Manufactured Gas Plant Site Management - Program 50

Program Overview

Program Description

Most former manufactured gas plants (MGPs) ceased operation by the 1960s, but by-products and wastes, often disposed of in the plant’s vicinity, still remain with the potential to cause adverse environmental impacts. More than 1,500 MGP sites exist in the United States, and an equal or greater number are in Europe. Many still require either investigation or remediation, at estimated cleanup costs typically in the millions of dollars per site. The wastes include tars (containing polycyclic aromatic hydrocarbons [PAHs]), ammonia and cyanide wastes, and oils and petroleum compounds, all of which can contaminate groundwater, soils, and sediments in nearby water bodies. Also, there is the potential for degradation of ambient air during site remediation activities. Indoor air quality in the vicinity of these MGP sites may be affected by transport of volatile organic compounds (VOCs) through the soil and into the building. Site managers need credible data and information on alternative investigation and remediation techniques and appropriate site-specific cleanup criteria.

The Electric Power Research Institute’s (EPRI’s) MGP site management research includes projects that assess site investigation methods and cost-effective alternatives for containment or remediation of contaminated soil, sediment, and groundwater. Program research informs regulatory deliberations and helps companies develop and implement cost-effective, environmentally protective management strategies for MGP sites. The program also addresses indoor air quality issues resulting from soil vapor intrusion (SVI) into buildings situated near MGP sites.

Research Value

The management of legacy MGP sites is a high-cost and high-liability endeavor. EPRI’s MGP research on rapid and effective MGP site characterization; development and evaluation of technologies for remediation of contaminated soil, sediments, and groundwater; and realistic assessment of risk from coal tar/PAH toxicity has been invaluable to the MGP community, resulting in substantial cost savings to individual companies and the industry as a whole. Continuing research, especially related to the remediation of contaminated sediments, demonstrations of alternative remediation technologies, and assessment of SVI/indoor air quality issues, can result in significant cost savings for site management and remediation, as well as reducing the potential for added environmental and economic liabilities from these legacy sites.

Approach

The MGP site management program provides scientific data, methods, and tools for the efficient characterization, assessment, and remediation of former MGP sites. The program helps site owners improve control of emissions/odor issues, evaluates alternative methods for remediating and potentially redeveloping MGP sites, and monitors key health risk issues. This program delivers

- Unique collaborative workshops and industrywide symposia;
- More than 20 years of EPRI and peer-reviewed publications and documentation, and a large network of experts;
- Field studies assessing the viability of SVI investigation methods employing innovative techniques such as microbial genetic methods, forensic chemistry, moisture monitoring, and sorption sampling;
- Modeling techniques such as the Remedial Assessment Options Model (ROAM), used to evaluate MGP site operations and maintenance costs, and the Model for the Assessment and Remediation of Sediments (MARS), used for assessing impacted sediment issues;
- Methods for rapid screening of MGP sites, providing for more cost-effective and thorough site investigations; and
- Evaluations of site remediation alternatives, including thermal treatment, in situ chemical oxidation, and smoldering.
Accomplishments

This research advances the impacts of state-of-the-art investigation, assessment, and remediation of former MGP sites on soil, sediment, and groundwater. Modeling helps site managers evaluate cleanup alternatives, and the program responds quickly to emergent regulatory issues such as SVI and naphthalene risks. The program also assesses alternative site remediation measures, providing clear and issue-specific guidance to site managers on feasible options for meeting individual site requirements. Program accomplishments include:

- Successful demonstration of capping technology for sediments;
- Development of improved PAH analytical methods providing more scientifically sound measurements in soils and sediments;
- Guidance on MGP-impacted sediment assessment/remediation, including application of bioavailability concepts, monitored natural recovery, and sediment capping;
- Continuing evaluation of methods to assess the performance of MGP soils solidification and resources to determine the applicability, implementation, and assessment of soils solidification;
- Review of current vapor intrusion methods and implementation of a field-based research program; and
- Analysis of background indoor air results from vapor intrusion studies.

Current Year Activities

Program R&D for 2013 will focus on sediment characterization and remediation technology investigations, including assessment of the applicability of "green" remediation. Specific efforts will include:

- Completion of a database of sediment chemistry and toxicity data for improved assessment of PAH bioavailability in sediments;
- Potential demonstration of in situ stabilization and solidification remediation technology in sediments;
- Assessment of additional treatment via biodegradation of PAHs absorbed in sediment caps;
- Evaluation of advanced chemical oxidation technologies for site remediation;
- Continued risk assessment evaluations of naphthalene and other relevant PAHs, including examination of the Relative Potency Factor approach for determining the carcinogenicity of PAH mixtures and the Integrated Risk Information System (IRIS) reassessment of benzo(a)pyrene;
- Assessment of MGP site closure and redevelopment and of applicability of green remediation technologies;
- Participation in Interstate Technology Regulatory Council (ITRC) development of sediment remediation and petroleum vapor intrusion guidance;
- Assessment and management of air emissions from remediation of MGP sites; and
- Air monitoring methodology optimization for odor control during site remediation.

Estimated 2013 Program Funding

$.8M

Program Manager

Jeffrey Clock, 845-608-0642, jclock@epri.com
### Summary of Projects

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<tr>
<th>Project Number</th>
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<th>Description</th>
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<tbody>
<tr>
<td>P50.001</td>
<td>Sediment Remediation</td>
<td>This research project investigates MGP sediment sites with new methods to ensure effective and appropriate cleanups.</td>
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<tr>
<td>P50.002</td>
<td>Site Remediation Technologies</td>
<td>This research project provides information on the feasibility, effectiveness, regulatory acceptance, and costs associated with alternative MGP site remediation technologies.</td>
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<tr>
<td>P50.003</td>
<td>Risk Assessment Studies</td>
<td>This project evaluates research results and regulatory developments related to risk assessment of naphthalene, benzo(a)pyrene, and PAH mixtures.</td>
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<tr>
<td>P50.004</td>
<td>MGP Site Closure, Redevelopment, and Green Remediation</td>
<td>This project will identify and evaluate green remediation metrics and technologies that are appropriate for utility facilities.</td>
</tr>
<tr>
<td>P50.005</td>
<td>MGP Site Contaminant Characterization and Source Attribution</td>
<td>The research carried out in this project seeks to make site characterization and remedial assessments more effective and more acceptable to regulatory agencies.</td>
</tr>
<tr>
<td>P50.006</td>
<td>Air Monitoring and Soil Vapor Intrusion</td>
<td>Air monitoring and soil vapor intrusion studies will provide tools for utility managers to control potential hydrocarbon emissions from MGP sites during both remediation and subsequent use or development of the property.</td>
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### P50.001 Sediment Remediation (Q55284)

#### Key Research Question

Remediation of coal tar–contaminated sediments remains an expensive and technically difficult problem for MGP site managers. There is a need to explore alternative remediation strategies such as monitored natural attenuation and recovery. Issues related to cleanup-level requirements remain tied to the toxicity of benthic and other aquatic organisms. It has been suggested by some agencies that point-source discharges may contribute to a watershed’s condition; therefore, background PAH or isotope studies may be needed. In situ technologies such as solidification/stabilization require further testing to be considered as an alternative to dig-and-haul methods.

#### Approach

This project informs decision making by defining methods to delineate, evaluate, and remediate contaminated sediments. The work seeks to protect and restore aquatic environments. Millions of dollars of dredging costs may be avoided by using alternative means of capping or control. In 2013 and future years, research will consider assessment of in situ alternatives to dredging, including stabilization/solidification, capping, monitored natural recovery, and others. Evaluation of biodegradation in capping systems may also be conducted. Included in this work will be support for the development of technical guidance by the Sediment Remediation Team of the Interstate Technology and Regulatory Council.

#### Impact

- Advanced assessment techniques, such as bioavailability testing, assist member companies with determining the location of “hot spots” in sediments.
- Acceptance of alternative, in situ remediation measures in lieu of dredging can potentially save hundreds of thousands of dollars in remediation costs.
How to Apply Results

The results of this work will provide site managers with additional potential alternatives to dredging. Field pilot tests will be strongly considered. Results will be delivered to members in technical and peer-reviewed reports. Briefings and presentations to regulatory agencies and the public will be available.

2013 Products

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<tr>
<td><strong>Biodegradation in Capping Systems</strong>: Recent projects indicate that contaminant biodegradation may be occurring within capping materials. The potential for this activity will be further assessed and methods will be developed that can be deployed in future projects to measure the occurrence of this phenomenon.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<tr>
<td><strong>PAH Bioavailability Database</strong>: This project will compile a complete online database of sediment chemistry and toxicity data from a number of former MGP sites.</td>
<td>04/01/13</td>
<td>Software</td>
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Future Year Products

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<tr>
<td><strong>PAH Toxicity Endpoints</strong>: Using Narcosis models, this project will evaluate PAH toxicity to aquatic benthic organisms.</td>
<td>12/31/14</td>
<td>Technical Report</td>
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P50.002 Site Remediation Technologies (Q55810)

Key Research Question

Site managers are seeking remediation alternatives to dig-and-haul operations in places where there is limited ingress/egress or where buildings and roadways exist over a former MGP site. The use of in situ treatments such as chemical oxidation or solidification will be considered important technologies to investigate. Other in situ technologies, such as thermal treatment, containment wall, barrier, or aquifer modification technologies, may require further evaluation.

Approach

This work aims to reduce costs by providing information regarding performance data on remediation technologies. Research is aimed at saving companies millions of dollars where conventional dig-and-haul technologies cannot be applied. In 2012, a pilot test was conducted to evaluate the Surfactant-enhanced In Situ Chemical Oxidation (S-ISCO) technology. Other technologies that could be evaluated include chemical/biological methods using persulfate and peroxide, improved chemical delivery methods using vacuum or pulse wave technologies, alternative product recovery methods, and in situ self-sustaining smoldering treatment.

Impact

- EPRI has already identified several reactive barrier additives that can cost-effectively remove MGP-related compounds from groundwater, thus reducing long-term operation and management costs.
- Selecting the appropriate in situ chemical oxidant and its delivery method can save hundreds of thousands of dollars per site with correct application.
- EPRI has documented that one innovative application of a thermal desorption process for treatment of heavily impacted MGP soils may save more than $3 million for one utility.
How to Apply Results

The results of this work may be applied by site managers who want to determine whether an in situ technology can be used as an alternative remediation strategy. Briefings will be made to federal and state regulatory agencies as appropriate or needed. Development of technologies for remediating MGP wastes may take several years from bench-scale to field-scale pilot tests.

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<tr>
<td>Develop Website with Information on MGP Remediation Projects: This research will provide case histories of MGP remediation projects in the United States and internationally. Case histories could include completed as well as ongoing projects. Using a web-based database will facilitate updating of the case histories.</td>
<td>12/31/13</td>
<td>Software</td>
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<tr>
<td>Conduct Post-S-ISCO Tests Based on Lessons Learned from Pilot Demonstration: Additional work on the S-ISCO project conducted in 2012 is needed to evaluate the groundwater pathway, the use of tracers with the Tar-Specific Green Optical Screening Tool (TarGOST) to define vertical and lateral chemical dispersion, and other factors affecting performance.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<tr>
<td>Conduct Laboratory Study of Chemical/Biological Treatment of MGP Soils: Laboratory experiments will be conducted on MGP soils to evaluate the results that can be obtained using a combination of chemical and biological treatment. This technology could be useful for in situ mixing and treatment of residual contamination at MGP sites.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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Future Year Products

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<tr>
<td>Tracking Advances in Remediation Technologies at MGP Sites: This work will monitor and report on uses of advanced technologies for investigation and remediation of MGP sites.</td>
<td>12/31/14</td>
<td>Technical Resource</td>
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P50.003 Risk Assessment Studies (058346)

Key Research Question

Coal tar contains a number of polycyclic aromatic hydrocarbons (PAHs), exposure to which can be associated with increased probability of cancer incidence. Remediation endpoints for sites contaminated with coal tar are driven by the carcinogenicity of these compounds, which include benzo(a)pyrene and naphthalene. Conflicting data on the human carcinogenicity of some of these compounds have led to the development of conservative cleanup criteria. Cleanup levels that are risk based, are supported by sound science, and remain protective of human health may result in a significant reduction in remediation costs.

Approach

This project tracks recent developments in the scientific literature and assesses the data to provide input into the regulatory process. This research will deliver accurate and credible scientific information regarding the environmental and health risks from MGP site contaminants. It will focus on naphthalene research to evaluate evidence that naphthalene is a possible human carcinogen and will evaluate EPA’s Integrated Risk Information System (IRIS) program results. The research will also examine developments regarding EPA’s Relative Potency Factor approach for determining the carcinogenicity of PAH mixtures, as well as the IRIS reassessment of
benzo(a)pyrene. Where appropriate, the project includes preparation of comments on IRIS documents and other key reports.

**Impact**
- Improves understanding of health risks associated with contaminants at MGP sites, leading to a more informed regulatory process for EPA and others that set standards and cleanup-level requirements
- Improves risk-based decision making and reduces long-term costs
- Supports public interest research

**How to Apply Results**
MGP site owners and managers will gain value from this research through an improved understanding of how to evaluate and manage the risks of certain PAH compounds. Site managers will gain value from this work by considering the role played by certain compounds such as naphthalene in determining specific risk-based cleanup criteria for soil and groundwater. Members should ensure that findings from the project are communicated widely, sending results to key stakeholders, making sure that stakeholders understand the findings, and suggesting that the findings be considered in the development of environmental policy. Members should also use this information to communicate with various public groups as necessary. In addition, EPRI staff will hold periodic briefings for members and key stakeholders, including regulatory and other government agencies, as appropriate.

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<tr>
<td><strong>Risk Assessment Communication and Support</strong>: This deliverable consists of communication to members on relevant issues, tracking of regulatory developments, and preparation of comments as appropriate.</td>
<td>12/31/13</td>
<td>Technical Resource</td>
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**P50.004 MGP Site Closure, Redevelopment, and Green Remediation (067511)**

**Key Research Question**
New "green" remediation paradigms are being developed and implemented by state and federal agencies, standards organizations such as ASTM International, and nongovernmental organizations. Green remediation evaluations may be required at utility legacy sites such as former MGP sites. While many existing technologies may meet green remediation criteria, additional research is needed to identify green remediation technologies, to evaluate green remediation standards and criteria being developed by standards organizations and others, and to develop and evaluate new metrics for determining the environmental footprints of remediation projects.

In addition, successful closure of MGP sites can often provide redevelopment opportunities. Redevelopment can impose additional requirements for site closure to accommodate the planned use of the site. In addition, site redevelopment workers need to have procedures available to ensure a safe workplace.

**Approach**
In 2013, this project will begin evaluating methods and approaches for addressing increased interest in green remediation, including possible development of models of carbon emissions from various remediation alternatives, alternative construction approaches, and green remediation technologies.
Impact

- Provides best-practices examples using management oversight review
- Provides site managers with alternative use assessments through case studies of completed projects requiring no further action
- Enables end-use evaluations using varying end-use visions

How to Apply Results

Workshops will provide technology transfer to inform members of current thinking on green remediation principles and projects. Reports will be prepared on methods and procedures for evaluating green remediation technologies and their environmental footprints.

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<tr>
<td>Development of Technical Protocol for RI/FS Studies at MGP Sites:</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<td>Complex MGP sites require remedial investigations and feasibility study work plans that are more advanced than those required for many other contaminated sites. This project will develop a more focused approach specifically applicable for MGP sites and may include standard assumptions as well as sustainability options for all aspects of these projects.</td>
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<td>Standard Practices for Utility Workers at MGP Sites: Water and sewer utility workers are often called upon to perform subsurface work at MGP sites. This project would seek to develop a training manual that could be provided to these workers that would identify work practices to be followed to protect worker safety and health.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<tr>
<td>Green Remediation Model at MGP Sites: Standards are being developed by regulators and NGOs for implementing green practices at remediation sites. These green standards are being developed to apply to all phases of a remediation project, including site investigation, remedy selection, construction, and long-term operation and management. The purpose of this project will be to provide examples of how these standards might be applied at an MGP site and to identify what green methods are available that might be relevant at MGP sites.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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Future Year Products

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<tr>
<td>Generic Site Management Plans: Many remediated MGP sites must develop plans for post-remediation work at the site. Such work must ensure that engineering and institutional controls are maintained during site operations and management activities. This project will seek to develop a generic plan that could be applied for most MGP sites.</td>
<td>12/31/14</td>
<td>Technical Update</td>
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P50.005 MGP Site Contaminant Characterization and Source Attribution (Q55325)

Key Research Question

Gaining regulatory acceptance of some rapid-characterization screening techniques to determine the physical and chemical extent of coal tar in soils still remains a challenge for site managers. More data are needed from some rapid-characterization techniques to prove that they are acceptably rigorous in meeting regulators’ requirements. The assessment of the effectiveness of the in situ stabilization (ISS) process for containment of PAHs from treated MGP soils also poses significant challenges to site managers. There is a need to develop and demonstrate an alternative assessment methodology for ISS materials containing PAHs. In addition, characterization of soils in difficult-to-access locations, such as under buildings, remains problematic.

Approach

This project will deliver new and improved methods for rapidly characterizing and delineating coal tar in soil. It will evaluate steady-state conditions and study mobility of coal tar as well as evaluate rapid-characterization techniques for delineating the presence of coal tar in the subsurface, including dense nonaqueous-phase liquid (DNAPL) in bedrock. Work will include research on techniques for characterization of contamination in difficult-to-access structures and areas.

Impact

- This work improves risk management and decision making by delivering more cost-effective methods for delineating the extent of contaminated soils.
- Treating contaminated soils from MGP sites with cementitious binders and disposing of them in situ prior to capping and rehabilitation of a site can provide a cost-effective alternative solution to remediation.
- An EPRI background-PAH project gained regulatory acceptance in Illinois and is predicted to save millions of dollars over the next decade.

How to Apply Results

Members participating in this work will be able to use the results to better evaluate and delineate contaminant source areas, saving companies money on excavation costs. Results will help site managers provide preremedial design alternatives. Results also may be used by site managers to apply more-appropriate cleanup strategies based on background data. Results will be delivered primarily through publications and peer-reviewed literature. Participants in this work are encouraged to distribute results widely to regulators as warranted.

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<tr>
<td>Use of Tracers for MGP Site Assessments: This project will review the state of the science for the use of tracers to determine groundwater and subsurface impacts associated with contaminants at MGP sites.</td>
<td>12/31/13</td>
<td>Technical Update</td>
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<tr>
<td>Update Remedial Options Assessment Model (ROAM): ROAM has been used to evaluate remedial alternatives at a number of MGP sites since it was released in 2004. However, it needs to be updated for use with current computer operating systems as well as to improve on the groundwater flow algorithms contained in the model.</td>
<td>12/31/14</td>
<td>Software</td>
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High-Temperature Field Probe with 3-D Visualization: Previous EPRI research identified the potential application of a heated transfer line-membrane interface probe for use in MGP site characterization. The utility of this equipment would be enhanced by coupling it with 3-D visualization capabilities to allow for rapid assessment, in the field, of MGP contaminant distributions.

Planned Completion Date: 12/31/15
Product Type: Hardware

P50.006 Air Monitoring and Soil Vapor Intrusion (Q55813)

Key Research Question
Release of volatile organic compounds (VOCs) from soils or groundwater at MGP sites can cause soil vapor intrusion (SVI) into buildings or can cause odor or VOC emissions during excavation of contaminated soils. These issues are receiving increased regulatory attention through guidance documents or permit requirements from regulatory and health agencies. Costly SVI investigations are being required on or near MGP sites, and mitigation is sometimes required. Perimeter air monitoring during remediation is also usually required, but uncertainty still exists on how to interpret the data obtained.

Approach
This project improves decision making and risk management by providing state-of-the-art science and technology information on ambient and indoor air quality. The project characterizes air emissions and odors during site excavation and investigates subsurface vapor intrusion to indoor air and mitigation system performance.

Impact
• Improved methods for assessing SVI at MGP sites will help utility managers reduce costs and uncertainty in complying with regulatory or third-party requirements.
• Investigations into low-cost/low-technology SVI mitigation measures may reduce long-term costs and liability.
• Improved tools to predict, measure, and control odor and VOC emissions during MGP site remediation will reduce complaints and work delays and will provide important documentation to reduce postcleanup litigation.
• Improved air monitoring methods will provide more-complete, more-timely analytical data to evaluate potential off-site emissions.

How to Apply Results
MGP site owners and managers can use the results to make better evaluations of how odor is quantified and managed during remedial actions. MGP site managers can use the results of SVI data to evaluate risks so that remedial action plans are more thoroughly managed with respect to exposure issues.

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<tr>
<td>Monitor Developments in Federal and other SVI Guidance: This research will monitor changes in federal soil vapor intrusion guidance and development of ITRC Petroleum Vapor Intrusion Guidance.</td>
<td>12/31/13</td>
<td>Technical Resource</td>
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<tr>
<td>Provide Opportunities for Air Monitoring Guidance: Existing and proposed MGP site air monitoring plans will be evaluated to determine if improvements can be made to monitor location, methods used, and data evaluation to improve data quality and defensibility</td>
<td>12/31/13</td>
<td>Technical Resource</td>
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Supplemental Projects

Multi-Year Sediment Remediation Technology Demos (073468)

Background, Objectives, and New Learnings
Former Manufactured Gas Plants (MGPs) were often located adjacent to water bodies. Byproducts and wastes from MGP processes can impact sediments in the adjoining water bodies. Removal of impacted sediments by dredging or excavation is often the default option in regulatory determinations for remedial alternatives. However, dredging can pose significant impacts to the environment beyond management of the contamination and may not be the most effective approach. Research by EPRI and others has demonstrated that other technologies, such as reactive capping, can be viable alternatives to physical dredging. Acceptance of alternative technologies can be delayed until they have been demonstrated to be effective in full scale conditions. The purpose of this project is to identify and demonstrate the effectiveness of sediment remediation alternatives. Knowledge gained by this project will be of use to remediation professionals in identifying effective cleanup approaches for sediment contaminant cleanups.

Project Approach and Summary
This project will identify sediment remediation alternatives that may be feasible for addressing MGP impacted sediments, but that have had limited or no field testing. Alternatives that have the best potential for addressing MGP impacted sediments will be evaluated for potential full scale application. Potential host sites for the field work will be identified, followed by site specific testing. Full scale projects will be conducted at sites deemed to have a reasonable likelihood of success.

In the initial phase of this project, In situ Stabilization and Solidification Technology (ISS) will be demonstrated at a host sediment site. Previous EPRI research has shown ISS to be feasible for permanently sequestering MGP contaminants. However, ISS has not been tested in the field. Therefore, the initial two years of the project will be focused on laboratory studies of host site sediments, obtaining necessary environmental permits and the conduct of field studies.

Additional sediment remediation alternatives that might be candidates for future demonstration projects will also be identified in the initial phase of this project.

Benefits
As sediment remediation alternatives are identified and demonstrated to be effective, site owners and decision makers will have a choice of technologies. This will lead to more effective, potentially less costly and more timely cleanups.