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RECORD OF DECISION

IOWA CITY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII
KANSAS CITY, KANSAS

SEPTEMBER 2006

RECORD OF DECISION
DECLARATION

SITE NAME AND LOCATION

Iowa City Former Manufactured Gas Plant Site
505 Burlington Street
Iowa City, Johnson County, Iowa
CERCLIS ID # IAD984591172

STATEMENT OF BASIS AND PURPOSE

The United States Environmental Protection Agency (EPA) has prepared this decision document to present the selected remedial action for the Iowa City Former Manufactured Gas Plant (FMGP) Superfund Site (Site) in Iowa City, Iowa. This decision was made in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended, and to the extent practicable the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). This decision is based on the Administrative Record for this Site. The Administrative Record is located in the following information repositories:

Iowa City Public Library 123 South Linn Street Iowa City, Iowa	U.S. Environmental Protection Agency 901 North 5th Street Kansas City, Kansas

The EPA has coordinated selection of this remedial action with the Iowa Department of Natural Resources (IDNR). The state of Iowa, acting through IDNR, concurs with the Selected Remedy.

ASSESSMENT OF THE SITE

The response action selection in the Record of Decision (ROD) is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

DESCRIPTION OF THE SELECTED REMEDY

The Selected Remedy is designed to prevent and/or reduce human exposure to groundwater with contaminant levels that exceed regulatory or health-based levels, prevent and/or reduce future soil exposure risks to acceptable levels by maintaining the present land use, prevent and/or reduce future human exposure to indoor air containing contaminants of concern (COCs) that exceed health-based levels, and maintain the existing ecological steady state and prevent and/or reduce future unacceptable risks to human health and the environment in Ralston Creek. The major components of the Selected Remedy include:

- Implementation of institutional controls in the form of environmental easements, ordinances, laws, or other limitations to restrict uses of the Site property; prohibit the installation of water wells; and maintain conditions in Ralston Creek and within the Iowa-Illinois Manor apartment building that limit exposure to Site contamination.
- Groundwater monitoring, sediment monitoring in Ralston Creek, and indoor air monitoring in the Iowa-Illinois Manor apartment building.
- Recovery of light nonaqueous phase liquid from the unconsolidated aquifer.
- Implementation of technical impracticability waiver of applicable or relevant and appropriate requirements or health-based levels within an area identified as the "technical impracticability zone."

A previous action was taken at the Site. In order to address contamination associated with the FMGP along the northern edge of the Site a removal action was conducted in 2003. This work was necessary to minimize exposure to city and utility workers doing construction work in the area (commencing in 2004) and to address an underground tank in the area. The contents of the underground tank were removed and it was filled with inert material. Recovered groundwater and light nonaqueous phase liquid (LNAPL) from two monitoring wells were taken off-site, treated, and disposed.

STATUTORY DETERMINATIONS

The Selected Remedy is protective of human health and the environment, is cost-effective, and utilizes permanent solutions and alternative treatment technologies to the maximum extent possible. The remediation of the groundwater to satisfy applicable or relevant and appropriate requirements (ARARs) or health-based levels is impracticable; therefore, a technical impracticability ARAR waiver has been granted. The Selected Remedy complies with federal and state ARARs except within the area where it was determined that a waiver is justified. Since the treatment of groundwater was found to be impractical, this remedy does not satisfy the statutory preference for treatment as a principal element of the remedy.

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a statutory review will be conducted within five years after initiation of the remedial action to ensure that the remedy is protective of human health and the environment.

ROD DATA CERTIFICATION CHECKLIST

The following information is included in the *Decision Summary* section of this ROD. Additional information can be found in the Administrative Record for this Site.

- The COCs and their respective concentrations
- Baseline risk represented by the COCs

- Cleanup levels for the COCs and the basis of these levels
- The degree to which source materials constituting principal threats are addressed
- Current and reasonably anticipated future land use assumptions and current and potential future beneficial uses of groundwater used in the baseline risk assessment and the ROD
- Potential land and groundwater use that will be available at the Site as a result of the Selected Remedy
- Estimated capital, operation and maintenance and total present-worth costs, discount rate, and the number of years over which the remedy cost estimates are projected
- Key factors that led to selecting the remedy

Cecilia Tapia, Director
Superfund Division
U.S. EPA, Region VII

9/26/06
Date

RECORD OF DECISION
DECISION SUMMARY

IOWA CITY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII
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SEPTEMBER 2006

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RECORD OF DECISION
DECISION SUMMARY

I. Site Name, Location, and Description

This Record of Decision (ROD) has been developed by the United States Environmental Protection Agency (EPA) to select a remedial alternative at the Iowa City Former Manufactured Gas Plant Site (herein, the Site) in Iowa City, Iowa. The Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) identification number for the Site is IAD984591172. The lead agency for the Site is the EPA. The support agency for the Site is the Iowa Department of Natural Resources (IDNR). Site characterization work, a removal action, a treatability study, and feasibility study conducted at the Site since 1999 have been paid for by a potentially responsible party, MidAmerican Energy Company (MidAmerican), including reimbursement for the EPA's oversight costs.

The Site was formerly a manufactured gas plant that is located in Iowa City, Johnson County, Iowa. The Site is located east of downtown Iowa City at 505 East Burlington Street in a mixed commercial and residential area. The Iowa-Illinois Manor apartment building currently occupies the Site. Burlington Street runs along the northern boundary and Van Buren Street runs along the western boundary. Ralston Creek runs north to south adjacent to Van Buren Street. A map of the Site including the location of historical features is attached as Figure 1.

II. Site History and Enforcement Activities

Manufactured coal gas was produced at the Site beginning in approximately 1857 until approximately 1937 when natural gas became available in the area. The manufactured gas plant (MGP) operated under several names throughout its years of operation. For the majority of the years it was operated by Tri-City Railway and Light Company, a subsidiary of United Light and Power Company. In the early 1940s Iowa-Illinois Gas and Electric Company (IIGE) purchased Tri-City Railway and Light Company.

Following closure of the MGP operations, the Site was utilized by IIGE as a service facility until approximately 1971. The MGP site property is currently occupied by the Iowa-Illinois Manor apartment building, which contains 54 units, occupied by approximately 150 residents. The residents generally are students of the University of Iowa. The Iowa-Illinois Manor apartments were constructed by the Iowa-Illinois Manor Partnership (Manor Partnership) in 1983. The Manor Partnership continues to own and operate the apartments.

The location of Ralston Creek was changed during the time the MGP operated. The creek was straightened and tile lined between 1948 and 1970 placing it in its current location. The portion of Ralston Creek adjacent to the Site is currently tile lined and heavily vegetated.

In 1983, during the design and construction of the apartment building, an investigation was conducted at the Site. During this investigation, it was determined that fill material containing what was believed to be coal gas plant refuse was present in the subsurface. As a result of the material encountered in the subsurface and vapors encountered during the investigation, the design of the foundation of the apartment building was modified to include a liner under a portion of the building and a passive venting system in the crawl space.

The EPA conducted investigations at the Site and issued an Expanded Site Investigation Report in 1998 in which it was determined further investigation was warranted due to the presence of elevated levels of volatile organic compounds (VOCs) specifically benzene, toluene, ethylbenzene, and total xylenes (BTEX); polynuclear aromatic hydrocarbons (PAHs); cyanide; arsenic; and lead.

In March 1999 the EPA, MidAmerican (a successor to IIGE), and the Manor Partnership entered into an Administrative Order on Consent (AOC) for site characterization activities. From October 1999 through March 2004 MidAmerican conducted this investigative work. The final Site Characterization Report, dated August 2003, including the baseline risk assessment and all amendments to the report constitute the final Remedial Investigation Report for the Site.

In December 2003 the EPA determined that a time-critical removal action was necessary to remove contamination associated with the MGP along the northern edge of the Site. This work was necessary to minimize exposure to city and utility workers doing construction work in the area, and to address an underground tank in the area. MidAmerican and the Manor Partnership entered into an AOC for this work. In January 2004 MidAmerican removed the contents of the underground tank, filled it with inert material, and recovered groundwater and light nonaqueous phase liquid (LNAPL) from two monitoring wells.

In August 2004 MidAmerican and the Manor Partnership entered into a third AOC with the EPA for a feasibility study. MidAmerican conducted some additional limited field investigations, completed a treatability study involving the removal of LNAPL, and completed a Feasibility Study (FS) Report dated June 2006. The Site Characterization Report, the FS Report, and other documents in the Administrative Record file may be reviewed for a more complete source of information regarding the history of the Site.

III. Community Participation

Throughout the time that investigation and removal activities have taken place at the Site community involvement activities have occurred. These include the distribution of fact sheets, meetings with the public, media interviews, and establishment of an information repository at the Iowa City Public Library.

The EPA established an Administrative Record at the Region 7 offices and the Iowa City Public Library which contains supportive documents for this decision. The notice of the availability of these documents was published in the Iowa City Press-Citizen on

July 28, 2006. The EPA issued a Proposed Plan for the Site on July 26, 2006. A 30-day public comment period occurred from July 28, 2006, to August 27, 2006. A public meeting was held on August 9, 2006, at the Iowa City Public Library in Iowa City, Iowa, to present the Proposed Plan and solicit comments from the public. The EPA's responses to comments received during the comment period are included in the Responsiveness Summary which is a part of this ROD.

IV. Scope and Role of Response Action

The remedy selected in this ROD is the final remedy planned for this Site. The scope of the actions to be taken at this Site will prevent unacceptable exposures to air in the apartment building, soil, groundwater, and further contributions of contamination to the sediment of Ralston Creek from the Site.

V. Site Characteristics

The contaminants usually associated with the production of manufactured gas include a group of semivolatile organic compounds (SVOCs) referred to as PAHs. There are sixteen PAH compounds which were analyzed for throughout the course of the investigations at this Site. Other contaminants usually found at former MGP (FMGP) sites include a group of VOCs, specifically BTEX. Some forms of cyanide, arsenic, phenolic compounds (also referred to as acid extractable compounds), and metals may also be found.

A. Surface Soil

At different points during the investigation a surface soil sample consisted of samples collected from different depths. Some samples were collected from the surface to a depth of three inches while others were taken from the surface to a depth of six inches. Some samples referred to as surface soil may have been collected from a depth of up to two feet. Also, some surface soil samples were actually collected from beneath the surface of the asphalt parking lot adjacent to the Iowa-Illinois Manor apartment building.

The highest concentrations of benzo(a)pyrene, naphthalene, and BTEX were detected at SS-4, located off-site west of Van Buren Street (see Figure 2, attached). On-site (property boundary) concentrations of benzo(a)pyrene ranged from below detectable levels to a high of 59.7 micrograms per kilogram (μg/kg). The highest concentration detected in surface soil sampling was located at SS-4 at 460 μg/kg. The concentration of naphthalene ranged from below detectable levels to a high of 431 μg/kg at location SS-4. Naphthalene was not detected at any of the on-site surface soil sampling locations. Acid extractable compounds were not detected in the surface soil samples.

Concentrations of BTEX compounds were low and detected only at isolated locations. Benzene was detected in only one of the surface soil samples (SS-4 at 7.8 μg/kg). Toluene and total xylenes were each detected in three of the surface soil samples. Maximum concentrations for toluene and total xylenes were detected at location SS-4 at concentrations of 15.6 µg/kg and 8.9 µg/kg, respectively. Ethylbenzene was not detected in any of the surface soil samples. None of the BTEX constituents were detected at the on-site surface soil sampling locations.

The highest concentration of total cyanide was detected at off-site location BH-12 at 42 milligrams per kilogram (mg/kg). Lead was detected at all of the surface soil sampling locations. The highest concentration was at off-site location BH-47 (470 mg/kg). The maximum detected concentration of arsenic in surface soil was at off-site location SS-6 (20 mg/kg). Overall, the surface soil samples demonstrated only isolated areas of potential FMGP-related impacts.

B. Subsurface Soil

Subsurface soil impacts were evaluated based on two vertical intervals: zero to six feet below ground surface (bgs) and six feet to the water table which is approximately ten feet bgs. Generally, the maximum concentrations of organic contaminants and cyanide in subsurface soil were detected on-site in the vicinity of potential source structures, while the maximum concentrations of metals were detected off-site.

The highest naphthalene and benzo(a)pyrene concentrations were detected on-site at MW-17 at concentrations of 350,000 µg/kg and 120,000 µg/kg, respectively (see Figure 2). Acid extractable compounds were infrequently detected at the Site and only at low concentrations below levels of concern. The extent of significant PAH impact in the vadose zone is primarily limited to the vicinity of known on-site source structures.

BTEX compounds were infrequently detected in vadose zone soils. The highest concentrations were detected at on-site location MW-17 (benzene at 10,200 µg/kg) and SB-A (benzene at 6,400 µg/kg, toluene at 3,930 µg/kg, ethylbenzene at 12,900 µg/kg, and total xylenes at 44,900 µg/kg). In both the zero- to six-foot and six- to ten-foot depth intervals, the extent of significant BTEX impact is limited to the immediate vicinity of known on-site source areas.

Soil impacts from total cyanide appear to be limited in extent with elevated concentrations occurring most frequently on the northern portion of the Site. However, the highest total cyanide concentration detected during the site investigation activities was encountered on-site at BH-9 (located on the southern portion of the Site) at a depth of two to four feet bgs (625 mg/kg).

The highest concentration of arsenic was detected off-site at BH-12 at a depth of two to four feet (34 mg/kg). The highest lead concentrations were detected at off-site locations BH-12 (four to six feet – 1,400 mg/kg) and BH-24 (two to four feet – 14,000 mg/kg). None of the subsurface soil sampling locations for barium, cadmium, chromium, copper, manganese, mercury, nickel, vanadium, or zinc were at levels of concern. No detectable concentrations of antimony, selenium, or silver were encountered at the Site.

C. Groundwater

A total of 55 monitoring wells have been installed to delineate the extent of groundwater impacts. Figure 3 (attached) shows the location of all monitoring wells. Groundwater samples have been collected from two zones within the surficial unconsolidated aquifer at the Site. Water table wells were screened to intersect the water table to provide data at the groundwater surface, and wells screened at the bedrock surface were used to determine if the chemicals of concern (COCs) have the potential to impact deeper bedrock aquifers. Because of the presence of impacted groundwater at the bedrock surface, monitoring wells were installed in the uppermost bedrock aquifer. Then with the subsequent detection of impacted groundwater in the bedrock aquifer additional bedrock monitoring wells were installed to further horizontally and vertically define impacted groundwater in bedrock. Through 2005, groundwater samples were collected on two to twelve occasions from each monitoring well (with the exception of MW-44 through MW-48 which were installed specifically for delineation of LNAPL). Aluminum, arsenic, chromium, cyanide, iron, lead, manganese, acenaphthene, acenaphthylene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, and BTEX were detected in groundwater at elevated concentrations.

Benzene and naphthalene are expected to be the most mobile of the organic COCs. Groundwater impact in the unconsolidated aquifer at the water table and bedrock surface has been defined, and impact on the Devonian and Silurian bedrock aquifer in the vicinity of the Site is defined. Delineation of the extent of contamination in the most downgradient direction in the bedrock aquifer will be further investigated during the remedial action. Delineation of this portion of the plume is hampered due to the fractured bedrock and potential off-site sources. Forty-two off-site sources with the potential to contribute similar contaminants (particularly benzene and naphthalene) have been identified in the Site vicinity. The actual contaminant contributions from the majority of these historic facilities have not been characterized because the sites were redeveloped for other uses prior to current environmental regulations. Determining the specific source of similar contaminants may not be technically feasible at this time.

Dense, nonaqueous phase liquid (DNAPL) has been detected at MW-9, MW-13, MW-26, and MW-27. LNAPL has been detected at LMW-4, MW-2, MW-8, MW-44, and MW-48. The extent of LNAPL around MW-8 has been defined and free product recovery at LMW-4, MW-8, and MW-48 has been conducted. A total of 105 gallons of LNAPL have been recovered.

Historical Site use, soil descriptions, and groundwater concentrations suggest the presence of at least residual nonaqueous phase liquid (NAPL) at locations other than those where it has been directly measured in monitoring wells. Table 1 of Decision Chart 1 in *Estimating Potential for Occurrence of DNAPL at Superfund Sites* identifies FMGPs as an industry type with a high probability of historical DNAPL releases. According to Table 5 of Decision Chart 2 of the same document, groundwater concentrations detected at the Site indicate the possible presence of DNAPL by meeting Condition 1, which states DNAPL-related contaminant concentrations exceed one percent of the pure phase or effective solubility. The following contaminants have been detected at concentrations exceeding one percent of the respective pure phase, single compound aqueous solubility: ethylbenzene, toluene, total xylenes, and each of the 16 monitored PAHs. In addition, 13 of the monitored PAH compounds were detected in Site groundwater at concentrations exceeding 100 percent of the respective single compound aqueous solubility. The lateral extent of impacted groundwater with BTEX and PAH concentrations exceeding 1, 10, and 100 percent of the respective single compound solubilities is depicted in Figures 2-10 through 2-15 in the FS Report.

Based on the Site groundwater data and field observations, residual and free product NAPL is likely present in the vadose zone and saturated alluvium on-site at the water table. At the water table, soil borings RP-5 through RP-7, and monitoring wells MW-2, MW-49, MW-50 and MW-51 define the western extent of potential free LNAPL along the bank of Ralston Creek. Only MW-2 has had measurable levels of free LNAPL along Ralston Creek. Deeper in the unconsolidated sediments, primarily at the bedrock surface, groundwater data and field observations indicate a zone of potential residual NAPL ranging in thickness from several inches on top of bedrock (MW-20 and SB-D) to the entire thickness of the saturated zone in some areas on-site (MW-8, MW-15, MW-17, and SB-A). Sheens have been noted during drilling in bedrock at MW-26, MW-27, MW-42, and MW-54 indicating that at least some fractures in bedrock at these locations have NAPL or residual NAPL present. Both residual and free product NAPL will act as continuing sources of dissolved contaminants to groundwater and prevent the restoration of the aquifer for many decades.

D. Air

Several rounds of air sampling have been conducted at various locations inside apartments, in the building crawlspace, and outdoors over the course of the investigation activities. Figure 4 (attached) shows the air sampling locations except for those inside apartments. The evaluation of air quality at the Site focuses on samples collected from the apartment crawlspace because samples collected from the apartments can have interference from materials stored or used in the apartments, and therefore are not necessarily representative of conditions resulting from the FMGP Site. Use of the crawlspace air data are conservative because the crawlspace has minimal air circulation that could lead to dilution from outdoor air. The crawlspace also has low potential to have detections that are not related to environmental releases. A total of 14 air samples for PAH and BTEX analysis have been collected from crawlspace locations.

The highest concentrations of benzene and naphthalene detected in the crawlspace air were 1.8 micrograms per cubic meter of air ($\mu g/m^3$) and 0.25 $\mu g/m^3$, respectively. No carcinogenic PAH compounds were detected in the crawlspace samples.

E. Ralston Creek Surface Water

Surface water samples were collected from Ralston Creek in 1995, 1997, and 2002. Samples have been collected from 16 locations in Ralston Creek including samples from upstream, adjacent, and downstream relative to the Site. VOCs, PAHs, and acid-extractable compounds were detected only sporadically and at low levels in the surface water samples. Cyanide was detected at low concentrations in sampling locations both up and downstream of the Site. Based on the samples collected, no changes in water quality were detected in Ralston Creek along the Site. The highest PAHs were detected downstream of a storm sewer outfall that appeared to have a sanitary sewer cross connection based on visual observations of the discharge. The Site does not appear to have a significant impact on water quality in Ralston Creek as evidenced by the fact that no COCs were detected above the applicable ecological screening benchmarks, or above the applicable state and federal criteria for surface water. The surface water samples also have exhibited virtually the same analytical results from the upstream to downstream sampling locations.

F. Ralston Creek Sediment

A total of 27 stream sediment samples were collected from 15 locations in Ralston Creek over the course of site investigations. Benzo(a)pyrene was detected at a maximum concentration of 1,400 μg/kg. Naphthalene was detected at a maximum concentration of 8,600 μg/kg. The highest PAH concentrations were detected adjacent to and downstream of the Site. Benzene was detected at a maximum concentration of 56 μg/kg.

Cyanide was detected in sediment samples at a maximum concentration of 1.6 mg/kg. All cyanide detections were from samples located in the stream segment adjacent to the Site. Lead was detected at concentrations ranging from 7.72 mg/kg to 3,300 mg/kg. Although the highest lead concentration was detected downstream of the Site, it does not appear to be Site related. Lead concentrations upstream, adjacent to the Site, and at other downstream locations are at consistently lower concentrations than the one elevated location.

Multiple sources including the Site, numerous storm sewer discharges, observed sanitary sewer discharges, and other potential sources are likely contributing to the observed impact to Ralston Creek sediment.

VI. Current and Potential Future Land and Water Uses

A. Land Uses

The Site is located in a mixed commercial and residential area. The Site is zoned as RM-44 High Density Multifamily. Almost the entire Site is covered with the 54-unit Iowa-Illinois Manor apartment building and its asphalt parking lot. The apartment building is occupied almost exclusively by university students. It is not anticipated the zoning will change in the foreseeable future or the use of the apartment building will change. The area immediately surrounding the Site is mostly multiple-family residences with some single-family residences mixed in. There are also two auto repair shops, a gas station, and a small office building near the Site. It is anticipated the area will maintain a similar mixed use in the future.

Institutional controls either already in place or those that will be implemented as a part of this remedy will restrict future uses of the Site from changing without advance notification to the EPA. A reevaluation of the remedy may be necessary depending upon the type of changes proposed.

B. Groundwater Uses

A survey of water wells and potential groundwater usage within a one-mile radius of the Site was conducted. Eleven water wells were identified within the search radius and four of these are potentially used as a source of drinking water. None of the existing water wells are located in the contaminated plume area or are likely to ever be impacted by the Site.

The city supplies potable water to the University of Iowa, residences, and businesses within the city limits of Iowa City. The municipal water supply is drawn from intakes located on the Iowa River and a well field located north of Iowa City, outside the one mile search radius. Wells screened in the Silurian and Cambro-Ordovician aquifers within the one-mile radius and owned by the University were utilized by the city primarily for blending with the surface water supply during spring runoff. However, with the completion of a new city water treatment plant the city no longer uses these wells as a blending source.

The University also supplies some of its own water. The University owned wells described in the previous paragraph are on standby as a potential blending source for times when the University's surface water supply is not of suitable quality. The other water wells located within the one-mile radius are not utilized for drinking water.

The potential for new water well installations within the search radius is low. The city enforces a municipal ordinance (City Code Section 14-3C-10) that prohibits the installation of private water wells where a municipal water supply line is available within 300 feet. Additionally, the ordinance provides the city authority to require owners of existing private wells to connect to the municipal water supply if a water supply line exists within 300 feet. The Iowa City well ordinance has been approved for use as an institutional control by the IDNR for leaking underground storage tank sites and other state-lead projects.

C. Surface Water Uses

Ralston Creek is a perennial stream with highly variable flow. It is managed more for storm water drainage than for recreational use. Buried utility lines run beside and beneath Ralston Creek near the Site. In the immediate vicinity of Ralston Creek it appears that groundwater discharges to the creek under base-flow conditions. It is not anticipated that the use or management of the creek will change in the future.

Ralston Creek ultimately discharges in the Iowa River several miles downstream of the Site. The confluence of Ralston Creek and the Iowa River is a fishery and likely a nursery for fish. The Iowa River is used as a source of drinking water for the city of Iowa City. It is not anticipated that this usage will change in the future.

VII. Summary of Site Risks

The Comprehensive Environmental Response Compensation and Liability Act (CERCLA) requires the EPA to seek permanent solutions to protect human health and the environment from hazardous substances to the extent practicable. These solutions provide for removal, treatment, or containment of dangerous chemicals so that any remaining contamination does not pose an unacceptable health risk to those who might come into contact with the contaminants. Actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this ROD, may present a current or potential threat to public health, welfare, or the environment.

D. Summary of Human Health Risk Assessment

The baseline risk assessment estimates what risks the Site poses if no action were taken. It provides the basis for taking action and identifies the contaminants and exposure pathways that need to be addressed by the remedial action. This section of the ROD summarizes the results of the baseline risk assessment for this Site.

MidAmerican prepared a Baseline Risk Assessment utilizing data collected during the Remedial Investigation (RI). This was documented in Section 7 entitled "Baseline Risk Assessment" of the Site Characterization Report dated August 2003. The tables of data that are referenced throughout this section of the ROD, and attached to the ROD, are taken from this Baseline Risk Assessment. The Baseline Risk Assessment may be found in the Administrative Record.

In general, the EPA requires or undertakes remedial actions for Superfund sites when the excess carcinogenic (cancer) risk exceeds 10^{-4}. A risk of 10^{-4} represents an increase of one in ten thousand, or 1/10,000, for a reasonable maximum exposure (RME). This risk represents the lifetime risk of developing cancer as a result of releases from the site being evaluated.

Remedial actions may also be conducted at Superfund sites when the hazard index (HI) equals or exceeds one for the RME scenario. The HI is a numeric expression of the noncarcinogenic risk to human health resulting from releases from the site being evaluated.

1. Identification of Chemicals of Concern (COCs)

   Tables 7-3.1 through 7-3.5 (attached) present the COCs and exposure point concentration (EPC) for each of the COCs detected in soil at various depths. These tables include the arithmetic mean (or average) concentration, the maximum detected concentration, and the value of the 95% upper confidence level of normally distributed data for each of the COCs in soil. For the RME, the EPC for each COC is listed along with the rationale for the selection of the EPC.

   Table 7-3.6 (attached) presents COCs and their respective EPC for groundwater. Tables 7-3.7 through 7-3.9 (attached) present the COCs and their respective EPC for surface water in Ralston Creek. Tables 7-3.10 through 7-3.12 (attached) present the COCs and their respective EPC for sediment in Ralston Creek. The tables list the arithmetic mean concentration and the maximum detected concentration for each of the COCs in groundwater. For the RME, the EPC for each COC is listed as well as the rationale for the selection of the EPC.

2. Exposure Assessment

   Exposure refers to the potential contact of an individual (the receptor) with a contaminant. The exposure assessment evaluates the magnitude, frequency, duration, and route of potential exposure. The RME scenarios are developed using current exposure pathways given existing land uses and also exposures which might reasonably be predicted based upon expected or logical future land use assumptions.

   The potential human receptors that were evaluated in the baseline risk assessment were adult and child residents, an apartment maintenance supervisor, an apartment groundskeeper, underground utility workers, construction workers, Ralston Creek cleanup volunteers (for the cleanup of Ralston Creek which is held annually), and children playing in the creek. These receptors were evaluated for potential exposure pathways including incidental ingestion of soil, dermal (skin) contact with soil, inhalation of dust and VOCs from soil, ingestion of groundwater, dermal contact with groundwater, inhalation of VOCs in groundwater due to household water uses (i.e., showering and cooking), and inhalation of volatile compounds migrating from subsurface soil and groundwater into air in the apartment building. Table 7-1 (attached) shows all of the exposure scenarios and pathways that were considered.

3. Toxicity Assessment

   Table 7-6.1 (attached) provides carcinogenic risk information for oral and dermal exposure to the COCs in soil, groundwater, and sediment. At this time slope factors are not available for the dermal route of exposure. Thus, the dermal slope factors used in the assessment have been extrapolated from oral values. An adjustment factor is applied and is dependent upon how well the chemical is absorbed via the oral route. Adjustments are particularly important for chemicals with less than 50% absorption via the ingestion route. Table 7-6.2 (attached) provides carcinogenic risk information for inhalation exposure to the COCs in soil and groundwater.

Table 7-5.1 (attached) provides noncarcinogenic risk information for oral and dermal exposure to the COCs in soil, sediment, and groundwater. As was the case with carcinogenic data, dermal reference doses are not available. The dermal reference doses can be extrapolated from oral values applying an adjustment factor as appropriate. Table 7-5.2 (attached) provides noncarcinogenic risk information for inhalation exposure to the COCs in soil and groundwater.

4. Risk Characterization

For carcinogens, risks are generally expressed as the incremental probability of an individual's developing cancer over a lifetime as a result of exposure to the carcinogen. Excess lifetime cancer risk is calculated from the following equation:

Risk = CDI x SF

where: Risk = a probability (e.g., $2x10^{-5}$) of an individual's developing cancer

CDI = chronic daily intake averaged over 70 years (mg/kg-day)

SF = slope factor, expressed as $(mg/kg\text{-}day)^{-1}$.

These risks are probabilities that usually are expressed in scientific notation (e.g., $1x10^{-6}$). An excess cancer risk of $1x10^{-6}$ indicates that an individual experiencing the reasonable maximum exposure estimate has a 1 in 1,000,000 chance of developing cancer as a result of site-related exposure. This is referred to as an *excess lifetime cancer risk* because it would be in addition to the risks of cancer individuals face from other causes such as smoking or exposure to too much sun. The chance of an individual developing cancer from all other causes has been estimated to be as high as one in three. The EPA's generally acceptable risk range for site-related exposures is 10^{-4} to 10^{-6}.

The potential for noncarcinogenic effects is evaluated by comparing an exposure level over a specified time period (e.g., lifetime) with a reference dose (RfD) derived for a similar exposure period. An RfD represents a level that an individual may be exposed to that is not expected to cause any deleterious effect. The ratio of exposure to toxicity is called a hazard quotient (HQ). A HQ less than one indicates that a receptor's dose of a single contaminant is less than the RfD and that toxic noncarcinogenic effects from that chemical are unlikely. The HI is generated by adding the HQs for all COCs that affect the same target organ (e.g., liver) or that act through the same mechanism of action within a medium or across all media to which a given individual may reasonably be exposed. A HI less than one indicates that, based on the sum of all HQs from different contaminants and exposure routes, toxic noncarcinogenic effects from all contaminants are unlikely. A HI greater than one indicates that site-related exposures may present a risk to human health.

The HQ is calculated as follows:

Non-cancer HQ = CDI/RfD
where: CDI = chronic daily intake
RfD = reference dose.

Tables 7-9.1 through 7-9.10 (attached) present the carcinogenic and noncarcinogenic risk estimates for each of the RME scenarios. These risk estimates are based upon a reasonable maximum exposure and were developed by taking into account various conservative assumptions about the frequency and duration of a receptor's exposure to soil, groundwater, sediment, and surface water as well as the toxicity of the COCs. Each table shows the total risks associated with direct exposure to COCs in the specified media for a particular timeframe, receptor population, and receptor age.

The potential carcinogenic and noncarcinogenic human health effects are within acceptable risk ranges for potential receptors for surface and subsurface soil, with the exception of noncarcinogenic effects on potential future construction workers. The HI for a potential future construction worker was 2.8. The potential future construction worker was evaluated for a large construction project, exposed to soil to a depth of ten feet bgs for 190 days over an exposure duration of one year. The main exposure pathway of concern was inhalation of outdoor air when up to ten feet of soil is disturbed. Naphthalene was the primary contributor to this risk with an HI of 2.1. The volatilization potential was estimated using conservative default parameters in an EPA model presented in the EPA's Soil Screening Guidance. The results of the modeling were likely to overestimate the actual outdoor air naphthalene concentration.

Potential risks for current/future residents were evaluated for exposure to constituents in surface soil and indoor air. For adults, the total estimated HI was 0.38 and the total cancer risk was 1.7×10^{-6}. For children, the HI was 1.4 (above the benchmark of 1.0) but no individual constituent had a hazard quotient greater than one and no total HI for a primary target organ exceeded unity. The cancer risk for a child resident was estimated to equal 9.3×10^{-6}. Most of the cancer risk for adult and child residents was related to arsenic which is present at concentrations that may be naturally occurring. These results indicate the Site risks are within acceptable ranges for current and future residents.

For the maintenance supervisor potential pathways including incidental ingestion, dermal contact with surface soil, and inhalation of constituents in indoor air were evaluated. The cancer risk was estimated to be 2.5×10^{-6} and the HI was estimated to be 0.12. These results indicate risks to the maintenance supervisor are within acceptable risk ranges established by the EPA.

A utility worker that performed maintenance/repairs to utility lines servicing the Iowa-Illinois Manor was evaluated for inhalation of dust and incidental ingestion of and dermal contact with soil to a depth of ten feet bgs, inhalation of volatile constituents encountered while excavating, and working within a utility trench. The exposure risks were initially assessed for the zero to six feet bgs interval. The estimated HI was 0.42 and the estimated cancer risk was 8.8×10^{-7}. These results indicate risks to utility workers are negligible. Utility worker exposure to soil below six feet was further evaluated via the construction worker, which is a more conservative receptor with greater exposure potential (including exposure frequency and duration) than the utility worker. Based on a comparative analysis of the exposure frequencies of the two receptors, risks to utility workers would be over an order of magnitude less than the risk to construction workers, resulting in a negligible risk for utility workers.

Although there are no current groundwater receptors, a hypothetical scenario was evaluated assuming that future residents would install a well in the shallow aquifer and use the most contaminated water as their household water supply. The cancer risk for an adult would be 2.1×10^{-2}. For a child the cancer risk would be 4.5×10^{-2}. The calculated HIs were 3,000 and 7,100 for adults and children, respectively. There would be a 96 percent probability that the ten micrograms per deciliter (µg/dl) blood-lead benchmark would be exceeded from lead exposure to young children six years old or younger. The majority of the carcinogenic risk is posed by benzo(a)pyrene, benzene, and dibenzo(a,h)anthracene. The majority of the noncarcinogenic risk is posed by naphthalene and benzene.

Potential risks for current/future residents were evaluated for exposure to constituents in indoor air. For adult resident exposure to indoor air, the estimated HI was 0.29 and the cancer risk was 9.5×10^{-7}. For a child resident exposed to indoor air, the HI was 0.68. The cancer risk for a child resident was estimated to equal 2.2×10^{-6}. For the maintenance supervisor, inhalation of constituents in indoor air resulted in a cancer risk estimate of 1.7×10^{-6} and an HI of 0.1. Based on these findings, air does not pose a significant health risk to Iowa-Illinois Manor residents or maintenance workers.

The cleanup volunteer was assumed to come into contact with constituents in surface water and sediment as a part of litter cleanup associated with Ralston Creek. This scenario was evaluated because an annual cleanup of the creek has been performed in the past. An evaluation was performed for reaches of the creek that are adjacent, upstream, and downstream of the Site. The HI associated with all three of these reaches was less than one, with values of 0.0014, 0.0004, and 0.0061 for the adjacent, downstream, and upstream reaches, respectively. The cancer risk estimates for all three reaches were less than 1×10^{-6}, with values of 3.1×10^{-7}; 1.5×10^{-7}, and 1.2×10^{-7} for the upstream, adjacent, and downstream reaches, respectively. These results indicate risks for this receptor are negligible.

The recreational visitor was assumed to be an older child who visited the stream twice per week during the warmer half of the year. Potential risks from exposure to surface water and sediment were estimated for the reaches of the creek that are adjacent, upstream, and downstream of the Site. The HI was less than one for all three reaches with values of 0.014, 0.063, and 0.004 for the adjacent, upstream, and downstream reaches, respectively. The total cancer risk slightly exceeded 1×10^{-6} for all three reaches with values of 3.1×10^{-6}, 1.4×10^{-6}, and 1.1×10^{-6} for the upstream, adjacent, and downstream reaches, respectively. These results indicate risks for this receptor are within the EPA's acceptable risk range, and are no greater for areas potentially affected by Site releases than areas clearly unaffected by the Site.

These estimates of risk, like all estimates of risk, have some degree of uncertainty associated with them. To ensure the protection of public health, uncertainties inherent in the risk assessment process typically err on the side of conservatism. Therefore, the risks presented are most often overestimated. Some of the uncertainties associated with this baseline risk assessment include:

- Due to limited collection of background soil samples, contaminants such as arsenic, which was detected on-site in surface soil at concentrations typical of background levels, may be overestimated.
- Due to the high variability in the limited number of surface water and sediment samples, risk may be over- or underestimated.
- The exposure duration for the apartment resident was based upon the current student population. If the residents were to be a less transient population in the future, the cancer risks may be underestimated. However, even if it is assumed that the exposure duration increases to the residential default of 30 years, the cancer risk would still be in the acceptable risk range.
- Much of the risk to a resident was assumed to occur through ingestion of soil, which is unlikely given that most of the Site has no exposed soil.
- The dermal carcinogenicity of PAHs has a high degree of uncertainty.

E. Summary of Ecological Risk Assessment

The qualitative macroinvertebrate assessment conducted in 2002 documented the degraded physical conditions of Ralston Creek and a pollution-tolerant benthic organism community reflective of a water body managed as a drainage channel. The benthic study indicated that the benthic organisms were generally the same throughout the study area, with the greatest species diversity adjacent to and just downstream of the Site. The benthic organisms were likely more dependent on the creek conditions and vegetation (shade, substrate, etc.) than on contaminant concentrations. Without changing the management of the creek from that of a drainage channel to that of a natural resource, improvement in the creek's ecological function cannot be expected.

The ecological assessment concluded that the significant ecological resource to be protected is the fishery located at the confluence of Ralston Creek and the Iowa River, and that contaminants of potential ecological concern were not migrating to the Iowa River in concentrations that are discernable above both background concentrations and screening values.

F. Basis for Action

The response action selected in this ROD is necessary to protect the public health or welfare or the environment from actual or threatened releases of hazardous substances into the environment.

VIII. Remedial Action Objectives

Remedial Action Objectives (RAOs) provide a general description of what the cleanup will accomplish. The RAOs are most often general objectives such as control of exposure to contaminants, control of plume migration, restoration of the groundwater to drinking water quality, etc. These objectives are based on available information and standards such as applicable or relevant and appropriate requirements (ARARs) of other environmental laws and risk-based levels established in the risk assessment. The RAOs for the Site are to:

- Prevent and/or reduce human exposure to groundwater containing COCs that exceed ARARs or health-based levels.
- Prevent and/or reduce future soil exposure risks to acceptable levels by maintaining the existing land use. The future soil RAO may be reevaluated if the building is removed or its use changed.
- Prevent and/or reduce future human exposure to indoor air containing COCs that exceed health-based levels.
- Maintain the existing ecological steady state and prevent and/or reduce future unacceptable risks to human health and the environment in Ralston Creek.

Action levels are the concentrations of the COCs in the affected media that must not be exceeded to ensure that the RAOs will be met. These levels were initially developed for this Site during the FS. The processes for doing so for each media are described below. The action levels for groundwater were determined based upon the following hierarchy:

- The maximum contaminant level (MCL) pursuant to the Safe Drinking Water Act for the contaminant when an MCL is available.
- For contaminants without an MCL, the action level was calculated based on an excess lifetime cancer risk of 1×10^{-6} and/or a target hazard quotient of 1.
- When the calculated risk-based action level is below the laboratory practical quantitation limit (PQL), the PQL is used as the action level, provided it falls within the acceptable risk range.

The action levels for groundwater at the Site and the rationale for their selection are listed in Table 1, attached.

There are no soil action levels as surface soil at the Site does not pose an unacceptable risk. Prevention of future subsurface soil exposure for construction workers will be addressed through institutional controls.

Benchmark concentrations for indoor air monitoring were calculated for benzene and naphthalene based on an excess cancer risk of 1×10^{-6} and/or a target hazard quotient of 1. The benchmark concentration for benzene is 0.8 microgram per cubic meter ($\mu g/m^3$) and the action level for naphthalene is 1.3 $\mu g/m^3$.

Sediment samples from Ralston Creek will be compared against consensus-based probable effects concentrations (PECs) of PAHs for freshwater ecosystems (nonhuman receptors) as indicators of possible new contribution of contaminants from the Site into the creek These are contaminant concentrations that have been developed for specific compounds above which the inhabitants of a body of freshwater could be negatively affected. The PECs are listed in Table 2, attached. These levels are significantly lower than any concentration that would pose a threat to human health, so they will also serve as benchmarks that would be protective of human exposure to creek sediment.

IX. Description of Alternatives

A feasibility study was conducted to develop and evaluate remedial alternatives for the Site. Remedial alternatives were assembled from applicable remedial process options and were initially evaluated for effectiveness, implementability, and cost. The alternatives meeting these criteria were further evaluated and compared to the nine criteria required by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP). In addition to the remedial alternatives, the NCP requires that a no action alternative be considered. The no action alternative serves primarily as a point of comparison for the other alternatives. Seven alternatives, including the no action alternative, were considered and are summarized below:

Table 3
Remedial Alternatives

1	No Action
2	Institutional Controls
3	Institutional Controls and Groundwater Monitoring
4	Institutional Controls and Monitored Natural Attenuation (MNA)
5	Institutional Controls and Biosparge with Groundwater Monitoring
6	Institutional Controls with Groundwater Extraction, Treatment, and Monitoring
7	Institutional Controls and LNAPL Recovery with MNA

All of these alternatives (except the no action alternative) include common elements. Descriptions of these elements follow.

Institutional Controls (ICs): Each of the alternatives (except for the no action alternative) includes implementation of ICs. The ICs include the following:

- An existing city code requiring connection to the public water supply.
- An existing county ordinance requiring notification regarding setbacks from contamination for groundwater well installation.
- An existing state rule governing installation of wells in areas of contamination.
- An environmental covenant prohibiting installation of on-site wells, limiting excavation, ensuring maintenance of the liner and the passive venting system beneath the apartment building, and providing notice prior to any changes in use of the Site property.
- An environmental covenant or other institutional control to prohibit installation of wells, disturbance of the tile lining, and maintenance of the tile lining in Ralston Creek in the area adjacent to the Site.

Air Monitoring: Each of the alternatives (except the no action alternative) includes periodic sampling of the air in the Iowa-Illinois Manor apartment building to determine whether occupants might be exposed to site-related contaminants exceeding health-based levels in the future.

Sediment Monitoring: Each of the alternatives (except the no action alternative) includes periodic sampling of the sediment in Ralston Creek adjacent to the Site to determine whether an on-going discharge of site-related contaminants are reaching the sediment at levels posing unacceptable ecological or health-based risks in the future.

Groundwater Monitoring: The specific type and frequency of monitoring may vary for each of the alternatives (except the no action alternative and Alternative 2) but at the very least would include periodic analysis of groundwater samples collected from monitoring wells on and off the Site for the COCs.

Monitored Natural Attenuation (MNA): Natural attenuation refers to the naturally occurring processes in the environment that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. For this Site, intrinsic biodegradation of groundwater is the process of interest. This process is occurring to some extent for all of the alternatives. Only those alternatives that include MNA as part of the description of the alternative (Alternatives 4 and 7) would include monitoring with analysis of special parameters to evaluate whether biodegradation is taking place.

A. Alternative 1 – No Action

The NCP requires that the EPA consider a no action alternative against which other remedial alternatives can be compared. Under this alternative no further action would be taken to monitor, control, or remediate the air, soil, sediment, or groundwater at the Site. There is no cost associated with this alternative.

The expected outcome of Alternative 1 is that RAOs would be unlikely to be met in decades or even centuries, since significant amounts of DNAPL are known to exist in the groundwater and contaminants remain in subsurface soil. There would be no measures in place to ensure that unacceptable levels of contamination would not be present in indoor air and the sediment in Ralston Creek in the future. There would be no environmental covenants implemented to control actions taken on the Site property or within the portion of Ralston Creek adjacent to the Site to limit current unacceptable exposures or prevent future unacceptable exposures.

B. Alternative 2 – Institutional Controls

Alternative 2 includes the ICs and air and sediment monitoring as described previously. There would be no groundwater monitoring. The objective of the ICs is to achieve the RAOs by prohibiting installation and use of water wells, preventing exposure to contamination in air, subsurface soil, and creek sediment. Data gathered at the Site indicate that natural attenuation is likely occurring and that conditions are conducive to sustaining groundwater contaminant plume stability through contaminant degradation. However, without groundwater monitoring there would be no way to determine what is occurring within the plume. There would be no actions taken to remove contamination from groundwater or to monitor the movement of the contaminant plume.

The expected outcome of Alternative 2 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. Without any groundwater monitoring it would be impossible to determine the extent of the contaminated groundwater, although it is not anticipated that the entire plume would ever achieve the groundwater action levels.

C. Alternative 3 – Institutional Controls and Groundwater Monitoring

Alternative 3 includes all of the components in Alternative 2 with the addition of periodic groundwater monitoring. The groundwater monitoring would occur at monitoring wells within and outside of the contaminated plume. The samples would be analyzed for the COCs.

The expected outcome of Alternative 3 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. Groundwater monitoring would provide a mechanism for monitoring the movement of contaminated groundwater, although it is not anticipated that the entire plume would ever achieve the groundwater action levels.

D. Alternative 4 – Institutional Controls and Monitored Natural Attenuation (MNA)

Alternative 4 includes all of the components of Alternative 3 with the addition of groundwater analysis to determine if and the rate at which natural attenuation is occurring. With this alternative no further actions are taken to accelerate the cleanup of the groundwater. The additional analysis will provide information to determine whether the groundwater plume is stable or decreasing, and whether Site conditions remain favorable for natural attenuation to occur.

The expected outcome of Alternative 4 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. Groundwater monitoring would provide a mechanism for monitoring the movement of contaminated groundwater, although it is not anticipated that the entire plume would ever achieve the groundwater action levels. Monitoring for the MNA constituents would provide additional information pertaining to the mechanisms that maintain plume stability.

E. Alternative 5 – Institutional Controls and Biosparge with Groundwater Monitoring

Alternative 5 includes all components of Alternative 3 with the addition of biosparging to stimulate bioremediation of contaminants in the saturated and unsaturated soils. Biosparging involves the use of low flow rates of air injected into the groundwater to enhance aerobic biodegradation. Sufficient oxygen typically remains to stimulate bioremediation in the unsaturated zone as well. One significant limitation to the effectiveness of biosparging for this Site is that many of the contaminants have relatively low volatility and would not likely be remediated through this technique. Also, there are concerns about minimizing vapor migration at this Site so contaminants do not move from the subsurface into the air in the apartment building. Biosparging would not be effective in the bedrock aquifer since the air would likely follow the fractures in the bedrock and would not be distributed through the groundwater in the bedrock aquifer. Also, it is possible that DNAPL could be mobilized. Movement of DNAPL would create a large plume of contamination increasing the volume of contaminated groundwater.

The expected outcome of Alternative 5 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. Biosparging may significantly reduce the amount of contaminant mass in the unconsolidated aquifer, but would not reduce contaminant mass in the bedrock aquifer. Biosparging may even lead to vapor accumulation in the air of the apartment building and mobilize DNAPL. It is not anticipated that groundwater in the unconsolidated aquifer would ever achieve the groundwater action levels, and since biosparging would not address the bedrock aquifer the action levels would not be achieved in that aquifer either.

F. Alternative 6 – Institutional Controls with Groundwater Extraction, Treatment, and Monitoring

Alternative 6 includes all of the components of Alternative 3 as well as extraction and treatment of groundwater from the unconsolidated and bedrock aquifers. Sufficient information is not currently known to accurately predict the number of extraction wells that would be needed but it was estimated that at least fourteen extraction wells would be required. The extracted groundwater would be pumped to a treatment system to remove contaminants prior to discharge to a storm or sanitary sewer. It is anticipated that centuries would be required to reduce the contaminant levels in groundwater to safe levels, so this alternative is considered a containment technology that would control the movement of contaminants in the groundwater rather than a method of achieving full aquifer restoration. There also is the potential that the process of extraction could mobilize the DNAPL and further spread contamination.

The expected outcome of Alternative 6 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. Since groundwater extraction and treatment would only remove dissolved-phase mass, the majority of contamination in the groundwater would not be removed and the groundwater action levels would not be met. Pumping could provide hydraulic control of the dissolved contaminated groundwater plume but may also have the opposite effect by causing DNAPL to move.

G. Alternative 7 – Institutional Controls and LNAPL Recovery with MNA

Alternative 7 includes all of the components of Alternative 4 with the addition of recovery of LNAPL from the unconsolidated aquifer. A treatability study into methods of LNAPL recovery was conducted and it was determined that the best method that could be employed at this point would be the placement of sorbent "socks" into existing monitoring wells in areas where LNAPL is present. The "sock" is a device that can be filled with a sorbent material that will preferentially absorb the contamination that is not dissolved in the groundwater (i.e., LNAPL). The sorbent socks would be checked periodically and replaced when saturated with LNAPL. This is a very low-risk, low-cost method of reducing the contaminant mass at the water table. Natural attenuation would be enhanced by the removal of this additional contaminant mass.

The expected outcome of Alternative 7 is that the ICs would prevent exposure to contaminated water, air, soil, and sediment. LNAPL recovery will remove contaminant mass from the unconsolidated aquifer; however, a significant level of contaminant mass will remain in that aquifer. There will be no reduction in contaminant mass in the bedrock aquifer through LNAPL recovery. Groundwater monitoring would provide a mechanism for monitoring the movement of contaminated groundwater, although it is not anticipated that the entire plume would ever achieve the groundwater action levels. Monitoring for the MNA constituents would provide additional information pertaining to the mechanisms that maintain plume stability.

X. Comparative Analysis of Alternatives

Nine criteria are used to evaluate the different remediation alternatives individually and against each other in order to select a remedy. The nine evaluation criteria are (1) overall protection of human health and the environment; (2) compliance with applicable, relevant and appropriate requirements (ARARs); (3) long-term effectiveness and permanence; (4) reduction of toxicity, mobility, or volume of contaminants through treatment; (5) short-term effectiveness; (6) implementability; (7) cost; (8) state/support agency acceptance; and (9) community acceptance. This section of the ROD profiles the relative performance of each alternative against the nine criteria, noting how it compares to the other options under consideration. The nine evaluation criteria are discussed below. The *Detailed Analysis of Alternatives* can be found in the FS Report.

A. Overall Protection of Human Health and the Environment

Overall protection of human health and the environment addresses whether each respective alternative provides adequate protection of human health and the environment and describes how risks posed through each exposure pathway are eliminated, reduced, or controlled, through institutional controls, engineering controls, and/or treatment.

All of the alternatives (except Alternative 1 – No Action) provide adequate protection of human health. All other alternatives utilize layered institutional controls to prohibit future well placement and control property usage in areas of contamination to achieve adequate protection of human health and the environment. Alternatives 3 and 4 include monitoring of current plume conditions and are effective due to the ICs. Alternative 5 combines ICs with biosparging, and would likely result in significant mass reduction of biodegradable compounds (VOCs and some PAHs) in the unconsolidated aquifer. Alternative 6 combines ICs with groundwater extraction and treatment and would potentially reduce contaminant migration, and achieves limited mass removal of VOCs, PAHs, and metals. Alternative 7 combines ICs and monitoring with LNAPL recovery to reduce the total contaminant mass present at the water table.

Alternatives 5 and 6 may pose a potential threat to the environment through mobilization of NAPL. Groundwater pumping is likely to disturb the steady-state DNAPL distribution and result in increased risk to human health and the environment by promoting migration and increasing contaminant dissolution. The presence of DNAPL in fractured bedrock suggests no groundwater alternative is likely to achieve remedial cleanup goals for carcinogenic PAHs such as benzo(a)pyrene and dibenzo(a) anthracene.

Because the no action alternative (Alternative 1) is not protective of human health and the environment, it was eliminated from consideration under the remaining eight criteria.

B. Compliance with ARARs

Section 121(d) of CERCLA, 42 U.S.C. Section 6921(d), requires that remedial actions at CERCLA sites at least attain legally applicable or relevant and appropriate federal and state requirements, standards, criteria, and limitations which are collectively referred to as ARARs, unless such ARARs are waived under CERCLA.

Applicable requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address hazardous substances, the remedial action to be implemented at the site, the location of the site, or other circumstances present at the site. Relevant and appropriate requirements are those substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law which (while not applicable to the hazardous materials found at the site, the remedial action itself, the site location, or other circumstances at the site) nevertheless address problems or situations sufficiently similar to those encountered at the site that their use is well suited to the site.

Compliance with ARARs addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements of other federal and state environmental statutes or provides a basis for invoking a waiver.

None of the alternatives are likely to comply with chemical-specific ARARs for all compounds due to the nature and distribution of the contaminants at the Site. Alternative 5 (biosparge) may achieve chemical-specific ARARs for VOCs and low molecular weight PAHs in the unconsolidated aquifer sooner than all other alternatives. However, Alternative 5 would not significantly shorten the timeframe in achieving chemical-specific ARARs for PAHs or metals, or have a significant impact on the bedrock aquifer. Alternative 6 provides hydraulic control of the plume and removes some contaminant mass but is not expected to increase the likelihood of achieving chemical-specific ARARs. Due to the presence of DNAPL in fractured bedrock it is unlikely that the EPA's MCLs, pursuant to the Safe Drinking Water Act for public water supplies, would ever be met for benzo(a)pyrene or even the more biodegradable compounds that comprise BTEX. It has been demonstrated through past experience at similar sites that long-term treatment of high levels of dissolved concentrations of PAHs cannot be remediated in a reasonable timeframe. At this time there is no known reliable method for removing and remediating the undissolved contamination in groundwater (DNAPL) or treating it in place.

When there are site-specific conditions that may inhibit groundwater restoration such as is the case at this Site, the EPA has established guidance and a mechanism to evaluate the technical impracticability of restoring groundwater to meet ARARs.

This has been documented in the FS Report and therefore it has been determined that a Technical Impracticability (TI) ARAR waiver is appropriate for the groundwater contaminants at the Site. The EPA refers to the portion of the aquifer where groundwater cannot be restored to drinking water standards within a reasonable timeframe as the "TI zone." The TI zone for this Site is shown in Figure 5. It is possible that the exact location of the TI zone may be modified in the future to the southwest as more information about the plume in this area is developed during implementation of the remedy.

All of the alternatives have common ARARs associated with the drinking water standards for groundwater. Acquisition of permits would not be necessary for on-site treatment options. A permit would be necessary for any surface discharge of treated water for Alternative 6. Alternative 7, which includes LNAPL recovery, would be required to meet Solid Waste Disposal Act requirements for proper handling and disposal of the recovered material.

C. Long-term Effectiveness and Permanence

Long-term effectiveness and permanence refers to expected residual risk and the ability of a remedy to maintain reliable protection of human health and the environment over time, once cleanup levels have been met. This criterion includes the consideration of residual risk that will remain on-site following remediation and the adequacy and reliability of controls.

All of the alternatives adequately protect human health and the environment because the ICs would effectively prevent any future groundwater exposure pathway and control future property uses. The ICs may include: (1) the city code requiring connection to the public water system; and (2) the county ordinance, which considers distance from contaminated groundwater when evaluating well permits; (3) existing IDNR rules; and (4) environmental covenants which prohibit future well installation, maintain existing conditions in Ralston Creek, and provide controls on the Site property. These ICs are layered to increase their reliability. The city code, which is recognized by the IDNR as a valid institutional control, the county ordinance, and existing IDNR rules are expected to have a high level of long-term effectiveness and reliability because they have been in existence for a significant period of time and have served as effective tools in controlling other contaminated sites in and around Iowa City. Because an environmental covenant is a legally binding document, approved by IDNR, and standardized in state code, a high level of long-term effectiveness and reliability is expected. All alternatives will require a five-year review.

Alternative 5 may significantly increase the mass removal rate of VOCs in the unconsolidated aquifer through enhancement of biological degradation processes, but its effectiveness is not well demonstrated at FMGP sites. Alternative 6 maintains hydraulic control and removes some dissolved contaminant mass; however, unless operation is continued indefinitely, experience at other sites has demonstrated this technology does not reliably remediate the groundwater at FMGP sites, and that concentrations will rebound after shutdown. Alternatives 5, 6, and 7 will require long-term monitoring and management. Alternatives 2, 3, and 4 are similar with the difference that Alternatives 3 and 4 employ monitoring to assess contaminant trends (Alternative 3) or natural attenuation processes (Alternative 4).

Alternatives 5 and 6 may mobilize DNAPL thus exacerbating current conditions. Groundwater extraction may draw DNAPL to the extraction wells and vertically downward without recovering the DNAPL. Mobilization of DNAPL is likely to increase the total volume of impacted groundwater. Disturbing the steady-state conditions will likely cause greater dissolution into groundwater, thus increasing contaminant concentrations. Biosparging could move DNAPL into bedrock fractures. Biosparging may also mobilize LNAPL (primarily at startup); however, system operation may be more readily adjusted to mitigate LNAPL migration than groundwater extraction to mitigate DNAPL migration.

D. Reduction of Toxicity, Mobility, or Volume of Contaminants through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the anticipated performance of the treatment technologies that may be included as part of a remedy.

Alternative 5 has the highest likelihood of achieving the greatest VOC mass removal within the shortest timeframe, thereby reducing toxicity and the volume of contaminants remaining. Alternative 6, although primarily a containment mechanism, will remove dissolved-phase contaminants in addition to reductions through natural attenuation processes. Alternatives 5 and 6 may potentially increase contaminant mobility by mobilizing NAPL. Alternative 7 removes free-phase product reducing the toxicity, mobility, and volume of contamination at the Site. Alternatives 2 through 4 do not involve active treatment and, therefore, create no greater degree of reduction in toxicity, mobility, or volume, than ongoing intrinsic remediation. Significant amounts of contaminant mass consisting of carcinogenic PAHs will remain at the Site under all alternatives.

E. Short-term Effectiveness

Short-term effectiveness addresses the period of time needed to implement the remedy and any adverse impacts that may be posed to workers, the environment, and the community during construction and operation of the remedy until cleanup goals are achieved.

In general, the alternatives with the fewest construction activities will pose the lowest risk to Site workers and the community during the remedial action. Alternatives 2 through 4 pose minimal risk to the community or environment from monitoring; however, a slight risk of field and laboratory worker exposure to contaminants is present while sampling and analyzing the environmental samples. Alternative 5 potentially exposes Site workers to soil contamination during system installation, but risk to the community is minimal. Operation of the biosparge system adds an additional risk to workers from the mechanical and electrical equipment. Since only clean air is injected, there is minimal increased risk of exposure to Site contaminants. The biosparge system may mobilize LNAPL and increase contaminant flux to Ralston Creek at initial startup and may cause vapor migration to the apartment building, potentially increasing exposures in both places. Alternative 6 actively extracts and treats groundwater; therefore, the risk to workers is increased during equipment repair, cleaning, and sludge handling. Some of the contaminants are transferred to the vapor phase during treatment; therefore, some additional community exposure is also likely. Alternative 7 recovers LNAPL resulting in potential exposure to Site workers, the community, and the environment in the event of an accidental release during recovery or storage. These risks can be minimized with proper personal protective equipment, standard operating procedures, and a secure storage alternative.

F. Implementability

Implementability addresses the technical and administrative feasibility of a remedy from design through construction and operation. Factors such as availability of services and materials, administrative feasibility, and coordination with other governmental entities are also considered.

All of the alternatives include ICs. The ICs provided by the city code, county ordinance, and IDNR rules have already been implemented. Environmental covenants on the Site property and the stretch of Ralston Creek adjacent to the Site should not be difficult to implement with the cooperation of the property owners, which is expected.

Alternative 6 is the most difficult alternative to implement because of the complex treatment process and equipment maintenance and reliability issues that are likely to result from downtime caused by pump failure, biofouling, metal precipitation, carbon fouling, and line breaks. In addition, significant off-site access to property owner by multiple parties is required to install and maintain the system. Alternative 5 is the next most difficult alternative to implement due to system scope and off-site property access. Alternatives 3 and 4 include ongoing monitoring which is relatively easily accomplished. Alternative 7 is the easiest active remediation alternative to implement because the activities have been shown to be effective at the Site, access to only the Site itself is required, and procedures are already in place.

G. Cost

Cost includes estimated capital and operation and maintenance costs as well as present worth costs. Present worth cost is the total cost of an alternative over time in terms of today's dollar value. Cost estimates are expected to be accurate within a range of +50 to -30 percent.

The estimated cost of each of the alternatives is given in the description of the alternatives. A detailed itemization of costs and assumptions for each alternative is included in Appendix H of the FS Report. Cost estimates for each of the alternatives were developed assuming the remedy would operate for 30 years for ease of comparison. None of the alternatives would be likely to achieve the RAOs in 30 years and the costs would increase significantly with much longer periods of operation.

The alternatives from most to least expensive are:

Alternative 6	$5,706,100
Alternative 5	4,116,300
Alternative 7	1,590,800
Alternative 4	1,442,200
Alternative 3	1,242,800
Alternative 2	590,500

H. State/Support Agency Acceptance

The IDNR has participated in the oversight of activities at the Site, including review of the RI and FS Reports. The IDNR supports the Selected Remedy: Alternative 7.

I. Community Acceptance

During the public comment period, including the public meeting held in Iowa City, numerous comments were received. The comments and the EPA's responses may be found in the Responsiveness Summary section of this ROD.

XI. Principal Threat Wastes

The NCP establishes an expectation that the EPA will use treatment to address the principal threats posed by a site wherever practicable [NCP §300.430(a)(1)(iii)(A)]. In general, principal threat wastes are those source materials considered to be highly toxic or highly mobile which generally cannot be contained in a reliable manner or would present a significant risk to human health or the environment should exposure occur.

The contaminated groundwater is not considered to be a principal threat for the Site. However, the LNAPL and DNAPL found in the groundwater may be considered source material. The extent of contamination underneath the Iowa-Illinois Manor apartment building is not known but it is possible that some highly contaminated source material exists in that area. Presence of that material would not affect the alternatives discussed above as they relate to groundwater.

XII. Selected Remedy

The Selected Remedy for the Site is Alternative 7. Alternative 7 provides for the implementation of institutional controls, periodic air monitor, periodic sediment monitoring, MNA, and the recovery of LNAPL through the placement of sorbent socks in affected monitoring wells.

A. Summary of the Rationale for the Selected Remedy

The Selected Remedy was chosen over the other alternatives because it is expected to achieve substantial reduction of the risks posed by contamination and implements measures to control any future exposure to contaminated groundwater, soil, air, and sediment. Although Alternatives 5 and 6 involve treatment of contaminants they may not provide more long-term effectiveness and are less effective in the short-term. Alternatives 5 and 6 are substantially more expensive than the Selected Remedy. Alternative 2 is the least costly to implement but it would not be possible to confirm compliance with the RAOs outside the TI zone without monitoring the groundwater. The costs of Alternatives 3 and 4 are essentially equivalent to the cost of the Selected Remedy but these alternatives do not include the advantage of the removal of contaminant mass provided by LNAPL recovery.

B. Description of the Selected Remedy

The Selected Remedy includes implementation of institutional controls, periodic air monitoring, periodic sediment monitoring, MNA, and LNAPL recovery. LNAPL recovery reduces a source of groundwater contamination and potential contaminant migration. A Treatability Study was conducted to test active LNAPL recovery by vacuum extraction at the Site. Based on results of the Treatability Study, it is unlikely extensive vacuum-aided recovery, active skimmer wells, or manual bailing of free product will remove sufficient volumes of LNAPL to be cost effective. For the Selected Remedy, free product recovery will be conducted primarily by passive recovery using sorbent socks placed in wells. Sorbent socks will be placed in monitoring wells LMW-4, MW-2, MW-8, and MW-48. Based on information gained during extensive drilling and well installation in the vicinity of MW-8, no additional wells will need to be installed for LNAPL recovery.

Sorbent socks would be checked on a routine monthly to quarterly schedule based on Site conditions. In wells where the sorbent socks are regularly saturated after one month, new socks will be placed on a monthly basis. In other wells, the socks can be left in place or wrung out and reused if the recovery rate is slow.

LNAPL recovery will not significantly reduce site-wide groundwater concentrations and institutional controls in conjunction with implementation of the TI zone will be required to continue to protect human health. MNA serves to monitor COCs and assess the ongoing potential for intrinsic remediation. LNAPL recovery represents a low-risk, low-cost option to reduce contaminant mass at the water table. Institutional controls on the Site property and periodic air monitoring in the apartment building will ensure continued protection of the apartment residents in the future. Institutional controls and period sediment monitoring will ensure continued protection of Ralston Creek in the vicinity of the Site in the future.

C. Cost Estimate of the Selected Remedy

Table 4 (attached) was taken from Appendix H of the FS Report and provides a detailed cost estimate for implementation of the Selected Remedy. The capital expenditures planned for this remedy include the costs of developing the monitoring plans and ICs; installing a limited number of additional monitoring wells; initial groundwater, air, and sediment sampling and analysis; LNAPL recovery; and producing reports. This amounts to $192,709 of the total costs.

The discount rate used in calculation of the present net-worth costs is five percent. The information in this cost-estimate summary table is based on the best available information regarding the anticipated scope of the Selected Remedy. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedy. Major changes may be documented in the form of a memorandum in the Administrative Record, an explanation of significant difference, or a ROD amendment. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost.

D. Expected Outcomes of the Selected Remedy

The expected outcome of Selected Remedy is that the ICs will prevent exposure to contaminated water, air, soil, and sediment. Monitoring of air and sediment will ensure that there are no exposures to unacceptable levels of contaminants in air and creek sediment. LNAPL recovery will remove some of the contaminant mass from the unconsolidated aquifer; however, a significant level of contaminant mass will remain in that aquifer. There will be no reduction in contaminant mass in the bedrock aquifer through LNAPL recovery. Groundwater monitoring will provide a mechanism for monitoring the movement of contaminated groundwater. Groundwater within the TI zone will never achieve MCLs and health-based action levels. Monitoring for the MNA constituents will provide additional information pertaining to the mechanisms that maintain plume stability.

XIII. Statutory Determinations

Under its legal authority, the EPA's primary responsibility at Superfund sites is to ensure that remedial actions achieve adequate protection of human health and the environment. In addition, Section 121 of CERCLA, 42 U.S.C. Section 6921, establishes several other statutory requirements and preferences. These specify that when complete the selected remedial action for this Site must comply with applicable or relevant and appropriate environmental standards established under federal and state environmental laws, unless a statutory waiver is justified. The Selected Remedy also must be cost effective and utilize permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Finally, the statute includes a preference for remedies that employ treatment that permanently and significantly reduce the volume, toxicity, and mobility of hazardous wastes as their principal element. The following sections discuss how the Selected Remedy meets these statutory requirements.

A. Protection of Human Health and the Environment

The proposed ICs in conjunction with implementation of the TI zone would eliminate potential exposure routes to groundwater. The ICs, LNAPL recovery, and monitoring are expected to be protective of human health and the environment. Natural attenuation processes may reduce groundwater concentrations over time for some compounds. LNAPL recovery would not significantly decrease the time period to achieve chemical-specific ARARs.

B. Compliance with ARARs

The Selected Remedy is expected to comply with ARARs. As described previously, pursuant to CERCLA 121(d)(4), compliance with ARARs may be waived when determined that it is technically impracticable to do so. The MCLs pursuant to the Safe Drinking Water Act are chemical-specific ARARs for the Selected Remedy. It has been documented in the FS Report that it is technically impracticable to achieve the MCLs and other health-based action levels within a specific portion of the contaminated groundwater plume. Therefore it has been determined that a TI ARAR waiver is appropriate for the groundwater contaminants at the Site. The EPA refers to the portion of the aquifer where groundwater cannot be restored to drinking water standards within a reasonable timeframe as the "TI zone." The TI zone for this Site is shown in Figure 5. It is possible that the exact location of the TI zone may be modified in the future to the southwest as more information about the plume in this area is developed during implementation of the remedy.

The Selected Remedy, which includes LNAPL recovery, would be required to meet Solid Waste Disposal Act requirements for proper handling and disposal of the recovered material.

C. Cost Effectiveness

The EPA believes the Selected Remedy is cost-effective and represents a reasonable value. In making this determination, the following definition was used: "A remedy shall be cost-effective if its costs are proportional to its overall effectiveness." [NCP §300.430(f)(1)(ii)(D)]. This was accomplished by evaluating the overall effectiveness of those alternatives that satisfied the threshold criteria (i.e., were both protective of human health and the environment and ARAR-compliant). Overall effectiveness was evaluated by assessing three of the five balancing criteria in combination (long-term effectiveness and permanence; reduction in toxicity, mobility, and volume through treatment; and short-term effectiveness). Overall effectiveness was then compared to costs to determine cost-effectiveness. The relationship of the overall effectiveness of the Selected Remedy was determined to be proportional to the cost and hence the Selected Remedy represents the most economically reasonable alternative.

D. Utilization of Permanent Solutions and Alternative Treatment Technology to the Maximum Extent Practicable

The Selected Remedy represents the maximum extent to which permanent solutions and treatment can be utilized in a cost-effective manner at this Site. Of the alternatives that are protective of human health and the environment and comply with ARARs outside of the TI zone, the EPA has determined that the Selected Remedy provides the best balance of trade-offs in terms of long-term effectiveness, reduction of toxicity, mobility, or volume achieved through treatment, short-term effectiveness, implementability, and cost. Additional considerations include the statutory preference for treatment as a principal element as well as state and community acceptance.

E. Five-Year Review Requirements

If there are hazardous substances, pollutants, or contaminants remaining at a site above levels that would allow for unlimited use and unrestricted exposure, pursuant to Section 121(c) of CERCLA and NCP §300.430(f)(5)(iii)(C), the EPA shall conduct a review of such remedial action no less often than each five years after the initiation of the remedial action to assure that human health and the environment are being protected. The Site will require a statutory five-year review.

XIV. Documentation of Significant Changes from Preferred Alternative of Proposed Plan

The Proposed Plan for the Site was released for public comment in July 2006. The Proposed Plan identified Alternative 7, institutional controls LNAPL recovery with MNA as the Preferred Alternative. The EPA reviewed the comments received during the public comment period. It was determined that no significant changes to the remedy, as originally identified in the Proposed Plan, were necessary or appropriate.

RECORD OF DECISION
RESONSIVENESS SUMMARY

IOWA CITY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA

PREPARED BY:

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION VII
KANSAS CITY, KANSAS

SEPTEMBER 2006

RECORD OF DECISION
RESPONSIVENESS SUMMARY

Introduction

This Responsiveness Summary has been prepared in accordance with the Comprehensive Environmental Response, Compensation and Liability Act, as amended, and the National Contingency Plan, 40 CFR §300.430(f). This document provides the response from the United States Environmental Protection Agency (EPA) to all significant comments received on the Proposed Plan from the public during the 30-day public comment period.

On July 28, 2006, the EPA released the Proposed Plan and Administrative Record which contains the pertinent documents for the Iowa City Former Manufactured Gas Plant Site (Site). The Proposed Plan discussed the EPA's proposed actions to address contamination at the Site. The public comment period began on July 28, 2006, and ended on August 27, 2006. The EPA held a public meeting on August 9, 2006, at the Iowa City Public Library to present the Proposed Plan and provide the public an opportunity to comment. A copy of the transcript from the public meeting is included in the Administrative Record.

Comments Received from the Public and Responses

The following comments were received verbally during the public meeting or in writing during the public comment period. In some cases several people made similar comments about an issue. Some of the comments were determined to relate to similar categories and have been grouped as such to provide some continuity in the responses. Similar comments have been grouped together whenever they can be addressed by a single response.

<u>Comments Regarding the Extent of Contamination</u>

Is the extent of soil, air, and groundwater contamination known, particularly at the properties adjacent to the Iowa-Illinois Manor (Manor) property?

During the course of the investigations conducted by the EPA and MidAmerican Energy Company, surface and subsurface soil samples were collected from adjacent properties surrounding the Site in all directions, fully characterizing the extent of soil contamination resulting from Site operations. During the same investigations air was sampled inside apartments and in the crawlspace beneath the Manor. Air samples were also collected outside the Manor near the crawlspace vent pipes and at locations near the property boundaries. Some of the air sampling was performed during cold weather when the building would be closed up with minimum air circulation but less opportunity for volatile contaminants to move out of the soil and into the air. Other air sampling was performed during warm weather when the opportunity for contaminant volatilization would be greater but the building may have a greater chance of being open for air circulation. Sufficient air sampling was performed to determine the risks that the Site poses to current residents. The extent of groundwater contamination has been determined through sampling of 55 monitoring wells installed at various depths on the Site and in the downgradient direction of groundwater flow. This network of monitoring wells has fully characterized the extent of groundwater contamination in the unconsolidated aquifer at the water table and at the bedrock surface. The extent of contamination in the bedrock Devonian and Silurian aquifer in the vicinity of the Site has been determined to the extent possible in fractured bedrock. The extent of contamination in this aquifer in the most downgradient direction has not been fully characterized and will be further investigated during implementation of the remedial action. At this time there is no indication that there would be a finding in this area that would have any impact on the Selected Remedy.

How can decisions regarding actions to be taken at the Site be made without knowing the extent of contamination beneath the Manor? Shouldn't samples be collected from beneath the building?

Determining the extent of contamination at a site is necessary to: (1) determine the potential human health and ecological exposure pathways, (2) quantitatively determine the risks that are associated with these exposure pathways, and (3) ultimately determine the appropriate remedial action(s) to address contamination that results in unacceptable levels of risk. Soil and groundwater samples were collected all around the Manor and air samples were collected in the building and its crawlspace. This information was sufficient to determine the potential exposure pathways that might pose a risk as a result of contamination from the Site and calculate the risks for each of these pathways. Soil directly beneath the building did not present a threat to building occupants. If contaminated soil exists beneath the Manor, and after demolition of the building it were possible to remediate it through some method (i.e., excavation and off-site treatment or disposal, in situ treatment, etc.) it would not significantly improve the downgradient groundwater contamination that exists. Due to the presence of dense, nonaqueous phase liquid (DNAPL) in the groundwater, even the removal of contaminated soil from beneath the Manor would have a very negligible impact on groundwater quality. For these reasons, it was determined that there was very limited benefit attempting to sample beneath the Manor. Doing so posed the possibility of damaging the support structure for the building.

Even though it was reported that natural gas was first introduced to the community in 1937, the manufactured gas plant (MGP) may have operated later than this date. How does that affect the determination of the extent of contamination associated with the Site?

The investigation into the extent of contamination resulting from MGP operations was not dependent upon the exact date when operations ceased. Historical records were reviewed in an attempt to determine where features of the plant were located as well as other geographical features such as Ralston Creek. This information provided a starting place for Site investigations. The results of initial sampling led to further investigations to determine the full extent of contamination emanating from the Site.

Was all of the coal tar material removed before the building was built? Is it known where any material that was removed from the Site was disposed?

It is unlikely that all of the coal tar material was removed prior to construction of the Manor. There is very limited information regarding the extent to which contaminated material was removed during decommissioning of the MGP or prior to the construction of the Manor. One report was found that indicates the feature identified as the "cistern" on Figure 1 was thoroughly cleaned out. The soil boring collected from within that cistern (SB-B) indicates that any waste was likely removed. However, there is no information to conclusively determine how much, if any, other coal tar material was removed prior to construction of the Manor. It is not known where any material that may have been removed historically was disposed. The disposition of any wastes generated during the investigations conducted at the Site is described in the work plans and reports describing the investigations.

Is the light nonaqueous phase liquid (LNAPL) seen in Ralston Creek coming from groundwater originating at the Site?

One monitoring well directly adjacent to Ralston Creek (MW-2) has exhibited the presence of LNAPL. The groundwater is in communication with the surface water in Ralston Creek. Sheens are sometimes seen on the surface of the water in Ralston Creek even when the creek bed has not been disturbed. It is difficult to determine from where these sheens originated since the creek serves as a drainage feature for numerous streets, parking lots, and storm sewers both adjacent to and upstream of the Site. These sources could contribute the same contaminants as those associated with the Site. It has been observed that a sheen appeared when samples were being collected from the creek bed in the vicinity of the Site. This material may have been released from the sediment and could be the result of a release of contaminants from the Site or any of the other sources previously mentioned. Implementation of the institutional controls pertaining to Ralston Creek is believed to be sufficient to maintain the quality of the creek in the future.

<u>Comments Regarding Risk Associated with the Site</u>

If there is no risk associated with the Site, why are additional actions being undertaken and additional money being spent?

In the Superfund program risk is evaluated for the conditions as they currently exist at the Site and as they may exist in the future if no actions are taken. While it is correct that there are <u>currently</u> no unacceptable levels of risk associated with the Site, the risks posed by the Site in the future may exceed acceptable levels if the Selected Remedy is not implemented. Currently no one is drinking the groundwater or being exposed to it through other household uses. Exposure to surface and subsurface soil does not pose an unacceptable risk to residents or utility workers. Currently there is no construction work taking place in areas of soil contamination. If construction work were to take place at the Site in the future, there could be elevated levels of risk to construction workers. Presently there are no measures in place to ensure that conditions remain the same in the future. Implementation of the Selected Remedy will ensure that conditions at the Site do not pose an unacceptable level of risk in the future.

Why wasn't an alternative included that addressed the removal of the apartment building and the cleanup of soil beneath the building?

Superfund is a program where actions are driven by current or future risks to human health and the environment. What this means is that if a current or future exposure exceeds a risk benchmark set in the Superfund statute an action at the Site may be warranted. For this Site, the following exposures were evaluated assuming no cleanup was taking place: student residents of the Manor; lifetime residents of the Manor, including children; an apartment maintenance worker; an underground utility worker; a construction worker; a Ralston Creek cleanup volunteer; and a child playing in Ralston Creek. Their exposures were evaluated for inhalation, ingestion, and dermal exposure to contaminants that were present in air, soil, groundwater, surface water, and sediment. The only exposure on the Site property that exceeded an acceptable level of carcinogenic or noncarcinogenic risk assuming that no cleanup was done, was a future construction worker exposed to naphthalene volatilizing from subsurface soil during excavation work or anyone who might consume groundwater at the Site if a well were installed in the future for drinking water purposes. For these reasons removal of the building was not evaluated as one of the remedial alternatives, but restrictions on property including excavation and future uses are a significant component of the Selected Remedy.

The set of conditions used in the assessment of Site risks could change in the future if, for example, the apartment building were demolished and construction work brought contamination currently existing in the subsurface to the surface, making it available for direct exposure. If changes to the set of conditions used in the risk assessment were to occur, potential exposures due to the changed conditions would need to be evaluated. The property restrictions, combined with EPA's duty to perform a Five-Year Review, will help ensure that if changes in the property uses or significant excavation work are planned, further evaluation of potential exposures will occur and any risks will be addressed.

Is someone who lives in the Manor for more than five years at risk?

No, they are not at an unacceptable level of risk. As stated in the previous answer, the risks were evaluated for a lifetime (30-year resident), including a child resident and the risks were not at unacceptable levels. This information is included in the Baseline Risk Assessment (Site Characterization Report, August 2003) and the Health Consultation prepared by the Iowa Department of Public Health dated September 14, 2006.

Were risks to apartment building employees considered?

Yes, the risk to an apartment building maintenance supervisor was evaluated and it did not exceed an unacceptable level of risk. It was assumed that this person worked at the Site 250 days per year for 25 years. This is a highly conservative estimate because it is very unlikely that someone would remain on this job for that period of time. The building management for this apartment building does not live in the building. If they did, they would be covered under the risk evaluation for the lifetime apartment resident.

Were risks to people on property adjacent to the Manor considered, specifically, risks due to soil contamination, vapor intrusion, and contact with groundwater when constructing a building foundation?

Risks to people were considered for all of these specific incidences. Surface and subsurface soil samples were collected both on the Site and on adjacent properties. The levels of contamination in surface and subsurface soil were substantially higher in the samples collected on the Site. All of these data were used in calculating the risks (dermal, ingestion, and inhalation) from exposure to soil contamination. There is no distinction in the evaluation of risk whether the exposed person lives at the Manor or lives next door to the Manor. In either case, the risk associated with this exposure to residents is not unacceptable.

Vapor intrusion into a building would occur through release via volatilization of contaminants from subsurface soil and groundwater in the unconsolidated aquifer. Vapor intrusion, or air exposures, were evaluated with samples collected from the Manor because the subsurface soil samples and unconsolidated aquifer groundwater samples were generally the most contaminated in that area. Risks to Manor residents, as well as nearby residents, from air exposures were evaluated using air samples from the Manor, because they represented the maximum exposure to Site contaminants someone could experience. Also, air samples from the crawlspace were utilized because the contact with the subsurface is the greatest, ventilation is limited, and the introduction of contaminants not related to the Site would be minimal. The risk associated with this exposure to residents is not unacceptable.

Contact with contaminated groundwater during foundation construction was evaluated in the risk assessment for construction workers. It was assumed that the worker would be exposed for 190 days per year for a period of one year. This would correspond to a large construction project. The risk associated with this exposure is not unacceptable. Risks to a resident of the building built over the contaminated groundwater would be covered by the air exposure evaluation described in the previous paragraph.

Comments Regarding the Remedial Alternatives

What is natural attenuation?

Natural attenuation refers to naturally occurring processes in the environment that act to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in various media. These in situ processes include biodegradation, dispersion, dilution, adsorption, volatilization, and chemical or biological stabilization or destruction of contaminants. Intrinsic biodegradation is the mechanism of interest for this Site. It is the process by which contaminants are transformed from toxic to nontoxic byproducts through biologically mediated reactions that occur naturally in the groundwater system.

If the condition of the liner beneath part of the Manor is not known, how can it be relied upon as part of a remedy?

The condition of the liner beneath part of the Manor is unknown. The gravel and soil cover over the liner has not been disturbed so that the liner could be exposed. It is believed that the liner was installed to serve as a barrier between vapors that might be present in the subsurface soil and the crawlspace air. Regardless of the current condition of the liner beneath the Manor, air sampling in the crawlspace indicates that at most, only miniscule amounts of site-related contamination have reached the air. Through implementation of the environmental covenant the condition of the liner can be verified and maintained in the future.

What is the condition of the venting system in the Manor?

The venting system is a passive system meaning that there are no fans or vacuum systems removing air through vents. The venting system consists of pipes protruding through the foundation of the apartment building to allow an exchange of air between the crawlspace and the outside. There is no underground piping involved in this system. The venting system appears to be in place as designed.

Comments Regarding Remedy Implementation

What will the role of the potentially responsible parties (PRPs) be in the future?

The PRPs that have been identified for this Site are MidAmerican Energy Company and the Iowa-Illinois Manor Partnership. The EPA will provide them the opportunity to implement the Selected Remedy for this Site.

What are the options the EPA has for implementing the remedy at this Site?

The EPA will first seek a consensual agreement with the PRPs to implement the remedy. If that effort is unsuccessful, the EPA could implement the remedy and seek to recover the costs of doing so from the PRPs through the courts.

Who will be responsible for conducting the monitoring that is part of the remedy and where will the details of this monitoring be spelled out?

The party(ies) responsible for implementation of the remedy will be responsible to conduct the monitoring. This would either be the PRPs or the EPA. The specific details of the monitoring activities will be included in a document called a remedial design which will be developed during implementation of the Selected Remedy and added to the Administrative Record.

Comments Regarding Environmental Covenants

What are environmental covenants and how do they work?

An environmental covenant is a real estate instrument which may be used by owners of property, responsible parties, the Iowa Department of Natural Resources, and other state and federal regulatory agencies for the purpose of restricting land use activities and managing the risk of exposure to existing contaminant sources. Environmental covenants in Iowa are established pursuant to the Iowa Uniform Environmental Covenants Act. Environmental covenants may, for example, require a notice of change in property ownership, notice of a substantial change in use of the property, and notice of noncompliance with the activity and use limitations by the owner of the property.

How would the covenants limit future use and development of the affected properties?

With respect to the Iowa-Illinois Manor Partnership property, the proposed environmental covenants for this Site provide that no groundwater wells may be placed on the property, no excavation below two feet is allowed without prior notification and approval by the EPA and the Iowa Department of Natural Resources (except for certain emergency repair activities), maintenance of the building's liner and venting system, and notification of EPA and Iowa Department of Natural Resources if there is a change in property use. With respect to Ralston Creek, the proposed environmental covenant provides for maintenance of the existing tile lining and prohibits activities which would disturb the tile lining without prior notification and approval by the EPA and the Iowa Department of Natural Resources (except for certain emergency repair activities).

Who is responsible for implementation of the environmental covenants?

The EPA will initiate implementation of these covenants with the property owners. In this case, that would involve the Iowa-Illinois Manor Partnership for the property that includes the Iowa-Illinois Manor and the city of Iowa City for Ralston Creek.

What is the burden to the Iowa-Illinois Manor Partnership and the city of Iowa City associated with the covenants?

That will depend upon the specific details of the covenants, which have only preliminarily been discussed with the property owners. As discussed above, the environmental covenants require notifications and approvals prior to certain activities and property transfers, and maintenance of the existing building liner and venting system and the existing tile lining of Ralston Creek.

Will covenants be required with any additional property owners above the contaminated groundwater plume?

It is not anticipated that any additional environmental covenants would be required for this Site. Existing city and county ordinances and state rules provide adequate protection with respect to exposure to contaminated groundwater for properties above the plume.

The city has indicated that it would likely be amenable to limiting its activities in ways requested by the EPA with respect to the proposed environmental covenant addressing Ralston Creek, but expressed concern regarding the maintenance of the tile lining in the creek bed since it is old and in poor condition.

The EPA is seeking to limit changes to the tile lining of Ralston Creek in the area adjacent to the Site. The EPA will work with the city and the PRPs to ensure that the tile lining of Ralston Creek does not further degrade or is repaired if it does.

The city anticipates the need for sewer and water main work along Ralston Creek, adjacent to the Site, at some point in the future and wants any additional costs imposed on the project by the presence of the Site to be covered by the PRPs.

The EPA will further facilitate discussions between the city and the PRPs and seek to address concerns raised by the city.

Comments Regarding Public Participation and Public Notification

How can the public stay involved with this Site during the next steps in the process and into the future?

Periodically the EPA sends out information about the Site directly to anyone who has indicated that they wish to be on our mailing list for the Site. Anyone can ask to be added to the mailing list at any time. Notices will be published in the local newspaper prior to any EPA-sponsored public meeting. Information regarding the Site is placed in the Iowa City Public Library in a file called the Administrative Record and updated periodically. The Administrative Record is available at the Reference section of the library, and the library staff will direct you to it. Stories about the Site will appear in the local media from time to time. Anyone may contact the EPA Region 7 Office of External Programs during business hours to receive information about the Site. They may be reached by telephone at 1-800-223-0425. Information including Fact Sheets and Five-Year Review Reports are available on the EPA Region 7 website at www.epa.gov/region07/.

Where can the public find the EPA's responses to the public comments?

The responses are included in the Responsiveness Summary which is a part of the Record of Decision (ROD). The Administrative Record will be amended to include the transcript of the public meeting held August 9, 2006, all written comments received regarding the Proposed Plan, the ROD, and the Responsiveness Summary. The amendment to the Administrative Record will be available in the Iowa City Public Library and the EPA Region 7 Records Center. The ROD and the Responsiveness Summary will also be available online at www.epa.gov.

Will notification be provided to property owners above the contaminated groundwater plume?

Not all property owners above contaminated groundwater are currently on the EPA's mailing list, but we will attempt to identify and include those property owners on the list for future notifications and mailings.

Were residents of the Manor notified about the Site?

Every apartment address is included on the EPA's mailing list and they are sent a copy of any information that the EPA sends out. Every apartment address received a notice about the public meeting held on August 9, 2006.

Notice should have been given to property owner over the LNAPL.

Owners of property with monitoring wells containing LNAPL are the Iowa-Illinois Manor Partnership and the city of Iowa City. Both property owners received copies of the Feasibility Study and the Proposed Plan.

General Comments

One commenter wrote to give their support for the preferred alternative, Alternative 7.

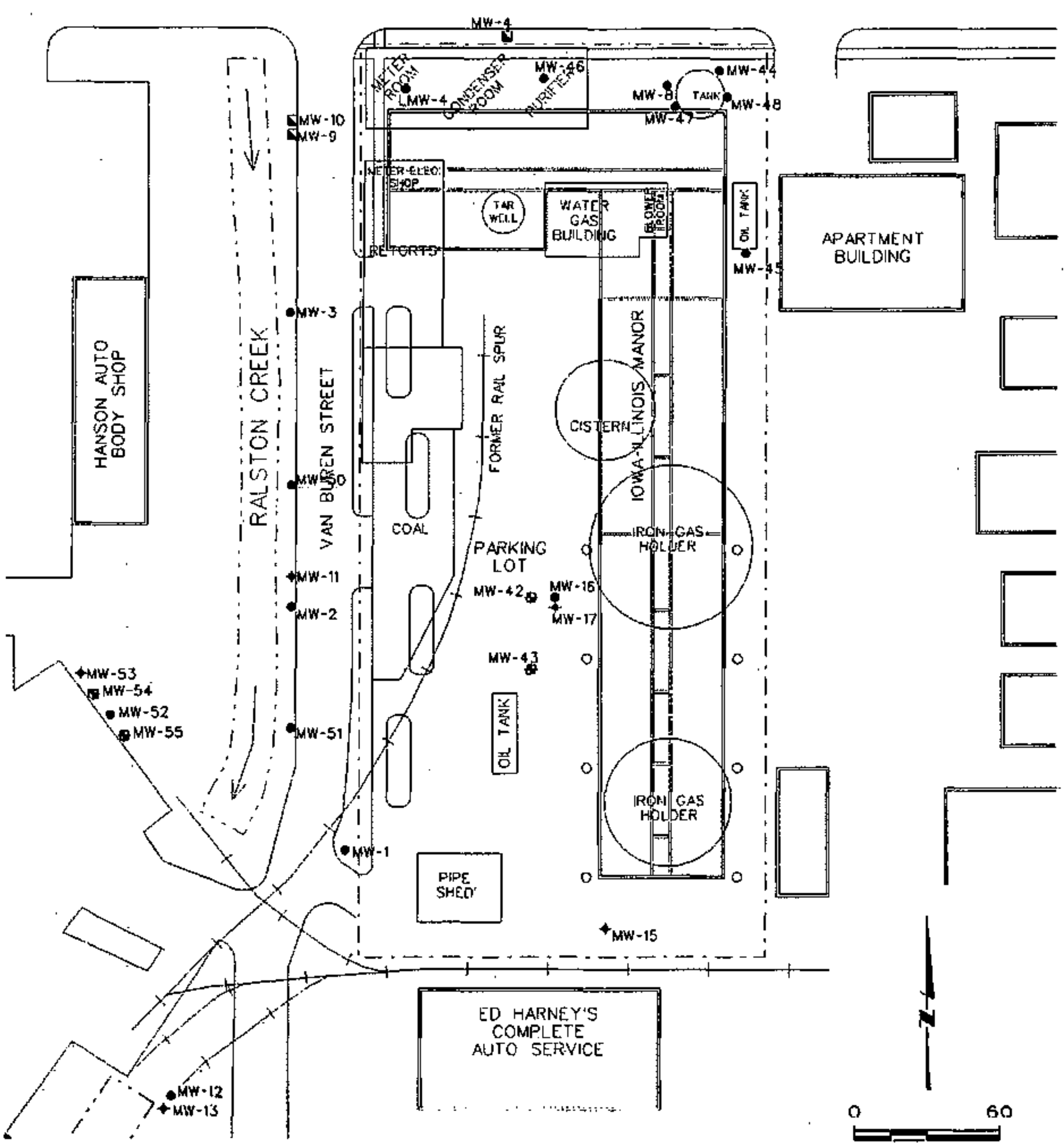
Numerous comments and questions were raised during the public meeting held on August 9, 2006, and in writing regarding liability as it relates to the Site.

The ROD is the decision regarding the cleanup actions to be taken to address the Site regardless of the parties that might be legally liable for the Site. This Responsiveness Summary addresses comments that might affect the decision regarding the appropriate remedy for the Site. The EPA will continue to address enforcement issues related to liability after the remedy has been selected.

Attachment 1

Figures

Figure 1



LEGEND:

- WATER TABLE MONITORING WELL
- BEDROCK SURFACE MONITORING WELL
- BEDROCK MONITORING WELL
- ABANDONED MONITORING WELL
- PASSIVE VENT

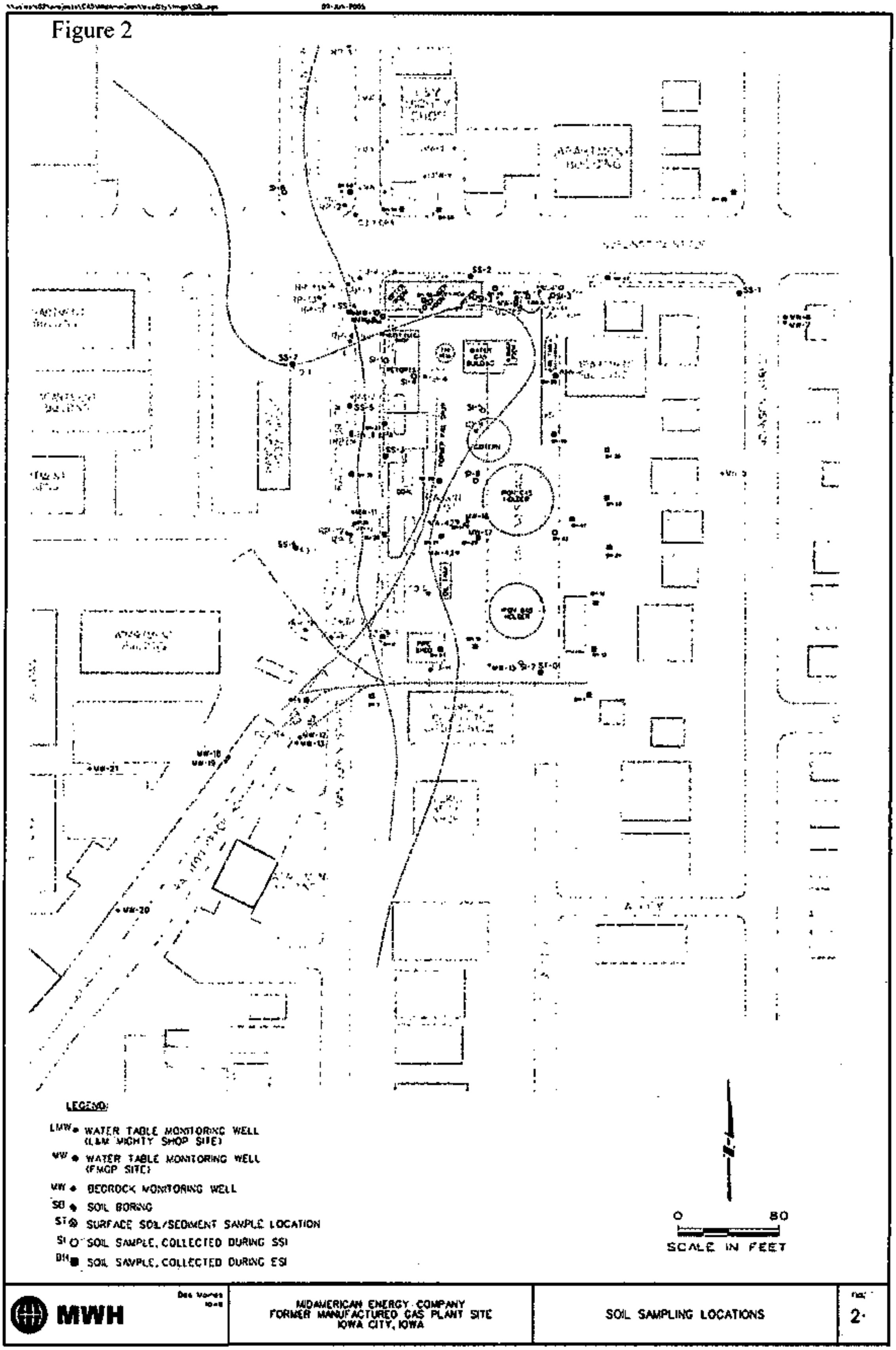
NOTES:

1. HISTORIC STRUCTURES SHOWN IN BLUE.
2. HISTORIC MAP SOURCE: 1926 & 1933 SANBORN FIRE INSURANCE MAPS

MWH Des Moines Iowa	MIDAMERICAN ENERGY COMPANY FORMER MANUFACTURED GAS PLANT SITE IOWA CITY, IOWA	SITE MAP	FIGURE 1

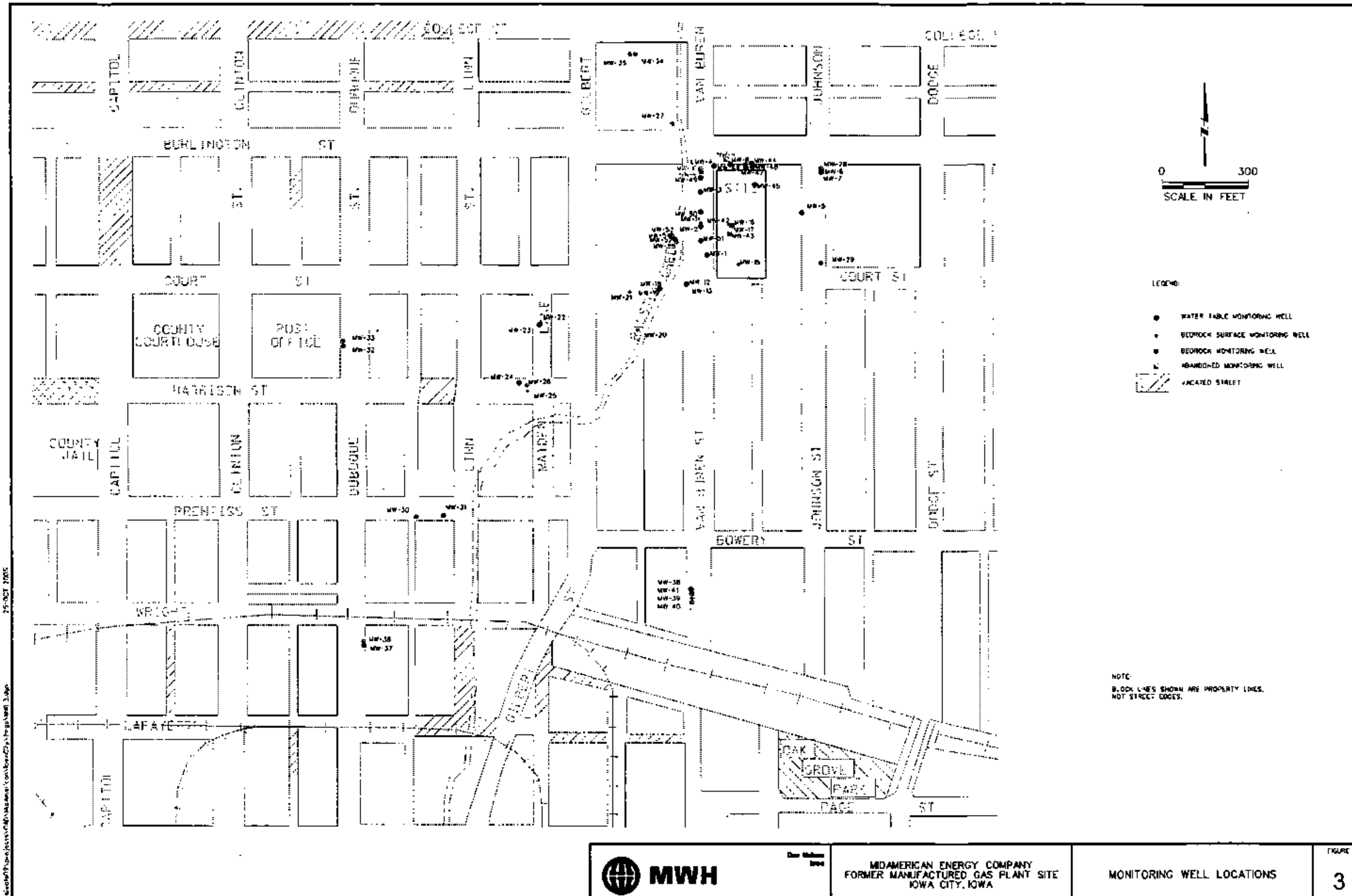
19-OCT-2005

Figure 2



LEGEND:
LMW WATER TABLE MONITORING WELL (L&M MIGHTY SHOP SITE)
MW WATER TABLE MONITORING WELL (FMGP SITE)
MW BEDROCK MONITORING WELL
SB SOIL BORING
ST SURFACE SOIL/SEDIMENT SAMPLE LOCATION
SI SOIL SAMPLE, COLLECTED DURING SSI
DH SOIL SAMPLE, COLLECTED DURING ESI
0 80
SCALE IN FEET
MWH
MIDAMERICAN ENERGY COMPANY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA
SOIL SAMPLING LOCATIONS
2

Figure 3


BURLINGTON ST
COURT ST
HARRISON ST
PRENTISS ST
BOWERY ST
CAPITOL
CLINTON
DUBUQUE
LINN
GILBERT
VAN BUREN
JOHNSON
DODGE
MAIDEN
VAN BUREN ST
JOHNSON ST
COUNTY COURTHOUSE
POST OFFICE
COUNTY JAIL
SITE
OAK GROVE PARK
0
300
SCALE IN FEET
LEGEND:
WATER TABLE MONITORING WELL
BEDROCK SURFACE MONITORING WELL
BEDROCK MONITORING WELL
ABANDONED MONITORING WELL
VACATED STREET
NOTE:
MWH
MIDAMERICAN ENERGY COMPANY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA
MONITORING WELL LOCATIONS
FIGURE
3

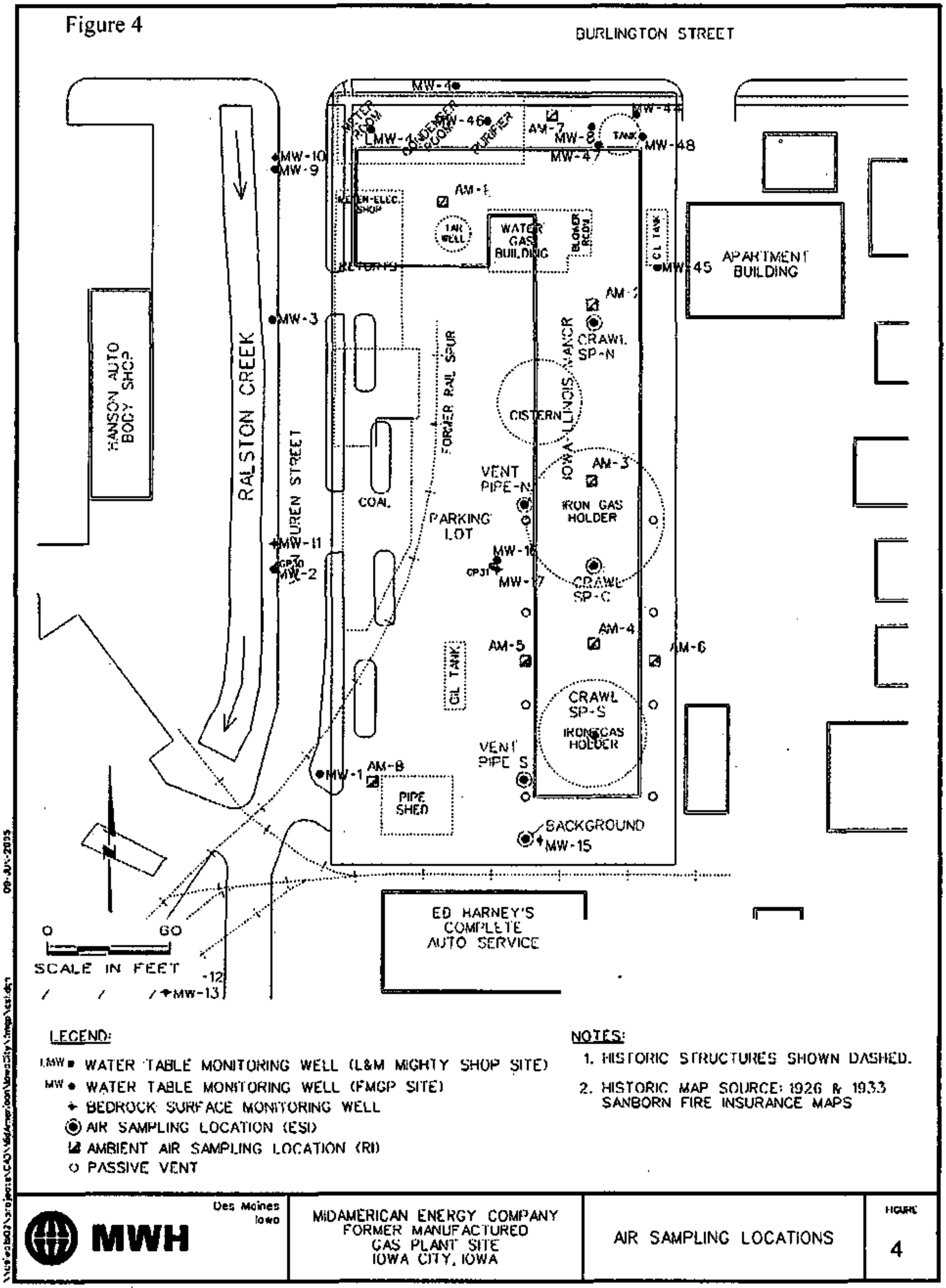
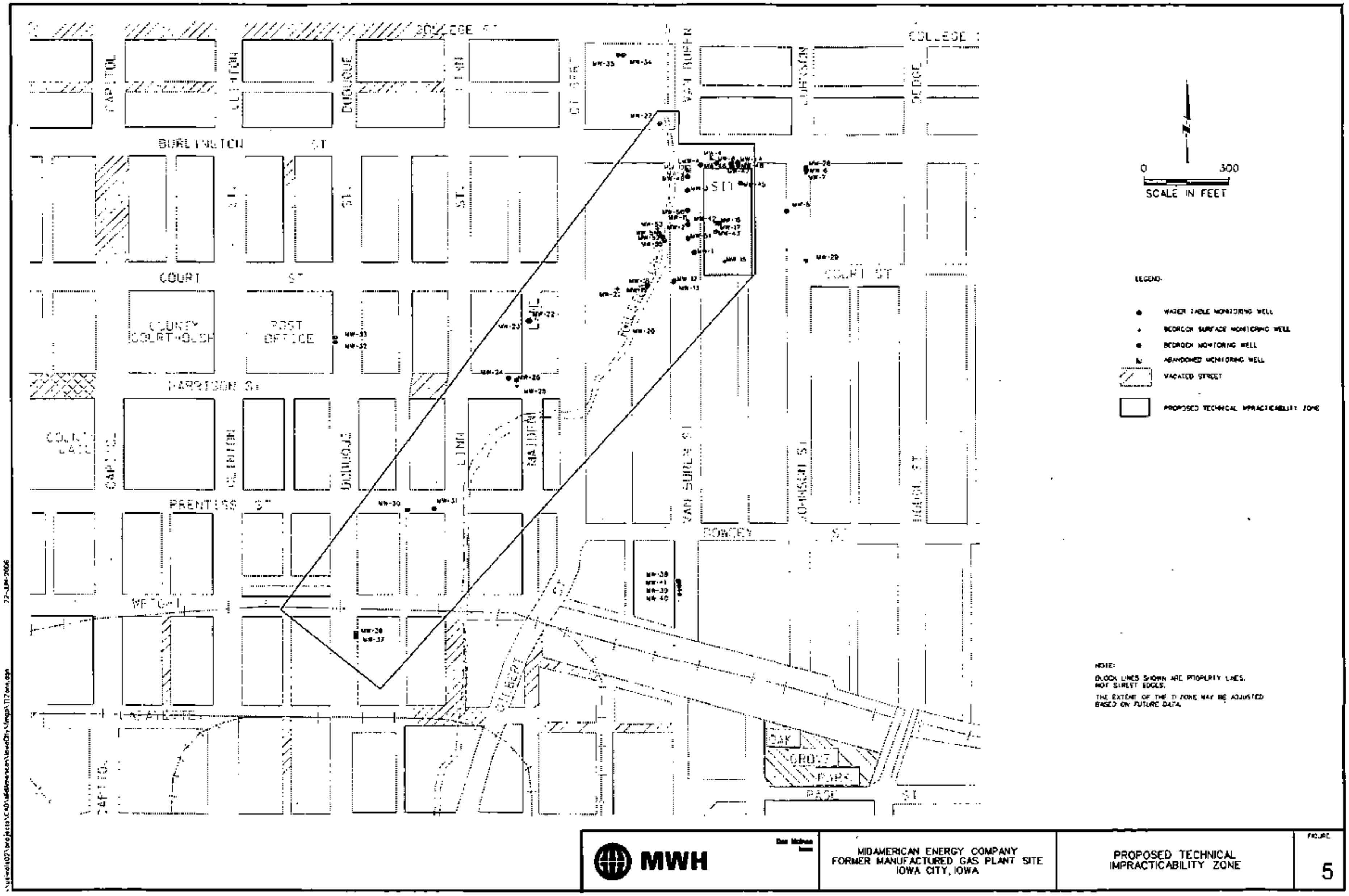


Figure 4
BURLINGTON STREET
MW-4
MW-46
LMW-4
MW-44
AM-7
MW-8
MW-48
MW-47
MW-10
MW-9
AM-1
WATER GAS BUILDING
APARTMENT BUILDING
MW-45
AM-2
CRAWL SP-N
MW-3
HANSON AUTO BODY SHOP
RALSTON CREEK
FORMER RAIL SPUR
CISTERN
IOWA-ILLINOIS MANOR
VAN BUREN STREET
VENT PIPE-N
AM-3
IRON GAS HOLDER
COAL
PARKING LOT
MW-11
MW-2
MW-16
MW-17
CRAWL SP-C
AM-4
AM-5
AM-6
OIL TANK
CRAWL SP-S
IRON GAS HOLDER
VENT PIPE S
MW-1
AM-8
PIPE SHED
BACKGROUND
MW-15
ED HARNEY'S COMPLETE AUTO SERVICE
0 60
SCALE IN FEET
MW-12
MW-13
LEGEND:
LMW ■ WATER TABLE MONITORING WELL (L&M MIGHTY SHOP SITE)
MW ● WATER TABLE MONITORING WELL (FMGP SITE)
✦ BEDROCK SURFACE MONITORING WELL
◉ AIR SAMPLING LOCATION (ESI)
☒ AMBIENT AIR SAMPLING LOCATION (RI)
○ PASSIVE VENT
NOTES:
1. HISTORIC STRUCTURES SHOWN DASHED.
2. HISTORIC MAP SOURCE: 1926 & 1933 SANBORN FIRE INSURANCE MAPS
MWH
Des Moines Iowa
MIDAMERICAN ENERGY COMPANY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA
AIR SAMPLING LOCATIONS
FIGURE
4

Figure 5



COURT ST
BURLINGTON ST
HARRISON ST
PRENTISS ST
COUNTY COURTHOUSE
POST OFFICE
VAN BUREN ST
SCALE IN FEET
0
300
LEGEND
WATER TABLE MONITORING WELL
BEDROCK SURFACE MONITORING WELL
BEDROCK MONITORING WELL
ABANDONED MONITORING WELL
VACATED STREET
PROPOSED TECHNICAL IMPRACTICABILITY ZONE
NOTE:
BLOCK LINES SHOWN ARE PROPERTY LINES, NOT STREET EDGES.
THE EXTENT OF THE TI ZONE MAY BE ADJUSTED BASED ON FUTURE DATA.
MWH
MIDAMERICAN ENERGY COMPANY
FORMER MANUFACTURED GAS PLANT SITE
IOWA CITY, IOWA
PROPOSED TECHNICAL IMPRACTICABILITY ZONE
FIGURE
5

Attachment 2

Tables

TABLE 1

PRELIMINARY REMEDIATION GOALS FOR GROUNDWATER
FORMER MANUFACTURED GAS PLANT - IOWA CITY, IOWA

Contaminant of Potential Concern	Chemical-Specific ARARs (MCLs)	Health-Based To-Be-Considered (TBC) Values Risk-Based Concentration (RBC)	PQL	Selected Groundwater PRG (basis for selection)
2-methylnaphthalene	-	61.2	-	61.2 (RBC)
Acenaphthene	-	914	-	914 (RBC)
Acenaphthylene	-	362	-	362 (RBC)
Benzene	5	-	-	5 (MCL)
Benzo(a)anthracene	-	0.009	0.13	0.13 (PQL)
Benzo(a)pyrene	0.2	-	-	0.2 (MCL)
Benzo(b)fluoranthene	-	0.005	0.1	0.1 (PQL)
Benzo(k)fluoranthene	-	0.05	0.14	0.14 (PQL)
Chrysene	-	0.85	-	0.85 (RBC)
Cyanide	200	-	-	200 (MCL)
Dibenzo(a,h)anthracene	-	0.0003	0.033	0.033 (PQL)
Ethylbenzene	700	-	-	700 (MCL)
Fluorene	-	490	-	490 (RBC)
Indeno(1,2,3-cd)pyrene	-	0.005	0.1	0.1 (PQL)
Naphthalene	-	6.2	-	6.2 (RBC)
Phenanthrene	-	294	-	294 (RBC)
Toluene	1,000	-	-	1,000 (MCL)
Xylenes, total	10,000	-	-	10,000 (MCL)

Notes:

All values are presented in micrograms per liter (μg/L).
MCL = Maximum contaminant level.
ARAR = Applicable or relevant and appropriate requirements.
PRG = Preliminary remedial goal.
PQL = Practical quantitation limit.
RB = Risk-based PRG.

TABLE 2

PRELIMINARY REMEDIATION GOALS FOR SEDIMENT IN RALSTON CREEK FORMER MANUFACTURED GAS PLANT - IOWA CITY, IOWA

Constituent of Potential Ecological Concern	Preliminary Remediation Goals (Consensus-Based Probable Effect Concentration [PEC])
Anthracene	845
Benzo(a)anthracene	1,050
Benzo(a)pyrene	1,450
Chrysene	1,290
Fluoranthene	2,230
Fluorene	536
Naphthalene	561
Phenathrene	1,170
Pyrene	1,520
Total Polynuclear Aromatic Hydrocarbons (PAHs)	22,800

Notes:

Values are presented in micrograms per kilogram (µg/kg) dry weight.

Source: MacDonald, D.D., C.G. Ingersoll and T.A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch. Environ. Contam. Toxicol.* 39: 20-31.

TABLE 4
GROUNDWATER ALTERNATIVE 7 - ACCESS RESTRICTIONS AND LNAPL RECOVERY WITH MNA
FORMER MANUFACTURED GAS PLANT SITE - IOWA CITY, IOWA

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
DIRECT COSTS					
Direct Capital Costs					
Legal Fees					
Prepare/Modify Access Restrictions	1	lump	$19,200	$ 19,200	See Table H-4
			Subtotal	$ 19,200	
Ralston Creek/Apartment Air Monitoring	1	lump	$16,600	$ 16,600	See Table H-3
			Subtotal	$ 16,600	
Vacuum Recovery Events					
Oversight/Vac Truck/Gauging/Disposal	0	lump	$970	$ -	6-hour event, contingency
			Subtotal	$ -	
Passive Recovery					
Sorbent Socks	30	each	$9	$ 270	Assumes monthly change-out of MW-8 and MW-48
Product Disposal	1	trip	$450	$ 450	Assume picked-up every 3 months
			Subtotal	$ 720	
MNA Costs					
Well Installation	1	total	$38,988	$ 38,988	See Table H-6
Well Abandonment	1	NPV	$416	$ 416	See Table H-6, Year 30
First Year Monitoring Costs	1	total	$55,500	$ 55,500	See Table H-6
			Subtotal	$ 94,904	
Contingency	20%			$ 26,285	
TOTAL-DIRECT COSTS			TOTAL	$ 157,709	
INDIRECT COSTS					
Indirect Capital Costs					
Work Plan and Health and Safety Plan	1	lump	$18,000	$ 18,000	
Project Management	1	lump	$5,000	$ 5,000	
Field Time (vacuum extraction events)	10	lump	$1,200	$ 12,000	One person for one extended day.
			Subtotal	$ 35,000	
Indirect Annual Costs					
Field Time (*1st year GW monitoring)Supplies*	4	event	$4,000	$ 16,000	Crew of 2 for 2 days per event
Field Time (MW installation & development)	1	event	$8,000	$ 8,000	5 days for installation & 3 days for development.
Project Management	12	months	$1,200	$ 14,400	
Semiannual Product Recovery Report	2	event	$6,000	$ 12,000	
Field Time (maintenance/inspection)	12	event	$500	$ 6,000	One person for one partial day.
Groundwater Monitoring Report and PM	2	lump	$12,000	$ 24,000	
			Subtotal	$ 80,400	
Project Close-out Costs	**ROR**	**Year**	**Cost**	**NPV**	
PM, Bid Prep/Select/Close-Out Report	5%	30	$6,000	$1,388	Abandonment of recovery trenches
Field Time	5%	30	$20,000	$4,628	
			Subtotal	$ 6,016	
	ROR	**Events**	**Each**	**NPV**	
Five Year Review Costs	5%	6	$18,000	$50,285	Every 5 years for 30 years.
			Subtotal	$ 50,285	
Contingency	20%			34,340	
TOTAL-INDIRECT COSTS			TOTAL	$ 206,041	
Ralston Creek/Apartment Air Components	1	lump	$510,600	$ 510,600	Costs NPV from Tables H-2 and H-3
			Subtotal	$ 510,600	
Net Present Value of Annual & Close-out Costs	**ROR**	**Years**	**Annual**	**PV**	
Projected for 30 years total (29 additional)					
Passive Recovery - Direct and Indirect	5%	5	$21,600	$93,517	
Quarterly - Yearly Direct and Indirect Costs	5%	1	$121,000	$115,238	MNA Groundwater Monitoring - See Table H-6
Semiannual - Yearly Direct and Indirect Costs	5%	3	$60,500	$156,911	MNA Groundwater Monitoring - See Table H-6
Annual - Yearly Direct and Indirect Costs	5%	25	$30,250	$350,752	MNA Groundwater Monitoring - See Table H-6
			TOTAL	$ 716,418	
TOTAL COST (30 Years)				$ 1,590,800	Costs rounded up to nearest $100.

Notes:

Unit costs based on previous projects, subcontractor bids or Means Heavy Construction (1999) or Environmental Remediation (2002) Cost Data.
ROR = Rate of Return.

TABLE 7-1
SELECTION OF EXPOSURE PATHWAYS
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future	Surface Soil	Surface Soil	Apartment Yard Surface Soil	Resident	Adult	Ingestion	On-Site	Quant	Residents currently live on site; incidental ingestion of soil could occur during daily activity.
						Dermal	On-Site	Quant	Residents currently live on site; dermal exposure to soil could occur during daily activity.
					Child	Ingestion	On-Site	Quant	Residents currently live on site; incidental ingestion of soil could occur during daily activity.
						Dermal	On-Site	Quant	Residents currently live on site; dermal exposure to soil could occur during daily activity.
				Maintenance Supervisor	Adult	Ingestion	On-Site	Quant	The site manager could have incidental ingestion of soil while performing his duties
						Dermal	On-Site	Quant	The site manager could have dermal exposure to soil while performing his duties
				Groundskeeper	Adult	Ingestion	On-Site	Qualitative	The pathway is complete, but exposure is less than that for a resident
						Dermal	On-Site	Qualitative	The pathway is complete, but exposure is less than that for a resident
		Fugitive Dust	Apartment Yard Air	Resident	Adult	Dust Inhalation	On-Site	Quant	Residents currently live on site, inhalation of fugitive dust could occur during daily activity.
					Child	Dust Inhalation	On-Site	Quant	Residents currently live on site; inhalation of fugitive dust could occur during daily activity.
				Maintenance Supervisor	Adult	Dust Inhalation	On-Site	Qualitative	The maintenance supervisor works primarily indoors; exposure outdoors will be less.
				Groundskeeper	Adult	Dust Inhalation	On-Site	Qualitative	The pathway is complete, but exposure is less than that for a resident
		Outdoor Air	Apartment Yard Air	Resident	Adult	Air Inhalation	On-Site	Qualitative	This pathway is complete, but exposure is less than for an indoor resident.
					Child	Air Inhalation	On-Site	Qualitative	This pathway is complete, but exposure is less than for an indoor resident.
				Maintenance Supervisor	Adult	Air Inhalation	On-Site	Qualitative	The maintenance supervisor works primarily indoors; exposure outdoors will be less.
				Groundskeeper	Adult	Air Inhalation	On-Site	Qualitative	The pathway is complete, but the indoor air pathway for a resident will be associated with higher risk levels.
		Indoor Air	Apartment Air	Resident	Adult	Air Inhalation	On-Site	Quant	Volatile constituents could volatilize from soil into indoor air where they could be inhaled by residents.
					Child	Air Inhalation	On-Site	Quant	Volatile constituents could volatilize from soil into indoor air where they could be inhaled by residents.
				Maintenance Supervisor	Adult	Air Inhalation	On-Site	Quant	Volatile constituents could volatilize from soil into indoor air where they could be inhaled by the apartment maintenance supervisor.
				Groundskeeper	Adult	Air Inhalation	On-Site	None	The groundskeeper works outdoors.
	Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil in Apartment Yard by Utility Lines	Utility Worker	Adult	Ingestion	On-Site	Quant	Utility workers could incidentally ingest soil to a depth of about 6 feet bgs while repairing or installing utility lines.
						Dermal	On-Site	Quant	Utility workers could have dermal exposure to soil to a depth of about 6 feet bgs while repairing or installing utility lines.
		Fugitive Dust	Dust in Trenches	Utility Worker	Adult	Dust Inhalation	On-Site	Quant	Utility workers could inhale dust originating from soil from excavations made to perform utility maintenance work.
		Outdoor Air	Air in Trenches	Utility Worker	Adult	Air Inhalation	On-Site	Quant	Utility workers could inhale constituents that migrate from soil into air during excavations made to perform utility maintenance work.

TABLE 7-1
SELECTION OF EXPOSURE PATHWAYS
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current/Future (continued)	Sediment	Sediment	Ralston Creek	Cleanup Volunteer	Adult	Ingestion	Off-Site	Quant	Volunteers performing litter cleanup along Ralston Creek could incidentally ingest sediment
						Dermal	Off-Site	Quant	Volunteers performing litter cleanup along Ralston Creek could have dermal conact with sediment.
				Recreational Visitor	Older Child	Ingestion	Off-Site	Quant	People walking along or playing by Ralston Creek could incidentally ingest sediment.
						Dermal	Off-Site	Quant	People walking along or playing by Ralston Creek could have dermal conact with sediment.
	Surface Water	Surface Water	Ralston Creek	Cleanup Volunteer	Adult	Ingestion	Off-Site	Quant	Volunteers performing litter cleanup along Ralston Creek could incidentally ingest surface water.
						Dermal	Off-Site	Quant	Volunteers performing litter cleanup along Ralston Creek could have dermal conact with surface water.
				Recreational Visitor	Older Child	Ingestion	Off-Site	Quant	People playing in Ralston Creek could incidentally ingest surface water. Note that because the water is very shallow (one can see the bottom of the creek), no swimming occurs in this creek.
						Dermal	Off-Site	Quant	People playing in Ralston Creek could have dermal conact with surface water. Note that because the water is very shallow (one can see the bottom of the creek), no swimming occurs in this creek.
Future	Groundwater	Groundwater	Shallow Groundwater - Tap Water	Resident	Adult	Ingestion	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer.
						Dermal	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer.
					Child	Ingestion	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer.
						Dermal	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer.
		Air	Shallow Groundwater - Household Vapors	Resident	Adult	Inhalation	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer.

TABLE 7-1
SELECTION OF EXPOSURE PATHWAYS
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe	Medium	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	On-Site/ Off-Site	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Future (continued)	Groundwater (continued)	Air (continued)	Shallow Groundwater - Household Vapors (continued)	Resident (continued)	Child	Inhalation	On-Site	Quant	This scenario is being evaluated hypothetically for risk information purposes. Note that this location is on a municipal water supply, that a city ordnance requires that there must be a hookup when within 300 feet of a water line, and that the water used by the city is from a much deeper aquifer
	Surface and Subsurface Soil	Surface and Subsurface Soil	Soil by Burlington Street near Ralston Creek	Construction Worker	Adult	Ingestion	Off-Site	Quant	Construction workers could incidentally ingest soil in the vicinity of where the Burlington Street bridge will be constructed in the near future.
						Dermal	Off-Site	Quant	Construction workers could have dermal exposure to soil in the vicinity of where the Burlington Street bridge will be constructed in the near future.
		Fugitive Dust	*Dust in Outdoor Air*	Construction Worker	*Adult*	*Inhalation*	*Off-Site*	*Quant*	Construction workers could inhale fugitive dust derived from contaminated soil *in the vicinity of where the Burlington Street bridge will be constructed in the* near future.
		Outdoor Air	Outdoor Air	Construction Worker	Adult	Inhalation	Off-Site	Quant	Construction workers could inhale constituents that migrate from soil into air while constructing the Burlington Street bridge.
		Surface and Subsurface Soil	Apartment Yard Surface and Subsurface Soil	Construction Worker	Adult	Ingestion	On-Site	Quant	While the property is already developed, if future construction were to occur, construction workers could incidentally ingest surface and subsurface soil on the facility property.
						Dermal	On-Site	Quant	While the property is already developed, if future construction were to occur, construction workers could have dermal contact with surface and subsurface soil on the facility property.
		Fugitive Dust	Dust in Outdoor Air	Construction Worker	Adult	Inhalation	On-Site	Quant	While the property is already developed, if future construction were to occur, construction workers could inhale fugitive dust derived from surface and subsurface soil on the facility property.
		Outdoor Air	Outdoor Air	Construction Worker	Adult	Inhalation	On-Site	Quant	While the property is already developed, if future construction were to occur, construction workers could inhale volatile constituents derived from surface and subsurface soil on the facility property

TABLE 7-3.1
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Indoor Air
Exposure Point:	Apartment Air

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Benzene	ug/m^3	1.2	N/A	1.8		ug/m^3	1.8	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max Maximum Detected Value
95%UCL-N 95% upper confidence limit on the mean for normally distributed data
95%UCL-T 95% upper confidence limit on the mean for the log-transformed data

(1) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.2
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Surface Soil
Exposure Medium:	Surface Soil
Exposure Point:	Surface Soil in Apartment Yard From 0-0.5' BGS

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	mg/kg	6,956	7,963	9,000		mg/kg	7,963	95% UCL-N	W-Test (1)			
Arsenic	mg/kg	3.8	4.8	7.1		mg/kg	4.8	95% UCL-N	W-Test (1)			
Iron	mg/kg	10,533	N/A	20,000		mg/kg	12,941	95% UCL-T	W-Test (2)			
Manganese	mg/kg	533	572	650		mg/kg	572	95% UCL-N	W-Test (1)			
Thallium	mg/kg	0.41	N/A	0.65		mg/kg	0.65	Max	(3)			
Cyanide	mg/kg	1.7	N/A	8.1		mg/kg	5.8	95% UCL-T	W-Test (4)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.
Statistics: Max Maximum Detected Value
95%UCL-N 95% upper confidence limit on the mean for normally distributed data
95%UCL-T 95% upper confidence limit on the mean for the log-transformed data

(1) Shapiro-Wilks W Test indicates data are normally distributed.
(2) Under the W-test, data not consistent with normal or lognormal distribution. UCL conservatively calculated assuming a log-normal distribution.
(3) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.
(4) Shapiro-Wilks W Test indicates data are log-normally distributed.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Surface and Subsurface Soil
Exposure Medium:	Surface and Subsurface Soil
Exposure Point:	Surface and Subsurface Soil in Apartment Yard From 0-6' BGS

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	3.8	N/A	6.4		mg/kg	6.4	Max	(4)			
Manganese	mg/kg	516	N/A	2,400		mg/kg	1,810	95% UCL-T	W-Test (3)			
Cyanide	mg/kg	10.7	19	36		mg/kg	19	95% UCL-N	W-Test (1)			
Benzo(a)anthracene	ug/kg	7,350	N/A	40,700		ug/kg	40,700	Max	(4)			
Benzo(a)pyrene	ug/kg	5,239	N/A	29,800		ug/kg	29,800	Max	(4)			
Benzo(b)fluoranthene	ug/kg	1,999	N/A	11,100		ug/kg	11,100	Max	(4)			
Dibenzo(a,h)anthracene	ug/kg	91	N/A	199		ug/kg	199	Max	(5)			
Indeno(1,2,3-c,d)pyrene	ug/kg	3,491	N/A	18,700		ug/kg	18,700	Max	(4)			
Naphthalene	ug/kg	25,682	N/A	125,000		ug/kg	125,000	Max	(4)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max — Maximum Detected Value
95%UCL-N — 95% upper confidence limit on the mean for normally distributed data
95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) Shapiro-Wilks W Test indicates data are normally distributed.
(2) Under the W-test, data not consistent with normal or lognormal distribution. UCL conservatively calculated assuming a lognormal distribution.
(3) Shapiro-Wilk W Test indicates data are log-normally distributed.
(4) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.
(5) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.4
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil
Exposure Point: Surface and Subsurface Soil in Apartment Yard From 0-10' BGS

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	6.2	N/A	23		mg/kg	6.3	95% UCL-T	W-Test (2)			
Cyanide	mg/kg	27	N/A	625		mg/kg	56	95% UCL-T	W-Test (3)			
Iron	mg/kg	13,943	N/A	46,000		mg/kg	17,171	95% UCL-T	W-Test (3)			
Manganese	mg/kg	712	N/A	3,100		mg/kg	924	95% UCL-T	W-Test (3)			
Aroclor 1254	ug/kg	60	N/A	310		ug/kg	310	Max	(4)			
Aroclor 1260	ug/kg	63	N/A	300		ug/kg	300	Max	(4)			
Acenaphthylene	ug/kg	11,413	N/A	187,000		ug/kg	30,429	95% UCL-T	W-Test (2)			
Benzo(a)anthracene	ug/kg	11,372	N/A	277,000		ug/kg	38,021	95% UCL-T	W-Test (3)			
Benzo(b)fluoranthene	ug/kg	4,574	N/A	44,000		ug/kg	36,446	95% UCL-T	W-Test (3)			
Benzo(k)fluoranthene	ug/kg	3,290	N/A	40,000		ug/kg	18,780	95% UCL-T	W-Test (3)			
Benzo(a)pyrene	ug/kg	6,339	N/A	120,000		ug/kg	40,766	95% UCL-T	W-Test (3)			
Chrysene	ug/kg	5,767	N/A	129,000		ug/kg	21,155	95% UCL-T	W-Test (3)			
Dibenzo(a,h)anthracene	ug/kg	482	N/A	2,750		ug/kg	1,109	95% UCL-T	W-Test (2)			
Indeno(1,2,3-c,d)pyrene	ug/kg	3,025	N/A	58,900		ug/kg	9,466	95% UCL-T	W-Test (3)			
2-Methylnaphthalene	ug/kg	17,877	N/A	290,000		ug/kg	64,638	95% UCL-T	W-Test (2)			
Naphthalene	ug/kg	30,178	N/A	360,000		ug/kg	214,100	95% UCL-T	W-Test (2)			
Benzene	ug/kg	441	N/A	10,200		ug/kg	441	Mean	(5)			
Ethylbenzene	ug/kg	983	N/A	25,200		ug/kg	3,095	95% UCL-T	W-Test (2)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max — Maximum Detected Value
95%UCL-N — 95% upper confidence limit on the mean for normally distributed data
95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) Shapiro-Wilks W Test indicates data are normally distributed.
(2) Under the W-test, data not consistent with normal or lognormal distribution. UCL conservatively calculated assuming a lognormal distribution.
(3) Shapiro-Wilk W Test indicates data are log-normally distributed.
(4) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.
(5) 95% UCL (based on log transformed data) is less than the arithmetic mean concentration. Therefore, the arithmetic mean was used for EPC

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.5
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Medium: Surface and Subsurface Soil
Exposure Medium: Surface and Subsurface Soil
Exposure Point: Soil by Burlington Street near Ralston Creek (0-10 Feet BGS)

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	4.4	N/A	6.1		mg/kg	6.1	Max	(2)			
Benzo(a)pyrene	ug/kg	211	278	420		ug/kg	278	95% UCL-N	W-Test (1)			
Benzo(b)fluoranthene	ug/kg	236	N/A	650		ug/kg	650	Max	(2)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.
Statistics: Max — Maximum Detected Value
95%UCL-N — 95% upper confidence limit on the mean for normally distributed data
95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) Shapiro-Wilks W Test indicates data are normally distributed.
(2) 95% UCL exceeds maximum detected concentration. Therefore, maximum concentration used for EPC.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-36
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Future
Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Point:	Tap Water

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value (1)	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Aluminum	ug/L	N/A	N/A	120,000		ug/L	120,000	Max	(1)			
Arsenic	ug/L	N/A	N/A	171		ug/L	171	Max	(1)			
Chromium	ug/L	N/A	N/A	67,800		ug/L	67,800	Max	(1)			
Cyanide	ug/L	N/A	N/A	10,300		ug/L	10,300	Max	(1)			
Iron	ug/L	N/A	N/A	290,000		ug/L	290,000	Max	(1)			
Lead	ug/L	N/A	N/A	438		ug/L	438	Max	(1)			
Manganese	ug/L	N/A	N/A	16,000		ug/L	16,000	Max	(1)			
Benzene	ug/L	N/A	N/A	11,900		ug/L	11,900	Max	(1)			
Ethylbenzene	ug/L	N/A	N/A	2,650		ug/L	2,650	Max	(1)			
Toluene	ug/L	N/A	N/A	6,950		ug/L	6,950	Max	(1)			
Xylenes, Total	ug/L	N/A	N/A	2,870		ug/L	2,870	Max	(1)			
Acenaphthene	ug/L	N/A	N/A	800		ug/L	800	Max	(1)			
Acenaphthylene	ug/L	N/A	N/A	602		ug/L	602	Max	(1)			
Benzo(a)anthracene	ug/L	N/A	N/A	118		ug/L	118	Max	(1)			
Benzo(a)pyrene	ug/L	N/A	N/A	44		ug/L	44	Max	(1)			
Benzo(b)fluoranthene	ug/L	N/A	N/A	20		ug/L	20	Max	(1)			
Benzo(k)fluoranthene	ug/L	N/A	N/A	12.7		ug/L	12.7	Max	(1)			
Chrysene	ug/L	N/A	N/A	60		ug/L	60	Max	(1)			
Dibenz(a,h)anthracene	ug/L	N/A	N/A	11.0		ug/L	11.0	Max	(1)			
Fluorene	ug/L	N/A	N/A	546		ug/L	546	Max	(1)			
Indeno(1,2,3-cd)pyrene	ug/L	N/A	N/A	23		ug/L	23	Max	(1)			
2-Methylnaphthalene	ug/L	N/A	N/A	2,220		ug/L	2,220	Max	(1)			
Naphthalene	ug/L	N/A	N/A	9,290		ug/L	9,290	Max	(1)			
Phenanthrene	ug/L	N/A	N/A	765		ug/L	705	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.
Statistics: Max- Maximum Detected Value
95%UCL-N 95% upper confidence limit on the mean for normally distributed data
95%UCL-T 95% upper confidence limit on the mean for the log-transformed data

(1) For groundwater, data were not averaged across wells, maximum detected concentration was used as the EPC.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.7
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Surface Water
Exposure Medium:	Surface Water - Adjacent
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Benzene	ug/L	0.80	N/A	1.0		ug/L	1.0	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max Maximum Detected Value
95%UCL-N 95% upper confidence limit on the mean for normally distributed data
95%UCL-T 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.8
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Future
Medium:	Surface Water
Exposure Medium:	Surface Water - Upstream
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Cyanide	ug/L	6.6	N/A	11		ug/L	11	Max	(1)			
Lead	ug/L	8.7	N/A	24		ug/L	24	Max	(1)			
Thallium	ug/L	2.2	N/A	2.9		ug/L	2.9	Max	(1)			
Bromodichloromethane	ug/L	0.7	N/A	1.0		ug/L	1.0	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.
W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS. Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max Maximum Detected Value
95%UCL-N 95% upper confidence limit on the mean for normally distributed data
95%UCL-T 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration
N/A - Not Applicable. Data not normally distributed.
UCL - Upper Confidence Limit on the mean.

TABLE 7-3.9
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Surface Water - Downstream
Exposure Medium:	Surface Water
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Lead	ug/L	17	N/A	47		ug/L	47	Max	(1)			
Benzene	ug/L	1.1	N/A	2.0		ug/L	2.0	Max	(1)			
Bromodichloromethane	ug/L	0.6	N/A	1.0		ug/L	1.0	Max	(1)			
1,2-Dibromoethane	ug/L	0.014	N/A	0.030		ug/L	0.030	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test. Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max — Maximum Detected Value

95%UCL-N — 95% upper confidence limit on the mean for normally distributed data

95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration

N/A - Not Applicable. Data not normally distributed.

UCL - Upper Confidence Limit on the mean.

TABLE 7-3.10
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment - Adjacent
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	6.5	N/A	18		mg/kg	18	Max	(1)			
Iron	mg/kg	20,182	N/A	45,000		mg/kg	45,000	Max	(1)			
Benzo(a)anthracene	ug/kg	500	N/A	1,300		ug/kg	1,300	Max	(1)			
Benzo(b)fluoranthene	ug/kg	358	N/A	1,200		ug/kg	1,200	Max	(1)			
Benzo(a)pyrene	ug/kg	303	N/A	890		ug/kg	890	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test. Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS, Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics. Max — Maximum Detected Value

95%UCL-N — 95% upper confidence limit on the mean for normally distributed data

95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration

N/A - Not Applicable. Data not normally distributed.

UCL - Upper Confidence Limit on the mean.

TABLE 7-3.11
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment - Upstream
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	18	N/A	61		mg/kg	61	Max	(1)			
Iron	mg/kg	23,000	N/A	52,000		mg/kg	52,000	Max	(1)			
Manganese	mg/kg	1,100	N/A	2,300		mg/kg	2,300	Max	(1)			
Benzo(a)pyrene	ug/kg	86	N/A	120		ug/kg	120	Max	(1)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max — Maximum Detected Value

95%UCL-N — 95% upper confidence limit on the mean for normally distributed data

95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

EPC - Exposure Point Concentration

N/A - Not Applicable. Data not normally distributed.

UCL - Upper Confidence Limit on the mean.

TABLE 7-3.12
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe:	Current/Future
Medium:	Sediment
Exposure Medium:	Sediment - Downstream
Exposure Point:	Ralston Creek

Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL of Normal Data	Maximum Detected Concentration	Maximum Qualifier	EPC Units	Reasonable Maximum Exposure			Central Tendency		
							Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale	Medium EPC Value	Medium EPC Statistic	Medium EPC Rationale
Arsenic	mg/kg	2.7	N/A	5.2		mg/kg	5.2	Max	(1)			
Lead	mg/kg	486	N/A	3,300		mg/kg	3,300	Max	(1)			
Benzo(a)anthracene	ug/kg	243	N/A	1,400		ug/kg	1,400	Max	(2)			
Benzo(b)fluoranthene	ug/kg	264	N/A	1,600		ug/kg	1,600	Max	(2)			
Benzo(a)pyrene	ug/kg	246	N/A	1,400		ug/kg	1,400	Max	(2)			

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration.

W-Test: Developed by Shapiro and Wilk, refer to Supplemental Guidance to RAGS: Calculating the Concentration Term, OSWER Directive 9285.7-081, May 1992.

Statistics: Max — Maximum Detected Value

95%UCL-N — 95% upper confidence limit on the mean for normally distributed data

95%UCL-T — 95% upper confidence limit on the mean for the log-transformed data

(1) UCL not calculated with less than eight samples; EPC set equal to the maximum detected concentration.

(2) UCL not calculated even though there are more than eight samples; locations are too widely spaced to be representative of a person's exposure.

EPC - Exposure Point Concentration

N/A - Not Applicable. Data not normally distributed.

UCL - Upper Confidence Limit on the mean.

TABLE 7-5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD Value	Oral RfD Units	Oral to Dermal Adjustment Factor (1)	Adjusted Dermal RfD (2)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfD: Target Organ	Dates of RfD: Target Organ (3)
Aluminum	Chronic	1.00E+00	mg/kg-day	NV(5)	1.00E+00	mg/kg-day	N/A	N/A	NCEA	N/A
Arsenic	Chronic	3.00E-04	mg/kg-day	0.95	3.00E-04	mg/kg-day	Skin	3	IRIS	Nov-02
	Subchronic	3.00E-04	mg/kg-day	0.95	3.00E-04	mg/kg-day	Skin	3	HEAST	Jul-97
Chromium (total)(4)	Chronic	3.00E-03	mg/kg-day	0.025	7.50E-05	mg/kg-day	NOAEL	900	IRIS	Nov-02
	Subchronic	2.00E-02	mg/kg-day	0.025	5.00E-04	mg/kg-day	NOAEL	100	HEAST	Jul-97
Iron	Chronic	3.00E-01	mg/kg-day	NV(5)	3.00E-01	mg/kg-day	NOAEL	30	NCEA	Nov-01
Lead	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	Chronic	2.40E-02	mg/kg-day	0.04	9.60E-04	mg/kg-day	CNS	1	IRIS	Nov-02
	Subchronic	2.40E-02	mg/kg-day	0.04	9.60E-04	mg/kg-day	CNS	1	HEAST	Jul-97
Thallium	Chronic	8.00E-05	mg/kg-day	1.00	8.00E-05	mg/kg-day	Blood	3,000	IRIS	Nov-02
	Subchronic	8.00E-04	mg/kg-day	1.00	8.00E-04	mg/kg-day	Liver; Blood; Hair	300	HEAST	Jul-97
Cyanide	Chronic	2.00E-02	mg/kg-day	>0.47	2.00E-02	mg/kg-day	WB; T	500	IRIS	Nov-02
	Subchronic	2.00E-02	mg/kg-day	>0.47	2.00E-02	mg/kg-day	WB; T	500	HEAST	Jul-97
Acenaphthene	Chronic	6.00E-02	mg/kg-day	0.58 - 0.89	6.00E-02	mg/kg-day	Liver	3,000	IRIS	Nov-02
	Subchronic	6.00E-01	mg/kg-day	0.58 - 0.89	6.00E-01	mg/kg-day	Liver	300	HEAST	Jul-97
Acenaphthylene	Chronic	2.00E-02	mg/kg-day	0.58 - 0.89	2.00E-02	mg/kg-day	N/A	N/A	Surrogate: Naphthalene	N/A
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Fluorene	Chronic	4.00E-02	mg/kg-day	0.58 - 0.89	4.00E-02	mg/kg-day	Blood	3,000	IRIS	Nov-02
	Subchronic	4.00E-01	mg/kg-day	0.58 - 0.89	4.00E-01	mg/kg-day	Blood	300	HEAST	Jul-97
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	Chronic	2.00E-02	mg/kg-day	0.58 - 0.89	2.00E-02	mg/kg-day	N/A	N/A	Surrogate: Naphthalene	N/A
Naphthalene	Chronic	2.00E-02	mg/kg-day	0.58 - 0.89	2.00E-02	mg/kg-day	WB	3,000	IRIS	Nov-02
PCB-Aroclor 1254	Chronic	2.00E-05	mg/kg-day	.80 - .96	2.00E-05	mg/kg-day	IS	300	IRIS	Nov-02
	Subchronic	5.00E-05	mg/kg-day	.80 - .96	5.00E-05	mg/kg-day	IS	100	HEAST	Jul-97
PCB-Aroclor 1260	Chronic	2.00E-05	mg/kg-day	.80 - .96	2.00E-05	mg/kg-day	N/A	N/A	Surrogate:	N/A
	Subchronic	5.00E-05	mg/kg-day	.80 - .96	5.00E-05	mg/kg-day	N/A	N/A	Aroclor 1254	N/A
Phenanthrene	Chronic	3.00E-02	mg/kg-day	0.58 - 0.89	3.00E-02	mg/kg-day	N/A	N/A	Surrogate:	N/A
	Subchronic	3.00E-01	mg/kg-day	0.58 - 0.89	3.00E-01	mg/kg-day	N/A	N/A	Pyrene	N/A
Benzene	Chronic	3.00E-03	mg/kg-day	>0.5 (6)	3.00E-03	mg/kg-day	N/A	N/A	NCEA	N/A
Bromodichloromethane	Chronic	2.00E-02	mg/kg-day	>0.5 (6)	2.00E-02	mg/kg-day	Kidney	1000	IRIS	Nov-02
1,2-Dibromoethane	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ethylbenzene	Chronic	1.00E-01	mg/kg-day	>0.5 (6)	1.00E-01	mg/kg-day	Liver; Kidney	1,000	IRIS	Nov-02
Toluene	Chronic	2.00E-01	mg/kg-day	>0.5 (6)	2.00E-01	mg/kg-day	Liver; Kidney	1,000	IRIS	Nov-02
	Subchronic	2.00E+00	mg/kg-day	>0.5 (6)	2.00E+00	mg/kg-day	Liver; Kidney	100	HEAST	Jul-97
Xylenes	Chronic	2.00E+00	mg/kg-day	>0.5 (6)	2.00E+00	mg/kg-day	CNS, WB	100	IRIS	Nov-02
	Subchronic	4.00E-01	mg/kg-day	>0.5 (6)	4.00E-01	mg/kg-day	CNS	1,000	NCEA	Dec-98

CNS = Central Nervous System
HEAST = Health Affects Assessment Summary Tables (U.S. EPA, 1997b)
IRIS = Integrated Risk Information System
IS = Immune System
N/A = Not Applicable
NCEA = National Center for Environmental Assessment. Values in memorandum dated 10/26/01.
NOAEL = No obseved adverse effects level; no adverse effects noted at any dose
RfD = Reference dose

RS = Respiratory system
T = Thyroid
WB = Whole body
(1) Values from Draft RAGS Dermal Risk Assessment Interim Guidance (U.S. EPA, 2001)
(2) If ABSo (Oral to Dermal Adjustment Factor) ≥ 0.5, RfDd = RfDo; If ABSo < 0.5, RfDd = ABSo × RfDo (U.S. EPA, 2001)
(3) For IRIS, the date IRIS was searched. For HEAST, the date HEAST was published
(4) Values are for hexavalent chromium (Cr(VI))
(5) No value provided in the Draft RAGS Dermal Risk Assessment Interim Guidance (U.S. EPA, 2001). The dermal RfD has been set equal to the oral RfD
(6) In accordance with Draft RAGS Dermal Risk Assessment Interim Guidance (U.S. EPA, 2001), organics without specific oral absorption factors generally have a gastrointestinal absorption efficiency greater than 50%

TABLE 7-5 2

NON-CANCER TOXICITY DATA – INHALATION

FORMER MANUFACTURED GAS PLANT

IOWA CITY, IOWA

Chemical of Potential Concern	Chronic/ Subchronic	Value Inhalation RfC	Units	Adjusted Inhalation RfD (1)	Units	Primary Target Organ	Combined Uncertainty/Modifying Factors	Sources of RfC:RfD Target Organ	Dates (2)
Aluminum	Chronic	0.005	mg/m³	0.0014	mg/kg/day	CNS	300	NCEA	N/A
Arsenic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iron	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Manganese	Chronic	0.00005	mg/m³	0.000014	mg/kg/day	RS	1,000	IRIS	Nov-02
Thallium	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Cyanide	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Acenaphthylene	Chronic	0.00003	mg/m³	0.00086	mg/kg/day	N/A	N/A	Surrogate: Naphthalene	N/A
Benzo(a)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(b)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(k)fluoranthene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzo(a)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Chrysene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Dibenz(a,h)anthracene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Indeno(1,2,3-cd)pyrene	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2-Methylnaphthalene	Chronic	0.00003	mg/m³	0.00086	mg/kg/day	N/A	N/A	Surrogate: Naphthalene	N/A
Naphthalene	Chronic	0.00003	mg/m³	0.00086	mg/kg/day	RS	3,000	IRIS	Nov-02
PCB - Aroclor 1254	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PCB - Aroclor 1260	Chronic	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Benzene	Chronic	0.006	mg/m³	0.0017	mg/kg/day	N/A	N/A	NCEA	N/A
Ethylbenzene	Chronic	1	mg/m³	0.29	mg/kg/day	DE	300	IRIS	Nov-02
Toluene	Chronic	0.4	mg/m³	0.11	mg/kg/day	CNS	300	IRIS	Nov-02
Xylenes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

CNS = Central nervous system

DE = Developmental effects

IRIS = Integrated Risk Information System

RS = Respiratory system

N/A = Not Applicable

NCEA = National Center for Environmental Assessment. Values in memorandum dated 10/26/01.

RfD = Reference dose

RfC = Reference concentration

(1) Inhalation RfD =(RfC*20 m³/day)/70 kg

(2) Date is the date IRIS was searched.

TABLE 7-6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Chemical of Potential Concern	Oral Cancer Slope Factor	Oral to Dermal Adjustment Factor (5)	Adjusted Dermal Cancer Slope Factor (1)	Units	Weight of Evidence/ Cancer Guideline Description	Source (2)	Date (3)
Arsenic	1.5	0.95	1.5	$(mg/kg/day)^{-1}$	A	IRIS	Nov-02
Chromium (Total)	N/A	N/A	N/A	N/A	D	IRIS	Nov-02
Benzo(a)anthracene	0.73	0.58 - 0.89	0.73	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(b)fluoranthene	0.73	0.58 - 0.89	0.73	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(k)fluoranthene	0.073	0.58 - 0.89	0.073	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(a)pyrene	7.3	0.58 - 0.89	7.3	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
Chrysene	0.0073	0.58 - 0.89	0.0073	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Dibenz(a,h)anthracene	7.3	0.58 - 0.89	7.3	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Indeno(1,2,3-cd)pyrene	0.73	0.58 - 0.89	0.73	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Naphthalene	N/A	N/A	N/A	N/A	C	IRIS	Nov-02
PCB - Aroclor 1254	2.0	0.80 - 0.96	2.0	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
PCB - Aroclor 1260	2.0	0.80 - 0.96	2.0	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
Benzene	0.055 (4)	>0.5 (6)	0.055	$(mg/kg/day)^{-1}$	A	IRIS	Nov-02
Bromodichloromethane	0.062	>0.5 (6)	0.062	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
1,2-Dibromoethane	85	>0.5 (6)	85	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02

IRIS = Integrated Risk Information System
NCEA = National Center for Environmental Assessment. Values in memorandum dated 10/26/01.
(1) If ABSo (Oral to Dermal Adjustment Factor) ≥ 0.5, SFd = SFo; If ABSo < 0.5, SFd = SFo/ABSo (U.S. EPA, 2001)
(2) Where two sources are provided, the first is for the slope factor and the second is for the weight of evidence.
(3) Date is the date that IRIS was searched.
(4) IRIS lists a range of 0.015 to 0.055. The value listed in this table is the maximum of this range.
(5) Data are from Draft RAGS Dermal Risk Assessment Interim Guidance (U.S. EPA, 2001)
(6) In accordance with Draft RAGS Dermal Risk Assessment Interim Guidance (U.S. EPA, 2001), organics without specific oral absorption factors generally have a gastrointestinal absorption efficiency greater than 50%.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of non-carcinogenicity

TABLE 7-6.2
CANCER TOXICITY DATA -- INHALATION
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Chemical of Potential Concern	Unit Risk	Units	Adjustment	Inhalation Cancer Slope Factor	Units	Weight of Evidence/ Cancer Guideline Description	Source (1)	Date (2)
Arsenic	4.3E-03	$(ug/m^3)^{-1}$	3,500	1.50E+01	$(mg/kg/day)^{-1}$	A	IRIS	Nov-02
Benzo(a)anthracene	8.9E-05	$(ug/m^3)^{-1}$	3,500	3.10E-01	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(b)fluoranthene	8.9E-05	$(ug/m^3)^{-1}$	3,500	3.10E-01	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(k)fluoranthene	8.9E-06	$(ug/m^3)^{-1}$	3,500	3.10E-02	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Benzo(a)pyrene	8.9E-04	$(ug/m^3)^{-1}$	3,500	3.10E+00	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Chrysene	8.9E-07	$(ug/m^3)^{-1}$	3,500	3.10E-03	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Dibenz(a,h)anthracene	8.9E-04	$(ug/m^3)^{-1}$	3,500	3.10E+00	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Indeno(1,2,3-cd)pyrene	8.9E-05	$(ug/m^3)^{-1}$	3,500	3.10E-01	$(mg/kg/day)^{-1}$	B2	NCEA/IRIS	Nov-02
Naphthalene	N/A	N/A	N/A	N/A	N/A	C	IRIS	Nov-02
PCB - Aroclor 1254	1.0E-04	$(ug/m^3)^{-1}$	3,500	4.00E-01	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
PCB - Aroclor 1260	1.0E-04	$(ug/m^3)^{-1}$	3,500	4.00E-01	$(mg/kg/day)^{-1}$	B2	IRIS	Nov-02
Benzene	0.0000078 (3)	$(ug/m^3)^{-1}$	3,500	2.70E-02	$(mg/kg/day)^{-1}$	A	IRIS	Nov-02

IRIS = Integrated Risk Information System
HEAST = Health Effects Assessment Summary Tables
NCEA = National Center for Environmental Assessment. Values in memorandum dated 10/26/01.
(1) Where two sources are provided, the first is for the slope factor and the second is for the weight of evidence.
(2) Date is the date that IRIS was searched.
(3) IRIS lists a range of 2.2×10^{-6} to 7.8×10^{-6}. The value listed in this table is the maximum of this range.

EPA Group:
A - Human carcinogen
B1 - Probable human carcinogen - indicates that limited human data are available
B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans
C - Possible human carcinogen
D - Not classifiable as a human carcinogen
E - Evidence of noncarcinogenicity

TABLE 7-9.1
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Apartment Yard Surface Soil	Arsenic	7.0E-07	--	8.4E-08	7.9E-07	Aluminum	CNS	1.1E-02		0.0E+00	1.1E-02
								Arsenic	Skin	2.2E-02	--	2.6E-03	2.5E-02
								Manganese	CNS	3.3E-02	--	0.0E+00	3.3E-02
								Thallium	Blood	1.1E-02	–	0.0E+00	1.1E-02
								Cyanide	Whole Body, Thyroid	4.0E-04	--	0.0E+00	4.0E-04
								(Total)		7.7E-02		2.6E-03	8.0E-02
	Fugitive Dust	Dust in Outdoor Air	Arsenic	–	4.3E-10	--	4.3E-10	Aluminum	CNS		4.7E-04	--	4.7E-04
								Manganese	Respiratory System	-	3.3E-03	--	3.3E-03
								(Total)			3.8E-03		3.8E-03
	Indoor Air	Apartment Air	Benzene	--	9.5E-07	–	9.5E-07	Benzene	Not Available	--	2.9E-01	--	2.9E-01

Total Risk Across Surface Soil	7.9E-07
Total Risk Across Indoor Air	9.5E-07
Total Risk Across All Media and All Exposure Routes	1.7E-06
Total Hazard Index Across All Media and All Exposure Routes	3.8E-01
Total Skin HI =	2.5E-02
Total CNS HI =	4.4E-02
Total Blood HI =	1.1E-02
Total Thyroid HI =	4.0E-04

TABLE 7-9.2
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Apartment Yard Surface Soil	Arsenic	6.6E-06	--	5.5E-07	7.1E-06	Aluminum	CNS	1.0E-01	--	0.0E+00	1.0E-01
								Arsenic	Skin	2.0E-01	–	1.7E-02	2.2E-01
								Manganese	CNS	3.0E-01	--	0.0E+00	3.0E-01
								Thallium	Blood	1.0E-01	--	0.0E+00	1.0E-01
								Cyanide	Whole Body, Thyroid	3.7E-03	–	0.0E+00	3.7E-03
								(Total)		7.2E-01		1.7E-02	7.4E-01
	Fugitive Dust	Dust in Outdoor Air	Arsenic	–	9.9E-10	--	9.9E-10	Aluminum	CNS	--	1.1E-03	--	1.1E-03
								Manganese	Respiratory System	--	7.8E-03	–	7.8E-03
								(Total)			8.9E-03		8.9E-03
	Indoor Air	Apartment Air	Benzene	--	2.2E-06	–	2.2E-06	Benzene	Not Available	--	6.8E-01	--	6.8E-01

Total Risk Across Surface Soil	7.1E-06
Total Risk Across Indoor Air	2.2E-06
Total Risk Across All Media and All Exposure Routes	9.3E-06
Total Hazard Index Across All Media and All Exposure Routes	1.4E+00
Total Skin HI =	2.5E-02
Total CNS HI =	4.1E-01
Total Blood HI =	1.0E-01
Total Thyroid HI =	3.7E-03

TABLE 7-9.3
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY IOWA

Scenario Timeframe: Current/Future
Receptor Population: Maintenance Supervisor
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface Soil	Surface Soil	Apartment Yard Surface Soil	Arsenic	6.3E-07	--	1.7E-07	8.0E-07	Aluminum	CNS	1.9E-03	-	0.0E+00	1.9E-03
								Arsenic	Skin	3.9E-03	--	1.1E-03	5.0E-03
								Manganese	CNS	5.8E-03	--	0.0E+00	5.8E-03
								Thallium	Blood	2.0E-03	--	0.0E+00	2.0E-03
								Cyanide	Whole Body, Thyroid	7.1E-05	-	0.0E+00	7.1E-05
								(Total)		1.4E-02		1.1E-03	1.5E-02
	Indoor Air	Apartment Air	Benzene	–	1.7E-06	–	1.7E-06	Benzene	Not Available	--	1.0E-01	--	1.0E-01

Total Risk Across Surface Soil: 8.0E-07

Total Risk Across Indoor Air: 1.7E-06

Total Risk Across All Media and All Exposure Routes: 2.5E-06

Total Hazard Index Across All Media and All Exposure Routes: 1.2E-01

Total Skin HI = 2.5E-02

Total CNS HI = 7.6E-03

Total Blood HI = 2.0E-03

Total Thyroid HI = 7.1E-05

TABLE 7-9.4
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Utility Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Surface and Subsurface Soil in Apartment Yard Utility Lines	Arsenic	2.6E-08	--	1.1E-09	2.7E-08	Arsenic	Skin	4.0E-03	--	1.7E-04	4.2E-03
			Benzo(a)anthracene	8.0E-08	--	1.4E-08	9.4E-08	Manganese	CNS	1.4E-02	--	0.0E+00	1.4E-02
			Benzo(a)pyrene	5.8E-07	--	1.0E-07	6.9E-07	Cyanide	Whole Body, Thyroid	1.8E-04	--	0.0E+00	1.8E-04
			Benzo(b)fluoranthene	2.2E-08	--	3.9E-09	2.6E-08	Naphthalene	Whole Body	1.2E-03	--	1.6E-04	1.3E-03
			Dibenzo(a,h)anthracene	3.9E-09	--	7.0E-10	4.6E-09	(Total)		2.0E-02	--	3.3E-04	2.0E-02
			Indeno(1,2,3-c,d)pyrene	3.7E-08	–	6.5E-09	4.3E-08						
			(Total)	7.5E-07	--	1.3E-07	8.0E-07						
	Fugitive Dust	Dust in Outdoor Air	Arsenic	--	3.3E-12	--	3.3E-12	Manganese	CNS	–	3.0E-04	--	3.0E-04
			Benzo(a)anthracene	--	4.3E-13	--	4.3E-13	Naphthalene	Whole Body	--	3.4E-07	--	3.4E-07
			Benzo(a)pyrene	--	3.1E-12	--	3.1E-12	(Total)		--	3.0E-04	--	3.0E-04
			Benzo(b)fluoranthene	--	1.2E-13	--	1.2E-13						
			Dibenzo(a,h)anthracene	--	2.1E-14	--	2.1E-14						
			Indeno(1,2,3-c,d)pyrene	--	2.0E-13	--	2.0E-13						
			(Total)	--	7.1E-12	--	7.1E-12						
	Outdoor Air	Air in Trenches	NA					Naphthalene	Whole Body	--	4.0E-01	--	4.0E-01
								(Total)		--	4.0E-01	--	4.0E-01

Total Risk Across Surface and Subsurface Soil: 8.8E-07

Total Risk Across All Media and All Exposure Routes: 8.8E-07

Total Hazard Index Across All Media and All Exposure Routes: 4.2E-01

Total Skin HI = 4.2E-03

Total CNS HI = 1.4E-02

Total Whole Body HI = 4.0E-01

Total Thyroid HI = 1.8E-04

NA No compounds selected as chemicals of potential concern with unit risk factors or cancer slope factors for this medium and/or pathway.

TABLE 7-9.5a
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Cleanup Volunteer
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Adjacent to Site	Arsenic	5.3E-08	--	3.6E-08	8.9E-08	Arsenic	Skin	8.2E-04		5.6E-04	1.4E-03
			Benzo(a)anthracene	1.9E-09	--	5.5E-09	7.4E-09						
			Benzo(b)fluoranthene	1.7E-09	--	5.1E-09	6.8E-09						
			Benzo(a)pyrene	1.3E-08	--	3.8E-08	5.0E-08						
			(Total)	6.9E-08		8.4E-08	1.5E-07						
Surface Water	Surface Water	Ralston Creek Adjacent to Site	Benzene	1.1E-11	--	9.2E-11	1.0E-10	Benzene	Not Available	4.6E-07	--	2.5E-06	3.0E-06

Total Risk Across Sediment: 1.5E-07
Total Risk Across Surface Water: 1.0E 10
Total Risk Across All Media and All Exposure Routes: 1.5E-07

Total Hazard Index Across Sediment: 1.4E-03
Total Hazard Index Across Surface Water: 3.0E 06
Total Hazard Index Across All Media and All Exposure Routes: 1.4E-03

Total Skin HI = 1.4E-03

TABLE 7-9.5b
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Cleanup Volunteer
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Upstream of Site	Arsenic	1.8E-07	--	1.2E-07	3.0E-07	Arsenic	Skin	2.8E-03	--	1.9E-03	4.7E-03
			Benzo(A)pyrene	1.7E-09	-	5.1E-09	6.8E-09	Manganese	CNS	1.3E-03	--	0.0E+00	1.3E-03
			(Total)	1.8E-07		1.3E-07	3.1E-07	(Total)		4.1E-03		1.9E-03	6.0E-03
Surface Water	Surface Water	Ralston Creek Upstream of Site	Bromodichloromethane	1.2E-11	-	5.3E-11	6.5E-11	Thallium	Blood	5.0E-05	--	1.8E-05	6.8E-05
								Cyanide	Whole Body Thyroid	7.5E-07	--	2.8E-07	1.0E-06
								Bromodichloromethane	Kidney	6.8E-08	--	3.0E-07	3.7E-07
								(Total)		5.0E-05		1.9E-05	6.9E-05

Total Risk Across Sediment: 3.1E-07
Total Risk Across Surface Water: 6.5E-11
Total Risk Across All Media and All Exposure Routes: 3.1E-07

Total Hazard Index Across Sediment: 6.0E-03
Total Hazard Index Across Surface Water: 6.9E-05
Total Hazard Index Across All Media and All Exposure Routes: 6.1E-03

Total Skin HI = 4.7E-03
Total CNS HI = 1.3E-03
Total Blood HI = 6.8E-05
Total Kidney HI = 3.7E-07
Total Thyroid HI = 1.0E-06
Total Whole Body HI = 1.0E-06

TABLE 7-9 5c
SUMMAF Y OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Cleanup Volunteer
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Downstream of Site	Arsenic	1.5E-08	--	1.0E-08	2.6E-08	Arsenic	Skin	2.4E-04	--	1.6E-04	4.0E-04
			Benzo(a)anthracene	2.0E-09	--	5.9E-09	7.9E-09						
			Benzo(b)fluoranthene	2.3E-09	--	6.8E-09	9.1E-09						
			Benzo(a)pyrene	2.0E-08	--	5.9E-08	7.9E-08						
			(Total)	4.0E-08		8.2E-08	1.2E-07						
Surface Water	Surface Water	Ralston Creek Downstream of Site	Benzene	2.2E-11	--	1.8E-10	2.1E-10	Benzene	Not Available	9.1E-07	--	7.8E-06	8.7E-06
			Bromodichloromethane	1.2E-11	--	5.3E-11	6.5E-11	Bromodichloromethane	Kidney	6.8E-08	--	3.0E-07	3.7E-07
			1,2-Dibromoethane	5.0E-10	--	1.6E-09	2.1E-09	(Total)		9.8E-07		8.1E-06	9.1E-06
			(Total)	5.3E-10		1.8E-09	2.3E-09						

Total Risk Across Sediment: 1.2E-07
Total Risk Across Surface Water: 2.3E-09
All Media and All Exposure Routes: 1.2E-07

Total Hazard Index Across Sediment: 4.0E-04
Total Hazard Index Across Surface Water: 9.1E-06
Total Hazard Index Across All Media and All Exposure Routes: 4.1E-04

Total Skin HI = 4.0E-04
Total Kidney HI = 3.7E-07

TABLE 7-9 6a
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Visitor
Receptor Age: Older Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Adjacent to Site	Arsenic	6.4E-07	--	2.5E-07	8.9E-07	Arsenic	Skin	9.9E-03	--	3.9E-03	1.4E-02
			Benzo(a)anthracene	2.2E-08	--	3.9E-08	6.1E-08						
			Benzo(a)pyrene	1.5E-07	--	2.6E-07	4.2E-07						
			Benzo(b)fluoranthene	2.1E-08	--	3.6E-08	5.6E-08						
			(Total)	8.4E-07		5.9E-07	1.4E-06						
Surface Water	Surface Water	Ralston Creek Adjacent to Site	Benzene	6.9E-11	--	8.4E-10	9.1E-10	Benzene	Not Available	5.5E-06	--	6.8E-05	7.3E-05

Total Risk Across Sediment: 1.4E-06
Total Risk Across Surface Water: 9.1E-10
All Media and All Exposure Routes: 1.4E-06

Total Hazard Index Across Sediment: 1.4E-02
Total Hazard Index Across Surface Water: 7.3E-05
Total Hazard Index Across All Media and All Exposure Routes: 1.4E-02

Total Skin HI = 1.4E-02

TABLE 7-9.6b
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Visitor
Receptor Age: Older Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Upstream of Site	Arsenic	2.2E-06	--	8.6E-07	3.0E-06	Arsenic	Skin	3.4E-02	--	1.3E-02	4.7E-02
			Benzo(a)pyrene	2.1E-08	--	3.6E-08	6.5E-08	Manganese	CNS	1.6E-02	–	0.0E+00	1.6E-02
			(Total)	2.2E-06	--	8.9E-07	3.1E-06	(Total)		5.0E-02		1.3E-02	6.3E-02
Surface Water	Surface Water	Ralston Creek Upstream of Site	Bromodichloromethane	1.5E-10	--	9.2E-10	1.1E-09	Thallium	Blood	6.0E-04	-	3.2E-04	9.2E-04
								Cyanide	Whole Body; Thyroid	9.1E-06	–	4.8E-06	1.4E-05
								Bromodichloromethane	Kidney	8.3E-07	–	5.2E-06	6.0E-06
								(Total)		6.1E-04		3.3E-04	9.4E-04
						Total Risk Across Sediment	3.1E-06					Total Hazard Index Across Sediment	6.3E-02
						Total Risk Across Surface Water	1.1E-09					Total Hazard Index Across Surface Water	9.4E-04
						s All Media and All Exposure Routes	3.1E-06					Total Hazard Index Across All Media and All Exposure Routes	6.4E-02

Total Skin HI =	4.7E-02
Total CNS HI =	1.6E-02
Total Blood HI =	9.2E-04
Total Whole Body HI =	1.4E-05
Total Thyroid HI =	1.4E-05
Total Kidney HI =	6.0E-06

TABLE 7-9.6c
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Current/Future
Receptor Population: Recreational Visitor
Receptor Age: Older Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Sediment	Sediment	Ralston Creek Downstream of Site	Arsenic	1.8E-07	--	7.9E-08	2.6E-07	Arsenic	Skin	2.87E-03	--	1.10E-03	4.0E-03
			Benzo(a)anthracene	2.4E-08	-	4.2E-08	6.6E-08						
			Benzo(b)fluoranthene	2.8E-08	--	4.7E-08	7.5E-08						
			Benzo(a)pyrene	2.4E-07	--	4.2E-07	6.6E-07						
			(Total)	4.8E-07		5.8E-07	1.1E-06						
	Surface Water	Ralston Creek Downstream of Site	Benzene	2.6E-10	--	3.2E-09	3.4E-09	Benzene	Not Available	1.1E-05	–	1.4E-04	1.5E-04
			Bromodichloromethane	1.5E-10	--	9.2E-10	1.1E-09	Bromodichloromethane	Kidney	8.3E-07	–	5.2E-06	6.0E-06
			1,2-Dibromoethane	6.0E-09	--	2.7E-08	3.3E-08	(Total)		1.2E-05		1.4E-04	1.5E-04
			(Total)	6.4E-09		3.1E-08	3.8E-08						
						Total Risk Across Sediment	1.1E-06					Total Hazard Index Across Sediment	4.0E-03
						Total Risk Across Surface Water	3.8E-08					Total Hazard Index Across Surface Water	1.5E-04
						s All Media and All Exposure Routes	1.1E-06					Total Hazard Index Across All Media and All Exposure Routes	4.2E-03

Total Skin HI =	4.0E-03
Total Kidney HI =	6.0E-06

TABLE 7-9.7
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water	Arsenic	5.0E-04	--	1.3E-08	5.0E-04	Cyanide	Whole Body, Thyroid	1.4E+01	--	3.5E-02	1.4E+01
			Benzene	1.3E-03	--	1.4E-04	1.4E-03	Aluminum	CNS	3.3E+00	--	8.2E-03	3.3E+00
			Benzo(a)anthracene	1.7E-04	--	1.6E-03	1.7E-03	Arsenic	Skin	1.6E+01	--	3.9E-02	1.6E+01
			Benzo(a)pyrene	6.3E-04	--	1.0E-02	1.1E-02	Chromium	NOAEL	1.2E+00	--	2.4E-01	1.5E+00
			Benzo(b)fluoranthene	2.9E-05	--	4.6E-04	4.9E-04	Manganese	CNS	1.8E+01	--	1.1E+00	1.9E+01
			Benzo(k)fluoranthene	1.6E-06	--	2.8E-05	3.0E-05	Benzene	Not Available	1.1E+02	--	1.2E+01	1.2E+02
			Chrysene	6.6E-07	--	7.9E-06	8.6E-06	Ethylbenzene	Liver, Kidney	7.3E-01	--	3.2E-01	1.0E+00
			Dibenz(a,h)anthracene	1.6E-04	--	3.9E-03	4.0E-03	Toluene	Liver, Kidney	9.5E-01	--	2.4E-01	1.2E+00
			Indeno(1,2,3-cd)pyrene	3.3E-05	--	5.3E-04	5.6E-04	Xylenes, Total	CNS, Whole Body	3.9E-02	--	1.9E-02	5.8E-02
			(Total)	2.8E-03		1.7E-02	1.9E-02	Acenaphthene	Liver	3.7E-01	--	3.7E-01	7.4E-01
								Acenaphthylene	Not Available	2.7E-01	--	2.0E-01	4.8E-01
								Fluorene	Blood	3.7E-01	--	5.5E-01	9.2E-01
								Naphthalene	Whole Body	1.3E+01	--	6.2E+00	1.9E+01
								Phenanthrene	Not Available	7.2E-01	--	1.4E+00	2.1E+00
								2-Methylnaphthalene	Not Available	3.0E+00	--	3.0E+00	6.1E+00
								(Total)		1.8E+02		2.6E+01	2.1E+02
	Air	Groundwater-Household Vapors	Benzene	--	3.1E-03	--	3.1E-03	Benzene	Not Available	--	9.6E+02	--	9.6E+02
								Ethylbenzene	Developmental Effects	--	1.3E+00	--	1.3E+00
								Toluene	CNS	--	8.3E+00	--	8.3E+00
								Naphthalene	Respiratory System	--	1.5E+03	--	1.5E+03
								2-Methylnaphthalene	Not Available	--	3.5E+02	--	3.5E+02
								(Total)			2.8E+03		2.8E+03

Total Risk Across Groundwater	2.3E-02
Total Risk Across All Media and All Exposure Routes	2.3E-02
Total Hazard Index Across All Media and All Exposure Routes	3.0E+03

Total Whole Body HI =	3.3E+01
Total Thyroid HI =	1.4E+01
Total CNS HI =	3.1E+01
Total Skin HI =	1.6E+01
Total Blood HI =	9.2E-01
Total Liver HI =	3.0E+00
Total Kidney HI =	2.2E+00
Total Developmental HI =	1.3E+00
Total Respiratory System HI =	1.5E+03

TABLE 7-9.8

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Tap Water	Arsenic	1.5E-03	–	2.8E-06	1.5E-03	Cyanide	Whole Body, Thyroid	4.3E+01	–	7.8E-02	4.3E+01
			Benzene	3.9E-03	–	2.8E-04	4.2E-03	Aluminum	CNS	1.0E+01	–	1.8E-02	1.0E+01
			Benzo(a)anthracene	5.1E-04	–	3.0E-03	3.6E-03	Arsenic	Skin	4.7E+01	–	8.7E-02	4.7E+01
			Benzo(a)pyrene	1.9E-03	–	1.9E-02	2.1E-02	Chromium	NOAEL	3.8E+00	–	5.3E-01	4.3E+00
			Benzo(b)fluoranthene	8.7E-05	–	8.9E-04	9.7E-04	Manganese	CNS	5.6E+01	–	2.5E+00	5.8E+01
			Benzo(k)fluoranthene	5.5E-06	–	5.4E-05	6.0E-05	Benzene	Not Available	3.3E+02	–	2.3E+01	3.5E+02
			Chrysene	2.6E-06	–	1.5E-05	1.8E-05	Ethylbenzene	Liver, Kidney	2.2E+00	–	6.2E-01	2.9E+00
			Dibenz(a,h)anthracene	4.8E-04	–	7.4E-03	7.9E-03	Toluene	Liver, Kidney	2.9E+00	–	4.7E-01	3.4E+00
			Indeno(1,2,3-cd)pyrene	1.0E-04	–	1.0E-03	1.1E-03	Xylenes, Total	CNS, Whole Body	1.2E-01	–	3.8E-02	1.6E-01
			(Total)	8.5E-03		3.2E-02	4.0E-02	Acenaphthene	Liver	1.1E+00	–	7.2E-01	1.8E+00
								Acenaphthylene	Not Available	8.3E-01	–	3.9E-01	1.2E+00
								Fluorene	Blood	1.1E+00	–	1.1E+00	2.2E+00
								Naphthalene	Whole Body	3.9E+01	–	1.2E+01	5.1E+01
								Phenanthrene	Not Available	2.2E+00	–	2.8E+00	4.9E+00
								2-Methylnaphthalene	Not Available	9.2E+00	–	5.9E+00	1.5E+01
								(Total)		6.5E+02		5.1E+01	6.0E+02
	Air	Groundwater-Household Vapors	Benzene	–	7.3E-03	–	7.3E-03	Benzene	Not Available	--	2.2E+03	–	2.2E+03
								Ethylbenzene	Developmental Effects	--	3.0E+00	--	3.0E+00
								Toluene	CNS	--	1.0E+01	.	1.9E+01
								Naphthalene	Respiratory System	--	3.5E+03	--	3.5E+03
								2-Methylnaphthalene	Not Available	--	8.3E+02	–	8.3E+02
								(Total)			6.5E+03		6.5E+03

Total Risk Across Groundwater: 4.8E-02

Total Risk Across All Media and All Exposure Routes: 4.8E-02

Total Hazard Index Across All Media and All Exposure Routes: 7.1E+03

Total Whole Body HI = 9.4E+01

Total Thyroid HI = 4.3E+01

Total CNS HI = 8.0E+01

Total Skin HI = 4.7E+01

Total Blood HI = 2.2E+00

Total Liver HI = 6.0E+00

Total Kidney HI = 6.2E+00

TABLE 7-9.9

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Receptor Population: Bridge Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Soil by Burlington Street near Ralston Creek	Arsenic	2.2E-07	--	9.1E-09	2.3E-07	Arsenic	Skin	3.4E-02	--	1.4E-03	3.6E-02
			Benzo(a)pyrene	4.9E-08	–	6.6E-09	5.6E-08						
			Benzo(b)fluoranthene	1.1E-08	–	2.0E-09	1.4E-08						
			(Total)	2.8E-07	..	2.0E-08	3.0E-07						
	Fugitive Dust	Dust in Outdoor Air	Arsenic	-	2.8E-11	..	2.8E-11	NA					
			Benzo(a)pyrene	--	2.6E-13	..	2.6E-13						
			Benzo(b)fluoranthene	--	6.1E-14	--	6.1E-14						
			(Total)	..	2.8E-11	..	2.8E-11						
	Outdoor Air	Outdoor Air	NA					NA					

Total Risk Across Surface and Subsurface Soil: 3.0E-07

Total Risk Across All Media and All Exposure Routes: 3.0E-07

Total Hazard Index Across All Media and All Exposure Routes: 3.6E-02

Total Skin HI = 3.6E-02

NA - No compounds selected as chemicals of potential concern with inhalation toxicity values for the medium and/or pathway

TABLE 7-9.10
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURE
FORMER MANUFACTURED GAS PLANT
IOWA CITY, IOWA

Scenario Timeframe: Future
Receptor Population: Construction Worker
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical	Carcinogenic Risk				Chemical	Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	Exposure Routes Total		Primary Target Organ	Ingestion	Inhalation	Dermal	Exposure Routes Total
Surface and Subsurface Soil	Surface and Subsurface Soil	Apartment Yard Surface and Subsurface Soil	Arsenic	2.6E-07	--	2.0E-08	2.7E-07	Arsenic	Skin	4.0E-02	--	3.1E-03	4.3E-02
			Aroclor 1254	1.7E-08	--	6.1E-09	2.3E-08	Manganese	CNS	7.3E-02	--	0.0E+00	7.3E-02
			Aroclor 1260	1.6E-08	--	5.9E-09	2.2E-08	Cyanide	Whole Body, Thyroid	5.3E-03	--	0.0E+00	5.3E-03
			Benzo(a)anthracene	7.5E-07	--	2.6E-07	1.0E-06	Acenaphthylene	Liver	9.6E-05	--	3.2E-06	1.0E-04
			Benzo(a)pyrene	8.0E-06	--	2.7E-06	1.1E-05	2-Methylnaphthalene	Not Available	6.1E-03	--	2.1E-03	8.2E-03
			Benzo(b)fluoranthene	7.2E-07	--	2.4E-07	9.6E-07	Naphthalene	Whole Body	2.0E-02	--	6.8E-03	2.7E-02
			Benzo(k)fluoranthene	3.7E-08	--	1.2E-08	4.9E-08	Aroclor 1254	Immune System	1.2E-02	--	4.3E-03	1.6E-02
			Chrysene	4.2E-09	--	1.4E-09	5.6E-09	Aroclor 1260	Immune System	1.1E-02	--	4.1E-03	1.5E-02
			Dibenzo(a,h)anthracene	2.2E-07	--	7.4E-08	2.9E-07	Benzene	Not Available	2.8E-04	--	0.0E+00	2.8E-04
			Indeno(1,2,3-c,d)pyrene	1.9E-07	--	6.3E-08	2.5E-07	Ethylbenzene	Liver, Kidney	6.8E-06	--	0.0E+00	6.8E-06
			Benzene	6.5E-10	--	0.0E+00	6.5E-10	(Total)		1.7E-01		2.0E-02	1.9E-01
			(Total)	1.0E-05		3.4E-06	1.4E-05						
	Fugitive Dust	Dust in Outdoor Air	Arsenic	--	6.1E-11	--	6.1E-11	Manganese	Respiratory System	--	2.9E-03	--	2.9E-03
			Aroclor 1254	--	4.0E-13	--	4.0E-13	Acenaphthylene	Not Available	--	1.8E-06	--	1.8E-06
			Aroclor 1260	--	3.9E-13	--	3.9E-13	2-Methylnaphthalene	Not Available	--	3.4E-06	--	3.4E-06
			Benzo(a)anthracene	--	7.6E-12	--	7.6E-12	Naphthalene	Respiratory System	--	1.1E-05	--	1.1E-05
			Benzo(a)pyrene	--	8.1E-11	--	8.1E-11	Benzene	Not Available	--	1.2E-08	--	1.2E-08
			Benzo(b)fluoranthene	--	7.3E-12		7.3E-12	Ethylbenzene	Developmental	--	4.9E-10	--	4.9E-10
			Benzo(k)fluoranthene	--	3.7E-13		3.7E-13	(Total)			2.9E-03		2.9E-03
			Chrysene	--	4.2E-14		4.2E-14						
			Dibenzo(a,h)anthracene	--	2.2E-12		2.2E-12						
			Indeno(1,2,3-c,d)pyrene	--	1.9E-12		1.9E-12						
			Benzene	--	7.8E-15		7.8E-15						
			(Total)		1.6E-10		1.6E-10						
	Outdoor Air	Air Inhalation	Benzene	--	3.1E-08	--	3.1E-08	2-Methylnaphthalene	Not Available	--	4.5E-01	--	4.5E-01
								Naphthalene	Respiratory System	--	2.1E+00	--	2.1E+00
								Benzene	Not Available	--	4.6E-02	--	4.6E-02
								Ethylbenzene	Developmental	--	9.7E-04	--	9.7E-04
								(Total)			2.6E+00		2.6E+00

Total Risk Across Surface and Subsurface Soil	1.4E-05
Total Risk Across All Media and All Exposure Routes	1.4E-05
Total Hazard Index Across All Media and All Exposure Routes	2.8E+00

Total Skin HI =	4.3E-02
Total CNS HI =	7.3E-02
Total Whole Body HI =	3.2E-02
Total Thyroid HI =	5.3E-03
Total Liver HI =	1.0E-04
Total Respiratory System HI =	2.1E+00
Total Developmental HI =	9.7E-04
Total Immune System HI =	2.7E-02