**3M Environmental, Health and Safety Operations**

3M Center, Building 0224-05-W-17
St. Paul, MN 55144-1000

3M

November 27, 2013

**UPS Next Day**

Ms. Addie Walker
Bureau of Land and Waste Management
South Caroline Department of Health and Environmental Control
2600 Bull Street
Columbia, SC 29201

Re: Historic Data Review – Plant 2
Laurens Ceramics Site, Laurens, South Carolina
Site ID #00172

Dear Ms. Walker:

This letter is being submitted by 3M Company (3M) in response to the South Carolina Department of Health and Environmental Control (DHEC) August 22, 2013 Letter to 3M requesting evaluation of elevated concentrations of volatile organic compounds (VOCs) associated with Plant 2 of the Laurens Ceramics Site, Laurens, South Carolina. Figure 1 shows the location of Plant 2 and the general layout of the Laurens Ceramics Site.

Recent groundwater monitoring data indicate that groundwater VOC concentrations remain elevated in the area of the Plant 2 groundwater aeration system (air-sparging system). As a result, DHEC requested further evaluation to update and confirm the nature and extent of groundwater VOC concentrations and to review potential options for management of the VOCs or enhancing the aeration system. This letter provides a review of available hydrogeologic and monitoring data is a precursor to the development of a scope of work (SOW) for additional investigation at the site.

## HYDROGEOLOGIC CONDITIONS

From 1988 to 2002, numerous environmental assessments were conducted in the area of Plant 2 to define the site's geologic and hydrogeologic framework, and to assess the distribution and migration of VOCs in groundwater. Early investigation identified elevated VOC concentrations associated with two wastewater ponds immediately east of Plant 2, which led to the capping and closure of the two ponds in 1995. Figure 2 provides an aerial view of Plant 2 in 1995 showing the location of the ponds. Under approval by DHEC, the corrective measures applied to the Plant 2 wastewater ponds, included removal and consolidation of the pond solids from Plant 2 in the Plant 1 wastewater pond prior to closure, stabilization of remaining sludge and soil in the Plant 2 ponds, and construction of impermeable caps over the pond sites.

Investigation data also identified dissolved-phase VOCs associated with the two former wastewater ponds were moving to the southeast. The data suggested that the groundwater was discharging into the surface water drainage. Field reconnaissance identified seeps associated with the drainage feature indicating the drainage receives groundwater discharge. Based on information provided by previous investigations (Source Control Alternatives Analysis (SCAA) for Plant 2, 1998; and supplemental

investigations including evaluation of specific remedial options such as In Situ Oxidation, 1998, 2003), the following observations are made regarding the hydrogeologic setting of Plant 2.

- Three hydrostratigraphic units are identified at Plant 2; the uppermost unconsolidated residuum zone which grades to a transitional weathering zone (transition zone) which in turn grades to competent bedrock. Bedrock in the area of Plant 2 includes biotite gneiss (west to northwest) and granitic gneiss (southeast).

- Groundwater in each of the three hydrostratigraphic zones flows radially away from an area southeast of Plant 1, such that flow across Plant 2 is to the southeast (see Figure 3). Continuing east, shallow groundwater is influenced by, and flows toward, the drainage feature.

- Historic groundwater data indicate that potentiometric pressures associated with the bedrock and transition hydrostratigraphic zones are (as a rule) higher than that of the residuum groundwater zone. This condition results in the upward movement of the transition zone and bedrock zone groundwater into the residuum.

- Hydraulic tests (slug tests, pump tests, packer tests) conducted on wells associated with Plant 2 indicate groundwater flow is highest in the transition groundwater zone. This highly fractured zone grades downward to more competent and less fractured competent bedrock. Additionally, the overlying residuum groundwater zone is more extensively weathered and contains a higher amount of silt and clay.

  Groundwater modeling and flow analysis conducted for the site indicate that groundwater originating from former source areas of Plant 2 flows southeast, eventually turning toward the drainage feature and ultimately discharging into the feature. The drainage feature is dry through much of the year, flowing primarily during precipitation events. However, during dry conditions, sections of the drainage remain wet due to seeps confirming discharge to the system by groundwater. A groundwater-fed spring is also observed at the head of the feature.

- Deep erosion associated with the un-named surface water drainage feature has resulted in shallower depths to bedrock along the drainage trace. This, combined with the positive net potentiometric pressure of bedrock and transitional groundwater zones have resulted in shallow to artesian groundwater conditions (i.e. wells MW72 and MW84) confirming an upward movement and discharge of bedrock groundwater to the drainage feature.

- The hydrogeologic investigations identified elevated VOCs associated with the two former wastewater ponds located along the east side of Plant 2 (see Figure 2). The ponds were closed in 1995; however, groundwater analytical data indicated that dissolved-phase VOCs were present in groundwater with a gradient toward the southeast. Data also confirmed that the groundwater was discharging into the drainage feature.

  Further review of the analytical data indicated that the VOCs were degrading naturally. However due to the concentration of VOCs encountered, 3M under approval by DHEC

constructed an air sparging system across the central portion of the delineated VOC plume to enhance site conditions for removal of VOCs from residuum groundwater.

- Long-term groundwater and surface water monitoring downgradient of Plant 2 indicate groundwater VOC concentrations are decreasing and VOC concentrations associated with the surface drainage system decrease rapidly reaching levels at or below laboratory reporting limits before leaving the site.

The investigation led to the completion of a Remedial Options Evaluation/Implementation Plant (ROE/IP) in 2000 proposing potential remedial options to address dissolved-phase VOCs at the site. The data suggested that of the options considered, air-sparging was considered the most effective based on the local hydrogeologic setting. In October 2001, an Action Plan was submitted by 3M and General Electric Company (GE) to DHEC in accordance with the Plant 2 Source Control Alternative Analysis (SCAA) and the Remedial Options Evaluation and Implementation Plan (ROE/IP) approved by DHEC. (The ROE/IP and SCAA were prepared to satisfy requirements of the Consent Agreement (No. 96-000-WP) effective 28 March 1997, between 3M/GE and DHEC.)

The Plant 2 Action Plan addressed the installation and operation of an air-sparging system to enhance the in-situ treatment of VOCs in shallow groundwater prior to discharging to the drainage feature with the understanding that any VOCs discharged to the system would be naturally aerated and attenuated.

The Plant 2 aeration system was approved by DHEC on 6 November 2001. DHEC requested the submission of an application for an underground injection control (UIC) permit, which was required prior to injecting air into the groundwater. 3M submitted the UIC permit application in December 2001 and the UIC Permit to Construct (#426M) was issued by DHEC on 17 December 2001. The Permit to Operate the Plant 2 aeration system was issued by DHEC on 22 April 2002.

Following activation of the air sparging system, a monitoring program was initiated to track groundwater and surface water conditions. In accordance with the DHEC-approved performance monitoring program, samples are collected quarterly from piezometers PZ-A1, PZ-H3, and PZ-C3; monitor well MW-33; and surface water stations WSW-03 and WSW-19. Also, samples are collected semiannually from surface water monitoring stations, WSW-15, WSW-02, and WSW-01 located downstream of the aeration system. The locations are shown in Figure 4.

**Hydrogeologic Evaluation**

Prior to activation of the air sparging system, VOCs identified in groundwater at the site near the former source areas reached as high as 114,739 µg/L (well MW36, September 1989). The groundwater monitoring program was initiated in 2002 after activation of the air-sparging system as a means to track groundwater and surface water conditions. In 2012, monitoring station PZ-A1 became damaged such that sampling from this location is no longer possible. Groundwater and surface water monitoring data acquired under this program suggest groundwater VOC concentrations are decreasing and that any VOCs discharged to the surface drainage system decrease rapidly reaching levels at or below laboratory reporting limits before leaving the site. The analytical data are summarized in Table 1.

Monitor wells MW33 and PZA1 are upgradient of the air-sparging system. Analytical data for well MW33 (See Table 1) indicate VOCs have decreased from 2,976 µg/L in April 2004 to 23 µg/L in March 2013. Well PZA1 was actively monitored until damage in 2012 prevented further sampling. VOCs at well PZA1 exhibited a decreasing trend in VOCs from 22,249 µg/L in 2002 to 12,981 µg/L in March 2012. The decrease may be attributed to the source remediation activities (pond closure) in 1995.

Monitor wells PZC3 and PZH3 are downgradient of the air-sparging system. Data provided by these wells are much more variable, ranging from 16,919 µg/L to 6,604 µg/L (well PZC3) and 16,020 µg/L to 7,560 µg/L (well PZH3); however, the data still suggest decreasing concentration trends at both wells.

Analytical data for water samples collected from the drainage feature also reflect variable results. This may be due to the flow conditions in the feature at the time of sampling. Station WSW03 is located at the head of the drainage immediately downstream of a spring discharge and generally exhibits a more consistent water flow. Averaged data for WSW03 from April 2004 and May 2006 indicate a VOC concentration of 3,220 µg/L. Similar data for March 2012 and March 2013 indicate an average VOC concentration of 51 µg/L.

Surface water stations downgradient of the air-sparging system have been established at locations which most often exhibit water. As mentioned, the drainage feature is non-flowing for much of the year; however, pools of water are maintained at selected locations due to groundwater recharge. Therefore in dry conditions, it may be expected that the samples collected are more representative of local groundwater conditions. During wet conditions, stormwater run-off actively flows in the channel resulting in higher aeration of the water, and as expected, lower concentrations of VOCs. Nevertheless, the analytical data provided indicate natural degradation / attenuation of VOCs in the surface water system such that concentrations at the discharge point from the site are at or below laboratory reporting limits. Data collected at station WSW01 in March 2013 indicated a total VOC concentration of 1.1 µg/L (See Table 1).

Based on the review of historic analytical and investigation data, the following observations are made:

- Site data and conditions indicate that groundwater downgradient (southeast) of Plant 2 within the bedrock and transition zones would flow upward into the shallower residuum groundwater zone.

- Residuum groundwater contours (See Figure 3) indicate the residuum groundwater is strongly influenced by the local surface drainage feature, resulting in discharge of residuum groundwater to the drainage system. Through most of the year, this appears to be the primary water source for the drainage.

- Remedial activities in 1995 for the Plant 2 wastewater ponds appear to have had a beneficial effect on groundwater VOC concentrations downgradient of the former source areas. This is reflected by groundwater and surface water monitoring data (See Table 1), which show decreasing concentrations.

- The effectiveness of the air-sparging system is difficult to quantify due to the apparent influence of precipitation events and fluctuations in the system operation. It has been observed that when the system is not in operation, analytical data downgradient of the system suggest higher concentrations; however, other variables are involved.

- VOC concentrations at the furthest downgradient sampling point in the drainage feature (WSW01) have remained at or below laboratory reporting limits, suggesting that natural attenuation of the VOCs is effective.

**SUMMARY**

The data suggest that although elevated VOC concentrations remain in groundwater downgradient of the former source areas, natural degradation and attenuation have been effective in reducing VOC concentrations to levels near the laboratory reporting limit (1 µg/L). Even so, the presence of elevated concentrations warrant further investigation to better delineate the extent of VOCs and to evaluate remedial technologies that may enhance degradation or VOC removal.

To further define the extent of VOCs and update groundwater concentrations between the former Plant 2 pond area and the air-sparging system, it is proposed that one round of groundwater samples be collected for VOC analysis from selected monitor wells in the area. At a minimum the wells would include MW07, MW36, MW39, MW05, MW47, and MW68 as shown in Figure 4. These wells are not included in the performance monitoring program for the air-sparging system but have been used for tracking water level measurements since activation of the sparging system in 2002. The information will be used to assess the benefit of additional remedial options.

3M remains committed to the management of groundwater at the Laurens Ceramics Site. As a result, the findings of this evaluation will be considered during development of a focused feasibility study for Plant 2.

If you have any questions regarding this information, please call me at (651) 736-3135.

Sincerely,

p.p. J. R. Kotsmith

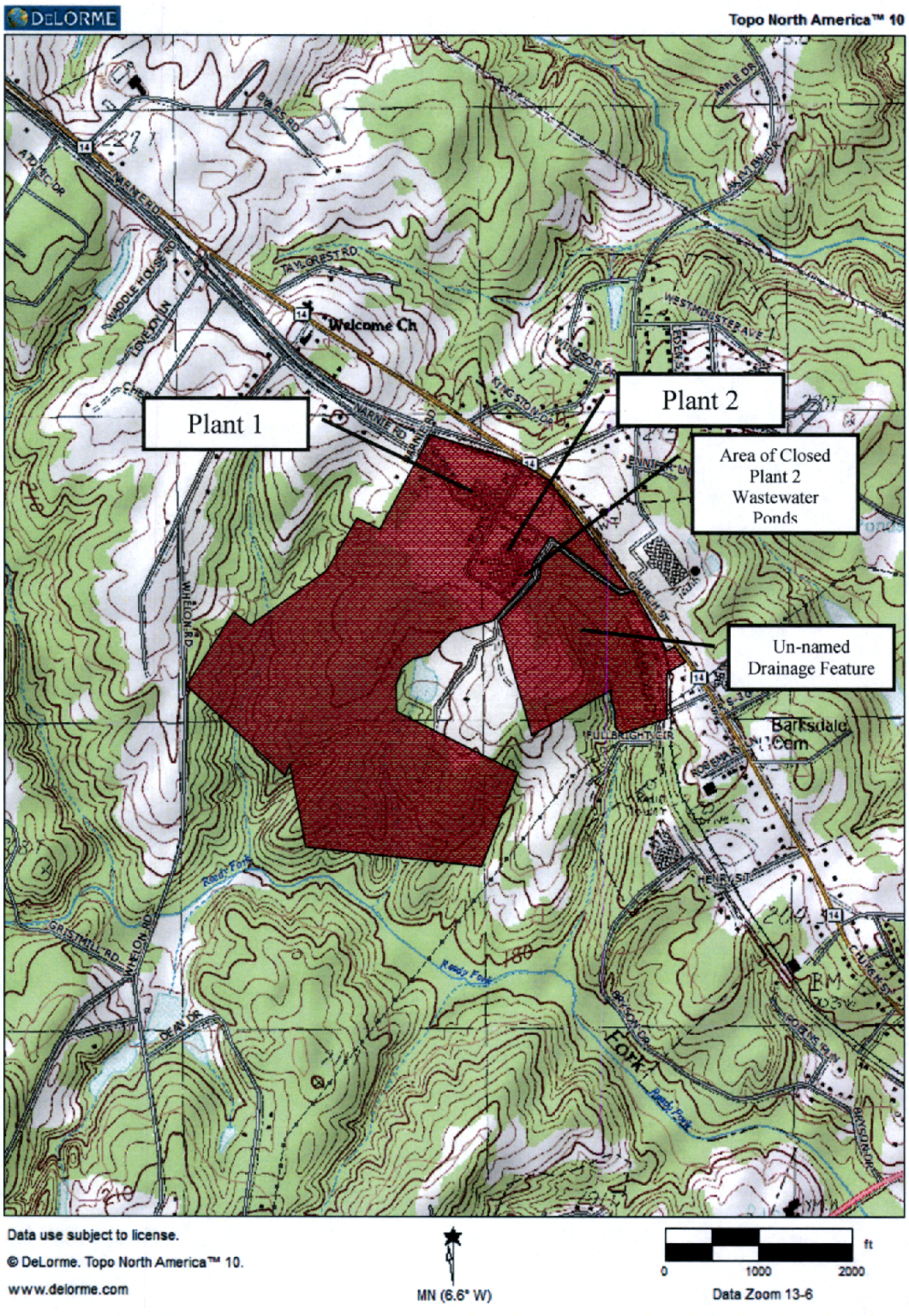
Jeannie Martin
Advanced Environmental Scientist
Building 224-5W-17

Enclosures

cc: Mike Corbin - Weston
Tim Frinak – Weston
Lance Hauer – GE
Jim Kotsmith – 3M – 224-5W-17

# Attachment

## Figures and Tables

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| **Figure 1** | Topographic map showing the Laurens Ceramics Site property, local topography, and the location of Plant 1 and Plant 2. |

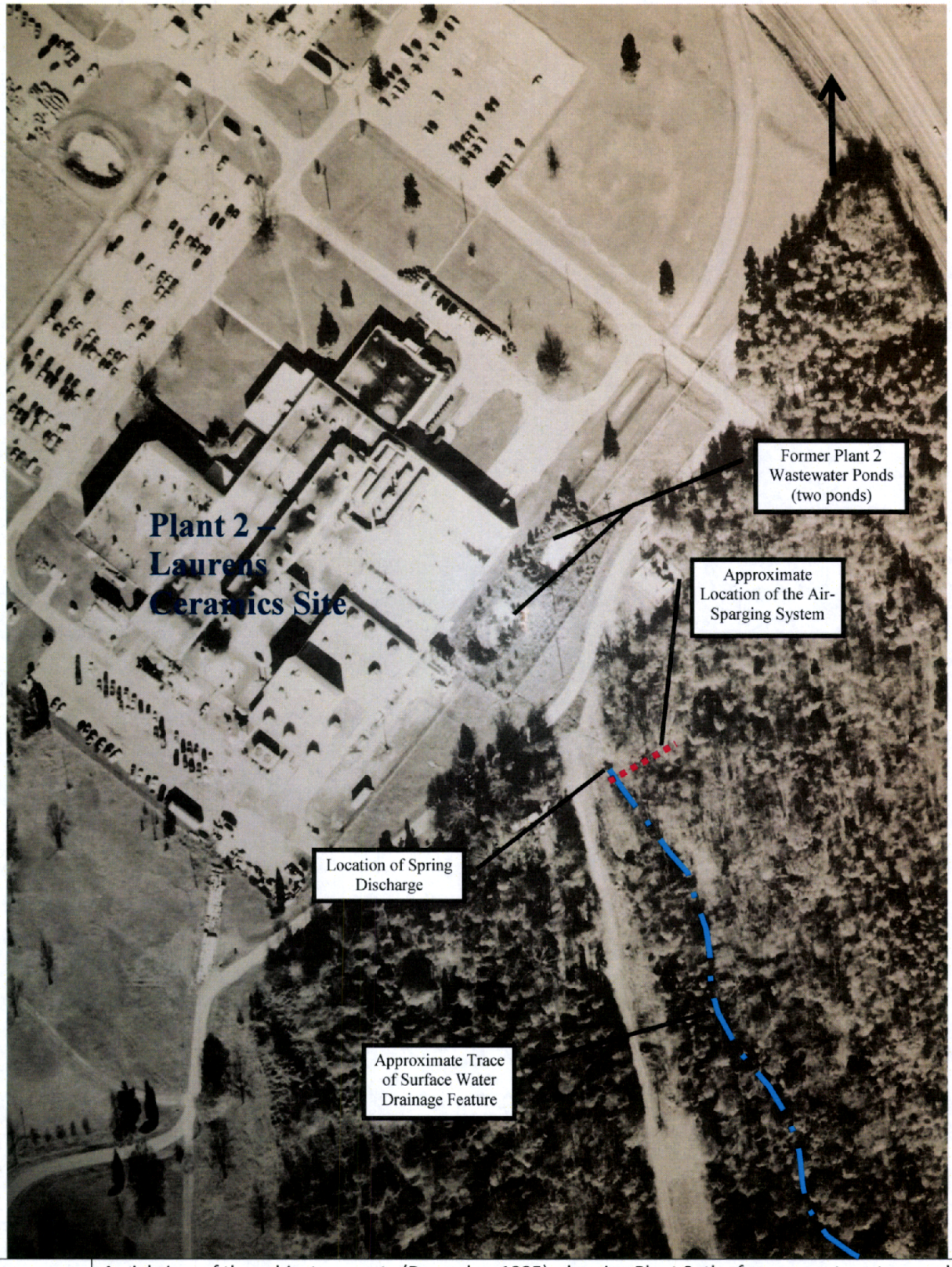



**Figure 2** Aerial view of the subject property (December 1995), showing Plant 2, the former wastewater ponds, the drainage feature, and the general location of the air sparging system.

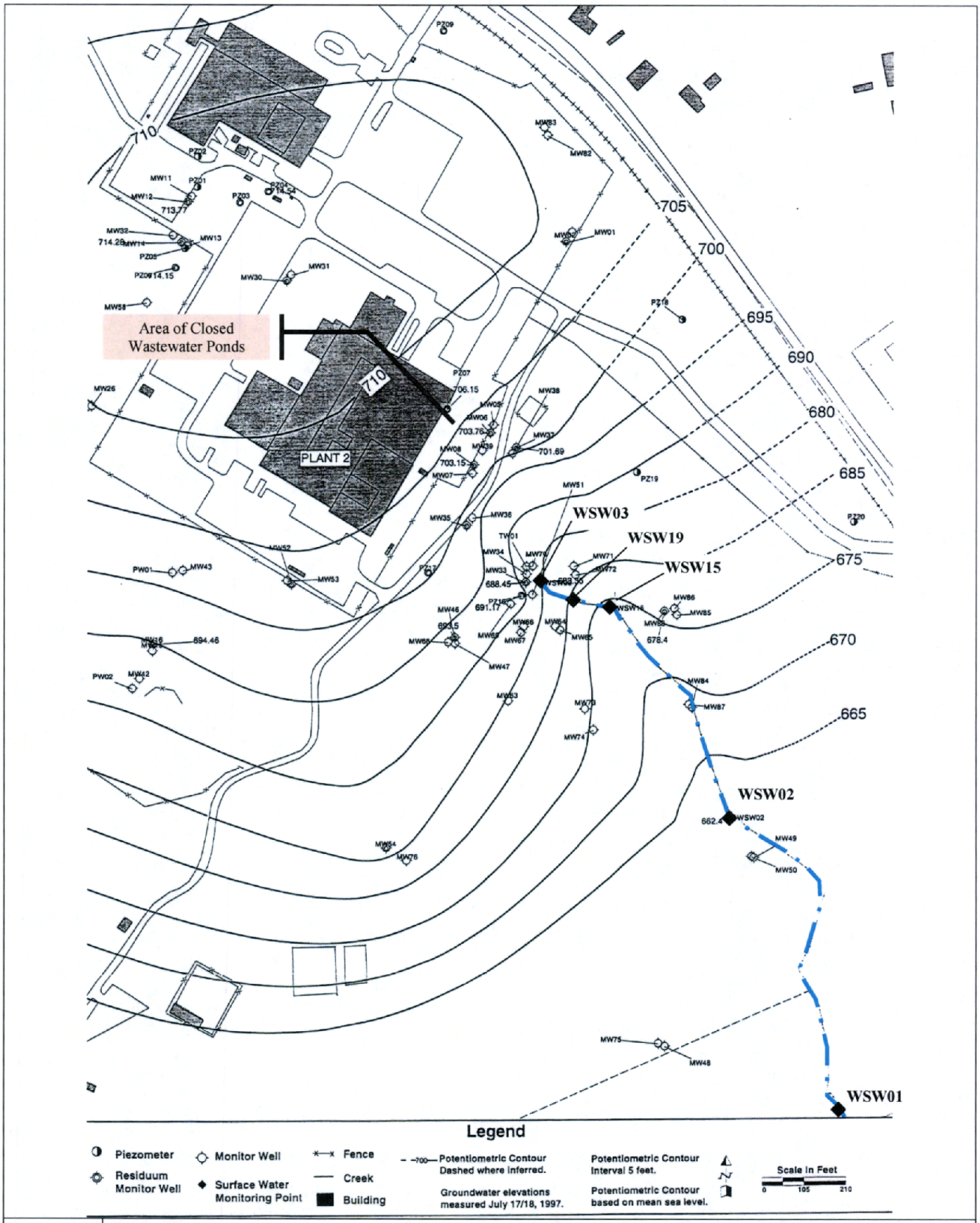
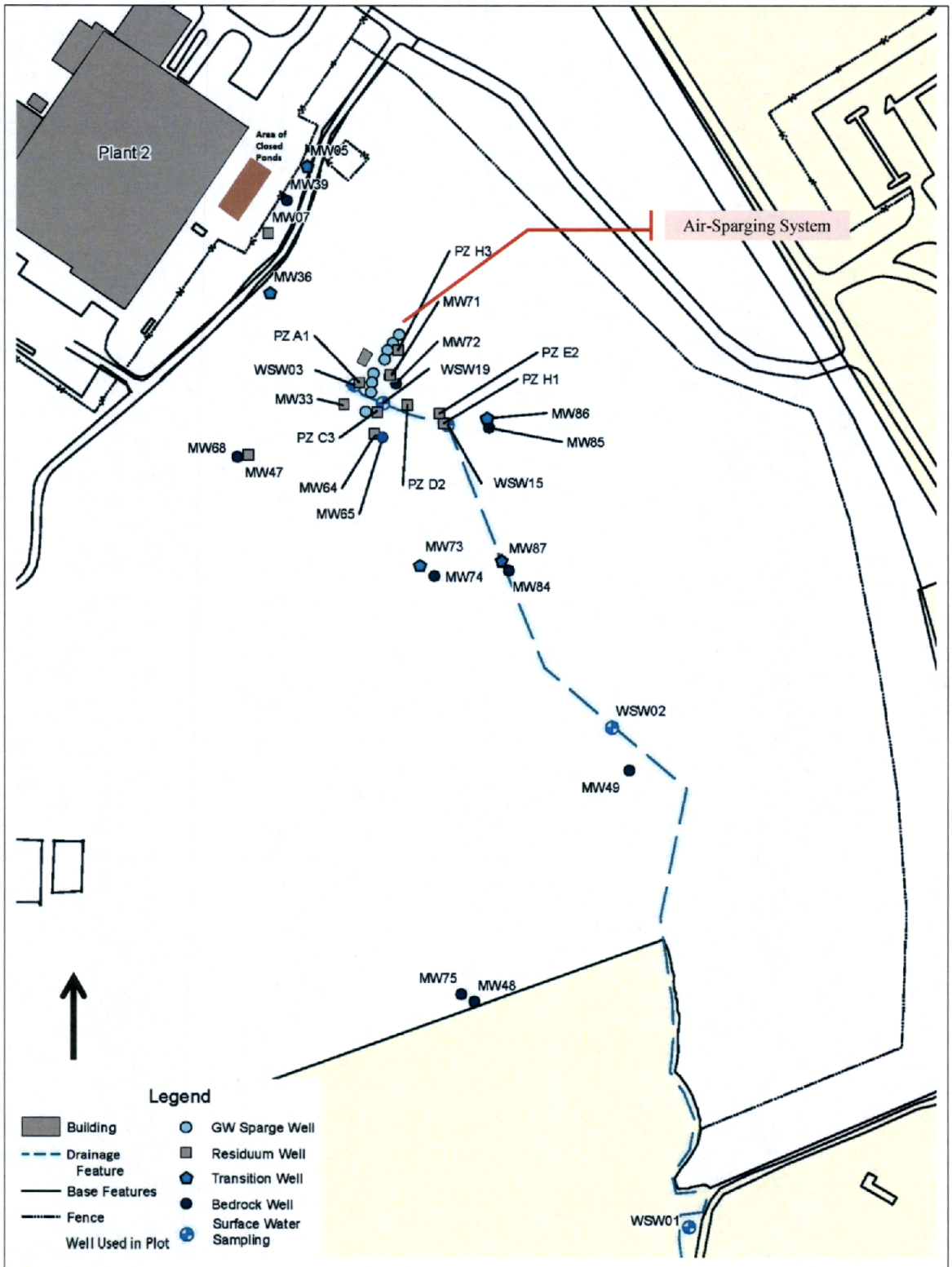



**Figure 3** Residuum groundwater contour map for data from September 1991 showing the radial flow of groundwater near Plant 1 and early well placements for the Plant 2 investigation area. Note the influence on groundwater flow by the drainage feature.

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| **Figure 4** | Current site map showing the location of the former sources, the location of the air-sparging system, and the location of wells and drainage monitoring stations, including those maintained as part of the ongoing groundwater monitoring program. |

# TABLE 1. Historic Groundwater Analytical Data – Plant 2 Groundwater Monitoring Program

| Station Number | Description | Analytical Results - Total VOCs (µg/L) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | March 2002 | April 2004 | May 2006 | March 2008 | March 2010 | March 2012 | March 2013 |
| MW33 | Upgradient of Air-Sparge System | 535 | 2,975 | 1,525 | 179 | 138 | 50 | 23 |
| PZA1 | Upgradient of Air-Sparge System | 22,249 | 13,535 | 14,600 | 13,430 | 11,657 | 12,981 | No Sample[a] |
| PZC3 | Downgradient of Air-Sparge System | 11,700 | 16,025 | 12,040 | 5,340 | 16,919 | 8,069 | 6,604 |
| PZH3 | Downgradient of Air-Sparge System | 16,020 | 10,411 | 7,560 | 12,169 | 9,119 | 8,176 | 7,850 |
| | | | | | | | | |
| WSW03 | Upstream (west) | 1,596 | 5,089 | 1,350 | 158 | 13 | 73 | 28 |
| WSW19 | ↓ | 24 | 2,730 | 552 | 84 | 41 | 32 | 35 |
| WSW15 | ↓ | 466 | 1,160 | 1,040 | 948 | 504 | 58 | 3,075 |
| WSW02 | ↓ | 180 | 181 | 30 | 61 | 398 | 50 | 317 |
| WSW01 | Downstream (east) | 0.6 | ND | 2.7 | 1.7 | 2.9 | 2.7 | 1.1 |

The sample stations reflect the active monitoring program for Plant 1. The locations of the sample stations are provided in Figure 4.

All results are provided in parts per billion (µg/L).

[a]Erosion damage in the area of PZA1 damaged the well preventing sampling.