MEMORANDUM – HYDROGEOLOGIC ZONES OF INTEREST: OW-4 & OW-6
HOFF VC SITE
NEW HANOVER TOWNSHIP, MONTGOMERY COUNTY, PENNSYLVANIA
REQUISITION NUMBER GTAC5-1-263

August 15, 2012

SAIC Energy, Environment & Infrastructure (SAIC) is pleased to present this memorandum to the Pennsylvania Department of Environmental Protection (DEP) to summarize the findings of the hydrogeologic assessment of the potential water bearing zones at the Gibraltar Rock Inc. property observation wells OW-4 and OW-6. On July 31 and August 1, 2012, borehole geophysical surveys were conducted on each of the wells. The geophysical survey logs were used in conjunction with the well construction/drilling logs (prepared by Walter B. Satterthwaite Associates, Inc.) to assess the primary water bearing zones and to determine potential zones of interest for future groundwater sampling and/or target well screen depths. Complete geophysical logs will be presented in more detail in a summary report to be completed and submitted under separate cover. The following sections present a summary of SAIC's assessment and recommendations.

METHODOLOGY

SAIC relied on a site conceptual model to assess and identify zones of potential interest within each well. The site conceptual model is based on known geology in the area of the site and assumed transport of the contaminants of concern (i.e. chlorinated volatile organic compounds [cVOC]). The site is underlain by a thin layer of clayey silt soil which rests atop weathered siltstone/sandstone bedrock. Competent bedrock is encountered at approximately 8 to 15 feet (ft). The siltstone/sandstone transitions to argillite and is underlain by hornfels with occasional diabase intrusions.

Based on field observations and monitor well data, SAIC assumes that a shallow aquifer exists in the weathered bedrock and upper portions of the unaltered siltstone/sandstone that extends into the hornfels. SAIC assumes that the diabase has very little storage capacity and groundwater flow is limited to fracture flow.

In regard to cVOC transport, SAIC assumes that the source(s) were surface or shallow subsurface releases. It is assumed that the cVOC were transported primarily through the shallow aquifer. However, due to the density of cVOC, some mass was conveyed to the deeper aquifer via a network of interconnected fractures. Given the limited permeability of the diabase as well as the low amount of organic carbon, it is assumed that cVOC exist primarily in the dissolved phase within the fractures of the rocks.

Based on the assumptions described above, SAIC believes that it is imperative to identify the

shallowest water bearing zones within the lower hornfels/diabase aquifer. These fracture zones are more likely to contain and convey cVOC. However, it is also important to identify deeper fracture zones to determine whether cVOC have migrated to these zones and also to assess the degree of fracture interconnection. The following sections present the zones identified to be likely pathways for groundwater flow and contaminant transport.

OW-4

OW-4 was drilled to a total depth of 350 feet (ft), cased to 40 ft and had an estimated blown yield of 12 gallons per minute (gpm). Well construction logs note water bearing zones at 92 ft (4 gpm) and 265 ft (8 gpm); however geophysical logs do not appear to corroborate the depth of the water bearing zones. In a broad sense, the well construction log describes the lithology as argillaceous siltstone grading to argillite and hornfels, back to argillite, then a thin layer of diabase underlain by argillite and then argillaceous siltstone. Rock strength was reported to be hard to very hard (diabase). Several zones were described as having calcite filled fractures and disseminated pyrite.

Based on review of the drilling logs and geophysical logs the primary zones of interest are: 45 to 75 ft, 130 to 160 ft, 185 to 215 ft, 223 to 253 ft, and 260 to 350 ft. The zone from 45 ft to 75 ft is described as argillaceous siltstone and argillite that is softer than deeper zones and has an upward vertical flow of 0.047 ft/second (ft/s). This zone may represent the shallow weathered bedrock zone.

The zone from 130 to 160 ft is described as bluish black hornfels as indicated by the well construction log, the low gamma, high resistivity, steady caliper diameter and lithologic banding indicated on the geophysical logs. This zone has an upward vertical flow of 0.032 ft/s and several open fractures, lithologic banding and partially open fractures.

The zone from 185 to 215 ft is described as dark to light grey argillite with calcite filled fractures and disseminated pyrite. The geophysical logs indicate relatively uniform borehole diameter, moderate natural gamma readings, relatively high resistivity, a prominent fracture at about 202 ft, and an upward vertical gradient of 0.030 ft/s.

The zone from 223 to 253 ft is described as light to dark grey argillite with calcite filled fractures. The geophysical logs indicate variable borehole diameter, moderate to high natural gamma readings, low to moderate resistivity, lithologic banding, partially open fractures, and an upward vertical gradient of 0.039 ft/s.

The zone from 275 to 350 ft is of interest primarily due to the depth. The geophysical and well construction logs do not indicate any obvious water bearing zones in this interval. To develop a thorough understanding of groundwater flow at the site, it is important to assess the extent of groundwater movement through deeper portions of the lithology.

OW-6

OW-6 was drilled to a total depth of 400 ft, cased to 20 ft and had an estimated blown yield of 6 gpm. Well construction logs note water bearing zones at 90 ft (3 gpm) and 190 ft (3 gpm); however geophysical logs indicate other potential water bearing zones. In a broad sense, the well construction log describes the lithology as siltstone grading to argillaceous siltstone then alternating layers of argillite and argillaceous siltstone to a depth of 335 ft. From 335 ft to 375 ft, the well constructions logs indicate hornfels. Below the hornfels is a 20 ft zone described as mixed argillaceous siltstone and argillite underlain by hornfels. Rock strength was reported to be hard throughout the borehole.

Based on review of the drilling logs and geophysical logs the primary zones of interest are: 25 to 55 ft, 80 to 110 ft, 155 to 185 ft, and 225 to 255 ft. The zone from 25 ft to 55 ft is described as siltstone grading to argillaceous siltstone then argillite. The borehole diameter varies significantly, which indicates fracturing, lithologic banding and softer rock than deeper zones in the borehole. The acoustic televiewer (ATV) indicates a fracture at 52 ft and the spontaneous potential and natural gamma logs show a deflection at this same depth. This zone displayed an upward vertical flow of 0.026 ft/s to 0.047 ft/s. This upper zone of weathered bedrock is likely to possess unique hydraulic properties compared to deeper zones.

The zone from 80 to 110 ft is described as purplish brown argillaceous siltstone and grey argillite. The transition between these rocks may be indicated by the fluctuation in the spontaneous potential and natural gamma logs at approximately 85 to 90 ft. The caliper log indicates a large deviation at 97 ft and the ATV shows several joints, fractures and bedding plane partings. The heat pulse flow meter indicates an upward flow of 0.019 ft/s in the interval between 70 to 92 ft.

The zone from 155 to 185 ft is described as dark to light grey argillite. The geophysical logs indicate relatively uniform borehole diameter, moderate to low natural gamma readings with two large spikes at 162 ft and 178 ft, and low to moderate resistivity. The ATV logs show two fractures at 164 ft and 178 ft, multiple lithologic bands and several partially open fractures. Although the well construction logs indicate a water bearing fracture at 190 ft, no vertical flow was observed. It is likely that the water bearing zone may be correlated to the fractures at 178 ft.

The zone from 225 to 255 ft is described as light to dark grey argillite, purplish brown argillaceous siltstone and brown to brownish grey argillaceous siltstone. The geophysical logs indicate several small increases in the borehole diameter, low to moderate natural gamma readings, low to moderate resistivity, lithologic banding, partially open fractures, and an open fracture at 252 ft. In addition, an abrupt change in the temperature and fluid conductivity are encountered between 225 and 250 ft. Heat pulse flowmeter readings indicate no vertical flow.

Recommendations

SAIC recommends straddle packer aquifer testing and groundwater sampling at up to five zones at both OW-4 and OW-6. The testing has two primary objectives: to determine the approximate yield from specific intervals and to determine the water quality at specific intervals. Results of

the packer testing will be used to assess the interconnectivity of aquifer zones, assess groundwater quality, and assess contaminant transport. Ultimately, nested wells will be designed and constructed in wells OW-4 and OW-6 based on the results from this straddle packer sampling work.

SAIC recommends that straddle packer testing be conducted on the following zones:

OW-4:

- 45 to 75 ft
- 130 to 160 ft
- 185 to 215 ft
- 223 to 253 ft
- 260 to 350 ft

OW-6:

- 25 to 55 ft
- 80 to 110 ft
- 155 to 185 ft
- 225 to 255 ft
- 275 to 400 ft