TRIENNIAL STRATEGIC PLAN (TSP)

Evaluation Period: February 1, 2015 to January 31, 2018

Please note that rows and boxes below expand as you enter the information

PART 1: Committee Name and Scope

This is an opportunity to review the officially approved name and scope that are posted on the TRB website and consider any necessary changes. If changes are needed, include the proposed scope statement and/or name and justification for the changes.

NOTE: A proposed committee name and/or scope change must have the approval of 2/3 of the official members of the committee. The balloting done at a committee meeting that has less than 2/3 of the members in attendance must be augmented with e-mail balloting of the members not in attendance.

Committee Code *	AFP60
Committee Name *	Standing Committee on Engineering Behavior of Unsaturated Geomaterials
- Date(s) reviewed	January 2016
- Change, if proposed***	Not Applicable
- No. of official members approving change/total number of members **	Committee Name reviewed, changed and approved in 2016 as part of the DCG Strategic Review.
Committee Scope *	This committee is concerned with the mechanics of unsaturated geomaterials in transportation infrastructure design, construction and performance through improved understanding of transient and permanent changes in strength, volume, and fluid flow behavior.
- Date(s) reviewed	January 2016
- Change, if proposed ***	Not Applicable
- No. of official members approving change/total number of members **	Committee Scope reviewed, changed and approved in 2016 as part of the DCG Strategic Review.

* Show current, as it currently appears in the TRB Online Directory
** Includes Chair, Standing Committee Members, Emeritus Members, and Young Members
*** Show proposed, or Not Applicable

PART 2: Committee History

NOTE: We have provided much of the information you need for boxes 2.2, 2.4, and 2.7 below and in attachments A, B, and C. We ask that you provide the remaining information.

2.1

Year	2015	2016	2017	2018
Number of Members in Attendance at Annual Meeting		17	20	15
Number of Visitors in Attendance at Annual Meeting		20	24	24
Number of Papers Reviewed		12	12	14
Total Number in Attendance at Mid-Year Meeting	NA	NA	NA	NA

2.2

Sessions and workshops sponsored/cosponsored at the Mid-Year meeting, including name of co-sponsoring committee(s) if applicable (by year):

NOTE: Sessions and workshops sponsored/cosponsored at the Annual Meeting are listed in attachment A. **List** below all sessions and workshops sponsored/cosponsored at Mid-Year meeting, including name of co-sponsoring committee(s) if applicable (by year).

The committee did not have a mid-year meeting due to scheduling conflicts with the committee membership. However, a mid-year virtual meeting is planned for May of 2018 with Jeb Tingle leading the organizing team.

2.3

Provide title(s) and presenter(s) for informal presentations made at Annual Meeting and Mid-Year Committee meetings:

2018 Annual Meeting:

- "Simple Methods to Characterize and Model Unsaturated Soils" Dr. Xiong Zhang
- "Calibration of a Transient Flow Model Useful for Developing a Landslide Warning System" Ms. Melia Iwamoto
- "A new Method to Quickly Estimate Hydraulic Conductivity and SWCC of Unsaturated Soils" Dr. Bill Yu
- "Implementing Unsaturated Geomechanics During Discrete Element Modeling" John Siekmeier
- "Seasonal Variation of Subgrade Resilient Modulus and Moisture Content" Kevin Gaspard

2017 Annual Meeting:

- "Controlling Soil Moisture Using Wicking Fabric" Dr. Billy Connor and Dr. Xiong Zhang
- "Comparing In Situ Soil Water Characteristic Curves to Lab Generated Curves" Colin Campbell
- "U.S. Army Engineer Research and Development Center Research Update" Jeb Tingle
- "Dessication Cracking of Expansive Soil: Experimental Characterization and Numerical Simulation" Yuan Guo 2016 Annual Meeting:
- "Introducing a Geogrid Gain Factor to Unsaturated Aggregate Base" by Mr. John Siekmeier from Minnesota DOT

- "A Simple Model for Predicting the Resilient Modulus of Unsaturated Soils" by Dr. Sai K. Vanapalli and Mr. Han Zhong from the University of Ottawa
- "Limitation of the Suction-Controlled Triaxial Tests for Unsaturated Soils" by Dr. Xiong Zhang from the University of Alaska, Fairbanks
- "When to Perform a 3D Slope Stability Analysis?" by Dr. Murray Fredlund from SoilVision Systems, Ltd.

2.4

Provide titles of new research need statements (RNS) posted in TRB's RNS database (by year):

NOTE: Attachment B shows all statements currently posted in TRB's RNS database. The following statements were submitted/revised during the last 3 years:

Measurement and Mitigation of Pavement Distress Caused by Moisture Changes in Expansive Clays
Committee: AFP60, Engineering Behavior of Unsaturated Geomaterials Date
Submitted: 3/27/2018 (pending final approval, indexing and posting)

Unsaturated Soil Testing Applied to Transportation Infrastructure
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 3/11/2015
Date Modified: 3/16/2016

Unsaturated Soil Mechanics of the Dry and Wet Side of Compaction
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 3/12/2015
Date Modified: 3/16/2015

Dynamic Properties of Earth Material during Rolling Compaction*
Committee: AFP60, Engineering Behavior of Unsaturated Soils Date
Posted: 6/12/2013
Date Modified: 2/28/2014
Funded: 09/27/2015

Investigation of Water Movement by Vapor Transport in Pavement Systems
Committee: AFP50, Frost Action; AFP60 is co-sponsor
Date Posted: 12/15/2006
Date Modified: 03/02/2015

2.5

Provide title(s) of RNS submitted for funding consideration:

NOTE: If funded, include research project title/number and name of funding organization(s).

***NCHRP 24-45 Evaluating Mechanical Properties of Earth Material During Intelligent Compaction**

This project was funded at $500,000 and initiated on 27 September 2015. The research is in progress, and the project is scheduled for completion on 27 September 2018. More information can be found at http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3888.

2.6

Provide titles of synthesis topics submitted (by year):

NOTE: **List** any synthesis topic(s) funded in a research program.

2018

- Improving Return on Investment by Implementing More Effective Moisture Testing
- Cost Reduction of Geotechnical and Pavement Projects Through Unsaturated Geomechanics Implementation

2015

- Pavement Design on Expansive Soils: State of the Practice
- Laboratory and Field Techniques for Measuring Soil Suction

2.7

Membership Make-up: Please see Attachment C provided by TRB for summary details.

NOTE: **Comment** on demographics, balance or lack of balance of membership. Provide an action plan to address any deficiencies. See attachment C for summary details.

The committee went through a membership rotation in 2016. Nine long-term members rotated off the committee, and fifteen new committee members were added. The goal of the rotation was to increase the number of non-academic representatives, female colleagues, and federal agency representatives. The committee is heavily weighted to the southwest region, but balanced across the other geographical regions. The committee was able to add one federal and one state agency representative. The committee also increased its nonacademic participation from seven to nineteen of the thirty eight total members, creating a reasonable balance. Finally, the committee was able to recruit two additional female colleagues, doubling the female membership. There is still a trend toward a large percentage of members from the SW, but this is likely a reflection of the committee scope (unsaturated/arid soils). A parallel between the membership make-up before and after the rotation is shown below. It can be noticed that the committee has more balanced demographics after the rotation.

	As of 1/1/16	As of 1/1/18		As of 1/1/16	As of 1/01/18
US Members	23	24	Women	2	4
Non US Members	5	5	Non-US	5	5
Minority	15	16	Emeritus	3	3
Female	2	4	Young	4	4
Northwest	2	4	Federal	0	1
Southwest	8	14	State	5	6
Central	4	4	Local	0	0
Northeast	3	4	Academia	21	19
Southeast	5	5	Industry	2	4
			Consultant	3	8

		0	0
	Other		

2.8

Provide any of the following:

- Any special publications, such as TR circular, and conference proceedings
- Sponsored or co-sponsored specialty conferences, symposia, workshops, webinars or other joint efforts with other TRB committees, other TRB entities, or other organizations (i.e. AASHTO, FHWA, State DOTs, ASTM, ASCE, and/or other modes of transportation)

Besides the workshops and multiple sessions this committee has organized as part of the annual TRB meeting, the following activities have been promoted by this committee with one or more of its members actively involved:

2018: Geo-Shanghai 2018, Shanghai, May 27-30, 2018. TRB co-sponsored the event. One member of the committee was on the Organizing and Technical Committee (X. Zhang) and several members plan on participating in the event.

2017: Second Pan-American Conference on Unsaturated Soils, Dallas, November 2017. AFP60 committee members joint efforts with ASCE Geo-Institute by reviewing papers and planning the technical content for two sessions.

2016: Third International Conference on Transportation Geotechnics, Guimaraes, Portugal, September 2016. TRB co-sponsored the event. AFP60 members joint efforts with organizers by reviewing papers and organizing two sessions.

2016: Co-sponsored webinar with AFP70 Committee on Mineral Aggregates entitled "Implementation of Unsaturated Soil Mechanics Into Practice" and presented by Dr. Claudia Zapata (AFP60 chair), Dr. Erol Tutumluer (AFP70 chair),and Mr. John Siekmeier (AFP60 member and incoming chair).

2015: The XV Pan-American Conference of Geotechnical Engineering and Soil Mechanics, Buenos Aires, Argentina, November 2015. TRB co-sponsored the event. Members of the AFP60 committee organized and delivered a Symposium on Transportation Geotechnics.

2015: AFP60 collaborated with ASCE Geo-Congress 2015/The International Foundations Congress Equipment Expo 2015, San Antonio, March 2015, by reviewing papers and moderating one session.

2015: International Symposium on Systematic Approaches to Environmental Sustainability in Transportation, Fairbanks, Alaska, August 2-5, 2015. AFP60 members helped organize the technical content of the event and actively participated as paper reviewers, authors, presenters and attendees. Activity co-sponsored by TRB, ASCE sponsored, with the best papers published in an ASCE proceedings.

PART 3: Committee Future Outlook Statement and Committee Three-Year Plan (Limit 1,500 words total)

Committee Future Outlook Statement

The committee future outlook statement should include a discussion of the primary factors and influences that will shape the transportation community and topic(s) within the committee's scope over the short- (one to three years) and long-term (four to seven years). This statement should include:

- *identification of emerging, critical, and cross-cutting issues **within the committee scope** (these issues could have been identified by the committee, Section, Group, Technical Activities Council, TRB Executive Committee, or other transportation committees and organizations);*
- *identification of emerging, critical, and cross-cutting issues **outside the committee scope** that provide opportunities for liaison and collaborative efforts (these issues could also come from a wide range of sources).*

While the basic soil science of unsaturated soil mechanics has been well established, the practical implementation of unsaturated soil mechanics to geotechnical and transportation engineering projects has not been fully realized. Widespread implementation of unsaturated soil mechanics in geotechnical and transportation engineering will require further development and clarification of unsaturated soil theory, development of effective analytical tools, incorporation of unsaturated soil mechanics parameters into design methods, robust monitoring of performance, and focused technical training on key principles and application techniques. These *critical* issues must be addressed to advance the science. As this emerging field evolves, it is anticipated that the profession will focus on the efficient application of unsaturated soil mechanics to study *cross-cutting* issues related to the effects of moisture/humidity on geomaterials (i.e., unbound materials, concrete and asphalt), energy problems like heat transfer, CO_2 sequestration, biogeotechnologies and nuclear waste disposal, among others. As the profession moves towards widespread implementation of unsaturated soil mechanics principles, research will likely focus on filling gaps in the basic constitutive relationships, developing new cost effective experimental techniques, development of new analytical and design tools for practitioners, and organization of verification programs for improvement of the science and implementation processes.

Fredlund described the following stages of implementation of unsaturated soil mechanics:
- State Variable Stage
- Constitutive Stage
- Formulation Stage
- Solution Stage
- Design Stage
- Verification and Monitoring Stage
- Implementation Stage

The following *emerging* areas are of interest to our committee in filling the technology gaps for the each of the stages leading to full implementation of unsaturated soil mechanics in geotechnical and transportation engineering:

- Development of constitutive relationships for moisture/thermal transport in unsaturated soils and unsaturated soil systems (Constitutive Stage)
- Development of constitutive relationships capable of representing the entire water content constitutive surface (Constitutive Stage)
- Experimental verification of new constitutive relationships for moisture/heat transport in unsaturated soil systems (Constitutive Stage).
- Increased understanding of unsaturated soil property effects on slope stability (Constitutive Stage).
- New physics-based formulas for relating the unsaturated soil behavior to geotechnical and transportation problems (Formulation Stage).
- Development of analytical tools that incorporate unsaturated soil principles for understanding the behavior of geotechnical and transportation geo-structures (Solution Stage).
- Incorporation of enhanced unsaturated soil models into modern design methods such as the MEPDG (Design Stage).
- Methods for characterizing expansive and collapsible soils in the design of geostructures (Design Stage).
- Advances in laboratory and field instrumentation and measurement methods for cost-effective characterization of key unsaturated soils properties (Implementation Stage).
- Development of methods for quantifying the effects of water content and suction on resilient modulus (Implementation Stage).
- Education through incorporation of unsaturated soil mechanics in webinars, workshops, textbooks, and lectures.

The National Cooperative Highway Research Program has funded several projects aimed at the incorporation of advanced material models in pavement design. As a result, unsaturated soil theories have been incorporated to characterize the unbound and subgrade material properties as a reliable design methodology for pavement structures. It is anticipated that there will be additional interest in making improvements to the initial design methodology and in identifying methods to improve implementation.

The committee's short-term activities will be aimed at promoting the development of the critical and emerging topics outlined above. To achieve cross-cutting goals, the committee will reach out and interact with other TRB committees and affiliated organizations. The committee's long-term goals are aimed at facilitating implementation of unsaturated soil mechanics in pavement engineering practice through development of improved test methods, models, and training materials.

Committee Three-Year Plan

The committee plan is a short, focused statement of where the committee wants to go and how to get there. The committee plan may include, but is not limited to: ***projects, activities***

and products *that the committee will undertake during the next three years to address the emerging, critical, and cross-cutting issues identified above;*

- *How the current or proposed changed membership composition will respond to issues identified above;*
- *strategies to encourage significant involvement by the committee's Young Members, state DOT members, and other key constituents, both during committee meetings and at other times;*
- *committee's communication activities, and efforts to provide assistance and technology transfer to the transportation community;*
- *research – for the TRB committees, "research" is a very broad concept that can begin with providing the user perspective on research needs, writing research needs statements, tracking research, understanding the funding available for research in their topic area, developing case studies, lessons learned, disseminating research, technology transfer, and other activities that will advance the state of the practice. Potential research activities are:*
    - *research directions, results, and needs or gaps;*
    - *plan for maintaining and augmenting the Research Need Statements (RNS) database;*
    - *efforts to address research implementation and user needs, and ways to identify research use and implementation.*

The committee added members from the industry, consulting, and federal agencies that are involved in the instrumentation and testing equipment used to characterize unsaturated soils in the laboratory and the field. The committee will work diligently to develop ideas for cost effective equipment and methods for experimentally measuring unsaturated soil properties. Two members of the committee are equipment designers and developers. Their companies are recognized world-wide. In addition, members from academia are heavily involved in equipment development. Cost effective laboratory and field methods for characterizing unsaturated soil properties is a key in facilitating the implementation of unsaturated soil mechanics into geotechnical and transportation engineering projects. The committee's international members will be leveraged to create opportunities for technology exchange by monitoring activities in Europe and Asia. The committee will also continue to pursue increased representation by female colleagues, as well as state and federal agencies.

During the last three years, the members of the committee have been involved in developing RNSs, developing synthesis topics, and organizing sessions for the annual meeting. The committee is in the process of planning future workshops to help educate practitioners on how to implement unsaturated soil mechanics in geotechnical and transportation engineering projects. The committee will continue to engage members by creating Task Force groups for each activity.

The committee's website has been populated with information relevant to the committee scope, and it has been a great venue to publish the annual technical presentations to the transportation community. We will continue updating the site with information relevant to our scope and members interests. Young members will be encouraged to manage and refresh the website content.

Several topics have been selected for sessions and workshops at the annual meetings. The following topics have been identified during discussions at annual meetings and they are rotated when preparing the *Call for Papers*:

- Simplified Test Methods for Determination of Unsaturated Soil Properties (Workshop 2019)
- Volume Change in Unsaturated Soils (Call for Papers 2019)
- Use of Unsaturated Geomechanics in Quality Control/Quality Assurance Testing (Workshop 2020)
- Prediction and Effects of Surficial Soil Cracking on Transportation Facilities (Call for Papers 2021)
- Coupled Mechanical and Moisture Diffusion in Unsaturated Soil (Call for Papers 2019)
- Predicting Unsaturated Soil Properties (Workshop 2021)
- Problematic Soils (Call for Papers 2019, 2020, 2021)
- In-situ Suction Measurement (Pavement Systems) (Call for Papers 2020)
- Moisture Damage in Pavements (Call for Papers 2020)
- Protocols for Laboratory Testing and Field Monitoring of Unsaturated Soil (Workshop 2019)
- Case Studies Applying Unsaturated Soil Mechanics Principles in Transportation Practice - Numerical Modeling of Pavement Performance Incorporating Unsaturated Soil Mechanics. (Call for Papers 2019, 2021)
-

Potential topics for developing new *Research Need Statements* and their champions include:

- J. Siekmeier – Unsaturated Soil Mechanics Applied to Compaction
- S. Khosravifar – In Situ Measurement of Unsaturated Soil Properties Using the LWD
- B. Connor – Application of Unsaturated Soil Mechanics to Slope Stability Problems
- J. Siekmeier – Rapid Suction Measurement During Construction
- J. Nevels – Earthwork/Compaction Specifications for Unsaturated Soils
- C. Zapata – LRFD, Incorporation of Unsaturated Conditions Into R Factors
- X. Zhang – Desiccation Cracking, Low-Volume Roads, Vegetation Effects
- Unsaturated Soil Interfaces
- C. Clarke – Construction Specifications to Manage Subgrade Moisture Variation.

State DOT members will be heavily engaged to identify the most important RNS for states and to help facilitate the flow of the committee's top RNS through the AASHTO prioritization process.

Potential topics for developing new NCHRP *syntheses* include:
- A. Siekmeier – Cost Reduction of Geotechnical and Pavement Projects Through Unsaturated Soil Mechanics Implementation
- K. Gaspard - Pavement Design on Expansive Soils: State of the Practice
- Sunil – Pavement Project Improvement through Unsaturated Geomechanical Implementation.

Potential topics for *webinars* include:
- Practical Tests for Implementing Unsaturated Mechanics to Achieve Performance Benefits
- Unsaturated Soil Mechanics 101 (Stress State, Matric Suction, Resilient Modulus) - Soil Water Characteristic Curve De-mystified!
- How to Effectively Measure and Use Matric Suction in Design
- Analysis of Test Results From Laboratory Testing to Modeling
- Unsaturated Soil Mechanics Use In Pavement Analysis and Design

A Working Group is in place to prepare at least two webinars per year. It includes the following members: C. Zapata, K. Gaspard (DOT representative), X. Zhang, C. Campbell, J. Brennan (DOT rep.) and M. Mazari.

As in the past, the committee has planned co-sponsoring sessions for the annual ASCE Geo-Congress with the ASCE GI committee on unsaturated soils. Sessions and workshops have been and will continue to be practice-oriented themes to facilitate the implementation of unsaturated soil mechanics principles.

TRB 97th Annual Meeting

January 7–11, 2018

Standing Committee on Engineering Behavior of Unsaturated Geomaterials

Session Type	Committee Code (including sponsoring committees)	Title
Lectern Session	AFP60	Unsaturated Expansive Soil Properties and Improvement
Poster Session	AFP60	Predicting Unsaturated Soil Properties to Advance Design of Transportation Infrastructure
Lectern Session	AFP60	Numerical Analyses and Modeling of Pavement Performance Considering Unsaturated Soil Conditions
Published Meeting - Committee	AFP60	Engineering Behavior of Unsaturated Geomaterials Committee

TRB 96th Annual Meeting

January 8–12, 2017

Standing Committee on Engineering Behavior of Unsaturated Geomaterials

Session Type	Committee Code (including sponsoring committees)	Title
Published Meeting	AFP60	Engineering Behavior of Unsaturated Geomaterials Committee
Lectern Session	AFP60	Considering Unsaturated Conditions in Numerical Analyses for Pavement Design
Lectern Session	AFP60	Monitoring of Unsaturated Geomaterials

TRB 95th Annual Meeting

January 10–14, 2016

Session Type	Committee Code (including sponsoring committees)	Title
Published Meeting - Committee	AFP60	Engineering Behavior of Unsaturated Soils Committee
Lectern Session	AFP60	Modeling and Monitoring Volume Change of Unsaturated Geomaterials
Lectern Session	AFP60	Field and Laboratory Monitoring of Unsaturated Geomaterials
Poster Session	AFP60	Unsaturated Geomaterials in Highway Embankment Design

Attachment B

Unsaturated Soil Mechanics of the Dry and Wet Side of Compaction
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 3/12/2015
Date Modified: 3/16/2015

Unsaturated Soil Testing Applied to Transportation Infrastructure
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 3/11/2015
Date Modified: 3/16/2015

Dynamic Properties of Earth Material during Rolling Compaction
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 6/12/2013
Date Modified: 6/13/2013

Determination of State of the Art of Applied Unsaturated Soil Testing for Transportation Testing
Committee: AFP60, Engineering Behavior of Unsaturated Soils
Date Posted: 3/21/2007
Date Modified: 4/14/2007

ATTACHMENT C
COUNT OF COMMITTEE MEMBERS
Committee Members as of December 4, 2017

Main Members	24
International Members	5
Minority	15
Female	4
Room for more Members	**Available Slot: 1** Main Member: 1 International Member: 0 State DOT Member: 0 Young Member: 0

Membership Make-up

Northwest	Southwest	Central	Northeast	Southeast
3	9	4	5	6

Women	Non-US	Emeritus	Young
4	30	3	4

Federal	Local	Academia	Industry	Consultant	Other
1	6	18	3	7	0