DOE/OR/01-2340
DRAFT FOR PUBLIC REVIEW

Environmental Baseline Survey Report for the Title Transfer of Building K-1008-F at the East Tennessee Technology Park, Oak Ridge, Tennessee

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Environmental Baseline Survey Report for the Title Transfer of Building K-1008-F at the East Tennessee Technology Park, Oak Ridge, Tennessee

Date Issued—July 2008

Prepared by
Science Applications International Corporation
Oak Ridge, Tennessee
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BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex   Oak Ridge National Laboratory
under contract DE-AC05-98OR22700
for the
U. S. DEPARTMENT OF ENERGY

06-305(E)/070308

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This report is intended to be used in its entirety. Excerpts, which are taken out-of-context, run the risk of being misinterpreted and are, therefore, not representative of the findings of this assessment. Opinions and recommendations presented in this report apply only to site conditions and features as they existed at the time of SAIC's site visit, and those inferred from information observed or available at that time, and cannot be applied to conditions and features of which SAIC is unaware and has not had the opportunity to evaluate.

The results of this report are based on record reviews, site reconnaissance, interviews, and the radiological report reviewed and approved by BJC. SAIC has not made, nor has it been asked to make, any independent investigation concerning the accuracy, reliability, or completeness of such information.

All sources of information on which SAIC has relied in making its conclusions are identified in Chap. 7 of this report. Any information, regardless of its source, not listed in Chap. 7 has not been evaluated or relied upon by SAIC in the context of this report.

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ABBREVIATIONS

BEAR	Baseline Environmental Analysis Report
bgs	below ground surface
BJC	Bechtel Jacobs Company LLC
CDR	Covenant Deferral Request
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COE	U. S. Army Corps of Engineers
CROET	Community Reuse Organization of East Tennessee
DCE	dichloroethene
DCGL	derived concentration guideline level
$DCGL_{EMC}$	derived concentration guideline $level_{elevated\ measurement\ comparison}$
DOE	U. S. Department of Energy
dpm	disintegrations per minute
DQO	data quality objective
DVS	Dynamic Verification Strategy
EBS	environmental baseline survey
EM	Environmental Management
EPA	U. S. Environmental Protection Agency
ESU	exterior survey unit
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FSU	furnishings survey unit
HI	hazard index
H_o	null hypothesis
ISU	interior survey unit
LBGR	lower bound of the gray region
MARSSIM	*Multi-Agency Radiation Survey and Site Inspection Manual*
MCL	maximum contaminant level
NaI	sodium iodide
NORM	naturally occurring radioactive material
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PRG	preliminary remediation goal
QA	quality assurance
QC	quality control
RADCON	Radiological Control (Organization)
RCRA	Resource Conservation and Recovery Act of 1976
ROD	Record of Decision
RL	Remediation Level
SAP	Sampling and Analysis Plan
SEC	Safety and Ecology Corporation
SU	survey unit
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TCE	trichloroethene
TDEC	Tennessee Department of Environment and Conservation
TL	trigger level

TVA	Tennessee Valley Authority
VOC	volatile organic compound

EXECUTIVE SUMMARY

This environmental baseline survey (EBS) report documents the baseline environmental conditions of the U. S. Department of Energy (DOE) Bldg. K-1008-F at the East Tennessee Technology Park (ETTP). DOE is proposing transfer of the designated K-1008-F footprint to the Heritage Center, LLC, a subsidiary of the Community Reuse Organization of East Tennessee. This report provides supporting information for the transfer of this government-owned facility at ETTP to a non-federal entity. This EBS is based upon the requirements of Section 120(h) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

Building K-1008-F is a 6300-ft^2, steel-framed structure with metal siding and roof on a concrete slab foundation. The transfer footprint includes the building and the attached heating, ventilating, and air-conditioning equipment and sprinklers located outside the building. The building is divided into offices, an industrial hygiene laboratory (no longer utilized), restrooms, various closets, and two conference rooms. Additionally, a small apron of land of about 0.12 acres around the building for access-related purposes is included in the transfer footprint. For this evaluation, the transfer footprint and adjacent land areas are collectively referred to as the "study area."

Preparation of this report included the detailed search of Federal government records, title documents, aerial photos that may reflect prior uses, visual and physical inspections of the property and adjacent properties, and interviews with current and former employees involved in operations on the real property to identify any areas on the property where hazardous substances and petroleum products or their derivatives and acutely hazardous wastes were stored for one year or more, known to have been released, or disposed of. Radiological surveys were conducted to assess the radiological condition of the transfer footprint.

Based on a review of historical information and analysis of results for radiological surveys and soil vapor sampling conducted for the K-1008-F transfer footprint, the K-1008-F transfer footprint is considered suitable for transfer. This evaluation is based on an assumption that the intended future use of the property will be limited to industrial activities.

The following is a summary of the findings of the evaluation that was performed:

- There was no evidence found of a release of hazardous substances or petroleum products or their derivatives occurring in Bldg. K-1008-F.

- There are ~ 4000 ft^2 of 12-in. by 12-in. vinyl floor tile, suspected of containing asbestos, beneath carpet. There also are ~ 6500 linear ft of asbestos and nearly 200 fittings associated with pipe fittings.

- The fluorescent lighting ballasts do not contain polychlorinated biphenyls (PCBs).

- Floor drains in Rooms 114A, 114B, 116, 118, 120A, and 120B are sealed. There is a hot water pressure relief drain in the janitor's closet.

- The presence of lead-based paint is considered a possibility due to the pre-1978 date of construction of part of the facility.

- There were no underground storage tanks located on the Bldg. K-1008-F footprint.

- Radiological surveys have been conducted on the building interior, exterior, and furnishings, along with adjacent outside electrical support equipment to assess the radiological contamination in the areas proposed for transfer. Survey results showed that the K-1008-F study area was below DOE contamination limits. The radiological surveys are discussed in Chap. 6 of this report.

- Current groundwater plume maps indicate the potential presence of volatile organic compounds (VOCs) in groundwater within 300 ft to the north of Bldg. K-1008-F. Also, a groundwater plume in the anticipated downgradient direction from K-1008-F has been interpreted to exist approximately 100 ft west of K-1008-F. The possibility of transport of a VOC plume through the flowpaths beneath K-1008-F cannot be completely discounted based on the available data. Therefore, the soil vapor in the area was sampled.

- Sub-slab soil vapor samples were collected during September of 2006 and February of 2007 to determine if a potential source for VOCs exists under the transfer footprint. Based on the results of the sampling events, the vapor intrusion pathway is not considered complete for the transfer footprint. None of the VOCs detected exceeded trigger levels (TLs) for Bldg. K-1008-F, and the sum of the TL fractions was below 1.0.

- An assessment of soil data collected from the K-1008-F study area indicated that no constituent had detected concentrations greater than Zone 2 Record of Decision (ROD) remediation levels (RLs) or industrial preliminary remediation goals (PRGs) for soil.

- A risk evaluation was completed and relied on the radiological survey data for the building interior and furnishings and also on surface soil data from within the study area. The risk evaluation indicated the cumulative risks from the Bldg. K-1008-F study area were below 1E-06 and the hazard index (HI) was below 1, since no constituents exceeded their respective preliminary remediation goals. Because the risks did not exceed the U. S. Environmental Protection Agency generally acceptable risk level of E-04 to E-06 (also expressed as 10^{-4} to 10^{-6}) or an HI of 1, no further evaluation was needed, and a full risk calculation was not conducted for soils. The evaluation was considered indicative of the low likelihood of adverse health effects from an industrial worker exposure associated with the Bldg. K-1008-F transfer footprint.

CONCLUSIONS

Based on the U. S. Department of Energy's (DOE's) detailed review of the existing information, including discussions and interviews referenced herein, and evaluation of the data gathered in preparation of the environmental baseline survey for the K-1008-F transfer footprint, DOE recommends the following:

1. Due to the need to complete evaluation and possibly address groundwater in the future, DOE recommends that the transfer of Bldg. K-1008-F be achieved by a covenant deferral per the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Sect. 120(h)(3). Land use restrictions associated with the covenant deferral are described below.

LAND USE RESTRICTIONS

Land use restrictions are an important component of a CERCLA covenant deferral; they help to ensure that transfer of the property is protective for the intended use. The restrictions that will apply to the K-1008-F transfer footprint are summarized below. Full details are found in the Covenant Deferral Request (CDR) package.

1. The property shall not be used or developed in a manner that is inconsistent with the land use assumptions of "industrial use" contained in approved applicable Records of Decision (RODs).

2. Extraction, consumption, exposure, or use, in any way, of the groundwater underlying the property to be transferred is prohibited without the prior written approval of the DOE, U. S. Environmental Protection Agency (EPA) Region 4, and Tennessee Department of Environment and Conservation (TDEC).

3. Development of the property must comply with all applicable federal, state, and local laws and regulations with respect to any present or future development of the property, including but not limited to, those laws and regulations that govern sewage disposal, facilities, water supply, and other public health requirements.

4. All structures, facilities, and improvements requiring a water supply shall be required to connect to an appropriate water system for any and all usage.

5. DOE reserves the right of access to all portions of the property for environmental investigation, remediation, or other corrective action.

6. In order to ensure that the vapor intrusion pathway [i.e., the migration of volatile organic compounds (VOCs) in contaminated groundwater and/or soil to indoor air] does not contribute to an unacceptable risk to human health, DOE will address the potential for vapor intrusion in the East Tennessee Technology Park final Sitewide ROD, which is currently under negotiation, and will take interim protective measures to ensure protectiveness until the ROD is signed. Any new building or structure built on the Property that is intended to be occupied by workers 8 hours or more per scheduled work day, or by public visitors, must be designed and constructed to minimize potential exposure to VOC vapors, including the use of engineered barriers as noted in the Quitclaim deed. A waiver from this requirement may be sought from the EPA, TDEC, and DOE based on alternative commitments or new information.

RESPONSE TO REGULATOR COMMENTS ON THE ENVIRONMENTAL BASELINE SURVEY REPORT FOR BUILDING K-1008-F TRANSFER FOOTPRINT

DOE received comments from the U. S. Environmental Protection Agency (EPA) on the Environmental Baseline Survey (EBS) report for Bldg. K-1008-F on January 29, 2008. Comments and responses are summarized below. The full text of comments and responses is found in the Covenant Deferral Request.

EPA requested additional information about references cited and also requested changes to achieve consistency in the deed and supporting documents. They also requested additional information about vapor intrusion sampling. There were also some editorial comments for clarity and to update information.

1. PROPERTY IDENTIFICATION

The study area discussed in this baseline environmental report is located in the southeastern portion of the East Tennessee Technology Park (ETTP) [formerly the Oak Ridge Gaseous Diffusion Plant (ORGDP) or K-25 Site] on the Oak Ridge Reservation (ORR) in Roane County, Tennessee. It includes Bldg. K-1008-F and adjacent areas. Figure 1.1 is the location map for Bldg. K-1008-F. Figure 1.2 is an ortho image showing the boundary of the K-1008-F study area. Figure 1.3 is an aerial photograph of Bldg. K-1008-F and the adjacent areas. Figure 1.4 shows the transfer footprint for Bldg. K-1008-F.

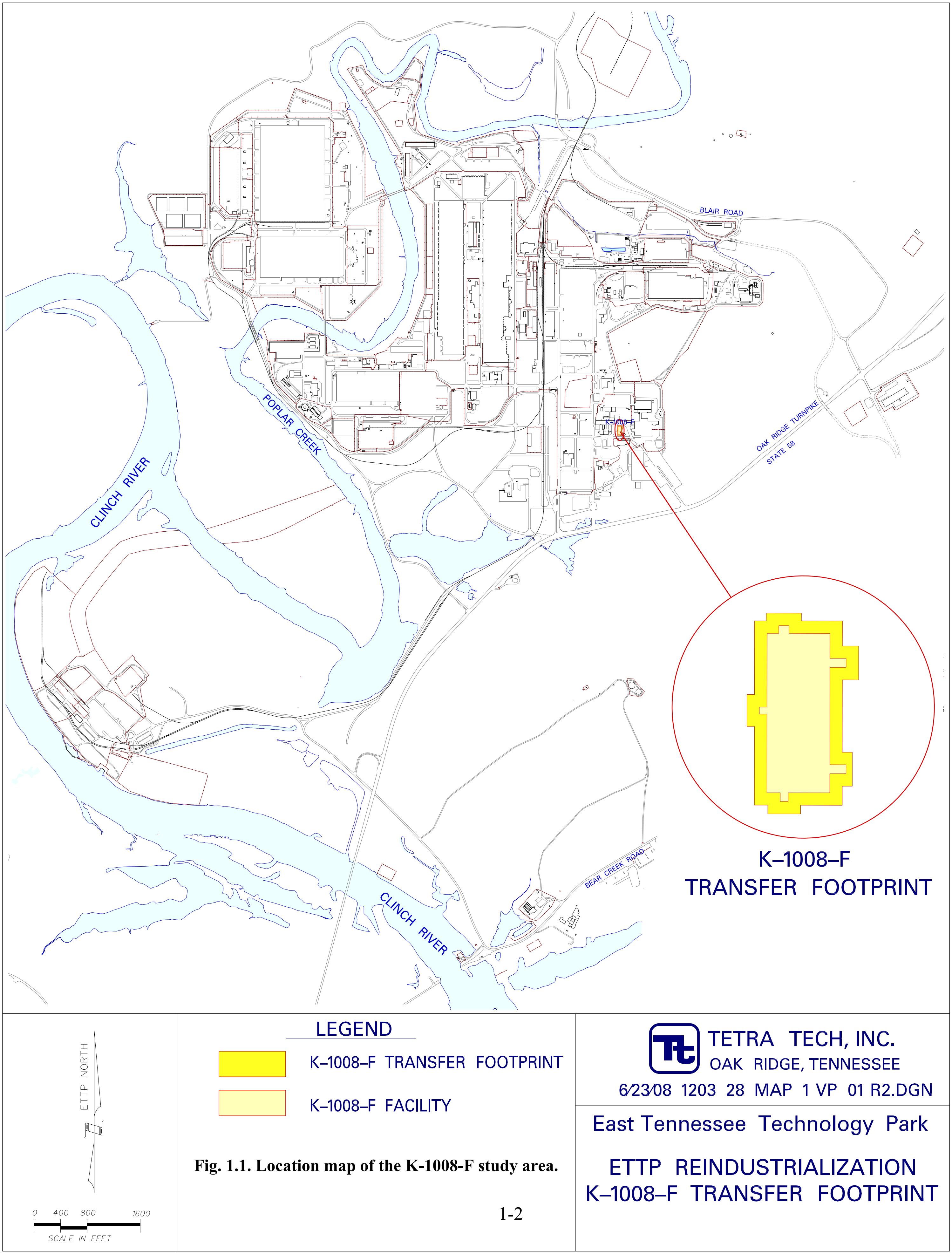
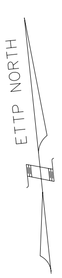


Fig. 1.1. Location map of the K-1008-F study area.



LEGEND

K–1008–F TRANSFER FOOTPRINT

Fig. 1.2. Ortho image of the K-1008-F study area.

TETRA TECH, INC.
OAK RIDGE, TENNESSEE
6/23/08 1203 12 map 4 ORTHO R2.dgn

K–1008–F TRANSFER FOOTPRINT

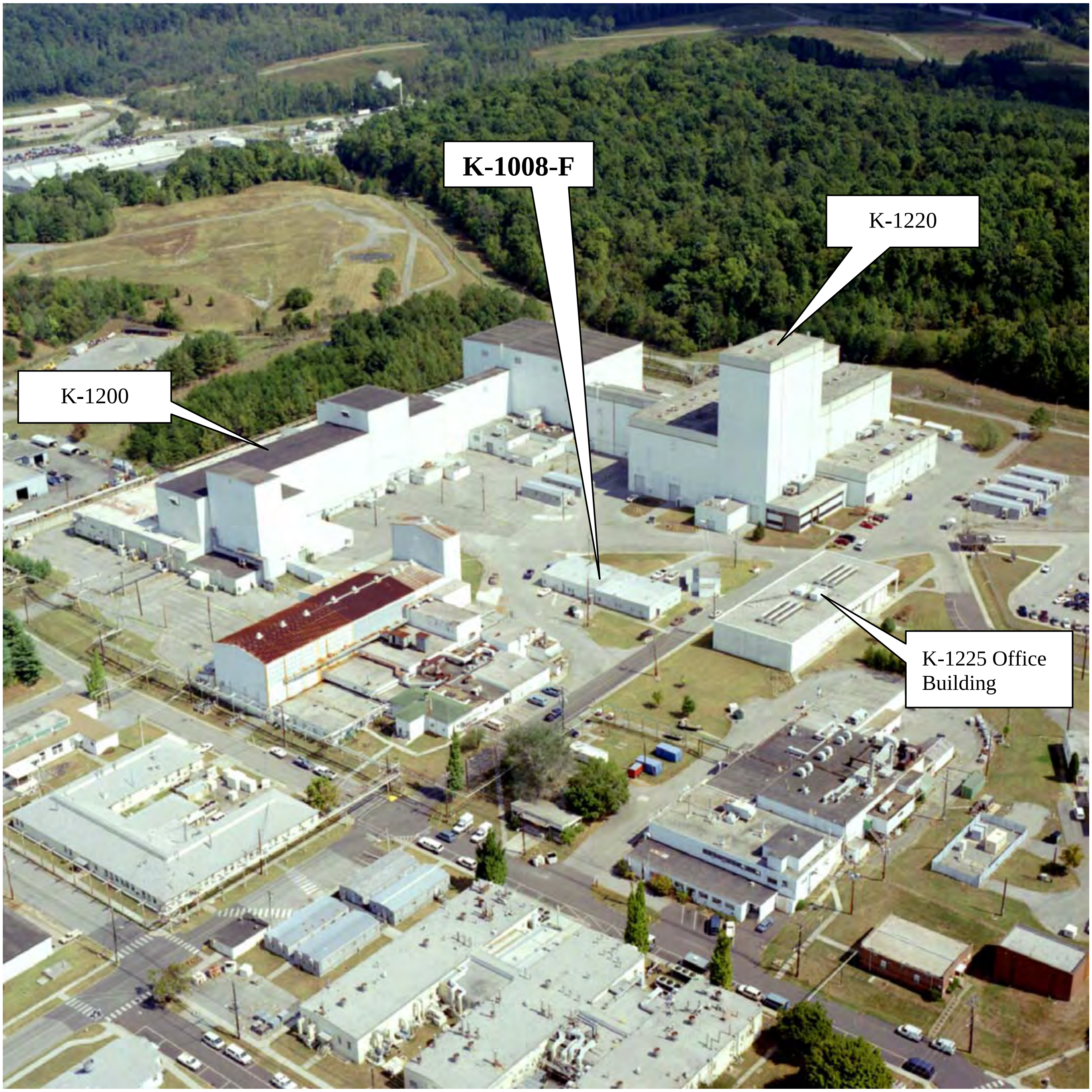
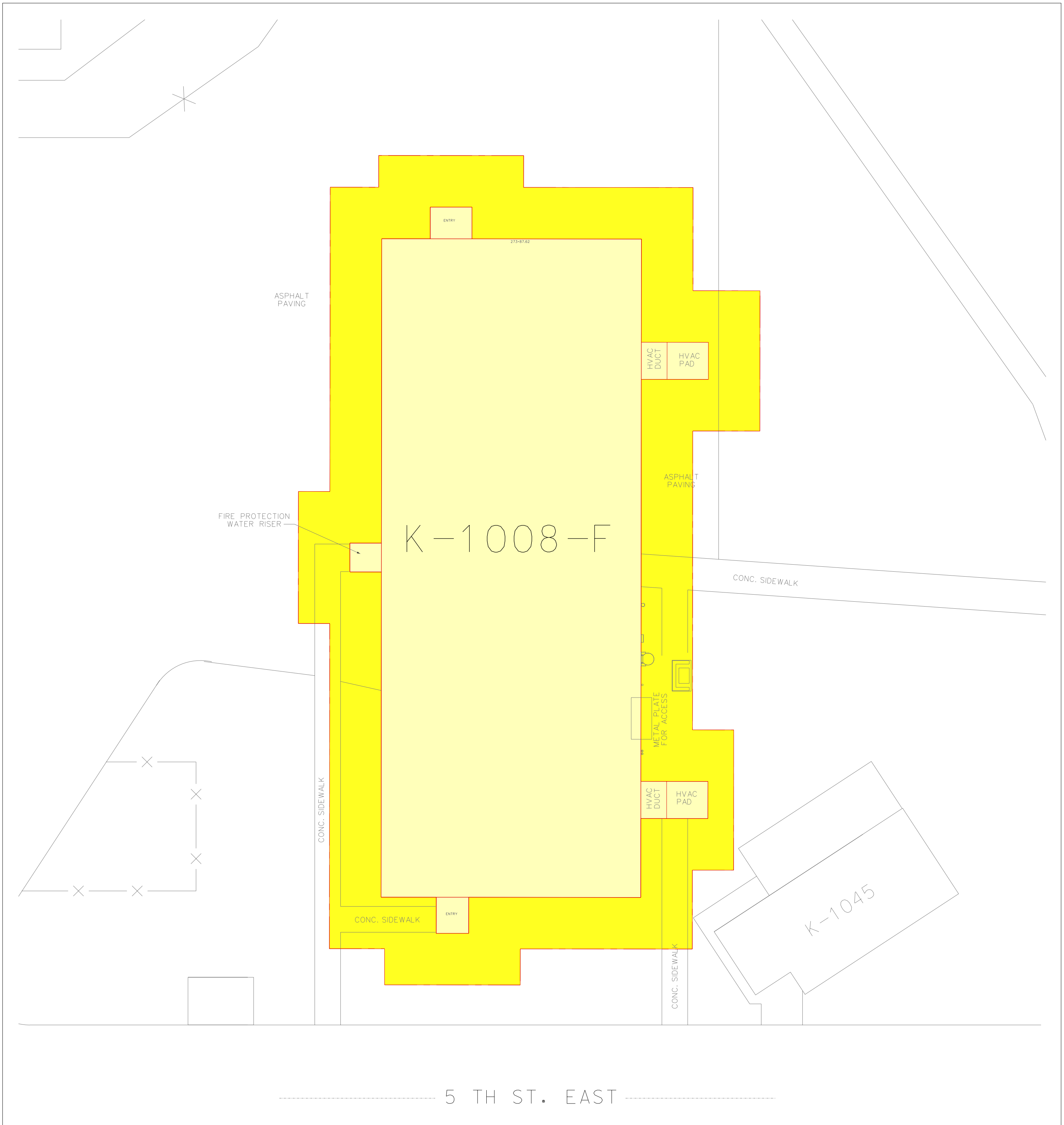


Fig. 1.3. Aerial photograph of the K-1008-F study area (circa 1989–1992).



ETTP NORTH

LEGEND

K–1008–F FACILITY

K–1008–F TRANSFER FOOTPRINT

TETRA TECH
OAK RIDGE, TENNESSEE
6/23/08 1203 28 map2 LP 01 r2.dgn

K–1008–F
BUILDING LAYOUT PLAN

Fig. 1.4. K-1008-F transfer footprint.

2. TITLE SEARCH

On June 4, 1996, a visit was made to the state of Tennessee Roane County Recorder's Office to conduct a review of the recorded deeds documenting previous ownership of the land tract where Bldg. K-1008-F and adjacent areas are located. The deeds contained no information or references to other recorded evidence that, prior to U. S. Department of Energy (DOE) ownership, the property was utilized for the storage of hazardous substances and/or petroleum products or their derivatives. Additionally, no information contained in the deeds would indicate that hazardous substances and/or petroleum products or their derivatives were released from or disposed of on the property.

3. FEDERAL RECORDS SEARCH

The Tennessee Valley Authority (TVA) in Knoxville, Tennessee, and the U. S. Army Corps of Engineers (COE) District Office in Nashville, Tennessee, were contacted in 1996, 1997, and again in 1998, to determine if they maintained any records reflecting past or present land use relative to the land presently comprising ETTP (TVA 1998; COE 1998). Neither TVA nor COE had any information regarding the history of past or present land use that would indicate if hazardous substances or petroleum products or their derivatives were released on the DOE-owned property currently comprising the ETTP.

The following pre-construction aerial photographs and maps reflecting prior use of this land were also reviewed. A copy of these photographs and maps is maintained on file in the DOE-Oak Ridge Office (ORO) Real Estate Office.

Aerial Photographs:

Photograph Nos. and Date	Flight By	Source
No. 130-3-9, dated 1939	Unknown	DOE-ORO, Real Estate Office
Nos. 820-2-20 through -23 and 820-3-20 through -24, dated September 25, 1942	Aero Service Corp. for Stone and Webster	DOE-ORO, Real Estate Office

These photographs, which were taken in 1939 and 1942, show that the land where the study area is located was predominantly used for agricultural purposes. The remaining land was wooded.

Topographic and real estate maps:

1. A November 2, 1942, topographic map identified as Section A-1 of ORR was prepared by Aero Services Corporation for Stone and Webster.

2. A February 19, 1945, real estate map (sheet 9 of 16) prepared by the U. S. Army shows the boundaries of all land tracts upon which facilities at the site are currently located. The study area is on Land Tract H-720 shown in Appendix A.

Neither the aforementioned photographs nor maps contained any information regarding the history of the past land use that would indicate that storage or releases of hazardous substances or petroleum products or their derivatives have occurred on the land where Land Tract H-720 is located. Copies of the 1942 topographic map and real estate map are maintained in the DOE-ORO Real Estate Office. The real estate map and letter included in Appendix A will be used to support the documentation for the proposed transfer of Bldg. K-1008-F.

4. PAST AND PRESENT ACTIVITIES

4.1 PAST AND PRESENT ACTIVITIES FOR THE REAL PROPERTY PROPOSED FOR TRANSFER

The K-1008-F transfer footprint consists of the K-1008-F Office Building and the attached heating, ventilating, and air-conditioning equipment and sprinklers located outside the building, as well as a small apron of land of about 0.12 acres around the building. The building is located in the southeast section of ETTP in the former Gas Centrifuge Project area.

Building K-1008-F is located on the site of two previous buildings. In 1944, the T-10 Warehouse was built to support the construction of the ORGDP. In 1947, it was renumbered Bldg. K-1209 and listed as a spare parts warehouse. In 1953, the K-1209 warehouse was dismantled. In 1958, the K-1045-A Fire Training Tower was constructed on the north end of the concrete pad that remained after Bldg. K-1209 was dismantled. The Fire Training Tower was located immediately under the present K-1008-F building footprint. During its operation from 1958 to 1977, the Fire Training Tower was used by the K-25 Fire Department to burn waste oils for training fire responders. K-1045-A was dismantled in 1977 and moved to its present location (east of Bldg. K-1423).

Union Carbide Corporation drawing S-KT-100 from 1975 indicates that Bldg. K-1008-E was built that year as a change house for personnel working on the Gas Centrifuge Project. The K-1045-A Fire Training Tower is also indicated as being in existence in this drawing, and as mentioned above was dismantled in 1977. In 1980, Bldg. K-1008-F was built immediately south of K-1008-E to expand the change house facilities. In 1989, K-1008-E and K-1008-F were combined and renovated to house two research (luminescent measurement and laser technology) laboratories and various offices. The building was designated K-1008-F. In the late-1990s, the research labs were closed, and Bldg. K-1008-F was renovated into offices. A small industrial hygiene laboratory formerly located in the building has been relocated to another facility on-site. Hazardous substances used in the industrial hygiene laboratory were limited to various instrument calibration gases (carbon monoxide, carbon dioxide, chlorine, hydrogen chloride, isobutylene, methane, propane, nitrogen, and nitrogen dioxide). In December 2006, after preparation of a Baseline Environmental Analysis Report (BEAR) [BJC/OR-2554] (BJC 2006a) to satisfy the requirements of the Federal Facility Agreement (FFA) and Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) 120(h), the building was leased by DOE to the Community Reuse Organization of East Tennessee (CROET). The building is used for office purposes.

4.2 PAST AND PRESENT ACTIVITIES FOR THE ADJACENT PROPERTY

The transfer footprint is located within the bounds of ETTP. The nearest non-DOE property is Building K-1225, approximately 80 ft to the south. This former DOE office building was transferred to CROET in 2005.There is no indication that activities from this non-DOE area would have contributed any contamination to the area to be transferred.

Several historical structures that were in close proximity to Bldg. K-1008-F, and several current structures that are in close proximity to Bldg. K-1008-F, had or have the potential for contamination. These areas were originally listed in a descriptive "baseline" report (Goddard et al. 1995) so that decisions could be made to establish cleanup priorities. All of these areas either have been, or will be, addressed under the ORR FFA (DOE 1992). [The FFA is an agreement between DOE, U. S. Environmental Protection Agency (EPA) Region 4, and the state of Tennessee to integrate the requirements of Resource Conservation and Recovery Act of 1976 (RCRA) corrective actions and CERCLA remedial investigations at specific sites within the ORR. The specific facilities to which the FFA applies are listed in Appendix C of the FFA.] The environmental restoration facilities/locations in the vicinity of Bldg. K-1008-F are discussed below in two subsections: one addressing structures that are no longer present and the second addressing structures that remain and are in proximity to Bldg. K-1008-F.

4.2.1 Historical Structures Removed from the Adjacent Property

Research into the historical plot plans, maps, photographs, and building directories indicates there were several structures located in and around the transfer footprint prior to construction of Bldg. K-1008-F. The general area was used during the 1940s and 1950s by companies under contract for the construction of the ORGDP.

For example, the K-1044 Heavy Equipment Repair Shop, built in 1943 or 1944 and originally designated T-18, repaired machinery used in the construction of the ORGDP. The building included one or more grease racks, a paint shop, and a heavy equipment store. By 1945, the building designation had been changed to T-6, a number also used by a building to the north. In 1946, the designation was changed to Bldg. K-1044. In early 1947, the building became a spare parts warehouse. By 1958, the building had been demolished. This building was located immediately southwest of Bldg. K-1045.

The K-1236 Building (T-7 prior to 1947) was a paint shop used during the construction of the ORGDP. It was demolished in late 1947 and stood in the immediate vicinity of Bldg. K-1220. It is listed in Appendix C of the FFA. Also in the vicinity of Bldg. K-1220 was the T-27/T-5 Pipe Welding Shop. T-27 was constructed in 1943 or 1944 and is thought to have included a cadmium spray booth for coating or metalizing uranium enrichment cascade traps and cylinders. In 1945, it was redesignated T-5. In 1947, it was dismantled and fabricated into two buildings that were used as voting booths. By 1958, these buildings had been demolished. The T-27/T-5 building is listed in Appendix C of the FFA.

North of Bldg. K-1008-F is the site of the T-21 Oil/Grease Station (also designated K-12). This facility was built in 1943 as a temporary oil and lubricant storage building. The building designation was changed to the K-1214 Acid Storage building in 1947. Drum quantities of acids and trichloroethylene are thought to have been stored there. The building was demolished by 1958. It is listed in Appendix C of the FFA.

The K-1045-A Waste Oil Burning Pit, which is listed in Appendix C of the FFA and as a Solid Waste Management Unit (SWMU) under RCRA, was located to the north of the Bldg. K-1008-F footprint. It was closed and filled-in in the 1960s.

4.2.2 Structures Currently in the Adjacent Property

Most of the existing structures adjacent to the transfer footprint were constructed in the early 1970s as part of the Gas Centrifuge Project. Construction of the complex began in the 1960s with the K-1004-J building. Building K-1023 was added in 1970, Bldgs. K-1052 and K-1200 were added in 1974, Bldg. K-1200 was added in 1976, and Bldg. K-1220 was added in 1982. These buildings form a semi-circle that surrounds a paved area adjacent to Bldg. K-1008-F.

BEARs have been published for a number of facilities and areas in the vicinity that have been leased. These include:

Building	Document Number	Date Published
K-1200	K/EM-531 and 532	August 1997
K-1052-B	K/EM-537 and 538	August 1997
K-1052	K/EM-539 and 540	August 1997
K-1200 External Laydown Areas	K/EM-550	November 1997
Roads and Grounds Phase I	K/EM-579	February 1998

K-1023	BJC/OR-26	June 1998
K-1005	BJC/OR-30	June 1998
K-1220	BJC/OR-74	December 1998
K-1200 Access and Laydown Area	BJC/OR-437	November 1999
K-1008-F	BJC/OR-2554	August 2006

These BEARs were published in the late 1990s to support lease of the properties, as well as the BEAR for K-1008-F itself (BJC 2006a), which was prepared in August 2006 (see Sect. 4.1). Current plans call for the demolition of Bldgs. K-1005 and K-1220 by FY 2009. Buildings K-1200, 1052, 1052-B, and 1023 are being evaluated for potential transfer, but the decision to proceed with the CERCLA 120(h) process has not yet been made. If the transfer of these buildings is not feasible, these facilities will also be demolished.

K-1045, the closest building to the K-1008-F transfer footprint, was originally built in 1943 as temporary building T-33-2 and was part of the Ford, Bacon, and Davis Construction Support Area. By early 1947, the building had been renumbered T-8 and converted to an incinerator. In 1947, it was again renumbered to Bldg. K-1045. The building was used as an incinerator through 1953. Building directories from 1954 through 1978 list K-1045 as a storage building. In 1982, it was converted into a valve certification laboratory associated with the centrifuge project. A restroom was added to the west end of the building in 1982. It was then used as a storage facility for reels of magnetic media for the Enrichment Business Services Department. In 1987, it began to be used as an office and break area for the carpenters. The magnetic tapes were removed in the early 1990s. It is currently used for storage of janitorial equipment (i.e., vacuum cleaners and floor buffers). This building will be demolished in the future.

Immediately to the south of the transfer footprint, across 5th Street, is the K-1225 Office Building. It was built in 1980 as office space for the Gas Centrifuge Project. Following shutdown of the project, the building was used by several organizations for offices. It was transferred under a Covenant Deferral Request from DOE to CROET in April 2005.

4.3 HYDROGEOLOGIC ENVIRONMENT

The Bldg. K-1008-F transfer footprint is located in the southern portion of ETTP, which is underlain by bedrock of the Chickamauga Supergroup. Although less prone to karst development than the Knox Group rocks in the vicinity of the ETTP, the Chickamauga formations are nevertheless subject to the development of karst. Solutionally enlarged fractures, joints, and bedding planes are common in exposures of Chickamauga rocks in the vicinity of ETTP. Structurally these formations have been folded into an anticline (convex upward fold) in the vicinity of Bldg. K-1008-F with the axis of this structure located approximately 200 ft south of the building and trending northeast to southwest. Bedding in the Chickamauga generally dips northwestward on the north side of this axis and southeastward on the south side of this axis. The Bldg. K-1008-F transfer footprint is located slightly north of the mapped anticline axis; thus, bedding is expected to dip primarily to the northwest in this area. The approximate location of the axis of this fold is indicated on Fig. 4.1. In addition to providing an indication of the direction of dip of bedding, the axis may also represent a zone of increased fracturing, thus providing potential pathways for groundwater movement.

The bedrock formations underlying K-1008-F are mapped as belonging to the Carters Limestone[1] and generally consist of thick to massive beds of limestone with some thin to medium beds and occasional interbedded argillaceous limestone. Some pods and lenses of chert are present in the lower and middle parts of the Carters Limestone. Although exposures were not observed during the geologic mapping of the ETTP, the middle part of the Carters Limestone also contains two distinctive metabentonite beds, which range from 1 to 3 ft in thickness. The Carters Limestone is subject to karst development due to the high carbonate content and thickness of beds. Evidence of karst development in

[1] P. J. Lemiszki, 1994. *Geological Mapping of the Oak Ridge K-25 Site, Oak Ridge, Tennessee,* K/ER-11.

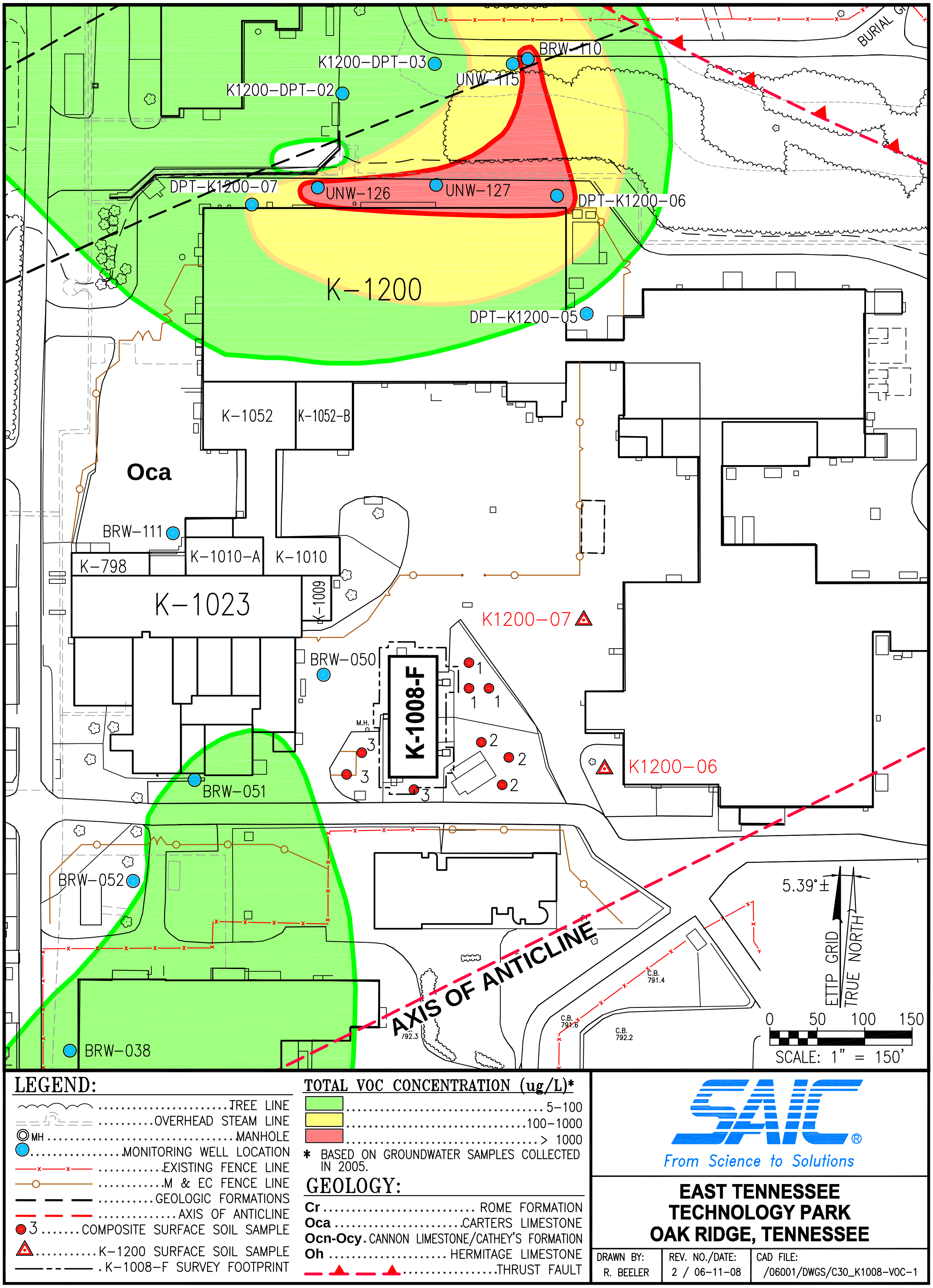


Fig. 4.1. Groundwater VOC concentrations in the K-1008-F area.

the Carters Limestone includes cavities encountered in drilling at ETTP. Approximately 30% of the monitoring wells that have been completed in the Carters Limestone at ETTP encountered cavities ranging in size from a few inches up to 7 ft. Although pre-construction topographic maps do not indicate the occurrence of sinkholes in the immediate vicinity of Bldg. K-1008-F, sinkholes have been identified from pre-construction maps and aerial photographs within the Carters Limestone along strike approximately 3200 ft to the southwest of Bldg. K-1008-F in the vicinity of the K-1007-P1 Pond. Groundwater flowpaths in bedrock are a key uncertainty in the conceptual model of ETTP, but fractures, bedding planes, and hydraulic gradient are expected to be the primary controlling factors.

There are currently three groundwater monitoring wells within 250 ft of the K-1008-F transfer footprint. The hydrogeologic characterization data presented below for K-1008-F are based on the data from these wells and on interpolation from other available ETTP site-wide information.

Because a limited number of monitoring points exist in the immediate vicinity of Bldg. K-1008-F, depth to bedrock and depth to groundwater are partly interpolated from other nearby wells. Comparison of pre-construction topographic maps to present-day topography suggests that site preparation work may have involved the removal of some soil material (< 10 ft) as opposed to the placement of fill material in the K-1008-F area. Depth to bedrock, interpolated from data in the general vicinity of K-1008-F, is expected to be from 3 to 22 ft below ground surface (bgs). Bedrock was encountered at depths of 21.5 and 19 ft bgs at wells BRW-050 and BRW-051, respectively, which are the wells located nearest to Bldg. K-1008-F (approximately 70 to 200 ft west). Bedrock outcrops are present approximately 600 ft east of Bldg. K-1008-F. The depth to groundwater, based on water levels in the nearest wells and interpolated from the ETTP sitewide potentiometric map, is expected to range from 8 to 16 ft bgs. Shallow groundwater flow is anticipated to be to the southwest toward the shallow ponds to the south of ETTP.

Hydrologic parameters, such as hydraulic conductivity and hydraulic gradient, are also estimated for K-1008-F using available data. Hydraulic conductivity for the Chickamauga bedrock and overburden materials, as determined from slug tests conducted in numerous monitoring wells throughout ETTP, is presented in Table 4.1 with additional hydrogeologic characterization parameters for K-1008-F.

Table 4.1. Summary of hydrogeologic conditions at Bldg. K-1008-F

Parameter	Site conditions
Is a groundwater plume present beneath K-1008-F?	Unknown
Distance from facility to nearest upgradient plume (ft)	300
Is karst present?	Yes
Depth to bedrock (ft)	3–22[a]
Depth to groundwater (ft)	8–16[a]
Are fill materials present at K-1008-F?	None identified
Composition of overburden materials present	silty clay[a]
Shallow groundwater flow direction	southwest
Hydraulic conductivity of overburden materials (cm/s)	1.15E-03[b]
Hydraulic conductivity of bedrock (cm/s)	4.08E-03[c]
Hydraulic gradient at the site (ft/ft)	0.02–0.06[a]
Is a perched water table present at K-1008-F?	unknown

[a]Represents interpolated value based on available data.

[b]Represents average hydraulic conductivity of unconsolidated zone materials at East Tennessee Technology Park (ETTP) based on slug tests of wells completed in overburden developed above Chickamauga bedrock.

[c]Represents average hydraulic conductivity based on slug tests of ETTP wells completed in bedrock of the Chickamauga Supergroup.

Current groundwater plume maps indicate the potential presence of volatile organic compounds (VOCs) in groundwater within 300 ft to the north and upgradient of Bldg. K-1008-F (Fig. 4.1). A groundwater plume in the anticipated downgradient direction from K-1008-F has been interpreted to exist approximately 100 ft west of K-1008-F. Due to the shallow nature of bedrock in this area of ETTP, the plume downgradient of K-1008-F represents a bedrock groundwater plume. Although hydraulic gradients indicate shallow groundwater flow is to the southwest, groundwater flowpaths in bedrock are unknown due to the complex geology and geologic structure underlying ETTP. The possibility of transport of the VOC plume through bedrock flowpaths beneath K-1008-F cannot be completely discounted based on the available data.

Table 4.2 summarizes the analytical results for the VOCs detected in groundwater samples collected from the five bedrock monitoring wells (BRW-038, BRW-050, BRW-051, BRW-052, and BRW-111). It should be noted that the concentrations presented in Table 4.2 might not be representative of groundwater beneath K-1008-F but represent concentrations in the downgradient bedrock plume nearest to the transfer footprint. The data for well BRW-111, which was installed in March of 2005, are inconclusive because the well has only been sampled twice in March 2005 with significantly different results obtained. The only VOC detected above a federal primary drinking water maximum contaminant level (MCL) in the monitoring wells located nearest to Bldg. K-1008-F (BRW-038, BRW-050, and BRW-051) in 2005 was trichloroethene (TCE) at well BRW-051 (Table 4.2). In general, VOC concentrations in the monitoring wells in the vicinity of K-1008-F exhibit decreasing concentration trends.

Concentrations of TCE and 1,2-dichloroethene (DCE) have generally been declining over recent years at the downgradient bedrock wells BRW-038 and BRW-051. The concentration of TCE in BRW-051 declined from 41 μg/L in 1994 to 6.2 μg/L in 2005. Concentrations of the TCE daughter product *cis*-1,2-DCE show similar trends to those of TCE at wells BRW-038 and BRW-051. Concentrations at BRW-050 and BRW-052 have remained relatively steady, but generally do not exceed an MCL.

Analytical results for the two unconsolidated zone wells (UNW-126 and UNW-127) and three drive point piezometers (DPT-K1200-5, DPT-K1200-6, and DPT-K1200-7) located north of the K-1008-F transfer footprint are provided in Table 4.3. It should be noted that the concentrations presented in these tables represent concentrations within the nearest known, upgradient unconsolidated zone plume, which is located north of Bldg. K-1008-F, and are not representative of groundwater quality in the immediate vicinity of K-1008-F. Table 4.3 summarizes the primary VOCs detected at the unconsolidated zone monitoring wells and piezometers located north of, and upgradient of, Bldg. K-1008-F. Concentrations of *cis*-1,2-DCE, chloroform, methylene chloride, tetrachloroethene (PCE), and TCE exceed the MCL at these locations; no other results exceed MCLs.

In the unconsolidated zone, the maximum detected PCE concentration detected in 2005 was in well UNW-126 at 3900 μg/L. Concentrations of PCE and TCE at well UNW-126 suggest a decreasing trend in concentration over time. Concentrations of PCE at well UNW-127 appear to be relatively steady over time. However, the concentration of TCE at well UNW-127 suggests an overall increasing trend in TCE since 1999 (Table 4.3). The concentration trend for *cis*-1,2-DCE at well UNW-127 generally corresponds with the trend observed for TCE at this well. Both of these wells are located at the bottom of the unconsolidated zone at the interface with the bedrock, immediately downgradient from the K-1070-C/D Burial Ground, the probable source of these VOCs. The increasing trends for TCE and *cis*-1,2-DCE may be a reflection of the ongoing degradation of PCE, which is the primary VOC present, at this well location.

Table 4.2. Summary of VOCs detected in groundwater samples from bedrock monitoring wells in the vicinity of K-1008-F

Analyte (µg/L)	MCL	BRW-038				BRW-050									
		Oct-94	Mar-95	Oct-95	June-05	Jun-98	Aug-98	May-01	Sep-01	Mar-02	Aug-02	Mar-04	Sep-04	Mar-05	Aug-05
1,1,1-Trichloroethane	200	100 U	14	25 U	1 U	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	NA	100 U	10 U	25 U	0.27 J	5 U	1 J	2 U	2 U	2 U	2	0.84 J	0.9 J	0.89 J	0.89 J
1,2-Dichloroethene	70[a]	49 J	6 J	33	7.6	5 U	2 J	2 U	2 U	2 U	2 U	0.94 J	1.2	0.98 J	1
Chloroform	100[b]	100 U	10 U	25 U	0.17 J	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	36 J	3 J	17 J	3.9	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
Trichloroethene	5	170	35	120	39	3 J	3 J	3	3	7	3	2.2	2.6	2	1.9

Analyte (µg/L)	MCL	BRW-051						BRW-052					
		Oct-94	Mar-95	Sep-95	Jun-98	Aug-98	Mar-05	Oct-94	Mar-95	Sep-95	Jun-98	Aug-98	Mar-05
1,1,1-Trichloroethane	200	5 U	5 U	5 U	5 U	2 J	0.5 U	5 U	5 U	5 U	5 U	2 U	0.5 U
1,1-Dichloroethane	NA	5 U	5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	5 U	5 U	0.5 U
1,2-Dichloroethene	70[a]	18	39	33	9 J	14 J	7.6	2 J	3 J	5 U	1 J	1 J	1.1
Chloroform	100[b]	1 J	5 U	1 J	5 U	5 U	0.5 J	1 J	5 U	5 U	5 U	5 U	0.5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	0.17 J	5 U	5 U	5 U	5 U	5 U	0.5 U
Trichloroethene	5	41	33	36	16 J	18 J	6.2	4 J	5 U	5 U	2 J	2 J	1.1

Analyte (µg/L)	MCL	BRW-111	
		Mar-05	Mar-05
1,1,1-Trichloroethane	200	0.5 U	0.5 U
1,1-Dichloroethane	NA	3.6	0.5 U
1,2-Dichloroethene	70[a]	190	0.5 U
Chloroform	100[b]	0.5 U	0.31 J
Tetrachloroethene	5	22	0.5 U
Trichloroethene	5	15	0.5 U

[a] Represents maximum contaminant level (MCL) for the *cis*-1,2-dichloroethene isomer.
[b] Represents MCL for total trihalomethanes.
J = estimated concentration.
MCL = maximum contaminant level.
U = analyte not detected at indicated concentration.

Table 4.3. Summary of VOCs detected in unconsolidated zone monitoring wells located north of K-1008-F

Analyte (µg/L)	MCL	UNW-126													
		Apr-99	Sep-99	Mar-00	Aug-00	May-01	Sep-01	Mar-02	Sep-02	Mar-03	Sep-03	Mar-04	Sep-04	Mar-05	Aug-05
1,1-Dichloroethene	7	5 U	50	20 U	400 U	46	200 U	86	200 U	200 U	200 U	100 U	2000 U	1 U	120 U
1,2-Dichloroethene	70[a]	3 J	4 J	20 U	4	5 U	200 U	20 U	200 U	200 U	200 U	2.5	2000 U	2.9	29 J
2-Butanone	NA	10 U	10 U	500 U	50 U	500 U	5000 U	500 U	5000 U	5000 U	5000 U	10 U	20000 U	10 U	1200 U
Acetone	NA	10 U	10 U	610	10000 U	500 U	5000 U	1800 J	5000 U	5000 U	5000 U	1000 U	20000 U	10 U	1200 U
Chloroform	100[b]	5 J	9	20 U	6	20 U	200 U	20 U	200 U	200 U	200 U	3.3	2000 U	1.8	120 U
Methylene chloride	5	8 U	5 U	54	2 U	26	200 U	20 U	200 U	200 U	200 U	8	3200 U	23	120 U
Tetrachloroethene	5	5000	2700 U	6300	6600	6100	5800	6700	5100	5600	5100	5500	2900	3800	3900
Trichloroethene	5	770	460	860	840	900	610	740	580	550	530	590	350	360	390

Analyte (µg/L)	MCL	UNW-127														
		Apr-98	Apr-99	Sep 99	Mar-00	Aug-00	May-01	Sep-01	Mar-02	Sep-02	Mar-03	Sep-03	Mar-04	Sep-04	Mar-05	Aug-05
1,1-Dichloroethene	7	620 U	5 U	5 U	24	20 U	20 J	200 U	72	200 U	200 U	200 U	5000 U	2000 U	10 U	50 U
1,2-Dichloroethene	70[a]	620 U	30	29	23	25	29	200 U	20 U	200 U	200 U	200 U	57	2000 U	72	64
2-Butanone	NA	NA	10 U	2 J	500 U	50 U	500 U	5000 U	500 U	5000 U	5000 U	5000 U	10 U	20000 U	100 U	500 U
Acetone	NA	1200 U	15 U	9 J	500 U	500 U	500 U	5000 U	1600 J	5000 U	5000 U	5000 U	50000 U	20000 U	100 U	500 U
Chloroform	100[b]	620 U	5 U	5 U	20 U	2 U	20 U	200 U	20 U	200 U	200 U	200 U	1 U	2000 U	10 J	50 U
Methylene chloride	5	620 U	11 U	5 J	20 U	2 U	20 U	200 U	20 U	200 U	200 U	200 U	1.2 U	3900 U	10 U	50 U
Tetrachloroethene	5	490 J	1100	1000 J	1000	820	970	1600	1400	1200	1400	1400	1300 J	930 J	1100	1200
Trichloroethene	5	1900	55	49	50	36	47	200 U	50	200 U	200 U	200 U	120	2000 U	140	110

Analyte (µg/L)	MCL	DPT-K1200-5	DPT-K1200-5	DPT-K1200-6	DPT-K1200-6	DPT-K1200-7
		Feb-05	Mar-05	Feb-05	Mar-05	Feb-05
1,1-Dichloroethene	7	0.5 U	0.5 U	8.8 J	10 U	10 U
1,2-Dichloroethene	70[a]	0.5 U	2.4	670	660	5.3 J
2-Butanone	NA	0.5 U	0.5 U	100 U	100 U	100 U
Acetone	NA	9.6 J	5 U	100 U	100 U	100 U
Chloroform	100[b]	0.5 U	0.5 U	10 U	10 U	690
Methylene chloride	5	0.5 U	0.5 U	19 U	10 U	46 U
Tetrachloroethene	5	0.5 U	0.5 U	370	190	10 U
Trichloroethene	5	0.5 U	2.5	1200	960	47

[a] Represents maximum contaminant level (MCL) for the *cis*-1,2-dichloroethene isomer.
[b] Represents MCL for total trihalomethanes.
J = estimated concentration.
MCL = maximum contaminant level.
NA = not applicable.
U = analyte not detected at indicated concentration.

4.4 EVALUATING THE POTENTIAL FOR VAPOR INTRUSION AT EAST TENNESSEE TECHNOLOGY PARK FACILITIES TARGETED FOR TRANSFER

EPA issued the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Draft Vapor Intrusion Guidance)*, EPA530-F-052, in November 2002. This guidance is intended to help determine if the vapor intrusion exposure pathway poses a significant risk to human health; it was originally written in support of the environmental indicators program. Vapor intrusion is the migration of VOCs in contaminated groundwater and/or soil to indoor air. According to the *Draft Vapor Intrusion Guidance*, in extreme cases, the vapors may accumulate in occupied buildings to levels that may pose safety hazards and/or adverse health effects. Typically, however, the chemical concentration levels are low or, depending on site-specific conditions, vapors may not be present at detectable concentrations. Generally, the *Draft Vapor Intrusion Guidance* is intended for residential settings and does not apply to occupational settings. However, due to the occurrence of VOCs in shallow groundwater in some areas at ETTP, and because a Covenant Deferral approach under CERCLA Sect. 120(h) will be used to support most transfers, EPA Region 4 recommended investigation of the vapor intrusion pathway for ETTP facilities that are targeted for transfer to CROET or other qualified parties.

In accordance with the *Draft Vapor Intrusion Guidance*, and through consultation with representatives from EPA Region 4, DOE-ORO has developed a process to evaluate the potential for vapor intrusion at existing ETTP properties to be transferred to the private sector under a CERCLA Sect. 120(h) Covenant Deferral Request (CDR). The following outlines that process and includes March 2006 guidance from EPA Region 4 (EPA 2006).

ORO, EPA Region 4, and the Tennessee Department of Environment and Conservation (TDEC) agree that vapor intrusion will be addressed in the ETTP final Site-wide Record of Decision (ROD), which is currently under negotiation. Until those actions of the ROD related to vapor intrusion are implemented, ORO will implement interim measures to ensure that transfer of these properties is protective of human health.

As part of the guidance received from EPA in March 2006 (letter from H. W. Taylor, Jr., to S. M. Cange, titled “Proposed Modifications to the Evaluation of the Vapor Intrusion Pathway in Support of Property Transfers at the East Tennessee Technology Park (ETTP), January 6, 2006, Oak Ridge, Tennessee”), it was determined that all properties (buildings and land parcels) will be considered for evaluation on a case-by-case basis. However, it should be noted that sampling is not planned for facilities not suited for occupancy, such as the railroad and its right-of-way. Additionally, sampling is not proposed in the future on land parcels. Deed requirements will note that at least until the measures identified in the final Site-Wide ROD are implemented and shown to be effective, all future buildings planned for occupancy will be constructed with engineered barriers to prevent vapor intrusion.

In evaluating the vapor intrusion pathway, ORO will collect soil-vapor samples for facilities proposed for transfer as follows:

a. EPA will review the soil-vapor planned sampling locations prior to implementation.

b. Two sampling events will be conducted, one during the winter (“wet” hydroperiod) and one during the summer (“dry” hydroperiod), to account for seasonal variability. The goal is to collect soil vapor samples around the hydrologic seasons; therefore, the dates when samples are collected will not necessarily coincide with the calendar-determined dates of the seasons.

c. Mean sample results for individual constituents will be compared to pre-established trigger levels (TLs) for soil vapor that were developed using a hazard index (HI) of 0.1 and a risk value of 10^{-5} (see Appendix C).

d. If the mean soil-vapor analytical results are below the TLs, interim monitoring may be conducted if building conditions change, and/or at the necessary frequency (see below for further details).

e. If the mean soil vapor analytical results are above the TLs, discussions will be held with EPA and TDEC to determine if indoor air samples should be collected to determine whether the vapor intrusion pathway is complete. Factors that will be considered to determine if air sampling is necessary will include the contaminant and how significant the exceedance is (i.e., whether the risk from the vapor intrusion pathway is greater than 10^{-4}, etc.).

f. If building air samples are collected, the mean results for individual constituents will be compared to the 25-year industrial preliminary remediation goals (PRGs). If the results exceed the PRGs, the risks will be deemed unacceptable, and the vapor intrusion pathway will be considered complete. If this occurs, ORO will consult with the transferee (e.g., CROET) to determine if they are still interested in transfer. If the transferee desires the building, it will be retrofitted as necessary to eliminate or reduce the risk to acceptable levels, and confirmatory sampling will be conducted.

g. If the mean results for indoor air samples of individual constituents do not exceed the PRGs, risks will be considered acceptable, and the building will be transferred. Annual indoor-air sampling will be conducted to ensure that the vapor intrusion pathway has not become complete due to any changed conditions in the integrity of the building structure.

h. After the initial evaluation (consisting of the winter and summer sampling events), and in accordance with EPA's *Draft Vapor Intrusion Guidance* and/or other appropriate EPA guidance, re-evaluation of the vapor intrusion pathway for the building may be conducted if the building use changes and/or as determined using the risk and hazard equations from the CERCLA risk assessment guidance. This will be done by aggregating the winter and summer sampling results and identifying the maximum detected concentration for each analyte. Next, the risk and hazard equations will be rearranged to solve for the quotient exposure duration. This approach will determine the number of years a worker would need to be exposed to the maximum detected concentrations of VOCs in order to have a cumulative risk of 1.0×10^{-6} or an HI of 1.0 and, hence, the frequency of sampling needed in order to be protective of workers. For perspective, the frequency of sampling corresponding to a cumulative risk of 1E-04 will also be determined. Once the frequency has been established, re-sampling will be conducted inside or immediately outside the building. The determination of inside or outside will depend on (1) the potential impact to the future owners, and (2) the calculated frequency. The complete approach for determining the interim monitoring frequency is contained in an agreement between EPA Region 4 and ORO titled *Approach to Interim Monitoring of the Vapor Intrusion Pathway for Transferred Facilities at the East Tennessee Technology Park (ETTP)* [DOE 2005a]. Additionally, comprehensive changes to the building structure or infrastructure (e.g., replacement of the heating, ventilating, and air-conditioning system) that have the potential to alter previous conclusions may require re-evaluation. If such changes are made, the transferee (i.e., CROET) will notify ORO and, if necessary, ORO will re-evaluate to ensure that the pre-transfer determination has not changed. It should be noted that the buildings will continue to be used for occupational purposes in accordance with deed restrictions.

i. A re-evaluation, as stated in h above, will consist of additional soil-vapor sampling and, if necessary, indoor-air sampling. If the results of the re-evaluation indicate that vapor intrusion poses a significant risk to human health, ORO will take necessary actions to ensure protectiveness.

Evaluation of the K-1008-F transfer footprint includes the analysis of soil vapor samples. Soil vapor sampling activities and data are discussed in Chap. 6 of this EBS.

5. RESULTS OF VISUAL AND PHYSICAL INSPECTIONS

5.1 VISUAL AND PHYSICAL DESCRIPTION OF THE PROPERTY FOR TRANSFER

The K-1008-F transfer footprint is shown in Fig. 1.2 and includes the building and a small apron of land of about 0.12 acres around the building. Building K-1008-F is a 6300-ft^2, steel-framed structure with metal siding and roof on a concrete slab foundation (Energy Systems 1991a). The building is divided into offices, restrooms in the center of the building, and conference rooms on the north and south ends. Approximately two-thirds of the building is carpeted (Fig. 5.1).

There is ~ 4000 ft^2 of 12-in. by 12-in. vinyl floor tile, suspected of containing asbestos, present in the building beneath the carpeting. The presence of the tile was confirmed during a walkdown conducted in June 2006, when a cursory inspection beneath a corner of the carpet in one room indicated that the carpet was installed directly over the existing floor tile. There is no carpet in the entryways, restrooms, electrical closet, telecommunications room, janitor's closet, or Rooms 114 and 120 (total of approximately 2500 ft^2). The tile in these uncarpeted areas is in good condition except for approximately 13 ft^2 (located in the men's restroom, Room 114, and the south entryway) that is damaged. There are approximately 6500 linear feet of asbestos and nearly 200 fittings as well as the floor tile. The linear feet and fittings are associated with pipe insulation.

The floors in the two pipe chases are unsealed concrete. The pipe chases have an open ceiling (no dropped tiles.) A through-the-wall heating/cooling unit is present in each of the offices located along the outside walls. Ventilation of the interior offices is provided by two, large heating and ventilating units located outside on the east side of the building.

The janitor's closet is posted as a hazardous material storage area, but only contains standard cleaning materials. The lighting is provided by fluorescent light fixtures mounted in a suspended ceiling. These fixtures do not have polychlorinated biphenyl (PCB)-containing ballasts. There are sealed floor drains in Rooms 114A, 114B, 116, 118, 120A, and 120B. A hot water heater pressure relief drain is present in the janitor's closet.

On April 4, 2007, Bldg. K-1008-F was subleased by CROET to the company, Materials and Energy Corporation (M&EC). This company is developing a commercial waste treatment facility in the nearby K-1200 Complex. There have been no significant changes to Bldg. K-1008-F subsequent to this lease.

5.2 DESCRIPTION OF THE ADJACENT PROPERTY

The areas adjacent to the K-1008-F transfer footprint are owned by DOE and have been assessed to determine actual or potential releases of hazardous substances or petroleum products or their derivatives. Information about each of the adjacent areas that may contain contamination is documented in Sect. 4.2.

The area surrounding the transfer footprint consists of the buildings that were used to support the Gas Centrifuge Project. This project was shut down in 1985, and several of the buildings have been scheduled for demolition. The buildings are steel-framed with metal siding, and most are several stories tall. Several buildings have been leased to CROET and subsequently subleased to private companies. The K-1225 building, located approximately 35 ft south of K-1008-F, has been transferred to CROET and is no longer a DOE-owned facility.

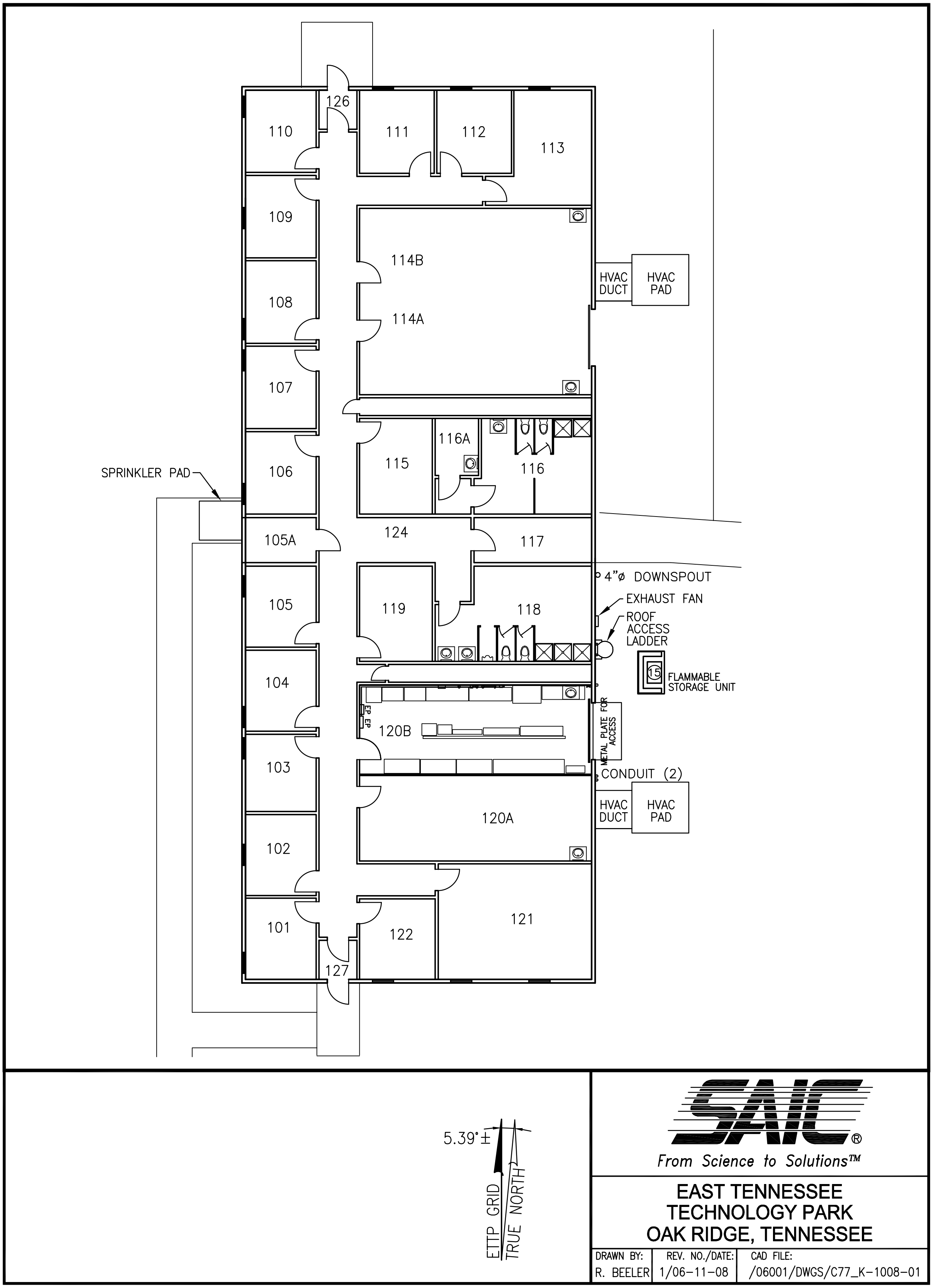


Fig. 5.1. Building K-1008-F Floor.

Building K-1045, located directly to the east of K-1008-F, is a two-story concrete block structure, approximately 880 ft^2, on a concrete slab foundation (Energy Systems 1991b). The building is used for offices and storage and is listed in Appendix C of the FFA.

An asphalt parking area is located on the north side and northwest corner of Bldg. K-1008-F. There are several grassy areas in the adjacent space located on the south, east, and southeast sides of Bldg. K-1008-F. There are three grassy areas adjacent to Bldg. K-1220 (see Fig. 1.3) on the east side of the transfer footprint. The remaining area is asphalt pavement. At the time of inspection, there were four dumpsters, two for sanitary waste and two for recycle paper, located on the west side of Bldg. K-1008-F.

6. RESULTS OF CHEMICAL SAMPLING AND RADIOLOGICAL SURVEYS CONDUCTED IN CONJUNCTION WITH THE PROPOSED TRANSFER

6.1 CHEMICAL SAMPLING

Based on discussions with EPA, it has been agreed that the need to collect soil samples to support title transfer activities will be determined on a case-by-case basis. Factors such as a facility's past operational history and geographic location will be considered. In addition, the history and knowledge of activities at adjacent properties are evaluated.

In 2005 and 2006, the Environmental Management (EM) Program sampled the exposure unit (EU) where K-1008-F is located using the approved data quality objectives (DQOs) package for the EU (BJC 2006b). Both systematic and biased sampling occurred in accordance with the EM Dynamic Verification Strategy (DVS) process (DOE 2005b). Sample results did not indicate the need for a response action (DOE 2006). Further, the DQO package did not specify the collection of any samples in the K-1008-F underlying fee. For these reasons, the only new samples proposed for transfer were soil vapor samples. The Soil Vapor Sampling and Analysis Plan (SAP) that was implemented is included in Appendix C, and the soil vapor sample results are provided in the next section.

6.1.1 Soil Vapor Sampling

The results of the soil vapor sampling conducted in September 2006 and February 2007 at Bldg. K-1008-F are presented in Tables 6.1 and 6.2, respectively. This sampling was conducted to determine if a potential source for VOCs exists under the transfer footprint. Samples were collected from three locations (shown on Fig. C.5.1 in Appendix C). The sampling results were validated, and the average concentration for each VOC was calculated and compared to its respective soil vapor TL, a concentration calculated to be health protective. In addition, to ensure that the VOCs did not cumulatively exceed TLs, the average concentration for each VOC was divided by its respective TL to determine what fraction the concentration represented. The resulting fractions were then added for all VOCs that had at least one detection. If, collectively, the VOC concentrations had exceeded the TLs, the resulting value would be above 1.0 (i.e., the fractions would add up to over 1.0.).

None of the VOCs detected in either of the sampling events had average concentrations that exceeded TLs for Bldg. K-1008-F, and the sum of TL fractions was below 1.0 (see Tables 6.1 and 6.2). Therefore, based on the results from the two soil vapor sampling events, the vapor intrusion pathway is not considered complete beneath the transfer footprint, and there is a low likelihood of adverse impacts to human health.

6.1.1.1 Re-sampling frequency

Soil vapor concentrations may vary due to groundwater movement, requiring additional rounds of sampling. The approach that was agreed to by EPA Region 4 and DOE-ORO for determining how often sampling is needed to ensure protectiveness to the workers inside the transferred footprint is described below (DOE 2004). This approach is intended to determine if re-sampling will be necessary before the final Site-wide ROD is implemented.

The combined dataset (i.e., both wet and dry hydro-periods) was evaluated to determine the maximum detected soil vapor concentration of each constituent for the transfer footprint. The equations used to calculate potential impacts to human health were rearranged to solve for the allowable days of exposure

Table 6.1. September 2006 sub-slab soil vapor results for Building K-1008-F

Analyte	Freq. detect	Min. detect conc.	Max. detect conc.	Arithmetic mean conc.	Scenario A trigger level[a]	Trigger level exceeded?	Arithmetic mean fraction of TL
Volatile organic compounds (μg/m³)							
1,1,1-Trichloroethane	1/3	5.50E+00	5.50E+00	2.93E+00	3.00E+05	No	9.77E-06
1,1,2,2-Tetrachloroethane	0/3			2.10E+00	6.69E+02	NA	NA
1,1,2-Trichloro-1,2,2-trifluoro-ethane	2/3	4.50E+02	5.90E+02	3.47E+02	3.98E+06	No	8.74E-05
1,1,2-Trichloroethane	0/3			1.68E+00	1.91E+03	NA	NA
1,1-Dichloroethane	0/3			1.20E+00	6.89E+04	NA	NA
1,1-Dichloroethene	0/3			1.18E+00	7.42E+02	NA	NA
1,2-Dichloroethane	0/3			1.22E+00	1.38E+03	NA	NA
1,2-Dichloroethene	0/3			2.30E+00	2.52E+03	NA	NA
1,2-Dichloropropane	0/3			1.40E+00	5.44E+02	NA	NA
1,2-Dimethylbenzene	2/3	1.10E+01	6.80E+01	2.68E+01	NA	No	NA
2-Butanone	2/3	3.60E+00	1.70E+01	7.17E+00	6.82E+05	No	1.05E-05
2-Hexanone	0/3			1.25E+00	7.95E+02	NA	NA
4-Methyl-2-pentanone	1/3	7.60E+00	7.60E+00	3.37E+00	4.02E+05	No	8.37E-06
Acetone	2/3	2.20E+01	2.10E+02	7.76E+01	3.85E+05	No	2.01E-04
Benzene	3/3	2.90E+00	3.10E+01	2.00E+01	3.99E+03	No	5.00E-03
Bromodichloromethane	0/3			2.00E+00	2.73E+03	NA	NA
Bromoform	0/3			3.12E+00	1.49E+04	NA	NA
Bromomethane	1/3	3.70E+01	3.70E+01	1.31E+01	6.91E+02	No	1.89E-02
Carbon disulfide	2/3	2.10E+00	2.80E+00	1.93E+00	8.99E+04	No	2.15E-05
Carbon tetrachloride	0/3			1.87E+00	3.34E+02	NA	NA
Chlorobenzene	0/3			1.40E+00	2.76E+03	NA	NA
Chloroethane	0/3			7.50E-01	1.38E+06	NA	NA
Chloroform	0/3			1.35E+00	1.56E+03	NA	NA
Chloromethane	2/3	1.30E+00	1.60E+00	1.17E+00	1.24E+04	No	9.39E-05
Dibromochloromethane	0/3			2.57E+00	1.34E+04	NA	NA
Ethylbenzene	2/3	5.10E+00	3.90E+01	1.51E+01	3.50E+04	No	4.33E-04
M + P Xylene	3/3	6.90E+00	2.20E+02	9.03E+01	NA	No	NA
Methylene chloride	0/3			1.05E+00	7.68E+04	NA	NA
Styrene	0/3			1.30E+00	1.39E+05	NA	NA
Tetrachloroethene	0/3			2.05E+00	6.68E+04	NA	NA
Toluene	3/3	1.00E+01	6.20E+01	4.40E+01	5.32E+04	No	8.26E-04
Total Xylene	2/3	5.40E+01	2.80E+02	1.13E+02	1.39E+04	No	8.09E-03
Trichloroethene	0/3			1.60E+00	5.43E+03	NA	NA
Vinyl chloride	0/3			7.00E-01	4.07E+03	NA	NA
cis-1,2-Dichloroethene	0/3			1.20E+00	4.82E+03	NA	NA
cis-1,3-Dichloropropene	0/3			1.40E+00	2.84E+03	NA	NA
trans-1,2-Dichloroethene	0/3			1.10E+00	9.72E+04	NA	NA
trans-1,3-Dichloropropene	0/3			1.45E+00	4.97E+03	NA	NA
					Sum of Fractions		**3.37E-02**

[a] Trigger level was developed with the Johnson-Ettinger (JE) model assuming an indoor air preliminary remediation goal (PRG) based on risk level of 1E-5 and hazard index (HI) of 0.1 for industrial exposure (250 d/year, 25 years).

NA = not applicable based on sampling or toxicological data.

Scenario A

L - Loam (used for Silty Clay, 45 to 75 % fines).
Contaminant 5 ft (1.5 m) below slab.
Conservative building assumptions.
Dataset evaluated consisted of sampling conducted September 2006.

Table 6.2. February 2007 sub-slab soil vapor results for Building K-1008-F

Analyte	Freq. detect	Min. detect conc.	Max. detect conc.	Arithmetic mean conc.	Scenario A trigger level[a]	Trigger level exceeded?	Arithmetic mean fraction of TL
Volatile organic compounds ($\mu g/m^3$)							
1,1,1-Trichloroethane	0/3			8.00E+00	3.00E+05	NA	NA
1,1,2,2-Tetrachloroethane	0/3			1.00E+01	6.69E+02	NA	NA
1,1,2-Trichloro-1,2,2-trifluoroethane	2/3	3.10E+01	8.00E+01	4.05E+01	3.98E+06	NO	1.02E-05
1,1,2-Trichloroethane	0/3			8.17E+00	1.91E+03	NA	NA
1,1-Dichloroethane	0/3			6.00E+00	6.89E+04	NA	NA
1,1-Dichloroethene	0/3			5.50E+00	7.42E+02	NA	NA
1,2-Dichloroethane	0/3			6.00E+00	1.38E+03	NA	NA
1,2-Dichloroethene	0/3			5.50E+00	2.52E+03	NA	NA
1,2-Dichloropropane	0/3			6.67E+00	5.44E+02	NA	NA
1,2-Dimethylbenzene	0/3			6.50E+00	NA	NA	NA
2-Butanone	0/3			4.25E+00	6.82E+05	NA	NA
2-Hexanone	0/3			6.00E+00	7.95E+02	NA	NA
4-Methyl-2-pentanone	0/3			6.00E+00	4.02E+05	NA	NA
Acetone	3/3	8.20E+00	2.30E+01	1.47E+01	3.85E+05	NO	3.82E-05
Benzene	1/3	2.70E+01	2.70E+01	1.21E+01	3.99E+03	NO	3.03E-03
Bromodichloromethane	0/3			9.67E+00	2.73E+03	NA	NA
Bromoform	0/3			1.52E+01	1.49E+04	NA	NA
Bromomethane	0/3			5.17E+00	6.91E+02	NA	NA
Carbon disulfide	0/3			4.20E+00	8.99E+04	NA	NA
Carbon tetrachloride	0/3			9.00E+00	3.34E+02	NA	NA
Chlorobenzene	0/3			6.67E+00	2.76E+03	NA	NA
Chloroethane	0/3			3.55E+00	1.38E+06	NA	NA
Chloroform	0/3			6.50E+00	1.56E+03	NA	NA
Chloromethane	0/3			2.78E+00	1.24E+04	NA	NA
Dibromochloromethane	0/3			1.23E+01	1.34E+04	NA	NA
Ethylbenzene	0/3			6.33E+00	3.50E+04	NA	NA
M + P Xylene	0/3			6.33E+00	NA	NA	NA
Methylene chloride	0/3			4.95E+00	7.68E+04	NA	NA
Styrene	0/3			6.17E+00	1.39E+05	NA	NA
Tetrachloroethene	0/3			1.00E+01	6.68E+04	NA	NA
Toluene	0/3			5.50E+00	5.32E+04	NA	NA
Total Xylene	0/3			6.50E+00	1.39E+04	NA	NA
Trichloroethene	0/3			7.67E+00	5.43E+03	NA	NA
Vinyl chloride	0/3			3.45E+00	4.07E+03	NA	NA
cis-1,2-Dichloroethene	0/3			5.83E+00	4.82E+03	NA	NA
cis-1,3-Dichloropropene	0/3			6.83E+00	2.84E+03	NA	NA
trans-1,2-Dichloroethene	0/3			5.50E+00	9.72E+04	NA	NA
trans-1,3-Dichloropropene	0/3			7.00E+00	4.97E+03	NA	NA
						Sum of Fractions	**3.08E-03**

[a] Trigger level was developed with the Johnson-Ettinger (JE) model assuming an indoor air preliminary remediation goal (PRG) based on risk level of 1E-5 and hazard index (HI) of 0.1 for industrial exposure (250 d/year, 25 years).

NA = not applicable based on sampling or toxicological data.

Scenario A

L - Loam (used for Silty Clay, 45 to 75 % fines).
Contaminant 5 ft (1.5 m) below slab.
Conservative building assumptions.
Dataset evaluated consisted of sampling conducted February 2007.

that, at the maximum detected soil vapor concentration, would result in an exposure to all detected contaminants that does not exceed health-based limits. For this analysis the acceptable risk level was 10^{-6} and the acceptable hazard level was 1.0. The allowable days of exposure derived from this calculation represent the re-sampling frequency.

The re-sampling frequency for Bldg. K-1008-F, based on all available soil vapor data, is 332 years. The result indicates that should maximum soil vapor concentrations remain constant, a hypothetical individual working in the building would be exposed to a risk of 10^{-6} and a hazard of 1.0 over the 322-year period due to all constituents combined. Primary constituents contributing to the magnitude of the re-sampling frequency were benzene (maximum detected concentration of 3.1E-05 mg/m^3 from fall 2006 sampling) and xylenes (2.84E-04 mg/m^3 from fall 2006 sampling). By comparison, 32,200 years would be required for a hypothetical individual working in the building to be exposed at a risk level of 10^{-4}.

6.2 RADIOLOGICAL SURVEY DATA

Radiological characterization surveys were conducted to determine if contamination levels were within DOE release criteria for unrestricted use of the proposed transfer footprint. Additionally, radiological and chemical data have been collected to characterize contamination within the adjacent areas and are addressed in the risk screen in Appendix E. The radiological data from the transfer footprint are discussed below (the chemical data are discussed in the risk screen). This section presents a summary of both the historical and current radiological survey data for the Bldg. K-1008-F proposed transfer footprint.

First, a general discussion of the survey data is presented, beginning with historical survey data and then followed by a discussion of the current survey results, and quality assurance (QA)/quality control (QC) of the data. (See Appendix D for the radiological survey plan.) The final subsection presents a summary of the data review and results of the analysis of the survey data set for the transfer footprint.

The process history of the ETTP site indicates uranium (natural, depleted, and/or enriched) is the most prominent radiological contaminant potentially present in the K-1008-F transfer footprint due to tracking of contamination from other on-site buildings**.** Uranium-235 enrichment levels expected from operations since the early 1960s are anticipated to be between 0.2 to 5.0%. Most facilities are potentially contaminated via tracking from enrichments of less than 3%.[2]

Other radionuclides (^{60}Co, ^{137}Cs, $^{89/90}$Sr, ^{237}Np, ^{99}Tc, and $^{238/239/240}$Pu) have also been detected on-site at ETTP. These radionuclides originated from the introduction of contaminated materials from the Oak Ridge National Laboratory and/or from the Hanford and Savannah River Reactor Returns Uranium Reprocessing Program; however, these radionuclides are expected to be found in much lower quantities than uranium and be undetectable in this area, based upon its operational history as a spare parts warehouse, change house, and office area. If radionuclides were present, it is estimated they would be found at ratios of 1140:1 for uranium to transuranic (U:TRU) and 350:1 for uranium to technetium-99 (U:^{99}Tc) [both ratios are process buildings weighted averages].[3]

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[2] *Contracted Health Physics Technician Training handouts*, K-25 Site, 1993.

[3] *Isotopic Distribution of Contamination Found at the U. S. Department of Energy Gaseous Diffusion Plants*, Science Applications International Corporation, BJC/OR-257, October 1999.

6.2.1 Historical Surveys

A search of the Bechtel Jacobs Company, LLC (BJC) Radiation Control (RADCON) electronic survey data collected between 1996 and 2006 showed 43 various surveys, including characterization, pre-job, and equipment-release surveys performed during this time frame associated with the K-1008-F transfer footprint. These surveys were reviewed for applicability; the ones used to develop the survey plan are listed in Table 6.3. Surveys reviewed indicate contamination levels are comparable to expected background measurements.

Equipment release surveys were within release limits with the exception of one survey where, in 1999, a compressor blade that was legacy of the prior use of the building in support of the enrichment process was found in a legacy cabinet in a conference room. The compressor blade had 24,255 disintegrations per minute per 100 square centimeters (dpm/100 cm^2) total beta-gamma activity as documented in survey 19990421KA36176004. A survey was conducted of the cabinet and conference room where the compressor blade was found. Survey results showed no transferable contamination in either the cabinet or the conference room (survey 19900421KA3617003). The survey documentation indicated the compressor blade was removed from the building and dispositioned appropriately. Exposure rate measurements taken during performance of several characterization surveys were comparable to expected background measurements.

Table 6.3. ETTP 1996 through 2006 radiological surveys reviewed

19960729KA36175001	19990421KA36176004	20000605KA36178001
19960313KA36151001	19990421KA36176005	20000606KA36178001
19960402KA36190013	19990422KA36192012	20020604KA36179002
19960403KA36190001	19990729KA36168003	20021011JA1DESK005
19960416KA36183007	19990831KA36154005	200408184PIDESK001
19960416KA36195006	20000525KA36194001	20050113Z9JDESK002
19960822KA36175001	20000120KA36184005	20050720AQEDESK001
19970529KA36161012	20000524KA36178001	20050818AQEDESK001
19970724KA36161012	20000530KA36178001	20050823AQEDESK005
19970911KA36161008	20000531KA36178001	20050915A8EDESK003
19980209KA36166001	20000531KA36178002	20060508AQEDESK001
19980331KA36176001	20000601KA38022001	
19990421KA36176003	20000602KA36178001	

6.2.2 Current Surveys

A total of 16 radiological surveys (including all associated QA/QC surveys) were conducted in the footprint in support of the title transfer. The survey numbers are listed in Table 6.4. The surveys were performed during June 2006, in accordance with ETTP RADCON procedures, the survey design document,[4] and the survey plan (see Appendix D).

[4] (BJC 2000). *Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park*, BJC/OR-554, Bechtel Jacobs Company, LLC, Oak Ridge, TN, March.

Table 6.4. ETTP current radiological surveys

20060609AQEDESK001	20060609AQEDESK001
20060609AQEDESK002	20060609AQEDESK002
20060609AQEDESK003	20060609AQEDESK003
20060609AQEDESK004	20060609AQEDESK004
20060609EBVDESK001	20060609EBVDESK001
20060609EBVDESK002	20060609EBVDESK002
20060609EBVDESK003	20060609EBVDESK003
20060615REWDESK001	20060615REWDESK002
20060620REWDESK001	20060815AQEDESK001

Radiological survey procedures and area survey units (SUs) are described in the survey plan presented in the Appendix D. Each area was classified as either a Class 3, 2, or 1 SU based upon historical data and process knowledge, as described in the design document. See Fig. 6.1 for the locations of the SUs.

Hand-held meter survey results were taken for the survey area and compared to the values listed in Table 6.5, which are the appropriate 10 *Code of Federal Regulations* 835 and DOE Order 5400.5[5] surface contamination gross alpha or gross beta criteria. These criteria are referred to as derived concentration guideline levels (DCGLs) in the design document.

Each SU data set was first evaluated by comparing the maximum result after background subtraction to the screening level for the SU classification. If the net maximum survey result was less than the screening level for the specific SU (e.g., 25% DCGL limits for Class 3 SUs), then the unit was said to pass [i.e., the null hypothesis, (H_o), that the residual contamination in each of the individual SUs exceeds the SU DCGL, was rejected]. If the net maximum result was greater than the screening level for any single reading, further readings were obtained in the 1-m^2 area to determine the average for the square meter. If the net average reading for the square meter was greater than the screening level for the specific SU, then Class 3 and 2 SUs were reclassified and resurveyed under the protocol of the new classification.

Table 6.5. Contamination limits (DCGLs) for all survey units

	DCGL (dpm/100 cm^2)	**Class 3 25% of DCGL (dpm/100 cm^2)**	**$DCGL_{EMC}$ (dpm/area)**
Total alpha	5,000	1,250	15,000
Removable alpha	1,000	250	N/A
Total beta-gamma	5,000	1,250	15,000
Removable beta-gamma	1,000	250	N/A

DCGL = derived concentration guideline level.
$DCGL_{EMC}$ = derived concentration guideline level$_{\text{elevated measurement comparison}}$.
dpm = disintegrations per minute.
N/A = not applicable.

[5] (DOE 1990). *Radiation Protection of the Public and Environment,* DOE Order 5400.5, Fig. IV-1, “Surface Contamination Guidelines,” p. IV-6, U. S. Department of Energy, February.

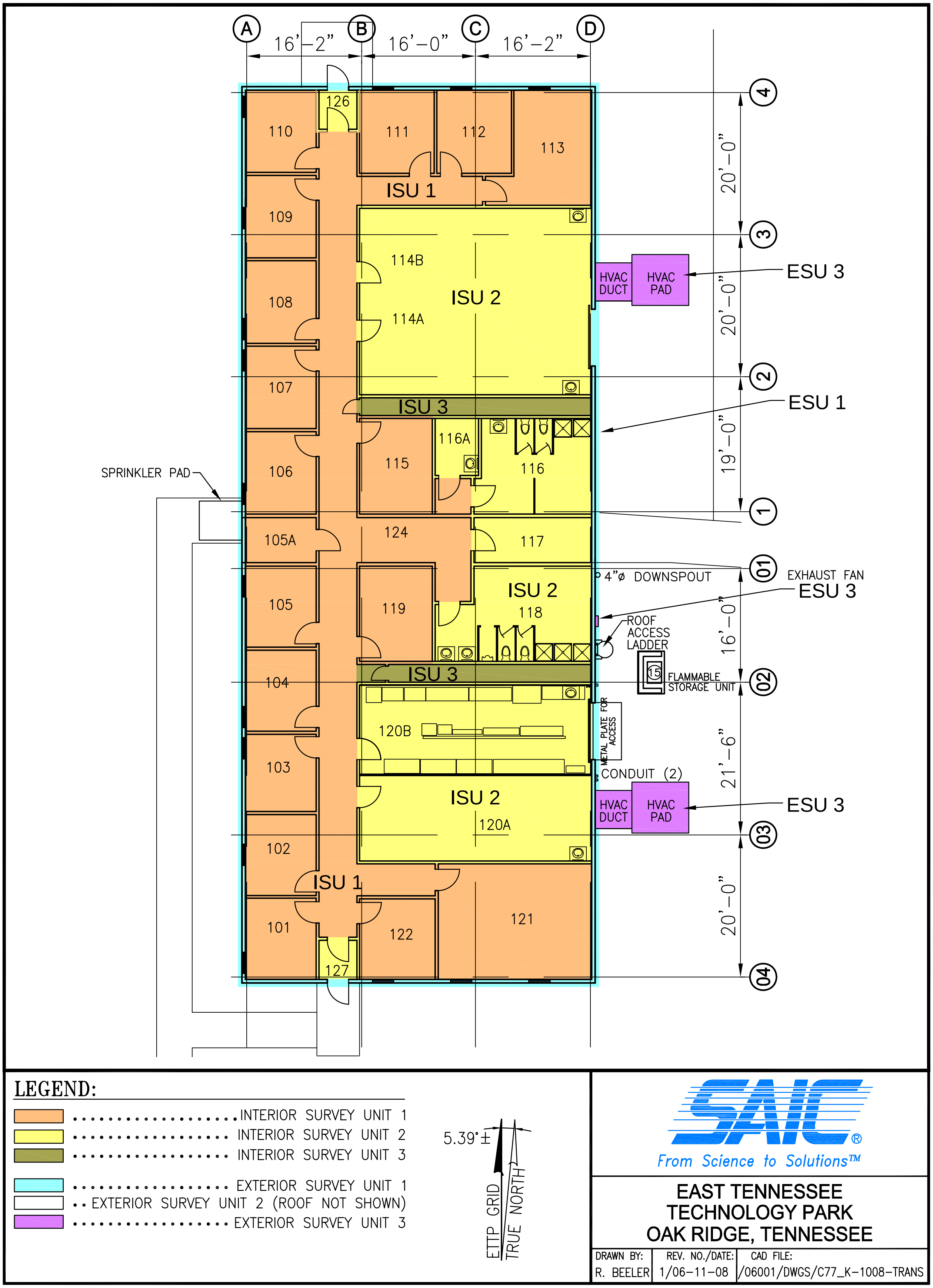

Fig. 6.1. K-1008-F transfer survey units.

If the net maximum result was greater than the DCGL for Class 1 units, the non-parametrical statistical Sign test was used to evaluate the data, as outlined in the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* [NRC 1997].[6]

6.2.3 Interior Survey Units

All interior survey units (ISUs) were classified as 3, as shown in Table 6.6 (there were no Class 2 or 1 ISUs per the survey plan). The Class 3 survey criterion for ISUs was the following: 10% scan of the primary traffic areas and work surfaces with floor monitors and hand-held meters (including usage of a floor monitor probe set up as a hand-held probe and calibrated to detect alpha and beta-gamma contamination for large-area scans of non-floor surfaces), as appropriate; any location on the walls or ceiling that, using professional judgment, potentially could have residual radioactivity present was to be scanned over the suspected area and documented on the survey. No removal of suspended ceiling tiles or floor panels was required for these surveys. Tools, office furniture, and equipment were a separate ISU and surveyed per the guidance found in Sect. 6.2.4. One total and removable contamination measurement, at a minimum, was recorded in each room, hallway, or open space at locations determined during the scan survey to have the highest activity.

Table 6.6. Survey units classification

Interior survey units	***Initial class***	***Final class***
K-1008-F Carpeted Office Areas 101–113, 115, 119,121, 122, 124, and hallway (ISU 1)	Class 3	Class 3
K-1008-F Tiled Areas, Industrial Hygiene Laboratory, and Airlocks 114 A–B, 116, 116A, 117, 118, 120 A–B, 126, 127 (ISU 2)	Class 3	Class 3
K-1008-F Pipe Chases with concrete floors (ISU 3)	Class 3	Class 3
Furnishings and equipment	***Initial class***	***Final class***
K-1008-F Office Areas, newer furnishings (FSU 1)	Class 3	Class 3
K-1008-F Older furnishings (FSU 2)	Class 2	Class 2
Exterior survey units	***Initial class***	***Final class***
K-1008-F Exterior walls and drain spouts (ESU 1)	Class 3	Class 3
K-1008-F Roof (ESU 2)	Class 3	Class 3
K-1008-F HVAC units and ducts, exhaust fans, through-the-wall heating/cooling units (ESU 3)	Class 3	Class 3

FSU = furnishings survey unit.
HVAC = heating, ventilation, and air-conditioning.
ISU = interior survey unit.
ESU = exterior survey unit.

All ISUs had results below 25% of the DCGL. Because all results were less than the screening levels for all ISUs, no further statistical analysis was performed. From an inspection of the individual surveys, including QA/QC surveys, all total activities were less than or equal to 41 dpm/100 cm^2 total alpha and 910 dpm/100 cm^2 total beta-gamma, with all removable contamination results less than or equal to 7.2 dpm/100 cm^2 removable alpha and 8 dpm/100 cm^2 removable beta-gamma. The maximum tissue-equivalent dose rate was 9 μrem/hr. See Table 6.7 for the summary of the survey results for all ISUs.

[6] (NRC 1997). *Multi-Agency Radiation Survey and Site Investigation Manual, Final Edition*, NUREG-1575, Nuclear Regulatory Commission.

Table 6.7. Summary of contamination and dose rates

Location	Alpha total		Alpha removable		Beta-gamma total		Beta-gamma removable		Dose equivalent rate (mrem/h)
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
Interior survey units – Class 3									
ISU 1	< 4.23	40.23	< -0.4	< 3.25	< -346.84	< -7.98	< -3.44	< 5.93	NEAD
ISU 2	< 8.94	35.76	< -0.4	< 3.25	< -340.86	< 47.84	< -1.1	< 8.27	NEAD
ISU 3	< 0	22.8	< 2.48	7.2	< -205.32	909.54	< 4.87	6.26	0.009
Furnishings survey units – Class 3									
FSU 1	< -7.69	26.47	-4.02	< 3.25	< -328.1	11.58	< -3.44	5.93	0.006
Furnishings survey units – Class 2									
FSU 2	< -11.96	30.74	< -4.02	3.25	< -378.28	2061.2	< -3.44	8.27	0.025
Exterior survey units – Class 3									
ESU 1	4.53	58.89	< 2.48	3.31	< -211.9	541.16	< 4.87	6.26	0.006
ESU 2	4.53	117.78	< 2.48	3.31	< -45.64	505.3	< 4.87	6.26	0.005
ESU 3	4.53	22.65	< 2.48	7.2	< -205.38	< -22.82	< 4.87	13.6	0.007
DOE contamination limits		5000		1000		5000		1000	20

Notes: All readings are in units of disintegrations per minute (dpm)/100 cm^2.
A "<" preceding a value indicates that the result cannot be distinguished from background at the 95% confidence level.
This table does not include results from quality assurance/quality control surveys.
DOE = U. S. Department of Energy.
ESU = exterior survey unit.
FSU = furnishings survey unit.
ISU = interior survey unit.
NEAD = no elevated activity detected (above background).
NR = not recorded.

6.2.4 Furnishings and Equipment Survey Units

All furnishings survey units (FSUs) were classified as either Class 3 or Class 2, based upon their as-found condition, process knowledge, and historical data, if available. Furnishings are defined as furniture, equipment racks, equipment, etc., and designated as either newer or older based upon visual inspection, use history of the item (if known), and RADCON professional judgment. Class 3 FSUs consisted of newer furnishings; they were scanned over 10% of all accessible areas, with a maximum surface area not to exceed 5000 m^2. Class 2 FSUs consisted of older furnishings; they were scan-surveyed over 25% of their accessible surfaces, with a maximum FSU area of 1000 m^2. At least 11 data points were to be collected from each FSU at the areas of the highest activity, as determined during the scan survey.

All FSUs (Class 3 and Class 2) had results below 25% of the DCGL, with the exception of one Class 2 source cabinet in Room 114 A that had been used by site radiological control personnel. Survey results for the source cabinet were 26 dpm/100 cm^2 total alpha and 2061 dpm/100 cm^2 total beta-gamma. This cabinet was initially classified as a Class 2 furnishing. Additionally, the initial source cabinet survey was performed with radioactive sources stored inside the cabinet at the time of survey. Since the time of the initial survey, the radioactive sources were removed and relocated, and the empty cabinet resurveyed (20060815AQEDESK001). The survey results verified the cabinet was below the DCGL; therefore, the source cabinet did not require reclassification to Class 1. All other FSU survey results were less than 25% of the DCGL of 5000 dpm/100 cm^2 for both total alpha and beta-gamma. From an inspection of the individual surveys, including QA/QC surveys, all total activities, excluding the source cabinet results, were less than or equal to 36 dpm/100 cm^2 total alpha and 178 dpm/100 cm^2 total beta-gamma with all removable contamination results less than or equal to 3 dpm/100 cm^2 alpha and 8 dpm/100 cm^2 beta-gamma. Because all results were less than the screening level for all FSUs, no further statistical analysis was performed. The maximum tissue-equivalent dose rate, excluding the source cabinet (while containing the sources) in Room 114 A, was 7 μrem/hr. The maximum tissue-equivalent dose rate for the source cabinet was 25 μrem/hr, which is consistent with these types of exempt radioactive check sources. See Table 6.7 for the summary of the survey results for all FSUs.

6.2.4 Exterior Survey Units

The exterior survey units (ESUs) were classified as Class 1, 2, or 3 as shown in Table 6.6. There were no Class 2 or 1 ESUs per the survey plan. The Class 3 survey criteria for ESUs was the following: 10% of the surfaces scanned with hand-held meters or with gas-proportional probes, as appropriate. For exterior areas with a potential for holding activity difficult to detect by alpha and beta-gamma scans (e.g., drain spouts, wall/floor interfaces), a scan was performed using a sodium iodide (NaI) meter. Eleven measurements of total and removable contamination, at a minimum, were recorded within each SU at locations determined during the scan survey to have the highest activity. At least one timed measurement was made on each piece of exterior equipment and on each facing and roof of the building. Any Class 3 area that exceeded 25% of the DCGL was reclassified as Class 2 and surveyed accordingly. Any Class 3 area that exceeded the DCGL required reclassification to Class 1 and was surveyed accordingly.

All ESU results were below 25% of the DCGL. Because all results were less than the screening level for the ESUs, no further statistical analysis was performed. From an inspection of the individual surveys, including QA/QC surveys, all total activities were less than or equal to 118 dpm/100 cm^2 total alpha and 821 dpm/100 cm^2 total beta-gamma, with all removable contamination results less than or equal to 7.2 dpm/100 cm^2 removable alpha and 13.6 dpm/100 cm^2 removable beta-gamma. The maximum tissue-equivalent dose rate was 7 μrem/hr. See Table 6.7 for the ESU survey results summary.

6.2.5 QA/QC Surveys

A 5% verification survey of the data gathered from each survey unit was performed in each survey unit for QA/QC. All QA/QC survey data gathered were in agreement with the initial survey unit data, within the uncertainty of the measurements.

6.2.6 Survey Data Review and Analysis

All survey data were reviewed by a health physicist before their use in this report. All surveys were conducted in accordance with the survey plan according to the lead health physicist (correct number of survey units, data points per survey unit, instrumentation data, QA/QC survey performed, etc.).

Results of the surveys performed in the study area and the statistical test performed on the data gathered in each survey unit indicate that the interior, exterior, and present furnishings are below the DOE surface contamination limits and within the acceptable dose-equivalent rate range for building interior and exterior surfaces. Because all results were less than the DCGL, no statistical analysis of the data for each survey unit was required. Radiological survey data, along with the building’s former use, indicate radiological surface contamination levels are within DOE release criteria and the property is suitable for title transfer.

7. REFERENCES

BJC (Bechtel Jacobs Company LLC) 1996. *Radiation Protection Program*, BJC-SH-04, Vol. 1, Sect. SH-B-4012, "Radiation Contamination Control and Monitoring," Oak Ridge, TN.

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APPENDIX A

REAL ESTATE ACQUISITION LETTER

PROPOSED TRANSFER OF BUILDING K-1008F
OAK RIDGE RESERVATION, TN

FILES RESEARCH FOR HAZARDOUS SUBSTANCE ACTIVITY

The following statement is provided in support of guidance promulgated under Section 120(h) of the Comprehensive Environmental Response, Liability, and Compensation Act, as amended (CERCLA) 42 U.S.C 9620(h) and in support of regulations issued by the Environmental Protection Agency at 40 CFR part 373.

The undersigned has made a complete search of existing and available Department of Energy (DOE) records, documentation, and data within the real estate files relating to the property that is subject to the proposed fee transfer action of Building K-1008F at the East Tennessee Technology Park within the Oak Ridge Reservation, Tennessee. The proposed action would result in transfer to the Community Reuse Organization of East Tennessee (CROET) under a 10 CFR 770 Proposal. The search conducted was considered reasonable with a good faith effort expended to identify whether any hazardous substances were known to have been released or disposed of on the property. The available real estate records of this office do not reflect any determinable reference that hazardous substance activity as defined by Section 101(14) of CERCLA took place on or in the property during the time the property was owned by the United States of America.

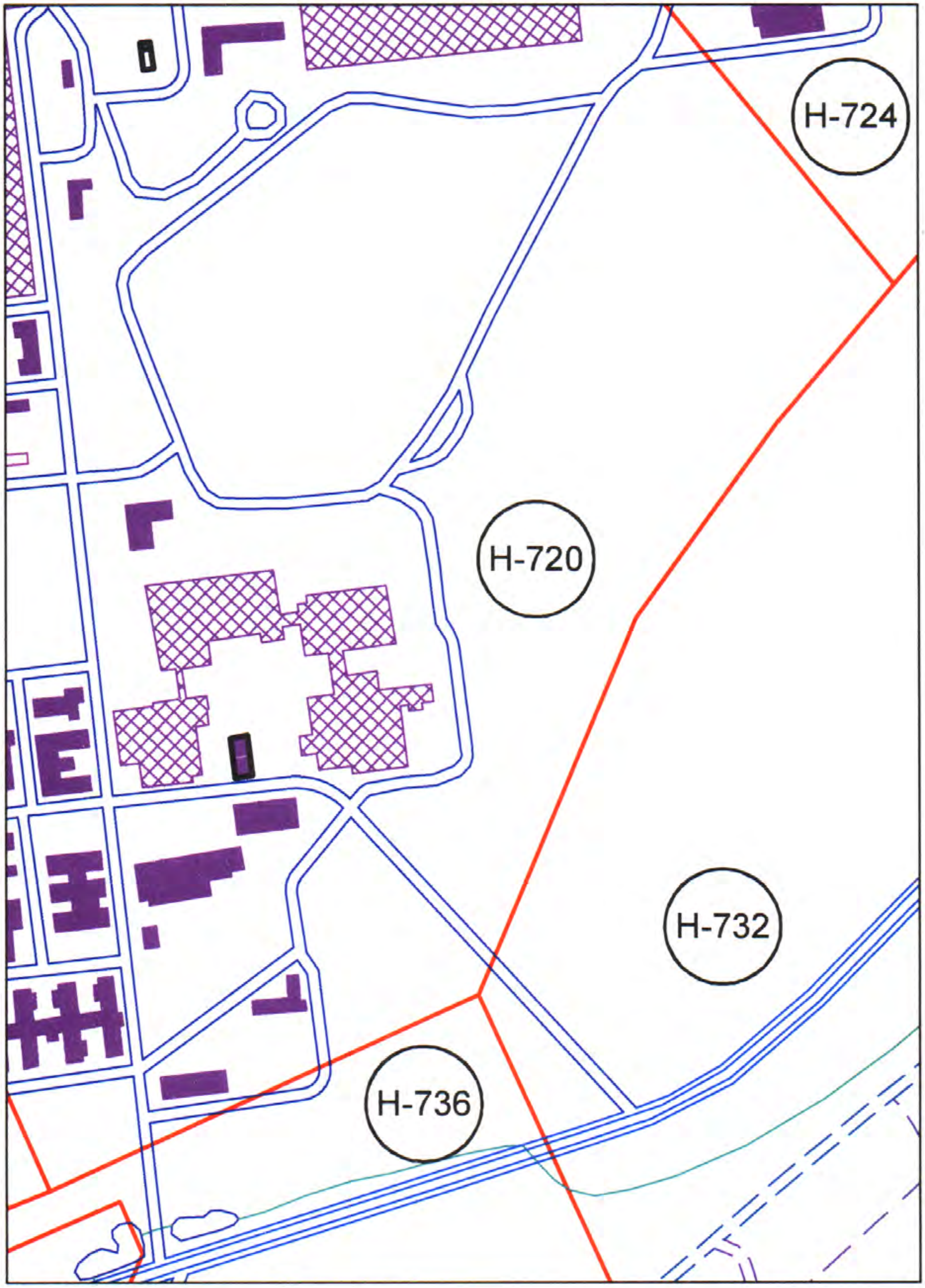
Lands affected by this action are identified as portions of the following original acquisition tracts in which the United States of America acquired title, (having been acquired for the Atomic Energy Commission as a forerunner of the Department of Energy) by Civil Action No. 429 filed in the United States District Court for the Eastern District of Tennessee, Northern Division:

> Building K-1008F is located on a portion of Tract H-720. Judgment on Declaration of Taking number 19, dated February 23, 1943, is filed for public record in Deed Book Y-5, Page 138, in the Roane County Register's Office, Tennessee.

This record shall be made a part of the CERCLA report currently being prepared.

Cindy Hunter s/June 16, 2006
Cindy Hunter, Realty Officer
Oak Ridge Office
U. S. Department of Energy

Attachment
Plat Exhibit

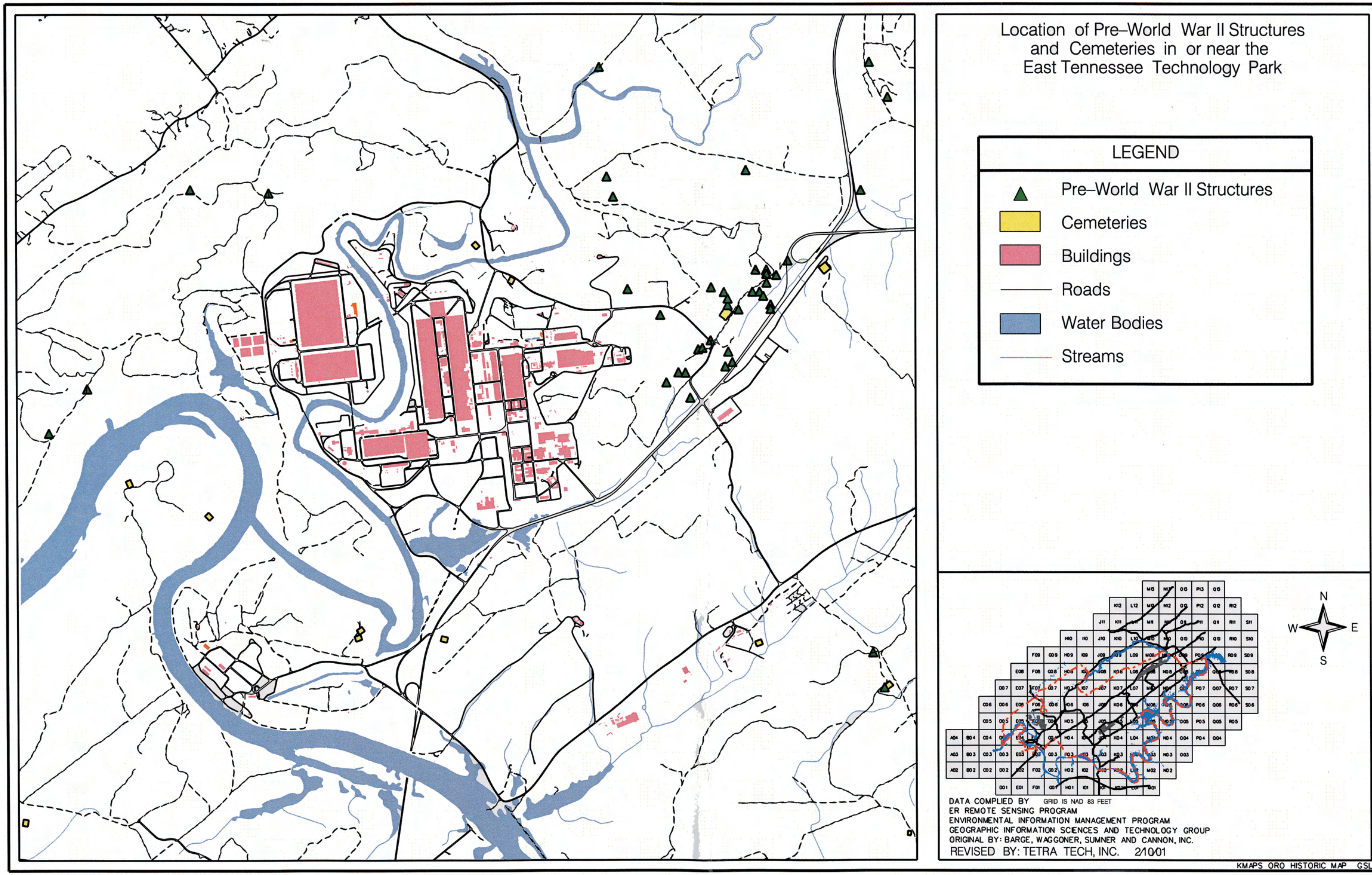


Tract H-720 Acquired from W. F. Elzey et ux
Deed Book/Page: Y-5/138
Judgment of Taking Number: 19 Dated: 2/23/43
Approximate Acreage: 211.0

○ = Acquisition Tract Numbers
▬ = K-1008F Boundary

APPENDIX B

STUDY AREA MAP FROM RECORDS SEARCH


Location of Pre–World War II Structures
and Cemeteries in or near the
East Tennessee Technology Park
LEGEND
Pre–World War II Structures
Cemeteries
Buildings
Roads
Water Bodies
Streams
N
S
E
W
DATA COMPLIED BY
GRID IS NAD 83 FEET
ER REMOTE SENSING PROGRAM
ENVIRONMENTAL INFORMATION MANAGEMENT PROGRAM
GEOGRAPHIC INFORMATION SCIENCES AND TECHNOLOGY GROUP
ORIGINAL BY: BARGE, WAGGONER, SUMNER AND CANNON, INC.
REVISED BY: TETRA TECH, INC. 2/10/01
KMAPS ORO HISTORIC MAP GSL

APPENDIX C

SAMPLING AND ANALYSIS PLAN FOR THE COLLECTION OF SOIL VAPOR SAMPLES FOR THE K-1008-F TRANSFER FOOTPRINT AT THE EAST TENNESSEE TECHNOLOGY PARK

BJC/OR-2596
FINAL

Sampling and Analysis Plan for Collection of Soil Vapor Samples for the K-1008-F Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

SCIENCE APPLICATIONS INTERNATIONAL CORPORATION

contributed to the preparation of this document and should not be considered an eligible contractor for its review.

BJC/OR-2596

Sampling and Analysis Plan for Collection of Soil Vapor Samples for the K-1008-F Building at the East Tennessee Technology Park, Oak Ridge, Tennessee

Date Issued—September 2006

Prepared by
Science Applications International Corporation
Oak Ridge, Tennessee
under subcontract 23900-BA-PR007U
under work release 000500

Prepared for the
U. S. Department of Energy
Office of Nuclear Fuel Supply

BECHTEL JACOBS COMPANY LLC
managing the
Environmental Management Activities at the
East Tennessee Technology Park
Y-12 National Security Complex   Oak Ridge National Laboratory
under contract DE-AC05-98OR22700
for the
U. S. DEPARTMENT OF ENERGY

06-180(E)/090106

CONTENTS

FIGURES

TABLES

ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CROET	Community Reuse Organization of East Tennessee
DOE	U. S. Department of Energy
EPA	U. S. Environmental Protection Agency
ETTP	East Tennessee Technology Park
FFA	Federal Facility Agreement
FY	fiscal year
HSWA	Hazardous and Solid Waste Amendments of 1984
NaI	sodium iodide
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORR	Oak Ridge Reservation
PCB	polychlorinated biphenyl
PID	photoionization detector
PRG	preliminary remediation goal
QC	quality control
SAP	Sampling and Analysis Plan
SOP	standard operating procedure
SSC	sampling subcontractor
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
VOC	volatile organic compound

C.1. INTRODUCTION

This Sampling and Analysis Plan (SAP) describes sampling efforts to be undertaken in order to evaluate the potential for vapor intrusion of volatile organic compounds (VOCs) from shallow groundwater into the K-1008-F building at the East Tennessee Technology Park (ETTP).

Building K-1008-F is a 6300-ft^2, steel-framed structure with metal siding and roof on a concrete slab foundation. The building is divided into offices, an industrial hygiene laboratory, restrooms, and conference rooms. The location of the K-1008-F building is depicted in Fig. C.1.1. This SAP presents the rationale and details of soil vapor sampling that will be conducted to support title transfer. These activities are being performed to determine the potential for vapor intrusion into the building by VOCs that may be present within the subsurface via groundwater.

C.2. SITE DESCRIPTION AND HISTORY

C.2.1 PAST AND PRESENT ACTIVITIES CONDUCTED AT THE K-1008-F BUILDING LOCATION

It is assumed that 12-in. by 12-in. vinyl floor tile suspected of containing asbestos is present in the building beneath carpeting since a cursory inspection conducted in June 2006 indicated that the carpet was installed directly over the existing floor tile in one room. Carpet was not installed in the entryways, restrooms, electrical closet, telecommunications room, janitor's closet, and Rooms 114 and 120 (total of approximately 2,495 ft^2). The tile in these uncarpeted areas is in good condition except for approximately 13 ft^2 (located in the men's restroom, Room 114, and the south entryway) that is damaged. In addition to the vinyl floor tile, there are approximately 6300 linear ft of pipe insulation and 200 associated fittings constructed of asbestos-containing material in the building.

There are sealed floor drains in Rooms 114A, 114B, 116, 118, 120A, and 120B in Bldg. K-1008-F. A hot water heater pressure relief drain is present in the janitor's closet.

The K-1008-F building is located on the site of two previous buildings. In 1944, the T-10 Warehouse was built to support the construction of the Oak Ridge Gaseous Diffusion Plant (ORGDP). In 1947, it was renumbered Bldg. K-1209 and listed as a spare parts warehouse. In 1953, the warehouse was dismantled. In 1958, the K-1045-A Fire Training Tower was constructed on the north end of the concrete pad that remained after Bldg. K-1209 was dismantled. The Fire Training Tower was located immediately under the present K-1008-F building footprint. During its operations from 1958 to 1977, the Fire Training Tower was used by the K-25 Fire Department to burn waste oils for training fire responders. The K-1045-A Fire Training Tower was dismantled in 1977.

Union Carbide Corporation drawing S-KT-100 from 1975 indicates that Bldg. K-1008-E was built in 1975 as a change house for personnel working on the Gas Centrifuge Project. Building K-1045-A is also indicated as being in existence in this drawing. In 1980, Bldg. K-1008-F was built immediately south of K-1008-E to expand the change house facilities. In 1989, Bldgs. K-1008-E and K-1008-F were combined and renovated to house two research (luminescent measurement and laser technology) laboratories and various offices. Hazardous substances used in these laboratories included acetone, ethyl alcohol, Freon 114, Freon TF, isopropanol, methanol, and trichloroethylene. All of these chemicals were maintained in small quantities of less than 50 lbs. In the late-1990s, the laboratories were closed, and Bldg. K-1008-F was renovated into offices and an industrial hygiene laboratory. Hazardous substances

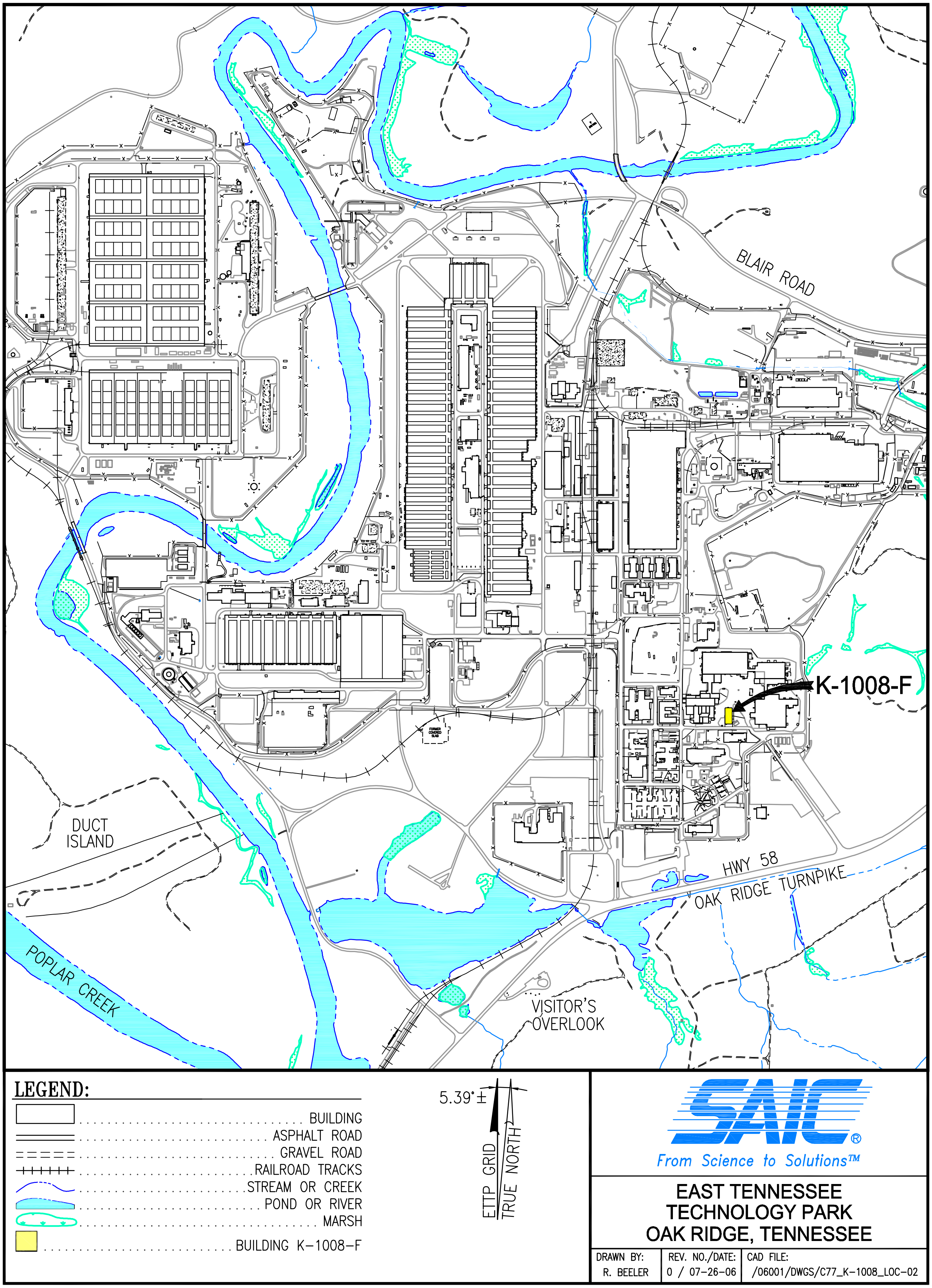


Fig. C.1.1. Location of K-1008-F building within ETTP.

used in the industrial hygiene laboratory are limited to various instrument calibration gases (carbon monoxide, carbon dioxide, chlorine, hydrogen chloride, isobutylene, methane, propane, nitrogen, and nitrogen dioxide). Figure C.2.1 presents the K-1008-F building footprint designated for title transfer. A floor plan for the building is provided in Fig. C.2.2.

It should be noted that although historic operations in Bldg. K-1008-F included research laboratories that used small quantities of solvents, due to the limited quantities of these VOCs and the fact that any residues would have volatilized since cessation of those operations, sampling for those contaminants on building surfaces is not warranted. The current industrial hygiene laboratory uses only small quantities of calibration gases that are vented to the atmosphere via a hood. These operations would not leave chemical residues in the building, and, therefore sampling for contamination resulting from that operation is unnecessary.

C.2.2 PAST AND PRESENT ACTIVITIES FOR THE ADJACENT PROPERTY

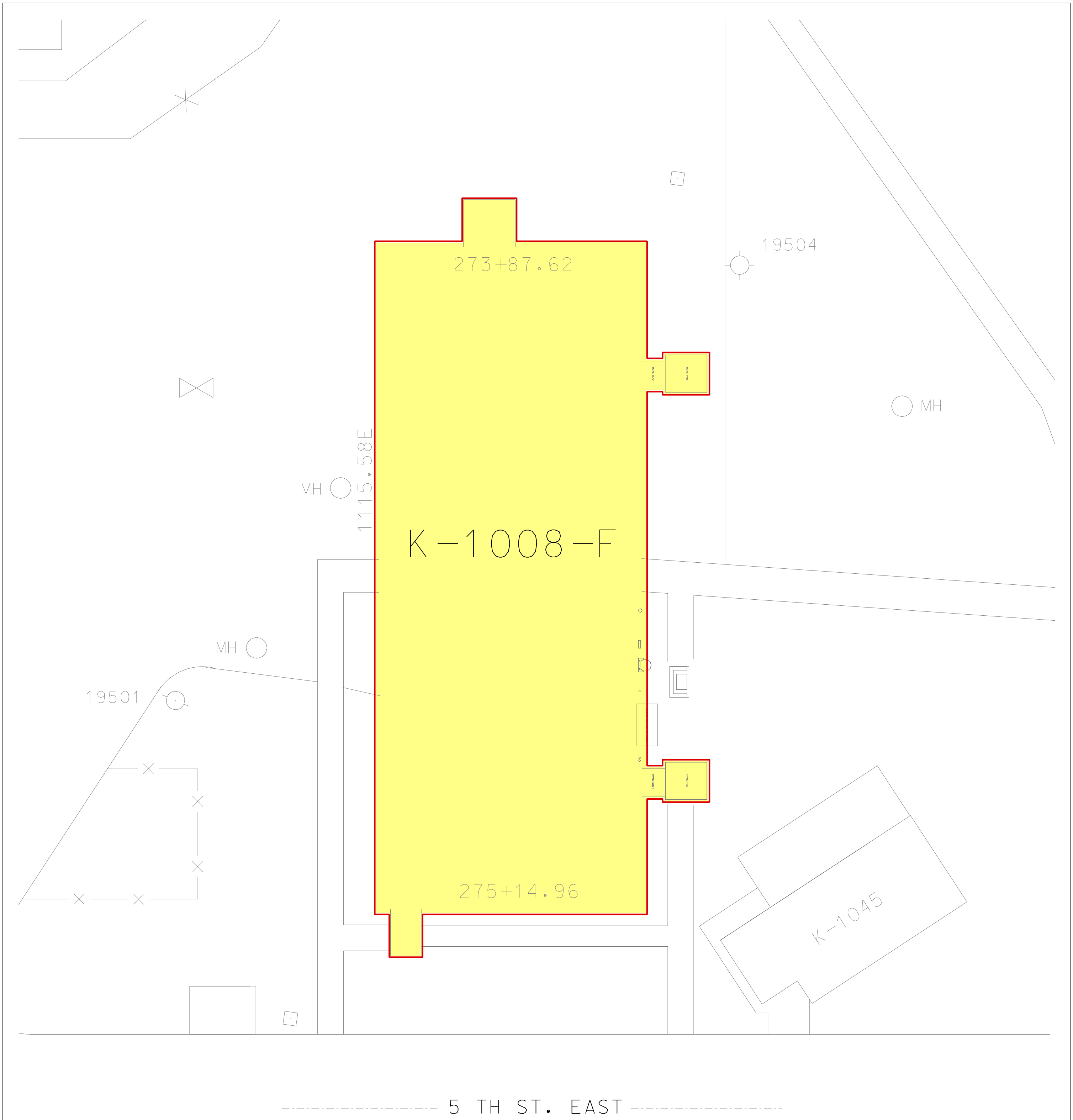
Research of the historical plot plans, maps, photographs, and building directories indicates there were several structures in the area around K-1008-F prior to its construction. The general area was used during the 1940s and 1950s by general contractors who were under contract for the construction of the ORGDP.

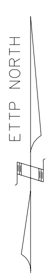
The K-1045-A Waste Oil Burning Pit was associated with the K-1045-A Fire Training Tower and was located to its northwest. The location of the former K-1045-A Waste Oil Burning Pit was adjacent to the current K-1008-F footprint. It was closed and filled in the 1960s. The K-1045-A Waste Oil Burning Pit is listed in Appendix C of the Federal Facility Agreement (FFA) and as a Solid Waste Management Unit (SWMU) in the Hazardous and Solid Waste Amendments of 1984 (HSWA) permit for the Oak Ridge Reservation (ORR). This former facility and others identified in Appendix C of the FFA are slated for future investigation and possible remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA).

Building K-1045, located to the east of K-1008-F, was originally built in 1943 as temporary building T-33-2 and was part of the Ford, Bacon, and Davis Construction Support Area. In 1947, the building was renumbered T-8 (and also as Bldg. K-1045). At this time, it was converted to an incinerator and remained in that function until 1953. From 1954 through 1978, Bldg. K-1045 was used as a storage building. In 1982, it was converted into a valve certification laboratory associated with the Gas Centrifuge Project. It was subsequently used for storage of magnetic media until 1987 when it was converted to use as an office and break area for carpenters. It is currently used for storage of janitorial equipment and scheduled for future demolition activities.

Most of the existing structures near K-1008-F were constructed in the early 1970s as part of the Gas Centrifuge Project. Construction of the complex began in the 1960s with the K-1004-J building. Building K-1023 was added in 1970, Bldgs. K-1052 and K-1200 were added in 1974, Bldg. K-1210 was added in 1976, and Bldg. K-1220 was added in 1982. These buildings form a semi-circle that surrounds a paved area adjacent to K-1008-F.

Immediately to the south of the study area, across 5th Street, is the K-1225 Office Building. It was built in 1980 as office space for the Gas Centrifuge Project. Following shutdown of the project, the building was used by several organizations for offices. It was transferred under 10 *Code of Federal Regulations* (*CFR*) 770 from DOE to the Community Reuse Organization of East Tennessee (CROET) in April 2005. A covenant deferral request under CERCLA Section 120(h) was approved by the U. S. Environmental Protection Agency (EPA) and concurred on by the state of Tennessee.





LEGEND

K–1008–F FOOTPRINT

Fig. C.2.1. Transfer footprint for the K-1008-F building.

TETRA TECH, INC.
OAK RIDGE, TENNESSEE
7/07/06 1203 28 map2 LP 01.dgn

K–1008–F
BUILDING LAYOUT PLAN

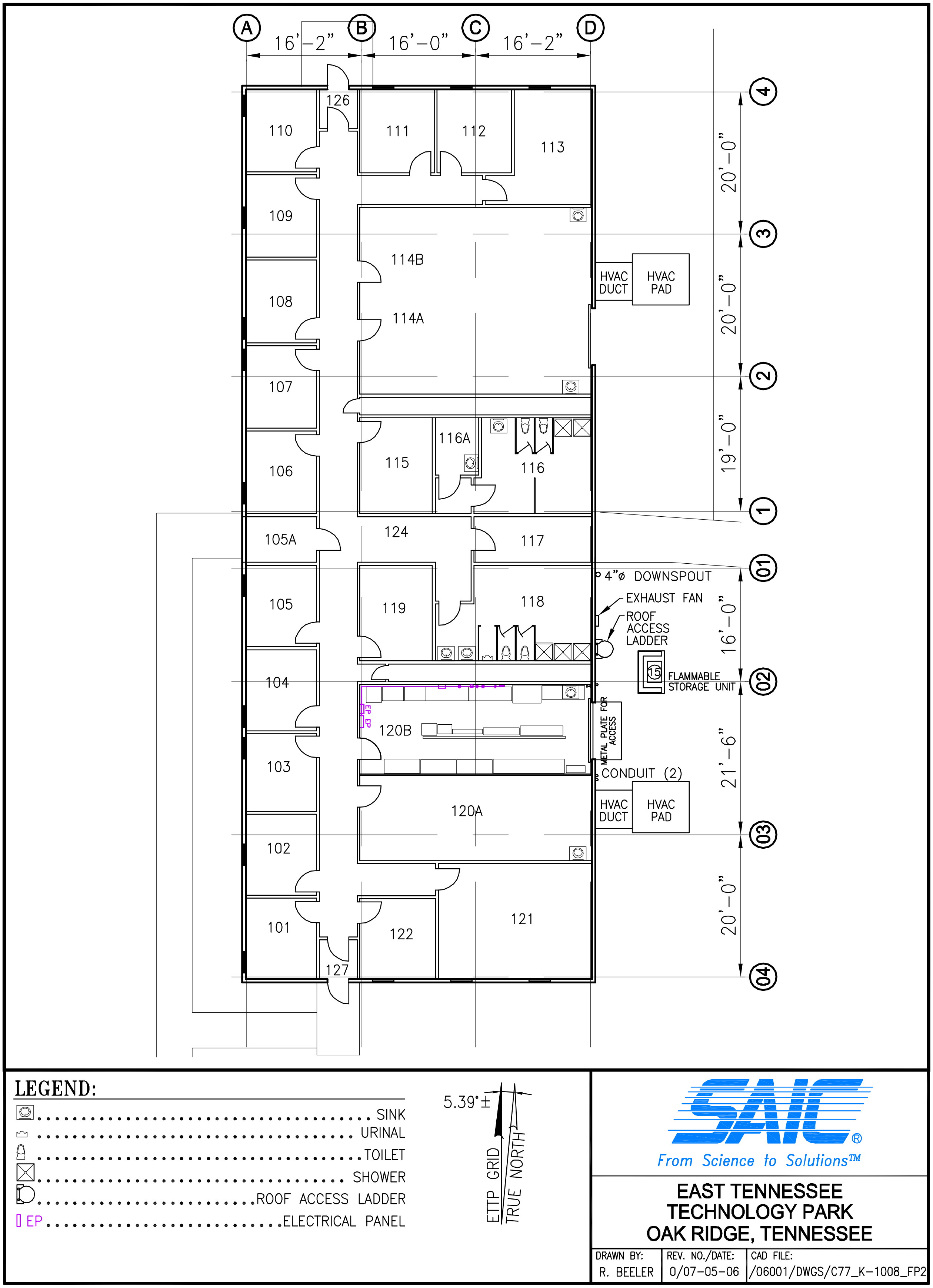


Fig. C.2.2. Floor plan for the K-1008-F building.

C.3. EXISTING/HISTORICAL DATA

Building K-1008-F is located in the southern portion of ETTP, which is underlain by bedrock of the Chickamauga Supergroup. Although less prone to karst development than the Knox Group rocks in the vicinity of the ETTP, the Chickamauga formations are nevertheless subject to the development of karst. Solutionally enlarged fractures, joints, and bedding planes are common in exposures of Chickamauga rocks in the vicinity of ETTP. Structurally these formations have been folded into an anticline (convex upward fold) in the vicinity of Bldg. K-1008-F with the axis of this structure located approximately 200 ft south of the building and trending northeast to southwest. Bedding in the Chickamauga generally dips northwestward on the north side of this axis and southeastward on the south side of this axis. Building K-1008-F is located slightly north of the mapped anticline axis; thus, bedding is expected to dip primarily to the northwest in the vicinity of the building. The approximate location of the axis of this fold is indicated on Fig. C.3.1. In addition to providing an indication of the direction of dip of bedding, the axis may also represent a zone of increased fracturing, thus providing potential pathways for groundwater movement.

The bedrock formations underlying K-1008-F are mapped as belonging to the Carters Limestone[1] and generally consist of thick to massive beds of limestone with some thin to medium beds and occasional interbedded argillaceous limestone. Some pods and lenses of chert are present in the lower and middle parts of the Carters Limestone. Although exposures were not observed during the geologic mapping of the ETTP, the middle part of the Carters Limestone also contains two distinctive metabentonite beds, which range from 1 to 3 ft in thickness. The Carters Limestone is subject to karst development due to the high carbonate content and thickness of beds. Evidence of karst development in the Carters Limestone includes cavities encountered in drilling at ETTP. Approximately 30% of the monitoring wells that have been completed in the Carters Limestone at ETTP encountered cavities ranging in size from a few inches up to 7 ft. Although pre-construction topographic maps do not indicate the occurrence of sinkholes in the immediate vicinity of Bldg. K-1008-F, sinkholes have been identified from pre-construction maps and aerial photographs within the Carters Limestone along strike approximately 3200 ft to the southwest of Bldg. K-1008-F in the vicinity of the K-1007-P1 Pond. Groundwater flowpaths in bedrock are a key uncertainty in the conceptual model of ETTP, but fractures, bedding planes, and hydraulic gradient are expected to be the primary controlling factors.

There are currently three groundwater monitoring wells within 250 ft of the K-1008-F building. The hydrogeologic characterization data presented below for K-1008-F are based on the data from these wells and on interpolation from other available ETTP site-wide information.

Because a limited number of monitoring points exist in the immediate vicinity of Bldg. K-1008-F, depth to bedrock and depth to groundwater are partly interpolated from other nearby wells. Comparison of pre-construction topographic maps to present-day topography suggests that site preparation work may have involved the removal of some soil material (< 10 ft) as opposed to the placement of fill material in the K-1008-F area. Depth to bedrock, interpolated from data in the general vicinity of K-1008-F, is expected to be from 3 to 22 ft below ground surface (bgs). Bedrock was encountered at depths of 21.5 and 19 ft bgs at wells BRW-050 and BRW-051, respectively, which are the wells located nearest to Bldg. K-1008-F (approximately 200 ft northwest). Bedrock outcrops are present approximately 600 ft east of Bldg. K-1008-F. The depth to groundwater, based on water levels in the nearest wells and interpolated from the ETTP sitewide potentiometric map, is expected to range from 8 to 16 ft bgs. Shallow groundwater flow is anticipated to be to the southwest toward the shallow ponds to the south of ETTP.

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[1] P. J. Lemiszki, 1994. *Geological Mapping of the Oak Ridge K-25 Site, Oak Ridge, Tennessee,* K/ER-11.

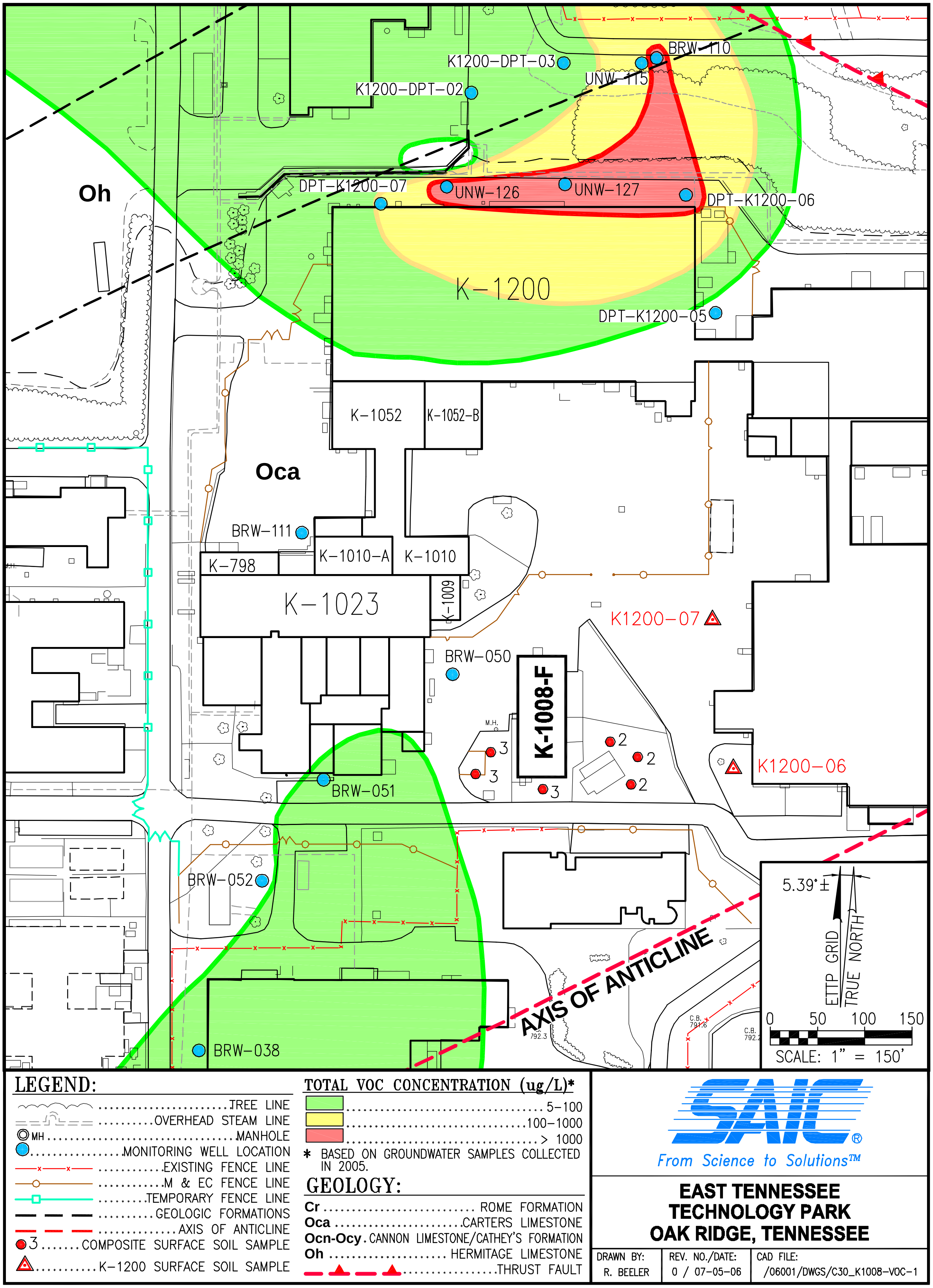

Fig. C.3.1. Groundwater VOC concentrations in the K-1008-F area.

Hydrologic parameters, such as hydraulic conductivity and hydraulic gradient, are also estimated for K-1008-F using available data. Hydraulic conductivity for the Chickamauga bedrock and overburden materials, as determined from slug tests conducted in numerous monitoring wells throughout ETTP, is presented in Table C.3.1 with additional hydrogeologic characterization parameters for K-1008-F.

Table C.3.1. Summary of hydrogeologic conditions at Bldg. K-1008-F

Parameter	Site conditions
Is a groundwater plume present beneath K-1008-F?	None identified
Distance from facility to nearest upgradient plume (ft)	300
Is karst present?	Yes
Depth to bedrock (ft)	3–22[a]
Depth to groundwater (ft)	8–16[a]
Are fill materials present at K-1008-F?	None identified
Composition of overburden materials present	silty clay[a]
Shallow groundwater flow direction	southwest
Hydraulic conductivity of overburden materials (cm/s)	1.15E-03[b]
Hydraulic conductivity of bedrock (cm/s)	4.08E-03[c]
Hydraulic gradient at the site (ft/ft)	0.02–0.06[a]
Is a perched water table present at K-1008-F?	unknown

[a]Represents interpolated value based on available data.

[b]Represents average hydraulic conductivity of unconsolidated zone materials at East Tennessee Technology Park (ETTP) based on slug tests of wells completed in overburden developed above Chickamauga bedrock.

[c]Represents average hydraulic conductivity based on slug tests of ETTP wells completed in bedrock of the Chickamauga Supergroup.

Current groundwater plume maps indicate the potential presence of VOCs in groundwater within 300 ft to the north of Bldg. K-1008-F (Fig. C.3.1). A groundwater plume in the anticipated downgradient direction from K-1008-F has been interpreted to exist approximately 100 ft west of K-1008-F. Due to the shallow nature of bedrock in this area of ETTP, the plume downgradient of K-1008-F represents a bedrock groundwater plume. Although hydraulic gradients indicate shallow groundwater flow is to the southwest, groundwater flowpaths in bedrock are unknown due to the complex geology and geologic structure underlying ETTP. The possibility of transport of the VOC plume through bedrock flowpaths beneath K-1008-F cannot be completely discounted based on the available data.

Table C.3.2 summarizes the analytical results for the VOCs detected in groundwater samples collected from the five bedrock monitoring wells (BRW-038, BRW-050, BRW-051, BRW-052, and BRW-111). It should be noted that the concentrations presented in Table C.3.2 might not be representative of groundwater beneath K-1008-F but represent concentrations in the downgradient bedrock plume nearest to the building. The data for well BRW-111 are inconclusive because the well was sampled twice in March 2005 with significantly different results obtained. The only VOC detected above a federal primary drinking water maximum contaminant level (MCL) in the monitoring wells located nearest to Bldg. K-1008-F (BRW-038, BRW-050, and BRW-051) in 2005 was trichloroethene (TCE) at well BRW-051 (Table C.3.2).

Concentrations of TCE and 1,2-dichloroethene (DCE) have generally been declining over recent years at the downgradient bedrock wells BRW-038 and BRW-051. The concentration of TCE in BRW-051 declined from 41 µg/L in 1994 to 6.2 µg/L in 2005. Concentrations of the TCE daughter product *cis*-1,2-DCE show similar trends to those of TCE at wells BRW-038 and BRW-051. Concentrations at BRW-050 and BRW-052 have remained relatively steady, but generally do not exceed an MCL.

Table C.3.2. Summary of VOCs detected in groundwater samples from bedrock monitoring wells in the vicinity of K-1008-F

Analyte (µg/L)	MCL	BRW-038				BRW-050									
		Oct-94	Mar-95	Oct-95	June-05	Jun-98	Aug-98	May-01	Sep-01	Mar-02	Aug-02	Mar-04	Sep-04	Mar-05	Aug-05
1,1,1-Trichloroethane	200	100 U	14	25 U	1 U	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
1,1-Dichloroethane	NA	100 U	10 U	25 U	0.27 J	5 U	1 J	2 U	2 U	2 U	2	0.84 J	0.9 J	0.89 J	0.89 J
1,2-Dichloroethene	70[a]	49 J	6 J	33	7.6	5 U	2 J	2 U	2 U	2 U	2 U	0.94 J	1.2	0.98 J	1
Chloroform	100[b]	100 U	10 U	25 U	0.17 J	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	36 J	3 J	17 J	3.9	5 U	5 U	2 U	2 U	2 U	2 U	1 U	1 U	1 U	1 U
Trichloroethene	5	170	35	120	39	3 J	3 J	3	3	7	3	2.2	2.6	2	1.9

Analyte (µg/L)	MCL	BRW-051						BRW-052					
		Oct-94	Mar-95	Sep-95	Jun-98	Aug-98	Mar-05	Oct-94	Mar-95	Sep-95	Jun-98	Aug-98	Mar-05
1,1,1-Trichloroethane	200	5 U	5 U	5 U	5 U	2 J	0.5 U	5 U	5 U	5 U	5 U	2 U	0.5 U
1,1-Dichloroethane	NA	5 U	5 U	5 U	5 U	5 U	0.5 U	5 U	5 U	5 U	5 U	5 U	0.5 U
1,2-Dichloroethene	70[a]	18	39	33	9 J	14 J	7.6	2 J	3 J	5 U	1 J	1 J	1.1
Chloroform	100[b]	1 J	5 U	1 J	5 U	5 U	0.5 J	1 J	5 U	5 U	5 U	5 U	0.5 U
Tetrachloroethene	5	5 U	5 U	5 U	5 U	5 U	0.17 J	5 U	5 U	5 U	5 U	5 U	0.5 U
Trichloroethene	5	41	33	36	16 J	18 J	6.2	4 J	5 U	5 U	2 J	2 J	1.1

Analyte (µg/L)	MCL	BRW-111	
		Mar-05	Mar-05
1,1,1-Trichloroethane	200	0.5 U	0.5 U
1,1-Dichloroethane	NA	3.6	0.5 U
1,2-Dichloroethene	70[a]	190	0.5 U
Chloroform	100[b]	0.5 U	0.31 J
Tetrachloroethene	5	22	0.5 U
Trichloroethene	5	15	0.5 U

[a] Represents maximum contaminant level (MCL) for the *cis*-1,2-dichloroethene isomer.
[b] Represents MCL for total trihalomethanes.
J = estimated concentration.
MCL = maximum contaminant level.
U = analyte not detected at indicated concentration.

Analytical results for the two unconsolidated zone wells (UNW-126 and UNW-127) and three drive point piezometers (DPT-K1200-5, DPT-K1200-6, and DPT-K1200-7) located north of the K-1008-F building are provided in Table C.3.3. It should be noted that the concentrations presented in these tables represent concentrations within the nearest known, upgradient unconsolidated zone plume, which is located north of Bldg. K-1008-F. Table C.3.3 summarizes the primary VOCs detected at the unconsolidated zone monitoring wells and piezometers located north of, and upgradient of, Bldg. K-1008-F. Concentrations of *cis*-1,2-DCE, tetrachloroethene (PCE), and TCE exceed the MCL at these locations.

In the unconsolidated zone, the maximum detected PCE concentration detected in 2005 was in well UNW-126 at 3900 μg/L. Concentrations of PCE and TCE at well UNW-126 suggest a decreasing trend in concentration over time. Concentrations of PCE at well UNW-127 appear to be relatively steady over time. However, the concentration of TCE at well UNW-127 suggests an overall increasing trend in TCE since 1999 (Table C.3.3). The concentration trend for *cis*-1,2-DCE at well UNW-127 generally corresponds with the trend observed for TCE at this well. Both of these wells are located at the bottom of the unconsolidated zone at the interface with the bedrock, immediately downgradient from the K-1070-C/D Burial Ground, the probable source of these VOCs.

Data for surface soils in the vicinity of the K-1008-F building are available from the historic composited surface soil sampling locations 2 and 3 shown in Fig. C.3.1. VOCs and semivolatile organic compounds (SVOCs) were not detected in these composite surface soil samples. Aroclor-1260 was detected at 63 μg/kg at one location. This detection may have been related to the historic burning of waste oils at the K-1045 Fire Training Tower. Elevated results were found for calcium, cadmium, and magnesium. These elevated detections may have been related to construction activities in the area or the burning of waste oils.

C.4. SCOPE

The overall scope of this SAP is to determine VOC concentrations in the soil vapor directly beneath the K-1008-F building slab to evaluate the vapor intrusion pathway. This overall objective will be met by sampling soil vapor directly beneath the slab using EPA-approved methods with detection limits that are sufficient to determine if the exposure pathway is complete as discussed in Chap. 5 of this SAP.

The non-radiological contaminants found in soil samples in the vicinity of K-1008-F were limited to certain metals at concentrations above background and trace concentrations of polychlorinated biphenyls (PCBs) and VOCs. The vapor pressures of the metals found above background and of PCBs are not sufficient that these contaminants could migrate into the building in the vapor phase. Based on their physical and chemical characteristics, PCBs and metals are unlikely to migrate into the building by other pathways. However, VOCs may migrate in the vapor phase from soil or groundwater to the building air space, and, therefore, soil vapor sampling for those contaminants found in the upgradient groundwater is warranted.

Table C.3.3. Summary of VOCs detected in unconsolidated zone monitoring wells located north of K-1008-F

Analyte (µg/L)	MCL	UNW-126													
		Apr-99	Sep-99	Mar-00	Aug-00	May-01	Sep-01	Mar-02	Sep-02	Mar-03	Sep-03	Mar-04	Sep-04	Mar-05	Aug-05
1,1-Dichloroethene	7	5 U	50	20 U	400 U	46	200 U	86	200 U	200 U	200 U	100 U	2000 U	1 U	120 U
1,2-Dichloroethene	70[a]	3 J	4 J	20 U	4	5 U	200 U	20 U	200 U	200 U	200 U	2.5	2000 U	2.9	29 J
2-Butanone	NA	10 U	10 U	500 U	50 U	500 U	5000 U	500 U	5000 U	5000 U	5000 U	10 U	20000 U	10 U	1200 U
Acetone	NA	10 U	10 U	610	10000 U	500 U	5000 U	1800 J	5000 U	5000 U	5000 U	1000 U	20000 U	10 U	1200 U
Chloroform	100[b]	5 J	9	20 U	6	20 U	200 U	20 U	200 U	200 U	200 U	3.3	2000 U	1.8	120 U
Methylene chloride	5	8 U	5 U	54	2 U	26	200 U	20 U	200 U	200 U	200 U	8	3200 U	23	120 U
Tetrachloroethene	5	5000	2700 U	6300	6600	6100	5800	6700	5100	5600	5100	5500	2900	3800	3900
Trichloroethene	5	770	460	860	840	900	610	740	580	550	530	590	350	360	390

Analyte (µg/L)	MCL	UNW-127														
		Apr-98	Apr-99	Sep 99	Mar-00	Aug-00	May-01	Sep-01	Mar-02	Sep-02	Mar-03	Sep-03	Mar-04	Sep-04	Mar-05	Aug-05
1,1-Dichloroethene	7	620 U	5 U	5 U	24	20 U	20 J	200 U	72	200 U	200 U	200 U	5000 U	2000 U	10 U	50 U
1,2-Dichloroethene	70[a]	620 U	30	29	23	25	29	200 U	20 U	200 U	200 U	200 U	57	2000 U	72	64
2-Butanone	NA	NA	10 U	2 J	500 U	50 U	500 U	5000 U	500 U	5000 U	5000 U	5000 U	10 U	20000 U	100 U	500 U
Acetone	NA	1200 U	15 U	9 J	500 U	500 U	500 U	5000 U	1600 J	5000 U	5000 U	5000 U	50000 U	20000 U	100 U	500 U
Chloroform	100[b]	620 U	5 U	5 U	20 U	2 U	20 U	200 U	20 U	200 U	200 U	200 U	1 U	2000 U	10 J	50 U
Methylene chloride	5	620 U	11 U	5 J	20 U	2 U	20 U	200 U	20 U	200 U	200 U	200 U	1.2 U	3900 U	10 U	50 U
Tetrachloroethene	5	490 J	1100	1000 J	1000	820	970	1600	1400	1200	1400	1400	1300 J	930 J	1100	1200
Trichloroethene	5	1900	55	49	50	36	47	200 U	50	200 U	200 U	200 U	120	2000 U	140	110

Analyte (µg/L)	MCL	DPT-K1200-5	DPT-K1200-5	DPT-K1200-6	DPT-K1200-6	DPT-K1200-7
		Feb-05	Mar-05	Feb-05	Mar-05	Feb-05
1,1-Dichloroethene	7	0.5 U	0.5 U	8.8 J	10 U	10 U
1,2-Dichloroethene	70[a]	0.5 U	2.4	670	660	5.3 J
2-Butanone	NA	0.5 U	0.5 U	100 U	100 U	100 U
Acetone	NA	9.6 J	5 U	100 U	100 U	100 U
Chloroform	100[b]	0.5 U	0.5 U	10 U	10 U	690
Methylene chloride	5	0.5 U	0.5 U	19 U	10 U	46 U
Tetrachloroethene	5	0.5 U	0.5 U	370	190	10 U
Trichloroethene	5	0.5 U	2.5	1200	960	47

[a] Represents maximum contaminant level (MCL) for the *cis*-1,2-dichloroethene isomer.
[b] Represents MCL for total trihalomethanes.
J = estimated concentration.
MCL = maximum contaminant level.
NA = not applicable.
U = analyte not detected at indicated concentration.

Sampling of the surrounding soil or soil beneath the facility is not proposed in order to support the title transfer of Bldg. K-1008-F. In 2005 and 2006, the Environmental Management (EM) Program sampled the exposure unit (EU) where the facility is located using the approved data quality objectives (DQOs) package for the EU (BJC 2006a). Systematic and biased sampling occurred in accordance with the EM Dynamic Verification Strategy (DVS) process (DOE 2005). Sample results did not indicate the need for a response action. Further, the DQO package did not specify the collection of any samples in the K-1008-F underlying fee. For these reasons, the only new samples proposed for transfer are soil vapor samples as described in Chap. 4.

If VOC concentrations in the soil vapor directly beneath the building slab exceed trigger levels specified in this SAP, a separate sampling plan would be developed. The plan would identify the need for indoor air samples collected at normal breathing zone height from within the building to determine exposure concentrations. If required, indoor air samples would also be collected using EPA-approved methods with detection limits that are sufficient to support the risk assessment. The objectives and rationale for soil vapor sampling are discussed in Chap. 5 of this SAP.

C.5. SOIL VAPOR SAMPLING RATIONALE AND DESIGN

C.5.1 SAMPLING OBJECTIVES FOR SOIL VAPOR

In accordance with the *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Draft Vapor Intrusion Guidance)* [EPA 2003], and the guidance provided by EPA Region 4 (EPA 2006), the DOE-Oak Ridge Office has developed a process to evaluate the potential for vapor intrusion at existing ETTP properties that are being considered for transfer to the private sector.

To achieve the objective of assessing the vapor intrusion pathway, sampling and analytical protocols for soil vapor samples must ensure that VOCs are quantified at levels that are equal to or below transport-derived trigger levels that would indicate the need for indoor air sampling in order to further evaluate the potential risks associated with the vapor intrusion pathway. For ambient air (indoor and outdoor) samples, the sampling and analytical protocols must ensure that VOCs are quantified at or below the 25-year industrial preliminary remediation goals (PRGs). The 25-year industrial PRGs are the lower of the airborne concentrations corresponding to an excess lifetime cancer risk of 10^{-5} or a hazard quotient of 0.1. A preliminary set of analytes of interest for the vapor intrusion pathway was identified for the K-1008-F building based upon groundwater in the vicinity of the building. This set of analytes of interest also includes the degradation (and parent) compounds of the detected VOCs. The list of analytes of interest for the K-1008-F building is provided in Table C.5.1. Table C.5.1 also provides the 25-year industrial PRGs for the preliminary set of analytes of interest. Any VOCs that are currently analyzed by the groundwater program that are detected will also be reported.

C.5.2 VAPOR SAMPLING DESIGN

Soil vapor action (or “trigger levels”) will inherently be larger than risk-screening criteria due to the attenuation within the foundation materials and dilution effects as the vapors migrate into the indoor air volume of the building. Therefore, detection and reporting limits for indoor air samples are suitable to meet the established objectives for soil vapor samples. Detection and reporting limits for the VOCs to be reported in soil vapor are further identified in Chap. 6 of this SAP.

Table C.5.1. Analytes of interest and respective indoor air PRGs[a] for the vapor intrusion pathway at K-1008-F

Chemical	Industrial PRGs[a] (mg/m^3)
Acetone	4.6E-01
2-Butanone	7.3E-01
Chloromethane	1.31E-02
Methylene chloride	8.67E-02
Chloroform	1.78E-03
Carbon tetrachloride	3.58E-04
Chloroethane	1.46E+00
1,1 Dichloroethane	7.31E-02
1,1 Dichloroethene	8.18E-04
1,2-Dichloroethene	4.60E-03
cis-1,2-Dichloroethene	5.11E-03
Tetrachloroethene	7.05E-02
1,1,1 Trichloroethane	3.21E-01
Trichloroethene	5.83E-03
Vinyl chloride	4.65E-03

[a] Industrial 25-year PRGs are the lower of the concentrations corresponding to an excess lifetime cancer risk of 10^{-5} or a hazard quotient of 0.1.
mg/m^3 = milligram per cubic meter.
PRG = preliminary remediation goal.

In order to evaluate the potential for VOC vapor intrusion into the ETTP buildings designated for transfer, the general sampling approach has been divided into two phases. The first phase involves collection of soil vapor samples from directly beneath the slab of the building. The second phase of sampling involves collection of indoor ambient air samples at the normal breathing zone height within the building. The indoor air sampling will be implemented only if the soil vapor trigger levels were exceeded in the first-phase samples. Additional indoor air samples would be collected at locations that are separate from the soil vapor sampling stations to identify VOC contributions to indoor ambient air from any existing industrial activities that may be sources of such emissions. An outdoor ambient air sample would also be collected in this second phase to identify any potential external sources that may contribute VOCs detected in the indoor air samples.

C.5.2.1 Phase 1 – Sub-slab Soil Vapor

During the first phase, three sub-slab vapor samples will be collected directly beneath the concrete slab of Bldg. K-1008-F. The VOC concentrations measured in these sub-slab soil vapor samples reflect equilibrium conditions resulting from attenuation in the soil column beneath the building. Samples taken in this fashion eliminate the uncertainty associated with partitioning modeling calculations.

The three sample locations for the sub-slab vapor sampling have been located on the basis of best professional judgment. Sample locations 01 through 03 were selected on the basis of preferential pathways. These sampling locations are in rooms with floor drains and, as such, the sub-slab piping runs provide preferential pathways if VOCs are present in the sub-surface. This Plan also provides two alternate sampling locations in the event difficulties are encountered at any of the indicated sampling stations. Therefore, the selection of sampling stations attempts to avoid locations immediately adjacent to activities that may be sources of fugitive VOCs (such as janitorial closets that might contribute VOCs from cleaners, floor wax stripping formulations, etc.). Additionally, sample locations have been located toward the building interior to avoid in-leakage of atmospheric air that can dilute the soil vapor sample if collected near the building's edge.

The soil vapor samples shall be collected by drilling a small (~ 7/8-in.-diameter) penetration through the first floor or foundation slab (estimated thickness of 6 to 12 in.). It should be noted that sample stations 01 through 03 are located in areas with flooring that is suspected of containing asbestos. Therefore, care must be exercised during penetration of the floor to minimize disturbance of this material. Care shall be taken to avoid disturbance or penetration of the underlying soil or aggregate. Soil vapor samples shall be grab samples (sample collection duration of less than 60 s) collected using 5-L, pre-evacuated SUMMA canisters. Vapor samples will be taken from immediately beneath the concrete slab (estimated 4 to 6 in.). Any VOCs that are currently analyzed by the groundwater program that are detected will also be reported.

C.5.2.2 Phase 2 – Ambient Air Sampling

If VOC concentrations in the Phase 1 soil vapor sampling exceed the site-specific soil vapor trigger levels presented in Table C.5.2, then Phase 2 ambient air sampling would be performed. Sampling stations for the Phase 2 indoor air samples will generally coincide with the locations selected for sub-slab soil vapor sampling. If necessary, a sampling addendum to this plan will be developed outlining the sampling locations and number of samples required in the event an exceedance of the site-specific trigger levels occurs in the sub-slab samples.

C.5.3 SOIL VAPOR SAMPLING PLAN

Prior to the mobilization event for the soil vapor sampling, the sampling subcontractor (SSC) will obtain evacuated 5-L SUMMA canisters that have been cleaned, conditioned, and certified in accordance with the requirements of EPA Method TO-15 (EPA 1999). Other sampling system components shall be cleaned in accordance with Method TO-15 prior to assembly of the sampling system. Non-metallic parts shall be rinsed in deionized water and dried in a vacuum at 50°C. Stainless steel parts and fittings shall be cleaned in an ultrasonic bath, using methanol followed by ultrasonic cleaning in hexane. These parts shall be subsequently rinsed in deionized water and baked in a vacuum oven at 100°C for 12 to 24 h. Soil vapor samples will be collected from directly beneath the floor slab of the building.

The sampling systems for soil vapor shall be 5-L sub-atmospheric SUMMA canisters. For collection of the soil vapor samples, flow restriction will be provided by a critical orifice set to charge the canisters to the desired end pressure over a 60-s sample collection period. The sampling systems shall be assembled in accordance with Fig. 1 of EPA Method TO-15 prior to mobilization to the field.

Table C.5.2. Site-specific soil vapor trigger levels indicating the need for indoor air sampling

Volatile organic compound	Trigger level (mg/m^3)	Concentration in building (μg/m^3)	Alpha[a]
1,1,1-Trichloroethane	3.01E+02	3.21E+02	1.07E-03
1,1,2,2-Tetrachloroethane	6.67E-01	7.05E-01	1.06E-03
1,1,2-Trichloroethane	1.91E+00	2.04E+00	1.07E-03
1.1.2-Trichloro-1,2,2-trifluoroethane	4.04E+03	4.38E+03	1.08E-03
1,1-Dichloroethane	6.88E+01	7.31E+01	1.06E-03
1,1-Dichloroethene	7.55E-01	8.18E-01	1.08E-03
1,2-Dichloroethane	1.43E+00	1.57E+00	1.10E-03
1,2-Dichloroethene	3.95E+00	4.60E+00	1.16E-03
1,2-Dichloropropane	5.45E-01	5.83E-01	1.07E-03
2-Butanone	6.84E+02	7.31E+02	1.07E-03
2-Hexanone	2.51E+01[b]	2.92E+01[b]	1.16E-03
4-Methyl-2-pentanone	4.06E+02	4.38E+02	1.08E-03
Acetone	4.13E+02	4.60E+02	1.11E-03
Benzene	4.05E+00	4.38E+00	1.08E-03
Bromodichloromethane	2.62E+00	2.38E+00	9.11E-04
Bromoform	1.39E+01	1.02E+01	7.38E-04
Bromomethane	6.89E-01	7.31E-01	1.06E-03
Carbon disulfide	9.31E+01	1.02E+02	1.10E-03
Carbon tetrachloride	3.35E-01	3.58E-01	1.07E-03
Chlorobenzene	2.75E+00	2.92E+00	1.06E-03
Chloroethane	1.38E+03	1.46E+03	1.06E-03
Chloroform	1.62E+00	1.78E+00	1.10E-03
Chloromethane	1.24E+01	1.31E+01	1.06E-03
cis-1,2-Dichloroethene	4.81E+00	5.11E+00	1.06E-03
cis-1,3-Dichloropropene	2.80E+00	2.92E+00	1.04E-03
Dibromochloromethane	1.26E+01	1.02E+01	8.11E-04
Ethylbenzene	3.49E+01	3.72E+01	1.06E-03
Methylene chloride	7.92E+01	8.67E+01	1.09E-03
Styrene	1.38E+02	1.46E+02	1.06E-03
Tetrachloroethene	6.66E+01	7.05E+01	1.06E-03
Toluene	5.39E+01	5.83E+01	1.08E-03
trans-1,2-Dichloroethene	9.67E+01	1.02E+02	1.06E-03
trans-1,3-Dichloropropene	4.91E+00	5.11E+00	1.04E-03
Trichloroethene	5.45E+00	5.83E+00	1.07E-03
Vinyl chloride	4.23E+00	4.65E+00	1.10E-03

[a] Alpha is the infinite source indoor attenuation coefficient and directly correlates the soil vapor concentration with the indoor air concentration.

[b] Toxicity data for 2-Hexanone are unavailable; values represent those associated with n-Hexane–a surrogate chemical approved for use for this purpose by Region 4 of the U. S. Environmental Protection Agency.

mg/m^3 = milligram per cubic meter.

μg/m^3 = microgram per cubic meter.

Three sub-slab soil vapor samples shall be collected during the sampling event at locations shown in Fig. C.5.1. Two alternative locations have also been identified to replace any of the designated locations if sampling is prevented by physical constraints. A penetration permit will be required for installation of the sub-slab sample ports. Floor penetrations shown in Fig. C.5.1 are approximate only and must be field located prior to installation based upon the requirements of the penetration permit.

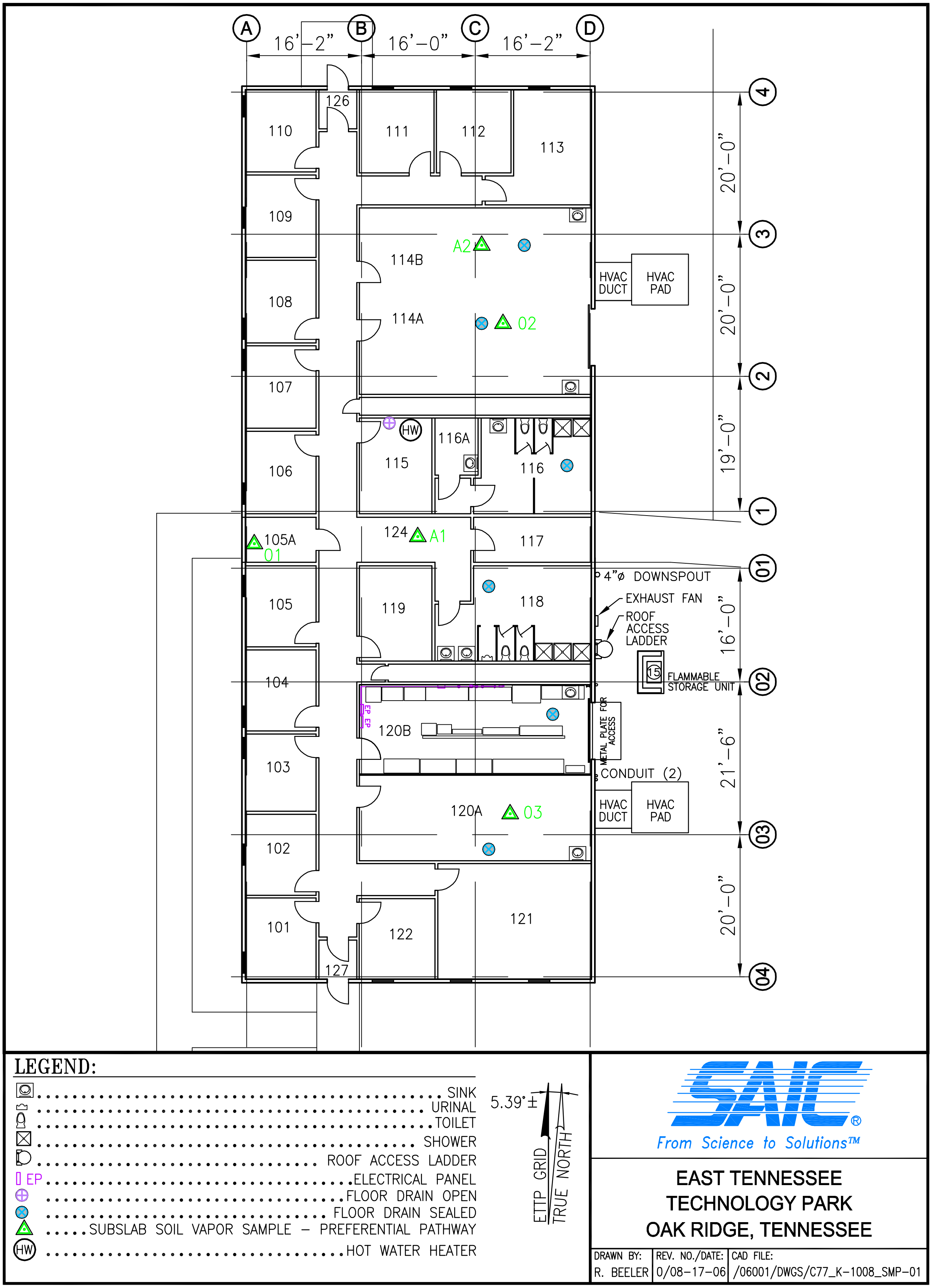

Fig. C.5.1. K-1008-F sub-slab soil vapor sampling locations.

Prior to penetration of the floor slab, the sampling system shall be located at the stations indicated in Fig. C.5.1. Once the sampling system has been set up at the designated locations, the SSC shall record temperature, humidity, and other parameters indicated by Method TO-15. The inlet tubing to the sampling system shall be as short as possible. Samples will be taken by drilling small (~ 7/8-in.-diameter) holes through the slab, taking care not to disturb the materials underlying the slab. During penetration of the floor in the K-1008-F building, care must also be exercised to minimize disturbance of suspect asbestos-containing vinyl floor tile. As previously indicated, this flooring material is believed to also be present underneath the carpeting in most rooms. If a vapor barrier is present beneath the slab, penetration of the barrier will be required. Consistent with EPA guidance, a capped brass or stainless steel tube will be inserted into the penetration. Immediately following insertion of the sampling tube, any annular space between it and the concrete will be sealed using non-VOC-bearing caulk or other appropriate materials. After completion of the penetration, the cap shall be removed from the stainless steel tube to attach the inlet tubing for the sampling system. The inlet line of the sample system shall be attached to the floor penetration tube and the flow valves opened.

Upon collection of the air samples, the SUMMA canisters shall be valved closed. The sampling line shall be disconnected from the canister and the canister removed from the sampling system. Upon collection of the samples, the final pressure shall be checked and recorded. The final system pressure should be ~ 88 KPa (~ 90 to 100 torr vacuum).

Upon collection of the SUMMA canister, it shall be labeled as required by the SSC's standard operating procedures (SOPs). The canisters shall be shipped to the laboratory in a canister shipping case as required by the manufacturer's specifications or the SSC's SOPs.

After the soil vapor sample has been collected, the floor penetration or sampling port shall be temporarily sealed by an appropriate method. The temporary seal shall ensure that the sampling port or penetration is vapor tight and does not present a trip hazard. After completion of all soil vapor sampling, the floor penetration shall be sealed by cutting it level with the floor or removing it and backfilling with a non-shrinking grout. A layer of non-shrinking grout should be applied to the floor, covering the penetration and immediate surrounding area, and it should be finished smooth with the surrounding surface.

Decontamination of sampling equipment used for collection of air samples is not required. All equipment, including the sampling inlet line, used at each sampling station shall be dedicated.

Field quality control (QC) samples are required only for ambient air sampling. The required QC samples are field equipment blanks and a duplicate. All samples shall have the appropriate radiological screening performed to comply with shipping protocols. Sample container, preservation, and holding time requirements are summarized in Table C.5.3.

Table C.5.3. Sample container, preservation, and holding time requirements for K-1008-F soil vapor samples

Event	Sample number[a]	Sample type	Parameters of concern	Analytical protocols	Container type/volume	Preservation	Holding time
			Vapor sub-slab sampling				
01	NS-01-61-1008-V	Soil vapor–grab	Volatile organics[b]	TO-15	5-L SUMMA Canister	None	14 days
01	NS-02-61-1008-V	Soil vapor–grab	Volatile organics[b]	TO-15	5-L SUMMA Canister	None	14 days
01	NS-03-61-1008-V	Soil vapor–grab	Volatile organics[b]	TO-15	5-L SUMMA Canister	None	14 days
01	NS-A1-61-1008-V	Soil vapor–grab	Volatile organics[b]	TO-15	5-L SUMMA Canister	None	14 days
01	NS-A2-61-1008-V	Soil vapor–grab	Volatile organics[b]	TO-15	5-L SUMMA Canister	None	14 days

[a] Sample station nomenclature is NS-AA-BC-DDDD-EE where the AA field is the station number 01-89. Stations A1–A2 are alternate locations to replace any designated stations where samples could not be obtained. Sample station numbers 91 and 92 are dedicated for air field blanks. The BC field designates the fiscal year and sampling event in that year. The DDDD field designates the building number. The EE field designates the sample type where V = soil vapor; I = indoor air; A = outdoor air; B = blank; and D = duplicate.

[b] Volatile organics of concern for air sampling at Bldg. K-1008-F include Tetrachloroethene, Trichloroethene, 1,2-Dichloroethene, Vinyl chloride, Acetone, 2-Butanone, Chloroethane, 1,1-Dichloroethene, 1,1-Dichloroethane, *cis*-1,2,-Dichloroethene, 1,1,1-Trichloroethane, Carbon tetrachloride, Chloroform, Methylene chloride, and Chloromethane.

C.6. ANALYTICAL REQUIREMENTS

Soil vapor samples will be analyzed for VOCs using gas chromatography/mass spectrometry analyses as required by EPA Method TO-15 (EPA 1999). If collected, indoor air samples will also be analyzed in this fashion. Any of the VOCs indicated in Table C.6.1 that are detected shall be reported. Additionally, the laboratory shall report up to twenty tentatively identified compounds. Quantitation of VOCs in air samples shall meet the reporting and detection limits specified in Table C.6.1.

Table C.6.1. VOCs and their respective quantitation and detection limits for soil vapor sampling

Analyte	Analytical method	Air quantitation level (mg/m^3)	Air detection level (mg/m^3)
1,1,1-Trichloroethane	TO-15	3.01E+02	3.01E+01
1,1,2,2-Tetrachloroethane	TO-15	6.67E-01	6.67E-02
1,1,2-Trichloroethane	TO-15	1.91E+00	1.91E-01
1,1,2-Trichloro-1,2,2-trifluoroethane	TO-15	4.04E+03	4.04E+02
1,1-Dichloroethane	TO-15	6.88E+01	6.88E+00
1,1-Dichloroethene	TO-15	7.55E-01	7.55E-02
1,2-Dichloroethane	TO-15	1.43E+00	1.43E-01
1,2-Dichloroethene	TO-15	3.95E+00	3.95E-01
1,2-Dichloropropane	TO-15	5.45E-01	5.45E-02
2-Butanone	TO-15	6.84E+02	6.84E+01
2-Hexanone	TO-15	2.51E+01[a]	2.51E+00[a]
4-Methyl-2-pentanone	TO-15	4.06E+02	4.06E+01
Acetone	TO-15	4.13E+02	4.13E+01
Benzene	TO-15	4.05E+00	4.05E-01
Bromodichloromethane	TO-15	2.62E+00	2.62E-01
Bromoform	TO-15	1.39E+01	1.39E+00
Bromomethane	TO-15	6.89E-01	6.89E-02
Carbon disulfide	TO-15	9.31E+01	9.31E+00
Carbon tetrachloride	TO-15	3.35E-01	3.35E-02
Chlorobenzene	TO-15	2.75E+00	2.75E-01
Chloroethane	TO-15	1.38E+03	1.38E+02
Chloroform	TO-15	1.62E+00	1.62E-01
Chloromethane	TO-15	1.24E+01	1.24E+00
cis-1,2-Dichloroethene	TO-15	4.81E+00	4.81E-01
cis-1,3-Dichloropropene	TO-15	2.80E+00	2.80E-01
Dibromochloromethane	TO-15	1.26E+01	1.26E+00
Ethylbenzene	TO-15	3.49E+01	3.49E+00
Methylene chloride	TO-15	7.92E+01	7.92E+00
Styrene	TO-15	1.38E+02	1.38E+01
Tetrachloroethene	TO-15	6.66E+01	6.66E+00
Toluene	TO-15	5.39E+01	5.39E+00
trans-1,2-Dichloroethene	TO-15	9.67E+01	9.67E+00
trans-1,2-Dichloropropene	TO-15	4.91E+00	4.91E-01
Trichloroethene	TO-15	5.45E+00	5.45E-01
Vinyl chloride	TO-15	4.23E+00	4.23E-01
Xylenes (total)	TO-15	1.38E+01	1.38E+00

[a] Toxicity data for 2-hexanone are unavailable; values represent those associated with N-hexane – a surrogate chemical approved for use for this purpose by U. S. Environmental Protection Agency Region 4.

mg/m^3 = milligram per cubic meter.

VOC = volatile organic compound.

C.7. DATA MANAGEMENT AND REPORTING

Data obtained from this sampling event shall be managed in accordance with the requirements of the *Data Management Implementation Plan for the Reindustrialization Program, Oak Ridge, Tennessee*, BJC/OR-865, Rev. 2 (BJC 2006b). Results will be provided to EPA Region 4 and to the Tennessee Department of Environment and Conservation DOE-Oversight Office.

C.8. REFERENCES

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EPA 2006. "Subject: Proposed Modifications to the Evaluation of the Vapor Intrusion Pathway in Support of Property Transfers at the East Tennessee Technology Park (ETTP), January 6, 2006, Oak Ridge, Tennessee," from Harold W. Taylor, Jr., Chief, KY/TN Federal Oversight Section, Federal Facilities Branch, Waste Management Division, to Susan M. Cange, Team Leader, Reindustrialization and Technical Assistance Team, Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN, March 15, 2006.

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APPENDIX D

RADIOLOGICAL SURVEY PLAN FOR BUILDING K-1008-F TRANSFER FOOTPRINT

D.1 AREA TO BE SURVEYED

The areas to be surveyed include the K-1008-F building and adjacent outside electrical support equipment. The transfer footprint is to be first leased and then, at a later date, the title transferred to the Community Reuse Organization of East Tennessee (CROET). Therefore, this plan will have sections that deal with the requirements for each phase. The K-1008-F transfer footprint is located in the southeast section of the East Tennessee Technology Park (ETTP) in the old Gas Centrifuge Project Area, and located north of the K-1225 Office Building and east of the K-1004-J Complex (K-1004-J, -Q, -R, -S, -T, and -U labs). For a detailed depiction of the footprint, refer to Fig. D.1.

Building K-1008-F is a 6300-ft^2, steel-framed structure with metal siding and roof on a concrete slab foundation (Energy Systems 1991). The building is divided into offices, an industrial hygiene laboratory, restrooms in the center of the building, and a conference room on the north and south end. The building is carpeted except for the entryways, restrooms, pipe chases, electrical closet, telecommunications room, Rooms 114 and 120, and janitor's closet. With the exception of the two pipe chases, these rooms (2495 ft^2) have vinyl floor tile that is suspected of containing asbestos. The tile is in good condition except approximately 13 ft^2 (located in the men's restroom, Room 114, and the south entryway) that is damaged. The two pipe chase floors are unsealed concrete with an open ceiling (no dropped tiles). Each of the offices on an outside wall has a through-the-wall heating/cooling unit. The inter-offices' ventilation is provided by two large heating and ventilating units located outside on the east side of the building. See Fig. D.2 for the floor plan of the K-1008-F building.

D.2 HISTORY OF THE AREA

The current K-1008-F building is located on the site of two previous buildings. In 1944, the T-10 Warehouse was built to support the construction of the Oak Ridge Gaseous Diffusion Plant (ORGDP). In 1947, it was renumbered Bldg. K-1209 and listed as a spare parts warehouse. In 1953, the warehouse was dismantled. In 1958, the K-1045-A Fire Training Tower was constructed on the north end of the concrete pad that remained after Bldg. K-1209 was dismantled. The Fire Training Tower was located immediately under the present K-1008-F transfer footprint. K-1045-A was dismantled in 1977 and moved to a different location. During its operations from 1958 to 1977, the Fire Training Tower was used by the K-25 Fire Department to burn waste oils for training fire responders.

In 1978, Bldg. K-1008-E was built as a change house for personnel working on the Gas Centrifuge Project. In 1980, Bldg. K-1008-F was built immediately south of K-1008-E to expand the change house facilities. In 1989, Bldgs. K-1008-E and K-1008-F were combined and renovated to house two research (luminescent measurement and laser technology) laboratories and various offices. The building was designated K-1008-F. In the late-1990s, the laboratories were closed, and Bldg. K-1008-F was renovated into offices that are presently used by the maintenance department and an industrial hygiene laboratory. The building transfer footprint has no previous lease history.

The history of the building includes the storage of spare equipment parts. Information, however, is not provided as to whether or not only new parts were stored in the building, or if used, potentially radiologically contaminated parts were also stored in the original facility. Additionally, as mentioned above, the history of the building includes the burning of waste oils for fire-training exercises. Building history does not provide information as to the origin of the waste oils, accidental spills, or if the oil received isotopic analysis prior to burning.

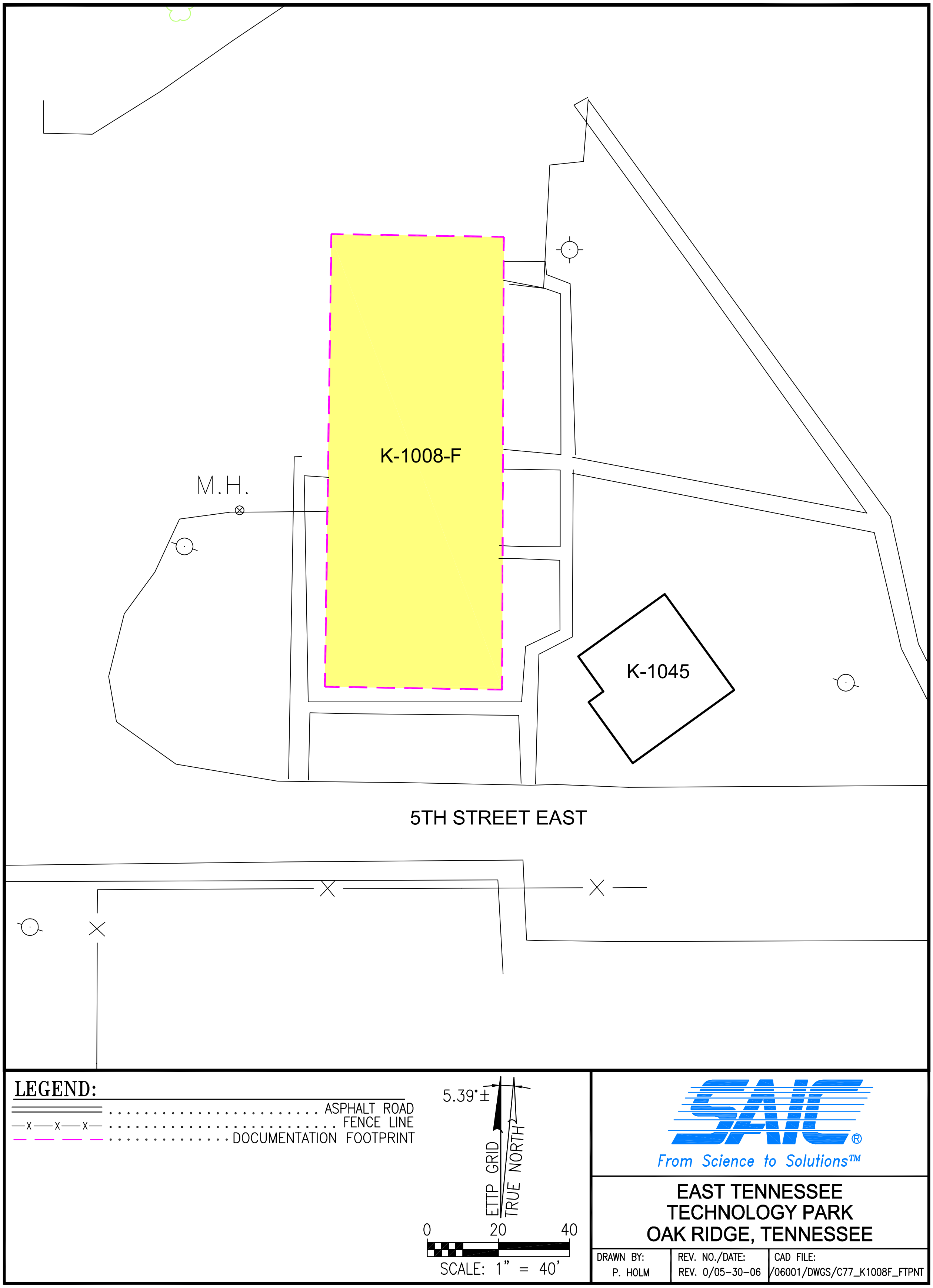

Fig. D.1. K-1008-F building transfer footprint.

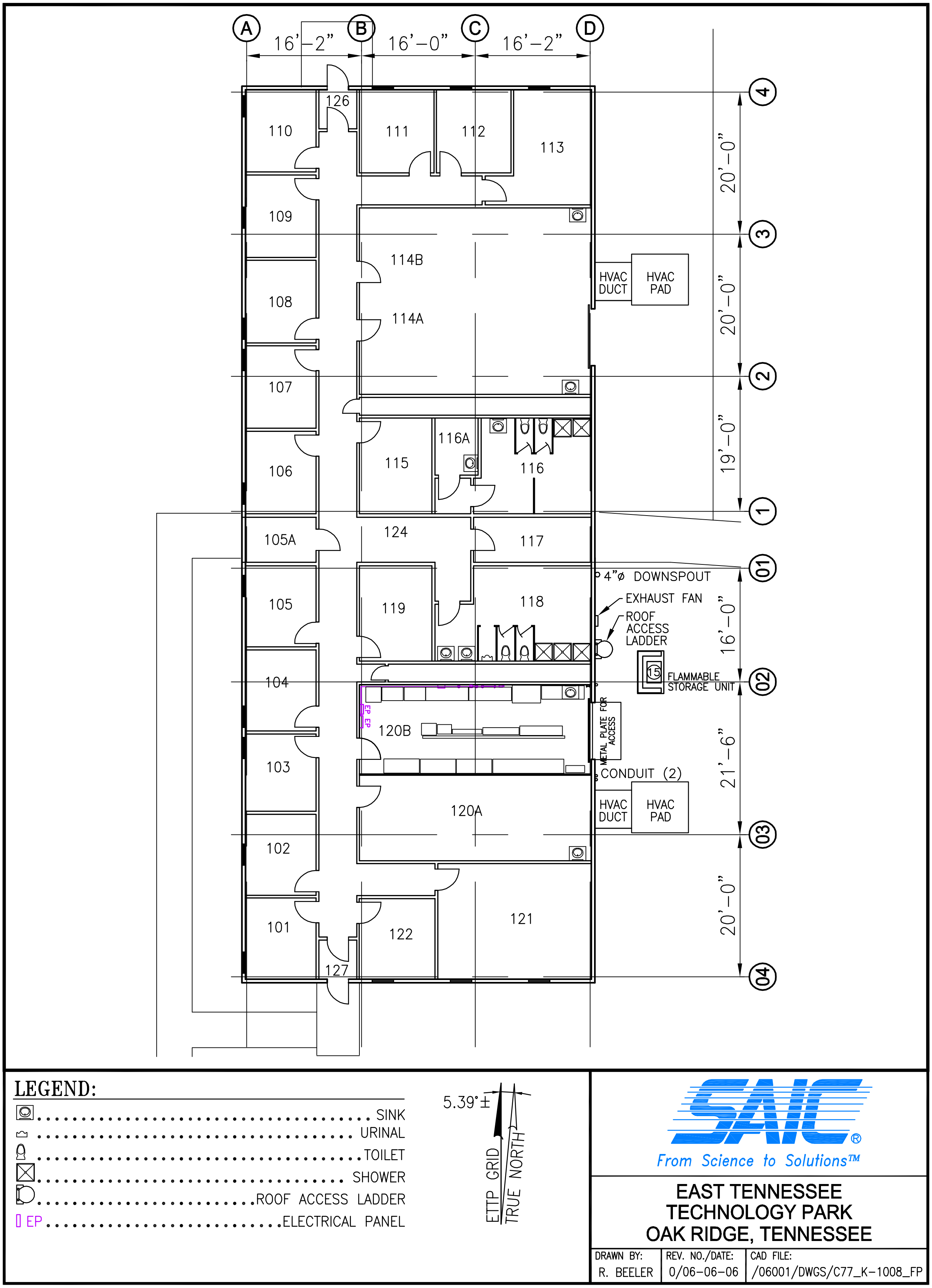

Fig. D.2. K-1008-F floor plan.

D.3 EXISTING SURVEY DATA SUMMARY

A search of the Bechtel Jacobs Company LLC (BJC) Radiation Control (RADCON) electronic survey data collected between 1996 and 2006 showed 11 characterization, 4 pre-job, 2 incident, 1 laboratory soil sample, 1 job-coverage, and 24 equipment-release surveys performed during this time frame associated with the K-1008-F building. The surveys reviewed to develop this survey plan are listed in Table D.1. These areas were surveyed to determine if there were any areas of fixed contamination exceeding 25% of the contamination limits given in Table D.2. Building surveys reviewed indicate contamination levels are comparable to expected background measurements. Equipment release surveys were within release limits with the exception of one survey. In 1999, a legacy compressor blade was found in a grandfathered cabinet in a conference room. The compressor blade had 24,255 disintegrations per minute per square centimeter (dpm/100 cm^2) total beta-gamma activity as documented in survey 19990421KA36176004. A survey was conducted of the cabinet and conference room where the compressor blade was found. Survey results showed no transferable contamination in either the cabinet or the conference room (survey 19900421KA3617003). The compressor blade was removed from the building and dispositioned appropriately. Exposure rate measurements taken during the performance of several characterization surveys were comparable to expected background measurements.

Table D.1. ETTP radiological surveys reviewed

19960729KA36175001	19990421KA36176004	20000605KA36178001
19960313KA36151001	19990421KA36176005	20000606KA36178001
19960402KA36190013	19990422KA36192012	20020604KA36179002
19960403KA36190001	19990729KA36168003	20021011JA1DESK005
19960416KA36183007	19990831KA36154005	200408184PIDESK001
19960416KA36195006	20000525KA36194001	20050113Z9JDESK002
19960822KA36175001	20000120KA36184005	20050720AQEDESK001
19970529KA36161012	20000524KA36178001	20050818AQEDESK001
19970724KA36161012	20000530KA36178001	20050823AQEDESK005
19970911KA36161008	20000531KA36178001	20050915A8EDESK003
19980209KA36166001	20000531KA36178002	20060508AQEDESK001
19980331KA36176001	20000601KA38022001	
19990421KA36176003	20000602KA36178001	

ETTP = East Tennessee Technology Park.

Table D.2. Contamination limits (DCGLs) for all survey units

	DCGL (dpm/100 cm^2)	**$DCGL_{EMC}$ (dpm/area)**
Total alpha	5,000	15,000
Removable alpha	1,000	N/A
Total beta-gamma	5,000	15,000
Removable beta-gamma	1,000	N/A

DCGL = derived concentration guideline level.
$DCGL_{EMC}$ = derived concentration guideline level elevated measurement comparison
dpm = disintegrations per minute.
N/A = not applicable.

D.4 DATA QUALITY OBJECTIVES PURPOSE

The purpose of this survey plan is to obtain radiological survey data to determine the presence of residual contamination in the K-1008-F building through the use of a scoping survey and a final status survey. The data gathered, combined with process knowledge, will be used to either lease the facility or transfer title of the K-1008-F building. The data quality objectives (DQOs) have been detailed in the Design of Radiological Surveys documents (hereafter referred to as the "design documents"[7] with one attached as Appendix A to this document).

D.5 MEASUREMENT TECHNIQUES/SURVEY APPROACH

D.5.1 RADIONUCLIDES OF CONCERN

Process history of the ETTP Site indicates that uranium (natural, depleted, and/or enriched) would be the most prominent radiological contaminant potentially present in the K-1008-F building due to tracking of contamination from other on-site buildings or from past activities when the building was used as a spare parts warehouse for the Gas Centrifuge Project. Uranium-235 enrichment levels expected from operations since the early 1960s would be anticipated to be between 0.2 to 5.5%. Most facilities would be potentially contaminated via tracking from enrichments of less than 3%.[8]

Other radionuclides (^{60}Co, ^{137}Cs, $^{89/90}$Sr, ^{237}Np, ^{99}Tc, and $^{238/239/240}$Pu) have also been detected on-site at ETTP. These other radionuclides originated from the introduction of contaminated materials from the Oak Ridge National Laboratory and/or from the Hanford and Savannah River Reactor Returns Uranium Reprocessing Program. These radionuclides, however, are expected to be found in much lower quantities than uranium and be undetectable in this area, based upon its operational history. If radionuclides were present, it is assumed that they would be present at ratios of 1140:1 for uranium to transuranic (U:TRU) and 350:1 for uranium to technetium-99 (U:^{99}Tc) [both ratios are process buildings weighted averages].[9]

D.5.2 DETERMINATION OF THE RESIDUAL RADIOACTIVITY LIMITS

The overall goal of this survey is to show that residual contamination exceeding the release criteria is not present in any of the survey units (SUs). As shown by modeling, the dose and risk obtained from exposure to radioactivity at the U. S. Department of Energy (DOE) surface contamination limits, as set forth in Title 10 *Code of Federal Regulations* 835[10] and also in DOE Order 5400.5,[11] is less than that from the dose and risk criteria, as explained in the design documents. As a result of this modeling, the derived concentration guideline levels (DCGLs) for this survey will be set at the DOE contamination limits for uranium (see Table D.2), which is the dominant contaminant present on-site. A separate limit for the

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[7] *Design of Radiological Surveys of Potential Lease Space at East Tennessee Technology Park, Oak Ridge, Tennessee,* BJC/OR-554, Bechtel Jacobs Company LLC, Oak Ridge, TN, March 2000, and *Design of Radiological Survey and Sampling to Support Title Transfer or Lease of Property on the Department of Energy Oak Ridge Reservation*, BJC/OR-554-R1, Draft, Bechtel Jacobs Company LLC, Oak Ridge, TN, September 2002.

[8] Contracted Health Physics Technician Training handouts, K-25 Site, 1993.

[9] BJC 1999. *Isotopic Distribution of Contamination Found at the U. S. Department of Energy Gaseous Diffusion Plants*, BJC/OR-407, Bechtel Jacobs Company LLC, Oak Ridge, TN, October 1999.

[10] (*CFR* 1999). 10 *Code of Federal Regulations*, entitled *Occupational Radiation Protection*; the values are taken from Appendix D, "Surface Radioactivity Values."

[11] DOE Order 5400.5 is entitled *Radiation Protection of the Public and the Environment*; the values are taken from Fig. IV-1, "Surface Contamination Guidelines."

maximum allowable contamination that is concentrated in a smaller area, the derived concentration guideline level$_{\text{elevated measurement comparison}}$ ($DCGL_{EMC}$), is normally calculated based upon modeling the dose obtained from an area determined by the number of samples taken in the SU and the spacing between them. However, the $DCGL_{EMC}$ will be set to three times the appropriate contamination limit, which equates to the contamination-averaging criteria as set forth by DOE in 5400.5 for an elevated reading within a 1-m^2 maximum size area.

D5.3 IDENTIFICATION OF SURVEY UNITS AND CLASSIFICATIONS

D.5.3.1 Lease Survey

Areas are classified as either Class 3, 2, or 1 based upon historical data and process knowledge. SUs must be of the same or similar material type. For example, an SU cannot contain both asphalt and soil; it would be divided into an SU of asphalt and another SU of soil. Refer to the design documents for complete descriptions of the different classifications of SUs. An area will be considered to be a Class 3 SU if it is not expected to have residual radioactivity levels above 25% of the DCGL (1250 dpm/100 cm^2 total activity or 250 dpm/100 cm^2 removable activity). A Class 2 SU is expected to have, or has had, residual radioactivity levels less than the DCGL. A Class 1 SU is expected to have, or has had, residual radioactivity levels above the DCGL.

The interior of the building is divided into SUs based on the physical layout of the facility, historical usage of the facility rooms, the type of flooring material, and the natural barriers for traffic. Based upon the existing survey data for the facility, all interior survey units (ISUs) will be initially classified as Class 3 areas. The K-1008-F facility will be composed of a total of two ISUs, as shown in Fig. D.3 and Table D.3. SU 1 contains those areas and rooms that are used as offices and conference rooms with carpet covering the floors. SU 2 is composed of those areas and rooms with tile covering the floors, such as the bathrooms, change rooms, and the laboratory. The pipe chase rooms will not be monitored for the lease survey since they are not expected to be accessed by the lessee.

The survey of equipment and furnishings will be performed along the lines of the survey protocol developed by Safety and Ecology Corporation (SEC) for the release of materials from the K-1001-A, -B, -C, and -D buildings prior to their demolition.[12] Each building ISU (Table D.3) is to be the basis for the furnishings survey unit (FSU). All newer furnishings will be grouped together in batches (SUs) and classified as Class 3 because they have a very low potential for having been used in other facilities or areas that are potentially contaminated. Older furnishings, which could have been used in other buildings or areas, will be grouped into SUs and classified as Class 2. Only furnishings belonging to DOE or that appear to have been DOE property will be surveyed. Any furnishings belonging to lessees will not be surveyed because they are not being released. However, any furnishings that have been previously transferred to lessees as property with the lease from DOE will be surveyed. Abandoned and currently utilized equipment associated with laboratory activities, including fume hoods and wall-mounted process gauges, that has a potential for having been used in other process buildings or areas, will be grouped together in batches (SUs) and classified as Class 2. The K-1008-F facility will be composed of a total of two FSUs, as shown in Table D.3.

[12] *Survey Protocol Unrestricted Release of Building Furnishings*, prepared by Safety and Ecology Corporation for Bechtel Jacobs Company LLC Radiation Control.

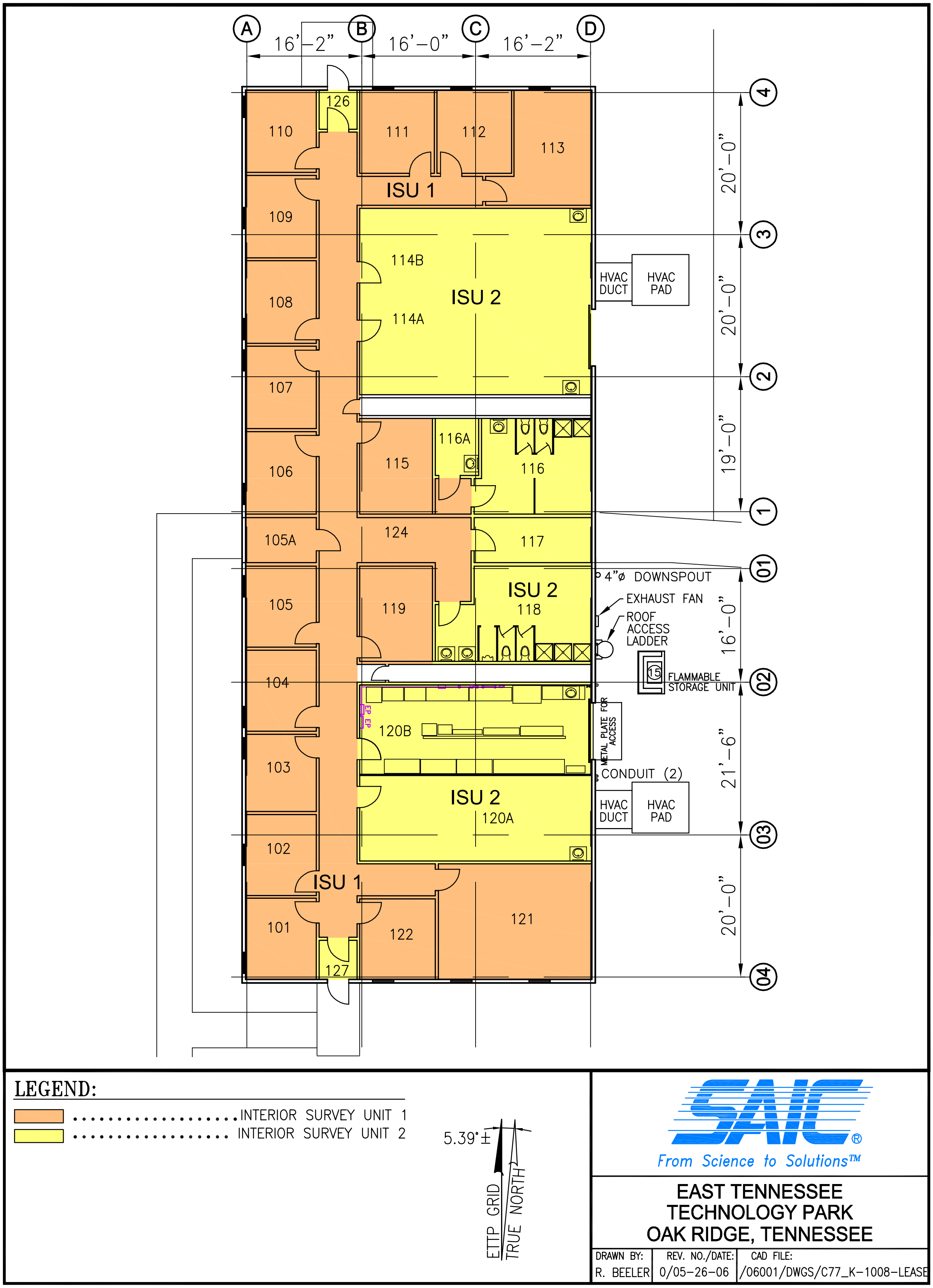

Fig. D.3. K-1008-F first floor plan, interior survey units for lease.

Table D.3. Lease survey unit classifications

Interior survey units	Class
K-1008-F Carpeted Office Areas 101–113, 115, 119,121, 122, 124 and hallway (ISU 1)	Class 3
K-1008-F Tiled Areas, Industrial Hygiene Laboratory, and Airlocks 114 A–B, 116, 116A, 117, 118, 120 A–B, 126, 127 (ISU 2)	Class 3
Furnishings survey units	
K-1008-F Office Areas New Furnishings (FSU 1)	Class 3
K-1008-F Old Furnishings (FSU 2)	Class 2

ISU = interior survey unit.
FSU = furnishings survey unit.

D.5.3.2 Transfer Survey

As discussed in Sect. D.5.3.1, areas are classified as either Class 3, 2, or 1 based upon historical data and process knowledge. As with the requirements of the lease survey, an area will be considered to be a Class 3 SU if it is not expected to have residual radioactivity levels above 25% of the DCGL (1250 dpm/100 cm^2 total activity or 250 dpm/100 cm^2 removable activity). A Class 2 SU is expected to have, or has had, residual radioactivity levels less than the DCGL. A Class 1 SU is expected to have, or has had, residual radioactivity levels above the DCGL. The interior of the building is divided into SUs similar to the SUs discussed in Sect. D.5.3.1. Based upon the existing survey data for the facility, all ISUs will be initially classified as Class 3 areas. For transfer purposes, the K-1008-F facility will be composed of a total of three ISUs, as shown in Fig. D.4 and Table D.4.

The exterior of the K-1008-F building will be divided into three Class 3 exterior survey units (ESUs): one for the exterior walls and drain spouts of the K-1008-F facility (ESU 1); one for the roof (ESU2); and one for the heating, ventilating, and air-conditioning (HVAC) units and ducts, exhaust fans, and through-the-wall heating/cooling units (ESU 3 as shown in Table D.4).

The survey of equipment and furnishings will be performed along the lines of the survey protocol developed by Safety and Ecology Corporation (SEC) as discussed in Sect. D.5.3.1. Each building ISU (Table D.4) is to be the basis for the FSU. All newer furnishings will be grouped together in batches (SUs) and classified as Class 3 because they have a very low potential for having been used in other facilities or areas that are potentially contaminated. Older furnishings, which could have been used in other buildings or areas, will be grouped into SUs and classified as Class 2. Only furnishings belonging to DOE or that appear to have been DOE property will be surveyed. Any furnishings belonging to lessees will not be surveyed because they are not being released. However, any furnishings that have been previously transferred to lessees as property with the lease from DOE will be surveyed. Abandoned and currently utilized equipment associated with laboratory activities, including fume hoods and wall-mounted process gauges, that has a potential for having been used in other process buildings or areas, will be grouped together in batches (SUs) and classified as Class 2. For transfer purposes, the K-1008-F facility will be composed of a total of two FSUs, as shown in Table D.4.

D.5.4 INSTRUMENTATION SELECTION AND SURVEY TECHNIQUES

Refer to the design documents in Appendix A for details on instrumentation selection. In general, for both the lease and transfer surveys, alpha scintillation and beta-gamma Geiger-Müeller (GM) detectors will be attached to scalar rate meters and have minimum detectable activities less than 25% of the DCGL. Gas-proportional floor monitors or floor monitors with the probe detached from the monitor cart for usage as a hand-held probe, calibrated to detect both alpha and beta-gamma radiations, will be used for as much

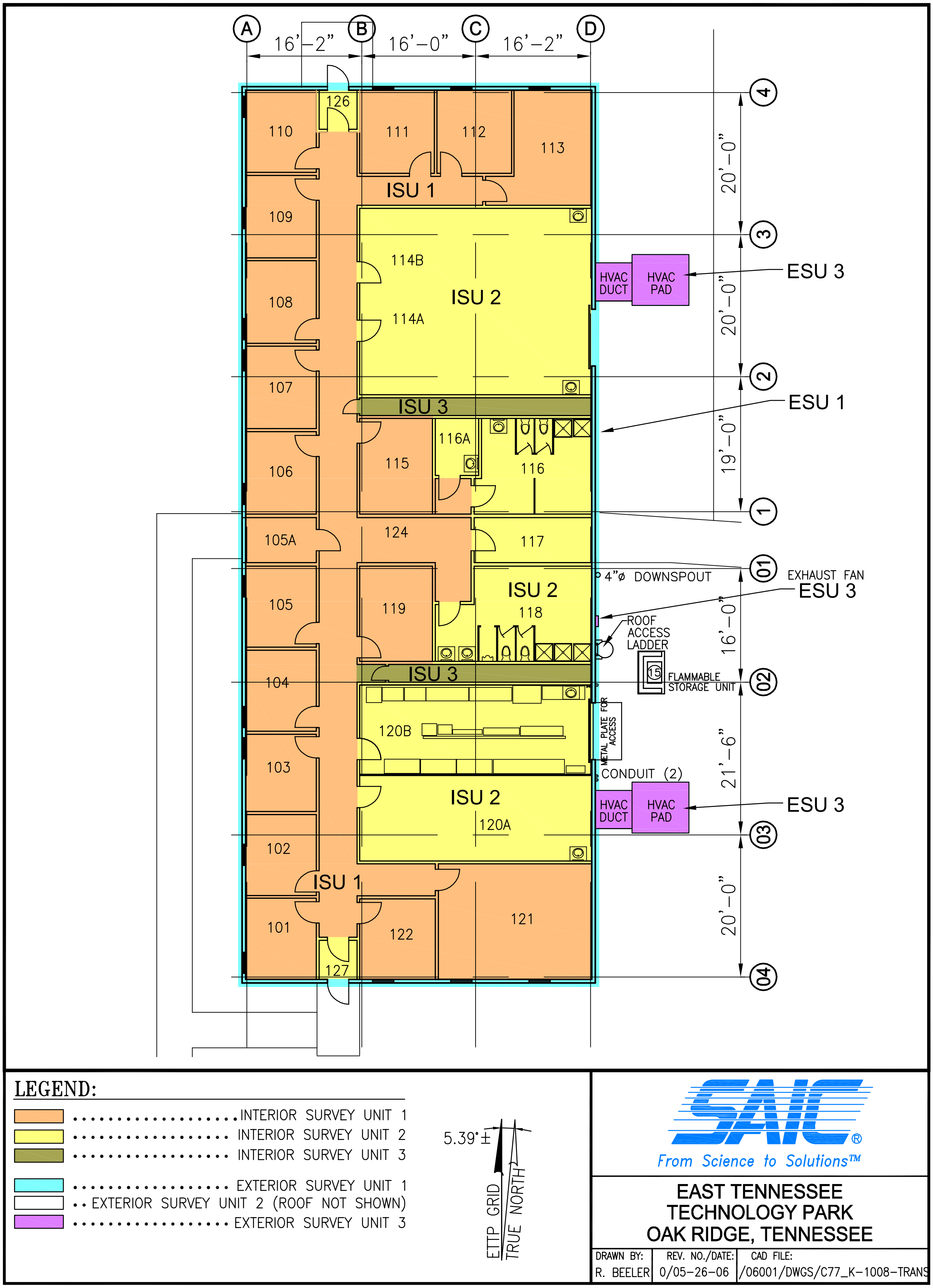

Fig. D.4. K-1008-F first floor plan, interior survey units for transfer.

Table D.4. Transfer survey unit classifications

Interior survey units	Class
K-1008-F Carpeted Office Areas 101–113, 115, 119,121, 122, 124 and hallway (ISU 1)	Class 3
K-1008-F Tiled Areas, Industrial Hygiene Laboratory, and Airlocks 114 A–B, 116, 116A, 117, 118, 120 A–B, 126, 127 (ISU 2)	Class 3
K-1008-F Pipe chases with concrete floors (ISU 3)	Class 3
Exterior survey units	
K-1008-F Exterior walls and drain spouts (ESU 1)	Class 3
K-1008-F Roof (ESU 2)	Class 3
K-1008-F HVAC units and ducts, exhaust fans, through-the-wall heating/cooling units (ESU 3)	Class 3
Furnishings survey units	
K-1008-F Office Areas New Furnishings (FSU 1)	Class 3
K-1008-F Old Furnishings (FSU 2)	Class 2

ISU = interior survey unit.
ESU = exterior survey unit.
FSU = furnishings survey unit.

of the scan surveys as possible, including the primary work surfaces, walls, and ceilings. Sodium iodide (NaI) meters and Bicron MicroRem® meters[13] will also be used, as specified in this survey plan. Removable contamination surveys (i.e., smear surveys) will be conducted at all locations where fixed/total measurements are taken. All removable contamination survey smears will be counted on a gas-proportional counter calibrated to detect both alpha and beta-gamma radiations.

For Class 3 areas, 10% surface scan surveys will be performed over the primary traffic and work surfaces of the entire SU, as accessible. Scanning of walls and ceilings will be based on visual inspection and professional judgment. One hundred percent of the floor area will be scanned in Class 2 SUs. Other surfaces that are classified as Class 2 areas, such as walls, ceilings, overhead areas, etc., will have a scan coverage that varies in accordance with how close the expected activity levels are to the DCGLs. (This is a deviation from the current design documents but is in accordance with the proposed revision that has been submitted for approval.) Although there are currently no Class 1 SUs, if found, Class 1 SUs will have a 100% scan of all surfaces. Emphasis will be placed upon entrances/high-traffic areas, suspect areas, and professional judgment for all scan surveys.

All surveys will be performed in accordance with established BJC RADCON procedures (e.g., scan rate, probe distance, source checks).

All areas will be surveyed in an "as-found" condition. Materials may be rearranged or moved to allow for survey access to areas covered by material and/or equipment.

D.5.5 REFERENCE COORDINATE SYSTEM FOR LEASE AND TRANSFER SURVEYS

Class 3 areas do not require a sample grid. A reference coordinate system will be used in each SU to reference measurements so they can be relocated/verified as needed, unless the measurement is at an easily identifiable location, such as "Room A, 4 ft up on west wall, approximately 2 ft from south wall." The starting point of the reference grid, if needed, will be the southwest corner of each SU, with the

[13] Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof.

distance north being Y and the distance east being X in an X–Y coordinate system [i.e., (X,Y)], with the units in feet.

Class 2 and Class 1 SUs require a sample grid with systematic measurements taken based upon a random starting point. These survey grids are based upon the SU's area and number of systematic sample measurements required in each.

If an SU has to be reclassified to a higher classification and survey requirements, an addendum to this survey plan that contains the sample grids of the reclassified SUs or sections will be issued and included in the survey report and in the Environmental Baseline Survey (EBS) Chap. 6, "Survey Results."

D.6 SURVEY DESIGN

D.6.1 QUANTIFY DATA QUALITY OBJECTIVES

The null hypothesis (H_o) for each SU is that the residual contamination exceeds the DCGL. The alternative hypothesis (H_a) is that the SU meets the DCGL. Decision error levels, as set forth in the design documents, are 0.05 for Type I (α) errors and 0.10 for Type II (β) errors in all SUs. The Lower Bound of the Gray Region (LBGR) is initially set to one-half of the DCGL. These parameters apply to all transfer SUs, regardless of their classification. The design documents discuss the DQO process in greater detail.

D.6.2 DETERMINATION OF THE NUMBER OF DATA POINTS

Using the prescribed statistical testing methodology found in the design documents (Sign test), a Δ/σ value (also known as the "relative shift") greater than 3 is estimated using the historical survey results for all Class 3 areas, where Δ is the DCGL – LBGR, the LBGR is 50% of the DCGL, and σ is the standard deviation of the data. (Note: This is true for survey data but does not apply to sample results from soil). However, the *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*[14] recommends that the relative shift be between 1 and 3. Due to uncertainty in the estimate of the standard deviation, no adjustment of the relative shift is recommended. The Sign test was used because the residual contamination present within the SUs should be at a very small fraction of the DCGL. Using a relative shift of 3 with the DQO parameters listed in Table D.5, 11 survey data points (fixed and removable readings) are needed for all SU, at a minimum, not including any tool, furniture, or equipment surveys.

D.6.3 LEASE SURVEY PROCEDURES

All surveys are to be performed in accordance with this survey plan, the design documents, and BJC RADCON procedures.[15] *Note:* Survey technique is covered in the design documents and will not be repeated in this plan. However, variations or clarifications of the design documents will be included.

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[14] (NRC 1997a). Nuclear Regulatory Commission, NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), Final Edition*, December 1997.

[15] Primarily SH-B-4012, "Radioactive Contamination Control and Monitoring," found in BJC-SH-04, Vol. I, *Radiation Protection Program*.

Table D.5. Comparison of parameters for computing number of samples

Parameter	SEC K-1001-A, -B, -C, and -D furnishings survey plan	Survey design document
Type I error rate (α)	0.05	0.05
Type II error rate (β)	0.05	0.10
Non-parametrical statistical test	Wilcoxon-Rank Sum	Sign[16]
LBGR	2500 dpm/100 cm^2	2500 dpm/100 cm^2
Number of data points per survey unit	20 (10 in each survey unit, 10 in each reference background survey unit)	11

dpm = disintegrations per minute.
LBGR = Lower Bound of the Gray Region.
SEC = Safety and Ecology Corporation.

In any area in which the survey indicates activity exceeding 5000 dpm/100 cm^2, direct alpha and beta-gamma measurements will be made following the establishment of a 1-m^2 grid to obtain data applicable to the DOE Order 5400.5 release criteria. BJC RADCON procedures will be followed for posting of the immediate area. In addition, any contamination survey location found in excess of two times the DCGL will also have a dose-rate measurement taken at a distance of 3 ft.

Any activity in excess of 25% of the DCGL (when averaged over 1 m^2) will require that a Class 3 SU, or sections thereof, be reclassified as Class 2 and surveyed appropriately. Any activity in excess of the DCGL will require that a Class 3 or 2 SU, or sections thereof, be reclassified as Class 1 and surveyed appropriately.

Many of the radionuclides found on the Oak Ridge Reservation (ORR) have natural background concentrations. Therefore, background subtraction will be required for all direct field measurements. Some comparison to background levels will also be required for the scanning because only a gross signal will be measured. Material-specific backgrounds might be necessary for materials such as tile, brick, and cinderblock because these materials contain elevated levels of naturally occurring radionuclides. For example, the background is 1716 dpm/100 cm^2 total beta-gamma above ambient background for a glazed clay tile floor, 1103 dpm/100 cm^2 total beta-gamma above ambient background for a red clay brick, and 142 dpm/100 cm^2 total beta-gamma above ambient background for a concrete block using a GM detector.[17] This level of radioactivity is within that of the naturally occurring radioactive material (NORM) contained in the glazed clay tile/brick matrix and will be subtracted from the net ambient readings for these materials before determining if the result is greater than 25% of the DCGL or the DCGL.

A summary of the requirements for each type of SU is found in Table D.6, and a survey technician summary is found in Table D.7.

D.6.3.1 Interior Survey Units

Any asbestos-controlled areas will be identified with any pertinent information on whether radiological contamination is suspected (e.g., ventilation hood, exhaust vents, posted radiological area) but not entered as part of this survey. Any ventilation exhausts and air intakes in the survey footprint will be surveyed for contamination.

[16] The Wilcoxon-Rank Sum statistical test is for use when the primary contaminants are found in background. The Sign test is to be used when the contaminant is not found in background or when the contaminants are in background, but at a small fraction of the DCGL. The Sign test will be used for this survey.

[17] Values computed based upon the beta-gamma background levels for brick, ceramic tile, and ambient found in Table 5.1 of NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions,* December 1997 (NRC 1997b), and an average beta-gamma Geiger-Müeller correction factor of 32.26 (dpm/100 cm^2)/cpm for a planar radiation source.

Table D.6. Summary of survey unit requirements for lease

Survey unit type	Class 3	Class 2	Class 1
Interior	• Ten percent scan of primary traffic and work spaces. • Use of professional judgment for wall scans. • At least one total and removable reading(s) per office, room, or open space. • Reading locations based on professional judgment and scan survey. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 2 if activity > 25% DCGL. • Upgrading to Class 1 if activity > DCGL.	• One hundred percent scan of floors/primary work areas. • Scan of walls and overhead areas with scan % = % of DCGL. • Five total and removable readings, at a minimum, per each horizontal and vertical surface in each room. • Smears and direct readings to be obtained from locations of the highest contamination as indicated by the scanning surveys. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 1 if activity > DCGL.	• One hundred percent scan of all surfaces. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based upon a grid to be determined, as needed. • Smears and direct readings to also be obtained from locations of the highest contamination with results greater than the DCGL, as indicated by the scanning surveys for each horizontal and vertical surface. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans.
Furnishings	• Ten percent scan of all accessible surfaces. • Maximum total surface area < 5000 m^2. • Removal of item and all other similar items to be placed in a new Class 2 SU if activity > 25% of DCGL.	• Twenty-five percent scan of all accessible surfaces. • Maximum total surface area < 1000 m^2. • Removal of item and all other similar items to be placed in a new Class 1 SU if activity > DCGL.	• One hundred percent scan of all accessible surfaces. • Maximum total surface area < 100 m^2.

DCGL = derived concentration guideline level.
NaI = sodium iodide.
SU = survey unit.

Table D.7. Survey technician summary of survey requirements for lease

Class 3	Class 2	Class 1
• Ten percent scan of interior floor/primary work areas, 10% of exterior accessible surfaces, and 10% of furnishings accessible surfaces. • Professional judgment for wall scans. • At least one total and removable reading(s) per room or open area. • Dose-rate walkover survey in each SU (minimum of one reading/office or open space or 1/20 ft of hallway). • Removal of item and all other similar items to be placed in a new Class 2 SU if furnishings activity > 25% of DCGL. • Notification of supervisor if activity > 25% DCGL.	• One hundred percent scan of interior floor/primary work areas. • Scan of lower walls with scan % = % of DCGL; scan of 10% accessible surfaces of upper walls and overhead areas. • Furnishings scan of 25% of accessible surfaces. • Five (minimum) total and removable readings per vertical and horizontal surface in each room. • Dose-rate walkover survey in each SU (minimum of one reading/office or open space, 1/20 ft of hallway). • Notification of supervisor if activity > DCGL. • Removal of item and all other similar items to be placed in a new Class 1 SU if furnishings activity > DCGL.	• One hundred percent scan of all surfaces. • Eleven (minimum) total and removable readings. • Reading locations based upon a grid to be determined. • Dose-rate walkover survey in each SU (minimum of one reading/office or open space, 1/20 ft of hallway).

DCGL = derived concentration guideline level.
NaI = sodium iodide.
SU = survey unit.

D.6.3.1.1 Class 3 interior survey units

Refer to Table D.3 for the ISUs. Ten percent of the primary traffic areas and work surfaces will be scanned with floor monitors, NaI meters, and hand-held meters (including use of a floor monitor probe set up as a hand-held probe and calibrated to detect alpha and beta-gamma contamination for large-area scans of non-floor surfaces), as appropriate. NaI scans will be performed for areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans (e.g., drains, floor cracks/joints/penetrations, wall/floor interfaces). Any location on the walls or ceiling that, using professional judgment, could potentially have residual radioactivity present will also be scanned over the suspected area and documented on the survey. Tools, office furniture, and equipment will be a separate SU and surveyed per the guidance found in Sect. D.6.3.3. One total and removable contamination measurement, at a minimum, will be recorded in each room, hallway, or open space at locations determined during the scan survey to have the highest activity. Any Class 3 areas that exceed 25% of the DCGL will be reclassified as Class 2 areas and surveyed accordingly. All reclassified areas will be discussed in the survey report and in the EBS Chap. 6, "Survey Results."

A general dose-rate walkover survey of each SU, using a Bicron MicroRem® meter, will be performed to determine if any variations exist in the penetrating radiation dose rate. If variations exist, then the location will be recorded. Dose-rate measurements will be obtained at a minimum of 1 per room and every 20 ft in hallways and large rooms.

D.6.3.1.2 Class 2 interior survey units

There are presently no Class 2 SUs; however, there is the potential for upgrading a Class 3 SU to Class 2 based upon survey results. The Class 2 survey protocols are as follows: 100% of the floor surface will be scan-surveyed using a floor monitor, NaI meter, or hand-held meters, as appropriate, and walls up to 8 ft and overhead areas will be scanned according to Table D.8 and the historical values found in Chap. D.3 of this plan or the values obtained during the Class 3 survey. Five (minimum) total and removable measurements per vertical and horizontal surface in each room will be recorded from locations of the highest contamination as indicated by the scanning surveys. Any Class 2 areas that exceed the DCGL will be reclassified as Class 1 areas and surveyed accordingly. All reclassified areas will be discussed in the addendum to this survey plan that will be issued and included in the survey report and in the EBS Chap. 6, "Survey Results."

Table D.8. Class 2 survey unit scan percentage versus percent of DCGL

% DCGL	Activity (dpm/100 cm^2)	Scan %
<30	<1500	10
<50	<2500	30
<70	<3500	50
>=70	<5000	100

DCGL = derived concentration guideline level.
dpm = disintegrations per minute (activity as observed from historical data).

Although there are currently no Class 1 SUs, the potential exists for having a Class 3 or 2 area upgraded to a Class 1. Class 1 SUs follow the Class 2 survey protocols, with the exception that walls and ceilings will be classified separately and, if Class 1, will have 100% of surfaces scanned.

D.6.3.2 Equipment and Furniture (Furnishings) Surveys

The survey of equipment and furnishings will be performed along the lines of the survey protocol developed by SEC for the release of materials from the K-1001-A, -B, -C, and -D buildings prior to their demolition.[18] The K-1001-A, -B, -C, and -D and design documents requirements that affect the number of survey data points are listed in Table D.4.

As stated in Sect. D.5.3, SUs are classified as either Class 1, 2, or 3 based upon historical data and process knowledge providing information on the contamination potential for the unit. Furnishings (which include all furniture, equipment racks, equipment, tools, etc., for the purposes of this portion of the survey) are considered to have a low potential for residual contamination being present (there have been several tool survey "sweeps" throughout the plant over recent years, which should have captured the vast majority of contaminated tools on-site). All SUs will have alpha and beta-gamma scan surveys performed on them, with the areas covered by the scans determined by professional judgment. In addition, direct and removable alpha and beta-gamma measurements will be taken, with the locations being the areas with the highest readings, as determined during the scan surveys. A detailed listing of all the items within the SU is not required; a generalized item listing of SU classification and number, NaI scan results, and the individual survey data points is the minimum data reporting requirement.

[18] *Survey Protocol Unrestricted Release of Building Furnishings*, prepared by Safety and Ecology Corporation for Bechtel Jacobs Company LLC Radiation Control.

The building ISU (Table D.3) is to be the basis for the FSU. The individual FSUs will be designated in a manner similar to the following example to identify the ISU and the FSU (e.g., ISU 4 FSU C3, which designates that the data are from the ISU 4 FSU Class 3). If removable equipment or furnishings are found in ESUs, they will also make up an FSU identified with the ESU number.

D.6.3.2.1 Furnishings – survey unit survey procedures

Class 3 Furnishings Survey Units

All newer furnishings will be grouped together in batches (SUs) and classified as Class 3, as they have a very low potential for having been used in other facilities or areas that are potentially contaminated. The total surface area of each Class 3 SU will not exceed 5000 m^2. The surface scan surveys will cover 10% of all accessible areas. If residual radioactive activity is found in excess of 25% of the DCGL, the item with the residual activity, and all items of a similar type and history in that SU, will be removed from that SU, reclassified as a separate Class 2 SU, and resurveyed accordingly.

Class 2 Furnishings Survey Units

Older furnishings, which could have been used in other buildings or areas, will be grouped into SUs and classified as Class 2. The total surface area of a Class 2 FSU will not exceed 1000 m^2. The surface scan surveys will cover 10% of all accessible areas. If residual radioactive activity is found in excess of the DCGL, the item with the residual activity, and all items of a similar type and history in that SU, will be removed from that SU, reclassified as a separate Class 1 SU, and resurveyed accordingly.

Class 1 Furnishings Survey Units

Only furnishings that have exceeded the DCGL during the Class 2 survey, above, will be classified and surveyed as a Class 1 SU. The total surface area of a Class 1 FSU will not exceed 100 m^2. The surface scan surveys will cover 100% of all accessible areas.

All furnishings survey data results (in each SU) that meet the above criteria will be evaluated against the Sign test criteria to determine if the items can be released. The null hypothesis (H_o) to be tested is that the residual radioactivity in the SU exceeds the DCGL. If the null hypothesis is rejected based upon the non-parametrical statistical test, then the alternative hypothesis (H_a) is accepted, which states that the residual radioactivity in the SU does not exceed the DCGL and, therefore, can be released.

D.6.4 TRANSFER SURVEY PROCEDURES

All surveys are to be performed in accordance with this survey plan, the design documents, and BJC RADCON procedures as discussed in Sect. D.6.3.

In any area in which the survey indicates activity exceeding 5000 dpm/100 cm^2, direct alpha and beta-gamma measurements will be made following the establishment of a 1-m^2 grid to obtain data applicable to the DOE Order 5400.5 release criteria. BJC RADCON procedures will be followed for posting of the immediate area. In addition, any contamination survey location found in excess of two times the DCGL will also have a dose-rate measurement taken at a distance of 3 ft.

Any activity in excess of 25% of the DCGL (when averaged over 1 m^2) will require that a Class 3 SU, or sections thereof, be reclassified as Class 2 and surveyed appropriately. Any activity in excess of the DCGL will require that a Class 3 or 2 SU, or sections thereof, be reclassified as Class 1 and surveyed appropriately.

As discussed in Sect. D.5.3, background subtraction will be required for all direct field measurements. Some comparison to background levels will also be required for the scanning because only a gross signal will be measured. Material-specific backgrounds might be necessary for some materials such as tile, due to the material containing elevated levels of naturally occurring radionuclides. Where the level of radioactivity is within that of the NORM contained in the tile matrix, background will be subtracted from the net ambient readings for these materials before determining if the result is greater than 25% of the DCGL or the DCGL.

A summary of the requirements for each type of SU is found in Table D.9, and a survey technician summary is found in Table D.10.

D.6.4.1 Interior Survey Units

Any asbestos-controlled areas will be identified with any pertinent information on whether radiological contamination is suspected (e.g., ventilation hood, exhaust vents, posted radiological area) but not entered as part of this survey. Any ventilation exhausts and air intakes in the survey footprint will be surveyed for contamination.

D.6.4.1.1 Class 3 interior survey units

Refer to Table D.4 for the ISUs. A minimum of 10% of the primary traffic areas and work surfaces will be scanned with floor monitors, NaI meters, and hand-held meters (including use of a floor monitor probe set up as a hand-held probe and calibrated to detect alpha and beta-gamma contamination for large-area scans of non-floor surfaces), as appropriate. NaI scans will be performed for areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans (e.g., drains, floor cracks/joints/penetrations, wall/floor interfaces). Any location on the walls or ceiling that, using professional judgment, could potentially have residual radioactivity present will also be scanned over the suspected area and documented on the survey. Tools, office furniture, and equipment will be a separate SU and surveyed per the guidance found in Sect. D.6.4.3. Eleven measurements of total and removable contamination, at a minimum, will be recorded within each SU at locations determined during the scan survey to have the highest activity. However, at least one reading will be made in each room. Any Class 3 areas that exceed 25% of the DCGL will be reclassified as Class 2 areas and surveyed accordingly. All reclassified areas will be discussed in the survey report and in the EBS Chap. 6, “Survey Results.”

A general dose-rate walkover survey of each SU, using a Bicron MicroRem® meter, will be performed to determine if any variations exist in the penetrating radiation dose rate. If variations exist, then the location will be recorded. Dose-rate measurements will be recorded at a minimum of 1 per room and every 20 ft in hallways and large rooms.

D.6.4.1.2 Class 2 interior survey units

There are presently no Class 2 SUs; however, there is the potential for upgrading a Class 3 SU to Class 2 based upon survey results. The Class 2 survey protocols are as follows: 100% of the floor surface will be scan-surveyed using a floor monitor, NaI meter, or hand-held meters, as appropriate, and walls up to 8 ft and overhead areas will be scanned according to Table D.8 and the historical values found in Chap. D.3 of this plan or the values obtained during the Class 3 survey. The static measurement locations will be systematically chosen per the survey grid for the floor only. In addition, smears and direct readings will be obtained from locations of the highest contamination with results greater than 25% of the

Table D.9. Summary of survey unit requirements for transfer

Survey unit type	Class 3	Class 2	Class 1
Interior	• Ten percent scan of primary traffic and work spaces. • Use of professional judgment for wall scans. • Eleven total and removable readings, at a minimum, per SU and at least one per office, room, or open space. • Reading locations based on professional judgment and scan survey. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 2 if activity > 25% DCGL. • Upgrading to Class 1 if activity > DCGL.	• One hundred percent scan of floors/primary work areas. • Scan of walls and overhead areas with scan % = % of DCGL. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based upon a grid to be determined, as needed. • Smears and direct readings to also be obtained from locations of the highest contamination with results greater than 25% of the DCGL, as indicated by the scanning surveys for each horizontal and vertical surface. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 1 if activity > DCGL.	• One hundred percent scan of all surfaces. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based upon a grid to be determined, as needed. • Smears and direct readings to also be obtained from locations of the highest contamination with results greater than the DCGL, as indicated by the scanning surveys for each horizontal and vertical surface. • Dose-rate walkover survey in each SU. • Minimum of one dose-rate reading per office or open space. • One dose-rate reading per every 20 ft of hallway. • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans.
Exterior	• Ten percent scan of accessible surfaces. • Scan of walls up to at least 8 ft. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based on professional judgment and scan survey; at least one timed measurement on each piece of exterior equipment and on each facing and roof for buildings. • Dose-rate reading for each static measurement location. • NaI scan of areas such as area directly under drain spouts that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 2 if activity > 25% DCGL. • Upgrading to Class 1 if activity > DCGL.	• Scan of surfaces with scan % = % of DCGL. • Scan of walls up to at least 8 ft. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based upon a grid. • Dose-rate walkover survey in/on each SU. • One dose-rate reading per every 20 ft. • NaI scan of areas such as area directly under drain spouts that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans. • Upgrading to Class 1 if activity > DCGL.	• One hundred percent scan of all surfaces. • Scan of walls up to at least 8 ft. • Eleven total and removable readings, at a minimum, per SU. • Reading locations based upon a grid to be determined, as needed. • Dose-rate walkover survey in/on each SU. • One dose-rate reading per every 20 ft. • NaI scan of areas such as area directly under drain spouts that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans.

Table D.9. Summary of survey unit requirements for transfer (continued)

Survey unit type	Class 3	Class 2	Class 1
Furnishings	• Ten percent scan of all accessible surfaces. • Maximum total surface area < 5000 m^2. • Removal of item and all other similar items to be placed in a new Class 2 SU if activity > 25% of DCGL.	• Twenty-five percent scan of all accessible surfaces. • Maximum total surface area < 1000 m^2. • Removal of item and all other similar items to be placed in a new Class 1 SU if activity > DCGL.	• One hundred percent scan of all accessible surfaces. • Maximum total surface area < 100 m^2.

DCGL = derived concentration guideline level.
NaI = sodium iodide.
SU = survey unit.

Table D.10. Survey technician summary of survey requirements for transfer

Class 3	Class 2	Class 1
• Ten percent scan of interior floor/primary work areas, 10% of exterior accessible surfaces, and 10% of furnishings accessible surfaces. • Professional judgment for wall scans. • Scan of exterior walls up to at least 8 ft. • Eleven (minimum) total and removable readings and at least one per room or open area.	• One hundred percent scan of interior floor/primary work areas. • Scan of lower walls with scan % = % of DCGL; scan of 10% accessible surfaces of upper walls and overhead areas. • Furnishings scan of 25% of accessible surfaces. • Scan of exterior walls up to at least 8 ft. • Eleven (minimum) total and removable readings.	• One hundred percent scan of all surfaces. • Scan of exterior walls up to at least 8 ft. • Eleven (minimum) total and removable readings. • Reading locations based upon a grid to be determined. • Dose-rate walkover survey in each SU (minimum of one reading/office or open space, 1/20 ft of hallway or exterior).
• Dose-rate walkover survey in each SU (minimum of one reading/office or open space, 1/20 ft of hallway or exterior). • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans based on professional judgment. • Removal of item and all other similar items to be placed in a new Class 2 SU if furnishings activity > 25% of DCGL. • Notification of supervisor if activity > 25% DCGL.	• Reading locations based upon a grid. • Dose-rate walkover survey in each SU (minimum of one reading/office or open space, 1/20 ft of hallway or exterior). • NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans with coverage equal to % of DCGL. • Notification of supervisor if activity > DCGL. • Removal of item and all other similar items to be placed in a new Class 1 SU if furnishings activity > DCGL.	• NaI scan of areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans based on professional judgment.

DCGL = derived concentration guideline level.
NaI = sodium iodide.
SU = survey unit.

DCGL, as indicated by the scanning surveys for each horizontal and vertical surface. Any Class 2 areas that exceed the DCGL will be reclassified as Class 1 areas and surveyed accordingly. All reclassified areas will be discussed in the addendum to this survey plan that will be issued and included in the survey report and in the EBS Chap. 6, "Survey Results."

D.6.4.1.3 Class 1 interior survey units

Although there are currently no Class 1 SUs, the potential exists for having a Class 3 or 2 area upgraded to a Class 1. Class 1 SUs follow the Class 2 survey protocols, with the exception that walls and ceilings will be classified separately and, if Class 1, will have 100% of surfaces scanned.

D.6.4.2 Exterior Survey Units

All exterior areas will be surveyed with hand-held meters or with a gas-proportional probe and with an NaI meter up to a minimum height of 8 ft. Exterior areas, other than the building exterior walls and roof, that are covered under this survey plan include the drain spouts, HVAC units and ducts, and exhaust vents. Emphasis is to be placed upon air vents/intakes, windowsills, gutter downspouts, valve handles, and wherever professional judgment would indicate a higher probability of finding elevated readings.

D.6.4.2.1 Class 3 exterior survey units

Class 3 exterior surveys will have 10% of the surfaces scanned with hand-held meters or with gas-proportional probes, as appropriate, For exterior areas that have a potential for holding activity that would be difficult to detect by alpha and beta-gamma scans (e.g., drain spouts, wall/floor interfaces), a scan will be performed using an NaI meter. Eleven measurements of total and removable contamination, at a minimum, will be recorded within each SU at locations determined during the scan survey to have the highest activity. At least one timed measurement will be made on each piece of exterior equipment and on each facing and roof of the building. Any Class 3 or 2 areas that exceed the DCGL will be reclassified as Class 1 areas and surveyed accordingly. All reclassified areas will be discussed in an addendum to this survey plan that will be issued and included in the survey report and in the EBS Chap. 6, "Survey Results."

D.6.4.2.2 Class 2 exterior survey units

There are presently no Class 2 SUs; however, there is the potential for upgrading a Class 3 SU to Class 2 based upon survey results. The Class 2 survey protocols are as follows: floors/ground, roof, and walls, up to 8 ft, will be scan-surveyed using hand-held meters and/or gas-proportional meters (if possible) and with an NaI meter according to the percentages listed in Table D.8 and the historical values found in Chap. D.3 of this plan or the values obtained during the Class 3 survey. The survey measurement locations will be systematically chosen per survey grid. In addition, smears and direct readings will be obtained from locations of the highest contamination with results greater than 25% of the DCGL, as indicated by the scanning surveys for each horizontal and vertical surface. Any Class 3 or 2 areas that exceed the DCGL will be reclassified as Class 1 areas and surveyed accordingly. All reclassified areas will be discussed in an addendum to this survey plan that will be issued and included in the survey report and in the EBS Chap. 6, "Survey Results."

D.6.4.2.3 Class 1 exterior survey units

Although there are currently no Class 1 exterior areas, the potential exists for having a Class 3 or 2 area upgraded to a Class 1. Class 1 SUs follow the Class 2 survey protocols, with the exception that 100% of the surfaces will be scanned.

D.6.4.3 Equipment and Furniture (Furnishings) Surveys

Equipment surveys will be performed in the same manner as for lease as described in Sect. D.6.3.3.

D.6.5 SPECIFICATION OF SAMPLING LOCATIONS

All recorded survey measurement locations are to be on a random basis for Class 3 internal and external SUs. For Class 3 ISUs and ESUs, the random points will be chosen on a judgmental basis and should include entrances, primary traffic areas, air vents, and primary workspaces; these are the areas that would be expected to have the highest probability of having elevated readings. Survey locations for Class 2 or 1 ISUs and ESUs will be based on a survey grid plus measurements from the highest point of each surface determined from the scan. If needed, further survey locations for Class 2 or 1 will be based on systematic points on the survey grid plus measurements from the highest point of each surface determined from the scan.

D.7 DOCUMENTATION

Survey data will be documented in accordance with the procedures and reviews required by the DOE contractor. A report will be prepared describing the survey methods, results, and evaluation. The report will include the findings of the assessment, describe the materials surveyed and their condition, and justify the contamination potential classification assigned. The data evaluation will be included, along with the assessment of the quality assurance (QA)/quality control (QC) documentation. This report, or a summary of the report, will also be included and referenced in the facility's baseline environmental conditions documentation. It should be noted that the transfer of K-1008-F cannot occur without the concurrence of both U. S. Environmental Protection Agency Region 4 and the Tennessee Department of Environment and Conservation.

D.8 QUALITY ASSURANCE

All appropriate QA/QC reviews to ensure the quality of the data gathered will be performed and documented.

Survey instruments and methods specified in applicable RADCON operating and technical procedures have been documented as to their ability to provide a 95% confidence level in detection of surface contamination at levels that meet the requirements of this protocol. Supporting data are provided on each survey form.

RADCON technicians not involved in the execution of this protocol will repeat approximately 5% of the direct and removable activity measurements on items destined for unrestricted release for verification. The results must confirm the initial findings for acceptance as satisfying release criteria.

A DOE contractor, RADCON-certified health physicist, or another designated health physicist, will review, evaluate, and validate the survey results, including assessment of the QA/QC information and data, prior to generation of the radiological survey report. The final radiological survey report will include the details of this assessment. It will be provided to the DOE contractor project QA manager, project manager, and site project health physicist for approval prior to its inclusion into the EBS.

APPENDIX E

RISK EVALUATION FOR BUILDING K-1008-F TRANSFER FOOTPRINT

CONTENTS

FIGURES

TABLES

ACRONYMS

bgs	below ground surface
COPC	contaminant of potential concern
DOE	U. S. Department of Energy
EBS	Environmental Baseline Survey
EPA	U. S. Environmental Protection Agency
ESU	exterior survey unit
ETTP	East Tennessee Technology Park
HI	hazard index
HQ	hazard quotient
ISU	interior survey unit
PCB	polychlorinated biphenyl
pCi/g	picocuries per gram
PRG	preliminary remediation goal
RAGS	*Risk Assessment Guidance for Superfund*
RL	remedial level
ROD	Record of Decision
SU	survey unit
TL	trigger level

EXECUTIVE SUMMARY

The goal of this risk evaluation is to determine the potential for adverse health effects associated with Bldg. K-1008-F located in the southeastern portion of the East Tennessee Technology Park (ETTP), and determine if conditions preclude the use of the facility for its intended future use as a small office facility. The U. S. Department of Energy (DOE) is proposing to transfer title of this building to the Heritage Center LLC, a subsidiary of the Community Reuse Organization of East Tennessee (CROET). For Bldg. K-1008-F, the representative exposure scenario considered for the risk screen was the industrial worker. The industrial worker scenario is defined by an individual who spends time doing light industrial activities or office work within a hypothetical building. The industrial worker scenario also assumes that soils are accessible to the receptors. The evaluation focuses on potential exposures within the study area, which is defined as the K-1008-F building, soils within the transfer footprint, as well as soils adjacent to the transfer footprint. The adjacent area was included in the evaluation to address exposures to individuals who may access areas adjacent to the transfer footprint.

The methodology followed in performing this risk evaluation included screening the site data against nationally available preliminary remediation goals (PRGs), as well as remediation levels (RLs) developed for the ETTP Zone 2 soils Record of Decision (ROD), to provide screening-level risk estimates and determine the need for a full risk calculation. The full risk calculation is conducted only when the screening-level risk estimates of constituents exceeding PRGs indicate the potential for elevated risks [cumulative screening-level risks exceeding E-04 or a hazard index (HI) above 1], or where no nationally recognized PRGs are available for the exposure scenario being considered.

The U. S. Environmental Protection Agency has established a generally acceptable target risk range of E-04 to E-06 (also expressed as 10^{-4} to 10^{-6}) and a generally acceptable HI of 1. The risk estimate is a value that represents the excess cancer incidence that might be expected due to the exposure scenario evaluated. The HI is a value that represents the potential for toxic effects to an exposed individual. The risk calculation for the building resulted in risks below 2E-09 and doses below 0.007 mrem/year. The screening-level risk estimate for the Bldg. K-1008-F study area soils indicated the cumulative risks were below 1E-06 and the HI was below 1. Because the risks for the building surfaces and soils did not exceed the generally acceptable upper risk level of E-04 or HI of 1, the risk evaluation was considered indicative of the low likelihood of adverse health effects associated with industrial worker exposure to the Bldg. K-1008-F study area. The facility, therefore, is considered suitable for transfer.

Additionally, the potential for soil vapor intrusion into the interior of a building was evaluated. Based on soil vapor sampling events conducted in September 2006 and February 2007, sub-slab soil vapor sampling results showed that the vapor intrusion pathway is not complete beneath K-1008-F, and, thus, there is no adverse impact to human health from soil vapor.

E.1. INTRODUCTION AND RISK EVALUATION METHODOLOGY

E.1.1 INTRODUCTION

The goal of this risk evaluation is to determine the potential for adverse health effects associated with Bldg. K-1008-F, which is proposed for transfer by the U. S. Department of Energy (DOE). Specifically, the objectives of this evaluation are (1) to determine exposure to constituents based on available data associated with the study area, and (2) to use these data to provide an estimate of the potential for adverse effects to human health. The evaluation focuses on potential exposures within the study area, which is defined as the K-1008-F building, soils within the transfer footprint, as well as soils adjacent to the transfer footprint. The risk calculations utilized in this evaluation are based on the document *Risk Assessment Guidance for Superfund* (RAGS) [EPA 1989]. The following sections describe the process used to provide a quantitative analysis of the risks to human health from exposure to the Bldg. K-1008-F study area.

E.1.2 RISK EVALUATION METHODOLOGY

The risk evaluation methodology utilizes a step-wise process in order to more efficiently determine if the property under consideration is suitable (from a health perspective) for transfer. As detailed below, the site data are screened against trigger levels first to determine if further examination of the data is necessary. By virtue of the decision needed to be made when examining the data (i.e., health protection), the screening process is conservative.

The risk evaluation method to support the title transfer of Bldg. K-1008-F includes analysis of both the surrounding soils and the building. In the case of the soils, a process agreed to by both DOE and the regulators [i.e., U. S. Environmental Protection Agency (EPA) and Tennessee Department of Environment and Conservation (TDEC)] is utilized in order to be consistent with other programs (e.g., Environmental Management). Soil sampling results are compared with Preliminary Remediation Goals (PRGs) or site-specific remediation levels (RLs). PRGs are health-protective concentrations that have been developed by EPA Region 9 as a set of national standards. RLs are health-protective concentrations that have been established in the site Records of Decision (RODs).

PRGs are developed based on a specific exposure scenario (i.e. industrial worker) and exposure pathways (soil ingestion, inhalation, and/or dermal contact) for a given level of risk and hazard [i.e., risk of 1E-05 and hazard quotient (HQ) of 1]. The risk represents the estimated number of increased cancer incidences for the exposed population (i.e., risk of 1E-05 means a 1-in-100,000 increased incidence). The HQ is a measure of the potential for toxic effects from an individual contaminant, and the sum of HQs for multiple constituents is referred to as the Hazard Index (HI). An HI that exceeds 1 indicates the possibility that toxic effects may occur in the exposed population. The RLs use site-specific data to develop health-protective concentrations for contaminants that are site-related and considered widespread. Because site-specific data are used to develop RLs, they are higher in concentration than the PRGs.

As indicated above, the evaluation of risk and hazards associated with soil is based on comparing soil sample results with PRGs or RLs. If there are constituents with concentrations in excess of the PRGs or RLs, further evaluation is conducted. To ensure risks are below 1E-04 and an HI is below 1 for the facility, as a back-check, the media concentrations are divided by the PRG to calculate a risk and hazard estimate. If the estimate indicates the potential for elevated risks and/or hazards, a full risk calculation is conducted. The full risk calculation is based on an exposure assessment and identified exposure parameters (e.g., soil ingestion rate, exposure frequency, body weight, etc.) for the anticipated receptors. The results of the full risk calculation are then compared to the acceptable risk and hazard levels to determine the potential for adverse health effects associated with soils in order to determine if the property is suitable for transfer.

For building surfaces, no PRGs are available. Therefore, a full risk calculation is performed for all buildings. The full risk calculation includes a determination of the concentration of contaminants at the point of exposure (a.k.a. an exposure point concentration), an exposure assessment to determine potentially exposed individuals and their respective exposure parameters, and estimation of risks and hazards based on available toxicity information. As with the screening risk estimate generated for soils, the results of the full risk calculation for the building are compared with the acceptable risk and hazard levels to determine the potential for adverse health effects associated with the building surfaces.

E.2. DESCRIPTION AND HISTORY

A full description and history of Bldg. K-1008-F, as well as site maps, is presented in Chaps. 1 through 5 of the Environmental Baseline Survey (EBS) Report for the Bldg. K-1008-F transfer footprint. Figure E.2.1 shows the location of the Bldg. K-1008-F transfer footprint within the ETTP.

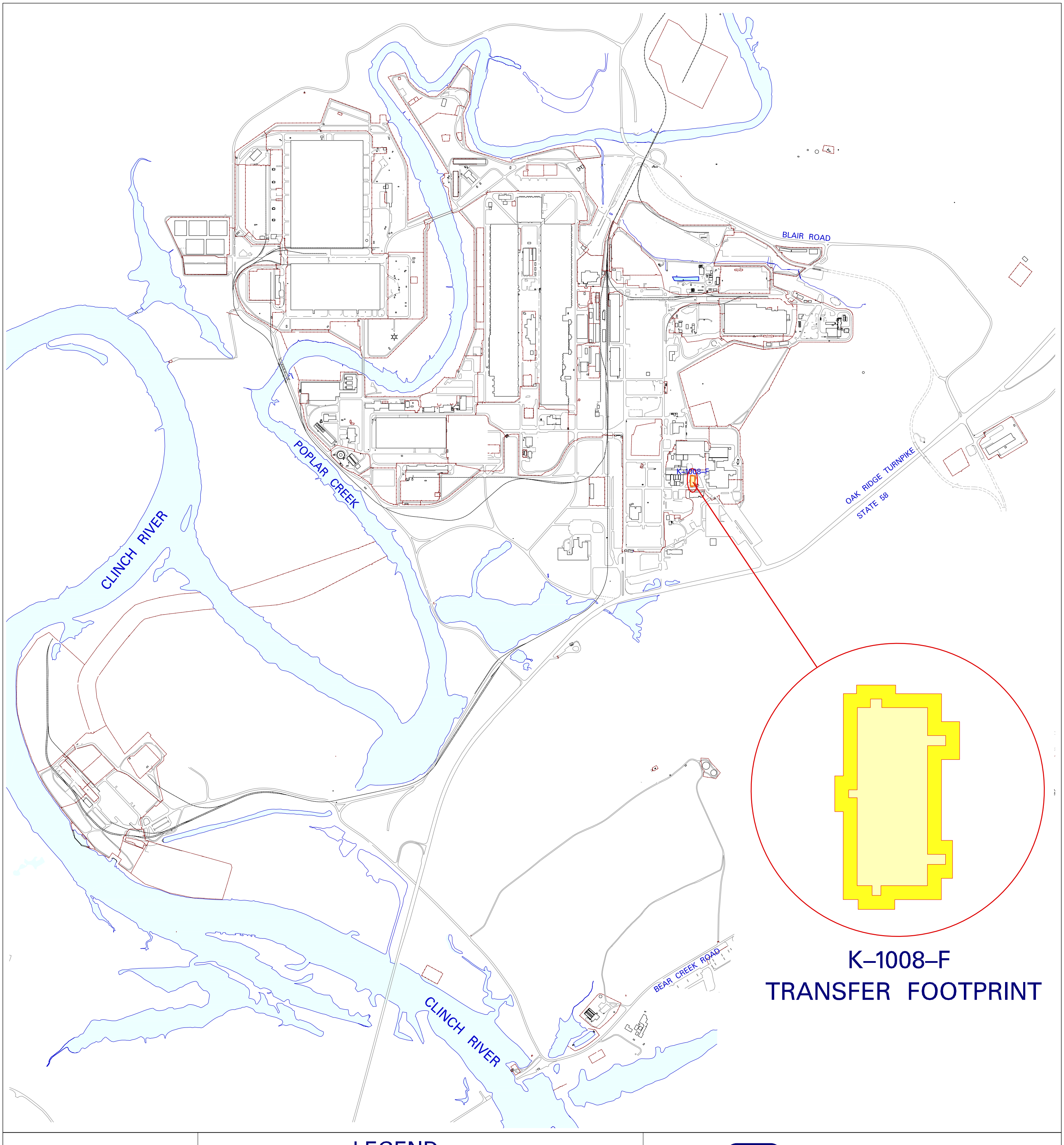

Fig. E.2.1. Location map of Building K-1008-F transfer footprint.

TETRA TECH, INC.
OAK RIDGE, TENNESSEE
6/23/08 1203 28 MAP 1 VP 01 R2.DGN

East Tennessee Technology Park

ETTP REINDUSTRIALIZATION
K–1008–F TRANSFER FOOTPRINT

E.3. AVAILABLE DATA

The available data for the Bldg. K-1008-F study area consist of sampling results from nine locations (see Fig. E.3.1). Soil [taken from 0 to 2 ft below ground surface (bgs)] from the nine locations within the study area was composited into three samples. The samples were analyzed for metals, organics, and radionuclides. The data were included because there are no barriers limiting exposure to these soils, which are covered by maintained grass.

Data collected during surveys of the building interior, furnishings and exterior were used to evaluate the K-1008-F building surfaces (see Sect. E.6.1).

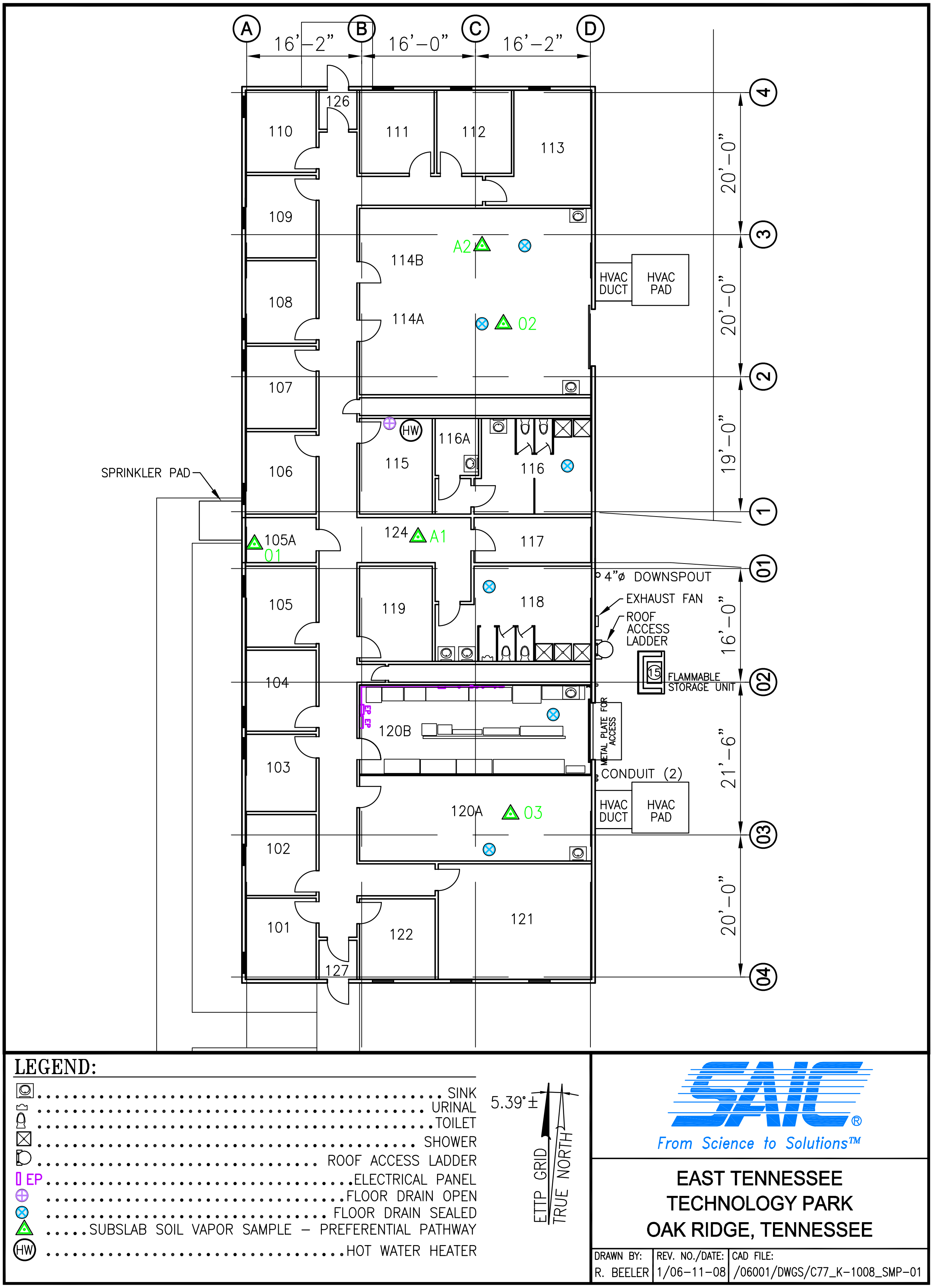

Fig. E.3.1. Building K-1008-F soil sampling locations.

E.4. EXPOSURE ASSESSMENT

An exposure assessment combines information about site characteristics and site-related data with exposure assumptions in order to quantify the intake of contaminants by a hypothetically exposed individual. The estimated exposure is based on the following:

- characterizing the exposure scenario based on site surveys and anticipated future property use,

- identifying complete exposure pathways based on assumed receptor activities and site-specific information, and

- quantifying receptor exposure based on exposure assumptions and chemical-specific data.

The steps in the exposure assessment are discussed in detail in the following sections.

E.4.1 EXPOSURE SCENARIO EVALUATION

Exposure scenarios are selected based on site surveys and anticipated uses of Bldg. K-1008-F. The ETTP area is being evaluated for industrial uses ranging from light to heavy industrial applications. The anticipated use scenario for K-1008-F is for light industrial and office activity; therefore, the likely exposure scenario is an industrial worker exposed to the building interior/exterior surfaces and study area soils.

Exposures to the industrial worker associated with the building were evaluated using available survey data. Soil sampling results were used to evaluate exposures to the industrial worker while spending time outside the building in the study area. Groundwater is not a pathway for exposure to an industrial worker because of transfer restrictions. Therefore, groundwater is not included in this risk screen. Uncertainties associated with the exposure scenario evaluation are presented in Chap. E.6.

E.4.1.1 Industrial Worker Scenario

An industrial worker is anticipated to be present in Bldg. K-1008-F in the future. It is assumed that the industrial worker is exposed to contaminated surfaces while working at the building and to contaminated soils while outside the building, within the study area.

E.4.2 EXPOSURE PATHWAY IDENTIFICATION

Evaluating the exposure pathways requires describing the mechanism by which an individual may become exposed to contaminants associated with soils in the Bldg. K-1008-F study area. A complete exposure pathway requires the following:

- a source of contamination,
- a pathway of migration from the source of contamination to the exposure point,
- a receptor present at the exposure point, and
- an exposure mechanism at the exposure point.

If any one component of a complete exposure pathway is missing, then the pathway is considered incomplete. Only complete exposure pathways were quantified in the risk screen.

Complete exposure pathways associated with Bldg. K-1008-F surfaces and soils include ingestion, inhalation, dermal contact, and external exposure to ionizing radiation. The ingestion pathway is complete because contamination may be present, a receptor may be present in the building or study area, and a receptor may contact and ingest contaminants. The inhalation pathway is complete because contamination may be present, contaminants may become airborne, a receptor may be present in the building or study area, and an individual may inhale contaminants in the air. The dermal pathway is complete because contamination may be present, a receptor may be present in or around the transfer footprint, and a receptor may contact and dermally absorb contaminants. External exposure to ionizing radiation is a complete exposure pathway because radionuclides may be present, ionizing radiation may be emitted, and a receptor may be present to absorb the radiation. The following section describes how each of the complete exposure pathways was quantified in the risk screen.

E.4.2.1 Vapor Intrusion Pathway Evaluation

Sub-slab soil vapor was collected in September 2006 and February 2007 to determine if a potential source for VOCs exists under the building. The results were validated, and the average concentration for each VOC was calculated and compared to its respective soil vapor trigger level (TL), a concentration calculated to be health protective. In addition, to ensure that the VOCs did not cumulatively exceed TLs, the average concentration for each VOC was divided by its respective TL to determine what fraction the concentration represented. The resulting fractions were then added for all VOCs that had at least one detection. If, collectively, the VOC concentrations had exceeded the TLs, the resulting value would be above 1.0 (i.e., the fractions would add up to over 1.0).

None of the VOCs detected in either sampling event exceeded TLs for Bldg. K-1008-F, and the sum of TL fractions was below 1.0. Therefore, based on the soil vapor sampling results, the vapor intrusion pathway is not considered complete beneath the building.

E.4.3 QUANTIFICATION OF EXPOSURE

Quantifying the exposure to the receptor requires the following:

- statistical evaluation of the representative dataset;
- selection of contaminants of potential concern (COPCs), based on comparison to PRGs;
- identification of the COPCs that have available toxicity data and can be quantitatively evaluated;
- estimation of the exposure parameters (Table E.4.1) appropriate to the exposure scenarios;
- selection of toxicity data appropriate for the receptor and exposure pathways; and
- calculation of the intake, risks, and hazard quotients (HQs) to the receptors based on the calculated exposure concentrations (Chap. E.5).

The ingestion, inhalation, dermal contact, and external exposure pathways were quantified using available soil and radiological survey data. The purpose of the quantification of exposures is to provide a conservative estimate of exposures related to the exposure scenarios evaluated. At each step in the quantification process, assumptions are made in order to provide an upper-bound estimate of risk that is protective of exposures associated with the Bldg. K-1008-F study area.

Table E.4.1. Parameters for evaluation of exposures to the K-1008-F building interior

Pathway	EF (d/year)	ED (year)	BW (kg)	CF (g/kg) [a]	IR_{soil} (kg/d)	FI (unitless)	IR_{air} (m^3/d)
			Industrial worker				
Ingestion	250	25	70	1000.00	0.000050	1.0	
Inhalation	250	25	70	1000.00			20

Other factors used:
PEF = 5.38E+09 m^3/kg for the inhalation pathway.
BW = body weight.
CF = conversion factor.
ED = exposure duration.
EF = exposure frequency.
FI = fraction ingested from contaminated source.
IR = intake rate.
PEF = particulate emission factor.

E.4.3.1 Building Interior/Exterior

The ingestion and inhalation pathways associated with the building surfaces were quantified for the industrial worker using the sampling data for removable contamination, as well as fixed contamination for the survey units (SUs). External exposure was evaluated using measured dose rates. Building interior/exterior survey data indicated that approximately 1 % of the fixed contamination is removable. Therefore, for the industrial worker exposure scenario, it was assumed that 1% of the detected removable contamination is available for ingestion each workday, and 1% of the detected removable contamination is available for inhalation each workday for each SU that showed detectable levels of removable contamination. For K-1008-F, both ISUs have removable contamination and were included in the evaluation of exposure to removable contamination. In these scenarios, there is no depletion of the source material over time.

The industrial worker scenario does not consider any renovation work; therefore, it is unlikely that any fixed contamination would be disturbed and be removed in any significant quantities. However, in an effort to be conservative and to account for that unlikely potential in the risk screen for the K-1008-F building, it was also assumed that the detected fixed contamination in each SU could be mobilized and become available for ingestion and inhalation, as described below.

E.4.3.2 Study Area Soils

Quantifying the exposure requires an estimate of the exposure parameters for the exposed individual. For Bldg. K-1008-F soil, the industrial worker exposure scenario was evaluated based on the following assumptions:

- the industrial worker is present at Bldg. K-1008-F for 25 years,
- the industrial worker is on-site for 250 days/year,
- the industrial worker is outdoors exposed to soils for 2 hrs/day,
- the industrial worker ingests 50 mg/day of soil, and
- the industrial worker inhales air at a rate of 20 m^3/day.

As described in the Risk Evaluation Methodology in Sect. E.1.2, for the Bldg. K-1008-F study area soils, detected concentrations were compared with EPA Region 9 industrial worker PRGs at a risk level of 1E-05 and an HQ of 1, as well as site-specific RLs. Exposure assumptions utilized in the Region 9 PRG calculations were more conservative than those presented above in several instances and, therefore, provide a health-protective assessment of the potential for adverse effects. Results of the risk evaluation are presented in Chap. E.5.

E.5. RISK RESULTS

The risk estimate is a value that represents the excess cancer incidence that might be expected due to the exposure scenario evaluated. The EPA has established a generally acceptable target risk range of E-04 to E-06 (also expressed as 10^{-4} to 10^{-6}) and a target HI of 1. The following sections present the risk results for the Bldg. K-1008-F study area.

E.5.1 INDUSTRIAL WORKER

Exposures for the industrial worker at a hypothetical building include exposure to the building surfaces, as well as to soil within the study area, and are summarized below.

The evaluation of the Bldg. K-1008-F interior/exterior surfaces indicated that all risks were below 2E-09 and that all doses were below 0.007 mrem/year (see Table E.5.1), indicating a low likelihood of adverse health effects from the building surfaces.

EPA Region 9 PRGs and ETTP Zone 2 RLs were used to screen the study area soils based on an industrial worker exposure. Data collected for the study area soils were screened as follows:

- each detected result was compared with EPA Region 9 PRGs for the industrial worker scenario at risk level 1E-05 and an HQ of 1, and a frequency of detection above PRGs and RLs was developed;
- detected results were compared with the Zone 2 RLs developed for the ETTP ROD; and
- detected results were compared with background levels provided by Bechtel Jacobs Company LLC.

Table E.5.2 presents the results of the Bldg. K-1008-F study area soils risk screen based on industrial worker exposures and indicates no COPCs exceeded their respective PRGs or their respective RLs.

As discussed in Sect. E.1.2, as a back-check, the results of the screen were evaluated to determine if the generally acceptable upper risk level of E-04 (also expressed as 10^{-4}) and HI of 1 were exceeded as follows:

- constituents with detected concentrations above the PRGs were evaluated to determine if the average detected concentration would result in a risk exceeding E-04 or an HI exceeding 1. These screening-level risk estimates are based on dividing average detected concentrations by their respective PRG or RLs where appropriate, and
- in the case of multiple constituents with detected concentrations above PRGs or RLs, an evaluation was conducted to determine if the screening-level risk estimates based on average detected concentrations might exceed a risk of E-04 or an HI of 1.

A screening-level risk estimate was completed and relied on the radiological survey data for the building interior/exterior and furnishings and also on surface soil data from the study area which, as noted in E.1.1. above, is defined as the K-1008-F building, soils within the transfer footprint, as well as soils adjacent to the transfer footprint. The screening-level risk estimate indicated the cumulative risks associated with the Bldg. K-1008-F transfer footprint were below 1E-06 and the HI was below 1, since no constituents exceeded their respective PRGs. Because the risks did not exceed the generally acceptable upper risk level of E-04 or HI of 1, no further evaluation was needed, and a full risk calculation was not conducted. The screening was considered indicative of the low likelihood of adverse health effects associated with industrial worker exposure associated with the Bldg. K-1008-F transfer footprint. The K-1008-F transfer footprint is, therefore, considered suitable for transfer.

Table E.5.1. Carcinogenic risk and radiological dose estimates for K-1008-F interior/exterior survey units[a]

Carcinogenic risk (risk/lifetime)	Removable activity			1.2% of total activity			
Interior survey unit	Ingestion risk	Inhalation risk	Total risk	Ingestion risk	Inhalation risk	Total risk	Overall total
ISU1	8.30E-10	3.78E-12	8.34E-10	1.81E-09	8.27E-12	1.82E-09	2.66E-09
ISU2	6.82E-10	3.11E-12	6.85E-10	2.11E-09	9.63E-12	2.12E-09	2.81E-09
ISU3	1.06E-09	4.81E-12	1.06E-09	1.77E-09	8.09E-12	1.78E-09	2.84E-09
ESU1	1.06E-09	4.81E-12	1.06E-09	1.06E-09	4.81E-12	1.06E-09	2.12E-09
ESU2	1.06E-09	4.81E-12	1.06E-09	7.85E-10	3.58E-12	7.89E-10	1.85E09
ESU3	2.29E-09	1.05E-11	2.30E-09	0.00E+00	0.00E+00	0.00E+00	2.30E-09
Average[b]	**1.16E-09**	**5.30E-12**	**1.17E-09**	**1.26E-09**	**5.73E-12**	**1.26E-09**	**2.43E-09**
Radiological dose (mrem/year)	**Removable activity**			**1.2% of total activity**			
Interior survey unit	**Ingestion dose**	**Inhalation dose**	**Total dose**	**Ingestion dose**	**Inhalation dose**	**Total dose**	**Overall total**
ISU1	2.87E-04	1.40E-06	2.88E-04	6.27E-04	3.07E-06	6.30E-04	9.19E-04
ISU2	2.36E-04	1.15E-06	2.37E-04	7.31E-04	3.58E-06	7.34E-04	9.71E-04
ISU3	3.65E-04	1.79E-06	3.67E-04	6.14E-04	3.00E-06	6.17E-04	9.83E-04
ESU1	3.65E-04	1.79E-06	3.67E-04	3.65E-04	1.79E-06	3.67E-04	7.34E-04
ESU2	3.65E-04	1.79E-06	3.67E-04	2.72E-04	1.33E-06	2.73E-04	6.40E-04
ESU3	7.93E-04	3.88E-06	7.97E-04	0.00E+00	0.00E+00	0.00E+00	7.97E-04
Average[b]	**4.02E-04**	**1.97E-06**	**4.04E-04**	**4.35E-04**	**2.13E-06**	**4.37E-04**	**8.41E-04**

[a] Uses exposure concentration = lesser of max and 95% upper confidence limit on the mean (UCL-95) [UCL-95 may be larger than max if data are limited].
[b] Assumes receptor is equally exposed to each interior survey unit throughout the workday.
ISU = interior survey unit.
ESU = exterior survey unit.

Table E.5.2. Building K-1008-F study area soils screening

Analyte	Frequency of detect	Minimum detect	Maximum detect	Location(s) of maximum detected result	Average detected result	Maximum RL	Frequency of detects exceeding maximum RL	Average RL	Frequency of detects exceeding average RL	PRG	Frequency of detects exceeding PRG limit	Background concentration	Frequency of detects exceeding background
Inorganics (mg/kg)													
Aluminum	2/2	9450 J	10300 J	K1008-02	9875		NA		NA	1.00E+05	0/2	40300	0/2
Antimony	0/2	ND	ND		ND		NA		NA	4.10E+02	0/2	1.52	0/2
Arsenic	2/2	3.81	6.15	K1008-02	4.98	900	0/2	300	0/2	1.60E+01	0/2	14.95	0/2
Barium	2/2	108 J	117 J	K1008-02	112.5		NA		NA	6.70E+04	0/2	124.93	0/2
Beryllium	2/2	0.46 J	0.83	K1008-03	0.65	6000	0/2	2000	0/2	1.90E+03	0/2	2.2	0/2
Cadmium	2/2	0.65	0.68	K1008-02	0.67		NA		NA	4.50E+02	0/2	0.22 U	2/2
Calcium	2/2	26700	39600	K1008-02	33150		NA		NA		NA	2400	2/2
Chromium	2/2	19.4	25.9	K1008-02	22.65		NA		NA	6.40E+02	0/2	44.88	0/2
Cobalt	2/2	5.75	10.7	K1008-03	8.23		NA		NA	1.30E+04	0/2	42	0/2
Copper	2/2	13.5	21.8	K1008-02	17.65		NA		NA	4.10E+04	0/2	22.48	0/2
Iron	2/2	19000	19300	K1008-03	19150		NA		NA	1.00E+05	0/2	58600	0/2
Lead	2/2	39.3 J	42 J	K1008-02	40.65		NA		NA	8.00E+02	0/2	37.91	2/2
Magnesium	2/2	7850 J	13900 J	K1008-02	10875		NA		NA		NA	3300	2/2
Manganese	2/2	516	904	K1008-03	710		NA		NA	1.90E+04	0/2	2200	0/2
Mercury	2/2	0.067 J	0.121 J	K1008-02	0.09	1800	0/2	600	0/2	3.10E+02	0/2	0.17	0/2
Nickel	2/2	15.2	18.1	K1008-02	16.65		NA		NA	2.00E+04	0/2	26.07	0/2
Potassium	2/2	718	948	K1008-03	833		NA		NA		NA	5074.69	0/2
Selenium	2/2	0.31 J	0.48 J	K1008-02	0.4		NA		NA	5.10E+03	0/2	1.47	0/2
Silver	0/2	ND	ND		ND		NA		NA	5.10E+03	0/2	0.6 U	0/2
Sodium	2/2	32	43.2	K1008-02	37.6		NA		NA		NA	497	0/2
Vanadium	2/2	19.5	28.5	K1008-02	24		NA		NA	1.00E+03	0/2	65.47	0/2
Zinc	2/2	53.4 J	55.5 J	K1008-03	54.45		NA		NA	1.00E+05	0/2	89.7	0/2
Organics, pesticides, and PCBs (µg/kg)													
PCB-1016	0/2	ND	ND		ND	100000	0/2	10000	0/2	3.70E+04	0/2		NA
PCB-1221	0/2	ND	ND		ND	100000	0/2	10000	0/2	7.40E+03	0/2		NA
PCB-1232	0/2	ND	ND		ND	100000	0/2	10000	0/2	7.40E+03	0/2		NA
PCB-1242	0/2	ND	ND		ND	100000	0/2	10000	0/2	7.40E+03	0/2		NA
PCB-1248	0/2	ND	ND		ND	100000	0/2	10000	0/2	7.40E+03	0/2		NA
PCB-1254	0/2	ND	ND		ND	100000	0/2	10000	0/2	7.40E+03	0/2		NA
PCB-1260	1/2	63 J	63 J	K1008-02	63	100000	0/2	10000	0/2	7.40E+03	0/2		NA
Radionuclides (pCi/g)													
Technetium-99	0/3	ND	ND		ND		NA		NA	8.90E+03	0/3		NA
Thorium-228	3/3	0.974	1.27	K1008-02	1.17		NA		NA	1.60E-02	3/3**	1.86	0/3
Thorium-230	3/3	0.833	1.16	K1008-02	1.03		NA		NA	2.10E+02	0/3	1.2	0/3
Thorium-232	3/3	1.01	1.29	K1008-02	1.11	15	0/3	5	0/3	1.60E-02	3/3**	1.95	0/3
Total Activity	1/3	9.7	9.7	K1008-02	9.7		NA		NA		NA		NA
Uranium-234	3/3	0.958	1.5	K1008-02	1.19	7000	0/3	700	0/3	3.30E+02	0/3		NA
Uranium-235	3/3	0.0581	0.0746	K1008-03	0.07	80	0/3	8	0/3	3.90E+00	0/3		NA
Uranium-238	3/3	0.892	1.29	K1008-02	1.07	500	0/3	50	0/3	1.80E+01	0/3	1.47	0/3

Table E.5.2. Building K-1008-F study area soils screening (continued)

Analyte	Frequency of detect	Minimum detect	Maximum detect	Location(s) of maximum detected result	Average detected result	Maximum RL	Frequency of detects exceeding maximum RL	Average RL	Frequency of detects exceeding average RL	10^{-5} PRG limit	Frequency of detects exceeding PRG limit	Background concentration	Frequency of detects exceeding background
						Semivolatile organics (µg/kg)							
1,2,4-Trichlorobenzene	0/2	ND	ND		ND		NA		NA	2.20E+05	0/2		NA
1,2-Dichlorobenzene	0/2	ND	ND		ND		NA		NA	6.00E+05	0/2		NA
1,3-Dichlorobenzene	0/2	ND	ND		ND		NA		NA	6.00E+05	0/2		NA
1,4-Dichlorobenzene	0/2	ND	ND		ND		NA		NA	7.90E+04	0/2		NA
2,4,5-Trichlorophenol	0/2	ND	ND		ND		NA		NA	6.20E+07	0/2		NA
2,4,6-Trichlorophenol	0/2	ND	ND		ND		NA		NA	6.20E+04	0/2		NA
2,4-Dichlorophenol	0/2	ND	ND		ND		NA		NA	1.80E+06	0/2		NA
2,4-Dimethylphenol	0/2	ND	ND		ND		NA		NA	1.20E+07	0/2		NA
2,4-Dinitrophenol	0/2	ND	ND		ND		NA		NA	1.20E+06	0/2		NA
2,4-Dinitrotoluene	0/2	ND	ND		ND		NA		NA	2.50E+04	0/2		NA
2,6-Dinitrotoluene	0/2	ND	ND		ND		NA		NA	2.50E+04	0/2		NA
2-Chloronaphthalene	0/2	ND	ND		ND		NA		NA	2.30E+07	0/2		NA
2-Chlorophenol	0/2	ND	ND		ND		NA		NA	2.40E+05	0/2		NA
2-Methyl-4,6-dinitrophenol	0/2	ND	ND		ND		NA		NA	6.20E+04	0/2		NA
2-Methylnaphthalene	0/2	ND	ND		ND		NA		NA	1.90E+05	0/2		NA
2-Methylphenol	0/2	ND	ND		ND		NA		NA	3.10E+07	0/2		NA
2-Nitrobenzenamine	0/2	ND	ND		ND		NA		NA	1.80E+06	0/2		NA
2-Nitrophenol	0/2	ND	ND		ND		NA		NA		NA		NA
3,3'-Dichlorobenzidine	0/2	ND	ND		ND		NA		NA	3.80E+04	0/2		NA
3-Nitrobenzenamine	0/2	ND	ND		ND		NA		NA	1.80E+05	0/2		NA
4-Bromophenyl phenyl ether	0/2	ND	ND		ND		NA		NA		NA		NA
4-Chloro-3-methylphenol	0/2	ND	ND		ND		NA		NA		NA		NA
4-Chlorobenzenamine	0/2	ND	ND		ND		NA		NA	2.50E+06	0/2		NA
4-Chlorophenyl phenyl ether	0/2	ND	ND		ND		NA		NA		NA		NA
4-Methylphenol	0/2	ND	ND		ND		NA		NA	3.10E+06	0/2		NA
4-Nitrobenzenamine	0/2	ND	ND		ND		NA		NA	8.20E+05	0/2		NA
4-Nitrophenol	0/2	ND	ND		ND		NA		NA		NA		NA
Acenaphthene	0/2	ND	ND		ND		NA		NA	2.90E+07	0/2		NA
Acenaphthylene	0/2	ND	ND		ND		NA		NA	2.90E+07	0/2		NA
Anthracene	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
Benz(*a*)anthracene	0/2	ND	ND		ND		NA		NA	2.10E+04	0/2		NA
Benzo(*a*)pyrene	0/2	ND	ND		ND		NA		NA	2.10E+03	0/2		NA
Benzo(*b*)fluoranthene	0/2	ND	ND		ND		NA		NA	2.10E+04	0/2		NA

Table E.5.2. Building K-1008-F study area soils screening (continued)

Analyte	Frequency of detect	Minimum detect	Maximum detect	Location(s) of maximum detected result	Average detected result	Maximum RL	Frequency of detects exceeding maximum RL	Average RL	Frequency of detects exceeding average RL	10^{-5} PRG limit	Frequency of detects exceeding PRG limit	Background concentration	Frequency of detects exceeding background
Benzo(*g*,*h*,*i*)perylene	0/2	ND	ND		ND		NA		NA	2.90E+07	0/2		NA
Benzo(*k*)fluoranthene	0/2	ND	ND		ND		NA		NA	2.10E+05	0/2		NA
Bis(2-chloroethoxy) methane	0/2	ND	ND		ND		NA		NA		NA		NA
Bis(2-chloroethyl) ether	0/2	ND	ND		ND		NA		NA	5.80E+03	0/2		NA
Bis(2-chloroisopropyl) ether	0/2	ND	ND		ND		NA		NA	7.40E+04	0/2		NA
Bis(2-ethylhexyl) phthalate	0/2	ND	ND		ND		NA		NA	1.20E+06	0/2		NA
Butyl benzyl phthalate	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
Carbazole	0/2	ND	ND		ND		NA		NA	8.60E+05	0/2		NA
Chrysene	0/2	ND	ND		ND		NA		NA	2.10E+06	0/2		NA
Di-n-butyl phthalate	0/2	ND	ND		ND		NA		NA	6.20E+07	0/2		NA
Di-n-octylphthalate	0/2	ND	ND		ND		NA		NA	2.50E+07	0/2		NA
Dibenz(*a*,*h*)anthracene	0/2	ND	ND		ND		NA		NA	2.10E+03	0/2		NA
Dibenzofuran	0/2	ND	ND		ND		NA		NA	1.60E+06	0/2		NA
Diethyl phthalate	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
Dimethyl phthalate	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
Diphenylamine	0/2	ND	ND		ND		NA		NA	1.50E+07	0/2		NA
Fluoranthene	0/2	ND	ND		ND		NA		NA	2.20E+07	0/2		NA
Fluorene	0/2	ND	ND		ND		NA		NA	2.60E+07	0/2		NA
Hexachlorobenzene	0/2	ND	ND		ND		NA		NA	1.10E+04	0/2		NA
Hexachlorobutadiene	0/2	ND	ND		ND		NA		NA	1.80E+05	0/2		NA
Hexachlorocyclo-pentadiene	0/2	ND	ND		ND		NA		NA	3.70E+06	0/2		NA
Hexachloroethane	0/2	ND	ND		ND		NA		NA	6.20E+05	0/2		NA
Indeno(*1*,*2*,*3*-*cd*)pyrene	0/2	ND	ND		ND		NA		NA	2.10E+04	0/2		NA
Isophorone	0/2	ND	ND		ND		NA		NA	5.10E+06	0/2		NA
N-Nitroso-di-n-propylamine	0/2	ND	ND		ND		NA		NA	2.50E+03	0/2		NA
Naphthalene	0/2	ND	ND		ND		NA		NA	1.90E+05	0/2		NA
Nitrobenzene	0/2	ND	ND		ND		NA		NA	1.00E+05	0/2		NA
Pentachlorophenol	0/2	ND	ND		ND		NA		NA	9.00E+04	0/2		NA
Phenanthrene	0/2	ND	ND		ND		NA		NA	2.90E+07	0/2		NA
Phenol	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
Pyrene	0/2	ND	ND		ND		NA		NA	2.90E+07	0/2		NA

Table E.5.2. Building K-1008-F study area soils screening (continued)

Analyte	Frequency of detect	Minimum detect	Maximum detect	Location(s) of maximum detected result	Average detected result	Maximum RL	Frequency of detects exceeding maximum RL	Average RL	Frequency of detects exceeding average RL	10^{-5} PRG limit	Frequency of detects exceeding PRG limit	Background concentration	Frequency of detects exceeding background
Volatile organics (µg/kg)													
1,1,1-Trichloroethane	0/2	ND	ND		ND		NA		NA	1.20E+06	0/2		NA
1,1,2,2-Tetrachloro-ethane	0/2	ND	ND		ND		NA		NA	9.30E+03	0/2		NA
1,1,2-Trichloroethane	0/2	ND	ND		ND		NA		NA	1.60E+04	0/2		NA
1,1-Dichloroethane	0/2	ND	ND		ND		NA		NA	1.70E+06	0/2		NA
1,1-Dichloroethene	0/2	ND	ND		ND		NA		NA	4.10E+05	0/2		NA
1,2-Dichloroethane	0/2	ND	ND		ND		NA		NA	6.00E+03	0/2		NA
1,2-Dichloroethene	0/2	ND	ND		ND		NA		NA	1.50E+05	0/2		NA
1,2-Dichloropropane	0/2	ND	ND		ND		NA		NA	7.40E+03	0/2		NA
2-Butanone	0/2	ND	ND		ND		NA		NA	1.00E+08	0/2		NA
2-Hexanone	0/2	ND	ND		ND		NA		NA		NA		NA
4-Methyl-2-pentanone	0/2	ND	ND		ND		NA		NA	4.70E+07	0/2		NA
Acetone	0/2	ND	ND		ND		NA		NA	5.40E+07	0/2		NA
Benzene	0/2	ND	ND		ND		NA		NA	1.40E+04	0/2		NA
Bromodichloromethane	0/2	ND	ND		ND		NA		NA	1.80E+04	0/2		NA
Bromoform	0/2	ND	ND		ND		NA		NA	2.20E+06	0/2		NA
Bromomethane	0/2	ND	ND		ND		NA		NA	1.30E+04	0/2		NA
Carbon disulfide	0/2	ND	ND		ND		NA		NA	7.20E+05	0/2		NA
Carbon tetrachloride	0/2	ND	ND		ND		NA		NA	5.50E+03	0/2		NA
Chlorobenzene	0/2	ND	ND		ND		NA		NA	5.30E+05	0/2		NA
Chloroethane	0/2	ND	ND		ND		NA		NA	6.50E+04	0/2		NA
Chloroform	0/2	ND	ND		ND		NA		NA	4.70E+03	0/2		NA
Chloromethane	0/2	ND	ND		ND		NA		NA	1.60E+05	0/2		NA
Dibromochloromethane	0/2	ND	ND		ND		NA		NA	2.60E+04	0/2		NA
Either trichlorotrifluoroethane or 1,1,1-trichloro-2,2,2-trifluoroethane	0/2	ND	ND		ND		NA		NA		NA		NA
Ethylbenzene	0/2	ND	ND		ND		NA		NA	4.00E+05	0/2		NA
Methylene chloride	0/2	ND	ND		ND		NA		NA	2.10E+05	0/2		NA
Styrene	0/2	ND	ND		ND		NA		NA	1.70E+06	0/2		NA
Tetrachloroethene	0/2	ND	ND		ND		NA		NA	1.30E+04	0/2		NA
Toluene	0/2	ND	ND		ND		NA		NA	5.20E+05	0/2		NA
Total Xylene	0/2	ND	ND		ND		NA		NA	4.20E+05	0/2		NA
Trichloroethene	0/2	ND	ND		ND		NA		NA	1.10E+03	0/2		NA
Vinyl chloride	0/2	ND	ND		ND		NA		NA	7.50E+03	0/2		NA
cis-1,3-Dichloropropene	0/2	ND	ND		ND		NA		NA	1.80E+04	0/2		NA

Table E.5.2. Building K-1008-F study area soils screening (continued)

Analyte	Frequency of detect	Minimum detect	Maximum detect	Location(s) of maximum detected result	Average detected result	Maximum RL	Frequency of detects exceeding maximum RL	Average RL	Frequency of detects exceeding average RL	10^{-5} PRG limit	Frequency of detects exceeding PRG limit	Background concentration	Frequency of detects exceeding background
trans-1,3-Dichloro-propene	0/2	ND	ND		ND		NA		NA	1.80E+04	0/2		NA

** - evaluated as part of the Th-232+D = Th-232 and Ra-228+D and Th-228+D decay chain (see Sect. E.6.3).
J = estimated.
NA = not applicable; ND = non-detect.
PCB = polychlorinated biphenyl.
pCi/g = picocuries per gram.
PRG = preliminary remediation goal at a risk level of 10^{-5} and hazard quotient of 1.
RL = remedial level.

E.6. EVALUATION OF UNCERTAINTIES

The estimation of uncertainty, whether quantitative or qualitative, is fundamental to scientific activities that involve measured or assessed quantities. Estimates of risk are conditional based on a number of assumptions concerning exposure. Generation of a point estimate of risk, as has been done in this screening-level assessment, has the potential to yield under- or overestimates of the actual value and can lead to improper decisions. Therefore, it is necessary to specify the assumptions and uncertainties inherent in the screening-level evaluation process to place the risk estimates in perspective and ensure that anyone making risk-management decisions is well informed.

Uncertainty about environmental risk estimates is known to be at least an order of magnitude or greater (EPA 1989). The evaluation of uncertainties for the assessment is qualitative, since the resource requirements necessary to provide a quantitative statistical uncertainty analysis for this study area would generally outweigh the benefits. The focus of the discussion in this section will be on the important variables and assumptions that contribute most to the overall uncertainty.

E.6.1 UNCERTAINTY IN THE SOURCE TERM

Several uncertainties are associated with the data set and the data evaluation process. These uncertainties include the selection of COPCs and the determination of the exposure point concentration.

Although the data evaluation process used to select COPCs adheres to established procedures and guidance, it also requires making decisions and developing assumptions on the basis of historical information, process knowledge, and best professional judgment about the data. Uncertainties are associated with all such assumptions. The background concentrations and PRGs used to screen analytes are also subject to uncertainty. The toxicity values used in the derivation of PRGs are subject to change; as additional information (from scientific research) becomes available, these periodic changes in toxicity values may cause the PRG values to change as well, causing increased uncertainty in the data screening process.

Representative concentrations and other statistics are calculated in this risk screen based on the assumption that the samples collected are truly random samples. Some of the data may not have been taken randomly, but rather may have come from biased sampling, aimed at identifying high contaminant concentration locations.

The Bldg. K-1008-F assessment included sampling locations that were located outside the transfer footprint, but within the adjacent area considered accessible by a potential receptor. Including these data is a source of uncertainty and conservatism in the evaluation.

E.6.2 UNCERTAINTY IN THE EXPOSURE ASSESSMENT

For each exposure pathway, assumptions are made concerning the parameters, the routes of exposure, the amount of contaminated media an individual can be exposed to, and intake rates for different routes of exposure. In the absence of site-specific data, the assumptions used in this assessment are consistent with EPA-approved parameters and default values. When several of these upper-bound values are combined in estimating exposure for any one pathway, the resulting risks can be in excess of the 99th percentile and, therefore, outside the range that may be reasonably expected.

The guidance values for intake rates and exposure parameters are assumed to be representative of the hypothetical populations evaluated. All contaminant exposures and intakes are assumed to be from the site-related exposure media (i.e., no other sources contribute to the receptor's risk). Even if these assumptions are true, other areas of uncertainty may apply. Selected intake rates and population characteristics (i.e., weight, life span, and activities) are assumed to be representative of the exposed population. The consistent conservatism used in the estimation of these parameters generally leads to overestimation of the potential risk to the postulated receptors.

E.6.3 UNCERTAINTY IN TOXICITY VALUES AND RISK PREDICTIONS

Uncertainty in the values used to represent the dose-response relationship will highly impact the risk estimates. These uncertainties are contaminant-specific and are embedded in the toxicity value. The factors that are incorporated to represent sources of uncertainty include the source of the data, duration of the study, extrapolations from short- to long-term exposures, intrahuman or interspecies variability, and other special considerations. In addition, toxicity varies with the chemical form.

Uncertainties related to the summation of carcinogenic risk and non-carcinogenic HI estimates across contaminants and pathways are a primary uncertainty in the risk characterization process. In the absence of information on the toxicity of specific chemical mixtures, additive (cumulative) risks are assumed (EPA 1989).

Limitations of the additive risk approach for exposure to multiple chemicals include the following:

1. The slope factors may represent the mean but often represent the upper 95th percentile estimate of potency (the central estimate on the mean for radionuclides), so the summation can result in an excessively conservative estimate of lifetime risk.

2. The reference doses do not have equal accuracy or precision and are not based on the same severity of effects.

3. The effects of a mixture of carcinogens are unknown, and possible interactions could be synergistic or antagonistic.

Despite these limitations and the general unavailability of data on these interactions, summations were performed for the carcinogenic risks and chemical HQs presented in the risk screen. This approach is consistent with RAGS (EPA 1989).

In order to avoid double-counting the short-lived daughters of specific isotopes, the daughters were excluded from the COPC list if analytical results for the parent were available; only daughters as defined by EPA (2001) were excluded. As a special case, the ^{232}Th decay chain was evaluated as "^{232}Th+D" (which combines the slope factors for ^{232}Th, ^{228}Ra+D, and ^{228}Th+D) when calculating risks. When evaluating data for "^{232}Th+D," a conservative approach was used, whereby the largest concentration among ^{232}Th, ^{228}Ra, and ^{228}Th was used to determine the maximum detected concentration and to estimate all summary statistics. Another special consideration for radioisotopes was to eliminate ^{40}K from the COPC list, as it was considered to be naturally occurring and, therefore, was not considered to be a COPC.

E.7. REFERENCES

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