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Final Report

Development of Graduate Level Course in Sustainable Pavements

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U.S. DOT DISCLAIMER

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TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The concept of sustainability is growing rapidly throughout the world; however, while many people know the term, they lack an understanding of its implications and how to implement sustainable concepts in common practices. Recent initiatives by both the asphalt and concrete industries have focused on the idea of becoming more sustainable; however, without proper training and education, both practicing and future engineers will not be able to make truly sustainable decisions which will affect this country's social, economic, and environmental well-being. This report documents an effort taken by the National Center for Asphalt Technology at Auburn University to begin a program which would educate both current graduate students at the university, but also practicing engineers in the region on concepts related to sustainable pavements. A graduate level course was developed for and taught at Auburn University in the Spring of 2013 which covered topics related to both asphalt and concrete sustainability in all five phases of a pavement's life-cycle. Additionally, one-day workshops were conducted throughout the Southeastern United States which gave practicing engineers the same opportunity to gain knowledge related to this subject. Overall, approximately 135 engineers were exposed to the idea of making pavements sustainable.

EXECUTIVE SUMMARY

Sustainability is a common interdisciplinary theme being stressed throughout not only academia, but in governmental affairs and community living. The desire of individuals to not only use resources responsibly but to also have a positive economic and social impact on society through choices has encouraged numerous individuals to become more aware of the direct impact their choices make on the world-at-large. As engineers attempt to make their trades more sustainable, additional education and training will be required as one of the main challenges will be to introduce many engineers to the concept of systems thinking and situational engineering.

This work had two objectives. First, the team was to develop and deliver a graduate level course on sustainable pavements. Second, the team was to complete technology transfer to practicing engineers on similar subjects. In January 2013, six graduate students in the Auburn University Civil Engineering Department registered for *Design and Assessment of Sustainable Pavements*. The course gave the students the opportunity to learn about sustainable practices and gain experience in conducting life-cycle assessments and using green rating systems for pavements. The course focused on providing the students with data which would allow them to make informative decisions for both situational questions on exams but in future practice as well.

Once the course was developed and delivered, the team conducted six one-day workshops throughout the Southeastern United States. Before the workshop was conducted, each state was contacted to determine the most pressing topics related to sustainability in their state. This allowed the workshops to be tailored to specific and current needs. Between the graduate course and the workshops, approximately 135 future or practicing engineers received education on the topic of sustainable pavements.

CHAPTER 1: BACKGROUND

INTRODUCTION

Sustainability is a common interdisciplinary theme being stressed throughout not only academia, but in governmental affairs and community living. The desire of individuals to not only use resources responsibly but to also have a positive economic and social impact on society through choices has encouraged numerous individuals to become more aware of the direct impact their choices make on the world-at-large.

While sustainability has been defined numerous ways, the most commonly used phrasing of this term means, "meeting the needs of the present without compromising the ability of future generations to meet their own needs (*1*)." The concept is centered on the theme of intergenerational equity stating that this generation cannot impart damage to the lives of future generations. In 1987, Dr. Edward Barbier connected the concept of sustainability to the "triple bottom line." The triple bottom line suggested that sustainability required one to consider the economic, environmental, and social benefits of decisions (*2*) causing individuals and policy makers to develop a more holistic view of society.

In the field of pavements, the goal of sustainability is lofty, and one must consider the entire life cycled of the pavement which includes raw material acquisition, production, construction, use, and end of life (*3*). Asphalt cement is a carbon based product. The production of cement powder used in concrete, on the other hand, as a process has one of the highest carbon

footprints. While some consider these products to be "unsustainable," new methodologies have been developed for both the asphalt and concrete industries to make their pavements more sustainable. Recycled products such as reclaimed asphalt pavement (RAP), reclaimed asphalt shingles (RAS), and recycled concrete aggregate (RCA) can be used in pavements today to replace the valuable, depleting natural resources available today. Additionally, pozzolans such as fly ash and metallurgical slags can be used to replace cement powder reducing the industry's dependence on the energy-intensive cement manufacturing process. Used truck and passenger car tires can be processed into ground tire rubber (GTR) in order to modify asphalt cements to replace expensive polymers which modify asphalt binders to increase the flexibility and stiffness of asphalt mixtures. Today's engineers need to be aware of these choices which can provide both economic and environmental solutions to many of today's challenges in the field of pavements.

While products like RAP, RAS, RCA, and WMA focus on the production side of pavements, one must also evaluate the use phase of the pavements in their overall sustainability. The use phase is quantified through pavement vehicle interactions which occur as vehicles travel over the pavement system as a whole. Pavement properties such as pavement structure, smoothness, and texture have all been shown to affect the rolling resistance of pavements which, in turn, increases or decreases the amount of fuel consumed by vehicles traversing the roadway. Numerous tools have been developed to evaluation the life cycle assessment (LCA) of pavements. Engineers should be aware of these tools when developing pavement management programs to keep their highway infrastructures as fuel efficient as possible.

Finally, rating systems are becoming common tools for assessing "green construction." While the green building industry has programs like Leadership in Energy and Environmental Design (LEED) to assess the sustainability of new construction, few points can be acquired in this rating system through pavements. Newer rating or assessment tools such as Greenroads, Federal Highway Administration's INVEST, Envision, and Green Leadership in Transportation Engineering (GreenLITES) are more effective tools for rating pavement sustainability. Engineers need to be educated on how to achieve points in the LEED system through pavement choices and how the other pavement rating systems can be used to develop, produce, and construct more sustainable pavement structures.

OBJECTIVE AND SCOPE

The purpose of this Education and Workforce Development project is to instill in civil engineering students the importance of sustainability aspects of pavement design and application that will enhance the prospect of developing livable communities. This course will be developed for graduate-level students and will teach them the need to emphasize sustainable, energy-efficient designs for construction of roads and streets, particularly in an urban environment. The course will provide classroom-based training to help students understand urban energy systems and the impact that pavement design and infrastructure development may have on minimizing the demand for such energy. Students will learn to use standard and innovative test procedures to measure the ability of both concrete and asphalt pavements to reduce the community carbon footprint, contribute to noise reduction, improve driver safety, and conserve natural resources through recycling. Another goal of this project is to develop technology transfer tools which can

provide practicing engineers with information that can aid in incorporating sustainability in the decision-making process.

CHAPTER 2: DEVELOPMENT OF GRADUATE LEVEL COURSE

OVERVIEW

The primary task of this project was to develop a graduate level course focusing on sustainable pavements which could be taught at Auburn University in the Civil Engineering Department. This task was completed in three steps. First, the course schedule was developed. This included choosing the topics which would be covered in the course and assigning them to a lecturer. Second, a literature review was completed on the chosen topics. While a formal document was not produced for this literature review, this review allowed each presenter to prepare a lecture using the most up-to-date information related to the economic, environmental, and social benefits or ramifications of each topic. Third, the group of presenters conducted a pilot course of the class. Course development will be covered in this chapter.

Choosing Course Topics

The topics for the course (Table 1) were chosen to reflect current topics related to sustainable pavements. Topics such as an introduction to sustainability, life-cycle assessment, and pavement rating systems were designed to provide students insight into defining and quantifying sustainability for pavement systems while many of the other topics were chosen to

focus on the five phases of a pavement's life: materials, construction, use, maintenance and rehabilitation, and end-of-life. However, material selection and use phase were considered the primary components of sustainability as for high volume roads the use phase can be the primary impact for sustainability while for low volume roads other factors might prove more impactful. Presenters from Auburn University and guest lecturers were invited based on areas of expertise in the field. For example, Dr. Steve Muench from the University of Washington who helped develop one of the most comprehensive and current pavement rating systems (i.e., GreenRoads) was invited to lecture on GreenRoads and sustainability.

In an effort to remain unbiased, Dr. Anton Schindler was consulted to determine which concrete topics were considered of most critical importance. In addition, references such as the Concrete Pavement Technology Center's Sustainable Concrete Pavement's guide (4) and the upcoming Federal Highway Administration's Sustainable Pavements Reference Document were used as guidance to ensure the sustainability of concrete pavements were adequately covered.

Table 1. Course Topics

Topic #	Topic	Presenter
1	What is Sustainability	Richard Willis
2	Life-cycle Assessment	Richard Willis
3	Material Selection: Reclaimed Asphalt Pavement	Richard Willis
4	Material Selection: Recycled Asphalt Shingles	Richard Willis
5	Material Selection: Ground Tire Rubber	Carolina Rodezno
6	Material Selection: Recycled Concrete Aggregate	Richard Willis
7	Material Selection: Industrial Byproducts	Richard Willis
8	Production/Construction: Warm Mix Asphalt	Carolina Rodezno
9	Production/Construction: Intelligent Compaction	Caterpillar
10	Production/Construction: In-place Recycling	Donald Watson
11	Use Phase: Pavement Noise	Michael Heitzman
12	Use Phase: Urban Heat Island/Albedo	Carolina Rodezno
13	Use Phase: Porous Pavements	Donald Watson
14	Use Phase: Pavement Vehicle Interaction	Richard Willis
15	Maintenance/Rehab: Sustainable Practices	Carolina Rodezno
16	Long-Life Pavements and Mechanistic Design	Richard Willis
17	Life-cycle assessment programs	Richard Willis
18	Pavement Rating Systems	Richard Willis
19	Development of GreenRoads	Steve Muench
20	Performance-Based Specifications and New Technology	Richard Willis

21	Transportation Systems	Jeff LaMondia

Literature Review

A thorough literature review was completed to develop the concepts presented in the course. While a formal document containing all the literature was not compiled, current literature was consulted to ensure the most up-to-date information could be provided. Each presenter was responsible for determining how to incorporate the triple-bottom line principle of sustainability for the different topics, if possible.

Pilot Course

Six graduate students enrolled in a graduate course entitled *Design and Assessment of Sustainable Pavements* in the spring semester of 2013. The course was offered as an online course; however, due to rescheduling the course for the spring instead of the summer as anticipated, there was no online enrollment.

The course involved three active areas of participation for the students: lectures, projects, and examinations. These areas will be described in the following sections.

Lectures

The lectures for this course were completed on Mondays and Wednesdays from 1:00 until 2:15 PM for the duration of the semester. The lectures were designed to spur conversation and facilitate active discussions. Most civil engineering students are programmed to find a

singular right answer; however, sustainability is situational engineering. What may be sustainable for one state agency may not be for another. Therefore, discussions were designed to show students that sustainability is not focused on a singular right answer, but it is designed for the right answer in the right context.

While the students were introduced to topics such as reclaimed asphalt pavement, recycled asphalt shingles, recycled concrete aggregate, photocatalytic concrete, and two-lift paving, they were provided information related to both the sustainable advantages which may be associated with the material and the inherent challenges of using it. Thus, knowing both sides of the coin allowed the students to be more pragmatic in their decision making.

Assignment #1: Literature Review

Each student was responsible for conducting a thorough literature review on a topic related to sustainable highways or pavements. The students were allowed to choose topics covered in class; however, they were required to provide deeper insight into the topic than that provided by the instructor. The students were required to address at minimum the following four questions in their review:

- How does the topic relate to sustainability?
- What are the environmental, social, and economic impacts of incorporating the topic in a pavement/highway system?
- What is the practicality of incorporating the topic into a highway/pavement system?

- What has past research shown the highway industry about your topic?

On January 23, 2013, six topics were chosen for reviews: intelligent compaction, foamed asphalt, WMA chemical additives, ground tire rubber, asphalt rejuvenators, and pavement deflection's effect on pavement vehicle interaction. Outlines of each review were due by February 1, 2013, and the final review was submitted March 1, 2013. The assignments were assessed for writing quality, grammar, and completeness.

Assignment #2: Life-cycle Assessment Project

To aid the students in learning how to conduct a life-cycle assessment, the class was asked to conduct a life-cycle assessment (LCA) on the 2009 Group Experiment mixtures which were placed at the National Center for Asphalt Technology Test Track. Using PE-2 and RoadPrint, the class wrote a report (capable of being published as an NCAT report or TRB paper) which described how each mixture would perform in an LCA program.

The structure of the report was as follows:

- Introduction
- What is an LCA?
- Methodology (a.k.a, How did you do this and what were the boundary conditions?)
- Test Results of the Group Experiment Mixtures
    - S9 - Control Mixture
    - N10 – 50% RAP

  - N11 – 50% RAP/warm-mix asphalt
  - S8 – Open-graded friction course
  - S10 – WMA
  - S11 – WMA
- Implications

The LCA was confined to just the materials and construction phases of a pavement's LCA. The students were then able to compare and contrast two LCA programs to determine what differences exist between those programs.

Assignment #3: Pavement Rating System Project

The final project for the students was to apply a pavement rating system to a local area. The students were told that the removal of the Oaks at Toomer's Corner, the City of Auburn is attempting to revitalize its downtown area by making the "Loveliest Village on the Plains" more sustainable and pedestrian friendly. As part of this project, the city wants to turn S. College Street from E. Samford Avenue to W. Glenn Avenue into a GreenRoad Certified project. The budget for this project is currently under debate; however, local businesses have offered to provide additional funding for the project if it would bring in more traffic for their establishments.

The students were asked to develop a proposal to the City of Auburn and local businesses assessing what a practical GreenRoad rating would be.

The questions/requirements to be addressed included: Can you meet all of the required criteria? How many points can this project get without making the budget fiscally irresponsible? The pavement can be asphalt or concrete. Be creative in your assessment of the situation. Talk with people on campus or in the city which might be able to guide you on what can easily be done. Talk with contractors in the area to see if your ideas are possible.

The two deliverables for the project were as follows:

1. The team delivered a report to Dr. Willis by noon on April 1, 2013 describing in detail the proposed plans for the College Street Sustainability Project. In the report, the student needed to assess which points they believed they can receive credit for and why they chose not to explore other point options.
2. The team l presented their proposal to a team of engineers, staff, and faculty members. Their job was to show why they developed this particular method for their GreenRoad project.

The teams were graded on the completeness of their proposals, presentations of the proposal, creativeness, and achievability.

Exams

Two exams were given to the students over the course of the semester. Each exam was a take-home exam which required the students to apply critical thinking skills and knowledge

gained in the class to engineering situations. Only then could they develop solutions to the presented problems on the exam.

For example, the following is a question that was given on an exam.

- You have been asked by the Southeastern Asphalt User-Producer Group to develop an asphalt sustainability rating system? You have been asked to limit the number of categories (not points in each category) to three. What three aspects of pavements would you select for these three categories and what could be included in the categories?

To answer this question correctly, the student would need to understand the audience (Southeastern Asphalt User-Producer Group) and its goals. This would allow the student to understand that the use phase, and end-of-life phases. This would allow the rating system to focus on materials, construction practices, and environmental stewardship.

Summary

Each exam and assignment accounted for 20 percent of each student's grade. These five grades were then used to assess how well each student understood and could then apply the information presented in the class. Open access to course materials is provided via the stride website or can be requested from the report authors.

CHAPTER 3: TECHNOLOGY TRANSFER TO PRACTICING ENGINEERS

OVERVIEW

Technology transfer of this information to practicing engineers was a critical component of this work. While it is important to train new engineers to understand the concepts of sustainability and how to incorporate them into decision-making, unless current practicing engineers understand these same concepts, implementation will not occur as rapidly.

To aid in this technology transfer, statewide training opportunities were to be offered to states associated with STRIDE: Florida, Alabama, Mississippi, Georgia, and North Carolina. The team attempted to work with both North Carolina and Georgia to complete a one-day workshop in the state; however, at the time of this report, the technology transfer team has not been able to find a mutually agreed upon time to meet with the states yet. These workshops will still be completed; however, they will be completed without the use of STRIDE funds. Instead, the STRIDE funds were used to complete additional trainings in Alabama and begin an online continuing education program through Auburn University's outreach program.

Prior to the workshop, the technology transfer team contacted each Department of Transportation (DOT) to determine which topics were of most interest. Details regarding each of the training workshops that were conducted are provided in the following sections. While many of topics were materials related, an effort was made not to repeat previous trainings related to

material properties, but rather to focus on how those materials impacted the triple-bottom line: economics, environment, and society. For example, carbon and cost impacts were commonly shown for pavement materials. Due to the short time of the class, concepts such as global warming were not covered in detail; however, the authors made an attempt to show that most of the "sustainable practices" would be completely appropriate and the correct decision even if global warming were not an issue. The general session on what is sustainability attempted to address concepts of global warming and why is this topic timely today.

Florida DOT Workshop

On August 7, 2013, Mr. Donald Watson and Dr. Richard Willis conducted a one-day workshop for the Florida Department of Transportation (FDOT). Members of the DOT, industry, and academia were in attendance the State Materials Office in Gainesville, Florida. Webmeeting technology was used to broadcast the workshop to the FDOT division offices for additional participation. Overall, 29 people attended this workshop. Table 2 provides a list of the topics covered over the course of the day.

Table 2. Florida Workshop Topics

Presentation #	Topic	Presenter
1	What is Sustainability	Richard Willis
2	Life-Cycle Assessment	Richard Willis
3	RAP Sustainability	Donald Watson
4	RAS Sustainability	Richard Willis
5	RCA Sustainability	Richard Willis
6	Warm Mix Asphalt	Donald Watson
7	Compaction for Sustainability	Donald Watson

8	Sustainable Maintenance and Preservation	Donald Watson
9	New and Innovative Technologies	Richard Willis

Mississippi DOT Workshop

On August 14, 2013, engineers from the Mississippi DOT came to Jackson, Mississippi for a one one-day workshop on sustainable pavements. The technology was not present to complete a statewide webinar; therefore, engineers traveled to a central site for the workshop. Overall, 27 people attended this workshop. Table 3 provides the topics covered over the course of the day.

Table 3. Mississippi Workshop Topics

Presentation #	**Topic**	**Presenter**
1	What is Sustainability	Richard Willis
2	Life-Cycle Assessment	Richard Willis
3	RAP Sustainability	Richard Willis
4	Ground Tire Rubber	Richard Willis
5	Intelligent Compaction	Richard Willis
6	In-Place Recycling	Richard Willis
7	Sustainable Maintenance and Preservation	Richard Willis

8	New and Innovative Technologies	Richard Willis

Alabama Workshops

Four workshops were completed throughout Alabama from October 1 – October 9, 2013 by Dr. Richard Willis. To reduce participant travel time and expense, the same information was presented at a series of workshops in Mobile, Montgomery, Huntsville, and Pelham, Alabama. Overall, 73 practicing engineers attended one of the four workshops. State employees, contractors, and trade association delegates all participated in these events. Table 4 provides a list of the topics covered at these workshops.

Table 4. Alabama Workshop Topics

Presentation #	Topic	Presenter
1	What is Sustainability	Richard Willis
2	Life-Cycle Assessment	Richard Willis
3	RAP Sustainability	Richard Willis
4	RAS Sustainability	Richard Willis
5	RCA Sustainability	Richard Willis
6	Industrial By-products	Richard Willis

7	Warm Mix Asphalt	Richard Willis
8	Long-Life Pavements	Richard Willis
9	Pavement Vehicle Interaction	Richard Willis
10	New and Innovative Technologies	Richard Willis

As a part of these workshops, evaluations were given to participants for future improvement. Appendix A provides the relevant feedback given by program participants.

Online Training

Dr. Willis began a series of on-line continuing education courses on sustainable pavements. The first session has been recorded as is available through the Auburn Engineering Online Professional Development office at the website: http://eng.auburn.edu/online/professional-development/course-listing/civil-structural.html. The first course is four hours and covers the topics shown in Table 5. In the future, Dr. Willis will continue to develop 2 hour courses which will contain additional information which was developed as a part of this work.

Table 5. Online-Training Course Topics

Presentation #	**Topic**	**Presenter**

1	What is Sustainability	Richard Willis
2	Life-Cycle Assessment	Richard Willis
3	RAP Sustainability	Richard Willis
4	RAS Sustainability	Richard Willis
5	RCA Sustainability	Richard Willis
6	Industrial By-products	Richard Willis

CHAPTER 4: CONCLUSIONS

The field of sustainability is one that is at the forefront of society. In the near future, engineers are going to be required to make decisions based on not only the engineering capabilities of a material, but its economic, environmental, and social ramifications as well. Many engineers are taught to find the right answer; however, sustainability shows engineers that the right answer is only found when one looks at an entire system.

It is imperative that the training of engineers to consider a systems approach begins now. At least 135 current and future engineers were trained with the funds provided by STRIDE. It is this team's hope that the groundwork has been laid where future participants in the Auburn University Civil Engineering program and practicing engineers how are in need of continuing education will be exposed to these concepts in order to make pavement structures and society more sustainable in general.

REFERENCES

1. Bruntland, G. Our common future: The world commission on environment and development. United Nations, New York, 1987.
2. Barbier, Edward B. "The concept of sustainable economic development", *Environmental Conservation* Vol. 14, No. 2, 1987, pages 101-110.
3. Gopalakrishnan, K. *Sustainable Highways, Pavements and Materials: An Introduction*. Tranzpendence LLC, 2011.
4. Van Dam, T. et al. Sustainable Concrete Pavements: A Manual of Practice. National Concrete Pavement Technology Center, August 2011.

APPENDIX A: TECHNOLOGY TRANSFER REVIEWS

Table A- 1. Mobile, Alabama Evaluations

		Excellent	Very Good	Good	Fair	Poor
1.	The program as a whole was	9	6	0	0	0
2.	The program content was	8	5	1	0	0
3.	The speaker's knowledge on the subject was	13	2	0	0	0
4.	The speaker's effectiveness in teaching the subject was	11	2	1	0	0
5.	The program organization was	10	4	1	0	0
6.	The variety of topics covered was	11	4	0	0	0

7. What did you like best about the program?

Content

Instructor/speaker's presentation skills were excellent!

Comprehensive explanation of "sustainable"

Diverse and detailed presentation

The variety of topic covered for sustainability not just pavements.

Interesting and varied subjects, great speaker!!

Very informative of new ideas. Challenges us to think outside our usual box.

Variety of topics covered including discussion of concrete.

Personal stories and examples

Great overview of subject that I had no knowledge of. Saw how cost effective benefit analysis used in pavements design

8. What did you like least about the program?

Instructor had a "green" agenda. Global warming due to man-made "GHG" production is not proven. Junk science

9. Additional remarks.

I have been out of the pavement field for 10-15 years. Yet I was very captivated by the leaps and bounds of improvements in the industry, including what I consider to be more of a common sense approach instead of engineering the process to death.

Dr. Willis is a very good speaker/presenter.

Very dynamic speaker – good job!

Table A- 2. Montgomery, Alabama Evaluations

		Excellent	Very Good	Good	Fair	Poor
1.	The program as a whole was	6	9	0	0	0
2.	The program content was	6	9	0	0	0
3.	The speaker's knowledge on the subject was	11	4	0	0	0
4.	The speaker's effectiveness in teaching the subject was	9	6	0	0	0
5.	The program organization was	7	8	0	0	0
6.	The variety of topics covered was	7	7	0	0	0

7. What did you like best about the program?

New technology applications

Learning about concrete that I know nothing about

Good topic of information; enjoyed the program

The review of new products and innovative technologies

Speaker easy to understand/well-spoken and knowledgeable

Speakers interaction and knowledge of material and the variety of potential recyclable/re-useable materials.

The speaker's knowledge of the subject matter and his ability/methods of getting information across.

Table A- 3. Huntsville, Alabama Evaluations

		Excellent	Very Good	Good	Fair	Poor
1.	The program as a whole was	9	1	0	0	0
2.	The program content was	9	1	0	0	0
3.	The speaker's knowledge on the subject was	10	0	0	0	0
4.	The speaker's effectiveness in teaching the subject was	10	0	0	0	0
5.	The program organization was	9	1	0	0	0
6.	The variety of topics covered was	8	1	0	0	0

7. What did you like best about the program?

Wide range of topics

Learning of all of the research and effort that is going into improve the sustainability of our road system. I felt Dr. Willis did an excellent job presenting this program and maintaining the students attention.

Variety/scope of subject area

Current information; well organized

Practicality of information presented

Excellent overview. Compliments to Dr. Willis for an extremely professional presentation and able to keep things interesting.

Supplied the exact information I was interested in learning from this seminar class.

Focused more on concepts rather than equations with details

8. What did you like least about the program?

Although I understand this is a lecture on the pros, I wish the cons had been presented. Cons of RCA, RAS, RAP, Fly Ash, etc. It all can't be perfect.

Nothing comes to mind.

9. Additional remarks.

Always good

Impressive presenter/technique

Table A- 4. Pelham, Alabama Evaluations

		Excellent	Very Good	Good	Fair	Poor
1.	The program as a whole was	7	13	2	0	0
2.	The program content was	7	12	3	0	0
3.	The speaker's knowledge on the subject was	18	3	1	0	0
4.	The speaker's effectiveness in teaching the subject was	12	9	1	0	0
5.	The program organization was	9	12	1	0	0
6.	The variety of topics covered was	5	12	5	0	0

7. What did you like best about the program?

Lunch

Diversity of subjects covered; relative to sustainable pavements.

Good info

Location – Pelham; Instruction – effective, good and laid back personality

Topic and speakers knowledge

Speaker's knowledge and enthusiasm regarding topic

Life cycle assessment

RAP usage

Coverage of material

Instructor was very informed about subject and was able to present in an interesting manner.

Committed to idea

Very instructive for creating sustainable pavement

Best Auburn program attended! Great job

8. What did you like least about the program?

First two sections presented and last two sections

Shingles material

Future

I was expecting more design instruction

The political science of climate change and CO2 which is constantly being debunked home every year. No instructions were issued as to how to RIDE MY UNICORN. Needs to be based on actual science not political science. See latest NPCC not IPCC.

9. Additional remarks.

Excellent presentation

Thanks

Outstanding

Humans are not “bad” (first section). But they are basically mislead. Whole first section should be thrown out. Way too much touchy feely. CO2 is NOT A POISON!! Your perfect cherry tree needs all we have! Factor that in your LCA.