

Final Questions for Groups

#	Category	Question	Asked by
1	Costing and cost decision support	What should be included in a framework for initial and life cycle cost comparisons for permeable pavement versus impermeable pavement?	KJ, AB, HL
2	Costing and cost decision support	How can life cycle cost analysis be made to be more widely used when comparing alternative stormwater systems including permeable pavement?	DH
3	Costing and cost decision support	Is there sufficient information regarding initial costs and life cycle costs available to practitioners? If not how can it be gathered? How can it be communicated for practical use?	JH, DH, PW, MI, HL
4	Costing and cost decision support	How can the costs of permeable pavement be reduced?	HL
5	Materials and Pavement Performance	How do we address damage from de-icing agents, plowing, frost effects and other cold weather pavement and hardscape safety management?	KJ, BJ
6	Materials and Pavement Performance	Can pervious concrete mix designs and performance be improved through better consideration of mix design approaches, construction processes, fibers, admixtures?	DH, JB, NF
7	Materials and Pavement Performance	How can more pilot projects be done to demonstrate and improve industry and owner experience with permeable pavements?	DH
8	Materials and Pavement Performance	Can materials design processes be improved for balancing strength and durability versus permeability for porous asphalt, pervious concrete, permeable pavers and permeable pre-cast concrete for different structural capacity and hydrological design situations? Is there sufficient information available regarding concrete and asphalt materials design?	PS, JH
9	Materials and Pavement Performance	Can materials design processes be improved for reservoir, sub-base and bedding layers for different design situations? Including materials selection, consideration of construction	JH, JBuck
10	Materials and Pavement Performance	Is there guidance for selection of PG grade for porous asphalt mixes that includes consideration of sealing of the surface under traffic and dust capture? Do we know if warm mix can be used beneficially for porous asphalt?	BC, JK
11	Education and training	How do we get this type of pavement/system into college curricula? For engineers, for planners, for architects? Who else should be on this list?	KJ, AQ

12	Education and training	What is best approach to get proper information into the hands of engineers (design, specifications, maintenance), owners (selection of contractors, maintenance, construction inspection, specifications), contractors (construction)? How to move a risk-averse engineer from no to yes?	PK, BM, AQ
13	Education and training	Should there be a training and certificate program for permeable pavement designers? If yes, how to set up?	JBuck
14	Education and training	What is best approach to get stormwater quality and flooding onto the performance criteria for public works and road agencies? What is best approach for communicating permeable pavement, multi-BMP systems including permeable pavement and other LID treatments to public works directors and their staff who must sign off on them?	JH
15	Education and training	What advances have been made in advancing permeable pavement technology, and are they being adequately communicated? Do people know what previous problems have been solved? If not, how to communicate?	HN
16	Communication	What is best approach to communicate awareness and valid information about permeable pavements to public works staff, the public and elected and appointed decision-makers? Who needs to be involved? Are permeable pavements just not ready yet?	DH, JA, ML
17	Communication	Why is permeable pavement being widely used in other countries for a number of years, more than in the US? What is different? Can this be changed?	AB
18	Communication	How can hardscape effects on quality of life be brought into competition for funding, in addition to stormwater and transportation benefits?	JA
19	Communication	How can public road funding decision processes be made to consider other functionalities of roads? In some places being used for simultaneous conversion to complete streets, can stormwater considerations in use of funding be included? If yes, how? If not, why?	JA
20	Communication	Is there adequate information regarding probabilities of different types of failures of permeable pavements to be considered in conceptual and project level design? If not, how could it be developed?	RL
21	Communication	How best to gather information regarding successes with permeable pavement and present to decision makers? Including good information regarding LCA and LCCA?	KP

22	Project-Level Design issues	How to handle design of permeable pavement next to buildings with basements, pavement shoulders next to impermeable pavements and other structures vulnerable to infiltrated water? Is there adequate information available regarding how to do these correctly?	KJ, JH, PW
23	Project-Level Design issues	What else is needed to be able to do mechanistic-empirical design of permeable pavements? Including consideration of lightly compacted saturated soils?	DH, JH, BJ, BM
24	Project-Level Design issues	Do we have sufficient information regarding effects of geo-grids on structural capacity?	DH
25	Project-Level Design issues	Do we have sufficient example standard specifications that designers can use, and how to train them to use them properly? If not, how to improve them? Where are most used specifications coming from (stormwater boards?) and are they being reviewed by permeable pavement experts?	DH, KL, JBuck
26	Project-Level Design issues	Is there a potential market for pre-cast permeable pavements? What applications?	PS
27	Project-Level Design issues	Is there adequate information and guidance regarding compaction of subgrades to balance permeability and structural capacity? Is there adequate information and guidance regarding characterization of subgrades, slopes, etc for permeable pavement suitability and design?	CH, JH, MI, HessN, JBuck
28	Project-Level Design issues	What is holding back applications for shoulder retrofits of highways?	PW
29	Project-Level Design issues	How can geotechnical investigations for selecting appropriate places for permeable pavements and their design be made better, faster, cheaper? Is there adequate guidance and standards for geotechnical investigations? If not, how to develop? If yes, how to understand and communicate and to communicate scope vs risk?	JK, MI,
30	Project-Level Design issues	What is experience and design guidance with check dams and other designs for internal slopes, spills, horizontal flows, slope stability and other considerations besides vertical flow?	JK, AM, BJ
31	Project-Level Design issues	Is there adequate guidance regarding retrofitting impermeable pavement and hardscape to become fully permeable? If not, what needs to be done to develop it?	MI
32	Project-Level Design issues	Do we have sufficient field and/or accelerated pavement testing data to design pavements for critical distresses (cracking, rutting, raveling, clogging)? For pervious concrete subbases for confinement of reservoir aggregate? And if not, how can it be gotten?	DH, JH

33	Project-Level Design issues	Is load transfer possible or useful for pervious concrete and pre-cast applications? Is there adequate design guidance regarding jointing and slab sizes? If not, how can it be developed?	PS, JH
34	Project-Level Design issues	Is there adequate guidance regarding design of full-width versus partial width alternatives? If not, how can it be developed?	KK
35	Project-Level Design issues	Do we have good tests to characterize strength, stiffness, fatigue, permanent deformation properties of subgrades and permeable pavement materials for mechanistic-empirical pavement design?	DH, JH, NF
36	Project-Level Design issues	Do we have adequate information about hybrid permeable pavements, such as concrete and asphalt bases for pavers, waste pavers as subbases, bound bedding layers, etc?	JH
37	Project-Level Design issues	Is there adequate information regarding the upper speed limit above which permeable pavements are no longer the right choice? If not, how to get it? If yes, how to communicate it?	MV
38	Project-Level Design issues	Can deflection testing be used to evaluate permeable pavements? If yes, is there guidance?	JBuck
39	Watershed and flood control design issues	Are there good mechanistic watershed hydrological data/models/tools that can capture the effects of permeable pavement and multi-BMP systems including permeable pavement on flood control and groundwater replenishment? Are they well calibrated with field data?	JB, KG, KL
40	Watershed and flood control design issues	Are there good mechanistic data/models/tools that can capture the effects of permeable pavement and multi-BMP systems including permeable pavement on stormwater quality? Including separated and combined sewer and stormwater systems	JH, MJ
41	Watershed and flood control design issues	Is there adequate guidance regarding selection of storm events for design? If no, how can it be developed and what needs to be considered? What about climate change? If yes, how can it be communicated?	BC, MI, ML
42	Designing for additional benefits and impacts	How can additional off-road and non-stormwater retention/detention benefits of permeable pavements be quantified and be included in design selection process? Examples are local heat island, noise, de-icing, active transportation suitability. Can these be included in life cycle assessment?	KJ, DH, JB, PW, AB, MI, JH
43	Designing for additional benefits and impacts	What are the roles of permeable pavements besides functioning as pavement, stormwater quality and stormwater flow, and how can they be quantified and brought into design/decision making process	JH

44	Designing for additional benefits and impacts	What are the chemical and biological processes that occur in a permeable pavement system? Can they be developed and incorporated to obtain greater benefits for water quality?	PW, JH
45	Designing for additional benefits and impacts	Is there adequate planning and design guidance for ratio of impervious to pervious surfaces for water quality and stormwater flow management? If no, how can it be developed? If yes, how can it be communicated?	BC
46	Designing for additional benefits and impacts	Do cities and counties have good groundwater and sub-surface flow and storage models to evaluate unintended consequences, benefits and risks? If not, how can they be developed? If yes, how can they be brought into decision-making easily?	JK, MJ
47	Designing for additional benefits and impacts	Is there an adequate life cycle assessment framework for permeable pavement to consider environmental impacts? How should permeable pavements be compared to other LID and impermeable systems?	RL
48	Construction standards and issues	How can industry standard specifications be better enforced?	KJ
49	Construction standards and issues	Do we have sufficient tests for construction quality control and assurance?	DH, JK
50	Construction standards and issues	How can qualifications for contractors and their personnel be made more rigorously enforced? How can contractor experience and understanding be improved?	KJ, DH
51	Construction standards and issues	How can owners get better at selecting designers and contractors, inspection, quality assurance?	DH
52	Construction standards and issues	What information is available regarding design of construction productivity, scheduling, traffic handling, selection of alternatives in traffic congestion or business access situations?	KK, JH
53	Maintenance	Do we have sufficient information regarding maintenance of permeable pavements? If not how can it be gotten? How can it be best communicated? Does it consider high trash and pollutant load areas like loading bays? How can information be made available to small and large private permeable pavement owners regarding maintenance?	DH, SI, MJ, KJ
54	Maintenance	Do we have sufficient information regarding localized repairs, handling of utility repairs and other localized work on permeable pavements? If not how can it be gotten? How can it be best communicated?	DH, JH
55	Maintenance	Are there regulatory drivers that could be used to support funding for operation and maintenance of permeable pavement, multi-BMP and other LID systems? If yes, what are they?	JH

56	Maintenance	What are the obstacles to effective operations and maintenance of permeable pavement, multi-BMP and other LID systems?	JH
57	Maintenance	Why aren't there more innovations in development of permeable pavement cleaning equipment for large and small scale applications?	CH
58	Maintenance	What is guidance regarding maintenance debris from cleaning permeable pavements? Are there special considerations? Are the costs included in life cycle cost framework?	AB
59	Maintenance	Is there adequate guidance regarding operations and maintenance for different permeable pavement systems for different rainfall environments (types of storms, frequencies of storm events)?	BC
60	Maintenance	Is there adequate guidance for utility repairs under permeable pavements of different types? If not, how to develop? If yes, how to communicate better?	MI
61	Asset management	Do we have adequate information to bring permeable pavement into pavement management systems? Whose asset is a permeable road?	DH, JH, AB, JK
62	Asset management	Are there stormwater asset management systems and LID asset management systems in place? If not, how to develop them? How to communicate them and their benefits? How to mandate them?	JH, AB
63	Asset management	Is there sufficient information regarding how long environmental benefits last? If not, how to develop?	PW
64	Asset management	Is there adequate information regarding end of life for permeable pavements? Can they be rehabilitated to restore benefits? Do they need to be reconstructed?	PW
65	Asset management	Is there a standard for condition survey of permeable pavements and other permeable hardscape? If not, how can one be developed?	MJ, JH
66	Funding for research, development, implementation	Do funding sources exist at state and federal levels to support research, development and implementation support for permeable pavements? If not, what can be done to create a pipeline and process for efficient RD&I? Consortia?	BK, RW, HL
67	Funding for research, development, implementation	What are top priorities for academic research on permeable pavements, LID, and their uses? What are top priorities for piloting of permeable pavement concepts coming from research and development?	SI
68	Funding for research, development, implementation	What would it take to get additional funding for stormwater flood control?	JH, MC
69	Funding for research, development, implementation	What university transportation center exists or should be created that should include permeable pavement and urban hardscape in its scope?	RW

70	Planning and development codes	Are there built in obstacles to permeable pavement in development codes or other policies and regulations? If yes, where? If yes, how can they be changed to get better results for their goals?	JH, BM
71	Planning and development codes	Is there sufficient information regarding permeable pavements or multi-BMP systems including permeable pavement in the typical stormwater BMP selection/design process? Can credits for handling stormwater be included in development systems?	JH, JBuck
72	Planning and development codes	What is the total potential market for permeable pavements? Retrofit of roadways, other hard scape, in multi-BMP systems? In terms of numbers of cities, counties, private owners; in terms of surface area of urban areas	PS, JH
73	Planning and development codes	Are cities and counties communicating effectively about permeable pavements to the development community and vice versa? What can be done to improve the development process to better consider permeable surfaces (pavement and other LID)?	JK
74	Planning and development codes	Is there adequate guidance regarding use of permeable hardscape for other than roads (sidewalks, etc) and including permeable hardscape/pavement into active transportation and complete street projects? If not, how to develop?	BL, AQ
75	Planning and development codes	Can maps be developed identifying suitable candidate areas for permeable pavements and other permeable hardscape for planning and conceptual design purposes? What would need to be in those maps?	MJ
76	Planning and development codes	Are there incentives available for permeable pavement for private applications? If not, should there be? How would they get funded?	JH

Questions from Permeable Pavement Workshop Day 1

14 November, 2017

Ken Justice NRMCA

1. how do we best show people cost comparisons of permeable systems vs impervious pavements with stormwater infrastructure
2. how do we address damage from de l cwa agents
3. how do we get this type pavement/system designs into curriculum
design of permeable pavements adjacent to building w/ basements
4. how can we constitute desicutas not to design as a glorified trerey draw

phic hnesce-nrmca

what vehicle can we use to put the propen information into the hands of the appropriate end users (engineers-design owners-waitenanece; proppen instaccation-contractons)

davidhein

1. what do we need to do mechenistic permeable pavement design
2. quantify the strength
3. pervious concrete acceptance test? Flexeral ? Density? Compressive? testing methods?
4. concrete mix design to prevent early onset ravelling
5. girds how to design structural capacity longevity
6. how does improve industry wide experience with permeable pavement
7. lack of designer spectcaton experience, constructor experience understanding, owener inspector experience
and testing
8. what are theirrgterm durability and key performance indicators: rutting cracking raveling clogging, how much is to much
9. how do we better communicate maintenance need

10. how do we promote awareness of permeable pavement by public and maintenance staff
11. guideline for localized repairs of permeable pavement
12. how do we properly quantify off-road benefits of permeable pavement
13. how do we convince people to use permeable pavement life-cycle costing for decision making

John Bolander

2. the mechanical properties of pervious concrete depend on the construction process even more so than for ordinary concrete pavement. What is the unrealized potential of pervious concrete, in terms of mechanical performance associated with the construction process

3. pervious concrete offers benefits that seem difficult to incorporate within LCA for example, the reductions in heat island effect, the noise, etc have positive impacts on the environment and human health, how do we broaden the scope of LCA to account for such impacts

4. is there a role for high-fidelity mechanical hydrological models in understanding the life-cycle performance of pervious concrete applications as a related question what resources are available for the development of such model

brian killingworth nrmca

typical funding source from federal and state entities cannot be relied upon because the primary market for permeable pavement is not within their purview, where will research and implementation funds come from for the local and private application

John Harvey

1.
 - a. What are the other goals and criteria to consider besides structural, hydraulic, capacity?
 - b. What information is needed in addition to hydraulic, structural design, maintenance, cost, etc.
2. Is sufficient initial cost especially LCC information available to use in practice?
3.
 - a. A. Are incentives for permeable pavement for private pavement owners available?
 - b. Is sufficient information available for them to easily act?
 - c. C. Do development codes allow them?

4. What is the full context of storm water BMP selection and how do permeable pavements (alone or in combinations) fit in? What is missing to be considered?
5. Are there any policies that exclude permeable pavements that may not be appropriate?
6. Is there sufficient information/model/data/tools regarding how ?? WQ stand and in different applications and contexts? Including CSO situations
7. Same questions for stormwater capture groundwater replenishment
8. Are there quantitative comparison tools for other treatments?
9. Any regulatory drivers to support O&M for permeable pavement? Obstacles to effective O&M? (reasonable ?? analysis, permeable pavement specific drivers by region over time)
10. .
 - a. How to change processes to bring permeable pavement onto menu
 - b. What field of education?
11. Evidence for use in PMS? Stormwater asset management?

Peter Smith

1. What percentage of the surface of pervious pavement made from pavers are voids that allow passage of water?
2. Is there a minimum standard for pass through of water?
3. Are there any standards or specifications that quantify acceptable durability?
4. Are there any standard or specifications that indicate what applications require ?? transfer?
5. Is there any data or information (prediction models) on how many cities, municipalities, agencies etc might be interested in pervious pavements?
6. Where can I find information on recommended concrete mix design?

Curtis Hinmon

1. Best subgrade verification balancing tradition density testing and permeability
2. Why don't we have more innovations and development of large permeable pavement cleaning equipment. This is necessary for large scale adoption. How does the US promote this?

Peter Weiss

1. Studies have found that permeable highway shoulders are feasible:
 - a. What the status of this application
 - b. What is preventing this application from moving forward?
2. Open graded friction courses have been found to last without much (or any) maintenance. Why? What processes are involved?
3. What is the true life cycle cost of permeable pavements?

- a. How to incorporate environmental benefits accurately?
- b. How long are environmental benefits active?
- c. If environmental benefits decrease over time, can they be regenerated?
- d. What are chemical and biological processes that occur in a PP system?

Ali Butt

1. How can permeable pavements be implemented? What are the steps that need to be taken to make it happen?
2. How can the PP benefit be identified and then quantified as in LCC and LCA?
3. Treatment of waste that is collected from the maintenance (cleaning pores/spaces from joints & pavement), isn't that an additional burden to move transportation of waste collected?
4. PP is being built in EU, why not USA? Why is that road administration are not comfortable or do not trust experience that EU has had for like 15 years.
5. How can the PP construction be based on requirements of that region? Example: may be detention basin, work at one location, but may not in another. Similarly, where ever impermeable surfaces are working why should we replace those with permeable?
6. PP has to be recognized as a localized/geo specific solution?
7. Shouldn't PP issue be tackled as asset management question?

Bob Cullen

For parking lots (retail, office, commercial)

What is the latest thinking about the ratio of impervious to pervious pavements to believe in capture of the "water quality"

Magnitude storm event and ?? any expectation of long term function w reasonable vacuum sweeping frequency

For Ms. Attarian,

The economic analysis discussed in the show placed a high value on "place making" could she explain what is meant by that term and also, how was that benefit monetized for comparison?

Have any municipalities or flood management agencies incorporated reduction in runoff factor (i.e. "C" value) or impervious percentage based on use of pervious pavements ?? calculating capital flood flow rates?

For our asphalt experts,

In general, would hot region binders e.g. PG76-22 be better to prevent warm weather kneading and sealing of porous AC, installation/ or is there a downside to using the stiffer binder?

Name : Hideki Naito

Questions :

1. Can you find out a void under pavement by non-destructive testing with acceptable probability?
2. What has the technology of permeable pavement been advanced for 20 years?

Name: Jessica Knickvbocker (City of Tacoma)

Questions:

1. Who's doing research on mix designs? (Fibers, Hydromax, Warm mix, Ethoterm)
2. Who has effective material testing procedures?
3. How do you test for density? (effectively)
4. Who's asset is a permeable road? Roads on surface water utility or property owner.
5. Geotechnical investigations are costly & timely.
How are cities helping the development community?

How many cities have groundwater models

Where is all the water going to go?

6. How are check dams holding up?

Name: Unknown

Questions:

How to nationally registered?

Name: Alejandro Martinez

Questions:

1. Several presenters said that soil permeability was not big issue. (even if soils are not "well-draining", water did not accumulate)
2. Is there a relationship to land gradient, where water might not have been implications the soil, but just flowing down slope through pavement?

Name: Janet Attarian

Questions:

1. How do you not only get the data so that engineer can make uniformed decisions but also political decisions makers like mayors.
2. How do we directly tie these investments to quality life of everyday citizens, but not just in the context of stormwater but as a comparison to other important and competing interests in limited overall funding situations.
3. How do you get Department of Public works out of the mill and fill. They have their Pacer ratings, politicians who want the greatest # of miles, and they do limited of any design work. All of these prevents any \$ being spent their "pavement" funds. Only gets dine through place-based, stormwater, and maybe park funds.
4. We know gas tax funds can be used for street tress, it is being used for beautifications in some places,

, but we need to tie the funding sources to stormwater better and admit that different funding streams need to be cojoined in a more standarding way- both for construction and maintenance.

- Michael Irvine, City of Vancouver

- In a built-out environment of impervious pavements, how much reconstruction of the road profile (asphalt, road base, subgrade) is required to transition to a permeable pavement?
- How much geotechnical investigation is required before determining if pervious pavement is suitable in a given area?
- What is the difference in life cycle costs for typical pervious vs traditional impervious pavements?
- What are BMPs for trench repairs in pervious asphalt pavements?
- Are there significant performance differences between the different porous pavements (pavers, asphalt, concrete)?
- Are there applications where even the most staunch proponent of permeable pavements would not recommend their use for streets infrastructure?

- Brian Lutey

- Why don't municipalities use pervious pavements with a deep infiltration bed beneath sidewalks?
- Is there value in constructing a deeper detention layer below porous pavements and how does it compare to the added excavation and stone cost?
- Could municipalities incentivize to do so to reduce costs of flooding + runoff?
- Permeable pavements require less de-icing salts. What is the impact of salts on biology of local waterways?

- Peter smith

- What percentage of the surface of pervious pavements made from pavers are voids that allow passage of water?
- Is there a min standard for pass through of water?
- Are there any standards or specifications that indicate what application require load transfers?

- Is there any data on information / prediction models on how many cities, municipalities agencies, etc, might be interested in pervious pavement?
- Where ca I find information on recommended concrete mix design?

Name: Ken Kortkamp

Questions:

1. Full width approach vs. "Catch Basin" run-on approach
2. Construction sequencing - no mention
3. Are gap width getting to small? How small is too small? Lose of function
4. System design - subbase key of design
 - Components of function

Name: Sonoko Ichimaru

Questions:

1. Because I work on modelling previous concrete mainly focusing on mechanical behavior, I am interested to know industrial perspective on why rutting, cracking, raveling, and clogging occurs and what maintenance techniques are used.
2. What academic research can contribute to industry? What engineering modelling/analysis are industry looking for?

Name: Kyle Gallup

Questions:

How was the change in hydrograph measured in project in Berkeley (by Amir Ehsaei)? 75% reduction?

Name: Hesam Nabizadeh

Questions:

What' s the optimum compaction for permeable pavement?

Name: Michael Leacox

Questions:

1. Is it possible the time for permeable pavements have not come yet; or is just setting here. If so, what is the best way to set it in the mainstream with all the various players involved (planning, public workers, maintenance, public, etc.)
2. Is linking climate change to permeable pavement another way to increase interest? [Reduction of run-off to avoid changes in expensive infrastructure drainage]

Name: Maria Javier

Questions:

1. Use of permeable pavement in areas with high ground water
2. Use of permeable pavement in conjunction with Silva Cells or below grade flow through plants/bioretenion areas.

3. Address high use/pollutant load (roads, trash/delivery trucks, loading bays) with permeable pavement - design maintenance
4. If we want to develop a map that shows area ideal vs. not ideal for pervious pavement use, what factors should we consider? - native soil infiltration, high groundwater level, fault lines, etc.
5. Why/what situation should permeable pavement be chosen over landscape based storm water treatment?
6. Situation specific design
 - Use of check dams (not sure)
 - Heavier loads: buses, trucks
 - High ground water
 - In conjunction with Silva Cells, tree well filters, below grade bioretention
7. Standardized maintenance plans inspection forms?

Rico Lardrabal, city of Fremont

1. Can we see a list of specific examples of the failures encountered with permeable pavement. It may be good to show this in timeline format to allow us to see what to expect during the pavement life cycle. Also, what have been examples of catastrophic failures in each of these systems.
2. Is there a study on impact on resources required for using these systems? For examples, amount of permeable rock material and consequences to requires quarrying? What's the environmental impact of this quarrying versus benefits or permeable pavement/base installation.

John Harvey,

1. Material tests appropriate for
 - a. Saturated and uncompacted soil
 - b. Granular
 - c. Porous asphalt
 - d. Pervious concrete
2. Construction gaps and how to fill
3. Adequate info regarding construction productivity, traffic handling
4. How to communicate effectively with all the stakeholders? Best info? Further improvement
5. LCCA framework that capture full system/ time / life cycle effect
6. Noise
7. Dedicated funding that covers pavement and storm water functions? SBI for storm water? Add to pavement
8. What is potential for market incentive for storm water handling and investigation on private land
9. How does urban permeability fit into upstream flood control and storm water management rules?

Bhaskan Josh

1. CT has specs but pervious pavement still not in many project
Issues: maintenance, use of full depth

2. Design pavement for saturated soils? Cost increase?
3. Even with the full depth design by ME principle how can we be sure no raveling under heavy traffic, high speed traffic
4. Strategies for dealing with toxic spill on porous pavement
5. Disintegration due to freeze thaw

Katherine Petros

- How can we best showcase success stories (objectively) to support the claims in LCCA and LCA as well as to better enable those who need quick access to information to convince decision makers?

Richard Willis

- If a new UTC gets set up,, could permeable pavement be part of its focus.
- Could some collaborative consortium be set up? Does APWA have funding?

Nathan Forrest

- Was anyone from the precast pervious concrete industry invited to participate? Storm-crete, Percoa, Spancrete, etc.
- Z main (and inter-related) issues I see with pervious concrete installations.
 - Concrete mixes that are very very fickle with regards to water content; the “widow” between too dry and too wet is too small. This leaves contractors constantly trying to correct it.
 - Contractors that are inexperienced with pervious concrete. The inter-related nature is that if the concrete mixtures weren’t so difficult to work with the level of experience required of contractors would not be so high.
 - Proposal: research admixtures/additives/materials to increase the range of acceptable/usable water contents I fresh pervious concrete.
- Another barrier to implementation is the current talk of ASTM standards for strength testing of pervious concrete. Many civil engineers are uncomfortable with designing and specifying any concrete that does not have a strength test and results attached to it.
 - Proposal- complete the development of flexural (primarily) and compressive strength testing standards.

Hui Li

- How to reduce the cost of permeable pavement? (If it is high)
- How to get numbers for LCCA and LCA for permeable pavement?
- Interactional joint funding for research projects are needed.

Mayra Velasquez

- How often do you need to maintain / reconstruct/fix streets with pavers.
- Has there ever been a thought of putting pavers on county roads/highways.

- How to reduce the amount of noise in permeable pavement?

Keith Lichten

- What modeling is needed to characterize permeable pavement co-benefits like increased flood resilience?
- What standard spec information is needed – design, installation, other methods to create a supportable, more holistic standard SPIC that can realize the range of possible permeable pavement benefits? Does it go in the spec or elsewhere?

Jonatan Buck, Engeo Inc.

- Subgrade compaction specs for all permeable pavements. We still have storm water regulators (Finishing?) that we do not compact sub base correct?
- Will we ever get storm water treatment credit for systems where we cannot filtrate the the amount volume?
- Or should the soil engineer ?? that. Is it close enough? Maybe ?? more research for clay soils.
- We need Better post construction specifications for for post project deflection) for prop pavements
- Who is the lead on the design of permeable pavement design. A geotech? I see mostly civil engineers doing this? I don't think they know how to do this. Maybe offer a design certificate for engineering professionals
- We have trouble getting into subgrade materials (number 52 stone) are there any acceptable substitutes
- Can smaller such as 4 -7 inch stone work just as well with a thicker section.
- Porous concrete we are still skir as design professionals is there a consensus. Current design mix. We need one standard.
- Porous concrete and porous asphalt
- My firm does not recommend this NEVER.
- Life cycle cost, how much does it cost. How do you maintain with now slurry seal?
- FYI, we have found out that PICP is less expensive re enforced pavement on a square feet basis, maybe I should ?? ?? ?? maybe I should talk to Hein.
- Most people are ?? there is specs for previous pavement from storm water magnitude regulatory manuals. Is the previous pavement industry reviewing this . Do they allow minor wiggle room for variations based on loading or soil conditions.
- Right now you will provably ?? ?? see a high traffic area in paved with permeable pavement unless the msy permits storm water management manuals provide more discretion to experience designers. We are told we cant deviate from poorly written specification. Generally tailor to low traffic areas.
- Construction

- Expects have improved but most public agency inspectors are clueless to these technologies in many cases we see no reasonable inspection of subgrade materials . We recommend third party inspection . If public agency is providing inspection services as part of code.
- As presented, yes . we see cost of pre qualified contractors who use staff who are not properly trained and therefore project failures.

Brandon Milar

1. What are the strategies used to move a risk-adverse engineer from no to yes?
2. During design and construction, do we have appropriate analysis or testing tools to ensure proper design or construction?
3. How does an owner fund urban installations? What are the legislative that hinder the use of permeable pavements?

Anne Quasarano

1. With limited funding sources at a local agency level are there opportunities to use permeable pavement while keeping existing infrastructure? Example: a city roadway diet project. Turn one lane into a bike track/trail using permeable pavement on top of existing AC thereby allowing existing drainage system to remain in place. Would that be a possibility? Changes? Design considerations?
2. Ideas for education. How to train instructors and educate city maintenance workers/plan reviewers/inspectors? How to educate utility companies that permeable pavements is okay over their facilities? Any outreach ideas in schools, local and state level?
3. Better, wider available specs and details and how to implement/tailor to local topography/watershed/etc.