1.0 INTRODUCTION

Through the Indefinite Quantity Contract No. DTFH-61-97-D00025, Parsons Brinckerhoff Quade & Douglas, Inc. (PB) was retained by NHI/FHWA to develop the curriculum materials and revise the existing NHI course 13212 "Soils and Foundations Workshop" per Task Order 99-T-25048. The purpose is to revise the existing 4-day course presentation to an interactive format so the learner is actively involved in the learning experience.

The Soils and Foundations Workshop is a basic geotechnical course which will provide practical knowledge for both generalists and those planning to take more advanced geotechnical courses in the future. The workshop will be of most benefit to bridge and foundation engineers; particularly those involved in the design and construction aspects of highway projects. The course objective is to impart to the participants the necessary knowledge and skills to determine the minimum level of geotechnical effort needed on a highway project. The participants will develop knowledge and appreciation of foundation activities in all project phases.

This Instructor's Guide is developed based on the approved revised Preliminary Lesson Plans submitted to NHI/FHWA on August 20, 1999 and provides an annotated outline of the course that can be used as a guide during the preparation and delivery of the course by FHWA approved qualified Instructors.

2.0 COURSE ORGANIZATION

The course will be presented by FHWA-approved instructors using a Participant Workbook, a Reference Manual, and various visual aids such as slides, transparencies, computer projections, and similar tools. The course is designed to begin at 1:00 PM on Monday and end at noon on Friday. Presentations by representatives of the host agency are planned for Monday PM and Friday AM in addition to a laboratory exercise in the agency soils lab on Tuesday AM.

All participants will be provided with a copy of the Reference Manual and Participant Workbook. The Reference Manual, which was based on the 2nd edition of the previous Workshop Manual (1993), is geared to the practicing engineer who routinely deals with soils and/or foundations but has little theoretical background in soil mechanics or foundation engineering. The manual content follows a project oriented approach whereby the actual foundation work for a bridge project is traced from preparation of the boring request, to laboratory work, through design computations to construction activities. Recommendations are presented on how to efficiently layout borings, how to minimize approach embankment settlement, how to design the most cost-effective pile foundation, and how to transmit design information properly to construction. Reference Manual will be referred to from time to time during the course so that the participants can become familiar with its contents.

The Participant Workbook is intended to be a set of copies of visual aids and student exercises that closely follows the presentations being made by the instructors. The student

exercises are designed to promote the interaction in the classroom, and to illustrate the basic principles and analyses.

The course is divided into ten (10) distinct lessons, as shown in the following table. The sequence of lessons follows the order of presentations in both the Reference Manual and the Participant Workbook. The times for each topic may be varied by the instructor based on special interest by the audience in certain topic areas.

Lesson No.	Title	TIME	DAY
1.	Topic 1 - Introduction to Soils and Foundations Workshop	10 min	One
	Topic 2 - General Overview of Geotechnical Input to Highway Projects	60 min	One
2.	Topic 1 – Site Investigation and Sampling Methods in Highway Engineering – Chapter 2 (w/ state presentation)	100 min	One
	Topic 2 – Layout of Subsurface Investigation for a Bridge Foundation - Chapter 2	25 min	Two
3.	Basic Soil Properties for Foundation Design-Chapter 3 (w/ Lab. Session)	200 min	Two
4.	Laboratory Testing for Foundation Design-Chapter 4	115 min	Two
5.	Topic 1 – Slope Stability – Chapter 5	165 min	Two & Three
	Topic 2 – Solutions to Slope Instability – Chapter 5	80 min	Three
6.	Topic 1 – Embankment Settlement – Chapter 6	135 min	Three
	Topic 2 – Treatment for Embankment Settlement – Chapter 6	30 min	Three
7.	Topic 1 – Spread Footing Design- Bearing Capacity – Chapter 7	85 min	Three
	Topic 2 – Spread Footing Design-Settlement – Chapter 7	75 min	Four
8.	Topic 1 – Deep Foundation Design – Load Capacity – Chapter 8	155 min	Four
	Topic 2 – Deep Foundation Design – Pile Groups – Chapter 8	60 min	Four
9.	Topic 1 – Construction Control Considerations – Instrumentation - Chapter 9	40 min	Four
	Topic 2 – Construction Control Considerations – Foundations – Chapter 9 (w/ Two Breaks)	120 min	Four & Five
	Topic 3 – Construction Control Considerations – Pile Load Testing – Chapter 9	45 min	Five
10.	Foundation Investigation Report-Chapter 10 (w/ state presentation)	65 min	Five
11.	Team Exercises, Course Summary, Review, and Critique	60 min	Five

3.0 RECOMMENDED CLASS SIZE

The maximum class size permitted by NHI is 30 people to achieve the learning objectives for this course. All students should be instructed to bring calculators that have the capability to perform logarithmic functions. The NHI will ship 30 copies of each of the Reference Manual and Participant Workbook to the local DOT training coordinator at the

address shown on the Course Request Form (1530). **It is recommended that the local DOT training coordinator distribute these manuals and workbooks to the participants 1 week in advance of the course and that the participants be encouraged by the local DOT training coordinator to scan the documents prior to coming to class.** In the event that these documents cannot be distributed prior to the course, a copy of each manual and workbook should be placed at each participant seating position by the local DOT training coordinator prior to the beginning of the class. All participants should also be advised to bring calculators that can perform trigonometric calculations, extract roots of numbers and accomplish similar functions; a writing pad for performing calculations; and a pen or pencil. NHI will also provide a registration form, course evaluation forms, CEU application forms, and course certificates. If changes to the number of manuals and workbooks or to the shipping address are necessary, please notify the NHI Training Officer at least 30 days prior to the course.

4.0 VISUAL AIDS/ ROOM AND EQUIPMENT NEEDS (INSTRUCTIONAL METHODS)

The classroom should be a large conference room or a similar room with a flat floor with sufficient tables and chairs for about 30 participants and an adequate ceiling height to permit visual aids to be clearly seen from the back of the room. The tables and chairs should be arranged in a classroom style with a suitable center aisle to permit instructor access to the students as a high level of interaction will be used to convey the learning objectives. The tables on either side of the center aisle should be placed at an angle to the aisle such that the overall configuration is a gentle 'V' shape that opens toward the instructor. All students should face the front of the room. The screen should be aligned with the center aisle. The room should be in a quiet area and should have a lighting system that permits convenient dimming of the room lights by the instructor. The room should also be available for the entire period of the course.

Visual aid information will be delivered primarily through PowerPoint presentations, overhead transparencies, flip charts, and computers although a 35 mm slides may be used to supplement certain presentations.

The instructors will provide the primary computer and a video display device to project the PowerPoint images on the screen; however, the Host Agency is requested to provide backup computer and LCD projector in case of the instructors' equipment failure.

The Host Agency should furnish the following materials and equipment, which will be needed by the instructors for presenting the visual aids. This equipment should be placed in the room and checked out at least 1 hour prior to beginning the first session by the instructor with technical assistance from the Host Agency.

- One overhead projector on a table or cart with wheels. A spare projector and bulb should be available that can be activated within 5 minutes in case of equipment failure.
- One 35 mm slide projector, similar to a Kodak Carousel, with a zoom lens

and 2 eighty-slide trays. A long extension cord (at least 6 m (20 feet) minimum) or other electronic remote device is needed to permit the instructor to advance the 35 mm slides from the front of the room.

- Two power strips.
- One dedicated large table in the front of the room for the overhead projector and computer.
- One dedicated small table on which to place the slide projector or video display device.
- One large screen positioned at the front of the room, which extends to a height of at least 3 m (10 feet).
- Two flip charts with markers.
- **BACK-UP EQUIPMENT.** An IBM compatible computer (with Pentium processor preferred at a speed of 700 MHz or faster) with Windows98 or later version of MS operating system and MS PowerPoint 2000 software installed and a compatible LCD projector that supports at least XGA resolution (1,024 by 768) and projects color images should be available that can be activated in 5 minutes in the event of equipment failure. Please provide any special computer commands or instructions necessary to project the computer screen images.

5.0 HOST STATE PARTICIPATION

One of the objectives of this training is to present practical aspects of geotechnical engineering, which can be used immediately by the students in everyday work. To accomplish this, the students need to understand the specific procedures used by the host State. The attached workshop schedule contains presentation times for representatives from the host State to explain their procedures.

Presentations of 30-45 minutes are proposed for both the State's Geotechnical Engineering Group on (Monday p.m.) and the Structures Unit on (Friday am). Suggestions for the Monday presentation by the Geotechnical Engineering Group include discussing both administrative details (how the unit is organized, the in-house capabilities as relates to soils borings and soils laboratory) and technical details (the basic geology of the State and the typical process followed to produce subsurface information for a typical project). Suggestions for the Friday presentation by a member of the Structures Unit include explaining the interaction of the structures and geotechnical units, and the procedures used by the structures unit in relation to design and/or review of foundations, and coordination with the geotechnical unit on response to field requests from construction for technical assistance related to foundations. The instructor should call the local NHI coordinator if additional information is needed for these presentations.

The objective of the Tuesday Host State presentation session is to familiarize the students with basic soil types found in the State, the procedures for soil description, and the laboratory facilities of the transportation agency. The session begins with the NHI instructors presenting a short slide and overhead presentation to explain basic soil

properties and the procedures to be followed in the laboratory demonstration. Then the students are moved to the State laboratory for hands-on exercises and a tour of lab facilities. For the laboratory portion on Tuesday morning, adequate amounts of various soil types should be provided by the host agency so that the visual description process can be demonstrated by the instructors and then performed by the students. About three gallons of each of the following types of native soils are suggested so that all students can participate in the exercise.

- Coarse sand and gravel
- Uniform sand
- Predominately silt
- Silty clay
- Fat clay
- Organic silt
- Peat or muck

These samples should be at natural moisture content except for a small portion of each which should be dry. A tour of the agency's soils laboratory is undertaken during the Tuesday morning session. Since the agency is most familiar with its laboratory, we normally ask for assistance of the state's personnel in this matter to demonstrate index tests and describe strength and consolidation tests. The instructors will ask for the name of the technical coordinator so arrangements for the laboratory session can be finalized.

6.0 TARGET AUDIENCE

The categories of personnel at the transportation agency who could benefit from this workshop include drillers, geotechnical, bridge design, highway design, construction, and maintenance personnel. The personnel who will benefit the most are the first-line supervisors involved in the design of highway structures and embankments. The greatest impact will be achieved by convincing structural, design, and construction engineers to use procedures from this course as a guide for routine geotechnical work. All attendees should be encouraged to attend the entire course, not just sections that are in their specialty. One of the major benefits of this course is to give engineers an appreciation of activities outside their specialties that influence, or are influenced by, the work of the geotechnical engineer. The one exception is for drillers, who could be invited to attend only the first day of the course (Monday PM and Tuesday AM).

6.1 Pre-Training Competencies

This course is geared to practicing engineers who routinely deal with soils and foundations problems. No theoretical background is required in soil mechanics or foundation engineering although computational skills are necessary for the design sessions. This course is the entry level in geotechnical engineering.

7.0 OVERALL COURSE LEARNING OBJECTIVES

The course objective is to impart to the participants the necessary knowledge and skills to determine the minimum level of geotechnical effort needed on a highway project. A high level of interaction between the expert instructor(s) and the students will be used to facilitate the development of knowledge and skills in basic geotechnical concepts and analyses. Upon completion of the course, the participants will have demonstrated learning of the following:

1. Knowledge of the minimum level of geotechnical input in various project phases of a highway project,

2. Knowledge of the equipment and procedures used to implement a subsurface investigation of soil and rock conditions,

3. Knowledge and basic skill in visual description of soils native to the host state,

4. Knowledge of the geotechnical laboratory facilities and personnel in the host state,

5. Knowledge of the basic soil test procedures and application of soil test results to highway projects,

6. Knowledge and basic skills in procedures used for both settlement and stability analysis, and knowledge of design solutions to stability and settlement problems,

7. Knowledge and basic skills in procedures used for determining bearing capacity and settlement of spread footing foundations,

8. Knowledge and basic skills in the design and construction management of driven pile foundations,

9. Knowledge of driven pile foundation construction equipment and construction inspection,

10. Knowledge of static load testing and basic skill to interpret static load test results, and

11. Knowledge of the format and minimum content of an adequate foundation report.

8.0 POTENTIAL INSTRUCTORS

Primary Instructor – Richard Cheney, Senior Supervising Geotechnical Engineer, Parsons Brinckerhoff Quade Douglas, Inc.

Second Instructor – John Walkinshaw, Senior Supervising Geotechnical Engineer,

The course is designed to be delivered by a primary instructor with extensive experience in applying geotechnical principles to design and construction of transportation facilities, and detailed knowledge of the geotechnical procedures and practices of both FHWA and the state DOT's. The course is also designed in a way that a qualified instructor from FHWA or the host state agency may serve as the second instructor.

9.0 COURSE AGENDA

DAY ONE P.M.

1:00 p.m.	Welcome Administrative Details	***State Representative***
1:15 p.m.	Lesson 1: Topic 1 Introduction to the Soils & Foundations Workshop	*1st Instructor*
	Lesson 1: Topic 2 General Overview of the Geotechnical Input to Highway Projects	*1st Instructor*
2:25 p.m.	BREAK	
2:40 p.m.	Lesson 2: Topic 1 Site Investigation Exploration and Sampling Methods	*2nd Instructor*
3:50 p.m.	MINI BREAK	
4:00 p.m.	Typical Foundation Exploration Program Done by Host Agency	***State Representative***
4:30 p.m.	CLOSING	

Wear work clothes to Tuesday a.m. lab sessions
<u> Hands-on student exercise problems begin Tuesday - bring calculators.</u>**

DAY TWO

8:00 a.m.	Lesson 2: Topic 2 How to Lay Out Subsurface Exploration Program for a Bridge Foundation	*1st Instructor*
8:25 a.m.	Lesson 3: Introduction to Soil Testing	*1st Instructor*
9:10 a.m.	Review Foundation Design Objectives A. Discuss Processing of Soil Samples in Lab B. Visual Soil Description System ("MUD")	*1st Instructor*
9:30 a.m.	BREAK	
	GO TO DOT LABORATORY	
9:45 am	Students Visual Soil Identification Exercise in DOT Lab.	***Instructors &***
& 10:45 a.m.	Lab Walk-Thru and Demonstration of Test Methods	***Host Lab Personnel***
	RETURN TO MAIN CLASSROOM	
11:30 a.m.	Lesson 3 (Cont'd.) Discussion of Lab Exercise ** GEOQUIZ	*1st Instructor*
12:00 p.m.	LUNCH	
1:00 p.m.	Lesson 4: Selection of Soil Design Parameters A. Effective Stress Principle B. Po Diagram * C. Po Diagram – Student Exercise	*1st Instructor*
2:00 p.m.	BREAK	
2:15 p.m.	Lesson 4 (cont'd): Lab Testing Program Developed D. Consolidation Tests for Settlement E. Strength Tests for Stability and Bearing Capacity F. Apple Freeway Design Problem	*1st Instructor*
3:10 p.m.	MINI BREAK	
3:15 p.m.	Lesson 5: Topic 1 Slope Stability A. Circular Arc Failure	*2nd Instructor*

	**B. Student Mini-Exercise	
4:30 p.m.	CLOSING	

DAY THREE

8:00 a.m.	Lesson 5: Topic 1 (Cont'd) C. Sliding Block Failure **D. Sliding Block - Student Exercise	*2nd Instructor*
	Demonstrate Slope Stability Computer Program	*1st Instructor*
9:15 am	BREAK	
9:30 am	Lesson 5: Topic 2 Solutions to Slope Instability A. Design Solutions to Stability Problems B. Cut Slope Stability C. Lateral Squeeze **D. Student Mini-Exercise- Stability Solutions E. Apple Freeway Workshop Design Problem	*2nd Instructor*
10:50 a.m.	MINI-BREAK	
11:00 a.m.	Lesson 6: Topic 1 Embankment Settlement A. Major Design Considerations Settlement Amount and Time B. Embankment Pressure Distribution	*2nd Instructor*
12:00 p.m.	LUNCH	
1:00 p.m.	C. Settlement Analysis - Granular Soils **D. Student Mini-Exercise - SPT Correction and "C Value E. Settlement Analysis - Cohesive Soils **F. Student Exercise - Settlement and Time Estimate for Embankment Over Clay Demonstration of EMBANK Program	*2nd Instructor*
2:15 p.m.	BREAK	
2:30 p.m.	Lesson 6: Topic 2 Treatments for Embankment Settlement Problems A. Methods To Reduce Settlement Amount And/Or Time B. Lateral Squeeze Settlement Analysis –	*2nd Instructor*

	Apple Freeway Workshop Design Problem	
3:00 p.m.	MINI-BREAK	
3:05 p.m.	Lesson 7: Topic 1 Spread Footing Design; Bearing Capacity A. Bearing Capacity of Spread Footings **B. Student Exercise - Bearing Capacity	*1st Instructor*
4:30 p.m.	CLOSING	

DAY FOUR

8:00 a.m.	Lesson 7: Topic 2 Spread Footing Design; Settlement A. Settlement of Spread Footings **B. Student Exercise - Footing Settlement Apple Freeway Workshop Design Problem C. Footing Bearing Capacity D. Footing Settlement	*1st Instructor*
9:15 a.m.	BREAK	
9:30 a.m.	Lesson 8: Topic 1 Deep Foundation Design - Load Capacity A. Granular Soils (Nordlund's Method)	*1st Instructor*
10:30 a.m.	MINI-BREAK	
10:40 a.m.	B. Cohesive Soils (Tomlinson's Method) **C. Student Exercise - Static Analysis	*1st Instructor*
12:00 p.m.	LUNCH	
1:00 p.m.	Demonstration of SPILE/DRIVEN Programs	*1st Instructor*
1:15 p.m.	Lesson 8: Topic 2 Deep Foundation Design -Pile Groups Workshop Problem - Pile Design	*1st Instructor*
2:15 p.m.	BREAK	

2:30 p.m.	Session 9: Topic 1 Construction Aspects– Instrumentation	*2nd Instructor*
3:10 p.m.	Mini-BREAK	
3: 15 p.m.	Session 9: Topic 2 Construction Aspects– Foundations A. Pile Driving Equipment B. Pile Driving Formula C. Dynamic Analysis/Wave Equation Introduction **D. Student Exercise – Pile Driveability	*1st Instructor*
4:30 p.m.	CLOSING	

DAY FIVE A.M.

8:00 a.m.	Session 9: Topic 2 Construction Aspects (Cont'd) **E. Student Exercise - Hammer Approval F. Apple Freeway Workshop Design Problem	*1st Instructor*
8:45 a.m.	Lesson 9: Topic 3 Construction Aspects -Pile Load Testing ** Student Exercise – Load Test Interpretation	*2nd Instructor*
9:30 a.m.	BREAK	
9:45 a.m.	DOT FOUNDATION REPORTS How field data are used. Alternates considered. Analysis methods used. Information presented in Foundation Report. Information presented in Plans and Specifications. Designer Utilization of Foundation Data.	***State Representative***
10:20 a.m.	MINI-BREAK	
10:30 a.m.	Lesson 10: Foundation Investigation Report A. Guidelines for Writing a Good Report B. What the Report Should Contain C. Use of Special Notes D. Information Made Available to Contractor E. Use of "Disclaimers"	*2nd Instructor*

	Workshop Design Problem – Foundation Investigation Report	
11:00 a.m.	Team Problem Session Group Discussion of Workshop Learning Objectives Complete Course Critique Forms	*ALL*

CLOSING

Lesson No: 1 (Topic 1)

Lesson Title: Introduction to Soils and Foundations Workshop

Performance Based Learning Objectives: Participants should be able to:

- Discern the difference between knowledge of geotechnical concepts and skills developed in geotechnical activities.

Instructional Method: Description of interactive teaching techniques. The lesson will begin with a display of overall learning objectives and the general sequence in which lessons will be taught. The group will be asked to comment on specific items in each lesson area, which they consider, of most interest. Ask group what they want to learn from this workshop, and list course objectives on a flip chart. After list is complete, tell students what will and will not be covered in course. Give recommendations for other courses where non-covered items are taught. Then the instructor introduces the concept that technical instruction seeks to produce one of two primary learning outcomes; knowledge and/or skill. Knowledge is the ability to intellectually understand a technical process and is learned by presentation or demonstration. Skill is the ability to perform the technical task and is learned by practice. Students will be asked to identify items from a list, which are either skills or knowledge. Instructor then notes that each lesson will begin with a statement of learning objectives and skills to be acquired.

Instruction Day: Day 1 – P.M.

Time Allocation: 10 minutes

Evaluation Plan: Group responds to questions to develop definition of skill versus knowledge to understand the need for the interactive approach.

Reference: *The First Time Trainer*; American Management Association, 1601 Broadway, NYC, NY. 10019; http://www.amanet.org

Lesson No: 1 (Topic 2)

Lesson Title: General Overview of Geotechnical Input to Highway Projects

Performance Based Learning Objectives: Participants should be able to:

- Recognize the general significance of basic geotechnical activities,
- Relate which geotechnical activities are performed in various project phases,
- Recall that testing, theory and experience are of equal importance in geotechnical engineering activities.

Instructional Method: This presentation will be used to establish that a practical approach will be used as well as to show group how case histories will be used to emphasize important learning objectives in the course. Use slides to show the names of each major geotechnical activity. Illustrate importance of geotechnical input in various project phases with single slide case histories. Review activities sequence in manual and ask students to highlight important areas.

Instruction Day: Day 1 – P.M.

Time Allocation: 60 minutes

Evaluation Plan: Question-answer session to determine students' pre-knowledge of geotechnical activities in various project phases before general description of each major phase. This pre-knowledge will provide the instructors an insight into the level of geotechnical knowledge of the students. Refer to objectives list after each session to reinforce what was learned in that session or to add to list if other objectives achieved which were not on original list.

Reference: None.

Lesson No: 2 (Topic 1)

Lesson Title: Site Investigation and Sampling Methods

Performance Based Learning Objectives: Participants should be able to:

- Recognize basic site exploration and sampling methods,
- Describe the SPT test.

Instructional Method: Use slides of site exploration equipment and case histories common to host state geologic conditions to show importance of good site investigation techniques. Review manual contents and highlight important items such as SPT information, typical boring log format, and general highway exploration layout guidelines. Use overheads to show minimum guidelines. Use guest speaker to focus on state procedures, familiarize students with agency personnel, and describe state geology, agency site investigation equipment and techniques. Encourage students to ask agency specific questions to speaker.

Instruction Day: Day 1 – P.M.

Time Allocation: 100 minutes

Evaluation Plan: Question-answer periods on general knowledge of drilling equipment, why standard procedures needed, how to find SPT value, and why minimum site investigation guidelines needed. Follow up after Lesson 2-topic 2 completed with additional questions on topic 1 area to test learning.

Reference: AASHTO Manual on *Subsurface Investigations*, 1988, Wash. DC 20001; http://www.aashto.org, telephone 1-202-624-5800

Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications; 1988, FHWA ED-88-053, http://www.fhwa.dot.gov/bridge/geotechnical

Lesson No: 2 (Topic 2)

Lesson Title: Layout of Subsurface Investigation for a Bridge Foundation

Performance Based Learning Objectives: The participant should be able to:

- Explain the steps in the layout of a subsurface investigation for a bridge foundation as described in lesson 1, topic 1.

Instructional Method: Use transparencies to emphasize the basic steps and the minimum extent of the subsurface program for a structure foundation. Review manual sections and ask students to highlight important areas of the guidelines. Introduce Apple Freeway serialized problem. Show how to layout the site investigation. Then show student exercise on overhead.

Instruction Day: Day 2 – A.M.

Time Allocation: 25 minutes

Evaluation Plan: Use group exercise to layout site exploration steps and fill in requirements for a site investigation plan on the Apple Freeway (1). Reinforce topic 1 area objectives (1) with questions on SPT and overall process of site exploration in the Apple Freeway including what shallow auger holes will be used for in design.

Reference: *AASHTO Manual on Subsurface Investigations*, 1988, Wash. DC 20001; http://www.aashto.org, telephone 1-202-624-5800

Checklist and Guidelines for Review of Geotechnical Reports and Preliminary Plans and Specifications; 1988, FHWA ED-88-053, http://www.fhwa.dot.gov/bridge/geotechnical

Lesson No: 3

Lesson Title: Basic Soil Properties for Foundation Design

Performance Based Learning Objectives: The participants should be able to:

- List main soil group and basic engineering uses,
- Differentiate between identification, description and classification.

Instructional Method: Use slide presentation to show basic soil properties of main soil groups. Review soil description procedure in manual via overheads. Pre-quiz students on what lab tests they think are now done in the lab. Take students to soils lab and spilt into groups for visual description exercise. Introduce soils lab personnel and ask for lab tour and demonstration of basic equipment in lab. Return to classroom for group quiz on soil uses. Overview rock properties in manual and show how basic soil information used to develop soil profile. Demonstrate soil profile development for Apple Freeway.

Instruction Day: Day 2 –A.M.

Time Allocation: 200 minutes

Evaluation Plan: Student exercise on soil description involves each student visualizing about 8 soil samples and responding as a group on the engineering properties of each sample (1,2). Lab tour by agency lab staff promotes questions on equipment and procedures. Group quiz on basic soil types and properties (1). Ask what information was used to develop Apple Freeway soil profile.

Reference: *AASHTO Manual on Subsurface Investigations*, 1988, Wash. DC 20001; http://www.aashto.org, telephone 1-202-624-5800

Lesson No: 4

Lesson Title: Laboratory Testing for Foundation Design

Performance Based Learning Objectives: The participants should be able to:

- Compute and plot total stress, water pressure and effective stress on a Po diagram
- Define the purpose of both consolidation and strength testing for foundation design.

Instructional Method: Begin by showing pre-quiz of what tests student thought were available in lab and ask for additions based on lab visit. Use slide presentation to present concepts of effective stress, consolidation, and soil strength. Use demonstration and then skills exercise to learn effective and total stress computational method. Relate strength to stability and consolidation to settlement and long-term maintenance. Focus on what students saw in lab tour when discussing soil testing and results. Demonstrate how to apply concepts and results to actual problem in Apple Freeway project. IMPORTANT: Review with students the basic concepts in the soil properties and lab test sections. Remind students that this is the data-gathering phase that must occur before analysis.

Instruction Day: Day 2 –P.M.

Time Allocation: 115 minutes (does not include lab tour)

Evaluation Plan: Use skill exercise to evaluate learning of effective and total stress computational method (1). Use Apple Freeway to test application of effective stress concepts lab tests and to summarize of lab test results. (1,2). Show original flip chart objectives and ask which learning objectives were achieved.

Reference: *AASHTO Manual on Subsurface Investigation* 1988, Wash. DC 20001; http://www.aashto.org, telephone 1-202-624-5800

Lesson No: 5 (Topic 1)

Lesson Title: Slope Stability

Performance Based Learning Objectives: The participants should be able to:

- Explain the effect of water on frictional resistance
- Compute resisting and driving forces, and
- Analyze an embankment by the sliding block method.

Instructional Method: Use slides presentation and case histories of local geologic area to overview embankment stability. Go to manual and highlight the effects of water and need for safety factors. Highlight recommended safety factor and discuss values with class. Use overheads to show basic circular stability concept. Demonstrate with Apple Freeway project hand solution. Continue with sliding block stability concept and student exercise. Demonstrate XSTABL and show why computer solution is necessary.

Instruction Day: Day 2 P.M. / Day 3 A.M.

Time Allocation: 165 minutes

Evaluation Plan: Use student exercise on simple block analysis to develop skill and relate how various treatments improve safety factor. Ask individual tables if safety factors are acceptable, what solutions they chose and why (2, 4, 5). Before starting Apple Freeway, ask students what 3 types of failure must be considered (1). Demonstrate practical application in Apple Freeway and extend to surcharge effects by asking questions about effects of surcharge before showing solution (4). Show original flip chart objectives and ask which learning objectives were achieved.

Reference: Transportation Research Board Special Report No.247 *Landslide; Investigation and Mitigation,*1996. http://www.nas.edu/trb

Lesson No:	5 (Topic 2)
Lesson Title:	Solutions to Slope Instability
Performance Based Learning Objectives:	The participant should be able to: • Discuss solutions to stability problems.
Instructional Method:	Overview the options for remediation stability problems by the use of schematics and case history slides. Ask what treatments have been used by the agency. Ask students to apply remedial methods to improve stability of embankment shown in earlier exercise in topic 1. Use Apple Freeway to test overall knowledge of stability concepts.
Instruction Day:	Day 3 AM
Time allocation:	80 minutes
Evaluation Plan:	Student exercise will be used to test student ability to select remedial treatments. Instructor will quiz students on practical aspects of building solutions in the field. After exercise the instructor will use the Apple Freeway to test overall student learning of stability concepts.
References:	None

Lesson No:	6 (Topic 1)
Lesson Title:	Embankment Settlement
Performance Based Learning Objectives:	The participant should be able to: • Estimate compressibility from basic soils data, • Calculate settlement.
Instructional Method:	Use slides presentation and case histories of local area to show settlement causes, and effects. Show basic procedures for settlement of embankments on both granular and cohesive soils. Use mini-exercises to develop settlement computation skills after showing concepts. Demonstrate FHWA computer program EMBANK to show how results are extended to more detailed solution with little effort.
Instruction Day:	Day 3 A.M. / P.M.
Time Allocation:	135 minutes
Evaluation Plan:	Use student exercise for SPT method in granular soils and relate to previous effective stress problem (1,2). Use student exercise for cohesive settlement problem and ask for both magnitude and time (2).
Reference:	NCHRP Synthesis 159*, Design/Construction of Bridge Approaches*, 1990; http://www.nas.edu/trb

Lesson No: 6 (Topic 2)

Lesson Title: Treatment for Embankment Settlement Problems

Performance Based Learning Objectives: The participant should be able to:

- Propose solutions to embankment settlement problems.

Instructional Method: Use slides presentation and case histories of local area to show remedial treatments. Pass around a section of a wick drain to impress students with simplicity of treatments. Ask what treatments agency has used and success or problems found. Use Apple Freeway to test knowledge of how to use treatment methods to reduce settlement. Relate methods used to costs of alternates in actual project.

Instruction Day: Day 3 –P.M.

Time Allocation: 30 minutes

Evaluation Plan: Ask students to identify which of the treatment methods can be effective to reduce settlement on the Apple Freeway. Show original flip chart objectives and ask which learning objectives were achieved.

Reference: NCHRP Synthesis 159*, Design/Construction of Bridge Approaches*, 1990; http://www.nas.edu/trb

Lesson No:	7 (Topic 1)
Lesson Title:	Spread Footing Design- Bearing Capacity
Performance Based Learning Objectives:	The participants should be able to: • Explain how footing embedment, width and water table affect bearing capacity.
Instructional Method:	Use a short slide presentation to show bearing capacity concepts. Emphasize basic concepts in case history. Explain computation process. Discuss factors influencing bearing capacity as part of group exercise. Ask students to do exercise on bearing capacity.
Instruction Day:	Day 3 P.M.
Time Allocation:	85 minutes
Evaluation Plan:	Use group exercise to provide awareness of major issues (embedment, width, water table) which impact bearing capacity. Use student exercise to develop skills in basic bearing capacity and settlement of spread footings. After exercise return to slide of failure and ask how did this occur?
Reference:	NCHRP Synthesis 107; *Shallow Foundations for Highway Structures,* 1983; http://www.nas.edu/trb FHWA RD86-185; *Shallow Foundations for Highway Structures*, 1987; http://www.fhwa.dot.gov/bridge/geotechnical

Lesson No: 7 (Topic 2)

Lesson Title: Spread Footing Design-Settlement

Performance Based Learning Objectives: The participants should be able to:

- Perform settlement analysis in both cohesive and granular soil,
- Name solutions to reduce settlement amount or time.

Instructional Method: Use short slide presentation to show settlement concepts for spread footing design. After slides, demonstrate settlement method and then ask students to do exercise. Ask students to interpret results. Show Apple Freeway solution and question students on both bearing capacity and settlement issues related to actual project.

Instruction Day: Day 4 A.M.

Time Allocation: 75 minutes

Evaluation Plan: Use student exercises to develop skills in settlement of spread footings (1). Ask students to interpret result from settlement problem (1). Quiz students during Apple Freeway solution on meaning of computational results (2). Show original flip chart objectives and ask which learning objectives were achieved.

Reference: NCHRP Synthesis 107; *Shallow Foundations for Highway Structures,* 1983; http://www.nas.edu/trb
FHWA RD86-185; *Shallow Foundations for Highway Structures*, 1987; http://www.fhwa.dot.gov/bridge/geotechnical

Lesson No:	8 (Topic 1)
Lesson Title:	Deep Foundation Design – Load Capacity
Performance Based Learning Objectives:	The participants should be able to: • Describe the properties of the pile and the ground which affect bearing capacity.
Instructional Method:	Use detailed slide presentation to show deep foundation types and basic concepts (including example problem) for the design of single driven piles. Demonstrate the analysis procedure for both granular soil and cohesive soil. Present student exercise involving both granular and cohesive soil concepts. Demonstrate SPILE and DRIVEN computer programs and stress alternate pile type analysis. Use group exercise to compute pile capacities for simple profile. Relate Apple Freeway computations of alternates to pile selection by designer.
Instruction Day:	Day 4 A.M. / P.M.
Time Allocation:	155 minutes
Evaluation Plan:	Use student skill exercise on static pile capacity (1). Exercise relies on knowledge and skills previously learned about effective stress and the SPT method (reinforces sessions 2 and 3 with questions). After demonstration of SPILE and DRIVEN, ask questions about driving resistance related to project situations such as scour. Quiz students during Apple Freeway solution about meaning of results (1).
Reference:	FHWA HI-97-013, *Design/Construction of Driven Pile Foundations*, 1997; http://fhwa.dot.gov/bridge/geotechnical

Lesson No:	8 (Topic 2)
Lesson Title:	Deep Foundation Design – Pile Groups
Performance Based Learning Objectives:	The participants should be able to: • Recognize the effect of pile spacing, settlement and negative skin friction.
Instructional Method:	Use slides presentation to overview group issues such as efficiency, pile settlement, and downdrag. Use Apple Freeway to quiz student on group issues for this practical problem.
Instruction Day:	Day 4 P.M.
Time Allocation:	60 minutes
Evaluation Plan:	Quiz students on potential group problems for the Apple Freeway project.
Reference:	FHWA HI-97-013, *Design/Construction of Driven Pile Foundations*, 1997; http://fhwa.dot.gov/bridge/geotechnical

Lesson No:	9 (Topic 1)
Lesson Title:	Construction Monitoring and Quality Assurance - Instrumentation
Performance Based Learning Objectives:	The participants should be able to: • Recall the basic types of geotechnical instrumentation.
Instructional Method:	Use a brief slide presentation to overview the use of geotechnical instrumentation on highway projects. Use Apple Freeway problem to test student knowledge of what instruments would be selected for a typical project.
Instruction Day:	Day 4 P.M.
Time Allocation:	40 minutes
Evaluation Plan:	Use the Apple Freeway as a mini-student exercise to test application of instrument knowledge to an actual project.
Reference:	FHWA HI-97-013, *Design/Construction of Driven Pile Foundations*, 1997; http://fhwa.dot.gov/bridge/geotechnical

Lesson No:	9 (Topic 2)
Lesson Title:	Construction Monitoring and Quality Assurance- Foundations
Performance Based Learning Objectives:	The participants should be able to: • Apply dynamic analysis to pile design, • Evaluate pile equipment acceptability.
Instructional Method:	Use slides to describe pile-driving equipment. Overview wave mechanics concepts and dynamic analysis. Use transparencies and highlight important items concerning dynamic formula in manual. It is optional for the instructor to use computer program GRLIMAGE to show wave mechanics and GRLWEAP to show wave equation features. Show how to interpret wave equation output and relate to hammer approval, design check of pile driveability and production pile driving criteria development. Use group student exercises to demonstrate concepts.
Instruction Day:	Day 4 P.M. / DAY 5 A.M.
Time Allocation:	120 minutes
Evaluation Plan:	Use group student exercises with wave equation results to select pile size and approve pile-driving equipment (1,2). Ask students what items are controlled in their pile specification (2).
Reference:	FHWA HI-97-013, *Design/Construction of Driven Pile Foundations*, 1997; http://fhwa.dot.gov/bridge/geotechnical

Lesson No:	9 (Topic 3)
Lesson Title:	Construction Monitoring and Quality Assurance- Pile Load Testing
Performance Based Learning Objectives:	The participant should be able to: • Relate pile construction control to design safety factor, • Determine pile failure load.
Instructional Method:	Present a slide presentation showing load testing on representative projects. Use overheads to overview load testing concepts in static and dynamic testing. Highlight procedure in an example for load test interpretation. Use student exercise to interpret load test curve for failure load. Discuss safety factor reductions if load testing used and ask students what safety factors they think should be used for various test methods. Relate load testing to cost savings; particularly on major projects.
Instruction Day:	Day 5 A.M.
Time Allocation:	45 minutes
Evaluation Plan:	Question students on agency policy on load testing and frequency of load tests on recent projects (1). Use student exercise to evaluate skill in load test interpretation (2). Use Apple Freeway to test student learning for the construction control lesson.
Reference:	FHWA SA 91-042, *Static Testing of Deep Foundations*, 1992. http://fhwa.dot.gov/bridge/geotechnical

Lesson No: 10

Lesson Title: The Foundation Investigation Report

Performance Based Learning Objectives: The participant should be able to:

- Recall the contents of a foundation report.

Instructional Method: Introduce the agency speaker from the foundation section who will explain the procedures used by the agency to develop a foundation report and respond to questions from the group/instructors. A recent typical project is commonly used to allow the students to relate to specific situations in the host state. After the presentation, the instructor uses overheads to review guidelines of what a foundation report should contain and what information should be placed in the contract documents. Ask students to read final report for Apple Freeway.

Instruction Day: Day 5 A.M.

Time Allocation: 35 minutes host agency
30 minutes instructor

Evaluation Plan: Group discussion of agency procedures for review and distribution of both in-house and consultant reports (1). Group discussion of information contained in a typical foundation report and of report distribution (1). Group discussions of final report (1).

Reference: *AASHTO Manual on Subsurface Investigations*, 1988, http://www.aashto.org, telephone 1-202-624-5800

Lesson No: 11

Lesson Title: Course Summary, Review, and Critique

Performance-Based Learning Objectives: Participants should be able to:

- Review the overall learning objectives
- Identify at least one new skill learned
- Apply new skill or knowledge to a particular issue

Instructional Method: Instructor prepares an assortment of student exercise to be done by teams as the "final exam." Topics selected for those final exercises are based on the topics which were found to be of most interest to the students. Teams record their answers on flip chart sheets and present the results to the group. Review overall learning objectives. Interactive discussion between both instructors and participants. Use overhead of basic project geotechnical phases (Site investigation, basic soil properties, etc.) to stimulate group discussion. Display overhead of lesson titles to stimulate discussion. Open the Reference Manual and point to key sections (construction, design, design examples, guide specification, inspection, integrity testing). Ask the participants to list the most important concepts and details learned in the course, lesson by lesson. List the concepts articulated by the students on the chalkboard or flip chart and summarize them to complete the course. Brainstorm on applying new knowledge and skills to problems back at participants' home office and problems not solved. Complete course critique forms.

Instruction Day: Day 5 -- AM

Time Allocation: 60 minutes

Evaluation Plan: Ask students to provide the important concepts learned in the team exercise. Instructor interacts with the teams to assess their level of learning. Interact with the participants as they list the most important concepts that, they learned during the exercise and ask clarifying questions when appropriate. End with overhead of learning objectives and discuss what students learned or did not learn. *(Use this feedback for future topics for the course, if appropriate.)*

Reference: None