DESIGN AND IMPLEMENTATION
WORK PLAN

RELIEF AND GAS HOLDER REMEDIATION

UGI COLUMBIA GAS PLANT SITE
Columbia, Pennsylvania

Prepared for:

PENNSYLVANIA POWER & LIGHT
Two North Ninth Street
Allentown, Pennsylvania 18101-1179

Prepared by:

REMEDIATION TECHNOLOGIES, INC.
9 Pond Land
Concord, Massachusetts 01742

Project # 3-1612-200

SEPTEMBER 1995
DESIGN AND IMPLEMENTATION
WORK PLAN

RELIEF AND GAS HOLDER REMEDIATION

UGI COLUMBIA GAS PLANT SITE
Columbia, Pennsylvania

Prepared for:

PENNSYLVANIA POWER & LIGHT
Two North Ninth Street
Allentown, Pennsylvania 18101-1179

Prepared by:

REMEDIATION TECHNOLOGIES, INC.
9 Pond Land
Concord, Massachusetts 01742

Prepared by:

Reviewed by:

Project # 3-1612-200

SEPTEMBER 1995
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>INTRODUCTION</td>
<td>1-1</td>
</tr>
<tr>
<td>1.1</td>
<td>Site Background</td>
<td>1-1</td>
</tr>
<tr>
<td>1.2</td>
<td>Previous Investigations</td>
<td>1-4</td>
</tr>
<tr>
<td>1.3</td>
<td>Unilateral Administrative Order</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Scope of Work</td>
<td>1-6</td>
</tr>
<tr>
<td>2.0</td>
<td>PROJECT ORGANIZATION</td>
<td>2-1</td>
</tr>
<tr>
<td>3.0</td>
<td>REMEDIAL SYSTEM DESIGN</td>
<td>3-2</td>
</tr>
<tr>
<td>3.1</td>
<td>Review of Remedy Selection</td>
<td>3-2</td>
</tr>
<tr>
<td>3.2</td>
<td>Design Sampling</td>
<td>3-3</td>
</tr>
<tr>
<td>3.3</td>
<td>Project Delivery Strategy</td>
<td>3-3</td>
</tr>
<tr>
<td>3.4</td>
<td>Relief Holder Enhanced Recovery Modeling</td>
<td>3-3</td>
</tr>
<tr>
<td>3.4.1</td>
<td>Well Design/Installation</td>
<td>3-11</td>
</tr>
<tr>
<td>3.4.2</td>
<td>Injection System</td>
<td>3-12</td>
</tr>
<tr>
<td>3.4.3</td>
<td>Injection System Piping</td>
<td>3-12</td>
</tr>
<tr>
<td>3.4.4</td>
<td>Extraction System</td>
<td>3-12</td>
</tr>
<tr>
<td>3.5</td>
<td>Removal Process Description</td>
<td>3-13</td>
</tr>
<tr>
<td>3.6</td>
<td>Construction Plans and Specifications</td>
<td>3-16</td>
</tr>
<tr>
<td>3.7</td>
<td>Tar Disposal</td>
<td>3-16</td>
</tr>
<tr>
<td>4.0</td>
<td>SYSTEM CONSTRUCTION</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1</td>
<td>Site Preparation</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1.1</td>
<td>Utilities</td>
<td>4-1</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Infrastructure</td>
<td>4-1</td>
</tr>
<tr>
<td>4.2</td>
<td>Construction Sequence</td>
<td>4-2</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Installation of Production and Injection Wells</td>
<td>4-2</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Installation of Recovery Pumps, Piping and Peripherals</td>
<td>4-3</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Installation of CROW™ Treatment System</td>
<td>4-3</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Installation of Water Treatment System</td>
<td>4-3</td>
</tr>
<tr>
<td>4.3</td>
<td>Construction Quality Assurance</td>
<td>4-4</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Preconstruction Inspections</td>
<td>4-4</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Construction Inspection and Testing</td>
<td>4-4</td>
</tr>
<tr>
<td>4.4</td>
<td>Compliance with ARARs</td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td>OPERATION</td>
<td>5-1</td>
</tr>
<tr>
<td>5.1</td>
<td>Responsibilities of Operator</td>
<td>5-1</td>
</tr>
<tr>
<td>5.2</td>
<td>Tank Failure</td>
<td>5-2</td>
</tr>
<tr>
<td>5.3</td>
<td>Completion Criteria</td>
<td>5-2</td>
</tr>
<tr>
<td>5.3.1</td>
<td>Relief Holder Criteria</td>
<td>5-2</td>
</tr>
<tr>
<td>5.3.2</td>
<td>Gas Holder Criteria</td>
<td>5-3</td>
</tr>
</tbody>
</table>
### TABLE OF CONTENTS (Cont'd)

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.0</td>
<td>SITE RESTORATION</td>
<td>6-1</td>
</tr>
<tr>
<td>6.1</td>
<td>Holder Stabilization</td>
<td>6-1</td>
</tr>
<tr>
<td>6.2</td>
<td>Demobilization</td>
<td>6-1</td>
</tr>
<tr>
<td>7.0</td>
<td>MEETINGS AND FINAL REPORTING</td>
<td>7-1</td>
</tr>
<tr>
<td>8.0</td>
<td>SCHEDULE FOR COMPLETION OF DESIGN AND REMOVAL ACTION</td>
<td>8-1</td>
</tr>
</tbody>
</table>

### LIST OF FIGURES

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>Site Location Map</td>
<td>1-2</td>
</tr>
<tr>
<td>1-2</td>
<td>Current Site Layout</td>
<td>1-3</td>
</tr>
<tr>
<td>3-1</td>
<td>Steam Rate as Cold Water Equivalent</td>
<td>3-7</td>
</tr>
<tr>
<td>3-2</td>
<td>Grid Block Configuration</td>
<td>3-8</td>
</tr>
<tr>
<td>3-3</td>
<td>Percentage of Holder Swept to Residual Organic Saturation</td>
<td>3-9</td>
</tr>
<tr>
<td>3-4</td>
<td>Production Well Temperature Curve</td>
<td>3-10</td>
</tr>
<tr>
<td>3-5</td>
<td>Process Schematic</td>
<td>3-14</td>
</tr>
<tr>
<td>8-1</td>
<td>Removal Action Schedule</td>
<td>8-2</td>
</tr>
</tbody>
</table>

### LIST OF TABLES

<table>
<thead>
<tr>
<th>NO.</th>
<th>DESCRIPTION</th>
<th>PAGE NO.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-1</td>
<td>Numerical Simulation Conditions and Assumptions</td>
<td>3-5</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

The former MGP Site in Columbia, Pennsylvania was placed on the National Priorities List in June, 1994. The process of site remediation has been modeled after the Superfund Accelerated Cleanup Model (SACM) as a non-time critical removal action. RETEC prepared an engineering evaluation/cost analysis (EE/CA) for the relief and gas holders at the site. The results of the EE/CA showed that the selected remedy for the relief holder should be enhanced recovery using steam injection. The selected remedy for the gas holder should be conventional pumping. The final step will be to remove residual liquids from both holders followed by grouting. The Electric Power Research Institute (EPRI) and Pennsylvania Power and Light Company (PP&L) have entered into a Tailored Collaboration to remediate the two gas holders at the site.

This Work Plan has been prepared to describe the tasks required to perform the removal action. The Plan is presented in eight sections: Section 1 contains an introduction; Section 2 outlines the project organization; Section 3 discusses the design activities; Section 4 describes the system construction; Section 5 describes the system operation; Section 6 discusses site restoration; Section 7 describes the final report; and Section 8 presents a schedule for completion of design and removal action activities.

1.1 Site Background

The site is located on 1.6 acres of land along Front Street in Columbia, PA. Figure 1-1 shows a site location map. The site is approximately 400 feet from the Susquehanna River. The MGP facility was operated from 1851 to 1948. Two holders exist at the site; the former relief holder is 60 feet in diameter and 27 feet deep, and the former gas holder is 40 feet in diameter and 17 feet deep. Each holder is covered with a reinforced concrete pad. Figure 1-2 shows a site map. Previous investigations have shown that the relief holder contains debris, soil, water, and significant quantities of coal tar. In contrast, the gas holder also contains debris, soil, and water but no free phase coal tar, although samples have revealed PAH contamination. The site is currently unoccupied. An active Conrail line is located on an 8 to 15 foot embankment adjacent to the site.
Concrete Slob
Over Holders
of MGP Operations
Boat Storage Area Property
Fence
Concrete Slab Over Holders
Extent of MGP Operations
Boat Dealership
Gravel Cover
Property Fence
Concrete Slab Over Relief Holder
Front Street
Gate
Gravel Area
Gross Area
Consolidated Rail Corporation
To Susquehanna River

PENNSYLVANIA POWER & LIGHT COMPANY
ugi columbia site
3-1972
CURRENT SITE LAYOUT
AR400171
Investigations have revealed that coal tar is present outside the holders. This has led to soil contamination and coal tar penetration into fractured bedrock. Groundwater moving through the site has subsequently become contaminated with coal tar constituents. Halliburton NUS (1993) performed a hazardous ranking for the site which has led to a recommendation that the site be placed on the National Priorities List (NPL).

1.2 Previous Investigations

UGI Corporation filed a Notification of Hazardous Waste Site Form with the EPA for the site on June 9, 1982. UGI was uncertain of the former practices of the gas manufacturing facility or the nature of the waste at the site. The company filed with the EPA as a precautionary measure.

On August 14, 1984, the Pennsylvania Department of Environmental Protection (PADEP) initiated a preliminary assessment of the site. During the assessment, coal tar that was moved to the former pedestrian tunnel was found. PP&L agreed to fund a site investigation along with UGI Corporation on December 7, 1984. The purpose of the site investigation was to determine the nature and extent of contamination. [Halliburton NUS, 1993]

In 1985, TRC Environmental Consultants, Inc. was hired by PP&L and UGI Corporation to perform an extensive field investigation of the property. These investigations included the construction of nine monitoring wells, test pits, and borings to determine the extent of contamination on and around the site. Also, seismic refraction surveys were performed to delineate fracture zones in the bedrock.

The site investigation conducted by TRC led to the removal action in 1987, which included the recovery of the materials in the tunnel area and the capping of the gas and relief holders with reinforced concrete. The sludge and soils from the pedestrian tunnel were removed and the tunnel walls steam cleaned. An eight-inch cement floor was constructed near the entrance of the tunnel. One leak was found during the closure of the two holders and was plugged with bentonite. An unknown amount of coal tar remained in the holders.

A second investigation was commissioned by PP&L in 1987 to determine the extent of coal tar contamination in the Susquehanna River. The investigation concluded that approximately 800 cubic yards of Susquehanna River sediment southwest of the site were contaminated with coal tar.
On August 18, 1988, the NUS Corporation performed a non-sampling site reconnaissance. The information obtained during this study can be found in a report entitled "Non-Sampling Site Reconnaissance Summary Report, UGI (PP&L) Columbia Gas Plant Site", dated November 3, 1988. In addition, the NUS Corporation completed a site inspection report in July 1989 using available information for the subject site.

In 1991, the NUS Corporation performed an expanded site inspection. The inspection characterized and evaluated the potential risk associated with a hazardous waste control problem at the site. This investigation characterized an unacceptable risk to groundwater and water supplies resulting from tars in the relief and gas holders at the site. Tars have migrated from the holders resulting in soil contamination and bedrock contamination. Subsequently, groundwater has come in contact with tars and contains dissolved constituents. In 1993 Halliburton NUS performed a hazardous ranking system for the site recommending the site for listing on the NPL. PP&L subsequently retained Remediation Technologies, Inc. (RETEC) to evaluate a removal action of the holders.

In September 1993, the Western Research Institute (WRI) performed a simulated distillation, viscosity, and density analysis on a sample taken from the relief holder at the site. The samples were collected by RETEC personnel using RETEC standard operating procedures (SOP) 201 for soil sample collection. One of the samples was taken from the gas holder and one was taken from the relief holder. Both samples were sent to WRI for analysis. However, during the organic-water separation process at the laboratory, it was discovered that the sample taken from the gas holder contained little separable organics. Therefore, this sample was not analyzed.

This led RETEC to perform an investigation of the gas holder at the site. The purpose of the gas holder investigation was to determine the contents of the smaller holder, to confirm the lack of NAPL, and to determine the extent of tar constituents within the holder. Three borings were drilled to the bottom of the gas holder (the holder's depth is 17 feet) in December 1993. Several samples were collected from the borings and analyzed for polynuclear aromatic hydrocarbons (PAH) and total solids. In addition, six samples were analyzed for oil and grease, and two samples were tested for BTU content. The results confirmed the presence of high concentrations of tar constituents throughout the holder strata, but very little separate phase tar.
1.3 Unilateral Administrative Order

Currently, PP&L and the PADEP are finalizing a Unilateral Administrative Order (UAO) that will describe the selected remedy for the holder pits as well as identify the required submittals for the removal action. A summary of the UAO will be presented once it has been completed.

The PADEP Statement of Decision, signed on July 17, 1995, which will be attached to the UAO, fully describes the selected remedy for the holder pits.

1.4 Scope of Work

The scope of work for this project includes the following tasks: system design including plans and construction specifications, contractor selection, site preparation including earthwork, concrete work, and fences, installation of nine wells in the relief holder, installation of one well in the gas holder, construction of a water treatment system, operation of the system, stabilization of the holders, site restoration, and final reporting.
2.0 PROJECT ORGANIZATION

The remediation of the two holders at the UGI Columbia Gas Plant site will be performed under a Unilateral Administrative Order (UAO) from PADEP.

The selected remedy for the relief holder is enhanced recovery. The Electric Power Research Institute (EPRI) will fund the effort using the contained recovery of oily wastes (CROW) process as developed by the Western Research Institute. RETEC will be the primary remedial contractor for this removal action. RETEC will prepare all the documents associated with design, construction, and operation of the CROW process. RETEC will subcontract portions of the design, construction, and operation to WRI. RETEC will also subcontract a drilling company, a general contractor, and a grouting company.

The selected remedy for the gas holder is pumping followed by grouting. PP&L will fund this effort and Clean Sites will serve as the oversight contractor. Because the design, construction, and operation of the gas holder remedy will overlap with the relief holder remedy, RETEC has included the gas holder remedy within the associated documents. RETEC will serve as a subcontractor to Clean Sites in this effort. However, documents for design, construction and operation of both holder pits will be reviewed by Clean Sites and PP&L.
3.0 REMEDIAL SYSTEM DESIGN

3.1 Review of Remedy Selection

In August, 1994, RETEC submitted, to PP&L, an Engineering Evaluation/Cost Analysis (EE/CA) for a removal action for the two holders at the site. The objective of this removal action is to eliminate the migration of constituents from the holders into the groundwater. In order to accomplish this removal action four alternatives were considered. These alternatives were:

No Action Accomplishing site objectives by providing institutional
With controls and groundwater monitoring, but not removing coal
Monitoring tar constituents from the holders,

Excavation Excavating the contents of the holders and disposing of them at a
licensed treatment or disposal facility,

Pumping Removing flowable liquids from the holders until the holders are
dry or until contamination levels diminish to an acceptable level and
subsequently stabilizing the contents by grouting with a stabilizing agent, and;

Enhanced Product Injecting steam to mobilize free coal tar to a flowable state and
Recovery pumping the liquid matrix until free coal tar levels diminish,
followed by stabilization by grouting with a stabilizing agent.

Because of the difference of the contents of the two holders, two different removal alternatives were selected. The gas holder removal will be accomplished by pumping the liquids out of the holder followed by stabilization of the remaining contents. The relief holder cannot be pumped due to the significant quantities of coal tar. Therefore, enhanced product recovery followed by stabilization was selected. The no action alternative was rejected because it provided no long term effectiveness or reduction in mobility, toxicity or volume. Excavation was rejected because of implementability factors due to the proximity of the active rail line.

The PADEP has supported the aforementioned remedy in their draft Statement of Decision (SOD). The SOD should be finalized in July 1995.
3.2 Design Sampling

In April 1995, RETEC collected a water sample from the relief holder to obtain additional data on possible metals pretreatment. The sample was analyzed for total and dissolved iron, calcium, aluminum, and manganese. Based on this information, an iron removal component was added to the design. Other metals were present at very low levels. However, calcium may deposit on hot portions of the system. These deposits are not likely to cause problems due to the short term nature of the remedy.

3.3 Project Delivery Strategy

As part of this design package, RETEC has submitted the following draft documents to PADEP and EPA Region III:

- a Work Plan,
- a Health and Safety Plan,
- a Contingency Plan,
- a Sampling and Analysis Plan,
- an Operations and Maintenance Plan, and
- Construction Plans and Specifications.

At some point during Agency review, a design review meeting will be held. This meeting will allow all interested parties to present, discuss and resolve any design issues. At the conclusion of the meeting, a list of comments will be identified. The design package will be modified and submitted to PADEP and U. S. EPA as final documents. Section 8 presents a schedule for the holder pits design.

3.4 Relief Holder Enhanced Recovery Modeling

Numerical simulations for the relief holder injection/extraction process were conducted with the Western Research Institute (WRI) numerical simulator (TSRS) that describes thermal recovery processes in porous media. TSRS is a highly implicit, four-phase, multicomponent, finite difference thermal simulator. The model formulation is based on a set of individual-component mass balance, energy balance, and related constraint equations that account for accumulation, vapor-liquid partitioning, chemical reaction, injection and production rates, heat...
conduction, heat loss, and the transport of mass and energy by Darcy's law. Interblock transport of mass and energy are calculated using a single-point upstream fluid mobility and enthalpy in a five-point, block-centered, finite difference scheme on fixed-size Cartesian grids. The components described by TSRS include noncondensable species (oxygen and inert gas), water (liquid and vapor), oil species (light and heavy), and coke. Source-sink terms are accommodated by specification of molar-rate at a grid block or by specification of a source-sink pressure.

For use as a field-scale simulator, TSRS has the following:

- Ability to describe one-, two-, or three-spatial dimensions
- Addition of point-centered spatial grids
- Ability to specify variable grid spacings
- Ability to describe directional permeabilities
- Ability to modify interblock transmissibilities
- Addition of radial well terms (i.e., source/sink) in both horizontal and vertical orientations
- Improvements to model numerics to reduce memory storage requirements, improve accuracy, and increase computation speed.

The conditions used for the numerical simulations are summarized in Table 3-1. Unfortunately, no data were available to determine accurately the hydraulic conductivity, porosity or initial organic saturation of the relief holder. Hydraulic conductivity was chosen from the range found at the Bell Lumber and PP&L Brodhead Creek CROW™ sites. A porosity value of 50% was chosen both to minimize simulator instabilities and maximize liquid content of the relief holder.

Residual organic saturations of 9% and 21%, on a pore volume basis, were chosen from literature for heavy oil field production using steam and water flooding, respectively. An initial organic saturation of 25% was chosen based on discussions with PP&L personnel. It was further assumed that there is currently mobile organic phase liquid in the relief holder, consequently, a value higher than the residual oil saturation to water (21%) was chosen.
Relative permeability curves for steam and heavy oil systems are available from published literature. These curves were used since no curves were available that more closely fit this situation.

Numerical simulations of both steam injection and hot-water injection were conducted and the results compared. As indicated earlier, residual oil saturations from steam injection are significantly lower than with hot water. It would be difficult to achieve steam conditions in an
<table>
<thead>
<tr>
<th>Numerical Simulation Conditions and Assumptions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Hydraulic Conductivity, Darcy(ft/day)</td>
<td>25(60)</td>
</tr>
<tr>
<td>Porosity, %</td>
<td>50</td>
</tr>
<tr>
<td>Initial Relief Holder Temperature, °F</td>
<td>70</td>
</tr>
<tr>
<td>Steam Injection Temperature, °F</td>
<td>250</td>
</tr>
<tr>
<td>Hot-Water Injection Temperature, °F</td>
<td>190</td>
</tr>
<tr>
<td>Initial Organic Saturation, % pore volume</td>
<td>25</td>
</tr>
<tr>
<td>Residual Organic Saturation to Steam, % pore volume</td>
<td>9</td>
</tr>
<tr>
<td>Residual Organic Saturation to Water, % pore volume</td>
<td>21</td>
</tr>
<tr>
<td>Injection Rates of Steam as Cold-Water, gpm(lb/hr)</td>
<td>2(1000) 5(2500) 10(5000)</td>
</tr>
<tr>
<td>Hot-Water Injection Rate, gpm</td>
<td>10</td>
</tr>
<tr>
<td>Organic Specific Gravity</td>
<td>1.06</td>
</tr>
<tr>
<td>Organic Viscosity at 70 °F, cp</td>
<td>30.8</td>
</tr>
<tr>
<td></td>
<td>120 °F, cp</td>
</tr>
<tr>
<td></td>
<td>180 °F, cp</td>
</tr>
</tbody>
</table>
aquifer, however, because of the relatively small, confined area of the relief holder, steam conditions throughout the relief holder should be possible. Therefore, steam stripping in addition to steam displacement to achieve the lower residual organic saturations is possible.

Steam injection rates of 2, 5, and 10 gpm of cold-water equivalent steam were chosen for the final conditions modeled. Hot-water injection at 10 gpm was also simulated for comparison.

The maximum steam and water injection pressures are presented in Figure 3-1 for the 4 conditions modeled. Due to boiler codes and field conditions, it is desirable to limit steam pressure to about 15 psig or 30 psia. Consequently, the data in Figure 3-1 indicates that if the model input conditions are close to actual field conditions, it is unlikely that injection rates greater than 10 gpm of cold-water equivalent steam could be used. The 10 gpm hot-water injection case was also run for comparison to the 10 gpm steam case.

Initial work on the project planned for four inner injectors and four outer injectors spaced at 45 degrees to create two off setting five spot patterns with a common inside extraction well. Early modeling runs indicated an immediate steam breakthrough from the inner injection wells. To minimize this affect, the four inner wells were moved to the edge of the relief holder. For the four modeling runs, the injected steam or water was equally divided between the eight injectors. In practice, the steam or water injection might be divided equally between the eight wells or limited to four wells at a time, depending on the actual field conditions.

For the numerical simulations, one quarter of the relief holder was modeled on a 6x6x4 point-centered grid (Figure 3-2). One injector received the fully allotted amount of steam or water while the other two injection wells received one half of the allotted injection rate as it is assumed that the other half of the injected fluid would go to the adjacent patterns.

Field results, as well as the modeling results, indicate there is always a tendency for the steam to override. Therefore, injection and extraction was limited to the bottom three grid node rows to simulate well completion in the bottom three-fourths of the injection and extraction wells. Areal and vertical sweeping of the relief holder essentially progressed up from the injection wells, across the top and then downward toward the extraction well, with time, for all steam injection cases. The bottom grid node row always took the longest time to reach residual saturation.

The numerical simulation results are summarized in Figures 3-3 and 3-4. Figure 3-3 gives an indication of how efficient and quickly the different injection rates swept the relief holder to
Steam Rate as Cold-water Equivalent

FIGURE 3-1

EQUIVALENT WATER INJECTION RATE

PRESSURE, psia

20 25 30 35 40

2 GPM 5 GPM 10 GPM 10 GPM WATER
Grid Block Configuration

Injection Wells

Extraction Well

FIGURE 3-2
Percentage of Holder Swept to Residual Organic Saturation

Legend:
- □ 2 gpm
- □ 5 gpm
- ● 10 gpm
- ○ 10 gpm water
Production Well Temperature Curve
residual saturation. It appears that higher injection rates resulted in a more efficient process. However, actual injection rates will be dictated by the injection pressure. As expected, the lowest steam injection rate, 2 gpm, took the longest to sweep the relief holder. However, a fairly good removal was achieved. The hot-water injection case also achieved a high sweep efficiency. However, hot-water flushing resulted in a residual saturation of 21% while steam flushing resulted in a residual saturation of 9%. Consequently, it would be expected that more organic would be recovered by using steam rather than water.

The predicted temperatures at or near the extraction well are shown in Figure 3-4. It is likely that steam breakthrough will occur early and the extraction well and surface production equipment will have to be designed to handle high temperatures and steam production.

3.4.1 Well Design/Installation

For the relief holder remediation, eight injection wells are planned to be installed inside the outer edge of the relief holder. One extraction well will be installed in the center of the relief holder. This configuration will form two five spot patterns at 45 degrees from each other with a commonly shared center extraction well.

For the eight injection wells, an 8-inch diameter hole will be augered to the bottom of the relief holder. A 4-inch stainless steel diameter casing string consisting of 20-foot of perforated casing on the bottom of the string will be set to the desired depth inside the hollow-stem auger. The perforated section of the casing string will consist of 12 one-quarter-inch-diameter perforations per foot. Gravel with a particle diameter between 5/16 and 3/4 inch will be placed around the perforated section. Sand will then be placed above this section to approximately 5 feet below ground surface (BGS). A five foot bentonite seal will be placed to the surface. The casing will then be cemented back to the concrete surface with a 4-foot diameter by 1-foot thick cement pad poured and pinned to the existing concrete. A 4-inch flanged wellhead will then be welded to the 4-inch casing for attachment of the surface casing. If surface casing is deemed necessary by the drilling contractor, provisions and specifications for it can be provided.

For the extraction well, an 18-inch diameter hole will be augered to the bottom of the relief holder. A 10-inch diameter galvanized well screen, 20 feet long, will be attached to similar diameter steel line pipe and set to the bottom of the relief holder. Sand, 20/40 mesh, will be placed around the well screen and then the hollow-stem auger will be pulled back to above the
well screen. Sand will then be placed above the well screen back to approximately 5-foot BGS. A 5 foot bentonite seal will be placed to the surface.

The casing will be cemented back to surface with a 3-foot diameter by 1-foot thick cement pad poured and pinned to the existing cement pad. A 10-inch diameter casing head will be affixed to the casing.

3.4.2 Injection System

Based on the literature and numerical simulation results discussed above, WRI believes steam injection at a rate of 10 gpm of water equivalent steam is the best option for in situ remediation of the relief holder. A natural gas fired boiler from National Vapor Industries is available as a trailer-mounted unit. This boiler will be able to generate steam up to 1200°F, between 8 and 1000 psi at 10 - 1000 CFM.

3.4.3 Injection System Piping

The injection system piping will be detailed in the Piping and Instrumentation Diagram produced with the design. Steam pipe sizes have been determined using curves for 1000 to 10,000 pounds of steam per hour (Practical Petroleum Engineers' Handbook, Fifth Edition by Joseph Aba and W. T. Doherty, page 78).

Due to the very low operating pressure (15 psig), pipe sizes must be larger than one would expect to keep pressure drops to a minimum, currently designed for 2-3 psi/100 feet. Also, when locating surface equipment, it will also be imperative that steam line runs be kept as short as possible to further minimize pressure drop and heat loss.

3.4.4 Extraction System

Liquids will be pumped from the extraction well at a maximum rate of 10 gpm by a submersible type pump. An oversized pump motor will permit the pump to be rated for the 220°F (the temperature that is expected in the extraction well during operation). If the well is pumped dry, the level switches will shut off the pump motor.
Produced liquids and gases (steam) will be pumped to an air cooled condenser where the fluids will be cooled prior to flowing to the vertical separator. Specific gravity information for this organic (Table 3-1) suggests that the heavy organic can be separated by gravity and pumped off the bottom of the vertical separator with a dump valve and pumped to a holding tank. The water will be pumped from the top of the separator to the boiler.

Again, to minimize pressure loss in case large amounts of steam are produced, 2" diameter, schedule 40, piping, valves and fittings are required for the piping run from the extraction wellhead to the heat exchanger. Two inch diameter, schedule 40, piping, valves and fittings are required for the piping run from the heat exchanger to vertical separator. Schedule 40, 2" diameter, piping, valves and fittings are required for the lines into and out of pumps 3 and 6, to the boiler or treatment system, and oil storage, respectively.

3.5 Removal Process Description

The removal of coal tar from the relief holder and the removal and treatment of the impacted water within the relief holder and gas holder will be accomplished in three stages. The three stages are as follows:

- Implementation of the CROW™ Process in the relief holder;
- Removal and treatment of water in the relief holder; and
- Removal and treatment of water in the gas holder.

These three stages will be implemented in this order to maximize the removal of coal tar and complete removal of impacted water. Figure 3-5 presents a Process Schematic for the system.

Once the system is constructed, the CROW™ portion of the system will be initiated. Coal tar and water will be extracted at 10 gpm from the center of the relief holder. A 10 inch diameter well will be utilized for the extraction well. This well will be screened across the bottom three quarters of the holder. The extracted coal tar/water mixture will be passed through a vertical separator. Once the separated tar reaches a specified depth, a product pump will be activated to remove the product. The separated coal tar will be stored at the site in a 6,000 gallon tank until it is shipped offsite for proper disposal. Eight 4-inch diameter wells will be utilized to reinject the recycle water as steam into the relief holder. These wells will be screened in the bottom 3/4
Process Schematic

- Heat Exchanger
- Separator Vessel
- Boiler
- Carbon Adsorption Units
- Recycle Water
- Discharge
- Oil Storage Tank
- Oil
- Production Well (Gas Holder)
- Production Well (Relief Holder)
- Injection Well (Typical For Relief Holder)
of the holder. These wells will be spaced equidistantly around the inside perimeter of the holder at a distance of 28-feet from the holder center. These wells will be utilized in two groups of four wells each. The groups will be established by using every other well per group. Steam will be reinjected at a rate of 1250 lb/hr per well. The groups will alternate in operation. This stage of the holder remediation will be operated until no measurable coal tar is being removed from the holder as defined in Section 5.3. This stage of the system will have complete recirculation of the extracted water from the holder, so no discharge is required. Therefore, no discharge requirements will have to be met. However, the effluent water quality will not adversely affect the operation of the boiler.

Once the CROW™ stage is completed, the production well used during the CROW™ process will be utilized to extract the water held within the large holder. Water will be extracted at a rate of 10 gpm. The water will pass through the oil/water separator, described above, to separate any free-phase tar from the extracted water. The water will be pumped from the oil/water separator through a series of bag filters. The filter sizes will be 15 microns and 5 microns. This unit will prevent suspended solids any larger than 5 microns in diameter from entering and fouling the carbon units. The water will then pass through two 1,800-pound activated carbon units in series to remove any residual tar and/or any dissolved phase organic constituents. Through a proactive sampling effort, the point of maximum loading will be predicted for the first carbon unit in the series. If this occurs prior to emptying the large holder the pumps will be turned off and the two carbon units will be rearranged in order to maximize their usage. The last unit will be put first in the series. The first unit will be removed, and a new unit will be placed in the series. The last unit is placed first because a majority of the constituents (on a pound basis) are removed prior to reaching the last unit. If this point does not occur prior to emptying the large holder then the units will be rearranged as described above prior to pumping the small holder. The carbon units will be brought offsite for regeneration by the vendor after the project is completed or their usage has been maximized whichever comes first. The water will then be discharged to the Susquehanna River via a 2-inch diameter PVC pipe. This treatment system will remove 99% of the dissolved coal tar related constituents.

Once the relief holder is empty, the pump in the extraction well in the center of the gas holder will be engaged. This pump will have a removal rate of 20 gpm. The same system described for the large holder will be utilized for treating the water extracted from the small holder.
Once the gas holder is empty, the pumps will be turned off and the system will be dismantled. The site will be restored as described in Section 6.0. The holders will be stabilized as described in Section 6.1. The stabilization of the holders will occur immediately after all water is pumped out, thereby minimizing the potential for groundwater infiltration.

There will be a series of sampling ports, valves, flow meters, flow totalizers, pumps and high and low-level indicators placed throughout the system for proper flow stream management and monitoring as described in Section 4.0.

For the main steam line carrying the full 5000 lb/hr (10 gpm water equivalent steam), 4\" diameter, schedule 40, welded piping, valves and fittings are required. For the four orifice meter runs which will each be used to meter steam to a pair of injection wells, 3\" diameter, schedule 40, welded piping, valves and fittings are required. Finally, for the piping runs to individual injection wells, 2\" diameter, schedule 40, welded piping, valves and fittings are required.

3.6 Construction Plans and Specifications

Submitted with this work plan, is a complete set of construction plans and specifications. The plans are produced on 24-inch by 36-inch sheets. They include a site location map and a current site layout map. The plans are divided into three categories; civil, mechanical, and electrical. The civil plans describe concrete work, earthwork, drilling, and well installation tasks. The mechanical drawings include a process piping and instrumentation diagram (P&ID), piping layout diagrams, and piping and fitting details. The electrical drawings include the power conduit layout, the data cable conduit layout, the motor control diagrams, logic diagrams, and wiring diagrams including conductivity, liquid levels, pressure, flow, and reset switches.

The construction specifications include the general requirements of the contract, civil construction specifications, mechanical construction specifications, electrical construction specifications, and relevant construction standards. The general requirements define responsibilities, define surveying requirements, define requirements for temporary utilities, discuss health and safety requirements, odor control requirements, and site security requirements. The construction specifications will describe each work item to be performed, specify materials to be procured, specify construction methods, and define the terms of measurement and payment.
3.7 Tar Disposal

All recovered coal tar will be properly manifested and removed from the site to a properly licensed disposal facility. The contracted disposal company will provide the necessary equipment to properly transfer coal tar from the 6,000 gallon holding tank on the site to the transfer truck. The oil transfer area at the site will be equipped with an inlet connection point. The contracted disposal company will ensure that the inlet connection point on the truck is positioned over the oil transfer area. A transfer hose which meets all applicable standards and is capable of properly connecting to the coal tar transfer point will be used to transfer the coal tar. After the site engineer inspects all connections and ensures their integrity, the valve will be opened and the coal tar will be transferred. The transfer hose will be disconnected in a manner that prevents any coal tar from spilling. The transporting company will be responsible for decontaminating the oil transfer hose.

The transporting company will also be responsible for any necessary spill prevention control and countermeasures while in route to the disposal facility. Any coal tar spilled during transfer from the holding tank to the transporting vehicle will be collected using sorbent pads. Affected soils and soiled sorbent pads or booms will be removed and placed in 55-gallon drums for proper disposal.
4.0 SYSTEM CONSTRUCTION

This section describes the installation of necessary site utilities and infrastructure facilities; construction of the CROW™ system; construction of the groundwater extraction and treatment system; and construction quality assurance plan.

4.1 Site Preparation

Site preparation will be comprised of two components, the installation of utilities and the construction of infrastructure facilities. The utilities required for the operation of the systems include electricity, gas, and water. The required infrastructure facilities are a decontamination area and portable toilets.

4.1.1 Utilities

Electric and gas service will be reestablished at the site prior to mobilization. Water service will be established at the site to the office, decontamination area and treatment system area.

4.1.2 Infrastructure

The first activity at the site will be to mobilize portable toilets to the site and place them adjacent to the office/treatment building. The second activity will be to install erosion control fencing on the three southern fencelines. The third activity will be to grade the site to provide work areas and construct the soil subgrade for the concrete tank farm. Provisions will be made for the characterization and disposal of any excess soil that will be graded out during site preparation. The bermed area will be sized to contain 1.5 times the volume of the largest tank. The tank farm will contain a sump from which all rain waters can be removed.

Upon completion of the construction of the site infrastructure, the treatment system will be installed.
4.2 Construction Sequence

The construction sequence of the treatment system will be as follows:

- Installation of production and injection wells in the relief holder and gas holder;
- Construction of the concrete tank farm;
- Installation of pumps, piping, pressure indicators, temperature indicators, flow meters, and low level sensors in the production and injection wells;
- Construction of the water treatment system; and
- Installation of the boiler.

It will be possible to construct some components of the system simultaneously.

4.2.1 Installation of Production and Injection Wells

Nine wells will be installed in the relief holder and one well in the gas holder. The nine wells in the relief holder will consist of one 10-inch diameter production well in the center of the holder and eight 4-inch diameter injection wells. The 10-inch well will be screened across the bottom three quarters of the holder. The eight 4-inch wells will be spaced equidistant from each other and 28 feet from the production well. The eight 4-inch wells will be perforated across the bottom 20 feet of the holder. The wells in the small holder will be 7-inch diameter well in the middle of the holder. It will be screened across the bottom three-quarters of the holder.

A concrete saw will be used to cut holes through the concrete caps over the holders in the locations of the wells. The 10-inch diameter well will have a 16-inch diameter opening and the 4-inch wells will have a 10-inch opening. A fully cased drilling method (i.e., barber rig) will be used to drill the boreholes used for well installation, if possible. The appropriate diameter casing will be placed in the borehole. The necessary amount of riser pipe will be used to construct the well to the ground surface. The annulus of the borehole will be filled with silica sand to five feet below the ground surface. Sand will be packed within five feet of the ground surface. Grout will then be placed above the sand to the ground surface. Concrete will then be used to secure the casing to the existing concrete cap.
4.2.2 Installation of Recovery Pumps, Piping and Peripherals

Pumps will be installed in the production wells capable of pumping at least 60 feet of head at 20 gpm. The pumps will be attached to 2-inch diameter piping. The piping used from the wellheads to the treatment system will be 2-inch diameter, carbon steel pipe. The wellhead of each well will consist of a cap through which a 2-inch diameter pipe will pass. In the production wellheads low water level sensing equipment, and a thermocouple, will also pass through the cap. All piping downstream of the acid injection port will be PVDF (Kynar) piping to avoid potential corrosion of the steel pipe.

4.2.3 Installation of CROW™ Treatment System

The components for the CROW™ treatment system includes flow meters/totalizers, ball valves, gate valves, globe valves, an oil/water separation vessel, an oil storage tank, tank level sensor equipment, centrifugal and metering pumps, a 15 micron bag filter, and a boiler. These components will be connected to the piping described in Section 4.2.2. Ball valves will be utilized to direct the flow of liquids to utilize the appropriate components of the CROW™ and carbon adsorption treatment systems.

4.2.4 Installation of Water Treatment System

The components for the water treatment system also includes flow meters/totalizers, centrifugal pumps, and valves. The system will utilize the same piping and componentry described in Section 4.2.3. Additionally, this system includes a 5 micron bag filter and two 1,800-pound granular activated carbon units. The ball valve described in this section will be opened when the carbon is in use and closed during CROW™ operation. The three ball valves around the bag filter will be used to direct flow through or around the bag filter when it requires maintenance. The gate valves will be used to change out or maintain any of the equipment without having to drain the piping. This equipment will be installed in the sequence it is identified. These components will be interconnected with 2-inch diameter, carbon steel piping.
4.3 Construction Quality Assurance

This section, which serves as the Construction Quality Assurance Plan, describes the observations and tests that will be performed throughout construction to ensure that the enhanced recovery system and water treatment system are installed in accordance with the approved plans and specifications.

RETEC will be responsible for all construction quality assurance. The individual subcontractors will be responsible for quality control. Clean Sites, on behalf of PP&L, will be acting as the supervising contractor. RETEC will submit copies of all CQA reports to Clean Sites. Clean Sites will distribute the reports to EPA and PADEP as appropriate.

4.3.1 Preconstruction Inspections

Preconstruction inspections will be performed in conjunction with preconstruction meetings with subcontractors prior to the onset of work. These inspections will include:

- reviewing work access provisions;
- reviewing methods for documenting and reporting inspection data;
- reviewing methods for distributing and storing documents and reports;
- reviewing work area security and safety protocol;
- conducting a site walk to verify that the design criteria, plans, and specifications are understood and to review material and equipment storage locations.

RETEC will be responsible for all inspections and QA documentation.

4.3.2 Construction Inspection and Testing

Inspection of all construction operations will be performed during installation of the enhanced recovery system, the gas holder pumping system, and the water treatment system. The inspection and/or testing will ensure that system installation is performed according to design criteria and specifications. The inspection and/or testing will also be used to verify compliance with environmental requirements such as air quality and emissions monitoring, waste disposal, health and safety procedures, and sample collection. The inspection and testing that will be performed during construction have been organized according to work task as follows:
**Well Installation**

WRI will be responsible for supervising the installation of recovery and production wells by the contract driller to ensure that the well installation specifications are adhered to and to record all pertinent data.

**Pipe Installation**

CQA of pipe installation will include:

- verification that proper materials are being used;
- ensuring that work is performed by qualified pipe fitters;
- confirmation that pipes are located as specified in the design including all valves, meters, sample ports, and other fittings;
- validation that pipes are properly supported as per the design specifications; and
- confirmation that all pipes have been appropriately hydrotested for pressure and leaks.

Piping installation will be inspected by RETEC personnel to ensure that all workmanship is performed as per manufacturer’s instructions and that all CQA procedures are followed.

Pipes will be installed and fitted according to the appropriate standards and codes that are pertinent to the particular piping being installed. For any piping that will contain either high pressure or organic materials, ASME/ANSI Standards B-31.1 and/or B-31.3 shall be followed. All other piping will be installed according to local piping and plumbing codes, including the latest BOCA plumbing codes.

Any problems, deficiencies, or leaks noted in piping work will be corrected as directed by RETEC personnel.
Pipe Heat Tracing and Insulation

Pipe heat tracing and insulation may be required if the operations schedule includes colder months. All steam lines will be insulated regardless of the time of year. Heat tracing will be inspected by RETEC personnel to ensure that it is installed as per the manufacturer's specifications. CQA inspection will include:

- verification that proper materials are being utilized;
- examination of heater cable before and after installation to ensure integrity of cable jacket;
- verification of minimum electrical resistance as per manufacturer's specifications;
- proper repair of any deficiencies;
- inspection of circuits prior to and after installation of insulation; and
- verification of proper operation of thermostatic controllers, as per manufacturer's specifications.

Installation of pipe insulation will be in accordance with the manufacturer's specifications. CQA procedures will include:

- verification of proper type of insulation being used as per design;
- verification of insulation thickness;
- examination of installation techniques to ensure proper overlap or sealing of insulation sections or layers; and
- inspection for proper installation of exterior coating or vapor barrier.

Inspections will be conducted by RETEC personnel, and results of inspections will be recorded in the field log. Any problems or deficiencies noted in the heat tracing or insulation work will be corrected as directed by RETEC personnel. All CQA testing will be documented in reports.
Tank Installation

Tank placement and installation will be conducted in accordance with manufacturer's instructions and the design specifications. The CQA inspector will oversee installation to ensure that:

- proper equipment is utilized;
- alignment and orientation of tanks is per design drawings;
- installation of tanks is conducted by qualified personnel; and
- workmanship is acceptable.

Any tanks that will contain organic materials will be installed according to ASME/ANSI Standard B-31.3 for Chemical Plant and Petroleum refinery piping. All fittings, pipes, and valves on these tanks will also be installed according to the same standard. All plumbing and tank codes, including the latest BOCA plumbing, mechanical, and fire prevention codes will be followed.

Tank installation will be inspected by RETEC personnel to ensure that all CQA procedures are followed.

Equipment Installation

Equipment placement will be conducted in accordance with the manufacturer's specifications and the design document details. All equipment installations will be reviewed to ensure:

- utilization of proper equipment that is in good condition;
- proper orientation and alignment of equipment;
- acceptable workmanship;
- examinations of fittings and attachments to the equipment to ensure that they are not inducing excessive stress in the equipment; and
- acceptable rotation of moving parts.
Any problems or deficiencies noted in equipment installation will be corrected as directed by CQA personnel.

**Electrical Installation**

Electrical installations will be CQA inspected. Inspections will be conducted on all installations of conduit, wire, motors, disconnect boxes, breakers, switches, controls and other electrical equipment. CQA activities will include:

- verification that all electrical work is performed by qualified electricians;
- verification of lockout/tagout prior to any electrical work;
- inspection of all materials to ensure that they meet specifications and are in good condition;
- verification of conduit and wire to ensure they meet specifications;
- verification of conduit and equipment locations;
- visual inspection of all connections;
- witnessing of continuity check and checkout of equipment operation; and
- assuring records are retained in the project files.

Any problems or deficiencies noted in electrical installations will be corrected as directed by RETEC personnel.

**Instrumentation**

RETEC personnel will check the installation, calibration, and functional testing of all instrumentation installed by the contractor. The manufacturer's instructions will be utilized as a guide for all testing and startup procedures. Any problems or deficiencies noted in instrumentation installation will be corrected as directed by RETEC personnel.
4.4 Compliance with ARARs

Because the UGI Columbia Gas Plant Site is a superfund site, obtaining specific permits will not be required. However, the Engineering Evaluation - Cost Analysis (EE/CA) (RETEC, 1994) identifies several applicable or relevant and appropriate requirements (ARARs). These requirements include state and federal environmental laws and regulations that are appropriate to consider during the forthcoming removal action.

Specifically, RETEC/Clean Sites will comply with Article VII, Chapter 92, 25 PA Code 92.1 et seq., which sets forth provisions for the administration of the National Pollutant Discharge Elimination System (NPDES) Program within Pennsylvania. RETEC/Clean Sites will apply for a NPDES permit for the discharge of treated waters to the Susquehanna River. Although an actual NPDES permit will not be granted, the discharge quality will comply with the criteria set in the permit equivalence as administered by PADEP.

In addition, the on-site boiler will be operated in such a manner as to comply with Pennsylvania Air Quality Laws including Article VII, Chapter 123, 25 PA Code 123.1 et seq., which sets requirements on fugitive emissions, and Article VII, Chapter 131, 25 PA Code 131.1 et seq., which adopts federal ambient air quality standards.

Any contaminated soils that are generated on the site will be analyzed for hazardous characteristics. All hazardous wastes will be transported and treated or disposed in compliance with Article VII, 25 PA code chapters 260-266, and 270. These regulations apply to the identification and listing, generation, transportation, storage, treatment and disposal of hazardous waste.

Because the removal action will include a waste stabilization step and an activated carbon treatment step. These activities will comply with PA SWMA, Act 97, Chapters 264 or 265 and 297.

Other contaminant-specific, location-specific, and action-specific ARARs are identified in Section 2.1.2 of the EE/CA for the site.
5.0 OPERATION

Operation and maintenance of the CROW™ system will include inspecting the system, obtaining process measurements and recording data. All equipment will be maintained and serviced according to the factory specifications and recommendations. All meters will be calibrated according to the manufacturers instructions. Inspections will be conducted on a daily basis. A detailed Operations and Maintenance (O&M) plan will be produced and submitted to PADEP and EPA Region III.

5.1 Responsibilities of Operator

The primary responsibilities of the system operator are to:

1) Maintain site security and control access;

2) Proactively monitor data points throughout the system including:
   - Flow rates,
   - Temperatures,
   - Pressures,
   - pH, and
   - Iron Levels

3) Collect samples as required;

4) Clean strainers and bag filters;

5) Inspect pipes and tanks for leaks;

6) Schedule trucks for tar disposal; and

7) Log all data and record all activities.

Detailed sampling and monitoring requirements are described in the Sampling and Analysis Plan. Other requirements will be described in the O&M Plan.
5.2 Tank Failure

In the event of a tank failure, the recovery system will be shut off. Under such a scenario, the site operator will follow the steps outlined below:

1. Turn off all injection and production pumps.
2. Divert all recycle water to the GAC units.
3. Pump the contents of the tank farm to the GAC units.
4. Repair or replace the damaged tank.
5. Bring the recovery system back on line.

Details for other emergencies are presented in the contingency plan.

5.3 Completion Criteria

5.3.1 Relief Holder Criteria

The remediation of the relief holder will be complete when all separable tars within the holder have been removed.

The separable tar within the relief holder is defined as tar that can be separated from water within the on-site oil-water separation vessel. Separation is no longer apparent when the increase in cumulative tar recovery drops to 0.5% or less per pore volume of water injected into the holder. Based on previous laboratory data from the Brodhead Creek Site and field data from the Bell Lumber and Pole Site, it is at this point that 98.5% of the total recoverable coal tar will have been recovered. Therefore, continued operation of the process will yield little benefit. If, however, it is determined that most of the separated material is inorganic in nature, then the process maybe terminated at an earlier stage.

Cumulative recovery will be monitored using a flow meter and measuring the total flow of oil, per pore volume, out of the oil storage tank. The total pore volume of the relief holder is approximately 170,000 gallons. To calculate the percent of cumulative recovery per pore volume injected, the following formula will be used:
Total tar collected during last pore volume \( \times 100 \)
Total tar collected during all previous pore volumes

The minimum measurable quantity of recovered coal tar is determined by the flow meter's capabilities. The specified flow meter will be capable of measuring 1 gallon with \( \pm 1 \) percent accuracy.

After all recoverable tar, as described above, has been removed from the relief holder, all remaining liquids will be pumped out and the holder cavity will be stabilized with flowable fly ash.

5.3.2 Gas Holder Criteria

The remediation of the gas holder will be complete when all liquids have been removed from the holder. The holder currently contains approximately 50,000 gallons of liquid. If the holder still contains a significant amount of water after 50,000 gallons of liquid have been removed, the holder walls are probable being breached by the aquifer. In such an event, the holder will continue to be pumped at a higher flow rate until the wells are depleted or the water level stabilizes. The holder will then be immediately stabilized with flowable fly ash as described in the following section.
6.0 SITE RESTORATION

The holders will be stabilized after the liquids have been removed. Stabilization will consist of adding flowable fill to the holder contents. Access ways will be cut into the concrete pads covering the holder at several locations. Flowable fill will be added under pressure until the holder becomes full. The aboveground piping will be dismantled.

6.1 Holder Stabilization

After removing the liquids from the holders, the holders will be stabilized by pressure grouting with flowable fill. A contractor will be selected to perform grouting activities. Flowable fill is a blend of cement, fly ash, and water which requires no compacting or finishing. It is a low strength, high density backfill which is more stable and less permeable than alternate compacted backfill. The flowable fill will leave very few void spaces in the holders. It has a 95% compaction rate which has proven very stable and greatly reduces the risk of surface settling and cracking.

The existing wells will be used to pump the flowable fill into the holders. It will take approximately 4 to 6 hours for the flowable fill to cure. After the fill has set within the holder, several split spoon samples will be collected, as described in the Sampling and Analysis Plan, to confirm the stabilization.

6.2 Demobilization

Following stabilization, all tanks and piping will be cleaned and removed from the site. All cleaning waters will be treated by the carbon units and discharged to the river. The carbon units will be removed after all cleaning has been accomplished. The concrete tank farm will not be demolished under this contract.
7.0 MEETINGS AND FINAL REPORTING

Prior to mobilization, a preconstruction meeting will be held at the UGI Columbia Site. The meeting will be attended by representatives from U. S. EPA and/or PADEP Clean Sites, PP&L and RETEC. The objectives of the meeting are to review lines of communication, reporting requirements, security and safety protocol and summarize design plans and specifications as they relate to equipment storage and facility footprints. The Supervising Contractor shall prepare meeting minutes and distribute to the other parties.

Upon completion of remedy instruction, the Supervising Contractor and the Engineer will conduct a final inspection. The final inspection shall consist of a walk-through of the entire site. The objective is to determine whether the project is complete and consistent with the project plans. The Engineer shall prepare a final inspection report and forward it to the Supervising Contractor.

After the conclusion of the project, a final report will be prepared. The report will document the proper construction and operation of the remediation system. The report will include field notes and construction quality assurance reports. In addition, the report will include tabulated data from the data logging system and analytical reports from the laboratory. EPA and PADEP will be copied on any daily or weekly reports generated during the construction and implementation of the remedy.
8.0 SCHEDULE FOR COMPLETION OF DESIGN AND REMOVAL ACTION

This section presents a schedule for the remaining design work and the removal action. The schedule is presented as Figure 8-1.
## Figure 8-1

### Schedule of Removal Action
Relief and Gas Holders
UGI Columbia Gas Plant Site
Columbia, PA

<table>
<thead>
<tr>
<th>Activity</th>
<th>Start Date</th>
<th>Duration</th>
<th>End Date</th>
<th>1995</th>
<th>1996</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>May</td>
<td></td>
</tr>
<tr>
<td>Submit Design to Client</td>
<td>May 26</td>
<td></td>
<td></td>
<td>June 9</td>
<td></td>
</tr>
<tr>
<td>Client Approval</td>
<td>June 9</td>
<td></td>
<td></td>
<td>July 21</td>
<td></td>
</tr>
<tr>
<td>Submit Draft Design to Agencies</td>
<td>June 29</td>
<td></td>
<td></td>
<td>July 31</td>
<td></td>
</tr>
<tr>
<td>Design Review Meeting</td>
<td>July 21</td>
<td></td>
<td></td>
<td>Sep 8</td>
<td></td>
</tr>
<tr>
<td>Submit Final Design to Agencies</td>
<td>July 31</td>
<td></td>
<td></td>
<td>Sep 27</td>
<td></td>
</tr>
<tr>
<td>Final Agency Approval</td>
<td>Sep 29</td>
<td></td>
<td></td>
<td>Nov 10</td>
<td></td>
</tr>
<tr>
<td>Submit Draft O&amp;M Plan to Client</td>
<td>Sep 8</td>
<td></td>
<td></td>
<td>Nov 17</td>
<td></td>
</tr>
<tr>
<td>Submit O&amp;M Plan to Agencies</td>
<td>Sep 27</td>
<td></td>
<td></td>
<td>Nov 27</td>
<td></td>
</tr>
<tr>
<td>Submit Bid Packages</td>
<td>Oct 16</td>
<td></td>
<td></td>
<td>Nov 27</td>
<td></td>
</tr>
<tr>
<td>Receive Proposals</td>
<td>Nov 10</td>
<td></td>
<td></td>
<td>Nov 27</td>
<td></td>
</tr>
<tr>
<td>Select Contractor</td>
<td>Nov 17</td>
<td></td>
<td></td>
<td>Dec 4</td>
<td>10 Weeks</td>
</tr>
<tr>
<td>Preconstruction Meeting</td>
<td>Nov 27</td>
<td></td>
<td></td>
<td>Mar 4</td>
<td>2 Weeks</td>
</tr>
<tr>
<td>Construction</td>
<td>Dec 4</td>
<td>10 Weeks</td>
<td>Feb 9</td>
<td>Aug 9</td>
<td>6 Months</td>
</tr>
<tr>
<td>Final Inspection</td>
<td>Feb 12</td>
<td></td>
<td></td>
<td>Aug 12</td>
<td>2 Weeks</td>
</tr>
<tr>
<td>Operation</td>
<td>Feb 13</td>
<td>6 Months</td>
<td>Aug 9</td>
<td>Aug 26</td>
<td></td>
</tr>
<tr>
<td>Pump Down of Relief Holder</td>
<td>Aug 12</td>
<td>2 Weeks</td>
<td>Aug 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grouting of Relief Holder</td>
<td>Aug 12</td>
<td>1 Week</td>
<td>Sep 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Down of Gas Holder</td>
<td>Sep 4</td>
<td>2 Weeks</td>
<td>Sep 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grouting of Gas Holder</td>
<td>Sep 4</td>
<td>1 Week</td>
<td>Sep 26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demobilization</td>
<td>Sep 19</td>
<td>1 Week</td>
<td>Oct 27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prepare Final Report</td>
<td>Oct 26</td>
<td>1 Month</td>
<td>Nov 28</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Milestone
- Activity

Note: All dates subsequent to submission of Draft Design are based on a 5 week agency review and approval time and will change to reflect actual time.