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Compliance

1. ADA Compliance: Preparing an Alternative Site Analysis for the Paradise Rail Station
   Marc Radell - URS Corporation

This project, sponsored by the Red Rose Transit Authority (RRTA), entailed analyzing the need and assessing site alternatives for a new un-staffed rail station in eastern Lancaster County, PA on Amtrak’s existing Keystone Corridor, New York to Harrisburg Line. A 24-mile service gap currently exists on the line. The proposed station will provide easier access for the general community of eastern Lancaster County to the Keystone Corridor, provide additional means of inter-city transportation for members of the local Plain Sect community, help improve regional air quality, and help reduce congestion on area roads.

Previous assessments of two alternative station sites within Paradise Township did not fully address the requirements of the Americans with Disability Act of 1990 (ADA), including the US Department of Transportation (DOT) and US Department of Justice’s ADA Accessibility Guidelines. DOT Disability Law Guidance provides that the norm for new commuter and intercity rail stations is a platform running the full length of the passenger boarding area of the station that permits level boarding to all accessible cars of trains stopping at the station. In cases such as the proposed Paradise Station, where there are concerns about accommodating freight trains, the guidance directs rail operators to employ solutions that accommodate full-length, high-level platforms, such as gauntlet or bypass tracks, unless doing so is technically or operationally infeasible.

The Alternative Site Analysis for the Paradise Rail Station analyzed the No Action alternative and five build alternatives for the ability to meet the project purpose and need, engineering feasibility, environmental and right-of-way impacts, compliance with the ADA, and estimated cost. The preferred alternative complied fully with ADA requirements and was presented to the public for comment. The Alternative Site Analysis, completed in December 2007, served primarily as a screening mechanism and assumed that detailed studies and environmental clearance documents would be later prepared, if necessary, for compliance with the National Environmental Policy Act and other applicable requirements.

2. Analysis and Comparison of Coal Transportation Costs for FutureGen Sites
   Ronald Swager and Chris Burger - Patrick Engineering, Inc.

In the competition between Illinois and Texas for the site of the proposed FutureGen coal fueled power plant, each site sought ways to distinguish itself technically and financially from its competitors. One aspect considered was the cost to supply coal from three different coal-producing regions to this proposed research and demonstration facility. This paper discusses the evaluation tool created by Patrick Engineering Inc. (Patrick) for the State of Illinois to analyze the economic and environmental costs to transport the required coal by rail.

Patrick compared the estimated costs to provide coal to the Tuscola and Mattoon FutureGen sites in Illinois and to the Texas sites at Jewett and Odessa from the Powder River Basin in Wyoming, the Illinois Basin mines, and the Northern Appalachian coal mines. The analysis takes into account spot market prices for coal and rail transport, the rail shipping distances from each mine site to each potential power plant site, the round-trip travel time by rail and the BTU content of each coal type. Calculations were conducted assuming either a constant consumption of coal by the FutureGen facility on a tonnage basis, or alternatively, on a constant energy input per day.

Since the major goal of the FutureGen project is to demonstrate carbon capture and sequestration, and near-zero emissions, the analysis tool also calculated CO2 emissions from the rail transport operations.

In the end, significant differences were found in both dollar and CO2 emission costs between the Illinois and Texas sites.

3. Benefits of Early and Ongoing Environmental Coordination in Linear Railroad Construction Projects in the Southeast
   Sara Moore and Evan Clark - ARCADIS
   Matt Adkins - CSX Transportation

By incorporating communication with environmental professionals at the initial stages of linear project planning and development followed by continued involvement until completion, CSXT improves design quality, construction efficiency, and timelines for project completion while reducing project interruptions and environmental impacts. CSXT demonstrates the importance of focusing attention on environmental compliance as a pivotal component of the design and construction of linear projects. The willingness of CSXT to adapt projects to comply with regulatory requirements and guidance results in the predictability of permit authorizations and minimal regulatory delays.
In the initial planning stage, ecologists and design engineers analyze corridor location alternatives while considering railroad requirements, jurisdictional wetlands and waters resources, sensitive federal- and state-protected species and their potential habitats, and other resources that could affect the project’s environmental permitting. Ecologists begin early coordination with regulatory agencies to address resource concerns and minimize the time needed to achieve permit authorization. Project ecologists and design engineers collaborate to reduce impacts to sensitive natural and cultural resources through shifts in corridor alignments and design and construction innovations to remain within standard thresholds for Section 404 Clean Water Act authorization.

Ecologists, civil engineers, and design engineers encourage construction contractor permit compliance throughout project development by adding environmental details and instructions into the construction design and erosion and sediment control plans. Therefore, prior to the start of construction, the permitted impacts and requirements are provided to contractors. Throughout the construction process, ecologists and civil engineers schedule routine inspections for compliance with the project’s environmental permits and report areas that require immediate maintenance to avoid regulatory violations, fines, or stop work orders. Regular construction monitoring enables CSXT to remain in compliance with federal and state environmental permits and reduce related project delays.

4. Compliance Solutions for a Small Railroad

*Paula Bond, Erica Geasler, and Kim Vaughn - AMEC Earth & Environmental, Inc.*

Maintaining environmental compliance for rail transportation facilities is a complex and difficult task. For smaller railroads with limited environmental resources, environmental compliance can be overwhelming, leading to regulatory notice of violations and potential fines. The difficulty lies in having facility personnel who do not have compliance or environmental backgrounds becoming familiar with numerous Federal, State, and local regulations. To address these issues, a systematic approach to achieving environmental compliance has been developed to bring a small rail facility into compliance and train the individual site personnel on the pitfalls of environmental compliance. Through this program training modules for environmental compliance were developed and administered to site personnel followed by the development of comprehensive environmental compliance checklists, monthly facility compliance inspections, and documentation to identify and track potential compliance issues. Through the developed environmental compliance program, facilities with existing compliance issues have been brought to the attention of the appropriate decision makers for corrective action which has resulted in regulatory and internal audits identifying fewer compliance violations. This approach has enabled facility personnel to work hand in hand with the governing regulatory agencies to quickly and efficiently resolve environmental compliance issues, extend the ownership of environmental compliance to the individual facility personnel, and prevent nonconformances from occurring.

**Energy, Emissions, and Air Quality**

5. A Summary of Applicable Requirements Under NSPS Subparts III and JJJJ to Owners and Operators of Stationary Engines

*Jaime Bretzmann, Jessica Coleman, and Jeff Stovall - Trinity Consultants*

The United States Environmental Protection Agency (U.S. EPA) recently promulgated two New Source Performance Standards (NSPS) that impact many railroad facilities. On July 11, 2006, the U.S. EPA published NSPS Subpart III – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines in the Federal Register. On January 18, 2008, the U.S. EPA published NSPS Subpart JJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines in the Federal Register. This poster presentation will provide a summary of the requirements of each NSPS that may apply to stationary diesel, gasoline, LPG, and natural gas fired engines commonly found at railroad facilities. Examples include engines powering generators, compressors, pumps, and welders. The requirements under each NSPS that affect engine manufacturers will not be considered, except to the extent that they affect owners and operators of stationary engines.

6. The EPA SmartWay Program at CSX

*Richard Nath - CSX Transportation
Ken Richardson - ARCADIS*

In 2007, CSX Transportation (CSXT) received the U.S. Environmental Protection Agency (EPA) SmartWay Excellence Award, which recognizes freight carriers that have made significant contributions to protecting the environment. CSXT is one of 34 companies – and the only railroad – among the SmartWay Transport Partnership’s 600-plus members to receive this distinction.

In recent years, CSXT has conserved 30 million gallons of fuel, improved fuel efficiency and invested more than $1 billion to upgrade its fleet with new locomotives that reduce fuel consumption and air pollutant emissions. CSXT has also pursued an aggressive voluntary 80% manual shutdown policy during idling, a program which conserves fuel and reduces emissions.
SmartWay was introduced in 2004 by EPA and a select group of fifteen shipping and business leaders, including CSXT. The program is an innovative, market-based partnership to reduce fuel use, greenhouse gas emissions, and air pollutants from the freight transportation sector. Together, based on their three-year commitments, these companies have conserved more than 600 million gallons of diesel fuel per year, saving the transport industry nearly $2 billion in annual fuel costs and eliminating nearly 7 million metric tons of carbon dioxide emissions.

This presentation describes the elements of the EPA SmartWay Program, CSXT participation, and the methods used to calculate and track these CSXT accomplishments.


The Diesel-electric locomotive is a machine which requires a high priced refined fuel, which is combusted in a manner causing excessive pollution which has been proven to cause cancer and other severe health problems. The oil when spilled is extremely toxic and kills everything it touches. The internal combustion engines require substantial amounts of heat to be dissipated into the atmosphere, which contributes to “global warming”.

The Steam-electric locomotive utilizes solid fuels which require little or no use of petroleum-based fuels in their production, and only minimal amounts of petroleum-based fuels for handling and transportation. The steam-expander engines do not emit heat to the atmosphere because they are completely jacketed with insulation. The steam-electric locomotive’s steam generating system is also completely insulated to prevent heat loss and to minimize fuel consumption. These steam generating systems are equipped with oxygen-enhanced combustion systems and electronic scrubbers to ensure complete fuel combustion and capture and control of any unburned particulates. Ashes remaining after fuel combustion are not hazardous and can be safely recycled or disposed of in landfills without environmental problems.

The steam-electric locomotive’s oxygen-enhanced combustion system also includes technologies which reduce “greenhouse gases.” In one system, a combustible gas mixture replaces the normal “secondary air” over the grates. Ordinary air is composed of about 20% oxygen and about 79% nitrogen. The oxygen is required for the combustion of the fuel, but the nitrogen does not burn and only remains to cause NOx. The use of the combustible gas mixture in lieu of “secondary air” increases the amount of oxygen, decreases the amount of nitrogen, and adds the element of hydrogen which in itself is a fuel and decreases the amount of solid fuel; required to generate the steam for propulsion.

The steam-electric locomotive can also be equipped with a separate system to produce liquid fuel from carbon dioxide. This liquid “octane” fuel is the sprayed over the solid fuel as it enters the locomotive firebox. This eliminates the carbon dioxide emission problem, creates a tertiary fuel which again reduces the amount of solid fuel need to generate steam, and also creates water as a byproduct which can again be used on the locomotive.

The use of readily available solid fuels creates fewer and less severe atmospheric emission, and causes no hazard to wildlife or humans when they come in contact. In every aspect, the modern steam-electric locomotive is less expensive to operate, less expensive to fuel, and less damaging to the earth and its inhabitants.

8. Strategies for Air Monitoring During Remediation of a Superfund Site: Performance and Cost Comparisons to Standard USEPA Methods
   Alan Nye and Brett Tarkington - CTEH
   Paul Kuhlmeier and Chester Culley - Kansas City Southern Railway

To protect the health of surrounding communities, USEPA sometimes requires air monitoring of the perimeter of a site undergoing remediation. USEPA methods for sampling particulate and metals in air require the use of high volume air samplers (HVS) in compliance with National Ambient Air Quality Standards (NAAQS). At undeveloped sites, HVS may be inconvenient due to AC power needs. Also, the more visible HVS may also tempt vandals to tamper with the samplers. HVS rent for $700 to $1100 per month. Sampling media, analytical costs, maintenance, and the need for AC power contribute significantly to the overall costs of the HVS. In contrast to the HVS, low volume air samplers (LVS) have lower power requirements and can be powered by rechargeable and replaceable lithium batteries. Although the sampling rate of the LVS is approximately 100 times lower than the HVS, sufficient sample is obtained from LVS to provide adequate protection of community health. Rental costs for LVS are much lower than that of the HVS. CTEH and KCS will present the results of air monitoring for antimony, lead, and particulate using the LVS, which will be contrasted with those obtained from a HVS colocated with the LVS. This side-by-side evaluation will allow the costs, effort, and sampling performance of the LVS and HVS methods to be compared.
9. N-ViroMotive™ Ultra Low Emitting Locomotives  
James Wurtz - National Railway Equipment Company  
William Hawkins - VP Engineering

National Railway Equipment Company, headquartered in Mt. Vernon, IL has developed the first GenSet locomotive, which has dramatic fuel savings and reduced emissions. Below is a summary of the capabilities of NREC's new N-ViroMotive™ locomotives.

1. Proven Product – Over a six year period of market analysis, engineering design, development and testing, NREC’s N-ViroMotive product has garnered critical Class I, Short line and Industrial railroad acceptance as a high adhesion, low fuel consumption, ultra low emitting locomotive (ULEL).

2. Modular Design- The N-ViroMotive ULEL design facilitates minimal production assembly time and maximum maintenance efficiency.

3. EPA Certified and CARB Recognized-The N-ViroMotive locomotives are EPA certified to switching and line haul duty cycles at 3.0 gphp/hour of NOx. The units meet and exceed all current EPA railroad emission standards for locomotives (Tier II). In addition, these locomotives are recognized by the Air Resources Board of California (CARB) as Ultra Low Emitting Locomotives (ULEL). Due to the design's inherently low levels of nitrous oxides (NOx) and particulate matter (PM) emissions, the N-ViroMotive is well established within the railway industry as a rugged, reliable and environmentally friendly four axle and six axle locomotive product. It is a high profile and preferred product for local, state and federal grant funding geared to the economics of cost per ton of NOx and PM reduced compared to conventional single engine locomotive products.

4. Fuel Reductions and Savings- End users can expect fuel savings of forty to sixty five percent (dependent on the specific locomotive application duty cycle) and at least an 80% reduction in emissions of nitrous oxide compounds and particulate matter.

5. Enhanced Tractive Effort- An anti-wheel slip and traction control system has exceeded original engineering projections for adhesion percent capability in actual field tests conducted in Illinois and California.

6. New FRA S-5506 Fuel Tank-This FRA compliant fuel tank is specifically designed and fabricated to eliminate diesel fuel leakage and spillage in the event of a locomotive derailment, wreck damage or rollover. The tank capacity is customized to meet varying locomotive switching and road haul requirements ranging from 400 gallons to 4,000 gallons in four axle and six axle applications.

7. Low Decibel Ratings- The N-ViroMotive products are remarkably quiet compared to traditional locomotives and can easily achieve the most stringent regulatory noise level requirements for off-road capital equipment.

8. Company Stability – Headquartered in Mt. Vernon, Illinois, National Railway Equipment Company is a U.S. owned and operated business established in 1984. It is a leading locomotive designer, developer and manufacturer of the industry’s first Ultra Low Emitting GenSet locomotives. It has a strong balance sheet with a rich history of reinvestment in research, product development, facilities and equipment inventories for the locomotive markets worldwide. NREC has locomotive, diesel engine, electronic controls and related mechanical and electrical parts manufacturing facilities in fourteen locations throughout the United States and Canada.

10. Net Air Quality Benefit GHG Reductions as a Result of North Coast Railroad Authority Rail Operations  
Maya Rohr - Kleinfelder

As part of resuming freight operations of the historic North Coast Railroad Authority (NCRA), Kleinfelder evaluated the potential air emissions associated with the project. The evaluation was conducted to meet environmental documentation requirements of an Environmental Consent Decree issued by the State of California’s Justice Department, and the California Environmental Quality Act. The project was particularly challenging due to conflicts between the Surface Transportation Board ICCTA exemptions and the Justice Department’s requirements, combined with the need to maintain operational flexibility for the railroad operator while addressing the environmental concerns of four counties, eight incorporated local jurisdictions, and over eleven regulatory agencies.

The NCRA line runs 142 miles through the Napa wine country and Russian River Valley of Northern California, passing through three separate California air quality control districts – each with different air quality standards and impact thresholds. The evaluation quantified the criteria emissions, toxic emissions (Diesel Particulate Matter and Acrolein) and green house gases (GHG) associated with the maintenance and operation of the railroad.

To optimize operational flexibility, the emissions and impacts were evaluated using various types of locomotives (Tier 0 engines and multi-engine platforms meeting Tier III off-road standards), emissions factors, speeds, engine loads, power ratings, operating times, train length, travel distances, cargo type and weight, idling, switching, sidings, loading operations, maintenance/construction activities, and yard operations. Start up, current full operations and future full operations scenarios were evaluated as well as health risks associated with air toxics and CO hot spots created by motor vehicle idling at crossings. An additional analysis was conducted to evaluate the emissions that would be eliminated as a result of a reduction in freight-hauling trucks that will be replaced by the proposed freight trains. Various USEPA approved modeling tools were utilized in the assessment including ISCST3, CALINE3, Cal3QHC and EMFAC2007 (derived from MOBILE 6.2).
The quantified emissions associated with all aspects of the project were subtotaled for each air district to allow comparison to their individual significance criteria. The results showed that the operation of the NCRA railroad would not exceed regulatory thresholds in any of the three air districts. In fact, the operation of the railroad will result in a net air quality benefit and an annual reduction in green house gases by over 50,000 tons per year (equivalent to nearly 5,000 average homes).

Environmental Response

11. Impact on Groundwater of an Ethanol Release from a Tanker Derailment at South Hutchinson, KS
R.F. Spalding and John Landwehr - Pinnacle Engineering

Since the ethanol tanker derailment in August 2005 at South Hutchinson, KS, ethanol tanker derailments have occurred in Montana, Pennsylvania and Minnesota. Because railroad spurs from many of these rural ethanol plants are old and more plants are permitted for construction almost weekly, there is little doubt that derailments will occur. The potential dangers of these releases are fish kills, methane accumulations in the unsaturated zone, ethanol and BTEX contamination of groundwater and, in anaerobic environments, liberation of metals.

The 10-foot thick unsaturated zone at the South Hutchinson site is composed of layered very fine-textured sediments (Hc = 10^-8 – 5.0 x 10^-10 cm/sec). These tight sediments appear to have prohibited most movement to the water table. Several cores indicated high concentrations of ethanol compounds in the top layers and methane concentrations as high as 6% in soil air at 8 to 10 feet bsl. Although slimes were not observed, many cores had a disgusting odor similar to sewage. The soils are performing bioremediation of the spill and soil bacterial assemblages are presently being investigated and will be discussed. Only two of 8 monitored sites in close proximity to the release have indications of fuel loading in the shallow groundwater. High concentrations of dissolved organic carbon and methane, detectable levels of benzene and toluene, and low dissolved oxygen are present in these wells. Concentrations of the indicator compounds appear to have increased at one of these sites during the last quarter suggesting an increase in contaminant loading. The two sites are both located on the slope of the track berm and were dry at the time of the release. The other well locations are in areas where ditch water ponded. Dissolved methane (~50 µg/L) was present in one shallow well; however, there were no additional indicators. The high water content in the clayey soils along the ditch may have partially sealed the soils from deep infiltration, while the dry soils on the berm likely contained desiccation cracks allowing for preferential flow. Results to date indicate that contaminant loading to the groundwater is extremely limited in concentration and scope and that this release will not adversely impact water quality in the area.

Site Summary
- Ignition was avoided at all three sites
- Considerable amounts of ethanol were lost to volatilization
- Quick action avoided a fish kill at the Balaton site; however, hundreds of fish were killed at the S. Hutch release.
- Fuel released at the South Hutchinson and Balaton sites were partially remediated by removal of residual fuel and by soil excavation

October 2007 RREC – Pinnacle presented the following findings:

Environmental Impacts
- Ethanol was detected in the groundwater at all sites regardless of the soil texture.
- DO concentrations are depleted in the impacted shallow groundwater
- Ethanol is actively degraded under anaerobic conditions and methane is produced at all sites.
- As evidenced by methane in the shallow oxidizing groundwater, anaerobic degradation in the capillary fringe followed by methane diffusion into the underlying shallow groundwater likely occurs at Balaton and S.Hutch.

Additional Site Activity
- Additional monitoring wells
- Installation of vapor points
- Collection of vapor data
- Site Surveys
- GIS Mapping
- Methane Data and Mapping
- Additional Groundwater Sampling

Conclusions
- Methane has accumulated to explosive levels in the soils at these sites
- Methane accumulation appears to be insidiously slow and has taken several years at sites with tighter soils. This suggests initial toxicity to ethanol.
- Dissolved methane concentrations in some of monitoring wells and Geoprobe sites suggests super saturation.
- Benzene exceeding the MCL was present in the groundwater at all 3 sites.
12. Ecological Evaluation of Potash Spill in Lampasas, TX
Jennifer Hurley - BNSF Railway
A. Paulisz, K. Forster, and C. Neal - Conestoga-Rovers

On March 24, 2007, thirteen railcars derailed releasing an estimated 700 tons of muriate of potash (potash) to the surrounding right of way, adjacent property, and an intermittent stream (over an area of approximately 1.13 acres). The derailment occurred on BNSF main track at mile post (MP) 274.0 located in Lampasas, TX. The salvage and recovery consisted of the potash and affected soil and subsequent transportation off-site for disposal. The installation of an irrigation and a groundwater recovery system, further reduced the amount of potash on the ground. However, subsequent soil, surface water, and sediment sampling revealed elevated levels of chloride and potassium. Because the amount of recovered potash was unknown and the right-of-way contained an intermittent stream, it was uncertain whether the leftover residues of potash would continue to leach from underneath railroad ballast for an extended period of time and potentially affect ecological receptors. Therefore, a formal ecological evaluation as dictated by the Texas Risk Reduction Program (TRRP), was recommended. In the case of Lampasas, the site was deemed ineligible for ecological exclusion and expedited stream evaluation criteria (i.e., Tier 1; rapid exit strategies) and, therefore, a full scale assessment (i.e., Tier 2 Screening Level Ecological Risk Assessment) was required.

Although generally regarded as safe, a high concentration of potash components may exert adverse effects on terrestrial and aquatic life via osmotic stress. Thus, rather than focusing on individual analytes, the assessment focused on the overall potential of potash to disrupt the water balance in plants and animals. This presentation discusses the site conceptual model, regulatory discussions, exposure pathways, potentially affected receptors, and the magnitude of the residual risk as well as the associated remedial options.

Remediation

13. Organophilic Clay and Its Use in Railroad Environmental Remediation
James Olsta - CETCO

Organophilic clays have proven to be effective adsorbents for insoluble and partially insoluble compounds in groundwater, soil and sediment remediation. Organophilic clays are surface-modified clays. The production of organoclay replaces the surface cation of bentonite or hectorite clay with an organic molecule. Quaternary amines are the most commonly used organic compound. The resulting organoclay is organophilic and hydrophobic. Adsorption data between organoclay and various PAH compounds will be presented. Organoclay has a high sorption capacity for non-aqueous phase liquid (NAPL). Column data on NAPL sorption will also be presented.

Organoclay has been used in reactive mats and in permeable reactive barriers (PRBs). Reactive mats are geosynthetic rolls filled with reactive material. They have also been used to cap contaminated soils, to line interceptor trenches and for aqueous capping of contaminated sediments. The concept of PRBs has generated great interest in the field of groundwater remediation in the last few years. Organoclay, either alone or mixed with an inert material such as pea gravel, can be used in the PRB trench. Organoclay is compatible with certain biopolymers and breakers allowing biopolymer trench construction techniques.

Organoclay has been used for various types of railroad environmental remediation. In one project, organoclay reactive mat was used to control a diesel fuel spill along a rail line. In another project, organoclay was used to treat contaminated groundwater. The project aquifer, located below a former railroad tie treating facility, was contaminated by creosote. The contamination became a threat to the nearby sea water bay when free oil product and soluble organics appeared on the surface of the bay. An interim measure combining an organoclay PRB and reactive mat were effective in eliminating sheen. Based upon the initial success of the organoclay and further assessment of the plume, the final design plans are to extend the PRB and reactive mat.

Eric Cherry and Mark Klemmer - ARCADIS
Paul Kurzanski - CSX Transportation

Railroad yards are commonly located in industrial and commercial areas that have had a long history of activities, which may have contributed to soil or groundwater impacts. Fueling operations, maintenance activities, and cargo releases at railroad yards are potential sources of groundwater impacts at these facilities. Although associated groundwater impacts may be identified at a railroad yard, it should not always be assumed that this release has migrated to adjacent sites where similar chemicals are identified. In situations were third-party claims of soil or groundwater impacts are made, it is important to evaluate the overall chemical signature at various locations, and migration potential in order to determine the actual or most likely source of release.

The case study of Wyoming Yard presents an application of environmental forensic techniques to resolve a third-party claim. The assessment evaluated the distribution of mono-aromatics (e.g. benzene, toluene) polynuclear aromatic hydrocarbons
15. Metals Stabilization for Remediation of Soil and Paint

Angela Hassell - ReSolution Partners, LLC

Stabilization of metals in soil and paint can be an integral component of site remediation and management of maintenance waste. Stabilization technologies can be applied to minimize the costs of ex situ soil management and can be used on-site with in situ management and reuse of the treated soil. Stabilization technologies can also be applied to lead bearing paint on surfaces of structures and rolling stock to avoid generation of a hazardous waste during maintenance of rolling stock and structures such as bridges. This presentation will focus on technologies that chemically stabilize metals, reducing the leachability of the metals in a variety of settings. The presentation will begin with a discussion of the general approach to successful stabilization projects and then review the various methods that are available for the evaluation of stabilization performance, including: the Toxicity Characteristic Leaching Procedure (TCLP), the Synthetic Precipitation Leaching Procedure (SPLP), the Multiple Extraction Procedure (MEP), and site-specific leaching test variations. The stabilization chemistry of several common contaminants, including arsenic, lead, and other heavy metals will then be reviewed. The effect of key controlling parameters such as pH, oxidation-reduction potential, counter ions, and competing ions will be discussed. Stabilization reagents can be applied by a variety of methods to match site-specific needs. A number of application methods representing a range of approaches will be presented. The presentation will close with several case histories of metals stabilization projects for sites contaminated with arsenic, lead, and other heavy metals. Example metals sources affecting the railroad industry include: pesticides, coal, paint and blast media.

16. Evaluating the Feasibility of In Situ Thermal Treatment beneath an Active Railyard

Ralph Baker, Gorm Heron, John Bierschenk, and John LaChance
TerraTherm, Inc.
Andrew Jay Coleman - Electric Power Research Institute
Dan Patel - Southern Company Services
Robert Mitchell and Darahyl Dennis - Georgia Power Company

A treatability study is being conducted to evaluate in situ thermal remediation (ISTR) at a former manufactured gas plant (MGP) site in Georgia where coal tar residuals underlie an active railyard. The researchers for this collaborative study have developed a comprehensive testing regimen, including characterization, geotechnical analyses and benchtop thermal tests. Laser-Induced Fluorescence (LIF) and the Tar-specific Green Optical Scanning Tool (TarGOST®) were used during Phase I to determine the remaining vertical and horizontal extent of the coal tar-affected zone. The TarGOST HD® technology was used, in part to evaluate the presence of tar residuals within the soil’s higher permeability zones. Phase I included permeability testing, which allowed for recommendation for the most appropriate ISTR technique (e.g., thermal conduction heating versus steam-enhanced remediation). Geotechnical testing was used to evaluate soil property changes and to determine the risk of subsidence during heating. As such, the thermal treatability parameters of this study were evaluated to determine the most appropriate target temperatures, optimize energy use, help select the appropriate off-gas treatment equipment and the duration of treatment at the site.

17. Remediation in Skykomish Washington

Michael Byers - ENSR Corporation
Bruce Sheppard - BNSF Railway

Skykomish Washington is a town of 250 people situated on the west-facing slopes of the northern Cascade mountain range in northwest Washington State. The town was incorporated in 1909 and much of the early development of Skykomish was shaped by the railroad, regional resource-based industries (such as logging and mining) and the commercial needs of the residents. Skykomish was initially the site of a construction camp for the Great Northern railroad and was used during construction of the last major section of the northern route of the Great Northern Railroad from St. Paul Minnesota to the Pacific coast. Once the rail line was completed in 1893 the town then became the Cascade Division point and was the location for a variety of facilities for storage, maintenance, and repair of engines and track. The types of facilities needed in Skykomish changed as railroad technologies evolved, so fueling facilities changed from support for steam power, bunker-C fuel, diesel power and even electrical power which was used at times from Skykomish through the tunnel at Stevens Pass. Skykomish was a bustling town of 2,500 people in it’s hey day.

The industrial history of the town and the activity on the railyard resulted in below-ground petroleum hydrocarbon contamination that extends from the railyard below a about half of the town as the fuel product followed groundwater from the railyard to seep out in the North Fork of the Skykomish River. The first phase of cleanup occurred in 2006 and included (e.g. naphthalene, phenanthrene) and chlorinated solvents in soil and groundwater samples from the railroad yard and an adjacent property. Chemical profiling and statistical evaluation of the results indicated the presence of three distinctly different sources on the railroad yard, which are currently being remediated. The evaluation furthermore indicated that these sources were not related to the groundwater impacts identified in soil and groundwater on the adjacent site. The spatial evaluation of groundwater impacts at the railroad yard, in conjunction with migration pathways, further supported the conclusion that the Wyoming Yard is not the source of the off-site impacts. Thus, using a forensic approach that incorporates chemistry, statistics, and spatial dynamics is an important tool for determining potential liability for groundwater impacts on adjacent sites.
removing and replacing the main flood control levee in the town, moving five residential structures to facilitate removal of impacted soil below the structures, and removal and replacement of about 20,000 cubic yards of impacted river sediment from the Skykomish River. Remediation on the project is anticipated to continue through 2011 with different parts of town being affected in different years. Monitoring and maintenance activities will continue beyond the active remediation.

18. An Innovative Remedial Approach

Rob Wallace - Norfolk Southern
Rory Mullinex - Marshall Miller & Associates

Norfolk Southern Railway Company (NSRC) owns and operates a rail car switching facility in Mississippi that was built in the early 1900’s. A locomotive fueling facility (diesel fuel) was constructed around 1950, which included one above ground storage tank (AST) (50,000 gallons) with pumps and associated underground piping. The locomotive fueling rack is underlain by two concrete box culverts that convey storm water from the rail yard and vicinity via Shearer’s Branch. The mouth of the culvert is constructed of two, 10-foot diameter corrugated steel pipes. Track drains beneath the locomotive fueling rack convey collected spills and surface water to the oil-water separator (OWS). Treated water from the OWS discharges to the city sanitary sewer.

In consultation with The Mississippi Department of Environmental Quality (MDEQ) Office of Pollution Control (OPC), NSRC conducted an environmental investigation to characterize petroleum hydrocarbon impacts to soil and ground water at the site. MOPC placed the site under the MDEQ’s MOPC Uncontrolled Sites Section. During the investigation, light non-aqueous phase liquid (LNAPL) was noted on the water table in wells surrounding the fueling rack and flanking the culvert. LNAPL was also seeping through cracks and joints in the concrete culvert, resulting in minor impacts to Shearer’s Branch. Over the duration of the project MDEQ OPC informed NSRC that the site had been placed in the inactive roster due to lack of funding and staffing in the agency. Despite its inactive status, NSRC continued to remove LNAPL from wells using skimmers and maintained absorbent boom across the mouth of the culvert to collect any LNAPL seepage. NSRC performed quarterly monitoring and LNAPL removal events, plus annual ground water monitoring.

While the MDEQ did not require further active assessment and remediation, NSRC took the next remedial step and commissioned the design of a concrete headwall to capture and convey LNAPL to the OWS. A minimally-invasive and innovative solution was employed to capture LNAPL using the compromised (leaking) corrugated steel culverts as part of the solution. This was accomplished by lining the lower portion of the culverts with galvanized plating to create an interstitial fluid control levee in the town, moving five residential structures to facilitate removal of impacted soil below the structures, and removal and replacement of about 20,000 cubic yards of impacted river sediment from the Skykomish River. Remediation on the project is anticipated to continue through 2011 with different parts of town being affected in different years. Monitoring and maintenance activities will continue beyond the active remediation.

19. LNAPL Migration in Fine Grained Soils – A Case Study at an Active Rail Yard and Former Fueling Facility

Kevin Hauschildt - Norfolk Southern
Steven R. Schubring and Adrian Fure - ENSR Corporation

Historic operation of an overhead fueling station at an active Norfolk Southern Railway Company (NSRC) rail yard (Site) resulted in diesel fuel impacts to an underlying clayey-silt aquifer. Various stages of investigation and remediation were conducted at the Site over an approximate ten year period. The previously developed conceptual site model (CSM) and resultant remedial decisions were based on the classical representation of light nonaqueous phase liquid (LNAPL) releases as oil saturated lenses floating on top of the water table. The remedial technology implemented at the Site in the late 1990’s consisted of a passive collection trench designed to intercept LNAPL migrating on top of the water table surface. The effectiveness of this remedial approach was limited due to unique LNAPL migration in fine grained soils (FGS) at this Site.

Investigations conducted over an approximate two month period by ENSR in 2007 indicated that the LNAPL distribution at the Site was more consistent with recent advancements in the understanding of LNAPL migration in FGS, where LNAPL primarily migrates through a complex network of vertically oriented higher conductivity pathways (e.g. macropores) present in the fine grained matrix to depths below the water table surface. In this case, LNAPL is present up to 12 feet below the water table surface. The investigation consisted of Ultraviolet Optical Screening Tool (UVOST) borings (a laser induced fluorescence technology), conventional direct push soil borings, the collection of Shelby tubes for free product mobility (FPM) evaluation, and LNAPL baildown tests. Results from the UVOST investigation were imported into spatial analysis software to construct a three-dimensional (3-D) rendering of the LNAPL plume.

The investigation identified many of the typical signatures associated with LNAPL migration in FGS. The updated CSM for the Site indicates there is a small volume of mobile LNAPL (i.e. free product) that migrates through a complex network of higher conductivity pathways in the vicinity of four onsite monitoring wells. These monitoring wells slowly accumulate LNAPL over time due to LNAPL-containing macropores that intersect the well screens at depths below the water table. LNAPL entering the wells bubbles to the water surface in the casing, in a manner somewhat analogous to an oil-water
separat. Over the course of a few months (the duration between quarterly monitoring events) Site wells can accumulate significant, measurable thicknesses of LNAPL. Relating observed product thicknesses to an oil saturated lens floating on top of the water table has lead the State regulatory agency to grossly overestimate the aerial extent and amount of recoverable product present when in actuality, Site data indicate that there is only a small volume of recoverable product present within a highly heterogeneous macropore network. While negotiations are still on-going with the State, it is expected that the information developed from this comprehensive assessment will demonstrate the limited extent of mobile LNAPL and will support the implementation of targeted remedial alternatives which will hasten progress toward site closure and significantly reduce overall project costs. This presentation discusses the parameters, investigation and sample collection techniques, and analyses used to develop an accurate site-specific conceptual site model incorporating LNAPL migration in fine grained soils.

20. Risk-Based Characterization and Assessment of Extractable Petroleum Hydrocarbon Contamination Using Comprehensive Two-Dimensional Gas Chromatography with Dean’s-Switch Modulation

Robert Brown - Lancaster Laboratories
Stacy K. Seeley - Kettering University
Steven V. Bandurski and John V. Seeley - Oakland University
James D. McCurry - Agilent Technologies, Inc.

Approximately ten years have passed since the first generation of risk-based petroleum methods was developed and put into production in the environmental laboratory. However, the precise amounts of the several different solvents needed, in addition to variables affecting the fractionation media, often result in “breakthrough” of target compounds into the wrong fraction(s) and/or contamination of the final extract(s). Advances in gas chromatographic and flow control technologies can now be used to replace the tedious sample preparation techniques previously required to obtain the separate sample extracts (“fractions”) used for site characterization/assessment.

Soil/wastewater samples are extracted using methylene chloride. Extracts are dried with sodium sulfate, concentrated and treated with silica gel to remove polar, non-petroleum related compounds. The final extract is then analyzed using a two-dimensional gas chromatograph (2-D GC; GC x GC) designed to separate the aliphatic and aromatic species present in the extract using flame ionization detection (FID).

This new approach meets the original intent of the Massachusetts state and TPH Working Group methods to measure and quantify collective aliphatic and aromatic hydrocarbon concentrations, as well as target polynuclear aromatic hydrocarbons (PAHs).

21. Novel Remediation Method for Ballast Gravels Polluted by Oil and Heavy Metal

Youngmin Cho, Duck-Shin Park, Woo-Sung Jung, and Jae-Young Lee
Korea Railroad Research Institute

Railroad sites are frequently polluted by various pollutants, like diesel, grease, lubricant, and heavy metal. The soil pollution in railroad sites has become a big problem due to the reinforced government regulations combined with complaint of residents in Korea. The railroad company spends about 10 million dollars annually for the remediation of these sites. So far, soil vapor extraction and bioventing method, chemical oxidation method, and bioremediation method are mostly applied, and these methods were effective for remediating the polluted soil in those sites. However, as for the ballast gravels, these methods has shown very low treatment efficiency because the pollutants are strongly adsorbed on the surface of the ballast. In this study, we designed a new dry cleaning method for decontaminating the polluted ballast gravels. We applied a blasting technology, where used melamine resin is reused as the blasting media, for remediating the polluted ballast gravels. The blasting media are blasted on the polluted ballast gravels polluted by oil or heavy metal, and the pollutants on the surface are physically removed from the surface. We could remediate the polluted ballast gravels sampled from the railroad switches. More than 90% of the total petroleum hydrocarbon (TPH) and heavy metal could be removed from the surface in 30 seconds. Comparison of the treatment cost with other methods will be carried out for the practical application of this system.

22. Design, Construction, and Operation of a Mobile LNAPL Recovery System

Robert Singer, Evan Barnan, and Marie Dowd
AMEC Earth & Environmental, Inc.
Paul Kurzanski - CSX Transportation

CSX Transportation, Inc. (CSXT) retained long-term environmental liability of a Former Rail Yard following major redevelopment. An extensive light non-aqueous phase liquid (LNAPL) plume has been delineated across the Site. CSXT has been conducting LNAPL recovery activities at the former rail yard in Kentucky since 1993. Since 2002 LNAPL recovery efforts have consisted of extracting accumulated LNAPL from 61 wells at the Site on a monthly basis using a vacuum-extraction truck. Given extensive site access constraints, and the lack of power available across most to of the Site, CSXT contracted AMEC to design, construct and operate a mobile LNAPL skimming system that would not require an electrical power source, and would discretely, efficiently and cost-effectively remove LNAPL from existing wells, without interfering with Site activities.
AMEC designed and constructed a self-contained system that is housed in a 5’x 8’ cargo trailer that runs off a combination of solar power and nitrogen gas. The system is equipped with a 100 gallon double-walled collection tank, a skimmer pumping system, two nitrogen gas cylinders on a DOT-approved safety rack, and necessary safety/first aid appurtenances. The system is also equipped with a small air compressor for locations where electrical power is available. The unit can easily be moved around the site, and fits within a typical parking space at the site.

The system has effectively been removing LNAPL from multiple recovery wells at the site since January 2008. The ability to understand the optimal LNAPL recovery rates at various locations throughout the large site will be utilized to assist in the determination of a site-wide remedy. Further, the unit is readily transportable to be relocated to other similar sites when its use at the current site is complete.

**Risk Management**

23. Risk Management Techniques for Selling Rail Road Properties for Non-Industrial Uses

*Rick Adams and Jeff Bonsteel - ARCADIS*
*Raghu Chatrathi - CSX Transportation*

Many Class I rail roads have policies in place which discourage the sale of surplus properties for non-industrial use purposes. The reasoning behind this is the fear of potential long-term liability. However, there are cases where the long-term liabilities can be eliminated or managed which can make these transfers less risky. There are many benefits to completing these types of project such as greater financial returns, eliminating potential dumping sites, and public relations. There are several techniques which can be used to mitigate risks in these cases. Some techniques include: 1) complete assessment and remediation to at or below residential standards, 2) negotiating with the buyer to modify development plans, or 3) requiring the buyer to enter a state or federal program. We will discuss three case studies which illustrate some of these techniques. The first example is a large parcel of land located in Wilmington, NC and on the Cape Fear River. The parcel was never utilized for rail road purposes but had been the location for several illegal dumping events. The parcel was assessed and remediated to below residential standards then sold for a mixed use (including residential) purposes. The sale price was greater than straight commercial use and the potential dumping area was eliminated. was successful. The second site was a small parcel located in Fredericksburg, VA. The abutting church wanted to purchase the property in order to construct a school. Given the proposed use, CSX required a thorough assessment to be performed. Several metals were identified in subsurface soils which were above residential clean-up thresholds. The clean-up of the parcel to below residential thresholds would have been cost prohibitive. Instead of terminating the deal, CSX discussed the findings with the purchaser and suggested modifying their development plans. The church then proposed utilizing the property for additional parking with a small recreational component. CSX required the purchaser to enter the state Voluntary Clean-up program utilizing their development plans as a final cap. The state agreed with the plan and the sale was completed. The final example is a small parcel located in Tivoli, NY. Historically, area residents were trespassing on CSX property by crossing the tracks to bring boats and kayaks to the Hudson River. The Village of Tivoli approached CSX with a plan to develop the parcel into a boating area and park, including constructing a bridge over the tracks for pedestrian access. CSX performed an environmental assessment of the parcel and identified some compounds of concerns in the soils which were above applicable State standards. CSX worked with the City to modify their development plans to cover a greater portion of the impacts with the development and preparation of a Site Management Plan (SMP). Once the Village takes ownership of the property, they will work directly with the state on the SMP and future maintenance obligations. This project has had a public relations benefit for CSX and made the area safer.


*Phil Daum - Engineering Systems, Inc.*

While there are many existing environmental remediation issues which railroads are addressing, equally important is the prevention of additional spills. One source of environmental risk is the release of hazardous materials resulting from damage to a container during an accident.

The primary goal of the Next Generation Rail Tank Car (NGRTC) project in 2008 is to deliver a prototype chlorine tank car design that meets the following performance criteria:

- 5-10X improvement in a standardized impact test (measured as the amount of kinetic energy impacting the tank car, without release of contents caused by a breach of the commodity tank);
- Equal or better performance than the 105/600W for other significant head and side impact scenarios, as determined through validated modeling and analytical techniques; and
- No significant new failure modes due to the use of new materials or construction techniques.

The secondary objective for 2008 is to begin work with tank car builders and TIH shippers to effectively transfer non-proprietary knowledge and experience that has been gained through this project. It is the project team’s belief that this
“technology transfer” will help promote broad-based industry acceptance and support for the new proposed federal tank car standard for TIH materials, by providing a technically feasible, reliable, cost-effective solution (i.e. design concepts and technologies) that can be used by any builder to meet the standard.

This presentation is aimed at informing the railroad environmental community about the NGRTC Project, the technology being developed, the performance achieved as of late October 2008, and the potential for transferring the technology to cars carrying other commodities, including environmentally sensitive chemicals.

The Next Generation Rail Tank Car (NGRTC) project is sponsored by Dow Chemical Company, Union Pacific Railroad and Union Tank Car Company, in cooperation with the Federal Railroad Administration, Transport Canada and the Transportation Security Administration.

25. Community and Regulatory Acceptance of Practical Long-Term Derailment Mitigation, McCormick, South Carolina

Jeff Beckner and Elizabeth Rhine - ARCADIS
Matt Adkins - CSX Transportation

Residual hydrocarbons (ethylbenzene, toluene, and xylene) in soil and groundwater from a 1990 derailment in McCormick, SC have resulted in long-term environmental liabilities that present both technical and management challenges for CSX Transportation, Inc. (CSXT). Following initial removal actions and subsequent remedial approaches that yielded mediocre results, CSXT implemented a remedial strategy to address the technical challenges of reducing overall hydrocarbon mass, controlling exposure, and meeting regulatory requirements while addressing the management challenge of attaining landowner and community acceptance.

Based on site characteristics, current and future land use, and current and hypothetical receptors to residual hydrocarbons at the site, there is minimal risk to human health and the environment. The primary source at the site is adsorbed hydrocarbons in silty-clayey soils that are being slowly released as dissolved components into shallow groundwater. Observed hydrocarbon concentrations in groundwater exceeding regulatory limits are limited to the water table that is not utilized as a potable water source, and public water supply is available within a one mile radius. In addition, groundwater monitoring data show intrinsic biodegradation and low groundwater flow rates are providing natural migration control and reducing the volume and toxicity of hydrocarbons in groundwater.

Based on current land use and landowner interest, the identified final remedial action objectives were 1) control migration and reduce the toxicity and volume of hydrocarbons in groundwater, 2) control soil erosion, and 3) return site to pre-derailment land use as quickly as possible. Due to landowner/community input and ongoing natural attenuation processes, site restoration/monitored natural attenuation was the preferred alternative. The preferred alternative met full landowner approval and contingent state regulatory agency approval with the addition of hybrid poplar and black willow trees to enhance mitigation of hydrocarbon concentrations in soil and groundwater. The selected remedy was implemented in 2002-2003 and to date, has met state agency requirements and reclaimed property aesthetics to the landowners satisfaction.

26. Long Branch Stream Restoration; Greenville, SC

Matthew Adkins - CSX Transportation
Alan Pinnix and Ben Farr - ARCADIS

In the early 1990s CSX Transportation (CSXT) sold a tract of land to a grading contractor in Greenville, South Carolina. The contractor proceeded to fill approximately 6.7 acres of the property, later determined to be a wetland, with concrete and soil. The contractor later failed to complete the purchase of the property, which left CSXT with a filled wetland. Further complicating the situation was an adjacent manufactured gas plant (MGP) owned by a third party that was determined to have also impacted the site. Due to the MGP site, restoration of the original wetland was not an option. CSXT began an exhaustive search for a remedy that would offset the impacts to the wetland area. Due to the nature of the area surrounding Greenville, South Carolina, wetland properties that could be restored or enhanced were very scarce. Given this, CSXT took the project in a different direction. Working with the appropriate regulatory agencies, CSXT agreed to restore an impaired tributary to the Reedy River in lieu of restoring wetlands.

The project involved restoration of approximately 1,300 feet of Long Branch (Tributary to the Reedy River) back to its original meandering conditions. This branch had been channelized many years ago, which contributed to lower water quality in the Reedy River. Restoration would provide the tangible benefits of assisting with flood control and improvement of water quality.

Multiple regulatory agencies were involved in the project including the US Army Corps of Engineers, the US Fish and Wildlife Service, the SC Department of Health and Environmental Control, the SC Department of Land and Natural Resources and the County of Greenville, South Carolina. In addition, CSXT established a mutually beneficial relationship with a local non-profit dedicated to restoration and preservation of the Reedy River. The Friends of the Reedy River own several tracts of land adjacent to the Reedy River and associated tributaries, however lack the resources to perform extensive restoration activities. This restoration project will not only satisfy the regulatory requirements for CSXT, but will provide direct and lasting benefit to the citizens of Greenville, South Carolina. It is also likely that this project will serve to assist the Friends of the Reedy River in furthering their mission of advancing restoration and protection of other segments of the Reedy River.
Storm Water and Waste Water

27. Assessment of Potential Wetland Areas at Active Railyards located in Illinois, Indiana, Michigan, and Ohio

Paul Kurzanski - CSX Transportation  
Linda Diebolt, Michele Gurgas, Terri Rubis, Bruce Rust, and Adam Tokarski  
ARCADIS

The potential existence of wetlands created by improper drainage at active railyards necessitate detailed strategy development towards restoration of storm water conveyances. During site audits at railyards in Illinois, Indiana, Michigan, and Ohio, areas described as potential wetlands were observed. After reviewing utility maps, existing storm water sewers and/or ditches were noted in each area in which wetlands vegetation was present. Field observations determined that pooling water in these areas was the result of siltation, roots, and debris collecting within existing storm water conveyances.

Prior to initiating maintenance activities for removal of obstructions within the conveyances to restore proper storm water drainage, ARCADIS contacted local municipalities and was informed that it was the responsibility of the permittee to maintain the drainage points at their facility. ARCADIS also contacted the U.S. Army Corps of Engineers (ACOE) and provided summaries of the saturated areas to assist the ACOE in determining if Section 404 of the Clean Water Act or Section 10 the Rivers and Harbors Act permits would be required.

After reviewing the existing condition summaries and proposed drainage way restoration activities, the ACOE concluded that the proposed maintenance activities did not require permits. Maintenance activities associated with discharges linked with removal of accumulated sediments and debris in the vicinity of existing structures and reshaping of existing drainage ditches are allowable without a permit if the activities are below the ACOE notification threshold. All maintenance activities must adhere to applicable ACOE General Conditions and care must be taken to avoid mobilizing sediments within the wetland. Material cleared during the cleaning must not be placed in or allowed to migrate back to the suspected wetland. ARCADIS recommended proceeding with the proposed storm water sewer cleaning activities to restore proper site drainage to the railyards. As a result, a wetlands delineation and permit were not required and drainage has been restored to the original conditions.

Sustainability

28. Sustainability Strategies and Solutions for Railroads

Brian Symons and Shawn Grindstaff - The Forrester Group

Sustainability is the Environmental Business of the future. More descriptively, sustainability is balancing environmental, social, and economic considerations to generate business practices that can continue in the long-term without creating short-term liabilities that must be borne by future generations. Traditionally, railroads have focused on the environmental, safety, and risk management aspects related to sustainability. The focus of this presentation is to develop a clearer understanding of how the four principle sustainability factors: environmental, social, economic, and energy interrelate in the railroad industry. The desired outcome is to develop otherwise obscure insights for more effective environmental practices within railroad operations.

Environmental concerns discussed at Railroad Conferences have included ISO 14001/9000, air emissions control, emergency response, wastewater and storm water management, and site remediation. Safety issues are a social element of railroad sustainability, focused primarily on railroad workers and contractors, but also seeking to improve overall public safety on railroad property. Lastly, risk management and environmental business planning have become standard economic practices in the railroad industry.

With recent concerns about global climate change and rising fuel prices, energy has risen in importance as the fourth element of corporate sustainability programs. Energy relates directly to power for locomotive and other on- and off-road vehicle operations. However, energy also influences virtually every other key sustainability element in some way. As fuel prices go up, logistics staff will shift cargo and other hauling away from over the road trucks to rail. This is a larger societal benefit of moving more mass with less energy, but it will present more challenges for railroads to be environmentally sensitive.

Sustainability as it related to railroads will be discussed in three phases. First, existing practices related to sustainability will be reviewed. Second, more innovative practices will be presented with reference to national and international initiatives. Case histories from the United Kingdom and Japan will be described. Lastly, potential future, but innovative practices will be considered along with challenges for implementing these new opportunities. Important sustainability issues considered will include use of diesel, electric, biofuels, and other renewable energy sources, “green” infrastructure, recycling, and energy efficiency.

Sustainability measurement and reporting are also key elements of a sustainability program that have not been fully utilized by railroads in general. Methods of measuring sustainability including sustainability indicators and current practice for sustainability reporting will be introduced.