5th Annual Technical Forum

GEOHAZARDS IN TRANSPORTATION IN THE APPALACHIAN REGION

August 3-4, 2005

DAY 1

8:00 a.m. Registration

9:45 a.m. Salon D: Welcome: Tony Szwilski (CEGAS)
Opening Speakers: Sam Beverage, Katrina Bradley: Kentucky Transportation Cabinet
'**Managing the Engineering of a State Highway System: Keeping the Emphasis Where it Needs to Be**.'

Opening Session: GIS: A Versatile Planning Tool Chair: Jane McColloch (WVGS)

1. **GIS-Based Coal Resource Maps as Infrastructure Development Planning Tools**
   Nick Fedorko, WV Geological and Economic Survey
2. **Using GPS and GIS for Erosion Abatement Control, Lambert Run Mine Site, WV.**
   John Ferguson, USACE
3. **Surficial Geologic Maps for Geotechnical Audiences**
   William M. Andrews, Kentucky Geological Survey

12:00 n LUNCH

1:00 pm Salon D (CONCURRENT SESSION with Salon E)
Session 1: Blasting Techniques and Geohazard Implications Chair: Steve Brewster (USACE)

1. **Rock Cut Slope Design and Construction, Grundy Redevelopment Site E**
   Calvin J. Konya, Precision Blasting Services; Steve Spagna, USCE.
2. **Difficulties and Suggestions When Drilling and Blasting in a Karst Environment.**
   James T. Ludwiczak, Blasting and Mining Consultants
3. **A New Era of Tunnel Blasting: Electronic Initiators and Geohazard Reduction.**
   Douglas A. Anderson: Parsons Brinckerhoff, Philadelphia.

3:00 pm Coffee Break

3:30 pm Salon D (CONCURRENT SESSION)
Session 2: Geohazard Inventories and Assessment Chair: John Stanton (USACE)

1. **Geotechnical Management Systems: Data Standards,**
   Thomas Leftchik, FHWA, Kirk Beach, ODOT
2. **Geohazard Assessment for Highway Planning: The Karst Factor**
   Dominick Amari, AGE Designs, Inc.; Daniel Hurst, AMEC Earth and Environmental Inc.; Harry Moore, TDOT
3. **Rockfall Hazard Inventory Development and Maintenance: A 20 year Perspective**
   Michael Vierling, New York State Thruway Authority; Richard Cross & Peter Ingram, Golder Associates, Inc
4. **Development of Landslide Susceptibility Map for the County of Summit, OH**
   Joseph Troxell, Michael Krokonko, Gannett Fleming; David Gilbert, Geodecisions

1:00 pm. <u>Salon E</u> (CONCURRENT SESSION)
Session 3: Seismic Issues and Tunneling Challenges **Chair: John Kiefer (KGS)**

1. **The New Madrid Seismic Zone: Is Kentucky at Risk?**
   John Kiefer, Kentucky Geological Survey
2. **Soft Ground Tunneling Through Contaminated Groundwater**
   Nasri Munfah, Parsons Brinckerhoff, New York
3. **Applies Seismology and Implications on Highway Planning.**
   Earnest C. Hauser, Wright State University

3:00 pm Coffee Beak

3:30 pm. <u>Salon E</u> (CONCURRENT SESSION)
Session 4: Innovations **Chair: John Bargo (FHWA)**

1. **Glenwood Canyon Rockfall**
   Barry D. Siel, FHWA
2. **Public-Private partnerships: The WV Experience**
   Yuvonne Cantrell, Henry Compton & Ron Krofcheck, FHWA
3. **Old Mines Require New Thinking**
   Thomas E. Leftchik, FHWA

Adjourn 5:30 pm

6:30 pm Appalachian States Committee Meeting **Salon A**

Note: 9.75 PDH's (Professional Development Hours) will be granted for this conference. However you must register both (2) days in order to receive the credit.

DAY 2

7:30 am Registration

8:00 am. <u>Salon D</u>

Session 5: Rock and Soil Reinforcement Chair: Steve Brewster (USACE)

1. **Use of launched Soil Nails to Stabilize Landslides in Summit County, OH**
   Mitchell Weber, Gannet Fleming Engineers and Architects; Greg Bachman, Summit County; Robert Barrett, Soil Nail Launcher, Inc.
2. **Landslide Stabilization Using Micropiles, State Route 837 in Washington County, PA.**
   James .R. James, Gannet Fleming, Inc.
3. **A Design Model for Pile Walls Used to Stabilize Landslides**
   Tia Maria Richardson, Fairmont State University, WV

10:00 am Coffee Break

10:30 pm. <u>Salon D</u>

Session 6: Geotechnical Design and Construction Chair: Kirk Beach (ODOT)

1. **The Industrial Parkway: So You want to Build a road in Mine Spoils**
   Scott Murray & Mark Litkenhus, Fuller, Mossbarger, Scott & May Engineers, Inc
2. **Geotechnical Design and Construction of the Pittsburgh Interchange: Ancient Landslides, Rock Bolts, Soil Nails and Geogrids, Oh My!**
   Paul Hale, Brian Heinzl, Gannett Fleming, Inc.
3. **Drilled Shafts for Bridge Foundation Stability Improvement, Ohio 833 Bridge Over the Ohio River.**
   Stan Harris, Eric Kistner: Fuller, Mossbarger, Scott and May Engineers, Inc
4. **Abutment Site Evaluation for Proposed Corridor H Bridge**
   Kamal Shaar, Bob Barclay, Doug Voegele, James Wang: H.C. Nutting Company

12:30 pm Closing Remarks

Note: 9.75 PDH's (Professional Development Hours) will be granted for this conference. However you must register both (2) days in order to receive the credit.

5th Annual Technical Forum: Geohazards in Transportation in the Appalachian Region

ABSTRACTS

DAY 1

Opening Speaker: Sam Beverage, Katrina Bradley, Kentucky Transportation Cabinet

Managing the Engineering of a State Highway System:Keeping the Emphasis Where it Needs to Be.

The State Highway Engineer is a registered professional engineer who works under the direction of the Commissioner of Highways to administer the design, construction, operation and maintenance of the more than 27,000 miles of state maintained roads in Kentucky. The diversity of terrain and geology in Kentucky presents special problems in managing and responding to geohazards along the state's existing highway system and at new construction sites. Assessing risk in a consistent way, ensuring the availability of necessary design and construction talent and dollars in such varied conditions is a challenge. As a proponent of the engineering program for the entire state highway system it is incumbent on me to assure that the available funds are used to ensure the safety and convenience of the traveler, the continuity of serviceable roads, the protection of the environment, and accountability to the taxpayer. To accomplish this, the Department teams with Architect Engineer firms, other State and Federal agencies, and private citizens. This presentation highlights some examples of how this system works.

OPENING SESSION: GIS: A Versatile Planning Tool Chair: Jane McColloch (WVGS)

GIS-Based Coal Resource Maps as Infrastructure Development Planning Tools

Nick Fedorko, WV Geological and Economic Survey

Infrastructure development, such as design and construction of new or improved roads, requires a geologic analysis and throughout much of West Virginia and surrounding Appalachian states this involves analysis of coal and coal-bearing rocks. Construction may present opportunity for recovery and sale of coal, offsetting some construction cost. Alternately, prior mining may present challenges or even hazards to construction, adding additional cost. The West Virginia Geological and Economic Survey has been remapping the economically important coal beds in the state utilizing Geographic Information System (GIS) technology, creating information that should make it much easier and more economical to analyze the impact of coal on a road design. For each coal bed, geologists are creating a series of coal resources maps including structural contours, outcrop, depth of overburden, compilation of mined areas by mining method (underground, surface, auger, and highwall), bed thickness, and others. Receiving coal geology information in a GIS format should allow the design engineer or geologist to readily analyze the interaction of the geology with the construction design. For example, the structural contours with the abandoned underground mines could aid in delineation of potential mine water hazards. Likewise, the coal thickness grids could be used with the overburden to determine the tons of coal that may be recovered in cuts. Development of this information by the Geological and Economic Survey should add efficiency and cost savings to project planning.

Using GPS and GIS for Erosion Abatement Control, Lambert Run Mine Site, WV: John Ferguson, USACE

During the early 1900's the Appalachian Mountain region was heavily mined for its coal and timber. These events have had a significant effect on the topography, geochemistry, and habitat for much of the area. West Virginia lies completely within the Appalachian Mountains and has had a tradition rich in the mining and timbering industries. The Monongahela National Forest, located in eastern central West Virginia, has recently been targeted by the United States Forest Service (USFS) as an area of reclamation. The Lambert Run Mine Site was selected from this area as an Erosion Control Abatement Project. This project required the use of GPS to further locate abandoned mine features, track drainage to, on, and off of the mine bench, and determine the relative drainage pattern differences between pre and post mining. Additionally, geochemical data was collected to determine the effects from the mining on the surface waters and help identify any necessary remediation. The results were compiled in a database and imported into a GIS for analysis using digital orthophoto's (DOQQ), 1958 aerial photos, USGS quadrangles, and topographic mapping, generated from surveys, as base maps. This analysis showed what measures, if necessary, would need to be taken to return Lambert Run to its pre-mining condition. The GPS and GIS methodology used to complete this study are believed to be valid for proposed highway and rail corridor studies, environmental impact investigations, and for abandoned mine, karst, or similar hazard feature surveys associated with new or existing transportation routes.

SESSION 1: Blasting Techniques and Geohazards Implications   Chair: Steve Brewster (USACE)

Rock Cut Slope Design and Construction, Grundy Redevelopment Site E**:** Calvin J. Konya, Precision Blasting Services; Steve Spagna, USCE.

The Grundy, Virginia Redevelopment Project had wall control problems on a 400 foot high cut which was composed of weak, highly jointed sandstone and shale. Blasting methods which are commonly used for wall control on highways projects were tried with poor results. Blasting techniques for wall control used for relining locks and for another USACE project were used in this weak rock. Blast holes were loaded with low energy charges on closer spacing so that a split would occur between blast holes and the weak rock would not be damaged. The results of the presplitting were much better than the older presplitting methods and produced stable slopes.

Difficulties and Suggestions When Drilling and Blasting in a Karst Environment
James T. Ludwiczak, Blasting and Mining Consultants

Drilling and blasting in a Karst (sinkholes and mud seams) environment has long been a problem for blasters, miners, quarry operators, contractors, and developers. While one cannot change the geological conditions, one can take some measures during the bidding process and the initial preparation of the blasting program to help reduce some of the problems.

During the geotechnical investigation and developing the test/core drilling grid, the owner/developer needs to take some additional measures that will provide important data to the blaster to help reduce the problems associated with blasting this type of geology. The owner/developer must also understand that, due to the geologic conditions, the results of the blasting will not be ideal and there may be additional blast-related costs. If provided the proper geologic data, the blaster can develop drilling patterns and blast designs that will help reduce some of the more problematic areas.

These additional measures are not just for production purposes, but also for the safety of the blasters and the workers. Although unintentional, and due to the geologic conditions, improperly drilled blast holes, blast designs, and explosives loading techniques can result in poor production and breakage. More importantly, it can also result in overloading the blast holes causing a loss of control of the blast itself. This loss of control of the blast can, and does, result in venting of the explosives gases and the creation of unexpected flyrock. In addition to injury, flyrock can also cause substantial damage to equipment and to property. While we cannot change the rock conditions, there are actions that can be taken by the developer and blaster that will reduce the problems associated with blasting in a Karst environment.

A New Era in Tunnel Blasting – Electronic Initiators and Geohazard Reduction
Douglas A. Anderson, Parsons Brinkerhoff, Philadelphia

Conventional tunnel blasting, using long-period detonators, either electric or non-electric, are at the outset of a revolution. Electronic detonators, which have computer chips as delay elements instead of pyrotechnic powder trains to generate the delays, are now being used extensively in both surface and underground operations. This change in technology reduces the scatter in firing times from tens of milliseconds for the higher period long-period delays to a fraction of a millisecond, independent of delay. While at first blush this may seem to relate merely to some improvements in fragmentation and vibration control, the scope is much further.

The original reason for development of long period delays was the need, in a confined underground operation, for adequate reliable relief, with an emphasis on reliable. Scatter in firing times meant that longer times were needed to provide this relief, which predicated more scatter, and so on, with the result being very long times (from a blasting perspective). Now, with the effect of scatter removed, blast designs can be totally rethought. The modifications will have significant implications on fragmentation, overbreak, and vibration, all of which have Geohazard implications, and will be discussed in this paper.

SESSION 2: Geohazard Inventories and Assessment   Chair: John Stanton (USACE)

Geotechnical Management Systems: Data Standards: Thomas E. Lefchik, FHWA and Kirk Beach, ODOT

An increasing amount of information associated with more complicated projects and reduced staffing are placing greater burdens on geotechnical staff. In the midst of this increasing pressure, State DOT's are looking to information technology to assist them in more efficiently managing geotechnical data, projects, hazards, and assets. The benefits in terms of time savings and cost savings can be substantial. Geotechnical assets and hazards can be more effectively and efficiently managed through the electronic storage and retrieval of data.

Several State DOTs, federal agencies, and other organizations have developed or are in the process of developing electronic geotechnical management systems of varying extent and complexity. These systems demonstrate the effectiveness of electronic geotechnical management systems for managing subsurface investigation data, managing geotechnical assets, and managing geologic hazards. The ideal system would facilitate interchange of information with other agencies and organizations permitting the exchange and use of existing information across arbitrary political boundaries or governmental agency lines.

It is time consuming and costly to develop geotechnical data management systems that work effectively to promote data exchange. Data dictionaries and data standards are critical components in the development of any geotechnical management system. Data exchange with other agencies and groups could be easily accomplished with uniform standards. Software producers could develop products, based on uniform standards, which were nationally marketable and would be compatible with other software developers.

The Federal Highway Administration (FHWA) in conjunction with the Ohio Department of Transportation (ODOT) has formed a work group comprised of 12 State DOT's, United Kingdom Highway Agency, USGS, USEPA, US Army Corps of Engineers, and FHWA to develop data dictionaries and data formats for geotechnical management systems. The Ohio Department of Transportation (ODOT) has initiated a pooled fund project to fund the activities of the work group. The work group is coordinating its efforts with other agencies and groups.

Geohazards Assessment for Highway Planning: The Karst Factor
Dominick Amari, AGE Designs, Inc.; Daniel Hurst, AMEC Earth and Environmental, Inc.; Harry Moore, TDOT

The Tennessee Department of Transportation (TDOT) is planning a new access-controlled roadway alignment that crosses carbonate bedrock of the Valley and Ridge Province of East Tennessee. The proposed location has been subject to intense debate because of the competing interests of a range of political bodies, industries, landowners and environmental groups. After much effort, a preliminary corridor was selected that attempted to address the concerns of the various parties. However, as a result of the karst geologic setting and presence of several known caves on the proposed corridor, and other non-geologic issues, a precise alignment has not yet been selected. TDOT has initiated a karst geohazards inventory and assessment to assist in selecting a satisfactory alignment. Caves offer special challenges relative to both the physical and environmental issues of highway development. The karst geohazards inventory study has disclosed the presence of additional caves, some of which may have detrimental structural, geologic and environmental issues for alignment and grade design considerations. The hidden nature of the problem demands a detailed examination of each cave, as well as swallets and fissures that may reveal additional caves, as part of a comprehensive geohazards inventory and assessment before the overall impact on the project can be completely evaluated.

While conducting a geohazards assessment of subsurface caverns on the interstate I-275 corridor in East Tennessee it was determined that the physical location of caverns and environmental issues regarding cave fauna may affect the selection of an alignment and the roadway design. The discovery of this information has increased the number of factors that will be evaluated by a Context Sensitive Solutions team. This project emphasizes the need to evaluate geohazards in advance planning stages of new roadway design processes.

Rockfall Hazard Inventory Development and Maintenance – A 20-Year Perspective
Michael Vierling, NY State Thruway Authority; Richard Cross and Peter Ingraham, Golder Associates, Inc.

The New York State DOT and Thruway Authority began developing rockfall hazard assessment tools in 1985 patterned after early rockfall hazard rating systems for railways. Following a fatal rock strike in 1986, a statewide rockfall hazard rating system was developed and implemented in 1987 and 1988.Data developed from the ratings of system-wide slopes was initially stored on note cards and catalogued. With the advent of more user-friendly data management systems, rock slope inventories and data associated with rockfall hazard ratings, maintenance, and repairs such as rock bolts, drapes, rockfall catch fences and retaining walls were incorporated into the Thruway's Oracle database and more recently a GIS database. Early development of the rock slope inventory included involvement by maintenance personnel to ensure that the personnel responsible for maintaining slopes and slope repairs would recognize the need and usefulness of the inventory and provide data pertaining to minor rockfalls and degradation of slope conditions as observed and keep the inventory an actively updated database. Thruway Design and management personnel were also involved in rock slope inventory development and a review of rock slope conditions and design of repairs/improvements included in improvement and widening projects. The rockfall hazard rating system generally follows FHWA RHRS guidelines and has evolved to include system-specific rating categories to reflect the nature of the Thruway system. The evolution of the rockfall hazard rating system and dynamic nature of the rock slope inventory have made them valuable tools in managing the rock slopes along the Thruway system, and an integral part of prioritizing rock slopes for the Thruway's 15-year rock slope improvement program

Development of Landslide Susceptibility Map for the County of Summit, Ohio

Joseph Troxell, Michael Krokonko, Gannet Fleming; David Gilbert, Geodecisions

According to USGS, landslides annually cause over $1 billion in damage and 25-50 fatalities. Increasing costs and risks to the county road system were identified in the northwest portion of the County. Gannett Fleming was retained for professional engineering services, including development of a susceptibility map to aid in the development of loss reduction measures.

Criteria evaluated for development of the susceptibility map included:

Percent Slope	Slope Facing	Depth to Rock	Distance from toe of slope to stream
Soil Type	Hydrology	Geomorphology	Depth to Groundwater

An inventory of existing landslides was completed and used to calibrate the susceptibility map.

Identifying high susceptibility areas can lead to Building Code or zoning requirements in these areas which would reduce damages and risks. Some highly susceptible areas with a high risk and damage potential could receive preventative measures, such as drainage improvements or stream bank protection. This can provide long-term cost savings as landslides induced by man are reduced and preventative measures can protect existing facilities and not require reconstruction after a failure.

SESSION 3: Seismic Issues and Tunneling Challenges   Chair: John Keifer (KGS)

The New Madrid Seismic Zone: Is Kentucky at Risk?: John D. Kiefer, Kentucky Geological Survey

To what extent are earthquakes a risk to Kentucky, its infrastructure, roads, railroads, bridges? Even moderate earthquakes, like the Sharpsburg earthquake in central Kentucky in 1980 and be costly. Damage from the Sharpsburg event was estimated at over $3 million. The answer to this question is dependent on a number of geologic factors, including magnitude, distance from epicenter, depth, and local geology. Although the state of our knowledge is insufficient to support the prediction of earthquakes, it does allow us to estimate risk over broad areas. Such estimates are dependent on both observational data and assumptions. The seismic zone with the greatest potential for catastrophic damage is the New Madrid which we know produced at least three very large earthquakes, and more than 1800 aftershocks in 1811-12. However, although the most active seismic zone in the eastern and central U.D., it has produced few earthquakes greater than magnitude 4.o in the past 200 years. Nevertheless, assessment of seismic risk and the consequences of those assessments on public safety, land use planning, and the state's economy are highly relevant. Current design ground motion for western Kentucky now controls that the area's development potential.

Current risk assessments stem from seismic hazard maps produced by the U.S. Geological Survey which depict predicted ground motion with a two percent probability of being exceeded in a 50-year period, the industry accepted life expectancy of most structures (Frankel and others, 1996 and 2002). Paleoliquefaction studies suggest that large earthquakes, similar to the 1811-12 New Madrid events, have been repeated on the average at 500 year intervals over the past 2000 years. This translates into an estimated 1 in 10 chance that a building might be affected by a major earthquake in western Kentucky over 50 years. What is not understood nor explained clearly is the high degree of uncertainty of this estimate. The magnitude of the standard deviation of 300 years has no corollary in the western U.S. where earthquakes are frequent, faults are visible at the surface and movement tends to be significantly greater. Considering the factor of

Soft Ground Tunneling through Contaminated Groundwater: N. A. Munfah, Parsons Brinkerhoff, NY

With a budget of $6.3B the East Side Access Project (ESA) is the largest transportation project ever undertaken in New York City. The construction of the project will require significant tunneling and underground work utilizing a variety of construction techniques. In Queens, the project will require the construction of four soft ground tunnels, using pressurized face TBM. The tunnels will be constructed under an active railroad yard and the main line of the Long Island Rail Road (LIRR). In addition, cut and cover tunnels and underpinning of existing transit lines will be required. In Manhattan the project requires the construction of several tunnels and
two large station caverns in rock. The project faces unique geotechnical and environmental conditions within the soft-ground tunnel portion of the project located in Sunnyside Yard and Harold Interlocking – mixed face tunnel excavation, a variety of groundwater contamination plumes, as well as tunneling through a New York State-listed Class II inactive hazardous waste site. This paper focuses on the technical challenges in the Queens segment and particularly the innovative construction and monitoring approaches identified to control movement of contaminated ground water. It addresses engineering aspects, public amenities, railroad operation, environmental issues, and technical challenges related to underground construction in a heavily developed railroad yard site while maintaining the existing facilities operational and with minimal impact on the public and health and safety.

Applied Seismology and Implications on Highway Planning: Ernest C. Hauser, Wright State University

Various applied seismology methods are used to address subsurface questions for both construction and hazard mitigation along roadways. The questions addressed range from issues of depth to bedrock and rip-ability of bedrock during construction, as well as the presence of subsurface voids (karst and mines) under roadways. Surface wave seismic methods are increasingly being used to determine the shear wave seismic properties of the near subsurface, giving information about the depth to bedrock and rock properties.

Probably the most widely recognized and commonly used seismic method for the study of the near subsurface is seismic refraction. Seismic refraction is most commonly used to determine depth to bedrock (thickness of overburden) and the rip-ability of bedrock (to determine the need for blasting). A novel application of the seismic refraction method is currently being tested by Wright State University which may help identify or map areas of potential underground coal mines or other voids.

SESSION 4: Innovations Chair: John Bargo (FHWA)

Glenwood Canyon Rockfall: Barry Siel, FHWA

On Thanksgiving Day, November 25, 2004 a rockfall occurred in Glenwood Canyon, Colorado just west of the Hanging Lake Tunnel that closed I-70, resulting in a 200 mile detour. The volume of rock that fell, estimated to be between 1300 and 1500 cubic yards, broke away from the canyon wall approximately 1300 feet above the roadway. 36 hours after the rockfall occurred, Colorado DOT maintenance crews were able to open one lane in each direction to restricted traffic. Damage included large holes in the pavement in the westbound lanes behind the retaining wall, damage to the retaining wall, damage to the bridge deck supporting the eastbound lanes and damage to the parapet and guardrail on the bridge. On November 30 CDOT contracted with Kiewit Western to make repairs in 60 days. Repairs began on December 1 and were completed by January 26, 2005.

Public Private Partnerships: The WV Experience: YuVonne Cantrell, Henry Compton, Ron Krofcheck, FHWA

A joint agreement between Nicewonder Contracting and the WVDOH was signed in May 2004 to facilitate project development and construction on 11.37 miles of King Coal Highway in Mingo County, WV. Known as the Red Jacket Project, the 11.37 mile segment includes 56.3 million cubic yards of excavation and extraction of coal (between 1.5 and 2.5 million tons). This presentation is intended to give an overview and current status of the Public Private Partnership, and how the FHWA-WV Division and the WVDOH are implementing/administrating this innovative project.

Old Mines Require New Thinking: Thomas E. Lefchik, FHWA

Countless mines were excavated in the United States and around the world before the areas surrounding the mines were developed or before modern transportation systems were conceived. These mines dating back to the 1700's and 1800's are now creating problems with modern transportation systems. Problems include collapses and seeps. Other problems relate to development over previously mined areas.

Abandoned mines create problems that need to be dealt with in innovative ways. The Interstate Technical Group on Abandoned Underground Mines was formed to share information regarding new methods tried by its members and to develop new methods of locating, assessing, and remediating abandoned mines beneath transportation facilities. This presentation will discuss some of the methods tried and used and some methods being developed through efforts of the group.

Adjourn for the Day 5:30 PM

6:30pm Appalachian States Committee Meeting SALON A.

DAY 2

SESSION 5: Rock and Soil Reinforcement Chair: Steve Brewster (USACE)

Use of Launched Soil Nails to Stabilize Shallow Landslides in Summit County, Ohio
Mitchell W. Weber, Gannet Fleming Engineers and Architects; Greg Bachman, Summit County; and Robert K. Barrett, Soil Nail Launcher, Inc.

This paper will present Launched Soil Nail technology, design considerations, and the applicability to the Summit County landslide projects. Landslide-prone areas of Summit County are located in the Cuyahoga River valley in Northeast Ohio. The valley is notorious for land sliding within the glaciolacustrine silt deposits that cover upland and valley areas. Ancient and active landslides populate the slopes. Many factors affect slope stability in the county including: urban development, storm water management practices, inherently weak soils, and steep tributary stream valleys. The above-normal precipitation of 2004 triggered dozens of landslides within Summit County.

The County Engineer sought an expedient and economical solution to repair and stabilize affected county highways. The utilization of launched soil nails to stabilize shallow landslides was evaluated by the County Engineer's staff and their consultant. The stabilization technique was deemed to be appropriate for about one-third of the slides affecting the county roads. The repaired landslides were generally small (< 35 feet high) and varied in width from 40 to 300 feet long. The crown of the slides was located in the traveling lane, paved or unpaved shoulder areas. The surface expression of the rupture surfaces and the aerial extent of the slides were readily visible. An engineering geology assessment of the slide geometries indicated that 2 to 3 rows of launched soil nails installed through the main slide scarps on 3 to 4-foot centers would reinforce the soil at the head of the slides.

Landslide Stabilization Using Micropiles, St. Route 837 in Washington Co., PA
James R. James, Gannet Fleming, Inc.

This paper's subject is a 2,900-foot long portion of two-lane highway that had experienced chronic vertical and lateral displacements for several decades. Extensive, small-scale pavement repair and resurfacing was periodically required throughout the area. In 1999, a project was initiated to investigate the root causes of the pavement distress and develop long-term solutions to the problems. Literature studies confirmed that the roadway traverses an ancient landslide. Observation of surface features and review of previous monitoring efforts indicated that the colluvial mass was experiencing ongoing movements. Subsurface exploration and instrumentation programs were implemented to determine the mechanisms contributing to the slope movements and to delimit the landslide. The failure plane was isolated within a layer of colluvium near the top of bedrock. Several remediation alternatives, ranging from traditional retaining walls to lateral drains, were evaluated with respect to economics and applicability to the site. Ultimately, micropiles were employed as soil reinforcement to provide long-term stabilization of the slope. Concurrent improvement of the site's drainage system was also deemed necessary. Construction was completed in 2004. This paper describes diagnosis of the landslide's origins and design of the remedial measures. An overview of the project's construction is also presented.

A Design Model for Pile Walls Used to Stabilize Landslides: Tia Maria Richardson, Fairmont State University

Pile walls are often used as a soil reinforcement technique to remediate failed slopes. Consisting of panels supported by driven or drilled piles, they work by transferring the landslide loads to the stronger, deeper strata. They are particularly useful when faced with space restrictions, yet, there is no generally accepted design procedure.

The analysis and design require defining two main factors: 1) The driving forces from the landslide and 2) The resistance provided by the piles. A soil model was developed to describe the driving forces based on a circular failure surface with consideration given to how the pile programs generate a solution. A relationship was formulated using the contributing slice information from the output critical circles generated in the slope stability analysis. This information was processed via an Excel spreadsheet programmed to calculate the total force acting on the pile and the location of this force. Based on the intersection of the pile with the slip, a procedure is suggested for inclusion of passive support in the pile analysis and an adjusted pile analysis length.

To validate the procedure, one full-scale test site was established and two full-scale pile walls were studied under working conditions for five years. Deflections were recorded by attaching slope inclinometer casing to the inside flanges of 15 piles, five at each site. The deformations generated in the pile programs were compared to the measured deflections. A finite difference technique was used to calculate moments along the pile length for comparison with the moments predicted.

The results of the study indicate that the proposed model is suitable for predicting the forces acting on piles used to stabilize a slope when the piles are placed at or near the top of the slope and only one slip plane is present. When the piles are situated at or near the toe of a slide, the model overestimates the landslide force.

SESSION 6: Geotechnical Design and Construction Chair: Kirk Beach (ODOT)

The Industrial Parkway- So You Want to Build a Road in Mine Spoils
Scott Murray and Mark Litkenhus, Foster, Mossbarger, Scott & May Engineers, Inc.

The Kentucky Transportation Cabinet constructed the Industrial Parkway in Boyd, Carter and Greenup Counties from 1998-2003, at an estimated cost of $90 million. The Industrial Parkway begins with an intersection at I-64 about six miles east of Grayson, extends 14.5 miles northward, and ends at-grade with US 23 near Wurtland. The corridor in which the roadway was built was extensively surfaced-mined to recover coal reserves. Bedrock in the area belongs to the Conemaugh and Breathitt formations, representing the Pennsylvanian geologic age. Rock along the alignment consists of non-durable shales that degrade to soil-like consistencies when exposed to weathering elements.

Past mining operations required mass excavation of bedrock to uncover coal reserves. Non-durable shales and other materials were used to refill mine benches, backfill high-wall cuts and were wasted in large hollow-fills. These spoils are present in thicknesses ranging form a few feet to over 70 feet. The materials were not placed in an engineered manner, but rather were bladed, end-dumped and pushed into place. Such operations resulted in thick deposits of soil-like materials that continue to degrade and settle over many years, even under their own weight. Roadway elements constructed on such materials can experience substantial settlements. Buried high-walls, acid drainage-producing materials, sediment ponds and existing landslides were also encountered at bridge and roadway locations.

This paper discusses how the site was characterized by performing preliminary geotechnical overviews as well as more comprehensive geotechnical explorations. It also focuses on applications of dynamic compaction, drilled-shaft foundations, geogrids, and acid drainage remediation, chemical modification of sub-grades, the problems encountered during construction, and the successes achieved.

Geotechnical Design and Construction of the Pittsburgh Mills Interchange: Ancient Landslides, Rock Bolts, Soil Nails, and Geogrids, Oh My! Paul A. Hale and Brian F. Heinzl, Gannet Fleming, Inc.

Gannett Fleming, Inc. is assisting the nationwide developer the Mills Corporation in the design and construction of a new interchange to serve the Pittsburgh Mills retail development, located at the northeastern edge of the Greater Pittsburgh Region. The interchange construction comprises intersection of an ancient landslide colluvial mass, an adversely jointed rock cut slope, a new structure over existing PA state route 28, and extension of a box culvert, buried over 50 feet below the existing 4-lane highway. The geotechnical treatments applied to the project include; buttressing, rock bolts, soil nails, and soil reinforcement. The construction was awarded in multiple phases through the use of traditional Plans, Specifications, and Estimates (PS&E) package and several Highway Occupancy Permits (HOP) packages to meet the developers schedule and project funding structure. The design scope was expanded significantly beyond the initial interchange design due to utility conflicts, necessitating the rapid design and approval of two additional retaining walls, and a reinforced soil slope. Gannett Fleming was retained during construction to perform shop drawing review of contractor designed items and to perform site inspections as necessary to evaluate unforeseen conditions encountered during the construction phase, as well as to confirm the assumptions used for design. The project is currently under construction.

Drilled Shafts for Bridge Foundation Stability Improvement Ohio 833 Bridge over the Ohio River Pomeroy, Meigs County, Ohio: Stan A. Harris and Eric M. Kistner, foster, Mossbarger, Scott & May Engineers, Inc.

The Ohio Department of Transportation (ODOT), the West Virginia Department of Transportation (WVDOT) and the Federal Highway Administration (FHWA) are working together to construct a replacement structure for the existing U.S. Route 33 Bridge over the Ohio River between Pomeroy, Ohio and Mason, West Virginia. The proposed structure will be a cable-stayed structure with an abutment to abutment length of 1,910 feet. Relocation of Main Street on the Ohio side of the river was to require new roadway embankment ranging up to 30 feet in height. The initial geotechnical exploration discovered the presence of existing fill materials and soft alluvial deposits overlying shale bedrock along the proposed Main Street alignment. As a result, a controlled rate of embankment construction was specified. Slope inclinometers and piezometers were recommended to monitor for possible slope movements and increases in pore water pressures.

Embankment construction began in October of 2003. Slope inclinometer data obtained in November of 2003 indicated the presence of deep slope movement. Subsequent explorations and monitoring confirmed the presence of what appeared to be a remnant landslide. The detected failure plane was generally at or below the interface between residual soil and soft shale (mudstone), at depths up to 65 feet. Although the proposed bridge foundations were not within the area of slope movement, it was decided that proactive steps should be taken to protect the new foundations in the event that the movement expanded. Working with URS, the bridge designer, and the ODOT Office of Geotechnical Engineering, a foundation protection scheme was developed consisting of the construction of nine, eight-foot diameter heavily-reinforced drilled shafts on the Ohio River bank, just uphill of the tower pier. The shafts were instrumented with slope inclinometer casing, strain gauges and tilt meters. The design methodology will be presented along with results of the instrumentation monitoring.

Abutment Site Evaluation for Proposed Corridor H Bridge
Kamal Shaar, Bob Barclay, Doug Voegele and James Wang, H.C. Nutting Company

H.C. Nutting Company's proposed presentation involves a recent geotechnical study and subsequent evaluation for an abutment site of a major proposed bridge structure over the South Branch of the Potomac River, located in Moorefield, Hardy County, WV. The proposed abutment is located near the edge of a highly weathered shale slope, within the Valley and Ridge Province of WV. The question of the integrity of the proposed foundation and the determination of how best to provide a stable design for the abutment in a location with a complex geology and limitations restricting the options for other alternatives are the basis of the presentation. The initial subsurface investigation and a following field inspection provide the insight for the concern for that site, and the options that are being considered for a remedial treatment. The recognition of the problem and the analysis of the engineering methodology to provide a design that will result in the long term stability of the structure is the purpose for the in depth study of this site. The project is a joint venture with Michael Baker Jr., Inc., WVDOH, and FHWA.

Closing Remarks 12:30 PM

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GOALS

The Appalachian states are tied by common geographical and geological challenges. Multi-Model transportation in the Appalachian region is essential for economic development. The coalition includes members from West Virginia, Virginia, Kentucky, Pennsylvania, Tennessee, North Carolina, Ohio Departments of Transport, and Geological Surveys, FHWA, USGS, CSX, Norfolk Southern and USACE. This grass root organization of federal, state and private entities confront similar geological hazard prevention and remediation issues in the Appalachian region.

OVERALL GOALS:

- Address geologic hazards in the Appalachian states related to transportation, highway, river, rail and air.
- Promote the sharing of technical resources and information.
- Provide and electronic medium for the exchange of ideas, experiences, and methodologies.
- Facilitate the development of geologic hazard inventories and to assemble remediation costs.
- Identify new and innovative technologies/research applicable to transportation projects involving remediation of geologic hazards.
- Identify resources to address geohazards.

SHORT-TERM GOALS

- Initiate appropriate communication channels that will benefit the Appalachian Coalition members and other interested parties.
- Develop a regional database/Geohazard Management System that will store geohazard inventories, remediation methods and costs.
- Develop a methodology and testing protocol for site characterization over karst and abandoned mine working for transportation infrastructure planning.
- Identify and characterize geohazards through the resources required (information, equipment, collaboration, funding) to assess and address geohazards.