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Vapor Intrusion - ASTM E2600 Overview

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WHITE PAPER

Upcoming ASTM Standard for Assessment of Vapor Intrusion

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Background

Vapor intrusion into structures on property can potentially create significant liability and have a material impact on property value. As such, it is a growing concern for property owners, prospective purchasers of property and the environmental professionals conducting due diligence. When property is acquired, a Phase I conducted in accordance with ASTM Standard E 1527 is typically used for environmental due diligence. Unfortunately, it is not clear in this standard whether or not vapor intrusion is included or excluded as part of the due diligence investigation. The standard defines a *recognized environmental condition* (REC) as “the presence or likely presence of any hazardous substances or petroleum products on a property under conditions that indicate an existing release...or a material threat of a release...into structures on the property...” Vapor intrusion can clearly be viewed as a “release into structures on the property.” At the same time, the *Non-scope Considerations* section of the standard identifies indoor air quality as outside the scope of the ASTM Phase I environmental site assessment standard. Although indoor air quality is not defined in the ASTM standard, there is little argument that vapor intrusion represents an indoor air quality issue. Hence, depending on one’s viewpoint, the ASTM E 1527 Phase I standard can be perceived as either including or excluding vapor intrusion. Unfortunately, litigation has already started against Phase I environmental site assessment firms for not taking vapor intrusion into consideration when conducting property environmental due diligence.

Current owners of property and prospective purchasers are also concerned for a number of reasons. Properties with “no further action (NFA)” letters can no longer be considered “safe” from having to conduct further envi-

ronmental investigation at a later date. In a number of states, including New York, hundreds of commercial properties with NFA letters have been re-opened because of potential vapor intrusion concerns. Tenants on commercial properties have also been known to use the “unsafe working environment” rationale purportedly created by vapor intrusion to break leases. In addition, there is serious concern for potential toxic tort litigation.

Vapor intrusion is now in the limelight and more than 23 states already have some form of vapor intrusion policy/guidance on their books or under development. There can be no doubt that more states will soon be joining this group.

With all this activity taking place and vapor intrusion problems continuing to make headlines, it is difficult for an environmental professional to completely ignore the possibility of vapor intrusion into existing structures or future structures on property when conducting environmental due diligence.

Approach

The ASTM standard for the assessment of vapor intrusion prescribes a tiered process designed to quickly screen out properties with a low risk of vapor intrusion. The standard introduces a number of new terms:

(1) *Vapor Intrusion Condition* (VIC), defined as “the presence or likely presence of any chemicals of concern in the indoor air environment of existing or planned structures on a property caused by the release of vapor from contaminated soil or groundwater on the property or within close proximity to the property, at a concentration that presents or may present an unacceptable health risk to occupants.” The standard only deals with indoor air emissions emanating from contaminated soil or groundwater.

(2) *Potential Vapor Intrusion Condition* (pVIC), defined by the standard as a condition that exists when screening indicates the possibility of a VIC, but where there is insufficient data to ascertain the presence or likely presence of chemicals of concern in the indoor air environment.

(3) *Chemicals of Concern* (COC), defined as chemicals in the subsurface environment that are known or reasonably expected to be present, that can potentially migrate as a vapor into an existing or planned structure on a property, and that are generally recognized as having the potential for an adverse impact on human health. COC meet specific criteria for volatility and toxicity, and include volatile organic compounds, semi-volatile organic compounds, and volatile inorganic analytes such as mercury. An appendix in the standard lists common COC meeting the criteria.

The process defined in this practice begins with a reasonably conservative screening effort requiring information that would be collected as part of an ASTM E 1527 Phase I environmental site assessment. If a pVIC is identified in this initial screening, the process gradually progresses toward a more complex assessment involving increasingly greater use of site-specific data. For those sites unable to be screened out, the process provides alternative methods to determine whether a VIC exists. If a VIC is found to exist, the process then describes general mitigation alternatives.

Specifically, the evaluation process consists of four tiers. The first two tiers are screening tiers designed to assess the *potential* for a vapor intrusion condition (i.e., pVIC) to exist so that properties with a low risk of vapor intrusion can be screened out quickly and inexpensively as the data justify. If the potential for vapor intrusion cannot reasonably be eliminated at the Tier 1 and/or Tier 2 levels, the process identifies three options:

- (1) proceed with a more site-specific and comprehensive investigation (Tier 3), in the hope that this investigation will eliminate vapor intrusion concerns;
- (2) proceed directly to mitigation (Tier 4), on the assumption that mitigation conducted pre-emptively may be more cost effective to address a pVIC; or
- (3) gain more certainty on the presence of a pVIC through additional investigation. Tier 3 presents a “toolbox” of activities that can accomplish this. Tier 4 then addresses mitigation alternatives.

Timeliness may be more important than investigation or mitigation costs during real estate transactions. As such, a user can proceed to any of the tiers in the process as appropriate. It is not necessary to progress sequentially through each tier. In most cases, however, it is expected that it would be more cost effective—and sufficient time would be available in the real estate transaction—to conduct a Tier 1 screening evaluation, and possibly a Tier 2 screening evaluation before proceeding to a more costly and time consuming Tier 3 investigation or, ultimately, to Tier 4 mitigation.

The vapor intrusion assessment process described in the standard is designed to complement existing federal or state vapor intrusion policies or guidance. The flow chart in Figure 1 of the standard indicates the four tiers of the vapor intrusion assessment process when conducted in conjunction with a Phase I environmental site assessment.

Tier 1

Tier 1 is designed as the initial screening step that can either supplement a Phase I environmental site assessment or stand on its own. The information required is the same information collected as part of an ASTM E 1527 Phase I, and includes government and historical records, and physical setting information on the property's location. There are three tests in Tier 1: (1) a search distance test to identify if there are any known or suspect contaminated sites in the area of concern; (2) a chemicals of concern test to identify if any of the known or suspect contaminated sites in the area of concern may have released chemicals of concern; and (3) a plume test to determine if the plume associated with a source of contamination is close enough to structures on a target property to cause vapors that may be released to adversely impact the indoor air environment.

There is a primary and secondary area of concern in the search distance test, distinguished by whether the radius search is performed com-

pletely around a target property or limited solely to a search in the up-gradient direction. Also, the search distances are different for sites contaminated with [non-petroleum hydrocarbon] chemicals of concern (such as chlorinated volatile organics) versus sites contaminated with petroleum hydrocarbon chemicals of concern. To identify the primary area of concern for contaminated sites with [non-petroleum hydrocarbon] chemicals of concern, the search distance is 1/3 mile around a target property. For sites with petroleum hydrocarbon chemicals of concern, the search distance is 1/10 mile around a target property. The screening search distances are shorter for petroleum hydrocarbons because these contaminants are known to undergo significant bio-degradation in the vadose zone in the presence of oxygen.

To identify the secondary area of concern for up-gradient contaminated sites with [non-petroleum hydrocarbon] chemicals of concern, the search distance is from either 1/3 mile or 1/10 mile (depending on whether or not the chemicals of concern are petroleum hydrocarbons) up to the search distance identified in the ASTM E 1527 Phase I standard for the specific database. Hence, for example, a gas station LUST site would be in the primary area of concern if located anywhere within 1/10 mile of the target property. It would be in the secondary area of concern if located up-gradient of the target property between 1/10 mile and 1/2 mile (the ASTM E 1527-specified search distance). A drycleaner site would be in the primary area of concern if located anywhere within 1/3 mile of the target property. It would be in the secondary area of concern if located up-gradient of the target property between 1/3 mile and 1/2 mile.

If a known or suspect contaminated site is located in the area of concern (primary or secondary), then the next test is to determine if the contaminants are chemicals of concern. If they are, the last test is the plume test.

If chemicals of concern are present at these sites, the plume test investigates whether the nearest edge of the contaminated plume is within the *critical distance*, defined as the lineal distance from the nearest edge of a contaminated plume to the nearest structure on the target property, or to the nearest property boundary if there are no structures on the target property. Information related to the size of the contaminated plume from known contaminated sites may or may not be available at the Tier 1 level.

If information related to the size of the contaminated plume from known contaminated sites is available, the critical distance assessment can be conducted. If the lineal distance from the

nearest edge of a contaminated plume to the nearest structure on the target property, or to the nearest target property boundary if there are no structures on the target property, is less than 100 feet, (except for dissolved petroleum hydrocarbon chemicals of concern in which case if this lineal distance is less than 30 feet), then it is presumed that a pVIC exists. If the lineal distance between the nearest edge of the contaminated plume and the nearest structure on the target property, or between the nearest edge of the contaminated plume and the nearest target property boundary if there are no structures on the target property, is greater than or equal to 100 feet, (or 30 feet for dissolved petroleum hydrocarbon chemicals of concern), then it is presumed unlikely that a pVIC will exist in current or planned structure(s) on the target property. The critical distance for petroleum hydrocarbon chemicals of concern in free product form (LNAPL) is the same as for [non-petroleum hydrocarbon] chemicals of concern (i.e., 100 feet). The environmental professional can modify the critical distance based upon experience, site-specific conditions and applicable state policy or regulation. If the critical distance is modified by the environmental professional, the basis for this modification must be identified in the report.

If information about plumes is not known, then the plume test cannot be completed (and therefore a pVIC would have to be presumed), except for known or suspect contaminated sites located down-gradient of a target property. At such sites, it is not necessary to know the dimensions of the plume. The critical distance is determined solely by the distance between the target property location and the location of the known or suspect contaminated property.

The Tier 1 assessment concludes either that vapor intrusion is not a likely concern for the property or that a pVIC exists. If a pVIC exists, the environmental professional would discuss the appropriate next steps with the client. For example, further investigation may be to proceed to Tier 2. Alternatively, the decision may be made by the client to proceed pre-emptively to mitigation as described in Tier 4.

Tier 2

If a pVIC is associated with a property after applying the Tier 1 screen, more refined screening may then take place in Tier 2. Tier 2 applies semi-site specific numeric screening criteria to existing or newly collected soil, soil gas and/or groundwater sampling results to assess whether or not a pVIC still exists. Tier 2 has two data collection components: one non-invasive and one invasive. The non-invasive component includes investigation and review at the appropriate regulatory agency of available Phase II reports on the extent of contamination for known or suspect sources

within the area of concern (identified in Tier 1). The invasive component of a Tier 2 investigation includes sampling of soil, soil gas and/or groundwater at or near the target property. The objective of the non-invasive component is to identify from existing Phase II reports the status of remediation, the size of the contaminant plume and its behavior, the specific chemicals of concern and their respective concentrations. If there are chemicals of concern within the critical distance, the concentrations of these chemicals in soil or soil gas or groundwater are compared to generic risk-based concentrations (RBCs) (i.e., from existing state policy/regulation, or from federal guidance) or site-specific RBCs developed by the environmental professional (e.g., by using the ASTM E 1739 standard). RBCs are typically presented in tables developed by conservatively applying (under conditions defined as “generally reasonable worst case”) the Johnson-Ettinger model to estimate potential indoor air levels that might result from vapor migration out of contaminated subsurface media, and comparing these to indoor air levels considered acceptable based upon a health risk assessment.

The non-invasive component of the Tier 2 screen may be combined with the Tier 1 screen if the user and environmental professional deem it appropriate. The invasive component of the Tier 2 screen will require careful planning by the environmental professional to ensure that the sampling strategy is able to answer the pertinent questions. Factored into the strategy should be the likelihood that the approval process for sampling off-site will be much more difficult and time-consuming to navigate through than for sampling on the target property.

The Tier 2 process may further screen out potential vapor intrusion sources identified in Tier 1. If the potential for a vapor intrusion condition still cannot be eliminated at the Tier 2 level, the environmental professional and client may choose to proceed to a Tier 3 investigation. Alternately, the decision may be made to proceed directly to pre-emptive mitigation in Tier 4.

Tier 3

If the potential for vapor intrusion cannot be screened out at the Tier 1 or Tier 2 levels, the user may choose to proceed to more sophisticated testing (Tier 3) to determine if a VIC exists. A Tier 3 investigation will generally utilize data based on interior (within or below the building) or exterior testing. Possible reasons for conducting interior testing may include regulatory requirements or a desire to directly measure concentrations at the actual point of exposure. Possible reasons for conducting exterior testing

might include lack of legal access to buildings, the fact that the property is undeveloped, a desire to keep transaction activities confidential, and/or concerns that interior tests may be adversely affected by background sources of chemicals of concern.

The specific scope of services for a Tier 3 investigation is established by the environmental professional and the client. The standard refers the user to existing federal or state vapor intrusion assessment policy or guidance, if available. For example, if the target property is owned by the U.S. Department of Defense such as the U.S. Army or U.S. Air Force, that agency’s vapor intrusion assessment guidance should be reviewed and adhered to. If the property is privately owned and located in a state with vapor intrusion assessment guidance such as California, New Jersey or New York, that state’s guidance should be reviewed and adhered to. If the privately owned property is located in a state without vapor intrusion assessment guidance, then the user and environmental professional may rely on federal guidance (e.g., EPA) or other guidance (e.g., ITRC).

A number of alternative approaches to conduct a Tier 3 vapor intrusion investigation are identified in the standard as follows:

- (1) Groundwater sampling, combined with a site-specific model
- (2) Soil gas sampling, combined with a site-specific model
- (3) Sub-slab soil gas sampling, combined with a site-specific model
- (4) Indoor air sampling

Knowledge of contaminant concentrations and location in the groundwater, soil, or soil gas directly beneath the slab (or in the crawl space), along with contaminant properties and building characteristics, can be used to estimate the impact on indoor air using either empirical or other types of models (such as the Johnson-Ettinger Model). Knowledge of the indoor air impact can then be used in a health risk assessment to determine if a VIC exists.

Indoor air sampling can measure indoor air concentrations directly and then be used in a health risk assessment to determine if a VIC exists. While this approach uses the fewest assumptions, the analysis is complicated because it is necessary to understand other contributors to the indoor air quality (background contributors), including but not limited to:

- activities that take place within the structure (such as smoking, wood burning, automobile parking, etc.),

- products used within the structure (such as paints, solvents, cleaners, etc.),

- building materials (such as carpeting, paint, adhesives, etc.), and

- outdoor ambient air quality (which may, for example, be impacted by nearby automobile traffic or industrial emissions).

Further complicating the analysis is the fact that indoor air quality can be influenced by the season of the year. Assuming that indoor air quality sampling can be conducted to provide representative results and that an adequate analysis of background contributors is possible, then the indoor air sampling approach is the only approach with the potential to conclusively determine if a VIC exists.

For the case where structures do not exist on the target property such as for an undeveloped property, or where structures may be substantially rehabilitated such as the case of a former industrial building being completely gutted and converted to residential use, then only approaches (1), (2) and (3) are likely to provide useful information.

Tier 4

Tier 4 identifies mitigation alternatives that may be required out of necessity (e.g., a VIC is found in the Tier 3 investigation) or taken as a precautionary measure (e.g., pre-emptive mitigation for a pVIC).

Options for the mitigation of subsurface vapors to reduce or eliminate migration to indoor air generally fall into one of the following categories:

- (1) institutional controls, such as deed restrictions or other mechanisms by which land uses or development of a site can be legally regulated to reduce or eliminate potential exposures;
- (2) engineering controls, such as contaminant source removal or treatment, or barriers (e.g., vapor barriers with and without venting) to reduce or eliminate potential exposures; or
- (3) intrinsically safe building design, such as well ventilated underground parking garages or residential condos with first floor open air parking or HVAC design and operation to maintain building internal positive pressure at all times.

Mitigation alternatives for new buildings are typically greater than for existing buildings. In addition, the installation of a vapor intrusion mitigation system at the time of building construction is typically more cost effective. Therefore, it is preferable for mitigation to occur at the time a building is constructed, rather than afterwards.

Implications for Environmental Professionals

Environmental professionals today have two choices on how to deal with vapor intrusion in a Phase I environmental site assessment; namely, to either (1) make sure the client is aware that vapor intrusion, as an indoor air quality issue, is a non-scope consideration in the ASTM E 1527 Phase I scope of work; or (2) include a vapor intrusion assessment as a supplement to the Phase I, much the same way that asbestos might be added to the scope of services. If it is to be included, the ASTM vapor intrusion standard provides a methodology that can be followed (e.g., to screen for a pVIC and decide what might be done if a pVIC is found). Unfortunately, completely ignoring the issue is no longer an option today because of the liability implications associated with doing so.

Status of the ASTM Vapor Intrusion Standard

The ASTM balloting process for the vapor intrusion standard began in February 2007 and ended in February 2008. The standard has been approved and given the designation E 2600, and will be released by ASTM for purchase in late February or early March 2008.

(Anthony J. Buonicore, PE, DEE, QEP is a past president and Fellow Member of the Air & Waste Management Association and is the Chairman and CEO of the Buonicore Group, a real estate and environmental risk management consulting company. He is also a Diplomate in the American Academy of Environmental Engineers, a Qualified Environmental Professional, and a licensed professional engineer.)

Mr. Buonicore is a member of ASTM Subcommittee E 50.02 Property Environmental Due Diligence, former chairman of its ASTM Phase I/Transaction Screen Task Group, and currently chairs the ASTM Task Group that developed the U.S. standard for vapor intrusion assessment in real estate transactions. He can be reached at 800-238-1841 or ajb@edrnet.com.)

Federal and State Agency Vapor Intrusion Web Resources

Federal

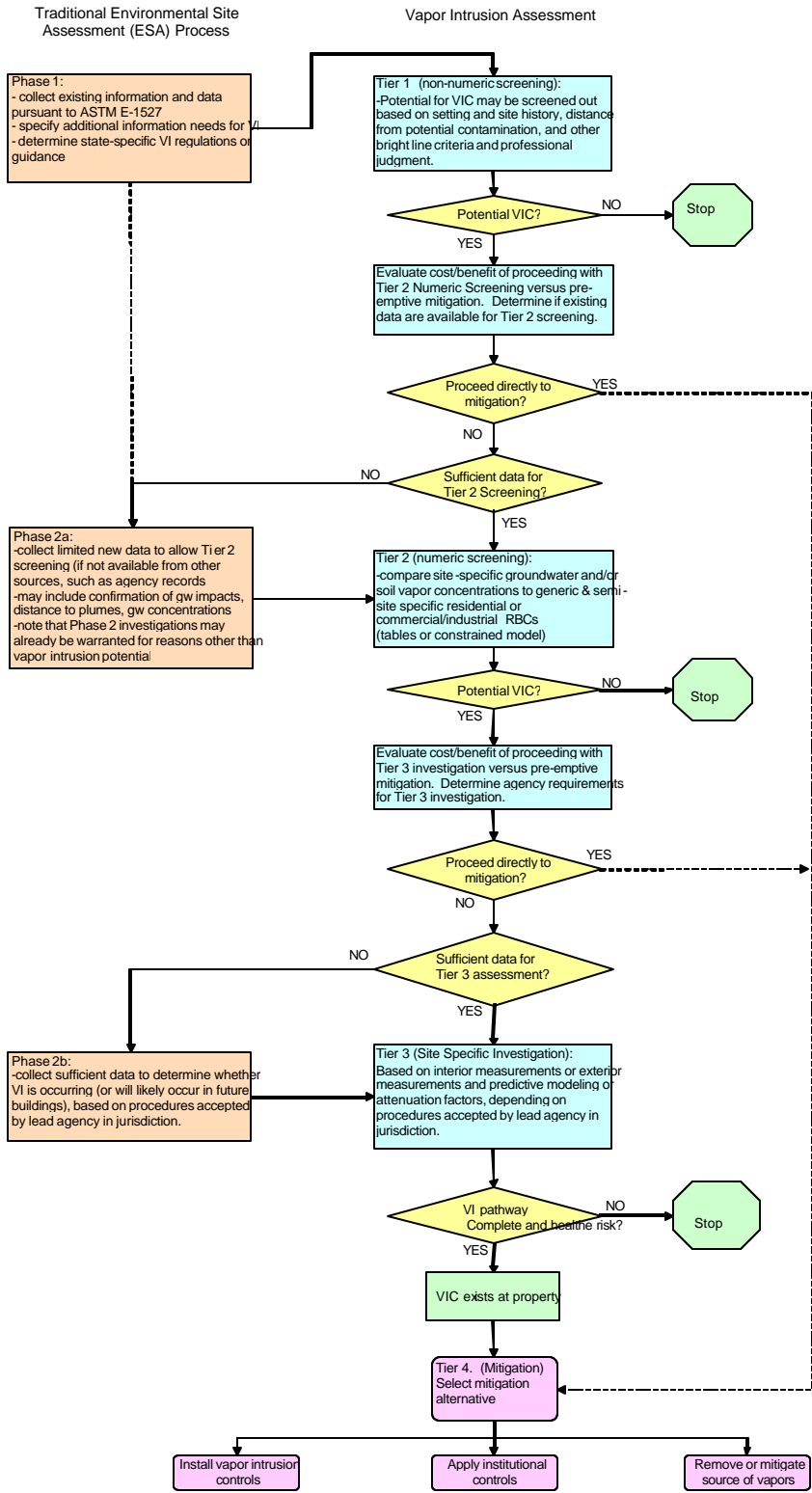
U.S. EPA:	www.epa.gov/correctiveaction/eis/vapor/complete.pdf www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm www.epa.gov/ATHENS/learn2model/parttwo/onsite/JnE_lite.htm
U.S. EPA Region III:	www.epa.gov/reg3hwmd/risk/index.htm
U.S. EPA Region IX:	www.epa.gov/region09/waste/sfund/prg/index.htm

State

AL:	www.adem.state.al.us/WaterDivision/Ground/UST%20GW/GWUSTCorrAction.htm
AK:	www.dec.state.ak.us/spar/csp/guidance/draft_vap_intr_tm_6_28.doc
CA:	www.dtsc.ca.gov/loader.cfm?url=/commonsspot/security/getfile.cfm&pageid=11492
CO:	www.cdphe.state.co.us/hm/indoorair.pdf www.oil.cdle.state.co.us
CT:	www.dep.state.ct.us/wtr/regs/RvVolCri.pdf
FL:	www.dep.state.fl.us/waste/categories/wc/pages/cleanup/default.htm
GA:	www.gaepd.org/Documents/index_haz.html
IN:	www.in.gov/idem/programs/land/risc/announcements.html#vapor
LA:	www.deq.louisiana.gov/portal/Portals/0/technology/recap/2003/RECAP%202003%-20Text%20%20final.pdf
ME:	www.maine.gov/dep/rwm/petroleum/pdf/inhaexpfg.pdf
MA:	www.mass.gov/dep/cleanup/laws/vph_eph.htm
MI:	www.michigan.gov/deq/0,1607,7-135-3311_4109_9846_30022_101581--,00.html#RRD_01
MN:	www.pca.state.mn.us/publications/c-prp4-01a.pdf
NH:	www.des.state.nh.us/desguid.htm
NJ:	www.nj.gov/dep/srp/guidance/vaporintrusion/vig.htm
NY:	www.health.state.ny.us/environmental/investigations/soil_gas/svi_guidance/
NC:	www.enr.state.nc.us/
OH:	www.epa.state.oh.us/derr/rules/vapor.pdf
OK:	www.epa.gov/earth1r6/6pd/rcra_c/pd-n/screen.htm
OR:	www.deq.state.or.us/wmc/tank/rbdm.htm
PA:	www.depweb.state.pa.us/landrecwaste/cwp/view.asp?A=1243&Q=465356
SC:	www.scdhec.gov/eqc/lwm/index.html
TN:	www.state.tn.us/environment/dor/sfdregs.shtml
WA:	www.ecy.wa.gov/biblio/9406.html
WI:	http://dhfs.wisconsin.gov/eh/air/pdf/VI_guide.pdf

Other

ITRC:	www.itrcweb.org/Documents/VI-1.pdf
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NOTE: VIC - Vapor Intrusion Condition, warranting mitigation and/or other actions to prevent unacceptable exposures to building occupants. Decision to not pursue acquisition of property may be made at any time (buyer). Decision to enter voluntary cleanup or other regulatory program may be made at any time. Other parties may be responsible for mitigation when sources are off-site. Delineation of extent of impacts may be necessary if more than one building involved (alternatively, blanket mitigation may be considered).