Cool Pavements and Sustainable Pavement Technology

Webcast Transcript

January 28th, 2010

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Webcast Agenda and Meeting Logistics

Slide 1: Title Slide

Operator: Good afternoon. My name is Sandra and I will be your conference operator today. At this time, I would like to welcome everyone to the U.S. EPA Heat Island Reduction Program webcast. All lines have been placed on mute to prevent any background noise. If you should need assistance during the call, please press star then zero and an operator will come back on line to assist you. Thank you. Ms. Patel, you may begin.

Slide 2: Introduction Slide

Neelam Patel: Thank you. I'd like to start by welcoming everyone to the Cool Pavements and Sustainable Pavement Technology webcast hosted by EPA's Heat Island Reduction Program. My name is Neelam Patel, and I am the program manager. I'm very excited to let you know that we have over 200 people registered on the call today and we have received a lot of interest on Cool Pavements and Sustainable Pavement Technology. One of the reasons we're interested, here at EPA's Heat Island Program, in Cool Pavements, is because it is a huge opportunity to help reduce the heat island impact in urban centers. Cool Pavements actually refer to a range of established and emerging materials and these technologies tend to hold or store less heat and often times have lower surface temperatures compared to conventional products.

So in the industry - the pavement industry, the conventional products tend to be impervious pavements which can reach peak summer's high temperatures of over 120 degrees Fahrenheit. Both the pavement and asphalt industries have been making advancements and helping introduce emerging materials into the market. So today, not only will you hear about topics related to heat islands and pavements, but because this is also the audience that works on heat island reduction through the pavements, this audience is also interested and puts effort into sustainable efforts at the local level related to pavements. We will – you will hear some presentations and initiatives related to sustainable pavements as well.

And we have an especially interesting city program, the Chicago Sustainable Street Pilot Program, which is what we'll be closing out with and this program really brings together not only heat island issues but also other environmental issues and ties together multiple different types of initiatives all in one program.

Slide 3: Webcast Agenda

So this time, I'd like to quickly run through today's agenda. I, Neelam, will be giving an overview of EPA's Heat Island Reduction Program followed by Kamil Kaloush from Arizona State University, The Center of Excellence. He'll be giving a scientific overview of pavements and heat islands. After that, we'll have brief introduction of the U.S. Department of Transportation, Federal Highway Administration's Sustainability Initiatives by David Carlson. And this is just to introduce some of the new topics that are being discussed at the Department of Transportation. And following David, we will have Matthew Corrigan from the Federal Highway

Administration. He's an expert on warm-mix asphalt technology. This is the sustainable pavement technology that uses less energy, so while it's not directly related to heat island impacts, again, it's a topic of interest to those who work on pavement technologies at both the state and local level. And again, as I already mentioned, Janet Attarian from the city of Chicago will be talking about the Chicago Sustainable Street Pilot Program.

At the end of all the presentations, we will have a question and answer session. I encourage everyone to be submitting questions using the GoTo meeting question function throughout the webcast and please include the name of the presenter that your question is directed to. And now, we'll have Nikhil from ICF go over logistics for the webcast. Nikhil?

Slide 4: GoTo Webinar Software Logistics

Nikhil Nadkarni: Yes, just a few – quickly - logistics here. First of all, as Neelam mentioned, you will be muted throughout the webcast and you'll be able to ask questions using the GoTo webinar format which I'll get to in just a second. This session today is being recorded and will be available for download in a few weeks at the URL shown on the screen. And, the URL has also been shown in the chat window on your right and the GoTo meeting window. Should you have any technical difficulties during the program with go to webinar, please feel free to email Lauren Pederson at Lpederson@icfi.com. Next slide, please.

Slide 5: Attendees (GoTo Meeting)

To see who is attending the webinar as well as who's presenting, you should be able to see this in the attendees window on the right and then go to webinar window. Next slide, please.

Slide 6: Questions (GoTo Meeting)

For questions, please use the questions in the GoTo webinar window. Just type it in and hit send, and we'll be compiling all the questions before the end and asking them to the panelists. To make the process as smooth as possible, please be sure to include the name of the panelist who should be answering your questions, so we can compile them accordingly. Next slide, please.

Slide 7: Optional Feedback (GoTo Meeting)

And finally, at the end, a pop-up window will appear once you exit webinar. Please take a minute to answer these questions and your feedback will be very useful. And, that's it for logistics.

Introduction to the Urban Heat Island Effect and EPA's Heat Island Reduction Program

Slide 8: Title Slide

Neelam Patel: Great. Thank you, Nikhil. So I will – this is Neelam, I will quickly go through EPA's Heat Island Reduction Program.

Slide 9: Outline

Neelam Patel: I'll provide a brief overview of the heat island effect. Kamil Kaloush will also be expanding on this during his presentation. I'll spend some time going over our program and resources. Also, some heat island implementation activities, how to leverage funding if you want to pursue these activities in your own jurisdiction. And lastly, just a quick list of upcoming meetings and recent initiatives related to heat islands and pavements.

Slide 10: Heat Island Effect Overview

Neelam Patel: So the heat island effect is as follows. Basically, in densely built-up areas, the temperature in these areas can be from 9 to 27 degrees higher than surrounding suburban and rural areas. And this impacts human health and causes other types of environmental issues, so what we'd like to do – what this program does - is focus on mitigation strategies, which I'll talk more about in a moment. But - some of the land use patterns and infrastructure in these dense areas that lead to the heat island impact which is the hotter central temperatures come from reduced vegetation and the materials used to build urban infrastructure and the support pavements come in. Roofing is another area that can be used to mitigate heat islands. And lastly, is the design, the urban geometry which limits air flow and kind of traps in some of the radiative heat.

Slide 11: Energy and Air Quality Impacts

Neelam Patel: So some of the impacts I'll quickly go through include energy and air quality impacts. Impacts in these urban areas that tend to be hotter is increased energy use in the summers because people use more air conditioning to cool down their buildings and other offices. At homes, the electricity demand is higher in these areas and has longer peak periods which adds pressure to electrical grid often leading to blackouts and brownouts. Air quality is affected from the warmer temperatures. And also, because of increased energy use, there's increased greenhouse gas emissions.

Slide 12: More Impacts

Neelam Patel: Other impacts include warmer water that is running off from these hard surfaces in cities. And also, there's human health impact such as respiratory difficulties, people having more asthma. There's heat exhaustion, and in the case of extreme heat events, there's also

mortality associated with the high temperatures. And EPA actually offers a resource guide to help address this issue. There's a picture of a guide that helps cities prepare and set up systems to help get people in their cities that are most susceptible to heat events to safe places and getting the proper resources they need to live through those situations.

Slide 13: Mitigation Strategies

Neelam Patel: So while - those are some of the impacts, our program focuses on mitigation strategies and these are things that communities can do to help reduce the urban heat island effect. There are four main mitigation strategies – trees and vegetation, green roofs, cool roofs, and cool pavements. Trees and vegetation and green roofs focus on the vegetating surfaces, whereas, cool roofs and cool pavements focus on other factors such as heat - holding capacity and also solar reflectance. And one of the main messages I'd like to send at this time is that, using cool pavements is a good approach for reducing heat island mitigation, but oftentimes, pairing these strategies together can have the most impact in reducing the heat island effect.

Slide 14: Mitigation Strategy: Trees and Vegetation

Neelam Patel: With trees and vegetation, you want to strategically plant trees around buildings to help maximize energy savings and also reduce greenhouse gas emission.

Slide 15: Mitigation Strategy: Green Roofs

Neelam Patel: With green roofs, again, the focus is on creating vegetative surfaces on the top of buildings.

Slide 16: Mitigation Strategy: Cool Roofs

Neelam Patel: Cool roofs, is – you can do this on different types of buildings with different types of roofs. So for example, low-slope roofs and steep-slope roof, but this is based on the reflectivity of and the emissivity of these materials. And more information about each one of these mitigation strategies is available on the EPA Heat Island website.

Slide 17: Mitigation Strategy: Cool Pavements

Neelam Patel: Cool pavements are the topic of today and we'll spend a lot of time on that. But cool pavements tend to be a little bit more difficult to recommend because there are not established standards like there are for a cool roof for example.

Slide 18: U.S. EPA Heat Island Reduction Program

Neelam Patel: Our program is basically a communication infrastructure between different parts of the heat island community which includes policy makers, program designers, researchers, industry and the general public.

Slide 19: Messages to Heat Island Community

Neelam Patel: We cover topics that are of interest to this community, including the heat island science, measurement, modeling, and also the emerging innovative technologies coming out on each one of the mitigation strategies.

Slide 20: Key Program Features

Neelam Patel: The way we get this information out to people is through our website. There is scientific information available on each one of the mitigation strategies and the heat island effect itself.

We have a calendar of events which I'll refer to later in the presentation. And also, we track two other things - heat island in the news. So anything related to any of the four mitigation strategies or modeling and measurement that comes up in localities. All of those articles are listed on our website.

Slide 21: Database

Neelam Patel: We have a database and our newest addition is a science corner where we connect to scientific papers that are submitted to different types of conferences. So of our resources, we have a database and this has examples of different heat island projects throughout the country. If you know of heat island projects or plans that you'd like to have added to this database, please let us know.

Slide 22: Compendium

Neelam Patel: We've a compendium of strategies, and it covers heat island basics, the three mitigation strategies that we're now focusing on, and the cool pavements.

Slide 23: Cool Pavements Compendium Chapter

Neelam Patel: Lastly, there's a heat island reduction activities after the talks about different policy and voluntary programs. The one I'd like to highlight for you is the cool pavements compendium chapter. Please take a look at this as you develop programs.

Slide 24: Webcasts

Neelam Patel: We offer webcasts through our program, and as you know, today is one of our webcasts. We'll be having another one in about three months. Some local – some heat island reduction activities that are happening and ways to get them integrated into your communities is our next topic. Basically, because heat islands are a multimedia type of issue, we try to fold heat island strategies into other types of programs. So for example - water quality, stormwater mitigation programs, land use programs, and green building initiatives.

Slide 25: Heat Island Reduction Implementation Activities

Slide 26: Heat Island Connections to Other Programs

Neelam Patel: And lastly, there's a huge focus on climate adaptation and how we can help improve the quality of life as the climate is – the climate will vary, and so linking heat island mitigation strategies into that is also a helpful way to address heat islands in your communities.

Slide 27: Urban Heat Island Mitigation and LEED

Neelam Patel: One thing to bring to light is the U.S. Green Building Council has a rating system, and under this rating system, there is a credit related to heat island reduction, there is a sustainable site program that includes for the heat island credit.

Slide 28: LEED and Pavements

Neelam Patel: There is the Sustainable Sites Program for the U.S. Green Building Council through LEED. And using this 7.1 credit, you can receive credit through many of the different LEED rating systems such as new construction, existing buildings, and commercial interiors. The LEED rating system for schools, for homes, for neighborhood development, and basically, you can see the criteria for this credit to get heat island credit through the LEED rating system. And Janet will also mention how that integrated into their program.

Slide 29: Implementation at the Local Level Activities

Neelam Patel: Other ways to integrate heat islands programs for local level is through volunteer in policy efforts. And also, as part of energy sustainability, water-air quality programs.

Slide 30: Heat Island Reduction- Voluntary Efforts

Neelam Patel: Here's the list of some voluntary efforts and more information on this is available in the heat island compendium.

Slide 31: Heat Island Reduction- Policy Efforts

Neelam Patel: Examples of policy efforts are listed and here are some programs that have heat island activities.

Slide 32: U.S. EPA Heat Island Supported Projects

Slide 33: EPA and Kansas City Project: Parking Lots to Parks

Neelam Patel: The one I'd like to focus on is in Kansas City, the Parking Lots to Parks Program. Using a small amount of grant funding, the city – Kansas City and a local regional alliance came together with EPA and focused on how to design parking lots to help reduce the heat island impact and reduce storm water runoff. And to learn more about this program, the websites are listed below, they actually have some interesting case studies listed as well.

And, the one I'd like to call out for people that are interested in learning more about this, is the vehicle impound facility parking lot, and here, they've taken different types of landscaping and partnered it with pavement to help reduce the heat island effect.

Slide 34: Cool Communities Program California-based Initiative

Neelam Patel: Another program that the State of California is supporting through the California Air Resources Board, the California Energy Commission and Lawrence Berkeley National Lab is the Cool Communities Program. This is a California-based initiative. It's part of the voluntary – it's developing a voluntary program to support the Global Warming Solutions Act of 2006 that was passed in the State of California.

Slide 35: Cool Communities Program Pavement Training Task

Neelam Patel: The Cool Communities Program is taking out a number of different tasks which are being implemented by Lawrence Berkeley National Lab and of those, two relate to pavements, and this is the Cool Communities – Cool Communities Program Pavement Training Task. Basically, they are putting together workshops on how to get pavements into city planning efforts, and they're bringing together different partners to design and participate in these workshops. If you're interested in more information, you can contact Haley Gilbert and her contact information is on the slide.

Slide 36: Cool Communities Program Pavement Study Task

Neelam Patel: Another task that they're pursuing at Lawrence Berkeley National Lab is doing a study on cool pavements, and it is similar in some ways to a literature review where different types of information on pavements is being collected and the results will be looked at in August of 2010. If you have information that will be helpful to the folks at Lawrence Berkeley National Lab, please contact Ronnen Levinson who is the project lead for this task.

Slide 37: Leveraging Federal Funding

Neelam Patel: So there's a lot of things going on in the field, and oftentimes, communities at the local level or state level might be interested on learning about – might be interested in pursuing some of these and you saw there's a lot of activity happening, but the question is how can you get funding to do these things.

Slide 38: Heat Island Funding Opportunity in ARRA 2009 (DOE)

Neelam Patel: And so one thing that I would like to just mention is there's way to leverage Federal funding and through the American Recovery and Reinvestment Act that was passed in February of 2009. Department of Energy received billions of dollars, but each one of these line items, the Weatherization, the State Energy Program, the Energy Efficiency Conservation Block Grant Program, each one of those programs can actually – the money that's coming out through those programs can be used to increase energy efficiency by including heat island mitigation

strategies into the plans and into the projects. So I encourage people to think creatively about how heat island mitigation strategies can fold into existing programs.

Slide 39: ARRA Tax Credits - Roofing

Neelam Patel: Another thing I want to bring to attention – bring to your attention, this is basically focused on roofing, but through the American Recovery and Reinvestment, there was an extension to the tax credits that are available for energy efficiency, and if you're interested in – as an individual or as a building owner, using this money for roofing, you can get a tax credit and these tax credits are available through December 31, 2010. More information is available at the URL at the bottom.

Slide 40: Heat Island Funding in Climate Showcase Communities Grant

Neelam Patel: And the last thing I'd like to mention is the Climate Showcase Communities Grant. In 2009 and in 2010, the EPA received money through the Appropriations Bill for a 10,000 – oh, excuse me – a $10 million competitive grant to assist local governments in pursuing climate change initiatives, and one of the categories in this grant is heat island management. So the next solicitation for this grant will be opened in late spring of 2010. If you're interested, I encourage you to see if you have a project or a program in your community that can relate to heat island mitigation and reduce greenhouse gas emissions.

Slide 41: Meetings and Initiatives Related to Heat Islands and Pavements

Neelam Patel: Lastly, there are some meetings that are upcoming.

Slide 42: Meetings and Initiatives

Neelam Patel: There's a Concrete Sustainability conference in April that's going to happen in Arizona, urban pollution - Urban Environmental Pollution conference in June in Boston. The American Meteorological Society is having symposium on the urban environment in August and that is in Colorado. And lastly, the Transportation Research Board Subcommittee on pavements in the urban environment will be hosting a meeting in January of 2011. Kamil Kaloush is about to speak in – tackle a bit more about that, but I want to point out that for the urban environment symposium through the American Meteorological Society, there's a call for papers, so if you have topics of interest, you can submit and also the TRB Subcommittee on pavements is accepting papers as well.

Last thing, before Kamil goes into his presentation, I'd like to mention is – a Concrete Sustainability Hub that MIT in Boston has created and this was created in October of 2009. There's interdisciplinary collaboration that will help accelerate science and engineering when it comes to sustainability of concrete, basically over five years, $10 million is going to go into this research center. And, folks from MIT School of Engineering, of architecture and planning, and the school of management are going to participate in research activities. So there'll be some interesting pavement and sustainability topics coming out through that.

Slide 43: Contact Info

Neelam Patel: If you have more questions, this is my contact information and our website, and with that, I would like to introduce Kamil Kaloush.

Scientific Overview of Pavements and Heat Islands

Neelam Patel: Kamil – Dr. Kaloush is an associate professor in the Department of Civil, Environmental and Sustainable Engineering at the – at Arizona State University, and he's also the director of the National Center of Excellence on SMART Innovation. He has a Ph.D. degree specializing in Pavements and Materials from Arizona State University and a Bachelor's and Master's Degrees in Civil Engineering from Ohio State University. And Kamil will be talking to you about pavements and the urban heat island effect, and also, may I mention a little bit left the TRB subcommittee. Kamil?

Slide 1: Title Slide

Kamil Kaloush: Thank you, Neelam. It's my pleasure to be part of this webcast, and I'm really glad to share with the participants and everyone here today some of our work and knowledge related to the urban heat island and pavements. So thank you for that long introduction. I'm glad Ohio State finally won in the Rose Bowl this year. Let's see, I'm trying to – I'm trying to move forward with my slides, and I'm not able to do it.

Neelam Patel: Kamil, go on and click on your screen with your mouse.

Slide 2: Do Pavements Contribute to UHI?

Kamil Kaloush: OK. Thank you for doing that. This slide right here is not really the agenda for this presentation. You know, the question, "Do pavements really contribute to the urban heat island or not? If so, how much and where within the urban environment that we have?" I will overview some of the evaluation techniques, what are some of those driving factors (Neelam has introduced some of them already) and talk about the different types of pavement materials, their properties, their design characteristics and how they interact and influence the urban heat island in a way. And I'll talk a little bit about some of the mitigation strategies out there and some of these opportunities that are already existing for both pavement industries out there. And a couple of slides at the end just to introduce some of the tools and the models that we have been using to – in order to assess the urban heat island and the contribution of pavements within that.

Slide 3: ASTER Satellite Imagery

Kamil Kaloush: This is - what you will see here is actually a – an ASTER satellite imagery, this is really one of my favorite satellite imagery that actually got me interested into this subject area. And, what you see here is a surface temperature for the Phoenix area and the surrounding urban locations and hold a quite few mountain ranges here around the Phoenix. This was taken back in 2003 at 11 o'clock at night in October. October was pretty warm. We had warm temperatures. And what you see here is actually a scale of temperatures. The bright yellow is actually the highest surface temperature that has been recorded for that moment. If we take the urban location and take the top twenty percent of the surface temperature from this image being analyzed, you will see that in the red markers over here. You know, one thing that you can really

– came out of this is that the highway system is very well-highlighted within this urban environment. And, we estimate these paved surfaces, not only highways and parking lots and the shopping center and everything else, about forty percent of the urbanized land cover in Phoenix. And the conclusion from this is really evidence that really pavements do contribute to the urban heat island effect.

Slide 4: How Much and Where?

Kamil Kaloush: On the next slide here, I will show you just a – one of several evaluations in terms of the air temperatures Neelam have mentioned. We have a range anywhere between 9 to 27 degrees. What you are looking at here is air temperature versus the hour of the day. It's a 24-hour cycle for an urbanized location within the Sky Harbor Airport here in the city of Phoenix, and Encanto Park which is a green space within the city, and a rural site which is the City of Maricopa. And, you also see the solar flux that has been recorded for that – in July 2005 for that day. So if you look at the peak temperatures, which are typical in the late afternoon here in the area, you will see that just about all of these sites have similar peak temperatures during the afternoon. But if you look at the late afternoon hours and the early morning hours, you see this is where we have the biggest or largest difference in temperatures between the sites. And basically, here what you are seeing is the urbanized location that you'll have, you know, in this particular case up to 10 degrees Fahrenheit. And again, we have seen anywhere between 12 to 15 degrees Fahrenheit difference there. And these are, again, representing the – an urban location versus a city of Maricopa which is an outside rural area.

Slide 5: UHI Evaluation Techniques

Kamil Kaloush: Evaluation techniques for the urban heat island, we've been successful, though I just showed you the ASTER thermal imagery and the effect of – or the results that you can get from the surface temperatures. We've been using the infrared thermal imagery cameras as they do a good job in looking at the, you know, city blocks to evaluate the different infrastructure. There are also some mobile transects that actually they are – these are equipment mounted on a vehicle. It has the infrared camera, the GPS. It has a humidity and air temperature sensors inside a solar shield, and what it does, it travel through the town or the city and can get a profile – line profile of the temperatures across a certain location. They've been, you know, very good to assess the temperature profile. We can use them with the thermocouple in pavements near the surface, you know, throughout the pavement itself or utilize a - also a weather station with that. Again, trying to understand the heating mechanism, the heat absorption and transfers and re-emittance into the atmosphere. Also, we can capture some of these properties in the lab, we can – we can run some thermal conductivity tests, so specific heat capacity on the different types of materials, really try to understand the - some of those fundamental properties as part of the process.

Slide 6: Infrared Lapse near Millennium Park

Kamil Kaloush: This is some of the use of the infrared camera that we have actually used back in 2007 for the city of Chicago with the time lapsed infrared view, and again, our interest here is to look at pavements and the sidewalks and the paved surfaces and as you go from the early

morning hours, 5:00 a.m., and again, the bright colors here that you see on this is actually, will indicate the higher surface temperature. If you go to the 8 a.m., you can start seeing that actually the roadways and the paved surfaces here are start showing the higher surface temperature, and you go to 11:00 a.m., and again, they are the brightest, and move on to 1:00 p.m. and they are the actually the last, you know, surfaces that actually will cool down into the evening hours. So again, that's - it's a – it's a – it's a good shot just showing how we can assess the different surface temperature using the infrared camera.

Slide 7: What are the driving factors?

Kamil Kaloush: What are some of those driving factors? I have a list here. They are not inclusive of everything, but, canyon geometry within the – within the city, the buildings, they will form some type of canyons that would tend to trap the thermal energy near the bottom surface and this is exactly the same thing for roadways and when you have a depressed highway section versus a highway section that's actually constructed at grade. The thermal properties are important. Dense materials will absorb and retain more thermal energy than the natural surface cover or even a porous material. Anthropogenic heat, these are heat released from combustion of fuels, electrical energy, including the vehicles driving on the highways and they can result in elevation of the temperatures within dense urban areas. And the urban greenhouse effect – the warmer air and air pollution within the city will act as a micro-greenhouse effect, if you wish, preventing the heat from radiating from the warm surfaces. And of course, we have the effect of reflectivity, albedo, again, the total reflectivity of a city is reduced, you know, due to trapping effect of shortwave radiation of the building canyons that I just mentioned.

Reduction of evaporating surfaces as the city expand and we change, you know, from the natural vegetation to a more of a paved infrastructure. There is a loss in the moisture that can actually adversely affect the temperature within the city itself and that will also contribute and be one the driving factors as well. And then finally, in some areas of the city, the wind patterns can actually be blocked, you know, causing pockets with little wind flow, and again, the – this reduced mixing of air greatly reduce the heat released from the streets, you know, or the highways within that urban environment.

Slide 8: Example

Kamil Kaloush: This is just an example. I mentioned about the, you know, canyon geometry and the depressed section versus at grade section. This is a – just a blowup of Interstate 101 here on the east side of the Phoenix area. This is exactly the same pavement. This is warmer comparing to what you see here, it's much cooler. You don't see the - as much red marks. If you look at the actual highway, this location right here has the advantage of being at grade. It has the – there is landscape along side and agricultural on the other side, and so, it kind of cools down faster at nighttime comparing to the same pavement structure that you see here, but this one is within residential area. We have sound walls and it's a depressed section because of the location. So that will have tendency to trap heat in this case.

Slide 9: Fundamental Properties

Kamil Kaloush: What we see here is some – you know, for pavements, we really – we need to understand some of those, you know, fundamental properties that actually we can control and understand better the mechanism of the urban heat island and the heating mechanism. Albedo is on top of the list here, which is really the measure of the surface reflectivity. It's an important factor of - but again, it's not really the only one. We have several others. Emissivity which controls the far infrared re-radiation from the surface back to the sky is also an important aspect. And then, there are several really fundamental properties in terms of thermal conductivity, the specific heat capacity, and the density of the material.

This is something that, you know, we have been producing different types of materials and we can – we thought - we think that we can actually control some of these properties within a material design. So the lower the thermal conductivity, the less specific heat capacity. And sometimes, if you have lower density that would really help to reduce the amount of heat being retained into that material. So they provide an opportunity to better understand the heat retention and improve – you know, upon our future design. Some of the mitigation strategies for pavements, increased albedo comes to mind. It's definitely a good thing if you use pigment, light-colored aggregates, resin binders. There are also opportunities for surface coatings with nanoparticles. This is not for the whole mix, just for the surface that actually can provide an increased reflectivity in that fashion.

Slide 10: UHI Pavement Mitigation Strategies

Kamil Kaloush: Porous pavements, both in the HMA, the hot mix asphalt, and the Portland cement concrete, the pervious concrete, they really help provide a good control of the thermal conductivity, the density of the material, and the thermal diffusivity. And, therefore, they provide that added benefit of retaining less heat. And, again, we are more concerned of the nighttime phenomenon urban heat island. Whitetopping strategies for the Portland cement concrete. They have the advantage or the albedo benefit. They also have the advantage of having a lower thermal mass, lower thickness as a pavement thickness, so you have less heat retention. So we have seen actually nice cool surfaces from this technology. Then, we move on to reflective asphalt pavement techniques. If you are a TRB or we have actually paper has been published in our subcommittee about two years ago that talks about different techniques. In fact, I do have a slide here later on, but again, this is a technique that can better control the albedo and especially for newly constructed pavements.

The use of thermal resistant materials, the specific aggregates types are better in heat conduction or retention comparing to others, admixtures. And here in Arizona, we use a lot of a crumb rubber – asphalt rubber in the valley. We see some benefits on less heat retention and absorption in this process too. And while the last couple of items here is not always economical or practical, but, you know, provides some kind of cover - trees in urban streets is very helpful, the use of solar panels especially for parking garages, they are - actually will provide a good mitigation option as well too.

My favorite line at the bottom, "To pave or not to pave." It's – and don't take me wrong here because I do earn my living basically from working with pavements. But there are also a lot of residential areas here in the Phoenix area that - they don't elect to pave their driveways. They go

with the natural landscape. They do some kind of stabilization process to kind of blend in with the design there. And that's still an option that, actually, we don't have to pave all the time.

Slide 11: Pavement Design Characteristics

Kamil Kaloush: Quick screens here of the pavement design characteristics. This is a thin – ultra-thin whitetopping pavements. It's about 2 inches of Portland cement concrete, have a good characteristics of having a lower surface temperature especially during the day. So again, this is the high albedo, lower thickness that will provide a good option for urban heat island.

Slide 12: Pavement Design Characteristics

Kamil Kaloush: Reflective asphalt pavements, surface chip seals, lighter color aggregates to being utilized, again, will increase the reflectivity. There's a - a couple of years ago, like I mentioned, some experiments dealing with the gritting and shot blasting and basically upgrading the surface binder. So it's almost like an accelerated process to lighten up the asphalt pavement at the beginning of its life, in a way, so it has been also showed to be a good pavement design characteristic for UHI.

This is a shot of the asphalt rubber that we have here in the valley. And, again, the thin layers that you see here, porous layer, that will have tendency to shed that heat much quicker at nighttime comparing to a thicker pavement. And you'll see here from a thermal image that's actually providing a thermal or a cool surface at nighttime. When you don't have traffic, traffic is an important factor, really add to the complexity of things. You can see that, actually, you do have a warmer surface. This is an HOV lane that has not been used at that time and you can see it stays much warmer at nighttime.

Slide 13: Pervious/Porous Parking Lots

Kamil Kaloush: So pervious and porous parking lots, they are actually – we have done some documentation where we provide good benefits for UHI; low thermal conductivity, specific capacity and density, in addition, of course, to the storm water management and recharging, of course, the groundwater aquifers, so it becomes a good option there as well.

Slide 14: Other?

Kamil Kaloush: Other non-pavement items that we have actually worked with. This is a U-haul parking lot here in the Phoenix area and they went with an option where they actually – I believe it's called gravel pave. So it's actually a plastic grid and membrane that they place on top of a subbase - on top of the subgrade and they can put any types of gravel size and color on top of it. So the plastic grid and membrane will provide that confinement and stability for the pavements to kind of actually, you know, help with the traffic load and so forth.

Slide 15: Hybrid Designs

Kamil Kaloush: So this is – actually shows it's – again it's another type of porous pavement that will have a benefit of less heat retention. These are some of the solar panels. Again, they are – provide a good shading for the asphalt here in this case. Reduced lower temperature in addition to, you know, getting energy for lighting and so forth from the solar panels. We can do hybrid designs, composite designs. This is, again, merging a pervious or combining pervious for parking stalls and conventional pavement for the actual passages of traffic depending on how much structure you need. That's a good combination in this process as well.

Slide 16: Modifying Radiative Properties

Kamil Kaloush: This is just a slide to show you the modifying – the radiative properties. And, again, this is something that's not really that new. There's a lot of paint technologies out there. You can paint your house dark brown, if you wish. And there are some additives that added to the paint that will help to reflect more of the solar energy being emitted. So that's something definitely - it can also be applied for pavements. We have done a couple of test sections here with the local companies here in the Phoenix area and it's under experimentation. But again, the idea is to reflect more of that solar radiation by controlling the additives into a surface sealant, if you wish, that you can – it can be placed on top of the pavement.

Slide 17: Laboratory Evaluation

Kamil Kaloush: This is just to show you some of the laboratory evaluation. There is an ESEM Standard that we do for thermal conductivity to measure the thermal property or thermal conductivity of asphalt or concrete materials. We have done a – or came up with a modified version where, instead of using plates, we use a cylindrical specimens and – to measure the, you know, basic thermal conductivity of that material. It will be a bit more practical for pavements since everything we do is basically looking into using cylinders for other testing. So again these are measurements – some of the specific, you know, fundamental properties to help us better understand and model our pavements.

Slide 18: Tools- Models

Kamil Kaloush: Some of the tools that we have, you know, we can take all this information and put into a simple model analysis looking into the environmental condition, you know, our pavement structure thicknesses, you know, the thermal properties now from laboratory measurements. We can actually model the heat conduction retention and re-emittance into the atmosphere from such – from such work. Or we can take the same formulation in a simple form, and we can apply the same thing for a large city, metropolitan area in this case. So – and again, understanding the landscape, how much of the pavement is really - is part of this landscape, how many of the roofs and vegetation and so forth.

Slide 19: City – Wide Analysis

Kamil Kaloush: We can control the different variables and try to understand if we implement a certain policy where we're using the more reflective roofs or more reflective pavements, what's

really the impact on the overall temperature and of course manner, in a way. So we have actually have done some of this work as well, too.

Slide 20: Concluding Remarks

Kamil Kaloush: So finally, I just want to conclude some of these remarks and I'm sure some of you will have some questions at the end. But pavements, really, definitely play an important role in the urban heat island effect. And I think some of those preceding slides actually kind of showed you that.

There is no one solution that actually fits all. Cooler pavement designs will likely need to be addressed with existing techniques and materials that we have. And I hope you appreciate the complexity of this - all these different various designs that we have and materials and, of course, the optimization process that we need to work on to meet other requirements, in a way. So more work still needs to be done; more research, testing, modeling and documentation of field experiments that, really, is taking place, will really help us to advance our knowledge in this area.

Slide 21: Thank you!

Kamil Kaloush: So with that, I think, I will conclude my presentation for now, and perhaps, we'll talk later on. Thank you very much.

Neelam Patel: Thank you, Kamil. That was a great overview. I'd just like to point out some of the topics – the characteristics of pavements that help reduce heat island effect that Kamil mentioned are in the heat island compendium chapter on cool pavements, and also the different types of cool pavements are also outlined in the cool pavement compendium chapter, if you're interested in more information. If you do have questions for Kamil at this time, I encourage you to send them in using the go to meeting question function and include his name, so we can get to those in the question and answer session.

U.S. Department of Transportation (DOT), Federal Highway Administration (FHWA) Sustainability Initiatives

Slide 1: Title Slide

Neelam Patel: And at this time, I would like to introduce David Carlson from U.S. Department of Transportation, Federal Highway Administration. And David works over at Federal Highway in their policy shop and he's going to be talking a little bit about upcoming sustainability initiatives at the Federal Highway Administration. David?

Slide 2: U.S. DOT FHWA and Sustainability

David Carlson: Thanks, Neelam. Good morning – good afternoon, everyone. I am David Carlson. I'm with the Sustainable Transport and Climate Change Team here at the Federal Highway Administration. And one of the things I wanted to bring up were some of the things that we're doing here at Federal Highways that support a broader sustainable highways initiative and agenda. And, we are currently using a – batting around a sustainable highways definition that we're using to try and orient the community around exactly what does it mean to create a sustainable highway. And in essence, sustainable highways are ones that allow for basic access and development needs in a manner that is consistent with human and ecosystem goals, allow for transport mode and choice regardless of age and ability, are affordable, and operate efficiency – efficiently, limits emissions of – and new and non-renewable resource use. And these principles are equally applicable in urban, suburban or rural areas and can be applied to all functional classifications. So that's kind of a working definition. It's a little clunky, but it seems to hit all the high points that a lot of people have given us input on.

So there are a number of activities that here at Federal Highways we're working on and that go towards sustainable efforts. The first one is a program that we call Context Sensitive Solutions which we've been doing for a number of years. And we do see a great intersection for a number of these issues that you've heard about here on the webinar and also that we're doing here in Federal Highways that addresses these. And so Context Sensitive Solutions is an approach that considers the total context within which a transportation improvement project exists. And CSS really refers to an approach or process as well as an outcome. And it calls for an interdisciplinary collaboration of technical professionals and local community interest groups, landowners, facility users and the general public who live and work near transportation facility or use them. And the process agencies can gain - using the process, agencies can gain an understanding and appreciation of the community values, so they can address these in transportation planning and project delivery. And, certainly, you know, how and – pavements are used and what types of pavements are used would be one of those issues that we would consider as part of the CSS process.

I also put up there another strategy that we have in our Asset Management Office. It's called Life-Cycle Analysis, and it's an engineering economic analysis tool that allows transportation officials to quantify the differential cost of different investment options for a given project. So they look at the broad scope of what the project would be costing and where are the opportunities

to save money and – on those projects and consider the expenditures and the user cost throughout the life of an alternative, not just only the initial investments. So – and they would – and we're broadening that perspective to include sort of both the co-benefits of making some materials and decisions and design decisions as being part of that cost analysis and that's going on in our Asset Management Office and we're – we here on the team are working with them on that.

The other initiative that we've got going on – we're working with EPA and the Forest Service on a green streets effort which is to use – when we use the term "green streets" we're referring to using natural systems for storm water management. And those would be swells and protected boxes that contain trees, bushes, shrubs, grasses that rainwater and storm water is funneled to. And those are our treatment options for that storm water. We also find it has a lot of other co-benefits as far as, you know, in aesthetic, attractiveness. We've found creative designs for such applications. And of course, they do have, as Neelam mentioned earlier, they do have an effect of heat island reduction or minimization.

The other initiative that we've got going on is the Green Highways Partnership, which is going on here in the Mid-Atlantic States between Pennsylvania, Virginia and Maryland and it's a partnership of the DOT, the state DOTs, and the EPA. And we are looking at different methods for - applying different methods to projects around pavements, the use of pavements, storm water control, storm water management and a number of other activities. And there is a website for the Green Highways Partnership, and I believe it is greenhighwayspartnership.org, I think, and that is worthy of checking out to see what are some of that unique technologies that we're developing as part of the partnership.

The last activity that we have going on is a new one and it's very broad and it is our Sustainable Communities Partnership that we are doing with EPA and HUD. It's the three-agency partnership. And those partnership principles look at providing more transportation choices, promoting equitable and affordable housing opportunities, enhancing economic competitiveness, supporting the existing communities, and coordinating and leveraging Federal policies and investment and then valuing communities and neighborhoods. So – and those are the things that are the focus for the three agencies to work on. And here in the Department of Transportation, we call that "livability" and that is our term for here in the department, but it does go towards the Sustainable Communities Partnership.

I mentioned all of these because like with EPA's programs, well, heat island is not necessary something that we're particularly focused on. I think you'll be able to see in the descriptions that I was giving you of the different strategies and programs that we're implementing and we are delivering to our partners that, certainly, heat island considerations would be folded into all of those kinds of activities. Certainly, in the Sustainable Communities Partnership and CSS and in Green Streets, I think you'll see that those kinds of considerations are getting folded in and we would be looking at those.

Now as far as the research that we've got going on, we are about to engage on a sustainable highways criterion tools development in which the heat island effects of pavements would be one of the criteria. It's similar to a LEED-type system that we'd be developing, are really closer to the Sustainable Sites Initiative in terms of having a UHI reduction as part – as one of the criteria

that we would be examining. And Dr. Kaloush, I'm excited that we'll probably be approaching you to help us understand how to incorporate some of those criteria into our overall effort.

And then, as Neelam mentioned, we have a number of projects and reports that have been developed by TRB, the Transportation Research Board and NCHRP researching the different pavement technologies and different elements that the pavement technologies deliver on in a variety of different ways. But the thing that – one of the things that we are predominantly focused on, certainly, is making the pavement more usable, recyclable and have a long life and minimize in the environmental effects. And again, while I say that UHI hasn't been one of our primarily focuses, it certainly is one of the considerations that we have in there, and my colleague, Matt, will now talk to you about what we've been doing when it comes to pavements. So I'll turn it back over to you.

Long-Life Asphalt Pavements for the 21st Century - Warm Mix Asphalt Technologies

Neelam Patel: OK. This is Neelam. I'll just take a quick minute to introduce Matt. And again, I encourage you to submit your questions electronically with the name of the presenter that you'd like to ask the question to. So our next speaker is going to be focusing on sustainability initiative with asphalt pavement. Matthew Corrigan is an asphalt pavement engineer for the Department of Transportation, Federal Highway Administration. And prior to joining the Office of Pavement Technology, he was a construction project engineer with Federal Highway Administration's Central Federal Land Highway Division, in charge of the road and bridge construction inside U.S. National Parks and Forests. So Matt, if you'd like to begin your presentation, we'd love to hear more about this emerging technology.

Matthew Corrigan: Sure. Is it – is it up? Can everybody see it?

Nikhil Nadkarni: Yes.

Neelam Patel: We sure can.

Slide 1: Title Slide

Matthew Corrigan: OK, great. Thanks for the welcoming and the introductions. I'm going to give a brief overview on one of the areas that we have worked on here in the Office of Pavement Technology in implementing new technologies for pavements this emerging area of warm-mix asphalt. And just so that everybody is aware, the primary focus of our office, Office of Pavement Technology, is really on the performance of these technologies and the materials that are used to make sure that we get a long life out of the pavements.

Slide 2: WMA Investigation and Implementation Premise

Matthew Corrigan: And we recognize that there are many factors driving the technologies, things that have already been discussed today. You know, environmental sustainability. But the primary purpose, that the industry really was looking at these technologies moving forward, was to reduce the amount of energy needed to produce the mixtures as well as reduce the localized fumes at the production facility.

Slide 3: What is WMA?

Matthew Corrigan: So what is warm-mix asphalt? Well, in a nutshell, it allows us to produce asphalt mixtures at lower temperatures and there are multiple ways to do that. Some of the technologies basically reduce the viscosity or make the liquid asphalt, the black sticky stuff, less sticky, if you will, to where you can still fully coat the aggregates or the rocks at lower temperatures. Traditionally, our hot-mix asphalts, we need the elevated temperatures and the energy associated with that not only to heat up the rocks in order to coat them, but also to

provide that heat exchange to the liquid binders so that it is fluid enough, that it is workable as we produce it and then transport it to the job site and then actually pave it on to the roadway.

Slide 4: WMA Temperature Ranges

Matthew Corrigan: Other technologies that have just recently been developed - we're still trying to fully understand the mechanism that allows us to take advantage of producing them at the lower temperatures because it's not always a reduction in viscosity that quantifies what that is. But across the board, they all allow us to reduce the temperature to different varying degrees from our traditional hot-mix asphalt pavements. So what you see here is something in the neighborhood of the general temperatures that we're looking at when we produce hot-mix asphalt versus warm-mix asphalt versus even cold-mix asphalt which traditionally is being used in maintenance area and pothole patching and things of that nature.

Slide 5: WMA Comparison

Matthew Corrigan: The technologies are very much different when it comes to the amount of temperature reduction, some of the technologies hovering about that 275, 265 range. Others really push the envelope and you can reduce the temperature down below 200 degrees Fahrenheit. So it very much depends on the technology. The localized fumes are very easily to see the – very easy to see the reduction. Here, if you look at the picture on the left-hand side, that's a traditional hot-mix asphalt being produced at 320 degrees Fahrenheit. And on the right-hand side, it's using a warm-mix technology where they reduce the temperature to 250 degrees Fahrenheit. And you can just see, visually, the localized fumes at the production site do get reduced with the reduction in temperature. And so that's been one of the drivers in addition to just reducing the energy needs and producing the mixtures at these higher temperatures as well.

Slide 6: Brief U.S. History

Matthew Corrigan: So just a brief U.S. history to let everybody know where we're at – most of these technologies came out over – at least were first developed in – and acknowledged in the European community. They were discovered early on by the National Asphalt Pavement Association on some of their different scanning tours and brought to the United States in San Diego as part of their annual meeting in 2003. And that's when I got involved as well as Federal Highway and the Office of Pavement Technology on looking at ways to implement the technologies with the goal of maintaining that long-term performance.

The Board of Asphalt conference, which is held every year, was one of the first demonstrations of the technology in the United States. We formed a technical working group around the technologies - Federal Highways Administration and NAPA in 2005. And then the Federal Highway Administration did an international scan tour which you see the report here on the right-hand side. That's available if you search our internet site or international program site for warm-mix. You'll be able to download that European Practice Guidance. And then we had an international scan tour, November of 2008, to kind of bring all these guidance together to the industry.

Slide 7: Why WMA?

Matthew Corrigan: So you can see, we've got a few years under our belt with acknowledging the technology and its usage, but it's really only been within the last three years that we've seen the pavements actually being produced on the roadways. These are the potential advantages that are typically being touted as far as moving towards warm-mix asphalt. And of course, if you see with the asterisk that, really, the only way you can take advantage of all of these advantages is to optimize the production operations. Producing asphalt mixtures is a complex process, and there is a lot of information that needs to be exchanged between the operation as well as lay down in order to achieve all of these results. And like I had mentioned, the energy savings in the decreased fumes are really kind of the two major movers. But there's other identified potential advantages.

Slide 8: Why WMA?

Matthew Corrigan: What's really kind of out there as far as the verdict, still needs to be determined is how much energy savings. We recognize that just by reducing the temperature, we do get decreased emissions and decreased fumes. But, from a life-cycle cost analysis standpoint, if we're not able to get the same performance as our hot-mix asphalt, and we have to go out there and build them more frequently, then in fact, things like energy usage and emissions in the long term in a life-cycle basis could increase. So again, as part of optimizing this process and really identifying how much energy savings, how much decreased emissions and fumes we're getting.

As well as things as increasing the recycled asphalt pavement content in our mixtures, there is a continuing research and study being done right now to address whether or not we can activate the recycled asphalt pavement in the mixtures at the reduced temperatures. And so these are still some of the potential advantages, that we acknowledge, come with lower temperatures. But we want to make sure that, indeed, we are getting the long-term performance and these are coming to realization.

Slide 9: How Many WMA Technologies are Available?

Matthew Corrigan: What makes this very difficult is, that, when we first started looking at the technology in the United States, there were only three warm-mix technologies available at that time.

Slide 10: How Many WMA Technologies are Available?

Matthew Corrigan: Currently now, as of my last count, which was about two weeks ago, we've got currently 20 different named warm-mix asphalt technology being marketed and used in the United States. And so being able to quantify their performance of all these technologies is going to be a difficult task for the industry to keep ahead of.

Slide 11: Technology Overview

Matthew Corrigan: This would be page one of the two pages recognizing the different technologies. Unfortunately, I don't have enough time within the context of this presentation to give you a lot of details on how each of these technologies work. But, you can really differentiate them in three major ways.

There are a couple of technologies, the WAM-Foam and the low-emission asphalt that basically they take, with some additional equipment at the production facility. They change how the existing materials for hot-mix are incorporated or processed in the production process. And so it's really just a different way of manufacturing the material. The other technologies here on the left-hand side, as you work down including up to the ready set, are what would be additives, either a chemical, or waxes, or something that's added to the mixtures or to the liquid asphalt, that allows you to reduce the temperature.

Slide 12: Technology Overview

Matthew Corrigan: And then you get into these technologies here on the right-hand side, which are primarily what they call "foaming technologies," where you're injecting some amount of water into the liquid asphalt, and it creates a rapid expansion, or a foam-kind of like a shaving cream type of consistency to allow us to produce at the lower temperatures. And of course, Federal Highway, we do not endorse any particular technology that's being marketed. These are the final ones that have just come out and these two are, again, they're admixture types. This is another foaming technology and another admixture type here.

Slide 13: WMA Trials and Demonstrations

Matthew Corrigan: And there are certainly more technologies being used internationally in Europe, in Australia, in South Africa, South America. So there are plenty other technologies being used around the world. To date, we've seen a lot of states get into the area of looking at the technologies and producing at least some small projects or demonstration projects. The yellow states are the states that have been identified by us as actually doing some sort of demonstration project. Now many of these projects, especially in the first couple of years, 2005 and 2006, were very small projects, low tonnage, low lane miles, not heavily trafficked routes. So it wasn't really until about the end of 2005 or rather, the end of 2007, 2008, 2009, that we've picked up larger projects, larger production, larger lane miles with heavily trafficked routes such as interstates.

So we're still, again, evaluating this long-term performance. And through that evaluation, our mobile asphalt mixture testing laboratory, which you see here, tractor-trailer pulled laboratory, we've been able to visit several of these warm-mix demonstration projects in order to evaluate the materials and the performance, and continue to monitor those sites, as far as how long they will perform under traffic. Right now, there are over 140 documented projects in some format. But like I said, most of those have been very small projects, up until the last couple of years. So we're really just starting to see the technologies take off.

Slide 14: WMA Technical Working Group

Matthew Corrigan: To make sure that we're giving information out on the proper usage of the technologies as well as the benefits and precautions on possible improper uses, we develop the technical working group. I help co-chair that as well as some industry representative. But it's a very broad, diverse representation of the industry, including our state agencies, asphalt pavement associations, AASHTO, labor, NIOSH, different academic groups. So we're really trying to get as much input into this process as possible.

Slide 15: WMA TWG Accomplishments

Matthew Corrigan: Some of the accomplishments that we've been able to do in a short amount of time is develop the warm-mix asphalt website and you can get a lot of information. In fact, most of the information and the rest of these bullets can be accessed there. We've got some recommendations on testing, as well as best practices for producing, using the technologies and a guide specification for state agencies to use constructing pavements.

Slide 16: National Research Initiatives

Matthew Corrigan: We've also managed to move forward many research-need statements on a national front that have been submitted to AASHTO, and the five research need statements we have put forward have all been funded through AASHTO, through the National Cooperative Highway Research Program, to a total of nearly $3 million. So you can see there's a large emphasis and a large need for knowledge in this area. These are the - the five research-need statements have been combined into three major projects by the NCHRP process, the 9-43, 9-47A, and the 9-49 projects. And really, again, the emphasis here is to understand the technologies, and make sure we're getting long-term performance.

The 9-43 project is about ready to finish here at the end of the spring, beginning of summer this year, which is developing a mixed design procedure for the technologies. The 9-47A is just getting started. But it's really looking at benchmarking the energy savings, to energy audits, as well as the emissions reductions, so that we don't just get a lot of marketing spin on what kind of reductions we can realistically see with these technologies. So this will benchmark those on a handful of well-controlled and select projects, as well as monitor the short-term field performance, again, making sure that we've got equal to or better performance than our conventional hot-mix pavements.

And then the 9-49 project is just getting underway as well. The phase one has been advertised on looking at whether some of these technologies, due to the lower temperatures, are more prone to moisture-susceptibility damage, which would reduce the performance, and recognizing whether or not that's an issue or not, and how to mitigate those. So again, a lot of national research being done, and a lot of questions on long-term performance still remain to be answered.

Slide 17: Written Summary of WMA

Matthew Corrigan: Unfortunately, again, due to time constraints, I can't get into too much more detail, but, we've put together a kind of a written summary on the technologies, and a lot of links

to the different research work, the warm-mix asphalt technical working group. And of course, my contact information there is available. So I'd encourage those of you that want more information to please visit our website. And with that, I'll turn it back over to the chair.

Chicago's Sustainable Streets Pilot Project

Neelam Patel: Great. Thank you, Matt. I just want to, again, encourage people to send questions. We're running a little over, so we may not get to all the questions. But we will answer these in writing and post them to our website. So please do continue to submit your questions. And again, now we have our last presenter, Janet Attarian, from the City of Chicago. In her presentation, she will pull together all of the concepts that we've heard, both on sustainability initiatives, as well as cool pavements to help reduce the heat island effect.

Janet Attarian is the project director of the Chicago Department of Transportation Streetscape and Sustainable Design Program and works to turn Chicago's streetscapes, river walks, and pocket parks into great urban places. She's originally in the design and management of hundreds of public works projects, and her accomplishments include the City Streetscape Guidelines, the Wacker Drive reconstruction project, and the Millennium Park Bicycle Station. So I'd like to turn it over to Janet from Chicago to talk about some of the new programs that she's working on.

Slide 1: Title Slide

Janet Attarian: Thanks, Neelam. I know we're running low in time, so I'm going to try to go fast. So pardon me if I sort of glaze over some things. But there are some topics, I think that have been certainly well covered by others, so, I will try to go through that. Let's see – we'll change slide. There we go.

Slide 2: Chicago Climate Action Plan

Janet Attarian: So just to kind of give a start off for Chicago, we do have the Chicago Climate Action Plan. And that is a plan that very specifically addresses our mitigation and adaptation efforts to reduce our greenhouse gas emissions. But as part of that plan, we actually did do a detailed climate analysis of what might happen to Chicago in this region, given our current emissions and even what would happen in the lower emission scenario. You'll see here, if we actually were able to meet the Kyoto Protocol.

So you can see, that either way, we are definitely looking at increased precipitation and also increased – in the number of days that exceed 100 degree temperatures, both of which are obviously very affected by pavements or - and certainly needs to – pavements need to adapt to these kinds of conditions too. So we have both aspects. As mentioned, you know, having all these pavements certainly does have a big impact on our ability to infiltrate and on the urban heat island.

Slide 3: The Urban Form

Janet Attarian: In Chicago, just our roadways are about twenty-three percent. From what I have been able to learn from talking to other cities, that's fairly consistent in major cities across the country. It's about a quarter of the land area. And that doesn't include things like parking lots

and all that. It definitely gets more up to the numbers that Kamil talked about, the forty to fifty percent when you start to add in those numbers.

Slide 4: Adding to Urban Design Framework Plan

Janet Attarian: So what we're trying to do here in Chicago is we actually set up a committee to sort of look at all these surfaces. So not the interior of buildings, but the roof and skins of buildings, the sites around buildings, the public right of way. To look at all those things and see if we could come up with a comprehensive set of strategies to address them, and also, to look at all of our initiatives across the city and sort of see, you know, do we have barriers in place and so forth. So those were organized around air, land, and water, and quality of life principles. Obviously, a lot of the things we're talking about today fall on the air principle, although there's obviously lots of synergies here, urban heat island in particular.

Slide 5: Urban Heat Island

Janet Attarian: Again, this has been touched on, so I'll go quickly. But you can see when you map and these are – this isn't all the warmer areas, but these are those sort of worst areas where it's really bad, if you will. Sort of some of the imagery that Kamil showed earlier, in the city. And again, you can see that the grid is definitely showing up, and the other thing that really shows up heavily in Chicago is our industrial areas and our parking lots.

Slide 6: Urban Heat Island

Janet Attarian: And of course, the interesting thing is then to look at this with our canopy cover, and of course, see not surprisingly, the strong relationship between the two and why we need an integrated strategy when we're looking at these things.

Slide 7: How Complete is your Street?

Janet Attarian: So the way we sort of been approaching all of this, and I know this is a little bit broader than we're even focused in, but I'll drill down pretty quickly, is sort of in creating our own, if you will, rating system. It's nowhere near, you know, the complexity of a LEED in terms of that we design points and all that kind of good stuff. But, when we started thinking about this seriously back in 2004, we said, "Well, we don't have any of those tools." There's a lot more of them – sort of coming onto play and we said, "How are we going to start to organize our efforts? What does it really mean to have sustainable roadways, sustainable pavements, sustainable streets?"

Slide 8: Green Alley Program

Janet Attarian: And so we began to sort of come to these certain sections or goals, if you will, that we wanted to start to organize ourselves around. And you can see they're listed here, and urban heat island is certainly a part of that. And I'll talk about this a little bit more in detail, project specific. So about that same time we started thinking about our alleys. Our alleys in Chicago represent a fair amount of land area. They're about – five of them are midway airports.

So they're just – they are spread throughout the city. We have a pretty consistent alley system behind every one of our roads. We actually think it's probably one of the biggest alley systems in the – in the country.

Slide 9: Chicago Examples: Green Alley Program

Janet Attarian: And so it represents a lot of pavement. And it also is a problem for us because it doesn't actually have, for the most part, any storm sewer system in it. And so over time, we were getting a lot of flooding complaints, and we wanted to look at those – this problem, and see if we could solve it in a more sustainable manner than the way we had been, which is basically, rebuilding the alleys with the sewer system, you know, impermeable, often asphalt surfaces. So we attempted to do a couple of things. Obviously, our main goal was to look at storm water, but we didn't want to stop there. We wanted to look at the urban heat island effect and see if we could affect that by looking at the design of our pavement. We wanted to look at recycled content. We even wanted to look at the relationship of those things, to dark sky lighting, and improve our lighting. Because in Chicago, actually, we light our alleys just as much, if not more than the streets, which obviously ties into some security issues. But therefore, how we light our alleys is really, really critical to our energy use and also the quality of life, because all that light basically goes into everyone's adjacent homes and bedrooms and windows.

Slide 10: High Albedo Pavement

Janet Attarian: So we developed a number of materials for this. We developed permeable asphalt, and a permeable concrete mixed design. We built that ourselves. We conducted our own lab testing, sort of worked with local materials. We really didn't have that stuff regionally at that time, and so, we sort of had to, you know, invent the installation methods, the mixed designs. We did some innovative things like adding ground tire rubber to our asphalt, which was permeable asphalt, which is the first time that had been done. But we also created what we call our high albedo traditional concrete mix by adding slag and lighter aggregates to the mix.

Slide 11: Wider Implementation

Janet Attarian: We also included those things in our permeable concrete, to kind of see what those impacts would be, and you can see, in this chart here that we took some measurements. These were – these measurements were done about six months after winter, after they were put in. So we were pretty happy. You can see the SRI numbers for, if you look at that, Glenwood and the Harding locations. The lower one under the Glenwood and the Harding are both of our high albedo mix designs. And you can see the SRIs are above 29. So that, of course will get you a LEED point, if you are using this on a building site.

What's also interesting to note, though, is that the permeable pavement, even with the slag, the permeable concrete, even with the slag, still has lower numbers, and that is because of course, it doesn't – because of the sort of Rice-Krispie texture of it, it doesn't reflect in the same way, even though it still has some of those agents that – and really all the same materials. Of course, as we've discussed, there might be other offsetting benefits with the fact that it's permeable, has lower densities. Those things are a little bit harder for us to measure. And so that's actually one

of the things that we're still trying to work on. You can also see in this slide that I specifically said, we didn't allow fly ash. And not because we don't think fly ash in pavements is good, but because fly ash definitely darkens the pavement, and we wanted to avoid that.

So the Green Alley Program sort of really gave us the impetuous and the confidence to start expanding what we were doing. We started using all of these materials, including permeable pavers, which were also throughout our infrastructure, permeable parking lanes, parking lots, parkways, plazas, all these kinds of things.

Slide 12: Maxwell Street Permeable Market Plaza

Janet Attarian: One of the next projects that we did was actually a streetscape project in combination with a local market that we have, weekly market. And what we did was we took over an adjacent parking lot, that was, I think, a little over an acre, and we again, didn't have any sewer infrastructure on it. So instead of doing that, we made it permeable. We used high albedo pavers. We put in a fair amount of vegetation. The slide you see here is before a lot of the seeding and stuff going in and very new vegetation. But sort of, again, combining those strategies to sort of maximize our benefit. One of the things we couldn't do in this parking lot, which you traditionally see, is trees in the middle. And the reason we couldn't that is because, every Sunday, it's got tents packed, and so, we had to maximize that space for the use of the vendors, and not sort of create obstacles with trees in the middle.

Slide 13: Market Plaza: Preliminary Monitoring Results

Janet Attarian: But one of the things that's really interesting about this program – this project is that it's one of the projects that we had been monitoring, actually, with the EPA, and I think this is a really interesting slide, because, while it's not directly related to Albedo, I think it does kind of go through this issue of how do permeable pavements possibly effect the urban heat island. And that is that we had temperature probes in the - underneath the pavers. One in the 2-inch setting bed, one in this 12 inches underneath that, and one in the 2 feet that was underneath that, in addition to a just an air temperature probe above ground. You can see the different lines there, and what you're seeing is that this past winter, even on our coldest day, on January 7th – or excuse me, January 16th, when we got to minus 7 degrees in the air temperature, even the temperature probe that was directly below the pavers, so in those first 2 inches, did not dip below freezing.

And so what that shows is that we're getting that convection. We're getting that more consistent temperature, because of the connection to the earth which, you know, stays at a constant 55 degrees, which is great for us in terms of helping us to know about all those kinds of things. But I think it also – it sort of explains why permeable pavements can help in other ways with evaporation and the ability for them to cool off quicker, and those kinds of things, or hold less heat.

Slide 14: Lawrence Avenue Streetscape

Janet Attarian: Some of the other efforts, of course, that we do is, you know, in marching along with things like the complete streets efforts, and contact surface design, we take a lot of streets that we have like this in Chicago, very narrow sidewalks, a lot of asphalt where we don't have even room for trees, and we do things like this. We're widening sidewalks, so we can add trees. We're adding bio infiltration swales at the corners to pick up water. And of course, mixing it with all of our alternative mode of transportation and all those kinds of good things to affect the urban heat island.

Slide 15: Lawrence Avenue Streetscape

Janet Attarian: But we're trying to bring more of this together in what we call our Sustainable Streets Program. And we have a pilot where, I'd like to say, pretty much threw everything in the kitchen sink at it, and so, you know, what would it mean if we have the equivalent if you will, of a platinum streetscape. I say that, as you can get in lead right, you can get the platinum rating. So we wanted to know what would a platinum streetscape look like. What could we do if we try to take advantage of everything we had, sort of, out there, post the technology barriers.

Slide 16: Cermark/Blue Island Sustainable Streetscape

Janet Attarian: And so we set up, you know, you'll see these are the kinds of categories that I showed earlier. And then, what you're seeing here is specific goals for this project that were set up in conjunction with those categories. And you can see again, there are some urban heat island issues here. But, really, the whole pavement technology affects many of these. And that's what I'm going to sort of walk through on this project on how we used these kinds of pavement technology techniques to effect our energy efficiency, our recycling, our urban heat island, beauty in community, alternative transportation, water management, all of these things, actually, are all being addressed through our pavements.

Slide 17: Urban Heat Island

Janet Attarian: So when it came to the urban heat island, per se, there were several strategies that we are implementing. One of them is, again, with our experience from the Green Alleys, using slag in our concrete mix. Another one is a microthin concrete overlay, over our asphalt. And the other one is using permeable and high albedo pavers, and with that, actually, putting some photocatalytic cement face mix to some of those pavers. And I'll talk about that more in a little bit. And of course, increasing our treatment canopy cover, and increasing our landscape surfaces as a whole.

Slide 18: Pavement Technology – Asphalt

Janet Attarian: So just a sort of step back, give a little bit of history on what we've been doing with asphalt, in particular, in the city. And several of these efforts has sort have been interwoven and some of these projects that I've showed you and what I sort of highlighted at the bottom is what's going into the sustainable streetscape project that I'm talking about right now. I think, some things to know is that we have piloted the warm-mix asphalt, pretty small-sized project. It was on one of the residential streets.

But, once again, when we introduced, you can see in 2006, with the Green Alleys, when we got the permeable asphalt and the GTR, that really sort of opened us up and we started trying a lot more things. We found that GTR is a great addition to a lot of our pavements, and we started adding those. You know, looking at the warm-mix, looking at our recycled aggregates. We tried the shingles this past year, which is very successful.

So we're trying to figure out what's the best technology, and push the industry, and also, it's a – it's a yin yang too, especially with the warm-mix, because, as mentioned – as Matthew mentioned, you know, until you kind of have a whole planet making warm-mix all the time, you know, how much of those benefits do you see? On the other hand, you're not going to ever get a plant making warm-mix if you don't start asking for it. So you know, how do we start that ball rolling?

So in this project, we will be doing a warm-mix asphalt. It's going to have a 15 percent RAP, and I was very interested to hear Matthew talk about the ability to increase RAP in warm-mix, 'cause what we are finding with our designs right now, is that we actually have to keep it down. So we wanted to bump that fifteen percent up, but we couldn't maintain the quality. So we needed to keep it fifteen percent. However, we could use the ten percent GTR. And then, what we're doing, on top of that, with the albedo, is putting the high albedo microthin concrete overlay on top of that.

Slide 19: Pavement Technology – Concrete

Janet Attarian: In terms of concrete, as I mentioned, we started off with the slag. But, some other efforts that we've done is to include recycled wash water, from the plant, in here, so we're saving energy and resources that way. We've also been redesigning our permeable concrete designs to better work with our maintenance equipment, and looking at that. And also, different ways of installing it, because it can be, especially in an alley, where we have very limited access, it can be very difficult for us to install. And so we actually did an installer with - putting the asphalt into an asphalt paver, which we got some pretty good results, very high strength, almost 2,000 psi, and still maintaining really high permeability. And then, on this project, we're going to do three percent recycled aggregates for the first time, and the recycled wash water, and the slag. So can we combine all those things together and see what we get.

Slide 20: Micro-thin Concrete Overlay

Janet Attarian: I talked about the micro-thin concrete overlay. They'll be over 100,000 square feet going in. The minimum SRI in our specification is 0.36. We're going to be doing some outer lanes on a very high (ADT) road. And we're also going to be doing a very large major intersection. I actually have a picture of that in a little bit here.

Slide 21: Integrated Infrastructure Design Example: Blue Island Cross-section

Janet Attarian: So to sort of bring some of these things together, and talk about how we're sort of trying to find those synergies in the design, to sort of maximize our sustainable benefits, this slide is a cross section through the Blue Island section of this project.
Slide 22: Photocatalytic Permeable Pavers

Janet Attarian: And what you're seeing here is that we've created permeable parking lanes and bike lanes that are created with obviously permeable pavers. These pavers have a high albedo surface, so they obviously help us with urban heat island. They are - also have this photocatalytic cement, which helps with air quality and also with some self-cleaning, to keep them, so that they remain with a high SRI, because, of course, we know, these things drop considerably with – over time. And so – and also, actually, this helps us with our lighting and our uniformity. And I'll talk about these things in a little bit more detail.

So this is a plan, and you can see, what's sort of highlighted in gray with sort of lighter brown on top of it. Those are the bike lanes. But that whole area, the gray plus the bike lane is the area which are going to have these pavers with the photocatalytic cement is going in a surface mix. That's going across the top of these pavers. And again, they will have a – start off with a pretty high SRI of at least 0.45. The manufacturer is saying we can get closer to 0.55.

Slide 23: Photocatalytic Cement in Pavements

Janet Attarian: The photocatalytic, we've done some testing. We developed with the manufacturer this mix design, and had it tested to make sure it really works. Photocatalytic cement basically is using titanium oxide to speed up the catalytic process that already happens in cement, to make it so that it essentially removes a lot of your organic and even some of your inorganic pollutants, and washes those away. So it has an ability to sort of, maintain its cleanliness and also remove some pollutants depending on the conditions of the air up to 8 feet from the surface. The other interesting aspect of this…

Neelam Patel: Janet?

Janet Attarian: Yes?

Neelam Patel: This is Neelam. I just – a quick – I just wanted to kind of message out to the audience. We are coming to the end of the time that we had allotted for the webcast. But we are going to continue on. I do encourage you, if you have questions, please submit them. We will have them answered in writing and circulate the answers to all the participants on the webcast today. And, again if you do have to leave, we thank you for joining us. But, if you can stay, please stay until the end of Janet's presentation and some of the questions and answers that we'll do when she's done. But if you're not able to stay, all these information will be available on our internet, and we'll send it out through the – through your e-mail addresses when you registered on to GoTo meeting. Sorry to interrupt, Janet.

Slide 24: Energy Efficiency

Janet Attarian: Well, that's OK. This is also helping with lighting. I know a lot of people are concerned about using reflective pavements, and that we might actually reduce the dark skies because, you're basically reflecting light back up. But what we have found is that if we use the reflective pavement, we can really then possibly lower our wattage in combination with things like going from high pressure sodium to white light sources like LED and metal halide, sort of taking advantage of the blue lumen argument. You know, using cutoff fixtures, using the white light, we can lower the wattage, and with the reflective pavements, we can kind of create – we cannot - not kind of, but we create a better uniformity, which is a very important factor when you're trying to make arguments for lower lighting levels, which here in Chicago, is a really big deal, 'cause we are one of the brightest cities in the country, when you look at it from the sky.

So we are also using that in combination. And that's why you see a lot of these pavements being specified in the outer lanes, because it really allows us to take advantage of this. And obviously, having those self-cleaning properties is also important if you're using it to help you with your lighting calculations.

Slide 25: Benito Juarez High School Water Feature

Janet Attarian: Another example of sort of pulling this all together, is one of the things that we're doing on this project is we're partnering with a renovation that's happening with a high school design here. And essentially, what we're doing is we took an impermeable plaza that they had between the old high school and the new addition, we made it permeable. We captured the water underneath that with a membrane. It all gets focused along with roof water, into a zero-depth water feature, then goes into a bioswale, and then if there's anywhere left after that, it could actually goes over into their ball field and infiltrate.

I think what's interesting about this from a pavement perspective is, again, you're combining you're landscaping, your permeability, and these are all high albedo pavers in really trying to create spaces that are beautiful and attractive and educational.

Slide 26: Integrated Infrastructure Design Example: Parkway Bioswale

Janet Attarian: Another example of course is the – is the landscaping aspect of this, which is, again, being done in combination with the high-albedo asphalt - pavement. So this cross section you're seeing here, the car is driving on the microthin concrete overlay, the water is all going into an adjacent bioswale, which provides, obviously, large stretches of native landscaping, again, helping us with the urban heat island.

Slide 27: Project Examples

Slide 28: Beauty and Community

Janet Attarian: Another example on this project is at one end, we have this pretty much awful corner. It's a big asphalt parking lot. And we were able to get a quarter of that and turn it into a sort of cascading bioswale planter and add a lot of green space, takeaway some pavers, a pavement, and create a gateway to the area.

Slide 29: Education

Janet Attarian: Another aspect of this project, of course, is education. With all of these things, it's really important we explain what we're doing. We think this is really a fundamental goal of any of these projects. And so there's a self-guided walking tour as a part of this. There is going to be kiosk on solar and wind-powered lights throughout the project, which are going to be explaining everything that you're seeing, how it works. So there's a whole bunch of efforts in conjunction with this effort to explain to people, you know, what we're doing and why we're doing it.

Slide 30: Commissioning

Janet Attarian: Commissioning – this is often something people talk about with buildings more than roads. But we think this is absolutely critical, especially, 'cause we're in such learning phase right now, and trying to figure out all these things. So the Green Alleys, the Maxwell Street Project, and the Cermak/Blue Island Sustainable Street Project are all receiving a lot of monitoring. The Cermak/Blue Island is being fully monitored from a storm water perspective, after our MWRD. We've got monitoring wells, just a whole host of equipment in there.

Slide 31: Meteorological Station

Janet Attarian: But, these things are really critical for us to sort of find out, you know, what works, what doesn't, what's the most cost-effective procedures, and what's really going to help us with the overall life cycle. Some of the efforts on this project that specifically relate to pavements and urban heat island, is we installed meteorological station at this large intersection. So that's a picture you see of that Ashland/Blue Island/Cermak intersection as it currently is. This station is constantly telling us real world information about temperature, air temperature, the surface temperature. So right at the surface, you know, humidity, a whole bunch of other information, which is great because this is going to be one of the – this is the intersection that's going to be covered with that microthin concrete overlay. So we're going to be able to hopefully get some sense of the impact on that local microclimate, which is very hard to tell when you're talking about urban heat island on a specific project.

Slide 32: Air Quality Pre-Data Collection

Janet Attarian: We're also – in conjunction with the photocatalytic cement, doing air quality data. These are pictures of the data, we did preconstruction. And obviously, we'll be following up with that.

Slide 33: Maintenance

Janet Attarian: And of course, we've been doing a lot of monitoring on the maintenance of these pavements, because that's just critical. We don't want to throw them out there, and then have them not work. So we've been looking, as you've seen, albedo, SRI, been doing on-site and lab

infiltration testing, and run many different kinds of maintenance equipment over these kinds of things, to develop a maintenance protocol and sort of bring all of these together.

Slide 33: Contact Information

Janet Attarian: So that was a very fast version, but hopefully, we'll get some good questions, and maybe answer some things I left out. So thanks.

Question and Answer Session

Neelam Patel: Janet, thank you. That was an excellent presentation and really that focused on the co-benefits of your program, but also tying in many of the things we've heard today. So what I'd like to do now is turn it over to Nikhil to ask some questions. And again, for those folks, thank you for staying with us 'til the end of Janet's presentation, excellent information about on-the-ground implementation, when it comes to pavements, and just generally, across the board livability, like Dave Carlson said from Federal Highway. I want to remind everyone that we are going to stay on the phone. But if you cannot stay with us through the question and answer session, we will take all of the questions that are asked and have them – have written answers available for you. So Nikhil, would you like to start asking some questions?

Nikhil Nadkarni: Sure. I guess the first few questions are for Janet. One of the questions we received from a couple of participants is related to the cost. So first of all, what is the cost difference between block pavers, concrete, and asphalt, and similarly, what is the difference on the Cermak/Blue Island street test in terms of the cost between normal construction and the test construction?

Janet Attarian: Well, costs, of course, are a very interesting thing, especially when you're piloting, because, you know, they don't always reflect long-term cost. To sort of give you a sense of what that is, let me tell you something about the Green Alleys. So when we piloted the Green Alleys and that was the fall of 2006, first time that it was being done in the region, our permeable concrete cost us, on the very first pour, $145 a square yard. By the next spring, we had put out a low-bid contract for use across the city, and that price dropped to $45 a square yard. And this is for an 8-inch thick pavement. So it's sort of interesting to see. We did not see the same sort of drop with the permeable asphalt. It dropped a little bit, but only a couple of dollars. So it was still up there, I think around $135 a ton. And part of the reason for that, of course, is that, you know, what - our concrete industry decided to jump on. You know, they were very skeptical, but once we sort of went to this process with them, they were like, "We want to do this. We want to make this happen."

The asphalt industry was a little bit more, you know, "It's a bigger deal for our plants. We want to have minimum orders, you know, before we do this." So it seems to sort of depend a lot on, you know, how the industry responds, and partnering with the industry, I think, is key on some of these things because, you know, you could specify all you want. But you got to make sure, you know, you have the capacity. But you got to push them too. In terms of the sustainable streets, it's an interesting question how much of a bump. Where we think we're going to see the biggest bump is not so much in the materials, although there definitely will be some on these really, you know, new technologies. So the photocatalytic, we priced it out, and I'm sorry I haven't these numbers exact, because I'm doing this from memory. But I think it – the pavers went up about 75 cents a square foot for us to add the photocatalytic. But I might be a little off on that. So I'd have to double check.

So there are certain things, like that, where yes, you're just – you're paying more. It's new. It's different. You know, there's very few people making it, and so, you're going to - you're going to pay that. But overall, a lot of the techniques are nothing special. It's still asphalt. You're still going to put it down like you put down asphalt. It's still concrete. You're going to do that. The issue, of course, is the contractor's familiarity with these things. That's one place where we see the bump. And also, one of the things that we're doing with that project, is we're forcing the contractors for the first time to track all their construction waste management. They're tracking their recycled content, their local materials, so just like in LEED. And that's really new and different for our roadway contractors. And that's where I think, you see a lot of the bump right now, 'cause, they're just not sure. And so they're sort of folding in those costs, for how to do some of those kinds of things.

But really, in the end, those things are very affordable, and sometimes, even a savings for them, because they get paid for recycling all that waste. So I think they'll even out over time.

Nikhil Nadkarni: OK. Our next question is in regards to the street lighting. Were you able to calculate the particular reduction in wattage and lighting by using reflective pavement?

Janet Attarian: Yes. It's hard to say, you know, because again, we're learning. It's hard to say exactly how much is from the reflective pavement, exactly, until we sort of get out there. But, when we were running the calculations, against through a combination of the white light and the reflective pavement, we are – this project, instead of having - usually, Chicago glows for two to two-and-a-half foot candles mid block and double that at the intersections, we're cutting all that in half, which is still, you know, way above the IF standards. So as I said, Chicago, we believe in light. So there are some pretty drastic reductions on this, and we're really trying to make the case with some of these efforts of you can still have good lighting that provide safety and security, and you know, good target visualization, if you do the right things. If you – if you take advantage of some of these other issues and these new technologies, because uniformity is such a key to good lighting. And often, we see a lot of wattage out there, but we have a lot of glare, and a lot of, you know, dark light - dark light spots, plus not very good color rendition and that's with the high pressure sodium. So that's – the combination of all those things is the argument we're making to sort of really reduce the energy use.

Nikhil Nadkarni: OK. Our next question is, is there – are there any problems with grass growth in the new types of alley pavement?

Janet Attarian: The only one we've had any issues with is the permeable pavers, because obviously, you can, you know, you can get some real areas of dirt, essentially building up. But we have not seen any of that on permeable concrete or permeable asphalt. You know, the pavers, all of these things, they do require maintenance, that's a whole other talk on that, and what we've found – but one of the things that I will say about the pavers that we found overall, and this I think, ties directly to the plant growth, you've got to make sure that you keep your stone up. It doesn't have – you know, the point is not to make it flush with the top of the paver, but kind of flushed with the bottom of the chamfers, since a lot of these pavers have a chamfer. If you don't, what happens is you get that stone lost, and everyone talks about, you know, the dirt stays on the top, you know, quarter to half inch. Well, it does, but, as soon as you get that stone

loss, if you, let's say, you have a half-an-inch of stone loss, now, your dirt is building up a quarter to a half-an-inch deeper, and it has the ability now to get to a, maybe, a good inch of dirt, this supports a lot more plant growth and also makes it much harder to clean. So that, I think is part of the success is at staying on top of that is making sure you keep your – the stone that's in the joints cut off.

Nikhil Nadkarni: OK. Next question, what is the realized performance gain of using the ten percent GTR in your asphalt?

Janet Attarian: So the 10 percent GTR is, of course, ten percent of the asphalt concrete. It is not ten percent of the overall materials of asphalt. Right? 'Cause most of asphalt is still the aggregate. So what you - the asphalt concrete is essentially the sludge at the bottom of the refining process, and I'm sorry, I'm not an asphalt person, so I talk about this in very much layman's terms. I call it the "black juice." But anyway, so what you're doing when you add GTR, is you're obviously offsetting that amount of just product you need from the oil refining process, which is really important for a number of reasons because a lot of the oil refining process these days, they're, because of the price of oil, they're using better equipment that is taking advantage of that, and so, there's much less of that available, which is part of the reason that asphalt prices were so driven up. So offsetting, that's a good thing. It uses less virgin material.

The other big benefit that we got with permeable, in particular, is permeable asphalt has a drain-down problem. It doesn't want to hold itself together, because right you're going for 20 – we got about twenty-five percent air. So usually, they felt that problem with fibers. Fibers are expensive. They were harder to get for us. And so by using the ground tire rubber, we didn't have to use the fibers. So it solved that drain-down problem and used recycled products. You know, it reduces your virgin materials.

So those were all the benefits that we got out of the ground tire rubber, and that's with the permeable. And there's other benefit also. The other thing, I think, is really interesting, when it comes actually to this issue of heat. When you add ground tire rubber to asphalt mixes, permeable or not, it has a higher, and I'm going to say this wrong, so all you asphalt specialists out there can yell at me, but has a higher – the has a temperature range, right? That it's good for, depending on if it's N30, N50, N70 and so on. It raises that upper temperature range, so that you'll going to have less heaving and those kinds of things when you have the ground tire rubber. So those are some other big benefits by adding that to the product.

Nikhil Nadkarni: OK. And the last question for Janet was, could you please provide some specifics on how thick a microthin concrete overlay is?

Janet Attarian: Well, it varies. But the ones that we're looking at is 1/16 to 1/8 inch thick. So it's thin. It's pretty thin. They are different technologies out there. You know, they're available, but the one that we're using on this project, it truly is a microthin, you know, overlay.

Nikhil Nadkarni: OK. Are - we have a couple of questions for Kamil. First of all, how will this porous pavement stand up to freeze and thaw in the northeast? Is it expensive to clean, and how much maintenance is there, if any?

Kamil Kaloush: Pervious concrete has been around for at least, 25, 30 years. It's been – it's not really a very new technology. It's just, now it's seeing a comeback, just because of some of these benefits that we've been discussing. Porous asphalt has also been used for a long time. We cover just about all of our highway system here in Arizona with that material. For the up northeast freeze and thaw, I get these questions once in a while. I haven't seen any evidence really that freeze and thaw is an issue, just because of the high voids in the porous material. So basically, unless if you have a flash freeze situation, that water will drain out before it can create any problem. So the high air void contents, really, it will help into that issue.

Nikhil Nadkarni: OK. The next question for Kamil, does increased pavement reflectance increase adverse glare?

Kamil Kaloush: Good questions. I haven't seen any studies on this specific area. But again, I think with the SRI and the reflectance, we're talking about, is within the existing, you know, whether it's an asphalt or concrete surface. So it's nothing really like a glaring white. So obviously, if you go to extreme, it is. My – you know, my hunch, yes, it would do that. But nothing within the range that we are, you know, we are trying to achieve.

Nikhil Nadkarni: OK. Is one kind of urban geometry more beneficial in mitigating urban heat island than other? For example, high-rise buildings versus single-family homes.

Kamil Kaloush: With the effect on the roadways, some of the canyon geometry I just explained. Yes, tall buildings will have tendency to trap heat basically. And also, the location of the roadway or the highway itself. So yes, things at grade and lower building geometry will help actually to ease up and free some of that hot air, especially during the evening hours.

Nikhil Nadkarni: OK. The next question, are there any human perceptual studies about the urban heat island effect? For example, in a hot urban environment like downtown Phoenix, how much is - how much large is the morning temperature have to be before residents perceive a more comfortable desirable environment?

Kamil Kaloush: I assume this is a question for me again here. So yes, I - there is a – some studies, in fact, by some of my colleagues. I don't have the specifics, but I'll be happy, maybe to supply a web link or maybe a contact person on this. Yes. There are health effects. I'm sure Neelam can talk about this elevated surface temperatures in places where people don't have air conditioning in certain cities. That would be the complicated problems. So yes. Elevated surface temperature at night definitely would have a health effect, and I believe, I might misheard the question. That's what you're asking, right? Health effect?

Nikhil Nadkarni: I think the question - the person who asked the question is referring mostly to both health effect as well as human perception of heat?

Kamil Kaloush: Yes. And again, you know, with regard to that question, you know, higher surface temperature definitely will have an impact on human health. In fact, there is a lot of – some statistics shows, if I recall correctly, that death from heat incidents is actually probably the highest, comparing to any other natural occurrence. So yes. Heat is very important, and it definitely have an impact on health.

Nikhil Nadkarni: OK. Our next question, also for Kamil, is – wondering if you could address why the cement concrete or photocatalytic cement strategies for cool pavement?

Kamil Kaloush: Yes. Definitely. I mean, as Janet has shown in some of her applications and there have been a lot of, yes, test sections and applications in this area, it has the benefit of high SRI value. It also has the benefit of a self-cleaning mechanism in a way for these surfaces. So the use of white cement, specifically, also, will produce or will give you that high SRI value, high reflectance. So definitely, help with the urban heat island effect and our concern in that area.

Nikhil Nadkarni: OK. We'll move on to some questions for David. First of all, how do you find more information in the sustainable community – sustainable com partnership?

Neelam Patel: Nikhil – this is Neelam – I can actually answer that question. So the sustainable communities partnership between the Department of Transportation Environmental Protection Agency and HUD is a partnership that was signed amongst the agencies in June 2009, and there has been many activities in terms of evolving the work that the partnership is going to be viewing. Recently, HUD adapted an office, the Housing – Housing and Urban Development Agency adapted an office of sustainable communities that is going to be focusing in on this issue. And more information is actually available on EPA's website through the Smart Growth Program. And, there are sister pages at both DOT and HUD that provide more information.

And also, to mention, next week in Seattle, there's a conference for new partners for Smart Growth, at which, DOT and HUD will also be present and participating to talk more about how to implement the principles that David defined about the partnership. So again, check EPA's website under Smart Growth to learn more about the partnership.

Nikhil Nadkarni: OK. One more question for David. In regards to highway swales, this participant wanted to ask, certain states aren't requiring highway swales, and was wondering if you could speak to why certain state DOT's wouldn't be requiring them?

Neelam Patel: Nikhil, actually David has a problem with his phone, so if we can answer that question later, that'd be…

Nikhil Nadkarni: OK. Sure.

Neelam Patel: Great. We'll add it to the list.

Nikhil Nadkarni: OK. Should we switch to questions for Matt then?

Neelam Patel: Yes. That'd be great. Matt?

Nikhil Nadkarni: OK

Matthew Corrigan: Yes?

Neelam Patel: OK. Great.

Nikhil Nadkarni: OK. The first question for Matt is, has there been any push at the Federal level to encourage the asphalt industry to be more interested in producing pervious asphalt, particularly in smaller batches?

Matthew Corrigan: You know, through our highways partnership and the stuff that is being done with David Carlson, there – you know, we certainly encourage innovation and utilizing these technologies where appropriate. The - I guess, the primary issue that comes from pervious pavement is that the majority of the roadways that get funded on a Federal level or the higher traffic, such as interstates and major routes - U.S. routes that have Federal participation. And so the application for permeable pavement in those high-traffic areas generally aren't going to work as effectively. Plus, they have to be generally in fairly flat areas in order to have a retainage basin for the water that moves down through the pavement. So the application on interstates and in large U.S. routes isn't always the best for a permeable-type pavement.

Neelam Patel: Thanks, Matt. And Nikhil if you could ask Matt one more question before we start closing out.

Nikhil Nadkarni: OK. Yes. The second question for Matt is how does the longevity of warm-mix asphalt compare to that of hot-mix asphalt or concrete pavement?

Matthew Corrigan: That's something that we are actively trying to establish right now. As I'd mentioned during the presentation is, really, you know, we are at a very introductory level of looking and evaluating performance of warm-mix pavements under high-traffic conditions such as interstate routes and looking at the performance and quantifying how long these pavements would perform. So we really are only into about our third year of monitoring warm-mix asphalt pavement sites that are being under traffic and we are starting to get a better picture, at least, on short-term performance. But, it looks like that, you know, we're still going to need some time to evaluate long-term performance in order to quantify those numbers.

Neelam Patel: OK. Great. Thanks Matt. Before we close out, I would like to just clarify comments I made earlier in the presentation when I was talking about the Cool Communities Program that is happening in the State of California. Again, this program is being funded by the California Energy Commission and the California Air Resources Board, and being implemented by Lawrence Berkeley National Lab. And the Cool Pavement Study that I had mentioned, as more of a literature survey. But actually, this particular study is intended to be an experiment and a demonstration project on different types of pavement. And for example, they will be looking at the photocatalytic pavement that we heard about both in Janet's presentation and Dr. Kaloush's comments on earlier. So this will give you a sense of while Lawrence Berkeley

National Lab is looking to get all of the most recent science on pavements, this particular task in their Cool Communities Program is really more of an experiment demonstration of the different pavements.

So with that, I would like to thank all of our speakers for sharing this wonderful information with us, and especially to Janet, of talking about her program and how all these different concepts have come together. It was really great to hear about emerging information on sustainability from both the concrete and asphalt industries, and how that can inform projects that do relate to heat island reduction. Also, something that we can look out for, is from Federal Highway, the rating system that they are looking out when it comes to – looking at developing, when it comes to different types of pavements that are used both for highway construction as well as around urban centers.

And of course, we look forward to hearing more results and seeing more results, either through papers or presentations from the City of Chicago's Sustainable Streets Project that looks at many different environmental impacts and uses many different pavement technologies.

So I want to thank all of our participants. We had over 150 participants on the call. And we do have a number of unanswered questions that we will again answer and provide in writing. So in behalf of EPA's Heat Island Reduction Program, and myself, Neelam Patel, I thank you all for joining us. Please look out for our next webcast, which will be coming in three months. You can hear about this either through our website or by signing up with our listener. And a link to that listener sign up is available in the presentation over here in EPA Heat Island Program. Thank you.

Operator: This concludes today's conference call. You may now disconnect.

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