Appendix I

The Former Holyoke Gas Works & The Holyoke Gas Tar Deposits

Project Summary Written by Lisa Jones, Massachusetts Department of Environmental Protection, Bureau of Waste Site Cleanup
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The Gas Works in Holyoke manufactured combustible gas from coal and oil for residential, commercial, and industrial heating and lighting from 1852 to 1951. The former Gas Works once occupied a 2-acre peninsula on the Connecticut River 1500 feet downstream of the Holyoke Dam. Historic operations resulted in large releases of tar and oil to soil, groundwater, sediment, and surface water. Assessment and cleanup are required under the Massachusetts Contingency Plan. The potentially responsible parties (PRPs), conducting the cleanup work, are the former owner/operators of the facility: Holyoke Water Power Company (HWP), owner/operator from 1852-1902, Holyoke Gas & Electric Department (HG&E), owner/operator from 1902-1952, and the City of Holyoke. Northeast Utilities Service Company, agent for HWP, is conducting the cleanup of tar deposits in the river (RTN 1-1055), and HG&E is conducting the cleanup of the upland area and the No.2 Raceway (RTN 1-816). Massachusetts Department of Environmental Protection (MassDEP) site management oversees the work. As of December 2007, approximately $20 million dollars has been spent on assessment and remediation at the two sites. The future costs are unknown.

The Gas Works utilized two types of manufacturing processes: coal carbonization and the carbureted water-gas (CWG) process. Each process generated tar as a by-product, namely coal tar and carbureted water-gas tar. According to records research and calculations performed by MassDEP, this manufactured gas plant ("MGP") produced approximately ten million gallons of MGP tar during its 100 years of operations. (The term "MGP tar" refers to both coal tar and carbureted water-gas tar since it is not necessary to distinguish between the two.)

Holyoke Gas Tar Deposits (River) – RTN 1-1055

While MGP tar was typically a valuable resource that could be sold or used by a gas works, tar was often released to the environment via spills, leaks, and direct surface water discharges. In the early years of the industry, excess tar was typically disposed or discarded into nearby water bodies since uses for tar, other than as fuel, had not yet been developed. As the industry progressed, MGP tar was less likely to be discarded however tar/ water emulsions produced by the CWG process became problematic: when an emulsion would not properly separate, it was usually discarded.

An 1898 plan of the Holyoke Gas Works shows that the facility was initially equipped with a piping system that enabled direct discharges of tar into the Connecticut River to the north and into the No. 2 Overflow Raceway ("Raceway") to the south. Additional site plans from the 1930s and 1940s show the presence of overflow and drain pipes originating from underground tar storage areas (tar wells), extending through the flood wall, and emptying into the river and Raceway. Tar inventory records of Holyoke Gas Works for the period between 1903 and 1952 revealed that 126,000 gallons of MGP tar and 124,000 gallons of gas-making oil were "lost" to the river during floods, reconstruction of the floodwall, and unexplained incidents. Tar and oil losses from prior years, 1852-1902, are presumed to have occurred but detailed bookkeeping records were

not found. Some large, one-time events occurred such as the loss of 30,000 gallons of tar and 87,000 gallons of gas oil lost in the 1936 flood, and 38,000 gallons of oil lost in the 1938 flood and hurricane.

Gas oil and tar emulsions released to the river may have floated or been suspended, but tar usually sank in waterways. The tar settled over very large areas of the Connecticut River within the 2.7-mile stretch between the Route 116 bridge in South Hadley Falls and the south end of Springdale Park in Holyoke. Visible tar deposits, observed by divers, occupy around 3 acres, and submerged tar areas may occupy another 20 to 30 acres. Tar thickness varies from 2 inches to 3 feet. Overlying substrates vary in composition- sand, silt, gravel, and cobbles, and the thickness of material covering tar deposits ranges from zero to 3.5 feet. Exposed areas are noted to silt over during summer and support caddis fly larvae. The topside of tar deposits is sometimes hardened like a rind, while underneath it can be sticky or friable. Softer tar deposits were observed to release liquid blebs on occasion and soft tar reportedly fouls the diver's tools. Tar hardness changes with water temperatures and UV influence.

The tar deposits exist in an area known to provide spawning habitat for the federally endangered short-nose sturgeon (*Acipenser brevirostrum*). Tar deposits also coexist in habitat for two state-protected mussel species and numerous finfish and shellfish. Human health exposures may occur through recreational activities taking place in and along the river. Under the presumption that tar deposits pose readily apparent harm and substantial environmental hazard, MassDEP required remediation of the tar deposits. HWP signed a consent order to complete the actions required by MassDEP. HWP also settled with federal and State natural resource trustees on a claim for injured resources.

Removal of tar deposits performed in 2002-2006 resulted in the removal and disposal of 11,714 yd^3 of tar and tarry sediment. The removal was accomplished using mechanical excavation in dry (dewatered) areas and in wet excavations where dewatering was impractical or not feasible. The project involved the use of temporary flow diversions, cofferdams, and silt curtains to minimize contaminant migration and prevent exposure to biota during excavation. The work was performed during summer and fall months to avoid critical fish life cycles, migratory periods, and dangerous high flow conditions. Mussel and fish relocation were conducted to reduce exposures in work areas. A barge-mounted excavator with a special environmental bucket was used to dredge in the river. Dry excavation was done with standard equipment. The excavated material was placed into containers on floats, transported to the shoreline, lifted out of the river, placed onto a staging pad, dewatered, then loaded and transported to an off-site treatment facility. Contaminated remedial wastewater, drained from the dredge spoils, was collected in fractionation tanks and treated to meet criteria established in a permit issued by the Holyoke Department of Public Works. The treated wastewater was then discharged into the main city sewer interceptor line and sent directly to the water pollution control facility.

Prompted by MassDEP's observation of unmapped tar deposits in 2005, HWP was required to conduct a more intensive survey for tar in 2006. Information obtained during remediation and diver surveys, confirmed that the extent of tar deposits was much greater than initial estimates. The tar deposits were originally thought to occupy less than 2 acres, but the new estimate is around 30 acres. Because of the larger volume and associated cost for removal, HWP proposed to complete a comprehensive ecological and human health risk characterization to guide in risk management and remediation planning rather than to continue with removal under the presumption of harm to biota.

An important aspect of the site, now being scrutinized, is the hardness due to weathering of some tar deposits. Studies and risk assessment tools are proposed to determine if the more weathered tar has undergone changes that render it less toxic and mobile than the softer tar deposits, and therefore, whether it poses less or no significant risk of harm to biota.

MassDEP is currently reviewing the revised risk characterization Scope of Work, which has been developed to investigate if any substantial hazard has been mitigated by the remediation conducted to date and weathering processes that have reduced the mobility and toxicity of the tar.

Former Holyoke Gas Works (Land Site) RTN 1-816

Coal tar and water gas tar are the most widespread contaminants at the two sites. Ten million gallons of tar were produced over the life of the plant and much of the tar was released into the environment. The properties of tar make the assessment and remediation very complex and technically challenging. Coal tar is a dense non-aqueous phase liquid (DNAPL) whereas CWG tar reportedly has a density nearly equivalent to water. Over time tar fractionates into light non-aqueous phase liquid (LNAPL) and DNAPL. Constituents of tar also dissolve more readily into groundwater when comingled with gas oil. Fate and transport of tar is complicated since the LNAPL and dissolved LNAPL move with groundwater while DNAPL sinks and flows along the underlying bedrock and seeps into bedrock fractures. Recovery of NAPL tar is necessary, expensive, and expected to take 10 to 20 years. Listed below are summarized findings, tasks, and plans pertaining to the Gas Works site:

- 8 acres, industrial /commercial area with residential areas 0.25 miles from site
- Oil / tar breaking out in the Tailrace first observed and reported to MassDEP in 1990
- Sources removed in 1994 to 1995 include 3 underground storage tanks, 2 aboveground storage tanks, 3 tar wells, 1000 yd^3 soil, & 100,000 gal. of tar / oil / water mix were recovered and recycled
- Gas oil and fuel oil (LNAPLs), and tar (DNAPL) observed to be migrating > 700 feet from sources; contaminants in groundwater & bedrock as seen in monitoring wells and soil borings
- Quarterly groundwater gauging program initiated in March 2001
- Weekly tar thickness gauging and tar bailing program initiated in November 2001
- Two pilot-scale NAPL recovery systems installed in 2003: no heat system along Tailrace; thermally-enhanced (steam sparge) on property near former east tar well
- In 2004, approximately 8000 tons of tar-impacted soil were removed from 2 gasholders and a tar separator, treated via on-site solidification & stabilization using addition of Portland cement (8%) and liquid asphalt (8 gallons per ton), and the end product was re-used as backfill in the gasholders
- Re-evaluation of arsenic and residual tar impacts in soil concluded no significant future health risk as long as site use is restricted to non-residential activities
- Removal and off-site disposal of approximately 1000 tons of tar solids and soil near valves along northern floodwall: accessible soil excavated & disposed off-site in 2005.
- Both NAPL recovery systems were upgraded to full scale between August 2006 and April 2007: installed cost of $750 K with estimated annual operational cost of $140 K
    - Steam-enhanced system has 7 sparge points and 7 recovery wells

    - Tailrace collection is non-thermal and uses 21 overburden recovery wells and 4 bedrock recovery wells; spacing is at 10-foot intervals.
- Future Remedies-
    - 2009 Raceway: In-situ Capping & Heated Recovery Well Installation
    - 2010 Tailrace: Bulkhead Installation and/or Embankment Capping