APPENDIX 5

Monitoring/Assessment History

Methane monitoring at the facility began in 1993. Methane monitoring from 1993 to the present has indicated that gas migration at the facility does not pose an environmental hazard. Additionally, data from groundwater monitoring has not indicated impacts typically associated with gas migration (i.e., VOCs).

Groundwater monitoring has been conducted at the facility since it began operations to ensure the early detection of any environmental impacts that might occur. Groundwater monitoring was initially conducted in six wells located on the southeast corner of the site. That system was replaced in 1993 by a network of 23 downgradient wells and two background wells in accordance with changes in the Solid Waste Management regulations. The two wells intended for background monitoring (GWA-1 and GWA-2) were found to be downgradient of the waste unit during the first sampling event. As a result, these wells were removed from the monitoring schedule but were retained for potentiometric data; their function was replaced by two new background wells (GWA-3 and GWA-4) located farther west of the facility.

More recently, the monitoring network has been augmented by three wells located between landfill quadrants (GWUL-24, -25 and -26), a deep well on the southern perimeter (GWC-29DR), and two wells (AMW-1 and AMW-2) installed west of the perimeter ditch and opposite two existing interior wells. Two additional background wells (GWA-5 and GWA-6) have also been installed farther west from the facility. A total of 33 wells were being monitored as of October 2005 and two additional wells are planned for installation before the end of 2007. Waste removal activities in the Southwest quadrant have since required plugging and abandonment of GWC-10 and GWC-11, but their function has been replaced by AMW-1 and AMW-2. Well locations are depicted on Figure 1 in Appendix 2.

Groundwater monitoring has been conducted semi-annually since 1993. No data from the pre-existing six-well system was used in preparation of this report. Detection monitoring data through October 2005 are tabulated in Appendix 10 for reference. At a minimum, sampling parameters have included Appendix I Metals and VOCs.

Ground water elevation and flow directions have been determined from measurements in the monitored wells, the two inactive monitoring wells, and a network of 10 piezometers.

In addition to the groundwater monitoring wells, five surface-water monitoring locations were established in the rim ditches. These locations are shown on the attached site plan and are sampled semi-annually for the Georgia Surface Water Parameters. To better understand groundwater flow and discharge relationships, six stream gauges have recently been installed in the perimeter ditch around the southern half of the landfill.

Since monitoring began at this facility, only six (6) VOCs have been detected. None of these constituents has appeared in any well more than once. The lack of repeated detections indicates that these were false-positive detections likely attributable to either sampler or laboratory error. With over 12 years of monitoring data showing no VOC

migration, it is AEM's opinion that the unlined, closed waste units at this facility do not pose an environmental hazard for VOC impacts to groundwater. This is likely to be attributable in part to the significant fraction of inert ash fill at this facility.

Early monitoring detected several inorganic constituents at elevated concentrations; this was thought to primarily be a result of excessive turbidity in the samples. Based on the data obtained during these events, all wells at the facility were redeveloped in 1994 in an attempt to obtain more representative samples. The redevelopment effort led to significant reductions in some inorganic concentrations, especially barium and lead. These reductions are seen in Figures 48 and 49, which show the entire history of barium and lead concentrations in site wells with respect to detection limits. Well development continued after this date as a consequence of standard purging activities each time the wells were sampled.

Following the redevelopment project, the facility was in compliance with EPD regulations relating to groundwater monitoring until the April 1996 monitoring event. Analytical results from that event included zinc levels that were considered to be statistically significant increases (SSIs) over background concentrations. High turbidity was documented in the wells of concern (GWC-10, GWC-11, GWC-14, GWC-15A, GWC-16, GWC-18, and GWC-20), and suspended sediment was suspected of causing the elevated zinc in these locations. Therefore, AEM recommended dissolved analyses of samples from these locations. As an additional factor, the statistical analyses included elevated results from events conducted prior to redevelopment.

While the dissolved analyses were performed, the concentrations of zinc in all wells except GWC-14 dropped to non-detectable levels during the October 1996 monitoring event. Therefore, zinc was no longer a compliance issue. However, results from October 1996 indicated elevated metal concentrations in several other wells. It was these detections that eventually led the Facility into Assessment Monitoring.

During the October 1996 monitoring event, several metals were detected in monitoring wells at concentrations in excess of the MCLs. Background well GWA-4 had concentrations of chromium, lead, and selenium above the MCLs. Compliance wells GWC-8 and GWC-11 also had MCL exceedances for beryllium and selenium (GWC-8) and cadmium (GWC-11).

During the next monitoring event in April 1997, only the cadmium exceedance in GWC-11 was confirmed. Additionally, beryllium and selenium were each detected in this well at concentrations exceeding MCLs. This general pattern was repeated during the subsequent October 1997 monitoring event. Based on these confirmed exceedances, an Assessment Monitoring Program (AMP) was designed and implemented for the facility.

Assessment Monitoring Program

The AMP included:

- analyzing samples from GWC-12, GWC-17, and GWC-17A for total and dissolved metals in an effort to assess the effects of turbidity on metal concentrations,
- installing six (6) test borings in the area of GWC-10 and GWC-11 to assess the potential for preferential migration pathways,
- installing two (2) assessment monitoring wells (AMW-1 and AMW-2) opposite from GWC-10 and GWC-11, but west of the perimeter ditch, to evaluate horizontal migration of cadmium, and
- analyzing samples from AMW-1, AMW-2, GWC-10, and GWC-11 for total and dissolved Appendix II metals in an effort to detect any additional constituents present and assess the effects of turbidity on metal concentrations.

Results of these assessment activities were documented in the July 7, 1998 Assessment Monitoring Report prepared by AEM. In general, the assessment indicated that the prior exceedances noted in wells GWC-10, GWC-12, GWC-17, and GWC-17A were likely to be false-positive detections. Only the impacts in GWC-11 were confirmed. The lack of the constituents in the assessment monitoring wells led AEM to conclude that the cadmium noted in GWC-11 was not migrating beyond the perimeter ditch. It was also noted during this assessment that depressed pH levels in GWC-11 were likely responsible for leaching metals from the surrounding formation.

The detections of metals continued in GWC-11 through the end of 1998. Thereafter, the cadmium detections ceased and other metals dropped to background levels. A correlation was evident between elevated metals detections and depressed pH levels in this location. Specifically, after 1998, pH levels increased in this well and the metal detections decreased.

The pH increased to more normal levels in GWC-11 (and metal detections dropped), after 1998. Low concentrations of metals were detected sporadically in several wells through the end of 1999. With no trends evident, these detections were generally attributed to turbidity effects.

Beginning in 1999, pH levels showed sharp declines in wells located to the east of the facility. As with GWC-11, the decreased pH levels were accompanied by increases in metal detections. Most notably, pH levels in GWC-2 dropped below 4.0 in April 2000 while total metal concentrations increased from non-detectable levels to greater than 800 ppb. During the April 2000 monitoring event, barium, cobalt and nickel were detected in this location. These and other metals have been detected consistently in GWC-2 since that time. Adjacent wells have shown similar consistent detections.

Assessment of Corrective Measures

Based on the presence of SSIs and the repeated pH depressions at the facility, the City initiated an Assessment of Corrective Measures study in 2002 as documented in the December 31, 2002 Assessment of Corrective Measures (ACM) Work Plan prepared by AEM. The ACM study began with an analysis of data from monitoring wells at the facility.

Preliminary analysis of the available data supported a general correlation between pH levels and metals detections in several wells. Additionally, relationships between water levels and metals detections were evident.

Additional assessment activities were conducted as part of the ACM study. These activities included the following:

- Probe surveys were conducted in the areas of GWC-2, GWC-5, and GWC-11. Water samples from these probes were tested for pH levels at varying intervals. Additionally, soils and water samples were visually inspected to detect pertinent data.
- Stream gauges were installed in the rim ditch and surveyed to allow for potentiometric data from this water body.
- Leachate and soil testing conducted at the site previously was compared to monitoring data.
- Site history was assessed for causal incidents.

The ACM study was documented in a December 26, 2005 report submitted to the EPD. After reviewing the ACM report, the EPD submitted comments to the City of Savannah indicating numerous activities proposed in the ACM Work Plan that were not completed. A revised work plan was prepared and approved by the EPD.

Alternate Source Demonstration Activities

Additional data analyses and field investigations were undertaken to provide data that would permit completion of an Assessment of Corrective Measures. These included the following:

- Geologic cross-sections were constructed to provide a framework for understanding the possible influence of site soils and the historic range of water levels in wells. Additional diagrams were prepared to compare stratigraphy and well construction details in areas of interest, and present the results of pH probe investigations.
- Historic rainfall data were obtained to document overall trends in site water levels. Water levels are measured in site wells twice per year, and while indicative of trends to some extent, they are subject to influence from heavy rainfalls preceding measurements and can miss significant fluctuations taking place between events.
- Charts were prepared to compare trends in water levels, rainfall, pH, and metals concentrations in various wells. The possible effect of changes in detection levels was

identified. These charts permitted the exploration of relationships between environmental factors and groundwater quality.

- Data were obtained for leachate and ditch water, and that was compared to well detections.
- Several water level measurements were made in perimeter ditches adjacent to or near monitoring wells, and the results compared to water levels in wells. An additional round of water level measurements was made in June 2006 to facilitate comparison.
- Areas of possible acid sulfate soils were observed and photographed in the borrow area and the southwest landfill quadrant. A deep force-main trench on the east side of the landfill, near well GWC-2, was inspected and sampled. Numerous soil samples were collected for testing and analysis.
- A total of 32 field peroxide tests were conducted on soil samples collected from the borrow area immediately west of the fill, and five samples received laboratory analysis using the Chromium Reducible Sulfate method as described in Australian guidance documents. This testing program provided evidence of marked decreases in pH upon oxidation and quantified inorganic sulfur associated with pyrite in sediments.

The results from the assessment activities conducted at the facility indicated an alternative source for the impacts noted at the facility. Therefore, the ACM was changed to an Alternative Source Demonstration.