those pockets, have picked up in the linear source of noise and then they are systematically undertaking that study. So, while at this stage, you also need to discuss with the local authority to identify how your assessment has to be in terms of, how much area you will cover, at what time, what period, what day of the week, what time of the week you would take, make the recording. So, all that has to be aligned with the requirements of the local authority.

And you also need to plan the monitoring site, where you will monitor all the recordings. Usually, the most sensitive receptor, like at the school or the hospital, so you locate your monitoring places at those sensitive sites. So, that is the basic idea behind that. And you may face problems in identifying sensitive receptors in case of linear development. So, here you see that, in the case which we are following that very systematically they are looking at all the pockets and different areas and receptors, how the study has to be done.

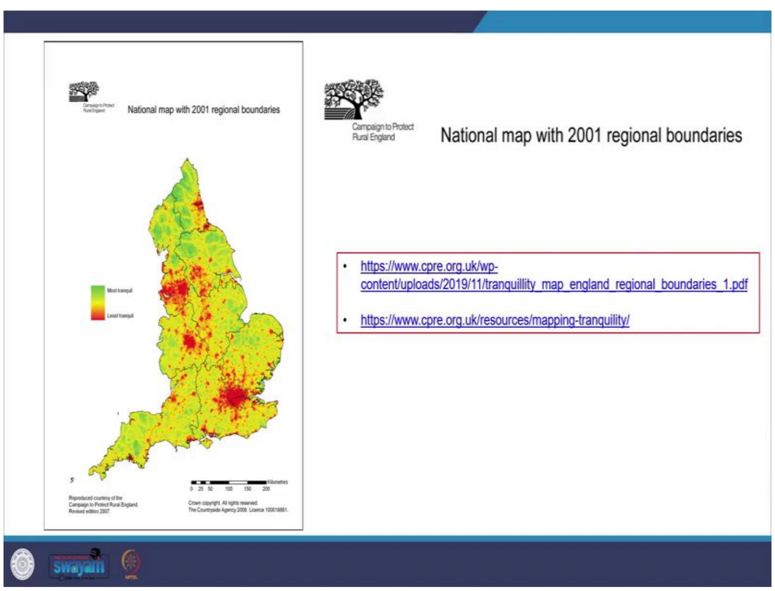
(Refer Slide Time: 35:03)



So, here you can see again how they are looking at various areas, all the other rail, roads railway crossings, and stations which are there in the project area. So, there are a lot of secondary data available. Usually, noise maps are prepared. So, in particular, in Europe, you would find the directive. They have assessment and management of environmental noise, CPRE, and tranquility maps, and they prepare and keep them. So, one can readily take those.

And they are very small-scale maps and then they create, they cover large areas, and then just to give it a general idea about the level of noise. However, for the detailed study you might have to undertake.

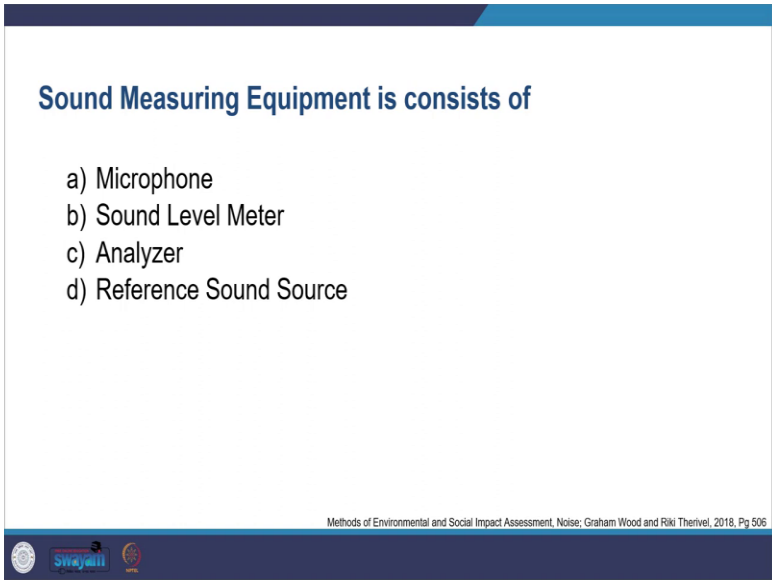
(Refer Slide Time: 35:52)



So, I have given you the link from where you can see, and explore this as well as download those maps if you need to see more. You also see that IEMA provides a summary of research studies which also show, what kind of variations happen, and what kind of noise monitoring data are there. So, that also you can see.

So, you see that there can be a lot of variations when you undertake, you measure the sound. And those variations can be because of the range of equipment which you are using and so on.

(Refer Slide Time: 36:41)



So, if you look at different kinds of equipment which are used for measuring the sound you have a microphone, which converts changes in ambient pressure into electrical quantity. And it is usually protected by the windshield. Then you have a sound level meter, which gives you information in dB. Then you have an analyzer, which records noise descriptors. So, you have LAeq, LA max, and so on over some time. So, they provide you with that.

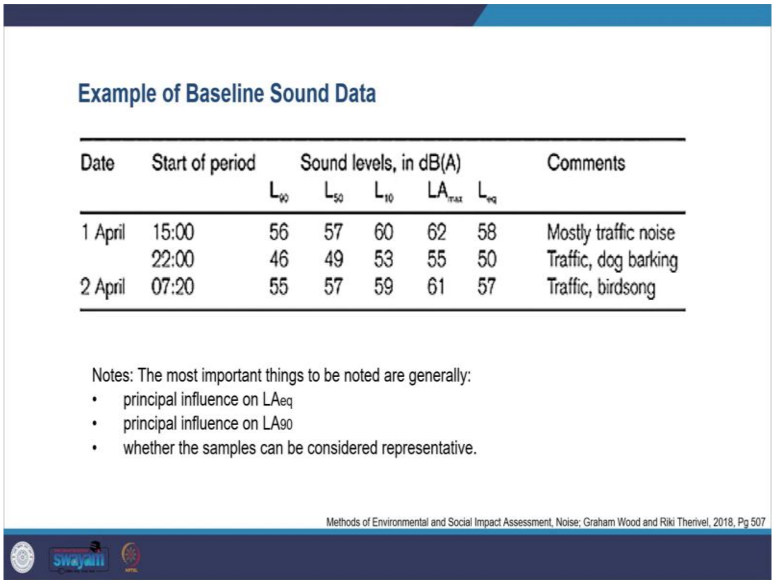
Then you also have a sound, reference sound source which you use for calibrating the equipment. So, all these can be also incorporated into one machine only. So, the sound level meter can have different settings also. So, you need to describe that all very clearly, and what meeting you are undertaking for that, also needs to be described properly in your report.

So, when you undertake noise measurements, you will look at, would take note of the equipment, and what equipment you are, you have used, and you will be also required to tell about the manufacturer and type of that thing, what equipment you have used. And then you also need to record the date and time of that, the weather conditions, and wind speed and wind direction. Then you also need what, how you are calibrating the sound meter and microphone. So, all that has to be given.

Plus you have to even tell about the setting up of the microphone, where you did it, where which site you fixed it, and you need to note the locations of those, wherever you took the measurements, and what were the criteria for taking the measurements, and you need to adhere to certain guidelines and you need to report that as well that which guidelines you are adhered to.

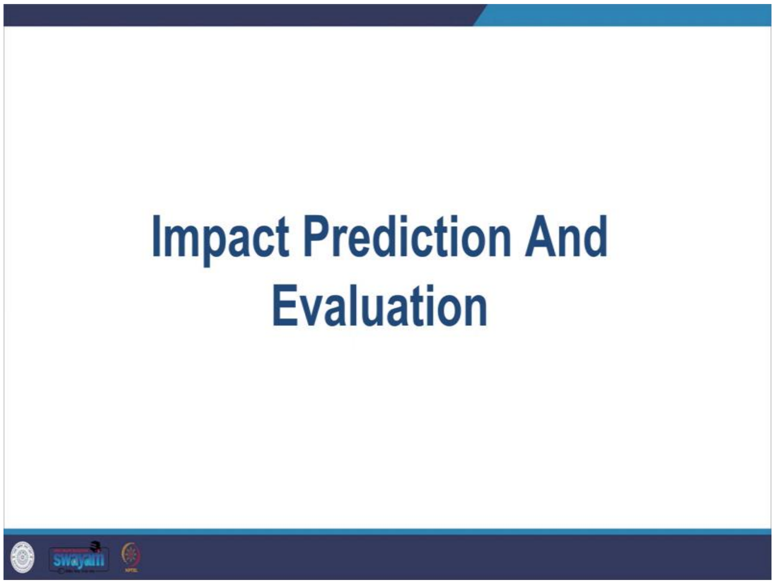
So, whether you were taking it continuously for 1 day, 24 hours or you took it for 1 hour in a day. So, those references have to be given. You also need to record the start and the finish time of all your recordings, and then how you check the calibrations.

(Refer Slide Time: 39:22)



So, here in, you can see in this example how the baseline noise data has been recorded for the EIA report. So, here you can see in this table you have the start periods, like you have April, April you can see what the start period at 3 o'clock then at 10 o'clock they are ending it, and then at 7:20 they are recording it again, and then the sound level which they have recorded and what are the comments there. So, you see this is one of the examples. So, this is about the baseline, what all the things you take care of.

(Refer Slide Time: 39:55)



Now, moving on to the impact prediction and evaluation. So, the main purpose of impact prediction and evaluation is you try to find out what kind of changes will happen in the noise level because of the kind of project that is coming up. And these changes, you have to look at both the short term and long term.

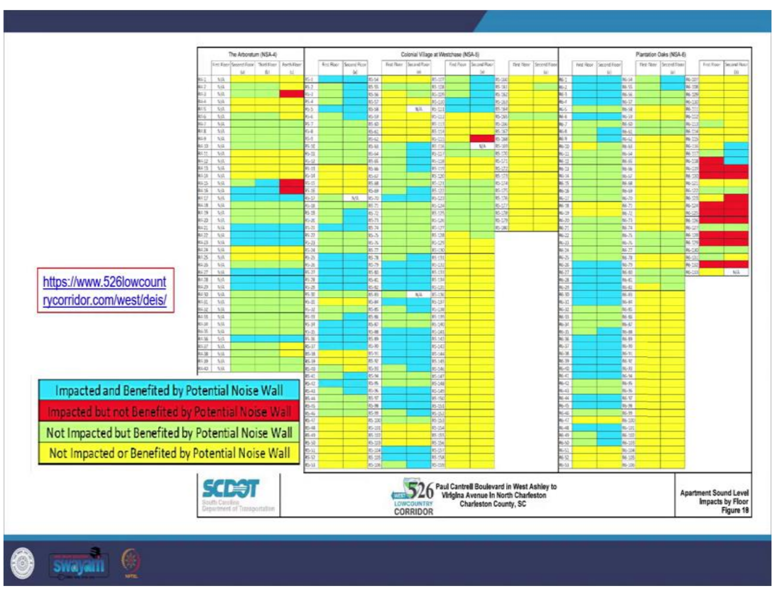
And then you need to, once you understand the changes you need to understand the significance of those changes, how important these changes are. You need to understand that predicting noise is a very complex process and it changes with a lot of conditions.

For example conditions like the existing and future baseline noise levels. So, if it changes then those things might change, what kind of equipment you are using, what is the duration of every stage of construction and operation of your project, and which day and time, when in your project, what kind of equipment will be used, and when it will be used, and what kind of activity will go in the site.

And then what is the location of the receiver, how close, how far they are, and how sensitive they are? And then what is the geography, the topography of the area, and then is it offering certain natural sound barriers, and what are the climatic conditions of that area? So, these factors will influence the quantity, the amount, or the kind of sound that will come from the project area, or the site.

So, it will be also influenced by how the sound is traveling and how the responder is responding to this noise level. And when you do undertake noise level prediction, you fix the sound power level at the source, and you predict the sound level at each receptor. So, how, what is the sound level at the source, and then what is the final ultimate sound level at the receptor? And then you would also add a new sound level if there are additional levels that are coming there.

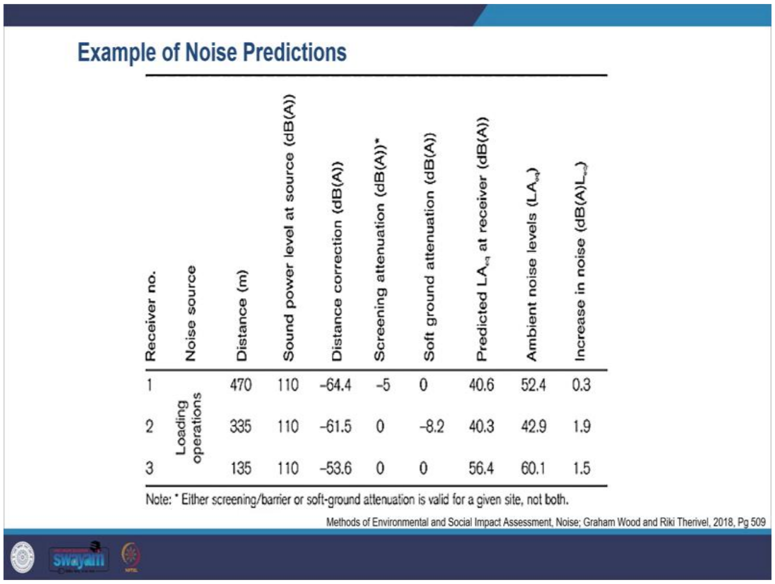
(Refer Slide Time: 42:26)



So, in this case, you can see from the same EIA report, I have taken, you can see the matrix that has been prepared here. So, you see the red color, impacted but not benefited by the potential noise wall. So, as a mitigation measure, they are using a protected noise wall. But then these red areas are not getting protected by that, despite they are getting impacted.

Then you can see the green, not impacted but they are getting benefited by that. And then the yellow you can see not impacted or benefited by the potential noise walls. So, they have no difference. So, that, you can see how they have presented in a matrix form to understand that.

(Refer to Slide Time: 43:06)



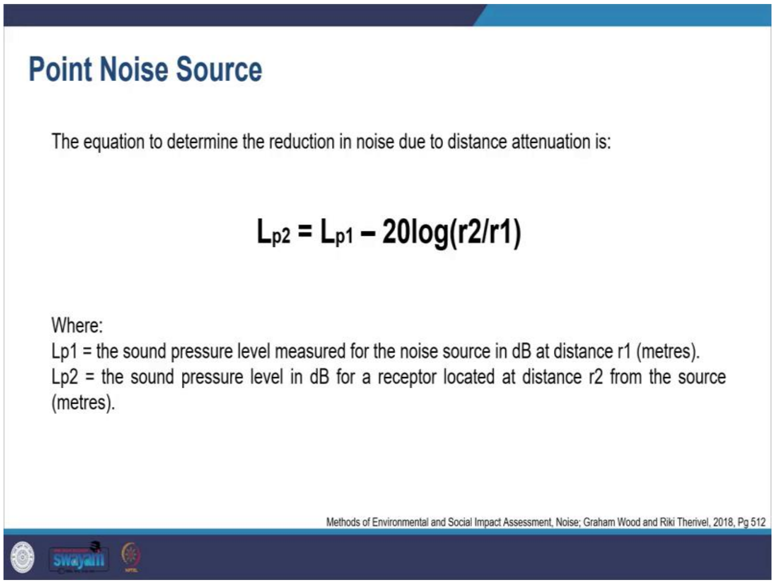
Here again, you can see different receiver numbers, 1, 2, and 3, and then the noise source and how far they are, what is the sound power level at the source, and then what is the distance corrections you are making. And then the screening, how the sound is reducing, what kind of soft surfaces are there, and then what is the predicted sound level at the receiver, and then what kind of ambient noise level is there, and what kind of what will be the increase in the noise.

So, you can see how it has been presented here, and you can take many of these references from the manufacturer of the equipment. So, here you can see how, in this particular case they have, for their modeling purpose, traffic noise model, they have taken all the classification and then used data from sources which give information.

So, now look at how you calculate, how the sound will reduce because of the geometrical form or the shape of how sound will travel. So, when you deal with sound pressure level data, so you have when you undertake sound when you deal with sound pressure level data, you measure the existing emission source, and what kind of source is there.

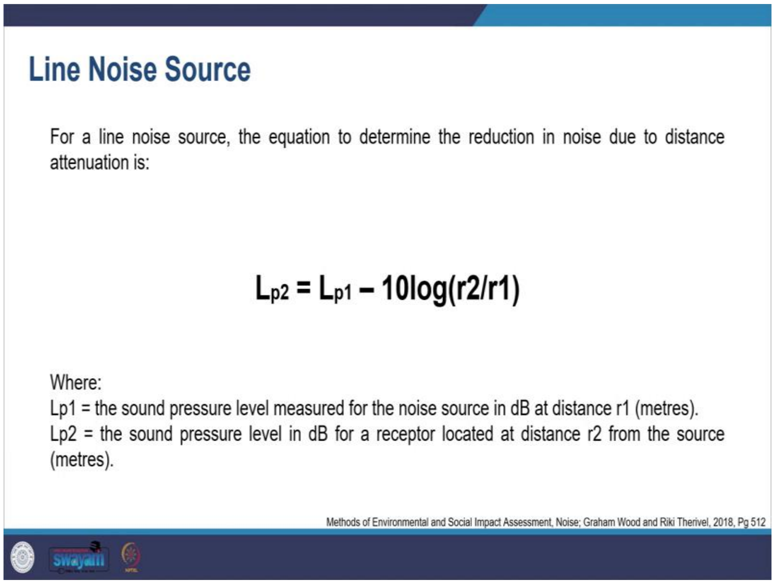
You take from the standards of what it is given there, and then you calculate the distance that it is going to travel, and you take the geometrical, which geometrical dispersion will it take. So, in the case of the point noise source, when your source is a point source, when you have an industry or any construction site, you take it as a point source. So, for that, your wave will travel in, like with the law of, inverse square law, and it will, with the, like we already mentioned, like with the doubling of the distance it will reduce to 6 decibels.

(Refer Slide Time: 45:26)



And the equation for that is you can see here the equation. So, you see that L p 1 is the sound pressure level measured for the noise source in dB at whatever distance you are taking, and then you have L p 2, the sound pressure level in dB for a receptor located at a distance r 2 from the source, meter. So, you take that and you are taking the 20 log which is the minimum audible sound we have. So, you have all the data which is usually that standard provides for what kind of equipment or vehicles, what kind of sound you will have.

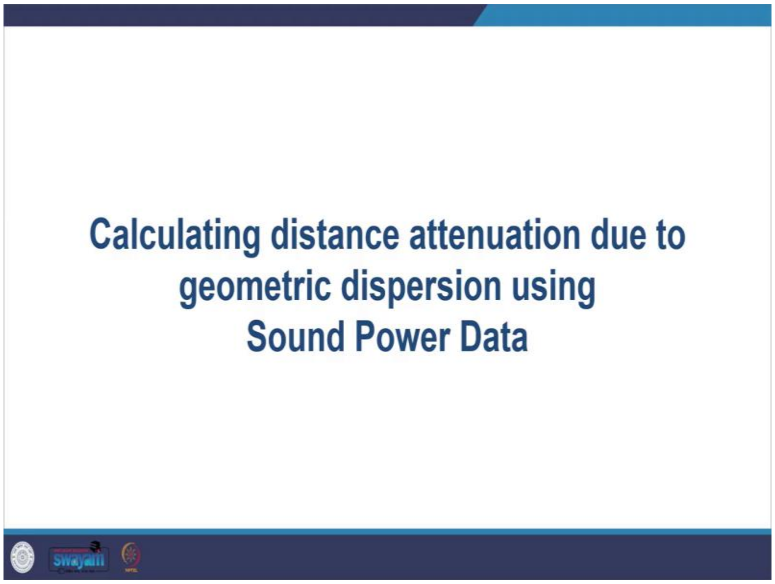
(Refer Slide Time: 46:07)



So, further calculating for line noise source, line noise source will be the road, railway, all these things. So, for that, we had already seen that it is 3 3-decibel reduction per doubling of the distance. And the sound will the geometrical form the sound will take is in the form of a cylinder. We see that. And then the formula for this would be L p 2 equals to L p 1 by minus 10 log. So, you see this here, the hemisphere formula which they would be using here. And then you could work out for different values and see that here.

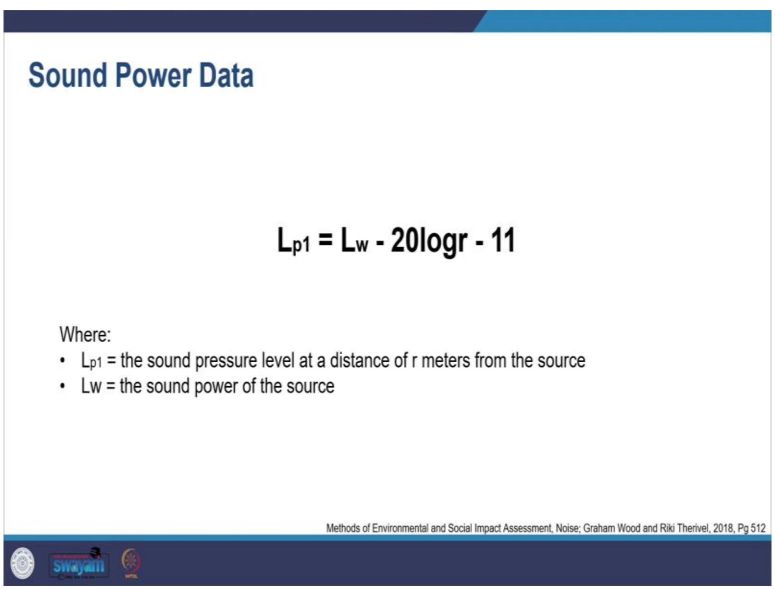
So, the general rule of thumb which you use when you are dealing with a line source, is how would you identify which one is a point source or which one is the line source. So, whenever you are dealing with it, wherever the receptor is if the source is 3 times as long as the distance between the source and the receiver, then it will be considered a line source, otherwise it will be considered a point source.

(Refer Slide Time: 47:35)



So, when you are now looking at the calculation, which, is for the reduction purpose when you have sound power data.

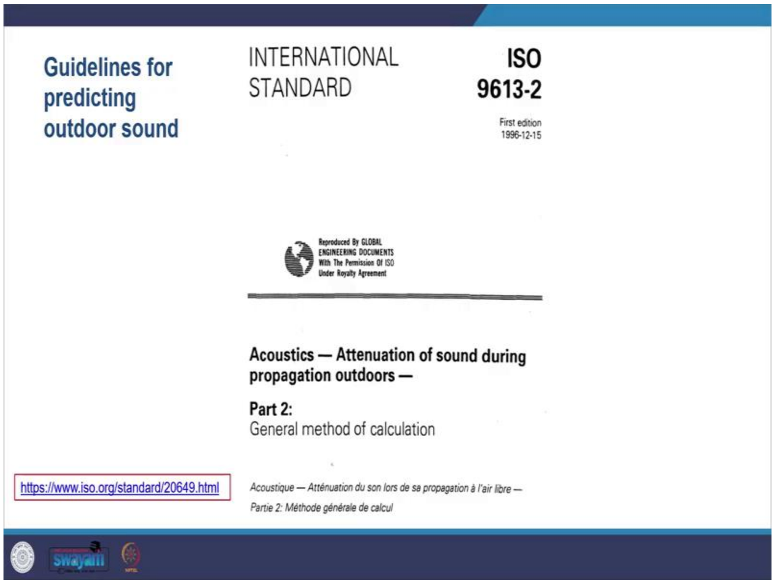
(Refer Slide Time: 47:42)



So, when you have sound power data, this is generally provided by the manufacturer, and you input data accordingly. So, here you can see the formula. So, it is a very basic calculation here, and what you see in 11 is like the correction that you make for the distance here. So, you have L p 1, the sound pressure level at a distance of r, from the source, and L w, the sound power of the source. And then 11 is taken as the correction factor.

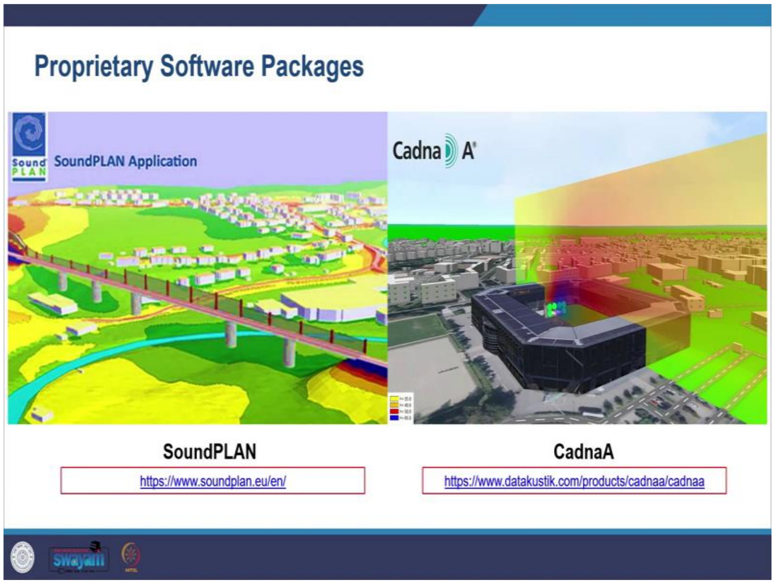
So, you would be required to undertake correction based on the material between the source and the receptor, and depending on the kind of surface you have, you have to apply the correction factor there. So, these would also be available through these standards, the correction factors. And whenever you have multiple sources, you might also come across a situation where you have multiple sources, then in that multiple individual point sources, you take is like, you calculate for all and you add up the values.

(Refer Slide Time: 48:51)



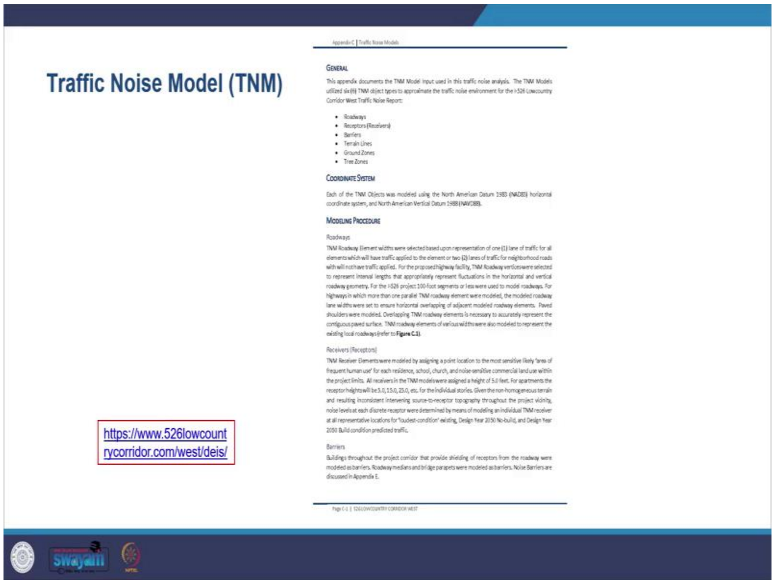
In particular, you have ISO 9613 1996 which is very much used for the purpose.

(Refer Slide Time: 49:01)



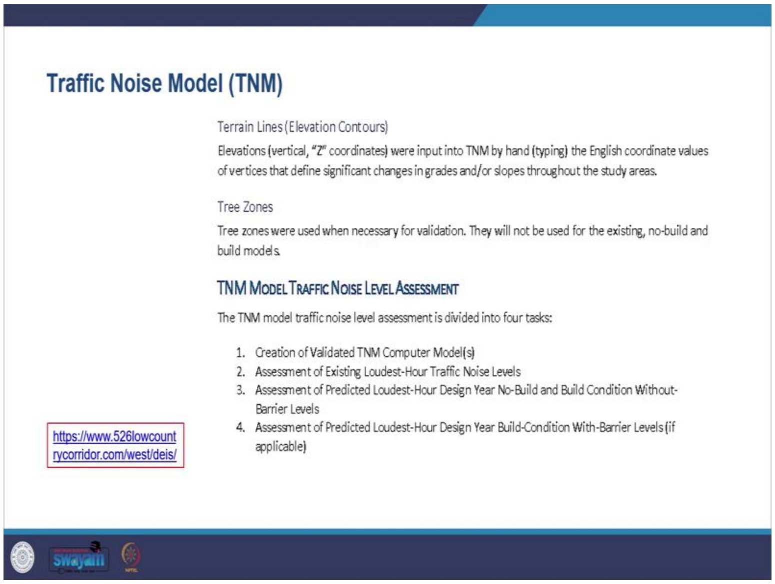
Then you have software packages like SoundPLAN and CadnA, which are also there. And then which aligns with the standards as well. The link for these is also given, from where you can learn more. GIS is also used a lot. And then you can also, with the help of GIS, you can create digital terrain models and then you can also have 3D acoustic modeling packages which are available. And then also have, the Department of Trade and Industry has also guided predictive modeling.

(Refer Slide Time: 49:36)



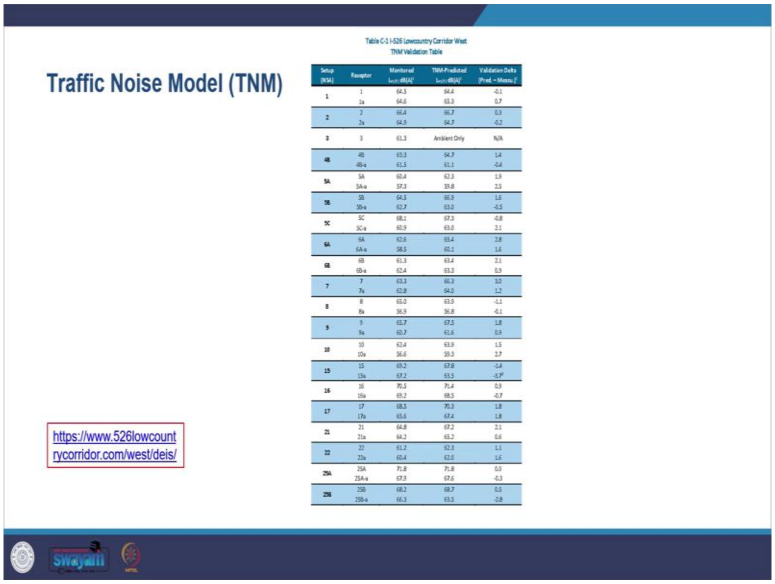
Here, from the case, we are seeing, which the case we are following, so we see this is, they have used a traffic noise model. So, here you can see that they have taken for roadways, receptors, barriers, terrain lines, ground zones, and tree zones, they have identified all those things.

(Refer Slide Time: 49:53)



And then there were certain steps that they followed like the creation of where they would validate the computer model and then they would look at the loudest hours traffic noise level and then they would analyze it with no build and build conditions. Without having barriers also they would see, without the mitigation also they will look at, they would also assess the difference in the impact.

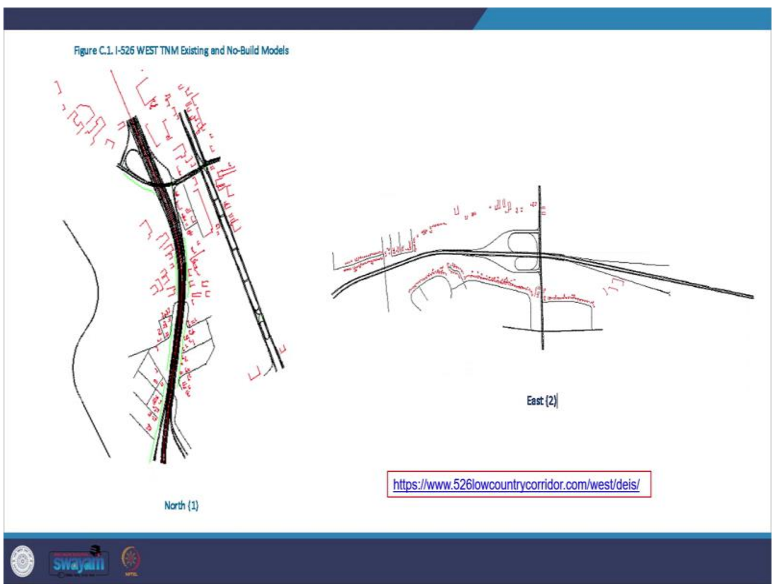
(Refer Slide Time: 50:20)



Setup (NSA)	Receptor	Monitored $L_{eq(h)}$ dB(A)[1]	TNM-Predicted $L_{eq(h)}$ dB(A)[1]	Validation Delta (Pred. – Meas.)[2]
1	1	64.5	64.4	-0.1
	1a	64.6	65.3	0.7
2	2	66.4	66.7	0.3
	2a	64.9	64.7	-0.2
3	3	61.3	Ambient Only	N/A
4B	4B	63.3	64.7	1.4
	4B-a	61.5	61.1	-0.4
5A	5A	60.4	62.3	1.9
	5A-a	57.3	59.8	2.5
5B	5B	64.5	66.9	1.6
	5B-a	62.7	63.0	-0.5
5C	5C	68.1	67.3	-0.8
	5C-a	60.9	63.0	2.1
6A	6A	62.6	65.4	2.8
	6A-a	58.5	60.1	1.6
6B	6B	61.3	63.4	2.1
	6B-a	62.4	63.3	0.9
7	7	63.3	66.3	3.0
	7a	62.8	64.0	1.2
8	8	65.0	63.9	-1.1
	8a	56.9	56.8	-0.1
9	9	65.7	67.5	1.8
	9a	60.7	61.6	0.9
10	10	62.4	63.9	1.5
	10a	56.6	59.3	2.7
15	15	69.2	67.8	-1.4
	15a	67.2	63.5	-3.7[3]
16	16	70.5	71.4	0.9
	16a	69.2	68.5	-0.7
17	17	68.5	70.3	1.8
	17a	65.6	67.4	1.8
21	21	64.8	67.2	2.1
	21a	64.2	65.2	0.6
22	22	61.2	62.3	1.1
	22a	60.4	62.0	1.6
25A	25A	71.8	71.8	0.0
	25A-a	67.9	67.6	-0.3
25B	25B	68.2	68.7	0.5
	25B-a	66.3	63.5	-2.8

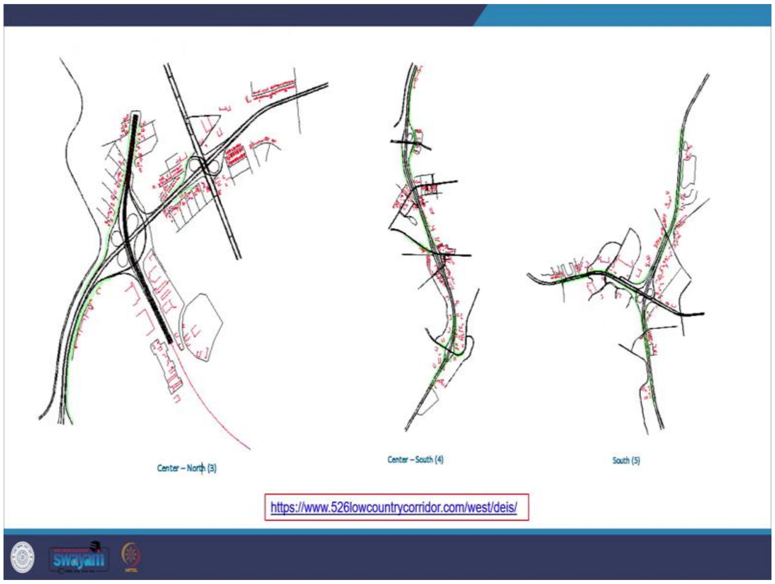
So, here you can see their model results where they have the receptor monitored level, the model predicted value, and then they have also validated that value.

(Refer Slide Time: 50:36)



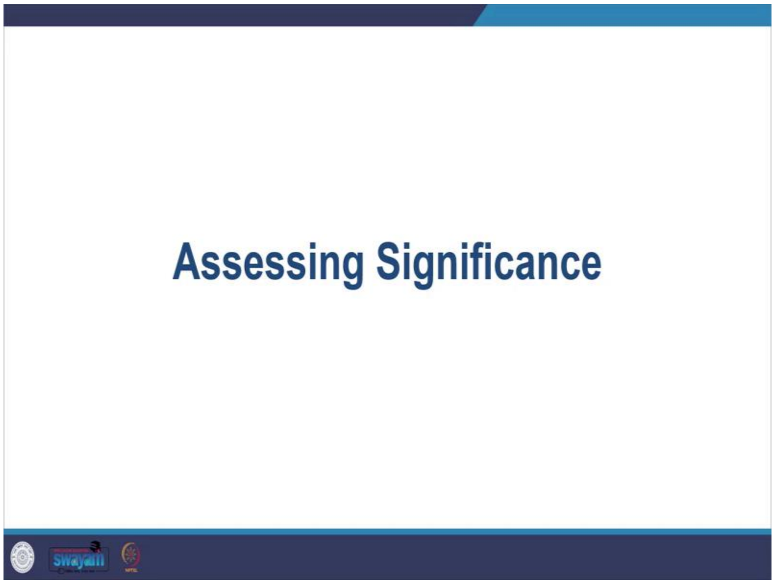
So, in this way, you can see how they have built those existing scenarios of the noise where, with no build model, they have no intervention, they are checking it that way.

(Refer Slide Time: 50:50)



And now in this, you can see with the build model what would be the noise level with all those new projects coming up and all those mitigation models coming up.

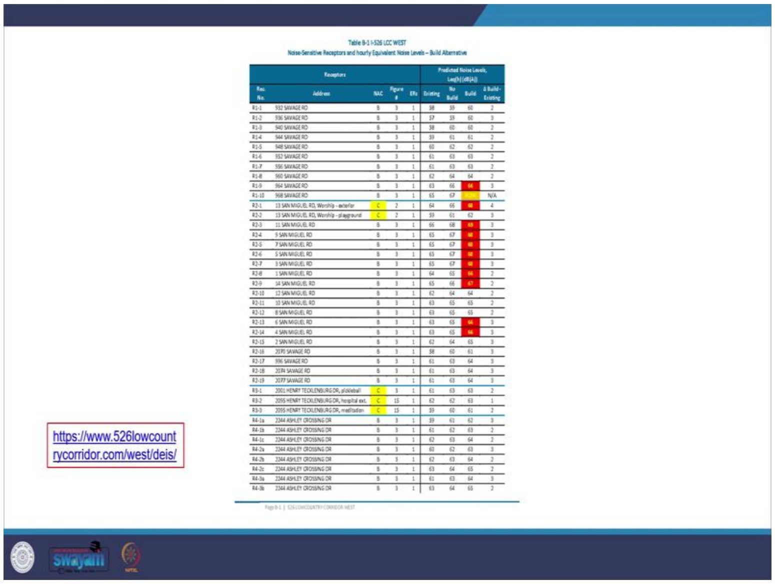
(Refer Slide Time: 51:00)



So, while, now we look at how we assess the significance. So, we see that significance is also very subjective because we are dealing with noise here, and it needs a lot of professional judgment. Significance criteria also differ a lot, but it is very important for EIA that you have a very consistent and transparent system.

So for the significance of noise, you undertake this sensitivity of the receptor, and then you also look at the magnitude of the kind of change that is going to happen. And you generally indicate in the form of an impact significance matrix.

(Refer Slide Time: 51:37)

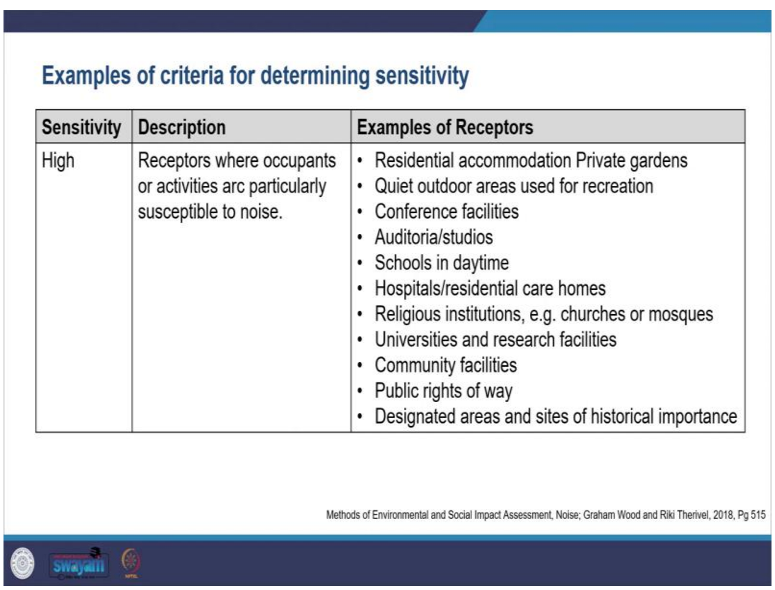


Receptors					Predicted Noise Levels, Leq(h) (dB(A))			
Rec. No.	Address	NAC	Figure #	ERs	Existing	No Build	Build	Δ Build - Existing
R1-1	932 SAVAGE RD	B	3	1	58	59	60	2
R1-2	936 SAVAGE RD	B	3	1	57	59	60	3
R1-3	940 SAVAGE RD	B	3	1	58	60	60	2
R1-4	944 SAVAGE RD	B	3	1	59	61	61	2
R1-5	948 SAVAGE RD	B	3	1	60	62	62	2
R1-6	952 SAVAGE RD	B	3	1	61	63	63	2
R1-7	956 SAVAGE RD	B	3	1	61	63	63	2
R1-8	960 SAVAGE RD	B	3	1	62	64	64	2
R1-9	964 SAVAGE RD	B	3	1	63	66	66	3
R1-10	968 SAVAGE RD	B	3	1	65	67	[illegible]	N/A
R2-1	13 SAN MIGUEL RD, Worship - exterior	C	2	1	64	66	68	4
R2-2	13 SAN MIGUEL RD, Worship - playground	C	2	1	59	61	62	3
R2-3	11 SAN MIGUEL RD	B	3	1	66	68	69	3
R2-4	9 SAN MIGUEL RD	B	3	1	65	67	68	3
R2-5	7 SAN MIGUEL RD	B	3	1	65	67	68	3
R2-6	5 SAN MIGUEL RD	B	3	1	65	67	68	3
R2-7	3 SAN MIGUEL RD	B	3	1	65	67	68	3
R2-8	1 SAN MIGUEL RD	B	3	1	64	65	66	2
R2-9	14 SAN MIGUEL RD	B	3	1	65	66	67	2
R2-10	12 SAN MIGUEL RD	B	3	1	62	64	64	2
R2-11	10 SAN MIGUEL RD	B	3	1	63	65	65	2
R2-12	8 SAN MIGUEL RD	B	3	1	63	65	65	2
R2-13	6 SAN MIGUEL RD	B	3	1	63	65	66	3
R2-14	4 SAN MIGUEL RD	B	3	1	63	65	66	3
R2-15	2 SAN MIGUEL RD	B	3	1	62	64	65	3
R2-16	2070 SAVAGE RD	B	3	1	58	60	61	3
R2-17	996 SAVAGE RD	B	3	1	61	63	64	3
R2-18	2074 SAVAGE RD	B	3	1	61	63	64	3
R2-19	2077 SAVAGE RD	B	3	1	61	63	64	3
R3-1	2001 HENRY TECKLENBURG DR, pickleball	C	3	1	61	63	63	2
R3-2	2095 HENRY TECKLENBURG DR, hospital ext.	C	15	1	62	62	63	1
R3-3	2095 HENRY TECKLENBURG DR, meditation	C	15	1	59	60	61	2
R4-1a	2344 ASHLEY CROSSING DR	B	3	1	59	61	62	3
R4-1b	2344 ASHLEY CROSSING DR	B	3	1	61	62	63	2
R4-1c	2344 ASHLEY CROSSING DR	B	3	1	62	63	64	2
R4-2a	2344 ASHLEY CROSSING DR	B	3	1	60	62	63	3
R4-2b	2344 ASHLEY CROSSING DR	B	3	1	62	63	64	2
R4-2c	2344 ASHLEY CROSSING DR	B	3	1	63	64	65	2
R4-3a	2344 ASHLEY CROSSING DR	B	3	1	61	63	64	3
R4-3b	2344 ASHLEY CROSSING DR	B	3	1	63	64	65	2

So, here you can see from the same case how they have created the matrix here. So, all the locations they have identified in this column receptors, and then you can see the predicted noise levels, so where they have existing, no built, built and building existing and then all those marked in red and yellow color, so you can see.

So, significance also depends on the existing noise level. And it would also, like any small change could also make a big difference there. And it would also depend on the nature of the sound. So, is that sound continuous, or does it have a break in that, what time is the frequency of that, and what time and day that it occurring? So, one also needs to average out the period but one needs to be very careful because averaging out would also lead to height, the high magnitude noise.

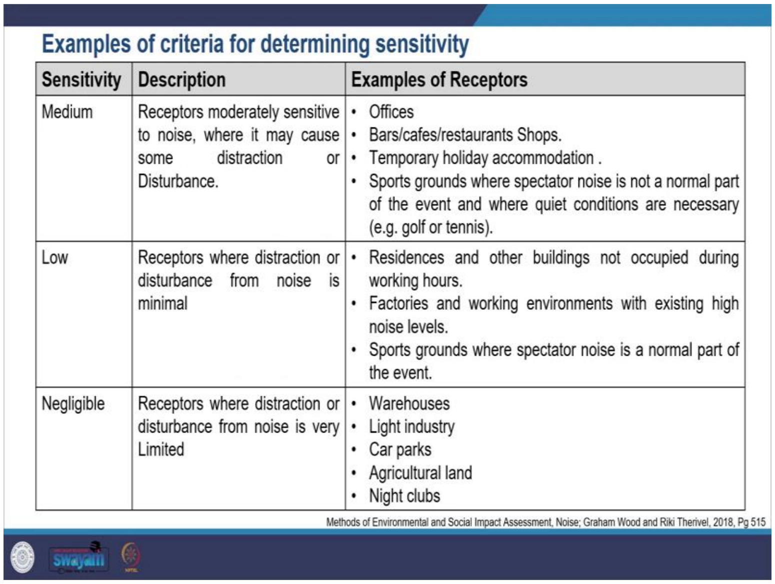
(Refer Slide Time: 52:29)



Sensitivity	Description	Examples of Receptors
High	Receptors where occupants or activities arc particularly susceptible to noise.	• Residential accommodation Private gardens • Quiet outdoor areas used for recreation • Conference facilities • Auditoria/studios • Schools in daytime • Hospitals/residential care homes • Religious institutions, e.g. churches or mosques • Universities and research facilities • Community facilities • Public rights of way • Designated areas and sites of historical importance

So, here you can see again another example of determining sensitivity, like how high, medium, low, and negligible sensitivity is there of the receptors. For example, you can say receptors where occupants or activities are particularly susceptible to noise. So, those can be residential accommodation, private gardens, and so on.

(Refer Slide Time: 52:52)



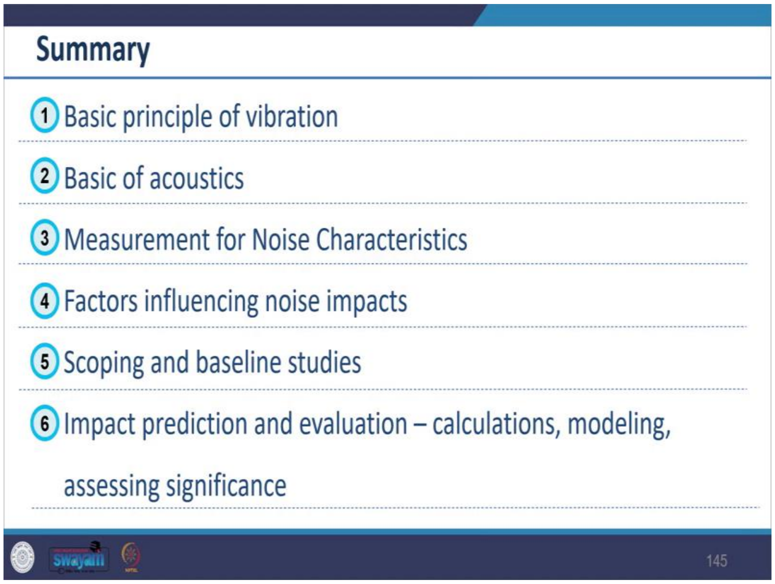
Examples of criteria for determining sensitivity

Sensitivity	Description	Examples of Receptors
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or Disturbance.	• Offices • Bars/cafes/restaurants Shops. • Temporary holiday accommodation . • Sports grounds where spectator noise is not a normal part of the event and where quiet conditions are necessary (e.g. golf or tennis).
Low	Receptors where distraction or disturbance from noise is minimal	• Residences and other buildings not occupied during working hours. • Factories and working environments with existing high noise levels. • Sports grounds where spectator noise is a normal part of the event.
Negligible	Receptors where distraction or disturbance from noise is very Limited	• Warehouses • Light industry • Car parks • Agricultural land • Night clubs

Methods of Environmental and Social Impact Assessment, Noise; Graham Wood and Riki Therivel, 2018, Pg 515

So, to understand the sensitivity of the recipients you can look at this table. So, that was about the noise.

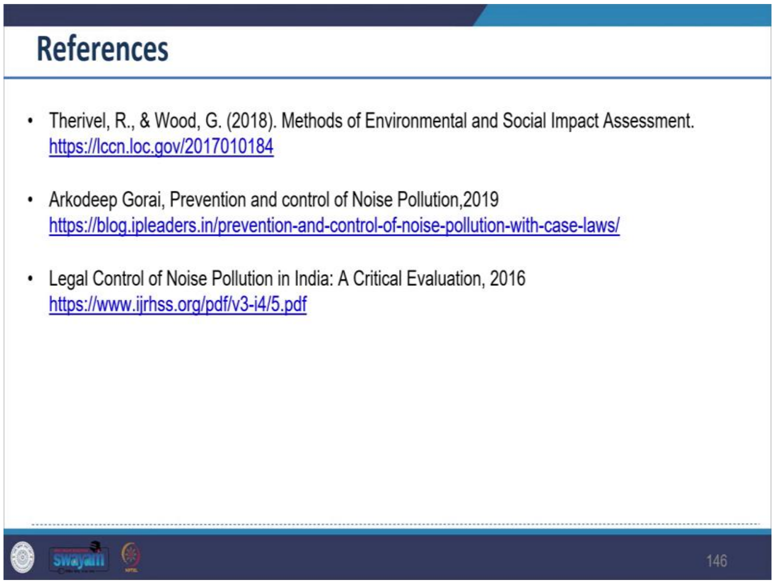
(Refer Slide Time: 53:02)



So, summarizing what we covered today, we looked at the basic principle of vibration, we looked at the basic concepts of acoustics, we looked at the measurement of noise characteristics, different characteristics, and then we looked at the factors that influenced the noise impacts, what are those factors.

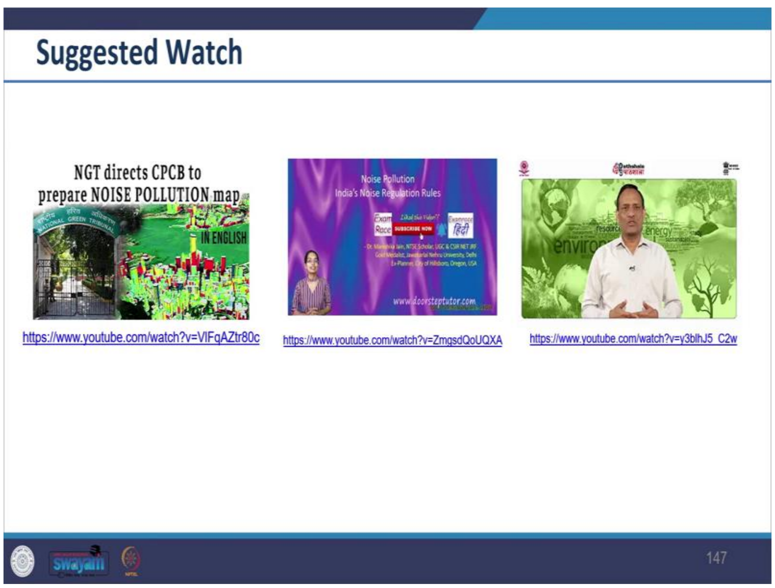
Then we looked at what one has to undertake during scoping and baseline assessment. Then we looked at various impact prediction and evaluation aspects, what kind of calculations have to be done, what modeling, and how you assess the significance of any kind of impact that you find out.

(Refer Slide Time: 53:39)



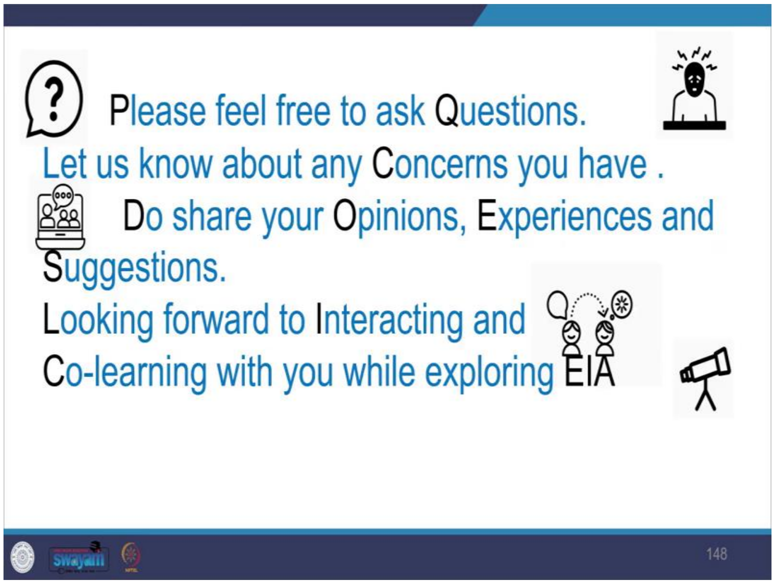
So, this was a key reference, Therivel and Wood's book here, and then we also took references for this case study, which I will be providing a link through the group forum.

(Refer Slide Time: 53:55)



And these are the suggested watches which you can, if you want to see more and more about certain concepts and things like that, you can see here.

(Refer Slide Time: 54:05)



So, winding up, please feel free to ask questions. Let us know about any concerns you have, and do share your opinions, experiences, and suggestions, looking forward to interacting and co-learning with you while exploring EIA. Thank you.