Environmental Protection Rules

Chapter 35

INVESTIGATION AND REMEDIATION OF CONTAMINATED PROPERTIES RULE

STATE OF VERMONT

AGENCY OF NATURAL RESOURCES

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

WASTE MANAGEMENT AND PREVENTION DIVISION

Final Adopted Rule

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Contents

SUBCHAPTER 1. GENERAL PROVISIONS

§ 35-101. AUTHORITY AND PURPOSE

(a) Authority. This rule is adopted by the Secretary of the Agency of Natural Resources pursuant to the authority granted by 10 V.S.A. chapters 47, 59, and 159.

(b) Purpose. This rule is intended to protect public health and the environment by establishing procedures and requirements for conducting investigations and corrective actions at properties where a release of hazardous materials has occurred. This includes procedures for identifying hazardous material contamination to environmental media as well as requirements for source treatment, removal, or containment, long term monitoring, institutional controls, and site closure.

§ 35-102. RELEASE PROHIBITION; REPORTING; EMERGENCY RESPONSE

(a) Release prohibition. The release of hazardous materials into the surface or groundwater, or onto the land of the State is prohibited.

(b) Releases and suspected releases. Any person required by 10 V.S.A. § 6617 shall immediately report any of the following releases or suspected releases:

(1) A release of hazardous material that exceeds two gallons.

(2) A release of hazardous material that is less than or equal to 2 gallons and poses a potential or actual threat to human health or the environment.

(3) A discharge of hazardous waste, or release of hazardous material that equals or exceeds its corresponding reportable quantity under CERCLA as specified under 40 CFR 302.4.

(4) The detection of non-aqueous phase petroleum liquid (NAPL) at a thickness greater than 0.01'.

(5) An exceedance of an environmental media standard other than an exceedance for which notification is required under subdivision (c) of this subsection.

(c) Notification of exceedances. Verbal notification within 24 hours of an exceedance of environmental media standard and written analytical results within five business days of the exceedance shall be provided to the Secretary under the following circumstances:

(1) When drinking water supply laboratory analytical results report an exceedance of the groundwater enforcement standards; and

(2) When indoor air quality laboratory analytical results report an exceedance of an indoor air standard.

(d) Reporting and notification under subsections (b) and (c) of this section must be directed to:

Monday through Friday, 7:45 AM to 4:30 PM; Waste Management & Prevention Division at (802) 828-1138.

At all other times including State holidays: Department of Public Safety Division of Emergency Management and Homeland Security at (800) 641-5005.

(e) Emergency response.

(1) Notwithstanding the site investigation and corrective action requirements of this rule, the Secretary may require or undertake an emergency response pursuant to 10 V.S.A. § 6615 when the Secretary determines that a release may cause an immediate and serious threat of harm to human health or the environment.

(2) When undertaking emergency responses pursuant to 10 V.S.A. § 1283, notification to the potentially responsible party (PRP) in advance of undertaking emergency response is not required, unless:

(A) The Secretary determines that there is need for additional investigation of the release to determine the impact to sensitive receptors and to human health and that it is appropriate for the PRP to conduct the investigation; or

(B) The Secretary determines that an additional response is necessary to address short-term impacts to sensitive receptors, impact to human health, and that it is appropriate for the PRP to conduct the additional response.

(3) The Secretary may direct the PRP to conduct a limited site investigation to determine if the release requires further site investigation or corrective action. As used in this subsection, "limited site investigation" means the steps the Secretary deems necessary to determine whether additional site investigation or corrective action is necessary to respond to the release of hazardous materials. In the event the PRP is unwilling, unable, or unknown, the Secretary may perform these actions and seek redress from the PRP at a later date as allowed by 10 V.S.A. § 1283.

§ 35-103. SEVERABILITY

The provisions of any section of this rule are severable. If any provision of this rule is invalid or if any application of this rule to any person or circumstance is invalid, the invalidity shall not affect other provisions or applications that can be given effect without the invalid provision or application.

§ 35-104. SIGNATORIES

All deliverables required by § 35-102 (emergency response; limited site investigation); § 35-304 (site investigation work plan), § 35-306 (site investigation report); § 35-503(response actions; releases of heating fuels; initial release investigation report); § 35-505 (additional site investigation); § 35-507(a) (response actions; releases of heating fuels; additional site characterization report); § 35-604 (evaluation of corrective action alternatives); § 35-606 (corrective action plan); § 35-608 (corrective action construction completion report); § 35-610 (corrective action performance monitoring and

O&M); § 35-702 (long term monitoring work plan); and § 35-704 (long term monitoring; reporting) shall be prepared, signed, and certified by an environmental professional.

Deliverables shall be signed with the following certification:

> "I certify under penalty of perjury that I am an environmental professional and that all content contained within this deliverable is to the best of my knowledge true and correct."

§ 35-105. DELIVERABLES

All deliverables shall be submitted electronically via text searchable PDF. Paper copies are to be submitted only upon request of the Secretary. Raw data, field notes, billing records, time sheets, or any other supporting documentation used to create the deliverable shall be made available upon request by the Secretary.

§ 35-106. HAZARDOUS MATERIAL LISTING

Pursuant to 10 V.S.A. § 6602(16)(A)(iv) any chemical or substance listed in Appendix D is a hazardous material.

§ 35-107. HISTORICAL FILL EXEMPTION

The Secretary shall make a determination in writing that historical fill is present at a site and may exempt the historical fill from the site investigation and corrective action requirements of this rule. No exemption shall apply without the prior, written approval by the Secretary.

SUBCHAPTER 2. DEFINITIONS

§ 35-201. DEFINITIONS

As used in this rule, terms shall have the following meanings:

(1) "Aboveground storage tank" or "AST" means any tank, other than an underground storage tank, used to store any of the following petroleum products: gasoline, diesel, kerosene, used oil, or heating oil.
(2) "Agency" means the Vermont Agency of Natural Resources.
(3) "Analysis" or "analyze" means to test for the presence of hazardous materials using a standard US Environmental Protection Agency (US EPA) method or an alternative approved by the Secretary.
(4) "Area of contamination" means a defined area on a site where contaminated environmental media that is a hazardous waste has been generated by site remediation activities (e.g., excavated).
(5) "Background" means naturally occurring constituents where the concentration detected in the environmental media sampled is not influenced by site related activities.
(6) "Background Air Quality" means pollutant concentrations due to: (1) natural sources; (2) nearby sources other than the one(s) currently under consideration; or (3) unidentified sources other than the one(s) currently under consideration.
(7) "Brownfield" means real property, the expansion, redevelopment, or reuse of which may be complicated by the presence, or perceived presence of, a hazardous material. "Brownfield" does not include any of the following:
    (A) A facility that is the subject of a planned or ongoing removal action under CERCLA.
    (B) A facility that is listed as a CERCLA site or is proposed for listing.
    (C) A facility that is the subject of any State or federal administrative or court order under any of the following authorities:
        (i) 33 U.S.C. § 1251 et seq. (federal Water Pollution Control Act) or 10 V.S.A. chapter 47 (water pollution control);
        (ii) 15 U.S.C. § 2601 et seq. (Toxic Substances Control Act);
        (iii) 42 U.S.C. § 300f et seq. (Safe Drinking Water Act) or 10 V.S.A. chapter 56 (public water supply).
    (D) A facility that is subject to either of the following:
        (i) corrective action under 42 U.S.C. §§ 6924(u) or 6928(h);
        (ii) corrective action permit or order issued or modified to require the implementation of corrective measures.
    (E) A land disposal unit in regard to which both of the following apply:
        (i) a closure notification under subtitle C of 42 U.S.C. § 6921 et seq. has been submitted;
        (ii) closure requirements have been specified in a closure plan or permit.

(F) A facility that is subject to the jurisdiction, custody, or control of any instrumentality of the United States, except for land held in trust by the United States for an Indian tribe.

(G) A portion of a facility to which both the following apply:

(i) a release of polychlorinated biphenyls has occurred;

(ii) is subject to remediation under 15 U.S.C. § 2601 et seq. (Toxic Substances Control Act).

(H) A portion of a facility for which assistance for response activity has been obtained under subtitle I of 42 U.S.C. § 6991 et seq. (Solid Waste Disposal Act) from the Leaking Underground Storage Tank Trust Fund established under 26 U.S.C. § 9508.

(8) "BRELLA" means the Vermont Brownfields Reuse and Environmental Liability Limitation Act.

(9) "Category one underground storage tank" means any underground storage tank, regardless of its capacity, except:

(A) Fuel oil storage tanks used only for on-premises heating purposes; or

(B) Farm or residential tanks used for storing motor fuel.

(10) "Compliance point" means:

(A) the point of compliance as defined in the Vermont Groundwater Protection Rule and Strategy; and

(B) any point established in an approved corrective action plan established to evaluate a release's impact on a sensitive receptor.

(11) "Conceptual Site Model" or "CSM" is a written description of the physical, chemical, and biological processes that control the transport, migration, and actual and potential impacts of contamination (in soil, groundwater, soil gas, indoor air, sediment, or surface water) to sensitive receptors. CSM may include illustrations as appropriate.

(12) "Contamination" or "Contaminated" means the presence of any hazardous material in soil, groundwater, soil gas, indoor air, sediment, surface water, or any other material at a concentration that has the potential to adversely affect human health or the environment. This term does not include naturally occurring substances at or below background levels.

(13) "Development soil" means unconsolidated mineral and organic matter overlying bedrock that contains only PAHs, arsenic, or lead in concentrations that:

(A) exceed the relevant Vermont Soil Standard;

(B) when managed in accordance with § 35-804 or the Vermont Solid Waste Management Rule:

(i) pose no greater risk than the Agency-established soil standard for the intended reuse of the property; and

(ii) pose no unreasonable risk to human health through a dermal, inhalation, or ingestion exposure pathway;

(C) do not leach compounds at concentrations that exceed groundwater enforcement standards; and

(D) do not result in an exceedance of Vermont Groundwater Enforcement Standards.

(14) "Direct contact" means physical exposure to contaminants or naturally occurring compounds in environmental media including soil, groundwater, soil gas, indoor air, sediment, or surface water via incidental ingestion, dermal contact, inhalation of vapors, or

fugitive dust via a completed contact pathway.

(15) "Environmental easement" means a legal restriction on a property that grants a real property interest to the State to enforce maintenance requirements, monitoring requirements, or land use restrictions.

(16) "Engineered control" means any physical barrier, system, technology, or method that removes or reduces exposure to a hazardous material by sensitive receptors.

(17) "Environmental media" means components of the environment including soil, groundwater, soil gas, indoor air, sediment, or surface water.

(18) "Environmental media standards" means numeric or narrative criteria adopted by the Secretary to protect human health and the environment.

(19) "Environmental professional" means a person who possesses the following education, training, and experience:

(A) A current professional engineer's (with certification within relevant area of expertise) or professional geologist's license or registration from a state, tribe, or U.S. territory (or the Commonwealth of Puerto Rico) and the equivalent of three years of relevant fulltime experience;

(B) A license or certification by the federal government, a state, tribe, or U.S. territory (or the Commonwealth of Puerto Rico) to perform environmental site work equivalent to that required by this rule and have the equivalent of three years of relevant fulltime experience;

(C) A baccalaureate or higher degree from an accredited institution of higher education in a discipline of engineering, geology, hydrogeology, or an applicable science and the equivalent of five years of relevant fulltime experience; or

(D) The equivalent of ten years of relevant fulltime experience in a discipline of engineering, geology, hydrogeology, or an applicable science.

(20) "Emergency response" means a response action to a situation that may cause immediate and serious threat of harm to human health or the environment.

(21) "Groundwater" means water below the land surface in a zone of saturation.

(22) "Hazardous material":

(A) means all petroleum and toxic, corrosive, or other chemicals and related sludge included in any of the following:

(i) any substance defined in section 101(14) of the federal Comprehensive Environmental Response, Compensation and Liability (CERCLA) Act of 1980;

(ii) petroleum, including crude oil or any fraction thereof;

(iii) hazardous wastes as defined by the Vermont Hazardous Waste Management Regulations; or

(iv) a chemical or substance that, when released, poses a risk to human health or other living organisms and that is listed by this rule.

(B) does not include herbicides and pesticides when applied consistent with good practice conducted in conformity with federal, state, and local laws and regulations and according to manufacturer's instructions.

(23) "Hazardous waste" means any waste subject to regulation as hazardous waste under the Vermont Hazardous Waste Management Regulations.

(24) "Heating fuel" means heating oil, kerosene, or other dyed diesel fuel that is not used to

propel a motor vehicle and which is typically used to heat a structure. Includes any blend of petroleum and biodiesel used to heat a structure.

(25) "Historical fill" means non-indigenous material deposited to raise the topographic elevation of the site, which, if contamination exists in such material, is not resultant from the land use or activities at the location of emplacement. Material is "historical fill" if, based on the weight of evidence the material is determined by the Secretary to meet the following criteria:

(A) was emplaced before May 20, 1985 (the effective date of § 6615.V.S.A.);

(B) is not primarily composed of, construction and demolition debris, reworked soils, dredge spoils, coal, coal ash, wood ash or other solid waste material;

(C) was contaminated with metals, hydrocarbons, or polycyclic aromatic hydrocarbons where such contamination occurred prior to emplacement and exists at concentrations consistent with the pervasive use and release of such materials prior to 1985;

(D) does not contain oil or hazardous materials originating from operations or activities at the location of emplacement;

(E) is not and does not contain a generated hazardous waste;

(F) does not contain chemical production waste, manufacturing waste, or waste from processing of metal or mineral ores, residues, slag or tailings; and

(G) does not contain waste material disposed in a municipal solid waste dump, burning dump, landfill, waste lagoon or other waste disposal location.

(26) "Impervious surface" means those fabricated surfaces, including paved and unpaved roads, parking areas, roofs, driveways, and walkways, from which precipitation runs off rather than infiltrates

(27) "Institutional controls" means non-engineered instruments, such as administrative and legal controls, that help minimize the potential for exposure to a hazardous material or protect the integrity of a remedy.

(28) "Investigation derived waste" means all waste generated during the site investigation or corrective action including, but not limited to, soil cuttings, groundwater, cleaning fluids and wash water, or disposable equipment.

(29) "Land record notice" means a notice on a property land record that informs individuals of the release of a hazardous material on a property and any steps necessary to address this release or residual contamination under the direction of the Secretary.

(30) "Legal description of property" is a description that identifies the location, boundaries, and any existing easements on the property, also referred to as metes and bounds.

(31) "Linear construction project" means construction and development activities, such as waterline and sewer line improvements, that take place within a public or private roadway, railroad, utility line, or their respective rights-of-way where contamination is encountered.

(32) "Long term monitoring" means sampling and analysis of environmental media for contaminants of concern in accordance with an approved monitoring plan. The purpose of long-term monitoring is to demonstrate that the selected remedial method is protective of human health and the environment.

(33) "Method detection limit" means the minimum concentration of a hazardous material that can be quantified consistently and reliably using methods approved by US EPA or another method approved by the Secretary.

(34) "Non-aqueous phase liquid" or "NAPL" means a liquid solution contaminant that does not dissolve in or easily mix with water, such as oil, gasoline, coal tar, or chlorinated solvents. A NAPL may be denser than water, sinking below the water table, or lighter than water, floating on the water table.

(35) "Non-hazardous waste contaminated soil" means soils that are contaminated with hazardous materials at concentrations above the Residential Vermont Soil Standard that are not hazardous wastes under the Vermont Hazardous Waste Management Rule.

(36) "Non-hazardous petroleum contaminated soil" means soils that are contaminated with petroleum but meet the exemption requirements of the Vermont Hazardous Waste Management Regulations in § 7-203(p) and may be managed in accordance with this Rule.

(37) "Non-residential" means any property or portion thereof that is designated as non-residential by municipal zoning ordinance or has a restriction prohibiting residential use.

(38) "Polyencapsulation" means action of storage of contaminated soil by stockpiling on plastic sheeting and enclosing the stockpile with plastic sheeting.

(39) "Potable water supply" means the source, treatment, and conveyance equipment used to provide water used or intended to be used for human consumption, including drinking, washing, bathing, the preparation of food, or laundering. This definition does not include any internal piping or plumbing, except for mechanical systems, such as pump stations and storage tanks or lavatories, that are located inside a building or structure and that are integral to the operation of a potable water system. This definition also does not include a potable water supply that is subject to regulation as a public water supply.

(40) "Potentially Responsible Party" or "PRP" means any individual or organization that is potentially liable for a release of hazardous materials pursuant to 10 V.S.A. § 6615.

(41) "Public water source protection area" means a surface and subsurface area from or through which contaminants are reasonably likely to reach a public water system source.

(A) "Public water system" shall have the same meaning as set forth in the 10 V.S.A. §1671.

(42) "Receiving site" means a location approved by the Secretary where excavated development soils are disposed in accordance with this rule.

(43) "Recognized environmental condition" means the presence or likely presence of a hazardous material at a property:

(A) due to a release;

(B) under conditions indicative of a release to the environment; or

(C) under conditions that pose a material threat of a future release to the environment.

(44) "Release" means any intentional or unintentional action or omission resulting in the spilling, leaking, pumping, pouring, emitting, emptying, dumping, or disposing of hazardous materials into the surface or groundwaters, or onto the lands in the State, or into waters outside the jurisdiction of the State when damage may result to the public health, lands, waters, or natural resources within the jurisdiction of the State.

(45) "Remedy" means an action that results in either a reduction of exposure to human

health to contaminants, or a lessening of risk to a sensitive receptor.

(46) "Residential" includes all locations used as or for residences as well as parks, playgrounds, schoolyards and child care facilities.

(47) "Residual contamination" means hazardous materials that remain in any environmental media above screening values or standards after all required site investigation and correction action has been completed and that the Secretary has determined does not pose a threat to human health or the environment given the current condition or location of the hazardous materials.

(48) "Secretary" means the Secretary of the Vermont Agency of Natural Resources or the Secretary's duly authorized representative.

(49) "Sensitive receptor" means any natural or human-constructed feature that may be adversely affected by a hazardous material and includes public health, public water sources, other sources of potable water supplies, groundwater, surface waters, wetlands, soils, sensitive ecological areas, outdoor and indoor air, and enclosed spaces such as basements, sewers, and subsurface utilities.

(50) "Site" means the area where a release is known or suspected to have occurred, including the extent of contamination resulting from the release. A site may not be limited by legal property boundaries.

(51) "Substantial completion" means:

(A) the site is enrolled in the BRELLA program; and

(B) the property has a remediation system constructed in accordance with an approved corrective action plan; and

(i) the remediation system is operating as designed following implementation of corrective action;

(ii) the institutional controls for the property have not been finalized; or

(iii) long term monitoring is necessary to determine whether remedial objectives are being achieved.

(52) "Surface water" includes all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the State or any portion of it.

(53) "Surface soil" means soil present at 0-18 inches below ground surface.

(54) "Survey benchmark" means a feature on a site or nearby to which the surveyed elevation of all monitoring wells and site features are referenced.

(55) "Suspected release" means when there is knowledge, information, or other evidence that a release has likely occurred. An exceedance of an environmental media standard shall be presumed to be a suspected release and shall be reported pursuant to § 35-102(b). Knowledge and information of a suspected release may include review of maintenance and operation records, land use history, or industry standard process details.

(56) "Treatment" means any method, technique, or process designed to change the physical, chemical, or biological character or composition, or remove, any contaminant in environmental media.

(57) "Underground Storage Tank" or "UST" shall be defined as set forth in the Vermont Underground Storage Tank Rule.

(58) "Urban Background Area" means any area designated by the Secretary, for reuse of

development soils that are below the applicable urban background values.

(59) "US EPA" means United States Environmental Protection Agency.

(60) "Vapor intrusion" means the migration of volatile or semi-volatile chemicals from contaminated environmental media or product into a building, subsurface conduit or structure.

(61) "Volatile Organic Compound (VOC)" are volatile carbon containing compounds which have a high vapor pressure at room temperature or dissolve into water.

(62) "Volatile Organic Compound (VOC) field screening instrument" means a photoionization detector, flame ionization detector, field portable gas chromatograph/mass spectrometer or another portable instrument approved by the Secretary to detect VOCs.

(63) "Water table" means the top of the saturated zone where the fluid pressure equals the atmospheric pressure.

SUBCHAPTER 3. SITE INVESTIGATION

§ 35-301. APPLICABILITY AND REQUIREMENT TO PERFORM SITE INVESTIGATION

(a) This section applies to any release or suspected release that is not fully investigated pursuant to § 35-102 (emergency response), or Subchapter 5 (response action; heating fuel) of this rule.

(b) A person who may be liable for the release or suspected release of a hazardous material as established in 10 V.S.A. § 6615 shall conduct a site investigation in accordance with the requirements of this chapter.

§ 35-302. OBJECTIVES OF SITE INVESTIGATION

Objectives of a site investigation are to:

(a) Develop a Conceptual Site Model (CSM) in accordance with § 35-303;
(b) Identify the source, degree, and spatial extent of contamination in all impacted or potentially impacted environmental media;
(c) Identify pathways that are conveying or could convey hazardous materials to sensitive receptors;
(d) Identify sensitive receptors that have been or may be impacted by the release;
(e) Identify data gaps that must be addressed to confirm the CSM or evaluate corrective action alternatives; and
(f) Identify the need to conduct further investigation or corrective action based on the results of all site characterization data gathered to date.

§ 35-303. CONCEPTUAL SITE MODEL

(a) A preliminary CSM shall be developed during the preparation of the site investigation work plan required by § 35-304. The CSM shall be further refined as new site data is collected.

(b) The CSM is a tool to identify sources, receptors, and pathways associated with the site and should support scientific and technical decisions. A CSM is an iterative process of characterizing site contamination based on available site data and both historical and existing conditions. The CSM shall evaluate and present the data in a narrative format that depicts the fate and transport of site contaminants, addresses the threat or potential threat to human health and the environment from the site contaminants, and identifies data gaps.

(c) The CSM shall identify the following or identify how the information will be obtained in the context of the site investigation:

(1) Source(s) of the release;
(2) The location, depths, and characteristics of existing and former engineered structures, subsurface infrastructure, tanks, and containers, from which or through which the suspected contaminants may have been released, transported, or may impact a sensitive receptor;

(3) Historical and current land uses and activities for the site and immediate surrounding area;

(4) Sources and contaminants;

(A) Identify all potential hazardous materials and all potential and actual sources of a release;

(B) Identify, to the extent possible, the release date(s), location(s) known volume(s), and any prior remedial actions;

(C) Identify all hazardous material phases (e.g. NAPL, sorbed to matrix, dissolved in groundwater or soil moisture, and in vapors in the vadose zone);

(D) Identify all hazardous material physical properties and the likely behavior (mobility, physical state, and persistence) of each chemical within environmental media;

(E) If known, an estimate of the amount of hazardous material mass on the site; and

(F) If known, an estimate of the amount of contaminated soil.

(5) Identify the environmental media that is affected or threatened from the release.

(6) Geology. A brief description of regional and site-specific soils and bedrock. Boring logs, well logs and groundwater confining layers shall be included, if available and not been previously submitted to the Secretary. If applicable, values for soil bulk density, porosity, fraction organic content, pH and reduction-oxidation potential, shall be included. If available include geologic maps, fracture trace maps, geophysical data, and cross sections;

(7) Hydrogeology. Describe regional and site-specific hydrogeology, horizontal and vertical groundwater flow gradients and direction, and an assessment of the potential for preferential pathways and multiple aquifers. If available, hydraulic conductivity, transmissivity, and other parameters shall be included;

(8) Contaminant fate and transport. Describe the hazardous material distribution, migration pathways, the amount of migration occurring, the predicted migration of the contamination over time, and if available, the adsorption, desorption, absorption, and retardation of the hazardous material, and naturally occurring degradation processes. If historical groundwater quality data have been collected, estimate the duration of groundwater contamination to determine if groundwater reclassification is warranted per the Groundwater Protection Rule and Strategy;

(9) Receptor study and evaluation. Identify all potentially threatened sensitive receptors and complete exposure pathways. A list of the names and addresses of impacted or threatened third parties shall be included, if applicable. Compare all measured concentrations of hazardous materials with applicable environmental media standards; and

(10) If appropriate, a figure illustrating the site setting and key contaminant migration mechanisms and pathways, both complete and incomplete.

§ 35-304. SITE INVESTIGATION WORK PLAN

(a) General requirements.

(1) A site investigation work plan shall be submitted to the Secretary no later than 30 days of the date the Secretary was notified of a release or upon request by the Secretary, unless the Secretary approves an alternative schedule.
(2) A site investigation work plan shall be approved by the Secretary prior to the initiation of site work.

(b) Content requirements. A site investigation work plan shall include the following:

(1) Site information. Table of names, addresses, email addresses, and phone numbers of the following:
(A) Property owner and operator; and
(B) Any person or entity who released a hazardous material at the site.
(2) Current land use and activities of the property.
(3) Land uses and activities of properties adjacent to the site.
(4) Site description. A physical and environmental description of the site.
(5) Site characterization objectives and strategy. This strategy shall address known data gaps and include contaminant characterization methods, sampling locations and methods, and how this strategy will meet the site investigation objectives;
(6) Identification of analytical methods.
(7) A list of consultant standard operating procedures to be used during the site investigation, which shall be submitted to the Secretary upon request.
(8) A CSM and a description on how the site investigation will gather information to further develop and refine the CSM.
(9) A discussion of how investigation derived waste will be managed, which shall be in accordance with § 35-611(c).
(10) A quality assurance and quality control (QA/QC) plan.
(11) Maps. Unless otherwise required by the Secretary, a vicinity map in accordance with § 35-306(b)(14)(A) and a site map in accordance with § 35-306(b)(14)(B) showing proposed environmental media sampling locations shall be included.
(12) Latitude/longitude of the site, as close as possible to the known or suspected release location or locations, referenced to the WGS1984 coordinate system (Mercator), in decimal degrees with a minimum acceptable accuracy of plus-or-minus 15 feet.
(13) Estimated costs, if requested by the Secretary.
(14) A site investigation implementation schedule.
(15) Signature. A site investigation work plan shall be signed by the environmental professional in accordance with § 35-104.

§ 35-305. SITE INVESTIGATION WORK PLAN; SECRETARY REVIEW AND DETERMINATION

(a) The Secretary shall only approve, in writing, a site investigation work plan upon finding the investigation will meet the objectives of § 35-302.

(b) A PRP shall implement an approved site investigation work plan no later than 60 days from the date of the Secretary's approval, unless an alternate implementation timeline is approved by the Secretary.

§ 35-306. SITE INVESTIGATION REPORT

(a) A site investigation report shall be submitted to the Secretary within 90 days of receipt of final laboratory data, or within an alternate schedule approved by the Secretary.

(b) A site investigation report shall include the following:

(1) Executive summary. A site investigation report shall include an executive summary of the site investigation, consisting of a summary of findings, conclusions, and recommendations based upon the data collected during the site investigation.
(2) Site contact information. Table of names, addresses, email addresses, and phone numbers of the following:
  (A) Property owner and operator.
  (B) Any Potentially Responsible Party who caused or may have caused a release a hazardous material at the site.
(3) Current use or uses of the property.
(4) Land uses and activities of properties adjacent to the site.
(5) Site description. A physical and environmental description of the site.
(6) Latitude/longitude of the site, as close as possible to the known or suspected release location or locations, referenced to the WGS1984 coordinate system (Mercator), in decimal degrees. Minimum acceptable accuracy is plus-or-minus 15 feet.
(7) Property history. Past and present land use, waste storage or disposal areas, potential sources of contamination, and hazardous waste and hazardous materials disposal practices, including any associated EPA ID numbers. The property history section shall include a description of current and historical property uses in the surrounding area. A list of all recognized environmental conditions should be provided if an ASTM Phase I or Phase II Environmental Site Assessment has been completed. Presentation may include copies of historical maps (including Sanborn Fire Insurance Maps, town maps) and copies of town directories.
(8) Site contaminant background. A description of all known releases of hazardous materials, including the following information:
  (A) The date and a description of each release, if known, the discovery date of each release, the location of each release, and the PRP for each release.
  (B) The date each release was reported to the Secretary.
  (C) A description of response actions taken for each release.
  (D) A list of any previous environmental investigations and reports (including Phase I Environmental Site Assessments) pertinent to the site relating to a release of hazardous materials, including a summary of findings.
  (E) A copy of any previous investigation or report relating to a release of hazardous materials, if not already on file with the Secretary.
  (F) A list of governmental records reviewed relating to the site.
(9) A CSM as detailed in § 35-303.
(10) Work plan protocol deviations. Any deviations from the approved work plan shall be identified and discussed.
(11) Sample-collection documentation. Documentation of the sample location, method of collection, and well identification number.
(12) Contaminated media characterization. Analytical results from the Site Investigation

and applicable prior investigations shall be tabulated and compared to the applicable environmental media standard in accordance with Subchapter 4, unless a site-specific risk assessment was conducted pursuant to § 35-306(b)(13) or a site-specific background study was performed in accordance with Appendix B (in which case the analytical results from the Site Investigation will be compared with these alternative values).

(13) As applicable, a site-specific risk assessment that includes use of chemical and endpoint specific toxicity values and site-specific exposure assumptions may be performed for both current and potential future site uses. A site-specific risk assessment shall follow standard U.S. E.P.A. risk assessment methodology to determine if an incremental lifetime cancer risk of 10^{-6} or a hazard index of 1.0 is exceeded.

(14) Maps. All maps shall include the location of the site, physical and environmental features, the Vermont Department of Environmental Conservation Hazardous Site number, legend, graphical scale bar, and a base map source reference. All maps shall be accurate and to scale. The following maps shall be included:

(A) Vicinity map. Prepared using the Vermont Agency of Natural Resources online Natural Resource Atlas as a base map including property boundary lines, surrounding land use, buildings, hazardous sites, hazardous materials sources, street names, drinking water sources, surface water bodies and any other sensitive receptors identified in § 35-303(c)(9) within 2,000 feet of the site. Alternative base maps and fewer map elements may be used if approved by the Secretary.

(B) Site map. A site investigation map shall include the following:

(i) Surface topography spot elevations or contours.

(ii) Property boundary lines.

(iii) Environmental media sample locations.

(iv) Contaminant source areas, including former or current tank locations, release areas, chemical storage or process areas, waste storage and disposal locations, or other areas as appropriate.

(v) Engineered structures, including asphalt parking surfaces, concrete sidewalks, drainage ways, diversion ditches, drain tiles, manholes, lined areas, leachate collection systems, septic systems, sewer lines, floor drains, drywells.

(vi) Survey benchmark. A permanent and recoverable site feature shall be assigned as the site survey benchmark. The use of the top of monitoring well risers, road box covers, or concrete pads as a benchmark is prohibited.

(C) Groundwater contour map. The groundwater contour map shall include the location of all monitoring points and data collected to create groundwater elevation contours. Multiple maps may be needed to show groundwater flow in different aquifers. A groundwater contour map will not be required if the site investigation did not include the installation of groundwater monitoring wells.

(D) Contaminant distribution map. A contaminant distribution map shall include the location of all monitoring points and laboratory analytical result

(including non-detect) for that monitoring point. As applicable, based on the site-specific geology and distribution of contaminants of concerns (i.e. exceeding a standard), isopleths shall be used to indicate the approximate location of compound-specific contaminant plumes that exceed the applicable environmental media standard. Multiple maps may be required to illustrate multiple contaminants or multiple aquifers. Maps solely depicting total contaminants (e.g. total VOCs) will not be accepted, unless otherwise approved by the Secretary. At sites where isopleth maps are not appropriate, contaminant concentrations shall be plotted on the maps adjacent to the sampling points.

(15) Discussion. The discussion shall include a descriptive analysis of how the data gathered further refines the CSM, how the CSM has been updated, and how the site investigation objectives in § 35-302(a) have been met. The discussion shall also establish that the data collected are suitable to determine the existing and future exposure to sensitive receptors and, the need for further characterization. Only data that meets quality assurance quality control (QA/QC) criteria will be accepted. A discussion of data which doesn't meet QA/QC criteria shall be included. The report shall evaluate if the data demonstrates that Vermont Groundwater Enforcement Standards (VGES) are met at compliance points, and if not, the estimated timeframe for meeting VGES at compliance points.

(16) Data presentation**.** All collected data shall be organized in a narrative, tabular, and graphical form; data shall be presented on maps and cross sections when appropriate. All detected hazardous material concentrations shall be reported. Hazardous materials that are not detected shall be reported as less than the numerical detection limit. Detection limits shall be below the environmental media standards and shall be provided in tabular format with the analytical results. All laboratory data qualifications must be included in tabulated data presentations.

(17) QA/QC sample results. At a minimum, a trip blank, a method blank and a duplicate sample will be required. If field analytical methods are approved in the work plan, the Secretary may require that a subset of samples be analyzed at a fixed base laboratory. Additional QA/QC samples (e.g. field blanks) may be required by the Secretary depending on the complexity of the investigation or sampling methods used. Any deviations from QA/QC procedures or acceptable limits shall be identified and discussed. Only data that meets quality assurance quality control (QA/QC) criteria specified in the QA/QC Plan will be accepted.

(18) Investigation derived waste. All investigation derived waste generated during the site investigation shall be managed in accordance with § 35-611(c). A discussion of how the investigation derived waste was managed shall be included in the site investigation report.

(19) Conclusions and recommendations. The site investigation report shall include a discussion of the findings of the investigation that substantiate the revised CSM, and, specifically, the risk that hazardous materials pose to identified sensitive receptors. Further this section shall identify completed exposure pathways, data gaps, and potential corrective actions. The PRP shall make recommendations on proposed monitoring and frequency and need for further investigation, an evaluation of corrective action alternatives, corrective action, institutional control, or site closure.

If additional data collection is necessary in order to identify an appropriate corrective action, then additional site investigation will be required.

(20) Signature and certification. A site investigation report shall be certified by the environmental professional that it was conducted in accordance with the approved workplan and signed in accordance with § 35-104.

(21) Appendices.

(A) Standard operating procedures. A list of consultant standard operating procedures (SOPs) that were used during site investigation. SOPs shall be provided to the Secretary upon request.

(B) Monitoring well and soil boring logs. At a minimum, logs shall include a description and discussion of monitoring well, soil boring and test pit installation. Logs shall include well boring or test pit location with latitude and longitude. In addition, logs shall include the installation method, blow count data, elevation, total depth, depth to groundwater, soil or rock descriptions, well construction, hole backfill, or sealing information, odors noted, and field screening results.

(C) Photographic documentation. Color images showing work performed at the site (UST closure, soil stockpiles, etc.) and pertinent site or vicinity features shall be included as an appendix. Each photographic presentation shall include the date and time, location, and orientation.

(D) Field notes. Copies of the original field notes shall be attached as an appendix and the field notes shall contain the following minimum content: the date the work was performed, name of the person conducting the work, tasks completed, date, documentation of weather conditions, sampling timeline with locations, sampling logs, field monitoring results, and calibration information for each type of field analytical equipment.

(E) Laboratory results. A copy of the laboratory results, chains of custody documentation and all QA/QC data, as specified in the approved work plan shall be included.

(F) Calculations. All calculations, such as contaminant mass or volume, travel and migration time, natural attenuation, Cumulative Risk Assessment and groundwater gradients. If computer modeling is conducted, a reference to the model used, the data inputs, and data output package shall be included.

(G) If a quantitative human health risk assessment is conducted, the full risk assessment report, including summary tables and electronic copies of calculating spreadsheets, shall be included.

(H) Hydrogeologic cross sections. When requested by the Secretary or approved in a work plan.

§ 35-307. REVIEW OF SITE INVESTIGATION REPORT

(a) The Secretary shall review the site investigation report for completeness with the requirements of § 35-306(b) and shall provide written notification to the PRP of one of the following determinations:

(1) The site investigation has met the objectives of § 35-302, has adequately defined the degree and extent of contamination, and risks to sensitive receptors have been appropriately evaluated and are absent or have been adequately managed, and that:
   (A) The site is eligible for closure in accordance with Subchapter 10;
   (B) Long-term monitoring may be required in accordance with Subchapter 7; or
   (C) Institutional Controls may be required in accordance with Subchapter 9.

(2) The site investigation has not met the objectives of § 35-302 and/or has not adequately defined the scope and extent of contamination or risk to sensitive receptors. The PRP shall submit a supplemental site investigation work plan that meets the requirements of § 35-304(b) within 30 days of the Secretary's notification to address data gaps or other deficiencies identified by the Secretary.

(3) The site investigation report is incomplete. The site investigation report will be returned to the PRP for additional information and resubmittal within a timeframe established by the Secretary; or

(4) The site investigation has met the objectives of § 35-302 and has adequately defined the degree and extent of contamination but risks to sensitive receptors are present or have not been adequately managed. An evaluation of corrective action alternatives, or corrective action plan shall be completed in accordance with Subchapter 6. If requested by the Secretary, a work plan or cost estimate for an Evaluation of corrective action alternatives (ECAA) and/or CAP may be required.

SUBCHAPTER 4. DATA EVALUATION

§ 35-401. EVALUATION OF ENVIRONMENTAL MEDIA LABORATORY ANALYTICAL RESULTS

(a) Applicability. A PRP shall evaluate laboratory analytical data for samples collected from environmental media as part of site characterization or to document corrective action implementation and completion. Acceptable methods for data evaluation include direct comparison to environmental media standards and cumulative assessment of risk. Specific environmental data evaluation methods shall be utilized as provided in this Subchapter.

(b) Applicable standards comparison. All analytical results shall be compared to the applicable standard set forth in Appendix A, the Vermont Groundwater Protection Rule and Strategy and the Vermont Water Quality Standards. In the absence of an applicable standard, a PRP shall refer to the applicable and most current US EPA Regional Screening Level.

(c) Soil analytical results comparison. All soil sample results for each sample shall be compared to the Vermont Soil Standards in Appendix A of this Rule. Laboratory analytical results shall be compared to Vermont Residential Soil Standards unless the property is zoned for non-residential use only.

(d) The following methods shall be applied to determine risk to public health, as applicable:

(1) Method 1 Soil Screening employs a direct comparison of individual soil sample laboratory analytical results to the applicable Vermont Residential or Non-residential Soil Standards as follows:

(A) All detected contaminant concentrations shall be compared to the applicable Vermont Soil Standard (VSS).

(B) All laboratory results that are estimated shall be compared to the VSS using the value reported from the lab. Alternatively, the sample may be re-analyzed by a more sensitive laboratory method to lower the MDL to generate a value that is not estimated.

(C) Any non-detect result for contaminants of concern with an MDL that exceeds the VSS shall be considered a detected concentration equivalent to the MDL.

(D) If the sample was collected from a depth of 0 to 18 inches below ground surface and detected compound concentrations for contaminants of concern do not exceed any VSS, a Method 2 cumulative risk assessment for surface soils shall be performed.

(2) Method 2 Cumulative Risk Assessments (CRA) for surface soils. The Method 2 CRA determines if an incremental lifetime cancer risk (ILCR) of 10^{-6} or a hazard index (HI) of 1.0 is exceeded based on direct contact. The risk is expressed as the total (summed) risk made up of each individual compound.

(A) Compounds with non-detect results shall be not be included in the Method 2 CRA.

(B) A Method 2 CRA shall be performed by using the calculations provided in Appendix E.

(3) Method 3 Site-Specific Risk Assessment. A PRP may elect to perform a site-specific risk assessment (SSRA). The Method 3 SSRA determines if an incremental lifetime cancer risk of 10^{-6} or a hazard index of 1.0 is exceeded.

(e) Vapor intrusion evaluations. If indoor air sampling is required based on existing soil gas or groundwater analytical data, the presence of non-aqueous phase liquid, and an assessment of vapor intrusion pathways, then an evaluation shall be conducted in accordance with this subsection.

(1) Soil gas analytical results. All detected compound concentrations shall be compared to the Vapor Intrusion Standards (VIS) for soil gas provided in Appendix A of this rule.

(2) Groundwater analytical results. All detected compound concentrations shall be compared to the VISs for groundwater provided in Appendix A of this rule.

(f) Indoor air sample analytical results. All indoor air sample results attributable to a release shall be compared to the applicable Vermont Indoor Air Standards found in Appendix A. Laboratory analytical results shall be compared to Vermont Residential Indoor Air Standards unless the property is zoned for non-residential use only.

(g) The following methods shall be applied to determine risk to public health, as applicable:

(1) Method 1 Indoor Air Screening employs a direct comparison of detected indoor air analytical concentrations in each sample to the applicable Vermont Indoor Air Standards (VIAS) as follows:

(A) All detected analytical concentrations shall be compared to VIAS.

(B) All laboratory estimated concentrations shall be compared to VIAS.

(C) Any non-detect result for contaminants of concern where the MDL exceeds the VIAS shall be considered a detection above a standard.

(D) If detected analytical concentrations for contaminants of concern do not exceed the VIAS, a Method 2 cumulative risk assessment shall be performed.

(2) Method 2 CRA for indoor air.

(A) Compounds with non-detect results shall be not be included in the Method 2 CRA.

(B) Method 2 CRA shall be performed by using the calculations provided in Appendix E.

(3) Method 3 SSRA. A PRP may elect to perform a site-specific risk assessment. The Method 3 SSRA determines if an incremental lifetime cancer risk of 10^{-6} or a hazard index of 1.0 is exceeded.

(h) Groundwater analytical results. All detected compound concentrations shall be compared to the Vermont Groundwater Enforcement Standards.

(i) Drinking water analytical results. All detected compound concentrations shall be compared to the Vermont Groundwater Enforcement Standards or, when available, the Vermont Action Levels.

(j) Surface water analytical results. All detected compound concentrations shall be compared to the Vermont Water Quality Standards.

(k) Sediment analytical results. All detected compound concentrations shall be compared to the Threshold Effect Concentration (TEC) and Probable Effects Concentration (PEC) provided in Appendix A.

(l) Data evaluation for specific contaminant classes.

(1) Some chemicals are members of the same family or group and have been shown to exhibit similar toxicological properties; however, each chemical may differ in the degree of toxicity. In such instances, a toxicity equivalence factor (TEF) or relative potency factor (RPF) shall be applied to convert the reported concentration of each member of the group to a toxicity equivalence quotient (TEQ) relative to the toxicity of the index chemical for the group. The index chemical is assigned a TEF of 1. Total TEQ for a sample shall then be compared to the value for the index chemical.

(2) Evaluating classes of contaminants such as dioxins, carcinogenic polycyclic aromatic hydrocarbons, and polychlorinated biphenyls shall be reported as follows:

(A) Dioxins, furans, and dioxin-like PCBs. Soil and sediment results must be compared to (2,3,7,8) tetrachlorodibenzo-p-dioxin (TCDD) toxic equivalency as follows:

(i) Laboratory results must include the 2,3,7,8-TCDD TEFs employed, raw concentrations and TEQ values for each individual dioxin-like compound. The TEF are found in Appendix F of this rule.
(ii) For dioxin-like compounds that are non-detect, a value equal to one half the reported MDL shall be used to calculate the TEQ.
(iii) The total TEQ per sample shall be reported.

(B) Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs). cPAHs shall be evaluated as follows:

(i) Soil analytical results for cPAHs shall be reported as benzo(a)pyrene TEQ.
(ii) For cPAH compounds that are non-detect, a value equal to one half the reported MDL shall be used for calculating the TEQ. Sediment shall be compared to the individual PAH in Appendix A. Relative potency factors are found in Appendix F.

(C) Polychlorinated Biphenyls (PCBs). Analytical results for PCBs shall be evaluated as follows:

(i) If results are analyzed as PCB Aroclors, analytical results shall be totaled and used to estimate total PCBs and compared to the VSS or VGES as applicable.

(ii) If PCBs are reported as homologs, the sum of all homologs will be used as an estimate of total PCBs and shall be compared to the VSSs located in Appendix A, or appropriate groundwater enforcement standards or VISs. If PCBs are reported as congeners, dioxin-like congeners shall be segregated and assessed and included in estimates of 2,3,7,8-TCDD TEQ, per the above section. Non-dioxin-like congeners shall be summed and compared to the VSS.

(iii) If PCBs are included in a Method 2 CRA, PCB Aroclor and homolog concentrations shall be added to the concentration for PCBs. PCB congener data shall be separated as described above.

(iv) The total PCBs will be evaluated for noncancer hazard based on the noncancer toxicity value of Aroclor 1254.

(m) Data Quality Assurance/Quality Control Analytical Results.

(1) Depending on site-specific conditions and quality assurance/ quality control (QA/QC) objectives included in the QA/QC plan, a trip blank, a method blank and a duplicate sample may be required.

(2) If field analytical methods are approved in the work plan, the Secretary may require that a subset of samples be analyzed at a fixed base laboratory.

(3) Additional QA/QC samples (e.g. field blanks) may be required by the Secretary depending on the complexity of the investigation or sampling methods used.

(4) Any deviations from QA/QC procedures or acceptable limits shall be identified.

(5) Only data that meets quality assurance quality control (QA/QC) criteria specified in the QA/QC Plan will be accepted.

SUBCHAPTER 5. RESPONSE ACTIONS; RELEASES OF HEATING FUELS

§ 35-501. APPLICABILITY

This subchapter applies to the release of heating fuel from underground storage tanks or aboveground storage tanks used for storage of heating fuel. At the Secretary's discretion, responses to releases of heating fuel may be managed under Subchapter 3 (site investigation) or Subchapter 6 (corrective action) of this rule.

§ 35-502. INITIAL RELEASE INVESTIGATION

(a) Soil removal. Following approval from the Secretary, a PRP may remove impacted soil in the area where a release of heating oil occurred. Removal shall occur until:

(1) VOC field screening instrument readings are below 10 ppmv, or
(2) the water table or bedrock is encountered, or
(3) a predetermined volume as approved by the Secretary is achieved.

(b) Soil treatment or disposal. Soil treatment or disposal shall be approved in writing by the Secretary and performed in accordance with Subchapter 8. A Soil Management Plan shall be required if requested by the Secretary.

(c) Soil analysis. Discrete post excavation soil samples shall be collected for laboratory analysis to document removal of contamination or to characterize soil contamination remaining in place. If removal of all contaminated soil is not possible due to physical constraints, the PRP shall:

(1) Collect and analyze a discrete sample of soil remaining in place from the area(s) determined to be the most contaminated based on VOC field screening instrument results; and
(2) If groundwater is encountered, collect a groundwater sample for laboratory analysis from the excavation area.

(d) Additional site investigation. If contaminated soil excavation is not feasible, additional site investigation in accordance with § 35-505 shall be required as directed by the Secretary. The Secretary shall have discretion to determine the feasibility of excavation of soil for purposes of this provision.

(e) Bedrock. If soil excavation is performed following approval from the Secretary, the excavation shall be extended to the soil bedrock interface to determine if contaminated soil is present unless:

(1) the vertical extent of contaminated soil is delineated and determined to be adequately separated from the bedrock surface;
(2) the water table is encountered; or
(3) excavation to bedrock is physically impossible, a confining soil layer is present, or an alternate remedial approach is approved by the Secretary.

(f) Drinking water. If a water supply well is located within 200 feet of the release, a sample shall be collected from this water supply for appropriate laboratory analysis.

(g) Vapor intrusion. If any building is located within 30 feet of the release, indoor air shall be screened with a VOC field screening instrument.

(h) Surface waters. If visual observations or VOC field screening instrument readings indicate that a release may have impacted surface water, the PRP shall immediately take measures to abate any continuing release to surface water and remove to the extent possible any heating fuel in the surface water.

§ 35-503. INITIAL RELEASE INVESTIGATION REPORT

(a) Within 30 days of receipt of laboratory data, or upon an alternate timeframe approved in writing by the Secretary, a PRP shall provide the Secretary a report that contains the following:

(1) Site description, in accordance with § 35-306(b)(5).
(2) Property history, in accordance with § 35-306(b)(7).
(3) Results of contaminated environmental media characterization, in accordance with § 35-306(b)(12).
(4) Maps, in accordance with §§ 35-306(b)(14)(A) and 35-306(b)(14)(B).
(5) Data presentation, in accordance with § 35-306(b)(16).
(6) Conclusions and recommendations, in accordance with § 35-306(b)(19).
(7) Photographic documentation in accordance with § 35-306(b)(21)(C).
(8) Laboratory reports, in accordance with § 35-306(b)(21)(E).
(9) Waste disposal manifests, bill of lading, and weight slips as appropriate.
(10) Recommendations for no further action, additional release characterization, or corrective action, as appropriate.

§ 35-504. RESPONSE TO REPORT

(a) The Secretary shall respond, in writing, to the investigation and reporting required by this section and shall provide written notification to the PRP of one of the following determinations:

(1) No further action is required;
(2) An additional site investigation in accordance with § 35-505 is required;
(3) A site investigation in accordance with Subchapter 3 or corrective action in accordance with Subchapter 6 is required; or
(4) The report is incomplete and will be returned to the PRP for revision and resubmission.

§ 35-505. ADDITIONAL SITE INVESTIGATION

(a) If required by the Secretary under § 35-504 of this subchapter, a PRP shall prepare an additional site investigation work plan and provide it to the Secretary for review and approval prior to implementation.

(b) An additional site investigation work plan shall include:

(1) Soil borings. Soil borings shall be advanced to characterize the degree and extent of petroleum impacts to soil and evaluate risk to groundwater. Soil borings shall be advanced:

(A) within the former UST location or AST release (if this/these area(s) have not been adequately characterized under § 35-502); and
(B) until VOC field screening instrument readings are below 10 ppmv for at least five consecutive feet, or other such depth as is required by the Secretary.

(2) Soil analysis. If required by the Secretary, soil samples shall be collected for laboratory analysis from each boring:

(A) at the water table or the deepest point of the boring if soil screening results from a VOC field instrument are non-detect throughout the soil boring, or
(B) from the location of the highest VOC field instrument reading if contamination is present.

(3) Groundwater monitoring wells. If VOC field screening instrument results exceed 10 ppmv in any boring at or within five feet of the water table, the PRP shall install monitoring wells to determine the extent of impacts to groundwater and groundwater flow direction and shall collect groundwater samples for appropriate laboratory analysis.

(4) Surface water and sediment. If applicable, representative samples shall be collected for laboratory analysis to determine whether there are exceedances of environmental media standards in surface water and sediment.

§ 35-506. ADDITIONAL SITE INVESTIGATION WORK PLAN; APPROVAL AND IMPLEMENTATION

(a) The Secretary shall approve an additional site investigation work plan if the work plan is designed to adequately characterize the degree and extent of the release and provides sufficient information to evaluate the impact of the release on any sensitive receptor. The Secretary's final decision under this section shall be made in writing.

(b) A PRP shall implement the approved additional site investigation work plan within 30 days of the date of the approval or within an alternate timeframe approved by the Secretary. The work plan shall be implemented under the supervision of an environmental professional.

(c) Any deviations to the approved work plan dictated by site conditions during site investigation implementation shall be approved by the Secretary prior to the change.

§ 35-507. ADDITIONAL SITE INVESTIGATION REPORT SUBMISSION AND REVIEW

(a) An additional site investigation report shall be submitted within 90 days of receipt of laboratory data or in accordance with an alternate schedule approved by the Secretary. The additional site investigation report shall include the elements of a site investigation report in § 35-306(b) that were approved by the Secretary per §35-506(a).

(b) Upon review of the additional site investigation report, the Secretary shall, in writing, notify the PRP of one of the following conclusions:

(1) The additional site investigation has adequately defined the degree and extent of contamination and risks to sensitive receptors have been appropriately managed. No further action will be required following proper decommissioning of any monitoring wells or other remedial equipment.

(2) The additional site investigation has not adequately defined the degree and extent of contamination and the PRP is required to conduct additional investigation of the site in accordance with Subchapter 3.

(3) The additional site investigation has adequately defined the degree and extent of contamination but risks to sensitive receptors have not been mitigated, and the PRP shall develop a corrective action plan in accordance with Subchapter 6 of this rule.

(4) The additional site investigation has adequately defined the degree and extent of contamination exceeding applicable environmental media standards and risks to sensitive receptors have been appropriately managed. An institutional control will be required in accordance with Subchapter 9.

(5) The additional site investigation report is inadequate and requires revisions. The Secretary shall identify the inadequacies and a revised report and any additional information shall be submitted within 30 days or an alternate schedule approved by the Secretary.

SUBCHAPTER 6 CORRECTIVE ACTION

§ 35-601. APPLICABILITY

Except as exempted in § 35-602 of this section, a PRP shall initiate corrective action upon a finding by the Secretary that a site investigation has adequately defined the extent of contamination but risks to sensitive receptors have not been appropriately managed.

§ 35-602. EXEMPTIONS

(a) The following are exempt from the requirements of §35-604, §35-606, §35-608, and §35-610 in this Subchapter:

(1) An emergency response performed pursuant to § 35-102 of this rule.
(2) A response action to address the release of heating fuels pursuant to Subchapter 5 of this rule.
(3) Following approval from the Secretary, removal of petroleum contaminated soils during the closure or replacement of an underground storage tank.
(4) Management of contaminated soils under an approved soil management plan per Section § 35-804 of this rule.

(b) A PRP shall not be required to conduct corrective action in accordance with this Subchapter upon conclusion of a site investigation report that:

(A) there are no exceedances of any applicable Vermont Groundwater Quality Standards (Vermont Groundwater Enforcement Standards or Vermont Action Levels) at drinking water sources, vapor intrusion is not occurring and there are no other impacts that may present a threat to human health or the environment;
(B) groundwater contamination is confined to the same property where the release occurred;
(C) a demonstration that contamination will not migrate at concentrations exceeding standards, given the current data that is available, and concentrations are stable or declining;
(D) the hazardous material release has been addressed through a removal of a limited amount of contaminated material;
(E) the site investigation demonstrates that there are no direct contact threats; and
(F) the Secretary has approved an institutional control plan that meets the requirements of Subchapter 9 of this rule.

§ 35-603. OBJECTIVES OF CORRECTIVE ACTION

(a) Corrective actions shall be designed to mitigate the impact of hazardous materials to sensitive receptors to the maximum extent practicable by implementing the following approaches, in order of priority:
(1) Treatment of environmental media to the maximum extent practicable, or to levels where the risk may be managed via engineered controls or institutional controls;

(2) Removal and proper disposal of environmental media impacted by hazardous materials;
(3) Use of engineered and other controls to contain hazardous materials and to mitigate impacts to environmental media and sensitive receptors; and
(4) Use of institutional controls to mitigate exposure to sensitive receptors.

§ 35-604. EVALUATION OF CORRECTIVE ACTION ALTERNATIVES

(a) Evaluation required. At sites that are not exempt in accordance with § 35-602 or subsection (b) of this section, the PRP shall evaluate corrective action alternatives prior to submitting a corrective action plan to the Secretary. If pilot testing or additional data collection is necessary as part of the evaluation, a work plan shall be submitted for approval by the Secretary.

(b) Exemption. A PRP may submit a corrective action plan without conducting an evaluation of corrective action alternatives pursuant to this section, provided all the following have been demonstrated to the satisfaction of the Secretary:

(1) The site investigation report demonstrates that there are no impacts to drinking water sources and vapor intrusion is not occurring.
(2) For impacted groundwater, the site investigation report demonstrates that the groundwater contamination meets Vermont Groundwater Enforcement Standards at established compliance points or will meet VGES at established compliance points within ten years as established in the Vermont Groundwater Protection Rule and Strategy.
(3) Any direct contact threats to sensitive receptors can be addressed through removal of a limited amount of source material or capping with an engineered barrier.
(4) A corrective action plan will document that the proposed remedy, with respect to the hazardous material in question, has been utilized at other sites and has been demonstrated to be reliable, cost effective, and effective in addressing remediation of the hazardous material.
(5) For development soil receiving sites, all requirements in § 35-805(d) have been met, and a corrective action plan which addresses potential direct contact with development soils by the public, including capping and land use restrictions, has been approved by the Secretary.

(c) Identification of corrective action alternatives. The PRP shall identify corrective action alternatives that will eliminate exposure pathways to sensitive receptors. The number and type of alternatives to be considered shall be determined by taking into account the scope, characteristics, and complexity of the problem being addressed. At each site, at least the following alternatives shall be considered:

(1) An alternative that reduces the toxicity, mobility, or volume of the hazardous materials released to the extent feasible. This alternative shall minimize the need for long term management at the site; and

(2) An alternative that involves little or no treatment, but controls impacts to sensitive receptors through engineered controls, containment, long term monitoring, and institutional controls.

(d) Evaluation of corrective action alternatives (ECAA). For each proposed corrective action alternative, the PRP shall evaluate and document the following:

(1) Overall protection of human health and the environment. Alternatives shall be assessed to determine whether they can adequately protect human health and the environment, by either eliminating, reducing, or controlling exposures to levels established by the corrective action objectives consistent with § 35-603. Overall protection of sensitive receptors shall also assess long-term effectiveness and permanence, short-term effectiveness, and compliance with federal, state, and local laws.

(2) Compliance with legal requirements. Alternatives shall be evaluated to determine whether the PRP can obtain all federal, state, and local permits for the proposed alternative as well as describe how the alternative will meet those regulatory requirements.

(3) Long-term effectiveness and permanence. Alternatives shall be assessed for long-term effectiveness and permanence. Adequacy and reliability of the proposed alternative such as containment systems and institutional controls that are necessary to manage treatment residuals and untreated waste. This factor addresses the uncertainties and risks associated with long term management of the remedy.

(4) Land use restrictions. Alternatives shall identify whether and what type of land use restrictions are required following implementation of the remedy.

(5) Reducing toxicity, mobility, or volume through treatment. The degree to which alternatives reduce toxicity, mobility, or volume shall be assessed, including how treatment is used to address the principal threats posed by the site. Factors that shall be considered include the following:

(A) The treatment or recycling processes the alternatives employ and materials they will treat;

(B) The amount of hazardous materials that will be destroyed, treated, or recycled;

(C) The degree of expected reduction in toxicity, mobility, or volume of the hazardous materials due to treatment or recycling and the specification of which reduction(s) are occurring;

(D) The degree to which rebound of contaminants may occur;

(E) The type and quantity of residual contamination that will remain following treatment, considering the toxicity, mobility, propensity to bioaccumulate, and persistence of such hazardous materials and their constituents; and

(F) The degree to which treatment reduces the inherent hazards posed by principal threats at the site.

(6) Short-term effectiveness. The short-term impacts of alternatives shall be assessed by considering the following:

(A) Short-term risks that might be posed to sensitive receptors during implementation of an alternative;

(B) Potential impacts to workers during corrective action and the effectiveness and reliability of protective measures; and

(C) Potential environmental impacts of the corrective action and the effectiveness and reliability of mitigation measures during implementation.

(7) Implementability. The relative degree of difficulty in implementing the alternatives shall be assessed by considering the following:

(A) Technical feasibility, including technical difficulties and uncertainty associated with construction and operation of a corrective action, the reliability of the technology, ease of undertaking additional corrective actions, and the ability to monitor the corrective action's effectiveness;

(B) Administrative feasibility, including activities needed to coordinate with other offices and agencies and the need to obtain any necessary approvals and permits; and

(C) Availability of services and materials, including the adequate off-site treatment, storage capacity, and disposal capacity and services; the availability of necessary equipment and subcontractors, and any necessary additional resources.

(8) Cost. The types of costs that shall be assessed include the following:

(A) Capital costs;

(B) Annual operation and maintenance (O&M) costs;

(C) Costs to implement land use restrictions; and

(D) Net present value of capital and O&M costs.

(9) Environmental impact and sustainability. Include a discussion of waste generation and disposal requirements, as well as a discussion of methods to implement best management practices to reduce the environmental impact of the proposed remedies in accordance with US EPA guidance or ASTM Standard Guide for Greener Cleanups.

(10) Community acceptance. This assessment includes determining which components of the alternatives interested persons in the community may support, have reservations about, or oppose. The Secretary may require a public comment period and informational meeting on the alternatives or consider community acceptance in the context of public input on the corrective action plan.

(e) Required elements. The PRP shall provide the Secretary with an ECAA report that contains the following:

(1) An executive summary of the corrective action alternatives considered, including a recommended alternative, based on criteria in subsection (d) of this section.

(2) Tabulated results and a narrative discussion of any pilot testing completed during the evaluation.

(3) A proposal for any site-specific background standards that the PRP proposes to apply to the site in accordance with Appendix B of this rule.

(4) A proposal for any waiver that the PRP proposes to apply to the site in accordance with Appendix C of this rule.

(5) A detailed evaluation of the criteria established under subsection (d) of this section for each remedial option selected under subsection (c) of this section.

(6) A proposal for additional pilot testing or data collection to refine the remedial design for the selected remedy.
(7) A detailed justification for the selected remedy.

§ 35-605. SECRETARY EVALUATION OF CORRECTIVE ACTION ALTERNATIVES

(a) The Secretary shall evaluate each corrective action alternative presented in the evaluation of corrective action alternative report utilizing the criteria of § 35-604(d).

(b) The Secretary shall provide a written response to the PRP that:

(1) Approves the corrective action alternative recommended in the report;
(2) Approves an alternate alternative that was considered but not recommended;
(3) Requires additional alternatives to be evaluated;
(4) Requires additional analysis, pilot testing, or data collection to support further evaluation of the alternatives reviewed as a part of the report; or
(5) The report is inadequate and will be returned to the PRP and the environmental professional for revisions.

(c) The PRP shall, within 30 days of the Secretary's response or within an alternate schedule approved by the Secretary), provide the Secretary with a response to any comment provided by the Secretary including a revised evaluation of corrective action alternatives or a corrective action plan for the selected alternative.

§ 35-606. CORRECTIVE ACTION PLAN

(a) Except as exempted in § 35-602 of this section, a PRP shall submit a corrective action plan to address impacts or risks to sensitive receptors that are not managed.

(b) A corrective action plan shall include the following:

(1) Executive summary. An executive summary that includes a description of the contamination, a review of the results of the investigation, remediation and remedial objectives, a summary of the alternatives considered, a description of the chosen corrective action technology, a statement of site operations and monitoring activities, and an estimate of the duration of the remedial action.
(2) Site history and updated Conceptual Site Model.
(3) Public notice; parcel map. A list of the persons who will receive notice under § 35-607(b)(1), including contact names, addresses, email addresses, and phone numbers. A parcel boundary map shall be included showing all such parcels.
(4) Performance standards, to include the following:
(A) A discussion of how the corrective action achieves the corrective action objectives identified in § 35-603.
(B) A list of environmental media standards that apply to the site.
(C) A map identifying the compliance points that will be used to monitor compliance with the environmental media standards.

(D) A narrative explanation as to why these compliance points were chosen.

(E) A narrative explanation as to how any corrective action will ensure that there are no completed pathways that would result in an impact to a sensitive receptor.

(F) An estimate of the contaminant mass or volume and expected removal rates.

(G) Identify performance standards for demonstrating substantial completion of the corrective action for sites receiving a Certificate of Completion.

(H) Estimated duration of active remediation and transition to long-term monitoring or site closure.

(5) Permits. A list of all local, state, and federal permits required for the project, and the contacts necessary to obtain these permits and a demonstration of compliance with all local, state, and federal rules and regulation.

(6) Remedial construction plan. Any corrective action involving construction of a treatment system, engineered system, including a cap, a containment system, or any other control that requires an engineered design, shall include the following:

(A) Detailed plans and specifications of the corrective action remedial design and related calculations.

(B) Tabulated results and narrative discussion of any additional analysis or pilot testing performed.

(C) A Vermont licensed professional engineer's signature of review of the remedial system design.

(7) Waste management; contaminated soil plan. A discussion of any waste material that will be generated by the corrective action, including a hazardous waste determination. If managing contaminated soil, the plan shall also include a plan for managing contaminated soil in accordance with Subchapter 8 and § 35-611.

(8) Implementation schedule. An implementation schedule that contains milestones for implementing the corrective action and dates for when those milestones will be reached. The schedule shall include proposed deliverables including the CACCR report and initial performance monitoring or operation and maintenance reporting, as applicable.

(9) Corrective action operation and maintenance plan. The plan shall describe the following:

(A) A description of how any engineered solution will be monitored and maintained to ensure that it continues to operate as designed.

(B) A discussion of the performance monitoring and data collection strategy during active remediation.

(C) A description of how any institutional controls will be monitored and maintained.

(D) As requested by the Secretary, a cost estimate for the implementation of the corrective action maintenance plan and a financial responsibility instrument to assure the implementation of the corrective action stewardship plan. Financial assurance under this rule shall be accomplished in the same manner as financial assurance under 40 C.F.R. Part 264 Subpart H.

(E) A discussion of the operation and maintenance of any active remedial option after its construction until it attains the corrective action objectives established in § 35-603.

(F) A discussion of how any treatment system will be deconstructed or decommissioned once remedial objectives have been met.

(10) Institutional control plan. The corrective action plan shall include an institutional control plan in accordance with § 35-901, unless the Secretary determines that no residual contamination remains in exceedance of any applicable environmental media standards.

(11) Long term monitoring plan. Where long term monitoring is the remedy or will be required following the completion of corrective action, a long-term monitoring work plan in accordance with § 35-702 will be required.

(12) Redevelopment and Reuse Plan. If applicable, the corrective action plan shall include the redevelopment and reuse plan for the property following implementation of the corrective action. Changes or modifications to this plan may require an amendment to the corrective action plan to ensure that sensitive receptors are not adversely impacted.

(13) Quality Assurance and Quality Control (QA/QC) Plan. The corrective action plan shall contain the following:

(A) A list of the Standard Operating Procedures (SOPs) appropriate to the technologies being proposed for the corrective action. The SOP's shall be provided to the Secretary upon request.

(B) A Quality Assurance/Quality Control plan. What methods will be employed to ensure the validity and accuracy of the data and technologies implemented.

(14) Cost Estimate.

(A) Applicability. A corrective action plan shall include a cost estimate if State or federal funding will be utilized, if the project is enrolled in the BRELLA program, or if requested by the Secretary.

(B) Contents. A cost estimate shall be broken down by task, materials, labor costs, sub-contractor costs, and equipment costs. Estimates for sub-contractors shall also be itemized into labor, materials, and equipment costs when available. The cost estimate shall contain a separate itemized cost estimate for Corrective Action Plan implementation and system operations and maintenance (O&M).

(15) An updated set of maps as per § 35-306(b)(14).

(16) Tabular, time series summaries of contaminant concentrations in environmental media in accordance with § 35-305(b)(16).

(17) Cross-sections of the contaminated zone depicting well or boring depths, soil stratigraphy, recent soil contaminant concentrations, and recent water levels as appropriate to site-specific conditions.

(18) A list of all proposed contractors, sub-contractors, including contacts, addresses, email addresses, and phone numbers.

§ 35-607. CORRECTIVE ACTION PLAN REVIEW; PUBLIC NOTICE; FINAL DECISION

(a) Review of draft corrective action plan. The Secretary shall approve a proposed corrective action plan upon finding:

(1) That the corrective action plan demonstrates that the proposed corrective action meets the criteria of § 35-603 and § 35-606, and that the proposed corrective action either:

(A) ensures that no sensitive receptor will be adversely impacted by the corrective action; or
(B) that the corrective action is an interim measure that addresses a portion of the release and that further corrective action is planned to ensure that no sensitive receptor will be adversely impacted; and

(2) The applicable requirements of 10 V.S.A. chapter 170 (pertaining to public notice) have been satisfied.

(b) Public notice of administratively complete draft corrective action plan.

(1) Upon a determination by the Secretary that the corrective action plan is administratively complete, a PRP shall provide notice of the draft corrective action plan to all property owners impacted by the release and to all impacted adjoining property owners on a form provided by the Secretary.
(2) The applicant shall provide signed certification to the Secretary that all adjoining property owners have been notified of the corrective action plan.
(3) The Secretary will post a copy of the draft corrective action plan electronically on the Environmental Notice Bulletin for public comment in accordance with 10 V.S.A. chapter 170.

(c) The Secretary will approve the draft corrective action plan upon a finding that the requirements of § 35-607(a) have been met. The Secretary shall provide notice, in writing, to the potentially responsible party and other interested parties of the final corrective action plan approval.

(d) Corrective action plan. The corrective action plan shall be implemented within 90 days of the approval or in accordance with a schedule approved by the Secretary.

(e) Amendments to a corrective action plan.

(1) Major amendments. All amendments that necessitate technical review shall be noticed in the same manner as required by subsection (b) of this section.
(2) Minor amendments. All amendments that require a change in a condition or requirement but do not necessitate technical review and are not administrative amendments shall be processed pursuant to 10 V.S.A. § 7715 (Type 4), except the Secretary need not provide notice of an administratively complete plan.

(3) Administrative amendments. All amendments that correct typographical errors, changes the name or mailing address of an individual, or makes other similar changes to a plan that do not require technical review or the imposition of new conditions or requirements shall not require review under 10 V.S.A. chapter 170.

§ 35-608. CORRECTIVE ACTION CONSTRUCTION COMPLETION REPORT

(a) A corrective action completion report shall be submitted within 90 days of completing the construction of any remedy, as applicable, or in accordance with the schedule approved in the corrective action plan.

(b) A corrective action completion report shall include the following elements, as applicable:

(1) Corrective Action Objectives.
(2) Description of work performed including preliminary data collection.
(3) Description of remedial system installed.
(4) A description of any field-based minor amendments to the corrective action and a justification for them.
(5) Site plans reflecting post-CAP implementation conditions.
(6) Mechanical system layout and list of major components with serial numbers.
(7) Piping, control, and instrumentation diagrams along with any modifications to the O&M chapters of the corrective action plan for the installed system.
(8) Photo documentation, including:
  (A) contamination encountered during the corrective action;
  (B) the installed remedy; and
  (C) the site before and after implementation of the CAP.
(9) Initial remedial system operation data, including:
  (A) Flow rate;
  (B) Pressure or vacuum radius of influence;
  (C) Contaminant removal rates; and
  (D) Treatment system influent and effluent sample results.
(10) Injection program specifications, including:
  (A) Reagent mixing data;
  (B) Flow rates and pressures;
  (C) Volume of injected material;
  (D) Amendment distribution; and
  (E) Initial post-injection data.
(11) Documentation that the site has been stabilized, physical hazards have been minimized, restored to the restoration plan included in the approved corrective plan;
(12) Recovery or injection well boring logs;
(13) Copies of all federal, state, and local permits;
(14) Waste disposal manifests and bills of lading;
(15) Applicable inspection results including building, zoning, plumbing, and electrical;
(16) Recommendations for additional work; and
(17) A certification that the activities were performed in accordance with the Corrective Action Plan.

§ 35-609. REVIEW AND FINAL DECISION OF CORRECTIVE ACTION CONSTRUCTION COMPLETION REPORT

(a) The Secretary shall review a corrective action completion report and determine whether the corrective action conforms to the CAP approved by the Secretary. The Secretary will respond, in writing, that either:
   (1) The corrective action conforms to the CAP;
   (2) The corrective action does not conform to the CAP and that additional work is required to bring the corrective action into compliance with the CAP; or
   (3) The corrective action is not functioning as designed and additional investigation is required to determine the cause, to develop an effective remedy, or to implement additional corrective action at the site.

§ 35-610. CORRECTIVE ACTION PERFORMANCE MONITORING AND O&M

(a) In accordance with the schedule approved by Secretary, periodic performance monitoring and O&M reports shall be submitted to the Secretary.

(b) As applicable, performance monitoring or O&M reports shall include a recommendation for:

   (1) continued performance monitoring or O&M;
   (2) discontinuance of corrective action due to poor system performance;
   (3) modifications to the approved corrective action plan; or
   (4) cessation of corrective action when the objectives specified in § 35-603 have been met.

(c) The Secretary shall provide a written response to the PRP in response to recommendations outlined in the report.

§ 35-611. SITE GENERATED WASTES

(a) Unless approved by the Secretary for management in an Area of Contamination, site generated hazardous waste shall be managed in accordance with the Vermont Hazardous Waste Management Rules.

(b) The Secretary may allow for the on-site remediation of a site contaminated with a hazardous material without requiring hazardous waste certification and permitting provided such activity is conducted in accordance with an approved Corrective Action Plan.

(c) Investigation derived wastes shall be managed and disposed as follows:

   (1) If a hazardous waste, in accordance with the Vermont Hazardous Waste Management Regulations.

   (2) If the waste contains polychlorinated biphenyls (PCBs) in excess of 50 parts per million (ppm), it shall be managed in accordance with the Toxic Substance Control

Act (TSCA). Such waste also shall be managed as a hazardous waste in accordance with the Vermont Hazardous Waste Management Regulations (VT01 hazardous waste code). If PCBs are present at concentrations below 50 ppm, the waste may also be subject to management under TSCA.

(3) If the waste does not meet the criteria of subdivisions (c)(1) or (c)(2) of this subsection, the waste shall be disposed of:

(A) in accordance with the Solid Waste Management Rules, or
(B) under a waste management plan approved as a part of the site investigation work plan, provided no investigation derived waste containing a hazardous material above an environmental standard is transported off the site.

(4) Petroleum contaminated purge water from groundwater monitoring wells and equipment decontamination water may be returned to the ground within the area where it was extracted as approved by the Secretary.

(5) Non-petroleum, non-hazardous waste contaminated purge water may be returned to the ground within the area where it was extracted as approved by the Secretary.

SUBCHAPTER 7 LONG TERM MONITORING

§ 35-701. APPLICABILITY

All required long term monitoring shall be performed in accordance with this subchapter. Long term monitoring of environmental media shall be conducted to evaluate the effectiveness of the remedial goals outlined in the corrective action plan and until the site meets the conditions for Subchapter 10 (site closure), or as required by the Secretary.

§ 35-702. LONG TERM MONITORING WORK PLAN

(a) A PRP shall submit an initial long term monitoring work plan within 30 days of receiving Secretary approval of a CAP where long term monitoring is a remedy or will be required following the completion of corrective action. Subsequent long term monitoring work plans may be required as requested by the Secretary.

(b) A long term monitoring workplan shall be approved by the Secretary prior to the initiation of monitoring work.

§ 35-703. GENERAL REQUIREMENTS FOR LONG TERM MONITORING

(a) Monitoring shall be conducted in accordance with an approved CAP, or as approved by the Secretary prior to July 27, 2017 if the site investigation has demonstrated that all requirements presented in § 35-304(b) are met. Any change to the plan shall be approved by the Secretary in writing.

(b) The Secretary shall be notified immediately if a change in site conditions affect the performance of an approved work plan. The Secretary may require revisions to the monitoring work plan based on site condition changes.

§ 35-704. REPORTING

(a) A long-term monitoring report shall be submitted on an annual basis, or on a schedule approved by the Secretary.

(b) Except as provided by subsection (c) of this section, the long-term monitoring report, including analytical results, shall be submitted to the Secretary no later than 45 days from the receipt of analytical results from the laboratory or within an alternate schedule approved by the Secretary.

(c) In the following circumstances, results shall be reported as indicated:

(1) Drinking water supply laboratory analytical results which report an exceedance of the groundwater enforcement standards shall be submitted verbally within 24 hours and written analytical results shall be provided to the Secretary within five business days thereafter.

(2) Indoor air quality laboratory analytical results that report an exceedance of an indoor air standard shall be submitted verbally within 24 hours and written analytical results shall be provided to the Secretary within five business days thereafter.

(d) A long-term monitoring report shall include the following, as applicable:

(1) Updated executive summary. Brief summary of findings, conclusions, and recommendations based upon the data collected during the monitoring event.
(2) An updated CSM in accordance with § 35-303.
(3) Contaminated media characterization in accordance with § 35-306(b)(12).
(4) Updated site maps in accordance with § 35-306(b)(14).
(5) Documentation of the sample location and method in accordance with the consultant's standard operating procedures (SOP). Justification for deviations from the SOPs shall be described.
(6) A discussion of first-time detections of contaminant concentrations or NAPL in any monitoring point. Also, include a discussion of significant changes in concentrations in any monitoring point if applicable.
(7) Any deviations from the approved work plan shall be identified and justified.
(8) A descriptive analysis of how the data gathered supports the CSM, and whether the corrective action or site investigation objectives continue to be achieved. The discussion must also establish that the data collected are suitable to determine the risk posed by the hazardous materials, the need for further characterization, and the potential remedial actions. Only data that passes Quality Assurance/Quality Control criteria will be acceptable.
(9) All collected data shall be organized in narrative, tabular, and graphical form, and shall include all appropriate historical site data. Graphs of hazardous material concentration versus time; including results from discontinued monitoring locations if necessary to support the conclusions in the report. All detected hazardous material concentrations shall be reported. Hazardous materials that are not detected shall be reported as less than the numerical detection limit. Detection limits shall be below the environmental media standards and shall be provided in tabular format with the analytical results. All laboratory data qualifications must be included in tabulated data presentations.
(10) Data used in spreadsheets or models shall be submitted if requested by the Secretary.
(11) NAPL recovery results, when applicable.
(12) Field screening results from contaminated stockpiled soils in tabular format, with a map showing the locations of the screened samples and the stockpile location in reference to other pertinent physical features including buildings, roadways, and surface water bodies.
(13) A description of the current site conditions, condition of the monitoring network, remediation system, soil stockpile, any maintenance activities conducted since the last monitoring event, and any required maintenance that must be completed with a schedule to complete the work.
(14) Observable changes in site and neighboring property conditions which may affect site management. These changes may include change in property use, change in property occupancy, water supply changes, and construction.

(15) Compliance with any institutional controls developed as part of the response to contamination.
(16) Documentation of the handling of any investigation derived waste, which shall be dealt with in accordance with § 35-611(c).
(17) Conclusions and Recommendations. A discussion of the findings of the investigation that substantiate the revised CSM, and, specifically, the risk hazardous materials pose to identified receptors, completed exposure pathways, the identification of data gaps, potentially appropriate corrective actions, proposed monitoring frequency, and need for further investigation, additional corrective action, or site closure.
(18) The report shall be signed by an environmental professional and certified in accordance with § 35-104.

(e) If required by the Secretary, interim data transmittals shall be used to submit results of monitoring events between long term monitoring reports. Interim data transmittals shall include:

(1) Contaminated media characterization in accordance with § 35-306(b)(12);
(2) Updated site maps in accordance with § 35-306(b)(14);
(3) Laboratory analytical reports; and
(4) If applicable;
(A) NAPL recovery results; and
(B) Photographic documentation.

§ 35-705. SECRETARY REVIEW OF LONG TERM MONITORING REPORT

(a) The Secretary shall review the long term monitoring report for completeness and shall provide written notification to the RPP that:

(1) The long term monitoring report demonstrates that the site has met the corrective action objectives and the site can be closed in accordance with Subchapter 10;
(2) Long term monitoring shall continue at the sampling locations and monitoring frequency established in the site investigation or corrective action plan, or at an alternate frequency based on site conditions as approved by the Secretary; or
(3) Additional site investigation or corrective action is required.

SUBCHAPTER 8 CONTAMINATED SOIL

§ 35-801. APPLICABILITY

(a) The following soils containing hazardous materials at concentrations exceeding the applicable Vermont Soil Standards shall be managed in accordance with this section:

(1) Non-hazardous waste contaminated soil.
(2) Development soils.
(3) Petroleum contaminated soils that are exempted from management under VHWMR § 7-203(p).

§ 35-802. EXEMPTIONS

(a) Petroleum contaminated soil that is excavated and then backfilled into a tank grave during an UST closure or replacement are exempt from management under this Subchapter. These soils may require future site investigation or corrective action.

(b) Petroleum contaminated soils excavated during an emergency response or UST closure or replacement are exempt from § 35-803(a) unless required by the Secretary.

§ 35-803. NON-HAZARDOUS WASTE CONTAMINATED SOIL

(a) Approval of management. All management of contaminated soil under this Subchapter shall be pre-approved by the Secretary.

(b) VHWMR petroleum-contaminated soil. Petroleum contaminated soils are not hazardous in accordance with the Vermont Hazardous Waste Regulations.

(c) On-site soil management and treatment.

(1) Soil Stockpiling. Non-hazardous waste contaminated soil may be stockpiled on the site where the release occurred in accordance with this section.

(A) Non-hazardous waste, non-petroleum soils may be temporarily stockpiled for up to 90 days. Stockpiling may not occur between December 1st and April 1st, unless under an alternate schedule or work plan that is approved by the Secretary. A final offsite disposal and treatment plan and request form shall be submitted and approved by the Secretary.

(B) On-site soil stockpiles shall meet the following criteria:

(i) Soils shall be completely contained or encapsulated within a polyethylene plastic liner, which shall be a minimum thickness of 6 mils or another containment method determined by the Secretary to be at least as effective in isolating the soils from impacting the environment.

(ii) The integrity of the polyethylene liner shall be maintained throughout stockpiling.

(iii) No additional soil may be added to the existing soil stockpile, unless first approved by the Secretary.

(iv) Soils shall be monitored at a frequency approved by the Secretary to ensure the integrity of the encapsulated soil pile.

(v) Unless otherwise approved by the Secretary, the location of the stockpiled soil shall be in an area where:

(I) There are no sources for public water systems or potable water supplies within a minimum 300-foot radius. This limit may need to be extended if water supply sources are shown to be hydraulically downgradient;

(II) There are no sensitive environments including a stream, river, lake, pond, state or federally listed threatened or endangered species or habitat, wetland, floodplain, Class I or II groundwater, residence, property boundary, or other similar areas, within 100 feet of the treatment location;

(III) The location is not within zone one or two of a groundwater source protection area;

(vi) Public access to the location where soils are stockpiled shall be prohibited through posting no trespassing signs and other appropriate means as approved by the Secretary;

(vii) If the landowner of the property where soils are to be stockpiled is different from the soil generator, written approval from the landowner that also grants access to the Secretary, has been obtained before stockpiling begins;

(viii) The location where soils are stockpiled shall be depicted on the site map;

(ix) Failure to adequately maintain soil may require additional investigation and corrective action as a new release as required by the Secretary.

(2) Soil Treatment.

(A) Polyencapsulation. Non-hazardous waste petroleum contaminated soil may be treated onsite by polyencapsulation following approval from the Secretary. Such treatment shall be subject to the following requirements:

(i) The soils shall remain polyencapsulated on-site until vapor levels are non-detectable (less than 1.0 parts per million by volume (ppmv) headspace) using a field screening instrument, and there is no olfactory or visual evidence of contamination.

(ii) Aerating the soil pile to accelerate remediation is prohibited.

(iii) Soils shall be periodically monitored at a frequency approved by the Secretary to track the rate of biodegradation using a VOC field

screening instrument and to ensure the integrity of the encapsulated soil pile.

(iv) Amendments shall be added to the soil stockpile only upon approval by the Secretary.

(B) Thin-spreading. Thin-spreading of non-hazardous waste petroleum contaminated soils shall be approved by the Secretary. Such treatment shall be subject to the following requirements:

(i) Vapor levels are less than 1.0 ppmv in discrete soil samples when measured with a VOC field screening instrument;
(ii) Soils contain no olfactory or visual evidence of contamination;
(iii) Confirmatory lab samples as required by the approved corrective action or soil management plan;
(iv) Results of laboratory analysis shall be below Vermont Residential Soil Standards;
(v) Thin-spreading shall be in an area that complies with § 35-803(c)(1)(B)(v).

(3) Additional treatment. Additional on-site treatment options for non-hazardous waste contaminated soil are only allowable following approval from the Secretary.

(4) On-site soil capping. Non-hazardous waste contaminated soil may be capped on the property where the release occurred and within the area of contamination, provided all the following have been demonstrated:

(A) The proposed capping area meets the siting criteria of § 35-803(c)(1)(B)(v).
(B) Capped soils shall be located above the seasonal high-water table.
(C) An engineered soil cap shall be installed to eliminate contact risk. The engineered soil cap shall be:
(i) If not covered by an impervious surface, a minimum of 18" thick; or
(ii) If covered by an impervious surface, 6" thick of fill or sub-base material under the impervious surface.
(iii) Alternate cap thicknesses may be utilized, provided additional institutional controls are placed on the property to ensure protection of human health and the environment, and approval is granted by the Secretary.
(iv) Clearly marked with a material that distinguishes the divide between the non-hazardous contaminated soils and the clean backfill;
(D) Soils managed under this subsection shall be shown not to be a risk to sensitive receptors, by appropriate sampling methodology.
(E) An institutional control plan has been approved by the Secretary.

(d) Off-site soil management and treatment.

(1) Off-site stockpiling or treatment of non-hazardous waste contaminated soil. The off-site stockpiling of soil under this section shall be approved by the Secretary prior to the shipment off-site. In addition to meeting the requirements of §35-803(c)(1)(B)(v), the following are required:

(A) PRP shall provide the Secretary with the following:

(i) the contaminant concentrations and amount of soil that is to be transported to the off-site location;
(ii) an ANR Atlas generated map including the latitude and longitude of the exact location where the soil will be stockpiled, referenced to the WGS1984 coordinate system (Mercator), in decimal degrees. Minimum acceptable accuracy is plus-or-minus 15 feet; and
(iii) A completed ANR Off-site Soil Treatment form.

(B) The municipality in which the soil will be stockpiled or treated shall be notified in writing of the soil stockpile or treatment location. If applicable, local permits have been obtained. All required local permits must be obtained prior to off-site management, or a demonstration made that no local permits are required.

(2) Off-site disposal. Non-hazardous waste contaminated soil may be treated or disposed at an off-site location. This soil may shipped to one of the following locations following approval by the Secretary:

(A) An in-state or out of state solid waste disposal facility;
(B) An in-state or out of state treatment facility; or
(C) For development soils, a location that meets the requirements of § 35-805(c).

§ 35-804. SOIL MANAGEMENT PLANS

(a) Applicability. A soil management plan may be required by the Secretary in the following instances:

(1) When soil management is necessary prior to meeting the objectives of Subchapter 3.
(2) The site is exempt from corrective action in accordance with § 35-602, and a project is being conducted where contaminated soil may be encountered or generated.
(3) The site has received a Site Management Activity Completed designation or Certificate of Completion that includes a land use restriction in a designated area. A project is being conducted in the designated area where residual contamination may be encountered.
(4) A public works or linear construction project is being proposed where contaminated soil may be encountered or generated.
(5) A construction or redevelopment project is being conducted by an impacted third party who is not a PRP under 10 V.S.A. § 6615 and contaminated soil may be encountered.

(6) A construction or redevelopment project is being conducted in an area with historical fill.
(7) When source removal is determined to be feasible during a UST removal.

(b) Plan content requirements. A soil management plan shall include the following:

(1) Description of project.
(2) Goals and objectives.
(3) Description of contamination (source, type, volume, area) to be encountered during the project.
(4) A discussion of any waste material that will be generated by the project
(5) A plan for managing contaminated soil in accordance with § 35-803.
(6) Excavation oversight and soil stockpile inspection frequency.
(7) Project schedule.
(8) Description of how the site will be restored upon project completion.
(9) An updated set of maps per § 35-306(b)(14) or as otherwise directed by the Secretary.
(10) List of contractors and contact information.

(c) Plan approval. A soil management plan shall be approved by the Secretary prior to implementation. The Secretary shall only approve, in writing, a soil management plan upon finding:

(1) The degree and extent of contaminated soil, in the area requiring excavation for proper treatment or disposal, has been delineated in a pre-characterization or site investigation report and has been determined to be non-hazardous. The pre-characterization report shall include the elements as outlined in § 35-306(b), or as directed by the Secretary. Additional site investigation and corrective action may be required.
(2) The planned construction or redevelopment project/activity will not worsen any existing contamination on the site, or cause impacts to receptors.

(d) Certification of completion. Following implementation of the soil management plan the PRP shall, within 90 days of completion, provide documentation to the Secretary demonstrating that the work has been completed in accordance with § 35-804(b). If soils were transported offsite, the PRP shall also provide disposal documentation including waste manifest and bill of lading.

§ 35-805. DEVELOPMENT SOILS

(a) Applicability. Soils exhibiting concentrations of contaminants limited to lead, arsenic, and/or PAHs in exceedance of Vermont Soil Standards may be managed in accordance with this section upon approval by the Secretary.

(b) Sampling work plan; content requirements. A person who proposes to manage development soils shall develop and submit a sampling work plan that includes the following:

(1) Soil sample collection methods shall consist of one of the following:

(A) Discrete sampling methodology in a grid pattern, which shall be appropriately scaled in order to cover the entire proposed area of excavation, and sample points shall be co-located in areas of concern;
(B) Application of Incremental Sampling Methodology consistent with the Interstate Technology and Regulatory Council's (ITRC) Incremental Sampling Methodology; or
(C) Other soil characterization methods, as approved by the Secretary.

(2) If soil is proposed to be disposed of in accordance with § 35-805(d), the number and location of soil samples that will be analyzed using Synthetic Precipitation Leaching Procedure (EPA Method 1312) (SPLP) to determine if there is a potential for contaminants to impact groundwater. The number of locations shall be based on the volume of soils planned for management and there shall be minimum one sample for every 200 tons of soil, or as approved by the Secretary. Samples shall be taken from the soils most likely to leach contaminants and from the most impacted soil locations based on laboratory analysis, field screening, and visual and olfactory evidence.

(c) Disposal of development soils. Upon approval by the Secretary, these soils may be disposed at:

(1) A categorical solid waste facility that is permitted to receive development soils;
(2) A solid waste facility for use as alternate daily cover; or
(3) An approved receiving site that meets the requirements of subsection (d) of this section.

(d) Receiving site.

(1) Work plan. Prior to receiving development soils, a work plan for sampling of the receiving site shall be submitted for approval which includes the following:

(A) Soil sample collection methods which shall consist of one of the following methods:

(i) Discrete sampling methodology in a grid pattern. The sampling grid shall be appropriately scaled in order to cover the entire area proposed for deposition of development soils and shall include information regarding seasonal groundwater elevations determined through subsurface characterization; or
(ii) Application of Incremental Sampling Methodology consistent with ITRC Incremental Sampling Methodology and shall include information regarding seasonal groundwater elevations determined through subsurface characterization.

(B) The address of the proposed receiving site location and the GIS coordinates of the area where the development soils are proposed to be disposed.

(2) General requirements. The following shall apply to management of development soils at a receiving site:

(A) A receiving site shall meet the siting requirements established in § 35-803(c)(1)(B)(v).

(B) The receiving site shall have concentrations of arsenic, lead, and PAHs that are equal to or greater than the concentrations of the development soils proposed to be received.

(C) Receiving sites that have concentrations of hazardous materials in exceedance of residential soil standards will be required to conduct a site investigation in accordance with Subchapter 3.

(D) The receiving site has an approved institutional control plan in accordance with § 35-901 that addresses potential direct contact with development soils by the public, including appropriate capping and establishment of land use restrictions.

SUBCHAPTER 9. INSTITUTIONAL CONTROLS

§ 35-901. INSTITUTIONAL CONTROL PLAN

(a) Purpose. The purpose of an institutional control plan is to identify a series of land use restrictions to ensure the protection of human health and the environment.

(b) Acceptable Alternate Institutional Controls. In addition to the institutional controls identified in § 35-902 and § 35-903, the following institutional controls may be acceptable when included as a part of an institutional control plan approved by the Secretary:

(1) Zoning Ordinances. Zoning ordinances that place restrictions on uses of an area where the property is located may be considered as a part of an institutional control plan, e.g. zoning an area for non-residential use only or limiting subsurface excavation. Institutional control plans shall address how reporting on zoning ordinances will take place to ensure that future modifications to ordinances or bylaws do not allow land use to adversely affect human health or the environment.

(2) Water Ordinances. Water ordinances that require all property owners to be connected to a public community water supply when service is available may be an acceptable institutional control for groundwater use restrictions. Institutional control plans shall address how reporting on water ordinances will take place to ensure that future modifications to ordinances or bylaws to ensure compliance with land use restrictions.

(3) Groundwater reclassification. Groundwater reclassifications may be an acceptable institutional control for groundwater use restrictions.

(4) Judicially approved controls. Judicial controls may be an acceptable institutional control. The institutional control plan shall identify how the judicially approved controls will allow the control to survive changes to property ownership or other transfers of the property.

(5) Approval of institutional control plan. The PRP shall submit an institutional control plan to the Secretary for approval. The plan shall include the following:

(A) The PRP has identified all residual contamination that remains on the property;

(B) The PRP has identified appropriate restrictions to ensure that exposure pathways are not created by uses or activities that take place on the property;

(C) The PRP has identified a control or controls that adequately address the land use restrictions identified in subsection (c)(2) of this section; and

(D) The PRP has identified a means to ensure that the controls continue to be effective until the contamination no longer poses an unacceptable impact to human health or the environment.

§ 35-902. NOTICE TO THE LAND RECORDS

(a) Purpose. The purpose of a notice to the land records is to inform present and future property owners of the presence of residual contamination at the property, and applicable land use restrictions.

(b) Applicability. A Notice to the Land Records is an acceptable institutional control when corrective actions have addressed exposure pathways to sensitive receptors, but residual contamination above applicable environmental media standards may be present on site.

(c) Required Elements. All notices to the land record shall contain:

(1) A brief description of the release of hazardous materials;
(2) A brief description of any corrective action that took place on the site;
(3) What residual hazardous materials remain on the site above applicable media standards and the location of those hazardous materials;
(4) A description of the necessary land use restriction(s) to ensure that no further exposure to hazardous materials can occur; and.
(5) The following language shall be included:
"If a person fails to follow the land use restrictions contained within this notice the person may be liable for further site investigation, remediation, and penalties pursuant to the Vermont Waste Management Act, 10 V.S.A. chapter 159."

(d) Filing. A PRP shall file a notice to the land records within one week of approval by the Secretary. The PRP shall provide a copy to the Secretary, including the recorder stamp, date of recording, book, and page number, of the recorded notice to the land record within 10 days of its recording.

§ 35-903. ENVIRONMENTAL EASEMENT

(a) Purpose. The purpose of an environmental easement is to place legally enforceable land use restrictions on a property to prevent exposure to any hazardous material left on the property and to ensure the protectiveness of any corrective action at the property.

(b) Applicability. The Secretary may require the use of an environmental easement in the following situations:

(1) When long term maintenance or monitoring of the corrective action, engineered remedy or land use restrictions are required to prevent contamination from posing a risk to human health or the environment;
(2) When land use restrictions will include restrictions for residential property use;
(3) When active remedial infrastructure must remain in place in order to prevent a risk to human health or the environment;
(4) When a Technical Impracticality (TI) Waiver has been granted by the Secretary in accordance with Appendix C; or

(5) When groundwater contamination remains or is projected to remain at the site above the Vermont Groundwater Enforcement Standards at a compliance point in accordance with the timeline established in the Vermont Groundwater Protection Rule and Strategy.

(c) Required Elements. The following shall be included in an environmental easement:

(1) A legal description of the site property;
(2) A description of the release, corrective action, and statement of the need for an environmental easement an environmental easement on the property;
(3) A grant of access to the Agency of Natural Resources to the property for any reason related to the purpose of the easement, including monitoring of the site, monitoring of the land use restriction, planning future corrective action;
(4) Restrictions on future uses of the property or portions of the property to prevent receptors from being exposed to any residual contamination that remains on the property and to ensure the effectiveness of any corrective action;
(5) A process for enforcing the terms of the easement; and
(6) A map including the most recent parcel boundary survey that depicts the area of the parcel to which the restrictions apply.

(d) Approval. The Secretary shall review and approve the environmental easement upon demonstration that easement complies with the requirements of § 35-903(c).

(e) Filing. A PRP shall file an approved environmental easement and all exhibits within one week of its approval by the Secretary and shall provide a copy to the Secretary, including the recorder stamp, book, and page number, of the recorded environmental easement on within one week of its recording.

§ 35-904. LAND USE RESTRICTIONS WITHIN A CERTIFICATE OF COMPLETION

(a) Purpose. The Secretary may establish land use restrictions within a certificate of completion upon closure of a site enrolled in BRELLA pursuant 10 V.S.A. Chapter 159. The purpose of these restrictions is to ensure the ongoing effectiveness of response actions taken at the site.

(b) Applicability. The Secretary may restrict future uses of a property as a part of a certificate of completion in any of the following situations:

(1) When long term maintenance or monitoring of the corrective action or land use restrictions are required to ensure a risk to human health or the environment will not occur;
(2) When land use restrictions will include constraints regarding residential property use;
(3) When active remedial infrastructure must remain in place in order to prevent contamination from posing a risk to human health or the environment;
(4) When a Technical Impracticality (TI) Waiver has been granted by the Secretary in accordance with Appendix C; or
(5) When groundwater contamination remains or is projected to remain at the site above the Vermont Groundwater Enforcement Standards at a compliance point in

accordance with the timeline established in the Vermont Groundwater Protection Rule and Strategy.

(c) Required Elements. A certificate shall include the following items:

(1) A legal description of the site property;
(2) A description of the release, corrective action, and statement of the need for land use restrictions on the property;
(3) Restrictions on future uses of the property or portions of the property to prevent receptors from being exposed to any residual contamination that remains on the property and to ensure the effectiveness of any corrective action; and
(4) A map including the most recent parcel boundary survey that depicts the area of the parcel to which the restrictions apply.

(d) Recording. The PRP shall record a certificate of completion and all supporting documentation and exhibits with the land records of the municipality or municipalities in which the site is located. Such recording shall be made within one week of the date of issuance of the certificate of completion. Within one week of the date of recording, the PRP shall provide a copy of the recorded and stamped certificate of completion and all recorded documents to the Secretary, which includes the book and page number of where those documents were recorded.

SUBCHAPTER 10. SITE CLOSURE

§ 35-1001. SITE MANAGEMENT ACTIVITIES COMPLETE

(a) Purpose. A Site Management Activities Complete (SMAC) designation may be issued to signify that, based on current information, no additional work related to a release is required.

(b) Eligibility. A PRP shall submit a request for a SMAC designation that summarizes the site investigation and corrective action undertaken at the site and that demonstrates all the following:

(1) Each source area that was removed, remediated, or adequately controlled.
(2) Hazardous material data trends collected from site specific environmental media demonstrate that contaminant concentrations are stable, falling, or are not detectable.
(3) Groundwater enforcement standards as adopted in the Groundwater Protection Rule and Strategy have been met at compliance points established for the site.
(4) No hazardous materials associated with the site are present in drinking water supplies at concentrations in excess of Vermont's groundwater quality standards (Vermont Groundwater Enforcement Standards or Vermont Action Levels, when one is available).
(5) Active remediation at the site has been completed.
(6) Soil standards have been met at compliance points or, if soil standards have not been met, then a corrective action plan has been implemented as well as approved institutional controls and land use restrictions, as necessary.
(7) Vermont Water Quality Standards have been achieved at all surface water compliance points established for the site.
(8) Sediment remediation has been completed or was not required.
(9) Migration of hazardous materials from soil to groundwater is not occurring at a concentration which will result in an exceedance of the Vermont Groundwater Enforcement Standards.
(10) No completed vapor intrusion pathway exists.
(11) The site has been properly closed following the corrective action, including:
    (A) All groundwater monitoring wells have been properly closed in accordance with the Vermont Water Supply Rule or an alternate plan has been approved by the Secretary for maintaining the monitoring wells. The Secretary shall be notified of the closure of the monitoring wells.
    (B) Abandoned water supply wells have been properly closed in accordance with the Vermont Water Supply Rule.
    (C) All site remedial infrastructure or monitoring points have been closed in a manner to prevent impacts to the environment or human health.
    (D) Excavated contaminated soils have been properly treated or disposed of in accordance with § 35-803, § 35-611, or § 35-804.
(12) Any outstanding or overdue balances owed to the State (e.g. Petroleum Cleanup fund "PCF" deferred deductible, PCF cost recovery, Environmental Contingency Fund (ECF) cost recovery, UST loan, settlement agreements, penalties, fines, natural resources damage assessments, taxes, unpaid child support, etc.) have been paid to the satisfaction of the State.

(13) Injection wells and floor drains have been closed in accordance with the Underground Injection Control Rule, as appropriate.
(14) All required institutional controls, engineered controls, and inspection plans are in place and copies have been provided to the Secretary.
(15) All documentation required by this rule has been submitted to and approved by the Secretary.

(c) Issuance of SMAC designation. The Secretary shall issue a SMAC designation for the site upon compliance with the requirements of subsection (b) of this section. The Secretary may issue a SMAC designation upon his or her own discretion upon a demonstration that the requirements of subsection (b) are met.

(d) SMAC as notice to the land records. A copy of the SMAC designation shall be recorded in municipal land records in the municipality where the site is located.

(1) The PRP shall within 10 days of recording provide to the Secretary a copy of the recorded SMAC letter with the recorder's stamp, recording date, Book and Page number(s).
(2) SMAC letters shall include a copy of the site map showing properly decommissioned monitoring points original source area(s), remediated area(s) and the approximate extents of residual contamination.

(e) Effect on liability. A SMAC designation shall not release the PRP(s) from any past or future liability associated with an identified release or a release discovered after such designation. A SMAC designation does not prevent the Secretary from requiring further assessment of the site pursuant to subsection (f) of this section.

(f) Reopening of SMAC designation. The Secretary may require additional investigation or remediation of a designated site upon finding any of the following:

(1) Previous remediation activities were inadequate;
(2) New information is discovered regarding the time, extent, amount, type, or nature of materials released;
(3) New information is discovered regarding the migration of the hazardous materials, health effects of the hazardous materials, or site conditions;
(4) The Secretary identifies errors or omissions in any of the investigation, or corrective action plan, or their associated implementation;
(5) A new hazardous material is listed or identified that requires a response by the PRP;
(6) Additional release(s) occur;
(7) A condition of the SMAC designation was not completed;
(8) A requirement of the institutional control plan or necessary reporting was not followed; or
(9) Any other condition that presents a threat of unreasonable exposure to humans or the environment from a hazardous material that was released from the site.

§ 35-1002. CERTIFICATE OF COMPLETION

(a) Eligibility for Certificate of Completion. A PRP may receive a certificate of completion pursuant to this section if the following have been established:

(1) The PRP meets the eligibility requirements identified in 10 V.S.A. § 6645, and has been accepted into the BRELLA program;
(2) The Secretary determines that all work required pursuant to 10 V.S.A. Chapter 159, Subchapter 3 has been completed; and
(3) The Secretary determines that the requirements of this section have been met.

(b) Request; review. A PRP may request the Secretary issue a certificate of completion by filing an application in the same manner as required by § 35-1001(b). The Secretary shall review a request for a certificate of completion in the same manner as § 35-1001(b).

(c) Substantial completion. A PRP may request that the Secretary issue a certificate of completion based upon substantial completion of the corrective action. A certificate of completion shall only be issued to persons who entered the BRELLA program as a prospective purchaser, and only upon determination by the Secretary that one of the following bases exists at the time the application:

(1) that long term monitoring is a component of the corrective action, but the long-term monitoring has not been completed; or
(2) institutional controls are required but have not yet been recorded at the time of the request.

(d) Failure to comply with conditions for a certificate of completion. Any protections provided by a certificate of completion shall be contingent upon the PRP's compliance with conditions identified by the Secretary. Failure to comply with such conditions shall nullify any such protections or other terms of a certificate.

SUBCHAPTER 11. REQUESTS FOR REIMBURSEMENT FOR MUNICIPAL WATER LINE EXTENSIONS FROM THE PETROLEUM CLEANUP OR ENVIRONMENTAL CONTINGENCY FUNDS

§ 35-1101. REIMBURSEMENT OF MUNICIPALITIES TO PROVIDE ALTERNATE WATER SUPPLIES

(a) Applicability. This section shall apply when:

(1) There has been a release of a hazardous material;
(2) The construction or expansion of or connection to a municipal water line eliminates a sensitive receptor's exposure to a hazardous material; and
(3) The work is performed by a municipality and meets the requirements of this section.

(b) Source of funds. When the release is predominately gasoline, fuel oil, or the release of another petroleum product that would potentially be eligible for reimbursement from the fund established under 10 V.S.A. § 1941 then the reimbursement shall be made from the Petroleum Cleanup Fund; all other reimbursements shall be made from the Contingency Fund established pursuant to 10 V.S.A. § 1283.

(c) Prohibition on Reimbursement.

(1) Reimbursements from the Petroleum Cleanup Fund shall be limited to the reimbursement caps established in 10 V.S.A. § 1941(a)(1) and shall only be for uninsured costs.
(2) Reimbursements from the Contingency Fund shall be limited to the caps established in 10 V.S.A. § 1283(b) or an amount established by the Secretary taking into consideration the current fund balance and known and estimated future obligations on the fund, whichever is lesser.
(3) Where there is a potentially responsible party who has refused to reimburse a municipality for the extension of a municipal water line, the Secretary may condition reimbursement on the successful recovery of funds from that responsible party.

(d) Requirements for reimbursement.

(1) The municipality has applied for all necessary permits required for the project, including public drinking water supply permits;
(2) Municipality must submit cost estimate for review and approval by the Secretary for all work proposed for reimbursement. If an evaluation of corrective action alternatives, including cost effectiveness compared to water treatment or well replacement, has not been completed prior to the final design of a municipal water line extension, the Secretary may require such an analysis prior to approval of the preliminary approval or prior to the construction of the water line extension.

(3) Prior to bidding on a construction project that may encounter contaminated media an environmental professional shall, at a minimum, provide the Secretary with the following:

(A) Identify any land uses that may have resulted in the release of hazardous materials on the route of the municipal water line extension. Identification shall be confined to a review of records at the Agency and municipal records.

(B) If sampling is necessary, submit a plan to conduct limited sampling to estimate the costs associated with management of contaminated soil and groundwater when installing the municipal water line.

(C) Soil management plan. This plan shall include work procedures, treatment, and disposal locations for contaminated soil encountered during the construction process. Contaminated soils shall be backfilled during construction unless it is clearly documented that the soils are geotechnically unsuitable or cannot be replaced within the excavation. Contaminated soils to be backfilled, shall be placed at the bottom of the trench with at least 18" of uncontaminated soil used for closing the trench.

(D) Groundwater management plan. If contaminated groundwater is expected to be encountered, the municipality shall have an environmental professional develop a plan for the treatment of contaminated groundwater. Treatment methods may include re-injection through an infiltration basin, filtration through activated carbon, air stripping, pumping to fractionation tanks, or disposal to a wastewater treatment plant (with appropriate permission from the plant owner and Wastewater Management Division).

(e) Approval of pre-bid preliminary investigation. Prior to implementing any work proposed for reimbursement, the Secretary shall approve the pre-bid preliminary investigation. The Secretary may require additional investigation and work as a part of the approval. The Secretary may disprove any cost associated with a request provided there is a reasonable basis for the disapproval. If an evaluation of corrective action alternatives has not been completed prior to the construction of a municipal water line extension, the Secretary may require such an analysis prior to approval of the pre-bid preliminary investigation.

(f) Final reimbursement request. As a part of any request for reimbursement, a municipality shall provide the Secretary, at a minimum, the following information:

(1) The results of any investigation, sampling, and field work that took place as a part of the investigation.

(2) Receipts for any waste discovered and disposed during the municipal water line extension.

(3) Documentation, such as as-builts and certificate of completions, that the constructed municipal water line extension was constructed per the applicable permit requirements.

(4) The amount requested for reimbursement, including detailed supporting information such as contracts to perform work, detailed invoices from contractors, and other similar information.

(5) The Secretary may require additional documentation to support the request for reimbursement.

(g) Approval of final reimbursement request. Prior to reimbursing a municipality for the extension of a municipal water line the Secretary shall approve the final reimbursement request. The Secretary may require additional documentation to support the request for reimbursement. The Secretary may disprove any cost associated with a request provided there is a reasonable basis for the disapproval.

APPENDIX A. ENVIRONMENTAL MEDIA STANDARDS

§-APX-A1. SOIL STANDARDS

§-APX-A2. VAPOR INTRUSION STANDARDS

§-APX-A3. SEDIMENT STANDARDS

Appendix A - § 35-APX-A1 - Soil Standards
(see notes at end of table)

		Vermont Soil Standards (TR=1E-06, HQ=1.0)		
Analyte	CAS Number	Resident Soil (mg/kg)	Non-Resident Soil (mg/kg)	Urban Background (mg/kg)
Acetochlor	34256-82-1	1,216	14,362	
Acetone	67-64-1	40,609	100,028	
Alachlor	15972-60-8	61	718	
Aldrin	309-00-2	0.02	0.10	
Aluminum	7429-90-5	72,507	941,748	
Antimony	7440-36-0	26	319	
Arsenic, Inorganic	7440-38-2	16	16	
Barium	7440-39-3	11,247	127,382	
Benomyl	17804-35-2	116	701	
Benzene	71-43-2	0.70	4.2	
Benzo[a]pyrene[(a)]	50-32-8	0.07	1.54	0.580
Beryllium	7440-41-7	35	289	
Bis(2-chloro-1-methylethyl) ether	108-60-1	2,804	36,274	
Boron	7440-42-8	14,658	196,100	
Bromate	15541-45-4	0.54	3.3	
Bromochloromethane	74-97-5	193	597	
Bromoxynil	1689-84-5	2.7	16	
Butylbenzene, n-	104-51-8	3,504	51,100	
Butylbenzene, sec-	135-98-8	7,009	102,200	
Butylbenzene, tert-	98-06-6	7,009	102,200	
Cadmium (food)	7440-43-9	6.9	87	
Carbaryl	63-25-2	317	1,915	
Carbon Disulfide	75-15-0	608	662	
Carbon Tetrachloride	56-23-5	0.37	2.2	
Chlorobenzene	108-90-7	414	726	
Chromium(III), Insoluble Salts	16065-83-1	40,223	360,223	
Chromium(VI)	18540-29-9	0.09	1.7	
Cobalt	7440-48-4	22	291	
Copper	7440-50-8	10,407	139,231	
Bis(2-ethylhexyl)phthalate	117-81-7	20	120	
Dibromochloropropane	96-12-8	0.01	0.06	
Dibromoethane, 1,2-	106-93-4	0.02	0.14	
Dichloroethane, 1,1-	75-34-3	2.1	13	
Dichloroethane, 1,2-	107-06-2	0.29	1.7	
Dichloroethylene, 1,2-cis-	156-59-2	140	1,814	
Dichloroethylene, 1,2-trans-	156-60-5	1,402	18,137	
Dichloropropane, 1,2-	78-87-5	1.5	9.1	
Dioxane, 1,4-	123-91-1	2.8	17	
Ethylbenzene	100-41-4	3.7	22	
Fluoranthene	206-44-0	2,301	26,371	
Fluorene	86-73-7	2,301	26,371	
Hexachlorobenzene	118-74-1	0.13	0.69	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	4.6	28	
Iron	7439-89-6	51,302	686,351	
Isopropylbenzene (cumene)	98-82-8	256	264	
Lead and Compounds	7439-92-1	400	800	
Manganese (Non-diet)	7439-96-5	1,118	11,350	
Mercury (elemental)	7439-97-6	3.1	3.1	
Methyl Ethyl Ketone (2-Butanone)	78-93-3	16,952	26,991	
Methyl tert-Butyl Ether (MTBE)	1634-04-4	649	4,464	
Molybdenum	7439-98-7	366	4,903	
Naphthalene	91-20-3	2.7	16	
Nickel	7440-02-0	940	9,707	
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	3,698	49,834	
Pentachlorophenol	87-86-5	0.48	2.9	
Pentaerythritol tetranitrate (PETN)	78-11-5	122	1,436	
Perchlorate	14797-73-0	51	686	

Appendix A - § 35-APX-A1 - Soil Standards
(see notes at end of table)

		Vermont Soil Standards (TR=1E-06, HQ=1.0)		
Analyte	**CAS Number**	**Resident Soil (mg/kg)**	**Non-Resident Soil (mg/kg)**	**Urban Background (mg/kg)**
Perfluoroheptanoic acid (PFHpA)	375-85-9	1.22[(b)]	14.36[(b)]	
Perfluorohexane sulfonic acid (PFHxS)	355-46-4			
Perfluorononanoic acid (PFNA)	375-95-1			
Perfluorooctane sulfonic acid (PFOS)	1763-23-1			
Perfluorooctanic Acid (PFOA)	335-67-1			
Polychlorinated Biphenyls (high risk)	1336-36-3	0.114[(c)]	0.68[(c)]	
Propoxur (Baygon)	114-26-1	79	476	
Propyl benzene, n-	103-65-1	253	261	
Selenium	7782-49-2	366	4,900	
Silver	7440-22-4	237	2,483	
Tetrachlorodibenzo-p-dioxin, 2,3,7,8- (TCDD)	1746-01-6	2.25E-06	1.37E-05	
Tetrachloroethane, 1,1,1,2-	630-20-6	1.3	8.0	
Tetrachloroethylene	127-18-4	2.4	14	
Thallium (soluble Thallium)	7440-28-0*	0.73	196,100	
Toluene	108-88-3	706	798	
Trichloroethylene	79-01-6	0.68	6.5	
Trichloropropane, 1,2,3-	96-18-4	3.11E-03	0.07	
Trimethylbenzene, 1,2,3-	526-73-8	144[(d)]	177[(d)]	
Trimethylbenzene, 1,2,4-	95-63-6			
Trimethylbenzene, 1,3,5-	108-67-8			
Trinitrotoluene, 2,4,6- (TNT)	118-96-7	12	70	
Uranium (Soluble Salts)	NA	44	588	
Vanadium	7440-62-2	2.8	27	
Vinyl Chloride	75-01-4	0.10	0.59	
Xylenes	1330-20-7	252	257	
Zinc	7440-66-6	21,986	294,150	

Notes:

1. Groundwater temperature of 15°C used in derivation of volatiziation factors with May 2018 Regional Screening Level Calculator.
2. Csat substitution used if soil inhalation screening value greater than Csat. Csats derived using May 2018 Regional Screening Level Calculator.
   2a. All cancer-based soil inhalation screening values were less than respective Csat thus no substitutions.
   2b. Residential noncancer-based soil inhalation screening value above respective Csat thus Csat substitiouion employed for the following: Acetone, Carbon Disulfide, Ethylbenzene, Isopropylbenzene (cumene), Mercury (elemental), Methyl ethyl ketone, Methyl tert-butyl ether, n-Propyl benzene, Tetrachloroethylene, Toluene, Trimethyl benzenes, Xylenes.
   2c. Non-residential noncancer-based soil inhalation screening value above respective Csat thus Csat substitution employed for the following: Acetone, Carbon Disulfide, Carbon tetrachloride, Chlorobezene, Ethylbenzene, Isopropylbenzene (cumene) Mercury (elemental), Methyl ethyl ketone, Methyl tert-butyl ether, n-Propyl benzene, Tetrachloroethylene, Toluene, Trimethyl benzenes, Xylenes.
3. Lead soil standards are based on the U.S. EPA Regional Screening Levels, effective November 2018.

* CAS Number is for Metallic Thallium

(a) Benzo(a)pyrene cancer-based resident value applicable to benzo(a)pyrene itself and to total benzo(a)pyrene toxic equivalents [B(a)P-TE]. Benzo(a)pyrene noncancer-based value applicable only to benzo(a)pyrene itself.

(b) PFAS - Sum of PFHpA, PFHxS, PFNA, PFOS and PFOA not to exceed applicable resident or non-resident values.

(c) PCBs- sum of all PCBs not to exceed 1.14E-01 mg/kg for the resident scenario and not to exceed 6.8E-01 for the non-resident scenario (IRIS high risk and persistence cancer toxicity values used in cancerassessment; oral reference dose for Aroclor 1254 used in noncancer assessment).

(d) Trimethyl benzenes -Sum of the three isomers not to exceed applicable resident or non-resident values, based on the most conservative value derived for an individual isomer.

VERMONT DEPARTMENT OF HEALTH
EXPOSURE ASSUMPTIONS, PARAMETER VALUES AND FACTORS
2019 RESIDENTIAL SOIL VALUES

SYMBOL	DEFINITION (units)	VALUE
RSV	Residential Soil Value (mg/kg)	Chemical-Specific
$RSV_{nc\text{-}ing}$	Resident, Soil, Noncancer, Ingestion (mg/kg)	Chemical-Specific
$RSV_{nc\text{-}der}$	Resident, Soil, Noncancer, Dermal (mg/kg)	Chemical-Specific
$RSV_{nc\text{-}inh}$	Resident, Soil, Noncancer, Inhalation (mg/kg)	Chemical-Specific
$RSV_{nc\text{-}comb}$	Resident, Soil, Noncancer, Combined Routes of Exposure (mg/kg)	Chemical-Specific
$RSV_{ca\text{-}ing}$	Resident, Soil, Cancer, Ingestion (mg/kg)	Chemical-Specific
$RSV_{ca\text{-}der}$	Resident, Soil, Cancer, Dermal (mg/kg)	Chemical-Specific
$RSV_{ca\text{-}inh}$	Resident, Soil, Cancer, Inhalation (mg/kg)	Chemical-Specific
$RSV_{ca\text{-}comb}$	Resident, Soil, Cancer, Combined Routes of Exposure (mg/kg)	Chemical-Specific
$RSV_{m\text{-}ing}$	Resident, Soil, Mutagenic, Ingestion (mg/kg)	Chemical-Specific
$RSV_{m\text{-}der}$	Resident, Soil, Mutagenic, Dermal (mg/kg)	Chemical-Specific
$RSV_{m\text{-}inh}$	Resident, Soil, Mutagenic, Inhalation (mg/kg)	Chemical-Specific
$RSV_{m\text{-}comb}$	Resident, Soil, Mutagenic, Combined Routes of Exposure (mg/kg)	Chemical-Specific
RfD_O	Chronic Oral Reference Dose (mg/kg-d)	Chemical-Specific
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Chemical-Specific
CSF_O	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Chemical-Specific
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-Specific
THQ	Target Hazard Quotient (unitless)	1.0
TR	Target Incremental Lifetime Cancer Risk (unitless)	$1x10^{-6}$
LT	Lifetime (years)	70
$AT_{R\text{-}nc}$	Averaging Time, Resident, Noncancer (days)	$365 \times ED_{YC} = 2190$
$AT_{R\text{-}ca}$	Averaging Time, Resident, Cancer (days)	$365 \times ED_{LT} = 25550$
IR_{YC}	Soil Ingestion Rate, Young $Child_{Birth\text{-}<6years}$ (mg/day)	200
IR_{OC}	Soil Ingestion Rate, Older $Child_{6\text{-}<18years}$ (mg/day)	100
$IR_{Birth\text{-}<2\ yr}$	Soil Ingestion Rate, Fine Age Range $Child_{Birth\text{-}<2years}$ (mg/day)	200
$IR_{2\text{-}<6yr}$	Soil Ingestion Rate, Fine Age Range $Child_{2\text{-}<6years}$ (mg/day)	200
$IR_{6\text{-}<16yr}$	Soil Ingestion Rate, Fine Age Range $Child_{6\text{-}<16years}$ (mg/day)	100
$IR_{16\text{-}<18yr}$	Soil Ingestion Rate, Fine Age Range $Child_{16\text{-}<18years}$ (mg/day)	100
IR_A	Soil Ingestion Rate, Adult (mg/day)	100
$IFS_{R\text{-}adj}$	Resident Soil Ingestion Rate Factor, Age-adjusted (mg/kg)	65,439
$IFSM_{R\text{-}adj}$	Resident Mutagenic Soil Ingestion Rate Factor, Age-adjusted (mg/kg)	250,620
SA_{YC}	Skin Surface Area, Young $Child_{Birth\text{-}<6years}$ (cm^2)	2336
SA_{OC}	Skin Surface Area, Older $Child_{6\text{-}<18years}$ (cm^2)	4591
$SA_{Birth\text{-}<2\ yr}$	Skin Surface Area, Fine Age Range $Child_{Birth\text{-}<2years}$ (cm^2)	2028
$SA_{2\text{-}<6yr}$	Skin Surface Area, Fine Age Range $Child_{2\text{-}<6years}$ (cm^2)	2490
$SA_{6\text{-}<16yr}$	Skin Surface Area, Fine Age Range $Child_{6\text{-}<16years}$ (cm^2)	4407
$SA_{16\text{-}<18yr}$	Skin Surface Area, Fine Age Range $Child_{16<18years}$ (cm^2)	5512
SA_A	Skin Surface Area, Adult (cm^2)	6034
$DFS_{R\text{-}adj}$	Soil Dermal Contact Factor, Age-adjusted (mg/kg)	266,522
$DFSM_{R\text{-}adj}$	Mutagenic Soil Dermal Contact Factor, Age-adjusted (mg/kg)	770,281
AD_c	Soil on Skin Adherence Factor, Child (mg/cm^2)	0.2
AD_A	Soil on Skin Adherence Factor, Adult (mg/cm^2)	0.07
BW_{YC}	Body Weight, Young $Child_{Birth\text{-}<6years}$ (kg)	15

BW_{OC}	Body Weight, Older $Child_{6-<18years}$ (kg)	48
$BW_{Birth-<2yr}$	Body Weight, Fine Age Range, $Child_{Birth-<2years}$ (kg)	10
$BW_{2-<6yr}$	Body Weight, Fine Age Range, $Child_{2-<6years}$ (kg)	17
$BW_{6-<16yr}$	Body Weight, Fine Age Range, $Child_{6-<16years}$ (kg)	44
$BW_{16-<18yr}$	Body Weight, Fine Age Range, $Child_{16<18years}$ (kg)	67
BW_A	Body Weight, Adult (kg)	70
ABS_d	Fraction of chemical absorbed from soil due to dermal contact (unitless)	Chemical-specific
ABS_{GI}	Fraction of chemical absorbed in gastrointestinal tract (unitless). If ABS_{GI} >50%, a value of 1 (100%) used.	Chemical-specific
EF_{YC}	Exposure Frequency, Young $Child_{Birth-<6years}$ (days/year)	365
EF_{OC}	Exposure Frequency, Older $Child_{6-<18years}$ (days/year)	365
$EF_{Birth-<2yr}$	Exposure Frequency, Fine Age Range $Child_{Birth-<2years}$ (days/year)	365
$EF_{2-<6yr}$	Exposure Frequency, Fine Age Range $Child_{2-<6years}$ (days/year)	365
$EF_{6-<16yr}$	Exposure Frequency, Fine Age Range $Child_{6-<16years}$ (days/year)	365
$EF_{16-<18yr}$	Exposure Frequency, Fine Age Range $Child_{16-<18years}$ (days/year)	365
EF_A	Exposure Frequency, Adult (days/year)	365
ED_{YC}	Exposure Duration, Young $Child_{Birth-<6years}$ (years)	6
ED_{OC}	Exposure Duration, Older $Child_{6-<18years}$ (years)	12
$ED_{Birth-<2yr}$	Exposure Duration, Fine Age Range $Child_{Birth-<2years}$ (years)	2
$ED_{2-<6yr}$	Exposure Duration, Fine Age Range $Child_{2-<6years}$ (years)	4
$ED_{6-<16yr}$	Exposure Duration, Fine Age Range $Child_{6-<16years}$ (years)	10
$ED_{16-<18yr}$	Exposure Duration, Fine Age Range, $Child_{16-<18years}$ (years)	2
ED_A	Exposure Duration, Adult (years)	52
ET_{YC}	Exposure Time, Young $Child_{Birth-<6years}$ (hours/day)	24
ET_{OC}	Exposure Time, Older $Child_{6-<18years}$ (hours/day	24
$ET_{Birth-<2yr}$	Exposure Time, Fine Age Range $Child_{Birth-<2years}$ (hours/day)	24
$ET_{2-<6yr}$	Exposure Time, Fine Age Range $Child_{2-<6years}$ (hours/day)	24
$ET_{6-<16yr}$	Exposure Time, Fine Age Range $Child_{6-<16years}$ (hours/day)	24
$ET_{16-<18yr}$	Exposure Time, Fine Age Range $Child_{16-<18years}$ (hours/day)	24
ET_A	Exposure Time, Adult (hours/day)	24
$InFSM_{R-adj}$	Mutagenic Soil Inhalation Factor, Age-adjusted (days)	42,340
PEF	Particulate Emission Factor (wind-driven) (m^3/kg)	1.36×10^9
VF	Volatilization Factor (m^3/kg)	Chemical-Specific
RBA	Relative Bioavailability (unitless)	1
SCMF	Snow Cover Modification Factor (unitless)	(e)

Notes:
(a) Surface areas derived using information presented in EPA, 2011 and Boniol et al., 2007 for sexes combined. Mean of 50th percentile (consistent with EPA, 1989 p. 3-39) Total Body Surface Area for each age range of interest developed. Head, hands, forearms, lower legs and feet considered in contact/exposed for all Child age ranges. Consistent with EPA, 2004 (p. 3-10), head, hands, forearms and lower legs considered for Adult. Percent of Total Surface Area represented by body parts considered in contact/exposed was calculated (mean across age range of interest).
(b) Average mean annual Body Weight for age range of interest (based on both sexes) derived using information presented in Portier, et al., 2007.
(c) Default value employed in U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites. (accessed January 2019).
(d) Chemical-specific Volatilization Factors from U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites. (accessed September 10, 2018 through February 4, 2019).
(e) Snow Cover Modification Factor (SCMF) of 0.7342 applied only to soil inhalation route and only for chemicals that meet "v" criteria (effectively yields exposure frequency of 268 days per year for this route of exposure for this receptor). SCMF of 1 employed for all other routes and for chemicals that do not meet "v" criteria.

References:

Boniol, et al, 2007. Proportion of skin surface area of children and young adults from 2 to 18 years old. J Investig Dermatol 128(2):461-464.

EPA, 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. United States Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/002. December 1989.

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". United States Environmental Protection Agency. . Office of Solid Waste and Emergency Response. OSWER Publication 9285.6-03. March 1991.

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. U.S. Environmental Protection Agency. Washington, D.C. OSWER 9355.4-24-02. December 2002.

EPA, 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. U.S. Environmental Protection Agency. Washington, D.C. OSWER 9285.7-02EP. July 2004.

EPA, 2011. Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency. Office of Research and Development. Washington, D.C. EPA/600/R-090/052F. September 2011.

EPA, 2018. United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. User's Guide. May and November 2018 editions. (accessed various times September 10, 2018 – February 4, 2019).

Portier et al., 2007. Body weight distributions for risk assessment. Risk Anal 27(1):11-26.

VERMONT DEPARTMENT OF HEALTH
ENDPOINT AND PATHWAY SPECIFIC EQUATIONS
2019 RESIDENTIAL SOIL VALUES

- **Noncarcinogenic (threshold type, systemic effects)**

Residential Soil Values

- Ingestion

$$RSV_{nc-ing}(mg/kg) = \frac{THQ * AT_{R-nc}\left(\frac{365\ days}{year} * ED_{YC}(6\ years)\right) * BW_{YC}(15\ kg)}{EF_{YC}\left(\frac{365\ days}{year}\right) * ED_{YC}(6\ years) * \frac{RBA}{RfD_0\left(\frac{mg}{kg-day}\right)} * IR_{YC}\left(\frac{200\ mg}{day}\right) * \frac{10^{-6}\ kg}{1\ mg}}$$

- Dermal

$$RSV_{nc-der}(mg/kg) = \frac{THQ * AT_{R-nc}\left(\frac{365\ days}{year} * ED_{YC}(6\ years)\right) * BW_{YC}(15\ kg)}{EF_{YC}\left(\frac{365\ days}{year}\right) * ED_{YC}(6\ years) * \frac{1}{\left(RfD_0\left(\frac{mg}{kg-day}\right) * ABS_{GI}\right)} * SA_{YC}\left(\frac{2336\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right) * ABS_d * \frac{10^{-6}\ kg}{1\ mg}}$$

- Inhalation

$$RSV_{nc-inh}(mg/kg) = \frac{THQ * AT_{R-nc}\left(\frac{365\ days}{year} * ED_{YC}(6\ years)\right)}{EF_{YC}\left(\frac{365\ days}{year}\right) * SCMF * ED_{YC}(6\ years) * ET_{YC}\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right) * \frac{1}{RfC\left({}^{mg}/_{m^3}\right)} * \left(\frac{1}{VF\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

- Combined Routes of Exposure

RSVs for individual routes of exposure and various routes combined are presented in Attachment 2a

$$RSV_{nc-comb}(mg/kg) = \frac{1}{\frac{1}{RSV_{nc-ing}} + \frac{1}{RSV_{nc-der}} + \frac{1}{RSV_{nc-inh}}}$$

- **Carcinogenic**

Residential Soil Values

- Ingestion

$$RSV_{ca-ing}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{CSF_0\left(\frac{mg}{kg-day}\right)^{-1} * RBA * IFS_{R-adj}\left(\frac{65{,}439\ mg}{kg}\right) * \frac{10^{-6}\ kg}{mg}}$$

Where:

$$IFS_{R-adj}\left(\frac{65{,}439\ mg}{kg}\right) = \frac{EF_{YC}\left(\frac{365\ days}{year}\right) * ED_{YC}(6\ years) * IRS_{YC}\left(\frac{200\ mg}{day}\right)}{BW_{YC}(15\ kg)} + \frac{EF_{OC}\left(\frac{365\ days}{year}\right) * ED_{OC}(12\ years) * IRS_{OC}\left(\frac{100\ mg}{day}\right)}{BW_{OC}(48\ kg)} +$$

$$\frac{EF_A\left(\frac{365\ days}{year}\right) *\ ED_A(52\ years) * IRS_A\left(\frac{100\ mg}{day}\right)}{BW_A(70\ kg)}$$

- Dermal

$$RSV_{ca-der}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{\left(\frac{CSF_0\left(\frac{mg}{kg-day}\right)^{-1}}{ABS_{GI}}\right) * DFS_{R-adj}\left(\frac{266{,}522\ mg}{kg}\right) * ABS_d * \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Where:

$$DFS_{R-adj}\left(\frac{266{,}522\ mg}{kg}\right) = \frac{EF_{YC}\left(\frac{365\ days}{year}\right) * ED_{YC}(6\ years) * SA_{YC}\left(\frac{2336\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right)}{BW_{yc}(15\ kg)} + \frac{EF_{OC}\left(\frac{365\ days}{year}\right) * ED_{OC}(12\ years) * SA_{OC}\left(\frac{4591\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right)}{BW_{OC}(48\ kg)} + \frac{EF_A\left(\frac{365\ days}{year}\right) * ED_A(52\ years) * SA_A\left(\frac{6034\ cm^2}{day}\right) * AD_A\left(\frac{0.07\ mg}{cm^2}\right)}{BW_A(70\ kg)}$$

- Inhalation

$$RSV_{ca-inh}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR\left(^{\mu g}/_{m^3}\right)^{-1} * \left(\frac{1000\ \mu g}{mg}\right) * EF_R\left(\frac{365\ days}{year}\right) * SCMF * \left(\frac{1}{VF\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right) * ED_R(70\ years) * ET_R\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

- Combined Routes of Exposure

RSVs for individual routes of exposure and various routes combined are presented in Attachment 2a

$$RSV_{ca-comb}(mg/kg) = \frac{1}{\frac{1}{RSV_{ca-ing}} + \frac{1}{RSV_{ca-der}} + \frac{1}{RSV_{ca-inh}}}$$

- **Carcinogenic via Mutagenic Mode of Action and Default ADAFs used**

Residential Soil Values

- Ingestion

$$RSV_{m-ing}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{CSF_0\left(\frac{mg}{kg-day}\right)^{-1} * RBA * IFSM_{R-adj}\left(\frac{250{,}620\ mg}{kg}\right) * \frac{10^{-6}\ kg}{mg}}$$

Where:

$IFSM_{R-adj}\left(\frac{250{,}620\ mg}{kg}\right) =$

$$\frac{EF_{Birth-<2yr}\left(\frac{365\ days}{year}\right) * ED_{Birth-<2yr}(2\ years) * IR_{Birth-<2yr}\left(\frac{200\ mg}{day}\right) * 10}{BW_{Birth-<2yrs}(10\ kg)} + \frac{EF_{2-<6yr}\left(\frac{365\ days}{year}\right) * ED_{2-<6yr}(4\ years) * IR_{2-<6yr}\left(\frac{200\ mg}{day}\right) * 3}{BW_{2-<6yrs}(17\ kg)} + \frac{EF_{6-<16yr}\left(\frac{365\ days}{year}\right) * ED_{6-<16yr}(10\ years) * IR_{6-<16yr}\left(\frac{100\ mg}{day}\right) * 3}{BW_{6-<16yr}(44\ kg)} + \frac{EF_{16-<18yr}\left(\frac{365\ days}{year}\right) * ED_{16-<18yr}(2\ years) * IR_{16-<18yr}\left(\frac{100\ mg}{day}\right) * 1}{BW_{16-<18yr}(67\ kg)} + \frac{EF_{A}\left(\frac{365\ days}{year}\right) * ED_{A}(52\ years) * IR_{A}\left(\frac{100\ mg}{day}\right) * 1}{BW_{A}(70\ kg)}$$

- Dermal

$$RSV_{m-der}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{\left(\frac{CSF_0\left(\frac{mg}{kg-day}\right)^{-1}}{ABS_{GI}}\right) * DFSM_{R-adj}\left(\frac{770{,}281\ mg}{kg}\right) * ABS_d * \left(\frac{10^{-6}\ kg}{mg}\right)}$$

Where:

$$DFSM_{R-adj}\left(\frac{770{,}281\ mg}{kg}\right) =$$

$$\frac{EF_{Birth-<2yr}\left(\frac{365\ days}{year}\right) * ED_{Birth-<2yr}(2\ years) * SA_{Birth-<2yr}\left(\frac{2028\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right) * 10}{BW_{Birth-<2yrs}(10\ kg)} + \frac{EF_{2-<6yr}\left(\frac{365\ days}{year}\right) * ED_{2-<6yr}(4\ years) * SA_{2-<6yr}\left(\frac{2490\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right) * 3}{BW_{2-<6yr}(17\ kg)} + \frac{EF_{6-<16yr}\left(\frac{365\ days}{year}\right) * ED_{6-<16yr}(10\ years) * SA_{6-<16yr}\left(\frac{4407\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right) * 3}{BW_{6-<16yr}(44\ kg)} \frac{EF_{16-<18yr}\left(\frac{365\ days}{year}\right) * ED_{16-<18yr}(2\ years) * SA_{16-<18yr}\left(\frac{5512\ cm^2}{day}\right) * AD_C\left(\frac{0.2\ mg}{cm^2}\right) * 1}{BW_{16-<18yr}(67\ kg)} + \frac{EF_{A}\left(\frac{365\ days}{year}\right) * ED_{A}(52\ years) * SA_{A}\left(\frac{6034\ cm^2}{day}\right) * AD_{A}\left(\frac{0.07\ mg}{cm^2}\right) * 1}{BW_{A}(70\ kg)}$$

- Inhalation

$$RSV_{m-inh}(mg/kg) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * \left(\frac{1000\ \mu g}{mg}\right) * SCMF * \left(\frac{1}{VF\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right) * \ InFSM_{R-adj}(42{,}340\ days)}$$

Where:

$InFSM_{R\text{-}adj}$ (42,340 days) =

$$\left[ET_{Birth-<2yr}\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right) * EF_{Birth-<2yr}\left(\frac{365\ days}{year}\right) * ED_{Birth-<2yr}(2\ years) * 10\right] +$$

$$\left[ET_{2-<6yr}\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right) * EF_{2-<6yr}\left(\frac{365\ days}{year}\right) * ED_{2-<6yr}(4\ years) * 3\right] +$$

$$\left[ET_{6-<16yr}\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right) * EF_{6-<16yr}\left(\frac{365\ days}{year}\right) * ED_{6-<16yr}(10\ years) * 3\right] +$$

$$\left[ET_{16-<18yr}\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right) * EF_{16-<18yr}\left(\frac{365\ days}{year}\right) * ED_{16-<18yr}(2\ years) * 1\right] +$$

$$[ET_A\left(\frac{24\ hours}{day}\ *\ \frac{1\ day}{24\ hours}\right) * EF_A\left(\frac{365\ days}{year}\right) * ED_A(52\ years) * 1]$$

- Combined Pathways

RSVs for individual routes of exposure and various routes combined are presented in Attachment 2a

$$RSV_{m-comb}(mg/kg) = \frac{1}{\frac{1}{RSV_{m-ing}} + \frac{1}{RSV_{m-der}} + \frac{1}{RSV_{m-inh}}}$$

VERMONT DEPARTMENT OF HEALTH
EXPOSURE ASSUMPTIONS, PARAMETER VALUES AND FACTORS
2019 COMMERCIAL WORKER SOIL VALUES

SYMBOL	DEFINITION (units)	VALUE
CSV	Commercial Worker Soil Value (mg/kg)	Chemical-Specific
$CSV_{nc\text{-}ing}$	Commercial Worker, Soil, Noncancer, Ingestion (mg/kg)	Chemical-Specific
$CSV_{nc\text{-}der}$	Commercial Worker, Soil, Noncancer, Dermal (mg/kg)	Chemical-Specific
$CSV_{nc\text{-}inh}$	Commercial Worker, Soil, Noncancer, Inhalation (mg/kg)	Chemical-Specific
$CSV_{nc\text{-}comb}$	Commercial Worker, Soil, Noncancer, Combined Routes of Exposure (mg/kg)	Chemical-Specific
$CSV_{ca\text{-}ing}$	Commercial Worker, Soil, Cancer, Ingestion (mg/kg)	Chemical-Specific
$CSV_{ca\text{-}der}$	Commercial Worker, Soil, Cancer, Dermal (mg/kg)	Chemical-Specific
$CSV_{ca\text{-}inh}$	Commercial Worker, Soil, Cancer, Inhalation (mg/kg)	Chemical-Specific
$CSV_{ca\text{-}comb}$	Commercial Worker, Soil, Cancer, Combined Routes of Exposure (mg/kg)	Chemical-Specific
RfD_O	Chronic Oral Reference Dose (mg/kg-d)	Chemical-Specific
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Chemical-Specific
CSF_O	Oral Cancer Slope Factor $(mg/kg\text{-}d)^{-1}$	Chemical-Specific
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-Specific
THQ	Target Hazard Quotient (unitless)	1.0
TR	Target Incremental Lifetime Cancer Risk (unitless)	$1x10^{-6}$
LT	Lifetime (years)	70
$AT_{R\text{-}nc}$	Averaging Time, Commercial Worker, Noncancer (days)	$365 \times ED_W = 9125$
$AT_{R\text{-}ca}$	Averaging Time, Commercial Worker, Cancer (days)	$365 \times ED_{LT} = 25550$
IR_W	Soil Ingestion Rate, Commercial Worker (mg/day)	100
SA_W	Skin Surface Area, Adult (cm^2)	3527
AD_W	Soil on Skin Adherence Factor, Adult (mg/cm^2)	0.12
BW_W	Body Weight, Adult (kg)	70
ABS_d	Fraction of chemical absorbed from soil due to dermal contact (unitless)	Chemical-specific
ABS_{GI}	Fraction of chemical absorbed in gastrointestinal tract (unitless). If ABS_{GI} >50%, a value of 1 (100%) used.	Chemical-specific
EF_W	Exposure Frequency, Ingestion & Dermal Commercial Worker (days/year)	250
ET_W	Exposure Time, Adult (hours/day)	10
PEF	Particulate Emission Factor (wind-driven) (m^3/kg)	1.36×10^9
VF	Volatilization Factor (m^3/kg)	Chemical-Specific
RBA	Relative Bioavailability (unitless)	1

Notes:
(a) Surface areas derived using information presented in EPA, 2011, Table 7-2; weighted average of mean values for head, hands, and forearms (male and female, 21+years)
(b) Average mean annual Body Weight for age range of interest (based on both sexes) derived using information presented in Portier, et al., 2007.
(c) Default value employed in U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (accessed January 2019).
(d) Chemical-specific Volatilization Factors from U.S. EPA Regional Screening Levels for Chemical Contaminants at Superfund Sites (accessed September 10, 2018 through February 2019).

References:

BLS, 2016. United States Bureau of Labor Statistics. Division of Labor Force Statistics. Labor Force Statistics from Current Population Survey. Household Data. Annual Average. Last modified February 8, 2017 (accessed 3/28/2017) https://www.bls.gov/cps/cpsaat19.htm.

EPA, 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. United States Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/002. December 1989.

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". United States Environmental Protection Agency. . Office of Solid Waste and Emergency Response. OSWER Publication 9285.6-03. March 1991.

EPA, 2002. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. U.S. Environmental Protection Agency. Washington, D.C. OSWER 9355.4-24-02. December 2002.

EPA, 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. U.S. Environmental Protection Agency. Washington, D.C. OSWER 9285.7-02EP. July 2004.

EPA, 2011. Exposure Factors Handbook 2011 Edition (Final). U.S. Environmental Protection Agency. Office of Research and Development. Washington, D.C. EPA/600/R-090/052F. September 2011.

EPA, 2015. United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. User's Guide. November 2015 edition. (accessed December 11, 2015).

EPA, 2018. United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. User's Guide. May and November 2018 editions. (accessed September 10, 2018 through February 2019).

Portier et al., 2007. Body weight distributions for risk assessment. Risk Anal 27(1):11-26.

VERMONT DEPARTMENT OF HEALTH
ENDPOINT AND PATHWAY SPECIFIC EQUATIONS
2019 COMMERCIAL WORKER SOIL VALUES

- **Noncarcinogenic (threshold type, systemic effects)**
  Commercial Worker Soil Values

  - Ingestion

$$CSV_{nc-ing}(mg/kg) = \frac{THQ * AT_{W-nc}\left(\frac{365\ days}{year} * ED_W(30\ years)\right) * BW_W(70\ kg)}{EF_W\ \left(\frac{250\ days}{year}\right) * ED_W(30\ years) * \frac{RBA}{RfD_0\left(\frac{mg}{kg-day}\right)} * IR_W\left(\frac{100\ mg}{day}\right) * \frac{10^{-6}\ kg}{1\ mg}}$$

  - Dermal

$$CSV_{nc-der}(mg/kg) = \frac{THQ * AT_{W-nc}\left(\frac{365\ days}{year} * ED_W(30\ years)\right) * BW_W(70\ kg)}{EF_W\ \left(\frac{250\ days}{year}\right) * ED_W(30\ years) * \frac{1}{\left(RfD_0\left(\frac{mg}{kg-day}\right) * ABS_{GI}\right)} * SA_W\left(\frac{3527}{day}\right) * AD_W\left(\frac{0.12\ mg}{cm^2}\right) * ABS_d * \frac{10^{-6}\ kg}{1\ mg}}$$

  - Inhalation

$$CSV_{nc-inh}(mg/kg) = \frac{THQ * AT_{W-nc}\left(\frac{365\ days}{year} * ED_W(30\ years)\right)}{EF_W\left(\frac{250\ days}{year}\right) * ED_W(30\ years) * ET_W\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right) * \frac{1}{RfC\left({}^{mg}/_{m^3}\right)} * \left(\frac{1}{VF\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right)}$$

  - Combined Routes of Exposure
    CSVs for individual routes of exposure and various routes combined are presented in Attachment 2b

$$CSV_{nc-comb}(mg/kg) = \frac{1}{\frac{1}{CSV_{nc-ing}} + \frac{1}{CSV_{nc-der}} + \frac{1}{CSV_{nc-inh}}}$$

- **Carcinogenic**
- Commercial Worker Soil Values

    - Ingestion

$$CSV_{ca-ing}(mg/kg) = \frac{TR * AT_{W-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{CSF_0\left(\frac{mg}{kg-day}\right)^{-1} * RBA * \left(\frac{EF_W\left(\frac{250\ days}{year}\right) * ED_W(30 years) * IRS_W\left(\frac{100\ mg}{day}\right)}{BW\ (70kg)}\right) * \frac{10^{-6}\ kg}{mg}}$$

    - Dermal

$$CSV_{ca-der}(mg/kg) = \frac{TR * AT_{W-ca}\left(\frac{365\ days}{year} * LT(70\ years)\right)}{\left(\frac{CSF_0\left(\frac{mg}{kg-day}\right)^{-1}}{ABS_{GI}}\right) * \left(\frac{EF_W\left(\frac{250\ days}{year}\right) * ED_W(30\ years) * SA_W\left(\frac{3527\ cm^2}{day}\right) * AD_W\left(\frac{0.12\ mg}{cm^2}\right)}{BW\ (70kg)}\right) * ABS_d * \left(\frac{10^{-6}\ kg}{mg}\right)}$$

    - Inhalation

$$CSV_{ca-inh}(mg/kg) = \frac{TR * AT_{W-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * \left(\frac{1000\ \mu g}{mg}\right) * EF_W\left(\frac{250\ days}{year}\right) * \left(\frac{1}{VF\left(\frac{m^3}{kg}\right)} + \frac{1}{PEF\left(\frac{m^3}{kg}\right)}\right) * ED_W(30\ years) * ET_W\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

    - Combined Routes of Exposure

      CSVs for individual routes of exposure and various routes combined are presented in Attachment 2b

$$CSV_{ca-comb}(mg/kg) = \frac{1}{\frac{1}{CSV_{ca-ing}} + \frac{1}{CSV_{ca-der}} + \frac{1}{CSV_{ca-inh}}}$$

Appendix A - § 35-APX-A2. Vapor Intrusion Standards

		Indoor Air Standards (TR=1E-06, HQ=1.0)		Vapor Intrusion Standards - Sub-slab Soil Gas		Vapor Intrusion Standards - Groundwater	
Analyte	CAS Number	Resident (µg/m3)	Non-resident (µg/m3)	Resident (µg/m3)	Non-resident (µg/m3)	Resident (µg/L)	Non-resident (µg/L)
Benzene	71-43-2	0.13	1.05	4.3	35	0.92	7.4
Carbon Tetrachloride	56-23-5	0.17	1.36	5.7	45	0.24	1.9
Chloroethane	75-00-3	10,000.00	35,040.00	330,000	1,200,000	31,000	110,000
Chloroform	67-66-3	0.04	0.36	1.3	12	0.41	3.7
Dichloroethane, 1,1-	75-34-3	0.63	5.11	21	170	4.2	34
Dichloroethylene, 1,1-	75-35-4	200.00	700.8	6,700	23,000	270	950
Ethylbenzene	100-41-4	0.40	3.27	13	110	2.2	18
Mercury (elemental)	7439-97-6	0.30	0.3 (b)	10	10	2.0	2.0
Methylene Chloride	75-09-2	60.34	817.60	2,000	27,000	680	9,300
Naphthalene	91-20-3	0.262[(c)]	0.262[(c)]	1.0	8.0	4	28
Tetrachloroethylene	127-18-4	0.63	5.11	21	170	1.5	12
Trichloroethylene	79-01-6	0.20	0.7 (a)	6.7	23	0.82	2.9
Trimethylbenzene, 1,2,3-	526-73-8	60[(d)]	210.24[(d)]	2000[(d)]	7000[(d)]	790	2,800
Trimethylbenzene, 1,2,4-	95-63-6					470	1,700
Trimethylbenzene, 1,3,5-	108-67-8					330	1,200
Vinyl Chloride	75-01-4	0.11	1.86	3.7	62	0.13	2.2

Notes:

1. The VI Screening Values for soil gas and groundwater were calculated from the indoor air standards using the USEPA Vapor Intrusion Screening Level Calculator. The sub-slab soil gas concentration is the target indoor air concentration divided by the generic attenuation factor for soil gas (0.03). Target groundwater concentrations were calculated based on an ambient groundwater temperature of 15˚ C and a generic attenuation factor for groundwater (0.001).

[(a)] Due to the nature and severity of a particular non-cancer endpoint (fetal cardiac malformations) that may be associated with a brief window of susceptability, there is significant uncertainty regarding the exposure period of concern. Thus, a target hazard quotient of 0.1 was used in the calculation of the non-cancer values.

[(b)] Due to the developmental toxicity associated with mercury exposure, the reference concentration is used as the nonresidental air value without adjusting for the exposure period.

[(c)]The indoor air values for naphthalene have been adjusted upwards from the risk-based values (0.03/0.24) to reflect the laboratory method detection limit value.

[(d)] Trimethylbenzenes - Sum of the three isomers not to exceed applicable resident or non-resident values, based on the most conservative value derived for an individual isomer.

VERMONT DEPARTMENT OF HEALTH
EXPOSURE ASSUMPTIONS, PARAMETER VALUES AND FACTORS
2019 RESIDENTIAL AIR VALUES (RAVs)
2019 NONRESIDENTIAL AIR VALUES (NAVs)

SYMBOL	DEFINITION (units)	VALUE
RAV	Residential Air Value ($\mu g/m^3$)	Chemical-Specific
$RAV_{nc\text{-}inh}$	Resident, Air, Noncancer, Inhalation ($\mu g/m^3$)	Chemical-Specific
$RAV_{ca\text{-}inh}$	Resident, Air, Cancer, Inhalation ($\mu g/m^3$)	Chemical-Specific
$RAV_{m\text{-}inh}$	Resident, Air, Mutagenic, Inhalation ($\mu g/m^3$)	Chemical-Specific
NAV	Nonresidential Air Value ($\mu g/m^3$)	Chemical-Specific
$NAV_{nc\text{-}inh}$	Nonresidential, Air, Noncancer, Inhalation ($\mu g/m^3$)	Chemical-Specific
$NAV_{ca\text{-}inh}$	Nonresidential, Air, Cancer, Inhalation ($\mu g/m^3$)	Chemical-Specific
RfC	Chronic Inhalation Reference Concentration (mg/m^3)	Chemical-Specific
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-Specific
THQ	Target Hazard Quotient (unitless)	1.0
TR	Target Incremental Lifetime Cancer Risk (unitless)	$1x10^{-6}$
LT	Lifetime (years)	70
$AT_{R\text{-}ca}$	Averaging Time, Resident, Cancer (days)	365 x ED_R=25550
$AT_{N\text{-}nc}$	Averaging Time, Nonresidential, Noncancer (days)	365 x ED_N=10950
$AT_{N\text{-}ca}$	Averaging Time, Nonresidential, Cancer (days)	365 x ED_N=25550
EF_R	Resident Exposure Frequency (days/year)	365
$EF_{Birth\text{-}<2yr}$	Resident Exposure Frequency, Fine Age Range $Child_{Birth\text{-}<2years}$ (days/year)	365
$EF_{2\text{-}<6yr}$	Resident Exposure Frequency, Fine Age Range $Child_{2\text{-}<6years}$ (days/year)	365
$EF_{6\text{-}<16yr}$	Resident Exposure Frequency, Fine Age Range $Child_{6\text{-}<16years}$ (days/year)	365
$EF_{16\text{-}<18yr}$	Resident, Exposure Frequency, Fine Age Range $Child_{16\text{-}<18years}$ (days/years)	365
EF_A	Resident Exposure Frequency, Adult (days/year)	365
EF_N	Nonresidential Exposure Frequency (days/year)	250
ED_R	Resident Exposure Duration (years)	70
$ED_{Birth\text{-}<2yr}$	Resident Exposure Duration, Fine Age Range $Child_{Birth\text{-}<2years}$ (years)	2
$ED_{2\text{-}<6yr}$	Resident Exposure Duration, Fine Age Range $Child_{2\text{-}<6years}$ (years)	4
$ED_{6\text{-}<16yr}$	Resident Exposure Duration, Fine Age Range $Child_{6\text{-}<16years}$ (years)	10
$ED_{16\text{-}<18yr}$	Resident Exposure Duration, Fine Age Range $Child_{16\text{-}<18years}$ (years)	2
ED_A	Resident Exposure Duration, Adult (years)	52
ED_N	Nonresidential Exposure Duration (years)	30
ET_R	Resident Exposure Time (hours/day)	24
$ET_{Birth\text{-}<2yr}$	Resident Exposure Time, Fine Age Range $Child_{Birth\text{-}<2years}$ (hours/day)	24
$ET_{2\text{-}<6yr}$	Resident Exposure Time, Fine Age Range $Child_{2\text{-}<6years}$ (hours/day)	24
$ET_{6\text{-}<16yr}$	Resident Exposure Time, Fine Age Range $Child_{6\text{-}<16years}$ (hours/day)	24
$ET_{16\text{-}<18yr}$	Resident Exposure Time, Fine Age Range $Child_{16\text{-}<18years}$ (hours/day)	24
ET_A	Resident Exposure Time, Adult (hours/day)	24
ET_N	Nonresidential Exposure Time (hours/day)	10
$IFAM_{R\text{-}adj}$	Resident Mutagenic Air Inhalation Factor, age-adjusted (hours)	1,016,160

Notes:
(a) General estimate of years of service for full benefits

References:

BLS, 2016. United States Bureau of Labor Statistics. Division of Labor Force Statistics. Labor Force Statistics from Current Population Survey. Household Data. Annual Average. Last modified February 8, 2017 (accessed 3/28/2017) https://www.bls.gov/cps/cpsaat19.htm.

EPA, 1989. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. United States Environmental Protection Agency. Office of Emergency and Remedial Response. Washington, D.C. EPA/540/1-89/002. December 1989.

EPA, 1991. Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors". United States Environmental Protection Agency. Office of Solid Waste and Emergency Response. OSWER Publication 9285.6-03. March 1991.

EPA, 2016. United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. User's Guide. May 2016 edition. (accessed June 6, 2016). https://www.epa.gov/risk/regional-screening-levels-rsls.

VERMONT DEPARTMENT OF HEALTH
SCENARIO, ENDPOINT AND PATHWAY SPECIFIC EQUATIONS
2019 RESIDENTIAL AIR VALUES (RAVs)
2019 NONRESIDENTIAL AIR VALUES (NAVs)

I. RESIDENTIAL AIR VALUES

- **Noncarcinogenic (threshold type, systemic effects)**

  - Inhalation (simplified equation)

$$RAV_{nc-inh}(\mu g/m^3) = INHALATION\ REFERENCE\ CONCENTRATION\ (\mu g/m^3) * \text{THQ}$$

- **Carcinogenic**

  - Inhalation

$$RAV_{ca-inh}(\mu g/m^3) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * EF_R\left(\frac{365\ days}{year}\right) * ED_R(70\ years) * ET_R\left(\frac{24\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

- **Carcinogenic via Mutagenic Mode of Action and Default ADAFs used**

  - Inhalation

$$RAV_{m-inh}(\mu g/m^3) = \frac{TR * AT_{R-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * \left(\frac{1\ day}{24\ hours}\right) * IFAM_{R-adj}(\ 1{,}016{,}160\ hours)}$$

Where:

$IFAM_{R\text{-}adj}$ (1,016,160 hours) =

$$[ET_{Birth-<2yr}\left(\frac{24\ hours}{day}\right) * EF_{Birth-<2yr}\left(\frac{365\ days}{year}\right) * ED_{Birth-<2yr}(2\ years) * 10] +$$
$$[ET_{2-<6yr}\left(\frac{24\ hours}{day}\right) * EF_{2-<6yr}\left(\frac{365\ days}{year}\right) * ED_{2-<6yr}(4\ years) * 3] +$$
$$[ET_{6-<16yr}\left(\frac{24\ hours}{day}\right) * EF_{6-<16yr}\left(\frac{365\ days}{year}\right) * ED_{6-<16yr}(10\ years) * 3] +$$
$$[ET_{16-<18yr}\left(\frac{24\ hours}{day}\right) * EF_{16-<18yr}\left(\frac{365\ days}{year}\right) * ED_{16-<18yr}(2\ years) * 1] +$$
$$[ET_A\left(\frac{24\ hours}{day}\right) * EF_A\left(\frac{365\ days}{year}\right) * ED_A(52\ years) * 1]$$

II. NONRESIDENTIAL AIR VALUES

- **Noncarcinogenic (threshold type, systemic effects)**
  - Inhalation

$$NAV_{nc-inh}(\mu g/m^3) = \frac{THQ * AT_{N-nc}\left(\frac{365\ days}{year} * ED_N\ (30\ years)\right) * \left(\frac{1000\ \mu g}{mg}\right)}{\frac{1}{RfC(\frac{mg}{m^3})} * EF_N\left(\frac{250\ days}{year}\right) * ED_N(30\ years) * ET_N\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

- **Carcinogenic**
  - Inhalation

$$NAV_{ca-inh}(\mu g/m^3) = \frac{TR * AT_{N-ca}\left(\frac{365\ days}{year} * LT\ (70\ years)\right)}{IUR(^{\mu g}/_{m^3})^{-1} * EF_N\left(\frac{250 days}{year}\right) * ED_N(30\ years) * ET_N\left(\frac{10\ hours}{day} * \frac{1\ day}{24\ hours}\right)}$$

Table 3-Recommended Sediment Quality Guidelines for the Protection of Aquatic Biota in Freshwater Ecosystems			
Analyte	**TEC**	**PEC**	**Notes**
Metals (in mg/kg - ppm DW)			
Arsenic	9.79	33	1,2
Cadmium	0.99	4.98	1,2
Chromium	43.4	111	1,2
Copper	31.6	149	1,2
Lead	35.8	128	1,2
Mercury	0.18	1.06	1,2,4
Nickel	22.7	48.6	1,2
Zinc	121	459	1,2
Polycyclic Aromatic Hydrocarbons (in µg/kg - ppb DW)			
Anthracene	57.2	845	1,3
Fluorene	77.4	536	1,3
Naphthalene	176	561	1,3
Phenanthrene	204	1,170	1,3
Benz(a)anthracene	108	1,050	1,3
Benzo(a)pyrene	150	1,450	1,3,4
Chrysene	166	1,290	1,3
Dibenz(a,h)anthracene	33	1,3	
Fluoranthene	423	2,230	1,3
Pyrene	195	1,520	1,3
Total PAHs	1,610	22,800	1,3
Polychlorinated Biphenyls (in µg/kg – ppb DW)			
Total PCBs	59.8	676	1,3,4
Organochlorine Pesticides (in µg/kg – ppb DW)			
Chlordane	3.24	17.6	1,3,4
Dieldrin	1.9	61.8	1,3,4
Sum DDD	4.88	28	1,3,4
Sum DDE	3.16	31.3	1,3,4
Sum DDT	4.16	62.9	1,3,4
Total DDTs	5.28	572	1,3,4
Endrin	2.22	207	1,3
Heptachlor Epoxide	2.47	16	1,3
Lindane (gamma-BHC)	2.37	4.99	1,3

Notes:**TEC** = Threshold Effect Concentration, **PEC** = Probable Effects Concentration, **DW** = dry weight

1. Consensus-Based Sediment Quality Guidelines (SQGs) from: MacDonald D.D., Ingersoll C.G. and Berger T.A. 2000. Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems. Archives of Environmental Contamination and Toxicology 39(1). 20-31.

2. SQGs for metals are based on bulk (unsorted) sediment concentrations. Concentrations of metals in sediments can be normalized on percent fines for the purpose of inter-site comparisons but not for comparisons to these SQGs.

3. The SQGs for organics are derived from samples normalized to 1 percent total organic carbon (TOC) in the sediment. The SQGs presented here are based on an assumed TOC of 1 percent. If site specific data show organic carbon content to be significantly different from 1 percent, concentrations should be normalized to 1 percent TOC (divide the site concentration by the percent TOC) prior to comparison with the SQGs in this table. If non site-specific TOC data are available, assume 1 percent TOC.

4. Included on USEPA's list of important persistent, bioaccumulative, toxic compounds (PBTs).

APPENDIX B. ESTABLISHMENT OF BACKGROUND CONCENTRATIONS

§ 35-APX-B1. ESTABLISHMENT OF SITE SPECIFIC BACKGROUND LEVELS

(a) Purpose. A PRP may conduct a site-specific background study when there is reason to believe that the contamination present is naturally occurring. An approved site specific background concentration will take the place of an adopted environmental media standard.

(b) Sampling plan. A sampling and monitoring plan must be prepared by an environmental professional that will produce data representative of the site at and around the area of interest. The plan shall identify, at a minimum, the following:

(1) The number of monitoring points that will be sampled to establish a statistically defensible data set that will substantiate the validity of the background concentrations;
(2) The location and depth of monitoring points, which shall be selected so as to be geologically and geochemically similar to the area of interest and to be unaffected by current and historic activities at the site, including by being hydrogeologically upgradient of such activities if possible;
(3) The number and frequency of the samples to be taken from the monitoring points and any existing sources of data for the media for which a background standard is proposed, including water for potable water supplies, public water sources, or non-potable wells or springs;
(4) The sampling methodology;
(5) The contaminants of concern to be analyzed in the samples that are collected;
(6) The analytical methods to be used in conducting the sample analysis;
(7) Identification of whether samples obtained prior to the approval of the monitoring plan will be used as data points and, if so, the sampling date, location, method of analysis for each of the samples to be used; and
(8) A quality assurance/quality control plan for sample collection, testing, and analysis.

(c) Review of sampling plan. The information required by subsection (b) of this section may be included in a site investigation work plan submitted under Subchapter 3. The Secretary may request additional information from an applicant when the Secretary determines that the sampling and monitoring plan may not provide data representative of the background conditions at and around the area of interest.

(d) Report on background investigation. Following the Secretary's approval of the sampling and monitoring plan and the completion of sampling, the person seeking to establish a site specific background standard shall report on the following as a part of their site investigation report required by § 35-306:

(1) All sampling results and data collected pursuant to the approved monitoring and sampling plan.

(2) An analysis of all data collected pursuant to the approved monitoring and sampling plan.

(3) Any discrepancies between the approved sampling and monitoring plan and the sampling completed for the area of interest.

(4) A proposed background concentration of all substances for which the person seeks to establish background standard and a justification for each concentration. The justification may include statistical analysis.

(5) Additional information the Secretary determines is necessary to approve or deny the proposed background groundwater concentrations.

(e) Site specific standard. Following submission of the background groundwater quality report to the Secretary, the Secretary shall approve or deny the proposed background groundwater concentrations or may establish alternative background groundwater concentrations based on the background groundwater quality report.

APPENDIX C. SITE MANAGEMENT WAIVERS

§ 35-APX-C1. TECHNICAL IMPRACTICALITY.

(a) Purpose. A technical impracticality (TI) waiver is a mechanism to manage risks to human health and the environment in situations where there is no readily available technology to complete remediation and achieve compliance with the applicable environmental media standards within a reasonable timeframe. A TI waiver does not waive the requirements to delineate the nature and extent of the release of pollutants, to remediate continuing sources of pollution, or to address potential risks to receptors.

(b) Applicability. A TI waiver may be considered as a part of § 35-903. TI waivers may be considered for any of the following:

(1) The Secretary determines that there are non-aqueous phase liquids that cannot be contained or removed.
(2) The Secretary determines that there is only one response action for the activity and it cannot obtain other necessary permits.
(3) The Secretary determines that remediation has taken place to reduce in concentration hazardous materials in groundwater and the plume has been controlled to the extent practical based on an evaluation of reliable and innovative technologies.
(4) The Secretary determines that achieving compliance with the applicable criteria is technically impracticable as determined using Directive No. 9234.2-25 issued September 1993 by the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response.

(c) Prohibition. A TI waiver is prohibited in the following circumstances:

(1) Situations where the Secretary determines that active remediation is necessary to control the migration of a plume or materially reduce the concentration of a hazardous material; or
(2) After approval of a TI waiver there would continue to be unmanaged exposure to human health receptors.

(d) Technical impracticality waiver documentation. For any PRP proposing a TI waiver, the site investigation report prepared under § 35-306 shall, in addition to all other requirements, contain the following materials:

(1) A proposal for the environmental standard or standards for which the PRP is seeking a TI waiver.
(2) A proposed TI zone for purposes of implementing the waiver that documents the following:
(A) The plume is not increasing in size or concentration in a manner which would alter the risk assumptions associated with the TI waiver request or the extent of the TI Zone.

(B) The plume is not increasing at compliance points at the TI Zone boundary.

(3) Documentation that all necessary permits have been applied for, made best efforts to obtain, and were denied.

(4) Documentation that the site has been adequately characterized including the nature and three-dimensional extent of the contamination.

(5) Any potential changes in contaminant concentrations will not pose a risk to human health or the environment.

(6) Documentation that potential exposure pathways threatening human health and the environment from polluted groundwater have been identified and appropriately managed.

(7) Documentation that all data gaps have been identified and evaluated for significance (a significant data gap would be one that limits the ability to formulate a single scientifically defensible interpretation of environmental conditions or potential risks, or that may affect the choice of remedial approach).

(8) An evaluation showing the remedial restoration times using active remedial treatments. All assumptions and the degree of uncertainty associated with any model shall be thoroughly discussed.

(9) An evaluation showing natural attenuation, based on monitoring subsequent to source remediation, has shown that groundwater will not achieve remedial criteria within a reasonable timeframe. All assumptions and the degree of uncertainty associated with any model shall be thoroughly discussed.

(10) An estimate the cost of remedial alternatives. Cost estimates shall include the present worth of construction, operation, and maintenance costs.

(11) An evaluation of implementing remediation alternatives for plume containment or for reduction of the concentration of hazardous materials in the plume.

Note: When conducting a TI waiver analysis as a part of an evaluation of cleanup options, the Agency recommends review of the following guidance documents in preparing a request for a TI waiver:

Technical Impracticability: Guidance for Evaluating Technical Impracticability of Ground-Water Restoration, September 1993. U.S. E.P.A. OSWER Directive 9234.2-25

Technical Impracticability Guidance for Groundwater, December 2013. New Jersey Department of Environmental Protection.

Draft Guidance for Applying Technical Impracticability of Groundwater, February 2014. Connecticut Department of Energy and Environmental Protection.

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APPENDIX D. HAZARDOUS MATERIALS LISTING

§35-APX-D1 HAZARDOUS MATERIALS LISTING

Pursuant to 10 V.S.A. § 6602(16)(A)(iv) any chemical or substance listed in the following table is a hazardous material.

CAS Number	Chemical Name
335-67-1	perfluorooctanic acid (PFOA)
1763-23-1	perfluoro-octane sulfonic acid (PFOS)
355-46-4	perfluorohexane sulfonic acid (PFHxS)
375-85-9	perfluoroheptanoic acid (PFHpA)
375-95-1	perfluorononanoic acid (PFNA)

APPENDIX E. CUMULATIVE RISK ASSESSMENTS

§35-APX-E1 Instructions for Calculating Cumulative Cancer Risk and Hazard Index Hypothetical Human Receptor: Soil and/or Indoor Air

Nota bene: risk-based concentration (rbc) means the calculated concentration of a chemical (or group of chemicals) in an environmental medium estimated to correspond to a fixed level of risk e.g., a target Hazard Quotient (THQ) of 1.0 for noncarcinogenic (systemic, threshold) effects or target incremental lifetime cancer risk (ILCR) of one-in-one-million ($1x10^{-6}$), for a predefined hypothetical human exposure scenario. Examples of rbcs for different environmental media based on different hypothetical exposure scenarios are included in this appendix as Tables 1-3.

I. SAMPLE-WISE APPROACH

For **each** Hypothetical Human Receptor Scenario and exposure medium (i.e., Soil, Indoor Air):

1. In accordance with the IRULE, **for each sample**, identify chemicals that are present above detection and retained for further consideration.
2. For each chemical, identify and record its receptor and medium-specific cancer and noncancer risk-based concentration (rbc) if both are available. Segregate cancer (c) from noncancer (nc) rbcs.
3. For each **carcinogen** in a sample, calculate the associated Incremental Lifetime Cancer Risk (ILCR):
    a. Calculate the ILCR associated with **each individual** chemical that has a cancer rbc:

For a given chemical *i* in sample *j*:

$$Receptor\ \&\ Medium\ ILCR_{i,j} = \frac{Site\ Sample\ Concentration_i}{rbc_{i\_c}} * Target\ Risk_{rbc-c}$$

    b. Calculate the cumulative ILCR across **all chemicals in a sample** that have a cancer rbc:

For a given number of chemicals (*n*) in sample *j*, where *i* is the first chemical:

$$Receptor\ \&\ Medium\ Cumulative\ ILCR_j = \sum_{i=1}^{n} Receptor\ \&\ Medium\ ILCR_{i,j}$$

4. For each **noncarcinogen** in a sample, calculate the associated Hazard Quotient (HQ) :
    a. Calculate the HQ associated with **each individual** chemical that has a noncancer rbc:

For given a chemical *i* in sample *j:*

$$Receptor\ \&\ Medium\ HQ_{i,j} = \frac{Site\ Sample\ Concentration_{\ i,j}}{rbc_{i-nc}} * Target\ Hazard\ Quotient_{rbc-nc}$$

    b. Calculate the Hazard Index (sum of HQs) **across all chemicals in a sample** that have a noncancer rbc. ***Do not segregate chemicals by critical effect.***

For a given number of chemicals (*n*) in sample *j*, where *i* is the first chemical:

$$Receptor\ \&\ Medium\ Hazard\ Index_j = \sum_{i=1}^{n} Receptor\ \&\ Medium\ Hazard\ Quotient_{i,j}$$

Example Sample-wise Calculation for Direct Contact to Soil: Residential Scenario

1. Benzene and ethylbenzene are detected in Soil Sample S01 at the following concentrations:

Analyte	Soil Sample S01 (mg/kg)
Benzene	4.00E^{-01}
Ethylbenzene	6.00E^{+00}

2. Use Table 1 to find Residential Soil cancer and noncancer rbcs for benzene and ethylbenzene:

Analyte	Sample Concentration Soil Sample S01 (mg/kg)	Resident - Soil rbcs from Table 1	
		rbc_{cancer}* (mg/kg)	**$rbc_{noncancer}$*** (mg/kg)
Benzene	4.00E^{-01}	6.98E^{-01}	1.11E^{+02}
Ethylbenzene	6.00E^{+00}	3.68E^{+00}	4.45E^{+02}

*Cancer rbcs are based on target ILCR=1E^{-06}; noncancer rbcs are based on target HQ=1.0

3. Calculate the Incremental Lifetime Cancer Risk (ILCR) associated with each individual chemical that has a cancer rbc:

For given chemical *i* in sample *j*:

$$Resident\ Soil\ ILCR_{i,j} = \frac{Site\ Soil\ Concentration_{i,j}(\frac{mg}{kg})}{\mathrm{rbc}_{i\_c}(\frac{mg}{kg})} * Target\ Risk_{rbc-c}$$

a. Benzene

$$Resident\ Soil\ ILCR_{Benzene,S01} = \frac{Sample\ S01\ Concentration_{Benzene}(\frac{mg}{kg})}{Resdient\ Soil_{rbc_{Benzene-c}}(\frac{mg}{kg})} * Target\ Risk_{rbc-c}$$

$$Resident\ Soil\ ILCR_{Benzene,S01} = \frac{4.00\mathrm{E}^{-01}\ \frac{mg}{kg}}{6.98\mathrm{E}^{-01}\ \frac{mg}{kg}} * (1E^{-06})$$

$$\boldsymbol{Resident\ Soil\ ILCR_{Benzene,S01} = 5.73E^{-07}}$$

b. Ethylbenzene

$$Resident\ Soil\ ILCR_{Ethylbenzene,S01} = \frac{Sample\ S01\ Concentration_{Ethylbenzene}(\frac{mg}{kg})}{Resident\ Soil\ rbc_{Ethylbenzene-c}(\frac{mg}{kg})} * Target\ Risk_{rbc-c}$$

$$Resident\ Soil\ ILCR_{Ethylbenzene,S01} = \frac{6.00\mathrm{E}^{+00}\ (\frac{mg}{kg})}{3.68\mathrm{E}^{+00}\ (\frac{mg}{kg})} * (1E^{-06})$$

$$\boldsymbol{Resident\ Soil\ ILCR_{Ethylbenzene,S01} = 1.63E^{-06}}$$

4. Calculate the Receptor and Medium cumulative ILCR by summing the individual chemical cancer risks generated for a sample:

For a given number of chemicals (*n*) in sample *j*, where *i* is the first chemical:

$$Resident\ Soil\ Cumulative\ ILCR_j = \sum_{i=1}^{n} Resident\ Soil\ ILCR_{i,j}$$

$$Resident\ Soil\ Cumulative\ ILCR_j = Resident\ Soil\ ILCR_{Benzene,j} + Resident\ Soil\ ILCR_{Ethylbenzene,j}$$

$$Resident\ Soil\ Cumulative\ ILCR_{S01} = (5.73E^{-07}) + (1.63E^{-06})$$

$$\boldsymbol{Resident\ Soil\ Cumulative\ ILCR_{S01} = 2.20E^{-06}}$$

5. Calculate the Hazard Quotient (HQ) associated with each individual chemical that has a noncancer rbc:

For given chemical *I* in sample *j*:

$$Resident\ Soil\ HQ_{i,j} = \frac{Site\ Soil\ Concentration_{\ i,j}(\frac{mg}{kg})}{rbc_{i-nc}(\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

a. Benzene

$$Resident\ Soil\ HQ_{Benzene,S01} = \frac{Sample\ S01\ Concentration_{\ Benzene}(\frac{mg}{kg})}{Resident\ Soil\ rbc_{Benzene-nc}(\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

$$Resident\ Soil\ HQ_{Benzene,S01} = \frac{4.00\text{E}^{-01}\frac{mg}{kg}}{1.11\text{E}^{+02}\frac{mg}{kg}} * 1.0$$

$$\boldsymbol{Resident\ Soil\ HQ_{Benzene,S01} = 3.60E^{-01}}$$

b. Ethylbenzene

$$Resident\ Soil\ HQ_{Ethylbenzene,S01} = \frac{Sample\ S01\ Concentration_{\ Ethylbenzene}(\frac{mg}{kg})}{Resident\ Soil\ rbc_{Ethylbenzene-nc}\ (\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

$$Resident\ Soil\ HQ_{Ethylbenzene,S01} = \frac{6.00\text{E}^{+00}\frac{mg}{kg}}{4.45\text{E}^{+02}\frac{mg}{kg}} * 1.0$$

$$\boldsymbol{Resident\ Soil\ HQ_{Ethylbenzene,S01} = 1.35E^{-02}}$$

6. Calculate the noncancer Hazard Index (HI) across all the chemicals with a noncancer rbc. ***Do not segregate chemicals by critical effect.***:

For a given number of chemicals (*n*) in sample *j*, where *i* is the first chemical:

$$Resident\ Soil\ Sample\ Hazard\ Index_j = \sum_{i=1}^{n} Hazard\ Quotient_{i,j}$$

$$Resident\ Soil\ Sample\ HI_j = HQ_{Benzene,j} + HQ_{Ethylbenzene,j}$$
$$Resident\ Soil\ Sample\ HI_{S01} = (3.60E^{-01}) + (1.35E^{-02})$$
$$\boldsymbol{Resident\ Soil\ Sample\ HI_{S01} = 3.74E^{-01}}$$

7. It may be helpful to consolidate all this information into a table such as the following:

		Resident - Soil			
		CANCER		NONCANCER	
Analyte	Site Concentration Sample S01 (mg/kg)	[a]rbc_{cancer} (mg/kg)	Sample S01 ILCR (unitless)	[b]$rbc_{noncancer}$ (mg/kg)	Sample S01 HQ (unitless)
Benzene	4.00E-01	6.98E-01	5.73E-07	1.11E+02	3.60E-02
Ethylbenzene	2.00E+00	3.68E+00	1.63E-06	4.45E+02	1.35E-02
		Sample S01 Cumulative ILCR =	**2.20E-06**	**Sample S01 Hazard Index =**	**4.95E-01**

a. Cancer rbcs are based on a target Risk of $1E^{-06}$
b. Noncancer rbcs are based on a target Hazard Quotient of 1.0

8. The Cumulative ILCR and HI can now be compared to the target ILCR and target HI to determine whether further action is warranted:
    a. Is the cumulative ILCR > the target cancer risk?

Is $2.20E^{-06}>1E^{-06}$?
Yes

    b. Is the HI > the target HI?

Is $4.59E^{-01}>1$
No

c. Because the Cumulative ILCR is greater than the target ILCR for the site, further attention is warranted.

II. SITE-WIDE/EXPOSURE UNIT APPROACH: Summary Statistic used as Exposure Point Concentration

For **each** Hypothetical Human Receptor Scenario and exposure medium (i.e., Soil, Indoor Air):

1. In accordance with the IRULE, **for each site**, or each exposure unit if appropriate, identify chemicals that are present above detection and retained for further consideration
2. Use appropriate Summary Statistic to develop chemical-specific Exposure Point Concentrations (EPCs).
3. For each chemical, identify and record its receptor and medium-specific cancer and noncancer risk-based concentration (rbc), if both are available. Segregate cancer (c) from noncancer (nc) rbcs.
4. For each **carcinogen**, calculate the associated Site Incremental Lifetime Cancer Risk (ILCR):
    a. Calculate the ILCR associated with **each individual** chemical that has a cancer rbc:

For given chemical *i*:

$$Receptor\ \&\ Medium\ Site\ ILCR_i = \frac{Site\ Concentration_i}{rbc_{i\_c}} * Target\ Risk_{rbc-c}$$

    b. Calculate the cumulative Site ILCR across **all the chemicals** that have a cancer rbc:

For a given number of chemicals (*n*), where *i* is the first chemical:

$$Receptor\ \&\ Medium\ Site\ Cumulative\ ILCR = \sum_{i=1}^{n} Receptor\ \&\ Medium\ Site\ ILCR_i$$

5. For each **noncarcinogen**, calculate the associated Site Hazard Quotient (HQ):
    a. Calculate the HQ associated with **each individual** chemical that has a noncancer rbc:

For given chemical *i*:

$$Receptor\ \&\ Medium\ Site\ HQ_i = \frac{Site\ Concentration_{\ i}}{rbc_{i\_nc}} * Target\ Hazard\ Quotient_{rbc-nc}$$

    b. Calculate the Hazard Index (sum of HQs) across **all chemicals** that have a noncancer rbc. ***Do not segregate chemicals by critical effect.***:

For a given number of chemicals (*n*), where *i* is the first chemical:

$$Receptor\ \&\ Medium\ Site\ HI = \sum_{i=1}^{n} Receptor\ \&\ Medium\ Site\ Hazard\ Quotient_i$$

Example Site-wide Calculation for Direct Contact to Soil: Residential Scenario

1. Benzene and ethylbenzene are detected in soil. The following Site-wide Exposure Point Concentrations (EPCs) are determined:

Analyte	Soil Exposure Point Concentration (mg/kg)
Benzene	$4.00E^{-01}$
Ethylbenzene	$6.00E^{+00}$

2. Use Table 1 to find Residential Soil cancer and noncancer rbcs for Benzene and Ethylbenzene:

Analyte	Soil Concentration (mg/kg)	Resident - Soil rbcs from Table 1	
		rbc_{cancer}* (mg/kg)	$rbc_{noncancer}$* (mg/kg)
Benzene	$4.00E^{-01}$	$6.98E^{-01}$	$1.11E^{+02}$
Ethylbenzene	$6.00E^{+00}$	$3.68E^{+00}$	$4.45E^{+02}$

*Cancer rbcs are based on a target ICLR=$1E^{-06}$; noncancer rbcs are based on target HQ=1.0

3. Calculate the Incremental Lifetime cancer Risk (ILCR) associated with each individual chemical that has a cancer rbc:

For given chemical *i*:

$$Resident\ Soil\ Site\ ILCR_i = \frac{Site\ Concentration_i\ (\frac{mg}{kg})}{rbc_{i\_c}(\frac{mg}{kg})} * Target\ Risk_{rbc-c}$$

c. Benzene

$$Resient\ Soil\ Site\ ILCR_{Benzene} = \frac{Site\ Concentration_{Benzene}(\frac{mg}{kg})}{Resident\ Soil_{rbc_{Benzene-c}}(\frac{mg}{kg})} * Target\ Risk_{\ rbc-c}$$

$$Resident\ Soil\ Site\ ILCR_{Benzene} = \frac{4.00\text{E}^{-01}\ \frac{mg}{kg}}{6.98\text{E}^{-01}\ \frac{mg}{kg}} * (1E^{-06})$$

$$\boldsymbol{Resident\ Soil\ Site\ ILCR_{Benzene} = 5.73E^{-07}}$$

d. Ethylbenzene

$$Resident\ Soil\ Site\ ILCR_{Ethylbenzene} = \frac{Site\ Concentration_{Ethylbenzene}(\frac{mg}{kg})}{rbc_{Ethylbenzene\_c}(\frac{mg}{kg})} * Target\ Risk_{rbc-c}$$

$$Resident\ Soil\ Site\ ILCR_{Ethylbenzene} = \frac{6.00\text{E}^{+00}\ (\frac{mg}{kg})}{3.68\text{E}^{+00}\ (\frac{mg}{kg})} * (1E^{-06})$$

$$\boldsymbol{Resident\ Soil\ Site\ ILCR_{Ethylbenzene} = 1.63E^{-06}}$$

4. Calculate the Receptor and Medium cumulative Site ILCR by summing the individual chemical cancer risks:

For a given number of chemicals (*n*), where *i* is the first chemical:

$$Resident\ Soil\ Site\ Cumulative\ ILCR = \sum_{i=1}^{n} Resident\ Soil\ Site\ ILCR_i$$

$$Resident\ Soil\ Site\ Cumulative\ ILCR = Resident\ Soil\ Site\ ICLR_{Benzene} + Resident\ Soil\ Site\ ILCR_{Ethylbenzene}$$

$$Resident\ Soil\ Site\ Cumulative\ ILCR = (5.73E^{-07}) + (1.63E^{-06})$$

$$\boldsymbol{Resident\ Soil\ Site\ Cumulative\ ILCR = 2.20E^{-06}}$$

5. Calculate the site Hazard Quotient (HQ) associated with each individual chemical that has a noncancer rbc:

For given chemical *i*:

$$Resident\ Soil\ Site\ HQ_i = \frac{Site\ Concentration_{\ i}(\frac{mg}{kg})}{rbc_{i-nc}(\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

a. Benzene

$$Resident\ Soil\ Site\ HQ_{Benzene} = \frac{Site\ Concentration_{\ Benzene}(\frac{mg}{kg})}{Resident\ Soil\ rbc_{benzene-nc}(\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

$$Resident\ Soil\ Site\ HQ_{Benzene} = \frac{4.00\text{E}^{-01}\frac{mg}{kg}}{1.11\text{E}^{+02}\frac{mg}{kg}} * 1.0$$

$$\boldsymbol{Site\ HQ_{Benzene} = 3.60E^{-02}}$$

b. Ethylbenzene

$$Resident\ Soil\ Site\ HQ_{Ethylbenzene} = \frac{Site\ Concentration_{\ Ethylbenzene}(\frac{mg}{kg})}{Resident\ Soil\ rbc_{ethylbenzene-nc}(\frac{mg}{kg})} * Target\ HQ_{rbc-nc}$$

$$Resident\ Soil\ Site\ HQ_{Ethylbenzene} = \frac{6.00\text{E}^{+00}\frac{mg}{kg}}{4.45\text{E}^{+02}\frac{mg}{kg}} * 1.0$$

$$\boldsymbol{Resident\ Soil\ Site\ HQ_{Ethylbenzene} = 1.35E^{-02}}$$

6. Calculate the noncancer Hazard Index (HI) across all the chemicals with a noncancer rbc. ***Do not segregate chemicals by critical effect.***:

For a given number of chemicals (*n*), where *i* is the first chemical:

$$Resident\ Soil\ Site\ Hazard\ Index = \sum_{i=1}^{n} Resident\ Soil\ Hazard\ Quotient_i$$

$$Resident\ Soil\ Site\ HI = HQ_{Benzene} + HQ_{Ethylbenzene}$$

$$Resident\ Soil\ Site\ HI = (3.60E^{-02}) + (1.35E^{-02})$$

$$\boldsymbol{Resident\ Soil\ Site\ HI = 4.95E^{-01}}$$

7. It may be helpful to consolidate all this information into a table such as the following:

		Resident - Soil			
		CANCER		NONCANCER	
Analyte	**Site Exposure Point Concentration (mg/kg)**	**[a]rbc_{cancer} (mg/kg)**	**Site ILCR (unitless)**	**[b]$rbc_{noncancer}$ (mg/kg)**	**Site HQ (unitless)**
Benzene	4.00E-01	6.98E-01	5.73E-07	1.11E+02	3.60E-02
Ethylbenzene	2.00E+00	3.68E+00	1.63E-06	4.45E+02	1.35E-02
		Site Cumulative ILCR =	**2.20E-06**	**Site Hazard Index =**	**4.95E-01**

a. Cancer rbcs are based on a target Risk of $1E^{-06}$
b. Noncancer rbcs are based on a target Hazard Quotient of 1.0

8. The Cumulative ILCR and HI can now be compared to the target ILCR and target HI to determine whether further action is warranted:
    a. Is the Cumulative Site ILCR > the target cancer risk?

Is $2.20E^{-06}>1E^{-06}$?
Yes

    b. Is the HI > the target Site HI?

Is $4.95E^{-01}>1$
No

Because the Cumulative Site ILCR is greater than the target cancer risk for the site, further attention is warranted.

TABLE 1
SUMMARY TABLE
2019 - RESIDENT SOIL risk-based concentrations (rbcs) (mg/kg)
INCIDENTAL INGESTION, DERMAL CONTACT AND INHALATION

Chemical Name	CAS No.	Resident - Soil risk-based concentations (rbcs)	
		Cancer Target Risk=1E-6	Noncancer Hazard Quotient=1
		Combined Routes mg/kg	Combined Routes mg/kg
Acetochlor	34256-82-1	NA	1.22E+03
Acetone	67-64-1	NA	4.06E+04
Alachlor	15972-60-8	NA	6.08E+01
Aldrin	309-00-2	2.02E-02	2.10E+00
Aluminum	7429-90-5	NA	7.25E+04
Antimony	7440-36-0	NA	2.60E+01
Arsenic, Inorganic	7440-38-2	2.32E-01	2.10E+01
Barium	7440-39-3	NA	1.12E+04
Benomyl	17804-35-2	1.16E+02	7.90E+02
Benzene	71-43-2	6.98E-01	1.11E+02
Benzo(a)pyrene[a]	50-32-8	7.28E-02	1.72E+01
Beryllium	7440-41-7	5.67E+02	3.45E+01
Bis(2-chloro-1-methyl ethyl)ether	108-60-1	NA	2.80E+03
Boron	7440-42-8	NA	1.47E+04
Bromate	15541-45-4	5.36E-01	2.93E+02
Bromochloromethane	74-97-5	NA	1.93E+02
Bromoxynil	1689-84-5	2.69E+00	9.12E+02
Butylbenzene, n-	104-51-8	NA	3.50E+03
Butylbenzene, sec-	135-98-8	NA	7.01E+03
Butylbenzene, tert-	98-06-6	NA	7.01E+03
Cadmium (food)	7440-43-9	7.56E+02	6.86E+00
Carbaryl	63-25-2	3.17E+02	6.08E+03
Carbon Disulfide	75-15-0	NA	6.08E+02
Carbon tetrachloride	56-23-5	3.72E-01	1.30E+02
Chlorobenzene	108-90-7	NA	4.14E+02
Chromium (III) (insoluble salts)	16065-83-1	NA	4.02E+04
Chromium (VI)	18540-29-9	9.06E-02	1.16E+02
Cobalt	7440-48-4	1.51E+02	2.19E+01
Copper	7440-50-8	NA	1.04E+04
Di (2-ethylhexyl) phthalate	117-81-7	1.98E+01	1.22E+03
Dibromochloropropane	96-12-8	6.00E-03	6.63E+00
Dibromoethane, 1,2-	106-93-4	2.27E-02	1.15E+02
Dichloroethane, 1,1-	75-34-3	2.10E+00	1.40E+04
Dichloroethane, 1,2-	107-06-2	2.85E-01	4.95E+01
Dichloroethylene, cis 1,2-	156-59-2	NA	1.40E+02
Dichloroethylene, trans 1,2-	156-60-5	NA	1.40E+03
Dichloropropane, 1,2-	78-87-5	1.51E+00	2.63E+01
Dioxane, 1,4-	123-91-1	2.78E+00	1.05E+03
Ethylbenzene	100-41-4	3.68E+00	4.45E+02
Fluoranthene	206-44-0	NA	2.30E+03
Fluorene	86-73-7	NA	2.30E+03
Hexachlorobenzene	118-74-1	1.31E-01	5.61E+01
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	4.60E+00	2.90E+02
Iron	7439-89-6	NA	5.13E+04
Isopropylbenzene (cumene)	98-82-8	NA	2.56E+02
Manganese (non-diet)	7439-96-5	NA	1.12E+03
Mercury (elemental)	7439-97-6	NA	3.13E+00
Methyl ethyl ketone	78-93-3	NA	1.70E+04
Methyl tert-butyl ether (MTBE)	1634-04-4	NA	6.49E+02
Molybdenum	7439-98-7	NA	3.66E+02
Naphthalene	91-20-3	2.72E+00	2.24E+02
Nickel	7440-02-0	5.23E+03	9.40E+02
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	NA	3.70E+03
Pentachlorophenol	87-86-5	4.84E-01	2.37E+02
Pentaerythritol tetranitrate (PETN)	78-11-5	NA	1.22E+02
Perchlorate	14797-73-0	NA	5.13E+01
Perfluoroheptanoic acid (PFHpA)[b]	375-85-9	NA	1.22E+00
Perfluorohexane sulfonic acid (PFHxS)[b]	355-46-4	NA	1.22E+00
Perfluorononanoic acid (PFNA)[b]	375-95-1	NA	1.22E+00
Perfluorooctane sulfonic acid (PFOS)[b]	1763-23-1	NA	1.22E+00
Perfluorooctanoic acid (PFOA)[b]	335-67-1	3.96E+00	1.22E+00
Polychlorinated biphenyls[c] (PCBs)	1336-36-3	1.14E-01	1.13E+00
Propoxur (Baygon)	114-26-1	7.88E+01	2.43E+02
Propyl benzene, n-	103-65-1	NA	2.53E+02
Selenium	7782-49-2	NA	3.66E+02
Silver	7440-22-4	NA	2.37E+02
Tetrachlorodibenzo-p-dioxin, 2,3,7,8- (TCDD)	1746-01-6	2.25E-06	4.91E-05
Tetrachloroethane, 1,1,1,2-	630-20-6	1.32E+00	2.10E+03
Tetrachloroethylene	127-18-4	2.38E+00	1.13E+02
Thallium (soluble Thallium)	7440-28-0*	NA	7.33E-01
Toluene	108-88-3	NA	7.06E+02
Trichloroethylene (non-moa / mmoa)	79-01-6	6.81E-01	6.21E+00
Trichloropropane, 1,2,3-	96-18-4	3.11E-03	8.67E+00
Trimethylbenzene, 1,2,3-[d]	526-73-8	NA	2.06E+02
Trimethylbenzene, 1,2,4-[d]	95-63-6	NA	1.66E+02
Trimethylbenzene, 1,3,5-[d]	108-67-8	NA	1.44E+02
Trinitrotoluene, 2,4,6- (TNT)	118-96-7	1.15E+01	3.49E+01
Uranium (soluble salts)	NA	NA	4.40E+01
Vanadium	7440-62-2	NA	2.77E+00
Vinyl chloride	75-01-4	9.83E-02	8.51E+01
Xylenes	1330-20-7	NA	2.52E+02
Zinc	7440-66-6	NA	2.20E+04

Notes:

* - CAS Number is for Metallic Thallium

Groundwater temperature of 15°C used in derivation of volatiziation factors with May 2018 Regional Screening Level Calculator.

Csat substitution used if soil inhalation screening value greater than Csat. Csats derived using May 2018 Regional Screening Level Calculator.

All cancer-based soil inhalation screening values were less than respective Csat thus no substitutions.

Noncancer-based soil inhalation screening value above respective Csat thus Csat substitiouion employed for the following:

Acetone, Carbon Disulfide, Ethylbenzene, Isopropylbenzene (cumene), Mercury (elemental), Methyl ethyl ketone, Methyl tert-butyl ether, n-Propyl benzene, Tetrachloroethylene, Toluene, Trimethyl benzenes, Xylenes.

(a) Benzo(a)pyrene cancer-based screening value applicable to benzo(a)pyrene itself and to total benzo(a)pyrene toxic equivalents [B(a)P-TE]. Benzo(a)pyrene noncancer-based value applicable only to benzo(a)pyrene itself.

(b) PFAS - Sum of PFHpA, PFHxS, PFNA, PFOS and PFOA not to exceed 1.22 mg/kg.

(c) Polychlorinated Biphenyls -IRIS high risk and persistence cancer toxicity values employed; noncancer assessment of Total PCBs based on oral reference dose and VF for Aroclor 1254.

(d) Trimethyl benzenes -Sum of the three isomers not to exceed 1.44E+02 mg/kg, based on the most conservative value derived for an individual isomer.

TABLE 2
SUMMARY TABLE
2019 - COMMERCIAL WORKER SOIL risk-based concentrations (rbcs) (mg/kg)
INCIDENTAL INGESTION, DERMAL CONTACT AND INHALATION

Chemical Name	CAS No.	Commerical Worker - Soil risk-based concentations (rbcs)	
		Cancer Target Risk=1E-6	Noncancer Hazard Quotient=1
		Combined Routes mg/kg	Combined Routes mg/kg
Acetochlor	34256-82-1	-	1.44E+04
Acetone	67-64-1	-	1.00E+05
Alachlor	15972-60-8	-	7.18E+02
Aldrin	309-00-2	9.76E-02	2.15E+01
Aluminum	7429-90-5	-	9.42E+05
Antimony	7440-36-0	-	3.19E+02
Arsenic, Inorganic	7440-38-2	1.41E+00	2.71E+02
Barium	7440-39-3	-	1.27E+05
Benomyl	17804-35-2	7.01E+02	9.34E+03
Benzene	71-43-2	4.19E+00	4.18E+02
Benzo(a)pyrene[a]	50-32-8	1.54E+00	1.94E+02
Beryllium	7440-41-7	4.63E+03	2.89E+02
Bis(2-chloro-1-methyl ethyl)ether	108-60-1	-	3.63E+04
Boron	7440-42-8	-	1.96E+05
Bromate	15541-45-4	3.27E+00	3.92E+03
Bromochloromethane	74-97-5	-	5.97E+02
Bromoxynil	1689-84-5	1.63E+01	1.08E+04
Butylbenzene, n-	104-51-8	-	5.11E+04
Butylbenzene, sec-	135-98-8	-	1.02E+05
Butylbenzene, tert-	98-06-6	-	1.02E+05
Cadmium (food)	7440-43-9	6.18E+03	8.72E+01
Carbaryl	63-25-2	1.91E+03	7.18E+04
Carbon Disulfide	75-15-0	-	6.62E+02
Carbon tetrachloride	56-23-5	2.23E+00	3.59E+02
Chlorobenzene	108-90-7	-	7.26E+02
Chromium (III) (insoluble salts)	16065-83-1	-	3.60E+05
Chromium (VI)	18540-29-9	1.75E+00	1.14E+03
Cobalt	7440-48-4	1.24E+03	2.91E+02
Copper	7440-50-8	-	1.39E+05
Di (2-ethylhexyl) phthalate	117-81-7	1.20E+02	1.44E+04
Dibromochloropropane	96-12-8	6.15E-02	2.75E+01
Dibromoethane, 1,2-	106-93-4	1.39E-01	3.49E+02
Dichloroethane, 1,1-	75-34-3	1.26E+01	2.04E+05
Dichloroethane, 1,2-	107-06-2	1.71E+00	1.40E+02
Dichloroethylene, cis 1,2-	156-59-2	-	1.81E+03
Dichloroethylene, trans 1,2-	156-60-5	-	1.81E+04
Dichloropropane, 1,2-	78-87-5	9.06E+00	6.81E+01
Dioxane, 1,4-	123-91-1	1.69E+01	4.49E+03
Ethylbenzene	100-41-4	2.21E+01	4.73E+02
Fluoranthene	206-44-0	-	2.64E+04
Fluorene	86-73-7	-	2.64E+04
Hexachlorobenzene	118-74-1	6.86E-01	5.74E+02
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	2.80E+01	3.84E+03
Iron	7439-89-6	-	6.86E+05
Isopropylbenzene (cumene)	98-82-8	-	2.64E+02
Manganese (non-diet)	7439-96-5	-	1.14E+04
Mercury (elemental)	7439-97-6	-	3.13E+00
Methyl ethyl ketone	78-93-3	-	2.70E+04
Methyl tert-butyl ether (MTBE)	1634-04-4	-	4.46E+03
Molybdenum	7439-98-7	-	4.90E+03
Naphthalene	91-20-3	1.64E+01	6.78E+02
Nickel	7440-02-0	4.28E+04	9.71E+03
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	2691-41-0	-	4.98E+04
Pentachlorophenol	87-86-5	2.90E+00	2.48E+03
Pentaerythritol tetranitrate (PETN)	78-11-5	-	1.44E+03
Perchlorate	14797-73-0	-	6.86E+02
Perfluoroheptanoic acid (PFHpA)[b]	375-85-9	-	1.44E+01
Perfluorohexane sulfonic acid (PFHxS)[b]	355-46-4	-	1.44E+01
Perfluorononanoic acid (PFNA)[b]	375-95-1	-	1.44E+01
Perfluorooctane sulfonic acid (PFOS)[b]	1763-23-1	-	1.44E+01
Perfluorooctanoic acid (PFOA)[b]	335-67-1	2.39E+01	1.44E+01
Polychlorinated biphenyls (PCBs)[c]	1336-36-3	6.83E-01	1.28E+01
Propoxur (Baygon)	114-26-1	4.76E+02	2.87E+03
Propyl benzene, n-	103-65-1	-	2.61E+02
Selenium	7782-49-2	-	4.90E+03
Silver	7440-22-4	-	2.48E+03
Tetrachlorodibenzo-p-dioxin, 2,3,7,8- (TCDD)	1746-01-6	1.37E-05	6.35E-04
Tetrachloroethane, 1,1,1,2-	630-20-6	8.00E+00	3.07E+04
Tetrachloroethylene	127-18-4	1.43E+01	1.51E+02
Thallium (soluble Thallium)	7440-28-0*	-	1.96E+05
Toluene	108-88-3	-	7.98E+02
Trichloroethylene (non-moa)	79-01-6	6.47E+00	1.86E+01
Trichloropropane, 1,2,3-	96-18-4	7.05E-02	2.29E+01
Trimethylbenzene, 1,2,3-[d]	526-73-8	-	2.82E+02
Trimethylbenzene, 1,2,4-[d]	95-63-6	-	2.12E+02
Trimethylbenzene, 1,3,5-[d]	108-67-8	-	1.77E+02
Trinitrotoluene, 2,4,6- (TNT)	118-96-7	7.00E+01	4.50E+02
Uranium (soluble salts)	Uranium	-	5.88E+02
Vanadium	7440-62-2	-	2.72E+01
Vinyl chloride	75-01-4	5.93E-01	3.24E+02
Xylenes	1330-20-7	-	2.57E+02
Zinc	7440-66-6	-	2.94E+05

Notes:
* - CAS Number is for Metallic Thallium
Groundwater temperature of 15°C used in derivation of volatiziation factors with May 2018 Regional Screening Level Calculator.
Csat substitution used if soil inhalation screening value greater than Csat. Csats derived using May 2018 Regional Screening Level Calculator.
(a) Benzo(a)pyrene cancer-based screening value applicable to benzo(a)pyrene itself and to total benzo(a)pyrene toxic equivalents [B(a)P-TE]. Benzo(a)pyrene noncancer-based value applicable only to benzo(a)pyrene itself.
(b) PFAS - Sum of PFHpA, PFHxS, PFNA, PFOS and PFOA not to exceed 14.4 mg/kg.
(c) Polychlorinated Biphenyls -IRIS high risk and persistence cancer toxicity values employed; noncancer assessment of Total PCBs based on oral reference dose and VF for Aroclor 1254.
(d) Trimethyl benzenes -Sum of the three isomers not to exceed 1.77+02 mg/kg, based on the most conservative value derived for an individual isomer.

TABLE 3
SUMMARY TABLE
2019 - RESIDENT AND NONRESIDENTIAL INDOOR AIR risk-based concentrations (rbcs) (µg/m^3)
INHALATION

Chemical Name	CAS No.	Indoor Air risk-based concentrations (rbcs)			
		Resident - Indoor Air		Nonresidential - Indoor Air	
		Cancer Target Risk = 1x10^{-6}	Noncancer Hazard Quotient = 1.0	Cancer Target Risk = 1x10^{-6}	Noncancer Hazard Quotient = 1.0
		Inhalation µg/m3	Inhalation µg/m3	Inhalation µg/m^3	Inhalation µg/m^3
Benzene	71-43-2	0.13	30.00	1.05	105.12
Carbon tetrachloride	56-23-5	0.17	100.00	1.36	350.40
Chloroethane	75-00-3	--	10000.00	--	35040.00
Chloroform	67-66-3	0.04	97.70	0.36	342.34
Dichloroethane, 1,1-	75-34-3	0.63	--	5.11	--
Dichloroethene, 1,1-	75-35-4	--	200.00	--	700.80
Ethylbenzene	100-41-4	4.00E-01	260.00	3.27E+00	911.04
Mercury (elemental)	7439-97-6	--	0.30	--	0.3 [(a)]
Methylene chloride	75-09-2	60.34	600.00	817.60	2102.40
Naphthalene	91-20-3	0.03	3.00	0.24	10.51
Tetrachloroethylene	127-18-4	0.63	40.00	5.11	140.16
Trichloroethylene	79-01-6	0.20	0.2[(c)]	1.99	0.7 [(b)]
Trimethylbenzene, 1,2,3-	526-73-8	--	60[(c)]	--	210.24[(c)]
Trimethylbenzene, 1,2,4-	95-63-6	--	60[(c)]	--	210.24[(c)]
Trimethylbenzene, 1,3,5-	108-67-8	--	60[(c)]	--	210.24[(c)]
Vinyl chloride	75-01-4	0.11	100.00	1.86 [(d)]	350.40

Notes:

(a) Mercury (elemental) - Due to the developmental toxicity associated with mercury exposure, the inhalation Reference Concentratio is used as the nonresidential air value without adjusting for exposure period.

(b) Trichloroethylene - Due to the nature and severity of a particular non-cancer endpoint (fetal cardiac malformations) that may be associated with a brief window of susceptibility, there is significant uncertainty regarding the exposure period of concern. Thus, a target hazard quotient of 0.1 was used in the calculatin of noncancer values.

(c) Trimethyl benzenes - The sum of the 3 isomers should not exceed 60 µg/m^3 for Resident - Indoor Air and not exceed 210.24 µg/m^3 for Nonresidential - Indoor Air

(d) Vinyl chloride - Inhalation Unit Risk of 4.4E-06 (µg/m^3)$^{-1}$ based on continuous lifetime exposure during adulthood using to develop cancer based value for Nonresidential - Indoor Air

APPENDIX F. TOXICITY EQUIVALENCE FACTORS

§35-APX-F1 Toxicity Equivalence Factors and Relative Potency Factors

Some chemicals are members of the same family or group and have been shown to exhibit similar toxicological properties; however, each chemical may differ in the degree of toxicity (EPA, 2019). In some such instances, a toxicity (sometimes referred to as toxic) equivalency factor (TEF) or relative potency factor (RPF) must be applied to convert the reported concentration of each member of the group to a toxicity (sometimes referred to as toxic) equivalent concentration (TEQ) or to toxic equivalents (TE) relative to the toxicity of the index chemical for the group. The index chemical is assigned a TEF or RPF of 1. Total TEQ or TE can be compared to risk-based values derived for the index chemical or assessed using as any other single chemical in a quantitative risk assessment.

Dioxins, Furans and dioxin-like Polychlorinated Biphenyls (PCBs)

The index chemical for this group is 2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD). As of this writing, Health recommends that the 2005 World Health Organization Toxic Equivalency Factors (Van den Berg et al., 2006) be employed in the evaluation of dioxins, furans and dioxin-like PCBs. These values are also presented in the May 2013 U.S. EPA fact sheet, "Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites" which references the 2010 U.S. EPA report, "Recommended Toxicity Equivalency Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-dioxin and Dioxin-Like Compounds" (EPA, 2019). TEFs for Di-ortho PCBs may be obtained from Ahlborg, U.G. et al., 1994 (EPA, 2019). TEFs may be applied to the ingestion, dermal (see EPA, 2004) or inhalation routes of exposure and adjusted values may be used in the assessment of both cancer and noncarcinogenic effects (EPA, 2013). The sum of adjusted concentrations is often referred to as 2,3,7,8-TCDD TEQ.

Dioxin Toxicity Equivalence Factors (EPA, 2019)

CAS Registry Number	Compound	2,3,7,8-TCDD Toxicity Equivalence Factor
Chlorinated dibenzo-p-dioxins		
1746-01-6	2,3,7,8-TCDD	1
40321-76-4	1,2,3,7,8-PeCDD	1
39227-28-6	1,2,3,4,7,8-HxCDD	0.1
72918-21-9	1,2,3,6,7,8-HxCDD	0.1
57653-85-7	1,2,3,7,8,9-HxCDD	0.1
35822-46-9	1,2,3,4,6,7,8-HpCDD	0.01

3268-87-9	OCDD	0.0003
Chlorinated dibenzofurans		
51207-31-9	2,3,7,8-TCDF	0.1
57117-41-6	1,2,3,7,8-PeCDF	0.03
57117-31-4	2,3,4,7,8-PeCDF	0.3
70648-26-9	1,2,3,4,7,8-HxCDF	0.1
57117-44-9	1,2,3,6,7,8-HxCDF	0.1
72918-21-9	1,2,3,7,8,9-HxCDF	0.1
60851-34-5	2,3,4,6,7,8-HxCDF	0.1
35822-46-9	1,2,3,4,6,7,8-HpCDF	0.01
55673-89-7	1,2,3,4,7,8,9-HpCDF	0.01
39001-02-0	OCDF	0.0003

PCBs			
	IUPAC No.	**Structure**	
Non-*ortho*			
32598-13-3	77	3,3',4,4'-TetraCB	0.0001
70362-50-4	81	3,4,4',5-TetraCB	0.0003
57465-28-8	126	3,3',4,4',5-PeCB	0.1
32774-16-6	169	3,3',4,4',5,5'-HxCB	0.03
Mono-*ortho*			
32598-14-4	105	2,3,3',4,4'-PeCB	0.00003
74472-37-0	114	2,3,4,4',5-PeCB	0.00003
31508-00-6	118	2,3',4,4',5-PeCB	0.00003
65510-44-3	123	2',3,4,4',5-PeCB	0.00003
38380-08-4	156	2,3,3',4,4',5-HxCB	0.00003
69782-90-7	157	2,3,3',4,4',5'-HxCB	0.00003
52663-72-6	167	2,3',4,4',5,5'-HxCB	0.00003

39635-31-9	189	2,3,3',4,4',5,5'-HpCB	0.00003
Di-*ortho**			
35065-30-6	170	2,2',3,3',4,4',5-HpCB	0.0001
35065-29-3	180	2,2',3,4,4',5,5'-HpCB	0.00001

*Di-ortho values come from Ahlborg, U.g., et al (1994), which are the WHO 1994 values from Toxic equivalency factors for dioxin-like PCBs: Report on WHO-ECEH and IPCS consultation. December 1993. Chemosphere Volume 28, Issue 6. March 1994. Pages 1049-1067.

Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAH)

Benzo(a)pyrene (B(a)P) is the index chemical for this group of compounds. As of this writing, Health recommends that the following RPFs (EPA, 1993) be employed in the evaluation of cPAH only with respect to carcinogenicity. The sum of adjusted concentrations is referred to as Benzo(a)pyrene toxic equivalents i.e., B(a)P-TE and may be used in the assessment of ingestion, dermal (see EPA, 2004) or inhalation exposure.

Relative Potency Factors for Carcinogenic Polycyclic Aromatic Hydrocarbons

CAS Registry Number	Compound	Benzo(a)pyrene Relative Potency Factor
50-32-8	**Benzo(a)pyrene**	**1**
56-55-3	**Benzo(a)anthracene**	**0.1**
205-99-2	**Benzo(b)fluoranthene**	**0.1**
207-08-9	**Benzo(k)fluoranthene**	**0.01**
218-01-9	**Chrysene**	**0.001**
53-70-3	**Dibenzo(a,h)anthracene**	**1**
193-39-5	**Indeno(1,2,3cd)pyrene**	**0.1**

References

EPA, 1993. Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons. U.S. Environmental Protection Agency. Research Triangle Park, N.C. EPA/600/R-93/089, July 1993.

EPA, 2004. Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. OSWER 9285.7-02EP.July 2004.

EPA, 2013. Use of Dioxin TEFs in Calculating Dioxin TEQs at CERCLA and RCRA Sites. United States Environmental Protection Agency. May 2013.

EPA, 2019. United States Environmental Protection Agency. Regional Screening Levels for Chemical Contaminants at Superfund Sites. User's Guide. November 2018 edition. (accessed February 27, 2019).

Van den Berg et al., 2006. The 2005 World Health Organization re-evaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds. Toxicol Sci 93(2):223-241.