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June 15, 2009

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Re: RCRA Facility Investigation Work Plan
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Dear Messrs. Dassatti and Litwin:

The enclosed document presents the International Business Machines Corporation (IBM) work plan for a RCRA Facility Investigation pertaining to an assessment of sources of volatile organic compounds (VOCs) in indoor air in certain occupied buildings at the IBM East Fishkill facility. This revised work plan reflects and incorporates the final understanding and agreement between IBM and the Agencies regarding the Agencies' comments on the initial work plan as communicated in the several letters and meetings since the submittal of the initial work plan.

If you wish to further discuss this document or have questions, please contact me at (845) 892-3176.

Sincerely,

David E. Speed , Ph.D.
Systems and Technology Group
International Business Machines Corporation

cc: A. Czuhanich (NYSDEC)
H. Wilkie (NYSDEC)
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Work Plan
RCRA Facility Investigation (RFI)
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Prepared for
IBM Corporation

East Fishkill, New York

Prepared by
Sanborn, Head Engineering P.C.

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1.0 INTRODUCTION

This document presents the International Business Machines Corporation (IBM) work plan for assessing the anomalous presence of volatile organic compounds (VOCs) in indoor air within certain occupied buildings at the IBM East Fishkill facility, also known as the Hudson Valley Research Park or the Main Site (the Site). It is intended in part to address a request from the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH) (collectively, the Agencies) for a "RCRA Facility Investigation (RFI) Work Plan" as conveyed in a letter received by IBM on April 7, 2008. It should be noted that IBM self-initiated this assessment work in September 2007, months in advance of receiving the Agencies' letter. Preliminary data and information in support of the preparation of this work plan have been communicated to the Agencies through regular meetings.

This document is a revised version of the work plan initially submitted to the Agencies on October 1, 2008. This revised work plan reflects and incorporates the final understanding and agreement between IBM and the Agencies regarding the Agencies' comments on the initial work plan as communicated in several letters and meetings since the submittal of the initial work plan. These communications have included the following:

- December 22, 2008 letter from NYSDEC (A. Czuhanich) to IBM (D. Speed);
- January 23, 2009 letter from IBM (D. Speed) to NYSDEC (A. Czuhanich);
- February 13, 2009 letter from NYSDEC (A. Czuhanich) to IBM (D. Speed); and
- March 18, 2009 meeting in Albany between IBM and the Agencies.

IBM commissioned Sanborn, Head Engineering P.C. (SHPC) to prepare this work plan. In developing this work plan, IBM has drawn from SHPC's extensive experience in hydrogeologic investigation and remediation work at the IBM East Fishkill facility. SHPC has been providing professional services at the East Fishkill facility for over 13 years, including: completion of RCRA Facility Investigations and Corrective Measures Studies focused on groundwater; design, construction and operations of groundwater remediation facilities; and management of IBM's groundwater supply wellfields.

1.1 Purpose and Objectives

The purpose of this work plan is to present the investigation rationale and procedures used to identify and evaluate the sources of anomalous VOC vapors in occupied buildings. The term "anomalous" is intended to denote indoor air quality conditions that cannot be explained by present storage and/or occupational uses of solvents or ambient (outdoor) air conditions. IBM's self-initiated testing in portions of 14 buildings has indicated a particular presence of chlorinated ethenes in certain areas of 2 buildings. This presence was out of proportion to levels of chlorinated ethenes found in the air within other Site buildings with similar historical use and cannot be explained by a review of ambient air conditions. The observed indoor air quality is believed to be attributable to solvent residuals remaining from their historical use and storage. Such conditions could reflect solvent mass entering the building from the subsurface, commonly referred to as vapor intrusion, and/or solvents used historically which remain within the structure.

The 29 buildings on Site listed in Table 1 house manufacturing operations, laboratories, site utilities, and offices totaling about 2.7 million square feet of building footprint. Given the complexity of use and vast size of the Site buildings, an objective of the work plan is to prioritize the work in a rational manner by taking advantage of available information and data, so that resources are appropriately allocated. Specifically, IBM focused the initial investigation efforts to buildings, or portions of buildings, where solvents were used historically, where there is evidence of solvent releases to the environment, and/or where there is a known presence of VOC solvents in the subsurface.

1.2 Organization and Scope of Work Plan

This work plan is organized into eight sections as described below:

Section 1 presents a general introduction and overview of the work plan.

Section 2 provides a summary of Site hydrogeology and the distribution of VOCs in groundwater, including a discussion of the conceptual model for the Site, how it relates to sources of VOCs, and the potential for migration of VOC vapors beneath buildings.

Section 3 presents an overview of Site building information, including size, use/function, occupancy, and details of heating, ventilation, and air conditioning (HVAC) systems. Existing data regarding the presence and distribution of VOCs in indoor air are also provided in this section.

Section 4 describes the methodology by which the Site conceptual model was combined with available building information, existing indoor air data, and other key factors to devise a work plan that organizes the 29 buildings on the Site into three categories: (1) Source Investigations, (2) Confirmatory Sampling, and (3) No Further Assessment. As summarized in Exhibit 1 below, IBM plans to investigate and sample almost 75% of the total square footage of building footprint, or 2 million sq ft out of a Site total of 2.7 million sq ft.

Exhibit 1 – Summary of Work Plan Scope

Planned Response	Response Description	Buildings		Factors Considered (one or more conditions below)	Schedule for Field Work
		No.	Footprint (sq. ft.)		
Source Investigations	Identify and assess need and options for mitigation of anomalous indoor air conditions.	2	590,000 22%*	1. Anomalous presence of PCE and breakdown products in indoor air 2. Confirmed or probable vadose zone source 3. Regular human occupation 4. Historical large volume use of solvents	3 to 5 months each building
Confirmatory Sampling	Sample to further assess other buildings for anomalous indoor air conditions.	10	1,400,000 52%*	1. Available indoor air VOC data at/near background levels 2. Evidence of potential subsurface sourcing (in vadose zone and/or groundwater) 3. Occupied on a regular basis 4. Historical solvent use in some buildings	4 months total for 10 buildings
Subtotal		12	2.0 74%*		
No Investigation Proposed	No further assessment	17	670,000 26%*	1. No regular human occupation 2. No historical solvent use 3. No evidence of subsurface source 4. Present occupational handling of target compounds	Not Applicable

*Percent of total footprint of Site buildings

Section 5 describes the planned work, including the methodology for indoor air confirmatory sampling, source investigations, and mitigation engineering, if necessary. Detailed procedures, including planned confirmatory sampling locations, are provided in the Appendices.

Section 6 describes data management, evaluation, and reporting plans.

Section 7 describes project organization and staffing.

Section 8 summarizes work initiated in 2008, including a schedule for upcoming work under the work plan.

2.0 BACKGROUND INFORMATION

This section presents an overview of background information relevant to the work plan. This overview takes into consideration the large body of data and information collected since groundwater monitoring was implemented at the Site in 1979, when IBM discovered hazardous constituents in Site soil and groundwater. IBM has conducted much of this past assessment work and monitoring as part of self-initiated investigations. More detailed information can be found in various reports, principally the RFI reports for Site subsurface contamination[1] and the annual corrective action status reports[2], previously submitted to NYSDEC in accordance with the requirements of IBM's Part 373 Hazardous Waste Management Permit[3] for the Site.

2.1 Site Setting

The IBM East Fishkill facility comprises about 500 acres located adjacent to and north of Interstate Route 84 and south of Route 52 as depicted on Figure 1. As listed on Table 1, 29 buildings are located on the Site totaling approximately 2.7 million square feet of building footprint housing more than 6,200 business occupants. No daycare facilities are present on Site, and the IBM East Fishkill medical department office does not treat individuals, and therefore the Site should not be categorized as an area where there are "sensitive" populations.

IBM has occupied the Site and used the facility since approximately 1962 for the manufacturing and development of semiconductor and electronic equipment. VOCs are present in the subsurface at seven Areas of Concern (AOCs), which are subject to corrective action under the Part 373 Permit. These are areas where solvents have been released to the subsurface as depicted on Figure 2 and include:

Exhibit 2 – Areas of Concern

Area of Concern (AOC)	**Location/Description**
Area A	Located in the northeast portion of the Site and underlies all or parts of Buildings 303, 308, 309, 310, 316, 384, 385, and 386.
Area B	Located proximate to Gate 4 on the east side of the Site and comprises the former fire brigade training area #1 and leachfield.
Area C	Building 330 and the former landfill area to the east.
Area D	Located in the northwest portion of the Site and comprises the former fire brigade training area #2.
Area E	Building 322 area.
SEQ	Known as the Southeast Quadrant located in the southeast portion of the Site between Area B and the former landfill area.
Deep Bedrock Aquifer	Underlying the Site – also considered an AOC.

The Site and surrounding area is generally served by bedrock and overburden water supply wells. IBM's process water is currently obtained from bedrock aquifer production wells, supplemented by overburden and bedrock wells located on properties north and west of the Site. Beginning in August 2007, IBM has supplemented its water supply from the production wells

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[1] See for example: Sanborn, Head & Associates, Inc., *Task VII Deliverable, Groundwater RFI Final Report, Building 322 Area of Concern, IBM East Fishkill Facility*, March 13, 1997, and Sanborn, Head & Associates, Inc., *Task VII Deliverable Groundwater RFI Final Report, Building 330 Area of Concern, IBM East Fishkill Facility*, August 22, 1997.

[2] See for example: Groundwater Sciences Corporation, *2007 Annual Corrective Action Status Report, IBM East Fishkill Facility*, May 29, 2008.

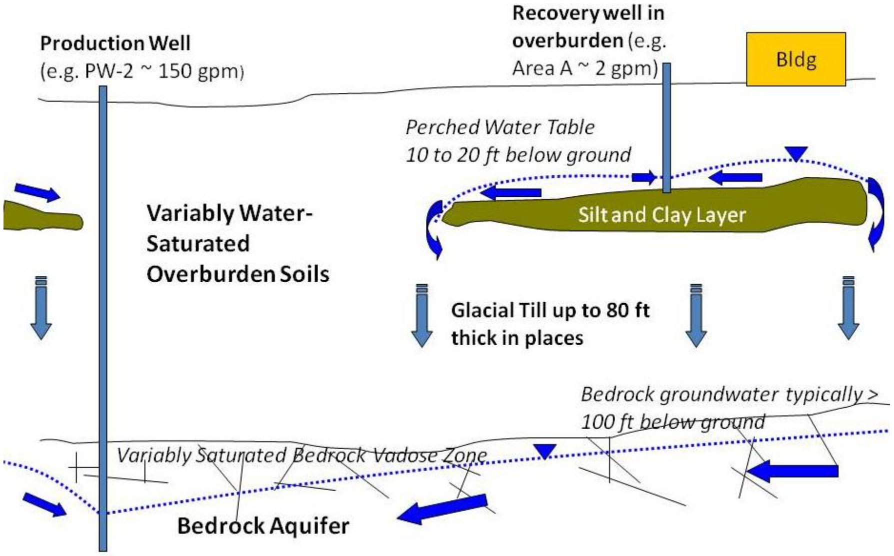
[3] New York State Department of Environmental Conservation, *Part 373 Hazardous Waste Management Permit,* DEC Permit No. 3-1328-00025/00249-0, September 29, 1995.

with municipal water from the Poughkeepsie Water Treatment Facility conveyed by the Central Dutchess Water Transmission Line. The combined process and potable water use for the Site is approximately 4 million gallons per day.

2.2 Conceptual Model of Hydrogeologic Conditions

Groundwater beneath the Site occurs in two zones of saturation: (1) a perched zone associated with an extensive but discontinuous layer of glaciolacustrine silt and clay soil, and (2) a deeper zone of saturation which is typically 100 feet or more below land surface, and lies within the bedrock. The following exhibit depicts a simplified conceptual model of Site hydrogeology.

Exhibit 3 – Conceptual Schematic of Site Hydrogeology



2.2.1 Overburden

As described in previous groundwater RFI studies for the Site[4], overburden is composed of five major stratigrahic units, which are described in descending order as follows:

- Soil fill - Underlies much of the developed portions of the Site at thicknesses ranging from about 2 to 10 ft. The fill terminates to the west at Gildersleeve Brook and to the south at the central drainage channel.

- Colluvial/alluvial deposits – Consist of a variable sequence of silty sands, sand and gravel, and/or sand and silt, interlayered with peat and organic silt deposits. These post-glacial deposits have been observed beneath soil fill over large portions of the Site.

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[4] Sanborn, Head & Associates, Inc., *Task VII Deliverable, Pre-Investigation Evaluation of Groundwater Corrective Measures, RCRA Facility Investigation, Building Nos. 322 and 330, IBM East Fishkill Facility*, January 31, 1996.

- Glaciolacustrine silt and clay – These fine-grained sediments are generally most prominent north of the central drainage channel crossing the Site, where they are draped over outwash sand and gravel, ice-contact sand and gravel, or lodgement till. The surface of these deposits is about 20 ft below grade on average, but it is undulating and discontinuous. Where present, this soil impedes vertical flow of infiltrating water and creates a perched zone of groundwater saturation. Figure 3 shows the inferred extent of the silt and clay layer.

- Glacial outwash and ice-contact (ablation till) – This soil, which is present intermittently across the Site, consists of a mixture of poorly sorted and well-sorted sand and gravel with lesser amounts of silt, clay, cobbles, and boulders. These deposits have been observed typically within depressions in the underlying till and/or bedrock.

- Glacial lodgement till – This soil was deposited directly onto bedrock beneath the majority of the Site. Its thickness ranges from a few feet to over 100 ft in the area of B321. The lodgement till generally consists of a heterogeneous mixture of sand, silt, and gravel, with generally greater density, and greater silt, clay, cobble, and boulder content than the ice-contact deposits.

The extent of the upper "perched" zone of saturation generally corresponds with the mapped limits of the glaciolacustrine silt and clay deposits, which as shown on Figure 3, are present in the area from the north sides of Buildings 323, 300, and 334, and extending north. In the central and southern portions of the Site, where the glaciolacustrine silt and clay soils do not exist, the overburden is believed to be unsaturated over a large area. Zones of saturated overburden, other than perched groundwater on the silt and clay, may exist seasonally within areas of low permeability glacial till.

2.2.2 Bedrock

Bedrock beneath the Site consists of a sequence of dolostone interbedded with lesser amounts of limestone, fine-grained sandstone, dolomitic siltstone, and shale. The rock is finely laminated to massive. Thin zones of weathering have been encountered in the upper portion of rock over much of the Site. Thicker weathered zones (penetrating to depths greater than 100 ft) have also been encountered in some borings. Particularly productive (water bearing) zones encountered in bedrock borings correspond to discrete fractures/joints.

The effective porosity, or the fraction of the bulk rock volume occupied by interconnected fractures and solution openings, is expected to be on the order of 10^{-5} to 10^{-2} based on published literature values. Groundwater transport calculations performed as part of groundwater RFI work by SHPC have assumed a range of effective porosity of 10^{-3} to 0.1, a range supported by specific yield/storage coefficient values derived from pumping tests. As the majority of the bulk rock volume is occupied by solids and water, the bedrock at the Site is not expected to readily transmit VOC vapors.

Groundwater flow in bedrock is directed inward from the Site boundaries toward the production well pumping centers, which have been in operation since the early 1960s for Site water supply and corrective action. The depths to groundwater in bedrock range from tens of feet in the vicinity of bedrock outcrops to greater than 150 feet at certain production wells (e.g., PW-1, PW-2, and PW-4). Long-term, continual groundwater withdrawals have caused formerly saturated overburden soils to become unsaturated where the depth to groundwater is now below the top of the bedrock surface in some areas, such as the vicinity of production wells PW-1 and PW-25.

2.3 Observed Subsurface Presence of VOCs

VOCs observed in Site groundwater consist predominantly of chlorinated ethenes and chlorofluorocarbons (CFCs). Combined these compounds comprise more than 90% of the VOC mass estimated in Site groundwater. Because they are relatively mobile and persistent in the subsurface, the most prevalent constituents were identified by NYSDEC as “Key Volatile Organic Compounds” in the Site’s Part 373 Permit.

Chlorinated ethenes (alkenes) comprise the predominant class of VOCs observed in Site groundwater. They include tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2-dichloroethene (cDCE), and vinyl chloride (VC). Both PCE and TCE have been used at the Site in bulk quantities. The presence of other chlorinated ethenes is attributed to chemical impurities in raw materials and/or wastes, and in-situ transformation processes.

CFC-113 (a.k.a Freon® 113 or Freon® TF) is reported to have been the principal CFC used in bulk quantities at the Site. CFC-113 and other CFCs, primarily CFC-123a, have been observed in Site groundwater. Other classes of VOCs have been also been detected, but typically in a relatively small number of locations and at relatively low concentrations compared to the chlorinated ethenes and CFCs. These other VOC classes detected include chlorobenzenes, aromatic hydrocarbons (e.g., benzene, toluene, ethylbenzenes, and xylenes), chlorinated ethanes (e.g., 1,1,1-trichloroethane and its breakdown products), and chlorinated methanes (e.g., carbon tetrachloride and its breakdown products). A review of database records for the last three years of groundwater monitoring indicate that the presence of these other VOC compounds in groundwater largely accompanies the presence of equal or higher concentrations of chlorinated ethenes.

As documented through reports submitted twice a year to NYSDEC for over 15 years, the observed presence of VOCs in bedrock and overburden is contained to lands owned by IBM and controlled by IBM through its groundwater extraction and treatment systems.

2.3.1 VOCs in Overburden

Figure 3 shows the inferred extent of Key VOCs in overburden groundwater typically found perched on the glaciolacustrine silt and clay layer. VOC presence in the overburden predominantly consists of PCE and its breakdown products. As shown on the figure, major areas of VOC presence in overburden proximate to buildings include:

- The Area A plume centered on the area between Buildings 308 and 310 and extending south to Building 316;

- The Building 322 plume (Area E) originating at the northeast corner of Building 322 and extending west; and

- Plumes proximate to and beneath the Building 330 C and D complex in the southern portion of the Site.

Groundwater extraction systems for hydraulic containment of VOCs in overburden are operated as corrective action at four areas. In 2007, consistent with prior years, these systems removed about 57 pounds of VOCs at a combined average flow rate of about 15 to 20 gallons per minute (gpm). Almost all of this VOC mass, predominantly PCE, was recovered by the Area A remediation system[5].

2.3.2 VOCs in Bedrock

Figure 4 shows the inferred extent of Key VOCs in bedrock groundwater. As shown on the figure, the major areas of VOC presence, primarily consisting of chlorinated ethenes, include:

- The Area A bedrock plume beneath the northern portion of the Site, which is being captured by production wells PW-1 and PW-2; and

- The plume centered on the Building 330 C and D complex, which is currently being managed by groundwater withdrawals from production wells PW-4 and PW-25.

In 2007, the bedrock production wells removed a total of about 7,000 pounds of VOCs at a combined average flow rate of about 850 gpm. Consistent with previous years, almost 90% of the VOC mass removed with bedrock groundwater is attributed to production well PW-2[6].

2.4 Site Conceptual Model Related to Subsurface Vapor Migration

Site hydrogeology is generally unfavorable for subsurface VOC vapor migration, in particular, vapor migration from VOCs present in bedrock. This is because the glaciolacustrine silt and clay, underlying glacial till, and bedrock are expected to exhibit a high degree of water saturation, and hence to serve as a barrier to vapor transport.

Vapor migration in the subsurface occurs due to advection and diffusion. Diffusion generally controls mass transport from water table depth to near foundation level. Near foundation level, advection may predominate as a transport mechanism. The effectiveness of both mechanisms is proportional to the amount of void space, or porosity, and in particular, the air-filled porosity. Saturated or nearly water saturated soils largely retard vapor transport.

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[5] Further details of remediation system operations are provided in the 2007 Annual Corrective Action Status Report.

[6] *Ibid.*

The effective diffusion coefficient, D^{eff}, for a VOC in a porous media containing both air and water can be estimated using what is referenced by USEPA as the Millington relationship:

$$D^{eff} = D_{air}\frac{\theta_a^{3.33}}{n^2} + \left(\frac{D_{water}}{H}\right)\left(\frac{\theta_w^{3.33}}{n^2}\right)$$

where, D_{air} = diffusion coefficient of the VOC in air [cm^2/s],
D_{water} = diffusion coefficient of the VOC in water [cm^2/s],
H = dimensionless Henry's law value for the VOC [unitless],
θ_a = air-filled porosity of the media [unitless],
θ_w = water-filled porosity of the media [unitless], and
n = total porosity of the media [unitless].

The above relationship indicates that, as the water content of the porous media increases (and the air content decreases), D^{eff} is more strongly dependent on diffusion in water. For the VOCs of particular interest, the diffusivity in water is about four orders of magnitude smaller than the diffusivity in air, as shown on the following table:

Properties	PCE	TCE
H [unitless] at 15°C	0.44	26
D_{water} [cm^2/s]	8.2×10^{-6}	9.1×10^{-6}
D_{air} [cm^2/s]	7.2×10^{-2}	7.9×10^{-2}

Source: http://www.epa.gov/ATHENS/learn2model/part-two/onsite/JnE_lite.htm

As such, all other things being equal, as the percentage of water-filled void space increases, and the portion of void space filled with air decreases, the effectiveness of diffusion decreases and the vapor transport rate decreases as well.

In particular, the glaciolacustrine soils, glacial till, and bedrock are expected to limit vapor transport due to high moisture content and low porosity (glacial till and bedrock). As documented in prior reports submitted to NYSDEC[7], samples of the silt and clay and glacial till have exhibited the following properties:

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[7] See Table 4 of Sanborn, Head & Associates, Inc., *RFI Task VII Deliverable, Groundwater RFI Final Report, Building 330 Area of Concern, IBM East Fishkill Facility*, August 22, 1997.

Exhibit 4 – Physical Properties of Certain Site Soils

Soil Type	General Description	Apparent Thickness	Porosity, n (unitless)	Volumetric Water Content, θ (unitless)	Hydraulic Conductivity, K (cm/sec)
Glaciolacustrine deposits	Silt, clay, sand, and minor amounts of gravel	Generally 10 to 20 ft thick, but thin and pinch out at the inferred limits shown on Fig 3	0.36 to 0.45	0.36 to 0.5	$5\text{x}10^{-8}$ to $2.5\text{x}10^{-7}$
Glacial till	Generally dense to very dense, heterogeneous mixture of clay, silt, sand, and gravel, with cobbles and boulders	Greater than 80 ft at depressions in the bedrock surface. Absent where bedrock is at the surface.	0.15 to 0.3	0.2 to 0.34	$3.8\text{x}10^{-9}$ to $1.8\text{x}10^{-4}$

Comparison of the porosity values to the volumetric water content values indicates that these soils are fully or near fully saturated, reflecting their low hydraulic conductivity, which results in their acting as an aquitard.

For VOC vapor migration sourced from bedrock groundwater, diffusion through the rock and overburden soils would be the dominant transport mechanism. Thus, site hydrogeology characterized by heterogeneous strata of nearly to fully saturated soils and bedrock provides a significant impediment to realizing VOC vapor migration sourced from VOCs in bedrock groundwater. Based on this site conceptual model, vapor intrusion potential from the subsurface is least likely where the source is VOC in groundwater at depth in bedrock, and relatively more likely where there may be VOC mass residing in the vadose zone just below the building foundation. The presence of VOCs in perched overburden groundwater likely represents intermediate potential for subsurface vapor intrusion.

3.0 BUILDING INFORMATION

This section presents an overview of Site building information relevant to the proposed scope of work and establishment of priorities for confirmatory sampling and VOC source assessment activities.

Table 1 provides a compilation of building-specific characteristics. A discussion of these characteristics and their relation to the proposed assessment of indoor air sourcing is provided in the subsections below. The locations of buildings are shown on Figure 2, and individual building plans are provided in Appendix C.

3.1 Size, Use, Occupancy, and HVAC Systems

For each building, the first group of columns in Table 1 provides data and information on building footprint, number of floors, current use/function, occupancy, and details on the engineered HVAC systems. The building HVAC systems are designed and maintained to meet the requirements of ASHRAE Standard 62, “Ventilation for Acceptable Indoor Air Quality”.[8] As indicated in the ASHRAE Standard 62 purpose statement, the purpose of this standard is to specify minimum ventilation rates and indoor air quality that will be acceptable to business occupants and are intended to minimize the potential for adverse health effects.

Each building is typically divided into zones served by specific air handling units (AHUs) operating under positive pressure relative to outdoor air. Depending on the type of use/activity in a zone (e.g., offices, laboratories, clean room manufacturing, warehousing) and the number of occupants, the AHUs are designed to achieve a minimum number of air changes per hour (ACH) using outdoor air. Table 1 indicates the number of air handling units and the approximate range of design ACHs per building depending on use and occupancy.

3.2 Review of Solvent Use and Solvent-Related Infrastructure History

The column on Table 1 titled “Solvent SWMUs within Building” provides summary information regarding whether solvents were used in a given building. This information is based on an assessment of historical building use and infrastructure history as previously performed and documented in Corrective Action Permit Module III under the Site’s Part 373 Hazardous Waste Management Permit. Module III identifies the solvent-related solid waste management units (SWMUs) located at the Site. The SWMUs and AOCs were evaluated and characterized for release potential to site media. As indicated on Table 1, solvent use, storage, or treatment was documented for 13 of the 29 buildings. The records indicate evidence of past releases to the subsurface associated with 6 of the buildings (B300, B309, B310, B320B, B330C, and B330D). The locations of solvent-related SWMUs for each building are presented on the building plans provided in Appendix C.

3.3 Proximity to Subsurface Contamination

To evaluate the potential for VOC vapors to exist and/or migrate beneath Site buildings, the columns in Table 1 termed “Subsurface VOC Source Data” indicate whether there are VOCs present in subsurface media beneath each building, and if so, whether they are present in the bedrock groundwater, overburden groundwater, or the vadose zone. The presence of VOCs in the bedrock or overburden groundwater beneath a building is denoted based on existing groundwater quality data as summarized on Figures 3 and 4, respectively. If there is evidence of VOCs present within the vadose zone beneath a given building, the designation that VOC presence has been "confirmed" in Table 1 is based on the availability of soil, soil vapor, or other data, including observed/reported releases. Designation of a "probable" vadose zone VOC presence is based on available groundwater and soil vapor data that suggest the likely presence of VOC residuals in the vadose zone.

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[8] American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., Standard 62-2001, *Ventilation for Acceptable Indoor Air Quality*, 2001

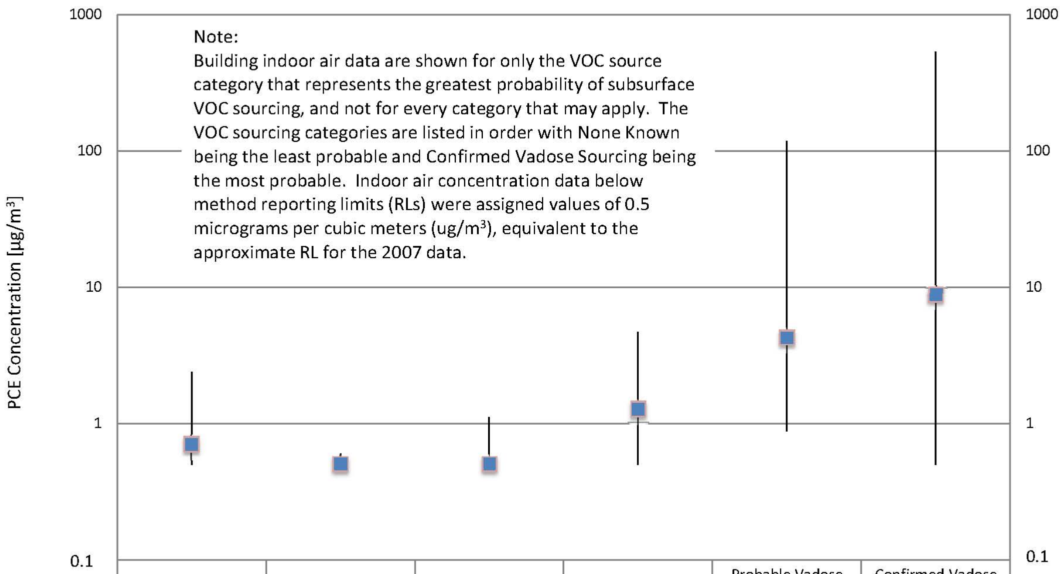
3.4 Review of Existing Indoor Air Data

In 2007, IBM self-initiated indoor air sampling within several Site buildings. Indoor air samples were collected by IBM personnel using sorbent tubes with charcoal media and a sampling pump operating at about 1.0 liter per minute (lpm) for a continuous sampling duration of approximately 8 hours. Actual sample flow rates and collection durations were used by IBM to calculate the time-weighted average concentration within the sampled air.

The IBM Hudson Valley Environmental Laboratory (IBM Lab) conducted the sampling and analysis using modified USEPA Method 18 (see Appendix A.8). Sample sorbent tubes were desorbed using carbon disulfide solvent and transferred to a gas chromatograph/mass spectrometer (GC/MS), which operated in selective ion monitoring (SIM) mode to provide lower detection limits for target analytes. The target analyte list consisted of the principal VOCs found within Site groundwater (i.e., PCE, TCE, and cDCE).

Sample collection points were identified by building, floor, and column location. A summary of the indoor air sample results is provided on Table 2. Sample locations and results are also presented on the individual building plans provided in Appendix C.
Exhibit 5 below presents a summary of the PCE concentrations in the 2007 air sample data organized by VOC source category.

Exhibit 5 – PCE Concentrations (Maximum, Minimum, and Median) in 2007
Air Samples Organized by VOC Sourcing Category



Note:
Building indoor air data are shown for only the VOC source category that represents the greatest probability of subsurface VOC sourcing, and not for every category that may apply. The VOC sourcing categories are listed in order with None Known being the least probable and Confirmed Vadose Sourcing being the most probable. Indoor air concentration data below method reporting limits (RLs) were assigned values of 0.5 micrograms per cubic meters (ug/m³), equivalent to the approximate RL for the 2007 data.

	Outdoor	None Known	Bedrock GW	Overburden GW	Probable Vadose Sourcing	Confirmed Vadose Sourcing
Max	2.4	0.6	1.1	4.7	117	531
Min	ND < 0.5	ND < 0.5	ND < 0.5	ND < 0.5	0.9	ND < 0.5
■ Median	0.7	ND < 0.5	ND < 0.5	1.3	4.3	8.9
No. of Samples	8	7	17	18	7	49
Freq. of Detection	63%	14%	24%	78%	100%	98%

The data demonstrate that PCE concentrations in buildings that do not overlie a known subsurface VOC presence, as well as in the buildings that overlie VOC presence in bedrock and overburden groundwater, are consistent with PCE concentrations in outdoor (ambient) air. PCE concentrations were relatively higher in buildings overlying probable or confirmed vadose zone VOC sourcing. In summary, the 2007 data support the site conceptual model for potential sources of VOCs.

4.0 OVERALL SCOPE AND PROJECT PLAN

This section provides an overview of the planned scope and rationale for the sampling, investigations, and testing to be performed under this work plan.

4.1 Summary Overview and Rationale

IBM plans to perform sampling, investigations, and testing in 12 of 29 buildings where the existing information and data suggests there is some potential for vapor migration resulting from VOC sources unrelated to present Site occupational use(s). These 12 buildings comprise about 2 million sq. ft. (about 75%) of the total of 2.7 million sq. ft. of building footprint. The 12 buildings have been categorized for one of the following two types of evaluation:

- Source investigation for 2 buildings – to evaluate the source of anomalous indoor air quality conditions and support an assessment of possible mitigation measures;

- Confirmatory indoor air sampling for 10 buildings – to further assess possible anomalous indoor air quality conditions where either indoor air sampling has not been conducted in the past, or where testing is to be repeated under Agency review.

Figure 5 shows the locations of the buildings identified for source investigations and confirmatory sampling in relation to the extent of VOC presence in overburden groundwater. Also shown are the 17 buildings where no additional investigations or testing is planned. These buildings are generally located in areas with no known or suspected sources of subsurface VOC presence; however, other factors were also considered in categorizing buildings as described below.

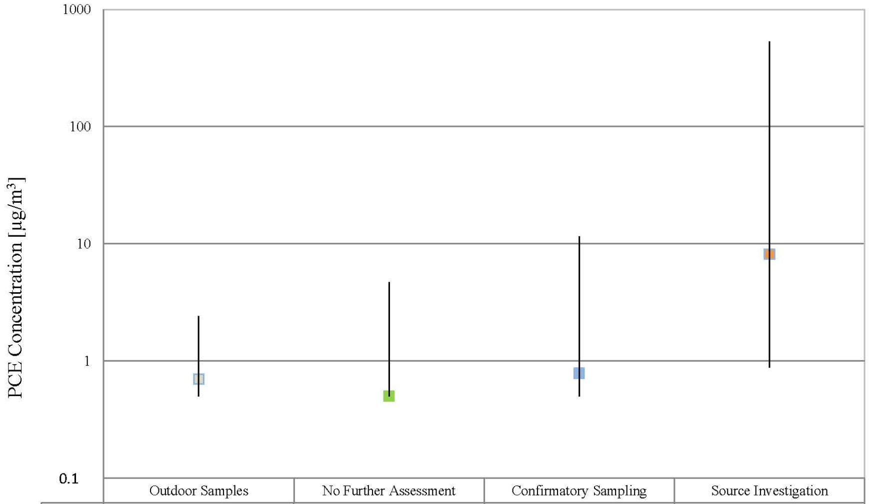
A summary of the scoping factors considered in identifying buildings for source investigation, confirmatory sampling, or no further assessment is as follows:

Scoping Considerations	Description/Discussion
Human occupancy	Assess occupied buildings if other factors suggest potential for anomalous VOC presence in indoor air. Exclude buildings not occupied and/or intended for routine occupation.
Historical solvent use and/or storage and release history	Target buildings with historical solvent use, particularly buildings where there are known or suspected historical releases. Consider excluding buildings with no historical solvent history from further assessment unless underlain by a VOC presence in groundwater.
Underlain by VOC presence in overburden and/or bedrock groundwater	Buildings overlying VOC presence in a shallow, perched overburden zone of groundwater saturation are more likely to exhibit anomalous indoor air conditions than buildings that overlie VOC presence deep within bedrock
Probable or confirmed vadose zone contamination	Buildings that directly overlie a probable or confirmed vadose zone source are more likely to exhibit anomalous indoor air conditions.
Historical indoor air data	Perform source characterization for buildings that exhibit anomalous concentrations of VOCs in indoor air, which cannot be attributed to current occupational uses.

Tables 3, 4, and 5 present the rationale for identifying individual buildings for source investigation, confirmatory sampling, or no further assessment, respectively, based on the above scoping considerations.

Exhibit 6 below presents a summary of the PCE concentrations detected in 2007 air sampling organized by planned building response category.

Exhibit 6 – PCE Concentrations (Maximum, Minimum, and Median) in 2007 Air Samples Organized by Planned Building Response Category



	Outdoor Samples	No Further Assessment	Confirmatory Sampling	Source Investigation
Max	2.4	4.7	12	531
Min	ND < 0.5	ND < 0.5	ND < 0.5	0.9
■ Median	0.7	ND < 0.5	0.8	8.2
Number of Samples	8	14	30	54
Frequency of Detection	63%	29%	53%	100%

Reorganized this way, the 2007 indoor air data indicate that for buildings identified for no further assessment or confirmatory sampling, the frequency of PCE detection was less than that of the outdoor (ambient) air samples. Further, for samples obtained in buildings excluded from further assessment, the median PCE concentration was less than the median outdoor concentration. For samples obtained in buildings identified for confirmatory sampling, the median PCE concentration was similar to the median outdoor concentration. Lastly, for samples obtained in buildings identified for source investigation, PCE was detected in all the indoor samples at a median concentration about one order of magnitude greater than the medians of the other categories, including the outdoor data. Overall, the data support the planned building response categories.

4.2 Buildings Identified for Source Investigations

IBM will initially conduct source investigations in two buildings (Buildings 310 and 330D) totaling over 590,000 sq. ft. of building footprint. These buildings, highlighted in orange on Figure 5, were identified based upon the following considerations:

- Anomalous levels of PCE were detected in the 2007 indoor air samples in these buildings at maximum concentrations on the order of 100 to 500 micrograms per cubic meter ($\mu g/m^3$), along with the presence of biochemical breakdown products;
- Both of these buildings overlie probable (B310) or confirmed (B330D) vadose zone contamination due to historical solvent releases;
- The buildings are currently occupied; and
- Historically, solvents were used or stored in these buildings, and in certain portions of the buildings, solvents were conveyed in inaccessible below-ground solvent waste pipelines.

Table 3 summarizes the factors IBM considered when deciding to conduct sourcing investigations within these buildings.

4.3 Buildings Identified for Confirmatory Sampling

IBM will perform confirmatory sampling in 10 buildings totaling over 1.4 million sq. ft. of building footprint. These buildings, highlighted in blue on Figure 5, were identified based upon the following considerations:

- The 2007 indoor air samples for buildings in this category indicated PCE concentrations similar to or greater than concentrations in outdoor air samples;
- The buildings overlie some form of subsurface contamination (e.g., a VOC presence in an overburden or bedrock saturated zone). For two buildings (Buildings 322 and 330C), it is probable or has been confirmed that vadose zone soils contain solvent residuals;
- The 10 buildings are currently occupied; and

- In 7 of the 10 buildings, solvents were historically used or stored, and in some cases, solvents were transmitted via inaccessible below-ground solvent waste pipelines.

Where indoor air sampling was previously conducted (7 of the 10 buildings), IBM will sample to confirm previous indoor air data, and to provide for greater spatial coverage of the building footprints. Where indoor air sampling was not previously conducted (3 of the 10 buildings), IBM will conduct sampling to confirm no anomalous VOC presence in indoor air.

Table 4 summarizes the factors IBM considered when deciding to conduct confirmatory sampling within these buildings. If confirmatory sampling results indicate anomalous indoor air conditions, the building may be subject to VOC source investigation, as described below in Sections 4.5.

4.4 Buildings Excluded from Investigations and Testing

No further assessment is proposed for 17 buildings totaling about 670,000 sq ft of building footprint. These buildings, highlighted in green on Figure 5, were identified based upon one or more of the following considerations:

- Ten of the 17 buildings in this category are not occupied;
- The normal occupational use of 2 buildings (Building 316 and Building 384) involves the treatment of primary target chemicals. Building 316 houses the Central Carbon Treatment Facility that treats millions of gallons of VOC-containing groundwater daily. Building 384 houses the Area A groundwater extraction and treatment operation;
- The 2007 indoor air data for 3 of the 5 buildings sampled in this category indicate no detections of PCE. In the 2 buildings where PCE was detected, the maximum concentrations were either consistent with Site background (ambient) levels (0.7 µg/m^{3}detected in the Building 315 utility plant), or consistent with the large-scale treatment of PCE-containing groundwater at the Central Carbon Treatment system plant (4.7 µg/m^3 detected in Building 316);
- Eleven of the 17 buildings in this category have either no known subsurface sources of VOCs, or the only potential source of VOCs is dissolved-phase in the deep bedrock aquifer; and
- Thirteen of the 17 buildings in this category have no documented historical use or storage of solvents.

Table 5 summarizes the factors IBM considered when deciding to exclude these buildings from further investigations and testing.

4.5 Identification and Prioritization of Additional Source Investigation Work

If confirmatory indoor air sampling in any building identified in Section 4.3 indicates anomalous presence of VOCs, IBM will conduct a source investigation in such building. Potential additional source investigations will be performed sequentially and prioritized to address those buildings, or portions thereof, with the higher indoor VOC concentrations and greater human occupancy. This prioritization may mean that additional source investigations might be initiated before completion of the planned confirmatory sampling program of the 10 buildings described in Section 4.3. IBM will keep the Agencies informed if it plans to initiate additional source investigations based on the results of confirmatory sampling.

Once a building has been identified for additional source investigation, IBM anticipates that it may need 3 to 5 months to complete the additional source investigation work with respect to such building. Building size and the number of buildings requiring re-characterization from "confirmatory sampling" to "source investigation" will influence the time required to perform the additional source characterization phase of the work plan.

4.6 Mitigation Engineering and Implementation

If source investigations reveal that mitigation is needed to address anomalous concentrations of VOCs in indoor air, the next steps would involve evaluation and engineering of remedial measures, followed by implementation and performance testing. Mitigation measures will depend on VOC sourcing, but would generally involve source reduction measures and/or containment/control measures, both having the ultimate objective of lowering VOC concentrations in indoor air. Containment/control measures might include:

- HVAC system modifications/adjustments;
- Vapor barriers, such as concrete coatings, grout, or subgrade geomembranes; and/or
- Subslab depressurization/ventilation systems (could also be considered a source reduction measure).

Source reduction measures might include:

- Removal of VOC-containing building materials (e.g., concrete floors, wall coverings, ceiling tiles);
- Subslab depressurization/ventilation systems;
- Soil vapor extraction systems; and/or
- Excavation and disposal of VOC-containing soil.

The implementation of mitigation measures may involve a multifaceted and iterative approach depending upon various factors, such as the VOC concentrations in indoor air, the current occupancy and use of the building, and IBM's longer-term plans for the building. Mitigation measures will likely be implemented using an observational approach, whereby remedial steps would be performed sequentially to allow for subsequent testing and the need for additional actions. Implementation might also be iterative in that the approach may involve systematic implementation and evaluation of the effectiveness of remedial steps. Under this approach, mitigation engineering and implementation is expected to require on the order of 6 to 18 months following completion of source investigations.

5.0 WORK PLAN ELEMENTS

This section describes the key elements of this work plan, including confirmatory indoor air sampling, VOC source investigations, and potential mitigation engineering, implementation, and testing.

5.1 Confirmatory Sampling

Confirmatory indoor air sampling is planned for the 10 buildings listed in Table 4. Confirmatory sampling will include the collection of outdoor, ambient air samples as reference/control samples - typically, one outdoor air sample per building.

5.1.1 Indoor Air Sampling Locations

Indoor air samples will be collected from the ground floor level of each building while HVAC systems are operating normally. The planned sampling locations are shown on the individual building plans provided in Appendix C. These plans also show the general layout of the buildings, the 2007 indoor air sampling locations and results, and solvent-related SWMU locations. The sampling locations were identified taking into consideration the following factors:

- The 2007 indoor air sampling locations and results;
- HVAC system zones;
- Existing use and occupancy;
- Current understanding of subsurface VOC presence; and
- Information regarding SWMU locations and/or historical solvent use, if any.

In addition, when defining final sampling locations, IBM will take into consideration the observations of pre-sampling building reconnaissance as described below, as well as review/input by the Agencies. Final sampling locations are subject to reasonable field adjustments from those shown on the Appendix C plans.

5.1.2 Building Reconnaissance to Finalize Sampling Locations

Prior to indoor air sampling, building reconnaissance will be performed with the following objectives:

- Confirm, or arrange for, access to the planned sampling locations;
- Confirm the locations are consistent with their representation on the building plans;
- Observe and document building conditions or uses that might affect sampling results (e.g., fresh paint, new floor coverings, change of use/function);
- Confirm that HVAC systems are operating normally; and

- Observe and document other building conditions related to vapor intrusion potential (e.g., slab penetrations, sumps, etc.).

Observations will be documented and entered into the project database. Reasonable field adjustments to the planned sampling locations will be made as IBM deems necessary based on the building reconnaissance.

5.1.3 Sampling and Analytical Methods

Indoor air samples will be collected as 8-hour, time-integrated samples using Summa® canisters in accordance with the procedure provided as Appendix A.1. Confirmatory samples will be analyzed by USEPA Method TO-15 or equivalent for the compounds listed in Table 6. These 22 compounds include the entire standard list of groundwater compounds that IBM has been required to monitor for the last 15 years under the Site's Part 373 Permit and for which there are calibration standards[9]. This is a very conservative approach given that the VOC concentrations detected in Site groundwater monitoring wells for the most recent reporting year (2007) indicate the following[10]:

- Three of the 22 compounds (methylene chloride, 1,2,4-trichlorobenzene, and acetone) were not detected in any of the samples;
- Five of the 22 compounds (1,1-dichloroethene, 1,4 dichlorobenzene, benzene, ethylbenzene, and o-xylene) were detected only at a small number of locations and at concentrations on the order of tenths of a microgram per liter (μg/l); and
- Seven of the compounds (carbon tetrachloride, chlorobenzene, 1,3-dichlorobenzene, trichlorofluoromethane [Freon 11], m,p-xylene, 1,1,1-trichloroethane, and toluene) were detected in samples from a small number of locations, generally at concentrations ranging from 1 to 10 μg/l.

Thus, over three-quarters of the analytes have been recently detected only in limited areas and at low concentrations in groundwater, suggesting a limited or even negligible presence in the subsurface to support vapor intrusion potential based on groundwater data. It should also be noted that the unsubstituted aromatic compounds (BTEX) are more likely to be found as background conditions in ambient (outdoor air) and indoor air, are readily biodegradable in the vadose zone, and are more likely to be in present occupational use in the buildings. As such, these compounds are more likely to be present in indoor air unrelated to subsurface vapor intrusion. In the event that these compounds are found at anomalous concentrations in indoor air, further work will focus on assessing chemical use/storage in the buildings as it relates to applicable occupational standards and IBM's or tenant practices.

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[9] Two compounds routinely monitored in groundwater, Freon 123a and 1,2,3-trichlorobenzene, will not be analyzed in the indoor air samples because these compounds are only capable of being reported as tentatively identified compounds (TICs) by typical environmental laboratories. Further, where these compounds have been detected in groundwater, chlorinated ethenes have typically also been detected at much higher concentrations.

[10] See Table 3-1 of *2007 Annual Corrective Action Status Report, IBM East Fishkill Facility*, May 29, 2008, prepared by Groundwater Sciences Corporation.

Confirmatory indoor air samples will be analyzed in accordance with USEPA Method TO-15 by a laboratory certified by the NYSDOH Environmental Laboratory Approval Program (ELAP) for the analytes in Table 6. Table 6 also lists relevant physical properties of each VOC and the expected laboratory reporting limits.

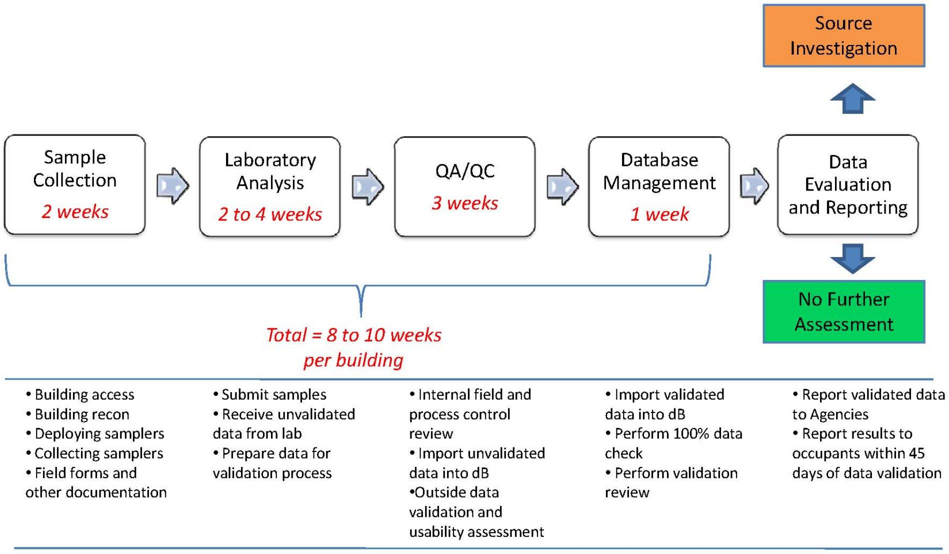
5.1.4 Quality Assurance/Quality Control

IBM will perform confirmatory indoor air sampling in accordance with the QA/QC project plan provided as Appendix B. The purpose of the QA/QC program is to establish procedures for meeting data quality objectives, data validation, and assessment of data usability.

5.1.5 Expected Work Flow

Exhibit 7 below shows the expected work flow process associated with confirmatory sampling.

Exhibit 7 – Work Flow Process for Confirmatory Sampling



The entire process beginning with sample collection and ending with data evaluation and reporting is expected to require 8 to 10 weeks for each building. Further discussion of data management is presented in Section 6.

5.2 Source Investigations

Source investigations are planned for the two buildings listed in Table 3. Additional buildings, or portions thereof, may be identified for source investigations depending on the results of confirmatory indoor air sampling proposed under Section 5.1.

5.2.1 Assessment Methods

Source assessment will involve a combination of several sampling techniques with the overall objective of identifying the causes of anomalous VOC concentrations in indoor air. These methods and their purposes are summarized below. The field procedures for each technique, including laboratory analytical methods, are provided in the referenced procedures.

Assessment Method	Purpose/Description	Procedure
Passive diffusion samplers	To help identify sourcing of VOCs in indoor air, these samplers would typically be used to obtain a "first cut" at source assessment by deploying these samplers on floors, walls, equipment, etc. to target suspect areas and building features. Results may also be used to select locations for subslab vapor sampling.	Appendix A.2
Sorbent tube samplers	To assess VOC concentrations in indoor air, these samplers would typically be used as to supplement the passive diffusion samplers.	Appendix A.3
Summa-type samplers	To assess VOC concentrations in indoor air, typically as part of performance verification sampling after mitigation measures. These samplers may also be used for subslab vapor collection.	Appendix A.1
Subslab vapor sampling	To assess potential subslab sourcing of VOCs. Subslab sampling ports would be constructed, integrity-tested, and sampled using Tedlar bags, syringes/vials, or Summa canisters.	Appendix A.6
Sampling of porous building materials	To assess potential sourcing of VOC mass potentially contained in porous building materials such as concrete due to historical building use.	Appendix A.5

In addition to the above methods, portable, hand-held screening instruments, such as a photoionization detector (PID) or flame ionization detector (FID) will be used to screen interior building space and features for potential VOC sourcing. Field screening data will be used to support selection of sampling locations. Additional samples may include building materials, such as floor tiles, ceiling tiles, etc., if available data and information suggest that these materials might be sourcing VOCs in indoor air.

5.2.2 Field Testing Procedures

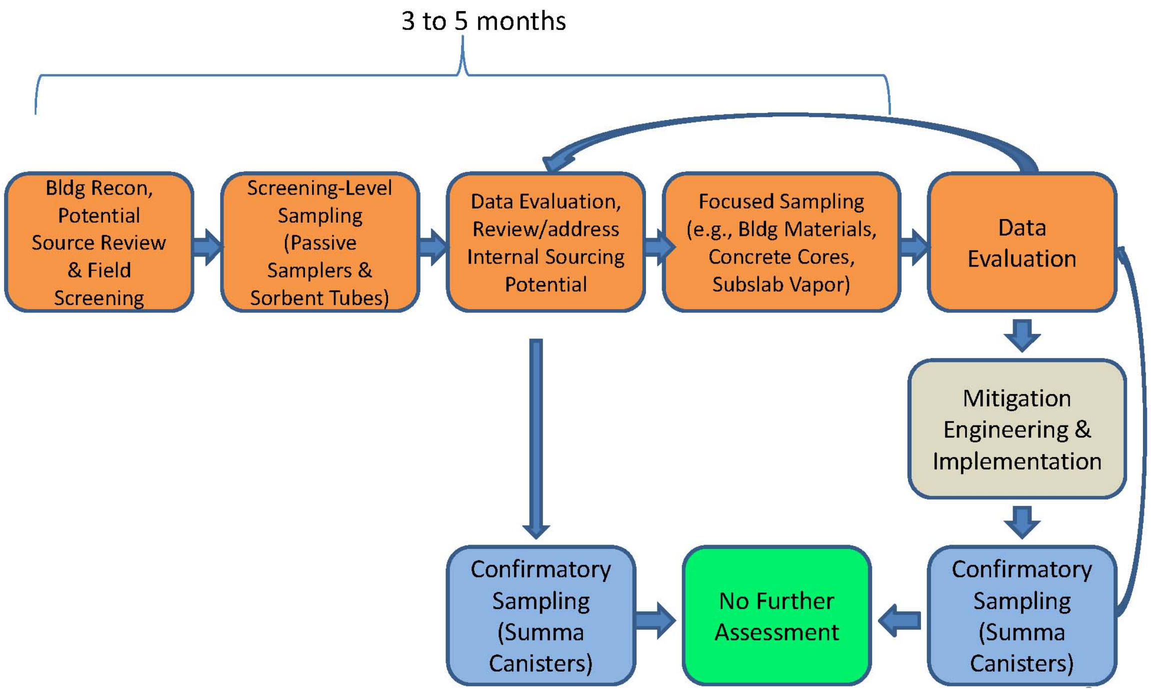
Source investigations may also involve field testing procedures intended to support VOC source assessment and potential mitigation. These procedures and their purposes are summarized below.

Field Testing Procedure	Purpose/Description
Assessment of building heating, ventilation, and air conditioning (HVAC) systems	To assess the potential role of HVAC systems in sourcing and/or mitigation of VOC presence in indoor air. HVAC evaluation may involve field reconnaissance of HVAC layout (e.g., air ducts, blowers), field measurements of air flow and pressure, and differential pressure monitoring across floor slabs. This information would support engineering evaluations of HVAC system operations and potential modifications, if necessary, to reduce VOC presence and concentrations in indoor air. Refer to Appendix A.6 for field testing procedures for differential pressure monitoring between building interior and subslab.
Subslab vapor extraction pilot testing	To assess viability and to provide information to support design of vapor extraction from beneath the floor slab as a potential measure to reduce subslab sourcing of VOC presence in indoor air. This procedure would involve installation of subslab vapor extraction testing ports connected to a portable blower. Subslab pressure and VOC concentrations in extracted vapor would be monitored during the test. This information would support engineering evaluations of potential mitigation options. Refer to Appendix A.7 for field testing procedures.

5.2.3 Expected Work Flow

Exhibit 8 below shows the expected work flow process for source investigations.

Exhibit 8 – Work Flow Process for Source Investigations



Source investigations are expected to be an iterative process that begins with building reconnaissance, field screening, followed by broad, screening-level sampling to identify areas of potential sourcing of anomalous VOC presence. If internal sourcing related to building uses are found and can be readily addressed (e.g., elimination of VOC-containing cleaning products), then confirmatory sampling would be performed to evaluate whether further assessment is necessary. If not, focused sampling iterations would be performed to target VOC sourcing from building materials and/or the subsurface. These data would be used to support evaluation, engineering, and implementation of mitigation measures, if needed. Following mitigation, confirmatory sampling would be performed to evaluate the effectiveness of the mitigation and the need for further assessment or remedial steps.

5.3 Mitigation Engineering, Pilot Testing, Design, Construction and Performance Testing

If source investigations indicate that mitigation is needed to address anomalous concentrations of VOCs in indoor air, the next steps would involve evaluation, selection, and engineering of remedial measures, followed by implementation and performance testing. Mitigation measures would likely involve VOC source reduction measures and/or contaminant control measures as described in Section 4.6. Certain mitigation measures, such as subslab depressurization or soil vapor extraction, may require design/pilot testing to size blowers and vapor treatment equipment. Other mitigation measures, such as HVAC modifications, may require engineering design and specifications development.

Once mitigation measures are designed and constructed, performance testing would be conducted to verify that the mitigation measures resulted in the intended reduction in VOC concentrations in indoor air. Iterative mitigation steps may be needed to achieve the performance objectives. Under this approach, IBM expects that such mitigation engineering and implementation will require an additional 6 to 18 months following the completion of source investigations.

6.0 DATA MANAGEMENT, EVALUATION, AND REPORTING

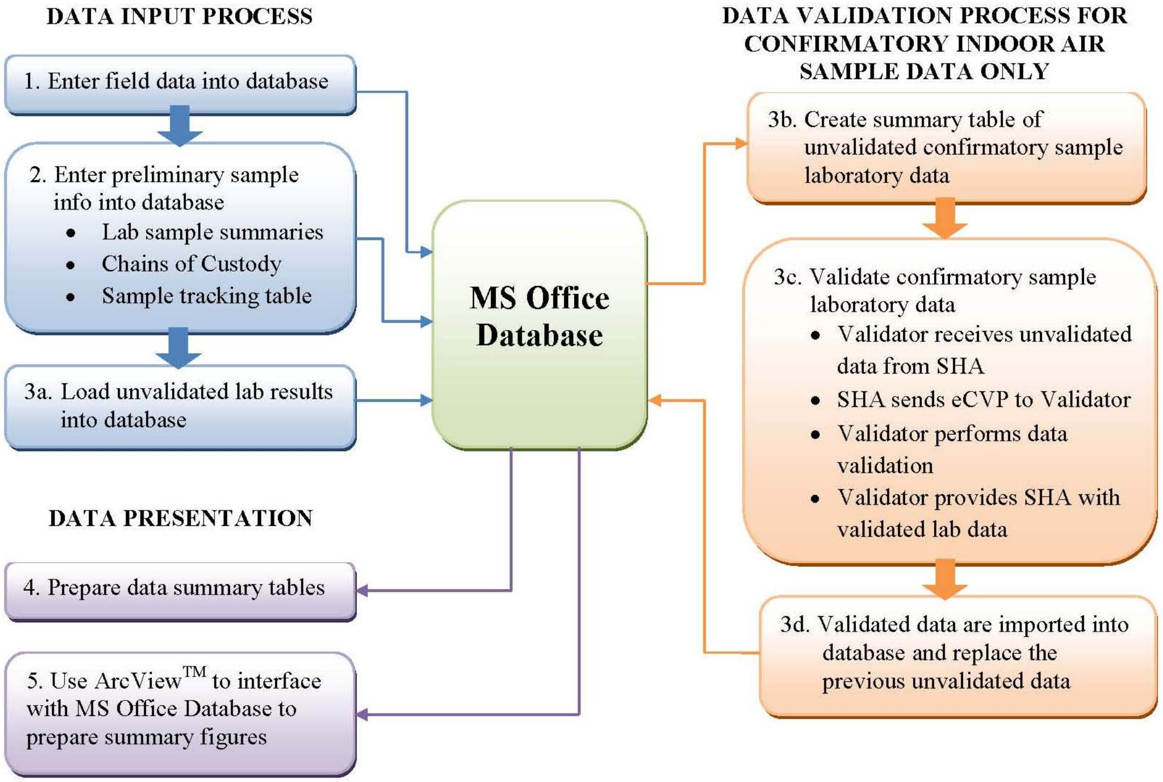
This section pertains to the management, evaluation, and reporting of data from the confirmatory sampling program and source area investigations. Data associated with confirmatory indoor air sampling will be subject to independent data validation. Source investigation data will not be independently validated. However, before a source area is ultimately identified for no further assessment, confirmatory indoor air sampling will be performed and the data will be independently validated as described below.

6.1 Data Management

Data generated as part of the proposed sampling activities will be stored and managed in a Microsoft® (MS) Access™ relational database. The MS Access™ database may be used in conjunction with ArcView™ as a geographical information system (GIS) platform to present and

evaluate the spatial distribution of data. The MS Access™ database/ArcView™ GIS platform provide a means for efficient storage, presentation, and evaluation of large, complex datasets.
Exhibit 9 below presents a summary of the data management process. In general, data will be received from the laboratory electronically and imported into the database. A summary table of the analytical results from the confirmatory indoor air samples will be sent electronically to the data validators with columns/rows established for the validators to insert the results of the validation/usability assessment. Following completion of the validation/usability assessment, a table with the qualified data will be sent back to SHPC electronically, and inserted in place of the previously unqualified data.

Exhibit 9 – Data Management Process



6.2 Data Validation for Confirmatory Indoor Air Samples

The laboratory data from the confirmatory indoor air samples will be validated by an independent data validator. Data from the source area investigations will not be validated until after mitigation, if necessary, when performance verification sampling will be performed. The confirmatory indoor air sample data validation will be conducted following USEPA and NYSDEC guidelines and project specific requirements summarized in Appendix B. A brief summary of data validation and usability assessment procedures and methods is provided below. Refer to Appendix B for further discussion of this matter.

The data validation assessment is performed using a two-tier process. The first tier involves an in-depth review of sample data, including raw data, to verify that the laboratory has performed the analyses in compliance with the analytical methods required, laboratory procedures, the work plan, and USEPA and NYSDEC Guidelines for data validation of organic data. A data usability report (DUR) for the in-depth assessment will be prepared by the validator to summarize the quality control (QC) issues that required action (qualification of data) and the effects of these actions on the usability of the results in terms of the data quality objectives (DQOs).

If the in-depth, first tier review indicates sample analysis meets the DQOs, then a second tier of data validation will be performed on the remaining data using a checklist review whereby all the project DQOs are assessed; however, evaluation of the raw data is not performed. The laboratory will provide NYSDEC Category B data packages that include sample results and summary quality control including method blank results, laboratory control sample/laboratory control sample duplicate (LCS/LCSD) recoveries, instrument QC sample results, and raw data for all analyses, including instrument tunes and calibrations for all data in the event that an in-depth assessment is needed in the future.

6.3 Data Reporting and Communications Planning

IBM expects to receive validated data associated with confirmatory indoor air sampling about 8 to 10 weeks following initiation of sample collection, as indicated in Section 5.1.5. IBM will then communicate the validated data to the Agencies. Validated data transmittals will include sample location diagrams and relevant summary information. IBM intends to communicate the indoor air data to the building occupants and tenants within 45 days of receiving the validated data.

7.0 PROJECT ORGANIZATION AND STAFFING

IBM plans to perform the work described in this document through a project team consisting of IBM personnel and external consultants, laboratories, and contractors. Exhibit 10 below shows the general organization of the project team.

Exhibit 10 – Project Team Organization

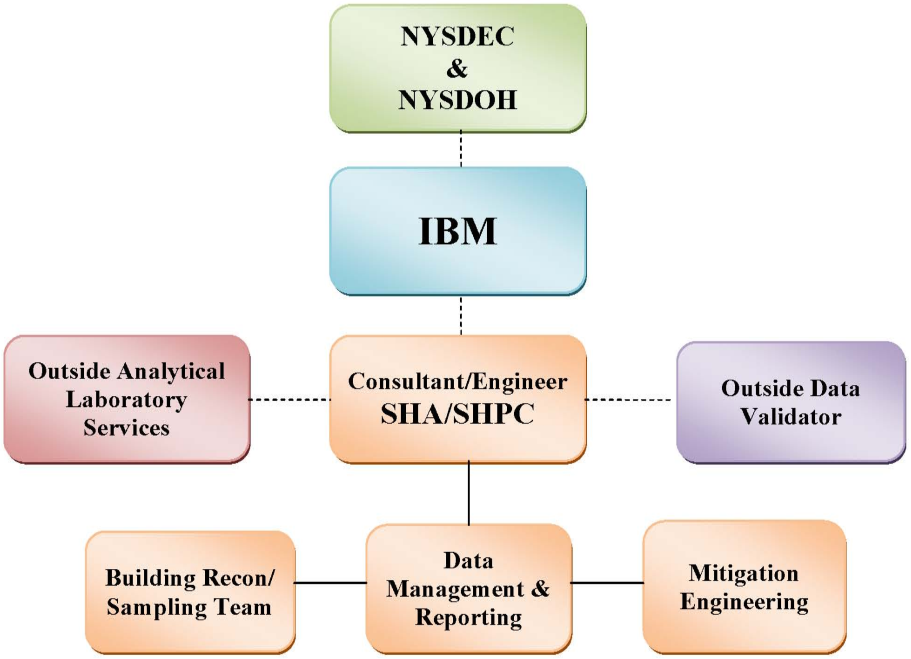
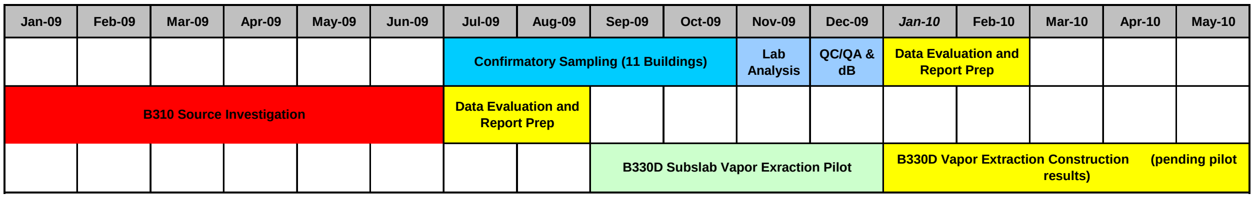


Table 7 provides further details regarding the anticipated roles of the team members along with contact information for project personnel. IBM reserves the right to modify the project team and its members while continuing to adhere to the objectives and procedures of the work plan. IBM will inform the Agencies of significant changes to the project team.

8.0 CURRENT WORK STATUS AND SCHEDULE PROJECTION

IBM initiated a portion of the work described in this work plan in summer 2008. Work already initiated by IBM includes source investigation in Building 330D and Building 310, and confirmatory indoor air sampling in Building 322. An update on this work is provided below. A projected schedule for the work beginning in 2009 is presented in Exhibit 11 and discussed further below.

Exhibit 11 – Schedule Projection



Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	*Jan-10*	Feb-10	Mar-10	Apr-10	May-10
						Confirmatory Sampling (11 Buildings)				Lab Analysis	QC/QA & dB	Data Evaluation and Report Prep				
B310 Source Investigation						Data Evaluation and Report Prep										
								B330D Subslab Vapor Exraction Pilot				B330D Vapor Extraction Construction (pending pilot results)				

8.1 Confirmatory Indoor Air Sampling

Confirmatory indoor air sampling of the buildings identified in Table 4 is expected to run approximately 4 months from July through October 2009. Since the sampling will occur in phases over this period, the overall work process for confirmatory sampling, including laboratory analysis and data validation (as indicated in Exhibit 11), is expected to be complete by the end of December 2009. IBM plans to provide results of validated data to the Agencies as they become available, and to submit a report of findings of the overall confirmatory sampling program by the end of February 2010. IBM intends to provide the confirmatory indoor air sampling results to the occupants within 45 days of receiving the validated data.

Confirmatory indoor air sampling consistent with the procedures described in this work plan was performed in Building 322 at nine locations on August 21, 2008. Air samples were collected using Summa® canisters equipped with flow controllers to obtain 8-hour time-weighted-average concentrations. The samples were analyzed by Air Toxics Ltd. of Folsom, California by USEPA Method TO-15. The results are presented in Table 8, and the sample locations and results are also depicted on Figure C-11 in Appendix C. These results indicate no detections of PCE in any of the nine samples, and relatively low-level detections for certain other compounds (predominantly acetone, toluene, Freon 11, and Freon 12) that are consistent with the industrial manufacturing use of this building. As disclosed by IBM's Building 322 tenant, NXP Semiconductors USA, Inc. (NXP), in its SARA chemical usage report and other reports, IBM understands that NXP uses acetone and toluene in its operations in Building 322 and, thus, IBM attributes the airborne acetone and toluene data to NXP's operations. As such, these results are not indicative of anomalous VOC presence in indoor air in Building 322 and support moving this building into the category for no further assessment.

8.2 Source Investigations

IBM initiated source investigation of Building 310, one of the two buildings identified in Table 2, in January 2009 and expects to continue such source investigations through June 2009. IBM expects to complete a separate report of the B310 source investigation findings by the end of August 2009. This timeframe does not take into account any potential mitigation measures, if needed, including engineering, implementation, or performance sampling. If source mitigation is necessary, these measures may require 6 to 18 months to engineer, implement, and performance test.

As previously communicated to the Agencies, IBM initiated source investigation and mitigation measures for Building 330D (which focused on the 80K manufacturing area as the source of anomalous PCE concentrations in this building) during the period of June through December 2008. IBM submitted a report of findings to the Agencies on December 24, 2008 entitled "Report of Findings, Building 330D VOC Source Investigation and Mitigation". As indicated in the report and communicated with the Agencies, IBM plans pilot testing in the 3rd and 4th quarter of 2009 of subsurface vapor extraction as a possible VOC source remediation measure. In addition, follow-up confirmatory indoor air sampling in Building 330D is planned for 2009.

If other buildings are identified for source investigations as an outcome of the confirmatory sampling program, those buildings will be prioritized as described in Section 4.5, with priority given to buildings with relatively more anomalous VOC concentrations and greater human occupancy. IBM expects that additional source investigations beyond the two buildings identified in this work plan would be implemented sequentially following completion of the Building 310 investigation.

8.3 Reporting to Agencies

Under the confirmatory sampling program, IBM will transmit the indoor air sampling results for each building to the Agencies once data validation is complete (expected 8 to 10 weeks following initiation of sample collection). IBM will be available to discuss the results with the Agencies and meet if necessary to review next steps.

IBM will apprise the Agencies if and when it identifies any additional buildings for source investigations.

A report of findings documenting the overall confirmatory sampling activities and results will be prepared and submitted to the Agencies at the completion of the program, as indicated on Exhibit 11.

During source investigations, IBM will inform the Agencies if sampling results suggest the presence of previously unknown VOC source areas. At the completion of each source investigation, IBM will provide an overall report of findings, including a discussion of planned next steps, if necessary.

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TABLES

Table 1 - Summary of Building Information
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building	Phase	Approx Gross Footprint[2] (ft^2)	No. of Floors[2]	Existing Use[2]	Nominal Occupancy[3]			No. of AHU[2]	Approx Range ACH[4]	Solvent SWMUs within Building?[5]	Subsurface VOC Source Data[6]					2007 Indoor Air Data[7]			
					IBM	Tenants	Total Occupants				None Known	Bedrock GW	Overburden GW	Vadose Zone		No. AHU Sampled	No. of Air Samples	Summary Results PCE ($\mu g/m^3$)	Other Compounds Detected?
														Probable	Confirmed				
300	**A-D**	174,700	4	Offices, laboratories, storage, data center	1,339	417	1,756	30	0.5 to 9.0	Module III, Table III-2 lists accumulation areas for solvent waste. Table III-6 lists inaccessible below-ground solvent waste pipelines.		✓				10	9	All < 0.5	No
303	-	9,700	1	Bulk chemical storage	0	0	0	1	5.5	Module III, Table III-2 lists a trailer tank storage area and accumulations/storage of solvent waste. No evidence of past releases.			✓			Not Sampled			
304	-	72,500	1	Container chemical storage/warehouse, offices	2	3	5	12	4.2	Module III, Table III-2 lists solvent mixed waste (spill tank) storage areas. No evidence of past releases.	✓					1	2	All < 0.5	No
308	-	99,800	1	Offices, shipping/receiving warehouse, emergency control	72	4	76	5	0.8 to 0.9	None known		✓	✓			3	7	1.5 to 3.6	cDCE
309	-	43,400	1	Offices, warehouse for hazardous and special waste storage	3	4	7	6	5.6	Hazardous waste storage and transfer warehouse with drum storage, trailer tank storage, drum loading/unloading dock, and accumulation areas for solvent and mixed solvent waste. Table III-6 lists inaccessible below-ground solvent waste pipelines.			✓			1	2	All < 0.5	No
310	-	371,400	1	Offices, cleanroom manufacturing, laboratories, storage	201	24	225	14	1.7	Module III, Table III-6 lists inaccessible below-ground solvent waste pipelines. Table III-2 identified solvent waste lift stations.		✓	✓	✓		5	7	0.9 to 120	TCE, cDCE
312	-	5,700	1	Industrial waste treatment	0	0	0	1	0.7	None known	✓					Not Sampled			
315	-	70,700	2	Central utility plant housing industrial boilers and cooling systems. Process water treatment.	0	15	15	5	0.3	None known	✓					1	1	0.7	No
316	-	89,500	2	Part of central utility plant housing water utility treatment including Central Carbon treatment system where VOC containing groundwater is treated for process and potable use. Small proportion of building used for office, laboratories, and storage.	41	0	41	15	0.2 to 0.5	None known			✓			2	2	3.0 to 4.7	TCE, cDCE
317	-	10,300	2	Water recycle and ammonia treatment	0	0	0	1		None known			✓			Not Sampled			
320A	**A**	100,300	2	Offices, storage, classrooms, cafeteria	348	292	640	14	0.6 to 0.8	None known	✓					5	5	< 0.5 to 0.6	No
320B	**B**	213,500	1	Cleanroom manufacturing, storage, laboratories	49	72	121	14	3.0	Module III, Table III-2 identified solvent mixed waste storage and solvent waste lift stations. Table III-6 lists inaccessible below-ground solvent waste pipelines.		✓	✓			4	4	0.7 to 1.1	TCE, cDCE
321	-	108,900	2	Offices, laboratories, data center	310	35	345	4	0.7 to 1.3	None known	✓	✓				4	4	All < 0.5	No
322	-	189,100	1	Cleanroom manufacturing, offices	3	465	468	21	10.5	Module III, Table III-2 lists accumulation areas for solvent wastes where there was no evidence of a past release. The building was equipped with below-ground solvent pipelines.		✓	✓	✓		Not Sampled			
323	-	224,900	3	Cleanroom manufacturing	519	9	528	26	0.3 to 10.9	Module III, Table III-2 identified solvent mixed waste storage and below ground pipelines, but no evidence of past releases.		✓	✓			Not Sampled			
323A	**A**	153,100	3	Cleanroom manufacturing	Included in count for Building 323, approx. 50 people work in B323A daily			31	0.3 to 6.4	None known		✓				Not Sampled			
325	-	12,000	1	Offices and laboratories for site water and wastewater treatment. Control instrumentation for WWTF.	17	6	23	1	2	None known	✓					Not Sampled			
327	-	7,700	1	Waste water treatment plant utilty buildings	0	0	0	1		None known	✓					Not Sampled			

Table 1 - Summary of Building Information

VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building	Phase	Approx Gross Footprint[2] (ft^2)	No. of Floors[2]	Existing Use[2]	Nominal Occupancy[3]			No. of AHU[2]	Approx Range ACH[4]	Solvent SWMUs within Building?[5]	Subsurface VOC Source Data[6]					2007 Indoor Air Data[7]			
														Vadose Zone					
					IBM	Tenants	Total Occupants				None Known	Bedrock GW	Overburden GW	Probable	Confirmed	No. AHU Sampled	No. of Air Samples	Summary Results PCE (μg/m^3)	Other Compounds Detected?
328	-	8,800	1	Bulk non-solvent chemical distribution	0	0	0	1	1.7	None known	✓					Not Sampled			
329	-	1,700	1	Electrical utility building	0	0	0	1		None known	✓					Not Sampled			
330C	C	261,300	1	Offices, laboratories, cleanroom manufacturing, cafeteria	340	106	446	33	3.2	Module III, Table III-2 identified solvent waste storage, mixed solvent waste associated with the OMF, and solvent waste lift stations. Table III-6 lists inaccessible below-ground solvent waste pipelines.		✓	✓		✓	2	2	< 0.5 to 12	No
330D	D	219,300	2	Offices, laboratories, cleanroom manufacturing	657	185	842	26	1.2 to 10	Module III, Table III-2 listed accumulation and storage areas for solvent waste, PCE waste, and mixed solvent waste, and solvent waste lift stations. Table III-6 lists inaccessible below-ground solvent waste pipelines.		✓	✓		✓	10	47	1.8 to 530	TCE, cDCE
334	-	164,200	3	Offices, cleanroom manufacturing, non-chemical warehouse storage	486	75	561	18	2	Module III, Table III-2 listed accumulation and storage areas for solvent waste, PCE, and PCE waste, but no evidence of past releases.		✓				Not Sampled			
335	-	8,900	0	Unoccupied former PCE recycling still and currently used for non-chemical storage.	0	0	0	1	0.2	Module III, Table III-2 listed accumulation and storage areas for PCE waste and recycled PCE.		✓	✓	✓		Not Sampled			
338	-	61,700	3	Manufacturing furnaces. Non-volatile chemical use, treatment, and storage.	65	32	97	11	4.2	None known		✓	✓			1	5	< 0.5 to 1.0	No
343	-	3,600	1	Waste water treatment plant utilty buildings	0	0	0	1		None known	✓					Not Sampled			
384	-	2,000	1	Area A groundwater treatment facility	0	0	0	1		PCE-contaminated groundwater treatment		✓	✓		✓	Not Sampled			
385	-	5,600	2	Recycling, decontamination, former fluoride waste treatment facility	0	0	0	2	5.3	None known			✓			Not Sampled			
386	-	15,200	2	Flouride waste treatment facility, some offices.	10	3	13	4	1.6	None Known		✓	✓			1	1	< 0.5	No
Totals		2,709,500			**4,462**	**1,747**	**6,209**	**301**		**Counts**	**10**	**15**	**16**	**3**	**3**				

Notes:

1. This table is intended to summarize the available information and inference compiled and derived from a review of building information provided by IBM and other sources as noted below. The information is intended to support assessment of occupied building space for a possible indoor air presence of VOCs that cannot be explained by an existing use or ambient air background conditions. Please refer to the RFI Work Plan text for additional details.

2. The building data including Approximate Gross Footprint square footage values, number of building floors, existing use, and number of air handling units (AHUs) were obtained from a spreadsheet provided by IBM entitled IBM OA Calculations revised November 19, 2007, a Groundwater Monitoring Plan Well Location Map prepared by Groundwater Sciences Corporation dated May 17, 2005, and Pre-Investigation Evaluation of Corrective Measures Location Plan prepared by SHA dated January 1996. The gross footprint square footage is intended to reflect the building footprint in plan view, not including link ways and other appurtenances, and are based on the referenced drawings and checked by SHA using scaling from the available drawings and review with IBM personnel.

3. Information on occupancy reflects the number of people assigned to each building as of the end of the first quarter 2008. This information was provided by IBM on August 12, 2008 in a spreadsheet entitled "MEAS 1Q 2008 042408.123". IBM occupants include permantent, supplemental and part-time employees. Tenants include IBM partners, vendors, contractors, and other non-IBM occupants.

4. Approximate range of air exchanges per hour (ACH) were computed by SHA based on the November 19, 2007 spreadsheet assuming ceiling heights of 8 to 20 feet based on SHA's recollection of building conditions. This data is intended to portray an assessment of relative HVAC system information based on available data. The actual HVAC system performance may be expected to vary temporally with building use conditions, equipment conditions, and other factors. In some cases, actual building HVAC conditions will be further assessed at the time of indoor air sampling or during source investigation work.

5. Solvent SWMU within Building - assessment of historical building use based on information contained in IBM's RCRA Corrective Action Permit Module III , dated September 29, 1995 and associated mapping.

6. Subsurface source data is based on IBM and SHA knowledge of historical building use information and available subsurface characterization data as generated by IBM in historical investigations, testing, and remediation work conducted both voluntarily and under RCRA Corrective Action. The screening designation is intended to reflect a weight of evidence assessment based on the available data and inference. Probable vadose zone sourcing reflect a condition where the available groundwater and soil vapor data suggests the probable presence of VOC mass in the vadose zone resulting from historical solvent liquid releases within and beneath or immediately adjacent to the building footprint. A Confirmed Vadose Zone source reflects the availability of soil vapor, soil, or other data including observed/reported releases that supports the presence of vadose zone sourcing.

7. Historical Indoor Air data - data from indoor air sampling self-initiated by IBM in 2007 as provided by IBM. Please refer to the Work Plan text and Appendices for additional details.

Table 2 - Summary of Historical Indoor Air Data
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building No.	Sample Date	Sample Location	Floor	PCE (µg/m^3)	TCE (µg/m^3)	cDCE (µg/m^3)
300	12/6/07	V4	1	< 0.47	ND	ND
		AB3	2	< 0.48	ND	ND
		L13	2	< 0.46	ND	ND
		N13	2	< 0.49	ND	ND
		R13	2	< 0.48	ND	ND
		S12	2	< 0.52	ND	ND
		C4	3	<0.47	ND	ND
		K13	3	<0.49	ND	ND
		R2	3	<0.48	ND	ND
304	12/10/07	R11	1	< 0.46	ND	ND
		X14	1	< 0.54	ND	ND
308	12/12/07	E4	1	**1.9**	ND	**1.9**
		F9	1	**1.5**	ND	ND
		J-1	1	**3.6**	ND	ND
		J2	1	**2.0**	ND	ND
		J7	1	**1.6**	ND	ND
		M6	1	**2.6**	ND	ND
		N-3	1	**3.1**	ND	ND
309	12/17/07	A-7	1	<0.50	ND	ND
		B-1	1	<0.50	ND	ND
310	12/12/07	C-7	1	**34.8**	**0.4**	**0.6**
		F-12	1	**117.4**	**1.0**	**0.7**
		S-7	1	**4.3**	ND	ND
		Y-2	1	**3.1**	ND	ND
		Y-9	1	**0.9**	ND	ND
	12/17/07	F-1	1	**2.4**	ND	ND
		G-4	1	**5.7**	ND	ND
315	12/19/07	H-15	1	**0.7**	ND	ND
316	12/19/07	L-2	1	**4.7**	**1.4**	**4.0**
		Q-6	2	**3.0**	**1.0**	**1.4**
321	12/6/07	D8	1	<0.5	ND	ND
		K7	1	< 0.47	ND	ND
		F12	2	<0.50	ND	ND
		F3	2	<0.49	ND	ND
338	12/19/07	L-40	1	**0.9**	ND	ND
		M-41	1	**0.9**	ND	ND
		P-40	2	<0.48	ND	ND
		V-40	2	**0.9**	ND	ND
		M-41	3	**1.0**	ND	ND
386	1/3/08	Break Room	1	<0.54	ND	ND
		Outside	Outside	<0.45	ND	ND
320/A1	12/18/07	AB-3	1	<0.48	ND	ND
		AH-8	1	<0.48	ND	ND
320/A2	12/18/07	AA-3	2	<0.51	ND	ND
		AH-7	2	<0.46	ND	ND
320/FL1	12/18/07	Y-19	1	**0.6**	ND	ND
320B	12/18/07	A-24	1	**0.9**	ND	ND
		H-33	1	**1.1**	**1.1**	**1.0**
		J-25	1	**0.7**	ND	ND
		P-34	1	**0.9**	ND	ND
330C	12/17/07	Z-30	1	**11.5**	ND	ND
		ZZ-22.7	1	<0.50	ND	ND

Table 2 - Summary of Historical Indoor Air Data
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building No.	Sample Date	Sample Location	Floor	PCE (µg/m^3)	TCE (µg/m^3)	cDCE (µg/m^3)
330D	9/26/07	AT31	1	**47.7**	ND	ND
		AY35	1	**6.4**	ND	ND
		BA28	1	**37.4**	ND	ND
		BA39	1	**5.9**	ND	ND
		BA44	1	**3.8**	ND	ND
		BA45	1	**5.2**	ND	ND
		BB40	1	**5.5**	ND	ND
		BC32	1	**19.7**	ND	ND
		BD24	1	**261.9**	ND	ND
		BE28	1	**3.6**	ND	ND
		AX25	2	**4.8**	ND	ND
		AX31	2	**23.4**	ND	ND
		AZ45	2	**15.3**	ND	ND
		BC36	2	**21.8**	ND	ND
		BD33	2	**19.9**	ND	ND
		BE29	2	**20.2**	ND	ND
		BJ45	2	**8.5**	ND	ND
		RTO 5	Outside	<0.5	ND	ND
	11/1/07	BA26	1	**4.2**	ND	ND
		BD24	1	**174.0**	ND	ND
		BD25	1	**7.8**	ND	ND
		BE26	1	**6.5**	ND	ND
		BF26 Return Air	1	**7.2**	ND	ND
		BG36 Return Air	1	**6.5**	ND	ND
		CS 3407	1	**3.1**	ND	ND
		CS3401	1	**21.5**	ND	ND
		CS3403	1	**7.1**	ND	ND
		RTO 5	1	<0.52	ND	ND
	11/15/07	AX31	2	**10.4**	ND	ND
		BB31	2	**7.0**	ND	ND
		BF31	2	**1.9**	ND	ND
		BG31	2	**2.8**	ND	ND
		RTO 5	Outside	**0.8**	ND	ND
	11/16/07	AX31	2	**10.2**	ND	ND
		BB31	2	**14.6**	ND	ND
		BF31	2	**11.6**	ND	ND
		BG31	2	**16.6**	ND	ND
		RTO 5	Outside	**0.6**	ND	ND
	11/26/07	Air intake North	1	**1.7**	ND	ND
		Air intake South	1	**2.4**	ND	ND
		AZ-26	1	**5.3**	ND	ND
		BA-25	1	**6.3**	ND	ND
		BB-25	1	**8.9**	ND	ND
		BC-23	1	**200.0**	**3.4**	**2.9**
		BD-23	1	**277.2**	**3.1**	**2.8**
		BD-24	1	**344.8**	**3.9**	**3.5**
		BF-24	1	**531.3**	**2.8**	**2.6**
		CS 3406	1	**11.4**	ND	ND
		RTO 5	Outside	**1.0**	ND	ND
	12/17/07	AY-41	2	**3.5**	ND	ND
		AZ-37	2	**4.3**	ND	ND
		BF-45	2	**1.8**	ND	ND
	1/3/08	AZ-25	2	**17.6**	ND	ND
		BE-34	2	**11.0**	ND	ND

Notes:

1. This table presents a summary of analytical results from indoor air samples collected by IBM in 2007 and January 2008.
2. Samples were analyzed by the IBM Hudson Valley Environmental Laboratory (IBM Lab) using a modified USEPA Method 18 - Measurement of Gaseous Organic Compounds by Gas Chromatography (GC).
3. IBM provided these data to SHA in electronic format in a table entitled "IBM EFK Indoor Air Samples Collected in 2007."
4. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 micrograms per cubic meter (µg/m^3).

Table 3 - Source Investigation Buildings

VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building	**Subsurface VOC Source Data**					**2007 Indoor Air Data**				**Scoping Consideration**					**Discussion**
				Vadose Zone Sourcing											
	None Known	Bedrock GW	Overburden GW	Probable	Confirmed	No AHU Sampled	No. of Air Samples	Summary Results PCE ($\mu g/m^3$)	Other Compounds Detected?	Occupied	Historical Solvent Use/Storage	VOC Presence in Overburden or Bedrock GW	Probable or Confirmed Vadose Zone Source	Anomalous Levels of PCE in Indoor Air	
310		✓	✓	✓		5	7	0.9 to 120	TCE, cDCE	✓	✓	✓	✓	✓	Anomalous levels of PCE identified in past sampling.
330D		✓	✓		✓	10	47	1.8 to 530	TCE, cDCE	✓	✓	✓	✓	✓	Anomalous levels of PCE identified in past sampling. Source assessment underway has confirmed a subsurface source of VOCs.
2	**Buildings**					**590,700 square feet, approximate gross footprint**									

Notes:

1. This table is intended to summarize the rationale for performing VOC source investigations in the above-listed buildings based upon the information and inference derived from review of available information summarized here and in Table 1. This information is further described in Table 1 and is discussed in the text of the RFI Work Plan.

2. Please refer to Table 1 for additional notes.

Table 4 - Confirmatory Sampling Buildings

VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building	Subsurface VOC Source Data					2007 Indoor Air Data				Scoping Considerations					Discussion
	None Known	Bedrock GW	Overburden GW	Vadose Zone Sourcing		No AHU Sampled	No. of Air Samples	Summary Results PCE ($\mu g/m^3$)	Other Compounds Detected?	Occupied	Historical Solvent Use/Storage	VOC Presence in Overburden or Bedrock GW	Probable or Confirmed Vadose Zone Source	Anomalous Levels of PCE in Indoor Air	
				Probable	Confirmed										
300		✓				10	9	All < 0.5	No	✓	✓	✓			Solvents were historically used in this building.
308		✓	✓			3	7	1.5 to 3.6	cDCE	✓		✓			The building overlies contaminated overburden groundwater. PCE was detected in indoor air. Further assessment of spatial variability is warranted.
309			✓			1	2	All < 0.5	No	✓	✓	✓			Solvents were historically used in this building. The building overlies contaminated groundwater.
320B		✓				4	4	0.7 to 1.1	TCE, cDCE	✓	✓	✓			Solvents were historically used in this building. PCE was detected in indoor air. Further assessment of spatial variability is warranted.
322			✓	✓		Not Sampled				✓	✓	✓	✓		Solvents were historically used in this building. The building overlies contaminated overburden groundwater and probable vadose zone contamination. No indoor air samples have been collected in this building.
323			✓			Not Sampled				✓	✓	✓			Solvents were historically used in this building. The building overlies contaminated overburden groundwater. No indoor air samples have been collected in this building.
330C		✓	✓		✓	2	2	< 0.5 to 12	No	✓	✓	✓	✓		Solvents were historically used in this building. The building overlies contaminated overburden groundwater and vadose zone contamination. PCE was detected in indoor air. Further assessment of spatial variability is warranted.
334		✓				Not Sampled				✓	✓	✓			Solvents were historically used in this building. No indoor air samples have been collected in this building.
338			✓			1	5	< 0.5 to 1.0	No	✓		✓			The building overlies contaminated overburden groundwater. PCE was detected in indoor air samples. Further assessment of spatial variability is warranted.
386			✓			1	1	< 0.5	No	✓		✓			The building overlies contaminated overburden groundwater.
10	**Buildings**					**1,447,800**	**square feet, approximate gross footprint**								

Notes:

1. This table is intended to summarize the rationale for performing confirmatory sampling in the above-listed buildings based upon the information and inference derived from review of available information summarized here and in Table 1. This information is further described in Table 1 and is discussed in the text of the RFI Work Plan.

2. Please refer to Table 1 for additional notes.

Table 5 - No Further Assessment Buildings

VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Building	Subsurface VOC Source Data					2007 Indoor Air Data				Scoping Considerations					Discussion
	None Known	Bedrock GW	Overburden GW	Vadose Zone Sourcing		No AHU Sampled	No. of Air Samples	Summary Results PCE ($\mu g/m^3$)	Other Compounds Detected?	Occupied	Historical Solvent Use/Storage	Overburden or Bedrock GW Contamination	Probable or Confirmed Vadose Contamination	Anomalous Levels of PCE in Indoor Air	
				Probable	Confirmed										
303	✓					Not Sampled					✓				Building is a routinely unoccupied chemical bulk storage facility. No known subsurface source of contamination.
304	✓					1	2	All < 0.5	No	✓	✓				No known historical sources of subsurface contamination. No known subsurface source of contamination. PCE was not detected in indoor air samples. Building is a container chemical storage facility.
312	✓					Not Sampled									Building is a routinely unoccupied industrial waste treatment facility. No know subsurface source of contamination.
315			✓			1	1	0.7	No	✓		✓			Current building is used as the industrial utility plant and an industrial waste treatment facility. Relatively low levels of PCE were detected in indoor air samples.
316			✓			2	2	3.0 to 4.7	TCE, cDCE	✓		✓			Building houses the central groundwater treatment system where millions of gallons of VOC-containing groundwater is treated daily as normal occupational use.
317			✓			Not Sampled						✓			Building is routinely unoccupied and houses an industrial process system.
320A	✓					5	5	< 0.5 to 0.6	No	✓					No known historical solvent use and no known sources of subsurface contamination. PCE was not detected in indoor air samples.
321		✓				4	4	All < 0.5	No	✓		✓			No known historical solvent use. VOC contamination is only in deep bedrock groundwater. PCE was not detected in indoor air samples.
323A		✓				Not Sampled				✓		✓			No known historical solvent use. VOC contamination is only in deep bedrock groundwater.
325	✓					Not Sampled				✓					No known historical solvent use and no known sources of subsurface contamination.
327	✓					Not Sampled									Building is routinely unoccupied. No known historical solvent use and no known sources of subsurface contamination.
328	✓					Not Sampled									Building is routinely unoccupied. No known historical solvent use and no known sources of subsurface contamination.
329	✓					Not Sampled									Building is routinely unoccupied. No known historical solvent use and no known sources of subsurface contamination.
335		✓	✓	✓		Not Sampled					✓	✓	✓		Building is routinely unoccupied.
343	✓					Not Sampled									Building is routinely unoccupied. No known historical solvent use and no known sources of subsurface contamination.
384		✓	✓		✓	Not Sampled					✓	✓	✓		Building is unoccupied and currently used for treatment of chlorinated ethene-contaminated groundwater as normal occupational use.
385			✓			Not Sampled						✓			Building is routinely unoccupied and used as a chemical storage, recycling, decontamination, and waste water treatment facility as part of normal occupational use.
17	**Buildings**					**671,000 square feet, approximate gross footprint**									

Notes:

1. This table is intended to summarize the rationale for not performing further source investigations or confirmatory sampling in the above-listed buildings based upon the information and inference derived from review of available information summarized here and in Table 1. This information is further described in Table 1 and is discussed in the text of the RFI Work Plan.

2. Please refer to Table 1 for additional notes.

Table 6 - Analyte List
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Analyte Name	Physical/Chemical Properties					Analytical Laboratory Methods and Nominal Reporting Limits									
						USEPA Method TO-15, Hi/Lo	Modified Method 18			USEPA Method TO-17		NIOSH Method 1003		Method AM 4.02	USEPA Method 8260B
	Molecular Weight	Aqueous Solubility	Vapor Pressure	Henry's Law Constant (25°C)	Free Air Diffusion Coefficient	Summa Canister	Tedlar Bags	Sorbent Tubes	Passive Samplers	Sorbent Tubes	Passive Samplers	Passive Samplers		Glass Vials	Concrete Samples
		mg/L	torr (mm Hg, 0°C)	atm-m^3 /mol	cm^2/sec	RL (µg/m^3)	RL (µg/m^3)	RL (µg/m^3)	RL (µg/m^3)	RL (nG)	RL (µg/m3)	RL (ug)	RL (µg/m3)	RL (µg/m^3)	RL (µg/kg)
Tetrachloroethene (PCE)	165.8	200	18.6	1.8E-02	7.2E-02	1.4	0.5	0.5	0.5	10	0.074	5	100	69	1.0
Trichloroethene (TCE)	131.4	1,100	73.5	1.0E-02	7.9E-02	0.22	0.5	0.5	0.5	10	0.068	-	-	55	1.0
cis-1,2-Dichloroethene (cDCE)	96.9	3,500	202.9	4.1E-03	7.4E-02	0.80	0.5	0.5	0.5	10	0.065	-	-	81	1.0
1,1-Dichloroethene (DCE)	96.9	2,250	600.0	2.6E-02	9.0E-02	0.80	-	-	-	10	-	-	-	40	1.0
Vinyl chloride (VC)	62.5	2,760	2,981.6	2.7E-02	1.1E-01	0.06	-	-	-	-	-	-	-	2,600	2.0
1,1,1-Trichloroethane (TCA)	133.4	1,330	123.7	1.7E-02	7.8E-02	1.1	-	-	-	10	-	-	-	28	1.0
Carbon tetrachloride	153.8	793	115.0	3.0E-02	7.8E-02	0.24	-	-	-	10	-	-	-	32	1.0
Methylene chloride (MeCl)	84.9	13,030	433.1	2.2E-03	1.0E-01	1.4	-	-	-	10	-	-	-	7,060	10
Chlorobenzene	112.6	472	12.0	3.0E-03	7.3E-02	0.92	-	-	-	10	-	-	-	468	1.0
1,2,4-Trichlorobenzene	181.5	34.6	0.4	1.4E-03	3.0E-02	7.4	-	-	-	50	-	-	-	742	5.0
1,2-Dichlorobenzene	147.0	156	1.4	1.9E-03	6.9E-02	1.2	-	-	-	10	-	-	-	611	5.0
1,3-Dichlorobenzene	147.0	133	2.2	3.1E-03	6.9E-02	1.2	-	-	-	10	-	-	-	611	5.0
1,4-Dichlorobenzene	147.0	73.8	1.0	2.4E-03	6.9E-02	1.2	-	-	-	10	-	-	-	611	5.0
Acetone	58.1	1,000,000	230.0	3.9E-05	1.2E-01	2.4	-	-	-	-	-	-	-	2,420	10
Benzene	78.1	1,750	95.0	5.6E-03	8.8E-02	0.64	-	-	-	10	-	-	-	325	1.0
Ethylbenzene	106.2	169	9.6	7.9E-03	7.5E-02	0.86	-	-	-	10	-	-	-	441	1.0
m-Xylene	106.2	161	8.5	7.3E-03	7.0E-02	0.86	-	-	-	10	-	-	-	882	2.0
p-Xylene	106.2	185	8.9	7.7E-03	7.7E-02		-	-	-			-	-		
o-Xylene	106.2	178	6.6	5.2E-03	8.7E-02	0.86	-	-	-	10	-	-	-	441	2.0
Toluene	92.1	526	28.4	6.6E-03	8.7E-02	0.77	-	-	-	10	-	-	-	383	1.5
Trichlorofluoromethane (Freon 11)	137.4	1,100	802.8	9.7E-02	8.7E-02	1.1	-	-	-	10	-	-	-	28	5.0
Dichlorodifluoromethane (Freon 12)	120.9	280	4,847.8	3.4E-01	8.0E-02	1.0	-	-	-	10	-	-	-	25	10
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	187.4	170	331.6	4.8E-01	2.9E-02	1.5	-	-	-	10	-	-	-	-	See Note 4

NOTES:

1. This table summarizes the proposed analytes along with expected reporting limits (RLs) for various analytical laboratory testing analysis.

2. RLs for United States Environmental Protection Agency (USEPA) Method TO-15 (Hi/Lo) and USEPA Method TO-17 were provided by Air Toxics Ltd. of Folsom, California; RLs for NIOSH Method 1003 were provided by Galson Laboratories of East Syracuse, New York; RLs for Method AM 4.02 were provided by Microseeps, Inc. of Pittsburgh, Pennsylvania; and RLs for USEPA Method 8260B were provided by Alpha Analytical, Inc. of Westborough, Massachusetts.

3. Actual RLs for field samples may be higher due to procedures associated with the preparation of field samples for analysis and will be a function of the actual sample volume provided to the laboratory, matrix effects, and other factors. The expected RLs for the TO-15 Hi/Lo analysis are presented with a presumed dilution factor of two, which is based on anticipated sample dilution during canister pressurization and possible dilution due to matrix interference.

4. The specified compound(s) are not included on the target analyte list for this analysis, but will be reported as tentatively identified compounds (TICs).

5. Physical and chemical property data were complied from information provided in the United States Environmental Protection Agency (USEPA) Superfund Chemical Data Matrix as provided at http://www.dep.state.pa.us/physicalproperties/CPP_Search.htm. When data was not available from the USEPA Superfund Chemical Data Matrix, the USEPA Region IX Preliminary Remediation Goals (PRG) chemical property database as provided at http://www.dep.state.pa.us/physicalproperties/CPP_Search.htm was used.

6. The analyte list for passive sampling devices represents the analytes with laboratory RLs for the sampling and analysis methodology and does not include analytes with poor uptake properties or those causing matrix intereferences.

Table 7 - Project Contact List

VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Company / Name	Role	Phone	E-mail
IBM			
David Speed, Ph.D.	Primary IBM contact for the RFI Work Plan	(845) 892-3176	speed@us.ibm.com
Jonathan Holder	Support for implementation of RFI Work Plan	(845) 892-1650	holder@us.ibm.com
Glenn Morrison, CIH	Industrial hygiene support	(845) 894-4354	gmorris1@us.ibm.com
Sanborn, Head Engineering, P.C. / Sanborn, Head & Associates, Inc. (SHA) Consultant/Engineer – responsible for implementing field sampling programs, data evaluation/management, reporting, and mitigation engineering support, if necessary.			
Brad Green, P.G.	Sr. Project Manager – Confirmatory Sampling	(603) 415-6160	bgreen@sanbornhead.com
Claire Lund, P.E.	Sr. Project Manager – Source Investigations	(603) 415-6144	clund@sanbornhead.com
David Shea, P.E.	Engineering Lead	(603) 415-6130	dshea@sanbornhead.com
Jim Chabot, P.E.	Engineering Support	(603) 415-6125	jchabot@sanbornhead.com
Daniel Carr, P.E.	Technical review and support	(207) 347-4714	dcarr@sanbornhead.com

Table 8 - Building 322 Confirmatory Indoor Air Sampling Results

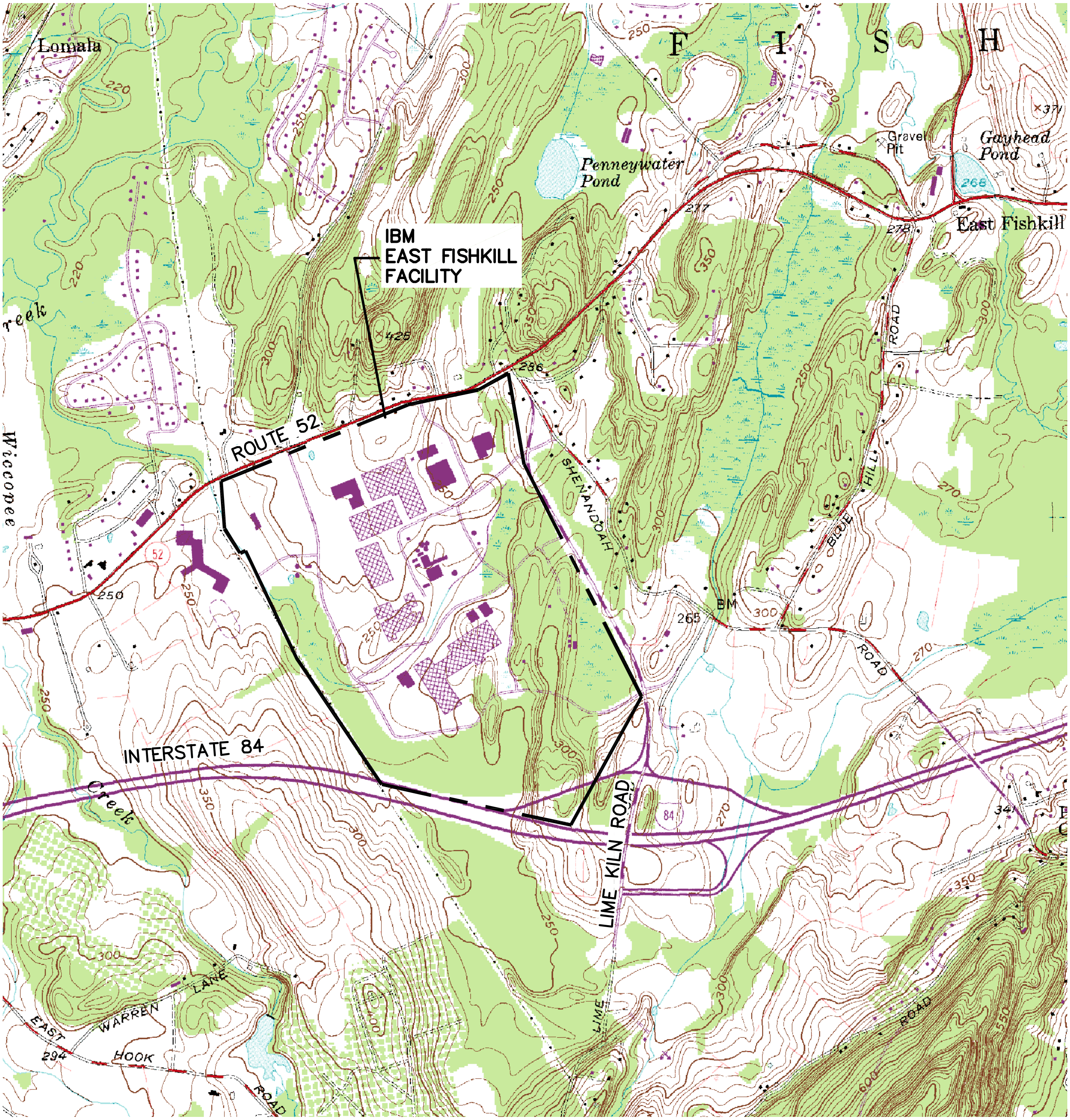
VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Analyte	**Column/Sample ID:**	**B-8**	**C-15**	**C-21**	**F-12**	**F-8**	**G-26**	**I-15**	**I-21**	**J-8**
	Date:	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**	**8/21/08**
Acetone		**27**	**150**	**10**	**53**	**24**	**10**	**22**	**22**	**6.6**
Benzene		<0.56	<0.57	<0.56	<0.57	**0.54**	<0.58	<0.58	<0.58	<0.55
Chlorobenzene		<0.80	<0.82	<0.80	<0.82	<0.77	<0.84	<0.84	<0.84	<0.79
Dichlorobenzene (1,2-)		<1.0	<1.1	<1.0	<1.1	<1.0	<1.1	<1.1	<1.1	<1.0
Dichlorobenzene (1,3-)		<1.0	<1.1	<1.0	<1.1	<1.0	<1.1	<1.1	<1.1	<1.0
Dichlorobenzene (1,4-)		<1.0	<1.1	<1.0	<1.1	<1.0	<1.1	<1.1	<1.1	<1.0
Dichloroethene (1,1-)		<0.69	<0.71	<0.69	<0.71	<0.67	<0.72	<0.72	<0.72	<0.68
Dichloroethene (cis-1,2-)		<0.69	<0.71	<0.69	<0.71	<0.67	<0.72	<0.72	<0.72	<0.68
Ethyl Benzene		<0.76	<0.78	<0.76	<0.78	<0.73	<0.79	<0.79	<0.79	<0.74
Freon 11		**1.2**	**1.3**	**1.1**	**1.2**	**1.3**	**1.5**	**1.2**	**1.4**	**1.2**
Freon 113		<1.3	<1.4	<1.3	<1.4	<1.3	<1.4	<1.4	<1.4	<1.3
Freon 12		**2.5**	**2.3**	**1.9**	**2.1**	**2.9**	**2.0**	**2.5**	**2.4**	**2.5**
Methylene Chloride		<1.2	<1.2	<1.2	<1.2	<1.2	<1.3	<1.3	<1.3	<1.2
Tetrachloroethene		<1.2	<1.2	<1.2	<1.2	<1.1	<1.2	<1.2	<1.2	<1.2
Toluene		**1.2**	**0.82**	**0.70**	**0.76**	**1.8**	**0.71**	**0.69**	**0.73**	**0.86**
Trichlorobenzene (1,2,4-)		<6.5 J	<6.6 J	<6.5 J	<6.6 J	<6.2 J	<6.8 J	<6.8 J	<6.8 J	<6.3 J
Trichloroethane (1,1,1-)		<0.95	<0.98	<0.95	<0.98	**3.9**	<1.0	<1.0	<1.0	<0.93
Trichloroethene		<0.94	<0.96	<0.94	<0.96	**1.9**	<0.98	<0.98	<0.98	<0.92
Vinyl Chloride		<0.45	<0.46	<0.45	<0.46	<0.43	<0.47	<0.47	<0.47	<0.44
Xylene (m,p-)		<0.76	<0.78	<0.76	<0.78	**0.93**	<0.79	<0.79	<0.79	<0.74
Xylene (o-)		<0.76	<0.78	<0.76	<0.78	<0.73	<0.79	<0.79	<0.79	<0.74

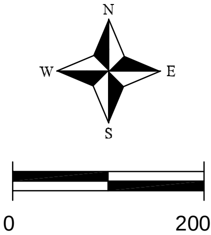
Notes:

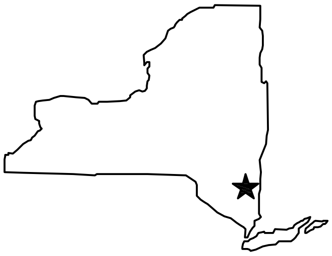
1. Indoor air sample concentrations are expressed in units of micrograms per cubic meter (ug/m^3).
2. Indoor samples were collected by SHA personnel on August 21, 2008 using 6-liter summa canisters equipped with 8-hour flow controllers.
3. Sample analysis was completed by Air Toxics Limited (ATL) of Folsom, CA, using USEPA Method TO-15.
4. "<" Indicate a non-detection at the reporting limit shown.
   "J" Indicates an estimated value.
5. **Bold** values indicate the analyte was detected above reporting limits.

FIGURES



Notes:
Base map taken from 7.5 minute
USGS Quadrangle Maps: Hopewell Junction,
New York, Dated 1957, Photorevised in 1981.





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PLOT DATE: 6-8-09

SHPC
E N G I N E E R S

Drawn By:	E. Wright
Designed By:	C. Lund
Reviewed By:	D. Shea
Date:	June 2009

Figure 1

Locus Plan

RFI Work Plan VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

Figure 2

Site Plan

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: C. Lund
Reviewed By: D. Shea
Date: June 2009

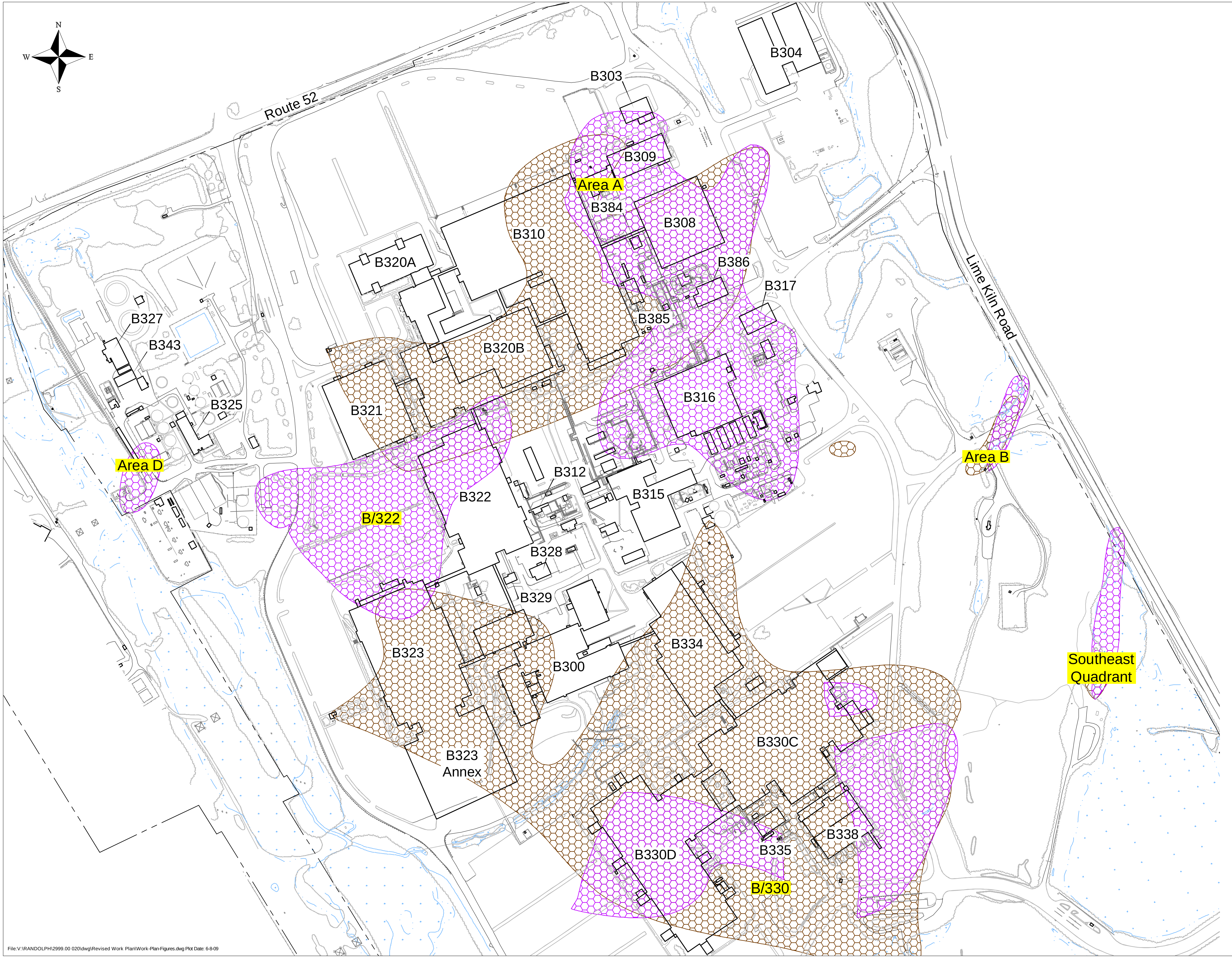

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Figure Narrative

This figure identifies the site buildings, the Areas of Concern (AOCs) subject to corrective action under IBM's Part 373 Permit, and the inferred extent of VOCs in overburden and bedrock groundwater. Please note that the deep bedrock aquifer underlying the site is also considered an AOC.

Legend

— — —	IBM Property Line
⌂	Unlabeled features include wastewater treatment tanks, pump houses, trailers, and other structures and features not intended for human occupancy
B310	Indicates building number
Area A	Indicates Area of Concern
▨	Inferred extent of VOCs in overburden groundwater
▨	Inferred extent of VOCs in bedrock groundwater

200' 100' 0 200' 400' Feet

ENGINEERS

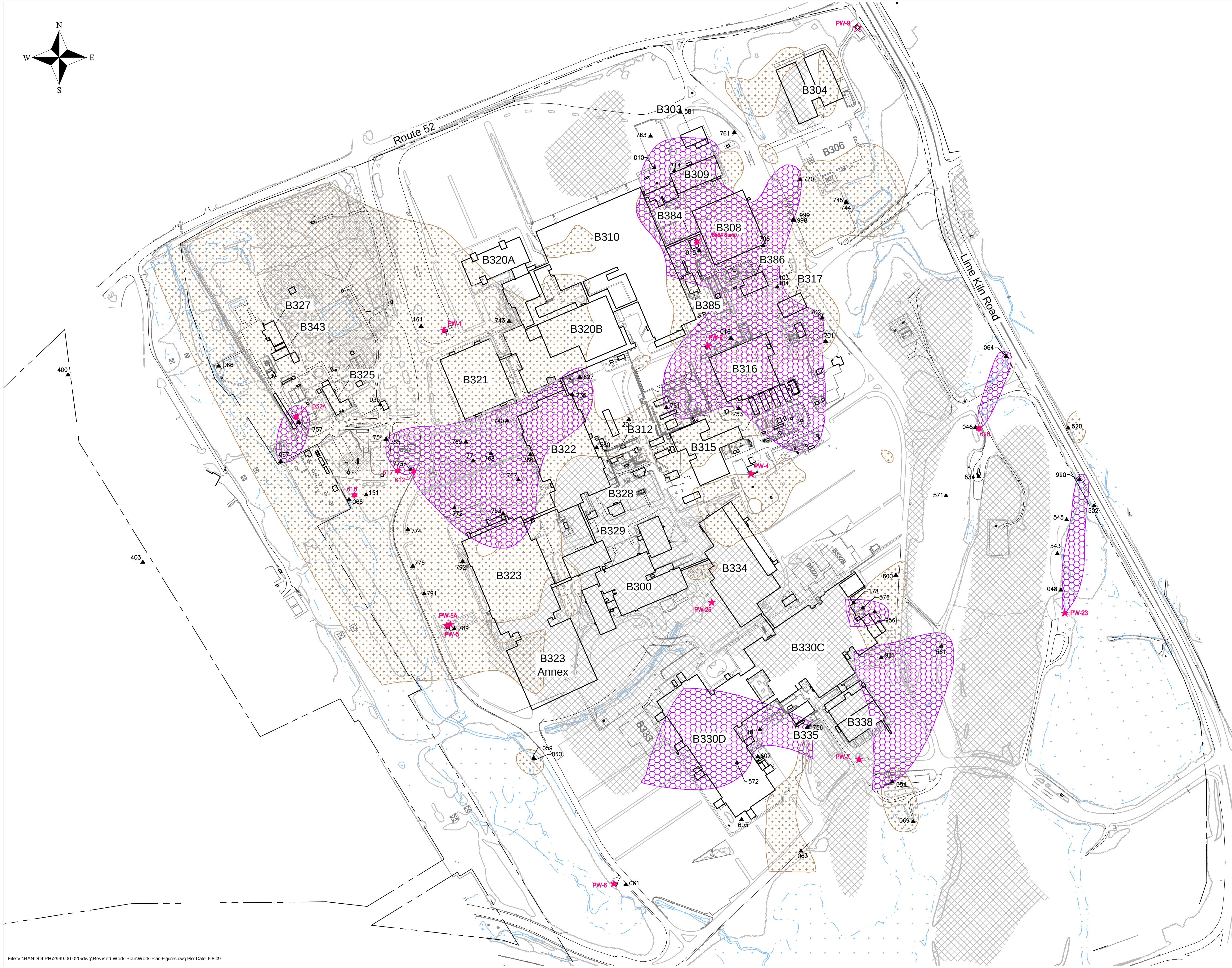

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Figure 3

Extent of VOCs in Overburden Groundwater

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: C. Lund
Reviewed By: D. Shea
Date: June 2009

Figure Narrative

This figure shows the inferred areal extent of key volatile organic compounds (VOCs) in the uppermost zone of overburden saturation, which typically occurs where groundwater is perched on a glaciolacustrine silt and clay layer beneath portions of the site. As depicted on the figure, the silt and clay layer is absent over much of the southern portion of the site, and discontinuous elsewhere. The inferred extent of key VOCs comprises chlorinated ethenes and chlorofluorocarbons (CFCs), and is based on groundwater RCRA Facility Investigations completed by IBM for Buildings 322 and 330 in 1997, as well as data and figures presented in the site's 2007 Annual Corrective Action Status Report prepared by Groundwater Sciences Corporation dated May 29, 2008.

Legend

▲	GMP Soil Monitoring Well
●	GMP Soil/Bedrock Monitoring Well
★	Bedrock Extraction Well
☆	Inactive Bedrock Extraction Well (as of mid-January 2003)
✱	Shallow Extraction Well
⊓	Unlabeled features include wastewater treatment tanks, pump houses, trailers, and other structures not intended for human occupancy
B306	Former Structure
▨	Extent of Glaciolacustrine Clay (Mapping)
▨	Inferred Area of No Saturated Soil (Approximate)
▨	Inferred Extent of VOCs in Overburden Groundwater

250' 125' 0 250' 500'
Feet

SHPC
ENGINEERS

Figure 4

Extent of VOCs in Bedrock Groundwater

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: C. Lund
Reviewed By: D. Shea
Date: June 2009

Figure Narrative

This figure shows the inferred areal extent of total volatile organic compounds (VOCs) in bedrock groundwater. The inferred extent of key VOCs comprises chlorinated ethenes and chlorofluorocarbons (CFCs), and is based on groundwater RCRA Facility Investigations completed by IBM for Buildings 322 and 330 in 1997, as well as data and figures presented in the site's 2007 Annual Corrective Action Status Report prepared by Groundwater Sciences Corporation dated May 29, 2008.

Legend

▼	GMP Bedrock Monitoring Well
★	Bedrock Extraction Well
☆	Inactive Bedrock Extraction Well (as of mid-January 2003)
✱	Shallow Bedrock Extraction Well
⌴	Unlabeled features include wastewater treatment tanks, pump houses, trailers, and other structures and features not intended for human occupancy
B306	Former Structure
▨	Inferred Extent of VOCs in Bedrock Groundwater

250' 125' 0 250' 500'
Feet

SHPC
ENGINEERS

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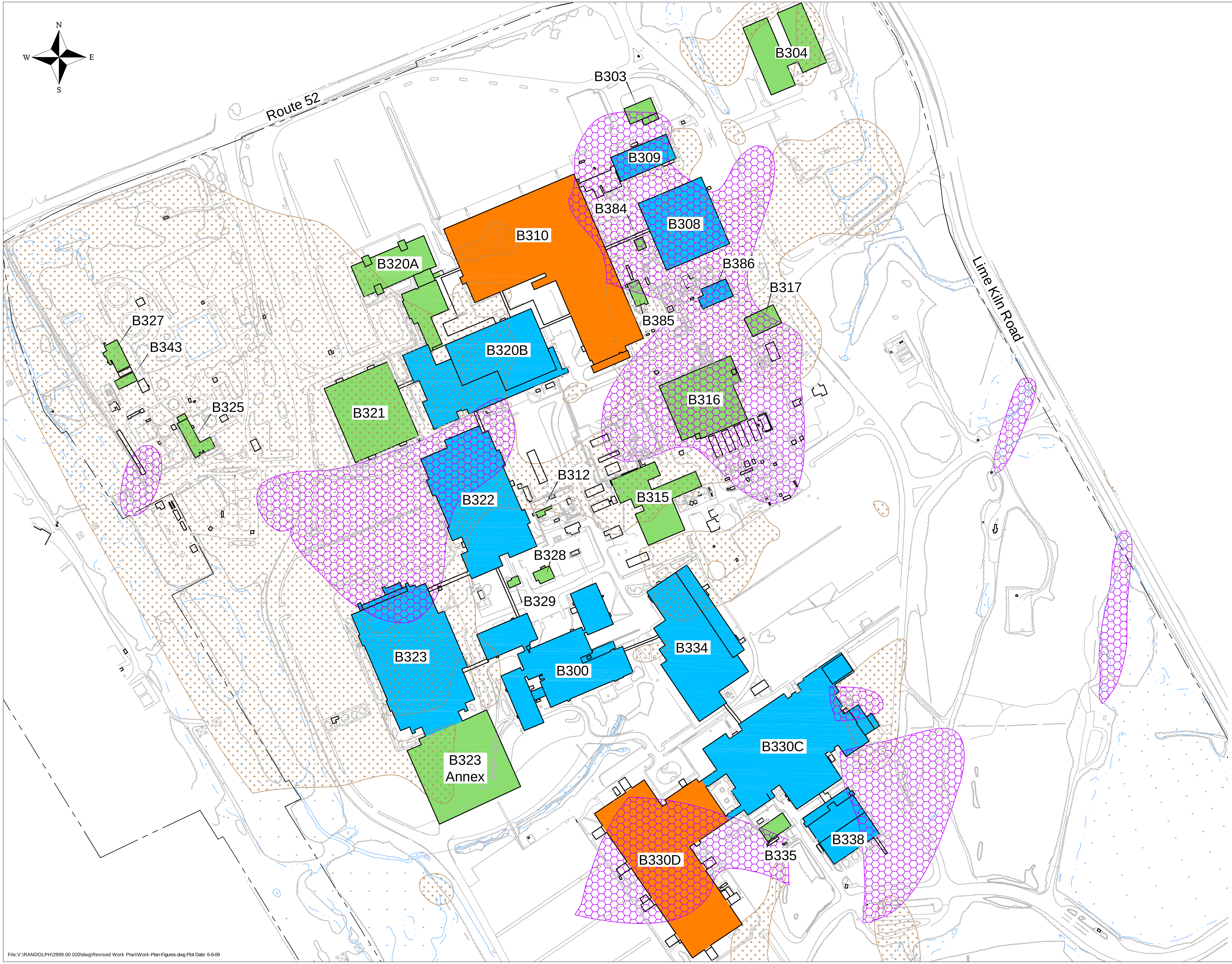

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Figure 5

Summary of Proposed Investigations and Sampling

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: C. Lund
Reviewed By: D. Shea
Date: June 2009

Figure Narrative

This figure presents an overview of buildings proposed for confirmatory sampling or VOC source investigations, as well as buildings proposed for no further assessment, as indicated in the legend. Factors considered in designating buildings as shown included human occupancy, current use/function, historical solvent use, subsurface VOC contamination data, and existing indoor air data. Further details are provided in the work plan text and tables.

Legend

⌐	Unlabeled features include wastewater treatment tanks, pump houses, trailers, and other structures and features not intended for human occupancy
B310	Indicates building number
🟩	No further assesment
🟦	Confirmatory sampling
🟧	Source investigation
▨	Extent of glaciolacustrine clay
▨	Inferred extent of VOCs in overburden groundwater

200' 100' 0 200' 400' Feet

APPENDIX A

PROCEDURES AND PROTOCOLS

APPENDIX A.1

PROCEDURE FOR INDOOR AIR SAMPLING AND ANALYSIS USING SUMMA® - TYPE CANISTER

SANBORN, HEAD ENGINEERING, PC
20 Foundry Street ▪ Concord, NH 03301
P (603) 229-1900 ▪ F (603) 229-1919

APPENDIX A.1
Procedure for Indoor Air Sampling and Analysis Using SUMMA®-type Canisters

Purpose:

This document provides guidance for the setup and collection of indoor air samples from industrial and multi-use buildings for laboratory analysis of volatile organic compounds (VOCs). Indoor air samples will be collected using SUMMA®-type air canisters equipped with metering regulators. The purpose of the collection method is to obtain a "time-weighted average" or "time-integrated" indoor air sample.

Equipment and Materials:

- Photoionization Detector (PID) equipped with 10.6 eV lamp and/or Flame Ionization Detector (FID)
- Wristwatch
- Open-end wrenches including two $^{9}/_{16}$-inch, one ½-inch, and one adjustable
- Indoor Air Sampling Summary Form (attached)

Laboratory Provided Equipment and Materials:

- 6-liter, stainless steel, pre-evacuated SUMMA® canister, individually certified clean (100% certification)
- Pressure gauge with integrated 8-hour metering regulator and inline 2-micron filter
- Laboratory chain-of-custody (COC) form

Procedure for Indoor Air Sample Collection:

The steps provided below should be considered a general guidance on the collection of indoor air samples; the sequence can be modified as needed based on site-specific conditions at the time of sample collection. This procedure does not address the documentation of historical and current building usage, VOC storage areas, and HVAC system information, as it is anticipated that documentation of this information will be performed prior to initiating the indoor air sampling event.

Selection and Preparation of Sample Collection Area

A. Observe the area for the apparent presence of items or materials that may potentially produce or emit VOCs and interfere with analytical laboratory analysis of the collected sample. Record relevant information on the Indoor Air Sampling Summary Form.

B. Using the PID (ppb detection limit PID is preferred) and/or FID, screen indoor air in the location intended for sampling and in the vicinity of potential VOC sources to preliminarily assess for the potential gross presence of VOCs (note that the detection limits for the laboratory analyses to be performed on the samples collected are considerably lower than the detection limits of the PID and FID). Record PID or FID readings on the Indoor Air Sampling Summary form. If the purpose of the indoor air sampling is to assess vapor intrusion (VI), items or materials within the building exhibiting PID or FID readings shall be considered probable sources of VOC interferences and isolated or removed prior to sampling if possible. If practicable, sampling will be rescheduled for 24-hours later.

Preparation of SUMMA® Canister Samples and Collection of Sample

The procedure for the collection of SUMMA® canister samples is provided below.

A. Place SUMMA® canister on a stable surface within the breathing zone (e.g., about five feet above the floor) in a secure location that will not interfere with worker safety or manufacturing operations. In general, areas near windows or other potential sources of 'drafts' and air supply vents shall be avoided unless those areas are being specifically targeted for indoor air quality assessment.

B. Confirm that that SUMMA® canister serial number and flow metering regulator serial number are identical and record on the Indoor Air Sampling Summary Form and COC. If the serial numbers do not match, the SUMMA® canister and metering regulator will not be used for sample collection and will be replaced with a matching SUMMA® canister and flow metering regulator set.

C. Assign sample identification (see Appendix A.4 for guidance) on canister ID tag, and record on the Indoor Air Sampling Summary Form and COC.

D. Remove brass plug from canister fitting.

E. Install pressure gauge/metering regulator assembly on canister valve fitting and tighten. Install the brass plug from canister fitting onto the open end of the pressure gauge/metering regulator assembly and tighten. Check all other fittings on pressure gauge/flow metering regulator for tightness.

F. Quickly open and close canister valve. If the vacuum gauge reading begins to drop (i.e., returns to zero), then the assembly is leaking and the fittings need to be tightened or reconfigured. Repeat this step if tightening or reconfiguration is required.

G. Once the pressure gauge/metering regulator assembly is deemed leak-tight, record the gauge pressure on the indoor Air Sampling Summary Form and COC. The pressure gauge must read 28 ± 2 inches Hg vacuum. Replace SUMMA® canister if pressure gauge initially reads a vacuum outside this range.

H. Remove brass plug from gauge fitting and store for later use.

I. Open SUMMA® canister valve to initiate sample collection.

J. Record date and local time (24-hour basis) of valve opening on the Indoor Air Sampling Summary Form and COC.

K. Revisit SUMMA® canister approximately once during the sample collection period (e.g., 4 hours after initiation of sample collection) and record any observed sampling discrepancies (e.g., no observed change in pressure gauge reading). For example, four hours after initiation of an 8-hour integrated sample the gauge should indicate a vacuum of approximately 17 inches Hg (approximately 2.5 liters of sample volume collected).

Termination and Shipment of Samples

A. Revisit SUMMA® canister approximately at end of sample collection period (e.g., 8 hours after initiation of sample collection) and record gauge pressure on sampling form and COC. The final vacuum of the SUMMA® canister should be between 3 to 10 inches Hg.

B. Record date and local time (24-hour basis) of valve closing on Indoor Air Sampling Summary form and COC.

C. Close SUMMA® canister valve.

D. Remove pressure gauge/metering regulator assembly from SUMMA® canister.

E. Reinstall brass plug on canister fitting and tighten.

F. Remove SUMMA® canister from sample collection area.

G. Pack SUMMA® canister in shipping container, verify installation of brass plug on tank fitting.

H. Complete COC and place requisite copies in shipping container.

I. Close shipping container and affix custody seal, if applicable, to container closure.

SUMMA® Canister Sample Analytical Method:

The SUMMA® canister samples shall be analyzed by a NYSDOH ELAP-certified laboratory using Method TO-15, analysis of VOCs by gas chromatography/mass mass spectrometry (GC/MS), for the target list of VOCs provided on Table 6 of the Work Plan.

Quality Assurance/Quality Control:

The collection of Quality Assurance/Quality Control (QA/QC) samples for the project will include the collection and submittal of duplicate samples for analyses of the target compounds. Duplicate samples will be collected using SUMMA® canisters placed in the same location (i.e., collocated or "side-by-side") and sampling concurrently over the same 8-hour time interval. Duplicate samples will be collected at a frequency of at least one per sample delivery group (SDG) or a minimum of one in every twenty samples (five percent).

In addition, field equipment blanks ("field blanks") will accompany sample containers (empty) to the field and the collected samples back to the lab. These equipment blanks will consist of a laboratory certified SUMMA® canister filled in the field with lab-grade nitrogen, and will not be opened during the course of its transport. Field blank collection frequency shall be one per SDG or a minimum of one in every twenty samples. Additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Final,* October 2006.
- New York State Department of Environmental Conservation, *NYSDEC Analytical Services Protocol*, relative to the Analysis of Air Samples for Volatile Organic Compounds (EPA TO-15), July 2005 as amended by the *NYSDEC Modifications to EPA Region 9 TO-15 QA/QC Criteria*, February 2008.
- Massachusetts Department of Environmental Protection, *Indoor Air Sampling and Evaluation Guide, WSC Policy #02-430*, April 2002, Appendix 4, Recommended SOP for Collection of Subatmospheric Air Samples.
- Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* November 2002.
- U.S. Environmental Protection Agency, 1990, *U.S. EPA Environmental Response Team, Standard Operating Procedures, Summa Canister Sampling, SOP 1704, Rev. 11/16/90.*
- Air Toxics Ltd. Environmental Analytical Laboratory, *Guide to Air Sampling and Analysis*, Fifth Revision, March 2007.
- U.S. Environmental Protection Agency, 1999, *Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Compendium Method TO-15,* Second Edition.

Attachments:

Indoor Air Sampling Summary Form

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Indoor Air Sampling Summary

SHA
IMPROVING EARTH

Project No.:
Date:
Project Name:
Building/Location:
Meters Used:
Project Manager:
Collector(s):

SAMPLING INFORMATION

Sample ID						
Sample Method/Device						
Sample Device(s) Serial No.						
Start Date/Time						
Start Pressure (inches Hg)						
Stop Date/Time						
Stop Pressure (inches Hg)						
Volume Air Sampled (L)						

OTHER SAMPLING INFORMATION

Story / Level						
Room / Area						
Indoor Air Temp (°F)						
HVAC Operating?						
Approximate Sample Height Above Floor Level (feet)						
Noticeable Odor?						
PID/FID Reading (ppmv)						
Duplicate Sample Designation						
Approximate Ceiling Height (feet)						
Comment Number						

COMMENTS

1.
2.
3.
4.
5.

APPENDIX A.2

PROCEDURE FOR INDOOR AIR SCREENING USING PASSIVE SAMPLER DEVICES

SHPC ENGINEERS

SANBORN, HEAD ENGINEERING, PC
20 Foundry Street ▪ Concord, NH 03301
P (603) 229-1900 ▪ F (603) 229-1919

APPENDIX A.2
Procedure for Indoor Air Screening Using Passive Sampler Devices

Purpose:

This document provides guidance for the deployment of passive sampler devices for screening indoor air within industrial and multi-use buildings for laboratory analysis of volatile organic compounds (VOCs). The purpose of the collection method is to obtain "diffusion-based" indoor air concentrations.

Equipment and Materials:

- Photoionization Detector (PID) equipped with 10.6 eV lamp and/or Flame Ionization Detector (FID)
- Wristwatch
- Indoor Air Sampling Summary Form (attached)
- Passive Sampler Device(s)
- Duct tape (or low-VOC tape)
- Laboratory chain-of-custody (COC) form

Procedure for Deployment of Passive Sampler Devices:

The steps provided below should be considered a general guidance on the collection of indoor air samples using passive sampling devices; the sequence can be modified as needed based on site-specific conditions at the time of sample collection. This procedure does not address the documentation of historical and current building usage, VOC storage areas, and HVAC system details, as it is anticipated that documentation of this information will be performed prior to initiating the indoor air sampling event.

Selection and Preparation of Sample Collection Area

A. Observe the area for the apparent presence of items or materials that may potentially produce or emit VOCs and interfere with analytical laboratory analysis of the collected sample. Record relevant information on the Indoor Air Sampling Summary Form.

B. Using the PID (ppb detection limit PID is preferred) and/or FID, screen indoor air in the location intended for sampling and in the vicinity of potential VOC sources to preliminarily assess for the potential gross presence of VOCs (note that the detection limits for the laboratory analyses to be performed on the samples collected are considerably lower than the detection limits of the PID and FID). Record PID or FID readings on the Indoor Air Sampling Summary form. If the purpose of the indoor air sampling is to assess vapor intrusion (VI), items or materials within the building exhibiting PID or FID readings shall be considered probable sources of VOC interferences and isolated or removed prior to sampling if possible. If practicable, sampling will be rescheduled for 24-hours later.

Preparation of Passive Sampling Device and Collection of Sample

The procedure for the collection of passive sampling device samples is provided below.

A. Remove the passive sampling device from its dedicated sample container.

B. Assign sample identification to passive sampling device (see Appendix A.4 for guidance), and record on the sample container, Indoor Air Sampling Summary Form, and COC.

C. Record date and local time (24-hour basis) of the passive sampling device deployment on the Indoor Air Sampling Summary Form and COC.

D. Place passive sampling device on the floor or on a stable surface in a secure location that will not interfere with worker safety or manufacturing operations. The passive sampling device should be placed face down (i.e., exposing the sampling media to the floor) for vapor intrusion screening and face up for screening indoor air concentrations. In general, areas near windows or other potential sources of 'drafts' and air supply vents shall be avoided unless those areas are being specifically targeted for indoor air quality assessment.

E. Secure the passive sampling device to the floor or surface using tape (or equivalent), being careful not to cover the sampling media.

Termination and Submittal of Passive Sampling Device Samples

A. Revisit passive sampling device approximately at the end of sample collection period, which is recommended to be at least 24 hours but not less than 8 hours. Check for signs that the sample may be compromised (e.g., crushed, damaged) and note any discrepancies on the Indoor Air Sampling Summary Form.

B. Collect the passive sample device and place in dedicated sample container. Record the date and local time (24-hour basis) the passive device was collected on the Indoor Air Sampling Summary Form and COC.

C. Complete the COC and retain requisite copies with the passive sampling devices.

D. Submit passive device samples to the laboratory for analysis.

Passive Sampling Device Sample Analytical Method:

The passive sampling device samples shall be analyzed by the laboratory using modified USEPA Method TO-17, analysis of volatile and semivolatile organic compounds by gas chromatography/mass spectrometry (GC/MS), modified USEPA Method 18 (see Appendix A.8), or National Institute for Occupational Safety and Health (NIOSH) Method 1003 for a target list of VOCs based on building-specific characteristics.

Modified TO-17

Modifications to Method TO-17 are based on changes to sample collection and preparation procedures required for using different sampling media (i.e., passive sampling devices versus active sampling with sorbent tubes). Additional modifications to Method TO-17 may be stipulated by the laboratory – these modifications will be documented along with the analytical results. For example, Air Toxics Ltd. of Folsom, California performs the following modifications to Method TO-17[1]:

Requirements	EPA Method TO-17	Air Toxics Ltd. Modifications
Lab Blank	At least 2 tubes from the same cleaning batch as the samples are analyzed at the beginning and end of the analytical sequence. Do not purge Lab Blanks	Sorbent media used for daily lab blank may or may not be from the same batch or sampling media. Only 1 lab blank is analyzed prior to sample analysis. Lab blanks are dry purged to eliminate the possibility of sample anomaly attributed to the dry purge process.
*Tune Check	4-Bromofluorobenzene (BFB).	Modification applies only to semivolatile lists such as polynuclear aromatic hydrocarbons (PAHs) in which a decafluorotriphenylphosphine (DFTPP) tune check is more appropriate to demonstrate accurate spectral performance.
*Sample desorption	Method involves primary and secondary desorption.	Modification applies only when using a Tekmar P&T system. After primary desorption, the stream of effluent gas is passed through 5 ml of clean purged D.I. water before the secondary desorption. D.I. water acts as a filter for excessive acidic moisture in the samples.

*Modifications are dependent on application.

The analytical results shall be presented in units of mass and converted to concentration data based on uptake rates for the analyte-specific diffusion constant. Uptake rate constants shall be calculated and validated by the passive sampling device manufacturer. The following formula should be used to estimate concentration data from analytical data for the passive sampling devices:

$$\left(\frac{M}{K*T}\right)*\left(10^{6}\right)= \text{Target Analyte Concentration } [\mu g/m^{3}]$$

where:

---

[1] Table 14-1. Summary of Method Modifications, TO-17, from Air Toxics Limited Methods Manual, Revision 16.1, 10/2007.

T = sample duration, minutes [min];
K = analyte-specific uptake rate constant, milliliters per minute [mL/min]; and
M = mass of analyte desorbed, micrograms [µg].

NIOSH Method 1003

This method, which is commonly used for industrial hygiene assessment, is intended for "screening-level" analysis to support VOC source investigation using passive sampling devices. The analytical technique is gas chromatograpy/flame ionization detection (GC/FID) after desorption of the badges using carbon disulfide. Refer to the Method specifications attached for further details.

Quality Assurance/Quality Control:

The collection of Quality Assurance/Quality Control (QA/QC) samples will include the submittal of blind field duplicates to the laboratory for analysis of the select target compounds. Duplicate samples will be collected at a frequency of at least one per sample delivery group (SDG) or a minimum of one in every twenty samples (five percent). Duplicate samples will be collected using "side-by-side" passive sampling device samplers over the same time interval. Additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* November 2002.

- New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Final,* October 2006.

- Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, *Compendium Method TO-17 – Determination of Volatile Organic Compounds in Ambient Air using Active Sampling onto Sorbent Tubes*.

- National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Fourth Edition, *Halogenated Hydrocarbons: Method 1003, Issue 3, March 15, 2003* (see attached).

Attachments:

Indoor Air Sampling Summary Form
NIOSH Method 1003 Specifications

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Indoor Air Sampling Summary

SHA
IMPROVING EARTH

Project No.:
Date:
Project Name:
Building/Location:
Meters Used:
Project Manager:
Collector(s):

SAMPLING INFORMATION

Sample ID						
Sample Method/Device						
Sample Device(s) Serial No.						
Start Date/Time						
Start Pressure (inches Hg)						
Stop Date/Time						
Stop Pressure (inches Hg)						
Volume Air Sampled (L)						

OTHER SAMPLING INFORMATION

Story / Level						
Room / Area						
Indoor Air Temp (°F)						
HVAC Operating?						
Approximate Sample Height Above Floor Level (feet)						
Noticeable Odor?						
PID/FID Reading (ppmv)						
Duplicate Sample Designation						
Approximate Ceiling Height (feet)						
Comment Number						

COMMENTS

1.

2.

3.

4.

5.

Modified for passive badges

HYDROCARBONS, HALOGENATED 1003

Table 1	MW: Table 2	CAS: Table 1	RTECS: Table 1

METHOD: 1003, Issue 3

EVALUATION: PARTIAL

Issue 1: 15 February 1984
Issue 3: 15 March 2003

OSHA : See TABLE 1
NIOSH: See TABLE 1
ACGIH: See TABLE 1

PROPERTIES: See TABLE 2

COMPOUNDS: See TABLE 1
(synonyms)

SAMPLING

SAMPLER:	SOLID SORBENT TUBE (coconut shell charcoal, 100 mg/50 mg) (Lot # 2000)
FLOW RATE:	0.01 to 0.2 L/min
VOL-MIN:	Table 3
-MAX:	Table 3
SHIPMENT:	Routine
SAMPLE STABILITY:	30 days for all analytes
BLANKS:	2 to 10 field blanks per set

ACCURACY

RANGE STUDIED:	see EVALUATION OF METHOD [1]
BIAS:	see EVALUATION OF METHOD [1]
OVERALL PRECISION ($\hat{S}_{rT}$):	see EVALUATION OF METHOD [1]
ACCURACY:	see EVALUATION OF METHOD [1]

MEASUREMENT

TECHNIQUE:	GAS CHROMATOGRAPHY, FID
ANALYTE:	compounds listed above
DESORPTION:	1 mL CS_2, stand 30 min
INJECTION VOLUME:	1 µL
TEMPERATURE:	Group A: Inj = 200°C, Det = 250°C ; 35°C (3 min) to 150°C (8°C/min). Group B: Inj = 225°C, Det = 250°C ; 35°C (3 min) to 190°C (8°C/min).
CARRIER GAS:	He, (Group A: 2.6 mL/min) (Group B: 4.7 mL/min)
COLUMN:	Group A: capillary, fused silica, 30 m x 0.32-mm ID; 1.80-µm film diphenyl/ dimethyl polysiloxane, Rtx® -502.2 or equivalent. Group B: capillary, fused silica, 30 m x 0.53 - mm ID; 3-µm film 35% diphenyl- 65% dimethyl polysiloxane, Rtx® -35 or equivalent.
CALIBRATION:	standard solutions of analytes in CS_2
RANGE:	see Evaluation of Method
ESTIMATED LOD:	Table 4
PRECISION ($\bar{S}_r$):	Table 4

APPLICABILITY: See Table 3 for working ranges. This method can be used for simultaneous determination of two or more of the analytes of interest either by use of both of the capillary columns listed above or by modifying the analytical parameters (i.e., temperature program) of the method. High humidity during sampling will decrease total breakthrough volume.

INTERFERENCES: None identified but as the number of different analytes sampled increases so does the chance for interferences. The choice of capillary column or analytical parameters may be modified to circumvent such interferences.

OTHER METHODS: This method is an update for NMAM Method 1003 (Issue 1, 2/15/84) [2]. Trichloroethylene, NIOSH Method 1022, was included in this method update [3]. Method improvements include higher recoveries at lower sample recovery levels, lower LOD and LOQ values, incorporation of capillary column chromatography, and acceptable recoveries in a 30 day storage stability study.

REAGENTS:

1. Carbon disulfide, chromatographic quality.*
2. Analytes, reagent grade quality.
3. Nitrogen or helium, purified.
4. Hydrogen, prepurified.
5. Air, filtered.

* See SPECIAL PRECAUTIONS.

EQUIPMENT:

1. Sampler: glass tube, 7 cm long, 6-mm OD, 4-mm ID, flame-sealed ends with plastic caps, containing two sections of 20/40 mesh activated (600 °C) coconut shell charcoal (front = 100 mg; back = 50 mg) separated by a 2-mm urethane foam plug. A silylated glass wool plug precedes the front section and a 3-mm urethane foam plug follows the back section. Pressure drop across the tube at 1 L/min airflow must be less than 3.4 kPa. Tubes are commercially available (e.g., SKC #226-01, Lot# 2000 or equivalent).
2. Personal sampling pump, 0.01 to 0.2 L/min, with flexible connecting tubing.
3. Gas chromatograph, FID, integrator and columns (see page1003-1).
4. Vials, 2-mL, glass, PTFE-lined septum crimp caps.
5. Volumetric flasks, 10-mL.
6. Syringes, 10-µL to 1-mL, readable to 0.1 µL.
7. Pipet, 1-mL, with pipet bulb.

SPECIAL PRECAUTIONS: Carbon disulfide is toxic and a serious fire and explosion hazard (flash point = −30 °C). Work with it only in a hood. Several of the analytes are suspect carcinogens (Table 1). Wear appropriate protection clothing and work with these compounds in a well ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Break the ends of the sampler immediately before sampling. Attach sampler to personal sampling pump with flexible tubing.
3. Sample at an accurately known flow rate between 0.01 and 0.2 L/min for a total sample size between the limits shown in Table 2.
4. Cap the samplers. Pack securely for shipment.

SAMPLE PREPARATION:

5. Place the front and back sorbent sections of the sampler tube in separate vials. The glass wool plug should be included in the vial containing the front sorbent section. Discard the glass wool and foam plugs.
6. Add 1.0 mL CS_2 to each vial. Cap each vial.
7. Allow to stand 30 min with occasional agitation.

CALIBRATION AND QUALITY CONTROL:

8. Calibrate daily with at least six working standards over the appropriate range from below the LOD to 10x the LOQ or greater if required (see Table 3).
   a. Add known amounts of neat analyte or calibration stock solution to CS_2 in 10-mL volumetric flasks and dilute to the mark.
   b. Analyze with samples and blanks (steps 11 and 12).
   c. Prepare calibration graph (peak area vs. µg analyte).

9. Determine desorption efficiency (DE) at least once for each lot of charcoal used for sampling in the range of interest. Prepare three tubes at each of five concentrations plus three media blanks.
    a. Remove and discard back sorbent section of a blank sampler.
    b. Inject a known amount (2 to 20 µL) of pure analyte, or calibration stock solution, directly onto front sorbent section with a microliter syringe.
    c. Cap the tube. Allow to stand overnight.
    d. Desorb (steps 5 through 7) and analyze together with working standards (steps 11 and 12).
    e. Prepare a graph of DE vs. µg analyte recovered.
10. Analyze three quality control blind spikes and three analyst spikes to insure that the calibration graph and DE graph are in control.

MEASUREMENT:

11. Set gas chromatograph according to manufacturer's recommendations and to conditions given on page 1003-1. Inject sample aliquot either manually using solvent flush technique or with autosampler.
    NOTE: If peak area is above the linear range of the working standards, dilute with CS_2, reanalyze and apply the appropriate dilution factor in calculations.
12. Measure peak area.

CALCULATIONS:

13. Determine the mass, µg (corrected for DE), of analyte found in the sample front (W_f) and back (W_b) sorbent sections and in the average media blank front (B_f) and back (B_b) sorbent sections.
    NOTE: If $W_b > W_f/10$, report breakthrough and possible sample loss.
14. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{W_f + W_b - B_f - B_b}{V}, mg/m^3.$$

EVALUATION OF METHOD:

The current laboratory evaluation of the analytes listed in this method included the incorporation of capillary column chromatography, the improvement of LOD/LOQ values, a desorption efficiency study ranging from approximately 3-5X LOQ to 0.1x the REL/PEL, and the inclusion of a 30 day storage stability study. Most of the analytes evaluated over this range exhibited acceptable recoveries [4]. However four analytes had unacceptable recoveries at the lowest level evaluated [4]. These analytes included benzyl chloride, chloroform, carbon tetrachloride and chlorobenzene. For these compounds the LOQ was adjusted accordingly. All of the analytes evaluated during the storage stability study were determined to be stable after 7, 14, and 30 days storage [4]. Bromoform was marginally stable at 30 days [4].

The initial laboratory evaluation was conducted using spiked samples and generated atmospheres and using SKC Lot 105 coconut shell charcoal as the collection media [1]. Results were:

Compound	Range mg/m^3	Sample Size	Bias %	Precision Overall	Precision Measurement	Accuracy ±%	Desorption Efficiency	Ref.
Benzyl chloride	2-8	10 L	-8.4	0.096	0.031	25.6	94% @ 96-303 μg	4
Bromoform	3-10	10 L	-1.3	0.071	0.043	14.0	94% @ 35-111 μg	4
Carbon tetrachloride	65-299	15 L	-1.6	0.092	0.037	18.0	93% @ 32-4800 μg	4,5
Chlorobenzene	183-736	10 L	0.3	0.056	0.025	11.0	92% @ 111-7100μg	4,6
Chlorobromomethane	640-2655	5 L	3.4	0.061	0.051	14.0	98% @39-13,000μg	4,7
Chloroform	100-416	15 L	1.3	0.057	0.047	11.6	97% @ 24-7400 μg	4,8
o-Dichlorobenzene	150-629	3 L	-1.9	0.068	0.013	13.7	94% @ 19-1900 μg	4,9
p-Dichlorobenzene	183-777	3 L	-4.3	0.052	0.022	12.5	98% @ 25-2700 μg	4,10
1,1-Dichloroethane	212-838	10 L	2.6	0.057	0.011	12.4	101% @20-8000 μg	4,11
1,2-Dichloroethylene*	475-1915	3 L	-2.9	0.052	0.017	11.3	101% @19-9500 μg	4,12
Ethylene dichloride	195-819	3 L	-2.0	0.079	0.012	15.7	94% @ 2.5-2500 μg	4,13
Hexachloroethane	5-25	10 L	-6.6	0.121	0.014	25.4	98% @ 34-756.8 μg	4
1,1,1-Trichloroethane	904-3790	3 L	-0.6	0.054	0.018	10.6	100%@23-11000μg	4,14
Tetrachloroethylene	655-2749	3 L	-7.2	0.052	0.013	15.1	95% @ 8-8000 μg	4,15
1,1,2-Trichloroethane	26-111	10 L	-9.0	0.057	0.010	17.5	100% @18-1200 μg	4,16
1,2,3-Trichloropropane	163-629	10 L	2.1	0.068	0.027	14.2	99% @ 21-6000 μg	4,17

*mixed isomers used (i.e., cis- and trans-).

REFERENCES:

[1] NIOSH [1977]. Documentation of the NIOSH Validation Tests, S101, S110, S113, S114, S115, S122, S123, S126, S133, S134, S135, S281, S314, S328, S335, S351, U.S. Department of Health, Education, and Welfare, Publ. (NIOSH) 77-185, available as Stock No. PB 274-248 from NTIS, Springfield, VA 22161.

[2] NIOSH [1994]. Hydrocarbons, Halogenated: Method 1003. In: Eller PM, Cassinelli ME, eds. NIOSH manual of analytical methods. 4th ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-113.

[3] NIOSH [1994]. Trichloroethylene: Method 1022. In: Eller, PM, Cassinelli, ME, eds. NIOSH manual of analytical methods. 4th rev. ed. Cincinnati, OH: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 94-113.

[4] Pendergrass SM [1998]. Backup Data Report for NMAM 1003, Issue 3 Method Development. Cincinnati, OH: National Institute for Occupational Safety and Health, (unpublished, December).

[5] NIOSH [1977]. Carbon tetrachloride: Method S314, NIOSH manual of analytical methods, 2nd ed., Vol. 1, Cincinnati, OH: U.S. Department of Health, Education, and Welfare, (NIOSH) Publication 77-157-A.

[6] Ibid., S133.

[7] Ibid., S113.

[8] Ibid., Vol 3., S351, (NIOSH) Publication 77-157-C.

[9] Ibid., S135.

[10] Ibid., S281.

[11] Ibid., Vol. 2, S123, (NIOSH) Publication 77-157-A.

[12] Ibid., S110.

[13] Ibid., S122.

[14] Ibid., Vol 3, S328, (NIOSH) Publication 77-157-C.

[15] Ibid., S335.

[16] Ibid., Vol. 2, S134, (NIOSH) Publication 77-157-A.

[17] Ibid., S126.

METHOD REVISED BY:

Stephanie M. Pendergrass, NIOSH/ DART.

TABLE 1. GENERAL INFORMATION.

Compound RTECS	Synonyms	OSHA/NIOSH/ACGIH (ppm)
Group A		
Bromoform $(CHBr_3)$; PB5600000	tribromomethane; CAS #75-25-2	0.5 (skin)/0.5 (skin)/0.5 (skin)
Carbon tetrachloride[ab] (CCl_4); FG4900000	tetrachloromethane; CAS #56-23-5	10, C 25/STEL 2 (1 h)/5 (skin)
Chlorobenzene (C_6H_5Cl); CZ0175000	monochlorobenzene; phenyl chloride; CAS #108-90-7	75/--/10
Chloroform[ab] $(CHCl_3)$; FS9100000	trichloromethane; CAS #67-66-3	C 50/STEL 2/10
1,1-Dichloroethane (CH_3CHCl_2); KI0175000	ethylidene chloride; CAS #75-34-3	100/100/100
Ethylene dichloride[ab] $(ClCH_2CH_2Cl)$; KI0525000	1,2-dichloroethane; CAS #107-06-2	50, C 100/1, STEL 2/10
Tetrachloroethylene[ab] $(Cl_2C{=}CCl_2)$; KX3850000	perchloroethylene; CAS #127-18-4	100, C 200, P 300/0.4 (LOQ)/ 25, STEL 100
Trichloroethylene[a] $(ClCH = CCl_2)$; KX4550000	ethylene trichloride; trichloroethene; CAS # 79-01-6	100 ppm (Ca 200 ppm)/Ca 50 ppm
1,1,1-trichloroethane (CH_3CCl_3); KJ297500	methyl chloroform; CAS #71-55-6	350/C 350/350, STEL 450
Group B		
Benzyl chloride[a] $(C_6H_5CH_2Cl)$; XS8925000	(chloromethyl) benzene; α-chlorotoluene; CAS #100-44-7	1/C 1.0/1
Chlorobromomethane (CH_2BrCl); PA5250000	bromochloromethane; Halon 1011; CAS #74-97-5	200/200/200
o-Dichlorobenzene[c] $(1,2\text{-}C_6H_4Cl_2)$; CZ4500000	1,2-dichlorobenzene; CAS #95-50-1	50/C 50/25 (skin); STEL 50
p-Dichlorobenzene[ac] $(1,4\text{-}C_6H_4Cl_2)$; CZ45500000	1,4-dichlorobenzene; CAS #106-46-7	75/1.7 (LOQ)/75, STEL 110
1,2-Dichloroethylene $(ClCH{=}CHCl)$; KV9360000	acetylene dichloride; 1,2-dichloroethene; CAS #540-59-0	200/200/200
Hexachloroethane[ac] (CCl_3CCl_3); KI4025000	perchloroethane; CAS #67-72-1	1 (skin)/1/1 (skin)
1,1,2-Trichloroethane[ad] (Cl_2CHCH_2Cl); KJ3150000	vinyl trichloride; CAS #79-00-5	10 (skin)/10 (skin)/10 (skin)
1,2,3-Trichloropropane[a] $(CH_2ClCHClCH_2Cl)$; TZ9275000	allyl trichloride; glycerol trichlorohydrin; CAS #96-18-4	50/10 (skin)/10 (skin)

[a]Suspect carcinogen [20,21,22]; [b]Group I Pesticide; [c]Group II Pesticide; [d]Group III Pesticide

TABLE 2. PHYSICAL PROPERTIES

Compound RTECS	M.W.	mg/m^3 = 1 ppm @ NTP	Synonyms	Properties
Group A				
Bromoform ($CHBr_3$)	252.75	10.33	tribromomethane	liquid, d 2.887; BP 148 °C; nonflammable
Carbon tetrachloride (CCl_4)	153.84	6.29	tetrachloromethane	liquid; d 1.585; BP 76.7 °C; FP -23.0 °C; VP 91.3 mm @ 20 °C; vapor density (air = 1) 5.3
Chlorobenzene (C_6H_5Cl)	112.56	4.60	monochlorobenzene; phenyl chloride	liquid; d 1.105 @ 25 °C; BP 131.6 °C; MP -45 °C; flash pt. 29.4 °C (CC)
Chloroform ($CHCl_3$)	119.39	4.88	trichloromethane	liquid, d 1.485 @ 20 °C; BP 61.2 °C; FP -63.5 °C
1,1-Dichloroethane (CH_3CHCl_2)	98.95	4.05	ethylidene chloride	liquid, d 1.174 @ 20 °C; BP 57 to 59 °C; FP -98 °C
Ethylene dichloride ($ClCH_2CH_2Cl$)	98.96	4.05	1,2-dichloroethane	liquid; d 1.2554 @ 20 °C; BP 83.5 °C; FP -35.5 °C; flash pt. 13 °C; explosive limits in air 6 to 16%
Tetrachloroethylene ($Cl_2C=CCl_2$)	165.83	6.78	perchloroethylene	liquid; d 1.625 @ 20 °C; BP 121 °C; FP -22.4 °C
1,1,1-trichloroethane (CH_3CCl_3)	133.42	5.45	methyl chloroform	liquid; d 1.325; BP 75 °C; FP -30.4 °C; nonflammable
Trichloroethylene ($ClCH=CCl_2$)	131.40	5.37	ethylene trichloride; trichloroethene	liquid; d 1.459 @ 20°C; BP 87.2°C; FP- 72.8°C; VP 58 mm Hg @ 20°C (9.9 kPa); explosive range 11 to 41% v/v in air
Group B				
Benzyl chloride ($C_6H_5CH_2Cl$)	126.58	5.17	(chloromethyl) benzene; α-chlorotoluene	liquid; BP 179 °C; MP -48 to -43 °C; d 1.100 @ 20 °C; flash pt. 67 °C
Chlorobromomethane (CH_2BrCl)	129.39	5.29	bromochloromethane; Halon 1011	liquid; d 1.93 @ 20 °C; BP 68 °C; MP -88 °C; nonflammable
o-Dichlorobenzene (1,2-$C_6H_4Cl_2$)	147.00	6.01	1,2-dichlorobenzene	liquid; d 1.284; BP 172 to 179 °C; FP -17 °C; flash pt. 65.5 °C
p-Dichlorobenzene (1,4-$C_6H_4Cl_2$)	147.00	6.01	1,4-dichlorobenzene	solid crystals; d 1.458; BP 173.7 °C; MP 53 °C; sublimes; flash pt. 65.5 °C
1,2-Dichloroethylene ($ClCH=CHCl$)	96.94	3.96	acetylene dichloride; 1,2-dichloroethene	liquid; transisomer; d 1.257; BP 47 to 49 °C; MP -57°C; cis-isomer; d 1.282; BP 58 to 60 °C; flash pt. 3.9 °C; FP -80 °C
Hexachloroethane (CCl_3CCl_3)	236.74	9.66	perchloroethane	solid; d 2.091; MP 185 °C; BP sublimes at 187 °C
1,1,2-Trichloroethane (Cl_2CHCH_2Cl)	133.41	5.45	vinyl trichloride	liquid; d 1.4432 @ 20 °C; BP 113.7 °C; FP -36.4 °C; VP 19 mm Hg @ 20 °C
1,2,3-Trichloropropane ($CH_2ClCHClCH_2Cl$)	147.43	6.03	allyl trichloride; glycerol trichlorohydrin	liquid; d 1.3888 @ 20 °C; BP 156.2 °C; FP -15 °C; flash pt. 82.2 °C (OC)

TABLE 3. SAMPLING LIMITS.

Compound	Air Sample Volume (L)			Working Range, ppm, at Max Sample Volume
	Min	Max	Target	
Bromoform	4 @ 0.5 ppm	70	10	0.2 to 4
Carbon tetrachloride	3 @ 10 ppm	150	15	2 to 105
Chlorobenzene	1.5 @ 75 ppm	40	10	10 to 430
Chloroform	1 @ 50 ppm	50	15	2 to 190
1,1-Dichloroethane	0.5 @ 100 ppm	15	10	4 to 250
Ethylene dichloride	1 @ 50 ppm	50	3	16 to 1320
1,1,1-Trichloroethane	0.1 @ 350 ppm	8	3	18 to 1450
Tetrachloroethylene	1.0 @ 100 ppm	40	3	9 to 1900
Trichloroethylene	0.2 @ 100 ppm	30	10	0.3 to 62.1
Benzyl chloride	6 @ 1 ppm	50	10	0.6 to 5.8
Chlorobromomethane	0.5 @ 200 ppm	60	5	18 to 450
o-Dichlorobenzene	1 @ 50 ppm	10	3	16 to 1100
p-Dichlorobenzene	1 @ 75 ppm	8	3	27 to 330
1,2-Dichloroethylene	0.2 @ 200 ppm	5	3	16 to 560
Hexachloroethane	3 @ 1 ppm	70	10	0.3 to 8.3
1,1,2-Trichloroethane	2 @ 10 ppm	60	10	1.8 to 64
1,2,3-Trichloropropane	0.6 @ 50 ppm	60	10	3 to 310

TABLE 4. MEASUREMENT PARAMETERS.

Compound	Limit of Detection (LOD)	Limit of Quantitation (LOQ)	Precision (S,)
Bromoform	6.0	19.3	0.051
Carbon tetrachloride	4.0	20.0	0.046
Chlorobenzene	0.6	110.0	0.025
Chloroform	0.8	15.0	0.035
1,1-Dichloroethane	2.0	5.1	0.030
Ethylene dichloride	0.7	2.3	0.026
Tetrachloroethylene	2.0	7.1	0.032
1,1,1-Trichloroethane	1.0	3.0	0.009
Trichlorethylene	0.6	1.9	0.018
Benzyl chloride	1.0	4.5	0.076
Chlorobromomethane	1.5	41.0	0.053
o-Dichlorobenzene	0.8	2.7	0.022
p-Dichlorobenzene	2.0	7.5	0.041
1,2-Dichloroethylene	2.0	5.1	0.041
Hexachloroethane	2.0	6.6	0.021
1,1,2-Trichloroethane	1.0	3.0	0.036
1,2,3-Trichloropropane	1.0	2.7	0.020

Units = µg analyte per sample

Note: For a few of the compounds in this method the LOQ values, when compared to the preceding method development results, may appear higher. This can be explained by the fact that in the initial method development no recovery study was conducted at a level near or above the instrumentally determined LOQ recoveries for each analyte.

APPENDIX A.3

PROCEDURE FOR INDOOR AIR SAMPLING AND ANALYSIS USING SORBENT TUBE SAMPLERS

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APPENDIX A.3
Procedure for Indoor Air Sampling and Analysis Using Sorbent Tube Samplers

Purpose:

This document provides guidance for the setup and collection of screening-level indoor air samples from industrial and multi-use buildings for laboratory analysis of volatile organic compounds (VOCs). Indoor air samples will be collected using sorbent tube samplers and sampling pumps programmed for specific sampling durations. The purpose of the collection method is to obtain a "time-weighted average concentration" or "integrated" indoor air sample.

Equipment and Materials:

- Photoionization Detector (PID) equipped with 10.6 eV lamp and/or Flame Ionization Detector (FID)
- Sorbent tube (two stages) with sampling pump programmed for 8-hour sample collection
- Laboratory chain-of-custody (COC) form
- Wristwatch
- Indoor Air Sampling Summary Form (attached)

Procedure for Indoor Air Sample Collection:

The steps provided below should be considered a general guidance on the collection of indoor air samples; the sequence can be modified as needed based on site-specific conditions at the time of sample collection. This procedure does not address the documentation of historical and current building usage, VOC storage areas, and HVAC system details, as it is anticipated that documentation of this information will be performed prior to initiating the indoor air sampling event.

Selection and Preparation of Sample Collection Area

A. Observe the area for the apparent presence of items or materials that may potentially produce or emit VOCs and interfere with analytical laboratory analysis of the collected sample. Record relevant information on the Indoor Air Sampling Summary Form.

B. Using the PID (ppb detection limit PID is preferred) and/or FID, screen indoor air in the location intended for sampling and in the vicinity of potential VOC sources to preliminarily assess for the potential gross presence of VOCs (note that the detection limits for the laboratory analyses to be performed on the samples collected are considerably lower than the detection limits of the PID and FID). Record PID or FID readings on the Indoor Air Sampling Summary form. If the purpose of the indoor air sampling is to assess vapor intrusion (VI), items or materials within the building exhibiting PID or FID readings shall be considered probable sources of VOC interferences and isolated or removed prior to sampling if possible. If practicable, sampling will be rescheduled for 24-hours later.

Preparation of Sorbent Tube Samplers and Collection of Sample

A. Place the sampling pump on a stable surface. Place the sorbent tube sampler within the breathing zone (e.g., about five feet above the floor) in a secure location that will not interfere with worker safety or manufacturing operations. Connect the sorbent tube to the sampling pump using flexible, one-time use silicone tubing. Sorbent tube samplers may be placed on the floor when screening possible subslab source areas. In general, areas near windows or other potential sources of 'drafts' and air supply vents shall be avoided unless those areas are being specifically targeted for indoor air quality assessment.

B. Record sample pump serial number on Indoor Air Sampling Summary Form and COC.

C. Assign sample identification (see Appendix A.4 for guidance) to the sorbent tube and record on the sorbent tube, Indoor Air Sampling Summary Form, and COC.

D. Remove end cap from the sorbent tube. Check connections for potential leaks and tighten/realign fittings as necessary.

E. Turn on sample pump to initiate sample collection.

F. Record date and local time (24-hour basis) when the sample pump was activated on Indoor Air Sampling Summary Form and COC.

Termination and Submittal of Active Sorbent Tube Sample

A. Revisit sorbent tube sampler approximately at the end of sample collection period (e.g., 8 hours after initiation of sample collection).

B. Record the date and local time (24-hour basis) when the sample pump was deactivated on the Indoor Air Sampling Summary Form and COC.

C. Remove the sorbent tube from the sample pump tubing and place a cap on each end of the sorbent tube.

D. Complete the COC and retain requisite copies with the sorbent tubes.

E. Submit sorbent tube samples to the laboratory for analysis.

Analytical Methods:

Sorbent tube samples shall be analyzed by the laboratory using USEPA Method TO-17, volatile and semivolatile organic compounds by gas chromatography/mass spectrometry (GC/MS) (see Appendix A.2), modified USEPA Method 18 (see Appendix A.8), or National Institute for Occupational Safety and Health (NIOSH) Method 1003 (see Appendix A.2) for a target list of VOCs based on building-specific characteristics.

Quality Assurance/Quality Control:

The collection of Quality Assurance/Quality Control (QA/QC) samples will include the submittal of blind field duplicates to the laboratory for analysis of the target compounds. Duplicate samples will be collected at a frequency of at least one per sample delivery group (SDG) or a minimum of one in every twenty samples (five percent). Duplicate samples will be collected using "side-by-side" sorbent tube samplers over the same time interval. Additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Final*, October 2006.
- Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway From Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* November 2002.
- Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, *Compendium Method TO-17 – Determination of Volatile Organic Compounds in Ambient Air using Active Sampling onto Sorbent Tubes*.
- National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Fourth Edition, *Halogenated Hydrocarbons: Method 1003, Issue 3, March 15, 2003.*

Attachments:

Indoor Air Sampling Summary Form

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Indoor Air Sampling Summary

SHA IMPROVING EARTH	Project No.:	Date:
	Project Name:	
	Building/Location:	
Meters Used:	Project Manager:	
	Collector(s):	

SAMPLING INFORMATION

Sample ID						
Sample Method/Device						
Sample Device(s) Serial No.						
Start Date/Time						
Start Pressure (inches Hg)						
Stop Date/Time						
Stop Pressure (inches Hg)						
Volume Air Sampled (L)						

OTHER SAMPLING INFORMATION

Story / Level						
Room / Area						
Indoor Air Temp (°F)						
HVAC Operating?						
Approximate Sample Height Above Floor Level (feet)						
Noticeable Odor?						
PID/FID Reading (ppmv)						
Duplicate Sample Designation						
Approximate Ceiling Height (feet)						
Comment Number						

COMMENTS

1.

2.

3.

4.

5.

APPENDIX A.4

SAMPLE DESIGNATION PROTOCOL

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APPENDIX A.4
Sample Designation Protocol

Purpose:

This document is a project-specific protocol for sample designation and labeling during collection of indoor air, substructure vapor, and soil gas samples from industrial and multi-use. This protocol was developed to provide a unique sample identification system that will be used for air/soil gas samples, confirmatory samples, and duplicates sampled as part of the VOC source assessment project at IBM's East Fishkill facility in Hopewell Junction, New York. The identification system was developed with the understanding that the number and type of samples will vary based on building-specific characteristics and that re-sampling may be performed for some buildings.

Protocol for Sample Designation:

In general, the unique sample designation will consist of a combination of fourteen to fifteen characters and digits that specify the building number, sample category identification, date, and sample type.

An explanation of each of these items is provided below:

1) Building Number: three digits for site-specific building number, potentially followed by one character (e.g., 330D).
2) Sample Category Identification: two character designation for sample category (as shown below) followed by a two digit designation identifying the sample location:
    - **SS -** vapor sample from directly beneath floor slab or other apparent vapor barrier, or
    - **IA** – indoor air sample.
3) Date the sample was collected: Six-digit designation in order of month, day, and year.
4) Sample Type Identification: single character designation for the type of sampling device used to collect the sample, as shown below:
    - **T** – Tedlar bag sample,
    - **S** – SUMMA canister sample,
    - **P** – passive sampling device,
    - **G** – syringe and glass vial, or
    - **C** – active sorbent tube sampler (charcoal tube).

Example: A soil vapor sample collected into a Tedlar bag from location SS-05 within Building 330D on July 1, 2008 would have a sample designation of: 330DSS05070108T,

where: 330D, indicates the Building Number;
SS05, indicates the Sample Category ID;
070108, indicates the date the sample was collected (Month, Day, Year); and
T, indicates the sample was collected into a Tedlar bag.

At the time of sample collection, placement, or deployment, the sample designation shall be recorded on the sampling device label, appropriate sampling summary form, and on the analytical laboratory chain-of-custody form.

I. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLES:

The collection of QA/QC samples will include the submittal of field duplicate samples to the laboratory for analyses of target compounds. In general, the unique designation for these types of samples will include a **D** for the sample type designation.

Example: A duplicate soil vapor sample collected into a Tedlar bag from location SS-05 within Building 330D on July 1, 2008 would have a sample designation of: 330DSS05070108D,

where: 330D, indicates the Building Number;
SS05, indicates the Sample Category ID;
070108, indicates the date the sample was collected (Month, Day, Year); and
D, indicates that the sample collected was a duplicate.

At the time of sample collection, the sample designation shall be recorded on the sampling device label, appropriate sampling summary form, and on the analytical laboratory chain-of-custody form. Additional QA/QC details are provided in Appendix B.

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APPENDIX A.5

PROCEDURE FOR PREPARATION OF CONCRETE SAMPLES

SHPC ENGINEERS

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APPENDIX A.5
Procedure for Preparation of Concrete Samples

Purpose:

This document provides guidance on the preparation of concrete samples for laboratory analysis of volatile organic compounds (VOCs) consistent with U.S. Environmental Protection Agency (USEPA) SW-846 Method 5035, which describes how samples are to be collected, preserved in the field, and analyzed in the laboratory. Concrete samples will be prepared from concrete cores and concrete chips generated during floor slab drilling activities.

Equipment and Materials:

- Zip-loc bags (varying sizes)
- 5-lb hammer
- Plastic cutting board
- Table-top balance/scale
- Laboratory chain-of-custody (COC) form
- 40 ml VOA vials sets (consisting of 3 vials as specified below)
  - Pre-weighed with methanol preservative – for high-concentration screening analysis
  - Pre-weighed with distilled water – for low-concentration analysis
  - Unpreserved – for moisture content
- Project-specific personal protective equipment

Procedure for Concrete Cores:

Concrete cores will be obtained by coring a 2-inch diameter hole through the floor slab, which is anticipated to be of varying thicknesses. Estimates of floor slab thickness will be based on construction plans provided by IBM, and modifications to the coring procedure will be evaluated, as necessary, to accommodate floor slabs greater than one foot.

Field personnel will take a clean chisel and hammer to remove the upper 2 inches (floor side of the slab) of the extracted core. This portion of the core will be placed within sealable plastic bags (approximately 2 to 4 bags) and placed on a flat plastic surface (e.g., cutting board). A hammer will then be used to crush the concrete sample into smaller pieces, targeting less than 1/8-inches in diameter but not to the point where the entire sample is in a dust form.

The crushing operation should be completed as quickly as possible to reduce the loss of any VOCs that may be present. Use a table-top scale/balance to estimate the mass of sample required for each sample container. Transfer approximately 5 grams of the crushed concrete sample from the sealable bags into a pre-weighed methanol preserved bottle provided by the laboratory. Transfer another approximately 5 grams of the crushed concrete sample from the sealable bags to a pre-weighed DI water sample bottle also provided by the laboratory. Place at least 10 grams of the crushed concrete sample into a third unpreserved VOA vial. Label the sample containers and record pertinent information on the COC.

Procedure for Concrete Cuttings:

Additional concrete samples may be collected from the cuttings generated during drilling of 1.25-inch diameter holes in the floor slab using handheld tools. These samples will be collected into sealable bags and prepared in a similar manner as the procedure outlined above for concrete cores.

Analytical Methods:

The samples shall be analyzed by the laboratory using USEPA Method 8260B, analysis of VOCs by gas chromatography/mass spectrometry (GC/MS), for a target list of VOCs based on building-specific characteristics.

Quality Assurance/Quality Control:

The collection of Quality Assurance/Quality Control (QA/QC) samples will include the submittal of field duplicate samples to the laboratory for USEPA Method 8260B analysis. Duplicate samples will be collected at a frequency of at least one per sample delivery group (SDG) or a minimum of one in every twenty samples (five percent). Duplicate samples will be obtained by filling two 40-ml VOA vial sets in succession. Additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- USEPA publication SW-846, *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* February 2007.

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APPENDIX A.6

PROCEDURE FOR SUBSLAB VAPOR SAMPLE PORT INSTALLATION, INTEGRITY TESTING, AND SAMPLING

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APPENDIX A.6
Procedure for Subslab Vapor Sample Port Installation, Integrity Testing, and Sampling

Purpose:

This document provides general guidance on the installation and sampling of subslab vapor sampling ports through concrete floors, including the protocol for integrity testing. The sequence of steps provided below may be modified based on the location specific conditions at the time of installation, but only if they will be at least as protective of the building environment as the procedure below.

Equipment and Materials:

- Electric hammer-drill with 1¼-inch and 3/8-inch drill bits
- Hard plastic containers (“dog dishes”) with holes/ports for hammer-drill and vacuum hose
- High-efficiency particulate air (HEPA)-rated wet/dry vacuum
- HEPA replacement filters
- Granular bentonite
- Quick-drying hydraulic cement
- Stainless steel tubing cutter
- Two 50-foot long electrical extension cords
- Open-end wrenches including two $^{9}/_{16}$-inch and one adjustable
- Photoionization Detector (PID) equipped with a 10.6 eV lamp and/or Flame Ionization Detector (FID)
- Tedlar bags (0.7 to 1.0 liter)
- Peristaltic pump with ¼-inch inner diameter (I.D.) silicone tubing
- Magnehelic gauges (0 to 10-inch water column range)
- Tracer gas (ultra-high-purity helium or sulfur hexafluoride)
- Tracer gas meter
- Oxygen, carbon dioxide, and methane meter
- Disposable polyethylene 60 cubic centimeter (cc) syringes

Subslab sampling/monitoring point parts

  - ¼-inch stainless-steel female ISO parallel thread to ¼-inch tube fitting connector
  - ¼-inch outside diameter (O.D.) stainless-steel tubing
  - Rubber gasket or fender washer
  - ¼-inch stainless steel parallel thread plug with o-ring (with appropriately sized hex wrench)
  - ¼-inch male ISO parallel thread connector with integrated o-ring
  - ¼-inch stainless steel 3-way switching valve
  - 1/8-inch I.D. by ¼-inch O.D. Teflon tubing
  - 3/16-inch I.D. by ¼-inch O.D. Teflon tubing

Clearance of Utilities, Floor Slab Thickness Survey, and Removal of Floor Coverings:

A. Observe the condition of the building floor slab for apparent penetrations such as concrete floor cracks, floor drains, or sump holes. Using the PID and FID, screen indoor air in the area of floor penetrations (note that the detection limits for the laboratory analyses to be performed on the samples collected are considerably lower than the detection limits of the PID and FID). Note the floor conditions on the sampling form along with the indoor air PID and FID readings.

B. Select a potential location or locations for a temporary or permanent subsurface vapor port. Review the proposed location with building utility and space owners for potential conflicts with space activities or utilities below and above the floor. Review available construction plans with personnel to evaluate the thickness of the slab in the area of the proposed location and describe how the sampling port or ports will be installed. After receiving permission from the occupant/owner, mark the proposed location(s) and describe the location(s) on the sampling form. Mark the proposed location on the floor using duct tape or other removable indicator.

C. Identify floor covering (e.g., tile) at proposed location and collaborate with facility personnel for its removal to expose the underlying concrete slab. Confirm whether the floor material contains asbestos and if asbestos is present, arrange for removal by a licensed asbestos handler.

Procedure for Subslab Sampling/Monitoring Port Installation:

A. Once utility clearance is complete and floor covering has been removed, make sure that an adequate open area exists around the proposed vapor sample port location to allow easy access with the concrete coring and dust capture equipment.

B. Place hammer-drill equipped with a 1¼-inch drill bit over the proposed sample port location. During drilling, a hard plastic container through which the drill bit passes should be placed over the proposed location to limit dust migration. A port on the container will be connected to a HEPA-rated vacuum, which can then collect dust and drill cuttings.

C. Drill a 1¼-inch diameter hole into the floor slab to a depth of approximately three inches (this depth may be decreased if the total slab thickness is less than 4 inches). During drilling, the HEPA-rated vacuum should be operated by the support person to collect dust and concrete cuttings as they are generated.

D. When the proper depth has been reached, the 1¼-inch drill bit should be removed and replaced with a 3/8-inch drill bit. Drill a 3/8-inch diameter hole through the remainder of the floor slab. The HEPA vacuum should be used during this process to collect dust and small concrete chips.

E. Install a stainless-steel female ISO parallel thread to ¼-inch tube fitting connector onto a short section of ¼-inch O.D. stainless steel tubing. The ¼-inch stainless steel tubing should be pre-cut so that it extends up to two inches below the bottom of the slab, once the subslab sampling port is installed. A porous backfill material (i.e., silica sand or glass beads) should be placed to cover approximately one inch of the sampling tube. A ¼-inch stainless steel plug with o-ring will be installed into the female ISO parallel thread connector end of the fitting. Place a rubber gasket/fender washer onto the ¼-inch stainless steel tubing and insert the tubing into the drilled hole, so that the gasket/washer rests on the top of the 3/8-inch diameter hole and the top of the steel plug is flush with the floor surface. A depiction of a finished subslab sampling/monitoring port is provided on Figure A.6.1, Detail 1 (attached).

F. Place a small amount of granular bentonite, hydrated with an appropriate amount of water, on top of the gasket/washer, centering the subslab sampling/monitoring port within the drilled hole. Place hydraulic cement in the annular space between the drilled hole and the subslab sampling/monitoring port to secure it in the cored hole. Make sure that the subslab sampling/monitoring port is flush with the surrounding floor after cement is placed in the hole and that the cement does not cover the steel plug or impede its operation.

G. Allow the hydraulic cement to cure prior to initiating subslab vapor port integrity testing and/or sampling.

Procedure for Sampling of Subslab Sampling/Monitoring Ports:

A. Remove the stainless steel plug from the subslab sampling/monitoring port. Verify that there are no obstructions present in the port. Install a clean ¼-inch male ISO parallel thread to ¼-inch tube connector with integrated o-ring into the subslab sampling/monitoring port, with a short piece of, ¼-inch Teflon or stainless steel tubing (either 1/8-inch or 3/16-inch I.D.) and a ¼-inch stainless steel 3-way inline switching valve installed on the tube connector using compression fittings. The valve should be installed quickly and in the closed position to minimize air flow either into or out of the subslab vapor port.

B. Connect a pressure gauge (e.g., magnehelic) to one port on the 3-way valve and ¼-inch Teflon tubing to the remaining open port of the 3-way valve for purging and sampling. Open the switching valve to the pressure gauge position to collect and record a diffential pressure reading at the subslab vapor sampling port relative to the room pressure. Reposition the 3-way switching valve to purge the sample train tubing of one equivalent volume using a polyethylene 60 cubic centimeter (cc) syringe. Close the valve, and remove and cap the syringe. **DO NOT DISCHARGE THE AIR/SOIL GAS SYRINGE INTO INDOOR AIR.**

C. Connect the ¼-inch Teflon® tubing on the 3-way switching valve to a Summa®-type canister. For duplicate sample locations connect a second canister before purging by installing a ¼-inch stainless steel “tee” fitting to the sampling port of the 3-way valve using ¼-Teflon tubing. Make sure that pipe and tubing fittings are tight prior to collection of subslab vapor samples. A depiction of a subslab sampling/monitoring port in the sampling configuration is provided on Figure A.6.1, Detail 2 (attached).

D. To collect a subslab vapor sample for laboratory analysis using a Summa®-type canister, place the canister adjacent to the subslab vapor sampling port and follow the methods and procedures outlined in Appendix A.1. During sampling, the subslab sampling/monitoring port will be connected to either the pressure gauge/metering regulator (for time-integrated samples) or to the Summa®-type canister valve fitting (for grab samples).

E. For screening of the subslab vapors (to be performed after the collection of a Summa®-type canister sample, if applicable), connect the ¼-inch Teflon tubing to a hand pump or peristaltic pump using an appropriate length of silicone tubing. Connect the open end of the silicone tubing to a short piece of ¼-inch Teflon tubing (1/8-inch I.D.).

F. Purge the tubing of one sample line volume if not previously performed for Summa®-type canister sampling. Install the ¼-inch Teflon tubing (1/8-inch I.D.) on the polyethylene valve of a clean Tedlar® bag. Using the hand pump, draw a sample from the sample port by opening the valve on the Tedlar® bag. Alternatively, using a peristaltic pump at a sampling rate equal to or less than 200 cubic centimeters per minute (cc/min), fill the Tedlar® bag and screen the contents of the Tedlar® bag using a PID and/or FID. A Tedlar® bag sample may also be collected for laboratory analysis using Method TO-15 (or equivalent method). Record relevant sampling information on the Indoor Air Sampling Summary Form and COC, as applicable.

G. Once sampling/monitoring has been completed, reposition the switching valve to the pressure gauge position to collect and record a post-sampling diffential pressure reading at the subslab vapor sampling port relative to the room pressure. Remove the ¼-inch male ISO parallel thread connector from the subslab sampling/monitoring point. Replace the stainless steel plug and tighten as necessary.

Analytical Methods:

Subslab vapor samples submitted for analysis shall be analyzed by the laboratory using USEPA Method TO-15 (or equivalent method).

Quality Assurance/Quality Control:

Quality Assurance/Quality Control (QA/QC) measures for the subslab sampling/monitoring ports will include integrity testing of the installed points using a tracer gas test. A tracer gas (e.g., helium or sulfur hexafluoride) will be used to assess the adequacy of the seal of the subslab sampling/monitoring port from ambient/indoor air leakage. The tracer gas will be dispersed around the floor surface in the vicinity of the subslab sampling/ monitoring port during the collection of a field screening sample into a dedicated, clean Tedlar® bag. The tracer gas will be confined to the vicinity of the port with a container (e.g., overturned bucket) set over the top of the port.

Applied vacuum measurements at the subslab sampling/monitoring port will be recorded with Magnehelic or equivalent gauges capable of measuring vacuums ranging from 0.1 to 10 inches of water column ("wc) during purging/sampling. Tracer gas testing will be performed at a sampling rate equal to or less than 200 cc/min. A second purging/sampling rate (also less than 200 cc/min) may be used to assess the relationship between the purging/sampling rate and measured vacuum. The extracted vapor will be directed to a Tedlar® bag and flow will be assessed using either an in-line flow meter, or by measuring the time to fill the known volume of the bag. No more than three liters of vapor will be withdrawn from the port during this testing to limit potential for introduction of ambient or indoor air.

The Tedlar® bag samples will be screened using a portable tracer gas meter with a detection limit of 25 parts per million on a volumetric basis (ppmv) or equivalent. The samples will also be screened for oxygen (O_2), carbon dioxide (CO_2), and methane (CH_4) using meters capable of reporting down to 1 percent (%) or less by volume. Should the tracer test indicate more than 10% tracer gas at an extraction rate equivalent to the sampling rate (i.e., equal to or less than 200 cc/min), the fittings and surface seal should be checked and repaired, as necessary. The results of the performance testing will be documented using the Soil Vapor Sampling Summary (attached). Additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Final,* October 2006.

Attachments:

Subslab/Soil Vapor Field Sampling Summary Form
Figure A.6.1 – Subslab Sampling/Monitoring Port

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Subslab/Soil Vapor Field Sampling Summary

SHA
IMPROVING EARTH

Project No.:	Date:
Project Name:	
Location:	
O_2 / CH_4 / CO_2 Meter Used:	Project Manager:
PID Meter Used:	Collector(s):
Other:	FID Meter Used:

SUBSLAB/SOIL VAPOR SAMPLE RECORD

Location No.						
Sample ID						
Implant Install Date						
Sample Date						
Sample Collection Depth/ Slab Thickness (ft bgs)						
Approx. Purge Volume (cm^3)						
Canister Serial No.						
Start Time						
Start Pressure (inches Hg)						
Stop Time						
Stop Pressure (inches Hg)						
Ambient Air Temp (°F)						
Weather Conditions						
O_2 Reading (%)						
CH_4 Reading (%)						
CO_2 Reading (%)						
PID reading (ppmv)						
FID reading (ppmv)						
Comment No.						

COMMENTS

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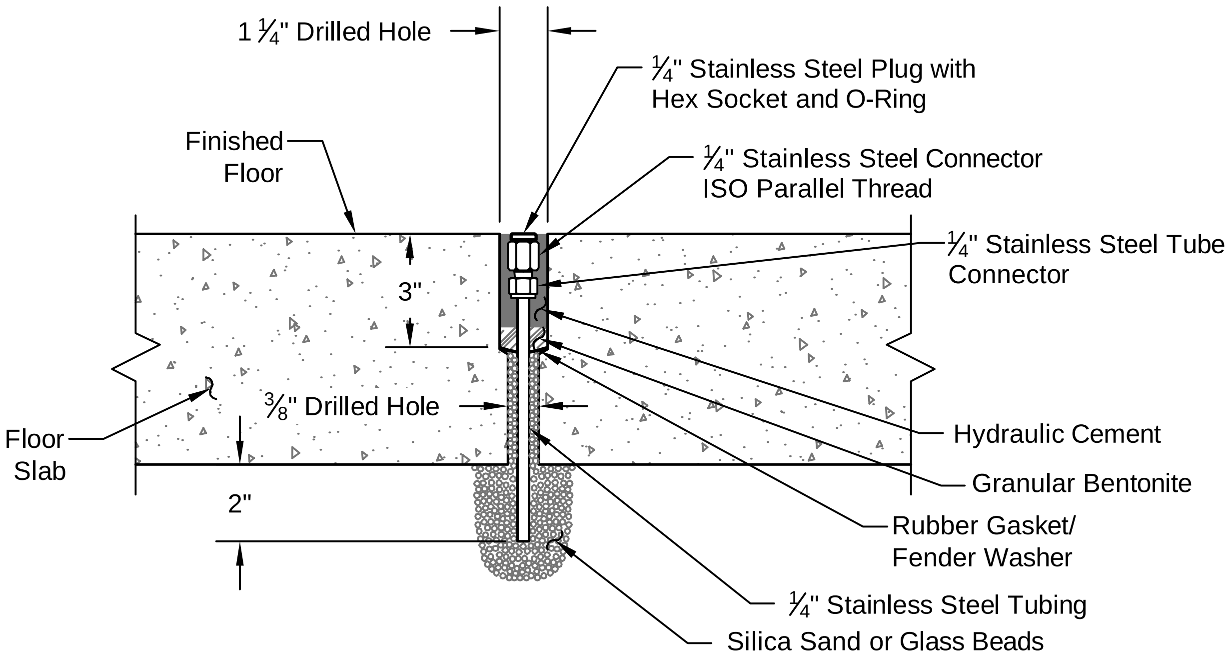
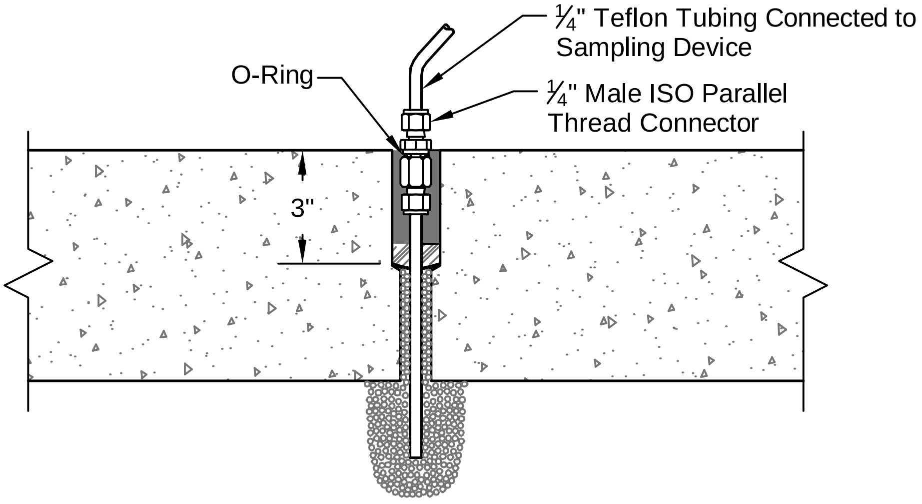


1 SUBSLAB SAMPLING/MONITORING PORT

NOT TO SCALE



2 SUBSLAB VAPOR SAMPLING CONFIGURATION

NOT TO SCALE

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Reviewed By: D. Shea
Date: January 2009

Figure A.6.1
Subslab Sampling/Monitoring Port

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PLOT DATE: 1-15-09

APPENDIX A.7

PROCEDURE FOR SUBSLAB VAPOR EXTRACTION TEST PORT INSTALLATION AND TESTING

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APPENDIX A.7
Procedure for Subslab Vapor Extraction Test Port Installation and Testing

Purpose:

This document provides general guidance on the installation and testing of subslab/substructure vapor extraction points. The sequence of steps provided below can be modified based on the location specific conditions at the time of installation, but only if they will be as protective of the building environment as the procedure outlined below.

Equipment and Materials:

- Portable, electric concrete coring drill with 2.5-inch core barrel
- Hard plastic containers (“dog dishes”) with holes/ports for coring equipment and vacuum
- Two, high-efficiency particulate air (HEPA)-rated wet/dry vacuums
- HEPA replacement filters
- Support sand
- Granular bentonite
- Quick-drying hydraulic cement
- Polyvinyl chloride (PVC) pipe cutter
- Two 50-foot long electrical extension cords
- Open-end wrenches including two $^{9}/_{16}$-inch and two adjustable
- Photoionization Detector (PID) equipped with a 10.6 eV lamp and/or Flame Ionization Detector (FID)
- Tedlar bags (0.7 to 1.0 liter)
- Peristaltic pump with ¼-inch inner diameter (I.D.) silicone tubing
- 1/8-inch I.D. by ¼-inch O.D. Teflon tubing
- 3/16-inch I.D. by ¼-inch O.D. Teflon tubing

Subslab vapor extraction testing equipment

- ➢ Hot-wire anemometer
- ➢ Digital manometer (0 to 1.000-inch water column)
- ➢ Discharge hose, size and length dependent on location and application
- ➢ Vacuum gauge (0 to 60-inch water column range)
- ➢ Rigid PVC pipe and flexible hose connections

Subslab vapor extraction port parts

- ➢ 1-inch stainless-steel female BSPP to 1-inch NPTF coupling
- ➢ Two, 1-inch Schedule 80 PVC pipe nipples
- ➢ 1-inch BSPP stainless steel plug with hex socket and o-ring (with appropriately sized hex wrench)
- ➢ 1-inch stainless-steel female BSPP to 1-inch male NPT adapter with o-ring
- ➢ ¼-inch male ISO parallel thread connector with integrated o-ring

Clearance of Utilities and Removal of Floor Coverings:

A. Mark the proposed location on the floor for the vapor extraction port using duct tape or other removable indicator.

B. Review the proposed location with building utility and space owners for potential conflicts with space activities or utilities below and above the floor.

C. Identify floor covering (e.g., tile) at proposed location and collaborate with facility personnel for its removal (if required) to expose the underlying concrete slab. Confirm whether the floor material contains asbestos and if asbestos is present, arrange for removal by a licensed asbestos handler.

Procedure for Vapor Extraction Point Installation:

A. Once utility clearance is complete and floor covering has been removed, make sure than an adequate open area exists around the proposed extraction port location to allow easy access with the concrete coring machine and dust capture equipment.

B. Place concrete coring drill over the proposed extraction point location and secure the corer to the floor using the vacuum-pump assembly. Test water delivery equipment prior to starting corer, and make sure that an adequate water supply is available to complete the core.

C. Core a 2.5-inch diameter hole through the floor slab. During coring, the water dust suppression/bit cooling system shall be operated at all times. A wet/dry vacuum with a HEPA-rated filtration system should be operated by the support person to collect excess water and concrete cuttings as they are generated.

D. When the bottom of the floor slab has been reached, the core barrel should be removed, and a hammer and chisel should be used to remove the core from the floor slab. If concrete samples are being collected, please refer to Appendix A.5. A light water mist from a portable water sprayer should be used during this step to suppress dust. The HEPA-rated vacuum should be used during this process to collect dust and small concrete chips from the core.

E. Thread the 1-inch Schedule 80 PVC pipe and the 1-inch BSPP stainless steel plug with o-ring into the 1-inch NPTF by 1-inch stainless-steel female BSPP coupling. Center the extraction port assembly in the core hole. The 1-inch PVC pipe should be pre-cut so that it does not extend below the bottom of the slab, once the subslab extraction port is installed. A depiction of a subslab vapor extration port is provided on Figure A.7.1, Detail 1 (attached).

F. Add support sand to anchor the extraction port assembly in place. Add a small amount (approximately 1-inch in depth) of granular bentonite, hydrated with an appropriate amount of water above the support sand. Place hydraulic cement in the annular space around the outside of the extraction port assembly to secure it in the cored hole. Make sure that the subslab vapor extraction port is flush with the surrounding floor after cement is placed in the hole and that the cement does not cover the steel plug or impede its operation.

G. Allow the hydraulic cement to cure prior to initiating vapor extraction testing or subslab vapor sampling.

Procedure for Subslab Vapor Extraction Testing:

A general procedure for subslab vapor extraction testing is provided below. Actual subslab vapor extraction testing procedures will be dependent on the location and conditions at the time of testing.

A. Remove the 1-inch stainless steel plug from the subslab vapor extraction port. Thread a 1-inch Schedule 80 PVC nipple into a 1-inch NPTF by 1-inch BSPP stainless steel adapter with o-ring and install in the subslab vapor extraction port. Check the connections for tightness. A depiction of the subslab vapor extraction testing configuration is provided on Figure A.7.1, Detail 2 (attached).

B. Connect the vacuum (or equivalent) to the vapor extraction port using both rigid PVC pipe and flexible fittings (e.g., fernco fittings). A vacuum gauge (to measure applied vacuum at the extraction port), a port for velocity measurements using the hot-wire anemometer, and a port for vapor sample collection should be installed in the rigid PVC pipe. Hose will also be connected to the outlet side of the vacuum to vent to the outside of the building. Adjustments to the applied vacuum and vapor extraction rate will be made with a valve installed in the rigid PVC pipe on the suction side of the blower.

C. During the tests, vapor flowrate will be measured using a hand-held, hot wire anemometer and vapor screening will be performed using a PID. Vapor samples may also be collected into Summa®-type canisters or Tedlar® bags using a peristaltic pump for laboratory analysis using Method TO-15 (or equivalent method).

D. Surrounding subslab sampling/monitoring and extraction ports will be arranged in their respective sampling configurations (see Appendix A.6 and section below). Vacuum monitoring will be performed using a digital manometer connected to the ¼-inch Teflon tubing.

The general procedure for the vapor extraction testing will consist of monitoring nearby subslab sampling/monitoring and extraction ports at intervals of approximately fifteen minutes while pulling a vacuum on the extraction test port. Monitoring measurements will include: (i) measurement of flow rates; (ii) screening of extracted vapors using a PID; and (iii) measurement of vacuum in the surrounding subslab sampling/monitoring and extraction ports. At the completion of the extraction testing, external fittings should be removed from the subslab sampling/monitoring and extraction ports and each port should be capped using the appropriate plug and o-ring.

Procedure for Sampling of Subslab Vapor Extraction Ports:

A. Remove the 1-inch stainless steel plug from the subslab vapor extraction port. Verify that there are no obstructions present in the port. Thread a clean 1-inch BSPP by ¼-inch female BSPP reducer bushing into the subslab vapor extraction port. Thread a clean ¼-inch male ISO parallel thread to ¼-inch tube connector with integrated o-ring and ¼” Teflon tubing (either 1/8-inch or 3/16-inch I.D.) into the reducer bushing. The Teflon tubing should be cut to a length that allows for connection to the applicable sampling device. Make sure that pipe and tubing fittings are tight prior to collection of subslab vapor samples. A depiction of a subslab vapor extraction port in the sampling configuration is provided on Figure A.7.1, Detail 3 (attached).

B. For screening of the subslab vapors, connect the ¼-inch Teflon tubing to a peristaltic pump using an appropriate length of silicone tubing. Connect the open end of the silicone tubing to a short piece of ¼-inch Teflon tubing (1/8-inch I.D.). Purge the tubing by drawing enough sample volume to flush the installed sampling line.

C. Install the ¼-inch tubing on the polyethylene valve of a clean Tedlar® bag. Open the valve on the Tedlar® bag and turn on the peristaltic pump at a sampling rate of < 200 cc/min. Fill the Tedlar® bag to approximately two-thirds of its volume. Screen the contents of the Tedlar® bag using a PID and/or FID. A Tedlar® bag sample may also be collected for laboratory analysis using Method TO-15 (or equivalent method).

D. To collect a subslab vapor sample for laboratory analysis using a Summa®-type canister, follow the methods and procedures outlined in Appendix A.1 for collection and analysis of the sample. During sampling, the subslab vapor extraction port ¼-inch Teflon tubing will be connected to either the pressure gauge/metering regulator (for time-integrated samples) or to the Summa®-type canister valve fitting (for grab samples).

E. Record relevant sampling information on the Indoor Air Sampling Summary Form and COC, as applicable.

F. Once sampling/monitoring has been completed, remove the ¼-inch male ISO parallel thread connector and reducer bushing (with o-ring) from the subslab vapor extraction point. Replace the 1-inch stainless steel plug and tighten as necessary.

Analytical Methods:

Subslab vapor samples submitted for analysis shall be analyzed by the laboratory using USEPA Method TO-15, analysis of VOCs by gas chromatography/mass mass spectrometry (GC/MS), or an equivalent method for a target list of VOCs based on building-specific characteristics.

Quality Assurance/Quality Control:

Quality Assurance/Quality Control (QA/QC) measures for sampling the subslab vapor extraction ports will include integrity testing of the installed points using a tracer gas test. The protocol for the tracer gas integrity test is outlined in the QA/QC section of Appendix A.6 and additional QA/QC details are provided in Appendix B.

Reference Guidance Documents:

- New York State Department of Health, *Guidance for Evaluating Soil Vapor Intrusion in the State of New York - Final*, October 2006.

Attachments:

Figure A.7.1 – Subslab Vapor Extraction Port

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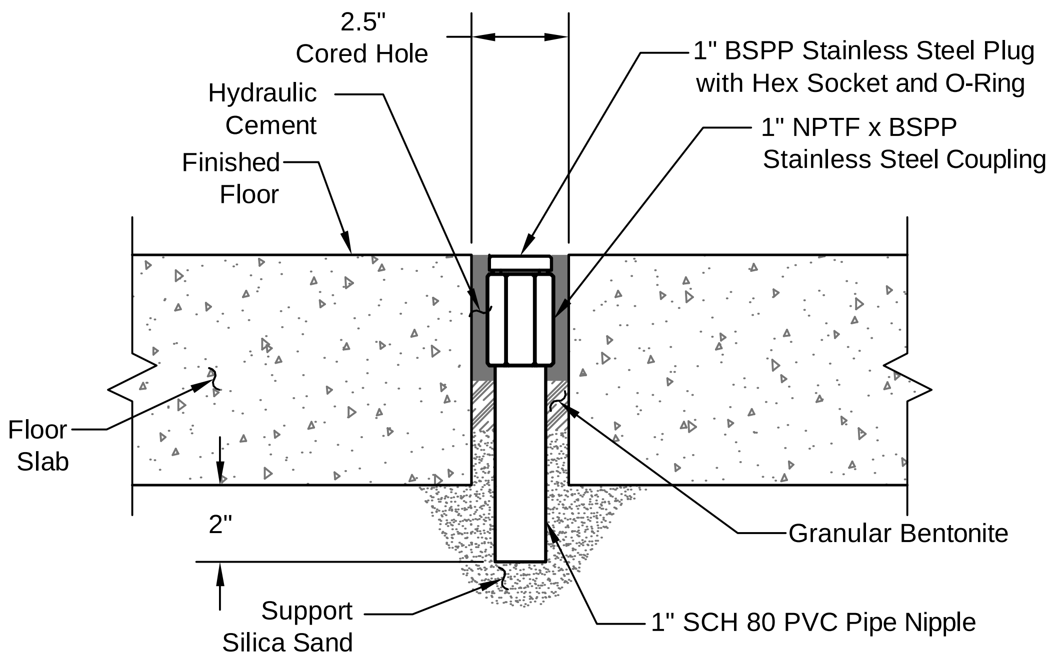

① SUBSLAB VAPOR EXTRACTION TEST PORT

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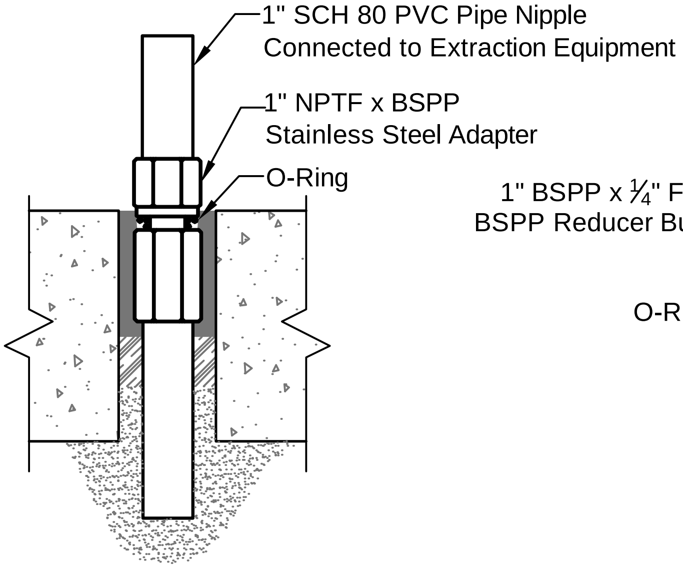

② VAPOR EXTRACTION TESTING CONFIGURATION

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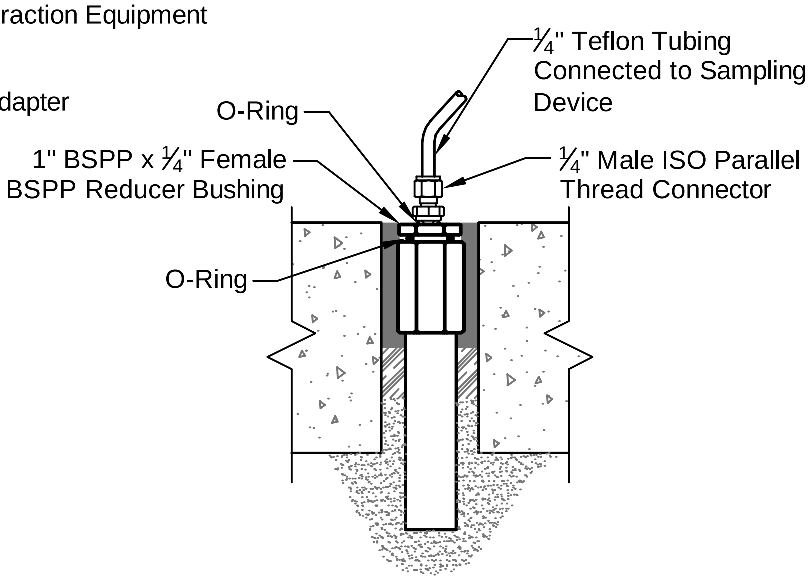

③ SUBSLAB VAPOR SAMPLING CONFIGURATION

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ENGINEERS

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Designed By: C. Lund
Reviewed By: D. Shea
Date: January 2009

Figure A.7.1

Subslab Vapor Extraction Port

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PLOT DATE: 1-15-09

APPENDIX A.8

MODIFIED USEPA METHOD 18

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APPENDIX A.8
Modified Method 18 Procedure

Purpose:

This document provides guidance for the analysis of volatile organic compounds (VOCs) using a modified U.S. Environmental Protection Agency (USEPA) Method 18 – Measurement of Gaseous Organic Compound Emissions by Gas Chromatography (GC). This procedure describes the methodology for collecting and analyzing vapor-phase samples associated with VOC source assessment and provides a summary of the analytical and quality control portions of the modified method. Please note that the sample collection techniques and procedures described in this modified Method 18 differ from the sampling methodologies described in the USEPA Method 18, which was developed as a stack testing method.

Sampling Procedures:

The modified Method 18 analytical procedure shall primarily be used to analyze indoor air, subslab, and soil vapor samples collected during VOC source investigation activities. These samples may be collected using various sampling equipment and devices, including sorbent tubes, passive sampling devices, and Tedlar bags. Sampling procedures for the different types of sampling equipment and devices are described below.

Sorbent Tube Sample Collection Procedure

Samples will be collected using pre-packed sorbent tubes with sorbent qualities suitable to the target analytes. The sorbent tubes will contain primary and secondary stages to evaluate potential breakthrough of target analytes (please note that SKC Anasorb CSC, Coconut Charcoal tubes with an 800 milligram (mg) primary adsorption section and a 200 mg secondary adsorption section were previously used for indoor air sampling and source investigation activities).

Samples will be collected using calibrated sampling pumps (e.g., SKC Universal® or equivalent) to collect vapor-phase samples using sorbent tubes. Sample pumps will be calibrated twice per year using a bubble flow-type calibrator (e.g., Buck™ flow calibrator). Sample pumps that do not hold calibration will not be used for testing. Sample pumps, fittings, and connections will be checked for leaks prior to sampling using a “dead-head” method. The “dead-head” method will include capping the suction side of the pump, drawing a vacuum, and monitoring whether the vacuum was maintained by the pump.

Calibrated sample pumps will be deployed for a sampling duration of 8 hours at a target sampling rate of 1.0±0.1 liters per minute (LPM), for a total target sample volume of 480 liters. The sorbent tubes will be purged with ambient air while the sampling flowrate is established. Each sampling pump will be checked pre- and post-sampling and an average flowrate will be used to calculate the total sample volume.

Sorbent tube samples will be transported to the laboratory under standard chain-of-custody (COC) procedures. Both the primary and secondary stages of the sorbent tubes will be analyzed to assess potential breakthrough of target analytes. Additional details for sorbent tube sampling are provided in Appendix A.3.

Passive Sampler Sample Collection Procedure

Samples may be collected using passive diffusion sampler devices with sorbent qualities suitable to the target analytes (please note that preloaded SKC Ultra® Passive Sampler devices were previously used for source investigation activities). The sorbent media will be cleaned and purged by SKC. Passive sampler device samples collected during source investigation activities will be transported to the laboratory under standard COC procedures. Additional details for passive sampler device sampling are provided in Appendix A.2.

Tedlar Bag Sample Collection Procedure

For subslab investigation activities, vapor-phase samples may be collected into Tedlar bags using a peristaltic pump and clean sampling equipment. Samples acquired for laboratory analysis will be collected into clean, dedicated Tedlar bags and transported to the laboratory for analysis under standard COC procedures. Additional details for Tedlar bag sampling are provided in Appendices A.6 and A.7.

Pre-Test Survey Procedure:

A pre-test survey may be performed during Method 18 testing to assess sources where target compounds and concentrations are not known. The intent of this modified Method 18 analysis is to use samples collected during source investigation activities as a pre-test survey when confirmatory indoor air sampling is anticipated.

Sample Preparation:

Samples will be stored in refrigeration to limit sample loss. Solvent desorption using carbon disulfide (CS_2) will be used to pre-process sorbent tube and passive sampler devices. The CS_2 solvent will be of 99.999% lab-grade purity. For sorbent tube samples, the sample will be desorbed from the sorbent media using approximately 2.5 milliliters (mL) of CS_2 for the primary stage and approximately 1.0 mL CS_2 for the secondary stage. The media and solvent will be placed in an ultrasonic bath for 15 minutes and then allowed to settle for 5 minutes before being transferred to the GC vial.

For passive sampler devices, the sample will be desorbed from the sorbent media using 1.5 milliliters (mL) of carbon disulfide soaked for 0.5 hours at ambient temperature. The sample will then be transferred to the GC vial.

Sample preparation is not required for vapor-phase samples collected into Tedlar bags. The samples will be directly injected into the GC/MS instrumentation as described below.

Analytical Equipment and Set-up:

This method is used to analyze target VOCs using a gas chromatograph (GC) equipped with a mass spectrometry (MS) detector and associated instrumentation. The GC column used for analyte separation is a 0.25 mm x 60 m capillary tube column with 1.4 micron liquid phase coating. The GC/MS will be run in 4-bromofluorobenzene (BFB) tune mode.

Sorbent tube and passive sampler device samples will be analyzed in selective ion monitoring (SIM) mode. Tedlar bags will be analyzed in full SCAN mode, using a sample concentrator. The modified Method 18 shall have a method detection limit of 0.5 parts per billion by volume (ppbv) for target analytes. Results from the modified Method 18 will be presented on a wet basis.

Sample Injection

Liquid samples (e.g., sorbent tubes and passive sampler devices) will be introduced using a 1.0 microliter (µL) splitless injection with a 0.5 minute injection time. Purge flow will be introduced approximately 0.5 minutes after the initial sample injection to minimize solvent tailing. Vapor-phase samples (e.g., Tedlar bag samples) will be introduced by direct injection. A BFB surrogate will be introduced with the vapor-phase samples to verify sample injection into the GC column, but will not be used for the surrogate recovery study. The analytical method run time is approximately 11 minutes with an 8 minute solvent delay, where applicable.

Instrument Calibration

A single 1,000 micrograms per milliliter (ug/mL) standard will be prepared for each target analyte using laboratory grade certified standards. The standard will be diluted to concentrations of 100, 10, 1, and 0.1 ug/mL for each target analyte and will be injected into the GC/MS to perform instrument calibration for liquid-phase samples. Vapor-phase calibration will be performed by injection of certified standards of target analytes into a 25 L clean Tedlar bag with a zero air or nitrogen background gas. A minimum of three calibration standards will be used for each target analyte. An average response factor (FR) will be used for the target analyte if RF standard deviation is less than 15%, otherwise the laboratory shall use a quadratic equation or equivalent to fit the calibration curve.

An initial calibration will be run daily and with a standard check performed after every ten samples using one of the calibration standards described above (rotating the standards throughout the day). A final calibration check will be performed at the end of each day.

Quality Assurance/Quality Control:

The collection of Quality Assurance/Quality Control (QA/QC) samples will include the submittal of trip blanks and field duplicates to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory for analysis of the target compounds. Duplicate samples will be collected using the following methods:

- Sorbent tubes - “side-by-side” sorbent tube samplers collected over the same sampling interval;

- Passive sampler devices - “side-by-side” passive sampler devices collected over the same sampling interval; and
- Tedlar bags collected sequentially using a peristaltic pump or equivalent.

Reference Guidance Documents:

- Office of Air and Radiation, Emission Measurement Center, U.S. Environmental Protection Agency, *Method 18 – Measurement of Gaseous Organic Compound Emissions by Gas Chromatography*.

- Center for Environmental Research Information, Office of Research and Development, U.S. Environmental Protection Agency, Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition, *Compendium Method TO-17 – Determination of Volatile Organic Compounds in Ambient Air using Active Sampling onto Sorbent Tubes*.

- National Institute for Occupational Safety and Health (NIOSH) Manual of Analytical Methods (NMAM), Fourth Edition, *Halogenated Hydrocarbons: Method 1003, Issue 3, March 15, 2003.*

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APPENDIX B

QUALITY ASSURANCE/QUALITY CONTROL PLAN

APPENDIX B
QUALITY ASSURANCE/QUALITY CONTROL PROJECT PLAN
CONFIRMATORY INDOOR AIR SAMPLING
RFI Work Plan – VOC Source Assessment
IBM East Fishkill Facility
Hopewell Junction, New York

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TABLES

Table B.1 – VOC Analyte List and TO-15 Reporting Limits
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B.1 INTRODUCTION

This appendix summarizes the quality assurance/quality control (QA/QC) project plan associated with the collection, analysis, and management of indoor air samples in support of confirmatory sampling activities, which are part of the Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI) VOC source assessment at the IBM East Fishkill facility located in Hopewell Junction, New York (the site). The purpose of the QA/QC program is to establish procedures for meeting data quality objectives, data validation, and assessment of data usability.

B.2 DATA QUALITY OBJECTIVES

The DQOs were established to assess the presence and concentration or absence of target volatile organic compounds (VOCs) in confirmatory indoor air samples within site buildings. The DQOs were prepared in recognition that these data will be used to evaluate the need for additional source investigation activities. The confirmatory samples will be collected in SUMMA® type canisters and submitted to a NYSDOH Environmental Laboratory Approval Program (ELAP)-certified laboratory for analysis. Samples will be collected using the procedures described in Appendix A.1. The analysis will be completed using USEPA Method TO-15 of the target analyte list provided in Table B.1.

The analytical data will undergo data validation and usability assessment prior to use of the data. Criteria for performance measures, including precision, accuracy/bias, representativeness, data comparability, sensitivity (quantitation limits), and completeness are discussed below.

B.3 MEASUREMENT PERFORMANCE CRITERIA

This section documents the performance criteria defined for the analytical measurement systems so that the project DQOs, as defined above, are met. Measurement Performance Criteria (MPC) for precision, accuracy/bias, representativeness, completeness, sensitivity, and comparability have been determined for the proposed laboratory analysis of VOCs in indoor air samples. The proposed frequency of quality assurance elements associated with the MPC are outlined in Table B-1.

B.3.1 Precision

Precision is the degree of agreement among repeated measurements of the same characteristic (analyte, parameter, etc.) under the same or similar conditions. Precision data indicate how consistent and reproducible the field sampling and/or analytical procedures have been. “Overall project precision” will be measured by collecting data from duplicate field samples. In addition, analytical laboratory precision will be measured by analyzing laboratory control sample/laboratory control sample duplicate (LCS/LCSD) samples and laboratory duplicates (LD). Comparing overall project precision and laboratory precision will help to identify sources of imprecision, such as possible error in sample integrity, if such imprecision exists.

Field duplicate (FD), LD, and LCS/LCSD precision will be evaluated by calculating the relative percent difference (RPD) of the duplicate results using the following equation:

$$RPD = \frac{\left|x_1 - x_2\right|}{\frac{x_1 + x_2}{2}} \bullet 100\%$$

Where,

RPD	represents the relative percent difference;
x_1	indicates the original sample concentration; and
x_2	indicates a replicate sample concentration.

The target for RPD for FD, LD and LCS/LCSD analyses is 20%.

B.3.2 Accuracy/Bias

Accuracy is the extent of agreement between an observed value (sample result) and the accepted, or true, value of the parameter being measured. Accuracy is frequently used synonymously with bias. Specifically, the term “bias” describes the systematic or persistent error associated with a measurement process. Sources of error in the field and the laboratory that may contribute to poor accuracy include laboratory measurement error, sampling inconsistency, field contamination, laboratory contamination, and preservation and handling issues. Accuracy/bias will be evaluated using several different types of QC samples including, LCS, internal standard (IS) and surrogate spikes, and field and laboratory blank samples. In addition, method-required instrument tuning, initial calibration, and continuing calibration criteria provide for acceptable accuracy of the analytical measurements for this program. For the QC samples that have a “true” value (e.g., LCS), the following equation will be used to calculate the accuracy or potential bias in the result as a “percent recovery:”

$$Accuracy/Bias = \%Recovery = \frac{Measured\ Value}{True\ Value} \bullet 100\%$$

The acceptance criteria for the IS is 60-140% recovery and for surrogates and LCS is 70-130% for all target compounds except acetone, which has an acceptance criteria of 60-140% recovery.

B.3.3 Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the site conditions. It takes into consideration the magnitude of the area represented by one sample and assesses the feasibility/reasonableness of that design rationale. Representativeness also reflects the ability of the sampling team to collect samples and laboratory personnel to analyze those samples in such a manner that the data generated accurately and precisely reflect the site conditions. As a quantitative measure of representativeness, field duplicate samples will be collected and analyzed. See above section on precision for detailed approach to duplicate collection, analysis, and criteria. Overall representativeness will be assessed once all of the data are validated and reviewed to determine whether or not the sampling design was adequate for defining the site conditions.

B.3.4 Comparability

Comparability is a qualitative parameter that expresses the confidence with which data sets can be compared. Comparable data allows for the ability to combine analytical results acquired from various sources taken during the period of the assessment. Comparability relies upon precision and accuracy within the individual data sets to be acceptable, to promote confidence in the data sets. The consistent use of the sampling and analytical methods defined in this plan will yield comparable results. In addition, comparability can be affected by QA/QC criteria such as sample preservation, holding times, blank contamination, quantitation limits, and matrix issues. The QC criteria for these parameters have been defined in this plan to provide comparability of the data generated during the program.

B.3.5 Sensitivity

Sensitivity is the ability of the method or instrument to detect the target VOCs at the concentration of interest. Several QC samples and procedures will be used to provide sensitivity consistent with site DQOs. These include collection and analysis of field blank, laboratory method blank samples, and instrument initial and continuing calibration criteria. The laboratory's lowest concentration initial calibration standard will be at a level at or below the project-required reporting limits, on a sample-equivalent basis. Adherence to method procedures, and field and laboratory instrument/equipment maintenance, testing, and inspection will also assist in providing the appropriate level of sensitivity.

Reporting limits for Method TO-15 analyses for the project-specific list of analytes are shown in Table B.1.[1] The reporting limits for a given sample are dependent on the sample residual vacuum at the time of receipt at the laboratory and upon sample-specific handling during TO-15 analysis. After the canister vacuum has been measured at the laboratory, the canister will be over-pressurized to 5 pounds per square inch (psi) as a part of the sample preparation procedure, which will lead to an expected sample dilution factor of about 2. A table depicting the relationship between receipt canister vacuum, final pressure of canister, and dilution factor is included below[2].

Receipt Canister Vacuum (in Hg)	**4**	**4.5**	**5.0**	**5.5**	**6**
Final Pressure of Canister (psi)	5	5	5	5	5
Dilution Factor	1.55	1.58	1.61	1.64	1.68

---

[1] The reporting limits were provided by Air Toxics Limited (ATL) of Folsom, California (a NELAC-certified laboratory).

[2] The information provided in this table is from Air Toxics Ltd. Environmental Analytical Laboratory, *Guide to Air Sampling and Analysis*, Fifth Revision, March 2007. The dilution factor presented assumes that the canister was pressurized to 5 psig prior to analysis.

If a compound is detected at a concentration above the instrument calibration range during TO-15 analysis, a secondary dilution at the GC/MS instrument level may be performed so that target compounds are quantitated within the accurate calibration range of the instrument. If a secondary dilution is performed, the reporting limits will be adjusted to account for this dilution in addition to the dilution made for over-pressurization of the canisters.

If the laboratory is able to identify a target compound at a level below the reporting limit (equivalent to the sample-specific level associated with the lowest concentration initial calibration), they will report the result as an estimated value (flagged “J”) due to uncertainty in quantitation at a level below the instrument calibration range. These results are qualitatively accurate and may be used for project decisions with the understanding of the uncertainty in the numerical value.

B.3.6 Completeness

Completeness is a measure of the amount of valid/usable data resulting from data collection and analysis activities. Completeness can be calculated as a percentage of the number of valid/usable results obtained compared to the total number of results (usable and rejected) obtained during the course of the investigation. Theoretically, a completeness target is reached through adherence to the methods and QC requirements. Deficiencies in the data may be due to sampling techniques, poor accuracy or precision, or laboratory error. While these deficiencies may affect certain aspects of the data, usable data may still be extracted from applicable samples. The completeness objective for this project is 90 percent.

B.4 EXECUTION OF SAMPLING AND ANALYSIS

B.4.1 Sampling Procedures

Indoor air and subslab vapor samples will be collected and analyzed using the procedures and protocols provided in Appendix A.

Collection of a single sample 6-liter canister will result in a sample volume of approximately 5.0 liters, which integrated over an 8-hour sampling period provides a sampling rate of approximately 0.012 liters per minute. Duplicate samples will be collected concurrently from a single indoor air monitoring point.

Field screening for a gross VOC concentration will be performed prior to collection of indoor air samples for screening and QA/QC purposes. Indoor air screening will be performed using a photo-ionization detector (PID) equipped with a 10.6 eV lamp and/or a portable flame ionization detector (FID) in the area of the indoor air sample.

B.4.2 Quality Assurance/Quality Control

The proposed schedule of Quality Control measures such as field duplicates and blanks, and analytical laboratory blanks are outlined in Table B.2. A summary quality assurance/control checklist is provided as Table B.3. As outlined in these tables and in the text to follow, QA/QC measures implemented during field sampling activities will include but not be limited to:

- confirmation of sample container and metering valve integrity before and after sample collection;
- sample collection pursuant to the methods outlined above;
- collection of field duplicate samples; and
- collection of field blanks for SUMMA® canister samples.

The SUMMA® canisters used for sample collection will be "individually certified clean" by the analytical laboratory to the laboratory reporting limits outlined in Table B.1, and confirmation of the presence of the certification seal or label for each container will be noted on sampling documentation. The flow metering regulator will also be "individually certified clean" and the laboratory will verify the flow rate. The canister vacuum will be noted and recorded before and after the collection of samples.

Equipment blanks ("field blanks") will accompany sample containers (empty) to the field, and collected samples sent back to the lab. These equipment blanks will consist of a laboratory certified SUMMA® canister filled in the field with lab-grade nitrogen, and will not be opened during the course of its transport. The equipment blanks should not contain any target analyte at a concentration greater than its corresponding reporting limit, or other non-target compounds that may interfere with the analysis of a target analyte.

Duplicate samples will be collected simultaneously (i.e., over the same time interval) and spatially adjacent to each other at the frequency outlined in Table B.2. The location selected for the collection of the duplicate sample should be a location where "upscale" but not "off scale" VOC concentrations are expected, if possible, so that small differences in absolute concentrations will tend not to yield large percentage differences.

B.4.3 Sampling Documentation

The collection of indoor air samples will be documented with the use of Indoor Air Sampling Summary forms. An example of this form is included in Appendix A. Information recorded on this form will include:

- identification of sample;
- date and time of sample collection;
- identity of sample collector(s);
- description of location of sample collection;
- weather conditions at the time of sample collection (for outdoor samples);
- sampling equipment and sample containers (e.g., type, serial number) used;
- starting and ending vacuums of SUMMA canisters; and
- height of sample collection above ground or floor surface.

The collection, transfer of custody, and shipping/transport of the samples to the analytical laboratory will be documented using chain-of-custody (COC) forms. Information recorded on the COC form will include:

- sample identification;
- date and time of sample collection;
- identity of sample collector(s);
- starting and ending vacuums of SUMMA canisters;
- requested analyses; and
- additional notes or comments pertinent to analysis of the samples.

B.4.4 Laboratory Analysis

IBM will use a NYSDOH ELAP-certified analytical laboratory to analyze for the target list of VOCs indicated in Table B.1 by USEPA Method TO-15.

B.5 DATA VALIDATION

The TO-15 data generated by the laboratory will be validated and assessed for usability compared to the project objectives by an independent data validator. The purpose of this data validation/usability assessment is to provide information on the uncertainty and bias in the data as considerations for decision-making. Data validation and usability assessment will be performed using professional judgment, QC criteria defined in this appendix, and guidance from the following USEPA and NYSDEC regulatory protocols:

- NYSDEC Analytical Services Protocol June 2005 with NYSDEC Modifications to the EPA Region 9 TO-15 QA/QC Criteria, February 2008;

- USEPA Region II SOP HW-31 based upon Method TO-15, October 2006; *Method TO-15: Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters & Analyzed by Gas Chromatography/Mass Spectrometry*, January 1999; and

- *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*; Publication USEPA540/R-07/003, July 2007.

The data validation/usability assessment is performed using a two-tier process. The first tier involves an in-depth review of sample matrix and batch QC results, a review of the raw data including initial and continuing instrument calibrations and sample-specific reporting limit and quantitation verifications, and sample collection QC (vacuums, FD, blanks) to evaluate whether the data meet the objectives described above and are compliant with the USEPA method of analysis. This in-depth review will use QC criteria defined in this appendix and applicable regulatory guidelines from USEPA (Region II and National Guidelines) and NYSDEC ASP.

A data usability report (DUR) will be prepared for the first tier assessment, which will describe the QC issues that required action (qualification of data) and the effects of these actions on the usability of the results. The DUR will also include the hand-completed in-depth checklist to document the review and a table of validated results.

If the in-depth, first tier review indicates sample analysis meets the project DQOs, then a second tier, abbreviated data validation review will be used for the remaining data. This second tier assessment is an abbreviated review whereby all the project QC criteria are assessed; however, evaluation of the raw data is not performed. This second-stage review is compliant in content to the NYSDEC Data Usability Summary Report, but, for time efficiency for this project, this review will be presented in an "exception" report. This report will consist of a brief letter tabulating any validation actions taken and effects (e.g., bias) on the results in terms of usability, the hand-completed abbreviated checklist, and a table of validated results.

The laboratory will still provide a NYSDEC Category B deliverable (i.e., sample results, summary QC, method blank results, LCS recoveries, instrument QC sample results, raw data for all analyses, instrument tunes, and calibrations) for the abbreviated second tier review, so in the event that an in-depth assessment is needed in the future, a full laboratory deliverable package is readily available.

S:\CONDATA\2900s\2999.00\Originals\Revised RFI Work Plan\Appendix B\20090608 Appendix B QA QC Plan.doc

TABLE B.1
VOC Analyte List and TO-15 Reporting Limits
VOC Source Assessment
RFI Work Plan
IBM - East Fishkill Facility
Hopewell Junction, New York

Analyte List	USEPA Method TO-15, Hi/Lo
	RL ($\mu g/m^3$)
Tetrachloroethene (PCE)	1.4
Trichloroethene (TCE)	0.22
cis-1,2-Dichloroethene (cDCE)	0.80
1,1-Dichloroethene (DCE)	0.80
Vinyl chloride (VC)	0.06
1,1,1-Trichloroethane (TCA)	1.1
Carbon tetrachloride	0.2
Methylene chloride (MeCl)	1.4
Chlorobenzene	0.92
1,2,4-Trichlorobenzene	7.4
1,2-Dichlorobenzene	1.2
1,3-Dichlorobenzene	1.2
1,4-Dichlorobenzene	1.2
Acetone	2.4
Benzene	0.64
Ethylbenzene	0.86
m-Xylene	0.86
p-Xylene	
o-Xylene	0.86
Toluene	0.77
Trichlorofluoromethane (Freon 11)	1.1
Dichlorodifluoromethane (Freon 12)	1.0
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	1.5

NOTES:

1. This table summarizes the proposed analytes along with respective reporting limits (RLs) for United States Environmental Protection Agency (USEPA) Method TO-15 laboratory analysis.

2. RLs for USEPA Method TO-15 Hi/Lo analysis were provided to SHA by Air Toxics, Ltd (ATL) of Folsom, California. The RLs are based upon a presumed dilution factor of two.

2. Actual RLs for may be higher due to procedures associated with the preparation of field samples for analysis and will be a function of the actual sample volume provided to the laboratory, matrix effects, and other factors.

Table B.2
Proposed Schedule of Quality Control Elements
RCRA Facility Investigation (RFI) Work Plan
IBM - East Fishkill Facility
Hopewell Junction, New York

Quality Control Element Sampling:	Description	Frequency	Purpose	Synonyms
Field Duplicate Samples	Two or more co-located samples collected simultaneously	At least one set of duplicate samples per sample delivery group or a minimum of one per 20 samples collected	To improve confidence in measured concentrations	Replicate samples Collocated samples Parallel samples
Field Blanks	Certified clean SUMMA canister which is filled with laboratory grade nitrogen in the field which accompanies samples back to laboratory	At least one per sample delivery group or a minimum of one per 20 samples collected	To assess for the presence of target compounds that could be due to equipment preparation and transportation of equipment to and from the field	Canister Blank Equipment Blank
Analysis:				
Method Blank	Analyte-free sampling device analyzed like samples	One per analytical batch after CCV	To assess contamination of analytical system	Blank
Laboratory Duplicate	Duplicate analysis of a sample	One LD per analytical batch	To assess analytical precision	Matrix Duplicate (MD)
Lab Control Sample (LCS) and Lab Control Sample Duplicate (LCSD)	Standard Matrix (air) with target analytes at verified concentrations	One LCS/LCSD per analytical batch	To assess accuracy and precision of analyses relative to matrix	Blank Spike (BS) and Blank Spike Duplicate (BSD)
Internal Standards and Surrogates	Compounds chemically similar to targets but not normally found in nature	Added to every field sample and quality control sample	To assess accuracy of measurement process	IS Spikes

Table B.3

Quality Assurance/Quality Control Checklist

RCRA Facility Investigation (RFI) Work Plan
IBM – East Fishkill Facility
Hopewell Junction, New York

- ☐ **Site Map Supplied With Sampling Locations Noted**

- ☐ **Pressure Readings**
  - ☐ Pre-sampling, post sampling and pre-analysis pressures/vacuums noted
  - ☐ Post-sampling pressures equivalent to pre-analysis pressures
  - ☐ Dilutions done on samples with low pre-analysis pressures (will be dependent upon laboratory equipment when dilution is required?)
  - ☐ Initial Canister Vacuum(s) satisfy(ies) NYSDEC criteria (i.e., vacuum should be greater than 28 ± 2 inches Hg, [in Hg])
  - ☐ Final Canister Vacuum(s) satisfy(ies) NYSDEC criteria (i.e., vacuum should be preferably be between 3 and 10 inches Hg)

- ☐ **Sample Labeling**
  - ☐ Check canister label against field sheets and COC when packing for shipment

- ☐ **Chain of Custody Record**
  - ☐ Present
  - ☐ Complete
  - ☐ Samples Clearly Identified
  - ☐ Date/Time Sampled Recorded
  - ☐ Transfer Signatures Completed
  - ☐ Name of Person Collecting Samples Listed

- ☐ **Appropriate Blanks Available**
  - ☐ Field Equipment Blank
  - ☐ Method Blank
  - ☐ Other Blank(s)
  - ☐ Blank Levels found Within Acceptable Criteria for Method (if no, explain below)

- ☐ **Recommended Holding Times Met for Samples**
  - ☐ Summa Canisters: 30 days from collection (Method TO-15 and NYSDEC February 2008 modification)

- ☐ **Reporting Limits**
  - ☐ Reporting Limit determined for each analyte of interest and consistent with project plan.
  - ☐ Reporting Limits adequate to address study objective (if no, explain below)

Table B.3
Quality Assurance/Quality Control Checklist
RCRA Facility Investigation (RFI) Work Plan
IBM – East Fishkill Facility
Hopewell Junction, New York

- ☐ **Results**
  - ☐ Correct method reference
  - ☐ Method modifications noted
  - ☐ Units noted and correct (µg/m^3 and ppbv)
  - ☐ Date of analysis listed for each sample
  - ☐ Dilution factors noted
    - ☐ Reporting limits and results corrected for dilution factors
    - ☐ Reason for dilution clear
  - ☐ Reporting limits reasonable
    - ☐ Data quality objective met
  - ☐ Media listed
  - ☐ Laboratory identification number listed

- ☐ **Tune (e.g., bromofluorobenzene) criteria**
  - ☐ Included
  - ☐ Satisfied (in accordance with method criteria)

- ☐ **Instrument Calibration**
  - ☐ Included
  - ☐ ICAL criteria satisfied (≥5-level, lowest concentration at RL, and %RSD ≤ 30%)
  - ☐ CCAL criteria satisfied (daily, mid-level, %D ≤ ± 30%)

- ☐ **Laboratory Control Samples (LCS/LCSD)**
  - ☐ One set of LCS/LCSD analyzed per analytical batch
  - ☐ Percent Recovery (R) 70-130% for all targets except acetone at 60-140%

- ☐ **Surrogate Recovery**
  - ☐ Percent Recovery (R) 70-130%.

- ☐ **Internal Standard Response and Retention Time**
  - ☐ IS Area %D ≤ ± 40% of CCV IS Area (60-140% recovery)
  - ☐ Retention Time (RT) ≤ ± 0.33 minutes of RT in CCV

- ☐ **Duplicate Sample Results**
  - ☐ Agreement Between Field Duplicates – RPD ≤ 20%
  - ☐ Agreement between Laboratory Duplicates – RPD ≤ 20%
  - ☐ Agreement between LCS/LCSD – RPD ≤ 20%
  - ☐ Larger variation between duplicate samples allowed if concentrations are near to RL.

- ☐ **Other Quality Control Results**
  - ☐ Any nonconformances noted and clearly explained
  - ☐ Method blank below reporting limit
  - ☐ Certification that canisters have been cleaned present

APPENDIX C

BUILDING PLANS

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Figure C-1

Building 300 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 300 and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

⊙ 60	Solid Waste Management Unit with ID number
CW	Container Waste
IW	Industrial Waste Unit Solvent
SO	Solvent Waste Unit
L/UL	Loading/Unloading Area
▨	Approx. Location of Above Ground Solvent Line
●	Planned Confirmatory Indoor Air Sampling Location

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Figure C-2

Building 304 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

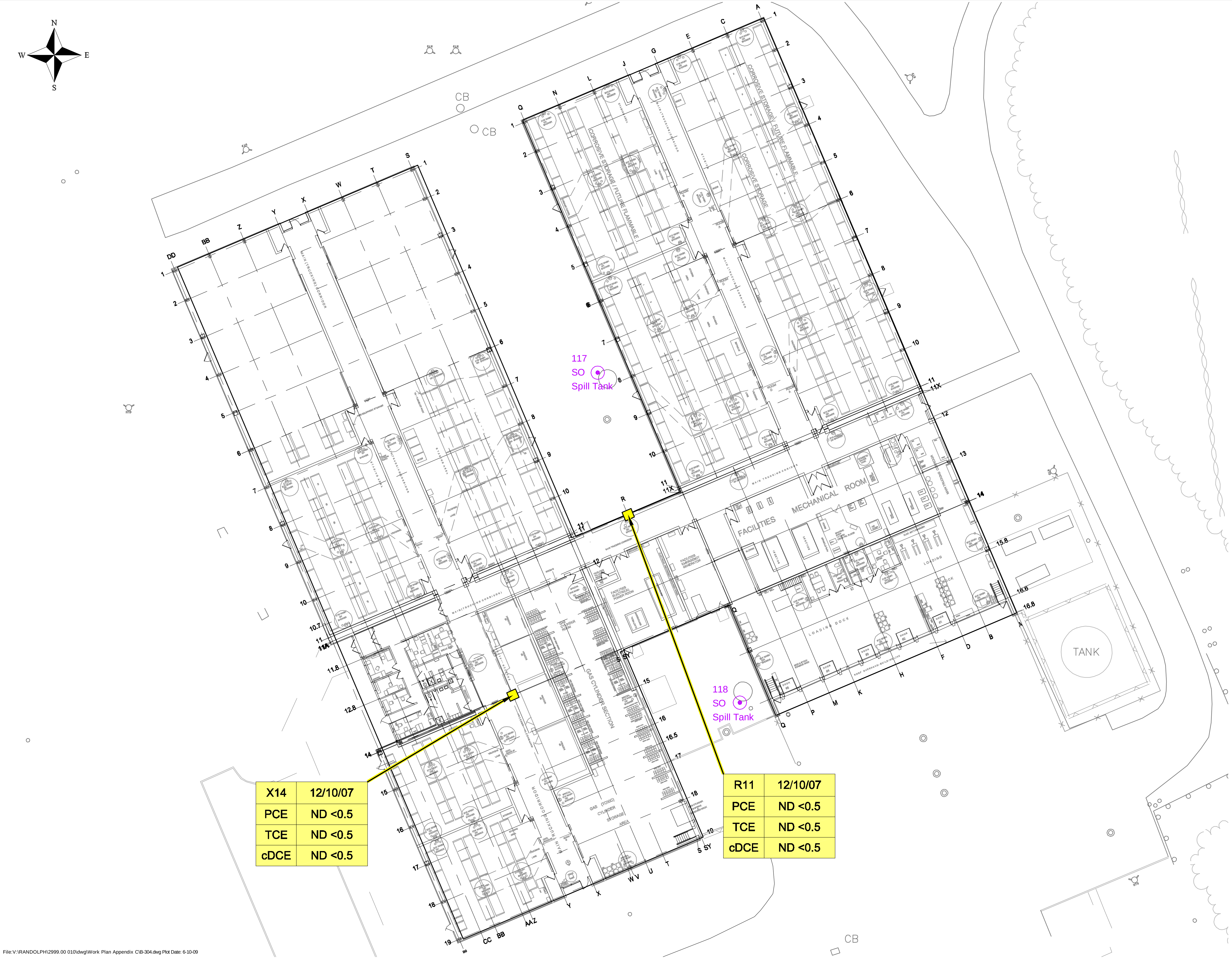
Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 304 and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

◉ 117	Solid Waste Management Unit with ID number
SO	Solvent Waste Unit
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.



X14	12/10/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

R11	12/10/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

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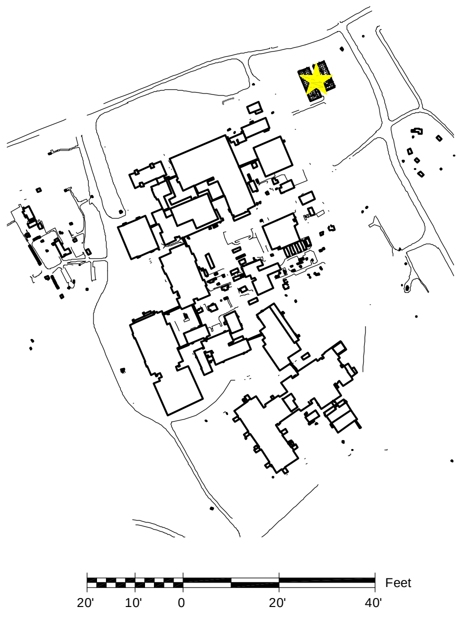

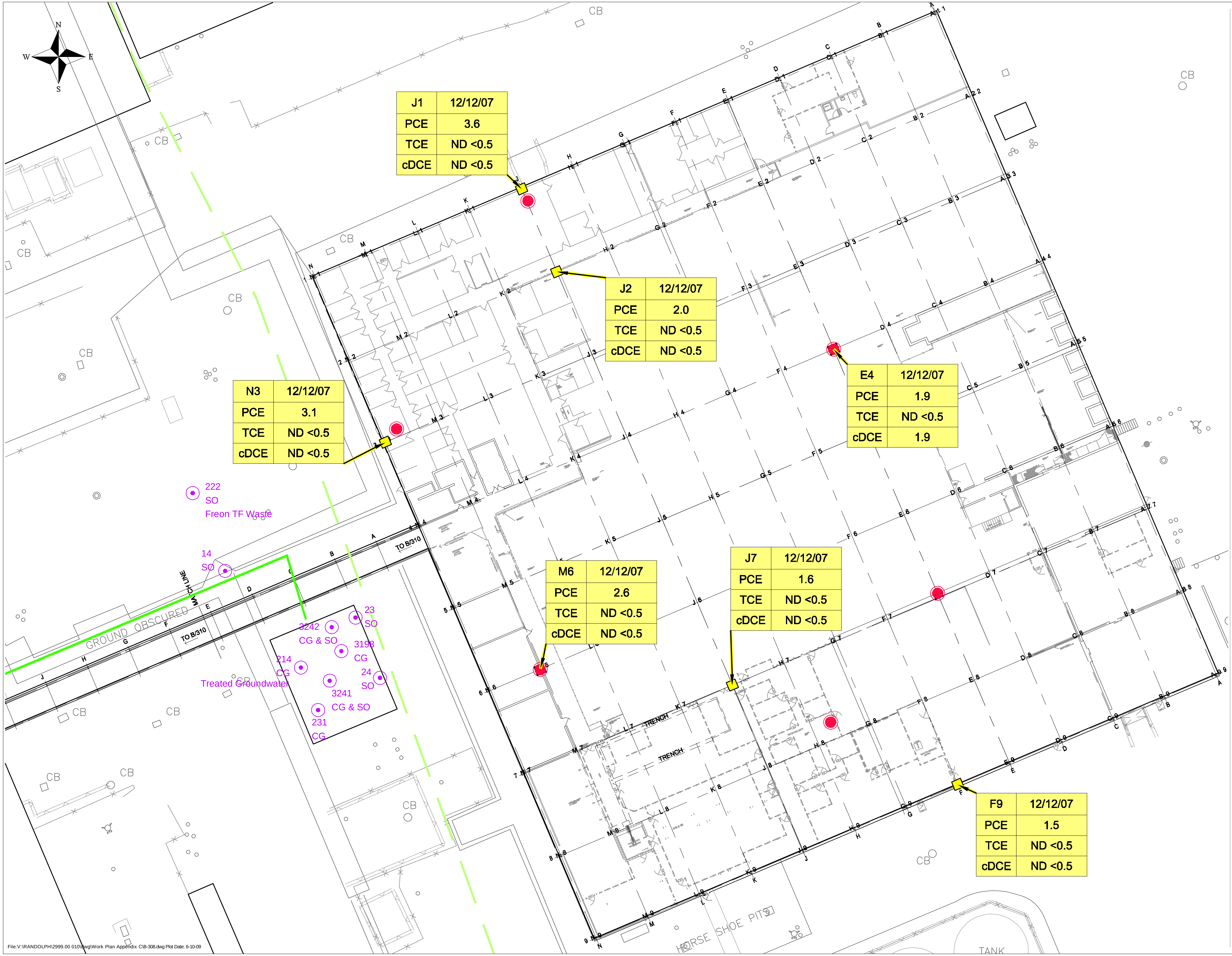

J1	12/12/07
PCE	3.6
TCE	ND <0.5
cDCE	ND <0.5

J2	12/12/07
PCE	2.0
TCE	ND <0.5
cDCE	ND <0.5

N3	12/12/07
PCE	3.1
TCE	ND <0.5
cDCE	ND <0.5

E4	12/12/07
PCE	1.9
TCE	ND <0.5
cDCE	1.9

M6	12/12/07
PCE	2.6
TCE	ND <0.5
cDCE	ND <0.5

J7	12/12/07
PCE	1.6
TCE	ND <0.5
cDCE	ND <0.5

F9	12/12/07
PCE	1.5
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-3

Building 308 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 308, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

⦿ 222	Solid Waste Management Unit with ID number
SO	Solvent Waste Unit
CG	Contaminated Groundwater Unit
■	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
– –	Approx. Location of Above Ground Solvent Line
—	Approx. Location of Below Ground Solvent Line
●	Planned Confirmatory Indoor Air Sampling Location

Feet
20' 10' 0 20' 40'

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B1	12/17/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

A7	12/17/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-4

Building 309 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

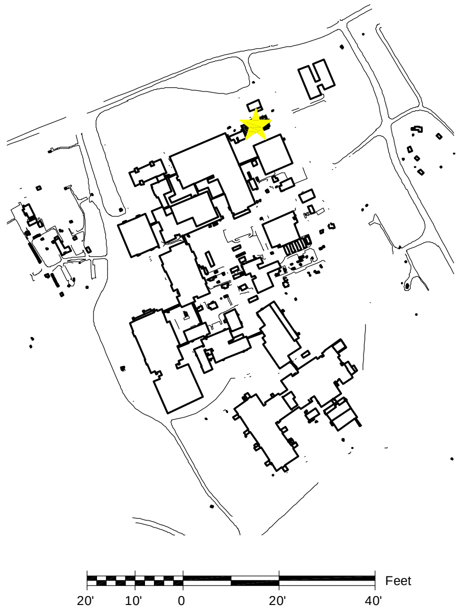
Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 309, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

⊙ 285	Solid Waste Management Unit with ID number
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
— —	Approx. Location of Above Ground Solvent Line
▨	Approx. Area of Below Ground Solvent Drains
●	Planned Confirmatory Indoor Air Sampling Location



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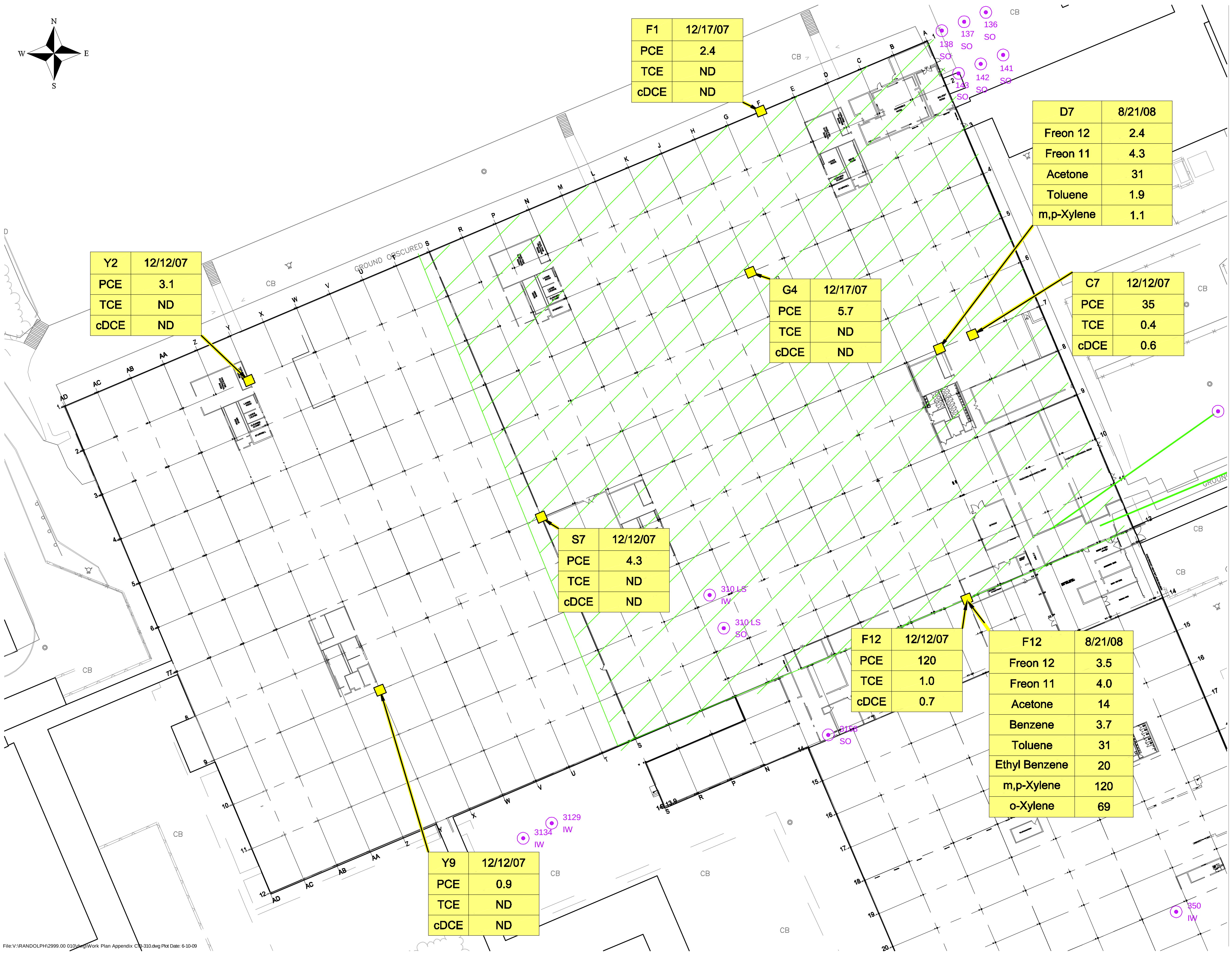

Y2	12/12/07
PCE	3.1
TCE	ND
cDCE	ND

F1	12/17/07
PCE	2.4
TCE	ND
cDCE	ND

D7	8/21/08
Freon 12	2.4
Freon 11	4.3
Acetone	31
Toluene	1.9
m,p-Xylene	1.1

G4	12/17/07
PCE	5.7
TCE	ND
cDCE	ND

C7	12/12/07
PCE	35
TCE	0.4
cDCE	0.6

S7	12/12/07
PCE	4.3
TCE	ND
cDCE	ND

F12	12/12/07
PCE	120
TCE	1.0
cDCE	0.7

F12	8/21/08
Freon 12	3.5
Freon 11	4.0
Acetone	14
Benzene	3.7
Toluene	31
Ethyl Benzene	20
m,p-Xylene	120
o-Xylene	69

Y9	12/12/07
PCE	0.9
TCE	ND
cDCE	ND

Figure C-5A

Building 310 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 310 and the locations and results of 2007 and August 21, 2008 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

⊙ 136	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
SO	Solvent Waste Unit
LS	Lift Station
🟨	Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
—	Approx. Location of Below Ground Solvent Line
▨	Approx. Area of Below Ground Solvent Drains

Feet
30' 15' 0 30' 60'

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B21	8/21/08
Freon 12	5.1
Freon 11	3.5
Acetone	12
Benzene	0.68
Toluene	3.3
m,p-Xylene	1.1

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Figure C-5B

Building 310 Layout Continued

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 310 and the locations and results of 2007 and August 21, 2008 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

- ● 350 Solid Waste Management Unit with ID number
- IW Industrial Waste Unit
- SO Solvent Waste Unit
- LS Lift Station
- 🟨 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
- — Approx. Location of Below Ground Solvent Line
- ▨ Approx. Area of Below Ground Solvent Drains
- – – Approx. Location of Above Ground Solvent Line

30' 15' 0 30' 60' Feet

Figure C-6

Building 315 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 315 and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

◉ 154	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.

H15	12/19/07
PCE	0.7
TCE	ND <0.5
cDCE	ND <0.5

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L2	12/19/07
PCE	4.7
TCE	1.4
cDCE	4.0

File:V:\RANDOLPH\2999.00 010\dwg\Work Plan Appendix C\B-316.dwg Plot Date: 6-10-09

Figure C-7

Building 316 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 316 and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

● 578	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.

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Figure C-8

Building 320A Layout

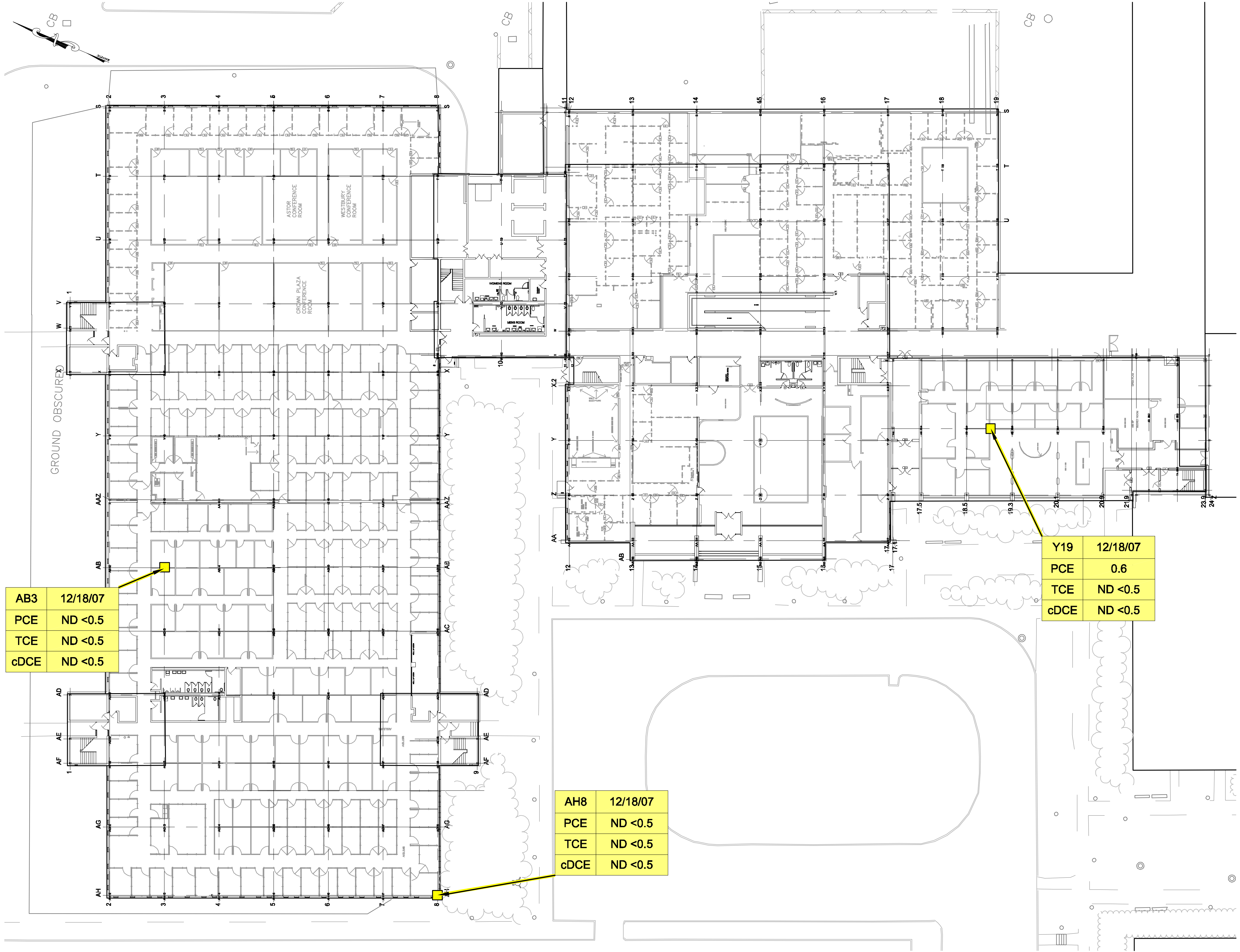
RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 320A and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.



AB3	12/18/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

Y19	12/18/07
PCE	0.6
TCE	ND <0.5
cDCE	ND <0.5

AH8	12/18/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

Legend

🟨 2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.

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J25	12/18/07
PCE	0.7
TCE	ND <0.5
cDCE	ND <0.5

A24	12/18/07
PCE	0.9
TCE	ND <0.5
cDCE	ND <0.5

H33	12/18/07
PCE	1.1
TCE	1.1
cDCE	1.0

P34	12/18/07
PCE	0.9
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-9

Building 320B Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 320B, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

◉ 125	Solid Waste Management Unit with ID number
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
━━	Approx. Location of Below Ground Solvent Line
▨	Approx. Area of Below Ground Solvent Drains
─ ─	Approx. Location of Above Ground Solvent Drain line
─ ─	Approx. Location of Above Ground Solvent Line
🔴	Planned Confirmatory Indoor Air Sampling Location

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Figure C-10

Building 321 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

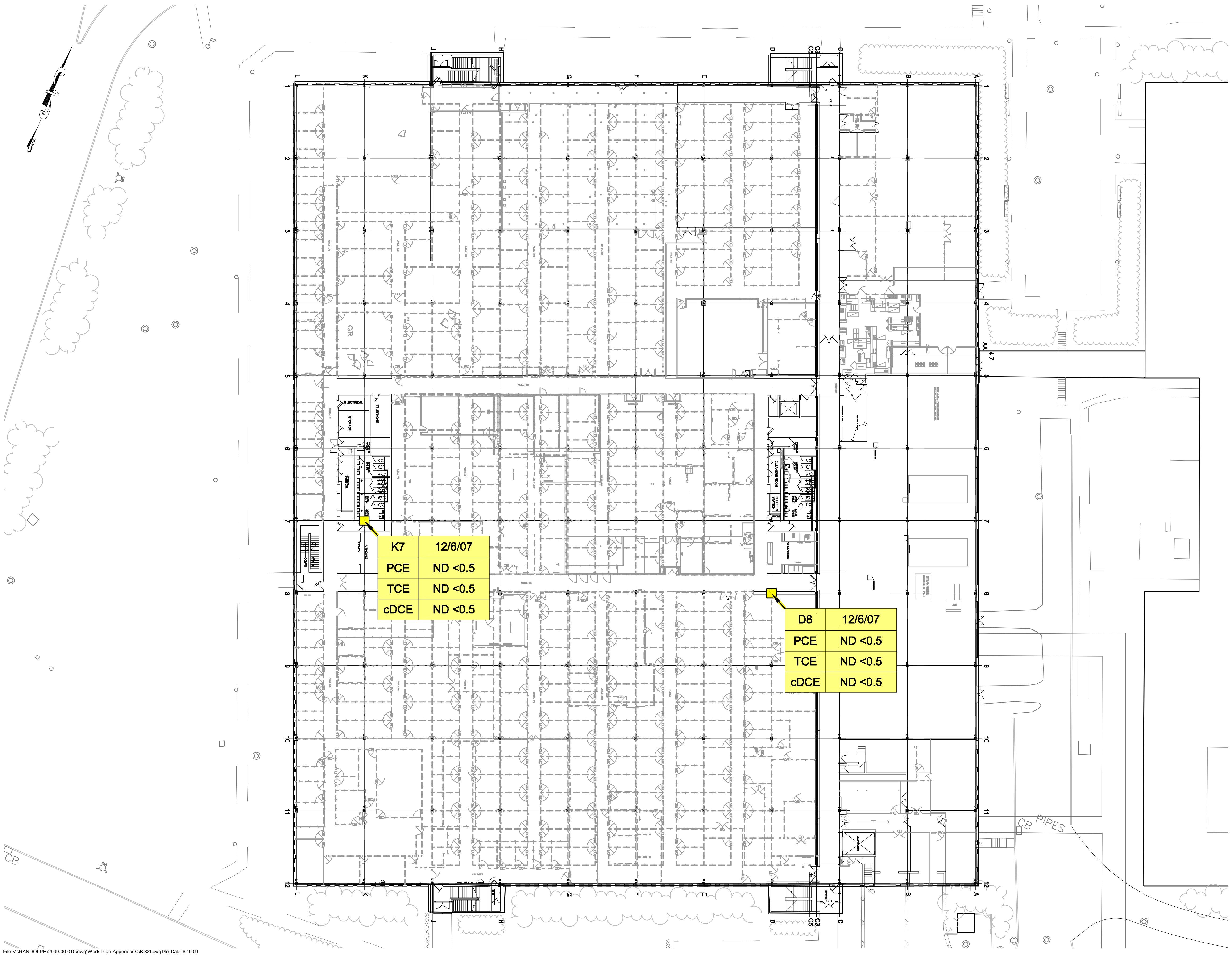
Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 321 and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

🟨 2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.



K7	12/6/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

D8	12/6/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

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File:V:\RANDOLPH\2999.00 010\dwg\Work Plan Appendix C\B-321.dwg Plot Date: 6-10-09

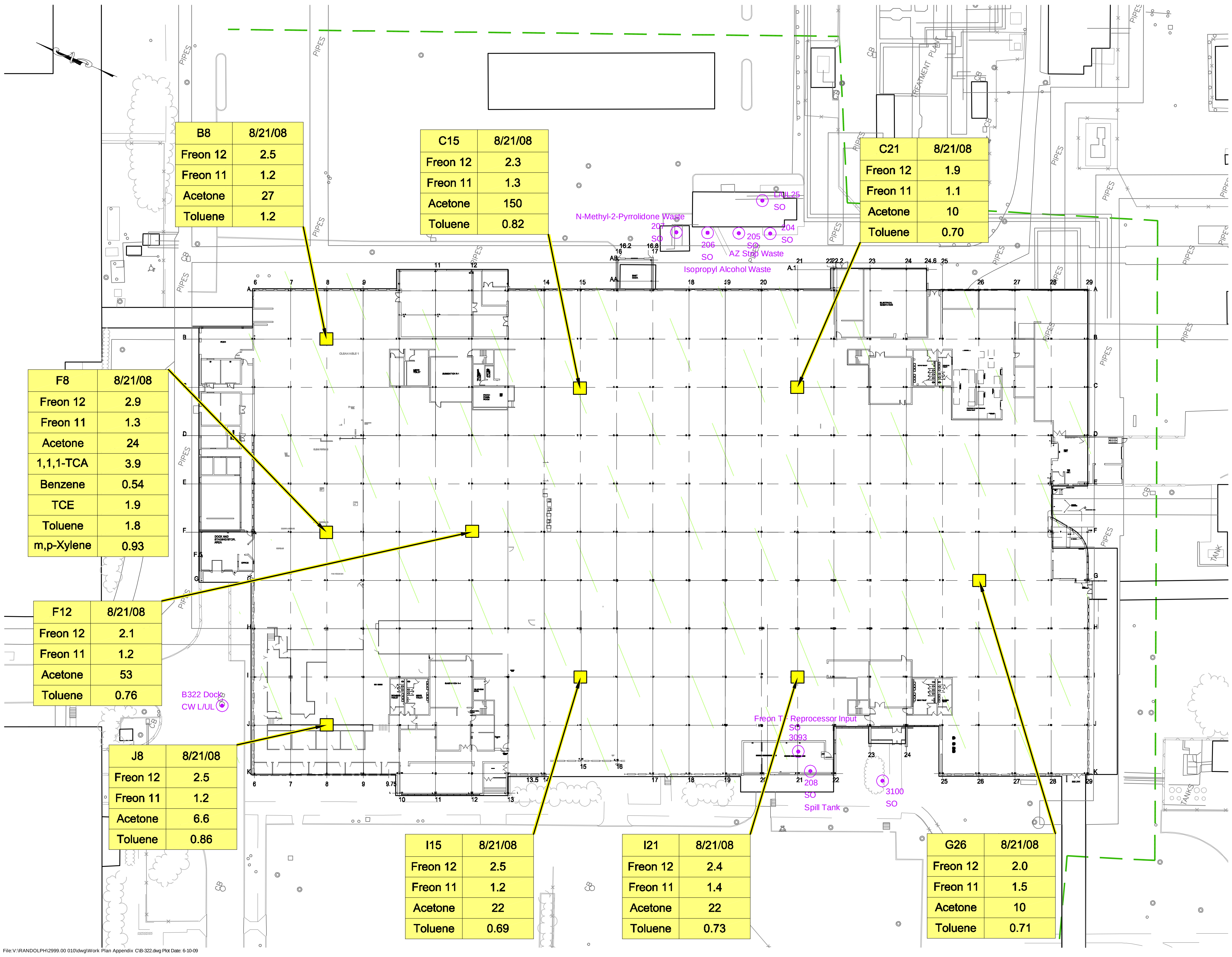
Figure C-11

Building 322 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009



B8	8/21/08
Freon 12	2.5
Freon 11	1.2
Acetone	27
Toluene	1.2

C15	8/21/08
Freon 12	2.3
Freon 11	1.3
Acetone	150
Toluene	0.82

C21	8/21/08
Freon 12	1.9
Freon 11	1.1
Acetone	10
Toluene	0.70

F8	8/21/08
Freon 12	2.9
Freon 11	1.3
Acetone	24
1,1,1-TCA	3.9
Benzene	0.54
TCE	1.9
Toluene	1.8
m,p-Xylene	0.93

F12	8/21/08
Freon 12	2.1
Freon 11	1.2
Acetone	53
Toluene	0.76

J8	8/21/08
Freon 12	2.5
Freon 11	1.2
Acetone	6.6
Toluene	0.86

I15	8/21/08
Freon 12	2.5
Freon 11	1.2
Acetone	22
Toluene	0.69

I21	8/21/08
Freon 12	2.4
Freon 11	1.4
Acetone	22
Toluene	0.73

G26	8/21/08
Freon 12	2.0
Freon 11	1.5
Acetone	10
Toluene	0.71

Figure Narrative

This figure shows the layout of the ground floor level of Building 322, and the locations and results of indoor air sampling. The samples were collected on August 21, 2008. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

⊙ 205	Solid Waste Management Unit with ID number
SO	Solvent Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
— —	Approx. Location of Above Ground Solvent Line
▨	Approx. Area of Above Ground Solvent Drains
🟨	Indoor Air Sampling Location. Concentrations in ug/m3.

30' 15' 0 30' 60' Feet

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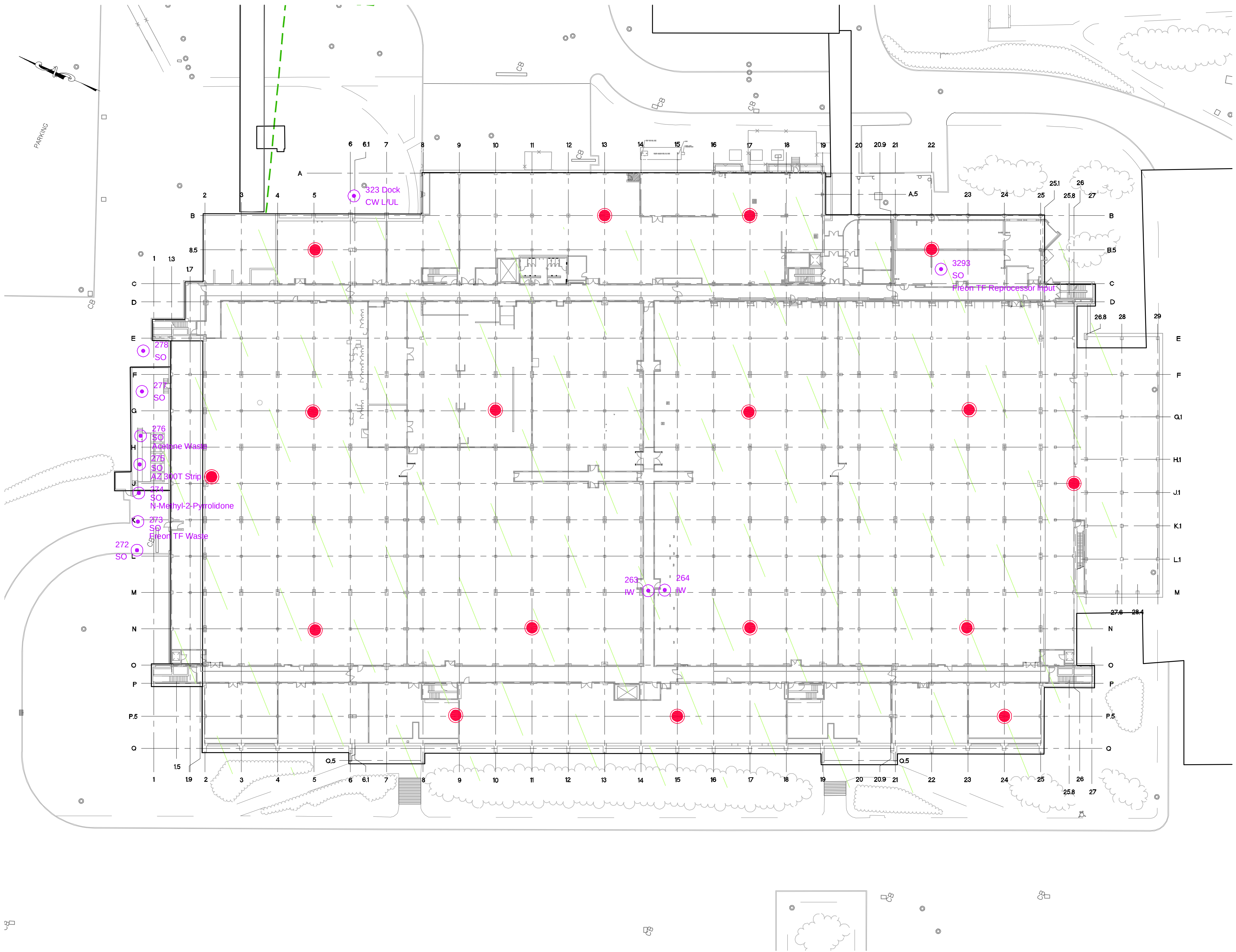

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Figure C-12

Building 323 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 323 and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

- ● 263 Solid Waste Management Unit with ID number
- IW Industrial Waste Unit
- SO Solvent Waste Unit
- CW Container Waste
- L/UL Tank Truck Loading/Unloading Area
- – – Approx. Location of Above Ground Solvent Line
- ▨ Approx. Area of Above Ground Solvent Drains
- ● Planned Confirmatory Indoor Air Sampling Location

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Figure C-13

Building 330C Layout

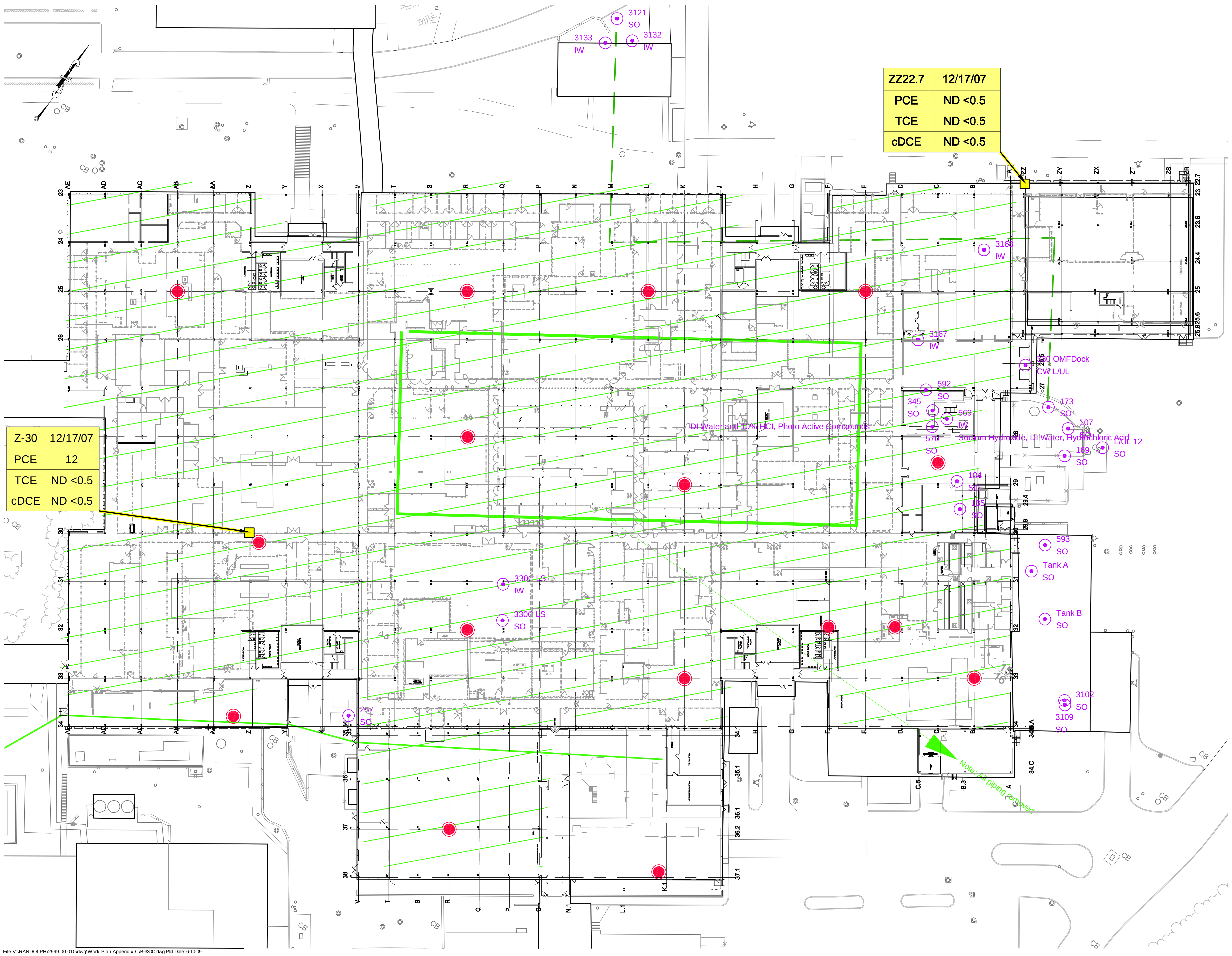
RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 330C, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.



ZZ22.7	12/17/07
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

Z-30	12/17/07
PCE	12
TCE	ND <0.5
cDCE	ND <0.5

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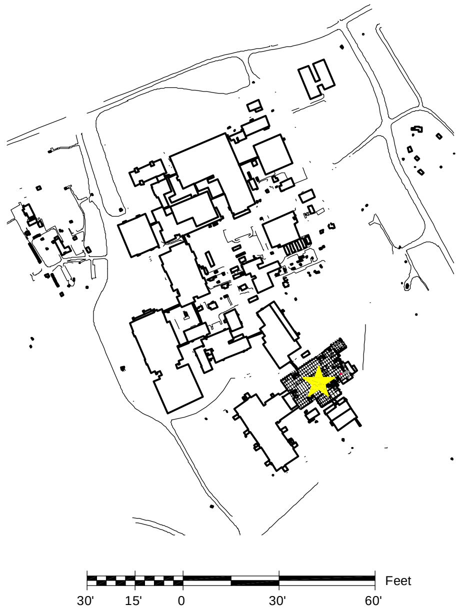
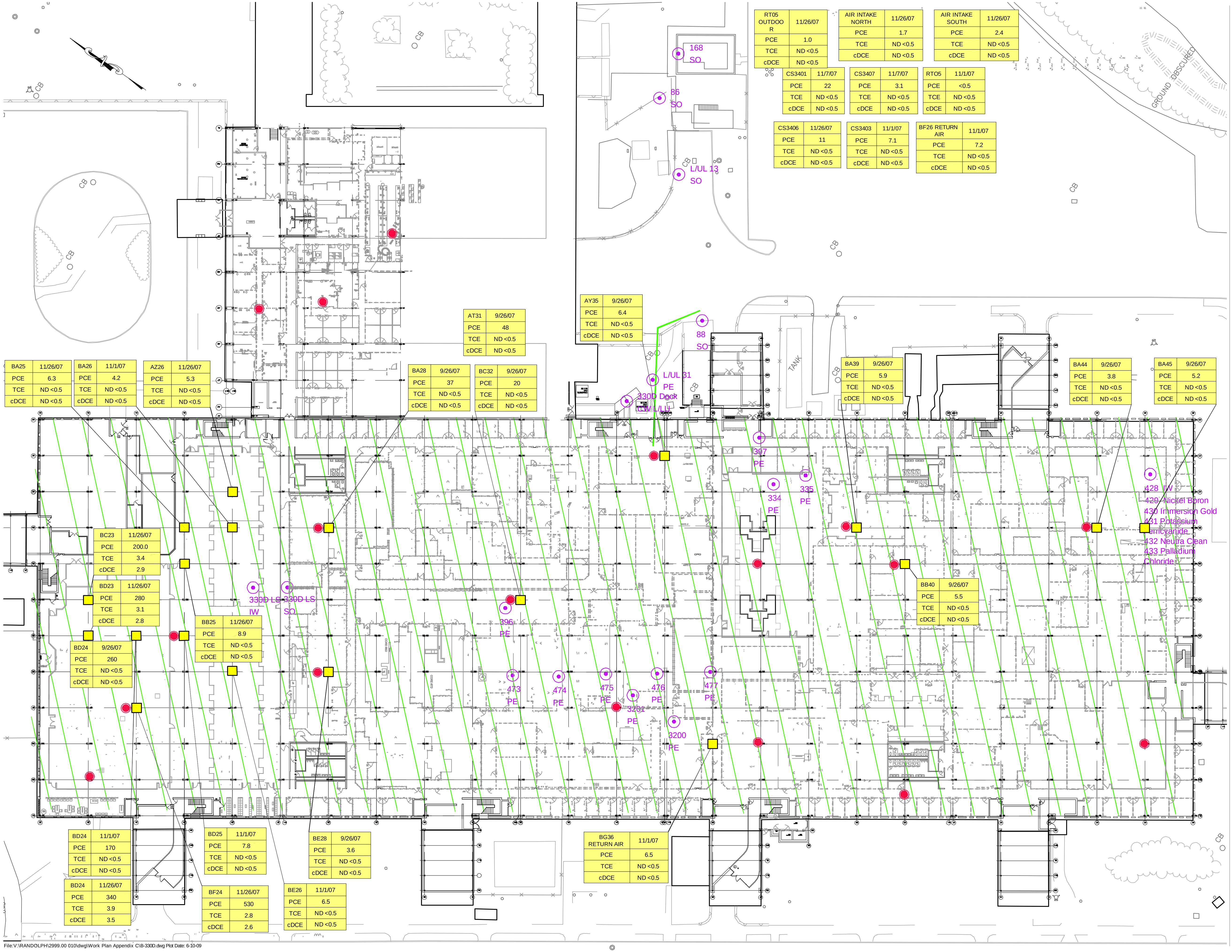
Legend

◉ 136	Solid Waste Management Unit with ID number
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
— —	Approx. Location of Above Ground Solvent Line
——	Approx. Location of Below Ground Solvent Line
▨	Approx. Area of Below Ground Solvent Drains
🔴	Planned Confirmatory Indoor Air Sampling Location





RT05 OUTDOOR	11/26/07
PCE	1.0
TCE	ND <0.5
cDCE	ND <0.5

AIR INTAKE NORTH	11/26/07
PCE	1.7
TCE	ND <0.5
cDCE	ND <0.5

AIR INTAKE SOUTH	11/26/07
PCE	2.4
TCE	ND <0.5
cDCE	ND <0.5

CS3401	11/7/07
PCE	22
TCE	ND <0.5
cDCE	ND <0.5

CS3407	11/7/07
PCE	3.1
TCE	ND <0.5
cDCE	ND <0.5

RTO5	11/1/07
PCE	<0.5
TCE	ND <0.5
cDCE	ND <0.5

CS3406	11/26/07
PCE	11
TCE	ND <0.5
cDCE	ND <0.5

CS3403	11/1/07
PCE	7.1
TCE	ND <0.5
cDCE	ND <0.5

BF26 RETURN AIR	11/1/07
PCE	7.2
TCE	ND <0.5
cDCE	ND <0.5

AY35	9/26/07
PCE	6.4
TCE	ND <0.5
cDCE	ND <0.5

AT31	9/26/07
PCE	48
TCE	ND <0.5
cDCE	ND <0.5

BA25	11/26/07
PCE	6.3
TCE	ND <0.5
cDCE	ND <0.5

BA26	11/1/07
PCE	4.2
TCE	ND <0.5
cDCE	ND <0.5

AZ26	11/26/07
PCE	5.3
TCE	ND <0.5
cDCE	ND <0.5

BA28	9/26/07
PCE	37
TCE	ND <0.5
cDCE	ND <0.5

BC32	9/26/07
PCE	20
TCE	ND <0.5
cDCE	ND <0.5

BA39	9/26/07
PCE	5.9
TCE	ND <0.5
cDCE	ND <0.5

BA44	9/26/07
PCE	3.8
TCE	ND <0.5
cDCE	ND <0.5

BA45	9/26/07
PCE	5.2
TCE	ND <0.5
cDCE	ND <0.5

BC23	11/26/07
PCE	200.0
TCE	3.4
cDCE	2.9

BD23	11/26/07
PCE	280
TCE	3.1
cDCE	2.8

BB25	11/26/07
PCE	8.9
TCE	ND <0.5
cDCE	ND <0.5

BD24	9/26/07
PCE	260
TCE	ND <0.5
cDCE	ND <0.5

BB40	9/26/07
PCE	5.5
TCE	ND <0.5
cDCE	ND <0.5

BD24	11/1/07
PCE	170
TCE	ND <0.5
cDCE	ND <0.5

BD24	11/26/07
PCE	340
TCE	3.9
cDCE	3.5

BD25	11/1/07
PCE	7.8
TCE	ND <0.5
cDCE	ND <0.5

BF24	11/26/07
PCE	530
TCE	2.8
cDCE	2.6

BE28	9/26/07
PCE	3.6
TCE	ND <0.5
cDCE	ND <0.5

BE26	11/1/07
PCE	6.5
TCE	ND <0.5
cDCE	ND <0.5

BG36 RETURN AIR	11/1/07
PCE	6.5
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-14

Building 330D Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 330D and the locations and results of 2007 indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

◉ 334	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
SO	Solvent Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
LS	Lift Station
PE	Perchloroethylene Recycle Unit
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
─	Approx. Location of Below Ground Solvent Drain Line
▨	Approx. Area of Below Ground Solvent Drains
🔴	Planned Confirmatory Indoor Air Sampling Location

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Figure C-15

Building 334 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 334 and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

◉ 297	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
SO	Solvent Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
PE	Perchloroethylene Recycle Unit
▨	Approx. Area of Below Ground Solvent Drains
●	Planned Confirmatory Indoor Air Sampling Location

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L40	12/19/07
PCE	0.9
TCE	ND <0.5
cDCE	ND <0.5

M41	12/19/07
PCE	0.9
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-16

Building 338 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 338, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled “Map 1 Solid Waste Management Unit Location Map”, last revised May 1995, and should be considered approximate.

Legend

⦿ 287	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
SO	Solvent Waste Unit
CW	Container Waste
L/UL	Tank Truck Loading/Unloading Area
PE	Perchloroethylene Recycle Unit
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
🔴	Planned Confirmatory Indoor Air Sampling Location

Feet
20' 10' 0 20' 40'

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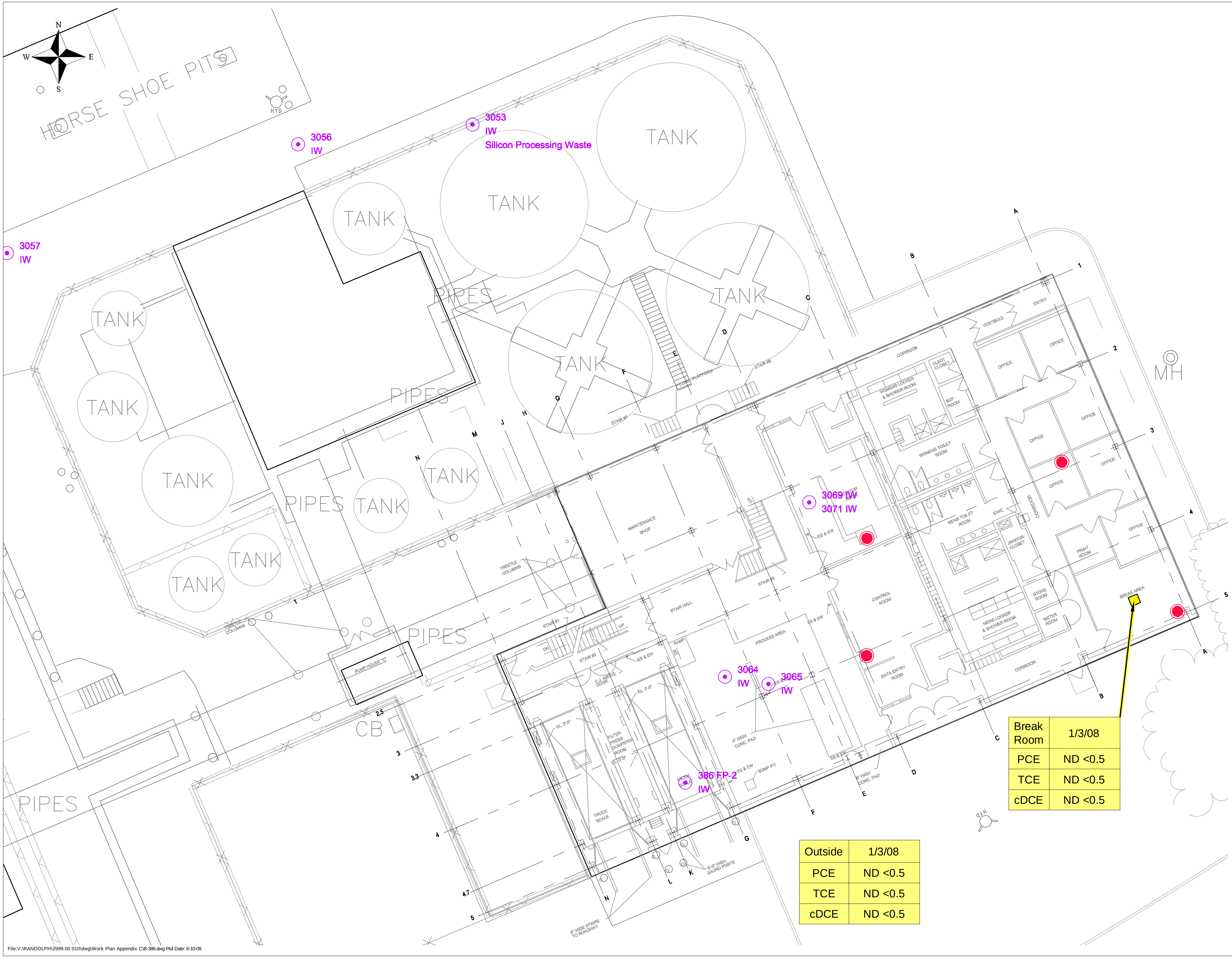

Break Room	1/3/08
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

Outside	1/3/08
PCE	ND <0.5
TCE	ND <0.5
cDCE	ND <0.5

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Figure C-17

Building 386 Layout

RFI Work Plan
VOC Source Assessment

IBM East Fishkill Facility
Hopewell Junction, New York

Drawn By: E. Wright
Designed By: R. Cook
Reviewed By: B. Green
Date: June 2009

Figure Narrative

This figure shows the layout of the ground floor level of Building 386, the locations and results of 2007 indoor air sampling, and the planned locations for confirmatory indoor air sampling. Solvent-related Solid Waste Management Unit (SWMU) locations were obtained from a plan provided by IBM entitled "Map 1 Solid Waste Management Unit Location Map", last revised May 1995, and should be considered approximate.

Legend

⦿ 3064	Solid Waste Management Unit with ID number
IW	Industrial Waste Unit
DB	Dumpster Bay (Sludge)
FP	Filter Press
🟨	2007 Indoor air sample location. Concentrations in ug/m3. ND indicates the compound was not detected above the laboratory reporting limit of about 0.5 ug/m3.
🔴	Planned Confirmatory Indoor Air Sampling Location

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