Soil Vapor Intrusion Mitigation Alternatives
Buildings 774, 776, 785, and 786
Former Griffiss Air Force Base
Rome, New York

FINAL
FEASIBILITY STUDY

EVALUATION OF ALTERNATIVES
AND
CONCEPTUAL DESIGN

Contract No. F41624-03-D-8601
Delivery Order No. 0045

Revision 0.0
February 2010

FPM group

DEPARTMENT OF THE AIR FORCE
AIR FORCE REAL PROPERTY AGENCY

February 12, 2010

MEMORANDUM FOR SEE DISTRIBUTION LIST

FROM: AFRPA - Griffiss
153 Brooks Road
Rome NY 13441-4105

SUBJECT: FINAL FEASIBILITY STUDY
Evaluation of Alternatives and Conceptual Design
Soil Vapor Intrusion Mitigation Alternatives
Buildings 774, 776, 785, and 786
Former Griffiss Air Force Base, Rome, New York
Contract No. F41624-03-D-8601-0045
Revision 0.0
February 2010

1. Enclosed please find the Final Feasibility Study for Buildings 774, 776, 785, and 786 Soil Vapor Intrusion dated February 2010.

2. Please provide any comments you may have by March 13, 2010.

3. Should any questions arise, please contact Mark Rabe at (315) 356-0810 ext. 203.

MICHAEL F. MCDERMOTT
BRAC Environmental Coordinator

Attachment: As noted

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AFRPA - Griffiss
153 Brooks Road
Rome NY 13441-4105 (4 hard copies, 2 CDs)

FINAL

FEASIBILITY STUDY

EVALUATION OF ALTERNATIVES
AND
CONCEPTUAL DESIGN

Prepared for:

Soil Vapor Intrusion Mitigation Alternatives
Buildings 774, 776, 785, and 786
Former Griffiss Air Force Base
Rome, New York

through

Air Force Center for Engineering and the Environment
3300 Sidney Brooks
Brooks City Base, TX 78325

Prepared by:

FPM Group, Ltd.
153 Brooks Road
Rome, NY 13441

Project No. 40-07-45

Revision 0.0
February 2010

RESPONSE TO
U.S.EPA COMMENTS ON
DRAFT FEASIBILITY STUDY,
SOIL VAPOR INTRUSION MITIGATION ALTERNATIVES,
BUILDINGS 774, 776, 785 and 786,
Former Griffiss Air Force Base, Rome, NY.
Revision 0.0, February 2009.

Received on April 23rd, 2009.

General Response – The purpose of this Feasibility Study and proposed work is to evaluate SVI mitigation, not remediation, alternatives at Buildings 774, 776, 785, and 786. Through SVI mitigation, possible soil vapor contaminants will be prevented from entering the buildings and/or otherwise mitigated upon their entry for the protection of indoor occupants. SVI mitigation evaluation and implementation is performed in parallel to, but distinct from, the ongoing source remediation. Groundwater remediation is performed at these sites through the On-base groundwater investigation and remediation program (IRP SD-52) and the Petroleum Spill Sites LTM program (NYSDEC Spill Program).

GENERAL NOTES		
#	**USEPA COMMENT**	**RESPONSE**
1	Points of compliance or preliminary remediation goals (PRGs) have not been established for Buildings 774, 776, 785, and 786 or clarified in detailed as to the remedial action objectives. As such, it is unclear how the performance of the to-be-selected remedies will be assessed, or how it will be determined if they are operating as designed. Further, without performance criteria, EPA will be unable to determine if the proposed remedy was successful or when the remedial objectives have been achieved allowing any active remedy to be shutdown. It is suggested that a detailed decision tree or flow diagram be developed for each building. Each decision tree/flow diagram should establish compliance points or PRGs to determine whether the selected remedies are operating as designed or if alternative remedies need to be evaluated. In addition, the decision trees/flow diagrams should establish these compliance points or PRGs to determine when implemented remedies have successfully addressed human health and environmental concerns and attained the intended objective, so they can be removed from operation. It should be noted that if points of compliance or PRGs and decision trees/flow diagrams are appropriately established and	As stated in the last paragraph of Section 1, Introduction, the objectives of this FS are to screen and evaluate all available alternatives and perform conceptual design for mitigation of soil vapor intrusion (SVI) into Buildings 774, 776, 785, and 786, and to recommend a preferred alternative for same. Thus, the goal of this FS and proposed work is SVI mitigation for the benefit of the occupants of these buildings (who are all workers), and any potential reduction in contaminant levels in the subsurface is incidental to the goal of this project. The project is not designed to withdraw vapors from the subsurface for the purpose of remediation, but, rather, to prevent any vapors present in the subsurface from entering the buildings. The last paragraph of Section 1, Introduction, of the FS has been revised to further emphasize this distinction. Also, a flow chart/decision tree illustrating the

	achieved, the duration of any selected remedy's operation may be reduced. Points of compliance or PRGs should be based on a quantitative reduction of sub-slab vapors.	performance/evaluation criteria for the selected alternative will be added to the FS and is provided with the response to comments.
2	Also, several technology options (e.g., directional drilling, vertical drilling) for Buildings 774, 776, 785, and 786 include the discharge of extracted vapors to the atmosphere through a stack that is at least three feet taller than the highest point of the building. Based on Tables 2-5 (Building 774 Short List Sub-slab Vapor Analytical Results), 2-6 (Building 775 Short List Sub-slab Vapor Analytical Results), 2-11 (Building 785 Short List Sub-slab Vapor Analytical Results), and 2-12 (Building 786 Short List Sub-slab Vapor Analytical Results), several sub-slab vapor concentrations exceed screening levels [e.g., 19,000 micrograms per cubic meter (ug/m^3) of trichloroethylene (TCE) at 786SSV1BB]. These concentrations could warrant air emission control devices to meet current RCRA standards and should be addressed in the document for our review.	Similar to the PRGs, air emissions and air emissions monitoring are generally considered part of the RA WP and therefore will be discussed in that future document. Several sub-slab vapor concentrations were high, however, these are most likely due to accumulated vapors and, as the conceptual design shows, the horizontal wells will remove air from under the entire slab and therefore average discharge vapor concentrations are expected to be significantly lower than the high maximum sub-slab vapor concentrations reported. Therefore, it is not believed that air emission control would be warranted; however, review of the need for air emission control will be performed as needed during the detailed design stage. Notes to this effect are included in Sections 5.2.2, 5.3.2, 5.3.3, and 5.6 of the revised FS.
GENERAL COMMENTS		
1	This comment serves to reiterate EPA Region 2's position with regard to proposed remediation goals for indoor air and soil gas based on vapor intrusion potential. As previously noted in technical review comments and conference call, USEPA is not in agreement with Griffiss AFB with regard to the proposed remedial standards for soil gas and indoor air. This fact limits USEPA's ability to assess the technical adequacy of the proposed remedial alternatives. From a pragmatic standpoint, USEPA has attempted to review the proposed and recommended alternatives and implementation measures. While the actual remedial goals need to be further refined, USEPA is amenable to moving negotiations forward in discussion of the proposed remedial strategy and seeks to define further the requirements for demonstrating compliance. The additional requirements under consideration center on the scope, frequency, and duration of monitoring contact and contributing contaminated environmental media, including: indoor air, ambient air, sub-slab vapor, soil gas, and groundwater. In addition, USEPA asks that the AF provide specific examples of any institutional or land use controls (IC/LUCs) it considers relevant in an assessment of current or future land use. Any IC/LUCs under consideration	Please see the General Response paragraph above. The SVI FS includes a simplified sampling scheme that does not discriminate among the preferred alternatives, however the Air Force envisions proposing the following sampling plan: outdoor (ambient) air, indoor air, sub-slab exhaust, and sub-slab sampling, see attached table. Groundwater sampling will not be performed as that is covered under the On-base Groundwater Investigation and Remediation Program and the Petroleum Spill Sites LTM Program. For sampling frequency, one baseline sampling event will be conducted to establish baseline levels. Indoor, outdoor, and sub-slab exhaust sampling will be performed 1 month after system startup, 6 months after system startup, and then every 6 months thereafter. Sub-slab sampling will be conducted 1 year after system startup, and then every 5 years. Given sampling results, sampling frequency and system operation will be optimized. The frequency of the sampling events will be provided in detail in the mitigation Work Plans. A comprehensive review will be conducted after 5 years of system operation, and recommendations will be made for

	must be legally enforceable and transferable.	future action, including future monitoring, as needed. SVI LUC/ICs will be developed in the future Record of Decision for Buildings 774, 776, 785, and 786 Soil Vapor Intrusion Operable Unit.
2	The discussion of groundwater contamination plumes in the vicinity of Buildings 774, 776, 785, and 786 lacks detail. For example, the influence or lack of influence of groundwater contamination on sub-slab vapor and indoor air quality (IAQ) concentrations has not been discussed. Furthermore, the locations of the groundwater contamination plumes in relation to Buildings 774, 776, 785, and 786 have not been presented. While groundwater concentrations are monitored as part of the On-Base Groundwater site and will not specifically be a point of compliance for this remedy, monitoring of groundwater concentrations could be useful as an indicator for the need of additional/continued sub-slab vapor and IAQ sampling to demonstrate that IAQ remains within compliance. Revise the FS to include a more detailed discussion of the groundwater contamination plumes in the vicinity of Buildings 774, 775, 785, and 786. Specifically, discuss how groundwater contamination is actively being addressed (i.e., source is under control) and whether the groundwater contamination is currently influencing or demonstrates a lack of influence on sub-slab vapor and IAQ concentrations.	Groundwater data is submitted separately under other reports. Current reported groundwater data will be provided in the pending 2008 Annual Report, Performance Monitoring for On-Base Groundwater Remediation at the Former Griffiss Air Force Base, Rome, NY. Building 774 and 776 is part of the Building 775 section of the report and Building 785 and 786 is part of the Apron 2 Chlorinated Plume section of the report. In addition, groundwater sampling performed at Building 785 and 786 is also provided in the Fall 2008 Petroleum Spill Sites LTM Report (FPM, August 2009). These reports along with other beneficial reports are provided in the Reference section of the SVI FS.
3	Several remedial options (e.g., directional drilling, vertical drilling) for Buildings 774, 776, 785, and 786 include the discharge of extracted vapors to the atmosphere through a stack that is at least three feet taller than the highest point of the building to which soil gas venting is proposed. Based on Tables 2-5 (Building 774 Short List Sub-slab Vapor Analytical Results), 2-6 (Building 775 Short List Sub-slab Vapor Analytical Results), 2-11 (Building 785 Short List Sub-slab Vapor Analytical Results), and 2-12 (Building 786 Short List Sub-slab Vapor Analytical Results), several sub-slab vapor concentrations exceed screening levels [e.g., 19,000 micrograms per cubic meter (ug/m^3) of trichloroethylene (TCE) at 786SSV1BB]. These concentrations could warrant air emission control devices to meet current RCRA standards. Revise the FS to clarify if the discharge of extracted vapors to the atmosphere would require control devices to meet the intent of current RCRA requirements, and site any applicable guidance used in the determination.	The discharge associated with the mitigation options for Building 774, 776, 785, and 786 is not associated with a process vent and therefore is not subject to RCRA requirements. However, the air emissions from the mitigation options will be monitored and regulated using the NYS Air Regulations (NYS Air Guide-1 [NYSDEC, November 1997]).
4	It is unclear how the proposed long term monitoring (LTM) will generate	As we discussed in our General Response paragraph and in our

	sufficient data over time to demonstrate effectiveness including: overall protection of human health and the environment; compliance with health standards and attainment of any yet to be determined cleanup goal; long term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; and, short term effectiveness. Based on Section 5.2.2 (Alternative 774/776-2: Directional Drilling + LTM), "LTM is included in theses alternatives to verify the effectiveness of the alternative and to show that the alternative meets its objective. One baseline sampling event will be performed which includes indoor, outdoor, exhaust pipe and sub-slab sample collection. Subsequent indoor sampling events will be performed one month after startup and reoccur every 6 months after that. Sub-slab verification will be performed after one year and every 5 years." It is unclear how one sub-slab vapor sampling event during the first five years of implementation will demonstrate that the remedy is effective and operating properly. For example, Alternative 785/786-3: Vertical Wells + LTM presented in Section 5.4.2.4 (Reduction of toxicity, mobility, or volume through treatment) states that, "LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes." One sub-slab vapor sampling event during the first five years of implementation does not constitute periodic assessment. Revise the FS to either substantiate that the performance of one sub-slab vapor sampling event within the first five years of implementation will demonstrate that the remedy is effective and operating properly, and that one sub-slab vapor sampling event every five years will demonstrate that the remedy is effective and operating properly, or revise the FS to allow for development of a baseline (one to two years worth of quarterly data to account for seasonal variations) and if the results demonstrate a stable or decreasing trend, allow for implementation of a reduced sampling frequency (semi-annually or annually) until the first five year review period when conditions will be re-evaluated.	response to General Notes 1, the purpose of this specific project is mitigation of SVI and not remediation. It is true that the SVI FS follows the methodology of the EPA's RI/FS guidance for a traditional remediation project, which possibly may have been a source of confusion during its review. Our framing of the SVI FS in the format of a traditional FS is purely a matter of convenience and expediency, an attempt to realize efficiency and cost savings in our study by gainfully recasting well tested criteria and methodology of the traditional remedial FS to our purpose. As such, while the methodology and criteria may appear similar to the traditional FS, their interpretation and evaluation is different in the SVI FS. The SVI FS has been revised to make these distinctions clear and to more closely document the definitions and interpretations given to the evaluation criteria and the alternatives evaluation methodology that was followed in the SVI FS. The LTM sampling is intended to confirm the ultimate goal of the SVI mitigation: the protection of indoor occupants from sub-slab vapors. Therefore, the majority of the monitoring is focused on measuring indoor air concentrations, as this is the direct environment of the receptors. In addition to indoor air sampling, outdoor and sub-slab exhaust sampling will be conducted at the same frequency. Outdoor sampling will be performed for ambient air concentration comparison and sub-slab exhaust sampling will be performed to determine vacuum effectiveness and will be used for system optimization. Less frequent monitoring is planned for the sub-slab sampling. Sub-slab sampling is only intended to confirm lower sub-slab concentrations resulting from the horizontal well installation and subsequent removal of sub-slab vapors.
5	Remedial Action Objectives (RAOs) have not been established in the FS. According to the USEPA *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA* (EPA/540/G-89/004), dated October 1988,	Please refer to the response for General Notes #1 and General Comments # 4 above regarding the non-applicability of RAOs and PRGs to this project, which is focused on the mitigation of SVI

	the alternative development process should start with the development of RAOs aimed at protecting human health and the environment. The RAOs should specify the contaminant(s) of concern (COCs), exposure route(s) and receptor(s), and an acceptable contaminant level or range of levels for each exposure route (i.e., a preliminary remediation goal). Only after the objectives and goals have been established can remedial action alternatives be identified, screened, and evaluated in detail. Revise the FS to include RAOs.	only. All references to RAOs that indevertently remained in the previous version of the SVI FS have been removed in the revised SVI FS. The mitigation goals were included in the form of screening levels design goals in the original FS, but without explicit identification. The SVI FS has been revised, including adding a new Section 3.1, Mitigation Goals, to clarify and emphasize the SVI mitigation goals of this project and to resolve any ambiguities that may be present indicating or suggesting otherwise.
6	A list of potential federal and state applicable or relevant and appropriate requirements (ARARs) for Buildings 774, 776, 785, and 786 and remedial alternatives has not been developed and included in the FS. At the conclusion of screening, sufficient information should exist on the technologies and the most probable configurations of technologies so that action-, chemical-, and location-specific ARARs can be defined. Section 121 of CERCLA requires that site cleanups comply with federal environmental ARARs or more stringent, enforceable state promulgated ARARs issued under state environmental or facility citing laws that are identified by the state in a timely manner. A list of potential federal and state ARARs for Buildings 774, 776, 785, and 786 that addresses all of the evaluated remedial alternatives should be developed and included in the FS. Revise the FS to include a list of potential federal and state ARARs for Buildings 774, 776, 785, and 786 for the remedial alternatives which underwent a detailed analysis.	Please see the General Response paragraph on the first page. Please also see our response to General Comment #5 above, which is directly applicable to this comment also. There are no ARARs applicable to this project, since it is focused only mitigation of SVI, for which mitigation goals have been stated in the revised FS. The goal of this project is SVI mitigation and not remediation. The SVI mitigation is planned to operate in parallel with the ongoing groundwater remediation at the sites under the On-base Groundwater Remediation and Investigation Program (IRP SD-52) and the Petroleum Spill Sites LTM Program (NYSDEC Spill Program).
7	It is unclear why institutional controls have not been included in the configurations of remedial technologies. Based on Section 4.1.3 (Institutional Controls), institutional controls were eliminated as a stand-alone solution because they are administratively not implementable, but were retained for detailed analysis as a complement to other remedial actions for all four buildings. However, institutional controls are not included in the evaluation of potential remedial alternatives presented in Section 5 (Evaluation of Alternatives). Revise the FS to include institutional controls in the configurations of remedial technologies and present the basic tenants of those controls. In addition, clarify what instruments are enforcing the currently established institutional controls for the four buildings, as stakeholders need to be able to verify that any current mechanism can be upheld as part of any	SVI LUC/ICs will be developed in the future Record of Decision for Buildings 774, 776, 785, and 786 Soil Vapor Intrusion Operable Unit. In addition, if the property has not been transferred (Building 785 and 786), SVI LUC/ICs will be incorporated into the deed. For property that has been transferred (Building 774 and 776), a modification to the deed will be made.

	proposed remedy. For example, stakeholders should be notified if renovations or changes to the internal structure of the buildings or floors/concrete slabs occur, as these changes could impact the effectiveness of any remedial technology implemented.	
8	Points of compliance or PRGs in relation to the RAOs have not been established for Buildings 774, 776, 785, and 786. As such, it is unclear how the performance of the to-be-selected remedies will be assessed, or how it will be determined if they are operating as designed. Further, without performance criteria, regulators will be unable to determine if the proposed remedy was successful or when the remedial objectives have been achieved allowing any active remedy to be shutdown. It is suggested that a detailed decision tree be established for each building. Each decision tree should establish compliance points or RPGs to determine whether the selected remedies are operating as designed or if alternative remedies need to be evaluated. In addition, the decision trees/flow diagrams should establish compliance points to determine when implemented remedies have successfully addressed human health and environmental concerns and attained the intended objective, so they can be removed from operation. It should be noted that if points of compliance and decision trees/flow diagrams are appropriately established and points of compliance or PRGs are met, the duration of any selected remedy's operation may be reduced. Points of compliance or PRGs should be based on a quantitative reduction of sub-slab vapors. Revise the FS to include decision trees/flow diagrams with specific points of compliance or PRGs for Buildings 774, 776, 785, and 786.	Please see the General Response paragraph on the first page, and our responses to General Notes 1, and General Comments 4 and 5. Also, a flow chart/decision tree illustrating the performance/ evaluation criteria for the selected alternative will be added to the FS and is provided with the response to comments.
9	The impact of season fluctuations on IAQ and IAQ action levels (ALs) have not been addressed in the FS. Based on Section 5 (Evaluation of Alternatives), the LTM sampling strategy for indoor air includes sampling during one baseline sampling event, one month after remedy startup and every six months after that. Revise the FS to include a sampling strategy to account for seasonal fluctuations. The proposed monitoring/sampling strategy should include a list of events which would trigger monitoring once remedial actions or controls have been implemented, and what agency is responsible for these assessments.	Seasonal fluctuations do have an impact on indoor air quality. However, as suggested in the final NYSDEC SVI Manual (October 2006), SVI sampling should be performed in the heating season, as the heated indoor air causes a vacuum which can increase the influx of soil vapors. This worst case scenario during winter months will likely cause the highest indoor air concentrations and therefore sampling is planned in that period to collect worst-case-scenario samples with the likely highest concentrations.
10	It appears in some section that the units of concentration are incorrect. Some values are reported as ug/m^3, other values are reported in ug/l, and still other values are reported as ppm. Please review the data provided and use the appropriate unit consistently throughout the document.	Different units of measurements are reported for different matrices; i.e., µg/m3 was used for indoor, outdoor, and sub-slab vapor results, µg/L was used for groundwater results and ppm was used for results from a PID, which measures total VOCs in an air sample.

SPECIFIC COMMENTS		
1	**Section 2.1.4, Summary of Previous Investigations, Page 2-5:** It is unclear whether Building 774 and 776 sub-slab vapor and IAQ samples were analyzed for 1,1,1-trichloroethane (1,1,1-TCA) and tetrachloroethene (PCE). Based on Section 2.1.4, "[Groundwater] Results showed that the primary contaminant exceeding [New York State Department of Environmental Conservation] NYSDEC Class GA Groundwater Standards is TCE, with minor detections of 1,1,1-TCA and PCE." However, only analytical results for cis-1,2-dichloroethene (DCE), trichloroethylene (TCE) and vinyl chloride have been provided in Tables 2-3 (Building 774 Short List Indoor Analytical Results, December 2006/April 2008), 2-4 (Building 776 Short List Indoor Analytical Results, December 2006/April 2008), 2-5 (Building 774 Short List Sub-slab Vapor Analytical Results), and 2-6 (Building 775 Short List Sub-slab Vapor Analytical Results). As such, it is unclear if 1,1,1-TCA and PCE were evaluated at Buildings 774 and 776. Revise the FS to clarify whether Building 774 and 776 sub-slab vapor and IAQ samples were analyzed for 1,1,1-TCA and PCE, and revise the FS as necessary to either correct the statements or include the supporting analytical data.	As detailed in Table 2-1 in the Final Work Plan for SVI Sampling (FPM, April 2008), samples from Building 774 were analyzed for TCE, cis-1,2-DCE, and VC only. This work plan was reviewed in draft form by EPA and NYSDEC and comments were addressed in the final version.
2	**Section 2.1.4.1.2, 2008 SVI Evaluation, Page 2-8:** The location of the additional indoor air sample, collected in Building 774 in the May 2008 sampling event (due to renovation activity), has not been identified or provided on Figure 2-3 (Building 774 and 776 – 2008 Sample Locations). As such, it is unclear if the sample is representative of the area where renovation activities took place. Identify the location of the additional air sample and the location of the renovation activity within Building 774 on Figure 2-3.	The additional sample was accidentally omitted from the figure. It will be added in the revised version of the FS.
3	**Table 2-12, Building 786 Short List Sub-slab Vapor Analytical Results – October 2006/April 2008, Page 2-26:** It is unclear why the sub-slab vapor concentrations at 786SSV-1 differed so significantly from 81,000 ug/m^3 to 19,000 ug/m^3 between October 2006 and April 2008. As such, it is unclear what mechanisms within the sub-slab vapor and/or indoor air pathways exist to cause this deviation. Revise the FS to clarify and discuss possible reasons as to why the sub-slab vapor concentrations at 786SSV-1 differed from 81,000 ug/m^3 to 19,000 ug/m^3 between October 2006 and April 2008.	Fluctuations in sampling results are not uncommon. Differences between duplicates and normal samples collected at one sampling time and data are reasonably expected up to 30 percent. Fluctuations will generally be higher once the time between sampling events increases, especially in highly volatile media such as soil gas. The difference in concentrations is within one order of magnitude and therefore is not considered uncommon, especially with an 18-month interval between samples. Factors that contribute to that difference are the seasons, sample collection, and also analytical, as two different air analytical labs

		were used for the two samples.
4	**Section 2.2.4.1.2, 2008 SVI Evaluation, Page 2-27:** It is unclear what conceptual design will be prepared under separate cover. According to the text on Page 2-27, "Discussions between AFRPA, EPA, NYSDOH, and NYSDEC have led to an agreement to evaluate a potential remedy to limit the (potential) exposure of receptors to these sub-slab concentrations. This remedy appears warranted and a conceptual design will be prepared under separate cover." Revise the FS to clarify what conceptual design will be prepared under separate cover.	The conceptual design referred to is this SVI FS. The last sentence will be deleted to address the comment.
5	**Section 4.1.10, Passive Barrier, Page 4-8:** It is unclear as to the AF's rationale for discussing the epoxy coating. According to the last paragraph in Section 4.1.10, "The epoxy coating passive barrier is considered for detailed analysis for Buildings 785 and 786 due to their open floor plan and light usage, and is not considered for Buildings 774 and 776, due to their finished status and occupancy." However, passive barriers have not been included in Section 5.3 (Alternatives for Buildings 785 and 786) with no further action, limited action/long-term monitoring (LTM), horizontal piping (wells)/trenching/sumps/vertical piping (wells), and directional drilling. Please clarify.	Passive barrier has not been included in the alternative evaluation because of the current use of Buildings 785 and 786. Both buildings are used for storing Griffiss International Airport equipment (mowers, snow blowers, snow plows, sanders, etc). This equipment can easily damage the epoxy coating if installed, which would negate the barrier. The AF cannot guarantee that the epoxy coating would not be damaged and therefore the passive barrier was eliminated from the list of alternatives. The text in section 4.1.10 has been updated to reflect the above response.
6	**Section 4.1.14, Demolition, Page 4-11:** It is unclear how the current utilization of Buildings 785 and 786 is considered light usage when Section 4.1.14 states that both buildings are currently in use for storage of Griffiss International Airport maintenance equipment (snow plows, snow blower trucks, mowers, etc). Clarify whether the current and future usage of Buildings 785 and 786 would be acceptable for an epoxy coating passive barrier, and clarify what is mean by the term "light usage".	The 'light usage' term refers to the infrequent traffic in Buildings 785 and 786, and no continuous occupancy which would be interest in developing mitigation alternatives. Both buildings are used for storage and are used twice a year; to move the summer equipment (mowers, etc.) out of the buildings and to move the winter equipment (snow plows, snow blowers, sanders, etc) in the buildings or vice versa. Associated maintenance work (oil changes, cleaning, preparation, etc.) is also performed at that time and expected to take several weeks. After that, the buildings are not occupied for the remainder of the year. The passive barrier in the form of an epoxy coating appears a good alternative for Buildings 785 and 786, but the heavy equipment stored in the buildings and moved twice a year can easily damage the coating and thereby nullify the remedy. Management, monitoring and maintenance costs of the passive barrier remedy are

		deemed too high for it to be a viable alternative.
7	**Section 5.2.3.1, Building 774 [of Section 5.2.3, Alternative 774/776-3: HVAC Manipulation + LTM], Page 5-14:** It is unclear why operation and maintenance (O&M) costs have not been provided for an entire years timeframe. The O&M costs presented on Page 5-14 only includes operation costs for nine months of the year. As such, it is unclear what O&M costs are associated with the remaining three months, when heating or cooling may not be necessary, but operation of the ventilation system will still be required in order to maintain positive pressure?. Please revise the FS to include the O&M costs for an entire years timeframe or clarify how the remedy will be maintained if the ventilation system is only operated nine months of the year.	The O&M costs have been detailed to include 6 months of heating and 3 months of cooling. For the additional 3 months that make up an entire calendar year, the outside temperatures are assumed to be equal to the indoor air temperatures, therefore making O&M heating or cooling costs negligible. The text has been revised to address the comment.
8	**Section 5.2.3.1, Building 774 [of Section 5.2.3, Alternative 774/776-3: HVAC Manipulation + LTM], Page 5-15:** It is unclear why LTM listed as subsurface verification sampling has only been proposed for the first five years. According to Section 5.4.2.3 (Long-term effectiveness and permanence) in the last sentence on Page 5-39, "Indefinite protection will require maintaining and operating the positive pressure system indefinitely." As such, it is unclear why LTM has only been proposed for the first five years and O&M costs have only been included for the first five years in Appendix B (Cost Estimates). Please revise the FS to clarify why LTM and O&M have only been proposed for the first five years, and not indefinitely as indicated by the text in Section 5.4.2.3.	In the SVI FS, all LTM costs have been projected for five years after system installation. Generally, costs become increasingly unreliable if time periods project past five years. The sub-surface verification sampling has been proposed for after 1 and 5 years only, because the goal of the alternative is the protection of receptors in the indoor air. Therefore, the LTM sampling is focused on sampling indoor air. Once the system is confirmed to function as designed, the sampling frequency will be evaluated for reduction. Finally, please note that LTM costs do not have an impact on relative costs between the alternatives since LTM is present in all alternatives except the No Further Action alternative and, hence, do not have an impact on the relative evaluation of the various alternatives.
9	**Section 5.2.3.3, Other Considerations for HVAC Manipulation, Page 5-17:** It is unclear how heating, venting and air conditioning (HVAC) manipulation will impact the computer systems currently being operated in Buildings 774 and 776. According to Sections 4.1.5 (Horizontal Piping) and 4.1.13 (Venting/Dilution), Building 774 and 776 occupants are high security computer firms with a significant amount of sensitive electronic equipment installed securely in-place. Therefore, a discussion of how remedy implementation may impact the operations of current occupants should be included in the Section 5.2.3.3 discussion. Please revise Section 5.2.3.3 to discuss how remedy implementation may impact the current occupant's operations.	The slightly higher indoor air pressures resulting from the implementation of this alternative are not expected to have an impact on the computer systems installed in Buildings 774 and 776. Most are high power PC systems which are not affected by slightly higher indoor air pressures. The increase in pressure is well within the normal range of changing air pressures in the outdoor environment and is not expected to have any effect on the PCs. Large mainframes or computer banks are installed in separate rooms with separate air handling systems which are on separate controls and are not expected to be impacted by the increased indoor air pressure.
10	**Section 5.3, Alternatives for Buildings 785 and 786, Page 5-26:** It is unclear why only one of the piping, trenching, and sump technologies was retained for	The FS was prepared to evaluate and compare distinct alternatives to ultimately select the preferred alternative based on a specific set

	detailed analysis in the FS. While the technologies are similar in basic design function, multiple combinations of the technologies are possible. For example, vertical piping, vertical piping with trenching, and vertical piping with sumps are all technologies that could be retained for detailed analysis. As such, it is unclear why only vertical piping (wells) was retained as the representative technology for the FS. As the conceptual designs provided in the FS are for development purposes only, revise the FS to indicate that the trenching and sump technologies in conjunction with vertical piping will be assessed for additional efficiency during system design phase should this alternative be selected.	of standards. It is indeed true that a virtually limitless set of combinations can be created for trench, vertical, and sump technologies. However, all fall within the same category of sub-slab vapor collection. Secondly, each technology has its own specific installation requirements, sub-slab vapor collection characteristics, etc. which are difficult to incorporate into one sub-slab vapor extraction system. Separate systems for separate technologies would sharply increase the capital and monitoring costs. Moreover, the FS would become an increasingly complex document to review with perhaps dozens of relatively similar alternatives. More generally, as the EPA is no doubt well aware, the FS process is based on selecting representative processes for different technology types (in this specific case, the technology of vapor collection through subsurface vapor collection systems). While the assembled alternatives are based on the selected representative process(es), it is understood that they are assumed to represent a broader range of alternatives constructed from a broader range of process options available for a technology type from within which the selected representative process was used in an alternative for study in the FS. [In fact, we have adopted this methodology for the SVI FS from EPA's methodology proposed in their traditional RI/FS guidance for remediation projects.] Thus, it is a given that, even when an alternative has been selected, the detailed design phase has the prerogative to consider other appropriate process options within the same type as the one that was considered in the selected alternative for inclusion as additions or as replacements for the representative option to arrive at a most beneficial design. That this prerogative is often not exercised and the selected alternative is implemented exactly does not negate this fundamental premise. Hence, in addition to making the FS a more complex document if the suggestions in the comment are implemented, their inclusion is unnecessary based on the FS process. That said, we appreciate the comment and will consider its suggestions in the detailed design phase as needed and appropriate.

11	**Section 5.3.2, Alternative 785/786-2: Directional Drilling + LTM: Page 5-27:** The variables utilized in the vapor extraction rate calculation have not been defined or referenced. Based on Section 5.3.2, "Assume vapor extraction at a rate of 450 SCFM, which is equal to the vapor extraction rate selected for the vertical wells alternative, which was selected based on using typical extraction rates for the types of soil conditions at the site and experience. This flow rate is equal to about 0.85 [Air Changes per Hour] ACH of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system) for the two wells under a building. That is, assuming 25% porosity, 0.85 ACH, (130 ft x 242 ft) x 2 ft thickness x 2 wells, design extraction flow rate is 26750 [Cubic Feet per Hour] CFH or 450 [Cubic Feet per Minute] CFM in each building (225 CFM per well)." Revise the FS to document the sources of the variables utilized in the vapor extraction rate calculation. Specifically, clarify why the flow rate is equal to 0.85 ACH and the porosity is 25%.	As stated, the 450 SCFM was derived from the vertical well alternative. This vapor extraction rate was also used in the horizontal wells alternative and the rate was converted to determine what impact this vapor extraction rate has on sub-slab vapors. 450 SCFM = 27,000 SCFH. The area under the slab is 130 x 242 = 31,460 ft2. Table 4-2 in Applied Hydrology (Fetter, 1988) shows a table with ranges of porosities for different soils. Mixed sand and gravel has a porosity range of 20-35% and silt has a range of 35-50%. The soils at the site are a mixture of both (poorly sorted, mixed silty sands), so a porosity of 35% can be assumed. However, the soils at the Building 785 and 786 site were compacted in layers during apron and building construction, which likely resulted in lower porosity than in natural soils. Therefore, the porosity was assumed at 25%. A 2-ft thick layer under the slab with a 25% porosity contains: 0.25x31,460x2= 15,730ft3. For two horizontal wells, the total is 2x15,730=31,460 ft3. The ACH is calculated by dividing the flow rate by the total volume: 27,000/ 31,460= 0.85. In this regard, please note that 0.85 ACH is not the driver in the conceptual design and is also not used as a design parameter. It was simply calculated to contribute to an intuitive understanding of the assumed system performance. The actual extraction flow rates will be determined during the detailed design of the system. More generally, in keeping with FS guidance recommendations, these conceptual designs were developed to provide estimates that are within +50% and -30% of likely costs based on our best professional judgment and experience.
12	**Section 5.3.3, Alternative 785/786-3: Vertical Wells + LTM, Page 5-31:** It is unclear if the proposed design allow for adequate overhead clearance to accommodate the current equipment stored within Buildings 785 and 786. According to Section 4.1.14 (Demolition), both buildings are currently in use for storage of Griffiss International Airport maintenance equipment (snow plows, snow blower trucks, mowers, etc). As such, it is unclear if the proposed design height of the components will be sufficient to accommodate the required overhead clearance for the maintenance equipment currently stored within the buildings. Please revise Section 5.3.3 to clarify how the proposed design height	The design of overhead components of the vertical wells alternative will be adjusted to accommodate the height of the GIA maintenance equipment. Buildings 785 and 786 are old aircraft maintenance hangars with a 50-ft roof peak height and an interior open area height of 34 ft to accommodate the B-52 bombers during maintenance work. Generally, road vehicles are limited to a height of 14 ft which leaves an additional 20 ft above to accommodate the installation of the vertical wells alternative components. Several rows of steel support beams are located within the buildings and will

	of the overhead components will be sufficient to accommodate the required overhead clearance for the maintenance equipment currently stored within the buildings.	be used to support the above ground piping for the vertical wells alternative.
13	**Section 5.4.2.4, Reduction of toxicity, mobility, or volume through treatment, Alternative 774/776-3, Page 5-40:** It is unclear how the toxicity, mobility and volume of subsurface vapors will be eliminated from indoor air when potential residuals will not be eliminated from entering. Section 5.4.2.4 states that, "However, the toxicity, mobility, and volume in indoor air will essentially be eliminated by preventing the subsurface vapors from entering the interior of the buildings, except for potential residuals." Please revise Section 5.4.2.4 to clarify how the toxicity, mobility and volume of subsurface vapors will be eliminated from indoor air when potential residuals will not be eliminated from entering.	The statement does not claim that toxicity, mobility, and volume (TMV) will be essentially eliminated even in the case of potential residuals being present, but that TMV will be essentially eliminated *except for* potential residuals. Unstated, but underlying the statement and associated engineering evaluations, is the context of meeting mitigation goals and levels of potential residuals being below such goals. All the same, for greater accuracy, the statement has been revised in the SVI FS to state: "However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met." The implemented design will be based on essentially eliminating TMV such that the mitigation goals are satisfied. If, in the future, sampling and monitoring indicate that the system is not being protective of human health and the indoor environment, and that the mitigation goals are not being met, then additional SVI mitigation measures will be taken as needed and appropriate, taking care first to make sure that the source of the detections is, in fact, residuals from the subsurface and not the chemicals already present in the indoor air or chemicals which are brought in or generated by activities of building occupants and operations. Chemicals that are already present or chemicals brought in by building occupants, or generated by their activities or building operations, are not addressed with this alternative.
14	**Appendix B, Cost Estimates:** It is unclear how O&M system default costs for the treatment system operator, loading of liquid into a 5,000 gallon bulk tank truck, transport of the bulk liquid/sludge hazardous waste, the wastewater disposal fee, and the associated electrical charges apply to Alternative 774/776-2: Directional Drilling + LTM. Please revise Appendix B to clarify how the	The two loads of 5,000-gallons and the transportation are related to the installation of the horizontal wells. During drilling, a bentonite drilling fluid is used to maintain bore hole integrity and move soil cuttings to the surface. This fluid must be disposed off after horizontal well installation, which incurs a cost.

	O&M system defaults apply to each of the alternatives presented in the FS.	
15	**Appendix B, Cost Estimates:** It is unclear if the carbon treatment system default costs provided for Alternative 776- 4: Carbon Treatment + LTM include replacement of the carbon filters. Similarly, it is unclear if the system default costs for the treatment system operator, loading of liquid into 5,000 gallon bulk tank truck, transport of the bulk liquid/sludge hazardous waste, the wastewater disposal fee, and the associated electrical charges apply to Alternative 776-4 or other alternatives. Please revise Appendix B to clarify what is included with system defaults for each alternative.	The carbon replacement costs were not included in the cost calculation. The flow rates for the filters as presented in the draft FS (15,000 cfm for Building 774 and 5,500 cfm for Building 776) result in very large vessels for the carbon filtration alternative. The maximum TCE concentrations in each building (4.70 µg/m3 in Building 774 and 3.28 µg/m3 in Building 776) are low. When calculating the daily load on the carbon filters, the pounds of carbon spent per day is 0.03 for Building 774 and 0.01 for Building 776. Due to the large flow through the carbon vessels and the low TCE loading, the time until the filters are saturated is measured in decades. Therefore, carbon replacement is not deemed likely and costs are negligible. Liquid removal and disposal and operator costs are not included in the alternatives which do not include this activity.
END OF COMMENTS/////		

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APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ACH	Air changes per hour
AF	Air Force
AFB	Air Force Base
AFCEE	Air Force Center for Engineering and the Environment
AFIOH	Air Force Institute for Operational Health
AFRPA	Air Force Real Property Agency
a/g	Aboveground
AOC	Area of Concern
ARAR	Applicable or Relevant and Appropriate Requirement
bgs	Below ground surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFH	Cubic feet per hour
CFM	Cubic feet per minute
COC	Contaminant of concern
DCE	cis-1, 2 dichloroethylene
E&E	Ecology and Environment
EEEPC	Ecology and Environment Engineering P.C.
ERV	Energy recovery ventilation
FPM	FPM Group
FS	Feasibility Study
Ft	feet
HP	Horsepower
HVAC	Heat, Ventilation and Air Conditioning
LUC	Land use control
LTM	Long-Term Monitoring
MNA	Monitored Natural Attenuation
MTBE	Methyl tert butyl ether
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health

O&M	Operation and Maintenance
OU	Operable Unit
Pa	Pascal
PBC	Performance Based Contract
PCE	Perchloroethylene
PDI	Pre-Design Investigation
PID	Photoionization Detector
ppb	Part per billion
PVC	Polyvinyl chloride
RACER	Remedial Action Cost Engineering and Requirements
RI	Remedial Investigation
ROD	Record of Decision
SAC	Strategic Air Command
SCFM	Standard cubic feet per minute
SOP	Standard operating procedure
Sq. ft.	Square feet
SVI	Soil Vapor Intrusion
TBC	To be considered
TCA	1,1,1-trichloroethane
TCE	Trichloroethylene
u/g	Underground
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound
W	Watt
w.g.	Inches of water
WSA	Weapon Storage Area
$\mu g/m^3$	Micrograms per cubic meter

1 Introduction

FPM Group, Ltd. (FPM) has been contracted by the Air Force Center for Engineering and the Environment (AFCEE) to formulate and evaluate Soil Vapor Intrusion (SVI) mitigation alternatives for Buildings 774, 776, 785, and 786 at the former Griffiss Air Force Base (AFB) in Rome, NY. This document presents the results of this feasibility study (FS), provides conceptual designs, and identifies the preferred alternatives.

The purpose of this FS is to evaluate SVI mitigation, not remediation, alternatives for Buildings 774, 776, 785, and 786. Through SVI mitigation, possible soil vapor contaminants will be prevented from entering the buildings and/or otherwise mitigated upon their entry for the protection of indoor occupants. SVI mitigation evaluation and implementation is performed in parallel to, but distinct from, the ongoing source remediation.

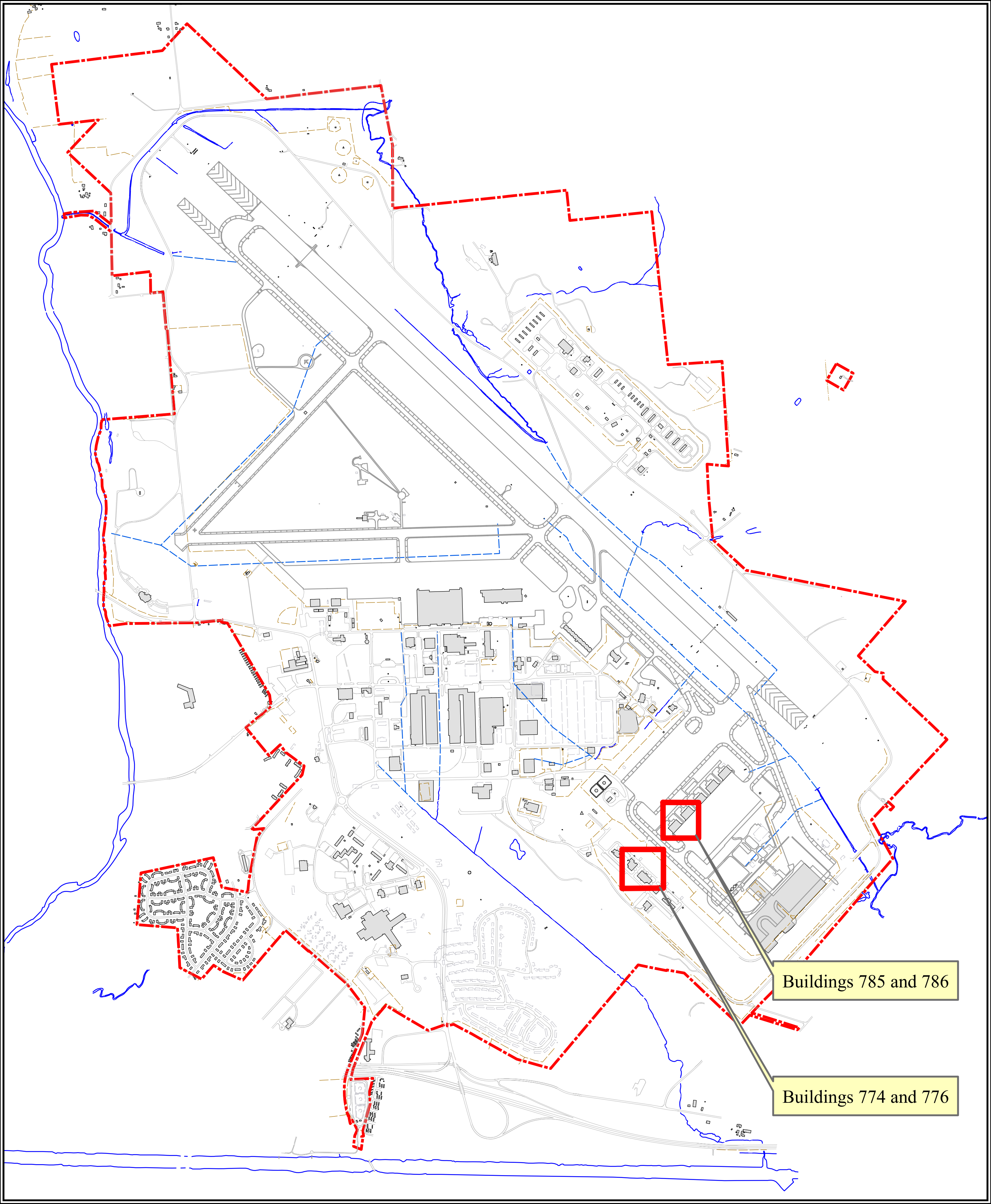
The sites included in this FS are sites which were investigated as part of the SVI Survey at the On-base Groundwater Areas of Concern [AOCs] (SD-52), consisting of Apron 2 [SD-52-01], Building 817/Weapon Storage Area [WSA] (SD-52-05), Building 775 [SD-52-02], and AOC9 [SD-62]. Ecology and Environment Engineering P.C. (EEEPC) performed an initial SVI survey between October and December 2006. The results of the EEEPC investigation were reported in the Revised Final SVI Survey, Data Summary Report (Air Force [AF], October 2007). This revised final SVI survey was reviewed by the Air Force Real Property Agency (AFRPA), New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYSDOH) and United States Environmental Protection Agency (USEPA) and, during discussions among these parties, a plan for additional sampling was established, which was then implemented by FPM in April and May 2008 (FPM, April 2008a).

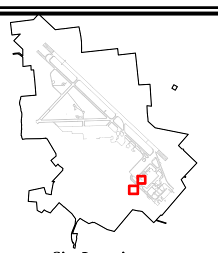
These sites are part of the SVI Operable Unit (OU), which includes AOC9, Buildings 43, 100, 101, 110, 131, 133, 774, 776, 782, 783, 784, 785, 786, 817, and Tank Farms 1 and 3. Buildings 43, 100, 101, 110, 133, 782, 783, 784, and Tank Farms 1 and 3 are being evaluated under individual proposed plans. AOC 9, Buildings 131 and 817 will be evaluated in the future.

All buildings are located within the former Griffiss AFB, currently known as the Griffiss Business and Technology Park (Figure 1-1). All sites are industrial/commercial sites and are not intended for future residential use. This industrial/commercial designation is enforced via Land Use Controls (LUCs) via deed or lease restrictions. All current and future receptors at all of the sites are therefore industrial/commercial workers. The sites are either currently or planned for industrial/commercial use via deed/lease restrictions.

All SVI investigation and evaluation results obtained during the EEEPC and FPM investigations performed between 2006 and 2008 were comprehensively reviewed during the preparation of this FS. The objectives of this FS are to screen all available alternatives for SVI mitigation; to evaluate the most applicable alternatives, including performing conceptual design for the alternatives as needed for assisting in their evaluaton; to provide a list of preferred alternatives;

and to recommend a preferred alternative. It is noted that the goal of this FS and proposed work is SVI mitigation for the benefit of the occupants of these buildings (who are all workers), and any potential reduction in contaminant levels in the subsurface is incidental to the goal of this project. The project is not designed to withdraw vapors from the subsurface for the purpose of remediation, but, rather, to prevent any contaminated soil vapors present in the subsurface from entering the buildings and/or otherwise mitigating them upon their entry into the buildings. Remediation of any subsurface source contamination with intent to meet cleanup goals will be addressed separately.





Site Location

Key to Features

- Road
- Airfield
- Base Boundary
- Fenceline
- Storm Drain
- Surface Water
- Demolished Facilities
- Existing Facilities

FIGURE 1-1
SVI Site Location Map

N

1,200 600 0 1,200 2,400

Feet

UNITED STATES AIR FORCE
GRIFFISS AIR FORCE BASE
ROME,NEW YORK

February 2, 2008

FPM group

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2 Environmental Setting and Site Background

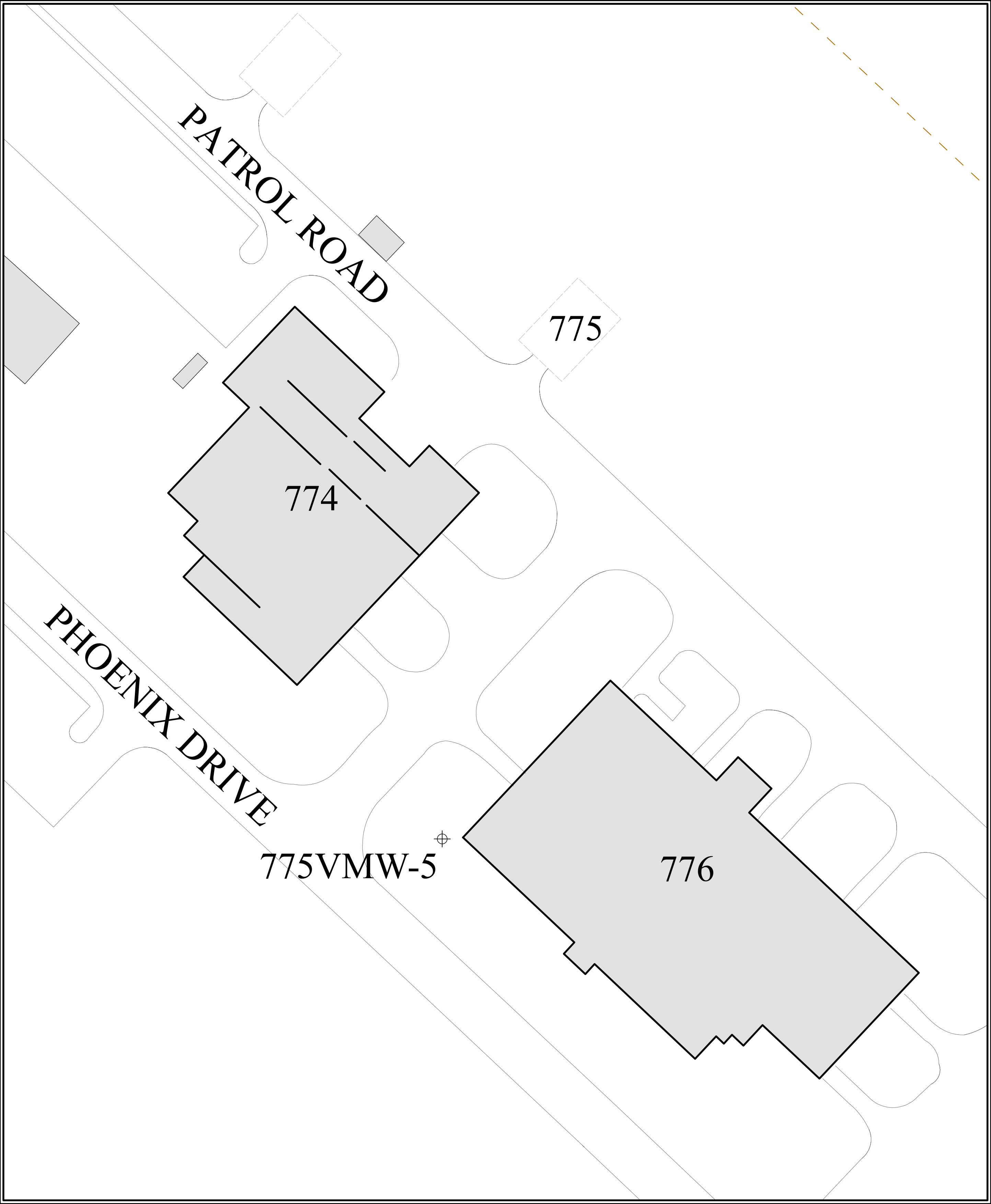
2.1 Buildings 774 and 776

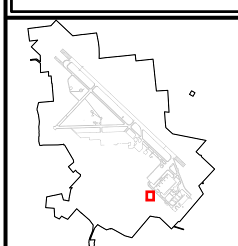
2.1.1 Building Setting

These two buildings are located between Phoenix Drive and Patrol Road on Strategic Air Command (SAC) Hill at the former Griffiss AFB in Rome, NY and are associated with the Building 775 site (SD-52-02) (Figure 2-1). Building 774 is a one-story, 18,990-square feet (sq. ft.) office building, currently occupied by a computer/security firm. The building is occupied on work days from 8 AM to 5 PM by approximately 45 people. Building 774 was built in 1959, but underwent major renovations in 2000. New windows and doors were installed, 36 new air handlers were installed, including new air ducts in ceilings and new cooling towers. The building is built on an 8-inch thick concrete slab, with no basement and most floors are covered with carpeting. Several floor drains exist in bathrooms, janitor closets and the boiler room. A summary of the building characteristics is provided in Table 2-1 below.

Table 2-1
Building 774 characteristics

Building identification	Building 774
ERP Site Association	SD-52-02/SS-38
Date constructed	1959
Square feet	18,990 sq. ft.
Primary use	Commercial Office Space (Occupied)
Other uses	NA
Type of foundation	Concrete, slab on grade, 8 inch thick.
Comments on foundation	Cracks at 4 floor drains were filled in during the 2000 renovations. Floors are currently finished with carpet, linoleum, tile, or similar floor covering.
Comments/ Observations	The building was completely renovated in 2000. Airtight with central heating and cooling. Air handlers and cooling towers. All new air ducts, windows and doors installed during the renovations of 2000. Average ceiling height: 8 ft, 6 inches.
Exterior sealing	Brick and mortar walls, unsealed.





Key to Features
- Monitoring Well
- B774 interior wall
- Fence
- Demolished Facility
- Existing Facility

FIGURE 2-1
Buildings 774 and 776
Site Layout Map

N

50 25 0 50 100
Feet

UNITED STATES AIR FORCE
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

December 5, 2008

FPM group

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Building 776 is a one-story, 27,410-sq. ft. office building, currently occupied by a software development firm. The building is occupied on work days from 7 AM to 6 PM by approximately 80 people. Building 776 was built in 1959, but underwent major renovations in 2002. New windows, which do not open, and doors were installed, the interior was refinished and most floors were covered with new carpeting. Heat and outdoor air are provided through 43 heat pumps. The building is built on a 3.5 to 6-inch thick concrete slab, with no basement. Several floor drains exist in bathrooms and one crack was observed in the concrete floor near the southeastern entrance door. A summary of the building characteristics is provided in Table 2-2 below.

Table 2-2
Building 776 characteristics

Building identification	Building 776
ERP Site Association	SD-52-02/SS-38
Date constructed	1959
Square feet	27,410 sq. ft.
Primary use	Commercial Office Space (Occupied)
Other uses	NA
Type of foundation	Concrete, slab on grade, 3 to 6.5 inch thick.
Comments on foundation	Bathroom floors drains, one crack near main conference room/room 100. Floors are currently finished with carpet, linoleum, tile, or similar floor covering.
Comments, Observations	Building completely rebuilt in 2002. Airtight with newer doors and windows. Heat pumps on roof circulate air in building. Average ceiling height: 8 ft, 5 inches.
Exterior sealing	Brick and mortar walls, unsealed.

2.1.2 Hydrogeological Setting

Buildings 774 and 776 are located on SAC hill which is an elevated area in the southeast section of the former Griffiss AFB, overlooking the Aprons. The immediate area around the building is flat with little or no elevation difference. The area is covered with grass, asphalt parking lots and roads, and concrete walkways. Past investigations have indicated that the groundwater flow direction is in the south-southwesterly direction towards Landfill 6.

2.1.3 Site Background

The Building 775 plume is located downgradient and south of former maintenance facilities in Buildings 774 and 776 and former fuel pump house Building 775. Although the source has not been identified, solvent use in Building 774 is thought to be a primary source of trichloroethylene (TCE) contamination. Solvent use was widespread in these facilities in the 1950s, 1960s, and early 1970s.

The contaminated aquifer comprises silty sands with an average thickness extending from 60 feet (ft) below ground surface (bgs) to 120 ft bgs, where shale bedrock is encountered. Due to a relatively flat gradient, average groundwater velocities at this site are slow and have been estimated at approximately 10 ft per year. Higher velocities may exist in discontinuous seams of coarse sand and gravel. Contamination is not found in the bedrock. Groundwater studies at the nearby Landfill 6 TCE site found relatively aerobic conditions and low dissolved organic carbon concentrations. The general absence of cis-1, 2 dichloroethylene (DCE) in the Building 775 plume indicates that reductive dechlorination is not occurring. Two buildings (Buildings 774 and 776) lie within the elevated Volatile Organic Compound (VOC) plume boundary associated with the Building 775 site. The potential also exists for future development within this area north of Perimeter Road (AF, October 2007).

2.1.4 Summary of Previous Investigations

The Building 775 plume is located downgradient and south of former maintenance facilities in Building 774 and 776 and former fuel pump house Building 775. Although the source has not been identified, solvent use in Building 774 is thought to be a primary source of TCE contamination. Solvent use was widespread in these facilities in the 1950s, 1960s, and early 1970s. The primary contaminant exceeding NYSDEC Class GA Groundwater Standards is TCE, with minor detections of 1,1,1-trichloroethane (TCA) and perchloroethylene (PCE). Monitoring well 775VMW-5, located near the corner of Building 776, is the only well in the maintenance area that contains significant levels of TCE (99 micrograms per cubic meter [$\mu g/m^3$] in September 2004). Most of the Building 775 plume appears to have migrated south toward Landfill 6. In September 2004, the maximum groundwater TCE concentration was 134 $\mu g/m^3$ (detected at well 775-MW20, located near the leading edge of the plume near Perimeter Road); however, TCE was detected at a concentration of 673 $\mu g/m^3$ in the hydropunch sample at 117 ft bgs in well 775VMW-20R during the 2000 Landfill 6 and Building 775 Groundwater Study (E&E, August 2000). TCE was detected at 132 $\mu g/m^3$ in well 775VMW-10, which is also located near the leading edge of the plume near Perimeter Road. TCE in both of these wells was detected in the bottom half of the sandy aquifer in screened intervals from 88 to 120 ft bgs. Nearby well LF6MW-1 is screened in the upper 10 ft of the aquifer and does not have detectable TCE concentrations. Based on the current TCE distribution, it appears that the TCE was likely spilled in the vicinity of Building 774 and has migrated southward and downward in the aquifer.
FPM started Long-Term Monitoring (LTM) sampling at Landfill 6 in June 2006. Several of the monitoring wells sampled under the LTM program (775VMW-10, LF6MW-1, and 775VMW-

20R) are located along Perimeter Road and therefore are located near or on the Building 775 site. LTM sampling results have shown TCE detections up to 96 µg/L (FPM, April 2008b).

Additional sampling was performed by E&E and FPM in 2006 as part of the feasibility study for the Building 775 site. EEEPC performed pre-design investigation (PDI) activities at the Building 775 site starting in September 2006. First, two monitoring wells were installed (775MW-27 and -28). The wells were developed and sampled at the end of October/beginning of November 2006. Results showed that the primary contaminant exceeding NYSDEC Class GA Groundwater Standards is TCE, with minor detections of 1,1,1-TCA and PCE. FPM performed sampling at several other monitoring wells at the Building 775 site in order to create a complete understanding of current site conditions. The results and conclusions were reported in the Final PDI Report, which also includes photos of samples collected (EEEPC, February 2007).

EEEPC also performed an SVI evaluation during the PDI activities. Sub-slab sampling at the Building 775/Pumphouse 3 site indicates that chloroform and TCE are present in the sub-slab vapor at Building 774 and 776 at concentrations above the AF screening levels. Indoor air sampling at both buildings indicates that these contaminants are present, but at concentrations below the AF screening levels. The TCE and chloroform detections are likely associated with the groundwater contamination plume located in the area: TCE has been detected in groundwater at concentrations above screening levels, while chloroform has been detected in groundwater at concentrations below screening levels. Soil vapor sampling at the Building 775 site indicates that several contaminants are present in the soil vapor at low levels.

The contaminated aquifer comprises silty sands with an average thickness extending from 60 ft bgs to 120 ft bgs, where shale bedrock is encountered. Due to a relatively flat gradient, average groundwater velocities at this site are slow and have been estimated at approximately 10 ft per year. Higher velocities may exist in discontinuous seams of coarse sand and gravel. Contamination is not found in the bedrock. Groundwater studies at the nearby Landfill 6 TCE site found relatively aerobic conditions and low dissolved organic carbon concentrations. The general absence of cis-1, 2-DCE in the Building 775 plume indicates that reductive dechlorination is not occurring. Building 774 lies within the elevated VOC plume boundary associated with the Building 775 site (AF, October 2007).

2.1.4.1 Previous SVI Investigations

2.1.4.1.1 2006 SVI Survey

As part of the On-Base Groundwater Performance Based Contract (PBC) contract, EEEPC performed an initial SVI survey at Buildings 774 and 776 between October 2006 and February 2007. The following samples were collected as part of this investigation (Figure 2-2):

1) Four soil vapor samples and one duplicate sample were collected from between 5 and 8 ft bgs using direct push methods in the area with the highest levels of groundwater

contamination. The samples were collected from the open grassy areas south of Buildings 774 and 776.

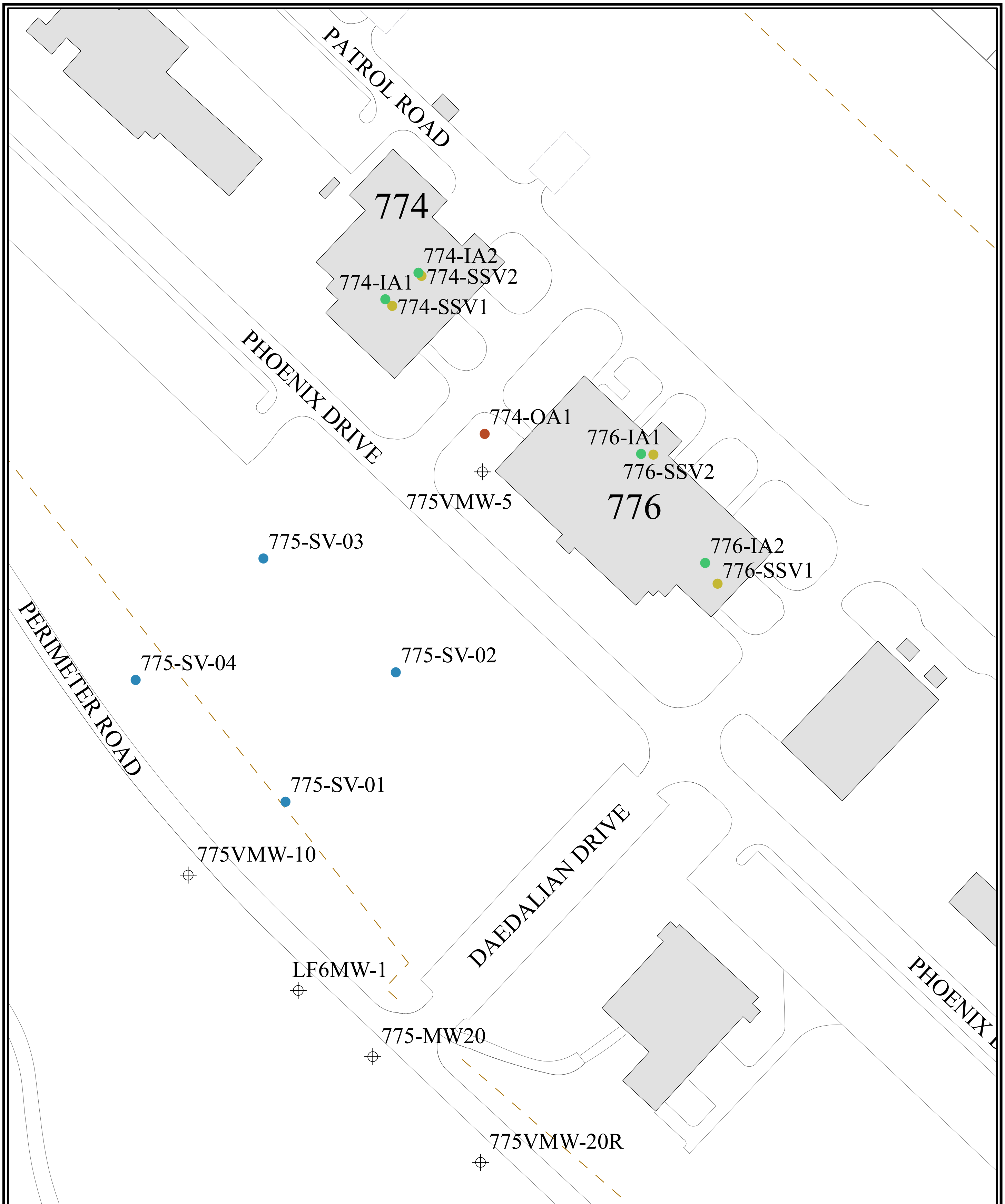
2) Two sub-slab vapor samples were collected from Buildings 774 and 776 each in October 2006. Two sub-slab samples were collected due to the large size of the building.
3) Two indoor air samples were collected from Building 774 and 776 each in December 2006 after evaluation of the sub-slab sampling results.
4) Simultaneous with the indoor air samples, one outdoor air sample was collected from between Buildings 774 and 776. The outdoor sample was collected where good air flow between the buildings exists.

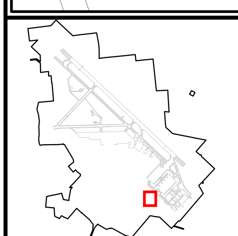
The results show TCE detections in the soil vapor samples up to 70 $\mu g/m^3$ (775-SV-03), in the sub-slab samples up to 3,000 $\mu g/m^3$ (776-SSV1), and in the indoor samples up to 4.4 $\mu g/m^3$ in Building 776. Several other contaminants of concern (COCs) were also detected in the outdoor air sample, but were below screening levels or not deemed to be a COC at these sites (AF, October 2007).

Site inspections and product inventories were recorded for Buildings 774 and 776. A photoionization detector [PID] was used to measure VOC concentrations throughout the buildings and total VOC concentrations ranged from 30 to 46 part per billion (ppb) in Building 774 and from 0 to 96 ppb in Building 776. Common office and bathroom products were reported in both buildings; white board cleaner, liquid hand soap, glass cleaner, dusting and cleaning spray and general purpose cleaner were observed.

No potential sources of the COCs present in the Building 775 groundwater plume were observed during the inventory of Buildings 774 and 776.

In summary, the sub-slab sampling at the Building 775/Pumphouse 3 site during 2006, indicates that chloroform and TCE are present in the sub-slab vapor at concentrations above the AF screening levels. Indoor air sampling at both buildings indicates that these contaminants are present, but at concentrations below the AF screening levels. The TCE and chloroform detections are likely associated with the groundwater contamination plume located in the area: Soil vapor sampling at the Building 775 site indicates that several contaminants are present in the soil vapor at low levels.





Site Location

Key to Features

Sample Type

- Indoor air
- Outdoor air
- Soil vapor
- Subslab
- Monitoring Well
- Fence
- Demolished Facility
- Existing Facility

FIGURE 2-2
Building 774 and 776
2006 Sample Locations

50 25 0 50 100
Feet

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UNITED STATES AIR FORCE
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

November 26, 2008

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2.1.4.1.2 2008 SVI Evaluation

FPM performed a follow-up SVI investigation at Building 774 and 776 in April/May 2008 to confirm the results of the 2006 SVI survey. It should be noted that in meetings between AFRPA, Air Force Institute for Operational Health (AFIOH), NYSDEC, NYSDOH, and USEPA, it was decided that "chloroform has been determined not to be a constituent of concern" (Appendix A).

The following samples were collected (Figure 2-3):

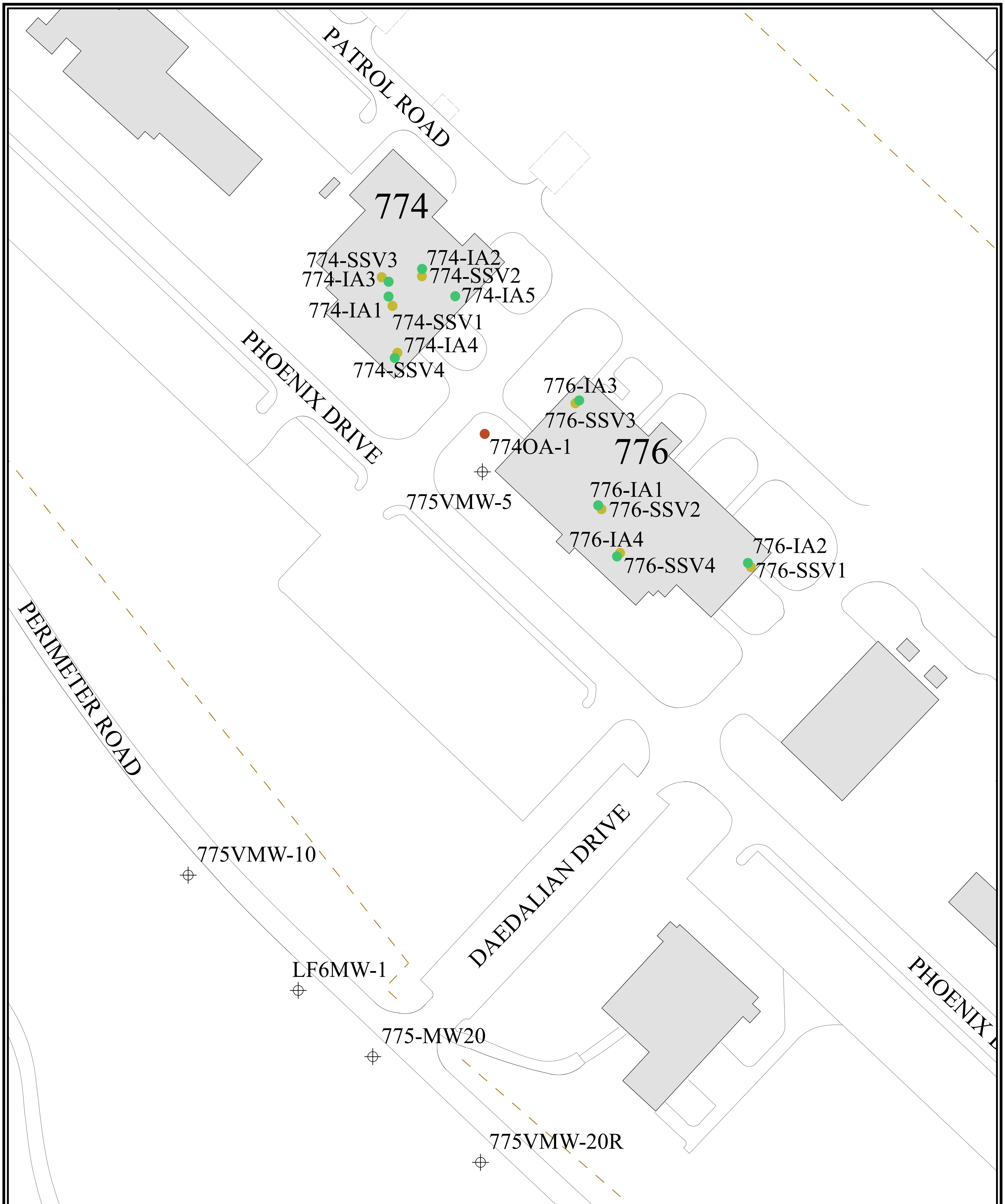
- Four sub-slab vapor samples from beneath Buildings 774 and 776 (each),
- Four indoor air samples from within the building envelope of Buildings 774 and 776 (each),
- One additional indoor air sample was collected in Building 774 in the May 2008 sampling event (due to renovation activity), and
- An outdoor background air sample.

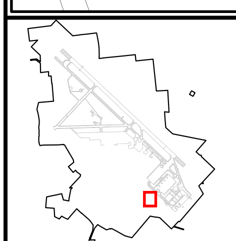
Site inspections and product inventories were recorded for Buildings 774 and 776. A PID was used during the site inspection and total VOC concentrations ranged from 30 to 60 ppb in Building 774 and from 15 to 19 ppb in Building 776. FPM used a digital micro-manometer with logging capability (Graywolf Zephyr II) to track the pressure differential between the indoor air and the sub-slab vapor to evaluate the SVI potential.

The indoor air TCE concentrations reported for Building 774 during the April 2008 sampling round were two orders of magnitude higher than those reported in the 2006 sampling round (Table 2-3). The Building 774 point of contact (Dave Perella) confirmed that renovations were performed in Building 774 between December 2007 and May 2008 which included carpet glue removal including solvent use. Indoor air results for Building 776 were comparable to 2006 results (Table 2-4). Sub-slab vapor results for Building 774 were lower but comparable to 2006 results (Table 2-5). Sub-slab vapor results for Building 776 were one to two orders of magnitude lower than 2006 results (Table 2-6).

Indoor and outdoor air samples were recollected in May 2008 in Building 774. The four indoor air sampling locations sampled in April 2008 were resampled and one additional indoor air sample was collected in the area which was renovated. An outdoor air sample was also collected. The results show that indoor air TCE concentrations comparable to levels reported in 2006.

In both Buildings 774 and 776, the indoor air concentrations are within an acceptable range and do not pose any unacceptable risk to building occupants. Current sub-slab vapor concentrations in Building 774 are within the same order of magnitude as those reported in 2006 and exceed AF screening levels. The sub-slab vapor concentrations reported in Building 776 are lower than those reported in 2006 and do not exceed AF screening levels.





Site Location

Key to Features

Sample Type
- Indoor air
- Outdoor air
- Soil vapor
- Subslab
- Monitoring Well
- Fence
- Demolished Facility
- Existing Facility

FIGURE 2-3
Building 774 and 776
2008 Sample Locations

50 25 0 50 100
Feet

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Table 2-3
Building 774 Short List Indoor Analytical Results December 2006/April 2008

Sample Location	Indoor Air Screening Level (µg/m³) 1	774IA-1			774IA-2			774IA-3	
Sample ID		**774-IA1**	**774IA1BB**	**774IA1CA**	**774-IA2**	**774IA2BB**	**774IA2CA**	**774IA3BB**	**774IA3CA**
Sample Type		**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**
Sample Date		**20-Dec-2006**	**15-Apr-2008**	**29-May-2008**	**20-Dec-2006**	**15-Apr-2008**	**29-May-2008**	**15-Apr-2008**	**29-May-2008**
Sample Depth (ft above ground)		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Sample Collection Duration (hr)	**12**	**8**	**12**	**12**	**8**	**12**	**12**	**12**	**12**
Volatiles (TO-15) in µg/m³									
cis-1,2-dichloroethene (DCE)	102	U	1.57 J	0.685	U	U	U	U	U
trichloroethylene (TCE)	41	2.4	347	3.99	3.4	559	4.21	389	4.70
vinyl chloride (VC)	186	U	0.130 J	U	U	U	U	U	U

Notes:
J- The analyte was positively identified, but the quantitation is an approximation.
U - Not detected.
µg/m³: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial indoor air screening level calculations.
Exceedance of the initial Indoor Air Screening Level.

Table 2-3 (Continued)
Building 774 Short List Indoor Analytical Results December 2006/April 2008

Sample Location	**Indoor Air Screening Level (µg/m³) [1]**	**774IA-4**		**774IA-5**	**774OA-1**		
Sample ID		**774IA4BB**	**774IA4CA**	**774IA5CA**	**774-OA1**	**774OA1BB**	**774OA1CA**
Sample Type		**Indoor**	**Indoor**	**Indoor**	**Outdoor**	**Outdoor**	**Outdoor**
Sample Date		**15-Apr-2008**	**29-May-2008**	**29-May-2008**	**20-Dec-2006**	**15-Apr-2008**	**29-May-2008**
Sample Depth (ft above ground)		**5**	**5**	**5**	**5**	**5**	**5**
Sample Collection Duration (hr)	**12**	**12**	**12**	**12**	**8**	**8**	**8**
Volatiles (TO-15) in µg/m³							
cis-1,2-dichloroethene (DCE)	102	U	U	U	U	U	U
trichloroethylene (TCE)	41	236	2.13	6.61	U	0.492	U
vinyl chloride (VC)	186	U	U	U	U	U	U

Notes:
U - Not detected.
µg/m³: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial indoor air screening level calculations.
Exceedance of the initial Indoor Air Screening Level.

Table 2-4
Building 776 Short List Indoor Analytical Results December 2006/April 2008

Sample Location	**Indoor Air Screening Level ($\mu g/m^3$) [1]**	**776IA-1**		**776IA-2**		**776IA-3**	**776IA-4**
Sample ID		**776-IA1**	**776IA1BB**	**776-IA2**	**776IA2BB**	**776IA3BB**	**776IA4BB**
Sample Type		**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**	**Indoor**
Sample Date		**20-Dec-2006**	**14-Apr-2008**	**20-Dec-2006**	**14-Apr-2008**	**14-Apr-2008**	**14-Apr-2008**
Sample Depth (ft above ground)		**5**	**5**	**5**	**5**	**5**	**5**
Sample Collection Duration (hr)	**12**	**8**	**12**	**8**	**12**	**12**	**12**
Volatiles (TO-15) in $\mu g/m^3$							
cis-1,2-dichloroethene (DCE)	102	U	U	U	U	U	U
trichloroethylene (TCE)	41	4.4	3.28 M	2.9	2.35	2.51	2.62
vinyl chloride (VC)	186	U	U	U	U	U	U

Notes:
M - A matrix effect was reported in the sample.
U - Not detected.
$\mu g/m^3$: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial indoor air screening level calculations.
Exceedance of the initial Indoor Air Screening Level.

Table 2-5
Building 774 Short List Sub-slab Vapor Analytical Results
October 2006/April 2008

Sample Location	**Sub-slab Vapor Screening Level (µg/m³) [1]**	**774SSV-1**		**774SSV-2**		**774SSV-3**	**774SSV-4**
Sample ID		**774-SSV1**	**774SSV1BB**	**774-SSV2**	**774SSV2BB**	**774SSV3BB**	**774SSV4BB**
Sample Type		**SSV**	**SSV**	**SSV**	**SSV**	**SSV**	**SSV**
Sample Date		**24-Oct-2006**	**15-Apr-2008**	**24-Oct-2006**	**15-Apr-2008**	**15-Apr-2008**	**15-Apr-2008**
Sample Depth (ft bgs)		**1**	**1**	**1**	**1**	**1**	**1**
Sample Collection Duration (hr)	**12**	**8**	**12**	**8**	**12**	**12**	**12**
Volatiles (TO-15) in µg/m³							
cis-1,2-dichloroethene (DCE)	1,022	U	U	U	U	0.64	0.60
trichloroethylene (TCE)	409	1,700	490	810	590	66	69
vinyl chloride (VC)	186	U	U	U	U	U	U

Notes:
SSV= Sub-slab vapor.
U: Not detected.
µg/m³: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial sub-slab vapor screening level calculations.
Exceedance of the initial Sub-slab Vapor Screening Levels.

Table 2-6
Building 776 Short List Sub-slab Vapor Analytical Results
October 2006/April 2008

Sample Location	**Sub-slab Vapor Screening Level (μg/m³) [1]**	**776SSV-1**		**776SSV-2**		**776SSV-3**	**776SSV-4**
Sample ID		**776-SSV1**	**776SSV1BB**	**776-SSV2**	**776SSV2BB**	**776SSV3BB**	**776SSV4BB**
Sample Type		**SSV**	**SSV**	**SSV**	**SSV**	**SSV**	**SSV**
Sample Date		**24-Oct-2006**	**14-Apr-2008**	**24-Oct-2006**	**14-Apr-2008**	**14-Apr-2008**	**14-Apr-2008**
Sample Depth (ft bgs)		**1**	**1**	**1**	**1**	**1**	**1**
Sample Collection Duration (hr)	**12**	**8**	**12**	**8**	**12**	**12**	**12**
Volatiles (TO-15) in μg/m³							
cis-1,2-dichloroethene (DCE)	1,022	U	U	U	U	0.64	U
trichloroethylene (TCE)	409	3,000	6.9	700	110	120	230
vinyl chloride (VC)	186	U	U	U	U	U	U

Notes:
SSV= Sub-slab vapor.
U: Not detected.
μg/m³: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial sub-slab vapor screening level calculations.
Exceedance of the initial Sub-slab Vapor Screening Levels.

Discussions between AFRPA, EPA, NYSDOH and NYSDEC have led to an agreement to evaluate a potential remedy to limit the (potential) exposure of receptors to these sub-slab concentrations.

2.2 Buildings 785 and 786

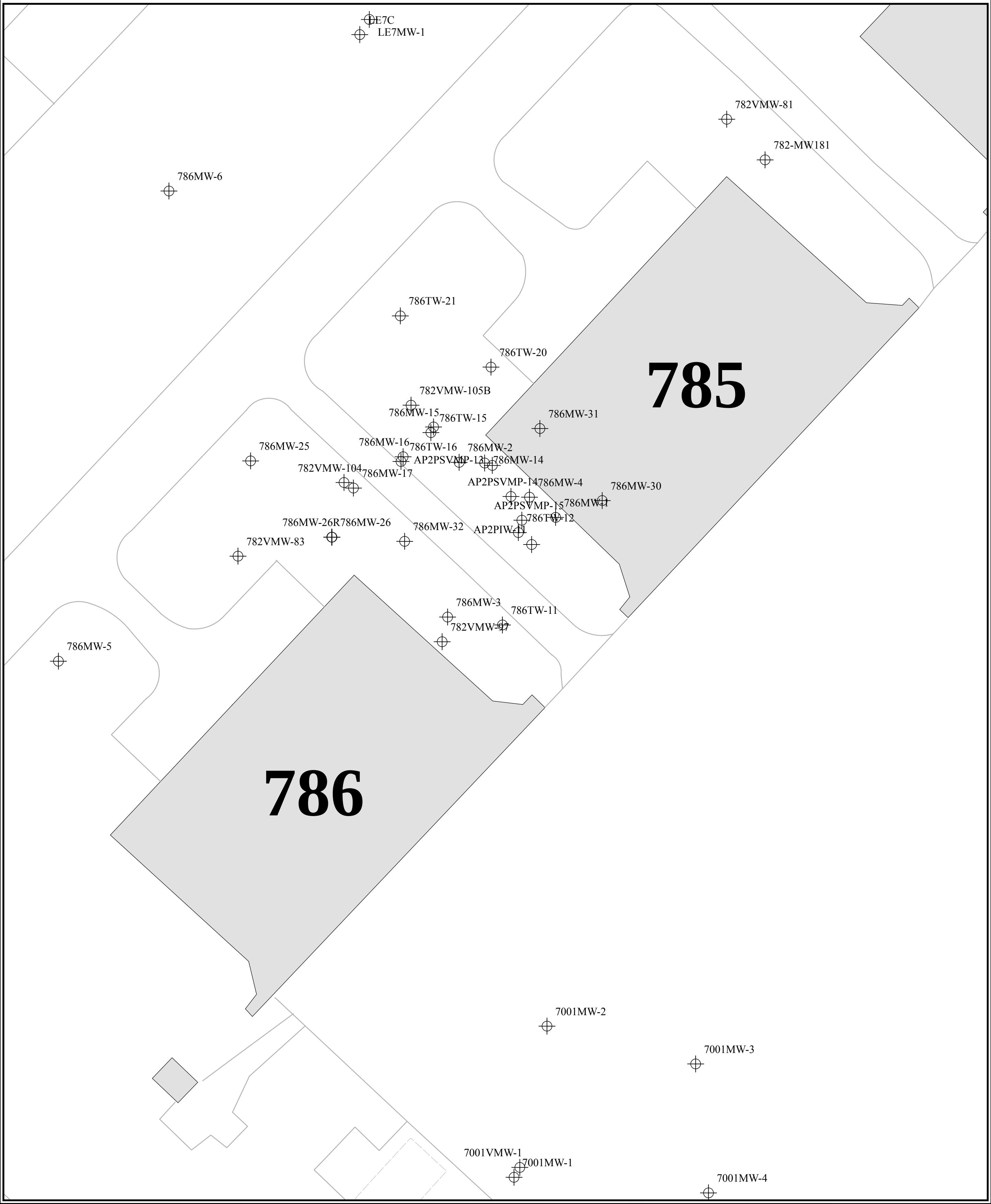
2.2.1 Building Setting

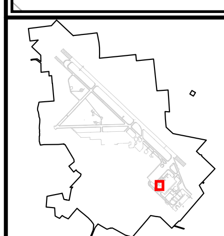
These two buildings are located on the Apron 2 Chlorinated Plume Site (SD-52-01) at the former Griffiss AFB in Rome, NY (Figure 2-4). Building 785 is a 28,251-sq. ft., unoccupied and unheated airplane hangar. The building is largely open with several first and second floor offices in the corners. Building 785 was built in 1959 and was taken out of service in 1995 after the former Griffiss AFB was closed. The building is built on a 13.5 to 14-inch thick unsealed concrete slab. Cracks in the concrete floor were repaired and painted. Two large trenches exist in the building; one along the large aircraft bay doors on the southeast side of the building and a smaller trench along the overhead door on the northwest side of the building. All heating and air handling equipment is in a state of disrepair and assumed inoperable. The building is poorly sealed due to broken windows, doors left ajar and holes observed in the sheet metal outer covering of the building. Several groundwater monitoring wells are currently present in the building. A summary of the building characteristics is provided in Table 2-7 below.

Table 2-7
Building 785 characteristics

Building identification	Building 785
ERP Site Association	SD-52-01/Apron 2
Date constructed	1959
Square feet	28,251 sq ft
Primary use	Storage (Unoccupied, unheated)
Other uses	NA
Type of foundation	Concrete, slab on grade, 13.5 to 14 inches thick.
Comments on foundation	Cracks in floor have been repaired. Unfinished concrete slab.
Exterior sealing	Unsealed, hangar doors are open, windows are broken.

Similar to Building 785, Building 786 is a 28,251-sq. ft., unoccupied and unheated airplane hangar. The building is largely open with several first and second floor offices in the corners. Building 786 was built in 1959 and was taken out of service in 1995 after the former Griffiss AFB was closed. The building was occupied for a few years by a pallet refurbishing company and was fully vacated in 2003. The building is built on a 13.5 to 14-inch thick unsealed concrete





Key to Features

- Monitoring Well
- Airfield
- Demolished Facility
- Existing Facility

FIGURE 2-4
Buildings 785 and 786
Site Layout Map

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50 25 0 50 100
Feet

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February 2, 2008

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slab. The concrete slab floor is in good condition. Two large trenches exist in the building; one along the large aircraft bay doors on the southeast side of the building and a smaller trench along the overhead door on the northwest side of the building. All heating and air handling equipment is in a state of disrepair and assumed inoperable. The building is poorly sealed due to broken windows, doors left ajar and holes observed in the sheet metal outer covering of the building. A summary of the building characteristics is provided in Table 2-8 below.

Table 2-8
Building 786 characteristics

Building identification	Building 786
ERP Site Association	SD-52-01/Apron 2
Date constructed	1959
Square feet	28,251 sq ft
Primary use	Storage (Unoccupied, unheated)
Other uses	NA
Type of foundation	Concrete, slab on grade, 13.5 to 14 inches thick.
Comments on foundation	Floor was found to be in good condition. Unfinished concrete slab.
Exterior sealing	Unsealed, hangar doors are open, windows are broken.

2.2.2 Hydrogeological Setting

Buildings 785 and 786 are located between Apron 1 and 2, facing southeast with bay doors opening to Apron 2. The immediate area around the building is flat, mostly covered with reinforced concrete (Aprons) and has little or no elevation difference. A groundwater divide exists at Building 786, which causes virtually stagnant groundwater near Buildings 785 and 786 in the area allowing for contamination to stay under the building for longer periods than under normal groundwater flow situations. Past investigations have indicated that at Building 785 and north, the groundwater flow direction is in the northeasterly direction towards Six Mile Creek.

2.2.3 Site Background

Buildings 785 and 786 are also known as Nosedocks 4 and 5. They are part of the group of Nosedocks (1 through 5) which are located on the northwestern side of Apron 2. They were built in 1959 and were used as maintenance facilities for B-52 bombers until base closure in 1995.

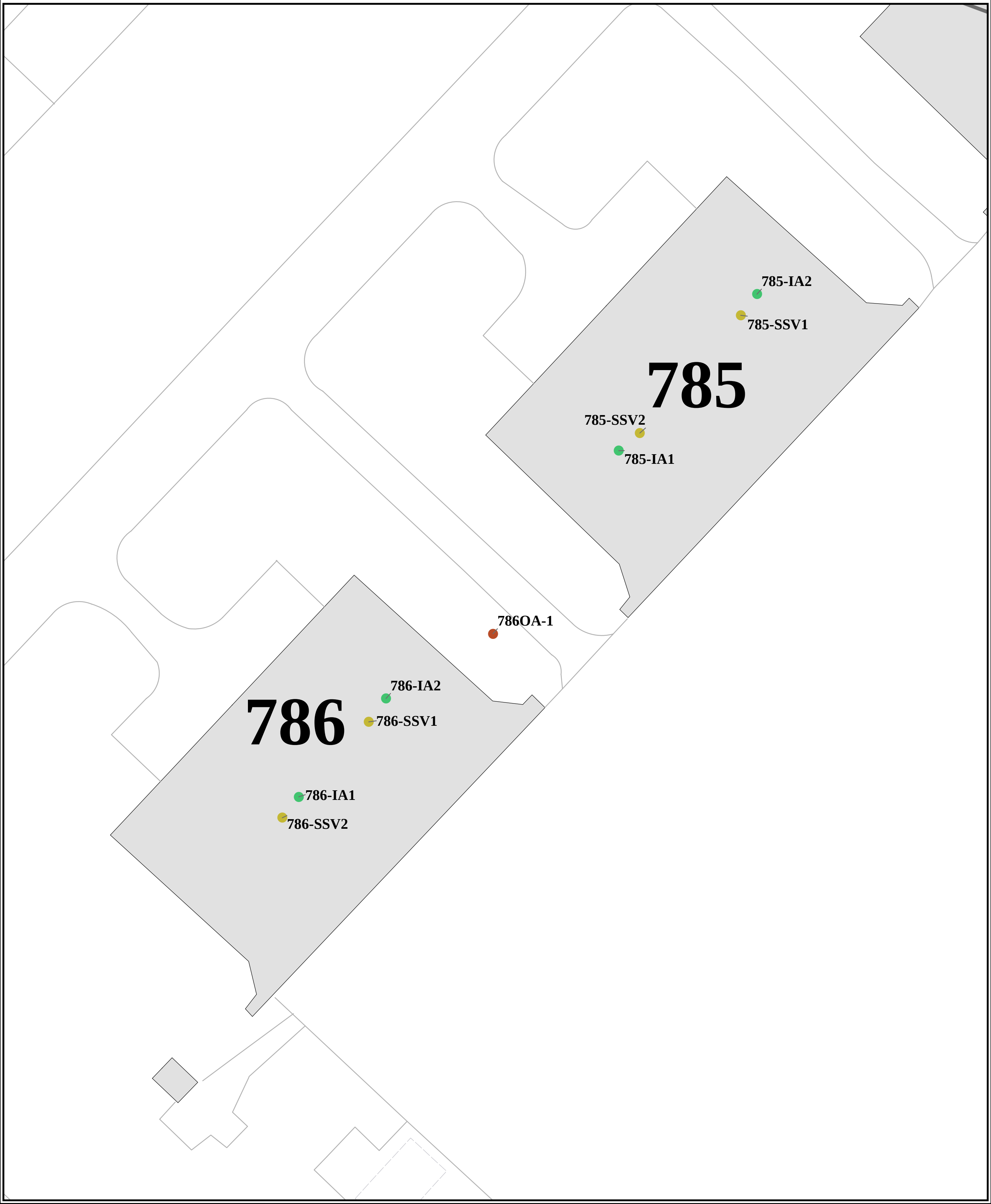
2.2.4 Summary of Previous Investigations

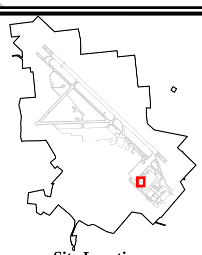
FPM performed a Remedial Investigation (RI) in 2002 and 2003. A chlorinated plume was delineated at Apron 2 and surrounding areas. This chlorinated VOC contamination associated with the Apron 2 chlorinated plume site is present in two plumes, referred to as the southern and northern plumes. The southern plume is approximately 2,800 ft long and 500 ft wide and appears to originate in the area of the nosedock wash water system near Building 786. The northern plume is smaller (480 ft long) and appears to originate along the sewer system north of Building 782. Chlorinated solvent probably was used in all nosedock facilities, and multiple small sources could exist along floor drains, sewer lines, and oil water separators (See Figure 3-1 in FPM, April 2004).

There are three primary contaminants in the plumes that exceed NYSDEC Class GA Groundwater Standards: TCE and its daughter products cis-1, 2 DCE and vinyl chloride (VC).

The contaminated aquifer is located at 9 to 25 ft bgs, with the shallow depth near Six Mile Creek. The aquifer is composed of several well-defined layers, including a silty-sand layer in the upper 5 ft, a 5- to 15 foot-thick coarse sand and gravel layer in the middle of the aquifer, and a 15- to 20-foot thick layer of till composed of fine sand, silt, and gravel resting on the shale bedrock. The total aquifer thickness ranges from 45 ft in the source areas to less than 20 ft in the downgradient areas near Six Mile Creek. Although the site has a relatively flat gradient, the high hydraulic conductivity of gravel layers has produced an estimated average groundwater velocity of 106 ft per year across the entire Apron 2. This velocity seems reasonable, given the 2,800 ft the VOC plume has migrated (FPM, February 2005).

The southern plume is commingled with several petroleum fuel plumes originating from the Apron 2 fueling system. At locations where TCE and fuel contaminants are commingled, significant reductive dechlorination is occurring and TCE is almost totally degraded to cis-1, 2 DCE and VC. In April 2005, the maximum groundwater TCE concentration was 24 $\mu g/m^3$, detected in the northern plume at well 782VMW97. The level of TCE has been steadily decreasing in both plumes and it appears that no significant source of TCE remains at the site. In April 2005, the maximum cis-1,2 DCE concentration was 54 $\mu g/m^3$ in well 782MW10, located in the southern plume in an area with commingled fuel contamination. The maximum VC concentration was 130 $\mu g/m^3$ at well 782MW-96, which is also located in the center of fuel-contaminated groundwater. The commingled fuel plume is providing significant reductions in TCE and cis-1,2 DCE through well-documented reductive dechlorination processes (AF, August 2004). At many locations, methyl tert butyl ether (MTBE) and benzene are also present at levels exceeding NYSDEC Class GA Groundwater Standards (FPM, February 2005). High petroleum contaminants might interfere with low detection limits for chlorinated solvents and the lab had standard operating procedures (SOPs) in place to alleviate any potential issues (FPM, April 2004).





Site Location

Key to Features

- Indoor air
- Outdoor air
- Soil vapor
- Subslab
- Airfield
- Demolished Facility
- Existing Facility

FIGURE 2-5
Buildings 785 and 786
2006 Sample Locations

50 25 0 50 100
Feet

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2.2.4.1 Previous SVI Investigations

2.2.4.1.1 2006 SVI Survey

As part of the On-Base Groundwater PBC contract, EEEPC performed an initial SVI survey at Buildings 785 and 786 between October 2006 and February 2007. The following samples were collected as part of this investigation (Figure 2-5):

- No soil vapor samples were collected in October 2006 from around Buildings 785 and 786 because the soil was saturated from ground surface to more than 8 ft bgs and NYSDOH guidelines suggest that no sample be collected under these conditions.
- Ten sub-slab vapor samples and one duplicate were collected in October 2006. Two samples from each building were collected from beneath the concrete floors of Buildings 782, 783, 784, 785, and 786 (two samples were collected due to the large size of each of the buildings). The samples were centrally located within the buildings because the center of a building typically exhibits the highest levels of sub-slab soil vapor.
- Two indoor air samples were collected from Buildings 785 and 786 each and one duplicate was collected in December 2006 after evaluation of the sub-slab sampling results. The indoor air samples were collected in the same locations as the sub-slab samples previously collected.
- Simultaneous with the indoor air samples, one outdoor air sample (ambient) was collected from between Buildings 785 and 786.

At Building 785, the results show two detections in sub-slab samples; chloroform was detected at 190 µg/m3 (785SSV1) and TCE was detected at levels up to 11,000 µg/m3 (785-SSV1). The results for Building 786 show TCE detections in the sub-slab samples up to 81,000 µg/m^3 (786-SSV1) and in the indoor samples up to 0.43 µg/m^3. Several other COCs (e.g. benzene) were reported in the sub-slab vapor and indoor samples, but were below screening levels, detected in the outdoor air sample, or not deemed to be a COC at these sites (AF, October 2007).

Site inspections and product inventories were recorded for Buildings 785 and 786. A ppbRAE meter was used to measure VOC concentrations throughout the buildings and total VOC concentrations ranged from 0 to 2,800 ppb. Several pallets were noted near the southwest side of Building 785 which held pails, paint cans, buckets and motor oil drums. In Building 786, a forklift, compressed gas and propane cylinders, a quart bottle or motor oil and an empty 5-gallon pail of hydraulic oil were reported. The highest concentration was detected in the general holding area for drums and cans in Building 785 and no potential sources of the COCs present in the Apron 2 groundwater plume (i.e., PCE, TCE, DCE, or VC) were observed during the inventories of Building 785 or 786 (AF, October 2007).

No detection exceeding screening levels were reported for Buildings 782, 783, and 784, so SVI was not deemed a concern for these buildings. Sub-slab sampling at the Apron 2 Chlorinated Plume Site indicates that chloroform, PCE, and TCE are present in the sub-slab vapor beneath Buildings 785 and 786 at concentrations above AF screening levels; indoor air sampling indicates that these contaminants are present, but at concentrations below the AF screening levels (it should be noted that neither of the buildings are airtight). Although TCE was detected in samples from wells within the groundwater contamination plume located in the area, chloroform has not been detected at levels above screening levels in the groundwater.

2.2.4.1.2 2008 SVI Evaluation

FPM performed a follow-up SVI investigation at Building 785 and 786 in April 2008 to confirm the results of the 2006 SVI survey. Please note that in meetings between AFRPA, AFIOH, NYSDOH, and USEPA, it was decided that "chloroform has been determined not to be a constituent of concern " (Appendix A).

The following samples were collected (Figure 2-6):

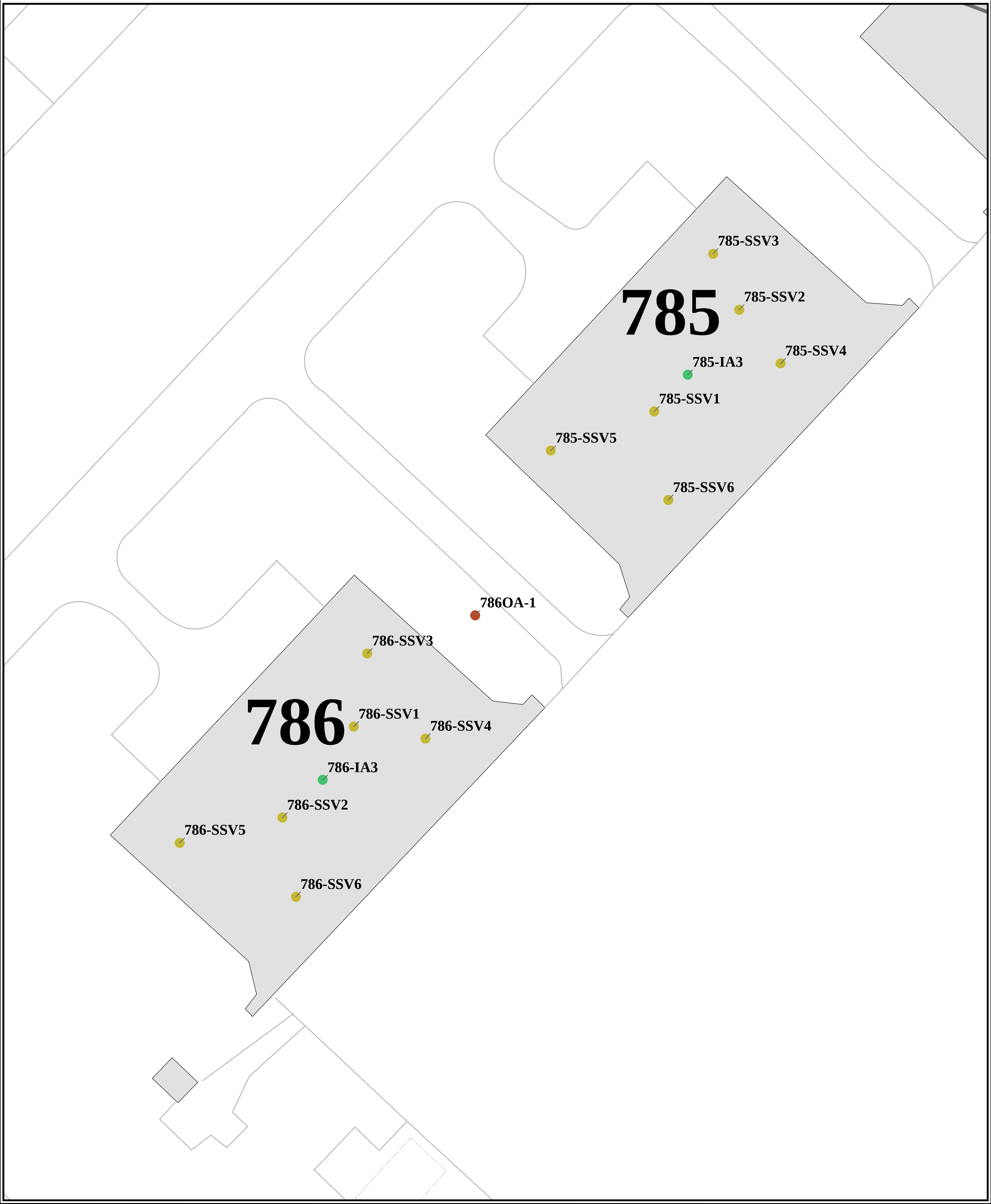
- Six sub-slab vapor samples from Building 785 and 786 each,
- One indoor air sample from Building 785 and 786 each, and
- One outdoor air sample from between Buildings 785 and 786.

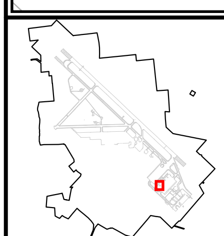
Site inspections and product inventories were recorded for Buildings 785 and 786. A ppbRAE meter was used during the site inspections and total VOC readings were 0 ppb in Building 785 with higher readings (up to 11.4 ppm) in the immediate vicinity (< 1 inch) of the miscellaneous drums, pails and cans on the southwestern side of Building 785. Total VOC concentrations in Building 786 were 0 ppb in the entire building. A higher reading (> 8.0 ppm) was recorded at the uncapped fuel filler stem of the old stake bed truck which was located within Building 786. Readings were 0 ppb at a foot or more away from the pallets or fuel filler stem, therefore their impact on indoor air quality appears limited. FPM used a digital micro-manometer with logging capability (Graywolf Zephyr II) to track the pressure differential between the indoor air and the sub-slab vapor to evaluate the SVI potential.

When the sample canisters were being collected, it was discovered that the sample canister for sub-slab vapor sampling location 6 in Building 785 was not in its original location. The canister, regulator, tubing, modeling clay and air filter were tossed on a pile of old car tires and the sampling location in the concrete was exposed. The head of air field security (Mr. Ed Arcuri) was contacted and was told of the situation. The sample container was compromised and replaced. The sample was recollected together with the Building 786 samples.

The indoor air TCE concentrations reported for Building 785 during the April 2008 sampling round were similar in magnitude as those reported in the 2006 sampling round (Table 2-9). A small TCE detection was reported (0.655 µg/m3) and several small petroleum detections. Indoor air results for Building 786 were comparable to 2006 results; no PCE or daughter products were detected and several small petroleum VOC detections were reported (Table 2-10). Sub-slab vapor results for Building 785 were one to two orders of magnitude lower than the 2006 results (Table 2-11). One TCE exceedance of the AF screening levels was reported for sampling location 785-SSV6. Sub-slab vapor results for Building 786 were lower but of the same order of magnitude as the 2006 results (Table 2-12). Four TCE exceedances were reported at sampling locations 786-SSV1, -SSV2, -SSV5, and -SSV6.

In both Buildings 785 and 786, indoor air concentrations are within an acceptable range and do not pose any unacceptable risk to future building occupants (it should be noted that these buildings are not airtight). Current sub-slab vapor concentrations are lower than those reported in 2006 but still exceed AF screening levels. Discussions between AFRPA, EPA, NYSDOH, and NYSDEC have led to an agreement to evaluate a potential remedy to limit the (potential) exposure of receptors to these sub-slab concentrations.





Site Location

Key to Features

- Indoor air
- Outdoor air
- Soil vapor
- Subslab
- Airfield
- Demolished Facility
- Existing Facility

FIGURE 2-6
Buildings 785 and 786
2008 Sample Locations

50 25 0 50 100
Feet

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February 2, 2009

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Table 2-9
Building 785 Short List Indoor Analytical Results
December 2006/April 2008

Sample Location	Indoor Air Screening Level ($\mu g/m^3$) [1]	785-IA1	785-IA2	785-IA3
Sample ID		785-IA1	785-IA2	785IA3BB
Sample Type		Indoor	Indoor	Indoor
Sample Date		20-Dec-2006	20-Dec-2006	17-Apr-2008
Sample Depth (ft above ground)		5	5	5
Sample Collection Duration (hr)	12	12	12	12
Volatiles (TO-15) in $\mu g/m^3$				
1,2,4-trimethylbenzene	NA	NA	NA	1.30
1,3,5-trimethylbenzene	NA	NA	NA	0.650 F
benzene	88	1.1	1.1	0.617
cis-1,2-dichloroethene (DCE)	102	U	U	U
ethylbenzene	743	NA	NA	0.441 F
m,p-xylene (sum of isomers)	292	NA	NA	1.28 F
naphthalene	NA	NA	NA	1.33
o-xylene	292	NA	NA	0.485 F
tetrachloroethylene (PCE)	102	U	U	U
toluene	NA	NA	NA	2.72
trichloroethylene (TCE)	41	U	U	0.655
vinyl chloride (VC)	186	U	U	U

Notes:
F - The result was detected between the MDL and RL.
NA - Not available. The COC was not analyzed for.
U - Not detected.
$\mu g/m^3$: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial indoor air screening level calculations.

Table 2-10
Building 786 Short List Indoor and Outdoor Analytical Results
December 2006/April 2008

Sample Location	Indoor Air Screening Level ($\mu g/m^3$) [1]	786-IA1	786-IA2	786-IA3	786-OA1	
Sample ID		786-IA1	786-IA2	786IA3BB	786-OA1	786OA1BB
Sample Type		Indoor	Indoor	Indoor	Outdoor	Outdoor
Sample Date		20-Dec-2006	20-Dec-2006	18-Apr-2008	20-Dec-2006	18-Apr-2008
Sample Depth (ft above ground)		5	5	5	5	5
Sample Collection Duration (hr)	12	8	8	12	12	12
Volatiles (TO-15) in $\mu g/m^3$						
1,2,4-trimethylbenzene	NA	NA	U	0.749	U	0.949
1,3,5-trimethylbenzene	NA	NA	U	U	U	U
benzene	88	1.2	1.2	0.747	0.96	0.617
cis-1,2-dichloroethene (DCE)	102	U	U	U	U	U
ethylbenzene	743	NA	NA	U	NA	U
m,p-xylene (sum of isomers)	292	NA	NA	0.750 F	NA	0.883 F
naphthalene	NA	NA	NA	1.01 J	NA	U
o-xylene	292	NA	NA	U	NA	0.441 F
tetrachloroethylene (PCE)	102	U	0.896 F	U	U	U
toluene	NA	NA	NA	1.92	NA	1.49
trichloroethylene (TCE)	41	0.43 J	U	U	U	U
vinyl chloride (VC)	186	U	U	U	U	U

Notes:
J- The analyte was positively identified, but the quantitation is an approximation.
U - Not detected.
NA- Not Available.
$\mu g/m^3$: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial indoor air screening level calculations.

Table 2-11
Building 785 Short List Sub-slab Vapor Analytical Results
October 2006/April 2008

Sample Location	**Sub-slab Vapor Screening Level (µg/m³) 1**	**785-SSV1**		**785-SSV2**		**785-SSV3**	**785-SSV4**	**785-SSV5**	**785-SSV6**
Sample ID		**B785-SSV1**	**785SSV1BB**	**B785-SSV2**	**785SSV2BB**	**785SSV3BB**	**785SSV4BB**	**785SSV5BB**	**785SSV6BB**
Sample Type		**SSV**	**SSV**	**SSV**	**SSV**	**SSV**	**SSV**	**SSV**	**SSV**
Sample Date		**24-Oct-2006**	**17-Apr-2008**	**24-Oct-2006**	**17-Apr-2008**	**17-Apr-2008**	**17-Apr-2008**	**17-Apr-2008**	**18-Apr-2008**
Sample Depth (ft bgs)		**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
Sample Duration (hr)	**12**	**8**	**12**	**8**	**12**	**12**	**12**	**12**	**12**
Volatiles (TO-15) in µg/m³									
1,2,4-trimethylbenzene	175	NA	1.9 M	NA	2.3 M	2.9 M	4.0 M	3.4 M	9.0 M
1,3,5-trimethylbenzene	175	U	0.70 F	U	0.90 M	1.1 M	1.6 M	1.6 M	3.5 M
benzene	105	U	10	15	3.5 J	17	19 M	14	20
cis-1,2-dichloroethene (DCE)	1,022	75	13	U	0.69 J	0.48 F	14 M	0.52 F	56.00
ethylbenzene	743	U	1.0 M	U	1.9 M	1.8 M	2.4 M	3.0 M	4.0 M
m,p-xylene (sum of isomers)	2,920	U	2.7 M	U	4.4 M	6.3 M	8.8 M	10 F	12 F
Naphthalene	NA	NA	1.2 M	NA	1.9 M	1.2 M	1.4 M	1.8 M	1.6 M
o-xylene	2,920	U	1.1 M	U	1.6 M	1.9 M	2.8 M	4.9 M	3.3 M
tetrachloroethylene (PCE)	139	U	U	U	U	U	U	U	U
toluene	146,000	60	5.5 M	13	5.1 M	12 M	18 M	64	28 M
trichloroethylene (TCE)	409	11,000	110	2,300	430 J	220	11 M	180	2,200
vinyl chloride (VC)	186	U	U	U	U	U	U	U	U

Notes:
J- The analyte was positively identified, but the quantitation is an approximation.
M= A matrix effect was reported in the sample.
NA= Not available.
SSV= Sub-slab vapor
U: Not detected.
µg/m³: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial sub-slab vapor screening level calculations.
Exceedance of the initial Sub-slab Vapor Screening Levels.

Table 2-12
Building 786 Short List Sub-slab Vapor Analytical Results
October 2006/April 2008

Sample Location	Sub-slab Vapor Screening Level (μg/m^3) 1	786SSV-1		786SSV-2		786SSV-3	786SSV-4	786SSV-5	786SSV-6
Sample ID		B786-SSV1	786SSV1BB	B786-SSV2	786SSV2BB	786SSV3BB	786SSV4BB	786SSV5BB	786SSV6BB
Sample Type		SSV	SSV	SSV	SSV	SSV	SSV	SSV	SSV
Sample Date		24-Oct-2006	18-Apr-2008	24-Oct-2006	18-Apr-2008	18-Apr-2008	18-Apr-2008	18-Apr-2008	18-Apr-2008
Sample Depth (ft bgs)		1	1	1	1	1	1	1	1
Sample Collection Duration (hr)	12	8	12	8	12	12	12	12	12
Volatiles (TO-15) in μg/m^3									
1,2,4-trimethylbenzene	175	NA	3.9 M	NA	4.8 M	4.5 M	4.2 M	170	4.8 M
1,3,5-trimethylbenzene	175	U	1.6 M	U	1.8 M	1.7 M	1.5 M	58	2.0 M
benzene	105	U	29	24 J	21	21	35	36 M	16
cis-1,2-dichloroethene (DCE)	1,022	480	230	U	12	1.2 M	U	3.1 M	5.4
ethylbenzene	743	U	2.3 M	U	3.1 M	2.3 M	2.9 M	29 M	2.3 M
m,p-xylene (sum of isomers)	2,920	U	9.0 M	U	8.4 F	8.9 M	8.4 F	91 M	9.2 M
naphthalene	NA	NA	1.3 M	NA	2.1 M	2.6 M	1.2 M	27 M	1.5 M
o-xylene	2,920	U	3.0 M	U	3.9 M	2.8 M	3.8 M	57 M	3.0 M
tetrachloroethylene (PCE)	139	2200	70	U	0.97 F	U	U	57 M	23
toluene	146,000	U	21	U	14	12	20	75 M	15
trichloroethylene (TCE)	409	81,000	19,000 J	4,700 J	1,500	69	320	3,600	6,500 M
vinyl chloride (VC)	186	U	U	U	U	U	U	U	U

Notes:
F-
J- The analyte was positively identified, but the quantitation is an approximation.
M- A matrix effect was present in the sample.
NA- Not Available.
U - Not detected.
μg/m^3: microgram per cubic meter.
1. See Appendix E of the Draft SVI evaluation (FPM, October 2007) for the initial sub-slab vapor screening level calculations.
Exceedance of the initial Sub-slab Vapor Screening Levels.

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3 Engineering and Regulatory Basis of the Feasibility Study

This FS has been produced to document the alternatives available for SVI mitigation at Buildings 774, 776, 785, and 786 on the former Griffiss AFB. These buildings were part of the On-Base Groundwater TCE sites and were investigated for SVI potential in 2006 and 2008, as described in detail in Section 2. Currently, they are grouped as part of the SVI OU.

After the initial SVI survey in 2006, a meeting was held between the AFRPA, AFIOH, NYSDEC, NYSDOH, and USEPA on December 13th, 2007 to discuss the SVI survey findings and issues at the former Griffiss and Plattsburgh AFBs in New York State. During this meeting, an agreement was reached that these buildings required additional investigation to confirm the 2006 survey results. This investigation was performed in 2008.

For Buildings 774 and 776, the AF agreed to install sub-slab depressurization indoor air mitigation systems in both buildings as a management decision. For Buildings 785 and 786, the decision was reached to take an appropriate remedial action, such as installing a SVE system under the building, to remove the source. Please note, however, that as was stated earlier in Section1, Introduction, the goal of this FS and proposed work is SVI mitigation for the benefit of the occupants of these buildings, and any potential reduction in contaminant levels in the subsurface is incidental to the goal of this project. The project is not designed to withdraw vapors from the subsurface for the purpose of remediation, but, rather, to prevent any vapors present in the subsurface from entering the buildings. Remediation of any subsurface contamination with intent to meet cleanup goals will be addressed separately. Thus, subsurface cleanup of the source(s) of contaminants in the soil vapor, and remedial alternatives for same, were not evaluated for this criterion in this FS; instead, it will be formally addressed in the ROD after comments are received on its associated RI/FS report and the Proposed Plan.

The meeting minutes are attached in Appendix A.

3.1 Mitigation Goals

Under the direction of the Air Force Real Property Agency (AFRPA), FPM Group assessed the potential for soil vapor intrusion (SVI) at properties with ongoing or planned industrial/commercial use, and, in coordination with the Air Force Institute of Operational Health (AFIOH), documented the baseline assumptions and calculated screening levels for SVI evaluations in a report titled "Assumptions and Screening Levels for Soil Vapor Intrusion Evaluation, Industrial/Commercial Scenario," dated October 2007 (FPM Group, October 2007).

The indoor air screening levels developed in this report for the industrial/commercial scenario are included in Table 3-1. This scenario will be applicable to the Griffiss AFB Buildings 774, 776, 785, and 786. The human health risk-based concentrations established in this guideline (screening values) for inhalation of indoor air utilize conservative assumptions that are intended for SVI screening analysis.

The State of New York does not have any regulatory levels for volatile contaminants in the subsurface. Indoor air quality standards such as the OSHA 8-Hour Time-Weighted Average (TWA) Permissible Exposure Limits (PELs) are typically many orders of magnitude higher than the risk-based screening levels given in Table 3-1. Hence, the screening levels in Table 3-1 have been established as the mitigation goals for indoor air for this SVI project.

Comparing the sampling results in indoor air in the four buildings presented in Section 2 of this report with the mitigation goals in Table 3-1, contaminant levels in indoor air are already below the mitigation goals. Thus, this SVI project is being undertaken very proactively to ensure that indoor levels continue to be below mitigation goals and to comply with programmatic agreements (Appendix A). To serve as a measurable design goal and to further improve the indoor air quality in the process, we set the acceptable goal for concentration of VOCs in indoor air at 1.0 $\mu g/m^3$. However, this is not a pass/fail criterion, but merely an ideal goal to attain subject to cost, convenience, implementability, and other criteria being within practical limits. The mitigation goals of Table 3-1 shall serve as the tracking concentrations for ensuring that the implemented mitigation action is protective of human health and the indoor environment

Control requirements for any discharges of extracted vapors to the outdoor environment will be specified based on meeting the New York State ambient air quality standards and guidelines as determined from using Air Guide 1 for any outdoor discharges of contaminated air. The target levels will be calculated once the actual flow rates are known during system design.

TABLE 3-1
SVI MITIGATION GOALS FOR INDOOR AIR (INDOOR AIR SCREENING LEVELS, INDUSTRIAL/COMMERCIAL SCENARIO)

Analyte	Unit Risk Factor Source[1]	Inhalation Unit Risk Factor (URF) $(\mu g/m^3)^{-1}$	Cancer Indoor Air Risk Based Concentration[2] $(\mu g/m^3)$	Reference Concentration Source[1]	Inhalation Reference Concentration (RfCi) (mg/m^3)	Non-Cancer Indoor Air Risk Based Concentration[3] $(\mu g/m^3)$	Indoor Air Screening Concentration[4] $(\mu g/m^3)$
benzene	IRIS	7.80E-06	105	IRIS	0.030	88	88
carbon disulfide	-	-	-	IRIS	0.700	2,044	2,044
carbon tetrachloride	IRIS	1.50E-05	55	-	-	-	55
chloroform	IRIS	2.30E-05	36	-	-	-	36
chloromethane (methyl chloride)	EPA-NCEA	1.00E-06	818	IRIS	0.090	263	263
allyl chloride (3-chloropropene)	-	-	-	IRIS	0.001	3	3
cyclohexane	-	-	-	IRIS	6.000	17,520	17,520
1,3-dichlorobenzene	-	-	-	EPA-NCEA	0.110	321	321
1,4-dichlorobenzene	-	-	-	IRIS	0.800	2,336	2,336
1,2-dichloroethane	IRIS	2.60E-05	31	-	-	-	31
cis-1,2-dichloroethylene	-	-	-	HEAST	0.035	102	102
ethyl acetate	-	-	-	EPA-NCEA	3.200	9,344	9,344
ethylbenzene	EPA-NCEA	1.10E-06	743	IRIS	1.000	2,920	743
n-hexane	-	-	-	IRIS	0.700	2,044	2,044
freon 11 (trichlorofluoromethane)	-	-	-	HEAST-A	0.700	2,044	2,044
freon 113 (1,1,2-trichlorotrifluoroethane)	-	-	-	HEAST	30.000	87,600	87,600
freon 12 (dichlorodifluoromethane)	-	-	-	HEAST	0.200	584	584
methyl ethyl ketone	-	-	-	IRIS	5.000	14,600	14,600
methyl isobutyl ketone	-	-	-	IRIS	3.000	8,760	8,760
methyl tert-butyl ether (MTBE)	-	-	-	IRIS	3.000	8,760	8,760
methylene chloride (dichloromethane)	IRIS	4.70E-07	1740	HEAST	3.000	8,760	1,740
styrene	-	-	-	IRIS	1.000	2,920	2,920
tetrachloroethylene (pce)	CalEPA	5.90E-06	139	CalEPA	0.035	102	102
toluene	-	-	-	IRIS	5.000	14,600	14,600
1,1,1-trichloroethane	-	-	-	IRIS	5.000	14,600	14,600
trichloroethene (tce)	CalEPA	2.00E-06	41	CalEPA	0.600	1,752	41
1,2,4-trimethylbenzene	-	-	-	EPA-NCEA	0.006	18	18
1,3,5-trimethylbenzene (mesitylene)	-	-	-	EPA-NCEA	0.006	18	18
Vinyl chloride	IRIS	4.40E-06	186	IRIS	0.100	292	186
xylenes, total	-	-	-	IRIS	0.100	292	292

Notes:

" - " Means no value was available to calculate cancer risk based concentrations or non-cancer risk values for this analyte in indoor air.

1. Unit Risk Factors and Reference Concentrations used to calculate target concentrations based on industrial exposure were taken from:
- CalEPA - California Environmental Protection Agency Air Toxics Hot Spots Program. Unit Risk Factors obtained from http://www.oehha.ca.gov/air/hot_spots/pdf/TSDNov2002.pdf. Reference Concentrations obtained from http://www.oehha.ca.gov/air/chronic_rels/AllChrels.html
- EPA-OSWER - United States Environmental Protection Agency (USEPA), OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance), EPA 530-D-02-2004, November 2002 containing Superfund Health Effects Assessment Summary Tables (HEAST), EPA-National Center for Environmental Assessment (NCEA), and HEAST Alternate (HEAST-A) values.
- IRIS - USEPA Integrated Risk Information System (IRIS), Database for Risk Assessment, accessed October 5, 2007 at http://www.epa.gov/iris/

2. Target indoor air cancer concentrations calculated based **1×10^{-4} Target Risk (1×10^{-5} for TCE)**. Industrial exposure assumptions utilized to adjust Unit Risk Factors include an averaging time of 70 years; exposure frequency of 250 days/year; exposure duration of 25 years; and daily inhalation rate of 10 m^3/day (or 12 hours/day exposure).

3. Target indoor air non-cancer concentrations calculated based a **Target Hazard Quotient of 1**. Industrial exposure assumptions utilized to adjust Reference Concentrations include an exposure frequency of 250 days/year and daily inhalation rate of 10 m^3/day (or 12 hours/day exposure).

4. Indoor Air Screening concentrations are based on the lowest of the cancer or non-cancer risk-based concentrations.

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4 Initial Screening of Technologies

In this section, all available technologies that can be considered for SVI mitigation are briefly discussed and screened. The purpose of this chapter is to list all available options and discuss their viability for the buildings discussed in this report, and to narrow the technologies list to the most appropriate technologies, which will be evaluated in detail in the next section (Evaluation of Alternatives). A summary of all technologies and their effectiveness, implementability, and cost is provided in Table 4-1 for Buildings 774 and 776, and in Table 4-2 for Buildings 785 and 786.

4.1 Technology

4.1.1 No Further Action

This technology is included as the default option. No further action implies the current status quo at the sites without performing any action.

Generally, this option is not the preferred method, but it is evaluated to serve as a baseline to compare with other alternatives. The effectiveness of this option is nil, as it leaves significant sub-slab vapor concentrations in place which can affect current or future building occupants. The technical implementability is excellent, as no action is required and the cost is low, as no action is performed. As described in the meeting minutes in Appendix A, the Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776. Also, for Buildings 785 and 786, the Air Force has agreed to take an appropriate remedial action, such as installing a SVE system under the building, to remove the source.[1] Therefore, the commitment of the Air Force to perform some action in all four buildings (774, 776, 785, and 786) effectively nullifies this option. Nevertheless, for baseline comparison purposes, this technology option will be retained for the detailed analysis phase of the FS for all four buildings (774, 776, 785, and 786).

[1]Please note, however, that as was stated earlier in Section 1, Introduction, the goal of this FS and proposed work is SVI mitigation for the benefit of the occupants of these buildings, and any potential reduction in contaminant levels in the subsurface is incidental to the goal of this project. The project is not designed to withdraw vapors from the subsurface for the purpose of remediation, but, rather, to prevent any vapors present in the subsurface from entering the buildings. Remediation of any subsurface contamination with intent to meet cleanup goals will be addressed separately. Thus, subsurface cleanup of the source(s) of contaminants in the soil vapor, and remedial alternatives for same, were not evaluated for this criterion in this FS; instead, it will be formally addressed in the ROD after comments are received on its associated RI/FS report and the Proposed Plan.

4.1.2 Limited Action / Long-Term Monitoring

The Limited Action response involves LTM of a specified duration or indefinite monitoring, as appropriate, to serve as an early warning system for the protection of potential receptors prior to completion of exposure pathways. No active mitigation measures will be conducted.

Monitoring will be performed following a specified schedule (with flexibility included therein to respond to rapidly changing situations or contingencies if such were to occur) of indoor, outdoor, sub-slab, and possibly soil vapors to determine the SVI potential. This technology can be continuous with permanently installed sensors, or periodic with portable monitors.

Table 4-1
Summary of Technologies for Buildings 774 and 776

Technology	Effectiveness	Technical Implementability	Administrative Implementability	Costs
1. No Further Action*	None	Good	None	Low
2. Limited Action / Long-Term Monitoring**	Low-High	Good	None	Low-High
3. Institutional Controls**	Low-High	Good	None	Low-Moderate
4. Monitored Natural Attenuation***	None	None	None	Not Considered
5. Horizontal Piping***	High	Limited	None	High
6. Trenching***	High	Limited	None	High
7. Sumps***	Moderate	Limited	None	Low-Moderate
8. Directional Drilling	High	Good	Good	High
9. Vertical Piping***	High	Limited	None	Moderate
10. Passive Barrier***	High	Limited	None	Moderate
11. HVAC manipulation	High	Good	Good	Low-Moderate
12. Carbon treatment	High	Good	Good	Moderate-High
13. Venting/Dilution	Moderate-High	Good	Good	Low-Moderate
14. Demolition***	High	Low	None	High

Notes:
* This option is retained to provide baseline comparison during detailed analysis.
** This option is eliminated as a standalone option, but retained for detailed analysis as a potential component in FS alternatives involving a combination of technologies.
*** This option is eliminated from further consideration during detailed analysis.
Please note that alternatives 5, 6, 7, 8, and 9 can all be combined with sub-slab depressurization.

All other technologies in this table are retained for further consideration during detailed analysis.

Table 4-2
Summary of Technologies for Buildings 785 and 786

Technology	Effectiveness	Technical Implementability	Administrative Implementability	Costs
1. No Further Action*	None	Good	None	Low
2. Limited Action / Long-Term Monitoring**	Low-High	Good	None	Low-High
3. Institutional Controls**	Low-High	Good	None	Low-Moderate
4. Monitored Natural Attenuation***	None	None	None	Not Considered
5. Horizontal Piping	High	Good	Good	High
6. Trenching	High	Good	Good	High
7. Sumps	Moderate	Good	Good	Low-Moderate
8. Directional Drilling	High	Good	Good	High
9. Vertical Piping	High	Good	Good	Moderate
10. Passive Barrier	High	Moderate	Moderate	Moderate
11. HVAC manipulation****	High	Limited	Limited	Low-Moderate
12. Carbon treatment****	High	Limited	Limited	Moderate-High
13. Venting/Dilution	Moderate-High	Good	Good	Low-Moderate
14. Demolition***	High	Good	Low-Moderate	High

Notes:
* This option is retained to provide baseline comparison during detailed analysis.
** This option is eliminated as a standalone option, but retained for detailed analysis as a potential component in FS alternatives involving a combination of technologies.
*** This option is eliminated from further consideration during detailed analysis.
**** This option is eliminated from further consideration during detailed analysis because the HVAC systems in these buildings are non-operable or are in a state of disrepair.
Please note that alternatives 5, 6, 7, 8, and 9 can all be combined with sub-slab depressurization.

All other technologies in this table are retained for further consideration during detailed analysis.

The monitoring data will be evaluated as it becomes available. For the site, a comprehensive review of prior monitoring data would be conducted every five years to determine whether appropriate mitigation action should be considered at that time, or whether monitoring should be continued or discontinued, as needed.

Monitoring has the potential to be effective in protecting the health of the occupants if the receptor exposures are within safe limits. Its effectiveness is low otherwise, as it does not prevent any exposure to potential vapors; it merely registers the exposure.

The technical implementability is good since continuous monitoring and periodic sampling methodologies are available, and minor changes to the building interior or exterior are required (typically limited to installation of permanent sensors or monitoring points). Interference with building activities is limited to sensor or monitoring point installation, and, when manual monitoring/sampling is needed, monitoring rounds generally take a few hours on two consecutive days. As noted earlier in Section 4.1.1, the Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in Buildings 774 and 776 and has agreed to take an appropriate remedial action, such as installing a SVE system under the building, to remove the source for Buildings 785 and 786. However, this FS addresses only mitigation of SVI in the buildings as was discussed before (see, for example, Footnote 1 in Section 4.1.1, No further Action).

The initial cost is low to moderate, depending on any permanent sensor or monitoring point installation. Operation costs are low for limited portable monitoring, moderate for permanent sensors to high for monitoring points, due to recurring cost for lab analysis and consultant fees.

However, scenarios are possible in which mitigation actions can be conducted until the main concerns are alleviated or reduced, followed, cost effectively, by long-term or indefinite monitoring or residual vapors. Hence, this technology option is eliminated as a standalone solution because it is administratively not implementable, but is retained for detailed analysis as a complement to other mitigation actions for all four buildings (774, 776, 785, and 786).

4.1.3 Institutional Controls

Institutional Controls are not technologies, but rather consist of non-technical or legal controls that are implemented to reduce or prevent the potential for human exposure to contaminants. This category of response action may include deed restrictions and other administrative LUCs such as zoning restrictions, or engineering controls such as access restrictions.

All four buildings (774, 776, 785, and 786) are located within the former Griffiss AFB, and are industrial/commercial sites that are not intended for future residential use. All current and future receptors at all of the sites are therefore industrial/commercial workers. The site use is currently restricted to industrial/commercial use via deed/lease restrictions.

For the same reasons cited in Sections 4.1.1 and 4.1.2, this technology option is eliminated as a stand-alone solution because it is administratively not implementable, but is retained for detailed analysis as a complement to other mitigation actions for all four buildings (774, 776, 785, and 786).

4.1.4 Monitored Natural Attenuation

Current USAF policy requires the evaluation of monitored natural attenuation (MNA) for all base FSs. It (MNA) is a response that uses ongoing physical, chemical, and/or natural biological processes to reduce the concentrations of contaminants, including biodegradation, abiotic degradation, sorption, volatilization, and dispersion. However, the subject of this FS is to address contaminant vapor mitigation in Buildings 774, 776, 785, and 786, which can persist in the subsurface at low concentrations even as the main source of contamination depletes. Since the aim includes addressing potential long-term health concerns even when contaminant vapor concentrations are low, MNA will not be effective in achieving the desired goals of the project in a finite time scale. Thus, this technology option is eliminated from further consideration in this FS. Any MNA that may be naturally occurring at the site will provide incidental relief to the mitigation actions that are undertaken under this project.

4.1.5 Horizontal Piping

This technology includes the installation of horizontal piping under the building slab and is used in conjunction with sub-slab depressurization. This piping can be either installed before the building foundation and slab are installed or, in the case of existing buildings, by cutting through and installing underneath the existing slab.

The effectiveness of this option is high, as the piping will accumulate the sub-slab vapors, which then can be transported from under the slab either by passive venting or by active withdrawal under induced negative pressure. The implementability is good in non-occupied buildings (e.g., Buildings 785 and 786) as it will not interfere with building use. In occupied buildings (e.g., Buildings 774 and 776), underslab installation is a viable option. The costs are high as it involves cutting concrete slab, trench excavation and piping installation, and backfilling and slab reconstruction, in addition to any potential repairs to existing carpeting and other interior fixtures.

Horizontal piping is considered for detailed analysis for Buildings 785 and 786 due to their open floor plan and unoccupied status. Buildings 774 and 776 are currently occupied, with a significant amount of sensitive electronic equipment installed securely in-place. The operation of the equipment and the work performed by the high security personnel may not be disrupted without strong justification. Therefore, since the technical and administrative implementability is limited and other more implementable options are available, the horizontal piping option is eliminated from further consideration for Buildings 774 and 776.

4.1.6 Trenching

Trenching is a technology which includes the installation of trenches through the existing concrete slab to capture the sub-slab vapors in conjunction with sub-slab depressurization. The top of the trench will be sealed air-tight and there will be no concrete or other impermeable finish applied to the sides (below floor slab) and bottom of the trench, i.e., the sides and bottom are open to the subsurface soils to allow for vapor flow into the trench. The vapors are extracted through a pipe installed in the trench, either by passive venting or by active withdrawal under induced negative pressure. This technology can be implemented at any length, depth, and location within a building, and accurately completed. Existing trenches can also be used if they are of proper design and condition, and are suitably located.

The effectiveness of new trenching is good, as the technology can be installed as designed, which should result in sufficient capture of the sub-slab vapors. The effectiveness of existing trenches is good if they can be modified as needed to fit the design for vapor recovery. The implementability of new trenching is good for unoccupied buildings with relatively open floor plans. For occupied and finished buildings, this is generally not an option, due to the intrusive nature of the installation. The cost of trenching is high, due to the work involved in cutting the slab, installing the trench, and finishing the installation.

This technology is not considered for Buildings 774 and 776 because there are no existing trenches that can be modified for vapor recovery purposes, and installation of new trenches is not implementable due to the current occupancy of the buildings and the intrusiveness of the installation. This technology is considered an option for detailed analysis for Buildings 785 and 786. The open floor plan and unoccupied status of these buildings (785 and 786) makes installation of new trenches in them feasible. Also, each of these buildings contain a large trench on both the northwest and southeast sides underneath the floor slab, which have the potential for being converted into vapor recovery trenches subject to meeting engineering design requirements.

4.1.7 Sumps

In this technology option, sumps are used to create a pathway for sub slab vapor to evacuate from below the building slab and this technology is used in conjunction with sub-slab depressurization. The sump will essentially function as a large size vapor extraction well. The top opening of the sump will be closed air-tight and there will be no concrete or other impermeable finish applied to the sides (below floor slab) and bottom of the sump, i.e., the sides and bottom are open to the subsurface soils to allow for vapor flow into the sump. The vapors are extracted through a pipe installed in the sump, either by passive venting or by active withdrawal under induced negative pressure. Since similar vapor capture results can be achieved by vapor extraction wells of much smaller diameter, generally, this technology is used in existing buildings where existing sumps are present which can be modified for their intended purpose.

The effectiveness of sumps depends greatly on the number, location, and size of said structures, and on whether the vapor recovery is passive or active. The implementability is also strongly dependent on the presence of existing sumps and trenches, and, if they are not present, on the feasibility of constructing new sumps in existing buildings. Cost can be low when existing sumps provide good aerial coverage and modifications are limited. Cost will increase if sumps have to be installed or large modifications are needed.

Sumps are considered for detailed analysis for Buildings 785 and 786 because of the open floor plan and unoccupied status of these buildings, which makes installing new sumps feasible. This technology is not considered for Buildings 774 and 776, because no sumps exist in Building 776 and one small sump exists in Building 774 which is limited in area of influence, and since installation of new sumps in these buildings (774 and 776) is not implementable due to the current occupancy of the buildings and the intrusiveness of the installation.

4.1.8 Directional Drilling

Directional drilling is a technology which includes the installation of horizontal piping under the floor slab of a building by drilling from the outside. This technology is used in conjunction with sub-slab depressurization. The sub-slab vapors are removed from under the building through the installed directional piping, which is typically oriented in a generally horizontal direction, either by passive venting or by active withdrawal under induced negative pressure. The depth of installation depends on the existing utilities, foundations and soil characteristics. This technology has minimal impact on interior building activities.

The effectiveness of directional drilling is high, because directional drilling can be performed at virtually any building. The implementability is good, as it interferes minimally with building activities. The cost is high; installation accounts for a major portion of the cost and operational costs are variable depending on installation options.

Directional drilling as a technology is a good option for all four Buildings (774, 776, 785, and 786), and is, therefore, retained for detailed analysis in this FS.

4.1.9 Vertical Piping

Vertical piping is a technology which includes the installation of venting points vertically through the slab and is used in conjunction with sub-slab depressurization. The number of venting points depends on the size of the building, the area of influence of each venting point and the technology used during venting.

The effectiveness of vertical piping is high. When accurately designed and installed, it will create a path for sub-slab vapors to be removed from under the slab. The implementability is good, but the installation includes the drilling and piping of potentially multiple vertical venting points, which are either vented separately or through a manifold. Vertical piping installation and the final installed system interfere with building activities. Installation costs are moderate and operational costs are variable depending on installation options.

This technology is not considered for Buildings 774 and 776, due to their occupancy and the intrusiveness of the installation and operation, but is retained as an option for detailed analysis for Buildings 785 and 786.

4.1.10 Passive Barrier

Passive barrier is a technology which includes the installation of a passive barrier between the soil gas and the building envelope (indoor air). A concrete floor slab may provide partial protection as a passive barrier depending on its thickness and composition (admixtures), permeability, and integrity. Due to the inherent porosity of concrete, even under the best of conditions just described, a vapor barrier system consisting of the floor slab is often complemented by applying a vapor barrier coating (e.g., epoxy coating) on its surface inside the building. However, most if not all slabs are compromised (expansion joint, crack, sump, drain, etc), which negates its task as passive barrier. Generally, a passive barrier in SVI mitigation refers to an applied material above or below the slab which is specifically applied to act as a barrier. Examples are epoxy coating (above the slab) or geomembrane (below the slab).

The effectiveness of a well designed and installed passive barrier is good. The effectiveness is dependent on its low permeability and high integrity. Ensuring the integrity of a passive barrier can become an issue if building activities compromise or degrade the epoxy coating or if building renovations unintentionally puncture the geomembrane below the slab, requiring some administrative controls to avoid such occurrences. The implementability of epoxy coating is good in unoccupied or lightly used buildings, especially when buildings have open floor plans. On the contrary, implementability is limited or very costly in buildings which are highly divided or finished with tile, carpet, or wood floors. The implementability of geomembrane is limited to new construction only, as it is generally applied to the building outline before the slab is poured. Costs are moderate for geomembrane and epoxy coating.

The epoxy coating passive barrier is not considered for detailed analysis for Buildings 785 and 786 due to the buildings' usage for storing Griffiss International Airport (GIA) maintenance equipment (mowers, snow blowers, snow plows, sanders, etc) which can easily damage the epoxy coating and negative it's effectiveness, and is not considered for Buildings 774 and 776, due to their finished status and occupancy. The geomembrane technology is not considered for any of the buildings, because its application is limited to new construction.

4.1.11 HVAC Manipulation

Heat, Ventilation and Air Conditioning (HVAC) manipulation is a technology in which the HVAC system currently installed in the building is used to create a positive pressure within the building envelope. This can be achieved by either physically changing parts of the system, changing the operation of the HVAC system, or both.

The effectiveness of HVAC manipulation is high because it prevents mass (advective) flow of sub-slab vapor gases from entering the building due to the positive pressure in the building. If it is ensured that the slab is leak tight (free of cracks, sumps, drains, exposed breaks near joints, etc.), any potential migration of sub-slab vapors via the mechanism of molecular diffusion, which is independent of pressure differential, will be negligible to none. The effectiveness is compromised if power is lost to the building. Also, the effectiveness of this technology is dependent upon good continuous automatic control, maintenance, and monitoring of system variables, including maintaining desired positive pressure differential between the sub-slab and indoor air, preventing and correcting potential backdrafting conditions, and ensuring good operation of measuring instruments and warning devices. Indoor air sampling should be performed to confirm the effectiveness of the technology after it has been implemented, and periodic sampling of decreasing frequency should be performed to verify continued effectiveness.

The implementability is good if only changes to the operation of the HVAC system are needed, and is dependent on existing site conditions if physical modifications are needed for HVAC system. The implementability can also be impacted by applicable codes and standards. The magnitude of positive pressure needed inside the building for preventing contaminants from entering the interior shall not be such that it will adversely impact the health and comfort of the occupants or the functional use of the building. For example, there are codes specifying the maximum amount of pressure needed to open a door.

Capital costs are low in case of operation changes only, and moderate to possibly high if system parts need to be replaced. Operational costs due to changes can be low to moderate depending on the changes in the operating conditions.

HVAC manipulation is not an option for Buildings 785 and 786, because both buildings have been unoccupied for years and HVAC systems are non-operable or in a state of disrepair. This technology is retained for detailed analysis for Buildings 774 and 776, since both buildings are occupied and HVAC systems are installed and continuously active.

4.1.12 Carbon Treatment

Carbon treatment is a technology which includes the installation of a carbon filter in the current HVAC system. The carbon adsorbs the COCs from the indoor air which is being circulated through the HVAC system.

The effectiveness of carbon treatment is high because it will filter the indoor air and remove the COCs. The effectiveness is influenced by the air flow rates through the carbon, the load, and the duration of operation. The implementability is typically good (subject to size and pressure drop considerations), especially in buildings which have central HVAC systems. Installation costs are moderate to high depending on the number and size (air flow rate) of HVAC systems in a building and the factor mentioned above. Operation costs can be moderate to high depending on the adsorptivity of the COCs and on their concentrations and total amounts over a given time. Additional costs would be incurred because carbon needs to be monitored for effectiveness and replaced when spent.

Carbon treatment is not an option for Buildings 785 and 786, because both buildings have been unoccupied for years and HVAC systems are non-operable or in a state of disrepair. This technology is a good option for Buildings 774 and 776, since both buildings are occupied and HVAC systems are installed and continuously active.

4.1.13 Venting/Dilution

Venting is a technology which entails the venting of a portion of the indoor air to the outside air. Since this will result in introducing fresh replacement air into the building, it effectively dilutes the COCs in the indoor air. To conserve energy (heating and cooling load energy, as well as energy for recirculation, which is a comparatively smaller component), the venting/ dilution rates are adjusted to minimum values required for reducing contaminant concentration in indoor air to below safe levels. This technology is typically accomplished actively (both mechanical and wind). A passive system may work in conditions where the required ventilation rate is of similar magnitude to the dilution air used as part of the normal HVAC system operation. An example of active mechanical venting/dilution is the increase of the outside air exchange in the HVAC system. An example of active wind is a wind driven vent cap and an example of passive venting is opening doors and/or windows, or a passive vent riser.

The effectiveness of venting is good when COCs are removed from the building envelope and indoor air concentrations are reduced uniformly throughout the building, but can be moderate (or even ineffective) when air exchange is localized and the venting/dilution system is not designed and/or operated such that the COC concentrations in indoor air in all areas of the building (or applicable zone of interest) are not uniformly reduced (e.g., internal rooms with no windows not venting as well as rooms with exterior walls with windows and/or doors).

The implementability of the venting/dilution technology is good, because higher outside air exchange rates require minimal changes to the HVAC systems, provided windows and doors remain easy to open and uniform dilution is achieved in all occupied or potentially occupied areas of the building. The installation costs are low for HVAC operation changes, because it requires no equipment, only reprogramming of the system. Installation costs of opening windows and doors are non existent. The operational costs for HVAC changes are moderate on average, as costs are low in spring and fall, but high in winter and summer, because heating and cooling costs will increase greatly with higher outside air exchange rates. The operational costs for opening windows and doors are identical to the costs for HVAC changes.

Natural venting/dilution is a good option for Buildings 785 and 786, because both buildings have large bay doors which are continuously open, many holes in the metal walls of the buildings, and many broken or open windows in both buildings. Plus both buildings are unoccupied. Natural venting/dilution via open doors and windows is not an option for Buildings 774 and 776, because the buildings are occupied and have active HVAC systems; they also have no or few windows that can open. Moreover, building occupants are high security computer firms working with classified information and are under tight security. Open doors and windows are not allowed. Natural venting/dilution is retained for detailed analysis for Buildings 785 and 786.

Venting/dilution through increased outside air exchange rates in the HVAC system is a viable option for Buildings 774 and 776 and is, thus retained for detailed analysis.

4.1.14 Demolition

Demolition as a technology involves the demolition and removal of all building structures, including above ground structures, slab and foundations.

The effectiveness is good because the demolition and removal of the building will effectively remove any potential receptors. Slab removal will decrease sub-slab vapor accumulation. The implementability is good for Buildings 785 and 786, as both buildings are unoccupied. The implementability for Buildings 774 and 776 is low, as both buildings have recently been fully renovated (at substantial cost) and both buildings are leased and currently used as office buildings. The costs are high for Buildings 785 and 786, because both buildings are large former aircraft maintenance hangars, which will require special equipment for demolition. The 14-inch concrete slab will also require special equipment for demolition.

Demolition is not considered an option for Buildings 785 and 786, because both buildings are currently in use for storage of GIA maintenance equipment (mowers, snow blowers, snow plows, sanders, etc.). It is also not an option for Buildings 774 and 776 for reasons stated above.

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5 Evaluation of Alternatives

In this section, potential mitigation alternatives are developed for prevention and/or mitigation of SVI from the technologies retained in Section 4 for detailed analysis. The alternatives are developed with the goals of protecting human health and the indoor environment and maintaining that protection over time, while at the same time minimizing and eliminating waste and disturbance to existing onsite operations to the extent feasible.

5.1 Alternatives Evaluation Criteria and Approach

The purpose of this SVI FS is develop and evaluate alternatives and to recommend preferred alternative(s) for the mitigation of soil vapor intrusion into Buildings 774, 776, 785, and 786 at the Former Griffiss AFB. Thus, its direct and only goal is control and maintenance of air quality in the buildings that is protective of its occupants and visitors. Hence, it is unlike a traditional remediation project that is concerned with protection of both the human health and the environment. Any potential reduction in contaminant levels in the subsurface as a result of actions for mitigation of SVI is incidental to the goal of this project. The project is not designed to withdraw vapors from the subsurface for the purpose of remediation, but, rather, to prevent any vapors present in the subsurface from entering the buildings. Remediation of any subsurface contamination that is the source of the contaminated soil vapor with intent to meet cleanup goals will be addressed separately.

To facilitate the SVI FS process, the template provided in the USEPA Guidance for Conducting RIs and FSs under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (EPA, October 1988) was followed in this study, with modifications as needed and appropriate for the current project. This was done simply to facilitate the current study within a framework that is well established, containing criteria and methodologies that are easily and beneficially adaptable to the SVI FS process. As such, while the format and look-and-feel of the current FS document may bear similarities to the traditional remediation FS, as will be evident below, the meanings and interpretations given to the evaluation criteria and to their analyses are distinctly different from those given to them in the CERCLA RI/FS Guidance, being focused as they are on the mitigation of SVI alone.

In this study, the SVI mitigation alternatives will be comparatively evaluated with respect to the following nine (9) criteria, which are categorized under the general descriptive headings of effectiveness, implementability, and costs.

Effectiveness

1. Overall protection of human health and the indoor environment from contaminated soil vapor entering the buildings from the subsurface
2. Compliance with health standards and indoor air quality goals, and with meeting ambient air quality standards for any discharges to the outdoors, as applicable. The risk-based mitigation goals for this SVI mitigation project are discussed in Section 3.1 and given in Table 3-1 for the indoor environment and its occupants, and meeting of the New York State ambient air quality standards and guidelines as determined from using Air Guide 1 is specified for outdoor discharge of any contaminated air.

3. Long-term effectiveness and permanence of the proposed SVI mitigation method
4. Reduction of toxicity, mobility, or volume in indoor air through treatment
5. Short term effectiveness

Implementability

6. Implementability (including technical feasibility, administrative feasibility, and availability of services and materials)

Costs

7. Cost [including total investment for each alternative and benefit for each alternative; cost is estimated in this FS using the Remedial Action Cost Engineering and Requirements (RACER) cost estimating software package]

State and Community Acceptance

8. State acceptance
9. Community acceptance

The above criteria are described briefly in the ensuing paragraphs.

5.1.1 Effectiveness

Effectiveness is defined in this FS for SVI mitigation as a measure of an alternative's ability to protect human health and the indoor environment and meet the criteria applicable criteria for the protection of human health and the indoor environment from contaminated soil vapor entering the buildings from the subsurface. The risk-based mitigation goals for this SVI mitigation project are discussed in Section 3.1 and given in Table 3-1 for the indoor environment and its occupants, and meeting of the New York State ambient air quality standards and guidelines as determined from using Air Guide 1 is specified for outdoor discharge of any contaminated air.

It should be noted here that the definition of effectiveness is specifically limited to control of contaminated soil vapors entering the buildings through the subsurface and is not concerned with the general indoor air quality, which is the general concern for any occupied buildings irrespective of where they are located, whether they be in contaminated or uncontaminated lands. Any improvement in the general indoor air quality over and above existing conditions (if they do, in fact, need improvement) as a result of actions for mitigation of SVI is a welcome, but incidental, beneficial outcome.

Each measure (protect human health/indoor environment and meet criteria of any outdoor discharges of contaminated air, if required) is considered for both the long-term and short-term. A concise interpretation of these criteria follows (also discussed in detail in Section 1.3 from a slightly different perspective):

5.1.1.1 Overall Protection of Human Health and the Indoor Environment

This criterion is a measure of how well the alternative reduces the potential for human exposure to contaminants present in the soil vapors, and exposure of ecological receptors to same, in the short-term and long-term. It considers the following:

- The net reduction in the toxicity, mobility, or volume of soil vapors in the indoor environment;
- The potential exposure pathway between humans or biota (considering future land use) and contaminated soil vapors entering the indoor environment from the subsurface;
- The estimated quantity (amount and volume) of residual soil vapors in the indoor environment; and
- The potential exposure pathway between humans or biota and releases or emissions from the active response alternatives.

5.1.1.2 Compliance with Health Standards and any Air Quality Goals and Standards

This criterion is a measure of how well the alternative meets the mitigation goals for protecting human health and indoor air, and for meeting ambient air quality standards for any discharges to the outddors per New York State air regulations and Air Guide – 1 protocols, during the long-term and short-term.

5.1.1.3 Long-Term Effectiveness and Permanence

This is a measure of how well the alternative meets the criteria of protecting human health/indoor environment and meets the criteria of the mitigation goals after implementation.

5.1.1.4 Reduction of Toxicity, Mobility or Volume through Treatment

The degree to which alternatives employ treatment that reduces toxicity, mobility, or volume are also to be assessed. It considers the following:

- The potential for the proposed treatment processes to achieve control of soil vapor contaminants in indoor air;
- The potential for its reversibility;
- The amount of hazardous materials that will be destroyed or treated;
- The degree of expected reduction in toxicity, mobility, or volume;
- The type and quantity of residuals that will remain following treatment; and
- Whether the alternative would satisfy a preference for treatment as a principal element without additional significant burdens, cost or otherwise, compared to non-treatment options.

5.1.1.5 Short-Term Effectiveness

This is a measure of how well the alternative meets the criteria, i.e., mitigation goals, of protecting human health/indoor environment, and meets the New York State ambient air quality standards and guidelines as determined from using Air Guide 1 for any outdoor discharge of contaminated air.

5.1.2 Implementability

Implementability is a measure of whether an alternative can be physically and administratively implemented, such as the ability to construct, install, or operate. It is also a measure of the availability of the services and materials needed to implement the alternative. Although state and community acceptance are listed separately among the alternatives evaluation criteria, they are also given consideration in the context of evaluations for implementability. A concise interpretation of the criteria governing implementability is as follows (also discussed in detail in Section 1.3 from a slightly different perspective):

5.1.2.1 Technical Feasibility

This criterion refers to:

- The reliability of the action with regard to implementation;
- The actual ease of field implementation (e.g., excavation, construction action);
- The ease in undertaking future actions related to the initial undertaking; and
- The ability to monitor the effectiveness of the action.

5.1.2.2 Administrative Feasibility

This criterion is a measure of the ease with which an alternative can be implemented in terms of permits and rights-of-entry, coordination of services to support the action (e.g., legal services), probability of continual enforcement, or the arrangement and delivery of security services.

5.1.2.3 Availability of Services and Materials

This criterion is a measure of the availability of goods and services needed to support implementation of the alternative. Examples of this criterion include the availability of specialized personnel (i.e., qualified environmental engineers, scientists, geologists/ hydrogeologists, technicians, and other professionals, as well as qualified environmental contractors and vendors who can provide competitive bids) and equipment, availability of the suitable storage facility for the contaminated soil (if any), materials, and activity derived waste.

5.1.3 Costs

Cost is a measure of the overall investment (dollars) to implement the alternative with consideration of the benefit of that investment to the public and site.

The cost of implementing each of the alternatives has been estimated using RACER. RACER is an environmental remediation/ corrective action cost estimating system that has been adopted as the standard cost estimating tool for the U.S. Air Force. The exception is No Action, which has no present associated costs (an administrative cost of $50,000 is assumed in the detailed analysis for No Action). A detailed summary of these costs and assumptions is presented in Appendix B.

5.1.4 State and Community Acceptance

5.1.4.1 State (Agency) Acceptance

This criterion deals with the acceptance of the alternative by applicable federal, state and local agencies, as expressed by representatives under the agencies' authority. As was stated earlier, the purpose of this study is develop, evaluate, and recommend alternatives for mitigation of SVI in Buildings 774, 776, 785, and 786. Thus, subsurface cleanup of the source(s) of contaminants in the soil vapor, and remedial alternatives for same, were not evaluated for this criterion in this FS; instead, it will be formally addressed in the ROD after comments are received on its associated RI/FS report and the Proposed Plan.

5.1.4.2 Community Acceptance

This criterion relates to the degree of acceptance of the alternative by the Griffiss community, including owners of property adjacent to the base. Public sentiment expressed during town hall meetings, public workshops, city council or county supervisor meetings, or institutional analysis is a means of determining community acceptance. As was stated earlier, the purpose of this study is develop, evaluate, and recommend alternatives for mitigation of SVI in Buildings 774, 776, 785, and 786. Thus, subsurface cleanup of the source(s) of contaminants in the soil vapor, and remedial alternatives for same, were not evaluated for this criterion in this FS; instead, it will be formally addressed in the ROD after comments are received on its associated Proposed Plan.

Criteria 8 and 9 depend on state and community response to the proposed SVI mitigation actions and any assessment of these criteria in this FS is only of a preliminary nature. Regulator and public acceptance of the selected alternative are needed before implementation.

5.2 Alternatives for Buildings 774 and 776

For Buildings 774 and 776, the following technology options were retained for detailed analysis in Section 4:

- No Further Action

- Limited Action / LTM
- Directional Drilling
- HVAC Manipulation
- Carbon Treatment
- Ventilation/Dilution

As was noted in Section 3, the Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776.

The following alternatives were developed for these buildings for detailed analysis:

- Alternative 774/776-1: No Further Action
- Alternative 774/776-2: Directional Drilling + LTM
- Alternative 774/776-3: HVAC Manipulation + LTM
- Alternative 774/776-4: Carbon Treatment + LTM
- Alternative 774/776-5: Ventilation/Dilution +LTM

The above five (5) mitigation alternatives will be comparatively evaluated with respect to the nine (9) evaluation criteria that were described earlier.

Please note that these conceptual designs, as well as the conceptual designs for the other alternatives in this FS, are developed for the purpose of this FS only, and the actual systems installed will be based on engineering designs that may or may not conform to these conceptual designs. However, in keeping with FS guidance recommendations, these conceptual designs were developed to provide estimates that are within +50% and -30% of likely costs.

5.2.1 Alternative 774/776-1: No Further Action

No associated costs. Assume a lump-sum $50,000 cost for administrative costs for implementing this alternative.

Description

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. This no-action alternative does not involve any proactive treatment of the soil vapors contaminated with chlorinated organics at the buildings. The No Further Action alternative is retained as a mitigation alternative for the detailed analysis phase of the FS.

5.2.2 Alternative 774/776-2: Directional Drilling + LTM

Description

Two horizontal wells will be installed under each building as shown in Figure 5-1. The interior of the buildings is untouched under this alternative, and there will be no sealing of floors or installation of vapor barrier. The sub-slab is actively depressurized by imposing negative pressure under the slabs by mechanical blowers, and the extracted vapors are discharged to the atmosphere through a stack that is at least three (3) ft taller than the highest point of the building. Please note that, similar to the PRGs, air emissions and air emissions monitoring are generally considered part of the RA WP and therefore will be discussed in that future document. Sub-slab vapor concentrations reported in past sampling efforts (Tables 2-5 and 2-6) are most likely due to accumulated vapors, and concentrations of contaminants through the proposed stack will decrease upon system startup both due to the initial accumulated vapors being removed and due to more representative concentrations being reduced further due to commingling with lower concentration vapors and fresh air intake. Therefore, it is not believed that air emission control would be warranted for the stack emissions; however, review of the need for air emission control will be performed as needed during the detailed design stage.

The systems will be checked on a weekly basis (vacuum gage readings, flow meter readings, etc) to ensure proper operation. System maintenance will be performed as specified by the blower manufacturer. The specific details of the systems assumed for this FS are discussed below.

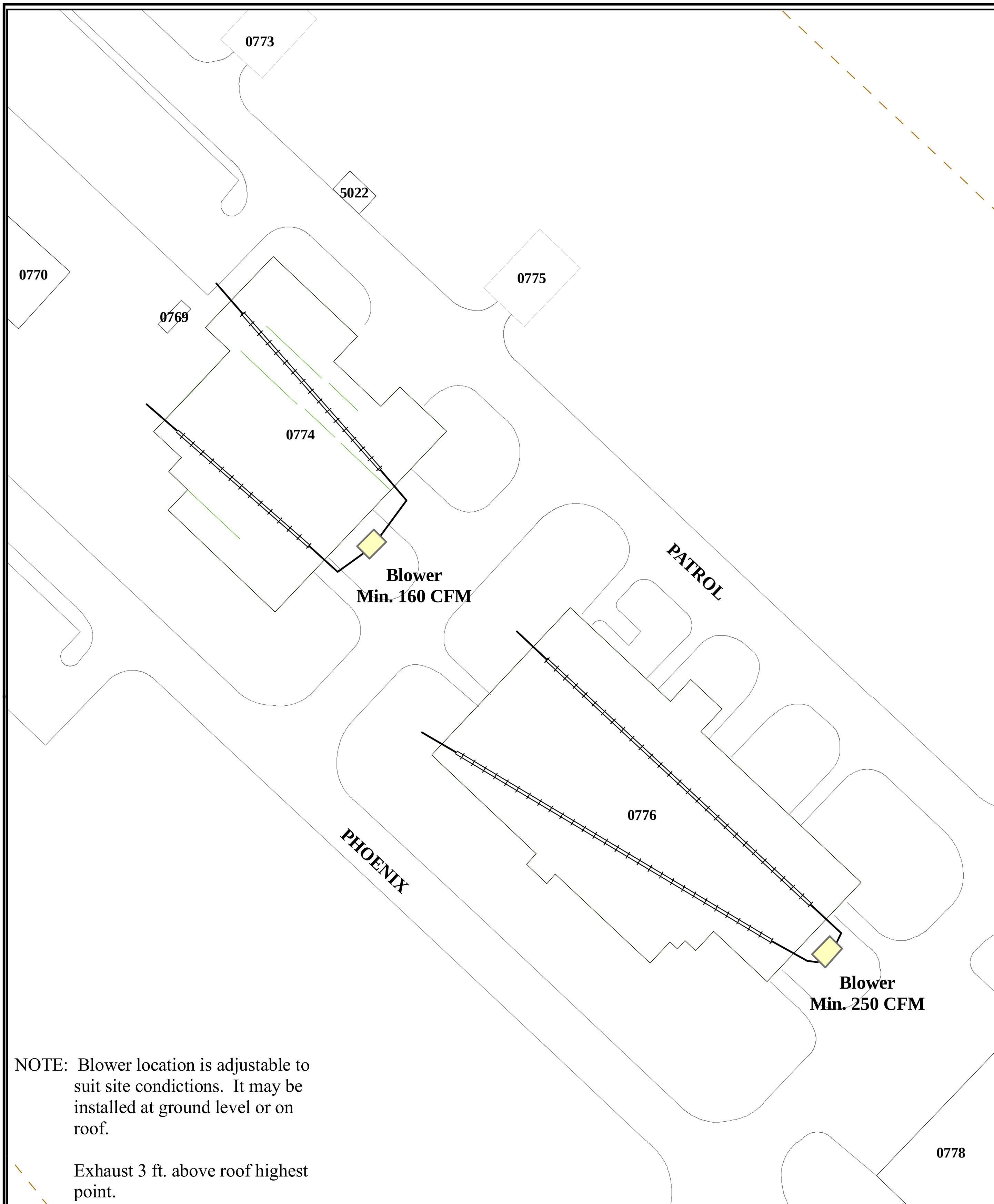
LTM will be performed under this and all other following alternatives. LTM is included in these alternatives to verify the effectiveness of the alternative and to show that the alternative meets its objective. One baseline sampling event will be performed which includes indoor, outdoor, exhaust pipe and sub-slab sample collection. Subsequent indoor sampling events will be performed one month after startup, six (6) months after startup, and reoccur every 6 months after that. Sub-slab verification will be performed after one year, after five (5) years, and then every 5 years. Results will be reported after each sampling event and the LTM program will be reviewed for effectiveness and redundancy. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

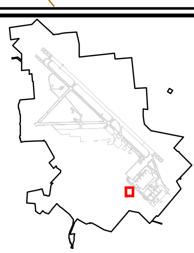
5.2.2.1 Building 774

Two (2) lines:

- Line 774-SVE1: 175 ft long (125 ft perforated/slotted, 25 ft solid at each end)
- Line 774-SVE2: 160 ft long (110 ft perforated/slotted, 25 ft solid at each end)

Both lines:
Total 335-ft long, 4-inch high density polyethylene (HDPE) perforated or slotted, non-corrugated. The pipe slot (open) areas are to be about 25-33% of pipe outer surface area, but are to be designed with the goal of withdrawing vapors at equal rates from all segments of pipe (i.e., fewer slots and/or more friction as one comes closer to the blower end from the far end).





Site Location

FIGURE 5-1
Buildings 774 and 776
Directional Drilling

Key to Features

- Riser (Solid 4 inch HDPE Pipe)
- Horizontal Well (Perf./Slotted 4 inch HDPE Pipe)
- Demolished Facility
- Existing Facility
- Building 774 Interiorwalls

0 20 40 80 Feet

UNITED STATES AIR FORCE
GRIFFISS AIR FORCE BASE
ROME, NEW YORK

December 01, 2008

FPM group

Y:\GIS_Projects\Griffiss\Projects\40-07-45\Conc_Design\Fig_5_1_774_776_Dir_Drilling.mxd

Drilling done such that piping is one (1) foot below footing (estimated piping depth of 5 ft. below grade), gradually traverses up to one (1) foot below bottom of slab at the center of the pipe length, and then traverses down such that it will be one (1) below bottom of footing at the other end of the building in an approximately symmetrical fashion (to the extent achievable practically).

However, the above described pipe travel route may be modified under field conditions, particularly since there are old foundation walls in the interior of unknown depth. Also the location of underground utilities will influence the exact location of the piping.

The two lines are to be joined into a 4-inch HDPE common header that is then connected to the suction side (inlet) of the blower.

Assume total 4-inch HDPE aboveground piping to be 100 ft (from underground piping on both lines to the common header/blower and then to exhaust point).

Assume vapor extraction at a rate of one (1) air change per hour of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system).

Assuming 25% porosity, 1 air changes per hour (ACH), 18990 sq. ft. x 2 ft thickness, design extraction flow rate is 9495 cubic ft per hour (CFH) or 160 cubic ft per minute (CFM) (say 160 CFM, with about 85 CFM for Line 774-SVE1 and 75 CFM for Line 774-SVE2).

Longer pipe controls the design.

- For longer pipe, underground piping (4 inch) pressure loss = 0.5 inch (inches of water [w.g.]) / 100 ft x 175 ft = 0.9 inch w.g.
- Add 10% for slot resistance, total u/g pressure loss = 1.0 inch w.g.
- Aboveground piping (4 inch) pressure loss = 1.5 inch w.g. / 100 ft x 100 ft = 1.5 inch w.g.
- Double to account for fittings, diameter changes, etc. = 3.0 inch w.g.
- Total pressure (i.e., vacuum) loss = 1.0 (underground [u/g]) + 3.0 (aboveground [a/g]) = 4 inch w.g.

Total flow of 160 CFM at 4 inch w.g. ==> 3 horsepower (HP) regenerative blower or equivalent, with approx. 1750 watt (W) (2.5 HP) power consumption. (Available data on Rotron blower is used; power consumption may possibly be reduced by selecting a better fit model during design stage.)

Install a mechanical blower on roof or at ground level, min. 160 CFM (assumed to be on ground in an enclosure for costing purposes). Discharge point to be minimum three (3) ft above roof ridge.

5.2.2.2 Building 776

Two (2) lines.

- Line 776-SVE1: 275 ft long (225 ft perforated/slotted, 25 ft solid at each end)
- Line 776-SVE2: 275 ft long (225 ft perforated/slotted, 25 ft solid at each end)

Both lines:
Total 550 ft-long, 4-inch HDPE perforated or slotted, non-corrugated. The pipe slot (open) areas are to be about 25-33% of pipe outer surface area, but are to be designed with the goal of withdrawing vapors at equal rates from all segments of pipe (i.e., fewer slots and/or more friction as one comes closer to the blower end from the far end).

Drilling done such that piping is one (1) foot below footing (estimated piping depth of 5 ft below grade), gradually traverses up to one (1) foot below bottom of slab at the center of the pipe length, and then traverses down such that it will be one (1) below bottom of footing at the other end of the building in an approximately symmetrical fashion (to the extent achievable practically).

However, the above described pipe travel route may be modified under field conditions.

The two lines are to be joined into a 4-inch HDPE common header that is then connected to the suction side (inlet) of the blower.

Assume total 4 inch HDPE aboveground piping to be 50 ft (from underground piping on both lines to the common header/blower and then to exhaust point).

Assume vapor extraction at a rate of one (1) air change per hour of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system). Assuming 25% porosity, 1 ACH, 27,410 sq. ft. x 2 ft thickness, design extraction flow rate is 13705 CFH or 230 CFM (say 250 CFM, with about 125 CFM for Line 776-SVE1 and 125 CFM for Line 776-SVE2).

Controlling pipe length 275 ft.

- Underground piping (4 inch) pressure loss = 1.0 inch w.g. / 100 ft x 275 ft = 2.75 inch w.g.
- Add 10% for slot resistance, total u/g pressure loss = 3.0 inch w.g.
- Aboveground piping (4 inch) pressure loss = 3.5 inch w.g. / 100 ft x 50 ft = 1.75 inch w.g.
- Double to account for fittings, diameter changes, etc. = 3.5 inch w.g.
- Total pressure (i.e., vacuum) loss = 3.0 (u/g) + 3.5 (a/g) = 6.5 inch w.g., say 7 inch w.g.

Total flow of 250 CFM at 7 inch w.g. ==> 3 HP regenerative blower or equivalent, with approx. 2200 W (3 HP) power consumption (Power consumption may possibly be reduced by choosing a better fit blower during design stage.)

Install a mechanical blower on roof or at ground level, min. 250 CFM (assumed to be on ground in an enclosure for costing purposes). Discharge point to be minimum three (3) ft above roof ridge.

5.2.2.3 For Both Buildings

Capital Cost items:

For Building 774:

- Underground directional drilling of a 175-ft long, 4-inch HDPE piping, of which the middle 125 ft is slotted/perforated per specifications described above and the two 25ft-each are to be solid pipe with end of line closed with an end cap
- Underground directional drilling of a 160-ft long 4-inch HDPE piping, of which the middle 110 ft is slotted/perforated per specifications described above and the two 25 ft-each are to be solid pipe with end of line closed with an end cap
- Drilling of both lines to be one (1) foot below bottom of footing, subject to specifications and remarks described above
- Installation of a total of 100 ft of 4-inch HDPE piping aboveground, which includes piping from underground exit points of the two underground lines to the common 4. inch header, its travel to the blower, and from the exit of the blower to the exhaust point three (3) ft above highest roof point
- Installation of one (1) three (3) HP, 160 CFM @ 4 inch w.g., regenerative blower or equivalent
- Blower can be installed at ground level or on roof, but assume ground level installation with a protective enclosure for costing purposes
- All electrical lines to blower and to control box

For Building 776:

- Underground directional drilling of a 275-ft long, 4-inch HDPE piping, of which the middle 225 ft is slotted/perforated per specifications described above and the two 25 ft-each are to be solid pipe with end of line closed with an end cap.
- A second line identical in length and specifications to the above first line (underground directional drilling of a 275 ft-long, 4-inch HDPE piping, of which the middle 225 ft is slotted/perforated per specifications described above and the two 25 ft-each are to be solid pipe with end of line closed with an end cap).
- Drilling of both lines to be one (1) foot below bottom of footing, subject to specifications and remarks described above.
- Installation of a total of 50 ft of 4-inch HDPE piping aboveground, which includes piping from underground exit points of the two underground lines to the common 4 inch header,

its travel to the blower, and from the exit of the blower to the exhaust point three (3) ft above highest roof point.

- Installation of one (1) three (3) HP, 250 CFM @ 7 inch w.g., regenerative blower or equivalent.
- Blower can be installed at ground level or on roof, but assume ground level installation with a protective enclosure for costing purposes.
- All electrical lines to blower and to control box.

Operation and Maintenance (O&M) Costs: Assume continuous operation, indefinite duration for blowers.
The systems will be inspected weekly to ensure proper operation. The pressure gage readings and flow measurements will be recorded. The system will be inspected for breaks, cracks, leaks, etc. The blowers will be maintained according to the manufacturer's recommendations.

Monitoring Costs:
For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and subsurface sampling (one in each pipe without blower, i.e., vent vapors) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.3 Alternative 774/776-3: HVAC Manipulation + LTM

Description

HVAC manipulation will be applied by manipulating the currently installed HVAC system to create a positive pressure within the building envelope. This prevents mass (advective) flow of sub-slab vapor gases from entering the building due to the positive pressure in the building. The effectiveness is compromised if power is lost to the building and it is dependent upon good continuous automatic control, maintenance, and monitoring of system variables. The positive pressure can be achieved by either physically changing parts of the system, changing the operation of the HVAC system, or both.

For the LTM part of this alternative: indoor air sampling should be performed to confirm the effectiveness of the technology after it has been implemented, and periodic sampling of decreasing frequency should be performed to verify continued effectiveness, as detailed below. As part of the LTM, pressure differential measurements will be collected to verify the sub-slab depressurization.

The LTM includes the sampling and analysis of indoor air, sub-slab air and exhaust air, as appropriate. The LTM sampling will consist of a baseline indoor sampling event (4 locations) and samples collected from the HVAC exhaust air. Subsequent sampling will be performed one month after startup, six (6) months after startup, and reoccur every six (6) months after that. Additionally, sub-slab verification will be performed after one year and every 5 years. Results will be reported after each sampling event and once every 5 years, and the LTM program will be reviewed in each report for effectiveness and redundancy. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

The specific details of this alternative are discussed below.

5.2.3.1 Building 774

Indoor/Sub-slab differential pressure readings (i.e., difference in air pressure between indoor and sub-slab environments) taken during daytime (work hours) were centered at approximately 3.5 Pascal (Pa) (approx. 0.014 inch w.g.) on April 15, 2008 and at approximately 1.75 Pa (approx. 0.007 inch w.g.) on April 16, 2008. Both days were workdays. On both days, evening (approx 8-10 pm) readings were approximately 2.25 Pa (approx. 0.009 inch w.g.). The pressure readings were taken using Graywolf Zephyr II micromanometer. Assume that the subsurface is in equilibrium with the ambient atmosphere, and interpret the differential pressure readings to be the same as the static gage pressure readings. Based on design flow rates, the building may likely be experience 6-8 ACH. Hence, assume that the velocity pressure in the indoor environment is negligible compared to the static pressure given the size of the building and slow air movement. Thus, assume that the measured differential pressures will be approximately equal to the static pressures, and, in turn, equal to the total pressure. Furthermore, in all these analyses for performing budget estimates, assume that velocity and static pressures fully convert from one form to the other and that the total pressure is either completely velocity pressure or completely static pressure (they will be used interchangeably without further notification).

The reduction in pressure during the evening on April 15th is due to the HVAC system switching to overnight mode to conserve energy. The reason for difference in readings during daytime on two consecutive working days is not known, but could be due to different weather conditions. In any case, there was positive pressure inside the building at all times on April 15 and 16, 2008.

Heating/cooling is provided by 26 heat pumps. In addition, the building has an Energy Recovery Ventilation (ERV) unit rated at 3,200 Standard Cubic Ft per Minute (SCFM) for supply and 2,960 SCFM for return, for a net additional flow rate of 240 SCFM available for building leakages through walls, windows, doors, etc. and for contributing to positive pressure inside building.

To comply with codes, the practical maximum positive pressure should be about 0.05 inch w.g. (12.5 Pa), and is typically in the range of 0.02-0.03 inch w.g. (5.0-7.5 Pa) for comfort and efficiency purposes.

Lower limit of flow:

For HVAC Manipulation, although it may be possible to maintain a positive pressure of 0.05 inch w.g. (12.5 Pa) while complying with the codes, the design limit will be set in this FS at 0.025 inch w.g. for the comfort of the office employees of the building to ensure that the primary function of the building (offices) is not compromised by the mitigation measure. From the above described measurements, assume that the average positive pressure in the building is 2.5 Pa (0.01 inch w.g.). Also, assume that this average pressure represents the excess inflow of 240 SCFM (per design rating) from the ERV. [This represents an escape velocity of about 400 FPM through building cracks and openings with a total (combined) area of about 85 square inches (0.6 sq. ft.), suggesting a tight building.]

Then, flow rate needed for HVAC Manipulation by increasing positive pressure to 0.025 inch w.g. = (240 SCFM) * sqrt (0.025/0.01) = 380 SCFM.

Of this, 240 SCFM is already provided by the existing ERV unit.

Therefore, additional flow rate needed for HVAC manipulation = 140 SCFM. This is the minimum flow, since it assumes that the entire positive pressure measured is due to the excess ERV flow rate of 240 SCFM.

Middle-Upper limit of flow:

Per the water to air heat pump schedule in the design plans, the 26 heat pumps have a combined flow rate of 34,430 SCFM. It is possible that these units contribute to the measured positive pressure by providing some pressure in excess of that needed to compensate for return losses to the plenum to provide for opening and closing of doors and windows.

Assuming pressure contribution of heat pumps to excess (positive) indoor pressure varies proportional to square of the ratio of their flow rate to total flow rate (heat pumps + ERV in), positive pressure from heat pumps = 0.01*[34430/(34430+3200)]^2 = 0.008 inch w.g.
Hence, positive pressure for leakage = 0.01-0.008 = 0.002 inch w.g.
(This represents a leakage velocity of 160 FPM, resulting in an openings area of 1.5 sq. ft. or 216 square inches, suggesting a relative tight building.)
Flow rate needed for HVAC manipulation = (240 SCFM) * sqrt [(0.025-0.008)/0.002] = 700 SCFM

Of this, 240 SCFM is already provided by the existing ERV unit.
Therefore, additional flow rate needed for HVAC manipulation = 460 SCFM (say 500 SCFM additional).

Radon measurements in existing schools, as reported by USEPA, show that a positive pressure of only 0.001 inch w.g. (0.25 Pa) relative to sub-slab and outdoor air pressure reduces indoor radon levels by preventing radon entry into the building (USEPA, June 1994).

Yet, at the present site, even assuming the lower pressure for leakage of 0.002 inch w.g., sampling results show presence of contaminants in indoor air at high enough levels to warrant mitigation measures. It is, therefore likely that the actual positive pressure for leakage is even lower than 0.002 inch w.g., potentially some of it accounted by contribution (pressure reduction) by opening and closing of doors.

Assuming USEPA reported values as the upper limit of actual conditions at site,
Positive pressure for leakage = 0.001 inch w.g., with rest (0.009 inch w.g.) by heat pumps and other causes (This represents a leakage velocity of 125 FPM, resulting in an openings area of 1.9 sq. ft. or 273 square inches.)

Flow rate needed for HVAC manipulation = (240 SCFM) * sqrt [(0.025-0.009)/0.001] = 960 SCFM.

Of this, 240 SCFM is already provided by the existing ERV unit.

Therefore, additional flow rate needed for HVAC manipulation = 720 SCFM.

Assuming 25% contingency since actual positive pressure available for leakage could be lower compared to USEPA value of 0.001 inch w.g. because contaminants were found indoors.
Design flow rate for HVAC manipulation = 720 * 1.25 = 900 SCFM (which represents a current leakage pressure of a little under 0.001 inch w.g.)

Thus, this alternative requires the installation of a 900 SCFM air supply unit, which would incur capital costs and recurring O&M costs for its operation and for its heating and cooling loads (assume 72 F during winter and 77 F during summer).

Capital Cost items:

- A new air supply unit rated at minimum 900 SCFM at 0.025 inch w.g. static pressure (plus any system losses). [Please note: The extra 900 SCFM can be realized by reducing the exhaust rate of the existing ERV unit. However, for the purpose of the FS, the costing will be based on adding a new unit so that the existing systems are not modified, except for readjustments for system balancing. Optionally, it may be possible to avoid the cost of a new unit during engineering design if modification of the existing is determined to not have any detrimental impact on the overall system performance.]

- Installation costs for this unit.
- If it is not already installed at present, a control system is needed for monitoring the pressures and for adjusting the flow rates of the entire system to maintain the desired positive pressure.

O&M Costs:

- Extra power, assume 1 HP (negligible), 24/7/365
- [Based on a Dayton model (Grainger), power requirement for the new 900 SCFM unit at 0.025 inch w.g. static = 370 W (0.4 HP), approx.
- Also, the entire existing system has to work against 0.025 inch w.g. instead of the current 0.01 inch w.g. The current flow rate of the total system is 37,630 SCFM. Assume 65% efficiencies for the existing system. Then, additional power needed = 37630 * (0.025-0.01)/6356/0.65 = 0.14 HP]
- Current system: 1700 CFM unit at 1 HP. Therefore, 37630 CFM at 37630/1700 = 22 HP power consumption approximate. Most of this is for overcoming friction losses. Per earlier ratios, add 9 HP for 128 hours/week (=7*24-40) for the main system for evenings, weekends, and holidays since it may be running in reduced mode at these times to account for any building pressure loss over time (conservative).
- Six (6) months per year heating of 900 SCFM to 72F = 45,000 Btu/Hr heating load (heating load based on same design assumptions as for existing system)
- Three (3) months per year cooling of 900 SCFM to 77F = 30,000 Btu/Hr cooling load (cooling based on same design assumptions as for existing system)
- The additional three months which make up one calendar year including the 6 and 3 months referenced in the two bullets above, are deemed negligible. For those three months outside temperatures are assumed to be equal to the indoor air temperatures, therefore making O&M heating and cooling costs negligible.
- Initial system balancing costs, assume lump-sum, say $20,000
- Annual system rebalancing costs, assume lump-sum, say $10,000
- Extra manhours, continuous for monitoring, verifying, adjusting positive pressures inside building, one (1) hour per week

Monitoring Costs (Same as for Directional Drilling):

For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and HVAC exhaust air sampling (one) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Pressure differential readings will be collected during every indoor and sub-surface sampling event
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years

- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.3.2 Building 776

This building exhibited negative, cyclic pressures when the readings were taken continuously between April 14, 2008, 5:00 PM and April 15, 2008, 12:00 noon. Higher wind speeds (13-14 mph) were reported during some portion of the readings. The building is newly renovated, including installation of un-openable windows. Therefore, building leakages for Bldg. 776 are likely to be less than may be the case for other typical, comparable buildings. However, it should be noted that even tightly constructed buildings can experience leakage through door openings/closings, vent openings, HVAC intake/exhaust imbalances, etc. The cyclic behavior can occur due to delayed response of sub-surface pressures of vapors relative to ambient conditions (readings were taken relative to sub-surface and not relative to ambient).

Although the pressures were negative for most of the duration, they begin to reach positive pressures of about 1.0 Pa by the end of the period (April 15, 2008, 12:00 PM), and from Bldg. 774 data (which was collected after the end of Bldg. 776 data gathering), the pressures were positive afterwards in that building (Building 774). Therefore, we conclude that Bldg. 776 also has potential for maintaining positive pressures. Since Bldg. 776's data is unreliable for estimating HVAC manipulation flow rates, Bldg. 776's flow rates will be estimated in proportion to the square footage of Buildings 774 and 776 (assumes heights are same).

Design flow additional for Bldg. 776 = 900 SCFM (Bldg. 774) X (27410 sq. ft./18990 sq. ft.) = 1,300 SCFM.

Capital Cost items:

- A new air supply unit rated at minimum 1,300 SCFM at 0.025 inch w.g. static pressure (plus any system losses). [Please note: The extra 900 SCFM can be realized by reducing the exhaust rate of the existing ERV unit. However, for the purpose of the FS, the costing will be based on adding a new unit so that the existing systems are not modified, except for readjustments for system balancing. Optionally, it may be possible to avoid the cost of a new unit during engineering design if modification of the existing is determined to not have any detrimental impact on the overall system performance.]
- Installation costs for this unit.
- If it is not already installed at present, a control system is needed for monitoring the pressures and for adjusting the flow rates of the entire system to maintain the desired positive pressure.

O&M Costs:

- Extra power, assume 1 HP (negligible), 24/7/365
- [Based on a Dayton model (Grainger), power requirement for the new 1300 SCFM unit at 0.025 inch w.g. static = 0.5 HP, approx.
- Also, the entire existing system has to work against 0.025 inch w.g. instead of the current 0.01 inch w.g., small value]
- Current system: Add 13 HP for 128 hours/week (=7*24-40) for the main system for evenings, weekends, and holidays since it may be running in reduced mode at these times to account for any building pressure loss over time (conservative).
- Six (6) months heating of 1,300 SCFM to 72F = 65,000 Btu/Hr heating load (heating load based on same design assumptions as for existing system)
- Three (3) months cooling of 1,300 SCFM to 77F = 45,000 Btu/Hr cooling load (cooling load based on same design assumptions as for existing system)
- Initial system balancing costs, assume lump-sum, say $20,000
- Annual system rebalancing costs, assume lump-sum, say $10,000
- Extra manhours, continuous for monitoring, verifying, adjusting positive pressures inside building, one (1) hour per week

Monitoring Costs (Same as for Directional Drilling):

For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and HVAC exhaust air sampling (one) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Pressure differential readings will be collected during every indoor and sub-surface sampling event
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.3.3 Other Considerations for HVAC Manipulation:

1. Ideally, internal building pressures should be positive during summer and neutral to slightly negative during winter to protect the building envelope from moisture related problems such as mold and moisture-related structural deterioration (pushing out air conditioned air that has a low level of humidity during summer and drawing in outside air having a low level of humidity during winter would minimize such problems). However, the HVAC manipulation

technique requires continuous internal positive pressure for an indefinite period, which could pose a problem during winter if the heated air is also humidified (which will condense in the building walls upon nearing the outer surface).

2. Both buildings are large in size (18,990 sq. ft. for Building 774 and 27,410 sq. ft. for Building 776) with numerous partitions, and have multiple heat pumps (26 in Building 774 and 43 in Building 776). Since the flow dynamics of such buildings can be complex, maintaining required levels of positive pressures in all areas may have uncoordinated impacts on different heat pumps, thereby adversely affecting their performance and efficiency, which, in turn, can subject the occupants to variable and unpredictable environmental conditions.

3. Since the response of the building and the subsurface to weather changes are likely to be different and generally out of synchronization (quick building response compared to slower and more cyclic sub-surface response) maintaining required positive pressures at all times would likely require a control system for changing process conditions (e.g., flow rates) as needed. It should be noted that maintaining the required positive pressures will require automatically monitoring and controlling the combined effects of weather, wind, sub-surface and building response, and mechanical ventilation settings and behavior.

4. Even when staying within building code requirements, higher internal pressures can create additional noise and other difficulties such as having to apply greater strength to open doors on a routine basis.

5. Finally, even if all of the above difficulties are overcome or managed, it should be noted that internal positive pressures will only prevent mass (advective) flow of sub-surface contaminants into the building. Since, molecular diffusion can occur even under such circumstances, a positive pressure HVAC manipulation system would still need periodic monitoring of air samples for an extended period until it can be established conclusively that there is no likelihood of such flow from the sub-surface into the building interior.

For the above reasons, because of difficult implementability and system control, considering that these buildings do not have one central system but numerous individual flow units, HVAC manipulation is not a technically assured solution for vapor mitigation at Buildings 774 and 776.

5.2.4 Alternative 774/776-4: Carbon Treatment of Indoor Air + LTM

Under this option, a portion of the indoor air is treated by a carbon treatment system and the clean air is recycled into the building. The VOCs to be removed, primarily TCE, are amenable to treatment by this technology.

For the LTM part of this alternative: indoor air sampling should be performed to confirm the effectiveness of the technology after it has been implemented, and periodic sampling of decreasing frequency should be performed to verify continued effectiveness, as detailed below.

The LTM includes the sampling and analysis of indoor air, sub-slab air and exhaust air, as appropriate. The LTM sampling will consist of a baseline indoor sampling event (4 locations) and samples collected from the carbon treatment exhaust air. Subsequent sampling will be performed one month after startup, six (6) months after startup, and reoccur every 6 months after that. Additionally, sub-slab verification will be performed after one year and every 5 years. Results will be reported after each sampling event and once every 5 years, and the LTM program will be reviewed in each report for effectiveness and redundancy. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

The specific details of this alternative for this FS are discussed below.

5.2.4.1 Building 774

Heating/cooling is provided by 26 heat pumps, which are installed under the roof above the ceiling. Per the water-to-air heat pump schedule in the design plans, the 26 heat pumps have a combined flow rate of 34,430 CFM. In addition, the building has an ERV unit rated at 3,200 SCFM for supply and 2,960 SCFM for return, for a net additional flow rate of 240 SCFM available for building leakages through walls, windows, doors, etc. and for contributing, at least partially, to positive pressure inside building.

The supply air is returned to a common plenum above the ceiling, which also houses the heat pumps. Therefore, irrespective of the distribution and rate of contaminant entry into the building through its floor slab from the sub-surface, it may be expected that all entering contamination will become mixed with all air circulating within the building. Therefore, under this option, a portion of the air will be withdrawn from the plenum area, passed through the carbon system, and the cleaned air is then return to the same plenum area but at a different location far removed from the carbon system to allow for better mixing and for eliminating the potential for short-circuiting the clean air back into the treatment system.

It should be noted that the carbon system is itself a very high performance air filter. However, as a precaution against entrainment of carbon system particles into the clean return air, and considering that computer operations in a clean room setting are performed in the buildings, low-cost high performance (maximum 5-micron) commercial HVAC filters will be installed at the exhaust of the carbon system followed, in series, by High Efficiency Particulate Arrestance (HEPA) filters, rated at minimum 99.97% retention of all particles larger than 0.3 micron in diameter, prior to reintroducing the air into the building occupant area.

With the addition of the commercial HVAC and HEPA filters to the already highly efficient carbon filters, we have taken an extremely conservative approach for protecting the health of the occupants and optimal operating conditions of sensitive equipment. As system performance data becomes available over time, the frequency of change-out of the commercial HVAC and HEPA filters may be reduced depending on the performance of the carbon system.

Assuming steady-state conditions, the contaminant flux entering through the floor slab (µg/min/sq. ft.), G, is given by the relation:
G = CQ/A,
where
C = concentration of mixed indoor air (µg/CF),
A = floor area for entry (sq. ft.), and
Q = exhaust airflow rate (CFM)

Substituting into the above equation the values A = 18,990 sq. ft. and Q = 3,200 SCFM (intake of fresh air, which will equal exhaust flow through the return duct and building leaks), and using latest indoor air sampling data given in Table 2-3, we estimate
G = 0.0224 µg/min/sq. ft. (maximum) and 0.0213 µg/min/sq. ft. (average) for Building 774.

From Table 2-3, from the most recent data, the maximum measured concentration of VOCs in Building 774 is 4.70 µg/m^3 (all of which is for TCE) and the average measured concentration of VOCs is 4.465 µg/m^3 (which includes TCE and cis-1,2-DCE). For improving the indoor air quality, we set the acceptable concentration of VOCs in indoor air at 1.0 µg/m^3 (0.0283 µg/ft^3). For comparison, the OSHA 8-hour TWA PEL limit is 260,000 µg/m^3, which is five (5) orders of magnitude above the limit being set for Building 774. Also, based on the NYSDOH Soil Vapor/Indoor Air Matrix 1, dated October 2006, mitigation in the form of maintaining indoor total VOC concentration below 1.0 µg/m^3would appear to be consistent with the spirit and rationale of the decision-making process recommended therein.

Again assuming steady-state conditions and, thus using the above equation, the dilution air required for achieving an indoor target concentration of maximum 1.0 µg/m^3 for total VOCs is given by the relation,
Q (dilution air, CFM) = GA/C (target),
Where
G = 0.0224 µg/min/sq. ft. (calculated maximum contaminant flux entering the building, which is assumed to remain constant with time),
A = 18,990 sq. ft., and
C (target) = 1.0 µg/m^3 (0.0283 µg/m^3), maximum

Calculating for Q (dilution) from the above equation,
Q (minimum dilution air based on maximum G value) = 15,030 SCFM

Using the calculated average value for G (0.0213 µg/min/sq. ft.), and again assuming it to remain constant with time,
Q (minimum dilution air based on average G value) = 14,300 SCFM

[We can take a short-cut on the above set of calculations by simply multiplying current exhaust rate by the before to after concentration ratio (e.g., average 4.465 conc. / 1.0 target conc. X 3200 SCFM = 14,300 SCFM), but the long method above is easier to follow.]

For design, Q (dilution air) = 15,000 SCFM

The carbon treatment will be sized to treat 15,000 SCFM of contaminated air and recycle it back into the indoor environment to maintain total VOC concentration below 1.0 $\mu g/m^3$.
Capital Cost items:

- Provide two (2) sets of carbon in series, each sized to 15,000 SCFM, so that the first unit can be replaced after it has breakthrough, and the previously second carbon can be switched to first place.
- Provide low-cost high performance (maximum 5-micron) commercial HVAC filters will, which are to be installed at the exhaust of the carbon system. Assuming 400 CFM/SF of filter for budget costing purposes, approximately 40 SF of commercial HVAC filters would be needed.
- Provide, in series arrangement with the commercial HVAC filters, a set of HEPA filters, rated at minimum 99.97% retention of all particles larger than 0.3 micron in diameter, prior to reintroducing the air into the building occupant area. Assuming 300 CFM/SF of filter for budget costing purposes, approximately 50 SF of HEPA filters would be needed.
- Provide three (3) gages for measuring air pressure (one before first carbon, one between carbon, and one after second carbon), correspondingly three (3) sampling ports, and quick connects for carbon switching and changing
- Installation costs for this unit.
- If it is not already installed at present, a control system is needed for monitoring the pressures and for adjusting the flow rates of the entire system to maintain the desired building HVAC pressure and flow conditions.

O&M Costs:

- Extra power for overcoming the carbon system pressure drop
- Cost adjustments for exothermic temperature rise during adsorption, if large enough to warrant for FS purposes
- Initial system balancing costs, assume lump-sum, say $20,000
- Annual system rebalancing costs, assume lump-sum, say $10,000
- For cost budgeting purposes, assume annual change-out of carbon initially; actual frequency will depend on carbon breakthrough.
- Commercial HVAC filter change, once per month initially, reduce frequency later if feasible depending on carbon system performance in preventing particulate entrainment; increase frequency otherwise, if needed.
- HEPA filter change, once every six months initially, reduce frequency later if feasible depending on carbon system performance in preventing particulate entrainment; increase frequency otherwise, if needed.

- Extra manhours, continuous for monitoring, verifying, adjusting positive pressures inside building, one (1) hour per week

Monitoring Costs (Same as for Directional Drilling):

For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and carbon treatment exhaust air sampling – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.4.2 Building 776

Use the same methodology as before for Building 774. Use indoor sampling data given in Table 2-4 for this building. For Building 776, from available plans, intake fresh air is 1,700 SCFM and foot area is 27,410 sq. ft.

Results are:
G = 0.0058 (maximum) and 0.0047 (average), µg/min/sq. ft.
Q (dilution) = 5,620 SCFM (maximum) and 4,550 SCFM (average)

For design, Q (dilution air) = 5,500 SCFM

Size carbon system for this flow rate and assume two (2) sets in series as before.

Capital Cost items:

- Provide two (2) sets of carbon in series, each sized to 5,500 SCFM, so that the first unit can be replaced after it has breakthrough, and the previously second carbon can be switched to first place.
- As in the case of Building 774 (Section 5.2.4.1), provide commercial HVAC and HEPA filters for added protection of occupants and sensitive equipment.
- Provide low-cost high performance (maximum 5-micron) commercial HVAC filters will, which are to be installed at the exhaust of the carbon system. Assuming 400 CFM/SF of filter for budget costing purposes, approximately 15 SF of commercial HVAC filters would be needed.

- Provide, in series arrangement with the commercial HVAC filters, a set of HEPA filters, rated at minimum 99.97% retention of all particles larger than 0.3 micron in diameter, prior to reintroducing the air into the building occupant area. Assuming 300 CFM/SF of filter for budget costing purposes, approximately 20 SF of HEPA filters would be needed.
-
- Provide three (3) gages for measuring air pressure (one before first carbon, one between carbon, and one after second carbon), correspondingly three (3) sampling ports, and quick connects for carbon switching and changing
- Installation costs for this unit.
- If it is not already installed at present, a control system is needed for monitoring the pressures and for adjusting the flow rates of the entire system to maintain the desired building HVAC pressure and flow conditions.

O&M Costs:

- Extra power for overcoming the carbon system pressure drop
- Cost adjustments for exothermic temperature rise during adsorption, if large enough to warrant for FS purposes
- Initial system balancing costs, assume lump-sum, say $20,000
- Annual system rebalancing costs, assume lump-sum, say $10,000
- For cost budgeting purposes, assume annual change-out of carbon initially; actual frequency will depend on carbon breakthrough.
- Commercial HVAC filter change, once per month initially, reduce frequency later if feasible depending on carbon system performance in preventing particulate entrainment; increase frequency otherwise, if needed.
- HEPA filter change, once every six months initially, reduce frequency later if feasible depending on carbon system performance in preventing particulate entrainment; increase frequency otherwise, if needed.
- Extra manhours, continuous for monitoring, verifying, adjusting positive pressures inside building, one (1) hour per week

Monitoring Costs (Same as for Directional Drilling):

For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and carbon treatment exhaust air sampling (one) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on

intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.4.3 Other Considerations For Carbon Treatment:

1. Both buildings are large in size (18,990 sq. ft. for Building 774 and 27,410 sq. ft. for Building 776) with numerous partitions, and have multiple heat pumps (26 in Building 774 and 43 in Building 776). Since the flow dynamics of such buildings can be complex, maintaining required levels of building pressures and flow rates in all areas may have uncoordinated impacts on different heat pumps, thereby adversely affecting their performance and efficiency, which, in turn, can subject the occupants to variable and unpredictable environmental conditions.

2. The contaminants are allowed to enter the building before they are treated, and any changes in the influx rate of contaminants would need adjustment of the flow control system for carbon. Thus, frequent monitoring for safe levels and adjustments as needed would be required.

For the above reasons, and considering that these buildings do not have one central system but numerous individual flow units, carbon treatment of indoor air is not necessarily the most assured solution for vapor mitigation at Buildings 774 and 776.

5.2.5 Alternative 774/776-5: Ventilation/Dilution +LTM

Description

In this option, indoor air concentrations are reduced to the target concentration of 1.0 $\mu g/m^3$ for total VOCs by simply diluting indoor air with fresh outdoor air and exhausting the same. The dilution flow rates will be the same as for the carbon treatment alternative above (15,000 SCFM for Building 774 and 5,500 SCFM for Building 776).

For the LTM part of this alternative: indoor air sampling should be performed to confirm the effectiveness of the technology after it has been implemented, and periodic sampling of decreasing frequency should be performed to verify continued effectiveness, as detailed below.

The LTM includes the sampling and analysis of indoor air, sub-slab air and exhaust air, as appropriate. The LTM sampling will consist of a baseline indoor sampling event (4 locations) and samples collected from the carbon treatment exhaust air. Subsequent sampling will be performed one month after startup, six (6) months after startup, and reoccur every 6 months after that. Additionally, sub-slab verification will be performed after one year and every 5 years. Results will be reported after each sampling event and once every 5 years, and the LTM program will be reviewed in each report for effectiveness and redundancy. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

The specific details of this alternative for this FS are discussed below.

Capital Cost items (applicable to both buildings):
- New air supply units rated at minimum 15,000 SCFM for Building 774 and 5,500 SCFM for Building 776
- Installation costs for these units, including roof reinforcement if any is needed
- If not already installed at present, control systems are needed (or augmented if present) for monitoring the pressures and for adjusting the flow rates of the entire systems to maintain the desired indoor pressures and flow rates

O&M Costs (applicable to both buildings):
The ERV for Building 776 is based on 1700 SCFM air supply with 1 HP power rating and 1200 SCFM air exhaust at 0.5 HP power rating. For the FS purpose, use the supply rating of this system to estimate O&M costs for this alternative by scaling proportionately. Thus:
- For Building 774, perform costing with 15,000 SCFM at 9 HP power rating for air supply and 15,000 SCFM at 9 HP power rating for air exhaust (total 18 HP), and
- For Building 776, perform costing with 5,500 SCFM at 3.5 HP power rating for air supply and 5,500 SCFM at 3.5 HP power rating for air exhaust (total 7 HP)
- For Building 774, six (6) months heating of 15,000 SCFM to 72F = 750,000 Btu/Hr heating load (heating load based on same design assumptions as for existing systems)
- For Building 776, six (6) months heating of 5,500 SCFM to 72F = 275,000 Btu/Hr heating load (heating load based on same design assumptions as for existing systems)
- For Building 774, three (3) months cooling of 15,000 SCFM to 77F = 520,000 Btu/Hr cooling load (cooling load based on same design assumptions as for existing systems)
- For Building 776, three (3) months cooling of 5,500 SCFM to 77F = 190,000 Btu/Hr cooling load (cooling load based on same design assumptions as for existing systems).

Initial system balancing costs, assume lump-sum, say $20,000
Annual system rebalancing costs, assume lump-sum, say $10,000
Extra manhours, continuous for monitoring, verifying, adjusting positive pressures inside building, one (1) hour per week.

Monitoring Costs (Same as for Directional Drilling):
For sampling and verification, assume the following suggested frequency:
- Baseline indoor (4 locations) and HVAC system exhaust air sampling (one) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start

- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Pressure differential readings will be collected during every indoor and sub-surface sampling event.
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.2.5.1 Other Considerations For Dilution/Ventilation:

1. Both buildings are large in size (18,990 sq. ft. for Building 774 and 27,410 sq. ft. for Building 776) with numerous partitions, and have multiple heat pumps (26 in Building 774 and 43 in Building 776). Since the flow dynamics of such buildings can be complex, maintaining required levels of building pressures and flow rates in all areas may have uncoordinated impacts on different heat pumps, thereby adversely affecting their performance and efficiency, which, in turn, can subject the occupants to variable and unpredictable environmental conditions. It is also unreasonable to expect occupants to pay higher utility costs due to the inefficient operation caused by this option.

2. The contaminants are allowed to enter the building before they are diluted, and any changes in the influx rate of contaminants would need adjustment of the flow control system. Thus, frequent monitoring for safe levels and adjustments as needed would be required.

For the above reasons, and considering that these buildings do not have one central system but numerous individual flow units, dilution/ventilation of indoor air is not necessarily the most desirable solution for vapor mitigation at Buildings 774 and 776.

5.3 Alternatives for Buildings 785 and 786

For Buildings 785 and 786, the following technology options were retained for detailed analysis in Section 4:

- No Further Action
- Limited Action / Long-Term Monitoring (LTM)
- Horizontal Piping (wells) / Trenching / Sumps / Vertical Piping (wells)
- Directional Drilling

Among the piping, trenching, and sump technologies, only one need to be retained for detailed analysis in the FS due to their similarity in basic design functions. Since installation of horizontal piping, trenching, and sumps would involve considerable amount cutting of the floor slab, vertical piping (wells) is retained as the representative technology for this FS.

The following alternatives were developed for these buildings for detailed analysis:

- Alternative 785/786-1: No Further Action
- Alternative 785/786-2: Directional Drilling + LTM
- Alternative 785/786-3: Vertical Wells + LTM

The above three (3) mitigation alternatives will be comparatively evaluated with respect to the nine (9) evaluation criteria that were described earlier.

Please note that these conceptual designs, as well as the conceptual designs for the other alternatives in this FS, are developed for the purpose of this FS only, and the actual systems installed will be based on engineering designs that may or may not conform to these conceptual designs. However, in keeping with FS guidance recommendations, these conceptual designs were developed to provide estimates that are within +50% and -30% of likely costs.

5.3.1 Alternative 785/786-1: No Further Action

No associated costs. Assume a lump-sum $50,000 cost for administrative costs for implementing this alternative.

The Superfund program requires that the "no-action" alternative be considered as a baseline for comparison with the other alternatives. This no-action alternative does not involve any proactive treatment or removal of the groundwater contaminated with chlorinated organics at the site.

5.3.2 Alternative 785/786-2: Directional Drilling + LTM

Description

Two horizontal wells will be installed under each building as shown in Figure 5-2 by directional drilling from the outside. The interior of the buildings is untouched under this alternative, and there will be no sealing of floors or installation of vapor barrier.

In each building, the two horizontal wells will be installed in the center along the long axis directly one below the other, with the shallow well installed at a depth of five (5) ft below ground surface (bgs) and the deep well installed at a depth of 10 ft bgs. The well depths were chosen to extract vapors from within the contaminated zones, thus preventing them from migrating upwards and entering the buildings through the floor slab. During detailed design, the possibility of installing only one (1) well and the effect of this choice on the separate remediation project, which is distinct from the current SVI mitigation project, and on its cleanup times should be examined, before selecting the ultimate well configuration. For the purpose of this FS, two (2) horizontal, directionally drilled wells will be assumed.

The sub-slab is actively depressurized by imposing negative pressure under the slabs by mechanical blowers, and the extracted vapors are discharged to the atmosphere through a stack that is at least three (3) ft taller than the highest point of the building. Please note that, similar to the PRGs, air emissions and air emissions monitoring are generally considered part of the RA WP and therefore will be discussed in that future document. Sub-slab vapor concentrations reported in past sampling efforts (Tables 2-11 and 2-12) are most likely due to accumulated vapors, and concentrations of contaminants through the proposed stack will decrease upon system startup both due to the initial accumulated vapors being removed and due to more representative concentrations being reduced further due to commingling with lower concentration vapors and fresh air intake. Therefore, it is not believed that air emission control would be warranted for the stack emissions; however, review of the need for air emission control will be performed as needed during the detailed design stage.

The specific details of the systems assumed for this FS are discussed below.

Specific Details:

Two (2) identical lines will be assumed in each building.

Building 785:
Line 785-SVE1: 225 ft long (175 ft perforated/slotted, 25 ft solid at each end)
Line 785-SVE2: 225 ft long (175 ft perforated/slotted, 25 ft solid at each end)

Building 786:
Line 786-SVE1: 225 ft long (175 ft perforated/slotted, 25 ft solid at each end)
Line 786-SVE2: 225 ft long (175 ft perforated/slotted, 25 ft solid at each end)

All lines:
4-inch HDPE perforated or slotted, non-corrugated. The pipe slot (open) areas are to be about 25-33% of pipe outer surface area, but are to be designed with the goal of withdrawing vapors at equal rates from all segments of pipe (i.e., fewer slots and/or more friction as one comes closer to the blower end from the far end).

Drilling done such that piping is installed five (5) bgs and 10 ft bgs in each building.

However, the above described pipe travel route may be modified under field conditions, particularly since there are old foundation walls in the interior of unknown depth, or if the shallow well depth is not enough to clear the bottom of the footing.

The two lines are to be joined into a 6 inch HDPE common header that is then connected to the suction side (inlet) of the blower.

Assume total 6 inch HDPE aboveground piping to be 100 ft (from underground piping on both lines to the common header/blower and then to exhaust point).

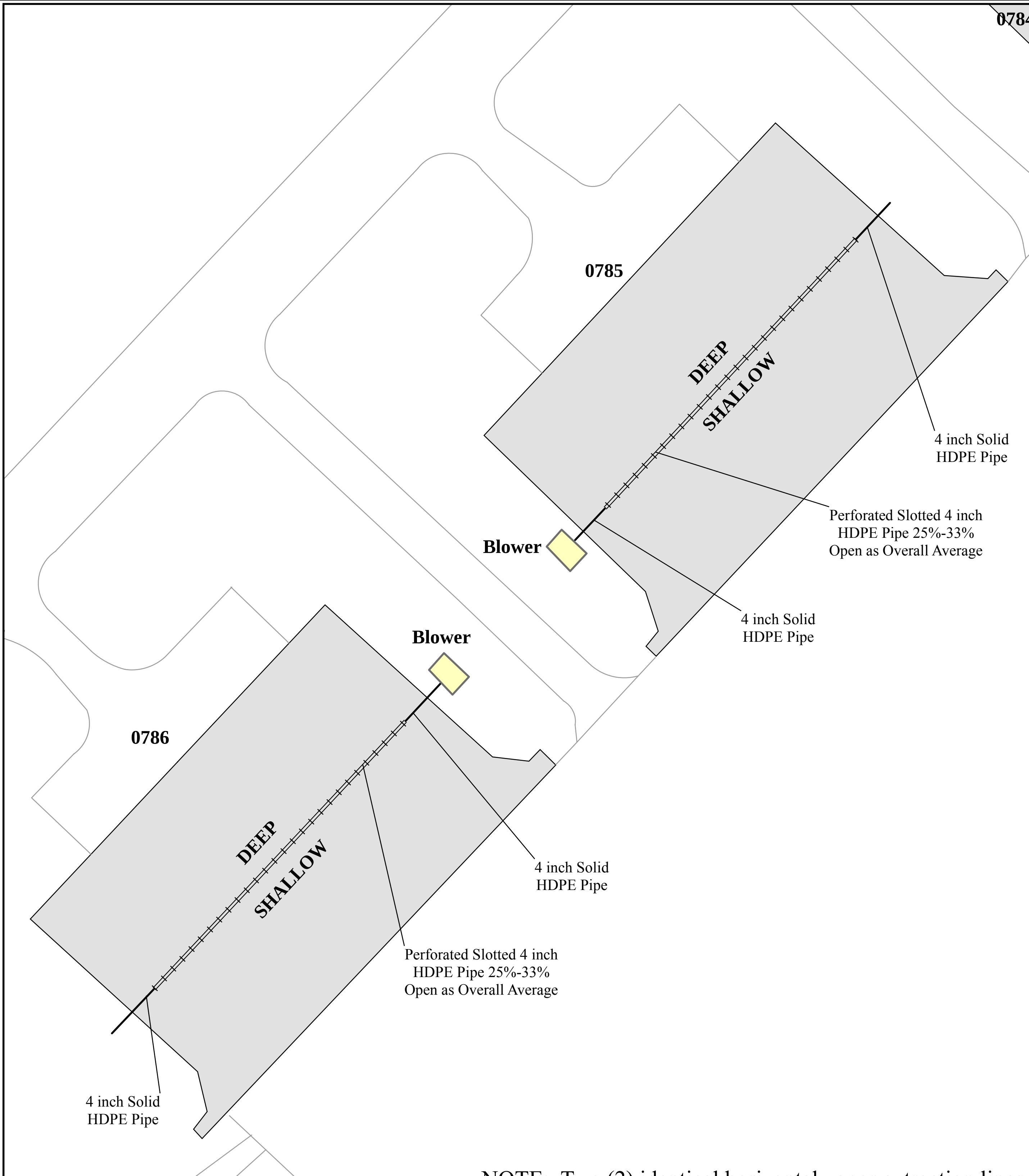
Assume vapor extraction at a rate of 450 SCFM, which is equal to the vapor extraction rate selected for the vertical wells alternative, which was selected based on using typical extraction rates for the types of soil conditions at the site and experience. This flow rate is equal to about 0.85 ACH of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system) for the two wells under a building. That is, assuming 25% porosity, 0.85 ACH, (130 ft x 242 ft) x 2 ft thickness x 2 wells, design extraction flow rate is 26750 CFH or 450 CFM in each building (225 CFM per well).

Controlling pipe length 225 ft.
For longer pipe, underground piping (4 inch) pressure loss = 3 inch w.g. / 100 ft X 225 ft = 6.75 inch w.g.
Add 10% for slot resistance, total u/g pressure loss = 7.5 inch w.g.

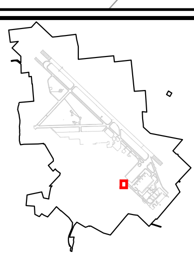
Aboveground piping (4inch) pressure loss = 1.5 inch w.g. / 100 ft X 100 ft = 1.5inch
Double to account for fittings, diameter changes, etc. = 3.0 inch w.g.
Total pressure (i.e., vacuum) loss = 7.5 (u/g) + 3.0 (a/g) = 10.5 inch w.g.

Total flow of 450 CFM at 10.5 inch w.g. ==> 10 HP regenerative blower or equivalent, with approx. seven (7) HP power consumption for each building. (Available data on Rotron blower is used; power consumption may possibly be reduced by selecting a better fit model during design stage.)

At each of the two Buildings 785 and 786, install a mechanical blower on roof or at ground level, min. 450 CFM (assumed to be on ground in an enclosure for costing purposes). Discharge point to be minimum three (3) ft above roof ridge.



NOTE: Two (2) identical horizontal vapor extraction lines one beneath the other at 5 ft. below ground surface (bgs) and 10 ft. bgs; both connected to the blower.



Site Location

Key to Features

- Riser
- Horizontal Pipe
- Existing Facility
- Demolished Facility

FIGURE 5-2
Buildings 785 and 786
Directional Drilling

N

0 30 60
Feet

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5.3.2.1 For Both Buildings 785 and 786:

Capital Cost items:
The following apply to each of the two Buildings 785 and 786.

- Underground directional drilling of a 225 ft long 4 inch HDPE piping, of which the middle 175 ft is slotted/perforated per specifications described above and the two 25 ft-each are to be solid pipe with end of line closed with an end cap
- A second line identical in length and specifications to the above first line (underground directional drilling of a 225 ft long 4 inch HDPE piping, of which the middle 175 ft is slotted/perforated per specifications described above and the two 25 ft-each are to be solid pipe with end of line closed with an end cap)
- Drilling of one line at a depth of about five (5) below ground surface (bgs), with field adjustments to ensure piping will pass one (1) foot below bottom of footings
- Drilling of the second line at a depth of about 10 ft bgs
- Installation of a total of 100 ft of 6 inch HDPE piping aboveground, which includes piping from underground exit points of the two underground lines to the common 6 inch header, its travel to the blower, and from the exit of the blower to the exhaust point three (3) ft above highest roof point
- Installation of one (1) 10 HP, 450 CFM @ 10.5 inch w.g., regenerative blower or equivalent
- Blower can be installed at ground level or on roof, but assume ground level installation with a protective enclosure for costing purposes
- All electrical lines to blower and to control box

O&M Costs: Assume continuous operation, indefinite duration for blower, i.e., add cost for seven (7) HP of power consumption continuously year-round (24x7x365).
Extra manhours (assume two manhours on average per week per blower = total four manhours per week) for monitoring the gages and making adjustments to system operating conditions, verifying the operation of blowers, adjusting blower performance, and performing maintenance work.

The systems will be inspected weekly to ensure proper operation. The pressure gage readings and flow measurements will be recorded. The system will be inspected for breaks, cracks, leaks, etc. The blowers will be maintained according to the manufacturer’s recommendations.

Monitoring Costs:
For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and subsurface sampling (one in each pipe without blower, i.e., vent vapors) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months

- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.3.3 Alternative 785/786-3: Vertical Wells + LTM

Description

Twenty eight (28) 2-inch polyvinyl chloride (**PVC**) vertical wells will be installed through the floor slab under each building as shown in Figure 5-3. The wells are joined into two (2) 6-inch PVC headers, which are then connected to the blower. Buildings 785 and 786 are former air craft maintenance hangars with an interior open space height of 34 feet. This provides adequate overhead clearance for header and piping installation. During detailed design, the number and arrangement of the wells should be examined through a pilot test, before selecting the ultimate well configuration.

The sub-slab is actively depressurized by imposing negative pressure under the slabs by mechanical blowers, and the extracted vapors are discharged to the atmosphere through a stack that is at least three (3) ft taller than the highest point of the building. Please note that, as was discussed in Section 5.3.2 above, it is not believed that air emission control would be warranted for the stack emissions; however, review of the need for air emission control will be performed as needed during the detailed design stage.

The specific details of the systems assumed for this FS are discussed below.

Specific Details (apply to both buildings):

Twenty eight (28) vertical wells, each eight (8) ft deep with five (5) ft of screen. One-half (14) of the wells will be joined to a 6-inch overhead header that is installed approximately 15 above floor. The other 14 wells will be joined to a 6-inch header installed below floor level in an existing trench.

The two lines are to be joined into a 6-inch HDPE common header that is then connected to the suction side (inlet) of the blower.

Assume vapor extraction at a rate of 450 SCFM, which assumes approximately 16 CFM per well, which is based on using typical extraction rates for the types of soil conditions at the site and experience.

Pressure loss calculations yield 4 inch w.g. using similar calculation methodologies as for the other alternatives.

Total flow of 450 CFM at 4 inch w.g. ==> 10 HP regenerative blower or equivalent, with approximately seven (7) HP power consumption for each building. (Available data on Rotron blower is used; power consumption may possibly be reduced by selecting a better fit model during design stage.)

At each of the two Buildings 785 and 786, install a mechanical blower on roof or at ground level, min. 450 CFM (assumed to be on ground in an enclosure for costing purposes). Discharge point to be minimum three (3) ft above roof ridge.

5.3.3.1 For Both Buildings 785 and 786:

Capital Cost items:
The following apply to each of the two Buildings 785 and 786.

- Drilling and installation of twenty eight (28) 2-inch PVC vertical wells through the floor slab. Each vertical well to be eight (8) ft deep with five (5) ft of screen)
- One-half (14) of the wells to be joined to a 6-inch overhead header installed approximately 15 ft above the floor
- The other 14 wells to be joined to a 6-inch header installed below floor level in an existing trench
- Joining of the two (2) 6-inch PVC headers, which are then connected to the suction side (inlet) of the blower
- Installation of a total of 100 ft of 6 inch PVC piping aboveground for joining of the two headers, travel of combined pipe to blower, and from the exit of the blower to the exhaust point three (3) ft above highest roof point
- Installation of one (1) 10 HP, 450 CFM @ 10.5 inch w.g., regenerative blower or equivalent
- Blower can be installed at ground level or on roof, but assume ground level installation with a protective enclosure for costing purposes

FIGURE 5-3
Buildings 785 and 786
Vertical Wells

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- All electrical lines to blower and to control box

O&M Costs: Assume continuous operation, indefinite duration for blower.
The systems will be inspected weekly to ensure proper operation. The pressure gage readings and flow measurements will be recorded. The system will be inspected for breaks, cracks, leaks, etc. The blowers will be maintained according to the manufacturer's recommendations.

Monitoring Costs:

For sampling and verification, assume the following suggested frequency:

- Baseline indoor (4 locations) and subsurface sampling (one in each pipe without blower, i.e., vent vapors) – Once at start
- First verification sampling (same locations as above) – One (1) month after start
- Second verification sampling (same locations as above) – Six (6) months after start
- Indoor verification sampling (same locations as above, may be reduced over time) – Every six (6) months
- Subsurface verification sampling – Once at end of one (1) year, once at end of five (5) years
- Prepare periodic reports and one five (5) year review, after which the O&M program can be modified as needed. The O&M program to be modified sooner depending on intermediate period sampling results. A comprehensive review will be conducted after five (5) years of system operation, and recommendations will be made for future action, including future monitoring, as needed.

5.4 Evaluation of Response Action Alternatives

The following evaluation analyzes the effectiveness, implementability, and cost (discussed in detail in Sections 5.1.1, 5.1.2, and 5.1.3) of each of the five (5) or three (3) alternatives identified in Section 5.2 and 5.3 for Buildings 774 and 776 and Buildings 785 and 786 respectively. The state and community acceptance criteria were not evaluated in this FS; instead, they will be formally addressed in the ROD after comments are received on the Proposed Plan.

5.4.1 Alternatives Evaluation Methodology

The evaluations for the individual criteria are presented briefly below and detailed in Table 5-1, Comparative Evaluation of Mitigation Alternatives (provided at the end of Section 5). Since the five (5) and three (3) different alternatives considered in this FS are likely to satisfy the different evaluation criteria identified in Section 5.1 to varying degrees and not necessarily with a consistent pattern relative to each other, a scoring system was adopted to aid in the ranking of the alternatives for the purpose of remedy selection. The scoring system is based on qualitatively assigning a numerical score of zero (0) to the worst or least successful alternative, and a numerical score of four (4) to the best or most successful alternative, with respect to its meeting the objectives of a given criterion under consideration. The assigned scores do not have any physical significance (i.e., they are not absolute numbers); however, the scores were qualitatively assigned by considering the trade-off between the different alternatives and using professional judgment to provide, at least, a preliminary ranking of the degree to which all the five (5) and three (3) alternatives fulfill any given criterion relative to each other.

For selecting recommended alternatives, the results of the evaluations for the individual criteria and their qualitative scores are then comprehensively considered in the discussions presented below and summarized in Table 5-2, Selection of Recommended Mitigation Alternatives (provided at the end of Section 5). Towards this end, for each alternative a total effectiveness score was determined by adding its scores for the individual effectiveness criteria from Table 5-1; specifically, for each alternative the total effectiveness score in Table 5-2 is the sum its scores for the overall protection of human health and the indoor environment; compliance with health standards and any air quality goals and standards; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. It should be noted that this methodology of totaling the effectiveness score without weighting factors implicitly assumes that all of the above five individual criteria are equally important.

To provide a common basis for the comparative evaluation of total effectiveness of the alternatives, the ratio of total effectiveness score to estimated cost in millions of dollars was computed (Table 5-2), which provides a relative assessment of the total degree of effectiveness that each alternative yields per one million dollars spent on the remedy, i.e., higher the total effectiveness score to estimated cost ratio for a given alternative, the more cost effective would be that alternative relative to others with lower ratios.

Finally, for the purpose of selecting the recommended alternatives, the cost-effectiveness as calculated above, the alternatives' implementability score, and the limitations of the methodology which are discussed above, were taken into consideration in the overall assessment that was qualitatively performed using professional judgment and past experience for each alternative to determine its potential for meeting the program goals and the mitigation action goals, while being cost-effective and implementable. The recommended alternatives are discussed in the following section and summarized in Table 5-2.

In conclusion, a scoring system was developed to clarify the relative merits of the various alternatives with respect to the evaluation criteria and to form a common basis for their comparative evaluation. With regard to evaluating the degree of fulfillment of the individual criteria, the common basis is the 0 (worst) – 4 (best) scoring system with which to compare the alternatives to each other. With regard to evaluating the overall cost-effectiveness of the alternatives, the common basis is the computed ratio of total effectiveness score per million dollars of spending on that remedy. The limitations of the methodology are that it is qualitative both in definition and assignment of scores. However, while the results of the ranking methodology were used to aid in clarifying the evaluations, such usage was not to the exclusion of other considerations, and the selection of recommended alternatives was made based on an understanding and overall assessment of the strengths and limitations of each alternative with regards to its potential for meeting the project goals.

5.4.2 Evaluations for Individual Criteria

The evaluations that were performed for the individual criteria are briefly presented below. They are further discussed in detail in Table 5-1.

For convenience, the alternatives for Buildings 774 and 776 are re-listed below from Section 5.2.

- Alternative 774/776-1: No Further Action
- Alternative 774/776-2: Directional Drilling + LTM
- Alternative 774/776-3: HVAC Manipulation + LTM
- Alternative 774/776-4: Carbon Treatment + LTM
- Alternative 774/776-5: Ventilation/Dilution +LTM

For convenience, the alternatives for Buildings 785 and 786 are re-listed below from Section 5.3.

- Alternative 785/786-1: No Further Action
- Alternative 785/786-2: Directional Drilling + LTM
- Alternative 785/786-3: Vertical Wells + LTM

5.4.2.1 Overall protection of human health and the indoor environment

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. This alternative does not provide overall protection of human health and the indoor environment as the occupants (workers) of the buildings will continue to be exposed to contaminated indoor air.

- Alternative 774/776-2: Directional Drilling + LTM. This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection.

- Alternative 774/776-3: HVAC Manipulation + LTM. This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing, in principle, the best level of protection. In practice, since the bottom of the slab will remain exposed to sub-surface contaminants, intrusion by molecular diffusion will remain although this mode of intrusion is orders of magnitude lower (i.e., negligible) than the advective type of intrusion that is prevented by this alternative. Also, since HVAC systems typically experience variability in operating conditions in response to atmospheric and other changes (e.g., heating/cooling loads), depending on the response time of the system for automatically making the needed adjustments, the potential for occasional advective intrusion of contaminants remains.

- Alternative 774/776-4: Carbon Treatment + LTM. This alternative will provide overall protection of human health and the indoor environment. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the carbon treatment system is operated. However, the contaminants are allowed to enter the interiors of the buildings before they are treated. Since, in order to reduce costs, only a portion of contaminated air is treated and reintroduced into the building to reduce the overall contaminant concentrations to below safe levels, the alternative will be protective of human health but the quality of air will not be pristine.

- Alternative 774/776-5: Ventilation/Dilution +LTM. This alternative will provide overall protection of human health and the indoor environment. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the ventilation dilution system is operated. However, the contaminants are allowed to enter the interiors of the buildings before they are treated. Since, in order to reduce costs, only a portion of contaminated air is exhausted and replaced with clean outside air to reduce the overall contaminant concentrations to below safe levels, the alternative will be protective of human health but the quality of air will not be pristine.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. This alternative does not provide overall protection of human health and the indoor environment as the occupants (workers) of the buildings will continue to be exposed to contaminated indoor air.

- Alternative 785/786-2: Directional Drilling + LTM. This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection. The subsurface contamination is also remediated by soil vapor extraction.

- Alternative 785/786-3: Vertical Wells + LTM. This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection. The subsurface contamination is also remediated by soil vapor extraction.

5.4.2.2 Compliance with health standards and any air quality goals and standards

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. This alternative will not be in compliance of the mitigation goals for the proposed mitigation action. The Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776. Thus, this alternative will not achieve the mitigation action goals for this site within a reasonable time compared to other alternatives.

- Alternative 774/776-2: Directional Drilling + LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed mitigation action. Although no treatment is proposed, LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.

- Alternative 774/776-3: HVAC Manipulation + LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed mitigation action. Although no treatment is proposed, LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings, except for the potential intrusion of residuals.

- Alternative 774/776-4: Carbon Treatment + LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed mitigation action. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that the concentrations remain below safe levels, except that contaminants remain in indoor air, albeit below safe levels.

- Alternative 774/776-5: Ventilation/Dilution +LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed mitigation action. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that the concentrations remain below safe levels, except that contaminants remain in indoor air, albeit below safe levels.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. This alternative will not be in compliance of the mitigation goals for the proposed mitigation action. For Buildings 785 and 786, the Air Force has agreed to take an appropriate mitigation action, such as installing a soil vapor extraction (SVE) system under the buildings, to remove the source. Thus, this alternative will not achieve the mitigation action goals for this site within a reasonable time compared to other alternatives. Please note that, as was discussed before, this FS addresses only mitigation of SVI in the buildings (see, for example, Footnote 1 in Section 4.1.1, No further Action).

- Alternative 785/786-2: Directional Drilling + LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed mitigation action by preventing the vapors from entering the buildings from the subsurface and by incidentally removing (treating) contamination from subsurface source areas. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.

- Alternative 785/786-3: Vertical Wells + LTM. This alternative will be in compliance with and will achieve the mitigation goals for the proposed action by preventing the vapors from entering the buildings from the subsurface and by removing (treating) contamination from subsurface source areas. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.

5.4.2.3 Long-term effectiveness and permanence

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. This alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives. However, the concentrations of contaminants in the air are small and it is possible that they will asymptotically decrease over the long-term through natural attenuation processes.

- Alternative 774/776-2: Directional Drilling + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting.

- Alternative 774/776-3: HVAC Manipulation + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as positive pressure is maintained at levels designed to prevent intrusion of vapors. Indefinite protection will require maintaining and operating the positive pressure system indefinitely.

- Alternative 774/776-4: Carbon Treatment + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the carbon treatment system is operated at levels designed to reduce indoor air concentrations to below safe levels. However, the workers will be exposed to some low level of contamination, although it will be below safe levels. Indefinite protection will require maintaining and operating the carbon treatment system indefinitely.

- Alternative 774/776-5: Ventilation/Dilution +LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the ventilation dilution system is operated at levels designed to reduce indoor air concentrations to below safe levels. However, the workers will be exposed to some low level of contamination, although it will be below safe levels. Indefinite protection will require maintaining and operating the ventilation dilution system indefinitely.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. This alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives. However, the concentrations of contaminants in the air are small and it is possible that they will asymptotically decrease over the long-term through natural attenuation processes, and the subsurface contamination may also decrease over the long-term through natural attenuation.

- Alternative 785/786-2: Directional Drilling + LTM. The buildings are dedicated to non-residential industrial/office use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting. The SVE system will permanently remove contamination from the subsurface over a period of time resulting in long-term effectiveness of this alternative.

- Alternative 785/786-3: Vertical Wells + LTM. The buildings are dedicated to non-residential industrial/office use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting. The SVE system will permanently remove contamination from the subsurface over a period of time resulting in long-term effectiveness of this alternative.

5.4.2.4 Reduction of toxicity, mobility, or volume through treatment

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. No treatment is proposed.

- Alternative 774/776-2: Directional Drilling + LTM. No treatment is proposed. However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

- Alternative 774/776-3: HVAC Manipulation + LTM. No treatment is proposed. However, the toxicity, mobility, and volume in indoor air will essentially be eliminated by preventing the subsurface vapors from entering the interior of the buildings, except for potential residuals (potential residuals refers to chemicals already present in the indoor air or chemicals which are brought in by building occupants). LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

- Alternative 774/776-4: Carbon Treatment + LTM. A sufficient portion, but not all, of the indoor contaminants are proposed to be treated for achieving indoor concentrations below safe levels through dilution when the treated air is reintroduced into the indoor environment. However, the starting concentrations in the air are low and are primarily being treated because of human health considerations. Thus, the advantage of this alternative over the other alternatives is only marginal when evaluated in the context of reducing the contaminants with respect to the overall environment. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

- Alternative 774/776-5: Ventilation/Dilution +LTM. No treatment is proposed. However, the toxicity, mobility, and volume in indoor air will be reduced by expelling a portion of the contaminants to outdoors without treatment. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. No treatment is proposed.

- Alternative 785/786-2: Directional Drilling + LTM. No treatment of extracted vapors is proposed, since their concentrations are expected to be dilute. However, the toxicity, mobility, and volume in indoor air will essentially be eliminated by preventing the subsurface vapors from entering the interior of the buildings, and the toxicity, mobility, and volume of subsurface contamination will be permanently reduced with time. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

- Alternative 785/786-3: Vertical Wells + LTM. No treatment of extracted vapors is proposed, since their concentrations are expected to be dilute. However, the toxicity, mobility, and volume in indoor air will essentially be eliminated by preventing the subsurface vapors from entering the interior of the buildings, and the toxicity, mobility, and volume of subsurface contamination will be permanently reduced with time. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.

5.4.2.5 Short term effectiveness

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. This alternative will not achieve the mitigation goals for this site and, thus, will also not be effective in the short-term in protecting human health and the indoor environment during implementation of the alternative.

- Alternative 774/776-2: Directional Drilling + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

- Alternative 774/776-3: HVAC Manipulation + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active venting system per design requirements, with the exception of the potential for occasional intrusion due to variations (fluctuations) in HVAC system and due to orders-of-magnitude lower levels of molecular diffusion of contaminants into indoor air. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

- Alternative 774/776-4: Carbon Treatment + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active carbon treatment system per design requirements, with the exception of the potential for occasional increases in concentration levels while the HVAC system is readjusting after being subjected to variations (fluctuations) in its operation in response to changing atmospheric and other conditions. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

- Alternative 774/776-5: Ventilation/Dilution +LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active ventilation dilution system per design requirements, with the exception of the potential for occasional increases in concentration levels while the HVAC system is readjusting after being subjected to variations (fluctuations) in its operation in response to changing atmospheric and other conditions. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. This alternative will not achieve the mitigation goals for this site and, thus, will also not be effective in the short-term in protecting human health and the indoor environment during implementation of the alternative.

- Alternative 785/786-2: Directional Drilling + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. SVE, which is an established remediation technology, will be designed to effectively remove source contamination during the implementation of the alternative. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

- Alternative 785/786-3: Vertical Wells + LTM. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. SVE, which is an established remediation technology, will be designed to effectively remove source contamination during the implementation of the alternative. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.

5.4.2.6 Implementability

Buildings 774 and 776

- Alternative 774/776-1: No Further Action. This alternative is technically incapable of achieving the mitigation goals, and is unlikely to receive administrative approvals. In fact, the Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776. The availability of services and materials for implementing this alternative is a non-issue since no action is proposed.

- Alternative 774/776-2: Directional Drilling + LTM. This alternative measures high on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to install a sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

- Alternative 774/776-3: HVAC Manipulation + LTM. This alternative measures low to moderate on technical implementability, because HVAC systems are typically subjected to variable (fluctuating) operating conditions because of changes in atmospheric and other conditions and, thus, the task of operating the system at conditions that are needed for preventing intrusion of air contaminants with positive internal pressure have to be dynamically controlled. Continuous dynamical control can be difficult due to lag in response time of the mechanical system and of the air pressures in all areas of the buildings. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

- Alternative 774/776-4: Carbon Treatment + LTM. This alternative measures moderate to high on technical implementability, because carbon systems are proven technologies for treating contaminants at a site. However, operating carbon systems would entail ensuring that the operating conditions are maintained within the tolerance ranges of the operating parameters of the carbon system, that the carbon is changes at required intervals, etc. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

- Alternative 774/776-5: Ventilation/Dilution +LTM. This alternative measures moderate to high on technical implementability because, when operated at design conditions, ventilation dilution can be successful in reducing indoor air concentrations to below safe levels. However, since HVAC systems typically experience fluctuations in operating conditions, the ventilation dilution system will also have to correspondingly readjust dynamically in concert with the main HVAC system, which can result in less than or more than the design dilution levels while the systems are readjusting with lags in response times. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action. This alternative is technically incapable of achieving the mitigation goals, and is unlikely to receive administrative approvals. In fact, for Buildings 785 and 786, the Air Force has agreed to take an appropriate remedial action, such as installing an SVE system under the buildings, to remove the source.[1] The availability of services and materials for implementing this alternative is a non-issue since no action is proposed.

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[1] However, this FS addresses only mitigation of SVI in the buildings as was discussed before (see, for example, Footnote 1 in Section 4.1.1, No further Action).

- Alternative 785/786-2: Directional Drilling + LTM. This alternative measures high on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program. The interiors of the buildings will not be disturbed. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to undertake remedial action[2]. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

- Alternative 785/786-3: Vertical Wells + LTM. This alternative measures moderate on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program, but with a potential limitation: since 28 vertical wells are proposed to be installed through the floor slab in each building, and associated piping will be installed both aboveground and underground inside the building, this alternative involves intrusive construction. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to undertake remedial action.[3] Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.

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[2] Ibid.
[3] Ibid.

5.4.2.7 Cost

Buildings 774 and 776

- Alternative 774/776-1: No Further Action
- Alternative 774/776-2: Directional Drilling + LTM
- Alternative 774/776-3: HVAC Manipulation + LTM
- Alternative 774/776-4: Carbon Treatment + LTM
- Alternative 774/776-5: Ventilation/Dilution +LTM

Buildings 785 and 786

- Alternative 785/786-1: No Further Action
- Alternative 785/786-2: Directional Drilling + LTM
- Alternative 785/786-3: Vertical Wells + LTM

5.5 Selection of Recommended Alternatives

The evaluations that were performed for the selection of recommended alternatives are discussed below and summarized in Table 5-2.

Following the methodology described in Section 5.4.1 for selecting the recommended alternatives, first, for each alternative a total effectiveness score was determined by adding the scores from Table 5-1 for the overall protection of human health and the indoor environment; compliance with health standards and any air quality goals and standards; long-term effectiveness and permanence; reduction of toxicity, mobility, or volume through treatment; and short-term effectiveness. The cost-effectiveness ratio of total effectiveness score to estimated cost in millions of dollars was computed next (Table 5-2); the higher the total effectiveness score to estimated cost ratio for a given alternative, the more cost effective would be that alternative relative to others with lower ratios.

Finally, taking into consideration the detailed comparative evaluations that were performed in Section 5.4.2 and Table 5-1, the cost-effectiveness ratios and implementability scores for the alternatives from Table 5-2, and the inherent limitations and qualitative nature of the ranking methodology (discussed in Section 5.4.1), an overall assessment was qualitatively performed using professional judgment and past experience for each alternative to determine its potential for meeting the project goals, while being cost-effective and implementable. The recommended alternatives are discussed below and summarized in Table 5-2.

It should be emphasized that, while the alternatives were evaluated and recommended for implementation with the aid of the scoring system described earlier, the critical remedy evaluation and selection process was not subjected to a formulaic analysis but was still based on a qualitative, holistic evaluation that has been performed of all alternatives in the selection or short-listing of remedies for implementation. The scoring system was simply a manifestation of this qualitative analysis and not the agent of analysis.

- Alternative 774/776-1: No Further Action

REJECTED ALTERNATIVE. This alternative is mainly included in this FS to provide a baseline comparison to other alternatives. No action would not reduce the SVI potential or potential exposure of humans and the indoor environment to elevated soil gas concentrations. It is not effective or implementable. Therefore, this alternative is rejected.

- Alternative 774/776-2: Directional Drilling + LTM

RECOMMENDED ALTERNATIVE. The buildings are currently occupied and not disturbing the interior facilities and operations is a singularly important goal. Directional drilling, which is an innovative technology, allows the successful implementation of SVI mitigation system while achieving this goal. This alternative is protective of human health and the indoor environment, prevents contaminants from entering the interior of the buildings, is judged to be the most technically effective and cost effective among all alternatives considered for Buildings 774 and 776, has the lowest estimated costs among the viable alternatives, and measures high on technical and administrative implementability.

- Alternative 774/776-3: HVAC Manipulation + LTM

VIABLE ALTERNATIVE, BUT CEDED IN FAVOR OF ALTERNATIVE 2. The buildings are currently occupied and not disturbing the interior facilities and operations is a singularly important goal. HVAC Manipulation allows for the implementation of a SVI mitigation system to achieve this goal. It is judged to be second-most technically effective and cost effective alternative, and has the second-lowest estimated costs comparable in order of magnitude to the recommended Alternative 2. Its implementability is moderately to significantly lower compared to Alternative 2 because of the dynamical nature of continuous control that would be required to maintain and operate the system at the design positive pressures for preventing soil vapor intrusion into buildings, but it can be a potential backup solution to Alternative 2.

- Alternative 774/776-4: Carbon Treatment + LTM

REJECTED ALTERNATIVE. Although this alternative does not cause disturbance to interior facilities and operations, compared to the recommended Alternative 2, this alternative is technically less effective, about one-third as cost effective (estimated cost), about 2.5 times as costly (estimate cost), and somewhat less implementable.

- Alternative 774/776-5: Ventilation/Dilution +LTM

REJECTED ALTERNATIVE. Although this alternative does not cause disturbance to interior facilities and operations, it is the least technically effective, least cost effective, and most costly at four (4) times the cost of the recommended Alternative 2 (estimated cost), among all the alternatives considered, and its implementability is moderate.

Buildings 785 and 786

- Alternative 785/786-1: No Further Action

REJECTED ALTERNATIVE.

This alternative is mainly included in this FS to provide a baseline comparison to other alternatives. No action would not reduce the SVI potential or potential exposure of humans and the indoor environment to elevated soil gas concentrations. It is not effective or implementable. Therefore, this alternative is rejected.

- Alternative 785/786-2: Directional Drilling + LTM

RECOMMENDED ALTERNATIVE. This alternative is protective of human health and the indoor environment, prevents contaminants from entering the interior of the buildings, is judged to be the most technically effective and cost effective among all alternatives considered for Buildings 785 and 786, has the lowest estimated costs among the viable alternatives, and measures high on technical and administrative implementability. By using soil vapor extraction technology, this alternative, while achieving the stated goal of SVI mitigation, also makes incidental contribution towards satisfying the Air Force intent to remedy the contaminated subsurface soils underneath the buildings.

- Alternative 785/786-3: Vertical Wells + LTM

VIABLE ALTERNATIVE, BUT CEDED IN FAVOR OF ALTERNATIVE 2. Like Alternative 2, by using soil vapor extraction technology, this Alternative 3 also satisfies the Air Force intent to remedy the contaminated subsurface soils underneath the buildings. It is technically as highly effective as the recommended Alternative 2. Its estimated costs are slightly higher and its cost effectiveness is slightly lower than for Alternative 2, but, considering the allowable estimation ranges for the purpose of the FS, the differences are not sufficiently large enough to place Alternative 3 at a great disadvantage relative to Alternative 2 on the basis of the above factors. However, its implementability is moderately lower compared to Alternative 2, and would involve intrusive construction inside the buildings. Furthermore, the recommended alternative for Buildings 774 and 776 is directional drilling, which is the same technology as Alternative 2 for Buildings 785 and 786. Selecting the same directional drilling for all four buildings may provide combined cost benefits and ease and efficiency in construction management. Therefore, cede Alternative 3 in favor of Alternative 2 for Buildings 785 and 786 pending a proposed pilot test.

5.6 Summary of Recommended Alternatives and Implementation Measures

Based on the evaluations in Section 5.5, the following are the results of the detailed analyses of alternatives:

RECOMMENDED ALTERNATIVE FOR BUILDINGS 774 AND 776:

- Alternative 774/776-2: Directional Drilling + LTM
  Estimated 5-year total cost: $630,000

RECOMMENDED CONTINGENCY ALTERNATIVE FOR BUILDINGS 774 AND 776:

- Alternative 774/776-3: HVAC Manipulation + LTM
  Estimated 5-year total cost: $700,000

RECOMMENDED ALTERNATIVE FOR BUILDINGS 785 AND 786:

- Alternative 785/786-2: Directional Drilling + LTM
  Estimated 5-year total cost: $660,000

RECOMMENDED CONTINGENCY ALTERNATIVE FOR BUILDINGS 785 AND 786:

- Alternative 785/786-3: Vertical Wells + LTM
  Estimated 5-year total cost: $750,000

For the selected alternatives for Buildings 774/776 and Buildings 785/786, a flow chart and decision tree have been developed. These provide guidance for system operation, system manipulation, and system shutdown. The flow chart is provided in Figure 5-4 and the decision tree is provided in Figure 5-5.

Please note that, as was discussed in Sections 5.2.2, 5.3.2, and 5.3.3 earlier in this FS, it is not believed that air emission control would be warranted for the stack emissions; however, review of the need for air emission control will be performed as needed during the detailed design stage. This will be documented in the RA WP.

Figure 5-4
SVI Mitigation System Operation Decision Tree

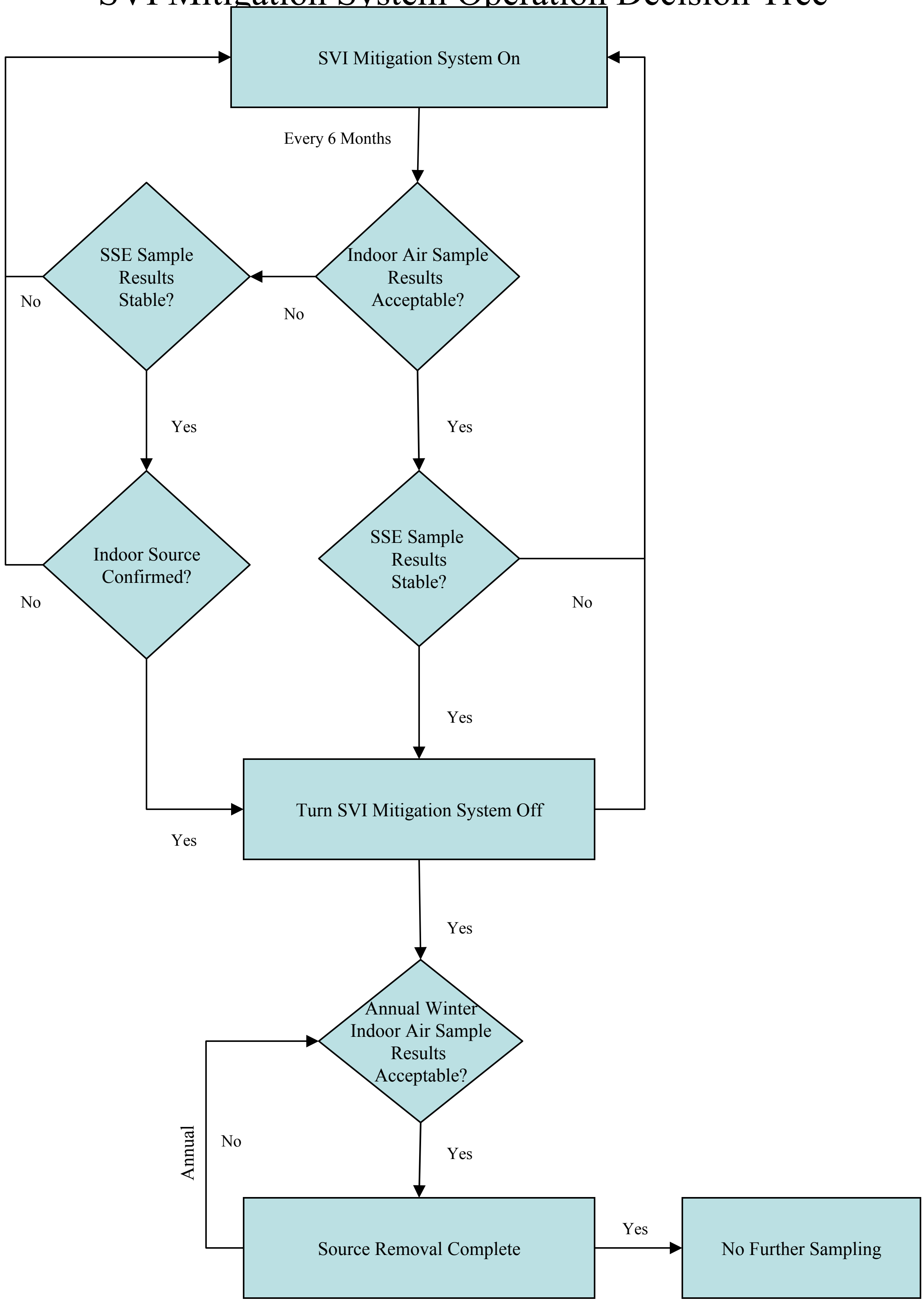

Figure 5-5 Indoor and Sub-Slab Exhaust Sampling Decision Tree

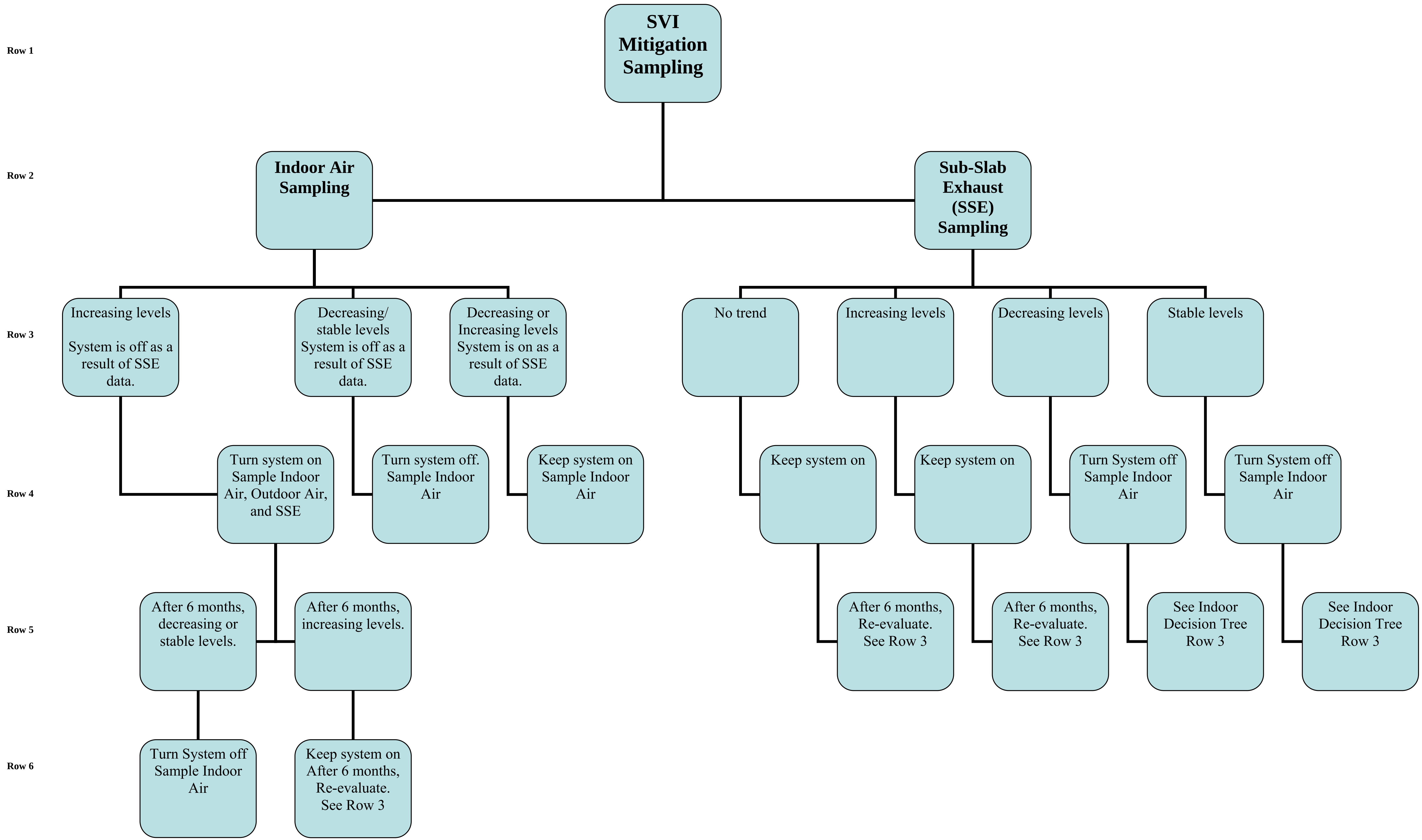

TABLE 5-1
COMPARATIVE EVALUATION OF MITIGATION ALTERNATIVES

ALTERNATIVE*	THRESHOLD CRITERIA				BALANCING CRITERIA				BALANCING CRITERIA (CONTD.)					MODIFYING CRITERIA			
	Overall Protection of Human Health and the Indoor Environment		Compliance with Health Standards and any Mitigation Goals, as applicable		Long-term Effectiveness and Permanence		Reduction of Toxicity, Mobility, or Volume Through Treatment		Short-term Effectiveness		Implementability		Estimated Cost (using RACER)	State Acceptance		Community Acceptance	
	Comment	Score**	Comment	Score	Comment	Score	Comment	Score	Comment	Score	Comment	Score	[All Present Worth]	Comment	Score	Comment	Score
BUILDINGS 774 and 776																	
1. No Further Action	This alternative does not provide overall protection of human health and the indoor environment as the occupants (workers) of the buildings will continue to be exposed to contaminated indoor air.	0.0	This alternative will not be in compliance of the mitigation goals for the proposed mitigation action. The Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776 as a policy decision. Thus, this alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives.	0.0	This alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives. However, the concentrations of contaminants in the air are small and it is possible that they will asymptotically decrease over the long-term through natural attenuation processes.	1.0	No treatment proposed.	0.0	This alternative will not achieve the mitigation goals for this site and, thus, will also not be effective in the short-term in protecting human health and the indoor environment during implementation of the alternative.	0.0	This alternative is technically incapable of achieving the mitigation goals, and is unlikely to receive administrative approvals. In fact, the Air Force has agreed to install sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776 as a policy decision. The availability of services and materials for implementing this alternative is a non-issue since no action is proposed.	0.0	$50,000 (for administrative work)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
2. Directional Drilling and LTM	This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection.	4.0	This alternative will be in compliance with the mitigation goals for the proposed mitigation action and will achieve mitigation goals. Although no treatment is proposed, LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.	4.0	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting.	3.5	No treatment proposed. However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	3.0	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	4.0	This alternative measures high on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to install a sub-slab depressurization indoor air mitigation systems in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	3.5	$280,000 for Bldg 774 + $345,000 for Bldg 776 (both with 5-year O&M and LTM) = Say $630,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
3. HVAC Manipulation and LTM	This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing, in principle, the best level of protection. In practice, since the bottom of the slab will remain exposed to sub-surface contaminants, intrusion by molecular diffusion will remain although this mode of intrusion is orders of magnitude lower (i.e., negligible) than the advective type of intrusion that is prevented by this alternative. Also, since HVAC systems typically experience variability in operating conditions in response to atmospheric and other changes (e.g., heating/cooling loads), depending on the response time of the system for automatically making the needed adjustments, the potential for occasional advective intrusion of contaminants remains.	3.5	This alternative will be in compliance of the mitigation goals for the proposed mitigation action and will achieve mitigation goals. Although no treatment is proposed, LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings, except for the potential intrusion of residuals.	3.5	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as positive pressure is maintained at levels designed to prevent intrusion of vapors. Indefinite protection will require maintaining and operating the positive pressure system indefinitely.	3.0	No treatment proposed. However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	3.0	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active venting system per design requirements, with the exception of the potential for occasional intrusion due to variations (fluctuations) in HVAC system and due to orders-of-magnitude lower levels of molecular diffusion of contaminants into indoor air. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	3.5	This alternative measures low to moderate on technical implementability, because HVAC systems are typically subjected to variable (fluctuating) operating conditions because of changes in atmospheric and other conditions and, thus, the task of operating the system at conditions that are needed for preventing intrusion of air contaminants with positive internal pressure have to be dynamically controlled. Continuous dynamical control can be difficult due to lag in response time of the mechanical system and of the air pressures in all areas of the buildings. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	2.5	$330,000 for Bldg 774 + $360,000 for Bldg 776 (both with 5-year O&M and LTM) = Say $700,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
4. Carbon Treatment and LTM	This alternative will provide overall protection of human health and the indoor environment. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the carbon treatment system is operated. However, the contaminants are allowed to enter the interiors of the buildings before they are treated. Since, in order to reduce costs, only a portion of contaminated air is treated and reintroduced into the building to reduce the overall contaminant concentrations to below safe levels, the alternative will be protective of human health but the quality of air will not be pristine.	3.0	This alternative will be in compliance with the mitigation goals for the proposed mitigation action and will achieve mitigation goals. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that the concentrations remain below safe levels, except that contaminants remain in indoor air, albeit below safe levels.	3.0	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the carbon treatment system is operated at levels designed to reduce indoor air concentrations to below safe levels. However, the workers will be exposed to some low level of contamination, although it will be below safe levels. Indefinite protection will require maintaining and operating the carbon treatment system indefinitely.	2.5	A sufficient portion, but not all, of the indoor contaminants are proposed to be treated for achieving indoor concentrations below safe levels through dilution when the treated air is reintroduced into the indoor environment. However, the starting concentrations in the air are low and are primarily being treated because of human health considerations. Thus, the advantage of this alternative over the other alternatives is only marginal when evaluated in the context of reducing the contaminants with respect to the overall environment. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	3.5	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active carbon treatment system per design requirements, with the exception of the potential for occasional increases in concentration levels while the HVAC system is readjusting after being subjected to variations (fluctuations) in its operation in response to changing atmospheric and other conditions. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	3.0	This alternative measures moderate to high on technical implementability, because carbon systems are proven technologies for treating the contaminants at the site. However, operating carbon systems would entail ensuring that the operating conditions are maintained within the tolerance ranges of the operating parameters of the carbon system, that the carbon is changes at required intervals, etc. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	3.0	$1,030,000 for Bldg 774 + $625,000 for Bldg 776 (both with 5-year O&M and LTM) = Say $1,660,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
5. Ventilation/Dilution and LTM	This alternative will provide overall protection of human health and the indoor environment. The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the ventilation dilution system is operated. However, the contaminants are allowed to enter the interiors of the buildings before they are treated. Since, in order to reduce costs, only a portion of contaminated air is exhausted and replaced with clean outside air to reduce the overall contaminant concentrations to below safe levels, the alternative will be protective of human health but the quality of air will not be pristine.	3.0	This alternative will be in compliance with the mitigation goals for the proposed mitigation action and will achieve mitigation goals. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that the concentrations remain below safe levels, except that contaminants remain in indoor air, albeit below safe levels.	2.5	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will be protected as long as the ventilation dilution system is operated at levels designed to reduce indoor air concentrations to below safe levels. However, the workers will be exposed to some low level of contamination, although it will be below safe levels. Indefinite protection will require maintaining and operating the ventilation dilution system indefinitely.	2.5	No treatment proposed. However, the toxicity, mobility, and volume in indoor air will be reduced by expelling a portion of the contaminants to outdoors without treatment. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	2.5	The buildings are dedicated to non-residential industrial/commercial use and the workers in the buildings will largely be protected during the implementation of this alternative, which involves operating an active ventilation dilution system per design requirements, with the exception of the potential for occasional increases in concentration levels while the HVAC system is readjusting after being subjected to variations (fluctuations) in its operation in response to changing atmospheric and other conditions. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	3.0	This alternative measures moderate to high on technical implementability because, when operated at design conditions, ventilation dilution can be successful in reducing indoor air concentrations to below safe levels. However, since HVAC systems typically experience fluctuations in operating conditions, the ventilation dilution system will also have to correspondingly readjust dynamically in concert with the main HVAC system, which can result in less than or more than the design dilution levels while the systems are readjusting with lags in response times. It ranks moderate to high on administrative implementability since it satisfies the Air Force intent to mitigate indoor air and thus achieve the overall health program goals, even while not exactly satisfying its intent to install a sub-slab depressurization system in both Buildings 774 and 776. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	3.0	$1,770,000 for Bldg 774 + $765,000 for Bldg 776 (both with 5-year O&M and LTM) = Say $2,540,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	

TABLE 5-1
COMPARATIVE EVALUATION OF MITIGATION ALTERNATIVES

ALTERNATIVE*	THRESHOLD CRITERIA				BALANCING CRITERIA			
	Overall Protection of Human Health and the Indoor Environment		Compliance with Health Standards and any Mitigation Goals, as applicable		Long-term Effectiveness and Permanence		Reduction of Toxicity, Mobility, or Volume Through Treatment	
	Comment	Score**	Comment	Score	Comment	Score	Comment	Score
BUILDINGS 785 and 786								
1. No Further Actio	This alternative does not provide overall protection of human health and the indoor environment as the occupants (workers) of the buildings will continue to be exposed to contaminated indoor air.	0.0	This alternative will not be in compliance of the mitigation goals for the proposed mitigation action. For Buildings 785 and 786, the Air Force has agreed to take an appropriate mitigation action, such as installing an SVE system under the buildings, to remove the source. Thus, this alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives.	0.0	This alternative will not achieve the mitigation goals for this site within a reasonable time compared to other alternatives. However, the concentrations of contaminants in the air are small and it is possible that they will asymptotically decrease over the long-term through natural attenuation processes, and the subsurface contamination may also decrease over the long-term through natural attenuation.	2.0	No treatment proposed.	0.0
2. Directional Drilling and LTM	This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection. The subsurface contamination is also remediated by soil vapor extraction.	4.0	This alternative will be in compliance of the mitigation goals for the proposed mitigation action and will achieve mitigation goals by preventing the vapors from entering the buildings from the subsurface and by removing (treating) contamination from subsurface source areas. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.	4.0	The buildings are dedicated to non-residential industrial/office use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting. The SVE system will permanently remove contamination from the subsurface over a period of time resulting in long-term effectiveness of this alternative.	4.0	No treatment of extracted vapors is proposed, since their concentrations are expected to be dilute. However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met, and the toxicity, mobility, and volume of subsurface contamination will be permanently reduced with time. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	4.0
3. Vertical Wells and LTM	This alternative will provide overall protection of human health and the indoor environment. The contaminant vapors from the sub-surface are prevented from entering the interiors of the buildings, thus providing the best level of protection. The subsurface contamination is also remediated by soil vapor extraction.	4.0	This alternative will be in compliance of the mitigation goals for the proposed mitigation action and will achieve mitigation goals by preventing the vapors from entering the buildings from the subsurface and by removing (treating) contamination from subsurface source areas. LTM will ensure that the proposed protective controls remain in place, that they remain protective, and that they are effective in preventing worker exposure to air contaminants inside the buildings.	4.0	The buildings are dedicated to non-residential industrial/office use and the workers in the buildings will be protected as long as the active venting system operates when the concentrations are high enough to warrant such a system, and will be protected indefinitely thereafter when the concentrations become low enough to switch to a passive mode of venting. The SVE system will permanently remove contamination from the subsurface over a period of time resulting in long-term effectiveness of this alternative.	4.0	No treatment of extracted vapors is proposed, since their concentrations are expected to be dilute. However, the toxicity, mobility, and volume in indoor air will be reduced to the point of essentially being eliminated by preventing the subsurface vapors from entering the interior of the buildings such that mitigation goals are met, and the toxicity, mobility, and volume of subsurface contamination will be permanently reduced with time. LTM will periodically assess concentration levels of sub-surface contaminants and will register any reductions in their toxicity, mobility, and/or volume due to natural attenuation processes.	4.0

ALTERNATIVE*	BALANCING CRITERIA (CONTD.)					MODIFYING CRITERIA			
	Short-term Effectiveness		Implementability		Estimated Cost (using RACER)	State Acceptance		Community Acceptance	
	Comment	Score	Comment	Score	[All Present Worth]	Comment	Score	Comment	Score
BUILDINGS 785 and 786									
1. No Further Actio	This alternative will not achieve the mitigation goals for this site and, thus, will also not be effective in the short-term in protecting human health and the indoor environment during implementation of the alternative.	0.0	This alternative is technically incapable of achieving the mitigation goals, and is unlikely to receive administrative approvals. In fact, for Buildings 785 and 786, the Air Force has agreed to take an appropriate mitigation action, such as installing a soil vapor extraction (SVE) system under the buildings, to remove the source. The availability of services and materials for implementing this alternative is a non-issue since no action is proposed.	0.0	$50,000 (for administrative work).	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
2. Directional Drilling and LTM	The buildings are dedicated to non-residential industrial/ commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. SVE, which is an established technology, will be designed to effectively remove source contamination during the implementation of the alternative. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	4.0	This alternative measures high on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program. The interiors of the buildings will not be disturbed. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to undertake mitigation action. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	3.5	$330,000 for Bldg 785 + $330,000 for Bldg 786 (both with 5-year O&M and LTM) = Say $660,000 for both Bldgs 785 and 786 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	
3. Vertical Wells and LTM	The buildings are dedicated to non-residential industrial/ commercial use and the workers in the buildings will be protected during the implementation of this alternative, which involves operating an active venting system per design requirements. SVE, which is an established technology, will be designed to effectively remove source contamination during the implementation of the alternative. The proposed monitoring system will provide data for verifying the effectiveness of the alternative during its implementation, and for making any adjustments to the operating parameters for continued effectiveness during the entire duration of its implementation.	4.0	This alternative measures moderate on technical feasibility due to the ease of undertaking the proposed action and related future actions, and the ability to monitor its effectiveness with the proposed, well-designed LTM program, but with a potential limitation: since 28 vertical wells are proposed to be installed through the floor slab in each building, and associated piping will be installed both aboveground and underground inside the building, this alternative involves intrusive construction. Field adjustments may need to be made to the design during drilling stage if any underground obstructions are encountered. It also ranks high on administrative implementability since it satisfies the Air Force intent to undertake mitigation action. Professional services and materials are easily and competitively available for implementing the alternative during the construction and operation phases and for implementing the LTM.	3.0	$375,000 for Bldg 785 + $375,000 for Bldg 786 (both with 5-year O&M and LTM) = Say $750,000 for both Bldgs 785 and 786 (with 5-year O&M and LTM)	This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.		This criterion will be addressed in the ROD, after comments on the RI/FS report and the Proposed Plan.	

* All the alternatives, except the No Further Action alternative, include a 5-year review to determine its effectiveness and/or progress towards achieving the Mitigation Goals for the Site.
**Scoring: 0 = the worst, i.e. least successful and 4 = the best, i.e. most successful

TABLE 5-2
SELECTION OF RECOMMENDED MITIGATION ALTERNATIVES

ALTERNATIVE		EFFECTIVENESS: Overall Protection of Human Health and the Indoor Environment	EFFECTIVENESS: Compliance w/ Hlth Stds & any Cleanup Goals, as applicable	EFFECTIVENESS: Long-term Effectiveness and Permanence	EFFECTIVENESS: Reduction of Toxicity, Mobility, or Volume Through Treatment	EFFECTIVENESS: Short-term Effectiveness	EFFECTIVENESS: Total Effectiveness Score	ESTIMATED COST	COST-EFFECTIVENESS OF REMEDIAL ALTERNATIVE [= Total Effectiveness Score per One Million Dollars of Estimated Cost]	IMPLEMEN-TABILITY	RECOMMENDATIONS/ COMMENTS
		Score*	Score	Score	Score	Score	Total Score	[Present Worth]		Score	
BUILDINGS 774 and 776											
1.	No Further Action	0.0	0.0	1.0	0.0	0.0	1.0	$50,000 (admin.)	Not Applicable - no remedial action	0.0	REJECTED ALTERNATIVE. Not effective or implementable.
2.	Directional Drilling + LTM	4.0	4.0	3.5	3.0	4.0	18.5	$630,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	29.4	3.5	RECOMMENDED ALTERNATIVE. This alternative is protective of human health and the indoor environment, prevents contaminants from entering the interior of the buildings, is judged to be the most technically effective and cost effective among all alternatives considered for Buildings 774 and 776, has the lowest estimated costs among the viable alternatives, and measures high on technical and adminstrative implementability.
3.	HVAC Manipulation + LTM	3.5	3.5	3.0	3.0	3.5	16.5	$700,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	23.6	2.5	VIABLE ALTERNATIVE, BUT CEDED IN FAVOR OF ALTERNATIVE 2. Judged to be second-most technically effective and cost effective alternative, and has the second-lowest estimated costs comparable in order of magnitude to the recommended Alternative 2. Its implementability is moderately to significantly lower compared to Alternative 2 because of the dynamical nature of continuous control that would be required to maintain and operate the system at the design positive pressures for preventing soil vapor intrusion into buildings, but it can be a potential backup solution to Alternative 2.
4.	Carbon Treatment + LTM	3.0	3.0	2.5	3.5	3.0	15.0	$1,660,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	9.0	3.0	REJECTED ALTERNATIVE. Compared to the recommended Alternative 2, this alternative is technically less effective, about one-third as cost effective (estimated cost), about 2.5 times as costly (estimate cost), and somewhat less implementable. Rejected.
5.	Ventilation Dilution + LTM	3.0	2.5	2.5	2.5	3.0	13.5	$2,540,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	5.3	3.0	REJECTED ALTERNATIVE. This is the least technically effective, least cost effective, and most costly at four (4) times the cost of the recommended Alternative 2 (estimated cost), among all the alternatives considered, and its implementability is moderate. Rejected.
BUILDINGS 785 and 786											
1.	No Further Action	0.0	0.0	2.0	0.0	0.0	2.0	$50,000 (admin.)	Not Applicable - no remedial action	0.0	REJECTED ALTERNATIVE. Not effective or implementable.
2.	Directional Drilling and LTM	4.0	4.0	4.0	4.0	4.0	20.0	$660,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	30.3	3.5	RECOMMENDED ALTERNATIVE. This alternative is protective of human health and the indoor environment, prevents contaminants from entering the interior of the buildings, is judged to be the most technically effective and cost effective among all alternatives considered for Buildings 785 and 786, has the lowest estimated costs among the viable alternatives, and measures high on technical and adminstrative implementability.
3.	Vertical Wells and LTM	4.0	4.0	4.0	4.0	4.0	20.0	$750,000 for both Bldgs 774 and 776 (with 5-year O&M and LTM)	26.7	3.0	VIABLE ALTERNATIVE, BUT CEDED IN FAVOR OF ALTERNATIVE 2. This Alternative 3 is technically as highly effective as the recommended Alternative 2. Its estimated costs are slightly higher and its cost effectiveness is slightly lower than for Alternative 2, but, considering the allowable estimation ranges for the purpose of the FS, the differences are not sufficiently large enough to place Alternative 3 at a great disadvantage relative to Alternative 2 on the basis of the above factors. However, its implementability is moderately lower compared to Alternative 2, and would involve intrusive construction inside the buildings. Furthermore, the recommended alternative for Buildings 774 and 776 is directional drilling, which is the same technology as Alternative 2 for Buildings 785 and 786. Selecting the same directional drilling for all four buildings may provide combined cost benefits and ease and efficiency in construction management. Therefore, cede Alternative 3 in favor of Alternative 2 for Buildings 785 and 786 pending a proposed pilot test.

*Scoring: 0 = the worst, i.e. least successful and 4 = the best, i.e. most successful

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FPM Group, Spring 2007 Long Term Monitoring Report, Landfills Areas of Concern, Long Term Monitoring Program, Former Griffiss Air Force Base, Rome, New York, Revision 1.0, April 2008b.

FPM Group, October 2007 Assumptions and Screening Levels for Soil Vapor Intrusion Evaluation, Industrial/Commercial Scenario, Revision 0.1, October 2007.

FPM Group, Final Work Plan, Soil Vapor Intrusion Sampling, Buildings 774, 776, 785, 786, and 817, Former Griffiss Air Force Base, Rome, New York, April 2008a.

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Appendix A

Meeting on Soil Vapor Intrusion Issues at Former Plattsburgh and Griffiss Air Force Bases in New York State, December 13, 2007

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Meeting on Soil Vapor Intrusion Issues at Former Plattsburgh and Griffiss Air Force Bases in New York State

December 13, 2007

Agencies Represented: Air Force Real Property Agency (AFRPA), Air Force Institute for Operational Health (AFIOH), NYS Department of Environmental Conservation (NYSDEC), NYS Department of Health (NYSDOH), U.S. Environmental Protection Agency-Region 2 (EPA)

Attendees: See Attached Attendees List

Meeting Purpose:

- Resolve the Soil Vapor Intrusion Issues that are preventing finalization of the remaining Records of Decision (RODs) at the former Plattsburgh and Griffiss AFBs.
- Resolve the substantive issues associated with the Plattsburgh FT-002 Dispute.
- Discuss status of the Plattsburgh SS-013 “Reporting” on Institutional Control issue.
- Identify and resolve any road blocks on the Plattsburgh FOSET request.

DISPUTE RESOLUTION ISSUES

- Soil Vapor Intrusion Dispute with FT-002

EPA clarified that the Plattsburgh Interim ROD is not the subject of the disagreement, as EPA currently has no concerns with the existing components of the groundwater remedy. Also the Institutional Controls (ICs) in the Final ROD submitted by the AFRPA in August 2005 are not an issue in the NYSDEC/EPA Dispute with the Air Force (AF). The sole issue under dispute with the Final FT-002 ROD is Soil Vapor Intrusion under some buildings that are over the TCE plume at the former Plattsburgh AFB. The second half of our meeting is intended to address the specific issues the regulatory agencies have with the buildings at the former Plattsburgh AFB and Griffiss AFB. EPA’s recommendations for these buildings were provided as enclosures (3 and 4) to the October 17 letter from Bill McCabe to Dexter Cochnauer and were also attached to this meeting’s agenda.

The State agrees with the existing components of the groundwater remedy for FT-002 but never concurred with the Interim ROD for administrative reasons. The State did not have any technical disagreement on the interim ROD. The State also agrees with the Institutional Controls in the Final ROD submitted by AFRPA in August 2005. The State agrees with the USEPA that the sole issue under dispute is Soil Vapor Intrusion under some buildings that are over the TCE plume.

Another issue that continues to be in dispute among the parties is the use of screening levels for vapor intrusion in New York State. As stated in a previous EPA letter dated August 10, 2006 EPA applies multiple lines of evidence in determining whether further evaluation of the sub-slab or indoor air is required in the VI investigation. EPA relies on a matrix that is consistent with the NYSDOH guidance regarding vapor intrusion. As discussed several times, the application of EPA's matrix results in significant differences in the need for further action and/or investigation at the sites. EPA also noted that it evaluates adult worker exposures based on inhalation at a rate of 20 cubic meters/ day based on the 1991 EPA Standard Default Exposure Assumption and not 10 cubic meters/day that the Air Force applied.

The AF acknowledges that NYS and EPA Region 2 have issued guidance with a matrix and is not aware of any efforts to formally promulgate the action levels presented in the guidance. The Air Force does not view the action levels or guidance documents as ARARs under CERCLA. The AF has derived risk-based concentrations using US EPA OSWER directives and the NCP. The AF considered the NYS and EPA Region 2 matrix when developing health protective screening levels. However, the AF position is that the matrix was developed from experience with SVI behavior in a residential setting, the AF feels the matrix does not account for construction and ventilation system exposure attributes in a commercial or industrial setting. The AF used conservative approaches to account for these differences in addition to site-specific SVI information at Griffiss and Plattsburgh to reach its recommendations. The AF screening (concentration) values were derived using an inhalation rate of 20 m^3/day, but assumed 12 hour/day exposure time, versus 24 hrs/day, and thus an "effective" inhalation rate of 10 m^3/day is shown in the calculation used. This is used to account for an industrial/commercial exposure scenario appropriate for the Griffiss and Plattsburgh sites. The AF approach was to find solutions which meet NYS, EPA Region 2, AF and NCP objectives for protecting public health.

- ROD Approval Authority

Another Disputable issue EPA has with the AFRPA concerns the authority over whether the AF can select remedy under CERCLA. EPA stated its position that the AF cannot unilaterally finalize the FT-002 ROD which was submitted to EPA in August 2005. Only EPA has that authority, which was delegated to it from the President. The dispute will proceed and The AF does not agree, and it also continues to disagree with EPA Region 2 and NYS concerning whether either New York or EPA invoked dispute resolution in an appropriate and timely manner so as to prevent the ROD for FT002 from becoming final. The parties have agreed that resolution of the SVI issues at Plattsburgh would allow issuance of a revised final FT-002 ROD, because it is the only issue identified.

- IC Reporting Requirement

The last disputable issue concerns IC "Reporting" after property transfer. This issue is linked to the SS-013 Draft Final ROD, RODs in other regions, and the proposed FOSET at Plattsburgh. This issue is being discussed separately between EPA and AF.

PLATTSBURGH'S FINDING OF SUITABILITY FOR EARLY TRANFER REQUEST

EPA informed the AF that, with the exception of the SS-013 ROD disagreement, there were no technical issues to prevent approval of the FOSET. EPA will provide the AF with the few comments it has within a week (Note: these comments were provided to the AF on Dec. 19). The one potential problem could be the need to resolve the above-mentioned assurance on "Reporting" ICs. EPA would need to have the SS-013 ROD finalized or an agreement in principle needs to occur before EPA can approve the FOSET. If no agreement can be reached then this issue would go into formal dispute.

SUMMARY OF AGREED UPON ACTIONS AT BUILDINGS THAT WERE SAMPLED IN THE WINTER OF 2006 - 2007

PLATTSBURGH

Overview: In order to move forward on the FT-002 Final ROD document, agreements need to be reached whether to address SVI over certain groundwater plumes, and if there is agreement that SVI must be addressed, how to do so. This requires agreement among the parties on an approach on sub-slab monitoring and/or addressing potential soil vapor intrusion related to certain buildings identified below.

Buildings 1807, 1812, 2616, 2786, 2796, 2797: All regulatory agencies accept the AF's proposed no further action on SVI for these buildings.

Building 2612: All regulatory agencies accept the AF's proposed no further action on SVI for this building, provided it remains in an unoccupied state. The AF will not allow occupancy while it has ownership of the building. A deed restriction will require that prior to any future occupation of the building, the future owner, in coordination with EPA and NYS, would be responsible for determining if there still is a SVI issue at this building.

Building 2622: All parties agreed that this building would be re-sampled (Sub-Slab and Indoor Air) as part of the Superfund Five Year Review process. The next review cycle will take place in 2009. All parties agreed that this building would be re-sampled (Sub-Slab and Indoor Air) prior to completion of the Five Year Review to determine whether decreasing the groundwater source decreases sub-slab levels. Based on the sampling results from the Five Year Review the agencies will determine if further action on SVI is appropriate or additional sampling or mitigation is required

Building 1810: All the parties agree that further evaluation and sampling is necessary to determine the source of the acetone. Since it may be a possible lab contaminant it was agreed another round of sub-slab soil gas sampling would occur utilizing TO 15 and another sampling method, to be agreed upon by the regulatory agencies; additional indoor air sampling is not necessary. If acetone contamination is confirmed to be under the slab, the AF will investigate for a source and if appropriate, explore remediation options to address the acetone.

Building 2793: All the parties agree that further evaluation is necessary to determine the source of the BTEX contaminants. The AF agreed to work with the regulatory agencies to address this issue. This is not believed to be an SVI issue because of industrial use of petroleum products inside this hangar. However, concentrations in the sub-slab for some of the BETX compounds exceed EPA screening values for SVI

Building 2753: All the parties agreed that the AF will install a SVE system in the northeast portion of the building to address the high TCE level. The AF will work closely with the regulatory agencies during agency review of the remedial design to insure that the SVE system does not create new pathways for contaminants to migrate through the slab. The design of the SVE system will include monitoring the operation at the perimeter of SVE system to confirm it is operating as designed. It was agreed that the monitoring would be based on the engineering design recommendations. Post-remediation sampling will be necessary to confirm that the TCE source has been remediated.

Building NB-C: Two rounds of sub-slab and indoor air sampling will take place in the 2007-2008 heating season. If contamination is generally the same level as measured in 2006-2007 winter season under the northern half of the building then remediation of a potential source will take place. A more complete inventory of chemicals used in the building will also be conducted to determine whether the source is located with in the building or beneath it. Sampling the building would require special care, as the integrity of the clean rooms located within it must be maintained. The AF will also take soil gas samples outside the building to determine if a source of PCE contamination is present.

Building 2766: This building has recently become occupied, and all the parties agreed that sub-slab and indoor air samples will be taken in the 2007-2008 heating season. Additional sub-slab location(s) will be sampled. Additional indoor air sampling of office areas will be performed if such areas are present. This building was not occupied when the first round of samples were taken. This building will be reevaluated once the new sampling results are available.

Building 2763: All the parties agreed that this building (Hangar) will be re-sampled (Sub-slab, Indoor Air, and Groundwater) in a time frame that allows the sampling results to be utilized in the next Superfund Five Year Review (2009) to determine whether a decrease in the groundwater source results in a decrease in sub-slab levels. The indoor air samples will be taken only in the office areas in this hangar. Also, the current owners of the building will ensure that the hangar doors are closed for a sufficient period of time before the sampling takes place. After obtaining these sampling results, the parties will consider, whether no further action on SVI is appropriate or if additional sampling or mitigation is required.

Griffiss

Overview: In order to move forward on the Soil Vapor Intrusion Draft ROD document, agreements need to be reached regarding whether and how to address SVI over certain groundwater plumes. This requires agreement among the parties on an approach on sub-slab monitoring and/or addressing the SVI at the buildings identified below. A summary of the agreed-to Action Items for the AF and the regulatory agencies appears below. In addition, EPA, DEC, and the AF will need to provide the Local Redevelopment Authority (LRA) a summary of this meeting and discuss appropriate concerns associated with the property involving vapor intrusion and early transfer as it affects the LRA.

Building 782, 783, 784: All the parties agreed that these buildings (Nose Dock Hangars) do not need any further CERCLA action (sampling or SVI mitigation) based on sub-slab concentrations below the level of detection for TCE of < 2.7 $\mu g/m^3$. However, there is petroleum contamination in proximity to the buildings that is being addressed under the NYSDEC Spills Program. The ROD can proceed as NFA with reference to the fact that the petroleum contamination is being addressed under the NYSDEC Spills Program.

Building WSA 817: All the parties agreed that chloroform and TCE have been detected under this building although the chloroform has been determined not to be a constituent of concern. The concentration of TCE in the sub-slab was 130 $\mu g/m^3$, which EPA and NYSDEC believe requires further investigation and potential remediation. The AF does not agree with this position. This site would not be a candidate for No Further Action (NFA). It was agreed ICs and IC monitoring would be required. ICs will prevent occupation of the building and require evaluation of the sub-slab and indoor air prior to occupancy. Regardless of occupancy, closeout sampling/monitoring will be required at a future date before a NFA determination for vapor intrusion can be obtained.

Apron 2 – Building 785, 786: All the parties agreed that the AF agreed to resample to determine the source of the high levels of TCE (from 2,300 and 81,000 $\mu g/m^3$ in the sub-slab). Once the source is determined, the appropriate remedial action, such as installing a SVE system under the building, will be taken to remove the source. Also, the buildings will be re-sampled prior to occupancy.

SAC Hill Area – Buildings 774, 776: Buildings 774 and 776 will be re-sampled based on a finding of 1,700 and 3000 $\mu g/m^3$ sub-slab and 3.4 and 4.4 $\mu g/m^3$ of TCE indoor, respectively.

As a policy decision, the AF agrees to install sub-slab depressurization indoor air mitigation systems in both buildings.

AOC 9: This property originally had no buildings; however, recent investigations of the ground water indicated that the plume extends upgradient of and adjacent to Building 913. Sampling of soil gas in this vicinity revealed a maximum of 810 µg/m3. All the parties agreed that there is a need for deed restrictions for future buildings constructed on this property and a SVI evaluation of Building 913. We thus anticipate including deed covenant language in any ROD for this property requiring that any new construction address SVI in coordination with NYS and EPA Region 2. The AF will continue to monitor groundwater to determine if the concentrations of COCs in the groundwater are decreasing.

Buildings – 43(ST026), 100(ST051), 110, 133, 771, Tank Farms 1 &3, FPTA, 101: Discussion on these buildings/locations was deferred. The regulatory agencies have not completed their review of the AF's recommendations for these buildings/locations. Comments will be issued by the end of the year. (EPA has finished its review and has provided its last set of comments to the AF on Dec. 20.)

FOLLOW UP ACTIONS

- A separate Action Items document, based on the meeting minutes, will be prepared by the AF and the regulatory agencies for each facility. These action items would be incorporated into the applicable RODs and/or FOSETs.

- AFRPA should begin implementing the actions agreed to (specifically, the additional sampling during the 2007-2008 heating season) reached during the meeting. **(***AF preparations for the sampling are underway.)*

- A follow up discussion needs to take place on how the results will be used from the new sampling events. *Buildings that will be re-sampled in the 2007-2008 heating season are Plattsburgh Buildings 1810, NB-C and 2766, and Griffiss Buildings 785, 786, 774 and 776. Based on the sampling results, the AF will present recommendations for coordination with NYSDEC, NYSDOH and EPA Region 2 as part of the report on results of the sampling events.*

Revisions to consider for the Plattsburgh Final FT-002 ROD:

- ROD should be updated to reflect current events at the former AFB.

- The final ROD should confirm that the interim remedy is final

- Don't take out anything from the ROD that was described in the prior released proposed plan for this remedy.

- The Final ROD should include the relevant action items pertaining to this operable unit which was agreed to at this meeting, including and the IC restrictions, addressing the potential for SVI.

For Griffiss, a FOSET encompassing the following can proceed with the coordination process:

- AOC9: Parcels F10C-2 & A4
- Building 817: Parcels F10C-3 & A5
- Buildings 782, 783, 784, 785, 786 (Nose Dock Area): Parcels A2, F6B-6, F6B-7, and F11B.

The FOSET will include the agreements discussed above as applicable to the respective sites. For real estate parcels with sites with potential for SVI, restrictive language would be included in the deed requiring any successive transferees to address SVI with NYS and EPA Region 2 prior to future construction or new buildings on the sites.

The parties will schedule a conference call before the end of January 2008 for the purpose of reaching agreement on how to address the remaining buildings and areas at Griffiss with potential for SVI, including those buildings identified in the draft reports submitted on 19 October and 9 November 2007. This includes the following:

- Buildings 43, 100, 101, 110, 133, and 771 and associated sites
- Tank Farms 1 & 3 (SS020) and Fire Protection Training Area (FT030)

Air Force will submit a target schedule for completing RODs and FOSETs impacted by the agreements on addressing SVI as reflected in this document.

Participant List for Plattsburgh/Griffiss Soil Vapor Intrusion Meeting

Date: December 13, 2007

Time: 9:00 AM – 3:00 PM

Location: NYSDEC, 625 Broadway, Albany, NY – Room 1219

EPA	NYSDEC	NYSDOH	Air Force
Doug Garbarini Special Projects Branch 212-637-4327 *garbarini.doug@* *epa.gov*	Chittibabu Vasudevan Remedial Bureau A 518-402-9625 *cxvasude@* *gw.dec.state.ny.us*	Rich Fedigan Bureau of Environmental Exposure Investigation *rjf01@health.* *state.ny.us*	Steve TerMaath, PhD, PE Air Force Real Property Agency Arlington, VA 703-696-5554 *Stephen.TerMaath@* *afrpa.pentagon.af.mil*
John Malleck Federal Facilities Section 212-637-4332 *malleck.john@* *epa.gov*	John Swartwout Remedial Section A 518-402-9620 *jbswarto@* *gw.dec.state.ny.us*	Wendy Kuehner Bureau of Environmental Exposure Investigation *wsk01@health.* *state.ny.us*	David Bell, PhD Air Force Institute for Operational Health, Brooks City-Base, TX 210-536-5553 *David.Bell@brooks.af.mil*
Bob Morse Plattsburgh RPM 212-637-4331 *morse.bob@* *epa.gov*	Dan Eaton Project Manager – Plattsburgh 518-402-9621 *djeaton@* *gw.dec.state.ny.us*	Greg Rys Bureau of Environmental Exposure Investigation *gar02@health.* *state.ny.us*	Steve Gagnier Plattsburgh Plattsburgh, NY 518-563-2871 x14 *Stephen.Gagnier@* *afrpa.pentagon.af.mil*

EPA	NYSDEC	NYSDOH	Air Force
Doug Pocze Griffiss RPM 212-637-4432 *pocze.doug@* *epa.gov*	Heather Bishop Project Manager – Griffiss 518-402-9692 *hlbishop@* *gw.dec.state.ny.us*		Dave Farnsworth Plattsburgh Plattsburgh, NY 518-563-2871 x15 *Dave.Farnsworth@* *afrpa.pentagon.af.mil*
Chloe Metz Human Health Risk Assessor 212-637-4449 *metz.chloe@* *epa.gov*			Michael McDermott Griffiss Rome, NY 315-356-0810 x202 *Michael.McDermott@* *afrpa.pentagon.af.mil*
Marian Olsen Human Health Risk Assessor 212-637-4313 *olsen.marian* *@epa.gov*			Cathy Jerrard Griffiss Rome, NY 315-356-0810 x204 *Catherine.Jerrard@* *afrpa.pentagon.af.mil*
James Doyle Office of Regional Counsel 212-637-3165 *doyle.james@* *epa.gov*			Carolyn White Associate General Counsel 703-696-5240 *carolyn.white@* *pentagon.af.mil* **By Telephone**

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Appendix B Cost Estimates

Project Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Project Cost Detail Report
(with Markups)

Project Cost Detail Report
(with Markups)

Site:

Site ID:	776: Alternative 3: HVAC Manipulation + LTM
Site Name:	776: Alternative 3: HVAC Manipulation + LTM
Site Type:	None

Media/Waste Type

Primary:	Air
Secondary:	Soil

Contaminant

Primary:	Volatile Organic Compounds (VOCs)
Secondary:	None

Phase Names

Pre-Study:	☐
PA, SI, PA/SI, RI, FS, RI/FS:	☐
RD:	☐
IRA-C:	☐
RA-C:	☑
IRA-O, RA-O:	☑
LTM:	☑
PCO:	☐

Documentation

Description:	SVI FS
Support Team:	AFRPA Griffiss
References:	...

Estimator Information

Estimator Name:	FPM
Estimator Title:	FPM
Agency/Org./Office:	FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: __________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: __________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
HVAC Manipulation	$22,065							$1,568	$23,633
(System Defaults)		$0	$0	$965	$242	$0	$360		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M YEAR 1	$33,381							$16,640	$50,021
(System Defaults)		$0	$0	$8,345	$3,338	$0	$4,957		
O&M YEAR 2	$33,381							$16,640	$50,021
(System Defaults)		$0	$0	$8,345	$3,338	$0	$4,957		
O&M YEAR 3	$33,381							$16,640	$50,021
(System Defaults)		$0	$0	$8,345	$3,338	$0	$4,957		
O&M YEAR 4	$33,381							$16,640	$50,021
(System Defaults)		$0	$0	$8,345	$3,338	$0	$4,957		
O&M YEAR 5	$33,381							$16,640	$50,021
(System Defaults)		$0	$0	$8,345	$3,338	$0	$4,957		
Total Site Cost	$225,548	$0	$0	$76,249	$22,541	$0	$33,473	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 785: Alternative 3: Vertical Drilling + LTM
Site Name: 785: Alternative 3: Vertical Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$163,069							$65,953	$229,022
(System Defaults)		$0	$0	$33,756	$12,957	$0	$19,241		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$41,488							$17,493	$58,981
(System Defaults)		$0	$0	$7,712	$3,936	$0	$5,845		
Total Site Cost	$241,136	$0	$0	$75,026	$22,501	$0	$33,414	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID:	776: Alternative 2: Directional Drilling + LTM
Site Name:	776: Alternative 2: Directional Drilling + LTM
Site Type:	None

Media/Waste Type

Primary:	Air
Secondary:	Soil

Contaminant

Primary:	Volatile Organic Compounds (VOCs)
Secondary:	None

Phase Names

Pre-Study:	☐
PA, SI, PA/SI, RI, FS, RI/FS:	☐
RD:	☐
IRA-C:	☐
RA-C:	☑
IRA-O, RA-O:	☑
LTM:	☐
PCO:	☐

Documentation

Description:	SVI FS
Support Team:	AFRPA Griffiss
References:	...

Estimator Information

Estimator Name:	FPM
Estimator Title:	FPM
Agency/Org./Office:	FPM

Project Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: __________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: __________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$162,112							$64,491	$226,603
(System Defaults)		$0	$0	$32,628	$12,822	$0	$19,040		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$24,250							$10,493	$34,743
(System Defaults)		$0	$0	$4,732	$2,319	$0	$3,443		
Total Site Cost	$222,941	$0	$0	$70,919	$20,749	$0	$30,812	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 785: Alternative 2: Directional Drilling + LTM
Site Name: 785: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type

Primary: Air
Secondary: Soil

Contaminant

Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names

- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation

Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information

Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$131,215							$52,560	$183,775
(System Defaults)		$0	$0	$26,645	$10,428	$0	$15,486		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$41,488							$17,493	$58,981
(System Defaults)		$0	$0	$7,712	$3,936	$0	$5,845		
Total Site Cost	$209,282	$0	$0	$67,915	$19,973	$0	$29,659	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 3: HVAC Manipulation + LTM
Site Name: 774: Alternative 3: HVAC Manipulation + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ____________________ Date: __________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ____________________ Date: __________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
HVAC Manipulation	$42,027							$11,636	$53,663
(System Defaults)		$0	$0	$6,054	$2,246	$0	$3,336		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M YEAR 1	$25,991							$12,956	$38,947
(System Defaults)		$0	$0	$6,498	$2,599	$0	$3,860		
O&M YEAR 2	$25,991							$12,956	$38,947
(System Defaults)		$0	$0	$6,498	$2,599	$0	$3,860		
O&M YEAR 3	$25,991							$12,956	$38,947
(System Defaults)		$0	$0	$6,498	$2,599	$0	$3,860		
O&M YEAR 4	$25,991							$12,956	$38,947
(System Defaults)		$0	$0	$6,498	$2,599	$0	$3,860		
O&M YEAR 5	$25,991							$12,956	$38,947
(System Defaults)		$0	$0	$6,498	$2,599	$0	$3,860		
Total Site Cost	$208,560	$0	$0	$72,100	$20,850	$0	$30,962	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 5: Dilution by Ventilatint + LTM
Site Name: 774: Alternative 5: Dilution by Ventilatin + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: __________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: __________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Dilution by Ventilation	$27,653							$4,353	$32,006
(System Defaults)		$0	$0	$2,362	$801	$0	$1,190		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$1,102,998							$549,845	$1,652,843
(System Defaults)		$0	$0	$275,750	$110,300	$0	$163,795		
Total Site Cost	$1,167,231	$0	$0	$311,670	$116,709	$0	$173,313	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 776: Alternative 4: Carbon Treatment + LTM
Site Name: 776: Alternative 4: Carbon Treatment + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Carbon Treatment	$296,350							$115,682	$412,032
(System Defaults)		$0	$0	$58,015	$23,206	$0	$34,461		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$84,133							$42,694	$126,827
(System Defaults)		$0	$0	$21,662	$8,464	$0	$12,568		
Total Site Cost	$417,062	$0	$0	$113,236	$37,278	$0	$55,358	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 2: Directional Drilling + LTM
Site Name: 774: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$115,670							$46,591	$162,261
(System Defaults)		$0	$0	$23,651	$9,231	$0	$13,708		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$24,250							$10,493	$34,743
(System Defaults)		$0	$0	$4,732	$2,319	$0	$3,443		
Total Site Cost	$176,499	$0	$0	$61,942	$17,158	$0	$25,480	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 4: Carbon Treatment + LTM
Site Name: 774: Alternative 4: Carbon Treatment + LTM
Site Type: None

Media/Waste Type

Primary: Air
Secondary: Soil

Contaminant

Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names

- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation

Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information

Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Carbon Treatment	$446,572							$174,416	$620,988
(System Defaults)		$0	$0	$87,470	$34,988	$0	$51,957		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$215,368							$108,115	$323,483
(System Defaults)		$0	$0	$54,471	$21,587	$0	$32,057		
Total Site Cost	$698,520	$0	$0	$175,499	$62,184	$0	$92,343	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 776: Alternative 5: Dilution by Ventilatint + LTM
Site Name: 776: Alternative 5: Dilution by Ventilatin + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☑
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Dilution by Ventilation	$25,245							$3,152	$28,397
(System Defaults)		$0	$0	$1,760	$560	$0	$832		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$435,423							$217,059	$652,482
(System Defaults)		$0	$0	$108,856	$43,542	$0	$64,660		
Total Site Cost	$497,248	$0	$0	$144,174	$49,711	$0	$73,821	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID: 786: Alternative 2: Directional Drilling + LTM
Site Name: 786: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Project Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$131,215							$52,560	$183,775
(System Defaults)		$0	$0	$26,645	$10,428	$0	$15,486		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$41,488							$17,493	$58,981
(System Defaults)		$0	$0	$7,712	$3,936	$0	$5,845		
Total Site Cost	$209,282	$0	$0	$67,915	$19,973	$0	$29,659	$0	$6,899,950

Project Cost Detail Report
(with Markups)

Site:

Site ID:	786: Alternative 3: Vertical Drilling + LTM
Site Name:	786: Alternative 3: Vertical Drilling + LTM
Site Type:	None

Media/Waste Type

Primary:	Air
Secondary:	Soil

Contaminant

Primary:	Volatile Organic Compounds (VOCs)
Secondary:	None

Phase Names

Pre-Study:	☐
PA, SI, PA/SI, RI, FS, RI/FS:	☐
RD:	☐
IRA-C:	☐
RA-C:	☑
IRA-O, RA-O:	☑
LTM:	☑
PCO:	☐

Documentation

Description:	SVI FS
Support Team:	AFRPA Griffiss
References:	...

Estimator Information

Estimator Name:	FPM
Estimator Title:	FPM
Agency/Org./Office:	FPM

Project Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: __________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: __________

Project Cost Detail Report
(with Markups)

Phase (Markup Template)	Direct Cost	Sub Overhead	Sub Profit	Prime Overhead	Prime Profit	Contingency	Owner Cost	Markup Total	Total
Directional Drilling + SVE	$163,069							$65,953	$229,022
(System Defaults)		$0	$0	$33,756	$12,957	$0	$19,241		
LTM	$36,579							$47,495	$84,074
(System Defaults)		$0	$0	$33,558	$5,608	$0	$8,328		
O&M	$41,488							$17,493	$58,981
(System Defaults)		$0	$0	$7,712	$3,936	$0	$5,845		
Total Site Cost	$241,136	$0	$0	$75,026	$22,501	$0	$33,414	$0	$6,899,950

	Direct Cost	Markups	Total
Total Project Cost	$4,514,445	$2,385,505	$6,899,950

Project Cost Over Time Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites

Project Cost Over Time Report
(with Markups)

within the Basewide SVI Operable Unit, Griffiss AFB, NY

Project Cost Over Time Report
(with Markups)

Site Name	Site ID	2009	2010	2011	2012	2013	Total
774: Alternative 2: Direction	774: Alternative 2: Direction	$220,177	$15,225	$15,225	$15,225	$15,225	$281,078
774: Alternative 3: HVAC Mani	774: Alternative 3: HVAC Mani	$143,578	$47,224	$47,224	$47,224	$47,224	$332,473
774: Alternative 4: Carbon Tr	774: Alternative 4: Carbon Tr	$736,652	$72,973	$72,973	$72,973	$72,973	$1,028,545
774: Alternative 5: Dilution	774: Alternative 5: Dilution	$413,542	$338,845	$338,845	$338,845	$338,845	$1,768,923
776: Alternative 2: Direction	776: Alternative 2: Direction	$284,518	$15,225	$15,225	$15,225	$15,225	$345,420
776: Alternative 3: HVAC Mani	776: Alternative 3: HVAC Mani	$124,621	$58,298	$58,298	$58,298	$58,298	$357,811
776: Alternative 4: Carbon Tr	776: Alternative 4: Carbon Tr	$488,365	$33,642	$33,642	$33,642	$33,642	$622,933
776: Alternative 5: Dilution	776: Alternative 5: Dilution	$209,860	$138,773	$138,773	$138,773	$138,773	$764,953
785: Alternative 2: Direction	785: Alternative 2: Direction	$246,538	$20,073	$20,073	$20,073	$20,073	$326,829
785: Alternative 3: Vertical	785: Alternative 3: Vertical	$291,785	$20,073	$20,073	$20,073	$20,073	$372,077
786: Alternative 2: Direction	786: Alternative 2: Direction	$246,538	$20,073	$20,073	$20,073	$20,073	$326,829
786: Alternative 3: Vertical	786: Alternative 3: Vertical	$291,785	$20,073	$20,073	$20,073	$20,073	$372,077

Project Cost Over Time Report
(with Markups)

Total Project Cost	$3,697,958	$800,498	$800,498	$800,498	$800,498	$6,899,950

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 2: Directional Drilling + LTM
Site Name: 774: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type: Remedial Action
Phase Name: Directional Drilling + SVE
Description: Two (2) lines.

Line 774-SVE1: 175 feet long (125 feet perforated/slotted, 25 feet solid at each end)
Line 774-SVE2: 160 feet long (110 feet perforated/slotted, 25 feet solid at each end)

Both lines:
Total 335' long, 4" HDPE perforated or slotted, non-corrugated, 25-33% open area uniformly distributed over length of pipe.

Drilling done such that piping is one (1) foot below footing (estimated piping depth of 5' below grade), gradually traverses up to one (1) foot below bottom of slab at the center of the pipe length, and then traverses down such that it will be one (1) below bottom of footing at the other end of the building in an approximately symmetrical fashion (to the extent achievable practically).

Blower may be installed at ground level or on the roof. Discharge point to be minimum three (3) feet above roof ridge.

The two lines are to be joined into a 6" HDPE common header that is then connected to the suction side (inlet) of the blower.
Assume total 6" HDPE aboveground piping to be 100 feet (from underground piping on both lines to the common header/blower and then to exhaust point).

Assume vapor extraction at a rate of four (4) air changes per hour of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system). Assuming 25% porosity, 4 ACH, 18990 SF x 2 FT thickness, design extraction flow rate is 37980 CFH or 635 CFM (say 650 CFM, with about 340 CFM for Line 774-SVE1 and 310 CFM for Line 774-SVE2). Conservative 4 ACH to make up for capture zone limit uncertainties.

Longer pipe controls.
For longer pipe, underground piping (4") pressure loss = 6.5 "w.g. / 100' X 175' = 11.4 "w.g.

11.4 "w.g.
Add 10% for slot resistance, total u/g pressure loss = 12.5 "w.g.
Aboveground piping (6") pressure loss = 2.75 "w.g. / 100' X 100' = 2.75"
Double to account for fittings, diameter changes, etc. = 5.5 "w.g.
Total pressure (i.e., vacuum) loss = 12.5 (u/g) + 5.5 (a/g) = 18 "w.g. (1.4 "Hg approx.)

Total flow of 650 CFM at 18 "w.g. ==> 20 HP regenerative blower or equivalent, with approx. 8000 W (11 HP) power consumption (Rotron catalog doesn't have a smaller blower that can deliver per specs, some other mfr. may have a model available. However, this should give a conservative capital cost for the blower.)
[Note: If all piping (u/g and a/g) is 6", the piping loss is 7.5 "w.g., and power consumption by this blower will be approx. 7000 W (10HP).]
(Power consumption may possibly be reduced by choosing a better fit blower during design stage.)

Approach: In Situ
Start Date: September, 2009
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Soil Vapor Extraction	Yes	100	0
Decontamination Facilities	Yes	100	0
Overhead Electrical Distribution	Yes	100	0
Professional Labor Management	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: Soil Vapor Extraction

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
17030449	Horizontal Boring Under Road, 10" Diameter 6' x 3' x 2' Pit	335.00	LF	56.22	129.84	34.43	0.00	$73,862.48	☐	☑
33132361	1000 SCFM, Vapor Recovery System	1.00	EA	34,120.84	0.00	0.00	0.00	$34,120.84	☐	☑
33132377	Equipment Enclosure, 8' x 15', Portable Building/Shed; lined, insulated, skid mounted, w/exhaust fan	1.00	EA	16,750.23	1,137.15	0.00	0.00	$17,887.39	☐	☑
33220112	Field Technician	34.00	HR	0.00	88.84	0.00	0.00	$3,020.48	☐	☑
33230144	4" High-density Polyethylene Horizontal Well Casing, Material Only	100.00	LF	3.09	7.37	1.12	0.00	$1,157.54	☐	☑
33230246	4" High-density Polyethylene, Horizontal Well Screen, Material Only	235.00	LF	16.44	15.50	0.10	0.00	$7,530.31	☐	☑
33230316	4" High-density Polyethylene, Well Plug	2.00	EA	159.75	0.00	0.00	0.00	$319.50	☐	☑
33260513	6" High-density Polyethylene, Transfer Pipe	100.00	LF	6.14	7.75	0.00	0.00	$1,389.19	☐	☑
33270302	6" High-density Polyethylene, Tee	1.00	EA	162.85	112.73	0.00	0.00	$275.58	☐	☑
33270311	4", 90 Degree, High-density Polyethylene, Elbow	2.00	EA	44.98	88.57	0.00	0.00	$267.10	☐	☑
33310209	Pressure Gauge	4.00	EA	125.16	94.62	0.00	0.00	$879.12	☐	☑

Total Element Cost $140,709.53

Phase Technology Cost Detail Report
(with Markups)

Total 1st Year Technology Cost	$140,709.53

Phase Technology Cost Detail Report
(with Markups)

Technology: Decontamination Facilities

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33170818	Spray washers, cold water, electric, 1800 psi, 5 GPM, 5 HP, rent/month	1.00	MO	0.00	0.00	0.00	1,271.78	$1,271.78	☐	☑
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	20.00	HR	0.00	97.23	0.00	43.12	$2,806.96	☐	☑

Total Element Cost	$4,078.74
Total 1st Year Technology Cost	$4,078.74

Phase Technology Cost Detail Report
(with Markups)

Technology: Overhead Electrical Distribution

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
20020301	1/0 ACSR Conductor	63.60	LF	0.37	1.33	0.10	0.00	$114.83	☐	☑
20020310	1/C #2 Aluminum, Bare, Wire	92.00	LF	0.27	1.28	0.10	0.00	$151.84	☐	☑
20020402	35' Class 3 Treated Power Pole	2.00	EA	369.13	802.22	88.89	0.00	$2,520.46	☐	☑
20020430	Terminal Structure, 5 KV Pole Top	2.00	EA	1,799.10	2,768.76	278.09	0.00	$9,691.90	☐	☑
20020511	5 KV, 3/0, Shielded Cable, Copper	105.00	LF	4.89	4.91	0.00	0.00	$1,028.29	☐	☑
20020545	5 KV, 1/0 to 4/0 Conductor, Terminations & Splicing	6.00	EA	161.30	220.41	0.00	0.00	$2,290.28	☐	☑
20039902	4" Rigid Steel Conduit	35.00	LF	32.57	32.09	0.00	0.00	$2,263.06	☐	☑

Total Element Cost	$18,060.66
Total 1st Year Technology Cost	$18,060.66

Phase Technology Cost Detail Report
(with Markups)

Technology: Professional Labor Management

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33220149	Lump Sum Percentage Labor Cost	1.00	LS	0.00	28,813.00	0.00	0.00	$28,813.00	☑	☐

Total Element Cost	$28,813.00
Total 1st Year Technology Cost	$28,813.00
Total Phase Cost	$191,661.93

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 2: Directional Drilling + LTM
Site Name: 774: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type

Primary: Air
Secondary: Soil

Contaminant

Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names

- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation

Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information

Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type:	Operations & Maintenance
Phase Name:	LTM
Description:	2 Soil Gas & 4 Indoor Air Samples 3 events (Baseline and semi-annual) during Year 1 1 event during Year 2 - Year 5
Start Date:	October, 2008
Labor Rate Group:	System Labor Rate
Analysis Rate Group:	System Analysis Rate
Phase Markups:	System Defaults

Technology Markups	Markup	% Prime	% Sub.
MONITORING	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: MONITORING

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33020306	Monitoring Gas Vents	6.00	EA	0.00	0.00	0.00	12.41	$74.45	☐	☑
33020307	Soil gas investigation & analysis, equipment rental	3.00	DAY	0.00	0.00	0.00	97.40	$292.20	☐	☑
33020401	Disposable Materials per Sample	9.00	EA	13.21	0.00	0.00	0.00	$118.88	☐	☑
33020402	Decontamination Materials per Sample	9.00	EA	12.12	0.00	0.00	0.00	$109.05	☐	☑
33021803	Testing, non-rad lab tests, tentative id of compounds GC/MS 30/5040/8240	9.00	EA	0.00	0.00	0.00	163.78	$1,474.02	☐	☑
33220102	Project Manager	4.00	HR	0.00	185.37	0.00	0.00	$741.48	☐	☑
33220112	Field Technician	52.00	HR	0.00	88.84	0.00	0.00	$4,619.55	☐	☑

Total Element Cost $7,429.64

Element: Air

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33020345	Portable Air Sampler, Continuous, Daily Rental	3.00	DAY	0.00	0.00	0.00	90.28	$270.85	☐	☑
33020401	Disposable Materials per Sample	17.00	EA	13.21	0.00	0.00	0.00	$224.56	☐	☑
33020402	Decontamination Materials per Sample	17.00	EA	12.12	0.00	0.00	0.00	$205.99	☐	☑

Phase Technology Cost Detail Report
(with Markups)

Element: Air

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33021803	Testing, non-rad lab tests, tentative id of compounds GC/MS 30/5040/8240	17.00	EA	0.00	0.00	0.00	163.78	$2,784.26	☐	☑
33220102	Project Manager	4.00	HR	0.00	185.37	0.00	0.00	$741.48	☐	☑
33220112	Field Technician	53.00	HR	0.00	88.84	0.00	0.00	$4,708.39	☐	☑

Total Element Cost $8,935.53

Element: Data Management

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33220102	Project Manager	10.00	HR	0.00	185.37	0.00	0.00	$1,853.71	☐	☑
33220105	Project Engineer	30.00	HR	0.00	164.42	0.00	0.00	$4,932.50	☐	☑
33220108	Project Scientist	63.00	HR	0.00	168.35	0.00	0.00	$10,605.94	☐	☑
33220109	Staff Scientist	80.00	HR	0.00	115.27	0.00	0.00	$9,221.72	☐	☑
33220110	QA/QC Officer	18.00	HR	0.00	151.66	0.00	0.00	$2,729.87	☐	☑
33220112	Field Technician	2.00	HR	0.00	88.84	0.00	0.00	$177.68	☐	☑
33220114	Word Processing/Clerical	14.00	HR	0.00	80.31	0.00	0.00	$1,124.27	☐	☑
33220115	Draftsman/CADD	10.00	HR	0.00	96.20	0.00	0.00	$961.99	☐	☑
33240101	Other Direct Costs	1.00	LS	425.75	0.00	0.00	0.00	$425.75	☑	☑

Total Element Cost $32,033.43

Phase Technology Cost Detail Report
(with Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33010104	Sample collection, vehicle mileage charge, car or van	30.00	MI	0.00	0.00	0.00	0.49	$14.55	☑	☐
33022043	Overnight delivery service, 51 to 70 lb packages	120.00	LB	0.00	0.00	0.00	2.03	$244.18	☐	☑
33220112	Field Technician	26.00	HR	0.00	88.84	0.00	0.00	$2,309.78	☐	☑

Total Element Cost	$2,568.51
Total 1st Year Technology Cost	$50,967.11
Total Phase Cost	$50,967.11

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID: 774: Alternative 2: Directional Drilling + LTM
Site Name: 774: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441
Telephone Number: 315-336-7721
Email Address: g.atik@fpm-group.com
Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information
Reviewer Name:
Reviewer Title:
Agency/Org./Office:
Business Address:
Telephone Number:
Email Address:
Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type:	Operations & Maintenance
Phase Name:	O&M
Description:	O&M
Start Date:	October, 2008
Labor Rate Group:	System Labor Rate
Analysis Rate Group:	System Analysis Rate
Phase Markups:	System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: Operations and Maintenance

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33223001	Treatment System Operator	64.00	HR	0.00	40.54	0.00	0.00	$2,594.67	☐	☑
33240101	Other Direct Costs	1.00	LS	64.87	0.00	0.00	0.00	$64.87	☑	☑

Total Element Cost $2,659.54

Element: Soil Vapor Extraction

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33190101	Liquid Loading Into 5,000 Gallon Bulk Tank Truck	2.00	EA	0.00	701.22	451.01	0.00	$2,304.46	☐	☑
33190207	Transport Bulk Liquid/Sludge Hazardous Waste, Maximum 5,000 Gallon (per Mile)	10.00	MI	0.00	0.00	0.00	2.26	$22.58	☐	☑
33197102	Wastewater Disposal Fee	500.00	KGA	0.00	0.00	0.00	2.51	$1,253.17	☐	☑
33420101	Electrical Charge	100,000.00	KW	0.09	0.00	0.00	0.00	$9,305.68	☐	☑

Total Element Cost $12,885.89

Total 1st Year Technology Cost $15,545.44

Total Phase Cost $15,545.44

Site Cost Over Time Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites

within the Basewide SVI Operable Unit, Griffiss AFB, NY

Site Cost Over Time Report
(with Markups)

Site:

Site ID: 774: Alternative 2: Directional Drilling + LTM
Site Name: 774: Alternative 2: Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Site Cost Over Time Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Site Cost Over Time Report
(with Markups)

Phase Type	Phase Name	2009	2010	2011	2012	2013	Total
Remedial Action	Directional Drilling + SVE	$191,662	$0	$0	$0	$0	$191,662
Operations & Maintenance	O&M	$15,545	$15,545	$15,545	$15,545	$15,545	$77,727
Operations & Maintenance	LTM	$50,967	$8,277	$8,277	$8,277	$8,277	$84,074
Total Site Cost		$258,174	$23,822	$23,822	$23,822	$23,822	$353,463

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID: 776: Alternative 2: 4" Directional Drilling + LTM
Site Name: 776: Alternative 2: 4" Directional Drilling + LTM
Site Type: None

Media/Waste Type

Primary: Air
Secondary: Soil

Contaminant

Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names

- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation

Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information

Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type: Remedial Action
Phase Name: Directional Drilling + SVE
Description: Two (2) lines.

Line 776-SVE1: 275 feet long (225 feet perforated/slotted, 25 feet solid at each end)
Line 776-SVE2: 275 feet long (225 feet perforated/slotted, 25 feet solid at each end)

Both lines:
Total 550' long, 4" HDPE perforated or slotted, non-corrugated, 25-33% open area uniformly distributed over length of pipe.

Drilling done such that piping is one (1) foot below footing (estimated piping depth of 5' below grade), gradually traverses up to one (1) foot below bottom of slab at the center of the pipe length, and then traverses down such that it will be one (1) below bottom of footing at the other end of the building in an approximately symmetrical fashion (to the extent achievable practically).

Blower may be installed at ground level or on the roof. Discharge point to be minimum three (3) feet above roof ridge.

The two lines are to be joined into a 6" HDPE common header that is then connected to the suction side (inlet) of the blower.
Assume total 6" HDPE aboveground piping to be 50 feet (from underground piping on both lines to the common header/blower and then to exhaust point).

Assume vapor extraction at a rate of four (4) air changes per hour of a two (2) foot soil thickness (assumed thickness of influence of the horizontal extraction system). Assuming 25% porosity, 4 ACH, 27410 SF x 2 FT thickness, design extraction flow rate is 54820 CFH or 915 CFM (say 900 CFM, with about 450 CFM for Line 776-SVE1 and 450 CFM for Line 776-SVE2). Conservative 4 ACH to make up for capture zone limit uncertainties.

Controlling pipe length 275'.
Underground piping (4") pressure loss = 10 "w.g. / 100' X 275' = 27.5 "w.g.
Add 10% for slot resistance, total u/g pressure loss = 30.3 "w.g.

Phase Technology Cost Detail Report
(with Markups)

Add 10% for slot resistance, total u/g pressure loss = 30.3 "w.g.
Aboveground piping (6") pressure loss = 5.1 "w.g. / 100' X 50' = 2.6"
Double to account for fittings, diameter changes, etc. = 5.2 "w.g.
Total pressure (i.e., vacuum) loss = 30.3 (u/g) + 5.2 (a/g) = 35.5 "w.g., say 36 "w.g. (2.7 "Hg approx.)

Total flow of 900 CFM at 36 "w.g. ==> 30 HP regenerative blower or equivalent, with approx. 22500 W (30 HP) power consumption (Rotron catalog doesn't have a smaller blower that can deliver per specs, some other mfr. may have a model available. However, this should give a conservative capital cost for the blower.)

(Power consumption may possibly be reduced by choosing a better fit blower during design stage.)

Approach: In Situ
Start Date: September, 2009
Labor Rate Group: System Labor Rate
Analysis Rate Group: System Analysis Rate

Phase Markups: System Defaults

Technology Markups	Markup	% Prime	% Sub.
Soil Vapor Extraction	Yes	100	0
Decontamination Facilities	Yes	100	0
Overhead Electrical Distribution	Yes	100	0
Professional Labor Management	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: Soil Vapor Extraction

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
17030449	Horizontal Boring Under Road, 10" Diameter 6' x 3' x 2' Pit	550.00	LF	56.22	129.84	34.43	0.00	$121,266.76	☐	☑
33132361	1000 SCFM, Vapor Recovery System	1.00	EA	34,120.84	0.00	0.00	0.00	$34,120.84	☐	☑
33132377	Equipment Enclosure, 8' x 15', Portable Building/Shed; lined, insulated, skid mounted, w/exhaust fan	1.00	EA	16,750.23	1,137.15	0.00	0.00	$17,887.39	☐	☑
33220112	Field Technician	34.00	HR	0.00	88.84	0.00	0.00	$3,020.48	☐	☑
33230144	4" High-density Polyethylene Horizontal Well Casing, Material Only	100.00	LF	3.09	7.37	1.12	0.00	$1,157.54	☐	☑
33230246	4" High-density Polyethylene, Horizontal Well Screen, Material Only	450.00	LF	16.44	15.50	0.10	0.00	$14,419.75	☐	☑
33230316	4" High-density Polyethylene, Well Plug	2.00	EA	159.75	0.00	0.00	0.00	$319.50	☐	☑
33260513	6" High-density Polyethylene, Transfer Pipe	50.00	LF	6.14	7.75	0.00	0.00	$694.60	☐	☑
33270302	6" High-density Polyethylene, Tee	1.00	EA	162.85	112.73	0.00	0.00	$275.58	☐	☑
33270311	4", 90 Degree, High-density Polyethylene, Elbow	2.00	EA	44.98	88.57	0.00	0.00	$267.10	☐	☑
33310209	Pressure Gauge	4.00	EA	125.16	94.62	0.00	0.00	$879.12	☐	☑

Total Element Cost $194,308.65

Phase Technology Cost Detail Report
(with Markups)

Total 1st Year Technology Cost	$194,308.65

Phase Technology Cost Detail Report
(with Markups)

Technology: Decontamination Facilities

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33170818	Spray washers, cold water, electric, 1800 psi, 5 GPM, 5 HP, rent/month	1.00	MO	0.00	0.00	0.00	1,271.78	$1,271.78	☐	☑
33170823	Operation of Pressure Washer, Including Water, Soap, Electricity, Labor	20.00	HR	0.00	97.23	0.00	43.12	$2,806.96	☐	☑

Total Element Cost	$4,078.74
Total 1st Year Technology Cost	$4,078.74

Phase Technology Cost Detail Report
(with Markups)

Technology: Overhead Electrical Distribution

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
20020301	1/0 ACSR Conductor	63.60	LF	0.37	1.33	0.10	0.00	$114.83	☐	☑
20020310	1/C #2 Aluminum, Bare, Wire	92.00	LF	0.27	1.28	0.10	0.00	$151.84	☐	☑
20020402	35' Class 3 Treated Power Pole	2.00	EA	369.13	802.22	88.89	0.00	$2,520.46	☐	☑
20020430	Terminal Structure, 5 KV Pole Top	2.00	EA	1,799.10	2,768.76	278.09	0.00	$9,691.90	☐	☑
20020511	5 KV, 3/0, Shielded Cable, Copper	105.00	LF	4.89	4.91	0.00	0.00	$1,028.29	☐	☑
20020545	5 KV, 1/0 to 4/0 Conductor, Terminations & Splicing	6.00	EA	161.30	220.41	0.00	0.00	$2,290.28	☐	☑
20039902	4" Rigid Steel Conduit	35.00	LF	32.57	32.09	0.00	0.00	$2,263.06	☐	☑

Total Element Cost	$18,060.66
Total 1st Year Technology Cost	$18,060.66

Phase Technology Cost Detail Report
(with Markups)

Technology: Professional Labor Management

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33220149	Lump Sum Percentage Labor Cost	1.00	LS	0.00	39,281.00	0.00	0.00	$39,281.00	☑	☐

Total Element Cost	$39,281.00
Total 1st Year Technology Cost	$39,281.00
Total Phase Cost	$255,729.05

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID: 776: Alternative 2: 4" Directional Drilling + LTM
Site Name: 776: Alternative 2: 4" Directional Drilling + LTM
Site Type: None

Media/Waste Type
Primary: Air
Secondary: Soil

Contaminant
Primary: Volatile Organic Compounds (VOCs)
Secondary: None

Phase Names
- Pre-Study: ☐
- PA, SI, PA/SI, RI, FS, RI/FS: ☐
- RD: ☐
- IRA-C: ☐
- RA-C: ☑
- IRA-O, RA-O: ☑
- LTM: ☐
- PCO: ☐

Documentation
Description: SVI FS
Support Team: AFRPA Griffiss
References: ...

Estimator Information
Estimator Name: FPM
Estimator Title: FPM
Agency/Org./Office: FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type:	Operations & Maintenance
Phase Name:	LTM
Description:	2 Soil Gas & 4 Indoor Air Samples 3 events (Baseline and semi-annual) during Year 1 1 event during Year 2 - Year 5
Start Date:	October, 2008
Labor Rate Group:	System Labor Rate
Analysis Rate Group:	System Analysis Rate
Phase Markups:	System Defaults

Technology Markups	Markup	% Prime	% Sub.
MONITORING	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: MONITORING

Element: Soil Gas

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33020306	Monitoring Gas Vents	6.00	EA	0.00	0.00	0.00	12.41	$74.45	☐	☑
33020307	Soil gas investigation & analysis, equipment rental	3.00	DAY	0.00	0.00	0.00	97.40	$292.20	☐	☑
33020401	Disposable Materials per Sample	9.00	EA	13.21	0.00	0.00	0.00	$118.88	☐	☑
33020402	Decontamination Materials per Sample	9.00	EA	12.12	0.00	0.00	0.00	$109.05	☐	☑
33021803	Testing, non-rad lab tests, tentative id of compounds GC/MS 30/5040/8240	9.00	EA	0.00	0.00	0.00	163.78	$1,474.02	☐	☑
33220102	Project Manager	4.00	HR	0.00	185.37	0.00	0.00	$741.48	☐	☑
33220112	Field Technician	52.00	HR	0.00	88.84	0.00	0.00	$4,619.55	☐	☑

Total Element Cost $7,429.64

Element: Air

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33020345	Portable Air Sampler, Continuous, Daily Rental	3.00	DAY	0.00	0.00	0.00	90.28	$270.85	☐	☑
33020401	Disposable Materials per Sample	17.00	EA	13.21	0.00	0.00	0.00	$224.56	☐	☑
33020402	Decontamination Materials per Sample	17.00	EA	12.12	0.00	0.00	0.00	$205.99	☐	☑

Phase Technology Cost Detail Report
(with Markups)

Element: Air

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33021803	Testing, non-rad lab tests, tentative id of compounds GC/MS 30/5040/8240	17.00	EA	0.00	0.00	0.00	163.78	$2,784.26	☐	☑
33220102	Project Manager	4.00	HR	0.00	185.37	0.00	0.00	$741.48	☐	☑
33220112	Field Technician	53.00	HR	0.00	88.84	0.00	0.00	$4,708.39	☐	☑

Total Element Cost $8,935.53

Element: Data Management

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33220102	Project Manager	10.00	HR	0.00	185.37	0.00	0.00	$1,853.71	☐	☑
33220105	Project Engineer	30.00	HR	0.00	164.42	0.00	0.00	$4,932.50	☐	☑
33220108	Project Scientist	63.00	HR	0.00	168.35	0.00	0.00	$10,605.94	☐	☑
33220109	Staff Scientist	80.00	HR	0.00	115.27	0.00	0.00	$9,221.72	☐	☑
33220110	QA/QC Officer	18.00	HR	0.00	151.66	0.00	0.00	$2,729.87	☐	☑
33220112	Field Technician	2.00	HR	0.00	88.84	0.00	0.00	$177.68	☐	☑
33220114	Word Processing/Clerical	14.00	HR	0.00	80.31	0.00	0.00	$1,124.27	☐	☑
33220115	Draftsman/CADD	10.00	HR	0.00	96.20	0.00	0.00	$961.99	☐	☑
33240101	Other Direct Costs	1.00	LS	425.75	0.00	0.00	0.00	$425.75	☑	☑

Total Element Cost $32,033.43

Phase Technology Cost Detail Report
(with Markups)

Element: General Monitoring

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33010104	Sample collection, vehicle mileage charge, car or van	30.00	MI	0.00	0.00	0.00	0.49	$14.55	☑	☐
33022043	Overnight delivery service, 51 to 70 lb packages	120.00	LB	0.00	0.00	0.00	2.03	$244.18	☐	☑
33220112	Field Technician	26.00	HR	0.00	88.84	0.00	0.00	$2,309.78	☐	☑

Total Element Cost	$2,568.51
Total 1st Year Technology Cost	$50,967.11
Total Phase Cost	$50,967.11

Phase Technology Cost Detail Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites within the Basewide SVI Operable Unit, Griffiss AFB, NY

Phase Technology Cost Detail Report
(with Markups)

Site:

Site ID:	776: Alternative 2: 4" Directional Drilling + LTM
Site Name:	776: Alternative 2: 4" Directional Drilling + LTM
Site Type:	None

Media/Waste Type

Primary:	Air
Secondary:	Soil

Contaminant

Primary:	Volatile Organic Compounds (VOCs)
Secondary:	None

Phase Names

Pre-Study:	☐
PA, SI, PA/SI, RI, FS, RI/FS:	☐
RD:	☐
IRA-C:	☐
RA-C:	☑
IRA-O, RA-O:	☑
LTM:	☐
PCO:	☐

Documentation

Description:	SVI FS
Support Team:	AFRPA Griffiss
References:	...

Estimator Information

Estimator Name:	FPM
Estimator Title:	FPM
Agency/Org./Office:	FPM

Phase Technology Cost Detail Report
(with Markups)

Business Address:	153 Brooks Rd. Rome, NY 13441
Telephone Number:	315-336-7721
Email Address:	g.atik@fpm-group.com
Estimate Prepared Date:	03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:	
Reviewer Title:	
Agency/Org./Office:	
Business Address:	
Telephone Number:	
Email Address:	
Date Reviewed:	

Reviewer Signature: ______________________ Date: ____________

Phase Technology Cost Detail Report
(with Markups)

Phase:

Phase Type:	Operations & Maintenance
Phase Name:	O&M
Description:	O&M
Start Date:	October, 2008
Labor Rate Group:	System Labor Rate
Analysis Rate Group:	System Analysis Rate
Phase Markups:	System Defaults

Technology Markups	Markup	% Prime	% Sub.
Operations and Maintenance	Yes	100	0

Phase Technology Cost Detail Report
(with Markups)

Technology: Operations and Maintenance

Element: Miscellaneous

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33223001	Treatment System Operator	64.00	HR	0.00	40.54	0.00	0.00	$2,594.67	☐	☑
33240101	Other Direct Costs	1.00	LS	64.87	0.00	0.00	0.00	$64.87	☑	☑

Total Element Cost $2,659.54

Element: Soil Vapor Extraction

Assembly	Description	Quantity	Unit of Measure	Material Unit Cost	Labor Unit Cost	Equipment Unit Cost	Sub Bid Unit Cost	Extended Cost	Cost Override	Markups Applied
33190101	Liquid Loading Into 5,000 Gallon Bulk Tank Truck	2.00	EA	0.00	701.22	451.01	0.00	$2,304.46	☐	☑
33190207	Transport Bulk Liquid/Sludge Hazardous Waste, Maximum 5,000 Gallon (per Mile)	10.00	MI	0.00	0.00	0.00	2.26	$22.58	☐	☑
33197102	Wastewater Disposal Fee	500.00	KGA	0.00	0.00	0.00	2.51	$1,253.17	☐	☑
33420101	Electrical Charge	200,000.00	KW	0.09	0.00	0.00	0.00	$18,611.37	☐	☑

Total Element Cost $22,191.58

Total 1st Year Technology Cost $24,851.12

Total Phase Cost $24,851.12

Site Cost Over Time Report
(with Markups)

System:

RACER Version: 10.0.0
Database Location: C:\Documents and Settings\GAA\Application Data\Earth Tech\RACER 10.0\Racer.mdb

Folder:

Folder Name: GRIFFISS SVI FS

Project:

Project ID: SVI FS
Project Name: SOIL VAPOR INTRUSION FEASIBILITY STUDY
Project Category: None

Location
State / Country: NEW YORK
City: GRIFFISS HOUSING

Location Modifier	Default	User
	1.035	1.035

Options
Database: System Costs
Cost Database Date: 2008
Report Option: Fiscal

Description: This project evaluates soil vapor intrusion mitigation RAs at various sites

Site Cost Over Time Report
(with Markups)

within the Basewide SVI Operable Unit, Griffiss AFB, NY

Site Cost Over Time Report
(with Markups)

Site:

Site ID:	776: Alternative 2: 4" Directional Drilling + LTM
Site Name:	776: Alternative 2: 4" Directional Drilling + LTM
Site Type:	None

Media/Waste Type

Primary:	Air
Secondary:	Soil

Contaminant

Primary:	Volatile Organic Compounds (VOCs)
Secondary:	None

Phase Names

Pre-Study:	☐
PA, SI, PA/SI, RI, FS, RI/FS:	☐
RD:	☐
IRA-C:	☐
RA-C:	☑
IRA-O, RA-O:	☑
LTM:	☐
PCO:	☐

Documentation

Description:	SVI FS
Support Team:	AFRPA Griffiss
References:	...

Estimator Information

Estimator Name:	FPM
Estimator Title:	FPM
Agency/Org./Office:	FPM

Site Cost Over Time Report
(with Markups)

Business Address: 153 Brooks Rd.
Rome, NY 13441

Telephone Number: 315-336-7721

Email Address: g.atik@fpm-group.com

Estimate Prepared Date: 03/28/2008

Estimator Signature: ______________________ Date: ____________

Reviewer Information

Reviewer Name:

Reviewer Title:

Agency/Org./Office:

Business Address:

Telephone Number:

Email Address:

Date Reviewed:

Reviewer Signature: ______________________ Date: ____________

Site Cost Over Time Report
(with Markups)

Phase Type	Phase Name	2009	2010	2011	2012	2013	Total
Remedial Action	Directional Drilling + SVE	$255,729	$0	$0	$0	$0	$255,729
Operations & Maintenance	O&M	$24,851	$24,851	$24,851	$24,851	$24,851	$124,256
Operations & Maintenance	LTM	$50,967	$8,277	$8,277	$8,277	$8,277	$84,074
Total Site Cost		$331,547	$33,128	$33,128	$33,128	$33,128	$464,059

Project Cost Over Time Report (with Markups)

Location: GRIFFISS HOUSING, NEW YORK

Site Name	Fiscal Year 1 2009	Fiscal Year 2 2010	Fiscal Year 3 2011	Fiscal Year 4 2012	Fiscal Year 5 2013
774: Alternative 2: Directional Drilling + LTM	$220,177	$15,225	$15,225	$15,225	$15,225
774: Alternative 3: HVAC Manipulation + LTM	$143,578	$47,224	$47,224	$47,224	$47,224
774: Alternative 4: Carbon Treatment + LTM	$736,652	$72,973	$72,973	$72,973	$72,973
774: Alternative 5: Dilution by Ventilatin + LTM	$413,542	$338,845	$338,845	$338,845	$338,845
776: Alternative 2: Directional Drilling + LTM	$284,518	$15,225	$15,225	$15,225	$15,225
776: Alternative 3: HVAC Manipulation + LTM	$124,621	$58,298	$58,298	$58,298	$58,298
776: Alternative 4: Carbon Treatment + LTM	$488,365	$33,642	$33,642	$33,642	$33,642
776: Alternative 5: Dilution by Ventilatin + LTM	$209,860	$138,773	$138,773	$138,773	$138,773
785: Alternative 2: Directional Drilling + LTM	$246,538	$20,073	$20,073	$20,073	$20,073
785: Alternative 3: Vertical Drilling + LTM	$291,785	$20,073	$20,073	$20,073	$20,073
786: Alternative 2: Directional Drilling + LTM	$246,538	$20,073	$20,073	$20,073	$20,073
786: Alternative 3: Vertical Drilling + LTM	$291,785	$20,073	$20,073	$20,073	$20,073
	$3,697,958	$800,498	$800,498	$800,498	$800,498

Cost Database Date: 2008
Cost Type: 0
Date: 12/3/2008
Time: 11:31 AM

Project Cost Over Time Report (with Markups)

Row Total	Site Type	Site Name
$281,078	None	774: Alternative 2: Directional Drilling + LTM
$332,473	None	774: Alternative 3: HVAC Manipulation + LTM
$1,028,545	None	774: Alternative 4: Carbon Treatment + LTM
$1,768,923	None	774: Alternative 5: Dilution by Ventilatin + LTM
$345,420	None	776: Alternative 2: Directional Drilling + LTM
$357,811	None	776: Alternative 3: HVAC Manipulation + LTM
$622,933	None	776: Alternative 4: Carbon Treatment + LTM
$764,953	None	776: Alternative 5: Dilution by Ventilatin + LTM
$326,829	None	785: Alternative 2: Directional Drilling + LTM
$372,077	None	785: Alternative 3: Vertical Drilling + LTM
$326,829	None	786: Alternative 2: Directional Drilling + LTM
$372,077	None	786: Alternative 3: Vertical Drilling + LTM
$6,899,950	**Total**	