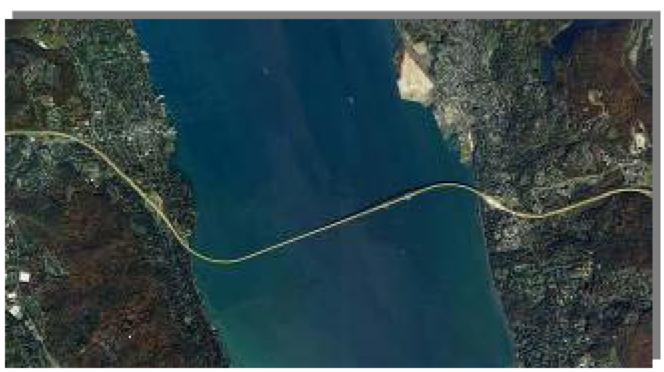
New York State Department of Transportation
Metropolitan Transportation Authority Metro-North Railroad
New York State Thruway Authority

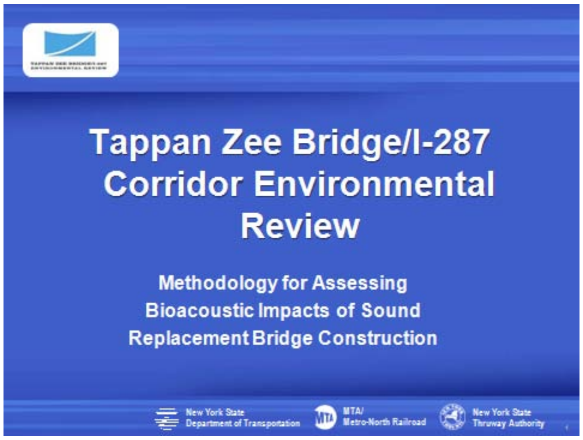
Presentation

Stakeholders' Advisory Working Groups (SAWGs) Joint Bridge (#19) and Environmental (#15) SAWG Meeting

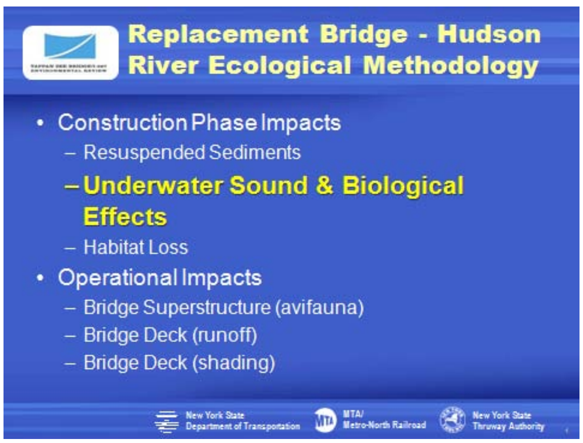
Tappan Zee Bridge/I-287 Corridor Project



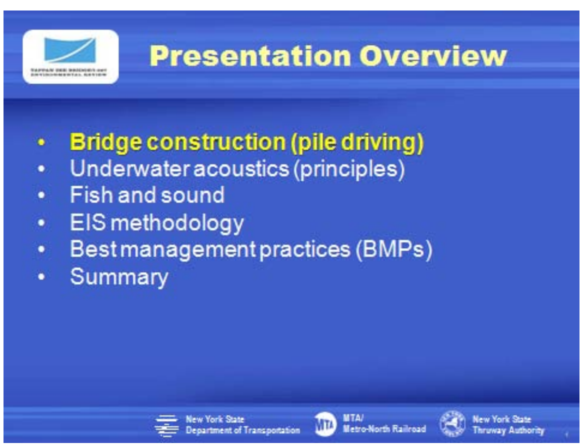
June 16, 2010



Slide 1. Robert Laravie (NYSDOT) welcomed members of the Bridge and Environmental Stakeholders' Advisory Working Groups (SAWGs) and introduced the evening's agenda. The goal of this meeting was to present and discuss the project team's plans to evaluate the effects of underwater noise on fish.

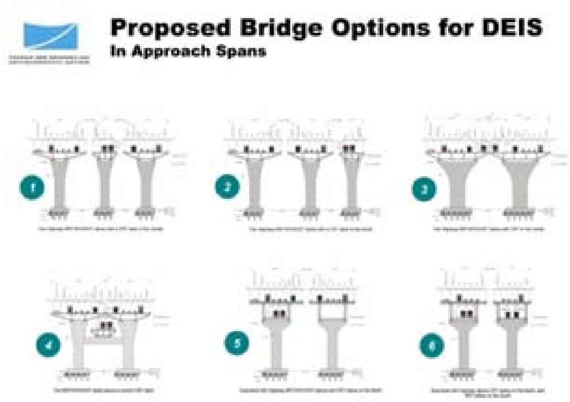


Slide 2. This presentation is the second of three in a series detailing how construction-phase impacts during the construction of the replacement Tappan Zee Bridge will be analyzed.

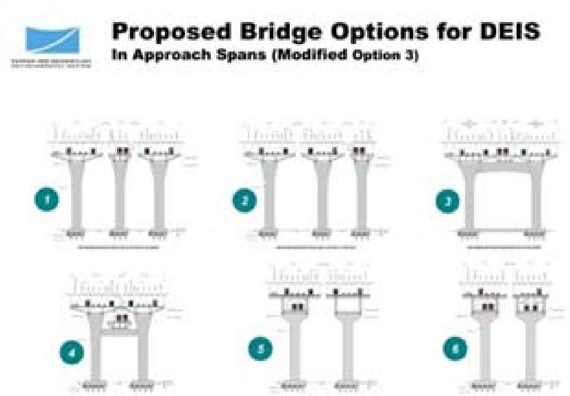


Slide 3. The presentation began with an overview of the specific technical matters related to underwater noise that were to be addressed during the meeting. The presentation consisted of five main sections, beginning with a description of the construction activities that are likely to cause noise in the underwater environment; then, background information on how sound travels in the underwater environment was provided. Next, there was a presentation on how fish use and are affected by sound. Finally, the methodology to be used in analyzing potential impacts for the project's EIS and a summary of some means of reducing noise from construction activities (best management practices) will be discussed.

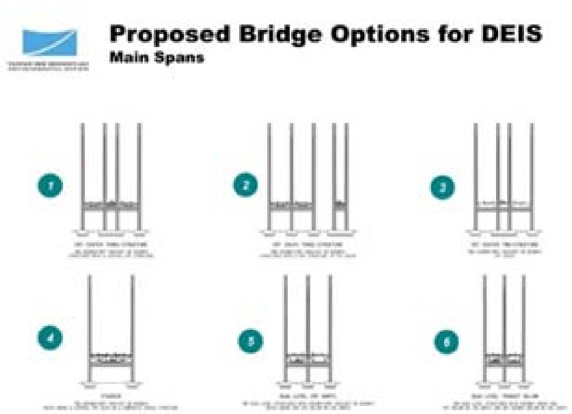
Slide 4. During the first part of the presentation, the construction activities required to build a replacement Tappan Zee Bridge was reviewed. The bridge configurations currently under study were presented with an emphasis on the activities that would generate underwater noise.



Slide 5. Members were shown the six bridge configurations, or options, still under study. The illustrations are of the approach spans, which are the spans on either side of the main span. The remaining options are three single-level bridge configurations (Options 1-3) and three dual-level configurations (Options 4-6).



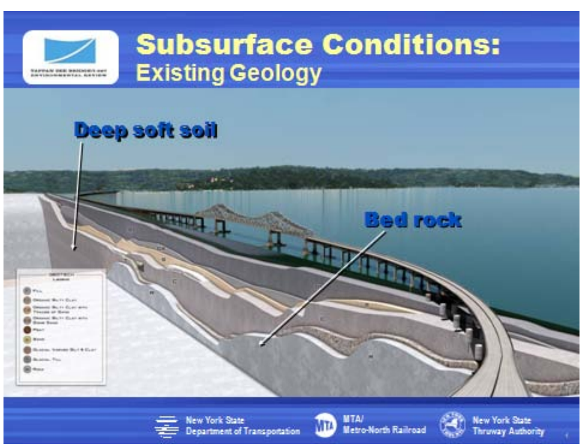
Slide 6. After our last Bridge SAWG meeting, the configuration of Option 3 was refined to reduce the asymmetry of the commuter rail transit (CRT) loading on the decks. This configuration also would allow the CRT to be phased in at a later date with the addition of a cross beam between the two spans.



Slide 7. This slide includes sketches of the main spans that could result from the six approach options presented in the previous slides, assuming a cable-stayed bridge. Other main span bridge types are possible and will be considered, however. The slide indicates how the decks could be configured around towers and cables.

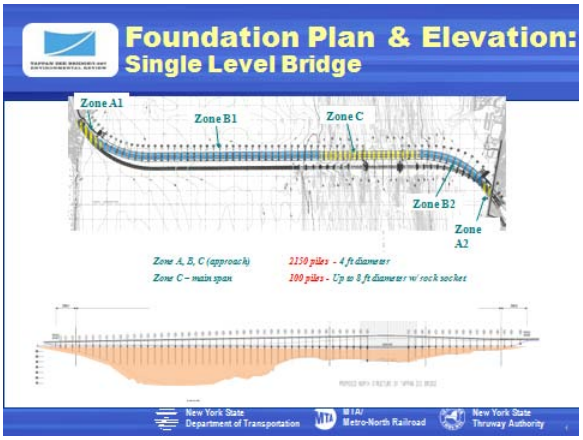
Slide 8. Two of the six options were shown to explain the primary components of the replacement structure, which include decks, piers, and foundations (pilecaps and piles).

The potential for noise impacts associated with the installation of the piles is the key item in tonight's discussion on underwater acoustics. The purpose of piles was discussed.



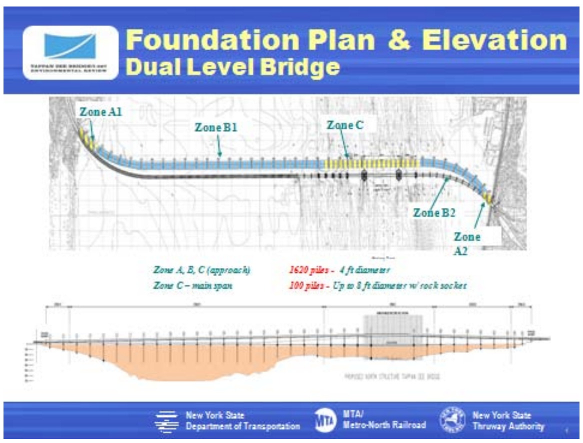
Slide 9. Various substrate components are found beneath the Hudson River bed, with rock at depths ranging from 200 to 700 feet below the mudline. As the substrate is generally soft and rock is deep, extensive piling would be required to support the replacement Tappan Zee Bridge (TZB).

Because the foundations are so deep (piles would need to reach 300-400 feet below the river bed), all piles are expected to be driven piles.



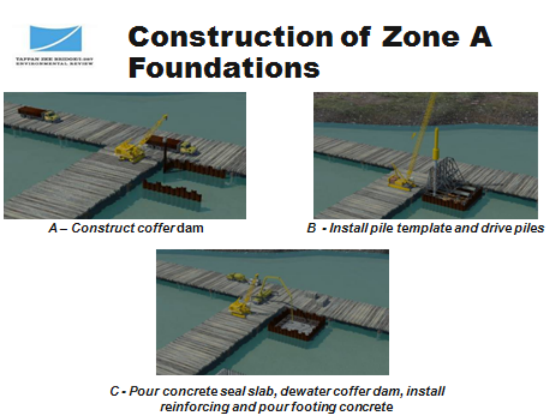
Slide 10. The extent of the new piers in the river to support a sample single-level option was shown. To support this option, 2150 and 100 piles of 4-foot and 8-foot diameter, respectively, would be needed. Each pile comprises an outer steel shell filled with concrete.

Piles would be constructed in different sequences in the areas highlighted as Zones A, B, and C - outlined in later slides.



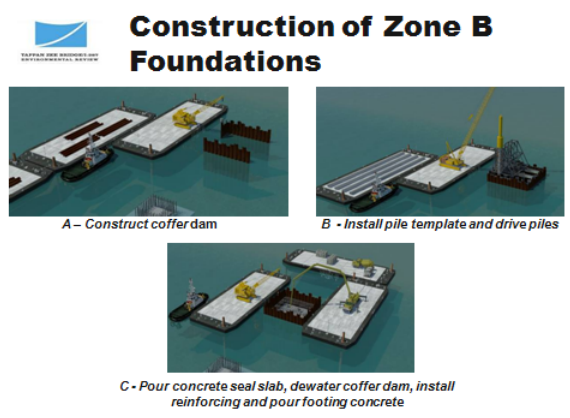
Slide 11. The extent of new piers in the river for a sample dual-level option was shown in this slide. In this option, 1620 and 100 piles of 4-foot and 8-foot diameter, respectively, are being considered for evaluation purposes. Each pile comprises an outer steel shell filled with concrete.

Piles would be constructed using different techniques in the areas highlighted as Zones A, B, and C as outlined in later slides.



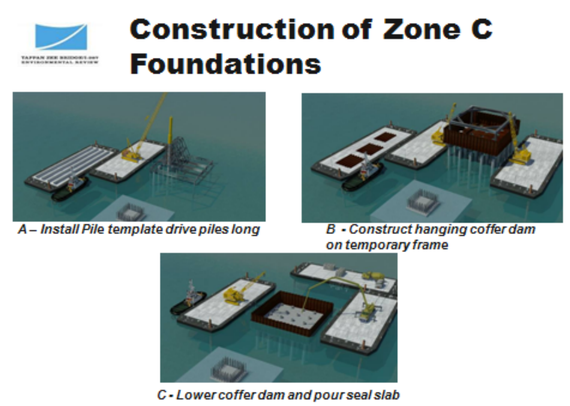
Slide 12. In Zone A, all foundations would be in shallow water (less than 5 feet deep) and near the shoreline on both sides of the river. Piles are expected to be constructed within standard cofferdams from temporary platforms in the following general sequence:

1. Install a temporary cofferdam around the foundations.
2. Install piles without removing the water from inside the cofferdam.
3. Remove water from the cofferdam and construct pilecap.



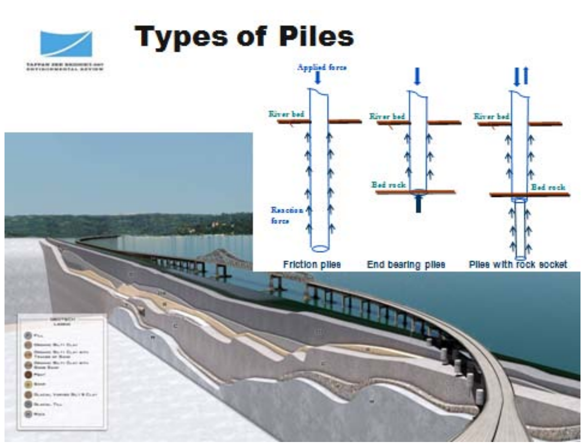
Slide 13. In Zone B, all foundations also would be in relatively shallow water (5-18 feet deep) and are expected to be constructed from within standard cofferdams. The cofferdams would be similar to those anticipated to be used in Zone A, but this time the piles would be installed from barges in the river. The construction sequence also would be similar:

1. Install a temporary cofferdam around the foundations.
2. Install piles without removing the water from inside the cofferdam.
3. Remove water from the cofferdam and construct pilecap.



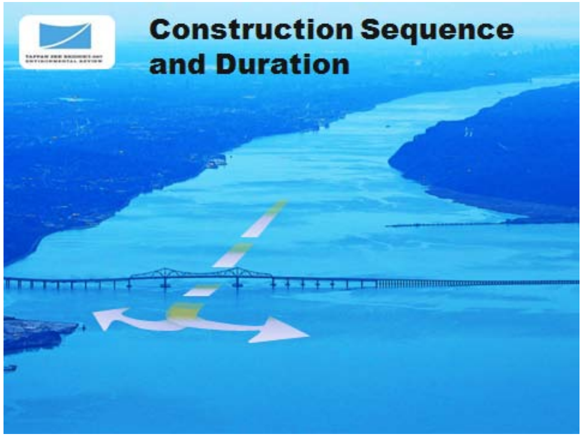
Slide 14. In Zone C, all foundations would be in deeper water (18-45-feet deep) and are expected to be constructed using "hanging cofferdams." As in Zone B, piles would be installed from barges in the river. However, the construction sequence differs from that in Zones A and B in that the piles would be driven <u>before</u> the cofferdams are installed:

1. Install piles first.
2. Install hanging cofferdam on top of completed piles.
3. Remove water from inside the hanging cofferdam and construct pilecap.



Slide 15. Three different types of piles are expected to be used across the river:

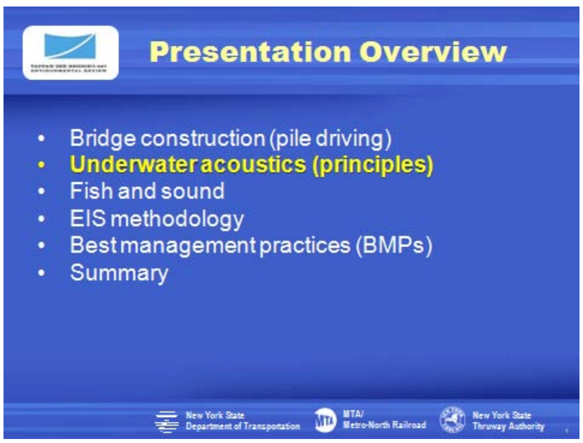
1. Friction piles are expected in the deep soft soils found in the western half of the river. These piles transmit the loads from the bridge to the substrate in friction along the side of the pile.
2. End bearing piles would be used where the piles reach rock and the loads from the bridge can be directly transferred to the rock below.
3. End bearing piles with rock sockets: These piles extend into the rock and are used where there the rock is in poor condition or where the piles have to resist large forces from the bridge, for example, during a seismic event.



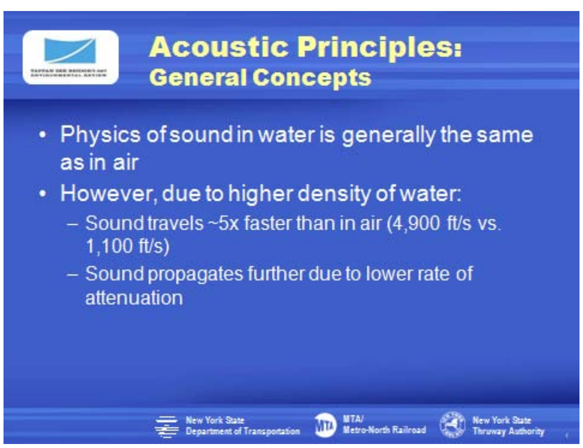
Slide 16. This slide indicates the expected progression of the overall construction sequence. Construction of the replacement bridge would commence near the middle of the river and progress towards the shorelines. As the preparatory activities, including dredging and armoring, are completed at the shore line, - construction would eventually also advance from the shorelines out toward the center.

It is anticipated that 2-3 piles would be installed simultaneously during construction with 2-3 piling crews working 8-10 hours every day. Pile installation would take up to 2.5 years and cofferdam construction up to 1.5 years.

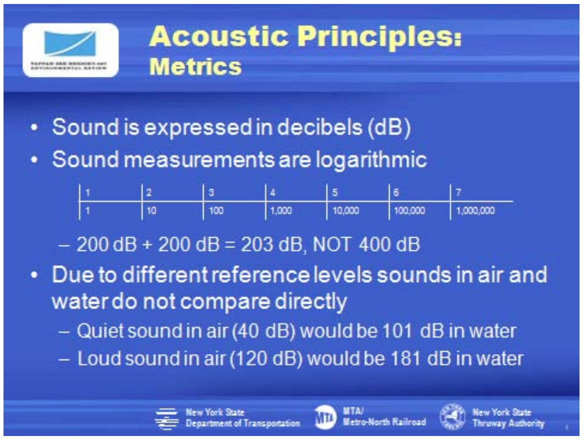
Overall construction durations in the river are expected to range from 4.5 to 5.5 years depending on the bridge option.



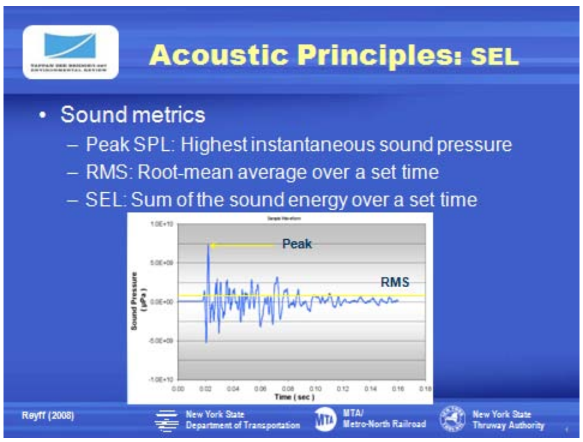
Slide 17. The next few slides briefly summarized the principles of noise propagation in the underwater environment.



Slide 18
Generally, the physics that define how sound behaves is the same in water as in air. However, because water is much denser than air, the mechanics of how the sound travels are different. In water, sound will travel about five times faster than it does in air. Because of the density of water, audible sound will also have a tendency to travel farther in water.



Slide 19. Just like sound in air, sound in water is measured in decibels (dB). It is important to realize that because the range over which humans and animals can hear sound energy is so great, decibels are measured on what is called a logarithmic scale. Unlike a traditional linear scale where values increase by a value of one for each unit, in a logarithmic scale each unit is ten times larger than the previous one. In the logarithmic scale, we can't add numbers directly. If you add 200 dB and 200 dB, the answer is 203 dB, *not* 400 dB. Also, you may already be familiar with what constitutes quiet and loud sounds in air. In water, because a different reference value is used for the bottom of the scale, quiet and loud sounds have different decibel values – about 101 dB and 181 dB for equivalent quiet and loud sounds, respectively.

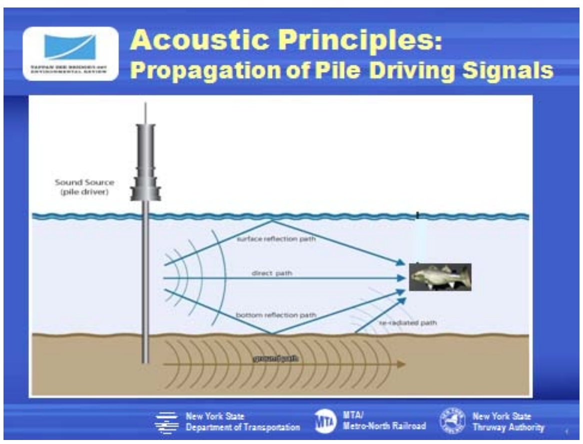


Slide 20. There are several means of measuring sound levels. One could use the peak, or absolute highest number, in a waveform. However, the sound level of an impulsive sound, as represented by the waveform shown here, is far lower for most of the time. As you can see on this graph, the average method known as root-mean square (RMS), can greatly underestimate the impacts of an impulsive sound since there is far more "quiet" time than there is loud time. An alternative measure, called Sound Exposure Level (SEL), looks at the waveform differently--summing *all* of the energy in a sound over a set period of time.

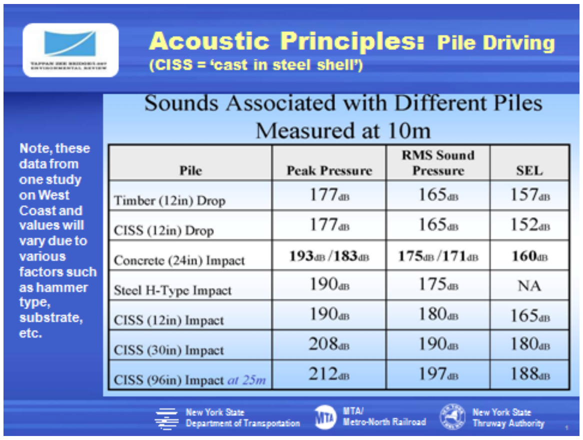
Slide 21. The current consensus is that SEL is the best metric for evaluating noise-related impact. This is because SEL takes into account the energy from the peak of an impulsive sound, as well as the quiet period, and can account for the impacts of not just a single strike but the cumulative impacts of several strikes. It also can be used to compare the noise from different types of sources, such as piles and boats.

Slide 22. There are numerous kinds of sound in the underwater environment. Biotic sounds are those made by living creatures. Fish and other underwater creatures do in fact make sounds, and some can be very loud; for example, oyster toadfish communicate through loud sounds. All other sounds are known as "abiotic" sounds. Some of these are naturally occurring such as the sounds of waves, rain, and wind. Others are man-made – for example, ship's engine noise, sonar, pile driving, and bridge traffic.

Slide 23. In the vicinity of the existing TZB, there are many existing sources of noise including ship traffic and vehicle traffic. Noise from the bridge itself is transmitted as vibration through the bridge supports and into the water column, where it becomes underwater noise. Construction-related noise would be in addition to this existing noise.

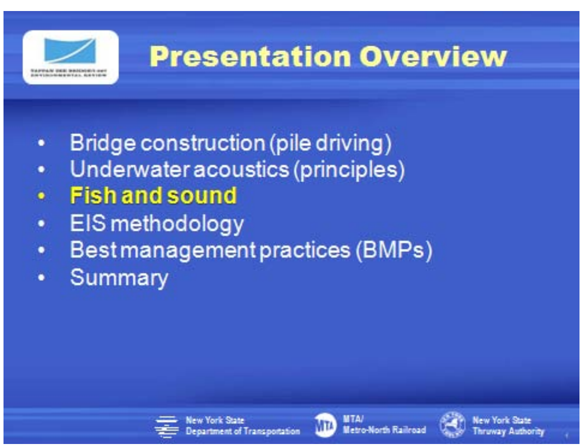


Slide 24. Noise travels from a source to a receiver over several paths. There is the direct path that sound takes between the two points. Sound can also bounce off the water surface and the river bottom, just like sound echoes off walls in a room. There is another way sound can travel: vibrations can travel through the ground, and then be radiated from the river bottom, much like the loud bass sounds you might hear from a neighbor's stereo.

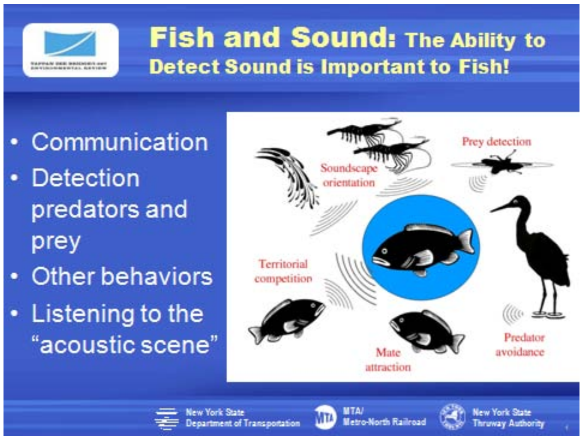


Slide 25. The noise generated by a pile as it is driven will vary based on the type of pile, how it is driven, the depth of water, the energy of the pile driver, the type of river bottom, and several other factors. In short, there is no single noise level that will predictably occur. However, CALTRANS has carried out extensive monitoring programs in an attempt to develop some typical ranges, and they have found that SELs from pile driving might vary from 152 dB to 188 dB.

Slide 26. Pile driving will not be the only source of noise in the underwater environment, but it will be the loudest single source. As we saw earlier, because of the logarithmic nature of decibel addition, loud sounds will dominate the analysis. If you add pile-driving noise at 200 dB to boat engine noise of 120 dB, the total sound is 201 dB, or only 1 dB higher than the pile driving alone. Even for driving multiple piles, the total sound level is still dominated by the noise of one pile; two piles simultaneously driven would be about 203 dB, and three piles would be about 205 dB. As a result, it is clear that the analysis in the EIS needs to focus on pile-driving noise.

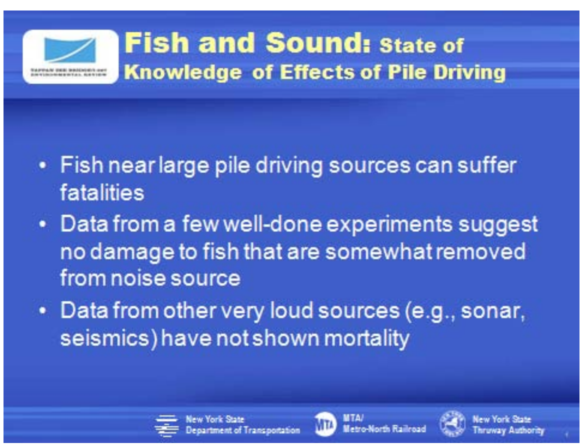


Slide 27. The next part of the presentation provided background on how fish hear, the manner in which fish use sound, and the range of potential effects that could occur as a result of construction-related noise.

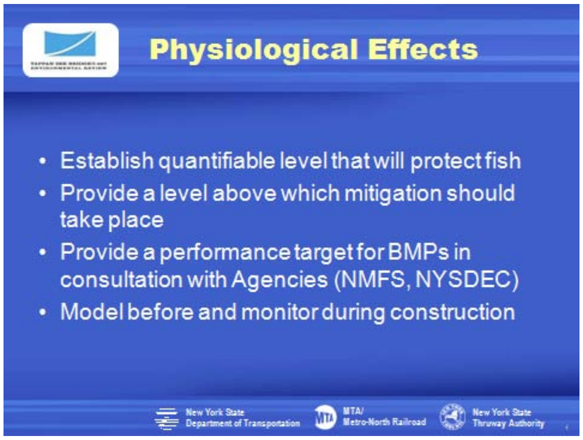


Slide 28. Despite a popular perception that the underwater world is a "silent" world, fish do hear and use sound. It is a means of communication between fish of the same species and is used to attract mates. Fish can hear predators or prey in the water, and respond accordingly. Fish also use sound to get a general sense of their environment, much like humans do. For example, sound helps us gain a sense of how big a room is, if there are others nearby, etc.

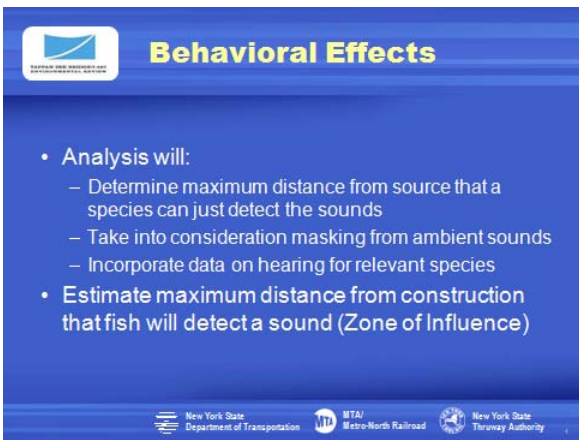
Slide 29. Physiological and behavioral impacts from underwater noise can range from no noticeable impact to immediate death. Immediate death will only occur if a fish is subjected to a noise of sufficient energy to cause physical damage to the fish. More typically, concerns will be about intermediate level impacts, such as behavioral changes or masking of biologically relevant sounds (e.g., prey detection or predator avoidance).



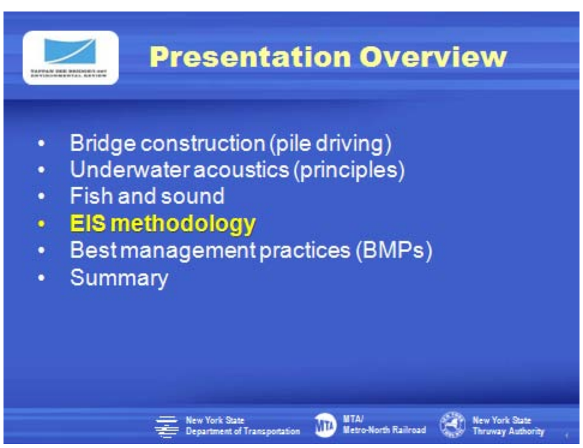
Slide 30. Experience in other projects has shown that fish in close proximity to certain pile-driving operations can suffer fatalities as a result of underwater noise. Experiments suggest that fish need to be very close to the source. Obtaining this distance through experimentation using actual pile-driving has been problematic so there is little actual data. Data from experiments using other very loud sources (such as sonar) that can be deployed in a lab setting have not shown mortality.



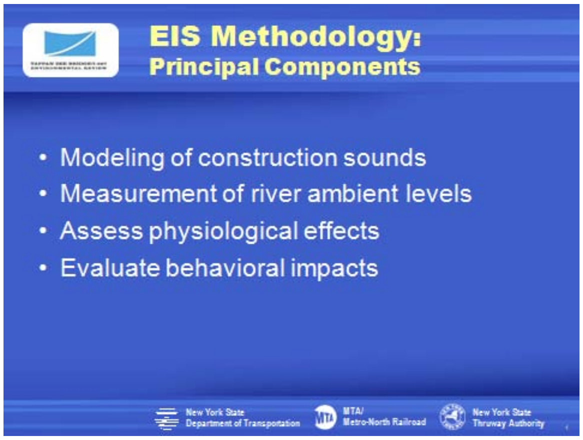
Slide 31. To avoid or minimize physiological impacts, the project team will work with regulatory agencies to establish quantifiable noise levels that will be protective of fish. If noise levels are expected to exceed the criteria, a variety of techniques (Best Management Practices, or BMPs) can be used to reduce noise levels. Noise modeling will be done as part of the EIS process to estimate where and what types of BMPs may be needed to comply with the noise criteria. During construction, it is expected that actual noise levels will be monitored, and techniques adjusted as necessary based on field test results.



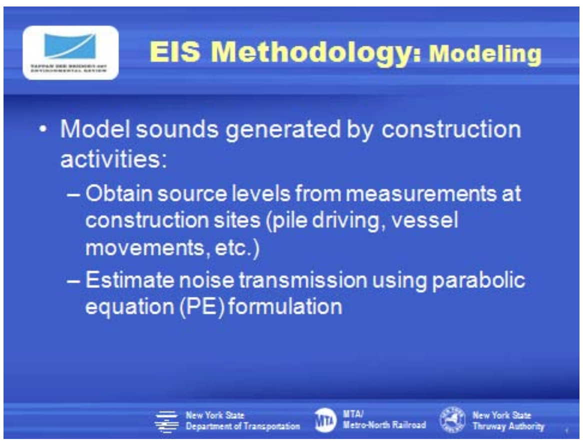
Slide 32. For behavioral effects, the analysis will use modeling and ambient noise measurements to predict the extent of areas in which fish may hear construction noise, even if there is no physiological danger. Based on available data about the hearing abilities of the various species and their motivation to respond based on the relative loudness of the noise above background conditions, a "Zone of Influence" will be estimated. Essentially, this Zone of Influence is the area within which we expect a fish to both hear a noise and alter its behavior because of it.



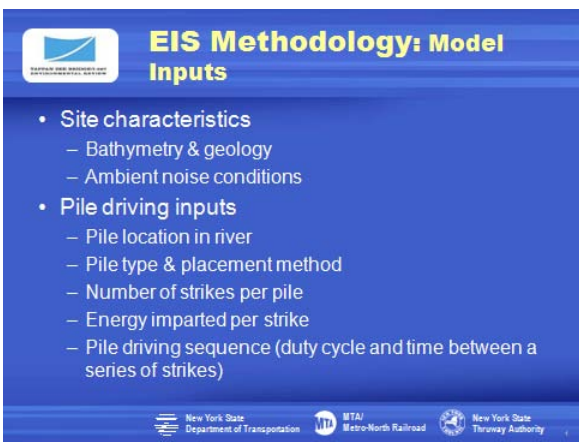
Slide 33. The next section of the presentation focused on the methodology to be used to document underwater noise impacts in the project's EIS.



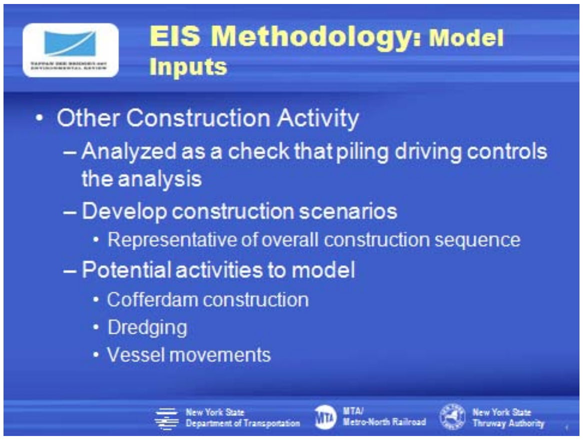
Slide 34. The principal components of the EIS underwater acoustic methodology--modeling, ambient measurements, and assessing physiological and behavioral impacts--were summarized on this slide.



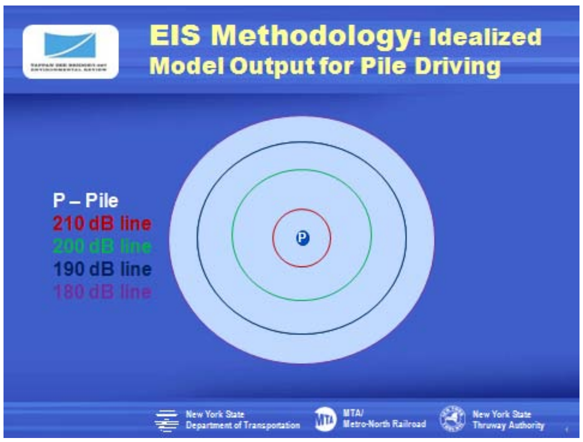
Slide 35. The expected modeling process was described. The first step in the process of estimating the project's acoustic footprint is to obtain data from actual pile-driving sites. That data will enable us to estimate the source strength of the pile driving. The next step is to estimate the transmission of sound though the Hudson River using highly sophisticated mathematical modeling techniques.



Slide 36. To use the selected mathematical model it will be necessary to generate a considerable quantity of input data such as that shown on this slide.

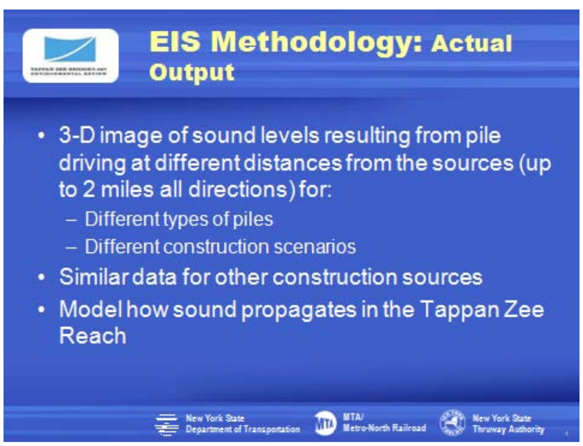


Slide 37. In addition to estimating sound levels from pile driving, we also will predict levels generated by other construction activities such as vessel movements and cofferdam construction.



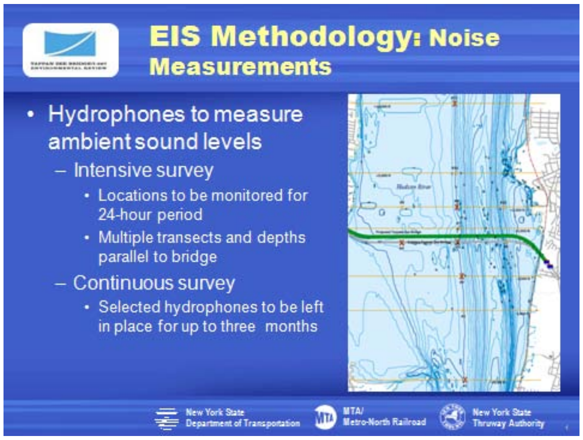
Slide 38. This slide illustrated a very simplified output of the modeling effort. It shows that the energy/sound resulting from pile driving will diminish as the distance from the pile is increased.

The actual acoustic pattern resulting from pile driving will be far more complex than shown here and will have both frequency and total energy components.

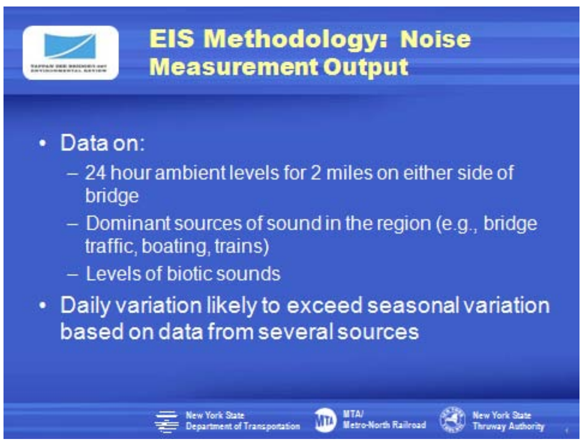


Slide 39. The model output that will be generated will be three-dimensional and show all the complexities of sound transmission through the variable Tappan Zee reach.

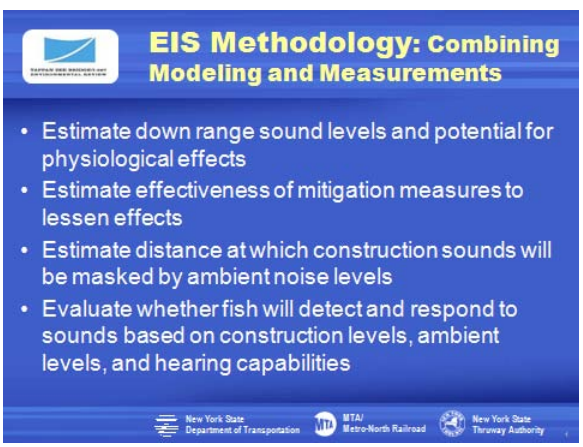
This output will be included in the EIS.



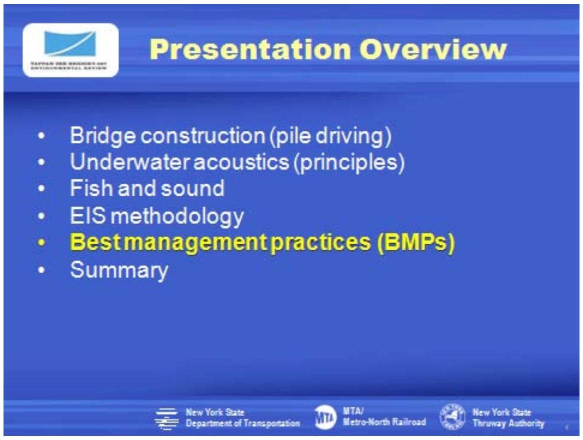
Slide 40. The map on this slide depicts locations where ambient noise measurements will be obtained. Measurements will be obtained at 12 locations during an intensive survey period and then for up to three months at six selected locations.



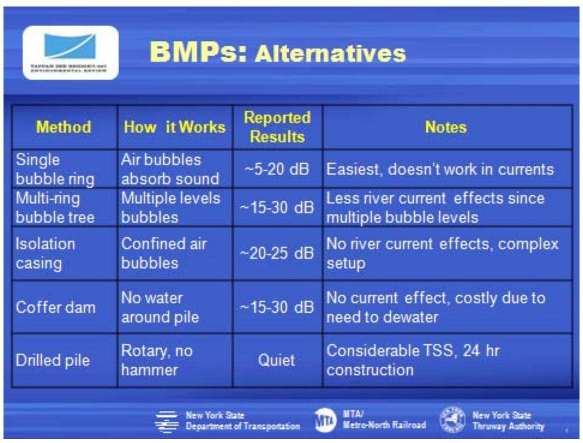
Slide 41. The dominant source of underwater sound in the Tappan Zee reach is expected to be the bridge itself. In addition, day-night variations in sound levels are expected to be greater than seasonal variations.



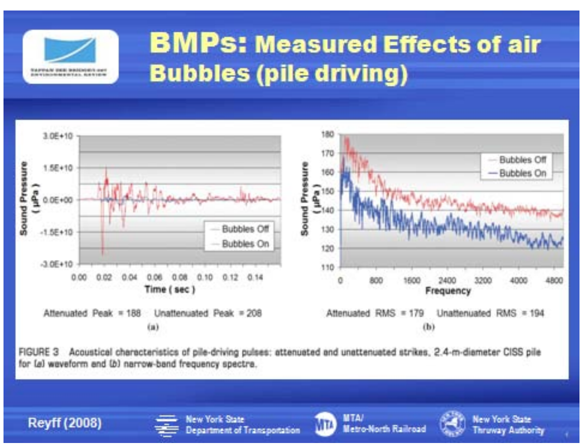
Slide 42. The ambient monitoring results will be combined with the mathematical model outputs to generate an estimate of the zone of influence of bridge construction activity, i.e., the distance over which construction noise can be heard by fish.



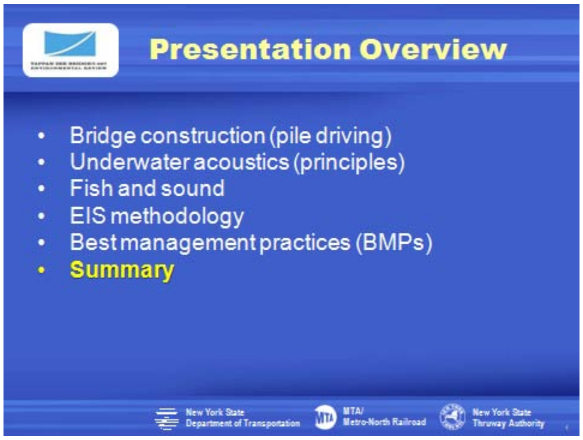
Slide 43. There are means of managing the noise level emanating from a construction site. This portion of the presentation described some of these methods and their effectiveness.



Slide 44. This slide illustrates the noise reduction benefits that can be expected from various BMPs based on data obtained from other bridge construction sites.



Slide 45
At a particular construction site, about 20 dB noise reduction benefit was obtained from the installed BMP.



Slide 46. The presentation summarized the plan to address underwater noise impacts to the Hudson River ecosystem during the construction of the replacement Tappan Zee Bridge. Consultation with cooperating regulatory agencies is ongoing. Results of the analysis and consultation will appear in the project's EIS.