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GROUNDWATER
CONTINUOUS ACTION PLAN

BRAMLETTW MGP SITE
GREENVILLE, SOUTH CAROLINA

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1.0 INTRODUCTION – SITE DESCRIPTION

The former Bramlette Manufactured Gas Plant (MGP) and CSX/Vaughn landfill site is located in the city of Greenville, North Carolina. The MGP site covers 3.69 acres in the western quadrant of the intersection of Bramlette Road and West Washington Street. The CSX/Vaughn Landfill site covers approximately 7.0 acres and is located approximately 800 feet west of the aforementioned intersection, south of Bramlette Road (**Figure 1**).

Both sites are owned by CSX Transportation (CSXT) and are part of more extensive CSXT property holdings that total approximately 40 acres, consisting of rail lines and an office for crew transfers and scheduling activities. The majority of these properties lie within the floodplain of the Reedy River, located to the west. Land use immediately east of the sites is primarily residential with the exception of the property located in the southern quadrant of the intersection of Bramlette Road and West Washington Street, which contains a school building owned by the Greenville County School District. The property bordering the MGP site to the north is owned by Suburban Propane.

2.0 REPORT OBJECTIVES

The objectives of this report are to: review groundwater contamination; present groundwater assessment data; and propose a long-term groundwater monitoring program for MGP constituents. Soil, sediment, and surface water contamination has been addressed in past reports (see Section 3.0) and will not be addressed in this Groundwater Continuous Action Plan (CAP).

3.0 SITE HISTORY

The Bramlette MGP site was originally developed as a manufactured gas plant by Southern Public Utilities in 1917. The site eventually contained a retort house, three gas holders, a water gas plant, tar and ammonia washer tanks, purifiers, a tar extractor and holder, and an underground heating oil tank. Locations of site structures are indicated on **Figure 2**.

Gas plant ownership and operation transferred to Duke Power Company in 1935. The Piedmont Natural Gas Company purchased the site in 1951 and subsequently demolished the gas plant sometime in the late 1950s. Site ownership transferred to Piedmont and Northern Railway in 1963. Piedmont and Northern Railway became part of Seaboard Coast Line (CSX) in 1967. The site is currently vacant and access is restricted by perimeter fencing.

Texas Oil Company operated a petroleum bulking facility during the same timeframe as the gas plant operation on property immediately north and adjacent to the MGP site. This property is now owned by Suburban Propane and is currently vacant.

The CSX/Vaughn Landfill site is located within the eastern bank floodplain of the Reedy River. The site was developed as an un-permitted landfill by Mr. Robert Vaughn of

Vaughn Construction and Demolition Company in Greenville. Mr. Vaughn attempted to purchase approximately 16 acres from CSXT in 1988 for the purpose of constructing a solid waste landfill. Following payment of a deposit, Mr. Vaughn began un-permitted land filling activities on the property. The property transfer was never finalized; however, Mr. Vaughn continued to operate the landfill. The South Carolina Department of Health and Environmental Control (SC DHEC) advised Mr. Vaughn in 1993 that his land filling activities were improper. In February of 1994, the U.S. Army Corps of Engineers (ACE) notified CSXT that the property on which the landfill is located was considered a wetlands and the land filling operation was a violation of Section 301 of the Clean Water Act. Following notification by the ACE, CSXT ordered Mr. Vaughn to cease land filling activities.

Past site investigations can be further researched in the following reports:

- March 1995: *Site Investigation; Soil, Sediment and Groundwater Sampling; Vaughn Landfill, CSX Real Property,* by Applied Engineering and Science (AES) of Atlanta, Georgia
- September 1996: *Site Investigation Phase II, Vaughn Landfill/Duke Power Sites, CSXT Real Properties, Bramlette Road, Greenville, South Carolina,* by AES
- April 1999: *Wetland Delineation Report, CSX Bramlette Road Property, Greenville, South Carolina* by AES
- June 2000 *CSX/Vaughn Landfill and Bramlette Road MGP Sites Phase III Investigation and Site Assessment Report* by Duke Power Company
- September 2000 *CSX/Vaughn Landfill and Bramlette Road MGP Sites Remedial Action Plan* by Duke Power Company
- January 2003 *CSX/Vaughn Landfill and Bramlette Road MGP Groundwater Monitoring Report, December 2002 Sampling* by Duke Power Company
- June 2003 *CSX/Vaughn Landfill and Bramlette Road MGP Sites Remedial Action Plan Final Report* by Duke Power Company
- Semi-annual groundwater reports from 2002 to present by Duke Power Company and Duke Energy.

4.0 SITE CHARACTERIZATION

Extensive site characterization has been performed at the Bramlette MGP Site and CSX/Vaughn Landfill. The results of the investigations have been presented to SC DHEC in the aforementioned reports. Information presented in these and other reports relevant to implementation of this CAP proposal is summarized in the following sections.

4.1 Site Geology

Borings for soil sampling and well installations on the MGP site prior to soil excavation indicated highly disturbed soils intermixed with MGP debris generally between 2 and 6 feet deep. Generally six feet of contaminated material was removed; backfill material consisted of thermally treated soil and clean backfill (see *Remedial Action Plan Final Report, June 2003*). Virgin soil types beneath the MGP debris tended to be silty clays

and clayey sands extending to depths between 7 and 16 feet below ground surface. Silty sands typically occurred below the clayey soils, eventually grading into saprolite with depth.

Borings for soil sampling and well installations on the Vaughn Landfill site indicated between 7 and 14 feet of demolition-type landfill debris and soil backfill. A 2 to 6 feet thick layer of clay or clayey soils was typically encountered below the landfill debris, followed by sands and silty sands. The sandy soils typically graded into stiffer saprolite material at 17 to 19 feet below the landfill surface. The lithologic units (clays, silty sands, and sands) across the Landfill site vary in thickness, location and in transition (gradual to abrupt) from one unit to another, indicative of alluvial deposits that might be found within a floodplain environment. Free coal tars were encountered at both the top of the clay layer immediately below the landfill debris and near the sandy soil-saprolite interface. Geologic cross sections of the Vaughn Landfill area, obtained from the *Phase III Investigation and Site Assessment Report, June 2000*, are included as **Figures 3 through 5**.

4.2 Groundwater Movement

Prior to soil excavation on the MGP site, 11 monitoring wells were installed. Currently only two monitoring wells remain; the other nine wells were properly abandoned prior to soil excavation. Hydraulic gradients across the MGP site ranges between 1.5% and 2.0%. Groundwater in the northern part of the site flows in a west-southwesterly direction towards the Reedy River while groundwater in the southern areas of the site turns to the south, towards the Landfill/wetlands area.

Fifteen monitoring wells are located on the Vaughn Landfill site and the wetlands beyond. Groundwater beneath the northern areas of the Landfill appears to flow to the west-southwest with a 2.0% gradient. Beneath the southern area of the Vaughn Landfill, groundwater appears to flow to the south-southwest with a gradient of 0.7% to 1.0%.

Groundwater elevations have fluctuated slightly since sampling began in June of 1999, as shown in **Table 1**.

Groundwater elevations and contaminant concentrations for the well pairs are shown in **Figures 6 through 8**. The downward gradient between shallow well MW-6/6A and deep well MW-21 and the upward gradient between deep well MW-23 and shallow well MW-24 suggests that there may be some groundwater contamination movement between the groundwater regions in this area.

The groundwater elevation differences in the MW-3&3D, MW 15&16, MW5&22 and MW-1&19 wells pairs are small enough, tenths of a foot, that no definitive conclusion can be reached concerning the movement of contaminants between the geostratigraphic layers in the area of these wells.

4.3 Risk Characterization

The characterization of risk from the exposure, or potential exposure, to MGP related contaminants involves an assessment of the chemicals of concern, potential exposure pathways, and an exposure pathway analysis. The chemicals of concern include volatile and semi-volatile organic compounds and certain inorganics. The primary pathways for exposure are through inhalation of contaminants in air, ingestions of contaminants absorbed onto soils, ingestion of contaminated water, and through direct dermal contact with contaminated materials.

The risk of inhalation through volatilization of organics (volatile organic compounds or VOCs), polycyclic aromatic hydrocarbons (PAHs) absorbed onto dust, or inorganics absorbed onto dust does not present a current significant risk at the sites. The majority of the contaminated material located on the MGP Site has been removed. Organics beneath the Vaughn Landfill are not available to be considered an inhalation risk.

A risk of ingestion implies ready access to contaminated surface soils at the sites. The surface soils at the MGP site have been removed and site access is restricted by perimeter fencing. Exposure to the contaminated soils at the Vaughn Landfill site is highly improbable since they are located under the landfill debris.

The surrounding area is served by the local municipal water supply system, therefore there are no risks associated with ingesting groundwater through drinking or inhalation of groundwater vapor particles through showering.

Dermal contact with the free tars under the Vaughn Landfill debris is unlikely and access to the MGP is restricted. Dermal contact with the surface soil at the MGP Site is not a concern since contaminated surface soil was removed and access to the site is restricted.

The exposure pathway analysis concludes that the current human risks on the site are minimal.

Also, as stated in a February 26, 2001 letter from Ms. Jennifer Boynton, GW Quality Section of SC DHEC to Mr. Fred Veal of US Army Corps of Engineers, "Biological and geotechnical assessments of the site have demonstrated that the coal tar constituents are not significantly impacting flora and fauna in the wetland area." Also, "Activities associated with physical removal of the fill would likely result in mobilization of the coal tars and destruction of the existing, unaltered wetlands."

4.4 Groundwater Contamination

Groundwater has been sampled semi-annually in 17 wells since June 1999. The groundwater data has been compiled in **Table 2**. Samples were analyzed by EPA Methods 8260 and 8270. The benzene and naphthalene results, as well as the groundwater elevations from the November 2008 sampling event are on **Figures 9**

through 11. The data collected to date allows a thorough review of the groundwater conditions at the site.

The groundwater analytical results have been assessed based on the SC DHEC Human Healthy Criterion for Consumption of Water and Organisms (W/O) standards and the US EPA Maximum Contaminant Levels (MCL), as shown in **Table 2**.

Starting in May 2006, a reduced sampling schedule was approved by SC DHEC; all wells would be sampled annually in November and key indicator wells would be sampled in May. As such, the November 2008 sampling results, the last sampling event where all wells were sampled, will be used in the discussion below.

The wells remaining on the MGP site, MW-15 and MW-16, have historically had non-detectable concentrations of both PAHs and VOCs. During soil excavation, material was unable to be excavated in the area to the west of the MGP site due to the presence of landfill debris. Source material may still be present in the area to the west of the MGP site, north of Bramlette Road.

The majority of the known source material is located beneath the landfill debris on the CSX/Vaughn Landfill. The wells located within the landfill have historically exhibited the highest contaminant concentrations. The historical benzene and naphthalene trends for shallow wells MW-1, MW-2 and MW-3, and for deep wells MW-3D, MW-19, MW-20 and MW-21, are shown in **Figures 12 through 15**. The benzene and naphthalene contaminant concentrations have remained relatively stable or have a slight decreasing trend since sampling began in 1999. Contaminant concentrations have decreased significantly in a number of wells since the source material at the MGP site was removed in 2002: in shallow wells MW-1, benzene decreased 39%, from 73 ppb to 44.6 ppb, and naphthalene decreased 24%, from 1500 ppb to 1140 ppb, and in deep well MW-3D benzene decreased 13%, from 850 ppb to 740 ppb, and naphthalene decreased 20%, from 5800 ppb to 4630 ppb between December 2002 and present. Seasonal fluctuations are also apparent in a number of the wells.

The remaining wells located in the wetlands area, downstream of the landfill and source area, have historically had non-detectable contaminant concentrations.

5.0 GROUNDWATER REMEDIAL ACTION TECHNOLOGY

The choice of remedial action is based on site-specific factors, including but not limited to the type and amount of contamination, the hydrogeology of the site, and the potential risk to humans and the environment. The coal tar located under the landfill debris is the main source of groundwater contamination. The groundwater plume has been relatively stable since 1996, downstream surface water has not been impacted, groundwater outside of the landfill area has not been impacted, and there are no drinking water wells within ½ mile of the site. The coal tar cannot be removed without removing the landfill debris. Removal of the debris would likely result in destruction of the wetlands and the mobilization of the coal tar.

Natural attenuation processes affect the rate and transport of organic compounds in all hydrologic systems. Natural attenuation is defined as the reduction in mass or concentration of a chemical of concern over time or distance from the source of a chemical of concern due to naturally occurring physical, chemical and biological processes, such as biodegradation, dispersion, dilution, adsorption, and volatilization.

Monitored Natural Attenuation (MNA) is defined as the use of natural attenuation within the context of a carefully controlled and monitored response action to achieve protective concentration levels at the point of exposure. Constituent levels need to be monitored at regular intervals to ensure the viability of the chosen technology. To maintain the integrity of the wetlands, MNA is the groundwater remedial action technology of choice.

According to the EPA (1998) there are three types of environmental monitoring required to implement and validate a MNA program:

1. Site Characterization (i.e. baseline monitoring) to describe the disposition of contamination and predict its future behavior;

2. Validation monitoring to determine if predictions based on site characterization are accurate; and

3. Long-term monitoring to ensure that the behavior of the contaminant plume does not change.

The site characterization was presented in Section 4.0. Validation monitoring has been collected in all of the wells since 1996. The data collected is used in the section below to determine if the site characterizations favor MNA. The long-term monitoring schedule is presented in Section 7.0.

5.1 MNA Demonstration Approach

A demonstration that MNA is an effective remedy can be made using a lines of evidence (LOE) approach. There are three lines of evidence (TNRCC, 2001) that can be used:

1. Primary lines of evidence (PLOE) relies on use of historical groundwater data that demonstrate a clear trend of stable or decreasing contaminants of concern (COC) concentrations over time and with distance away from the source at appropriate monitoring or sampling points.

2. Secondary lines of evidence (SLOE) uses geochemical indicators to document certain geochemical signatures or "footprints" in the groundwater that demonstrate (indirectly) the type of natural attenuation process(es) occurring at the affected property and the destruction of COCs or uses distance-based / time based biodegradation rate calculations to demonstrate attenuation.

3. Other lines of evidence (OLOE) most often consists of predictive modeling studies and other lab/field studies that demonstrate an understanding of the natural attenuation process(es) occurring at the affected property and their effectiveness in controlling protective concentration limit exceedence zone migration and decreasing COC concentrations. These approaches are recommended in cases where predictive modeling may be used to demonstrate plume stability if PLOE data collected over four consecutive quarters fails to provide a clear trend of stable or decreasing COC concentrations.

5.1.1 Primary Lines of Evidence (PLOE)

The historic groundwater elevations, **Table 1**, show that groundwater has remained relatively constant. **Figures 12 through 15** contain the benzene and naphthalene trends for key indicator wells. **Figures 9 through 11** show the November 2008 naphthalene and benzene concentrations, as well as the groundwater elevations.

With the exception of MW-6/6A and MW-4, all of the monitoring wells have been sampled at least 13 times beginning in 1999; MW-6 has not been sampled due to tar being present in the well and MW-4 has been inaccessible during many sampling events due to high water, but was sampled in May and November of 2008. The data indicates that the contaminant plume is relatively stable (see Section 4.4). The results meet the intent of the reviewed guidance (EPA, 1999; EPRI, 2002; TNRCC, 2001) regarding MNA: the contaminant concentrations are either stable or decreasing.

5.1.2 Secondary Lines of Evidence (SLOE)

The geochemical indicator parameters included in **Table 3** were reviewed to evaluate the potential effectiveness of natural attenuation processes at the site. The figures referenced in the bulleted section below show the trends in the specified parameter along an inferred straight line "contamination pathway" starting at MW-1 for the shallow wells and MW-19 for the deep wells, moving to the south-southeast. Naphthalene was used as the contaminant of concern in the figures since it is present at higher concentrations than benzene. The naphthalene data is from the November 2008 sampling event.

In the figures, the naphthalene concentration in each well is represented by a triangle, with the concentration scale on the left y-axis. The indicator parameter concentration is represented by a star, with the concentration scale on the right y-axis. Each region is a different color. For example, in **Figure 17**, for shallow wells MW-2, the values are in blue, the naphthalene concentration is 1110 ppm and the iron concentration is 19.6 mg/l.

Observations from the site data related to naturally occurring biodegradation are summarized below:

- pH – Since aerobic and anaerobic processes are pH-sensitive, the near neutral pH values in the wells near the source of contamination indicate that the site