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Subject: Submittal of HDP-TBD-EHS-001 Subsurface Water (License No. SNM-00033, Docket No. 070-00036)

Reference: 1) NRC (J. J. Hayes) letter to Westinghouse (E. K. Hackmann), dated December 3, 2010, "Westinghouse Hematite Decommission Plan Review Requests for Additional Information for the Decommissioning Plan Chapters 8 and 9"

Several NRC Requests for Additional Information (RAI) on the Hematite Decommissioning Plan (DP) have concerned the issue of subsurface water. Westinghouse Electric Company LLC (Westinghouse) offers the summary herein to provide an overview of that topic and assist in the NRC's understanding of the subsurface water conditions at the Hematite facility.

Attachment 1 provides the subsurface water overview. Please contact Mark Michelsen, Acting Licensing Manager of my staff at 314-810-3376 should you have questions or need any additional information.

Sincerely,

E. Kurt Hackmann
Director, Hematite Decommissioning Project

Attachment: 1) HDP-TBD-EHS-001 Subsurface Water

cc: J. J. Hayes, NRC/FSME/DWMEP/DURLD
J. W. Smetanka, Westinghouse, w/o attachment
J. E. Tapp, NRC Region III/DNMS/MCID, w/o attachment

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Hematite Decommissioning Project

Technical Basis Document

NUMBER: HDP-TBD-EHS-001

TITLE: Subsurface Water Overview

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SUBSURFACE WATER OVERVIEW

1.0 Summary

The silty clay soil immediately underlying the sources of radioactive contamination in the soil has attenuated migration of radiological contaminants in the soil, thus protecting the potential sources of drinking water near the Hematite Site. The planned removal of the contaminated soil associated with these sources will remove the threat to groundwater sources of potable water. Total uranium does not exceed the background threshold value in these potential sources of drinking water. Tc-99 has been found in the shallowest potential source of drinking water at $1/6^{th}$ of the drinking water standard. However, due to the presence of volatile organics exceeding drinking water standards, this potential source cannot be used for drinking water. The furthest downgradient detection of Tc-99 contamination is from a well located halfway between the site security fence and Joachim Creek, at about $1/500^{th}$ of the drinking water standard.

2.0 Purpose

The purpose of this document is to provide a summary of the current understanding of the radioactive contamination in subsurface water at the Hematite Site. This overview is intended to convey in four dimensions (east-west, north-south, vertical, and temporal) the results of sampling subsurface water near the Hematite Site. This overview provides the current understanding of subsurface water conditions, an understanding that has been continuously refined since 2002 when studies of subsurface water at the Hematite Site started. Some early concepts about subsurface water have given way to refined concepts as more data has been collected, more wells have been installed, and more analyses have occurred. This paper summarizes information presented in the Hematite Decommissioning Plan, Supplemental reports, and responses to requests for additional information (References 9.6, 9.7, and 9.8).

3.0 Locations of Monitoring Well and Sources of Radioactivity

Analysis of subsurface water is conducted through monitoring wells placed at differing locations, screened at differing depths, and monitoring differing water bearing zones both on and off Westinghouse property. The locations include monitoring wells in the areas of soil contamination, in areas outside the soil contamination but where contaminates have been detected in water samples, and in areas where no site contamination has been detected (sentry) to detect migration of the contamination from the source areas. Figures 1 and 2 show the locations of the Central Tract Area and Outlying Area monitoring wells discussed in this document, and Figure 3 shows the locations of the sentry wells.

Figure 1 also shows the locations of the former process buildings (Buildings number 240, 253, 254, 255, 260), the burial pit area, the limestone storage area, the former evaporation ponds, the former leach field, and the cistern/red room roof burial area. These locations have soil contamination and are the sources of the radioactivity that have been detected in the subsurface water, or leachate. The radiological soil contamination is primarily total uranium (U-234, U-235, and U-238) and Technetium-99 (Tc-99). Isolated areas of soil contaminated with radium-226 (Ra-226) and thorium-232 (Th-232) are also present. These locations of soil contamination are within the Central Site Tract Area of the site where operational activities were historically conducted. The Central Site Tract Area is bounded by State Road P to the north, the Northeast Site Creek to the east, the Union-Pacific Railroad to the south and the Site Creek/Pond to the west.

The limestone storage area contains spent limestone that was utilized in scrubbing hydrogen fluoride from the off-gas associated with the conversion of uranium hexafluoride to uranium dioxide. During Hematite operations, the limestone scrubber media became contaminated with Tc-99. The source of the Tc-99 is a contaminant in the government supplied uranium hexafluoride that originated from the use of recycled uranium. In addition to Tc-99, trace amounts of neptunium-237 (Np-237) and americium-241 (Am-241) were also identified to have originated from the government supplied uranium hexafluoride.

4.0 Hydrostratigraphic Units (HSUs)

The composition of the subsurface ground has a significant effect on the movement of subsurface water. In the area of the Hematite Site, the subsurface ground fits three categories, presented in order from shallow to deep: silty clay, sand/gravel, and bedrock. The water in each of these layers of subsurface ground has separate properties, so they are analyzed as separate hydrostratigraphic units (HSUs). The interconnectivity of these units is also evaluated to identify potential migration pathways. The bedrock layer consists of two HSUs, as described below. The following summaries of the four HSUs are based on References 9.3 and 9.4:

- The Silty Clay Aquitard HSU nominally extends 24 feet below the surface. The thickness ranges from 4 to 38 feet, and is typically thicker near the Site buildings and thinner near Joachim Creek. General lateral flow in the Silty Clay Aquitard HSU has not been evident, but there may be local lateral movement if heterogeneities are encountered in the clay layers. The calculated vertical hydraulic gradient through the clay is downward-directed. The mean hydraulic conductivity (2.85 x 10-5 cm/sec) indicates limited water flow through the silty clay. Based on a conceptual model of vertical seepage in the silty clay layer with localized conduit flow along vertical wellbores that cross connect the silty clay layer and the underlying sand/gravel layer, it is theorized that the vertical migration of radiological contamination is being attenuated by the silty clay layer.

- The Sand/Gravel HSU nominally extends 2 feet below the Silty Clay Aquitard HSU. The thickness ranges from 0 to 20 feet, and is typically thicker near Joachim Creek and thinner near the Site buildings. Lateral flow in the Sand/Gravel HSU is to the southeast towards Joachim Creek under a prevailing hydraulic gradient of approximately 0.0109 feet/foot. The estimated velocity of flow is 20 to 300 ft/year (Reference 9.5).

- The Jefferson City-Cotter Bedrock HSU nominally extends 50 feet below the Sand/Gravel HSU. The lateral flow in the Jefferson City-Cotter Bedrock HSU is easterly under a mean hydraulic connectivity of 1.29E-3 cm/sec.

- The Roubidoux Bedrock HSU is below the Jefferson City-Cotter Bedrock HSU. Lateral flow in the Roubidoux Bedrock HSU is northeasterly under a mean hydraulic connectivity of 7.55E-5 cm/sec.

Notes: The bedrock does not provide a clear dividing line between the Jefferson City-Cotter Bedrock HSU and the Roubidoux Bedrock HSU. This transition uncertainty is called the contact zone. The contact zone has lower transmissivity than the bedrock HSUs.
The estimated velocity of flow in the bedrock is 2 ft/year to greater than 300 ft/year (Reference 9.5).

5.0 HSUs Viability as Sources of Drinking Water

Each of these HSUs has been analyzed to determine whether they are a viable source for drinking water or irrigation water (Reference 9.3).

- The Silty Clay Aquitard HSU is not viable as a sustainable water supply for the purposes of drinking water, irrigation, or industrial use based on its mean hydraulic conductivity (2.85 x 10-5 cm/sec), its low mean matrix permeability (3.48 x 10-8 cm/sec) and its apparent lack of internal interconnected flow pathways. The State of Missouri Well Construction Code (10 CSR 23-3) for the Hematite location requires "No less than twenty feet of casing shall be set above the screened or perforated interval of the well". This restriction would preclude development of a water supply for domestic or irrigation purposes from the Silty Clay Aquitard HSU (unless the State of Missouri approved a variance to its regulations).
- The Sand/Gravel HSU underlying the immediate facility area has insufficient quantities of shallow water to sustain feasible and economic production based on its limited extent and thickness. The sand and gravel deposits are an effective underdrain for the Silty Clay Aquitard HSU and could provide a viable water resource south of the Site buildings. However, due to the presence of volatile organics exceeding drinking water standards, the Sand/Gravel HSU is currently restricted for use (through deed restrictions) as a source of potable water.
- The Jefferson City-Cotter Bedrock HSU is a viable water supply.
- The Roubidoux Bedrock HSU is a viable water supply.

Based on 10 CFR 20.1402 and 10 CFR 40, the term "groundwater" is applied to sources of subsurface waters that are sources of drinking water or aquifers that are capable of yielding a significant amount of groundwater to wells or springs. Based on these regulatory descriptions of groundwater, the water in the Sand/Gravel, Jefferson City-Cotter Bedrock, and Roubidoux Bedrock HSUs is groundwater. The term "leachate" is used for the water in the Silty Clay Aquitard HSU and is used to describe wells that are screened only in the Silty Clay Aquitard HSU.

6.0 HSU Interconnectivity

The Sand/Gravel HSU and the Silty Clay Aquitard HSU are interconnected. Except for one paired well location (PL-06/GW-V), the potentiometric surface of subsurface water is higher than the thickness of the sand/gravel. This saturates the sand/gravel and slows the downward drainage of leachate through the silty clay. (On occasion, monitoring wells in the Sand/Gravel

HSU have exhibited upward pressure gradients.) At wells PL-06/GW-V, the thicker sand/gravel layer can become unsaturated with seasonal variation of the potentiometric surface and allow nearby leachate in the overlying clay to drain into the Sand/Gravel HSU.

Some degree of hydraulic communication is suggested between the Sand/Gravel HSU and the underlying Jefferson City-Cotter Bedrock HSU. Although volatile organic compounds (VOCs) are not analyzed in this overview, VOCs originating from the Hematite Site are present in the Jefferson City-Cotter Bedrock HSU. This suggests the potential for a hydraulic connection between the Sand/Gravel HSU and Jefferson City-Cotter Bedrock HSU through vertical migration pathways. Alternatively, the VOCs may be present in the Jefferson-City Cotter Bedrock HSU by the introduction of the VOCs directly through the excavation of direct pathways or downward seepage along well casings. Of 17 vertical hydraulic gradients calculated for well pairs monitoring the overburden HSUs and the Jefferson City-Cotter Bedrock HSU from 1998 to 2009, all but 3 well pairs indicate that flow is predominantly downward directed. The 3 well pairs (BR-03-JC/RB, BR-08-JC/RB, and BR-10-JC/RB) that indicated an upward direction were on the floodplain of Joachim Creek and are within the zone of groundwater convergence.

The results of testing conducted in December 2004 in the paired wells at PW-06-JC/RB, PW-16-JC/RB, and PW-19-JC/RB inferred a lack of hydraulic communication between the Jefferson City-Cotter Bedrock HSU and the Roubidoux Bedrock HSU based on the observed response of the Jefferson City-Cotter Bedrock HSU wells to pumping in the Roubidoux Bedrock HSU wells. However, vertical hydraulic gradient analysis suggests some degree of communication between the two bedrock HSUs with the rate of groundwater movement controlled by the hydraulic conductivity of the bedrock formations and the availability of secondary porosity (fractures, joints, dissolution features). The general direction of the vertical hydraulic gradients is predominantly upward directed, with intermittent downward directed gradients prior to December 1997. Festus production wells facilitated the downward hydraulic stresses by their pumping action from the Roubidoux Bedrock HSU. In 2003, the use of the Festus production wells was curtailed, causing a rebound in the Roubidoux Bedrock HSU in the vicinity of the Hematite Site. This rebound reduced the downward hydraulic stresses in the Roubidoux Formation, as well as relieved hydraulic stresses that had been transferred to the Jefferson City-Cotter Bedrock HSU through wells PW-06, PW-16, and PW-19. These Festus production wells are used occasionally to supplement the primary well fields which are installed in the Mississippi River Alluvium. This occasional use has not had an effect on the Roubidoux Aquifer in the vicinity of the Hematite Site.

7.0 Monitoring Results

The monitoring wells have been grouped by the associated HSUs for which they are screened, with the following exception: wells that are either screened or have filter packs that cross both the silty clay layer and the sand/gravel layer. Figure 4 shows graphically how wells differ in terms of vertical reach into the Silty Clay Aquitard and Sand/Gravel HSUs. These wells were installed during early characterization efforts, prior to understanding of the difference in the Silty Clay Aquitard HSU and the Sand/Gravel HSU. Since hybrid wells located in contaminated soil present a pathway that is less restrictive to contamination migration than the silty clay soil, HDP is taking the necessary steps to grout and close such wells in the near-term.

In September 2009, 11 additional wells were installed in the Sand/Gravel HSU to aid in understanding the Sand/Gravel HSU. Nine of these wells were paired with existing wells to specifically examine the potential downward flow of contamination from the Silty Clay Aquitard HSU to the Sand/Gravel HSU. Based on the radionuclide analytical results and the proximity of the paired wells, the contamination identified in the hybrid wells is attributable to the Silty Clay Aquitard HSU and not the Sand/Gravel HSU. Thus, the data collected from the hybrid well samples are grouped with the data for the Silty Clay Aquitard HSU. The nine paired wells are: GW-D/WS-17B, GW-S/BD-14, GW-T/DM-02, GW-V/NB-31, GW-W/NB-81, GW-X/PL-06, GW-Y/NB-33, GW-U/EP-20, and GW-Z/WS-13.

The Tc-99 and total uranium results from the most recent four quarters of sample data of all four HSUs are shown on Figures 5 to 8 and 9 to 12, respectively. The most recent four quarters of sample data are selected based on the data available from the 11 additional wells installed in 2009, on the intent of this document to provide temporal information and on the intent of this document to provide the current understanding of radiological contamination in subsurface water associated with the Hematite Site. In addition to the data on the figures, the text discusses prior data that represent elevated results.

- In Figures 5 through 8, Tc-99 results are separated into four categories: results not exceeding the minimum detectable concentration (MDC), results greater than the MDC but not exceeding the MDC plus the error band, results greater than the MDC plus the error band but not exceeding the EPA drinking water standard, and results greater than the drinking water standard. Based on the drinking water standard for beta emitters of 4 millirem/year, 900 pCi/l was used for the Tc-99 drinking water standard.
- In Figures 9 through 12, uranium results are separated into three categories: results below the Background Threshold Value (BTV) of 8.6 pCi/l, results between the BTV and the EPA drinking water standard, and results above the drinking water standard; Reference 9.8 describes how the BTV for total uranium of 8.6 pCi/l was calculated. The EPA drinking water standard of 30 mg/l was assumed to be equivalent to 20 pCi/l of total uranium activity.

7.1. Tc-99 Results

Tc-99 in the Silty Clay Aquitard HSU

Tc-99 was detected in the Silty Clay Aquitard HSU at concentrations up to 6970 pCi/l. With the exception of wells NB-31, PL-06, NB-34 and NB-35, the locations of Tc-99 detected in the Silty Clay Aquitard HSU align with the locations of Tc-99 contamination in the soil. These exceptions are discussed below:

- For well NB-31, the silty clay overburden in the immediate area does not have sufficient Tc-99 to be the source of the Tc-99. This suggests that a series of interconnected sand lenses from the Central Site Tract Area is present in the silty-clay overburden and providing horizontal transport. During the installation of monitoring wells NB-31 in June 2004 and GW-V in September 2009, soil samples were collected from the boreholes and analyzed for radiological parameters including Tc-99. For NB-31, the soil samples were collected from 5, 15, 27, and 32 feet below ground surface, and the Tc-99 results were less than the

MDC (MDC ranged from 0.78 to 0.83 pCi/g). For GW-V, the soil samples were collected from 26 and 32 feet below ground surface, and the Tc-99 results were 1.09 pCi/g (MDC of 0.52 pCi/g) and less than the MDC (MDC of 0.51 pCi/g). The boring logs for wells within this area did not clearly define any sandy or gravely lenses, but such lenses can be too thin to be visually identified. Well NB-31 is located south of the rail line and south of the limestone storage area.

- For well PL-06, the silty clay overburden in the immediate area does not have sufficient Tc-99 to be the source of the Tc-99. This suggests that a series of interconnected sand lenses from the Central Tract area is present in the silty-clay overburden and providing horizontal transport. During the installation of monitoring wells PL-06 in June 2004 and GW-X in September 2009, soil samples were collected from the boreholes and analyzed for radiological parameters including Tc-99. For PL-06, the soil samples were collected from 7, 13, 17, 29 and 33 feet below ground surface, and the Tc-99 results were less than the MDC (MDC ranged from 0.96 to 1.04 pCi/g) to 1.18 pCi/g (MDC 1.02 pCi/g). For GW-X, the soil samples were collected from 14 and 28 feet below ground surface, and the Tc-99 results were less than the MDC of 0.56 and 0.58 pCi/g. While the boring logs for wells within this area did not clearly define any sandy or gravely lenses, these wells are in close proximity to a buried natural gas pipeline that has a downward slope towards PL-06, which makes the pipeline a potential horizontal conduit. Upgradient and in close proximity to the pipeline are the former evaporation ponds and the limestone storage area. Well PL-06 is located near Building 231.
- For wells NB-34 and NB-35, eight sample results have exceeded the error band around the MDC (results not exceeding the error band around the MDC may be false positive detections due to the statistics involved in counting radioactivity decay). For NB-34, soil samples were collected during construction from 5, 15, and 25 feet below ground surface; the Tc-99 results were less than the MDC (MDC ranged from 0.84 to 0.88 pCi/g). For NB-35, soil samples were collected during construction from 1, 15, and 25 feet below ground surface; the Tc-99 results were less than the MDC (MDC ranged from 0.81 to 0.85 pCi/g). NB-34 and NB-35 are hybrid wells that penetrate into the Sand/Gravel HSU, and are downgradient of wells GW-X and GW-U. The lack of Tc-99 soil contamination, the upgradient results of Tc-99 in the Sand/Gravel HSU, and the depth of these wells suggests migration/flushing through the Sand/Gravel HSU to these wells. Well NB-34 and NB-35 are south of the rail line and the former evaporation ponds.

Well	Sample Date	Tc-99 Result (pCi/L)	MDC (pCi/L)	Error (pCi/L)
NB-34	12/10/2009	3.7	1.6	1.1
NB-34	6/25/2009	3.8	1.4	1.0
NB-34	3/10/2009	3.3	1.1	0.87
NB-34	12/10/2008	7.1	1.3	1.2
NB-34	9/17/2008	8.0	3.3	2.2
NB-35	6/25/2010	3.2	1.5	1.0
NB-35	12/10/2008	3.2	1.3	0.97
NB-35	3/10/2009	3.0	1.3	0.96

Tc-99 in the Sand/Gravel HSU

Tc-99 was detected in the Sand/Gravel HSU at concentrations from -1.8 to 157 pCi/l, which is about 1/6th of the EPA Drinking Water Standard. Those data that exceeded the error band around the MDC are discussed further below:

- The highest Tc-99 in the Sand/Gravel HSU was detected at well GW-X at levels of 96 to 157 pCi/l. This well is located in the thickest layer of sand and gravel identified within the fenced portion of the facility. A thicker layer of sand corresponds to a thinner Silty Clay Aquitard HSU separating the source areas and groundwater. It is possible that within this area, the Tc-99 has either migrated through the silty clay or well PL-06 is acting as a conduit for the contamination to migrate into the sand/gravel layer. In addition, the thickness of the sand and seasonal variation of the potentiometric surface (which can vary by as much as thirteen feet, Reference 9.3) can cause the sand to be unsaturated and allow water containing Tc-99 in the overlying Silty Clay Aquitard HSU to drain into the Sand/Gravel HSU. The Tc-99 levels detected in well PL-06, which monitors the Silty Clay Aquitard HSU, are equivalent with those in GW-X. This is indicative of draining from the Silty Clay Aquitard HSU. Well GW-X is located near Building 231. Well PL-06 is a hybrid well and is scheduled for removal in early 2011.

- Tc-99 was detected in well GW-V at levels of 3.2 to 7.1 pCi/l. This well is located next to well NB-31, which detected Tc-99 in the Silty Clay Aquitard HSU at levels of 66 to 107 pCi/l during the same time period. Well NB-31 may be providing a conduit from the Silty Clay Aquitard HSU to the Sand/Gravel HSU. Well GW-Y is located on the south side of the rail line and south of the limestone storage area. Well NB-31 is a hybrid well and is scheduled for removal in early 2011.

- Tc-99 exceeded the error band around the MDC in well NB-72 on 3/9/2009, 12/10/2009, and 6/24/2010 with results of 3.3 pCi/l (MDC 1.3 pCi/l, error 0.99 pCi/l), 3.9 pCi/l (MDC 1.8 pCi/l, error 1.3 pCi/l), and 2.9 pCi/l (MDC 1.7 pCi/l, error 1.1 pCi/l). Well NB-72 is downgradient of well GW-V which also had slightly positive results for Tc-99. Well NB-72 is located about halfway between the rail line and Joachim Creek.

- Tc-99 was detected in well GW-D at levels of 2.2 to 3.0 pCi/l. This well is located next to well WS-17B, which detected Tc-99 in the Silty Clay Aquitard HSU at levels of 1390 to 2320 pCi/l. Well WS-17B may be providing a conduit from the Silty Clay Aquitard HSU to the Sand/Gravel HSU and is scheduled for removal in early 2011. Well GW-D is located on north of the rail line and in the vicinity of the limestone storage area.
- Tc-99 was detected in well GW-T at levels of 2.4 to 4.3 pCi/l. This well is located next to well DM-02, which detected Tc-99 in the Silty Clay Aquitard HSU at levels of 157 to 414 pCi/l. Well DM-02 may be providing a conduit from the Silty Clay Aquitard HSU to the Sand/Gravel HSU and is scheduled for removal in early 2011. Well GW-T is located between Building 256, the burial pit area, and the limestone storage area.
- Tc-99 was detected in well GW-U at levels of 2.1 to 3.1 pCi/l. This well is located near to well EP-20, which had detected Tc-99 in the Silty Clay Aquitard HSU at levels of 735 to 952 pCi/l during the same time period. Well EP-20 may be providing a conduit from the Silty Clay Aquitard HSU to the Sand/Gravel HSU and is scheduled for removal in early 2011. Well GW-U is located along the natural gas pipeline, between the former evaporation ponds and the rail line.
- Tc-99 exceeded the error band around the MDC in well NB-74 on 3/26/2009 at 4.2 pCi/l (MDC 1.3 pCi/l, error 1.0 pCi/l). This well is located near well EP-20, which had detected Tc-99 in the Silty Clay Aquitard HSU at levels of 735 to 952 pCi/l. Well EP-20 may be providing a conduit from the Sitly Clay Aquitard HSU to the Sand/Gravel HSU. Well NB-74 was located between the former evaporation ponds and the limestone storage area, along the natural gas pipeline. Well NB-74 was grouted and closed to allow for installation of the rail spur. Well EP-20 is a hybrid well and is scheduled for removal in early 2011.

Tc-99 in the Jefferson City-Cotter Bedrock HSUs

Tc-99 was not detected in the Jefferson City-Cotter Bedrock HSU with the following exceptions:

- A sample taken on 06/28/2007 at BR-01-JC had a Tc-99 result of 48.9 pCi/l. All of the 14 other Tc-99 results for this well were less than MDC.
- Four of fifteen samples collected from BR-08-JC had Tc-99 results slightly above the MDC, but that did not exceed the error band around the MDC. The dates, result, MDC, and error are shown in a table following the next paragraph. The remaining eleven results were below the MDC. An evaluation in Reference 9.4 concluded that the data are oscillatory around zero activity and are not indicative of bedrock groundwater contamination.
- Three samples from PZ-03 had Tc-99 results slightly above the MDC. The dates, result, and MDC are shown below. The 7 results preceding these outliers were all less than MDC. The evaluation in Reference 9.4 concluded that because well PZ-03 is located in an area of elevated Tc-99 activity in the overburden groundwater, the potential exists for vertical leakage from the overburden or along the well bore

to the bedrock. However, the time series plot does not reflect an overall increasing trend in Tc-99 activity at PZ-03 and the observed activity is approximately three orders of magnitude less than the activity observed in the overburden. This well was an interference to the rail spur and was abandoned in 2009. Well GW-D is located on north of the rail line near the former location of PZ-03 and directly overlies the Jefferson City HSU. It is sampled on a quarterly basis, with Tc-99 detected between 2.2 and 3.0 pCi/l.

BR-08-JC Tc-99 Results				PZ-03 Tc-99 Results			
Date of Sample	Result (pCi/l)	MDC (pCi/l)	Error (pCi/l)	Date of Sample	Result (pCi/l)	MDC (pCi/l)	Error (pCi/l)
03/11/2009	2.0	1.2	0.82	12/08/2008	3.7	1.2	0.97
07/01/2009	1.96	1.5	0.97	03/19/2009	2.5	1.5	0.99
03/23/2010	2	1.7	1.1	07/06/2009	2.8	2.3	1.5
06/24/2010	1.7	1.6	1.0				

- A sample taken at WS-31 on 03/29/2010 had Tc-99 results of 1.7 pCi/l, which did not exceed the error band around the MDC (1.6 pCi/l, error 1.0 pCi/l). All other 14 Tc-99 results for this well were less than MDC.

Tc-99 in the Roubidoux Bedrock HSUs

Tc-99 was not detected in the Roubidoux Bedrock HSU.

7.2. Uranium Data

Total uranium was detected in the Silty Clay Aquitard HSU at concentrations up to 8480 pCi/l. The locations of total uranium exceeding the BTV in the Silty Clay Aquitard HSU align with the locations of total uranium contamination in the soil.

Total uranium did not exceed the BTV in the Sand/Gravel HSU, the Jefferson City-Cotter Bedrock HSU, or the Roubidoux Bedrock HSU. During the calculation of the BTV for total uranium, the software program ProUCL identified one total uranium value at BR-12-RB as an outlier (13.7 pCi/l), so this sample was not used in the background threshold value calculation.

7.3. Ra-226

Two samples from leachate wells have had Ra-226 results significantly greater than the MDC. These two samples were analyzed by gamma spectroscopy and are likely a false detection as indicated by the relatively high error associated with each sample and the inconsistent gross alpha and beta results.

- A result from well WS-09, taken in January 2005, was 153 pCi/l (MDC 100 pCi/l, error 153 pCi/l); the same sample's gross alpha and gross beta radioactivity were less than 3 pCi/l and less than 8 pCi/l, respectively. Since gross alpha and gross beta results are much lower than the Ra-226 result, the Ra-226 result is suspect. Well WS-09 is located south of the rail line and the former evaporation ponds.

- A result from well WS-15, taken in May 2003, had a result of 294 pCi/l (MDC 151 pCi/l, error 320 pCi/l); the same sample's gross alpha and gross beta radioactivity were less than MDC and less than 11 pCi/l, respectively. Since gross alpha and gross beta results are much lower than the Ra-226 result, the Ra-226 result is suspect. Well WS-15 is located in the burial pit area.

Four other radium results (0.331 to 0.759 pCi/l) from the Silty Clay Aquitard HSU and one from the Sand/Gravel HSU were greater than the associated MDC. These samples were taken in 2004 at EP-20 and NB-33 (which sample the Silty Clay Aquitard HSU), hybrid well NB-54, and NB-44 (which samples the Sand/Gravel HSU). These results are consistent with the known elevated levels of natural radium within the area. For example, the public water system in Farmington, Missouri, which is upgradient about 29 miles south of the Site, reported a running annual average of 22 pCi/l (Reference 9.2). In addition, wells BR12JC and BR12RB, which sample the Jefferson City-Cotter Bedrock HSU and Roubidoux Bedrock HSU upgradient of the site, had samples with detected Ra-226 ranging from 0.73 to 1.38 pCi/l.

7.4. Th-232

For wells that sample the Silty Clay Aquitard HSU, positive Th-232 results were generally only slightly greater than MDC, with a highest result of 0.83 pCi/l. The one exception was at leachate well WS-16. Well WS-16 had a Th-232 result of 4.51 pCi/l in 2004. Well WS-16 is located in the burial pit area in a section known to have Th-232 contamination in the soil.

Th-232 was not detected in the Sand/Gravel HSU, Jefferson City-Cotter Bedrock HSU, or Roubidoux Bedrock HSU.

7.5. Np-237

Np-237 results in all HSUs were less than MDC with the following exceptions:

- Well DM-02 had a result of 0.09 pCi/l in 2004. Per Battelle 2006 (Reference 9.1), an activity fraction of 0.00182 for Np-237 to total uranium was established for the Np-237 contaminant in U.S. Department of Energy supplied uranium that originated from reprocessed/ recycled spent nuclear fuels for DOE. This same sample had a total uranium result of 388 pCi/l. Based on this activity fraction and this total uranium result, detecting 0.09 pCi/l of Np-237 is not unrealistic. This hybrid well is located between Building 256, the burial pit area, and the limestone storage area. Well GW-T, which is located adjacent to well DM-02 but samples the Sand/Gravel HSU, has not detected total uranium greater than the corresponding error band around the MDC. With such low results for total uranium, Np-237 would not be detectable at 0.182 percent of total uranium.

- Well BP-7A had a result of 8.1 pCi/l (MDC of 1.4, error of 2.7) in 2004. This same sample had a total uranium result of 8480 pCi/l. Based on the activity fraction and the total uranium result, detecting 8.1 pCi/l of Np-237 is not unrealistic. This is a leachate well and is located in the burial pit area.

- Well BD-16 had a result of 0.02 pCi/l in 2004. This result did not exceed the error band (0.02 pCi/l) around the MDC (0.02 pCi/l) and may be a false positive result. This well has been abandoned, but it monitored the Silty Clay Aquitard HSU and was located near the eastern corner of Building 256.

7.6. Am-241

Am-241 results in all HSUs were less than MDC with the following exception:

- Well NB-64 had a result of 0.03 pCi/l in 2004. This result did not exceed the error band (0.04 pCi/l) around the MDC (0.03 pCi/l) and may be a false positive result. This well monitors the Sand/Gravel HSU and is located about halfway between the facilities and Joachim Creek.

8.0 Conclusions

The silty clay soil immediately underlying the sources of radioactive contamination in the soil has attenuated migration of radiological contaminants in the soil, thus protecting the potential sources of potable water near the Hematite Site. The planned removal of the contaminated soil associated with these sources will remove the threat to groundwater sources of drinking water.

The radioactive contaminants in the soil within the Central Tract Area have migrated into the Silty Clay Aquitard HSU. The silty clay soil severely retards the further downward migration of radioactive contamination to the Sand/Gravel HSU. With two exceptions identified at wells GW-V and GW-X, the silty clay soil also severely retards horizontal migration of radiological contamination.

Total uranium does not exceed the background threshold value in the potential sources of drinking water (Sand/Gravel HSU, Jefferson City-Cotter Bedrock HSU, and Roubidoux HSU).

Tc-99 has been found in one well in the Sand/Gravel HSU at $1/6^{th}$ of the drinking water standard (representing dose contribution of less than 1 mrem/year). However, due to the presence of volatile organics exceeding drinking water standards, this potential source cannot be used for drinking water. The furthest extent of Tc-99 contamination is about halfway between the rail line and Joachim Creek, at about $1/500^{th}$ of the drinking water standard.

9.0 References

9.1 Battelle 2006. Battelle-TBD-6001. "Site Profiles for Atomic Weapons Employers that Refined Uranium and Thorium." December 13.

9.2 Farmington 2010. Farmington Public Notice. June 14.

9.3 SAIC 2009a. EO-09-003. Report prepared for Westinghouse Electric Company, Hematite, Missouri, "Supplemental Analysis of Hydrogeologic Conditions in Overburden at Westinghouse Hematite Facility, Hematite, Missouri." Revision 0. July.

9.4 SAIC 2009b. Report prepared for Westinghouse Electric Company, Hematite, Missouri, "Radionuclide Activity in Bedrock Groundwater at Westinghouse Hematite Facility, Hematite, Missouri." Revision 0. July.

9.5 SAIC and GEO Consultants, LLC 2007. Report prepared for Westinghouse Electric Company, Hematite, Missouri, "Remedial Investigation Report for the Westinghouse Hematite Site, Rev 1, Volume 1: Text and Volume II Appendices." January.

9.6 Westinghouse 2009. Hematite Decommissioning Plan. August.

9.7 Westinghouse 2010a. HEM-10-126. Westinghouse (E. K. Hackmann) letter to NRC (Document Control Desk), "Partial Responses to Requests for Additional Information on Decommissioning Plan Chapters 1, 4, 6 and 7 (License No. SNM-00033, Docket No. 070-00036)." December 10.

9.8 Westinghouse 2010b. HEM-10-132. Westinghouse (E. K. Hackmann) letter to NRC (Document Control Desk), "Remaining Responses to Requests for Additional Information on Decommissioning Plan Chapters 1, 4, 6 and 7 (License No. SNM-00033, Docket No. 070-00036)." December 21.

Figure 2. Locations of Monitoring Wells in Outlying Areas

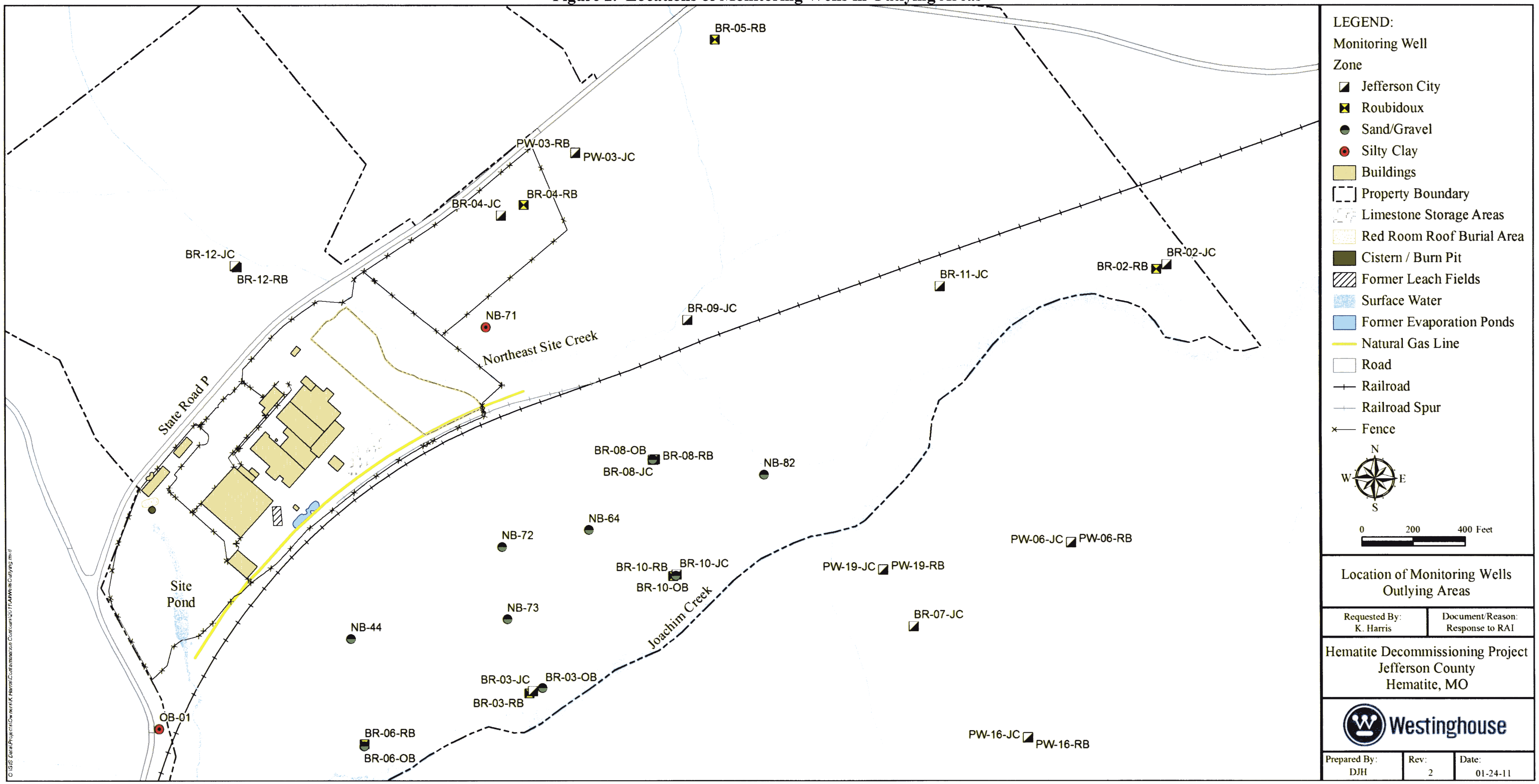


Figure 3. Locations of Sentry Wells

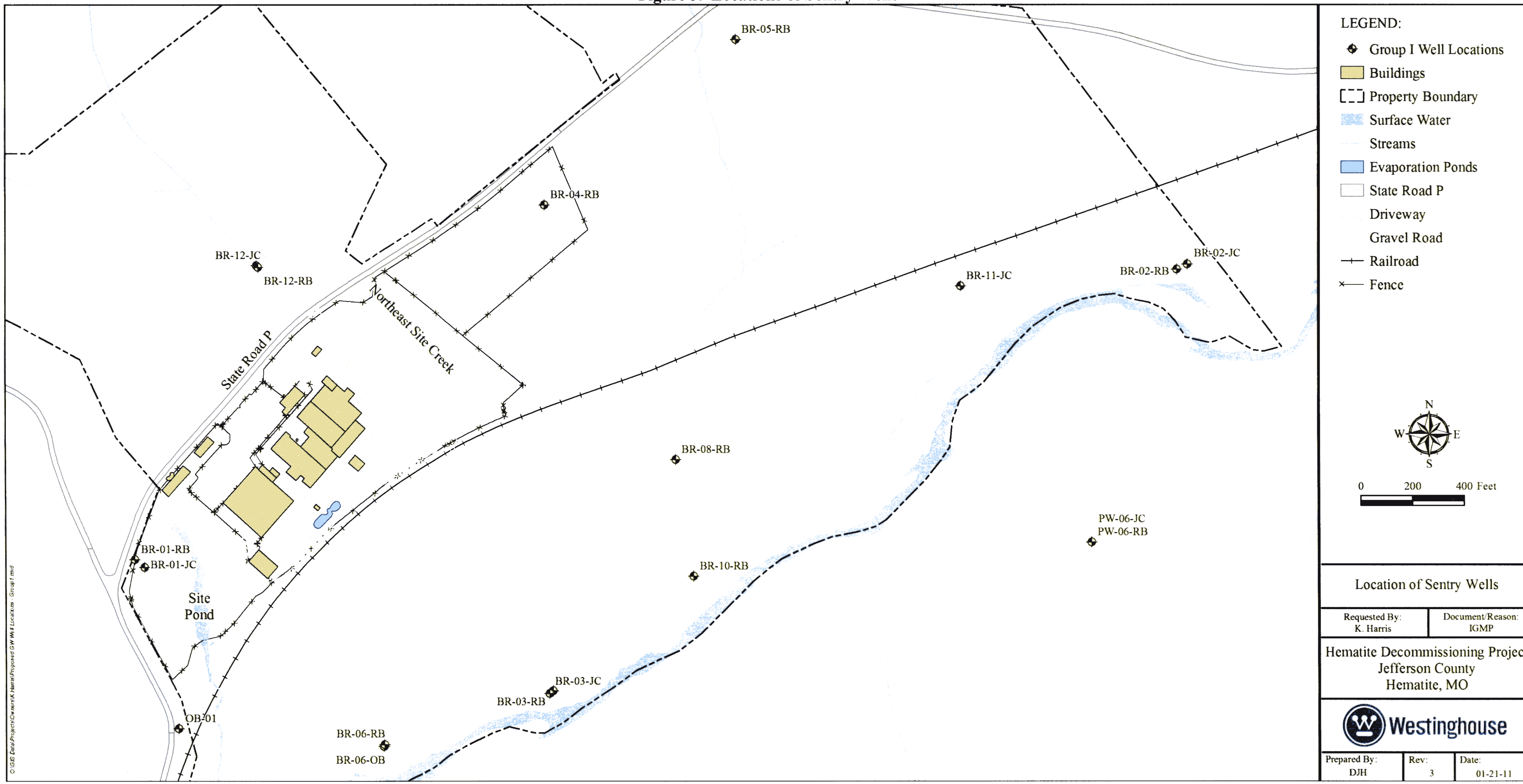


Figure 3. Locations of Sentry Wells

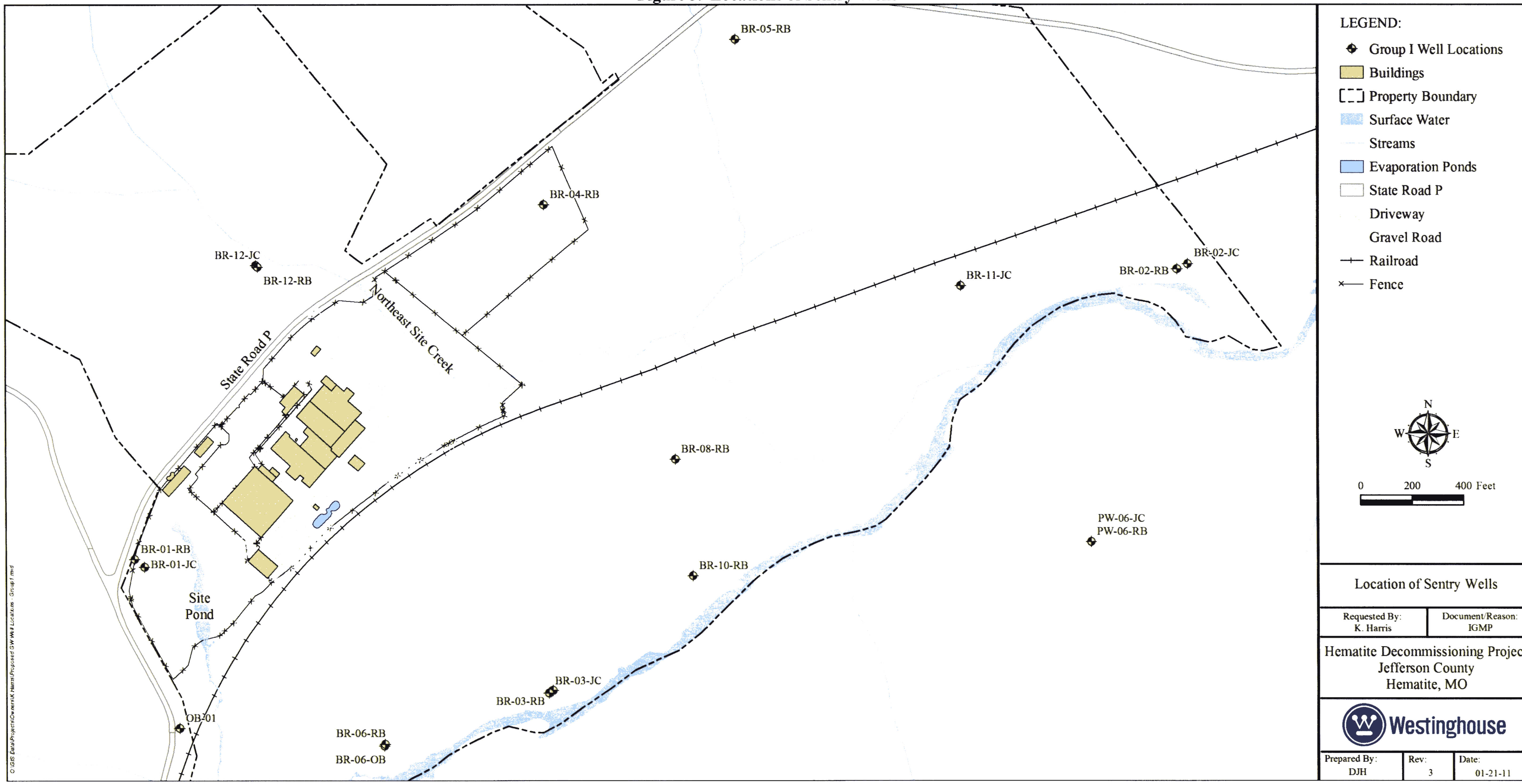


Figure 4. Sand/Gravel Layer Thickness above the Bedrock in Paired Hybrid Wells and Wells Sampling the Sand/Gravel HSU

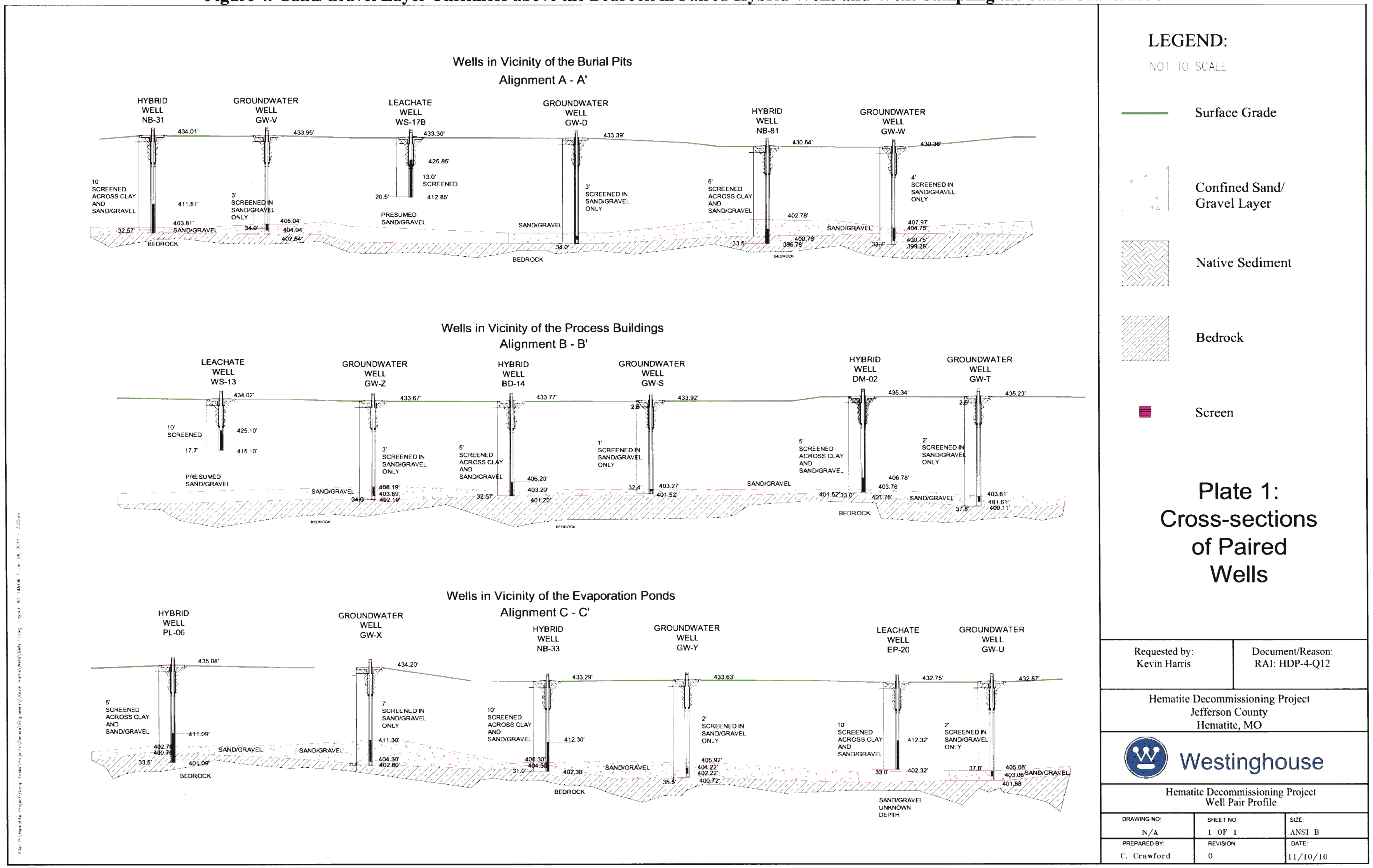


Figure 5. Silty Clay Aquitard HSU Tc-99 Results for Year Ending Third Quarter 2010

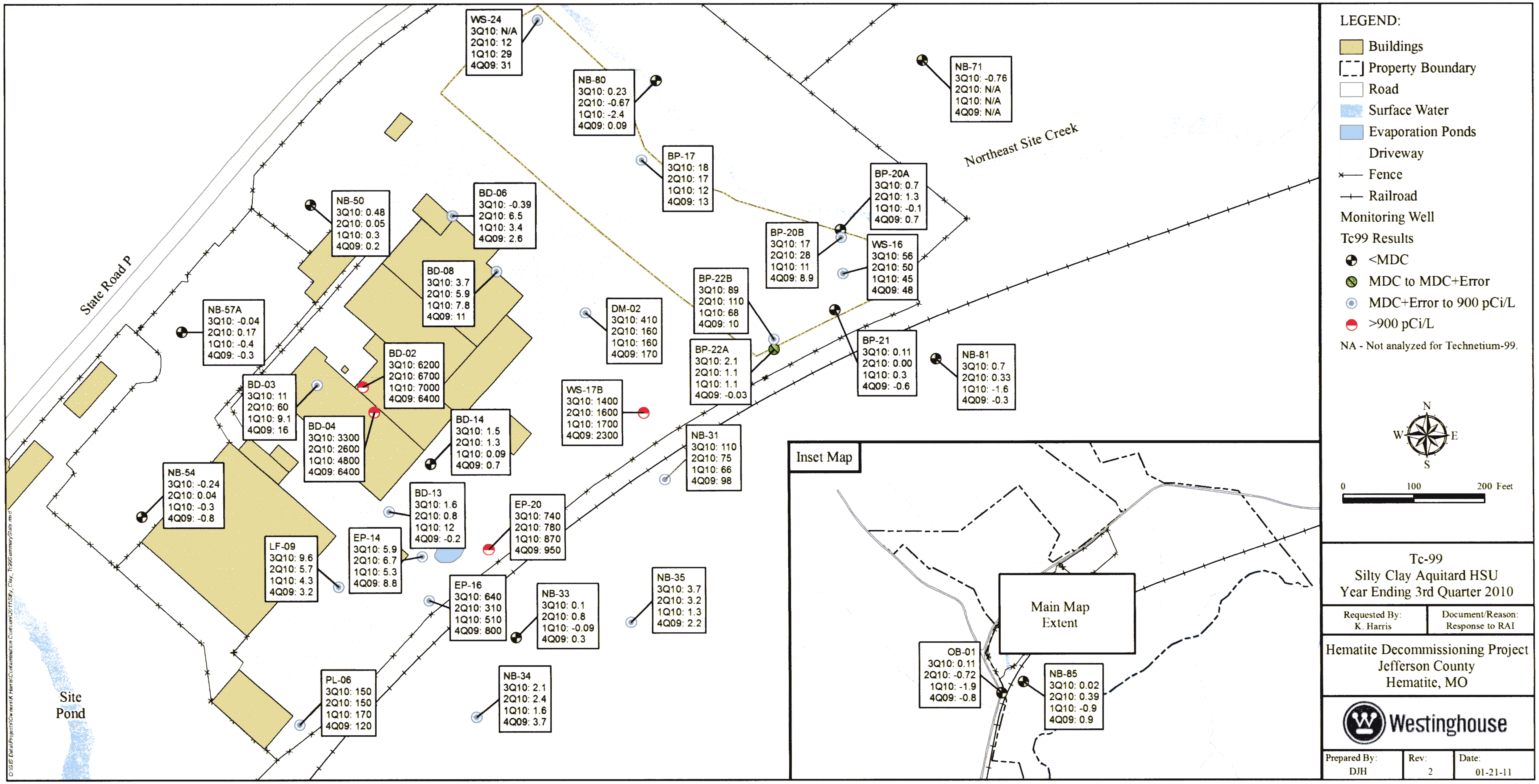


Figure 6. Sand/Gravel HSU Tc-99 Results for Year Ending Third Quarter 2010

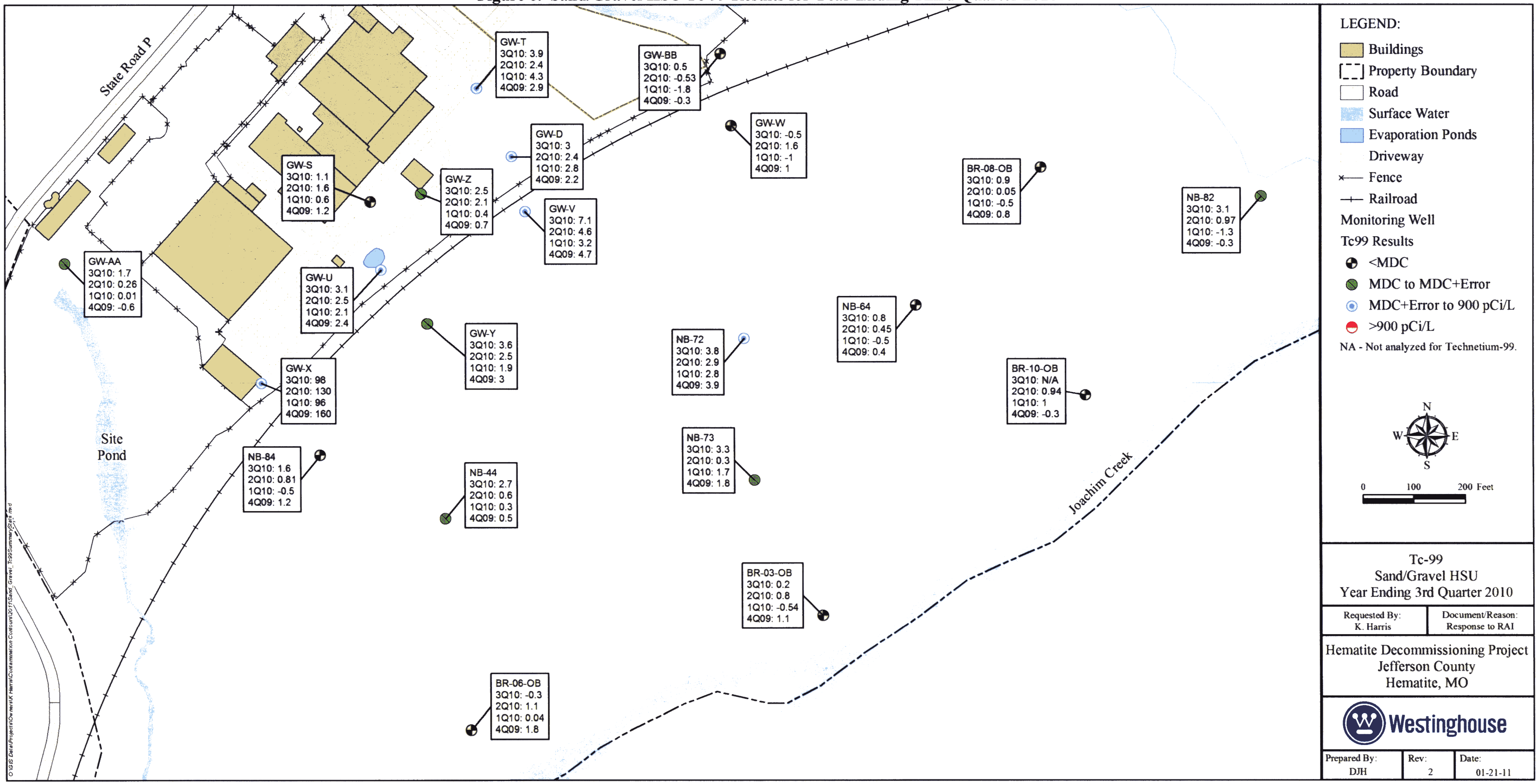
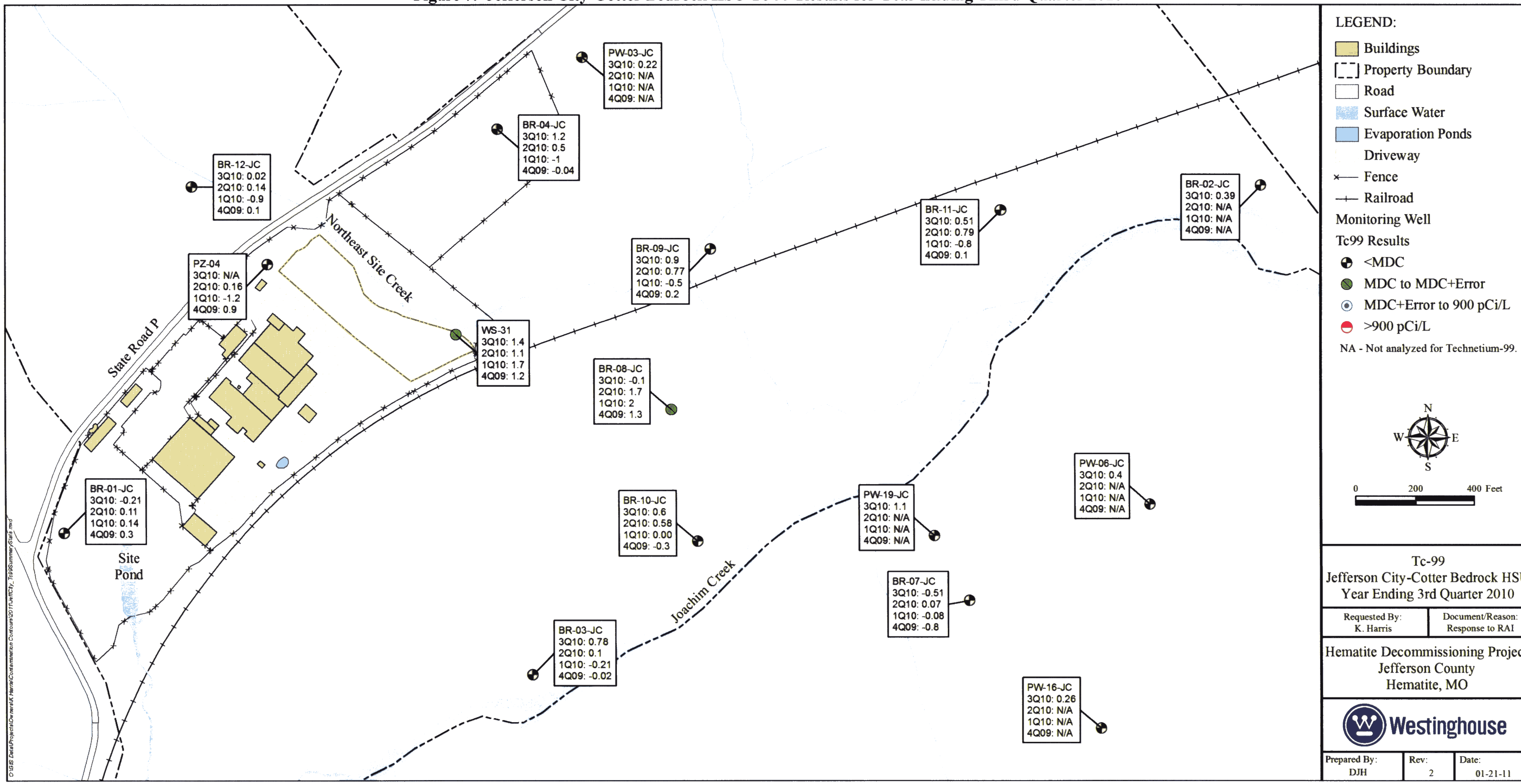


Figure 7. Jefferson City-Cotter Bedrock HSU Tc-99 Results for Year Ending Third Quarter 2010



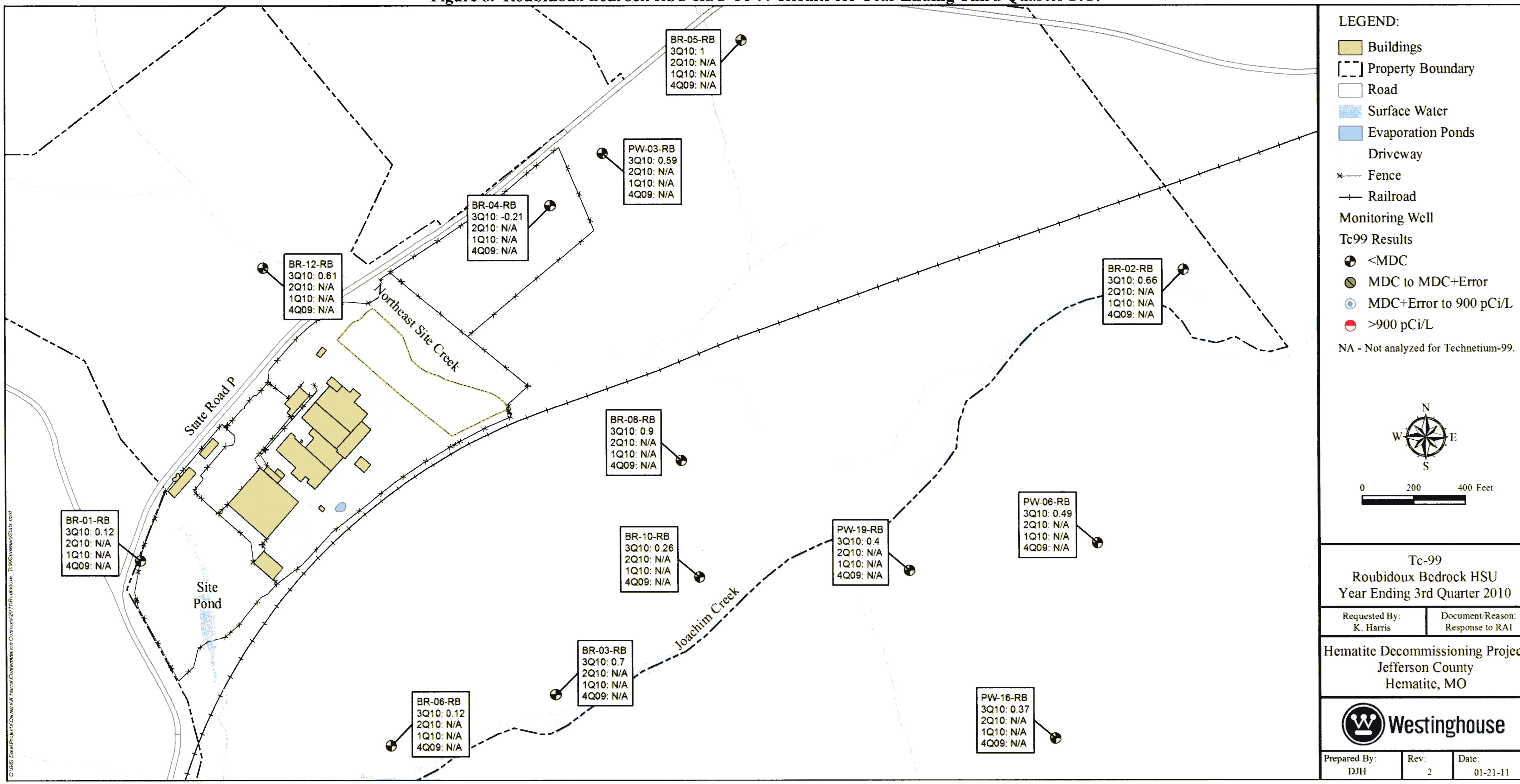


Figure 8. Roubidoux Bedrock HSU HSU Tc-99 Results for Year Ending Third Quarter 2010

Figure 9. Silty Clay Aquitard HSU Total Uranium Results for Year Ending Third Quarter 2010

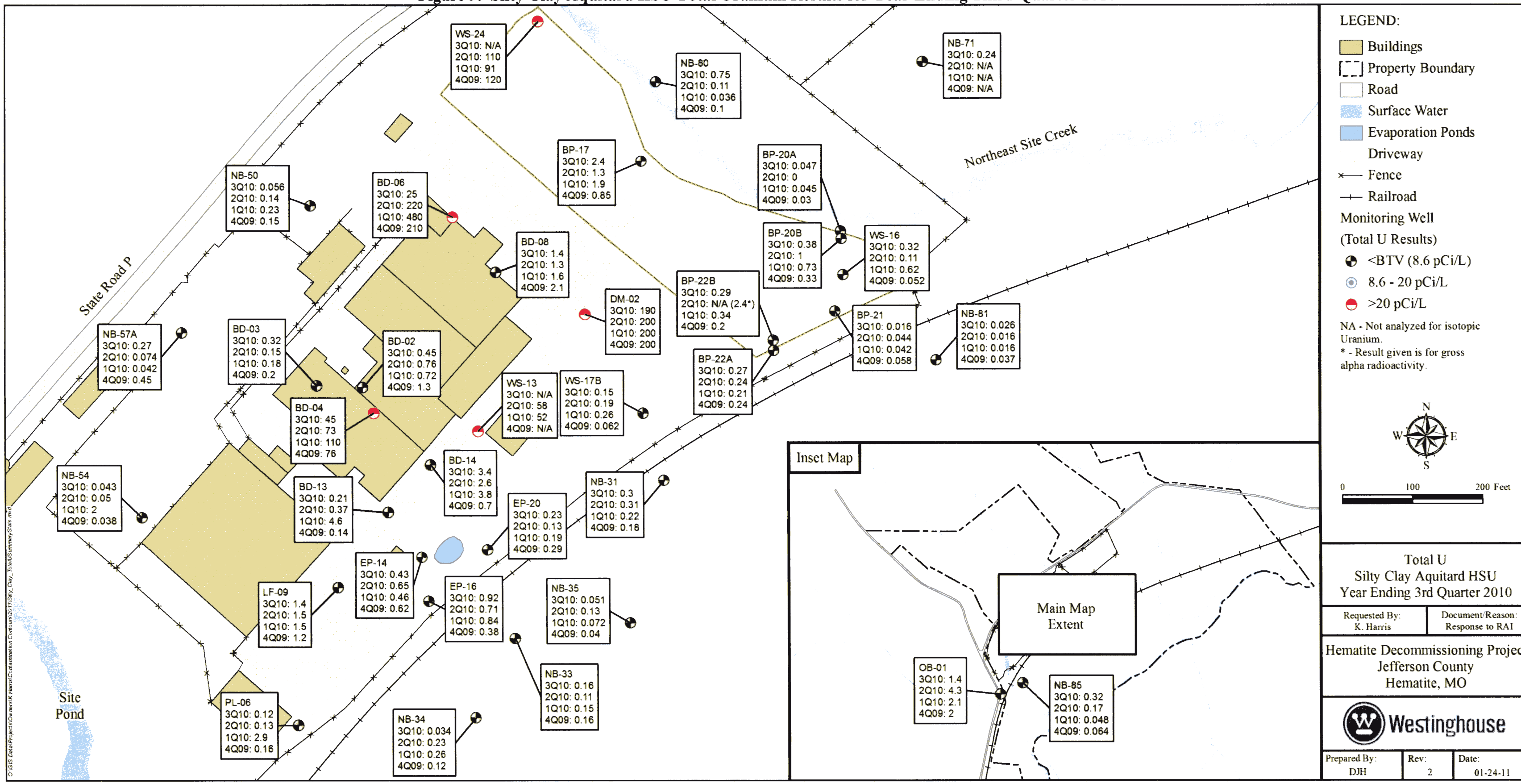


Figure 10. Sand/Gravel HSU Total Uranium Results for Year Ending Third Quarter 2010

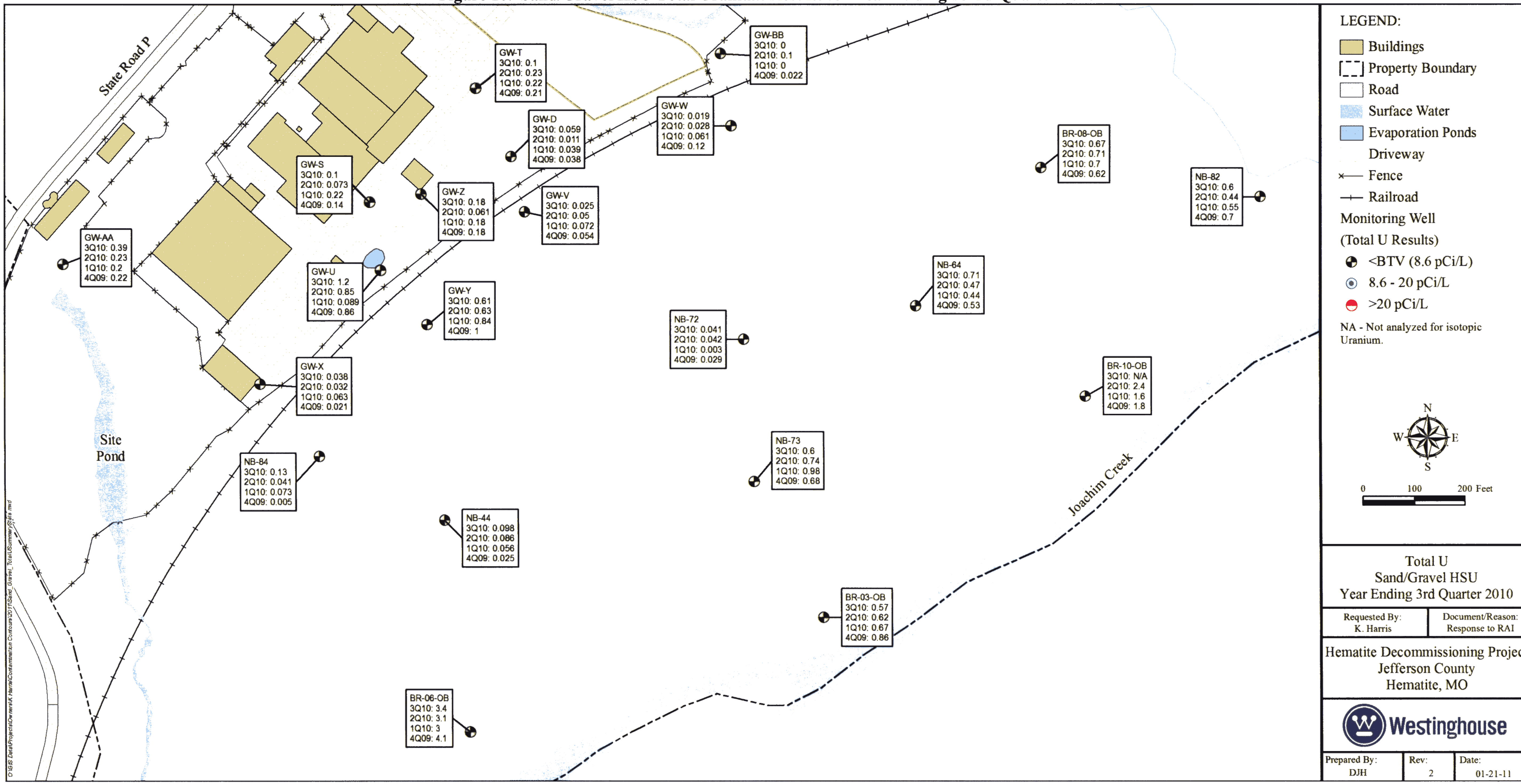


Figure 11. Jefferson City-Cotter Bedrock HSU Total Uranium Results for Year Ending Third Quarter 2010

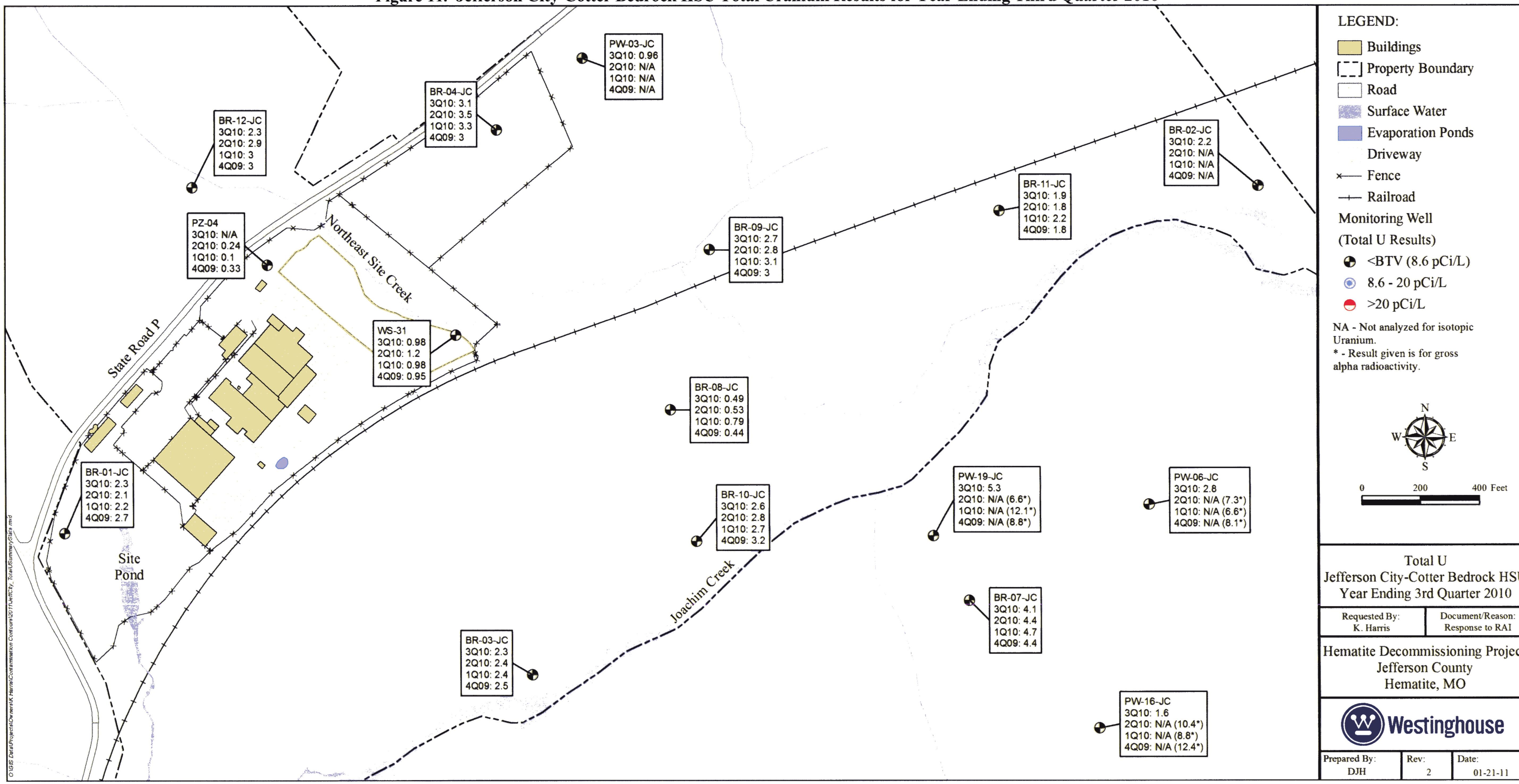


Figure 12. Roubidoux Bedrock HSU HSU Total Uranium Results for Year Ending Third Quarter 2010