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Forensic Engineering / Architecture / Biomechanics

EXPLOSIVES/BLASTING SPECIALIST'S REPORT

Adverse Effect Analysis
Wake Stone Corporation – Triangle Quarry
Mining Permit No. 92-10
Modification Application
Dated April 8, 2020

Located Near:

William B. Umstead State Park
2100 N. Harrison Ave.
Cary, NC 27513

Prepared for: **Dr. Jean Spooner, Chair**
The Umstead Coalition
PO Box 10654
Raleigh, NC 2760

Prepared by: **Kenneth K. Eltschlager**
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Date: November 22, 2021

Introduction: The Wake Stone Corporation (WSC) proposes to expand the Triangle quarry across Crabtree Creek onto the Odd Fellows lot. The quarry application proposes to conduct mining operations within 25 feet of the Umstead State Park and 175 of the Dunn residence. Based on the available blasting information to date, this analysis will estimate the adverse effects (ground vibrations, airblast and flyrock) caused by blasting at the quarry and make recommendations to ensure the protection of people and property outside the permit boundary.

The existing quarry is primarily Reedy Creek metagrandiorite. Coring data from the exploratory cores on the Odd Fellows tract are unavailable and the site could contain significantly different and or weathered rock.

Review Parameters:
The law calls for an application to be denied upon finding:

> **§ 74-51. Permits - Application, granting, conditions**.
> (d) The Department may deny the permit upon finding:
> (4) That the operation will constitute a direct and substantial physical hazard to public health and safety or to a neighboring dwelling house, school, church, hospital, commercial or industrial building, public road or other public property, excluding matters relating to use of a public road;
> (5) That the operation will have a significantly adverse effect on the purposes of a publicly owned park, forest or recreation area;

The law is implemented in the NC rules at:

> **15A NCAC 05B .0104 INFORMATION REQUIRED IN PERMIT APPLICATION**
> The completed application for the mining permit shall include information concerning the (a) mining operation and (b) reclamation plan for the restoration of all affected land.
> (a) (7) method to prevent physical hazard to any neighboring dwelling house, school, church, hospital, commercial or industrial building, or public road if the mining excavation will come within 300 feet thereof; and
> (b) (7) intended measures to provide for safety to persons and adjoining property in excavation in rock;

Together these require a description of how blasting will be conducted in order to protect public and property outside the permit area.

The existing modified Triangle permit issued by the North Carolina Division of Energy, Mineral and Lane Resources is dated March 28, 2018.

> **Condition 10, Blasting,** addresses the adverse effects of blasting and requires each blast to be monitored with a blasting seismograph at the nearest structure.
>
> A. Ground vibrations will be limited to the Office of Surface Mining Reclamation and Enforcement (OSM), alternat blasting level criteria.

B. Ground vibrations, in in/s, without monitoring can be estimated with $V = 160 (D/W^{1/2})^{-1.6}$, limit 1.0 in/s.
C. Airblast limit is 129 dB, with exceptions.
D. Airblast, in psi, without monitoring can be estimated with $U = 82 (D/W^{1/3})^{-1.2}$, limit 0.0082 psi or 129 dB.
E. Blast records must be maintained.
F. WSC is required to report vibration exceedances to the Department.
G. Fyrock must not be throw beyond the area of access control.
H. Flyrock occurrences must be reported to the Department and investigated.
I. Requirement to share studies with the Department.
J. Notice of blasting to the Department, when requested.
K. Haulroad blasting and mitigation.

To facilitate the review and approval process, the Application for a Mining Permit, question 11 is:

11. Will explosives be used? Yes No .

If yes, specify the types of explosive(s) and describe what precaution(s) will be used to prevent physical hazard to persons or neighboring property from flying rocks or excessive air blasts or ground vibrations. Depending on the mine's location to nearby structures, more detailed technical information may be required on the blasting program (such as a third-party blasting study). Locate the nearest offsite occupied structure(s) to the proposed excavation(s) on the mine map and indicate its approximate distance to the proposed excavation.

Public safety and protection of adjacent property must be assured in the response based on the location of blasting. Public safety can be assured with adequate blast area security and sufficient explosives confinement to prevent dangerous concussion and flyrock. Property protection is achieved by sufficient explosives confinement to prevent flyrock and explosives charge size limitations and distance to minimize ground vibrations and airblast.

In response to question 11, in the **Modification Application dated April 8, 2020** the applicant states:

ANFO and emulsion blasting agents have been utilized for many years for production blasting at the Triangle Quarry. All blasting agents are brought on-site just prior to blasting and loaded in blast holes from contract bulk dispensing truck. No blasting agents are stored on-site. Blast hole drill logs are used in conjunction with laser face profiling and crushed stone stemming material to custom load each blast hole. Detonation of blasts is by electronic blasting caps utilizing a computerized timing system to maximize control of flying rocks, air blasts and ground vibrations. A seismograph is used to monitor each blast at the nearest offsite occupied structure. These procedures ensure well controlled

blasts and greatly reduce the potential for flying rocks or excessive air blasts or ground vibrations.

In addition, Wake Stone frequently uses Dyno Nobel, a nationally recognized explosives and blasting consulting firm, to assist us with our blasting. Using data collected from our current blasting program at the Triangle quarry, Dyno Nobel performed an analysis of expected air blasts and ground vibrations that might be expected for blasting within the new pit expansion on the RDU Odd Fellows tract. Their analysis confirms that blast events can be designed and performed to keep airblasts and ground vibrations in the expanded pit well below allowable limits for structures as close as 500' from the blast site. Dyno Nobel's blasting analysis summary report is included with this application.

In essence, we have blasted for many years at this site and have the tools to control the adverse effects of blasting. However little supporting documentation has been provided to support this claim and blasting will be much closer to structures and people than the current permit. Blasting information made available to date include:

- a summary of blasting information for calendar years 2015 – 2019 that includes date, # of holes, Maximum charge weight per delay and elevation. Missing is critical information necessary for evaluation of the adverse effect potential is the distance to the nearest structure, ground vibration levels, airblast levels and powder factors. The only usable data for adverse effects evaluation is the Maximum Charge Weight per Delay that ranges from 80 to 478 pounds from 290 blasts. The highest occurred in 2020, thus the trend is increasing.

- two blast logs dated 11/18/20 and 12/9/20, each absent the blasting seismograph record at the Embassy Suites for verification of the event based on the waveform appearance and vibration frequency components. Conformance to the blasting level chart and airblast limits in the permit conditions is unverifiable. The blasts occurred at the -40 feet level with the largest being 1154 pounds per delay and 384 pounds per hole. These will be the basis for the evaluation of adverse effects.

- a DynoNobel regression analysis that is meant to describe the propagating (geologic and atmospheric) characteristics of ground vibrations and airblast for the style of blasting at this site. 16 blasts, with no dates or charge weight per delay, were seismically and acoustically recorded at 500 feet from the blast with unreported charge weights per delay. An acceptable/valid data set would include at least 30 data pairs (OSM Blasting Guidance Manual). The regression analysis graph only includes 14 data pairs. Additionally the regression is meant to define ground vibration propagation across a given geologic area. This analysis uses only measurements at 500 feet. A valid analysis would contain measurements in the near field (100 feet), far field (3000 ft), and numerous points in between. Another complicating factor is that all the blasts were likely to be below the 0 feet level and monitoring occurred within the pit excavation area and not outside the permit area. This is further substantiated by the low k- factor numbers of 33 and 70. Blasting deep in the pit causes less ground vibrations and airblast on original ground (370 feet Dunn residence) than in a disturbed area of the pit

at a distance of 500 feet. Lastly, the equations are significantly more liberal than that the current permit condition at 10B allows with a k-factor of 160.

Adverse Effects Analysis

The lack of blast log data makes evaluation of the application's statements difficult. Charge weight per delay data was provided for 2015 to 2019 that ranged for 80 to 478 lbs/delay. To evaluate the overall health of the Triangle Quarry blasting program, summary data should be compiled with a program like the OSMRE Blast Log Evaluation Program. Based on the existing permit conditions, seismic and acoustic data for all the mine's blasting should be available to complete a thorough analysis. This would do for past blasting practices and demonstrate the operator's ability to protect people and property when blasting distantly from each.

Moving into the Odd Fellows tract, blasting will encounter new materials other than the current stone. Overburden of an unknown character will need to be removed, possibly with blasting. Past blasting activities have also been needed for road construction at the permit boundary. If the current proposed permit boundary is approved, blasting could occur at 25 feet from the park boundary where people could be standing and about 175 feet from the Dunn residence. Based on a typical blast size as submitted in support of the noise study in 2020, the maximum charge weight per delay was 1154 lbs, with three holes detonating within an 8-millisecond window. Individual holes were loaded with 384 lbs of explosives. Since the WSC noise study considers these charge weights typical, ground vibration and airblast levels can be estimated at both the Umstead park boundary and the Dunn residence.

Ground Vibration Estimates

This adverse effect has the potential to cause structure damage above 0.5 in/s. However the ground vibration limit in the permit in terms of Peak Particle Velocity is 1.0 in/s without monitoring and is 0.75 in/s with monitoring at low frequencies (<11 Hz). Using the DynoNobel regression analysis equation at 600 feet and 1154 lbs/delay, the 1.0 in/s limit cannot be met at the Dunn residence with a high level of confidence.

@ 25 feet, $PPV = 70\ (25/1154^{1/2})^{-1.426} = 108$ in/s

@ 175 feet $PPV = 70\ (200/1154^{1/2})^{-1.426} = 6.76$ in/s

@ 300 feet $PPV = 70\ (300/1154^{1/2})^{-1.426} = 3.1$ in/s

@ 400 feet $PPV = 70\ (400/1154^{1/2})^{-1.426} = 2.04$ in/s

@ 500 feet $PPV = 70\ (500/1154^{1/2})^{-1.426} = 1.51$ in/s

@ 600 feet $PPV = 70\ (600/1154^{1/2})^{-1.426} = 1.17$ in/s

(ref. DynoNobel regression)

However, as blasting approaches the Dunn residence and park boundary, hole firing times will likely be adjusted to one hole per delay, in this case 384 lbs/delay (1154/3). Using the DynoNobel regression analysis equation with one hole per delay, which is in

the range of the 2015 to 2019 quarry data, shows that the 1.0 in/s limit will be barely met at 400 feet from the Dunn residence with a high level of confidence. A blast at 400 feet from the house would be about 300 feet from the property line.

@ 25 feet, PPV = 70 $(25/384^{1/2})^{-1.426}$ = 49 in/s

@ 175 feet PPV = 70 $(200/384^{1/2})^{-1.426}$ = 3.08 in/s

@ 300 feet PPV = 70 $(300/384^{1/2})^{-1.426}$ = 1.43 in/s

@ 400 feet PPV = 70 $(400/384^{1/2})^{-1.426}$ = 0.95 in/s

@ 500 feet PPV = 70 $(500/384^{1/2})^{-1.426}$ = 0.69 in/s

(ref. DynoNobel regression)

Airblast or Air Overpressure Estimates.

This adverse effect has the potential to damage property and hurt people. The human body can survive relatively high blast overpressure without experiencing barotrauma. A 5 psi blast overpressure will rupture eardrums in about 1% of subjects, and a 45 psi overpressure will cause eardrum rupture in about 99% of all subjects. The threshold for lung damage occurs at about 15 psi blast overpressure. (Glasstone and Dolan, 1977; TM 5-1300, 1990). Structures may be damaged at about 140 dB and the limit for this permit is 133 dB of air overpressure.

For a typical quarry blast with normal confinement and 384 lbs per hole, damage to a house would be possible at 400 feet and exceed the allowable limit of 133 dB at 800 feet. A blast at 400 feet from the house would be about 300 feet from the property line.

@ 25 feet, AB = 1.32 $(25/384^{1/3})^{-0.97}$ = 0.397 psi or 163 dB

@ 175 feet AB = 1.32 $(200/384^{1/3})^{-0.97}$ = 0.0601 psi or 146 dB

@ 300 feet AB = 1.32 $(300/384^{1/3})^{-0.97}$ = 0.0357 psi or 142 dB

@ 400 feet AB = 1.32 $(400/384^{1/3})^{-0.97}$ = 0.0270 psi or 139 dB

@ 500 feet AB = 1.32 $(500/384^{1/3})^{-0.97}$ = 0.0217 psi or 137 dB

@ 800 feet AB = 1.32 $(800/384^{1/3})^{-0.97}$ = 0.0138 psi or 133.5 dB

(ref: ISEE Blasters Handbook, Table 26.7, Quarry equation)

For a blast with a hole that blows out or is not stemmed or backfilled the energy released will be like an open air detonation. With a 384 lbs charge, injury to a person could happen at 300 feet at about 1 psi.

@ 25 feet, AB = 187 $(25/384^{1/3})^{-1.38}$ = 34 psi or 201 dB

@ 175 feet AB = 187 $(200/384^{1/3})^{-1.38}$ = 2.31 psi or 178 dB

@ 300 feet AB = 187 $(300/384^{1/3})^{-1.38}$ = 1.09 psi or 171 dB

@ 400 feet AB = 187 $(400/384^{1/3})^{-1.38}$ = 0.0739 psi or 168 dB

@ 500 feet AB = 187 $(500/384^{1/3})^{-1.38}$ = 0.543 psi or 165 dB

@ 800 feet AB = 187 $(800/384^{1/3})^{-1.38}$ = 0.284 psi or 160 dB

(ref: ISEE Blasters Handbook, Table 26.7, Open Air equation)

Flyrock

Flyrock is the most likely way to injure people either inside or outside the permit area. Fly rock is caused by loss of confinement by poor design, poor loading practices, or changing geology. The most dangerous part of the blast is in front of the free face, which is normally facing the interior of the permit when close to houses or permit boundaries. Rocks from the free face have been known to travel in excess of 2,000 feet. Flyrock leaving the top of the blast and traveling away from the free face may land near the permit boundary, as would be the case at the Dunn residence when blasting is nearby. The following chart estimates possible flyrock travel distance from the top of the blast. The horizontal axis is $s/W^{1/3}$, where s is stemming and W is the charge weight per hole. The bold lines represent rock type granite and the individual lines are hole diameter (d). The vertical axis is flyrock range. Using the blast log data of December 9, 2020 fly rock is estimated to possibly travel 600 feet.

S = 11 ft

W = 384 lbs

$s/W^{1/3} = 1.5$

Rock type = granite

Hole diameter = 5.75 inches (round up to 6)

Maximum Flyrock range = 600 feet

Additionally the amount of explosives used in this typical blast is likely to be excessive for the existing overburden or weathered limestone near the surface. Powder factor (PF) is a typical gauge for comparing the amount of explosives in one hole, in pounds, needed to break the in front of the hole rock, in cubic feet. This blast has a powder factor of:

PF = W / (B * S * H/ 27)

B = Burden

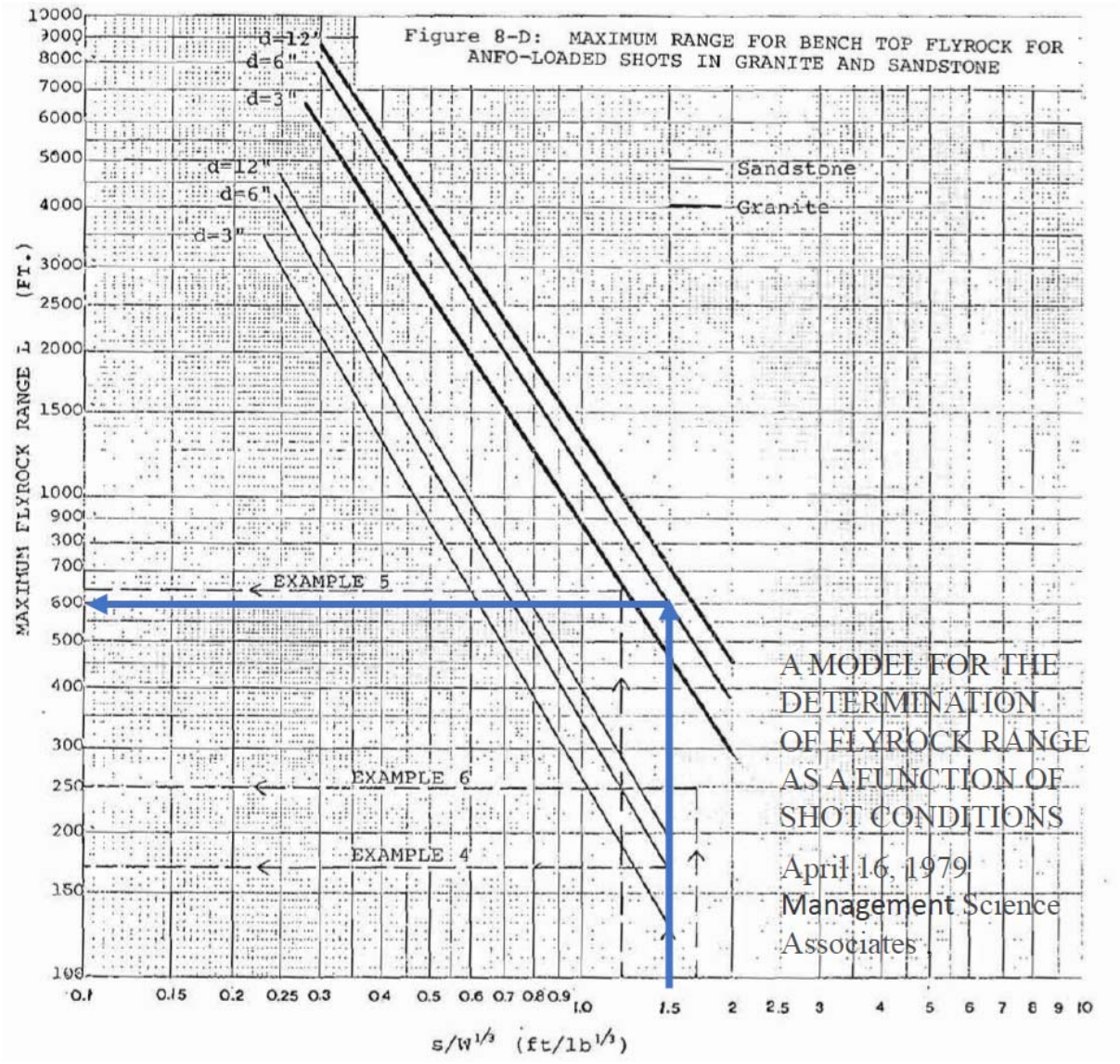
S = Spacing

H = Hole depth

PF = 384 (10 * 12 * 42 / 27)

PF = 2.1 lbs/yd^3

This powder factor of 2.1 lbs/yd^3 is twice as high as the common values specified in Table 29.3 of Dowding for blasting limestone. The chance of explosive energy confinement being lost is real and the chance of flyrock leaving the permit is elevated.



Conclusion

Question 11 of the WSC application to modify the Triangle quarry permit prompts the applicant to provide details about the blasting program that will minimize the adverse effects of blasting as required by the North Carolina law and rules. For an expanding quarry that has been in operation for over 30 years and based on the permit conditions to conduct ground vibration and airblast monitoring for each blast, and document the critical blast parameter of each blast as listed in condition 10E, a wealth of information should be available to demonstrate the quarry's ability to blast safely. Then as they move into an Odd Fellow Lot area to blast, which will much closer to structures and people, the adverse effects can be gauged with more confidence. Unfortunately, little of the quarry blasting data are provided in the application.

Based on the typical blast of December 9, 2020, as asserted by WSC, mining within 25 feet of the Umstead park boundary and within 175 feet of the Dunn residence could be dangerous to people and property. Of particular interest is the protection of people from air overpressures and flyrock. Both dangers come from the catastrophic loss of explosive confinement. Based on the analysis above flyrock is possible to 600 feet and elevated air over pressure is possible to 300 feet. Structure damage to the Dunn residence, which is 110 feet from the property line, is possible when blasting at a distance of 400 feet. A minimum of 300 feet undisturbed buffer zone at the property boundaries would be a prudent minimum for protecting the public hiking and living outside the permit area.

This recommendation is further affirmed as a safe buffer by the Surface Mining Control and Reclamation Act of 1977 that designates specific areas unsuitable for coal mining and is codified at 30 CFR 761.11, Areas where surface coal mining operations are prohibited or limited. This includes areas:

- near public parks where adverse effects are possible
- within 100 feet of the outside right-of-way of a public road
- within 300 feet of an occupied dwelling
- within 300 feet of a public building, school, church, community or institutional building, or a public park.
- within 100 feet of a cemetery.

These distances are meant to reduce the annoyance and danger to the public based on public testimony before Congress.

Based on the information available, the State reviewing agency has incomplete information in which to make a blasting impact assessment with respect to the current and future blasting impacts of Triangle Quarry and proposed new quarry on the Odd Fellows lot on north side of Crabtree Creek. Historical blasting data, as required by Permit Condition 10 E, should be summarized and a more precise blasting plan is needed to thoroughly evaluate the adverse effects impacts and ensure protection of the public and property outside the permit boundary. A historical blasting review for each blast at a minimum should include the blast location (gps coordinates), monitoring location, distance from the blast location to the monitoring location, depth of holes, amount of explosives used per hole, the amount of explosives per delay, the air overpressure and ground vibration levels as monitored and a copy of the blasting seismograph time history. A blast plan that addresses the anticipated blast designs based on the rock type of the Odd Fellows lot are also necessary to evaluate the quarry's ability to control the adverse effects.

A Blasting Impact Analysis at a minimum should estimate the potential for harm to people and damage to property from quarry blasting for the following:

- People standing at the park boundary
- Residents and animals of the Dunn property

- Traveling public on Old Reedy Creek road
- People using Crabtree Creek
- Cary's Water Reclamation plant
- Endangered species

References:

Dowding, C.H., Construction Vibrations, Prentice Hall, 1996.

Eltschlager, K.K., Regulatory Review of Blasting Related Citizen's Complaints, International Society of Explosives' Engineers' Annual Conference, 2001.

Rosenthal, M.F., Blasting Guidance Manual, Office of Surface Mining, 1987.

Stiehr, J.F., Blasters' Handbook, 18th Edition, International Society of Explosives Engineers, 2011.

Zipf, D.K., Explosions and Refuge Chambers, Center for Disease Control, www.cdc.gov › niosh › docket

CURRICULUM VITAE
Kenneth K. Eltschlager
Explosives and Blasting Consultant

Professional Experience

2004 - Present **Keystone Engineering Consultants, Inc., Venetia, PA**
Associate. A multi-disciplined forensic engineering investigation company providing technical services to attorneys, insurance companies, independent adjusters, restoration companies, contractors, municipalities, and individuals. Experience in the areas of blasting damage studies and investigations, review of blasting programs, evaluation of blasting logs, flyrock, air blast and ground vibration investigations, blasting seismographs, pre- and post blast surveys, structure damage claims, blasting fumes evaluations, conducting blaster certification training, and presentations at blasting seminars.

1985 - Present **Office of Surface Mining Reclamation and Enforcement (OSMRE), Appalachian Region, Pittsburgh, PA**
Explosives and Blasting Engineer / Mining Engineer. Administers the OSMRE Blaster Certificate program and coordinates Federal actions on all blasting related issues at surface coal mining operations nationally. Provides technical services to state personnel in the areas of blasting and explosives, conducts special studies and investigations of blasting damage complaints, conducts reviews of state blasting programs, assists state personnel with blast damage investigations, conducts seminars on blasting compliance for Federal and state personnel, regularly presents technical topics at conferences of the International Society of Explosives and at meetings with state blasting professionals, conducts blaster certification training and continuing education training, developed the Blast Log Evaluation Program for evaluation of the accuracy of blast logs and gauging the adverse effects of blasting, conducts special studies on vibrations and flyrock, and provides advise on blasting issues to other governmental agencies such as the Mine Safety and Health Administration; National Institution of Occupational Safety and Health; Bureau of Alcohol, Tobacco, Firearms and Explosives, US Park Service, US Forest Service, US Bureau of Land management, and the Arms Control and Disarmament Agency. Other responsibilities include:

- Administers the OSMRE Blasting WebPages at https://www.osmre.gov/resources/blasting.shtm
- Develop and instruct OSMRE National Technical Training Program (NTTP) classes entitled:
  "Blasting and Inspection"
  "Advanced Blasting: Investigation and Analysis of Adverse Effects"

"Coal Field Communications: How to Get It Right"
"Mine Gas Safety and Investigation"
"Instructor Training Course"

- Conduct investigations on mine and blasting related gases (methane, oxides of nitrogen, carbon monoxide, and carbon dioxide).
- Use and support of the OSM Technical Innovation and Professional Services (TIPS) software for the analysis of data and generation of graphics to resolve complex technical issues.
- Develop and instruct TIPS classes entitled:
  "Blast Log Evaluation Program"
  "Introduction to GPS with the Garmin eTrex Vista HCx"
  "Blast Induced Vibration Data Evaluation Program"
- Conduct investigations on mine subsidence complaints.
- Evaluate the performance of experimental practices in mining.
- Estimate coal production for Fee Compliance (coal tax) auditors.
- Determine the eligibility of abandoned mine land (AML) sites for emergency funding in areas of mine gases and subsidence.
- Review coal mine permit applications on Federal lands.

1983 - 1985 **Maryland Bureau of Mines**

Energy Resources Officer. Responsibilities included:

- Developed a format for and prepared Cumulative Hydrologic Impact Assessments (CHIA) for coal mines.
- Supervised abandoned mine lands (AML) reclamation projects, including realty acquisition, grant application, environmental assessment, project design, and construction inspection.
- Responded to citizen complaints on hydrology and subsidence.
- Reviewed the engineering aspects of surface coal mine permits.

1981 -1985 **SRW Associates, Inc., Pittsburgh, PA**

Mining Engineer. Responsibilities included:

- Gathered geotechnical data and designed coal refuse disposal areas.
- Conducted hydrologic investigations under the Small Operators Assistance Program (SOAP).
- Prepared applications for surface and underground coal mine permits in Kentucky, Pennsylvania, and Virginia.

1980 – 1981 **Mountain State Surveying, Kingwood, WV**

Mining Engineer. Responsibilities included:

- Prepared applications for surface and underground coal mine permits in West Virginia.
- Responsible for developing underground mine plan projections and updating maps to document progress.

Education B.S. Engineering of Mines - West Virginia University 1979

Professional Affiliations

International Society of Explosives Engineers (ISEE)
- Standards Committee, Chair, 2006 to present
- Board of Directors - 2002 to 2007
- Blast Vibration and Seismograph Section Chair 2002 - 2007
- Public Education and Public Relations Committee, Chair, 2005-2007

National Fire Protection Association (NFPA)
- Technical Committee on Explosives, NFPA 495 and 498

Society for Mining, Metallurgy, and Exploration (SME)

Publications

"Blast Vibration Measurements at Far Distances and Design Influences on Ground Vibrations", Steven V. Crum, David E. Siskind, and Kenneth K. Eltschlager, International Society of Explosives Engineers 18th Annual Conference on Explosives and Blasting Technique, 1992.

"Blast Design Effects on Ground Vibrations in McCutchanville and Daylight, Indiana from Blasting at the AMAX Ayrshire Mine", Kenneth K. Eltschlager and Peter R. Michael, Part III of Investigation of Damage to Structures in the McCutchanville-Daylight Area of Southwestern Indiana, Office of Surface Mining Reclamation and Enforcement, 1994.

"ISEE Seismograph Performance Specifications & General Guidelines for Field Use", Richard R. Brochu and Kenneth K. Eltschlager, International Society of Explosives Engineers 25th Annual Conference on Explosives and Blasting Technique, 1999.

"Current Technologies to resolve Blasting Related Citizen Complaints", Kenneth K. Eltschlager, American Society for Surface Mining and Reclamation 17th Annual Meeting, 2000.

"Carbon Monoxide Poisoning at a Surface Coal Mine… A Case Study", Kenneth K. Eltschlager, William Shuss and Thomas E. Kovalchuk, International Society of Explosives Engineers 27th Annual Conference on Explosives and Blasting Technique, 2001.

"Technical Measures for the Investigation and Mitigation of Fugitive Methane Hazards in Areas of Coal Mining", Kenneth K. Eltschlager, Jay W. Hawkins, William C. Ehler, Fred Baldassare, Office of Surface Mining Reclamation and Enforcement, 2001, pp125.

"Regulatory Review of Blasting Related Citizen Complaints", Kenneth K. Eltschlager, International Society of Explosives Engineers 27th Annual Conference on Explosives and Blasting Technique, 2001.

"Blast Vibration and Seismograph Section – 2002", Kenneth K. Eltschlager, International Society of Explosives Engineers 29th Annual Conference on Explosives and Blasting Technique, 2003.

"Fugitive Carbon Based Gases, Blasting Related or Not", Kenneth Eltschlager, Marcia Harris, Fred Baldassare, International Society of Explosives Engineers 30th Annual Conference on Explosives and Blasting Technique, 2004

"Microphone Height Effects on Blast-Induced Air Overpressure Measurements", Kenneth Eltschlager, Randall Wheeler, International Society of Explosives Engineers 31st Annual Conference on Explosives and Blasting Technique, 2005

"Acoustic Response of Structures to Blasting Analyzed Against Comfort Levels or Residents Near Surface Coal Operations", Dr. Braden Lusk, Jhon Silva, Ken Eltschlager, Josh Hoffman, OSM Cooperative Agreement S07AR12481, 2008

"Federal Blaster Certificate Program", Kenneth Eltschlager, International Society of Explosives Engineers 36th Annual Conference on Explosives and Blasting Technique, 2010

"A Public Relations Plan Based on Structure Generated Sounds and Public Input", B.T. Lusk, J. Silva-Castro, L.M. Hoffman, K. Eltschlager, The Journal of Explosives Engineering, January/February 2011

"ISEE Blasters' Handbook" Chapter 26 Vibration, Chapter 27 Record Keeping and Chapter 31 Blast Planning, Jon Stiehr Editor, International Society of Explosives Engineers, 2011

"Blasting Seismograph Comparison in Side-by-Side Blast Monitoring Tests", E. Sheehan, M. Mann, K. Eltschlager, J. Ratcliff. International Society of Explosives Engineers, 41st Annual Conference on Explosives and Blasting Technique, 2015

OSMRE Contracting Officers Technical Representative

Served as the technical expert for the Federal government on the following projects:

“Racking Response of Large Structures from Airblast, A Case Study”, D. E. Siskind, S.V. Crum and W. Pierce, US Bureau of Mines, December, 1992.

“Assessment of Low-frequency blast Vibrations and Potential Impacts on Structures”, W.E. Pierce, S.V. Crum and D.E. Siskind, US Bureau of Mines, January 1996.

“House Response from Blast-Induced Low Frequency Ground Vibrations and Inspections for Related Interior Cracking”, S.V. Crum, S-Wave GeoTech, July 14, 1997.

“Comparative Study of Structure Response to Coal Mine Blasting”, C. T, Aimone-Martin, M. A. Martell, L. M. McKenna, D. E. Siskind, C. H. Dowding, Aimone-Martin Associates, February 2003.

"Acoustic Response of Structures to Blasting Analyzed Against Comfort Levels or Residents Near Surface Coal Operations", Dr. Braden Lusk, University of Kentucky, OSM Cooperative Agreement S07AR12481, 2006

"Field Testing and Analysis of Blasts Utilizing Short Delays with Electronic Detonators" Dr. Braden Lusk, University of Kentucky, OSM Cooperative Agreement S09AP15632, 2010.