GROUNDWATER SCIENCES CORPORATION

2601 Market Place Street, Suite 310
Harrisburg, PA 17110-9340
(717) 652-6832
FAX (717) 657-1611

August 7, 2017

Dean Chartrand
Program Manager
IBM Corporate Environmental Affairs
8976 Wellington Road
Manassas, VA 20109

Re: *Work Plan for Pilot Test Boring to Support the Design of Bedrock Production Well PW-2R*
Former IBM East Fishkill Facility
Town of East Fishkill, Dutchess County, New York

Dear Mr. Chartrand:

Groundwater Sciences Corporation (GSC) is pleased to provide this work plan for a pilot test boring to support the design of a new bedrock production well, designated PW-2R, at the former IBM East Fishkill facility in the Town of East Fishkill, Dutchess County, New York (Site). Well PW-2R is proposed to serve as a backup and/or possible replacement to active bedrock production well PW-2. PW-2 currently serves a dual role of providing process water to the current property owner, GLOBALFOUNDRIES U.S. 2LLC (GF), while also serving as one of three wells that provide hydraulic containment of volatile organic compound (VOC) plumes in bedrock groundwater within the Bedrock Remediation Area (Operable Unit 2/ OU2) of the Site. OU2 is being remediated as part of the Site's Resource Conservation and Recovery Act (RCRA) Corrective Action (CA) program which is regulated by the New York State Department of Environmental Conservation (NYSDEC) under a New York State Part 373 RCRA permit[1]. Although the Site is owned by GF, IBM Corporation (IBM) has maintained responsibility for implementation of the Site's RCRA CA program.

BACKGROUND

Production well PW-2 serves a critical role in preventing off-Site migration of VOC-containing groundwater in bedrock in the northeastern portion of the Site. Over the previous three calendar years (2014 through 2016), groundwater withdrawals from PW-2 have averaged 113 gallons per minute, and VOC mass removals have averaged about 8,400 pounds per year. These averages represent approximately 21 percent (%) of the total withdrawals and approximately 92% of the total VOC mass removals by Site deep bedrock production wells over the past three years.

[1] NYSDEC, November 2, 2011, *6NYCRR Part 373 Hazardous Waste Management Permit, IBM Corporation East Fishkill Facility*.

PW-2 has a long history of operational issues that includes shortened optimal operations of pumping systems and carbon treatment media due to biomass fouling and accumulation of sediment in the well and in the lead vessel of the Granular Activated Carbon (GAC) treatment train. At the time of a 2014 video survey, formation material had accumulated to a depth of about 260 feet below TOC, leaving about 178 feet of open bedrock borehole. Well redevelopment efforts to remove the accumulated formation material in PW-2 have been discouraged due to the potential for reducing the stability of the open bedrock borehole and causing a catastrophic borehole collapse. Due to the gradually decreasing available drawdown resulting from the accumulation of formation material and concerns regarding the overall integrity and stability of the well, IBM Corporate Environmental Affairs (CEA) has requested that GSC assist them in siting and design of a new production well to serve as a backup and/or possible replacement to PW-2. The pilot test boring described in this work plan is being performed to support the design of a replacement well for PW-2.

SCOPE OF WORK

The proposed scope of GSC's environmental consulting services and related subcontracted services consist of four general work scope categories, including: 1) performance of a pilot core boring; 2) possible well bore video logging; 3) possible borehole temperature profiling; and 4) possible groundwater characterization profile sampling.

GSC will coordinate with Eichelbergers Well Drilling of Mechanicsburg, Pennsylvania to complete a pilot test boring at the primary production well drilling location that was selected near existing production well PW-2, as shown on the attached figure. The proposed pilot test boring drilling method was developed with the goals of:

- Optimizing rock core recoveries and the collection of bedrock rock quality information;
- Advancing the test boring quickly;
- Minimizing the generation of investigation-derived wastes;
- Allowing for potential temperature and VOC profiling upon termination of rock coring, if the rock quality of the boring suggests limited potential for core hole collapse; and
- Allowing for reuse of the pilot test boring location for the large diameter production well location via reaming of the pilot test core hole.

The test boring location was selected after a review of available utility maps and completion of ground-penetrating radar and electromagnetic radio-trace geophysical surveys to assess for the possible presence of subsurface utilities. The selected location will be subjected to additional utility clearance review via performance of a vacuum excavation to assess for the absence of subsurface utilities for both the pilot test boring and potentially a subsequent 24-inch diameter production well boring. The pilot test boring will be advanced through overburden and the upper five feet of bedrock using hollow stem auger (HSA) drilling techniques. A temporary nominal 5-inch steel spin casing will be placed in the HSA borehole, extending into the upper five feet of the bedrock. The pilot test borehole will be advanced beyond the bottom of the 5-inch casing using a combination of

4-inch inner diameter (I.D.) HW spin casing rotary drilling techniques and 3 $^{7}/_{8}$-inch HQ wire-line core drilling techniques. The HW casing will be spun into the bedrock about 2 feet beyond the bottom of the 5-inch casing. The boring will be advanced beyond the HW casing using HQ wireline coring drilling techniques. If highly weathered/fractured and unstable zones are encountered, the core hole will be stabilized by advancing the HW casing using rotary drilling techniques between coring intervals. The approximately 2.5-inch diameter HQ rock core will be placed in core boxes and logged to produce a detailed log of the bedrock geologic conditions encountered, noting the lithology, the apparent degree of weathering/rock alteration and the depth and character of potential water-bearing fractures and voids. Solid drilling cuttings generated during drilling advancement will be contained and placed in 55-gallon drums. Drilling fluids/water generated during drilling will be contained in 55 gallon drums or plastic water tanks and transferred to the Building 384 groundwater treatment facility or disposed as directed by IBM.

The pilot bedrock test boring will be advanced to a minimum depth of about 310 feet below ground surface (bgs), the approximate original depth of PW-2. Depending on the condition of the bedrock at 310 feet, the test boring may be extended up to an additional 90 feet (to a maximum depth of 400 feet bgs), about 20 feet deeper than the depth where competent bedrock was encountered at PW-25. The depth of drilling termination will be determined in the field based on the apparent decline in the degree of weathering/fracturing. Upon termination of drilling advancement, the pilot test boring will be completed by one of two methods depending on the condition of the bedrock encountered during coring as described below:

1) If the test boring encounters competent bedrock with discrete fractures or fracture zones – The HW casing will be extracted, leaving an open bedrock core hole and a locking cap will be placed on the top of the temporary 5-inch casing; or

2) If the test boring encounters highly weathered/fractured zones that have the potential to collapse – the open bedrock core hole will be backfilled with sand as the HW casing is extracted. The sand will extend up to the bottom of the temporary 5-inch casing. A locking cap will be placed on the top of the temporary casing.

For either test boring termination option, the temporary casing will remain in place until Eichelbergers remobilizes to the Site to drill and install the large diameter production well. The intent would be to remove the temporary 5-inch casing as a first step in the drilling and construction of the larger diameter production well.

In the case of test boring termination option #1), the open bedrock core hole will be profiled for the presence of VOCs in groundwater. The groundwater profiling will begin with a downhole camera video log of the core hole followed by a vertical temperature survey of the core hole using a down-hole temperature probe. The test boring log and the video log will be compared with results of the temperature survey to help identify possible water-bearing zones in the well (A temperature profile interval having a lower temperature typically corresponds to the presence of a water-bearing zone where water is flowing into the core hole).

Based on the findings of the logging and temperature profiling, up to six passive diffusion bag (PDB) samplers will be set at depths near apparent water-bearing fractures or fracture zones. The PDBs will remain in the core hole for a minimum of four weeks. The PDBs will be removed,

transferred to 40 milliliter VOA vials, placed in coolers with ice, and shipped via chain-of-custody protocols to Eurofins Lancaster Laboratories for VOC analysis using EPA Method 8260C. Depending on the condition of the open bedrock core hole, other geophysical profiling methods, such as the use of a heat-pulse flow meter, will also be considered.

Drill cuttings generated during the soil augering and bedrock coring process will be collected in open-top 55-gallon drums and transported to an approved staging area on the Site for eventual off-site shipment and disposal. Drums will be provided by either GF or Eichelbergers for use during the project. All drums will be labeled according to the requirements of the Site waste management personnel. Solids and water will be segregated as much as possible during the drilling process and an attempt will be made to dewater drums containing predominantly solids before they are hauled to the on-site staging area.

Potable water will be needed during the coring phase of the work and for decontamination during the duration of the field work. Potable water will be acquired by the drillers from an on-site location approved by Global Foundries to fill their truck mounted water tanks and haul it to the drilling site as needed throughout the project. Access to the water source may be needed several times per day during the core drilling phase of work.

Decontamination of drilling equipment will be performed upon arrival at the site, during the drilling period as needed, and at the end of the project before leaving the site. A temporary decontamination pad, composed of plastic sheeting and bermed with wood and/or hay bales, will be built in an asphalt parking lot area located west of the drill site to allow the containment of decontamination water and sediment from the drill rig and drilling tools (see attached figure). Decontamination waste water and sediment will be collected and drummed for proper disposal or treatment, and hauled to a designated staging area on the Site, or to the Site groundwater treatment facility. The proposed location of the decontamination pad is shown on the attached figure.

PROJECT STAFFING

The proposed scope of services will be performed by GSC personnel in our Beacon, New York office, supported by additional personnel in our Harrisburg, Pennsylvania office. GSC's project staffing would include Robert C. Watson, P.G., who would serve as Project Director, Stephen M. Fisher, P.G. who would serve as Project Manager and Dorothy A. Bergmann, P.G. who would serve as Quality Assurance Project Manager. Mr. Watson, Mr. Fisher, and Ms. Bergmann would be assisted, as necessary, by other GSC professionals with direct experience at the Site including: C. Edward Stoner, P.G., Mitchell W. Ruchin, Glenn S. Carson, Matthew T. Luckman, P.E., Janis A. Ronis, Christopher J. Shannon, and David F. Baldwin.

PROJECT SCHEDULE

GSC anticipates the pilot test boring activities would be completed in September 2017. If the integrity of the borehole allows, the subsequent video log and the temperature profiling is planned to be completed in early October 2017, while the groundwater profile sampling by PDBs will take place between Mid-October 2017 and mid-November 2017. Based on this schedule our data analysis, well design, and preparation of a letter report with a recommended drilling methodology

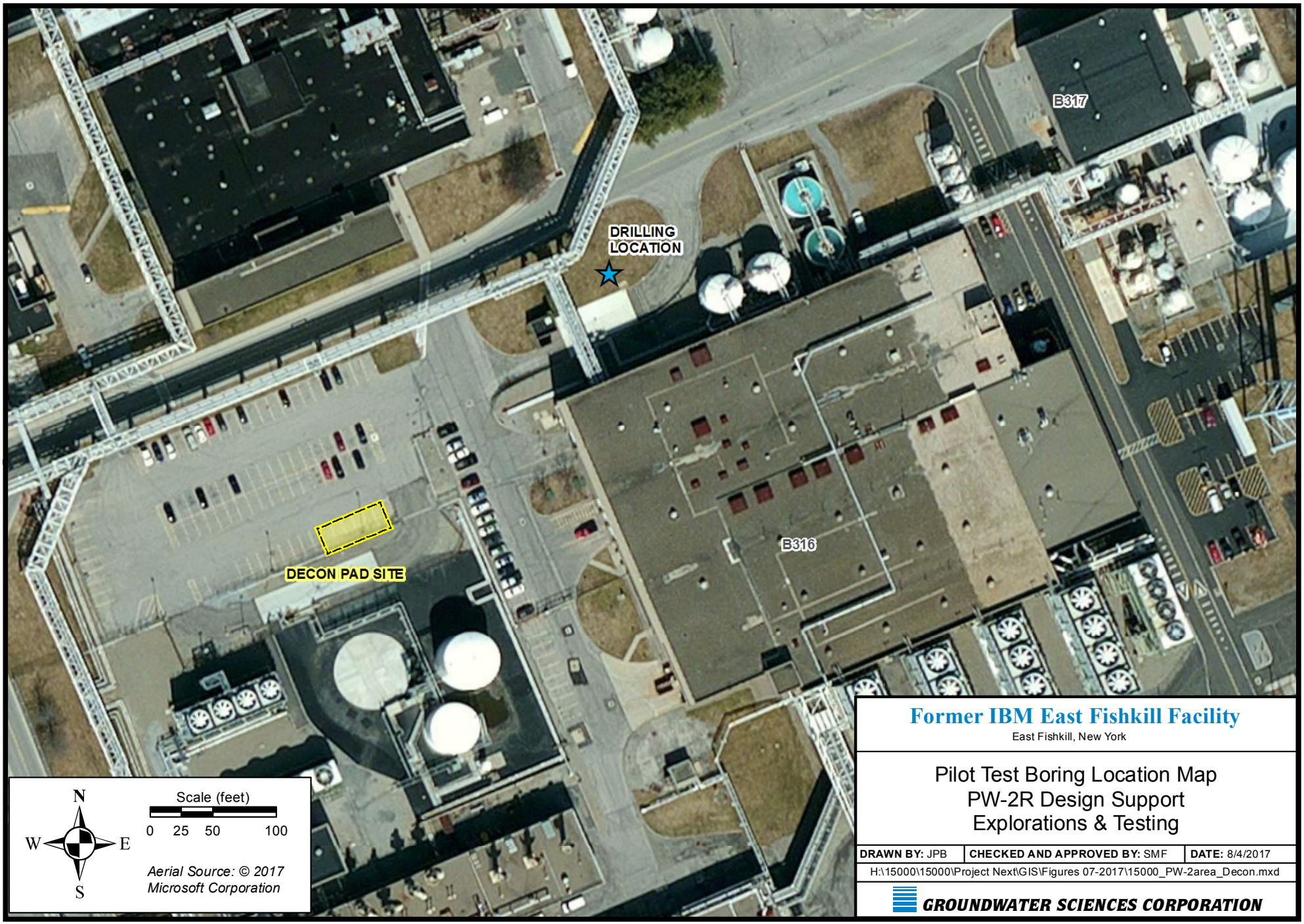
for the PW-2R production well would be submitted as a draft for IBM review near the end of the fourth quarter of 2017 or early in the first quarter of 2018.

GSC appreciates the opportunity to be of service to IBM CEA on this important project. Please do not hesitate to contact us if you have any questions or if you need additional information.

Very truly yours,
GROUNDWATER SCIENCES CORPORATION

Robert C. Watson

Robert C. Watson, P.G.
President



Former IBM East Fishkill Facility

East Fishkill, New York

Pilot Test Boring Location Map
PW-2R Design Support
Explorations & Testing

DRAWN BY: JPB	CHECKED AND APPROVED BY: SMF	DATE: 8/4/2017

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