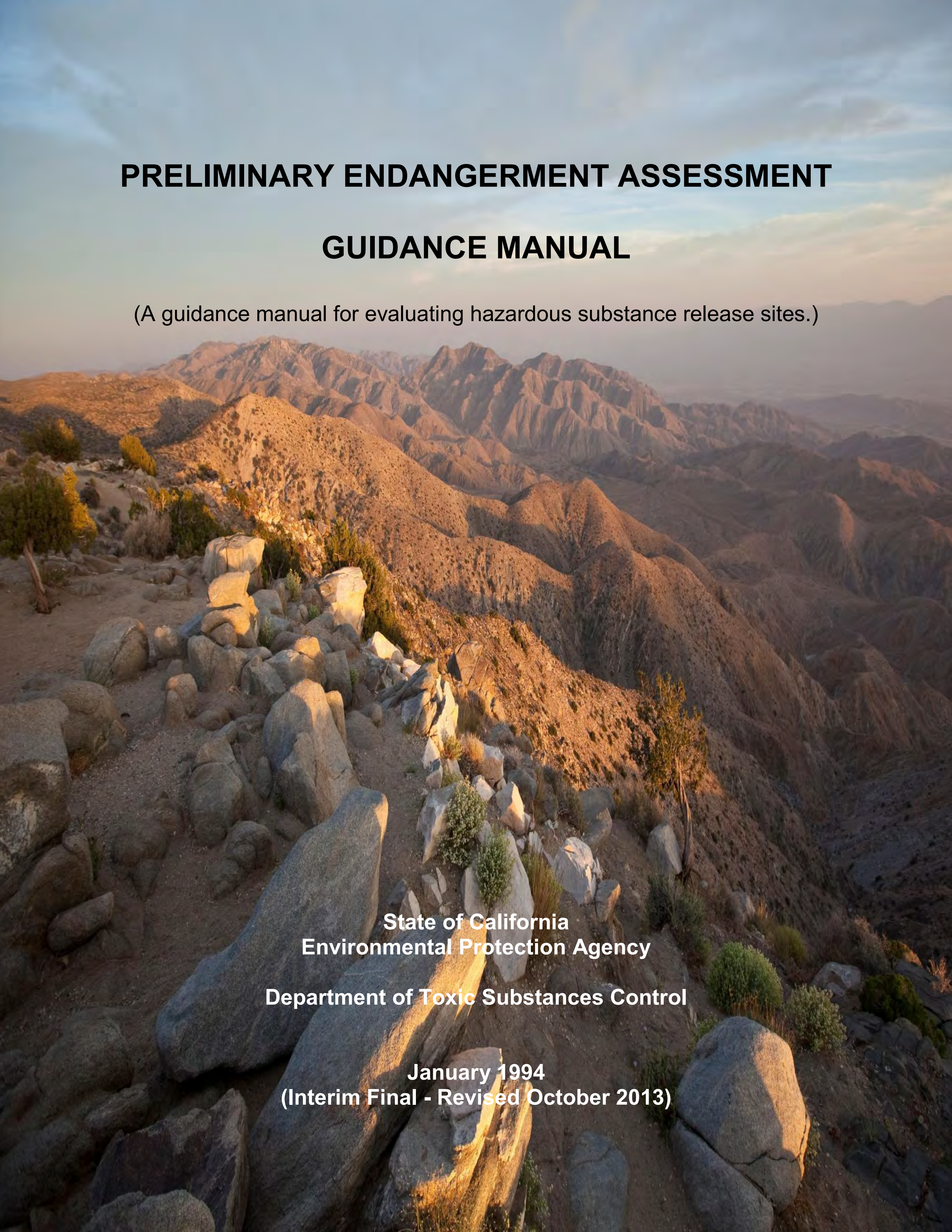
Appendix O

DTSC Preliminary Endangerment Assessment Guidance Manual (PEA)



PRELIMINARY ENDANGERMENT ASSESSMENT

GUIDANCE MANUAL

(A guidance manual for evaluating hazardous substance release sites.)

State of California
Environmental Protection Agency

Department of Toxic Substances Control

January 1994
(Interim Final - Revised October 2013)

FORWARD

DTSC fully expects that use of this revised PEA Guidance Manual will identify areas that can be improved upon. As the protocols in this document are implemented, issues may be identified which warrant document revision. DTSC will solicit comments from interested parties for a period of one year (ending October, 2014). At that time, DTSC will review and incorporate changes as needed.

Comments and suggestions for improvement of the PEA Guidance Manual should be submitted to:

PEAManualComments@dtsc.ca.gov

Please Note: Links to non-Cal/EPA sites do not imply any official Cal/EPA or DTSC endorsement of or responsibility for the opinions, ideas, data, or products presented at those locations, or guarantee the validity of the information provided. Links to non-Cal/EPA servers are provided solely as a pointer to information on topics related to the PEA that may be useful to DTSC staff and the public.

Cover Photograph: Joshua Tree National Park, Keys Point, Photo Courtesy of J. Michael Eichelberger.

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ACRONYMS AND ABBREVIATIONS

AAI	- All Appropriate Inquiries
AQMD	- Air Quality Management District
ARAR	- Applicable or Relevant and Appropriate Requirement
AT	- Averaging Time
ATSDR	- Agency for Toxic Substances and Disease Registry
BaP	- Benzo(a)pyrene
BIOS	- Biogeographic Information and Observation System
BTEX	- Benzene, Toluene, Ethyl Benzene and Xylenes
Cal/EPA	- California Environmental Protection Agency
CARB	- California Air Resources Board
CCR	- California Code of Regulations
CEQA	- California Environmental Quality Act
CERCLA	- Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	-Comprehensive Environmental Response, Compensation and Liability Information System
CFR	- Code of Federal Regulations
CGI	- Combustible Gas Indicator
CHHSL	- California Human Health Screening Level
COPCs	- Chemicals of Potential Concern
CSM	- Conceptual Site Model
CUPA	- Certified Unified Program Agencies
DFW	-California Department of Fish and Wildlife (formerly California Department of Fish and Game (**DFG**)
DPH	- California Department of Public Health
DOT	- Department of Transportation
DTSC	- Department of Toxic Substances Control
DQO	- Data Quality Objective
DWR	- California Department of Water Resources
ERNS	- Emergency Response Notification System
ESL	- Environmental Screening Levels
GC	- Gas Chromatography
HASP	- Health and Safety Plan
HEAST	- Health Effects Assessment Summary Tables
HERO	- Human and Ecological Risk Office
HHRA	- Human Health Risk Assessment
HI	- Hazard Index
HSC	- Health and Safety Code
HWIS	- Hazardous Waste Information System
IDW	- Investigation Derived Waste

IRIS	- Integrated Risk Information System
IUR	- Inhalation Unit Risk
J&E	- Johnson & Ettinger
LEL	- Lower Explosive Limit
MCL	- Maximum Contaminant Level
mmHg	- Millimeters of Mercury
MOA	- Memorandum of Agreement
NAWQA	- National Water Quality Assessment Program
NCP	- National Contingency Plan
NDDB	- Natural Diversity Database
NFA	- No further action
NPDES	- National Pollution Discharge Elimination System
NPL	- National Priorities List
NOA	- Naturally Occurring Asbestos
NOAA	- National Oceanic and Atmospheric Administration
OEHHA	- Office of Environmental Health Hazard Assessment
O&M	- Operation and Maintenance
OSHA	- Occupational Safety and Health Administration
OVA	- Organic Vapor Analyzer
PAH	- Polycyclic Aromatic Hydrocarbons
PA/SI	- Preliminary Assessment/Site Investigation
PCBs	- Polychlorinated Biphenyls
PCDD	- Polychlorinated Dibenzo-p-dioxins
PCDF	- Polychlorinated Dibenzofurans
PEA	- Preliminary Endangerment Assessment
PEF	- Potency Equivalency Factor
PHG	- Public Health Goal
PID	- Photoionization detector
PLMve	- Polarized Light Microscopy visual evaluation
PPB	- Parts per billion
PPTVs	- Provisional Peer Reviewed Toxicity Values
PQL	- Practical Quantification Limit
PRP	- Potential Responsible Parties
QA/QC	- Quality Assurance/Quality Control
RAGS	- Risk Assessment Guidance for Superfund
RAO	- Remedial Action Objective
RCRA	- Resource Conservation and Recovery Act
REL	- Reference Exposure Level
RME	- Reasonable Maximum Exposure
RfC	- Reference Concentration
RfD	- Reference Dose
RI/FS	- Remedial Investigation/Feasibility Study
RSL	- Regional Screening Level

RWQCB	- Regional Water Quality Control Board
SF	- Slope Factor (also Cancer Potency Factor)
SF RWQCB	- San Francisco Regional Water Quality Control Board
SQL	- Sample Quantification Limit
STSC	- Superfund Health Risk Technical Support Center
SWAMP	- Surface Water Ambient Monitoring Program
SWRCB	- State Water Resources Control Board
2,3,7,8-TCDD	- 2,3,7,8-tetrachloro-dibenzo-p-dioxin
TIC	- Tentatively Identified Compound
TPH	- Total Petroleum Hydrocarbons
TRI	- Toxics Release Inventory
TSD	- Treatment, Storage, and Disposal
UCL	- Upper Confidence Limit
UEL	- Upper Explosive Limit
URFs	- Unit Risk Factors
USEPA	- United States Environmental Protection Agency
USGS	- United States Geological Service
VOC	- Volatile Organic Compound
WHO	- World Health Organization

PREFACE

This document updates the *Preliminary Endangerment Assessment Guidance Manual* (Second Printing, June 1999). The previous guidance should no longer be used; however, issuance of this new manual does not invalidate Preliminary Endangerment Assessments (PEAs) completed before (or in progress prior to) its release. This guidance manual differs from the previous guidance most significantly in the inclusion of components of the All Appropriate Inquiries (AAI) process, simplification of human health screening risk evaluation, and addition of a methodology for evaluating human health risks from soil vapor.

The primary intended users of the manual are environmental consultants conducting PEAs for private parties with Department of Toxic Substances Control (DTSC) oversight. Because experience and professional judgment are vital for drawing the conclusions and presenting the recommendations requisite in the PEA, private parties are responsible for procuring the services of a competent environmental professional when preparing a PEA report. The manual should also be used by State Contractors and DTSC staff conducting PEAs with State funds. Other agencies or private entities requiring the use of the manual will be responsible for acting as lead agency and providing oversight for the project. Sites being evaluated as abandoned mine lands, should refer to the most current version of the *Abandoned Mine Lands Preliminary Assessment Handbook* [1]. School districts, county offices of education and charter entities seeking state bond funding and who are required to prepare a PEA in accordance with Education Code §17078.54, subdivision (c)(1) (charter schools) or §17268 and §17213.1 (public schools) should discuss the contents of the PEA with the DTSC project manager assigned to their site to ensure that the document will satisfy all requirements.

The PEA incorporates much of the information required for completion of the preliminary assessment and site inspection (PA/SI) investigations currently used by the USEPA. The PEA also has background information requirements similar to a Phase I Environmental Site Assessment required by most lending institutions prior to commercial real estate transactions. An attempt has been made to include information required by the AAI Rule. Although overall PEA requirements are more comprehensive than requirements for the PA/SI and Phase I Assessments, it is anticipated that information gathered for the PEA may also be useful for those purposes, as well as address potential data gaps and address the "degree of obviousness of the presence or likely presence of contamination at the property, and the ability to detect the contamination by appropriate investigation" criterion as part of the AAI. Specific requirements of the PEA that are not typically required for these other types of investigations include the site-specific human health and

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[1]DTSC. 1999. *Abandoned Mine Lands Preliminary Assessment Handbook, Second Printing, February.* http://www.dtsc.ca.gov/sitecleanup/brownfields/upload/aml_handbook.pdf

ecological screening evaluations, public participation requirements, data collection, and scoping activities.

The manual attempts to provide useful guidance for all possible site sizes and scenarios. A critical goal of scoping the PEA is to agree upon the focus of the PEA investigation and the degree to which each requirement in the manual applies to the subject site. Although each element of the PEA report should be addressed, the scope of the investigation and level of detail required for each section should be discussed with the DTSC's project manager overseeing the PEA activities. This manual is not intended to be a "cook book" of mandatory ingredients required to produce a PEA report. Each section should be reviewed to determine the appropriate level of action for a given site; however, it is DTSC's expectation that a PEA will be written as a stand-alone document. While other reports may be referenced if specific detail needs to be provided, information used as the basis for site conclusions needs to be included within the PEA.

ACKNOWLEDGEMENTS

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CHAPTER ONE

INTRODUCTION

The Preliminary Endangerment Assessment (PEA) provides basic information for determining if there has been a release of a hazardous substance that presents a risk to human health or the environment. The PEA is a formal step in the Department of Toxic Substances Control's (DTSC) cleanup program (While the program has been traditionally known as the site mitigation program, since incorporation of several additional components, the process will be referred to as the cleanup process or cleanup program to encompass the additional program elements). The PEA is intended to be the initial investigation of a site or property(ies) (hereinafter site also means property or properties) and is the first step in identifying whether a release or threatened release of a hazardous waste/substance/material has occurred, estimating the potential risk to public health and the environment, evaluating whether immediate response is needed to reduce the risk, and determining if further action/investigation is needed. In comparison, "All Appropriate Inquiries" (AAI) is the process of evaluating a property's environmental conditions and assessing potential liability for any contamination. An AAI is conducted to obtain certain liability protections under the federal Superfund Law known as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The federal regulations for conducting All Appropriate Inquires can be found in 40 Code of Federal Regulations Part 312 (40 CFR 312).

1.1 ORGANIZATION OF THIS MANUAL

This guidance manual is organized into three chapters. Chapter 1 provides background information defining the PEA, explains how the PEA ties into the cleanup process and discusses DTSC's responsibility to recover costs associated with oversight of the PEA. Chapter 2 provides technical guidance for conducting the PEA investigation, which includes scoping the project, acquiring background information, procedures for gathering reliable chemical and physical data, and methodologies for conducting the human health and ecological screening evaluations. Chapter 3 provides the suggested outline for presentation of the PEA investigation results in a PEA report. Chapter 3 also provides general guidance on how to organize the PEA report and a detailed description of information that should be included in the report.

1.2 DEFINITION/OBJECTIVES OF THE PEA

The PEA is defined in California Health and Safety Code (HSC), Division 20, Chapter 6.8, Section 25319.5 (HSC §25319.5) as follows:

Preliminary Endangerment Assessment means an activity which is performed to determine whether current or past waste management practices have resulted in the release or threatened release of hazardous substances which pose a threat to public health or the environment. The PEA is also applicable to releases of hazardous materials.

Specific objectives of the PEA include:

- Determining if a release of hazardous wastes/substances/materials has occurred at a site and delineating the general extent of the contamination.
- Estimating what is the potential threat to public health and/or the environment posed by the site and providing an indicator of the relative risk.
- Determining if an interim action is required to reduce an existing or potential threat to public health or the environment.
- Completing preliminary project scoping activities to determine data gaps and identify possible remedial action strategies to form the basis for development of a site strategy.
- Providing the data and information to the DTSC.
- Assessing and providing for the informational needs of the community.

1.3 THE PEA WITHIN THE CLEANUP PROCESS

The DTSC's cleanup process can be divided into several general phases: site evaluation, interim action, site characterization, remedial action, certification and operation and maintenance. The PEA is intended to be an initial investigation of the site and is completed during the site evaluation phase. Elements of the site evaluation phase are discussed in the following section. Figure 1-1 presents a flow chart of the site cleanup process. Detailed information regarding the entire cleanup process can be obtained by contacting one of the DTSC's regional offices or headquarters office.

The site evaluation phase of the cleanup process includes activities such as site discovery; site screenings; the PEA; and potentially responsible party searches.

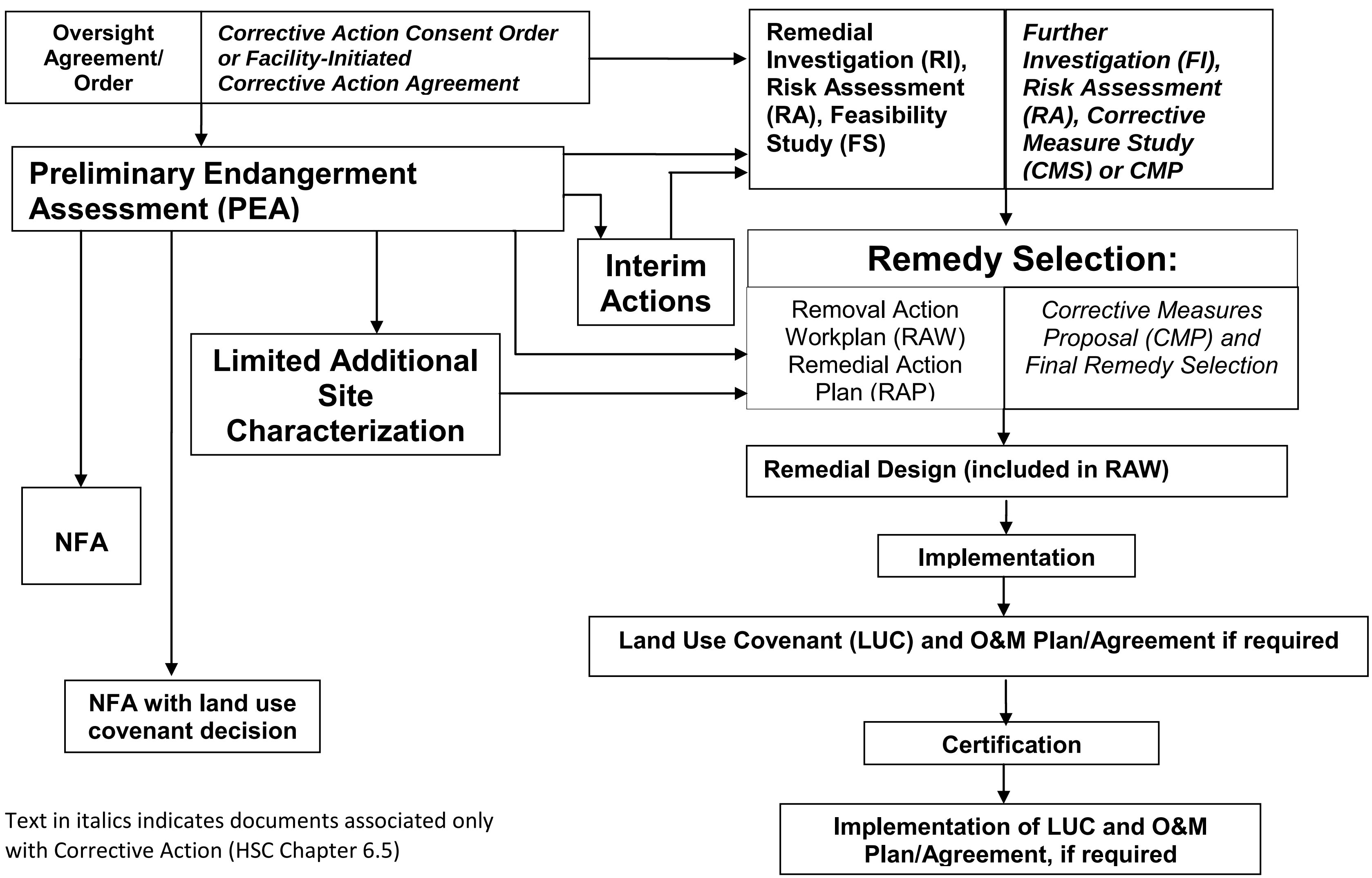
Throughout the site evaluation phase, human and ecological risk-based assessments are conducted. The risk-based assessments begin as qualitative judgments that become progressively more quantitative as additional site specific information is collected and the conceptual site model becomes more refined. As indicated in Figure 1-1, there may be circumstances when a PEA may not be initially conducted, and remedial investigation (RI) and quantitative risk assessment (RA) are performed instead.

At any time during or following the site evaluation phase, an interim action may be necessary. Interim actions are those actions taken to eliminate any immediate threats to public health or the environment resulting from conditions at the site. These actions generally include, but are not limited to, fencing the site, hot spot removals of contaminated areas, removing containers of hazardous substances/wastes, and/or providing alternative water supplies. Interim actions should be identified and implemented as early as possible during the site evaluation process.

Site discovery, the first step of site evaluation, involves the identification of known or potentially contaminated properties that were previously unknown to the DTSC. Following discovery, a site screening is conducted by DTSC staff to determine whether a property should be evaluated further and whether the property falls within the jurisdiction of DTSC's cleanup authority. Based on the screening, one or more of the following recommendations will generally be made:

- No action required;
- Site referred to another agency;
- PEA required; and/or
- Interim action required.

FIGURE 1-1 CLEANUP PROCESS



Text in italics indicates documents associated only with Corrective Action (HSC Chapter 6.5)

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The determination that a PEA is needed may occur after a property has been screened during the site discovery phase or a Project Proponent may voluntarily request DTSC to provide oversight of the preparation of a PEA. Typical scenarios for conducting the PEA include:

- The DTSC identifies a property with a known or suspected release of hazardous substances/wastes/materials and contacts the Responsible Party(s) to initiate the investigation. The Responsible Party(s) either agrees to assess the site and enters into a Cleanup Agreement or the DTSC issues an administrative order requiring the completion of the PEA with penalties for non-compliance.

- A Project Proponent who voluntarily requests oversight from DTSC or a Regional Water Quality Board to oversee completion of a PEA, submits an application to DTSC or a Regional Water Quality Control Board (RWQCB) initiating the Memorandum of Agreement (MOA) process[2]. The California Environmental Protection Agency, the DTSC, the State Water Resources Control Board and Regional Water Quality Control Boards have signed a MOA regarding the regulatory oversight of brownfield sites. The purpose is to improve coordination between the DTSC and the boards and the oversight of cleanup activities. The MOA was designed to accomplish several objectives including limiting oversight to only one agency and establishing procedures and guidelines to identify that agency. The MOA also designed a uniform site assessment procedure, defines the roles of support agencies, requires opportunity for public involvement, commits regulatory agencies to timeframes for review, and commits the agencies to coordinate and communicate on brownfield properties.

- A site with a known or suspected release of hazardous substances/wastes/materials is identified, but the responsible person(s) have not been identified and potential or significant public health or environmental threats warrant use of the DTSC's resources to assess the site.

Figure 1-2 presents a diagram of the PEA process from the point of initiation with the DTSC to preparation of the final report. As seen in the diagram, Initiate PEA, Background Research, Data Evaluation, and Report Preparation are steps required for all PEA investigations. The majority of the investigation's flexibility lies within Public Participation, Sampling, and Human Health and Environmental Screening Evaluations. The requirements under these sections are dependent upon site-specific circumstances and DTSC staff should be consulted prior to proceeding. All of the sections in the diagram are flexible with regard to the level of effort required for each site.

[2] The MOA process is more fully described on CalEPA's Web site at: http://www.calepa.ca.gov/brownfields/MOA/

The completed PEA report provides the information necessary to determine the need for further action at the site. DTSC staff will review the data provided in the PEA report to determine if the recommendations in the report are justified and supported. Sites requiring no further action will be released from DTSC oversight requirements. However, if information becomes available at a later date which indicates previously unknown or additional problems may exist, the DTSC may initiate additional investigations at the site. Sites with significant contamination requiring further action will move along in the cleanup process for removal and/or remedial actions. In either case, the DTSC will issue a letter formalizing completion of the PEA, approving or disputing the recommendations, and detailing any recommendations or requirements not presented in the PEA report that the DTSC feels are necessary to address the site's contamination.

DTSC approval of a "no further action (NFA)" recommendation signifies that the DTSC's concerns at the site have been addressed; however, a qualified NFA may be provided if other agencies require further action based on concerns not addressed during the PEA. For example, the RWQCB may require actions to remove an underground tank holding petroleum products. Whenever possible, the preparer and DTSC staff should coordinate with other agencies to address their concerns during the PEA.

Following completion of the PEA, a base-line potentially responsible party (PRP) search may be necessary to identify the principal parties potentially liable for mitigating contamination at the site. The most current version of US EPA's PRP search Manual may be consulted to assist in the search[3,4]. Much of the information required to complete the baseline PRP search should be contained in the PEA report. PRPs identified by the search may be required to participate in the work to be conducted beyond the PEA.

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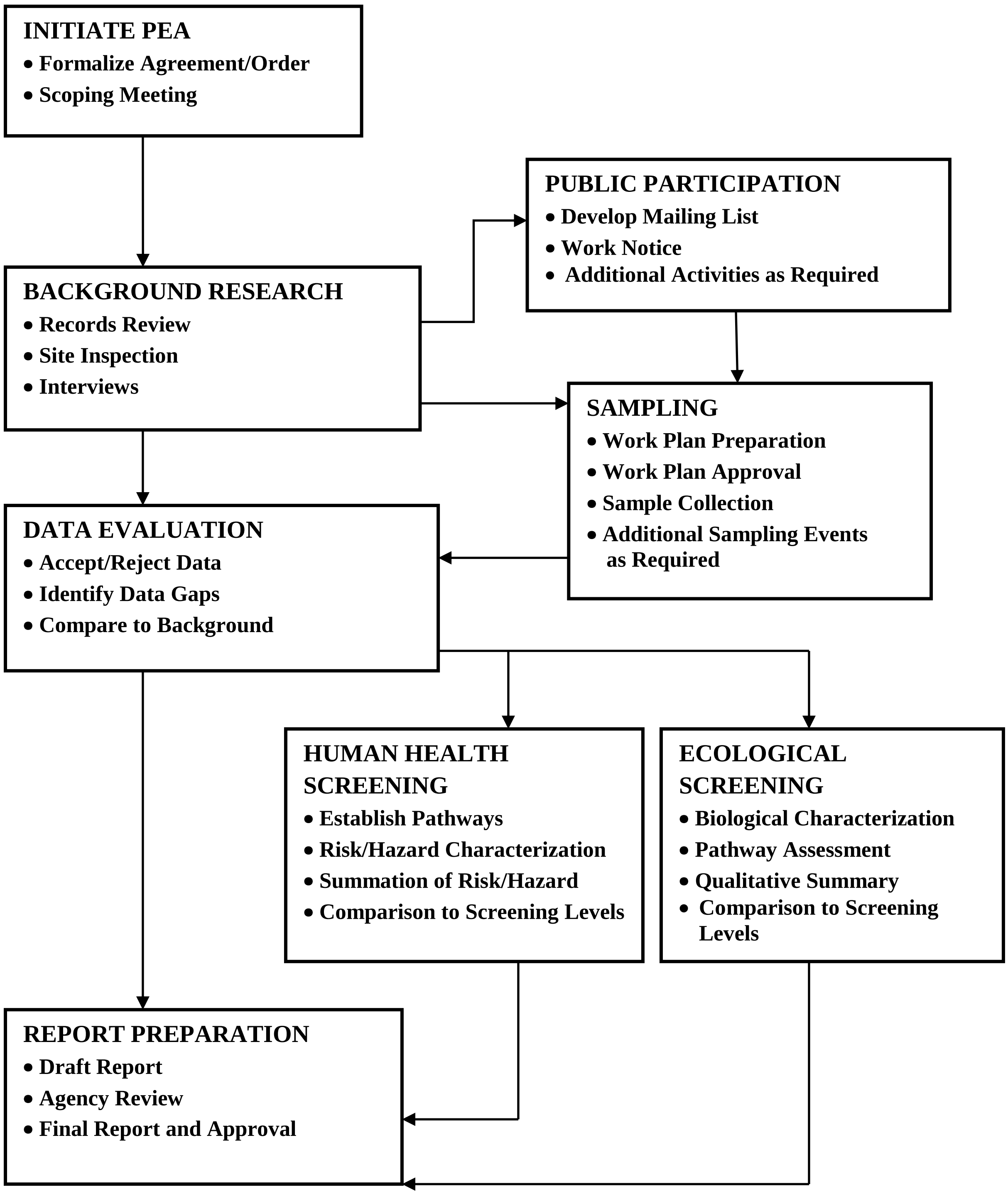
[3] USEPA. 2009. *PRP Search Manual.* EPA 330-K-09-001. September. http://www.epa.gov/compliance/cleanup/superfund/prpmanual.html

[4] USEPA. 2011, *Addendum to the EPA PRP Search Manual.* EPA 330-K-09-001A. November. http://www.epa.gov/compliance/resources/publications/cleanup/superfund/prpmanual/prp-man-09appenda-11.pdf

FIGURE 1-2 PRELIMINARY ENDANGERMENT ASSESSMENT PROCESS DIAGRAM



1.4 COST RECOVERY

California law requires the DTSC to recover all costs, including any accrued interest, incurred by the DTSC associated with the investigation and cleanup of contaminated sites (HSC § 25360 and §25360.1). The final cost for oversight depends on the number of hours expended by DTSC staff. The Responsible Party(s) or Project Proponent(s) will be billed on a quarterly basis for costs incurred. Depending on the type of cleanup agreement, the Responsible Party(s) or Project Proponent(s) may be required to provide the DTSC with an advance payment based on an estimate of the oversight costs.

CHAPTER TWO

THE PEA INVESTIGATION

Conducting a PEA investigation involves scoping the project, collecting and reviewing background information and chemical data, defining the community, and evaluating potential risks to public health and the environment. This chapter discusses methodologies for assessing the level of community interest in the site, identifies potential sources for locating information pertinent to the site investigation, provides procedures for acquiring reliable chemical data, and presents methodologies for completing screening level evaluations of human and ecological health risks related to site conditions.

If the PEA is being conducted as part of an All Appropriate Inquiries (AAI), the persons or businesses conducting the PEA will need to meet the standards and practices included in the U.S. Environmental Protection Agency's (USEPA) final rule dated November 1, 2006 as required under §101 (35) (B) (ii) and §101 (35)(B) (iii) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and 40 CFR Part 312[5] or the most recent approved rule. This manual attempts to include those requirements, but the reader is advised to review the federal statute to ensure compliance with the regulatory requirements and standards for AAI. The AAI requires that completion of specific portions be conducted by an environmental professional having specific educational and experience requirements. With respect to the PEA, individuals conducting engineering and geological work must be in conformance with applicable state law including, but not limited to, Business and Professions Code § 6735 and §7835.

2.1 SCOPING

The Environmental Professional[6] responsible for preparing the PEA has some flexibility regarding the focus of the PEA and the emphasis to be placed on each part of the investigation. Limits of this flexibility will be defined for each site by the DTSC project

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[5] More information regarding US EPA's All Appropriate Inquiries can be found on their Web page at: http://www.epa.gov/brownfields/aai/index.htm

[6] The term Environmental Professional is used to describe the person who is preparing the PEA; however, geologic or engineering plans, specifications, drawings, and reports must be prepared by, or under the direct supervision of a California professional geologist or civil engineer, as appropriate, who will review and sign all such documents indicating responsibility for their content.

manager through the scoping process. The Environmental Professional and project manager should identify the scope of activities to be performed to ensure the activities are appropriate for site-specific conditions and objectives. Agreeing ahead of time to the scope of activities and remedial action objectives (RAOs) should aid in maximizing effective expenditure of time and money. The final report should document activities performed according to this manual and provide rationale for those PEA requirements not addressed.

2.1.1 SCOPING MEETING

After signing an agreement or order, the first step in conducting the PEA investigation is to hold a scoping meeting between DTSC staff (e.g., geologist, toxicologist, project manager, etc.), the party required to complete the PEA and the environmental professional(s) assigned to do the work. The purpose of the meeting is to agree upon the approach for collecting information and develop a strategy for completing activities appropriate for the site. During the scoping meeting, plans should be made to identify:

- A schedule for activities;
- Roles and responsibilities;
- The level of information previously collected and assess the need for background research and data collection;
- The desire to include "All Appropriate Inquiries" requirements within the PEA;
- Public participation needs; and
- Need for expedited response actions.

Additional meetings may be held throughout the investigation to review new information collected and/or update site strategy. The USEPA currently recommends the Triad approach to site investigation and cleanup. There are three components to Triad: systematic (or strategic) planning, dynamic work strategies, and real-time measurement systems. An agreement to use the Triad approach should be considered at the scoping meeting. For more information, go to the US EPA Triad Central website at www.triadcentral.org.

2.1.2 CONCEPTUAL SITE MODEL

The PEA uses the Conceptual Site Model (CSM) to develop a preliminary understanding of the site's potential risks to human health and the environment and is used to assist in developing the sampling plan. The CSM presents information about site conditions and potential impacts to receptors and may be updated as new information is obtained. The information can be provided in a schematic presentation as shown in Figure 2-1 or pictorially. The CSM should illustrate possible contaminant transport mechanisms and exposure pathways from various media that may be affected: air, soil, sediments, and water, including soil vapor, groundwater, and surface water. Information regarding the development of the CSM is available from a variety of sources including USEPA's most current version of the RI/FS guidance document[7], the Triad Resource Center[8], and the most current version of Appendix A of DTSC's *Remediation of Metals in Soil*[9] . The Triad approach has expanded the CSM to include past use, previous investigations, geology and hydrogeology, intended reuse, decision criteria, potential remedies, and exit strategies, and these elements may in included in the CSM for a PEA, if appropriate.

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[7] USEPA. 1988. *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA.* EPA/540/G-89/004. OSWER Directive 9355.3-01. October. http://www.epa.gov/superfund/policy/remedy/pdfs/540g-89004-s.pdf

[8] Triad Resources Center Website: http://www.triadcentral.org/

[9] DTSC. 2008. P*roven Technologies and Remedies Guidance, Remediation of Metals in Soils, Appendix A.* August 29. http://www.dtsc.ca.gov/SiteCleanup/upload/Appdx_A1_083108.pdf

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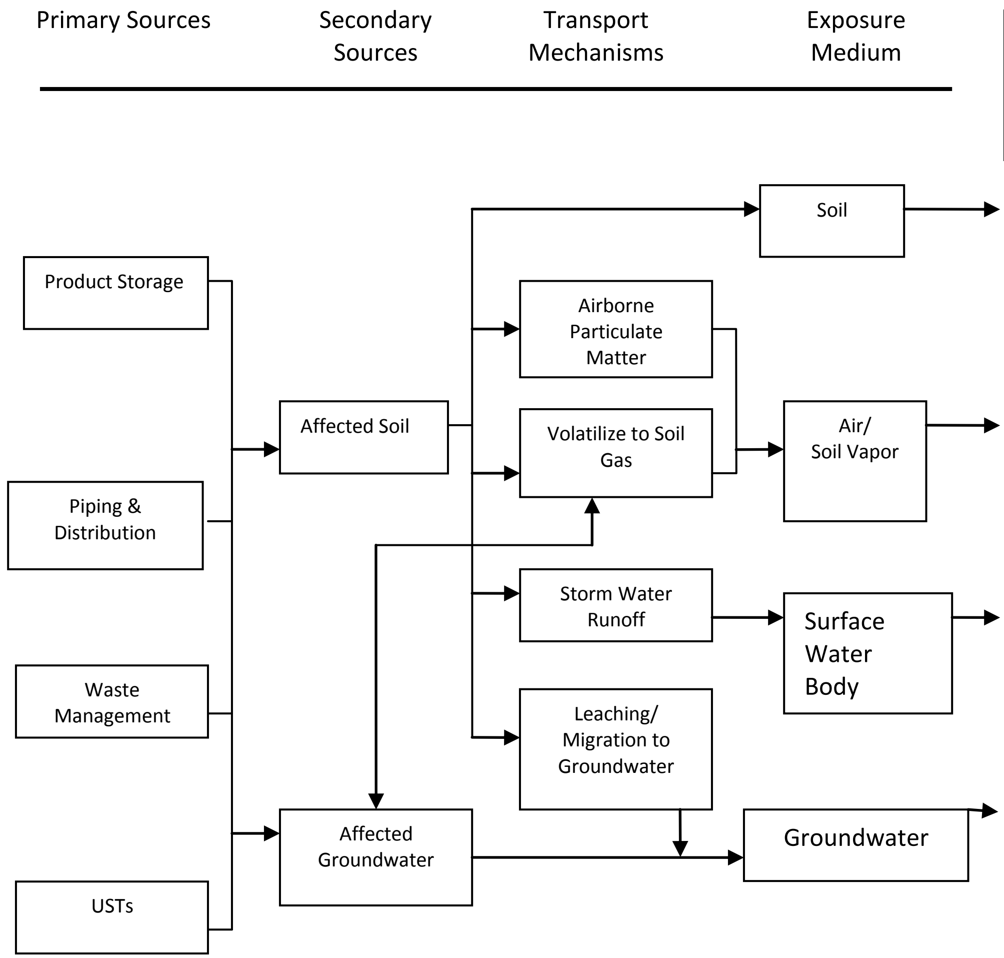
FIGURE 2-1 EXAMPLE OF CONCEPTUAL SITE MODEL PATHWAY RECEPTOR NETWORK



Exposure Route	Receptor			
	Human		Biota	
	Residents	Site Workers	Terrestrial	Aquatic
Ingestion	X		X	X
Inhalation	X	X		
Dermal Contact	X	X	X	
Ingestion				
Inhalation	X	X	X	
Dermal Contact				
Ingestion				
Inhalation				
Dermal Contact	X	X		X
Ingestion	X	X		
Inhalation	X	X		
Dermal Contact	X	X		

2.2 BACKGROUND RESEARCH

The purpose of the background research is to collect pertinent site information about the following:

- Site location, including legal description or easement;
- Regulatory status;
- Physical and environmental characteristics;
- Zoning, including any potential upcoming zoning or general plan changes;
- Current and past property uses and occupancies;
- Facility operations;
- Recorded environmental cleanup liens;
- Chain of title documents;
- Current and past corrective actions and response activities undertaken to address past and on-going releases of hazardous substances/wastes/materials;
- Engineering controls;
- Institutional controls;
- Current and past uses of hazardous substances/materials;
- Hazardous substance/waste/material management practices;
- Land use in the immediate area that might influence onsite conditions; and
- Environmental permits, both current and past, such as waste discharge requirements (WDR), National Pollution Discharge Elimination System (NPDES) permits, air quality management district permits, local permits, wastewater discharge permits, etc.

The Environmental Professional conducting the historical site search may exercise professional judgment as to how far back in time it is necessary to search historical records. Generally, the historical documents and records reviewed should cover a period of time as far back in the history of the property as it can be shown that the property contained structures or from the time the property was first used for residential, agricultural, commercial, industrial, or governmental purposes. At sites where information of past operations is limited, the type of operation known to have been conducted and any standard business or manufacturing practices applicable to operations of that kind and period should be researched. If there are data gaps in the information developed that affects the ability of the person conducting the PEA to identify conditions indicative of releases or threatened releases, the Environmental Professional should identify the data gaps, identify the sources of information consulted to address the data gaps, and comment on the significance of the data gaps with regard to the ability to identify conditions indicative of releases or threatened releases on, at, in or to the property.

Complete and accurate site information is essential for determining the apparent problem, the potential exposure pathways and receptors, and the sampling needs for the PEA investigation. Records reviews, interviews, and site inspections should be conducted to complete this information-gathering phase of the PEA investigation. The specific information to be collected during these activities is outlined in Sections 3.2.3 Site Description, and 3.2.4 Background. The following sections provide guidance for completing these activities.

2.2.1 RECORDS REVIEW

This section provides potential data sources for the information requested to complete the background research for the PEA. Not all of the sources listed need be explored for each PEA. The review should begin with sources most likely to contain information on a given site. If conducting an AAI, searches and reviews for recorded environmental cleanup liens and reviews of government records must be conducted or updated within 180 days of and prior to the date of acquisition of the subject property.

1) **Agency Files:** The preparation of a complete history of onsite operations requires the review of all appropriate regulatory agency files. These files often provide documentation of releases and usually contain information not available in site records. If the information is not available on-line, then each agency should be contacted by telephone prior to making a visit to review files. Appointments are often necessary and fees may be charged for copying.

    a) **DTSC, Regional Office** for inspection results, permits, previous removal or cleanup activities. DTSC's EnviroStor Data Base[10] can also be reviewed on-line to obtain information on permitted facilities, environmental investigation and cleanup projects.

    b) **USEPA** for inspection results, permits, listing on the Federal Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS), National Priorities List (NPL), Emergency Response Notification System records (ERNS), Toxics Release Inventory (TRI) or Resource Conservation and Recovery Act (RCRA) Treatment, Storage, and Disposal (TSD) Facilities lists.

[10] DTSC EnviroStor Web Site. http://www.envirostor.dtsc.ca.gov/public/

c) **RWQCB** for waste discharge permits, National Pollutant Discharge Elimination System (NPDES), previous cleanup activities, landfill or solid waste disposal lists and state leaking or registered underground storage tank lists. The State Water Resources Control Board GeoTracker [11]data base is available online and includes information on leaking underground storage tank cleanup sites, land disposal sites, permitted underground storage tank facilities and other cleanup sites overseen by the State Water Board and Regional Water Quality Control Boards. The Department of Resources Recycling and Recovery or the Local Enforcement Agency (LEA) may also have records concerning solid waste disposal.

d) **County and Local Offices** including Environmental Health Department; Planning Department; Certified Unified Program Agencies (CUPA); Public Works Department; Public Health Offices, Air Pollution Control Districts; County Agriculture Commissioner's Office; County Tax Assessor's Office for all pertinent records regarding the site.

e) **Local Fire Department** for records regarding emergency response activities and hazardous materials storage at the site.

f) **California Secretary of State's Office** for information regarding corporate ownership, officers, etc.

g) Public health records such as the Agency for Toxic Substances and Disease Registry (ATSDR) public health assessment and consultations.

h) Division of Oil, Gas & Geothermal Resources (DOGGR) is the repository for oil, gas, and geothermal well information and publishes statistics on drilling, production, and injection. General information, technical report, and statewide maps with locations and status of all oil, gas and geothermal wells are also available.

2) **Site Owner/Operator Records:** Facility records may be the primary source for information on hazardous substance/waste/material management practices at the site. Owner/operator files may include such records as product purchase invoices; waste manifests or bill of ladings; permits; material safety data sheets; safety plans, preparedness and prevention plans; spill prevention, countermeasure and control plans; etc. that will provide valuable information regarding chemical usage and waste/material types, quantities, and treatment, storage and disposal practices.

3) **Professional Trade Organizations:** These organizations will have information on manufacturing processes and common industry practices.

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[11] State Water Resources Control Board GeoTracker Database. http://geotracker.waterboards.ca.gov/

4) **Maps and Photographs:** Maps, including electronic maps, and photographs will be useful for establishing the physical setting of the site and identifying property uses at specified times.

   a) **USGS 7.5 Minute Topographic Maps** produced by the United States Geological Survey (USGS) provide a basis for establishing site location and topographic information.

   b) **Aerial photographs** of areas encompassing the site may allow for identification of historical development or site activities.

   c) **Photographs** may be available from private collections, libraries of local governments or colleges and universities, or historical societies that document historical site activities.

   d) **Fire Insurance Maps** produced by private fire insurance map companies indicate uses of properties at specified dates.

   e) **Sea Level** rise inundation maps, if applicable to site location.

Government records or databases should be reviewed for reported releases or threatened releases for nearby or adjoining properties. The record and database searches with their associated distances should include the following:

- NPL sites or tribal- and state-equivalent sites (one mile);
- State facilities subject to corrective action (one mile);
- Federally-registered, or state-permitted or registered, hazardous waste sites identified for investigation or remediation, such as sites enrolled in state and tribal voluntary cleanup programs and tribal-and state-listed Brownfields sites (one-half mile);
- Leaking underground storage tanks (one-half mile);
- Properties that previously were identified or regulated by a government entity due to environmental concerns at the property. Information that should be searched includes the following:
  - Delisted NPL sites (one-half mile);
  - Registries of publicly available lists of engineering controls (one-half mile);
  - Former CERCLIS sites with no further remedial action notices (one-half mile).
- State small quantity and large quantity generators

BOX 2-1: EXAMPLES OF PHYSICAL FEATURES

- Property boundaries and existing structures
- Locations and boundaries of all onsite operations (present and past)
- Foundations of former structures
- Storage tanks and storage areas (including “empty” drum storage)
- Odors
- Pools of liquid (including standing surface water)
- Electrical or hydraulic equipment known or likely to contain PCBs
- Unidentified substance containers
- Stained soil and pavement, corrosion, and degradation of floors and walls
- Drains and sumps
- Pits, ponds and lagoons
- Surface drainage pathways
- Stressed vegetation (from something other than insufficient water)
- Solid waste and waste water
- Unique geologic features
- Wells (including dry wells, irrigation wells, injection wells)
- Septic systems

(adjoining properties);

- Federally-permitted, tribal-permitted, or state-permitted (or registered) landfills and solid waste management facilities (one-half mile);
- Registered storage tanks (adjoining properties); and
- DFW sites or other habitat areas where releases have occurred (one mile).

The search distance from the property boundary for reviewing government records or databases may be modified based upon the professional judgment of the environmental professional. The rationale for the modification must be documented.

2.2.2 SITE INSPECTION

A site inspection is essential to document the physical setting of the site, verify information obtained from owner/operator and agency records, and/or obtain site specific information when no records are available. The site inspection should consist of a walk-through of known and potential exterior operations areas as well as the interiors of all structures. A visual inspection of areas where hazardous substances/materials may be or may have been used, stored, treated, handled, or disposed should be conducted. Quantities of hazardous substances/materials observed and potential releases should be documented. Box 2-1 contains examples of the specific physical features the observer should attempt to identify. Physical limitations to the on-site visual inspection should be noted.

In addition to the on-site inspection, a visual inspection of the adjoining properties is needed. This inspection may be conducted from the subject property line, public rights-of-way, or other vantage points (e.g., aerial photography), and include a visual inspection of areas where hazardous substances/materials may be or may have been stored, treated, handled or disposed. Observations of any locations where human or ecological receptors may exist and may be potentially affected by on-site contamination moving off the property should also be noted. Any physical limitations related to the inspection of the adjacent properties should be noted.

Visual inspections of the property and of adjoining properties must be conducted or updated within 180 days of and prior to the date of acquisition of the subject property if performing an AAI.

2.2.3 INTERVIEWS

Interviews with current or former property owners, operators, facility managers, employees, occupants and/or site neighbors (owners and/or occupants) are necessary to obtain information regarding uses and historical physical characteristics of the site. Often based upon personal experience, this information can provide greater insight as to how the facility may have operated or who may be gaining access to the site. These personal accounts may confirm information found in agency files and provide missing details about the site. In some cases the information obtained from interviews may differ or contradict that obtained from records reviews. In these instances additional research may be required to determine which information is accurate. Notes taken during interviews may be used as reference documents.

Telephone interviews may also be conducted with State and local agencies to obtain information not readily available through file review, including drinking water supplies, well locations, population served, and aquifer information.

For AAIs, interviews with past and present owners, operators, and occupants must be conducted or updated within 180 days of and prior to the date of acquisition of the subject property.

2.3 PUBLIC PARTICIPATION

Public participation is an integral component of the cleanup process. The DTSC's formal Public Participation Program establishes the mechanism for initiating and maintaining two-way communication between the community affected by a contaminated site and the regulatory agencies responsible for site investigation and cleanup. Public participation is essential at any site where chemicals in soils or groundwater may intrude to indoor air. Solicitation of community concerns, suggestions, and comments throughout the cleanup process allows DTSC to make more informed decisions and reduces the potential for delays that might arise if the community objects to or does not understand an action or decision. It is the DTSC's policy that public participation activities be initiated from the onset of a project and continue throughout the entire cleanup process. DTSC's most current version of the *Public Participation Policy and Procedures Manual* [12], which describes in more detail public participation requirements and other activities during the investigation and cleanup of sites, and the most current version of the *Vapor Intrusion Public Participation Advisory*[13] , which discusses the public participation issues arising when indoor air may be contaminated by vapors coming from the sub-surface, are available on DTSC's web site.

During the PEA, development and distribution of a work notice describing field work may be necessary if the investigation is near a sensitive receptor or in a residential area. The mailing list should consist of known interested parties/agencies, contiguous property owners and occupants. If during the PEA, it becomes clear that the site will require additional steps beyond the PEA phase, or if there is high community interest, the DTSC Public Participation Specialist should be contacted to determine if additional community outreach, (e.g., additional noticing at or near the site, etc.), is needed. If a Land Use Covenant may be implemented during the PEA phase as a final remedy, the DTSC Public

[12] DTSC. 2001. *Public Participation Manual.* Revised, October. http://www.dtsc.ca.gov/LawsRegsPolicies/Policies/PPP/PublicParticipationManual.cfm
[13] DTSC. 2012. *Vapor Intrusion Public Participation Advisory.* Final. March. http://www.dtsc.ca.gov/SiteCleanup/Vapor_Intrusion.cfm

Participation Specialist will prepare an abbreviated community profile, and develop a public notice and fact sheet announcing a public comment period for the remedy.

2.4 DATA COLLECTION AND EVALUATION

This section deals with collecting samples from the field and evaluating the quality of the data collected. The Environmental Professional conducting the PEA should meet with the DTSC project manager and technical support staff, as appropriate, to review background information collected and discuss the need for additional sampling and a sampling strategy for the site. The Environmental Professional should submit a proposed work plan to DTSC for review and approval. Upon approval, the samples are collected and analyzed, and the resulting data are evaluated by the Environmental Professional and submitted to DTSC for review. Once the sampling and quality objectives are met, the data are ready for use in the screening evaluation (Section 2.5) and preparation of the PEA report.

The scope and type of field sampling will vary depending upon the site history and the nature of the release of hazardous substances/materials. If sampling has been conducted in the past, the results and related information needs to be reported and evaluated as part of the PEA. Additional sampling activities may be needed as part of the PEA investigation unless prior sampling data are of sufficient quality and quantity to fulfill the PEA requirements and objectives. Past sampling activities conducted without DTSC oversight will need to be reviewed by a DTSC project manager to evaluate the adequacy of the data for use in the PEA investigation.

2.4.1 WORK PLAN PREPARATION

The work plan should include all information necessary for implementing field work. A generic sampling plan table of contents is included as Table 2-1. DTSC has developed various Proven Technologies and Remedies Documents[14] that contain generic field sampling plans that the Environmental Professional may wish to review and use if appropriate when preparing the PEA work plan. The following points should be addressed in the sampling plan:

1) **Introduction, Site Background, and Description:** Provide the scope and purpose of the work plan, a history and site description relevant to sampling which identifies past activities that may have resulted in the contamination and the location and possible extent of the original release(s). The plan should also include other relevant site information such as site location, topography, hydrology, climate conditions and past sampling information. Maps should be presented that show the site in relation to its surroundings and identify site- specific features. The plan should also include a map(s) dedicated to identifying all sampling points,

[14] Proven Technologies & Remedies Documents resources page. DTSC Web site. http://www.dtsc.ca.gov/SiteCleanup/PTandR.cfm

contamination sources, surface water and general groundwater flow directions, and site boundaries.

2) **CSM and Data Quality Objectives (DQOs) Process:** Provide a description of the CSM in text and/or figures. Identify the type, quality, and quantity of data that are needed and the intended use of the data based on the CSM and through the DQO process. More information on the DQO process can be found at the USEPA's Triad website and various USEPA quality assurance and quality control documents.

3) **Rationale for Sampling Strategy:** As part of the DQO process, provide the reason for choosing the locations, depths, types of sample matrices, number of samples (including quality assurance/quality control samples), analytical parameters, such as target analytes, detection limits and field screening methods. Any statistical approach used to select the locations should be explained.

4) **Sampling Methods:** Include step-by-step procedures and/or standard operating procedures describing how each sample will be collected for each matrix type and sampling technique. Any special methods to prevent losses of volatile or unstable compounds, such as, USEPA Method 5035 for collecting soil samples for volatile compound analysis, should be described. All equipment used to obtain samples and number and type of field quality controls should be identified.

5) **Sample Containers and Preservation:** Show analytical methods, types and volume of containers and preservation methods to be used for the different matrices in a table. Describe the type of pre-cleaning method used for the containers or provide a reference.

6) **Sample Packaging and Shipment:** Describe the methods for packaging, labeling, marking and shipping the samples.

7) **Sample Documentation:** Provide a description of the sample label with an example. A unique numbering system that positively identifies each sample and does not distinguish the quality assurance and quality control (QA/QC) samples from other samples should be described.

8) **Record Keeping:** Discuss field documentation including field logs (log book, drilling logs etc.), photographs, and quality control checklist or logs, and chain of custody forms and seals. The specific types of entries to be made in the various logs should be stated.

TABLE 2-1 GENERIC FIELD SAMPLING WORK PLAN TABLE OF CONTENTS

2.4.2 SAMPLING STRATEGY

The first objective of sampling during the PEA is to provide analytical data of known quality to identify the contaminants at the site. These data are used in the PEA screening evaluation to estimate the risk to public health and the environment. The highest concentrations of each contaminant detected onsite should be used to estimate the site's potential threat. The sampling strategy should ensure that locations which would likely contain the highest contaminant concentrations will be sampled.

The second objective of sampling is to determine the general extent of contamination in order to assess immediate potential threats, scope of removal and remediation needs. Sufficient information should be gathered from the sampling to determine: 1) the need for expedited response actions such as restricting site access; and 2) the areas of the site with highest levels of contamination.

The degree to which the sampling strategy includes surface soils, subsurface soils, groundwater, surface water, soil vapor, and air is based on past chemical handling practices, available analytical data, suspected contamination sources, probable migration routes, and potential exposure pathways identified in the CSM (Section 2.1.2). Expectations regarding the extent of the investigation should be discussed with the DTSC project manager. Overall, the investigation should be performed in a manner that will determine the nature of the contaminants, their general distribution in the environment, and their potential to migrate.

The sampling can occur in one event or can be addressed in a phased approach, depending on the information known prior to sampling and the specific goals of each investigation event; however, the goal of the sampling should be to gather sufficient data to complete a PEA. If it becomes apparent during the sampling phase that field investigations beyond the scope of a PEA is needed, a meeting with the DTSC project manager should be held to determine whether the site should progress into the next steps of the cleanup process. In that case, the PEA is concluded with a recommendation for further investigation and/or remediation. Sites with little known and suspected contamination may require only one sampling event to gather sufficient information to address the objectives. A phased approach may be desired at sites with suspected contamination. In a phased approach, the first step may be to determine the nature and general extent of soil contamination prior to determining the need for a groundwater investigation, soil vapor sampling, surface water sampling and/or air monitoring. The Environmental Professional and DTSC staff should explore the most cost-effective approaches to collecting the required information while maintaining the scientific integrity of the investigation.

Geologic or engineering plans, specifications, drawings, and reports must be prepared by, or under the direct supervision of a California professional geologist or civil engineer, as appropriate, who will review and sign all such documents indicating responsibility for their content.

2.4.2.1 SOIL SAMPLING (VADOSE ZONE)

The primary strategies used during the PEA to determine soil sampling locations are authoritative and systematic random sampling. Authoritative or "biased" sampling can be used to detect the highest concentrations of each contaminant and the general extent of contamination at sites where potential release locations are known. In this strategy, the person collecting the samples selects the sampling locations and depths using personal judgment, generally in areas where the highest concentrations of contaminants are suspected. Systematic random sampling can be used to determine the location and general extent of contamination at sites where the area of release is not well known. Systematic random sampling involves the collection of samples at predetermined, regular intervals of a grid placed over an area potentially impacted by a release. See the most current version of Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (USEPA SW-846[15]) for more detail on sampling strategies. In either case, the selection of sample locations, number of samples collected, and sample depths need to meet the goals of the DQO process.

For PEA screening risk evaluations, surface soil sampling at zero to 6 inches below ground surface may be necessary, since exposure to contaminants in surface soil is a likely possibility. The depth of all soil sample data for use in the human and ecological risk evaluations should be specified in the DQO process. Surface and subsurface soil sampling should address the horizontal extent of contamination

Sufficient subsurface soil samples should be collected to assess the vertical and horizontal extent of contamination to determine whether a release has occurred and additional investigation is needed to evaluate the magnitude of the contamination, if there is a potential impact to groundwater, or if there are no potential impacts to soil or groundwater. The maximum depth of sampling will depend on the potential for migration of the contaminants through soil. Individual sample depths should be based on site-specific lithology. Continuously cored boreholes should be installed to the anticipated depth of sampling at suspected locations of contamination. The continuous cores should be geologically logged and described for use in determining the depths at which samples are to be collected. Specifically, contacts between fine- and coarse-grained sedimentary units should be defined. Samples for analysis should be collected from fine-grained sediments occurring immediately adjacent to contacts with coarse-grained units. In the vadose zone (i.e. above the water table), fine-grained materials may act as avenues for contaminant migration and/or may retard or restrict the downward migration of contamination if it is moving by semi-saturated (or saturated) flow. Sampling locations should also be targeted at depths where information collected from direct reading instruments and physical observations indicate contamination may exist.

The samples collected and analyzed for the PEA should be discrete samples at most sites. Composited sampling may not allow the identification of localized contaminated

[15] SW-846 resources page. US EPA Web site. http://www.epa.gov/osw/hazard/testmethods/sw846/index.htm

areas or ‘hot spots’ and is generally not recommended during the PEA. However, composite sampling or incremental sampling can be approved by the DTSC in advance for specific purposes, if such sampling is appropriate for site conditions.

Soil matrix sample results should be reported on a dry weight basis, if they will be compared to screening values that assume dry weight concentrations, such as the USEPA Regional Screening Levels (RSLs) for non-VOCs.

2.4.2.2 SOIL VAPOR SAMPLING

The DTSC has determined that, at sites where volatile organic compounds (VOCs) are suspected, soil vapor (or soil gas) sampling is the method of choice for evaluating inhalation exposure.. Both soil vapor and soil matrix sampling are usually necessary for indicating the presence and general extent of VOC soil contamination, and the potential for groundwater contamination. See the most recent version of Cal/EPA’s *Active Soil Gas Investigation Advisory*[16] for collection of soil gas and *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air*[17] for soil gas sampling directly under building foundations.

2.4.2.3 GROUNDWATER SAMPLING

The determination of whether groundwater sampling is necessary at the site, including construction of monitoring wells, should be based on the CSM, as discussed in Section 2.1.2. Groundwater sampling should be performed at the site if any of the following conditions exist:

- Previous sampling data indicate groundwater is contaminated;
- Historical operations at the site indicate a potential for groundwater contamination due to quantity and/or types of chemicals released and the permeability of onsite soils; or
- Soil and/or soil gas data indicate the potential for groundwater contamination.

Grab groundwater samples may be collected to determine whether groundwater is affected by site operations as a more time efficient and cost effective sampling strategy. However, relative gradient and flow measurements cannot be obtained without fixed elevation data. The need to install permanent groundwater monitoring wells and the

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[16] Cal/EPA. 2012. *Advisory, Soil Gas Investigations.* April. http://www.dtsc.ca.gov/SiteCleanup/upload/VI_ActiveSoilGasAdvisory_FINAL_043012.pdf

[17] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance).* October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

number of wells needed should be discussed with the DTSC project manager. If installed, the purpose of monitoring wells is to determine whether groundwater is affected by migration of contaminants and to establish the direction of groundwater flow. In addition to sampling for suspected contaminants, monitoring wells may also be sampled for water quality parameters and water levels to evaluate water surface fluctuations and obtain groundwater elevation data not biased by short term aberrations, seasonal fluctuations, or off-site intermittent well pumping. These measurements may be used to construct water surface contour maps, calculate gradients, and identify flow direction.

If it is decided that monitoring wells are needed, the design of monitoring wells should be based on the geology and hydrogeology of the site and the types of contaminants that are present. The first wells installed at a site are usually screened across the water table, assuming that contaminants migrating from the site would be detected in the shallowest groundwater. If data from the initial wells indicate the need for more wells or the need for wells in deeper water-bearing zones, this may indicate that the investigation is exceeding the scope of the PEA and the DTSC project manager should be contacted to determine if the project should proceed into the next phases of the cleanup process. In that case, the PEA should be concluded with a recommendation for further investigation and/or remediation.

DTSC's Site Cleanup web site should be consulted for the most current guidance manuals on groundwater investigations[18]; however, site-specific guidelines for the groundwater monitoring program should be developed in conjunction with DTSC staff.

If initial monitoring results exceed the groundwater screening values identified in the PEA work plan, the PEA is concluded with a recommendation for further investigation and/or remediation. If there is uncertainty about the sampling results, the DTSC project manager should be consulted to determine whether additional sampling as part of the PEA would be appropriate to resolve the issue.

2.4.2.4 SURFACE WATER SAMPLING

Surface water bodies that pass through or border the site and have a potential to be affected by the contamination may need to be sampled. Regulatory personnel capable of evaluating ecological risks should be consulted to determine if sampling is needed and to ensure that the proper sampling methods, locations and analytical methods are used. In general, water and sediment samples should be taken to determine the up-gradient and down-gradient concentrations of chemicals. The methods used to collect sediment or water samples should be based on the type of contaminants, type of water body, flow rate and other physical features. Sediment samples should be collected from locations where the potential exists for insoluble or slightly soluble contaminants to settle. Samples should be collected from various locations along the runoff course that leads from the contamination to the water body; at the point where the runoff course enters the water

[18] Guidance Manuals for Groundwater Investigations resource page. DTSC Web site. http://www.dtsc.ca.gov/SiteCleanup/Ground_Water_Investigations.cfm

body; up-gradient from that point; and down-gradient from that point. This sampling may be delayed and incorporated into future sampling events if the PEA recommends that further assessment is required, and the DTSC project manager agrees to delay the sampling.

General guidance on surface water sampling is available from the USEPA, the Surface Water Ambient Monitoring Program (SWAMP) of the California State Water Resources Control Board (WRCB), and the USGS National Water Quality Assessment Program (NAWQA) Protocol for Collecting and Processing Stream Water Samples.[19]

2.4.2.5 INDOOR AIR SAMPLING

The PEA determines the risk from VOCs via the inhalation pathway by using the maximum contaminant concentrations in soil vapor to estimate potential concentrations in indoor air. This approach is described in Section 2.5.4.5.3. Occasionally, indoor air sampling may be done within the context of a PEA to determine, for example, if evacuation is warranted. Indications that evacuation should be considered include: the presence of odors, physiological effects , wet basements, and/or fire or explosive conditions. Outdoor or ambient air monitoring data are not necessary for use in a PEA screening risk evaluation, as VOC levels in outdoor air emanating from a site would be quite low because of dilution with atmospheric air compared to estimated VOC levels in a confined indoor air space. Outdoor air monitoring can provide a synoptic estimation of air concentrations, and therefore may be useful for worker health and safety monitoring, or monitoring during removal actions with adequate background air monitoring.

Guidance on indoor air sampling and evaluating the intrusion of soil vapors into indoor air, including evaluation for acute hazards within an existing building is available in the most current version of DTSC's *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*[20]

2.4.2.6 BACKGROUND SAMPLING

Background samples are collected to distinguish between site–related contamination and naturally occurring or anthropogenic contaminant levels. In general, the use of regional background levels for comparison to site contamination is not acceptable. Background samples should be collected for each medium (e.g. water, soil or air) being investigated at or near the site but not in areas likely to be influenced by the contamination and/or facility

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[19] USEPA. http://www.epa.gov/region9/qa/fieldsamp.html;
Surface Water Ambient Monitoring Program (SWAMP) WRCB web site. http://www.waterboards.ca.gov/water_issues/programs/swamp/tools.shtml;
USGS NAWQA Protocol. http://water.usgs.gov/nawqa/pnsp/pubs/ofr94-455/sw-t.html

[20] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance).* October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

operations (past or present). Background samples should be collected from locations that are upgradient/ upstream of the suspected contamination. It may be difficult to obtain true background samples in highly urban, industrialized areas because of commingled plumes, etc. In such cases, consultation with the DTSC staff may be necessary.

Background samples should be analyzed for naturally occurring chemicals. With few exceptions, background levels for manmade chemicals are zero. The few exceptions may arise when an off-site source has contributed to the onsite contamination, the site is part of a regional contamination problem, or the site-related contaminants are the same as certain ubiquitous, manmade chemicals, such as dioxins/furans and polycyclic aromatic hydrocarbons (PAHs).

It is unlikely that a sufficient number of background samples will be collected during the PEA investigation to be considered statistically valid. However, the information is useful in comparing relative ranges of background results to onsite contamination. If chemicals of potential concern (COPCs) include metals that are also naturally occurring in soil, background samples should be collected from a minimum of ten locations to determine the average contaminant concentration that is not a result of releases from the site. Background samples at each location should be collected from strata similar to onsite samples to which they will be compared. If initial sampling reveals a high variability between levels in each sample, more samples should be collected to increase the confidence in the average.

More information on background soil sampling is provided in the most current versions of *Appendix B – Strategies for Establishing and Using Background estimates of Metals in Soil* in the DTSC's *Proven Technologies and Remedies Guidance – Remediation of Metals in Soil*[21], the DTSCs *Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities*[22] . and the DTSC *Final Report Background Metals at Los Angeles Unified School Sites – Arsenic*[23].

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[21] DTSC. 2008. *Appendix B – Strategies for Establishing and Using Background Estimates of Metals in Soil, Proven Technologies and Remedies Guidance – Remediation of Metals in Soil.* August 29. http://dtsc-cm/SiteCleanup/upload/Appdx_B_083108.pdf

[22] DTSC. 1997. *Selecting Inorganic Constituents as Chemicals of Potential Concern at Risk Assessments at Hazardous Waste Sites and Permitted Facilities.* February. http://www.dtsc.ca.gov/AssessingRisk/upload/backgrnd.pdf

[23] DTSC. 2005. *Final Report Background Metals at Los Angeles Unified School Sites – ARSENIC.* June 6. *http://www.dtsc.ca.gov/AssessingRisk/upload/Background_Arsenic.pdf*

2.4.3 QUALITY ASSURANCE AND QUALITY CONTROL MEASURES

The sampling strategy for the site should include quality assurance and quality control (QA/QC) measures to be implemented as part of the sampling and analytical procedures. The purpose of these measures is to produce data of a known quality. These QA/QC measures are established to monitor both field and laboratory procedures. QA/QC procedures specifically for the collection of soil gas can be found in the most current version of the *Advisory - Active Soil Gas Investigation*[24] (Cal/EPA, 2012).

To check the precision and accuracy of field data, QA/QC samples should be collected for analysis. Field QC samples consist primarily of co-located samples, split replicates, travel blanks, equipment blanks, and field blanks. Field quality control samples should be collected, stored, transported, and analyzed in a manner consistent with the site samples. Table 2-2 provides the minimum field QA/QC sample requirements for each medium. Samples for QA/QC purposes should be collected from areas not likely to be highly contaminated.

In addition to samples listed in Table 2-2, QA/QC measures can be employed throughout the sample collection to improve the quality of the results. When selecting devices to collect, store, preserve, and transport the samples, consider the effect the device may have on the integrity of the samples. The devices should not alter the samples so as to be reactive, promote adsorption, leach analytes, or otherwise influence contaminant concentrations prior to analysis. Sample collection should also be performed in a manner that does not adversely affect the sample integrity. The collected samples need to be representative of existing site conditions, and influences due to the sampling and analysis procedures should be minimized. In order to evaluate any potential influences, persons conducting the sampling should document the manner in which samples are handled from the time of collection until final analysis.

The State Certified laboratory performing the analysis should have its own internal QA/QC procedures. They include method blanks, surrogates, matrix spike and matrix spike duplicates, laboratory duplicates and initial and continuing calibration checks. These procedures will more than likely vary between laboratories.

[24] Cal/EPA. 2012. *Advisory – Active Soil Gas Investigation.* April. http://www.dtsc.ca.gov/SiteCleanup/upload/VI_ActiveSoilGasAdvisory_FINAL_043012.pdf

TABLE 2-2: QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Sample Type	Ratios
Co-located replicates	5% of total # of samples
Split replicates	5% of total # of samples
Travel blanks	1 per sample shipment (volatiles)
Equipment blanks	1 per field decontamination event (as needed)
Field blanks	1 per sampling day

A current list of State Certified laboratories is available from the Department of Public Health's Environmental Laboratory Accreditation Program web site[25].

2.4.4 ADDITIONAL REGULATORY REQUIREMENTS

DTSC will provide oversight for the preparation and implementation of the majority of the work required to complete the PEA. However, in doing so, DTSC does not relieve the responsible person(s) from liability for compliance with all other applicable laws and regulations. The PEA must be conducted in compliance with all applicable Federal, State and local requirements including, but not limited to requirements to obtain permits and to ensure worker safety.

The following are some examples of other regulatory requirements whose applicability should be investigated prior to initiation of PEA sampling activities:

- County or local oversight program (LOP) agency requirements for drilling permits for installation and destruction of borings and wells. The drilling must be conducted by a C-57 licensed driller and Well Completion Reports signed by the driller must be submitted to the Department of Water Resources (DWR) for each boring, other specific county or LOP reporting requirements may apply.

- Manifest and Department of Transportation (DOT) requirements for transporting hazardous waste/materials;

- Air Pollution Control District permit requirements for air emissions (e.g. from stockpiles of soils contaminated with volatile chemicals and for emissions during excavation);

[25] Environmental Laboratory Accreditation Program (ELAP) resources page. California Department of Public Health Web site. http://www.cdph.ca.gov/certlic/labs/Pages/ELAP.aspx

- RWQCB requirements for protection of stormwater, surface water and ground water quality;
- Occupational Safety and Health Administration (OSHA) requirements for worker safety (29 CFR 1910.120 and 8 CCR 5192). The site health and safety plan should be provided to DTSC prior to the start of field work;
- Land disposal restrictions for wastes/contaminated soils transported for disposal; and
- California Department of Fish & Wildlife (DFW) requirements for identification and management of threatened or endangered species and habitats.

2.4.5 DATA EVALUATION

The PEA investigation usually requires the collection of a variety of data for a number of different purposes. Data collected can range from field monitoring data for health and safety precautions to laboratory analysis results to determine contaminant levels. Each sample collected may have been analyzed for a number of different chemicals, depending upon the rationale for the sample. However, not all of the chemicals detected will be attributable to an onsite release and not all of the data are guaranteed to be of an acceptable quality. The purpose of the data evaluation is to determine which of the chemicals identified by the data are likely to be site-related and to assess whether the reported concentrations for these chemicals are of acceptable quality for use in the screening evaluation. Much of the information in the following sections was excerpted from USEPA's *Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A)*[26]

2.4.5.1 EVALUATION OF ANALYTICAL METHODS

Not all of the data collected during the field investigation are appropriate for use in the screening evaluation. Analytical results that are not specific for a particular compound or results of insensitive analytical methods (e.g., portable field instruments) generally are not appropriate for quantitative risk assessment. Table 2-3 provides examples of the types of analytical techniques and data that could potentially be unsuitable for use in the screening evaluation. However, these types of results may be useful when considering sources of contamination, potential fate and transport of contaminants, or qualitative discussions of risk. In addition, the results of analytical methods associated with unknown, few, or no QA/QC procedures should be eliminated from further quantitative use.

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[26] USEPA. 1989. *Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A).* December. Web site. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

TABLE 2-3 EXAMPLES OF POTENTIALLY UNSUITABLE ANALYTICAL TECHNIQUES

Analytical Instrument or Method	Purpose of Analysis	Analytical Result
Photoionization Detector (PID)	Health and Safety, Field Screen	Ionizable Organic Vapor
Organic Vapor Analyzer (OVA)	Health and Safety, Field Screen	Total Organic Vapor
Combustible Gas Indicator with O_2 meter (CGI)	Health and Safety	Combustible Vapors, Oxygen-deficient Atmosphere
Field Gas Chromatography (GC)	Field Screen/ Analytical Method	Specific Volatile and Semi-volatile Organic Chemicals

2.4.5.2 EVALUATION OF REPORTING LIMITS

Before eliminating chemicals because they are not detected, the following points should be considered:

- The reporting limit for a chemical may be greater than corresponding standards, criteria, or concentrations derived from toxicity reference values, such as, USEPA Regional Screening Levels (RSLs) or other applicable risk-based screening values agreed upon by the project manager and DTSC toxicologist. Therefore, the chemical may be present at levels greater than these corresponding reference concentrations, which may result in undetected risk.

- A particular reporting limit may be significantly higher than positively detected values in other samples in a data set.

After considering the above points and other reasons why contaminants may not have been detected, those chemicals that have not been detected in any medium may be eliminated. If information exists indicating that the chemicals are present, they should not be eliminated. For example, if chemicals with similar fate and transport characteristics are detected frequently in soil, and some of these chemicals are also detected frequently in groundwater while the others are not detected, then the undetected chemicals are probably present in the groundwater and additional sampling should be conducted to attempt to confirm their presence. The PEA report can identify the possibility of undetected contaminants and recommend the additional sampling for the contaminants as part of the RI/FS.

2.4.5.3 EVALUATION OF QUALIFIED DATA

For analytical results, various qualifiers pertaining to the quality of the data are attached to certain data by either the laboratories conducting the analysis or by persons conducting the data evaluation. The data evaluation process will determine if each qualified data point should be flagged as rejected, or determine and document that qualified data are valid and useable.

2.4.5.4 EVALUATION OF BLANKS

Analysis of blank samples provides a way to determine whether contamination has been introduced into a sample set either (1) in the field while the samples were being collected or transported to the laboratory or (2) in the laboratory during sample preparation and analysis. To prevent the inclusion of non-site-related contaminants in the screening evaluation, the concentrations of chemicals detected in blanks should be compared with concentrations of the same chemicals detected in site samples. Detailed definitions of different types of blanks are provided in Chapter 5 of the *Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A)*[27].

Blanks containing common laboratory contaminants. Acetone, 2-butanone (or methyl ethyl ketone), methylene chloride, toluene, and the phthalate esters are common laboratory contaminants[28]. If the blank contains detectable levels of common laboratory contaminants, then the sample results should be considered positive only if the concentrations in the sample exceed ten times the maximum amount detected in any blank. If the concentration of a common laboratory contaminant is less than ten times the concentration detected in the blank, then it may be concluded that the chemical was not detected in the particular sample and the blank-related concentrations of the chemical may be considered to be the quantitation limit for the chemical in that sample. If all samples contain levels of a common laboratory contaminant that are less than ten times the level of contamination noted in the blank, then that chemical may be eliminated from the screening evaluation. However, the analysis results should still be presented in the report with an explanation.

Blanks containing chemicals that are not common laboratory contaminants. If the blank contains detectable levels of one or more organic or inorganic chemicals that are not considered by the USEPA to be common laboratory contaminants, then site sample results should be considered positive only if the concentration of the chemical in the site sample exceeds five times the maximum amount detected in any blank. Samples

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[27] USEPA. 1989. Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A). December. Web site. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

[28] USEPA. 1989. Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A). December. Web site. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

containing less than five times the amount in any blank should be treated as non-detects, and the blank-related chemical concentration should be considered the quantitation limit for the chemical in that sample. Again, if all samples contain levels of a chemical that are less than five times the level of contamination noted in the blank, then that chemical may be eliminated from the set of sample results. The analysis results should still be presented in the report with an explanation.

2.4.5.5 EVALUATION OF TENTATIVELY IDENTIFIED COMPOUNDS

Both the identity and reported concentration of a tentatively identified compound (TIC) are questionable. Two options for addressing TICs exist, depending on the relative number of TICs compared to non-TICs. A discussion of TICs is provided in Chapter 5 of USEPA's *Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual (Part A)*[29].

2.4.5.6 COMPARISON OF SITE DATA WITH BACKGROUND

A comparison of site concentrations with background concentrations is useful for identifying the non-site-related chemicals that are found at or near the site. Metals present at levels equivalent to background can be eliminated as chemicals of potential concern (COPCs) and need not be considered in the screening evaluation; however, metals whose concentrations are above background should be included. Under no circumstances should background concentrations be subtracted from concentrations observed at the site. If background risk might be a concern, it should be calculated separately from site-related risk. The comparison process is as follows:

- If the maximum site metal concentration is less than the maximum background, the metal can be excluded as a COPC.
- If the mean site metal concentration is equal to or less than the mean local background metal concentration, the metal can be excluded as a COPC. Before carrying out this step, refer to the listed resources on background data sets to make sure those data sets are adequate.
- The site metal data set should be compared to the background metal data set. If there is good overlap of the site and background data sets, the metal can be excluded as a COPC.

More detailed discussion on comparing site data to local background data is provided in the most current version of *Appendix B – Strategies for Establishing and Using*

[29] USEPA. 1989. Risk Assessment Guidance for Superfund, Volume 1 Human Health Evaluation Manual (Part A). December. Web site. http://www.epa.gov/oswer/riskassessment/ragsa/index.htm

Background estimates of Metals in Soil in the *Proven Technologies and Remedies Guidance – Remediation of Metals in Soil*[30]

2.4.5.7 IDENTIFICATION OF CHEMICALS OF POTENTIAL CONCERN

All chemicals that are not eliminated by any of the above evaluations should be considered COPCs for the site and should be evaluated further through the PEA screening evaluation. The Environmental Professional should work closely with DTSC staff when evaluating data that are thought to be non-site-related. DTSC approval should be received before a chemical can be eliminated from evaluation through the human health screening risk evaluation described in the following section.

2.5 HUMAN HEALTH SCREENING RISK EVALUATION

The purpose of a human health screening risk evaluation is to estimate the potential chronic human health risk/hazard from soil and groundwater contamination at the site. This screening evaluation is intended to be a health-conservative preliminary evaluation of potential risk and hazard and, therefore, assumes that the site will be used for residential purposes, the scenario that would result in the greatest exposure and risk. This screening evaluation will assist the project manager, in consultation with the rest of the project team, in deciding whether further site characterization, risk assessment, or remediation is necessary. The recommendations presented in this section are intended only for a human health screening risk evaluation. The DTSC's Human and Ecological Risk Office (HERO) *Human Health Risk Assessment (HHRA) Note 4* [31]provides additional guidance on carrying out a screening level human health risk evaluation. Recommendations for performing a quantitative human health risk assessment are beyond the scope of the PEA Guidance Manual.

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[30] DTSC. 2008. *Appendix B – Strategies for Establishing and Using Background estimates of Metals in Soil in the Proven Technologies and Remedies Guidance – Remediation of Metals in Soil*. August 29. http://www.dtsc.ca.gov/PublicationsForms/upload/Guidance_Remediation-Soils.pdf

[31] DTSC Human Health Risk resources page contains HHRA Note 4. Web site http://www.dtsc.ca.gov/assessingrisk/humanrisk2.cfm#Guidance

The basic screening risk approach is to calculate the estimated risk or hazard posed by the maximum concentration of a chemical detected in each medium (soil, water, air) using an established human health-risk-based residential screening level/concentration as a comparator, that is, the USEPA Regional Screening Level (RSL)[32] for residential land use, modified as necessary by the DTSC in HHRA Note 3[33]. The basic screening risk equations for each medium (soil, water, air) are as follows.

For a carcinogenic chemical:

$$\frac{\text{Maximum concentration}}{\text{Screening concentration}} \times 10^{-6} = \text{Cancer Risk}$$

For a non-carcinogenic chemical:

$$\frac{\text{Maximum concentration}}{\text{Screening concentration}} = \text{Hazard Index}$$

SOIL. Before using these RSLs, or other risk-based generic screening levels agreed upon by the project manager and DTSC toxicologist, to conduct a human health screening risk evaluation, it is critical to examine the site-specific CSM to make sure that the exposure pathways and site conditions match those assumed in developing these RSLs. These generic screening concentrations are calculated by assuming exposure to soil via pathways most frequently encountered in a residential setting. Although health-conservative exposure input parameters are used, not all potential exposure pathways are included. For example, the ingestion of fruits and vegetables grown in backyard gardens located in contaminated soil are not included as an exposure pathway in the development of the RSLs. The sections below further discuss exposure pathways not included in RSLs.

SOIL VAPOR. The major exposure pathway for VOCs detected in soil vapor is the inhalation of vapors that have migrated indoors through diffusion and advective processes. In the absence of generic soil vapor screening levels, a method for performing a screening risk evaluation for VOCs detected in soil vapor is described in Section 2.5.4.5.3.

GROUNDWATER. The approach for the risk evaluation of chemical contaminants detected in groundwater assumes that groundwater may be used as a source of drinking water in a residential setting and compares the maximum groundwater concentration of a chemical to its tap water RSL. For constituents for which tap water RSLs (or alternate screening levels recommended by DTSC) are not available, California Public Health Goals (PHGs) may be used[34]. Maximum Contaminant Levels (MCLs) should not be used

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32 USEPA Regional Screening Levels (Formerly PRGS) Web site. http://www.epa.gov/region9/superfund/prg/

33 DTSC Human Health Risk resources page contains HHRA Note 3. Web site http://www.dtsc.ca.gov/assessingrisk/humanrisk2.cfm#Guidance

34 Office of Environmental Health Hazard Assessment. Web site. http://www.oehha.ca.gov/

in a screening risk evaluation, because they are not risk-based levels. However, since MCLs are commonly Applicable or Relevant and Appropriate Requirements (ARAR) in the cleanup program, they may be used as comparators as a potential requirement in a site cleanup.

If VOCs are detected in groundwater, groundwater should be further evaluated as a potential source of vapors that may intrude indoors with subsequent exposure by humans. Section 2.5.4.5.4 below describes an approach for calculating a screening risk from this pathway. The most current version of the *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*[35] should be consulted for recommended approaches.

2.5.1 HUMAN HEALTH SCREENING LEVELS

Various suites of human health screening levels/concentrations are described below. If a chemical identified as a chemical of potential concern does not have a screening level, the PEA preparer should consult with the DTSC project manager and toxicologist to decide if the equations shown in Section 2.5.4 – Alternative Simplified Exposure and Risk Equations, are appropriate for use in the PEA.

Regional Screening Levels (RSLs). USEPA RSLs[36] are human-health-risk-based soil, air, or water concentrations developed by the USEPA for more than 670 chemicals using toxicity criteria established or agreed upon by the USEPA and assuming residential land and commercial/industrial land use. The DTSC's Human and Ecological Risk Office (HERO) reviews the USEPA RSL list periodically and releases their recommendations in a *Human Health Risk Assessment (HHRA) Note 3*[37]. Both reference lists are updated periodically, and the most recent versions should be consulted when preparing a PEA. It is imperative that RSLs be used with modifications as discussed in DTSC HHRA Note 3 so that the screening levels utilized are those specifically recommended by the DTSC. For a limited number of constituents, DTSC HHRA Note 3 recommends use of alternate screening levels, other than the RSLs.

The limitations of the RSLs are discussed as follows. 1) The inhalation of VOCs intruding indoors from the sub-surface is not included as an exposure pathway in the soil RSLs. Thus, soil RSLs for VOCs cannot be used in a PEA screening evaluation to evaluate the indoor air pathway. Soil RSLs for VOCs may be used to evaluate soil ingestion and outdoor ambient air exposures. Since the inhalation of vapors intruding into indoor air is

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[35] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*. October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

[36] USEPA Regional Screening Levels (Formerly PRGS) Web site. http://www.epa.gov/region9/superfund/prg/

[37] DTSC Human Health Risk Web site contains HERO Note 3. http://www.dtsc.ca.gov/AssessingRisk/humanrisk2.cfm#guidance

not included in the development of the soil RSLs, this exposure pathway must be evaluated separately, as discussed in Section 2.5.4.5.3. 2) RSLs do not consider ecological receptors. 3) The derivation of soil RSLs does not consider the potential for contaminants to migrate to groundwater or surface water from soil. However, the RSL Tables do list risk-based and MCL-based screening levels in soil (SSLs), representing chemical concentrations in soil that may affect the groundwater through leaching. The DTSC geologist and the RWQCB should be contacted regarding the protection of groundwater and surface water.

Public Health Goals (PHGs). PHGs are health-risk-based water concentrations developed by the OEHHA for more than 80 chemicals assuming the use of the water as tap water. The list of PHGs is available at OEHHA's web site[38]. However, tap water RSLs are suggested for use as screening concentrations in a PEA screening risk evaluation, unless otherwise recommended in the DTSC HHRA Note 3.

California Human Health Screening Levels (CHHSLs). CHHSLs are soil or soil vapor concentrations developed by the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) for about 60 chemicals using toxicity criteria primarily established by the OEHHA. This list was originally published in 2005 and last revised in 2010. CHHSLs are no longer generally recommended for use in a human health risk evaluation, because they are not routinely reviewed and revised as new scientific information becomes available.

2.5.2 SCREENING EVALUATION ASSUMPTIONS AND EXPOSURE FACTORS

The parameters of the human health screening evaluation used to develop the USEPA RSLs are outlined in Section 2.5.2.1 below. These exposure parameters should be the same as those assumed for the site in a preliminary evaluation.

2.5.2.1 EXPOSURE PATHWAYS AND MEDIA OF EXPOSURE

The exposure pathways used to develop the RSLs are those recommended by the USEPA to represent a reasonable maximum exposure (RME) in a residential setting at Superfund sites.

SOIL. The exposure pathways included in the calculation of RSLs for soil are: incidental ingestion of soil, dermal absorption of nonvolatile chemicals in soil, and inhalation of airborne dust and volatile chemicals in ambient air.

GROUNDWATER. The exposure pathways included in the calculation of RSLs for water assumed to be used as tap water are: ingestion from drinking, dermal exposure, and

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[38] Office of Environmental Health Hazard Assessment. Web site. http://www.oehha.ca.gov/

inhalation of volatile chemicals generated during household use (e.g. showering, dish washing).

OTHER EXPOSURE PATHWAYS. Other exposure pathways are possible under a residential scenario at a particular site, but for a screening evaluation in which RSLs will be used as direct comparators, the pathways listed above are the only pathways considered complete.

- The ingestion of fruits and vegetables grown in backyard gardens located in contaminated soil are not included as an exposure pathway in the development of the RSLs, so if food chain contamination is suspected or is plausible, then RSLs should not be used in a screening level evaluation, and a DTSC toxicologist should be consulted.

- The inhalation of vapors intruding into indoor air is not included as an exposure pathway in the development of the soil RSLs. Therefore, the vapor intrusion to indoor air pathway must be evaluated separately, if VOCs have been detected in soil vapor

- The tap water RSLs **do not** include vapor intrusion to indoor air of VOCs present in groundwater. Nor do they include ingestion of water during swimming, nor transfer of chemicals in water to aquatic organisms, like fish, with subsequent ingestion by humans. It is the responsibility of the Environmental Professional, in consultation with the project manager and DTSC toxicologist, to determine whether additional exposure pathways should be considered.

- Early life exposure is not included as an adjustment for exposure to carcinogens in a PEA for the following reasons. First, age-dependent adjustment factors have been included in the RSLS for those chemicals considered mutagens. Second, the other conservative assumptions included in the PEA screening evaluation should be adequately protective for all potentially exposed populations.

- Exposure pathways associated with specific cultural or traditional practices are not included in the development of RSLs. If such pathways are plausible, then a DTSC toxicologist should be consulted for the appropriate approach.

2.5.2.2 LAND USE

<u>For purposes of a PEA screening evaluation, the land use of the site is assumed to be residential, regardless of the current use and zoning for the site</u>. Residential land use is assumed, because the most health-conservative exposure parameters are folded into that assumption; thus, a no further action determination can be made if the screening evaluation indicates that the contaminants present pose an insignificant risk or hazard. However, the residential scenario would not necessarily be protective of unrestricted land use for those chemicals that bioaccumulate in food products (e.g., dioxins). The

Environmental Professional should consult with the project manager and DTSC toxicologist, if bioaccumulative chemicals are present at the site.

Additional evaluations and actions are necessary to address land uses other than residential. Therefore, the DTSC project manager must approve the assumption of any alternative land use in a PEA screening evaluation, such as, commercial/industrial land use. Restriction of the site to commercial/industrial use will probably require a land use covenant.

2.5.2.3 CHEMICAL GROUPS

Certain chemical groups are beyond the scope of a PEA evaluation, since they require more complex toxicological evaluations or represent acute health risks. Examples are: wastes/soils which have a pH less than or equal to 2.0 or greater than or equal to 12.5; medical wastes; reactive/explosive wastes (e.g., munitions, strong oxidizers); asbestos and radioactive wastes. These wastes require other techniques of investigation and assessment.

The discussions below should be taken into account when considering a PEA evaluation of the following chemicals and chemical groups:

1) **Polycyclic Aromatic Hydrocarbons (PAHs):** PAHs are often present in ambient concentrations in urban area soils due to past industrial activities. Therefore, ambient levels of PAHs may be considered in a site evaluation, if agreed upon by the DTSC project manager and toxicologist. More information on ambient PAH concentrations may be found in the current version of *Use of the Northern and Southern California Polynuclear Aromatic Hydrocarbon (PAH) Studies in the Manufactured Gas Plant Site Cleanup Process*[39]. Potentially carcinogenic PAHs detected in soil and listed in Table 2-4 below should be converted to benzo(a)pyrene (BaP) equivalent concentrations utilizing the most current US EPA equivalency factors shown in the table[40]. The total BaP equivalent concentration would then be compared to the BaP RSL and ambient PAH levels. Naphthalene is also a carcinogenic PAH but is not included in Table 2-4. Risk from exposure to naphthalene is evaluated separately.

   As of the release date of this guidance manual, revisions to the toxicity criteria for benzo(a)pyrene are being considered. Therefore, the most current guidance on PAHs should be consulted if PAHs are potential chemicals of concern at a site.

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[39] Human Health Risk Assessment Guidance resources page. DTSC Web site. http://www.dtsc.ca.gov/AssessingRisk/humanrisk2.cfm#guidance

[40] USEPA. 2012. *USEPA Regional Screening Table – User's Guide*. November. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/usersguide.htm

Table 2-4 POTENCY EQUIVALENCY FACTORS (PEF) FOR PAHs

Chemical Name	Equivalency Factor
benzo(a)pyrene	1.0
benzo(a)anthracene	0.1
benzo(b)fluoranthene	0.1
benzo(k)luoranthene	0.01
Chrysene	0.001
Dibenzo(a,h)anthracene	1.0
indeno(1,2,3-c,d)pyrene	0.1

2) **Polychlorinated Biphenyls (PCBs):** Assume all PCBs analyzed as Aroclor mixtures are equivalent to Aroclor 1254 in cancer potency and noncancer toxicity.

3) **Polychlorinated Dibenzo-*p*-dioxins, Dibenzofurans (PCDD/PCDF), and certain PCBs:** PCDDs and PCDFs are often present in ambient concentrations due to widespread air dispersion during the burning of polyvinyl chloride (PVC) plastics and other chlorine containing compounds in incinerators, backyard trash fires, forest fires, etc. They are also contaminants of pentachlorophenols, other pesticides and sewage sludge. Consequently, ambient or background dioxin concentrations may need to be considered at sites where dioxins are potential site-related chemicals of concern. Assume unspeciated PCDD/PCDF are equivalent in cancer potency to 2,3,7,8-tetrachloro-dibenzo-p-dioxin (2,3,7,8-TCDD). However, if congeners have been speciated, use the Toxicity Equivalency Factor (TEQ) approach with the TEQs shown in Table 2-5 below[41]. Total Dioxin-TEQ concentrations would then be compared to the Dioxin RSL.

[41] Van den Berg, M. et al. 2006. The 2005 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-Like Compounds. Toxicological Sciences 93(2):223-241.

Table 2-5 TOXIC EQUIVALENCY FACTORS FOR DIOXINS AND DIOXIN-LIKE COMPOUNDS

Compound	WHO 2005 TEF
Chlorinated dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8,-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Chlorinated dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,6,7,8,9-HpCDF	0.01
OCDF	0.0003
Non-ortho substituted PCBs	
PCB 77	0.0001
PCB 81	0.0003
PCB 126	0.1
PCB 169	0.03
mono-ortho substituted PCBs	
105	0.00003
114	0.00003
118	0.00003
123	0.00003
156	0.00003
157	0.00003
167	0.00003
189	0.00003

4) **Chromium:** Assume total chromium is all hexavalent unless valid data on speciation are available.

5) **Total Petroleum Hydrocarbons (TPH):** TPHs are found in crude oils, petroleum products, and various wastes from refineries and petroleum-related facilities. At sites where petroleum wastes may be present, soil samples should be analyzed for TPHs and reported by the carbon range and as aliphatic or aromatic compounds. The critical toxic components will vary according to the fuel source. The more toxic components of TPH should be specifically analyzed for in soil and soil vapor, including: BTEX compounds (i.e., benzene, ethylbenzene, toluene, and xylenes), butadiene, hexane, methyl tert-butyl ether (MTBE), 2-methylnaphthalene, PAHs, including naphthalene, Title 22 California Assessment Manual (CAM) metals, and, in some circumstances, dioxins and PCBs. The alternative simplified exposure and risk equations discussed in Section 2.5.4 may be used along with the toxicity criteria listed in Table 2-6 to evaluate aliphatic and aromatic components of TPHs. The HERO toxicity criteria are values recommended by the HERO upon review of the toxicity criteria developed by the Total Petroleum Hydrocarbon Criteria Working Group (TPHCWG) and the Massachusetts Department of Environmental Protection (MADEP). If the screening risk evaluation concludes that TPHs at a site are not present at levels of concern, TPHs should be further evaluated for gross contamination, odor, and nuisance and its potential to affect groundwater,

Table 2-6 TPH TOXICITY CRITERIA

Exposure Route	Carbon Range	TPHCWG (mg/kg/day)	MADEP (mg/kg/day)	HERO (mg/kg/day)
Oral	***Aliphatic***			
	C_5-C_8	5	0.04	**0.04**
	C_9-C_{18}	0.1	0.1	**0.1**
	C_{19}-C_{32}	2.0	2.0	**2.0**
	Aromatic			
	C_6-C_8	Evaluate benzene	Evaluate each COPC	**Evaluate each COPC (e.g.. BTEX)**
	C_9-C_{16}	0.04	0.03^	**0.004/0.03#**
	C_{17}-C_{32}	0.03	0.03^	**0.04**
		(mg/m^3)	**(mg/m^3)**	**(mg/m^3)**
Inhalation	**Aliphatic**			
	C_5-C_8	18.4	0.2	**0.7**
	C_9-C_{18}	1.0	0.2	**0.3**
	C_{19}-C_{32}	-*	-*	**-**
	Aromatic			
	C_6-C_8	Evaluate benzene	Evaluate each COPC	**Evaluate each COPC (e.g., BTEX)**
	C_9-C_{16}	0.2	0.05	**0.05**
	C_{17}-C_{32}	-*	-*	-

0.03 mg/kg-day may be used instead of 0.004 mg/kg-day if naphthalenes and methylnaphthalenes have been analyzed and evaluated individually.
^ Value is for C9-C32
* Not developed due to low volatility of the COPCs in this hydrocarbon range. Although inhalation exposure to C_{17+} TPH may occur via TPH bound to airborne dust HERD does not recommend performing a quantitative evaluation of inhalation exposure for C_{17+} not be performed because of the significant uncertainty involved.

Locations for soil vapor sampling should be decided in consultation with the DTSC project manager and geologist. In general, soil vapor sampling probes should be located close to source areas and within high-permeability soils. The necessity of soil vapor sampling for TPH gasoline should be discussed with DTSC staff.

The method(s) for TPH analysis in soil should be chosen in consultation with DTSC staff. If the source of the petroleum hydrocarbons is unknown, then a full scan for organic analytes should be conducted to identify the presence of critical constituents and their concentration prior to conducting the screening evaluation.

If the PEA indicates that TPHs are the only major chemicals of potential concern, the DTSC project manager should be consulted to determine the most suitable environmental oversight agency for guidance in conducting an in-depth, site-specific evaluation. Additional information on the evaluation of TPHs in the environment may be found in the most current version of the State Water Resources Control Board's *Low-Threat Underground Storage Tank Case Closure Policy*[42] and the Massachusetts Department of Environmental Protection's *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach.*[43]

As of the release of this guidance manual, TPHs are under study by the US EPA. Therefore, the most current guidance on TPHs should be consulted if TPHs are potential chemicals of concern at a site.

6) **Metals:** For the purposes of this document, the term "metals" is taken to include true metals, such as cadmium and zinc, as well as metalloid elements, such as arsenic and selenium.

7) **Arsenic**: Arsenic is naturally present in soil at concentrations often greater than its risk-based screening level. Environmental concentrations of arsenic may be elevated at a site because of past use of arsenic-containing products, such as pesticides, wood preservatives, paints, dyes, electrical components and medical drugs, or as a contaminant in mine tailings. Site soil arsenic concentrations should first be compared to local background concentrations to determine whether further evaluation of this chemical is warranted, since naturally occurring background arsenic concentrations vary widely in different geographic regions. If further evaluation is necessary, it should be done in consultation with the DTSC project manager and may need to include the consideration of additional background data, bioavailability, end use of the property, and administrative controls. Detailed discussion on evaluating arsenic at a site is found in the most current version of DTSC's *Arsenic Strategies*[44]

8) **Inorganic Lead:** Lead is most often elevated at sites because of historical uses of leaded gasoline and lead-based paints. The Cal/EPA OEHHA revised its toxicity evaluation of lead in 2007 by replacing the threshold blood lead concentration of 10 µg/dl with a source-specific, benchmark change of one µg/dl for the protection of children. One µg/dl is the estimated incremental increase in the blood lead level in children that would reduce intelligence quotient (IQ) by up to one point. The DTSC

[42] State Water Resources Control Board. 2012. *Low-Threat Underground Storage Tank Case Closure Policy*. http://www.waterboards.ca.gov/ust/lt_cls_plcy.shtml
[43] Massachusetts Department of Environmental Protection. 2002. *Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach.* Final Policy. October 31. http://www.mass.gov/dep/cleanup/laws/02-411.pdf
[44] DTSC. 2009. *Arsenic Strategies, Determination of Arsenic Remediation Development of Arsenic Cleanup Goals.* January 16. http://www.dtsc.ca.gov/AssessingRisk/upload/Arsenic-Cleanup-Goals-Jan09.pdf

revised the Lead Risk Assessment spreadsheet (Version 8, 2011) to reflect this change in approach. Using this spreadsheet, the recommended residential soil lead screening level is 80 mg/kg, as stated in the DTSC HHRA Note 3. For more information, see *User's Guide to Leadspread 8 and Recommendations for Evaluation of Lead Exposures in Adults*[45].

9) **Methane and Hydrogen Sulfide**: Methane and hydrogen sulfide can be naturally present in certain areas, such as old oil fields and marshlands, as well as a result of past manufacturing activities, such as petroleum refineries, pulp and paper operations, and at waste disposal facilities, such as landfills and wastewater drying beds. Evaluation of methane and/or hydrogen sulfide should be included in the PEA work plan if they are suspected of being present at the site through the DQO process. More information on sampling for methane is contained in *Advisory - Active Soil Gas Investigations* [46]. Methane is explosive between its Lower Explosive Limit (LEL) of 5% by volume and its Upper Explosive Limit (UEL) of 15% by volume. If potentially explosive gas levels are detected, an imminent and substantial danger may exist and a response action may be needed. In addition, methane can be a carrier gas for other volatile organic compounds in which case, the presence of methane may affect vapor intrusion assessments.

   More information on methane investigations may be found in the most current *Advisory on Methane Assessment and Common Remedies at School Sites* [47] and *Evaluation of Biogenic Methane, A Guidance Prepared for the Evaluation of Biogenic Methane in Constructed Fills and Dairy Sites*[48].

   Hydrogen sulfide is a flammable, colorless, and toxic gas with a characteristic odor of rotten eggs. Humans are extremely sensitive to hydrogen sulfide odors and can smell such odors at concentrations as low as 0.5 to 1 part per billion (ppb) (0.70 to 1.39 micrograms per cubic meter (µg/m^3). At levels approaching 50 ppb (69.7µg/m^3), the odor can be offensive[49]. At high concentrations, a person may lose the ability to smell hydrogen sulfide. Hydrogen sulfide has a LEL of 4% and an UEL of 44%. The

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[45] More information can be found at LeadSpread 8 resources page. DTSC Web site. http://www.dtsc.ca.gov/AssessingRisk/LeadSpread8.cfm

[46] Cal/EPA. 2012. *Advisory – Active Soil Gas Investigations.* April. http://www.dtsc.ca.gov/SiteCleanup/upload/VI_ActiveSoilGasAdvisory_FINAL_043012.pdf

[47] DTSC. 2005. *Advisory on Methane Assessment and Common Remedies at School Sites*. June. http://www.dtsc.ca.gov/Schools/upload/SMBRP_SCHOOLS_Methane.pdf

[48] DTSC. 2012. *Evaluation of Biogenic Methane, A Guidance Prepared for the Evaluation of Biogenic Methane in Constructed Fills and Dairy Sites*. March 28. http://www.dtsc.ca.gov/PublicationsForms/upload/BF_Schools_Eval_of_Biogenic_Methane_March_2012.pdf

[49] Agency for Toxic Substances and Disease Registry (ATSDR). 2001. *Chapter 3: Landfill Gas Safety and Health Issues in Landfill Gas Primer, An Overview for Environmental Health Professionals.* http://www.atsdr.cdc.gov/hac/landfill/html/ch3.html

OEHHA Inhalation Reference Exposure Level (REL) for acute exposure is 42 μg/m^3. The REL for chronic exposure is 10 μg/m^3. If hydrogen sulfide is suspected to be present near or above these levels, handheld instruments should be employed at the site for screening purposes.

10) **Naturally Occurring Asbestos (NOA)**: The PEA should consider whether NOA is present in surface or subsurface soils or rock at the site. Six regulated asbestos minerals belonging to two different mineral groups (i.e., serpentine and amphibole) occur in California. NOA may be associated with specific rock types, faults or shear zones, geologic contacts, and zones of hydrothermal alteration. Asbestos minerals may also be present in soils or fill derived from asbestos-containing parent material.

    If the presence of NOA is suspected, information sources such as site records and files regarding manufacturing and disposal activities, statewide asbestos maps, mineral sheets, USGS and California Geologic Service open file reports, and other studies should be reviewed. A site inspection should be conducted by a California professional geologist or engineer properly trained and experienced in the identification of NOA. Based on the information gathered, sampling to determine if NOA is present at the site may be needed. The sampling strategy and analytical methods should be included in the PEA work plan. All NOA samples should be analyzed using the California Air Resources Board (CARB) Polarized Light Microscopy (PLM) method with a detection limit of 0.25% or less (CARB 435 PLM). If NOA is detected at greater than or equal to 0.25% by PLM, the PEA should recommend further evaluation of the site.

    More information on NOA may be found in *Interim Guidance – Naturally Occurring Asbestos (NOA) at School Sites* (DTSC rev. 9/2004) at http://www.dtsc.ca.gov/Schools/upload/SMBRP_POL_Guidance_Schools_NOA.pdf

11) **Radon**: Radon is a naturally occurring, radioactive, noble gas that is odorless and tasteless. It is formed as part of three radioactive decay chains that begin with uranium or thorium. These elements are found in small amounts in most rock, soil, and water. If radon is suspected of being present at the site, the Environmental Professional should contact the California Department of Public Health (DPH) Radon program as well as the DTSC project manager to determine whether and how the site should be evaluated for radon.

12) **VOCs**: VOCs are commonly encountered at hazardous waste sites and some require special consideration because of unique attributes. VOCs contaminating sub-surface soil and groundwater can volatilize upward and intrude into indoor air spaces resulting in potential exposure. If the VOC, trichloroethylene (TCE), has been detected at a site where women of child-bearing age may reside, a DTSC toxicologist should be consulted, since. short-term exposure to TCE has been determined to pose a risk to the developing fetus, and this potential hazard must be addressed in a screening risk evaluation.

2.5.2.4 EXPOSURE POINT CONCENTRATIONS

An exposure point concentration of a chemical is the estimated concentration that is contacted by a receptor over an assumed duration of exposure. Generally, in a PEA, the maximum contaminant value detected from sampling should be used as the exposure point concentration.

For chemicals which were treated or stored on site, or for chemicals which are suspected to have been released on the site but sample data indicate the contaminant concentration is below the sample quantification limit (SQL, the practical quantification limit or PQL), then the value of the SQL should be used as the exposure point concentration.

In cases where there is adequate characterization, the 95 percent upper confidence limit (UCL) of the arithmetic mean may be used for the exposure point concentration, subject to review and approval by the DTSC project manager and toxicologist.

2.5.2.5 TOXICITY VALUES

Toxicity values are included in the derivation of the media-specific screening levels, such as RSLs. In general, the most conservative toxicity values developed by entities within the Cal/EPA or the USEPA are used in calculating those screening levels. Therefore, selecting appropriate toxicity values is not necessary when using the method described above where the maximum medium concentration is compared to a generic screening concentration. If no screening level exists for a COPC, a DTSC toxicologist should be consulted.

Toxicity values will be needed if conducting a PEA using the alternative simplified exposure and risk equations described in Section 2.5.4. The selection of applicable toxicity values should always be based on a rigorous, scientific evaluation of the supporting toxicity studies and on the best available science. The most often cited sources of toxicity values include:

- US EPA's Integrated Risk Information System (IRIS)[50].
- Cancer potency factors and reference exposure levels (RELs) developed by OEHHA[51, 52].
- Toxicity values used to develop environmental criteria promulgated into California regulations, such as those used to calculate “No Significant Risk Levels” and “Maximum Allowable Dose Levels” (Proposition 65), or those used to derive California

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50 Integrated Risk Information System (IRIS) Database. US EPA. http://www.epa.gov/iris/

51 OEHHA Toxicity Criteria Database. OEHHA. http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

52 OEHHA Reference Exposure Levels. http://www.oehha.ca.gov/air/allrels.html

drinking water Maximum Contaminant Levels (MCLs) or the health-based dose criteria used to develop Public Health Goals (PHGs, which serve as the starting point for the ultimate development of MCLs)

- Provisional Peer Reviewed Toxicity Values (PPRTVs) derived by the US EPA Superfund Health Risk Technical Support Center (STSC). A DTSC toxicologist should be consulted prior to using any PPRTV in a PEA.

Use of oral cancer potency factors or chronic non-cancer toxicity criteria does not correct for differences in absorption and metabolism between the oral and dermal routes, nor are direct toxic effects on the skin accounted for. Thus, the use of oral potency factors or chronic non-cancer toxicity criteria may not satisfactorily express the dermal risk or hazard of a particular chemical. However, the other routes of exposure evaluated in the PEA usually overwhelm the dermal route and minimize any methodological uncertainty.

2.5.3 RISK/HAZARD CHARACTERIZATION

For a chemical identified as a carcinogen, the maximum soil or groundwater concentration detected is divided by its residential soil or tap water screening level (RSL), modified, if necessary, as discussed in DTSC HHRA Note 3 so that the screening levels utilized are those specifically recommended by the DTSC, and multiplied by 10^{-6} to calculate the cancer risk posed by that chemical. For a chemical identified as causing adverse non-cancer health effects, the maximum concentration is simply divided by its screening level to get a Hazard Quotient (HQ) for that chemical. The excess lifetime cancer risk for carcinogenic compounds is calculated for those compounds considered by Cal/EPA or USEPA to pose a carcinogenic risk to humans. This value represents the risk, or theoretical probability, of developing cancer from that chemical upon exposure to that medium. The HQ is calculated for all compounds, carcinogenic as well as non-carcinogenic. This value is a measure of the non-carcinogenic toxicity of a compound; it is not a probability. The HQ is the ratio of the estimated dose from exposure to a compound in a medium, to a value which is believed not to produce adverse health effects.

For a VOC, the maximum soil vapor concentration detected is evaluated as described in Section 2.5.4.5.3 Vapors Indoor – Soil Vapors. If VOCs are detected in groundwater, the maximum VOC concentration detected in that medium is evaluated as described in Section 2.5.4.5.4 Vapors Indoor – Groundwater. The objective of the methods described in these sections is to calculate indoor air concentrations from soil vapor and groundwater VOC concentrations and then compare those indoor air concentrations with screening air RSLs modified, if necessary, as discussed in DTSC HHRA Note 3 so that the screening levels utilized are those specifically recommended by the DTSC in the same way as described above for soil and groundwater.

CUMULATIVE RISK CALCULATION. As stated above, the maximum chemical concentration for each site-related chemical in each relevant environmental medium should be divided by their corresponding soil, tap water, or air risk-based screening level.

For a carcinogenic chemical, the ratio is multiplied by 10^{-6} to get a risk estimate for that chemical. For multiple carcinogenic chemicals, the risks for individual chemicals are added to get a screening estimate of the cumulative risk.

CUMULATIVE HAZARD INDEX (HI) CALCULATION. For all chemicals causing non-carcinogenic health effects, the ratios derived by dividing the maximum concentration of each chemical by its corresponding soil, tap water, or air screening level based on non-cancer effects are summed to get a site-related HI over all chemicals and all media evaluated (soil, air, water, as appropriate).

If the cumulative risk is less than one-in-a-million (1×10^{-6}) and the Hazard Index is less than one, the PEA human health screening risk evaluation report may be used as support for a “no further action” (NFA) decision.

2.5.4 ALTERNATIVE SIMPLIFIED EXPOSURE AND RISK EQUATIONS

It is unlikely that the site soil or water will be contaminated with chemicals considered toxic that do not have generic screening levels. For chemicals without such levels, the Environmental Professional should consult with the DTSC project manager and toxicologist to decide if the approach and equations discussed below should be used and how toxicity criteria will be selected.

Equations for evaluating exposure to VOCs coming from the sub-surface soil and/or groundwater and intruding indoors are provided in Sections 2.5.4.5.3 and 2.5.4.5.4 below.

The equations in the figures below are risk and hazard equations based on the USEPA *Risk Assessment Guidance for Superfund* (RAGS)[53]*, Volume 1, Human Health Evaluation,Manual, Part A (1989), Part E Supplemental Guidance for Dermal Risk Assessment (2004), and Part F Supplemental Guidance for Inhalation Risk Assessment (2009)* which have been simplified by incorporating default exposure values to achieve a reasonable maximum estimation of exposure in a residential setting. These equations are presented because they provide information on the default exposure and risk/hazard evaluation approach, and they may be used if comparison to generic, established screening levels is not adequate for performing a PEA. These equations show how the risk and hazard for each exposure pathway are calculated. The equations for risk and hazard use the same default factors, except for the averaging time (AT) which is expressed in units of days (oral, dermal) or hours (inhalation). For cancer risk, exposures are averaged over a 70 year lifetime. . For non-carcinogenic hazards, exposures are averaged over the assumed exposure duration. When evaluating non-carcinogenic hazard, a child (the receptor with the greatest estimated exposure) is generally evaluated. If the HI is not exceeded for the child, it will not be exceeded for any other age. The

[53] Links to USEPA’s Risk Assessment Guidance documents can be found on their Human Health: Exposure Assessment Web page at: http://www.epa.gov/oswer/riskassessment/human_health_exposure.htm

risk/hazard equations are simplified to a pathway exposure factor and three variables: the chemical-specific toxicity value (slope factor (SF) or inhalation unit risk (IUR); Reference Dose (RfD); or Reference Concentration (RfC) or Reference Exposure Level (REL)), the concentration of the chemical in the medium (C), and a dermal bioavailability term, if necessary.

2.5.4.1. SELECTION OF PATHWAYS INVOLVING ENVIRONMENTAL MEDIA

The soil and air risk/hazard estimates must be calculated for all sites. If groundwater is contaminated with VOCs, the risk/hazard from the vapor intrusion exposure pathway must be calculated for the site, regardless of any beneficial use determinations. The assessment of the potential impact that onsite contamination may have on surface and groundwater is complex and will vary with site-specific conditions. In a PEA, groundwater should be considered a potential drinking water source, even though tap water is usually supplied by a municipal water source. Under certain circumstances, it may not be necessary to evaluate site groundwater as a drinking water source. If the property itself has contaminated the site groundwater and the groundwater flows offsite, then offsite receptors should be evaluated. A detailed rationale for eliminating the drinking water pathway must be provided in the PEA report.

The following are potential preliminary evaluation results and the required risk/hazard calculations for each case:

1) At sites with limited soil contamination, the contaminants may not affect surface water or the water bearing zone, now or in the future. In these cases the risk/hazard from water exposure need not be calculated. Calculation of the risk/hazard from soil and air will suffice.

2) When the characterization of surface or groundwater contamination is adequate and the available water data are likely to represent the maximum concentrations of the contaminants, then the risk/hazard from water, soil, and air should be calculated.

3) When an acknowledged potential (which requires further investigation) exists for surface or groundwater to be affected by onsite contaminants, and available water data do not fully represent the nature and extent of the contamination, then the risk/hazard from water, soil, and air should be calculated. A qualifying statement should be included in the PEA to indicate clearly that the estimate of risk/hazard is based on data from water that may not represent the maximum contaminant concentrations present and that a final decision will be deferred until after further investigation.

4) When site-specific information is insufficient to judge the potential impact of contaminants in surface water and groundwater, then the calculation of risk/hazard should not proceed, because the resulting estimates may not reflect the potential risk/hazard posed by onsite contamination. In these instances the scoping and data

collection phases of the investigation should be reviewed, as it is likely that additional site work will be necessary to gather the information to complete the calculations.

2.5.4.2 WATER PATHWAY

If water is a pathway of exposure for the site, the maximum groundwater concentration of a chemical is compared to its tap water RSL. As stated earlier, MCLs should not be used in a risk evaluation. If the chemical concentration is above its RSL, the DTSC should be consulted, as additional evaluation may be necessary. The risk calculated is a summation of ingestion exposure, inhalation of VOCs released from water used indoors, inhalation of vapors migrating indoors from groundwater, and dermal exposure, for child and adult. These equations do not include exposure from ingestion of aquatic organisms in surface water but do include dermal absorption of contaminants in water. Chemical-specific Kp values for use in these following water equations may be found in the Estimation Programs Interface (EPI) Suite, developed by the USEPA[54].

[54] USEPA Exposure Assessment Tools and Models. http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm

FIGURE 2-2 DERIVATION OF HAZARD INDEX EQUATION FOR NON-VOCs IN WATER

Basic Equation:

$$\text{Hazard index}_{\text{nonvoc, water}} = (1/RfD_o) \times C_w \times \frac{IR_w \times EF \times ED_{child}}{BW \times AT}$$

$$+ (1/RfD_o) \times C_w \times \frac{SA \times K_p \times ET \times EF \times ED \times (1L/1000cm^3)}{BW \times AT}$$

Where:

RfD_o = oral reference dose (mg/kg-day)
BW = body weight (15 kg-child)
AT = averaging time (ED x 365 days/year; 2190 days-child)
EF = exposure frequency (350 days/year)
ED = exposure duration (6 years-child)
IR_w = intake rate (1 L/day-child)
ET = exposure time during bathing (child - 1 hr/day)
SA = skin surface area available for contact (6,600 cm^2-child)
K_p = chemical-specific dermal permeability coefficient from water (cm/hour)
C_w = concentration of chemical in water (mg/L)

Reduced Equation:

$\text{Hazard index}_{\text{nonvocwater}} = [(C_w/RfD_o) \times 0.0639] + [(C_w/RfD_o) \times 0.422 \times K_p]$

FIGURE 2-3 DERIVATION OF HAZARD INDEX EQUATION FOR VOCs IN WATER

Basic Equation:

$$\text{Hazard index}_{voc,\ water} = (1/RfD_o) \times C_w \times \frac{IR_w \times EF \times ED_{child}}{BW \times AT_{ing}}$$

$$+ (1/RfD_o) \times C_w \times \frac{SA \times K_p \times ET_B \times EF \times ED \times (1L/1000cm^3)}{BW \times AT_{derm}}$$

$$+ (1/RfC) \times C_w \times \frac{K \times ET_{air} \times EF \times ED_{child}}{AT_{inh}}$$

$$+ \text{Hazard index}_{Vapor\ Intrusion\ to\ Indoor\ Air}$$

Where:

RfD_o = oral reference dose (mg/kg-day)
RfC^* = reference concentration (mg/m^3)
BW = body weight (15 kg-child)
$AT_{ing,derm}$ = averaging time (ED x 365 days/year; 2190 days-child)
AT_{inh} = averaging time (ED x 365 days/year x 24 hours/day; 52,560 hrs-child)
EF = exposure frequency (350 days/year)
ED = exposure duration (6 years-child)
IR_w = intake rate (1 L/day-child)
ET_B = exposure time during bathing (child – 1 hr/day)
SA = skin surface area available for contact (6,600 cm^2-child)
K_p = chemical-specific dermal permeability coefficient from water (cm/hour)
ET_{air} = 24 hr/day
K^* = Andelman volatilization factor (0.5 L/m^3)
C_w = concentration of chemical in water (mg/L)

Reduced Equation:

$\text{Hazard index}_{water}$ = [(C_w/RfD_o) x 0.0639] + [(C_w/RfD_o) x 0.422 x K_p] + [(C_w/RfC or REL) x 0.479] + $\text{Hazard index}_{Vapor\ Intrusion\ to\ Indoor\ Air}$

[*] Notes:
1. RfCs have units of mg/m^3, whereas reference exposure levels (RELs) have units of $\mu g/m^3$. This equation is based on an inhalation toxicity criterion with units of mg/m^3. Therefore, if a REL will be used in the equation, the REL units must first be converted from $\mu g/m^3$ to mg/m^3.
2. The Andelman volatilization factor (K) of 0.5 L/m^3 is used to evaluate household use of water e.g. showering, laundering, and dish washing.

FIGURE 2-4 DERIVATION OF RISK EQUATION FOR NON-VOCs IN WATER

Basic Equation:

$$Risk_{nonvoc,\ water} = SF_o \times C_w \times \frac{IR_w \times EF \times ED_{adult}}{BW_{adult} \times AT}$$

$$+ SF_o \times C_w \times \frac{IR_w \times EF \times ED_{child}}{BW_{child} \times AT}$$

$$+ SF_o \times C_w \times \frac{SA_{adult} \times K_p \times ET \times EF \times ED_{adult} \times (1L/1000\ cm^3)}{BW_{adult} \times AT}$$

$$+ SF_o \times C_w \times \frac{SA_{child} \times K_p \times ET \times EF \times ED_{child} \times (1L/1000\ cm^3)}{BW_{child} \times AT}$$

Where:

SF_o = Slope factor ($[mg/kg\text{-}day]^{-1}$)
BW = body weight (70 kg-adult; 15 kg-child)
AT = averaging time (70 years x 365 days/year; 25,550 days)
EF = exposure frequency (350 days/year)
ED = exposure duration (24 years-adult; 6 years-child)
IR_w = ingestion rate (2 L/day-adults; 1 L/day-child)
ET = exposure time during bathing (0.58 hr/day-adult; 1 hr/day-child)
SA = skin surface area available for contact (18,000 cm^2-adult; 6,600 cm^2-child)
K_p = chemical-specific dermal permeability coefficient from water (cm/hour)
C_w = concentration of chemical in water (mg/L)

Reduced Equation:

$Risk_{water} = (SF_o \times C_w \times 0.0149) + (SF_o \times C_w \times 0.0852 \times K_p)$

FIGURE 2-5 DERIVATION OF RISK EQUATION FOR VOCs IN WATER

Basic Equation:

$$Risk_{voc,\ water} = SF_o \times C_w \times \frac{IR_w \times EF \times ED_{adult}}{BW_{adult} \times AT_{ing}}$$

$$+ SF_o \times C_w \times \frac{IR_w \times EF \times ED_{child}}{BW_{child} \times AT_{ing}}$$

$$+ SF_o \times C_w \times \frac{SA_{adult} \times K_p \times ET_B \times EF \times ED_{adult} \times (1L/1000\ cm^3)}{BW_{adult} \times AT_{derm}}$$

$$+ SF_o \times C_w \times \frac{SA_{child} \times K_p \times ET_B \times EF \times ED_{child} \times (1L/1000\ cm^3)}{BW_{child} \times AT_{derm}}$$

$$+ (IUR) \times 1000\ \mu g/mg \times C_w \times \frac{K \times ET_{air} \times EF \times ED_{resident}}{AT_{inh}}$$

$$+ Risk_{Vapor\ Intrusion\ to\ Indoor\ Air}$$

Where:

SF_o = Slope factor ($[mg/kg\text{-}day]^{-1}$)
IUR = Inhalation unit risk factor ($[\mu g/m^3]^{-1}$)
BW = body weight (70 kg-adult; 15 kg-child)
$AT_{ing,derm}$ = averaging time (70 years x 365 days/year; 25,550 days)
AT_{inh} = averaging time (70 years x 365 days/year x 24 hours/day; 613,200 hrs)
EF = exposure frequency (350 days/year)
ED = exposure duration (24 years-adult; 6 years-child; 30 years-resident combine (adult and child))
IR_w = Intake rate (2 L/day-adults; 1 L/day-child)
ET_B = exposure time during bathing (15 min/shower=0.25 hr/day-adult; four 15 min. baths/week = 0.14 hr/day-child)
SA = skin surface area available for contact (18,000 cm^2-adult; 6,600 cm^2-child)
K_p = chemical-specific dermal permeability coefficient from water (cm/hour)
ET_{air} = 24 hr/day
K^* = Andelman volatilization factor (0.5 L/m^3)
C_w = concentration of chemical in water (mg/L)

Reduced Equation:

$$Risk_{water} = (SF_o \times C_w \times 0.0149) + (SF_o \times C_w \times 0.0852 \times K_p) + (IUR \times C_w \times 205.48) + Risk_{Vapor\ Intrusion\ toIndoor\ Air}$$

* Note: The Andelman volatilization factor (K) of 0.5 L/m^3 is used to evaluate household use of water e.g. showering, laundering, and dish washing.

2.5.4.3 SOIL PATHWAY

Contaminated soil is evaluated by comparing the maximum soil concentration of a chemical to its generic screening level to derive the risk/hazard posed by that concentration as discussed in Section 2.5.3. If additional or alternative evaluation is necessary, the equations in the figures below may be used. The risk calculated is a summation of the incidental soil ingestion exposure for a child and an adult, and the dermal exposure for a child and an adult. Hazard is calculated for the first 6 years of childhood. If the HI is not exceeded for the child, it will not be exceeded for any other age. The equations do not include exposure from ingestion of homegrown fruits and vegetables, or products from animal (e.g., meat, milk, eggs) that feed on vegetation grown on contaminated soil. Risk and hazards from vapors emanating from soil are discussed in Section 2.5.4.4.

The dermal absorption fractions for specific chemicals and chemical classes for use in these soil equations are given in Appendix A, Table 1.

FIGURE 2-6 DERIVATION OF HAZARD INDEX EQUATION FOR SOIL

Basic Equation:

$$\text{Hazard index}_{soil} = (1/RfD_o) \times C_s \times \frac{IR_{s,\,child} \times EF \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT}$$

$$+ (1/RfD) \times C_s \times \frac{SA_{child} \times AF \times ABS \times EF_{child} \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT}$$

Where:

RfD_o	=	oral reference dose (mg/kg-day)
BW	=	body weight (15 kg-child)
AT	=	averaging time (6 years x 365 days/year; 2190 days-child)
EF	=	exposure frequency for soil ingestion and dermal contact (350 days/year)
ED	=	exposure duration (6 years-child)
IR_s	=	incidental soil ingestion rate (200 mg/day-child)
SA	=	exposed skin surface area (2900 cm^2-child)
AF	=	soil to skin adherence factor (0.2 mg/cm^2-child)
ABS	=	fraction of chemical absorbed from soil
C_s	=	concentration of chemical in soil (mg/kg)

Reduced Equation:

Hazard index_{soil} = [(C_s/RfD) x 1.28 x 10^{-5}] + [(C_s/RfD) x 3.70 x 10^{-5} x ABS]

FIGURE 2-7 DERIVATION OF RISK EQUATION FOR SOIL

Basic Equation:

$$Risk_{soil} = SF_o \times C_s \times \frac{IR_{s,\,adult} \times EF \times ED_{adult} \times 10^{-6}\ kg/mg}{BW_{adult} \times AT}$$

$$+ SF_o \times C_s \times \frac{IR_{s,\,child} \times EF \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT}$$

$$+ SF_o \times C_s \times \frac{SA_{adult} \times AF \times ABS \times EF \times ED_{adult} \times 10^{-6}\ kg/mg}{BW_{adult} \times AT}$$

$$+ SF_o \times C_s \times \frac{SA_{child} \times AF \times ABS \times EF \times ED_{child} \times 10^{-6}\ kg/mg}{BW_{child} \times AT}$$

Where:

SF_o = Slope factor ($[mg/kg\text{-}day]^{-1}$)
BW = body weight (70 kg-adults, 15 kg-child)
AT = averaging time (70 years x 365 days/year; 25,550 days)
EF = exposure frequency for soil ingestion (350 days/year)
EF = exposure frequency (350 days/year)
ED = exposure duration (24 years-adult, 6 years-child)
IR_s = incidental soil ingestion rate (100 mg/day-adult, 200 mg/day-child)
SA = exposed skin surface area (5700 cm^2-adult, 2900 cm^2-child)
AF = soil to skin adherence factor (0.07 mg/cm^2-adult, 0.2 mg/cm^2-child)
ABS = fraction of chemical absorbed from soil
C_s = concentration of chemical in soil (mg/kg)

Reduced Equation:

$Risk_{soil} = (SF_o \times C_s \times 1.57 \times 10^{-6}) + (SF_o \times C_s \times 5.1 \times 10^{-6} \times ABS)$

2.5.4.4 AIR PATHWAY

The risk and hazard index, or HI, for the air pathway are based on either the exposure to volatile emissions coming from soil for VOCs and/or the exposure to fugitive dust emissions from soil for non-VOCs. A VOC is a chemical with a Henry's Law constant of 1×10^{-5} atmospheres-m^3/mole or greater. A representative list of VOCs is given in the DTSC *Vapor Intrusion Guidance*[55].

The risk and hazard equations for VOCs and non-VOCs are presented in the figures below. The estimated risk is based on childhood and adult exposure. The HI is calculated for the first 6 years of childhood, since the HI for the child will not be exceeded by the HI for any other age. Air monitoring data generally are not needed for a PEA screening evaluation but are useful for worker health and safety monitoring and fence line monitoring for non-occupational receptors during removal actions.

[55] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance).*October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

FIGURE 2-8 DERIVATION OF HAZARD INDEX FOR EQUATION FOR AIR

Basic Equation:

$$\text{Hazard Index}_{air} = \frac{1}{\text{RfC x 1000 ug/mg}} \text{ x } C_a \text{ x } \frac{\text{ET x EF x ED}_{child}}{\text{AT}}$$

Where:

RfC* = Reference concentration (mg/m^3)
C_a = Concentration in air ($\mu g/m^3$)
EF = Exposure frequency (350 days/year)
ED_{child} = Child exposure duration (6 years)
ET = Exposure time (24 hours/day)
AT = Averaging time (6 years x 365 days/year x 24 hours/day; 52,560 hrs-child)

Reduced Equation:

$\text{Hazard Index}_{air}$ = 1/(RfC) x Ca x 0.000959

* Note:
1. RfCs have units of mg/m^3, whereas reference exposure levels (RELs) have units of $\mu g/m^3$. This equation is based on an inhalation toxicity criterion with units of mg/m^3. Therefore, if a REL will be used in the equation, the REL units must first be converted from $\mu g/m^3$ to mg/m^3.

FIGURE 2-9 DERIVATION OF RISK EQUATION FOR AIR

Basic Equation:

$$Risk_{air} = IUR \times Ca \times \frac{ET \times EF \times ED_{adult + child}}{AT}$$

Where:

IUR	=	Inhalation unit risk factor $(ug/m^3)^{-1}$
C_a	=	Concentration in air ($\mu g/m^3$)
EF	=	Exposure frequency (350 days/year)
$ED_{adult +child}$	=	Exposure duration for resident (30 years total)
ET	=	Exposure time (24 hours/day)
AT	=	Averaging time (70 years x 365 days/year x 24 hours/day; 613,200 hours)

Reduced Equation:

$Risk_{air}$ = IUR x C_a x 0.411

2.5.4.5 ESTIMATION OF AIR CONCENTRATION

The air concentration of VOCs and Non-VOCs emanating from soil are calculated differently. Semi-volatile organic compounds and metals in soil are evaluated in outdoor air using particulate emission factors (PEFs) to obtain concentrations of chemicals in dust. VOCs in soil are evaluated as discussed in Sections 2.5.4.5.2 and 2.5.4.5.3.

2.5.4.5.1 PARTICULATE MATTER

PEFs are used to develop an estimate of the concentration of a chemical in dust based on its concentration in soil. It assumes that the dust from the site is caused by the wind and not created by mechanical means (e.g. construction activities, tilling, automobile traffic, etc.). A default PEF of 1.32E+09 (m^3/kg) is used, because this is the same default value used by the USEPA in their Soil Screening Guidance[56]. It assumes an infinite source of chemicals, a vegetative cover of 50%, and a mean annual wind speed of 4.69 m/s. This is equivalent to a dust concentration of 0.76 $\mu g/m^3$ at the receptor. The default dispersion term (Q/C) of 90.80 (g/m^2-s per kg/m^3) is based on a site of 0.5 acres and dispersion modeling runs of 29 sites across the United States. The default Q/C provides a conservative estimate of the long-term exposure to dust. Q/Cs that are more site-specific may be used if they can be shown to be applicable for estimation of long-term exposure to dust at a site.

Figure 2-10 provides an equation for estimating a non-volatile chemical concentration in air as suspended soil particulates.

[56] USEPA. 1996. *Soil Screening Guidance: User's Guide. Second Edition. Publication 9355.4-23.* July. http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg496.pdf

FIGURE 2-10 ESTIMATION OF AIR CONCENTRATION FOR NON-VOCs

$$Ca = \frac{Cs}{PEF} \times 1000 \text{ ug/mg}$$

Where,

Ca = Chemical Concentration in Air, ug/m^3

Cs = Maximum Reported Soil Concentration, mg/kg

PEF = Particulate Emission Factor (default = 1.32E + 09 m^3/kg)

$$= Q/C \text{ x } \frac{3600 \text{ sec/hr}}{0.036 \text{ x } (1 - V) \text{ x } (Um/Ut)^3 \text{ x } F(x)}$$

Where,

Q/C = Inverse of mean concentration at the center of a 0.5 - acre - square source

$$\left(\text{default} = \frac{90.80 \text{ g/m}^2 \text{ - sec}}{\text{kg/m}^3}\right)$$

V = Fraction of vegatative cover (default = 0.5 or 50%)

Um = Mean annual wind speed (default = 4.69 m/sec)

Ut = Equivalent threshold value of windspeed at 7 m (default = 11.32 m/sec)

F(x) = Function dependent on Um/Ut (default = 0.194)

a USEPA Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, December 2002

2.5.4.5.2 VAPORS OUTDOOR

Although there may be exposure to VOCs in the outdoor or ambient air emanating from soil, this pathway is usually insignificant compared to the indoor air pathway. Therefore, the VOC outdoor air pathway is not included in these equations for the sake of simplicity.. This represents a deviation from the equations used to develop RSLs which do include inhalation of VOCs in outdoor air

2.5.4.5.3 VAPORS INDOOR – SOIL VAPORS

VOCs in indoor air may be present as the result of volatilization of compounds intruding indoors from sub-surface soil. The inhalation of indoor air contaminated by vapors coming from soil is the overriding exposure pathway for VOCs. The following approach may be used to estimate hazard and risk in a screening risk evaluation. First, the indoor air concentration is calculated based upon the following equation.

$$\alpha = C_{Indoor}/C_{Soil\ Vapor}$$

where:

- α = Steady-state attenuation factor, the ratio of the concentration of the VOC indoors to the concentration of the VOC in soil vapor
- $C_{Soil\ Vapor}$ = Measured soil vapor concentration in μg/m^3
- C_{Indoor} = Indoor air concentration in μg/m^3

Therefore:

$$C_{indoor} = \alpha \times C_{soil\ Vapor}$$

The attenuation factor to be used is 0.002 for existing residences or 0.001 for future residences. If the soil vapor concentration represents a sub-slab concentration beneath an existing building, the attenuation factor to be used is 0.05. The attenuation factors used should be those recommended in the most current version of the *Vapor Intrusion Guidance*[57]. The equation is solved for the indoor air concentration in the building. If a carcinogen, this indoor air concentration is divided by its DTSC-recommended residential air screening level and multiplied by 10^{-6} to calculate the cancer risk. If identified as causing adverse non-cancer health effects, the indoor air concentration is divided by its screening level to get a HQ for that chemical. If no screening level exists for the chemical, the concentration may be input as the C_a in the equations shown in Figures 2.8 and 2.9 to calculate the hazard and risk posed by the VOC.

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[57] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*. October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

2.5.4.5.4 VAPORS INDOOR – GROUNDWATER

Evaluation of the inhalation of a vapor migrating indoors from groundwater may be performed by first converting the groundwater VOC concentration to a soil vapor concentration as described in the *Vapor Intrusion Guidance*. The conversion equation is:

$$C_{soil\ vapor} = C_{groundwater} * H_c * C_f$$

Where:

$C_{soil\ vapor}$	= Soil vapor concentration in µg/m^3
$C_{groundwater}$	= Groundwater concentration in µg/L
H_c	= Henry's law constant (unitless)[58]
C_f	= Conversion factor (1000L/m^3)

The calculated soil vapor concentration is used to estimate the indoor air concentration, as shown in Section 2.5.4.5.3 and the risk and/or hazard calculated.

If VOCs are detected in soil vapor and/or groundwater, it is important to consult the current version of DTSC's *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion To Indoor Air (Vapor Intrusion Guidance)*[59] for more detailed information, as the issue of vapors intruding indoors from the subsurface is rapidly evolving.

2.5.4.6 SUMMATION OF RISK/HAZARD FOR ALL MEDIA

For cancer risk, sum risks from each carcinogen over all exposure media and for all carcinogens to obtain the total excess lifetime cancer risk posed by the contaminants at the site. For hazard, sum the hazard quotients from each compound over all exposure media and for all chemicals to obtain the HI posed by the contaminants at the site. For screening purposes, this simplifies the calculation of HI by disregarding the toxic manifestation/target organ affected by each compound. <u>If this HI is greater than 1, then the HIs should be recalculated by only summing exposure to all media for chemicals which have the same toxic manifestation or affect the same target organ</u>. The DTSC toxicologist should be contacted for guidance in grouping compounds.

In general, a cancer risk estimate greater that 10^{-6} or a HI greater than 1 indicates the presence of contamination which may pose a significant threat to human health.

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[58] USEPA Exposure Assessment Tools and Models. http://www.epa.gov/opptintr/exposure/pubs/episuitedl.htm
The chemical-specific Henry's law constant, given in atm-m^3/mol, is multiplied by 41 to obtain the unitless value used in this equation.

[59] DTSC. 2011. *Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)*. October. http://www.dtsc.ca.gov/AssessingRisk/upload/Final_VIG_Oct_2011.pdf

Exceptions will generally include sites with elevated background concentrations, sites where other agency criteria are more stringent, and sites with specific circumstances that allow for a risk management decision to increase the acceptable screening levels. In cases where chemical are left in place exceeding acceptable levels according to a residential scenario, a restricted land-use covenant (LUC), an on-going operation and maintenance (O&M) agreement, or other controls may be required. All potential scenarios should be discussed with the DTSC project manager prior to selection of the most applicable scenario for the site.

2.5.5 UNCERTAINTY ANALYSIS

As an option, the PEA report may contain a section qualitatively discussing uncertainties in the human health screening evaluation. This discussion should not debate the validity of the default exposure factors, since such factors are generic to assumed behavioral and physiological factors appropriate for humans in a residential setting (e.g., soil ingestion rates for a child). The uncertainty section instead should focus on specific site conditions which contribute most significantly to uncertainty in the risk and hazard estimates. Reliance on the information presented in the uncertainty analysis to decide "no further action" or NFA when the screening evaluation estimates risk greater than 10^{-6} or a HI greater than 1, warrants discussions with DTSC.

A quantitative or stochastic uncertainty analysis should not be presented, as such an analysis is beyond the scope of a screening evaluation and is more appropriate in a full baseline risk assessment. An in-depth uncertainty analysis is of no value in a screening evaluation when the outcome of the PEA process is binary, i.e., whether further action or investigation is warranted.

2.6 ECOLOGICAL SCREENING EVALUATION

An ecological screening evaluation should be performed for all sites in a PEA, even sites located in heavily urbanized areas. The ecological screening or scoping evaluation adopts the basic approach suggested by the DTSC (DTSC, 1996)[60] and USEPA (USEPA 1989b[61],1992[62], 1997[63]); however, the evaluation is qualitative rather than quantitative.

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60 DTSC. Ecological Risk Guidance and Tools Web site. http://www.dtsc.ca.gov/assessingrisk/eco2.cfm

61 USEPA, 1989. *Environmental Evaluation Manual. Volume II. Risk Assessment Guidance for Superfund. Interim Final*, EPA 540/1-89/001. Office of Emergency and Remedial Response. March. Available from the National Service Center for Environmental Publications (NSCEP) Web site. http://www.epa.gov/nscep/index.html

62 USEPA. 1992. *Interim Report Dermal Exposure Assessment: Principles and Applications*, EPA/600/8-0 011. January. http://www.epa.gov/ncea/pdfs/efh/references/DEREXP.PDF

63 USEPA. Waste and Cleanup Risk Assessment Web site. Ecological Risk

The ecological screening evaluation relies on the professional judgment of the Environmental Professional to qualitatively evaluate the potential risk to non-human receptors posed by contaminants released from practices on the site. The preparer cannot assume that the human health screening evaluation provides an estimate of the threat to biota. The term "biota" excludes humans, and generally refers to non-domesticated terrestrial and aquatic plants and animals, but can also include domesticated species, such as livestock.

The approach used in the screening-level ecological evaluation is to identify potentially complete exposure pathways between the areas of contamination and biota which occupy or potentially could occupy the site in the future, or habitats outside of the site boundary that could potentially be affected by contamination from the site. If there are potentially complete exposure pathways, further site investigation and assessment may be warranted.

2.6.1 SITE CHARACTERIZATION

The chemical and physical characterization of a site for an ecological screening evaluation is similar to that needed to support a human health screening evaluation. However, certain aspects, such as contamination of plants and sediments, may require additional investigation. Particular attention should be given to identification of chemicals of ecological concern to biota, since a chemical not generally considered a threat to human health may be a chemical of concern for biota. The PEA should contain a table listing all detected chemical contaminants, with maximum and minimum concentrations, number of samples collected and number of detections, as well as any information on the specific habitats present where the contaminants were detected.

2.6.2 BIOLOGICAL CHARACTERIZATION

The initial biological characterization of sites in highly urbanized or developed areas with little or no plant community (e.g., paved facilities) is described in the most current Scoping Assessment guidance[64] (DTSC, 1996). For other sites, a biological characterization of the site, conducted by a qualified field biologist, is needed to identify the biota actually or potentially occurring at the site. Concerned regulatory agency personnel should be contacted and provided with advance notice of the date and time of the site survey. In many California habitats, a biological characterization should preferentially be conducted during the time of year in which plants are actively growing (late winter through spring).

Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final.
http://www.epa.gov/oswer/riskassessment/ecorisk/ecorisk.htm

[64] DTSC. Ecological Risk Guidance and Tools Web site contains guidance on preparation of scoping assessment documents.
http://www.dtsc.ca.gov/assessingrisk/eco2.cfm

Plant surveys conducted outside of this time of year may be of limited use as many species that are present may be senescent and may be difficult to identify or not present.

The biological characterization should allow identification and determination of the extent of coverage of all site-specific habitats. The PEA should include a discussion of how the measure of coverage was selected. Off-site habitats that may be affected by site-related contamination should also be evaluated to the extent practical. Marine or estuarine habitats should be evaluated in terms of both the water and sediment components.

Terrestrial habitats such as forest, oak woodland, grasslands, vernal pools, riparian, lacustrine, palustrine, desert, sand dune, coastal chaparral, and agricultural or maintained landscapes, such as golf courses, should be evaluated and characterized. Transition zone habitats such as freshwater wetlands, saltwater wetlands, brackish wetlands, marine intertidal and mudflats of rivers, lakes or streams should be evaluated and characterized. Biological characterization of the site should also identify the species and types of communities potentially impacted due to their occurrence at nearby areas (i.e., within 1 mile). The location of all wildlife areas, preserves, reserves, sanctuaries, parks, natural areas, conservation areas, or other protected areas within 1 mile of the site should be identified.

Particular emphasis should be placed on identification of special status species and their habitats which occur on or within a one-mile radius of the site. Special status species include California species of special concern; state and federally listed rare, threatened or endangered species; and, species which are proposed or recommended for state or federal listing. The California Department of Fish and Wildlife's (DFW) Biogeographic Data Branch[65] can be contacted for the current special animal and special plant lists. The DFW's California Natural Diversity Database (NDDB) and the Biogeographic Information and Observation System (BIOS) online mapping tool can be a starting point for location information on special status species which have been found near the site; however, the NDDB and BIOS are not all-inclusive listings.

In lieu of an extensive site-specific biological survey conducted over an extended period of time to identify species occupying each distinct habitat, the species expected to occupy each habitat can be identified. In such an instance, a qualified field biologist would first identify each distinct habitat occupying the site and the surrounding area within one mile (include identification of locations where contaminants may be transported). Then the species which can be expected to occupy those habitats can be identified based on the literature.

2.6.3 PATHWAY ASSESSMENT

Once potential species and habitats are identified, a pathway assessment is conducted. Pathway assessment identifies the potentially complete exposure pathways for which

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[65] California Department of Fish and Wildlife Biogeographic Data Branch. Web site. http://www.dfg.ca.gov/biogeodata/

there is contact between biota and chemicals of concern in any medium and by any route. Media to be considered include soil, air, water, and biota. Physical and chemical characteristics which influence environmental fate and transport must also be considered. In particular, offsite transport of contaminants must be evaluated, e.g., surface drainage pathways or potential contact of ecological receptors via groundwater transport to surface waters. Pathways may be direct, such as inhalation of air, or indirect, such as dietary contamination through the food web. Exposure routes to be evaluated include inhalation, ingestion, and dermal contact. Pathways shall be considered potentially complete unless evidence can be provided to demonstrate that the chemical will not enter the medium or the receptor will not contact the medium, either directly or indirectly, now or in the future. A qualitative description of the magnitude, duration, and frequency of exposure for representative biological receptors, representing multiple trophic levels, should be provided for each contaminant and area of contamination. A tabular summary of the exposure pathway analysis for each habitat type, as depicted in Table 2, Appendix A, should be provided. Such an exposure pathway analysis is an expansion of the conceptual site model shown in Figure 2.1.

2.6.4 QUALITATIVE SUMMARY

A site-wide habitat map is required as part of the ecological screening. All major habitats should be displayed on a map equivalent to a USGS quadrangle map (1:25000). Separate indication of the coverage of tree canopy, shrubs, or dominant herbaceous plants may be appropriate. A site-wide map of similar dimension should indicate historical land use patterns, particularly those land uses which may have resulted in release of hazardous substances. Current land use which differs from historical land use should be indicated. Location of former landfills, waste piles, material stockpiles, burn pits, surface impoundments, firing ranges, strafing or bombing ranges, hazardous waste storage areas, reutilization areas, and surface drainages are especially important. Both the habitat coverage and the land use may be displayed on the same map if the degree of detail is not confusing. Additional smaller scale maps of portions of the site may be necessary, as appropriate, to adequately portray habitat-specific information. Industrial sites where future land use is industrial or commercial may not require smaller habitat-specific maps. Chemical concentration data can be overlaid if it can be presented clearly on the same map with sample locations and site use information. If chemical concentration data cannot be presented clearly on a map, then sample location identifiers should be provided which can be used to match concentrations presented in a table with sample locations on the map.

A qualitative statement should be provided which summarizes the findings of the screening-level ecological assessment. If the site is found to be impacted by COPCs, but no ecological risks are present because the site is not utilized by biota, wildlife habitats are not present, or there are no actual or potentially complete exposure pathways, this conclusion must be clearly stated and justified based on the information collected. Supporting documentation may include site photographs depicting the lack of habitat. If it is determined that the potential for exposure to ecological receptors exists, further investigation and assessment may be warranted.

2.7 FAIR MARKET VALUE OF THE PROPERTY

The AAI rule requires an evaluation of the relationship of the purchase price to the fair market value of the property, if the property was not contaminated. This includes making a comparison of price and fair market value and considers whether any differential is due to potential environmental contamination. The evaluation may be conducted by the prospective landowner, grantee, environmental professional conducting the inquiry, or another third party hired by the prospective land owner or grantee.

The AAI rule does not require that a real estate appraisal be conducted to meet this criterion. However, if a formal appraisal is conducted for other purposes, the results may serve as a source of information on the fair market value of the property. If a formal appraisal is not available, the determination of fair market value may be made by comparing the price paid for the particular property to prices paid for similar properties located in the same vicinity of the subject property, or by consulting with a qualified real estate expert. The objective is to determine whether the purchase price paid reflects the fair market value and not the exact value of the property. Any significant differences in the purchase price and the fair market value should be noted as well as any reasons for the differences.

If the information is not collected by the environmental professional or a person under their supervision or charge, the AAI rule does not require that the information collected and determination made be provided to the environmental professional. If the information is not provided, and it is determined that the lack of such information affects his or her ability to identify conditions indicative of releases or threatened releases of hazardous substances, then the environmental professional should identify the lack of information as a data gap and comment on its significance. DTSC recommends that this information be made available to the environmental professional to avoid creating a data gap.

2.8 COMMONLY KNOWN OR REASONABLY ASCERTAINABLE INFORMATION

Commonly known or reasonably ascertainable information about the property is a requirement of the AAI rule. Information about a property that is generally known to the public within the community where the property is located, and that can be easily sought and found from individuals familiar with the property or from easily attainable public sources of information must be collected and considered when conducting all appropriate inquiries. In many cases, this information may be incidental to other information collected and separate or distinct efforts to collect the information may not be necessary. Examples of sources of information include: current owners or occupants of neighboring properties; local and state government officials who many have knowledge or information related to the subject property; others with knowledge of the subject property; and other sources of information (e.g., newspapers, websites, community organizations, local libraries, and historical societies).

CHAPTER THREE

PREPARATION OF THE PEA REPORT

This chapter provides guidance on how to organize the PEA report and what information should be included in the report. The purpose of the report is to document the results of the PEA investigation and screening evaluations and to recommend a course of action for the site.

3.1 SUGGESTED REPORT FORMAT

To provide consistency in documentation of PEA investigations, DTSC recommends use of the report format provided in Figure 3-1.

3.2 SUGGESTED REPORT CONTENTS

The specific information that is suggested to be included in the PEA report is discussed in the following section. If any information cannot be obtained, a statement to that effect should be included in the report. If information is omitted because it seems irrelevant to the site, the rationale for this omission should be included in the report. Omission of information and rationale for omission are subject to approval by DTSC staff. If it is the intention of the Environmental Professional to include AAI requirements, it is the Environmental Professional's responsibility to ensure that all specific reporting requirements identified in 40 CFR §312.21 and §312.31 are included.

3.2.1 EXECUTIVE SUMMARY

The executive summary is a complete summary of the site. This section should inform the reader of all the major aspects of the site. Specifically, this section should include, but not be limited to, very brief descriptions of the following:

- Purpose and objectives of investigation;
- Site background and current status;
- Known and potential releases;
- Significant contamination;
- Pathways demonstrating potential threat;
- Potentially exposed populations; and
- Conclusions and recommendations.

FIGURE 3-1 SUGGESTED REPORT FORMAT

Title Page

i. Table of Contents
ii. List of Figures
iii. List of Tables
iv. List of Appendices

Executive Summary

I. Introduction, purpose and objectives, scope of work
   Significant assumptions made
   Modifications or deviations from the final AAI rule
   Information obtained from the landowner or user (for AAI)

II. Site Description
   a. Site Identification Information
   b. Site Geology and Hydrogeology

III. Background
   a. Site status/historical site information
   b. Hazardous material/substance/waste Management information
   c. Current and historical use(s) of surrounding properties
   d. AAI required information
   e. Records review information
   f. Site reconnaissance
   g. Interviews

IV. Apparent Problem

V. Environmental Setting
   a. Conceptual Site Model
   b. Factors related to soil pathways
   c. Factors related to water pathways
   d. Factors related to air pathways

VI. Sampling Activities and Results
   a. Summary of activities
   b. Presentation of data
   c. Discussion of results

VII. Human Health Screening Evaluation
   a. Exposure pathways and media of concern
   b. Exposure concentrations and chemicals
   c. Human Health Screening Levels
   d. Toxicity values
   e. Risk characterization summary

VIII. Ecological Screening Evaluation
   a. Site characterization
   b. Biological characterization
   c. Pathway assessment
   d. Qualitative Summary

IX. Community Profile

X. Opinion of Environmental Professional (required by AAI)

XI. Conclusions and Recommendations
   a. Summary and conclusions
   b. Recommendations
   c. Data gaps (required by AAI)
   d. Preliminary scoping recommendations

XII. References

XIII. Signature(s) and qualifications of Environmental Professional(s), including statements required by AAI

XIV. Supporting Documentation (Appendices)

3.2.2 INTRODUCTION

This section should briefly introduce the site and the organization of the report. In doing so, the Environmental Professional should provide the reason for performing the PEA investigation; the methodology used to complete the PEA; any significant assumptions made; the types and years of site operations; and the guidance documents followed during the investigation. For PEAs that include AAI requirements, any modifications or deviations from the final rule requirements should be discussed as well as information obtained from the landowner or user. The Environmental Professional and the person(s) who conducted the site reconnaissance and interviews should be identified.

3.2.3 SITE DESCRIPTION

The site description should include information that identifies the physical setting of the site in relation to the surrounding area.

3.2.3.1 SITE IDENTIFICATION

The following information is recommended for inclusion in this section of the PEA report.

1) **Site Name:** Name of current business operation and/or land use at the site.

2) **Contact Person(s):** Name of the main contact person(s) for the above cited operation.

3) **Site Address:** Street address or nearest cross streets, city, state, county, and zip code.

4) **Mailing Address:** Mailing address for the site if different from the street address (e.g., post office (P.O.) box or offsite business).

5) **Phone Number:** Phone number of any onsite or offsite business office.

6) **Other Site Names:** Former or alternate names for the current and historical operations onsite.

7) **USEPA Identification Number:** Any current or previously assigned numbers.

8) **Property Location:** Describe the property location, including any site or nearby characteristics, including any ecological characterization features. Also describe any structures, roads, and site improvements. A site location map and a site-specific map (facility diagram) may be used to help describe these features. The site location map, with a suggested scale of 1:2400, should show the general location of the site relative to its surroundings. The site location map may identify major highways, surface

waters, land use, sensitive populations and critical habitats. The site-specific map should include all significant site features (buildings, tanks, ponds, sumps, etc.) Maps depicting current and historical features should be drawn to a scale appropriate for the site size. All maps should be oriented with north at the top of the page. Also provide the site's latitude and longitude in the geographic NAD83 coordination system.

3.2.3.2 SITE GEOLOGY AND HYDROGEOLOGY

Summarize the site geology, including relevant information from published sources and observations made in the field. Discuss the geologic setting, stratigraphy, surface water hydrogeology, and subsurface hydrogeology. The level of detail may vary based on the nature of the impacts to the site. A more detailed description with respect to potential soil and groundwater pathways should be included in sections 3.3.6.2 and 3.3.6.3, described below.

3.2.4 BACKGROUND

3.2.4.1 SITE STATUS AND HISTORY

Each data element below should be provided for all current and past business operations at the site.

1) **Business Type:** Identity and description of the types of businesses which are currently operating or have operated at the site in the past.

2) **Years of Operation:** Operating dates for each business identified.

3) **Prior Land Use:** Identity of the land use prior to development of the site (including the placement of fill upon the property).

4) **Facility Ownership/Operators:** Identity of all persons or corporations which owned and/or operated businesses on the site. Description of the organizational structure of the businesses (i.e., corporation, limited partnership, etc.). Names of operators, partners, and/or any person(s) having operational control of the facility. Description of the roles these persons/corporate officers played in the day-to-day operations at the site. Current street addresses, mailing addresses, and phone numbers for each person and/or corporation identified.

5) **Property Owners:** Narrative summary of the property ownership at the site extending back to the date of first business operations. The narrative should reference title documents and tax assessor parcel maps which should be included as appendices. The narrative should also include current contact information for all

persons/corporations identified. If a title search was conducted include the document as an appendix to the PEA.

3.2.4.2 HAZARDOUS MATERIAL/SUBSTANCE / WASTE MANAGEMENT INFORMATION

The following information regarding hazardous material/substance/waste management activities for all current and former businesses that have operated on the property should be provided in the PEA report.

1) **Business/Manufacturing Activities:** Concise description of activities or manufacturing processes for each business currently and formerly operating onsite which utilized or generated hazardous materials/substances/wastes. Summary descriptions, diagrams, flow charts, and/or tables are preferable to long narrative descriptions. At a minimum the following information should be provided.

   a) Type and approximate quantities of products produced/sold per year or the number of services rendered per year.

   b) Amount/type of hazardous substances and/or wastes generated per year.

   c) Primary materials and chemicals used, handled, or sold onsite.

   d) Descriptive overview of the major physical/chemical processes used (e.g. mixing, distillation, combustion, oxidation, polymerization, etc.) for each process or activity.

2) **Onsite Storage, Treatment, and Disposal:** Concise description of waste/substance storage, treatment, and disposal practices for each business currently and formerly operating onsite. Summary descriptions, diagrams, flow charts, and/or tables are preferable to long narrative descriptions. At a minimum the following information should be provided.

   a) Type, capacity, contents, and location of storage units (e.g., tanks, drum storage areas, sumps, pits, ponds, etc.).

   b) Type, capacity, and location of treatment facilities (e.g., neutralization, filtration, distillation, incineration, etc.).

   c) Onsite disposal practices (e.g. land disposal, land spreading, injection, etc.), including volumes of waste disposed.

   d) Containment measures specific to each treatment, storage, and disposal unit onsite.

e) Waste recovery and/or recycling practices utilized onsite. Indicate volumes and types of wastes recovered/recycled annually.

f) Origin, types, and quantities of any substances/wastes from offsite sources treated, disposed, or stored on the site.

g) Identification of all leaks, spills, releases or threats of releases of any substances at or from the site (into the environment or within onsite structures). Include when, how and where such releases occurred, and the volume and types of materials released.

3) **Regulatory Status:** The status of any federal, state, or local permits currently or previously held by the facility. Include effective dates of the permit(s) and specific permit requirements and conditions. Attach copies of the permits in the appendices of the PEA report.

4) **Prior Assessments/Remediation:** Identity, evaluation and summary of all assessments, sampling efforts and cleanup activities which have taken place at the site prior to the PEA.

3.2.4.3 CURRENT AND HISTORICAL USES OF SURROUNDING PROPERTIES

Surrounding Land Use: History and/or general uses of properties in the area surrounding the site should be researched to the extent to which the information is useful to determine the influence of surrounding property use(s) on the site.

3.2.4.4 AAI REQUIRED INFORMATION

Any additional information required by the AAI that is not identified as a component of the PEA should be included in this section. Examples of this type of information include fair market value of the property (Section 2.7) and commonly known or reasonably ascertainable information (Section 2.8).

3.2.4.5 RECORDS REVIEW

This section should summarize the information found during the records review.

1) **Land Records:** Records such as title records/chain of title documents, environmental liens, easements, recorded documents such as land use covenants (LUCs), engineering controls or institutional controls should be described. Also, describe current land use and zoning, and any proposed land use or zoning changes. If known, the type of allowable land uses associated with the zoning designations should be

included. Identify the Assessor's Parcel Number for the site and include a copy of the County Assessor's plat map for the parcel(s) where the site is located. The corresponding Township, Range, Section, and Meridian for the site location should also be included.

2) **Aerial Photographs/Site Photographs:** The results of interpretation of aerial photographs with regard to identification of historical development or site activities at the property and at nearby areas (if applicable). If available, information obtained from photographs that document historical site activities.

3) **Fire Insurance Maps:** Information included on insurance maps indicating use of the property by specified dates.

4) **Other Historical Use Sources:** Summary of information obtained from other sources such as street directories, newspaper archives, etc.

5) **Federal, State, Tribal, and Local Records:** Summary of information obtained from records review or databases. Summarize significant findings of federal, state, or local inspections of current or past operations onsite. Include significant sampling results, scope and purpose of the inspection, and conclusions drawn by the inspector.

6) **Site Owner/Operator Records:** Summary of applicable information obtained from the site owner or site operator.

3.2.4.6 SITE RECONNAISAANCE

A section describing the methodology used to conduct the visual inspection of the subject property and adjoining properties should be included.

1) **Inspection:** Describe when the inspection was conducted and by whom.

2) **Physical Limitations:** Describe any physical limitations that prevent visual observation of the property (e.g., limited access, safety concerns, etc.)

3) **Interior Observations:** Describe observations made while inspecting interiors of structures or features.

4) **Exterior Observations:** Describe observations made while inspecting exterior portions of the property.

5) **Evidence of Release or Threatened Release:** Describe any observations made that might suggest a release or threatened release of hazardous substances/materials. Examples include: staining, spills, odors, stressed vegetation, corrosion, pools of liquid, discolored water, ground surface alterations, dead or ill wildlife, or other conditions.

3.2.4.7 INTERVIEWS

A summary of the interviews conducted should include a description of when the interview was conducted and with whom the interviews were conducted (e.g., current property owner and occupants, site manager, local/state/federal government officials, past site owners and occupants, etc.). The method used to conduct the interview (e.g., in person, written communications, telephone, etc.) should also be identified. If the property is abandoned, interviews with neighboring property owners should be summarized and, if applicable, interviews with past owners and occupants.

3.2.5 APPARENT PROBLEM

This section should summarize the available information regarding known or potential sources of contamination which constitute the primary reason for investigating the site. The summary should include documentation of spills or releases (i.e., date, location, material, and quantities), identification of the contaminants of concern, identification of the primary human and environmental resources of concern, and a description of the exposure pathways. Detailed information related to the apparent problem should be described in subsequent sections of the report.

3.2.6 ENVIRONMENTAL SETTING

During the background research, information should have been collected on the site's environmental characteristics. This information identifies the site environmental conditions which would influence the transport of contaminants from the source of contamination through identified potential exposure pathways to the exposed individual or environmental receptor. DTSC will use the information provided to prioritize those sites requiring remediation.

3.2.6.1 CONCEPTUAL SITE MODEL

Include the Conceptual Site Model (CSM) described in Section 2.1.2. The initial CSM should be updated based on information and data collected during preparation of the PEA.

3.2.6.2 FACTORS RELATED TO SOIL PATHWAYS

1) Describe the topography of the site and the surrounding areas.

2) Describe the predominant soil types at the site, using unified soil classification system (UCSC) terminology and site-specific geologic logs when available. Identify the least and most permeable continuous layers of soil and the permeability of each layer.

3) Describe the surface slope at the site. Also, provide the slope of any intervening terrain between the site and the nearest downhill surface water body. If the site is in a closed basin or is actually located in surface water, this fact should be stated.

4) Describe accessibility to the site in terms of both natural and man-made features or structures which currently restrict human access to the site.

5) Describe any measures which have been taken to contain or prevent direct contact with hazardous substances/materials in or on the soil at the site.

6) Provide the distance to and location of the nearest potentially affected residential area, school, business, day care center, nursing home, senior citizen community, and hospital (for facilities within one mile of the site).

3.2.6.3 FACTORS RELATED TO WATER PATHWAYS

The following information should be provided if a release or threatened release of hazardous substances/materials to water exists at the site.

1) Describe the hydrogeology beneath the site in terms of known aquifers, depth to aquifers, hydraulic conductivities, confining layers (i.e., aquitards or aquicludes), discontinuities, aquifer interconnections, and any other features of significance. Cite the professional geologist or professional civil engineer who presented this information.

2) Identify the aquifers which have been contaminated by a release from the site, or which are threatened to be contaminated as a result of migration of hazardous substances from a release at the site. Identify any aquifers which are connected to an aquifer that has been contaminated by a release from the site. Also identify if the site is located within a regional groundwater plume or describe nearby releases to groundwater that have or may have the potential to impact the site.

   Potential data sources: sampling data; local water districts and utilities; county health departments; Department of Public Health, Public Drinking Water Program; Department of Water Resources (DWR); Regional Water Quality Control Board (RWQCB).

3) For each of the aquifers identified above, provide the following information for wells within a three-mile radius of the site:

   a) The current use(s) of groundwater from wells that draw from the aquifer(s) (e.g., drinking water, irrigation, industrial process water, etc.).

   b) The distances to the nearest well and nearest drinking water well that draws from the aquifers(s).

c) The direction and velocity of flow within the aquifer(s).

d) The approximate number of service connections and population served by drinking water wells from the aquifer(s).

Potential data sources: Local water districts and utilities; County planning and health departments; Local irrigation districts; Department of Public Health, Public Drinking Water Program; DWR; U.S. Geological Service (USGS); RWQCB.

4) Describe the possible migration route(s) from the areas of hazardous substance contamination and/or storage to nearby surface waters, marshlands, wetlands, or wildlife habitats in the event of surface water runoff or flooding.

Potential data sources: Personal observation; aerial photographs; USGS Maps.

5) Describe the locations and uses of surface waters, marshlands, wetlands, and wildlife habitats which may be potentially affected by migration of contaminants from the site. Provide the location and distance to the <u>nearest</u> surface water, marshland, wetland, and wildlife habitat which may be affected by migration of the contaminants. Also describe the relationship of the site to potential impacts from future sea level rise.

Potential data sources: USGS Maps; other maps; California Department of Fish and Wildlife (DFW); local planning department; U.S. Bureau of Reclamation; State Water Resources Control Board (SWRCB); San Francisco Bay Conservation and Development Commission; California Coastal Commission.

6) Describe any past or existing measures for preventing or mitigating surface water runoff from the site (e.g., berms, diversion systems, diking, sealed containers for hazardous substances, runoff collection systems, etc.).

Potential data sources: Facility records; DTSC files; RWQCB files; other agencies.

7) Identify the approximate population served (number of people drinking water) by <u>each</u> surface water intake within three (stream) miles downstream of the probable point of entry of runoff from a site to a stream/river and one mile from the probable point of entry to a static body of water. Also identify the approximate number of acres of food/forage cropland irrigated by water from each intake and the approximate number of livestock or poultry which consume water from each intake.

Potential data sources: U.S. Census Bureau; Local/regional planning or health departments; Department of Public Health, Public Drinking Water Program; Local irrigation district DWR.

8) Provide the approximate slope (in percentage) of the site and the intervening terrain between the site and any surface water which may potentially accept runoff.

3.2.6.4 FACTORS RELATED TO AIR PATHWAYS

Information for this section should be provided only if sampling data exist to document a release of a hazardous substance/material to the atmosphere or if the threat of a release exists. If there are data indicating an on-going release to the atmosphere, the local Air Quality Management District (AQMD) should be notified. If there is evidence that a hazardous substance/material has been historically released to the atmosphere or that a hazardous substance/material has been released to surface soil, the possibility exists that surface soil could be a reservoir for atmospheric contamination. Contaminated surface soils are subject to wind dispersal, evaporation, and dispersal from fire/explosion. If a release has been documented or a threatened release exists at the site, provide the following information.

1) Describe the known or potential sources(s) and mechanism for the release or threatened release.

   Potential data sources: Site records; local AQMD.

2) Provide the daily prevailing wind direction and daily average wind velocity for the site.

   Potential data sources: Local air district; local weather stations; National Oceanic and Atmospheric Administration (NOAA).

3) Describe local climatic factors (e.g., seasonal temperatures, seasonal precipitation, seasonal temperature inversions, seasonal wind patterns, and seasonal extreme events).

   Potential data sources: Local AQMDs; local weather stations; NOAA.

4) Describe the timing of the release or threatened release (e.g., intermittent release related to facility operation, continuous release from an impoundment, potential release if heavy machines disturb soils, etc.).

   Potential data sources: Facility records; local AQMDs.

5) Describe the possible dispersion route(s) for a release or threatened release (e.g., via a stack emission, evaporation, wind, fire/explosion, etc.).

   Potential data sources: Local AQMDs; facility records.

6) Provide the approximate population of residents and workers which may be affected by a release or threatened release of hazardous substances/materials.

   Potential data sources: U.S. Census Bureau; local/regional planning databases.

7) Provide the location and distance from the site to any of the following areas which may be impacted by a release or threatened release of hazardous substances/materials:

- Residential areas and schools;
- Commercial/industrial zones;
- National/state parks, forests, wildlife reserves;
- Agricultural lands (in production within five years) for both prime and non-prime agricultural land; and,
- Historic/landmark sites.

Potential data sources: Local planning departments; Department of Food and Agriculture; DWR; Department of Forestry; maps

8) If not previously indicated in other sections of the PEA report, provide the type, location, and distance from the release or threatened release of hazardous substances/materials to the following sensitive environments:

- Schools
- Day care centers
- Hospitals
- Nursing homes
- Retirement communities
- Locations of any other sensitive populations
- Coastal wetlands (within a two-mile radius);
- Fresh-water wetlands (within a one-mile radius);
- Habitat for special species (within a one-mile radius); and,
- National parks or preserves.

Potential data sources: Local planning department, maps, NDDB, DWR, SWRCB, physical measurement.

3.2.7 SAMPLING ACTIVITIES AND RESULTS

In the three subsections that follow, the report should summarize the sampling activities performed, present the analytical data, and provide a discussion of the results.

3.2.7.1 SUMMARY OF ACTIVITIES

The sampling plan provided a framework for field activities and allowed flexibility for some decisions to be made in the field. This section should describe the activities that were performed; document decisions made in the field; identify any deviations from the work plan; and provide explanations for any deviation.

3.2.7.2 PRESENTATION OF DATA

Use tables, charts, etc. to summarize the sample analysis results for each medium. At a minimum the information presented should include the chemical name, sample type, sample designation, sample location, sample depth (if appropriate), detection limit, units, and date collected. Analysis results as reported from the laboratory, including quality assurance/quality control (QA/QC) data, should be provided in an appendix to the report. Also include information regarding the handling of analytical samples from the time of collection until final analysis.

3.2.7.3 DISCUSSION OF ANALYTICAL RESULTS

Provide a summary of the conclusions reached upon evaluation of the analytical data. Identify unexpected or conflicting results, unusable data, and field and/or laboratory interferences and provide potential rationale. Appropriate figures or tables should be used to support the discussion. This section should also identify secondary analysis performed to confirm original results that may have been questionable. Any hot spots, (i.e., areas of elevated concentrations), areas of special concern and/or separate areas of contamination present at the site should be discussed.

3.2.8 HUMAN HEALTH SCREENING EVALUATION

The introduction to the human health screening evaluation should contain a brief summary of the information presented in the remainder of the section. The summary should introduce the four components of the human health screening evaluation: exposure pathways, exposure concentrations of chemicals of concern, toxicity values, and risk characterization.

3.2.8.1 EXPOSURE PATHWAYS AND MEDIA OF CONCERN

Refer to the conceptual site model (CSM) in Section 3.2.6.1 to show potentially complete exposure pathways (See Figure 2.1 for example). If there are several distinct areas of contamination, presentation of separate CSMs for each area may be necessary. If the pathways of exposure are the same for each area, then one CSM is sufficient; however, a statement to that fact should be included. A statement should be included supporting the approach that the default exposure pathways embedded in the screening levels, as described in Section 2.5.2.1, can be considered complete and reasonable to assume at the site.

3.2.8.2 EXPOSURE CONCENTRATIONS AND CHEMICALS

Include tables identifying the chemicals of concern, their physical constants, and the concentrations in each medium that were used as input for the screening evaluation (this should be displayed for each separate area of contamination). Every table should have a descriptive title name and the name of the potentially contaminated area it represents, if applicable. If the site has historic sampling data, significant results should be included in separate, chronological tables with each table clearly noting the sampling date. If there are large volumes of data, include only the significant findings in this section and include all other data in an appendix. Provide the rationale if a particular chemical is to be excluded from evaluation. All background data should be included in this section, with any suspected anomalies noted. A table can be used to compare metals found on site with local background levels. A table may be included comparing ambient levels for selected organic chemicals, if appropriate.

3.2.8.3 HUMAN HEALTH SCREENING LEVELS

Include a table of the human health screening levels for residential land use used to perform the human health screening evaluation. This table should include the source of the screening level, the units of measurement, and the environmental medium to which the screening level should be compared. The environmental media to be considered are soil, soil vapor, groundwater, and surface water (if used as a drinking water source). Screening levels for soil are the USEPA RSLs with modifications described in the most current DTSC HHRA Note 3[66]. The source of screening levels for groundwater for risk evaluation may be the US EPA tap water RSL or the California Public Health Goals (PHG). California Maximum Contaminant Levels (MCLs) and water quality objectives of basin plans are not all strictly risk-based, but they may be potential requirements for site cleanup. Screening levels for indoor air are the air RSLs, which are compared to indoor air levels calculated from soil vapor and/or groundwater concentrations as described in Sections 2.5.4.5.3 and 2.5.4.5.4. The units of measurement are mg/kg for soil, mg/m^3 or $\mu g/m^3$ for soil gas and indoor air, and µg/liter or mg/liter for groundwater. The table should identify each chemical as being evaluated as either a carcinogen, non-carcinogen, or both.

[66] DTSC Human Health Risk resources page contains Note 3. Web site. http://www.dtsc.ca.gov/AssessingRisk/humanrisk2.cfm#guidance

3.2.8.4 TOXICITY VALUES

Toxicity values are embedded in the derivation of the screening levels for specific chemicals. If screening levels are not used in the human health screening evaluation, and the equations based on the USEPA *Risk Assessment Guidance for Superfund (RAGS)* are used instead, as described in Section 2.5.4, each chemical of concern should have all relevant and significant human toxicity information described. This should include a summary table with the cancer potency factor, reference dose and reference concentration for each chemical of concern, and for each route of exposure. The table should cite the source and date of the toxicity values (e.g., Cal/EPA, USEPA). Toxicity data for each route can be displayed in a table. This section should clearly indicate which toxicity values are based on cross-route extrapolation.

3.2.8.5 RISK CHARACTERIZATION SUMMARY

Include two tables comparing the maximum concentration of each chemical of concern to its appropriate screening level, as described in Section 2.5.3. One table should list the comparison of chemicals considered carcinogens, and the other table should list the comparison of chemicals considered non-carcinogens. The summed ratio for carcinogens, multiplied by 10^{-6}, should be included in the carcinogenic chemicals table representing the cumulative risk from all carcinogens detected at the site. The summed ratio for non-carcinogens represents the cumulative HI for the site. Conclusions regarding the screening evaluation determination should be provided in this summary.

The risk and hazard estimates which result from application of this screening evaluation do not represent absolute estimates at a specific site, since generic assumptions for residential land use are used. The information provided for the PEA screening evaluation is often based on limited sampling information. The goal of the PEA screening evaluation is to ensure that no potential health hazard is overlooked; therefore, the screening evaluation's assumptions and default values are restricted to a reasonable maximum exposure (RME) scenario.

3.2.9 ECOLOGICAL SCREENING EVALUATION

The introduction to the ecological risk assessment should contain a summary of the information presented in this section of the PEA Report.

3.2.9.1 SITE CHARACTERIZATION

Identify the chemicals of ecological concern to biota and provide information on habitat-specificity of contamination.

3.2.9.2 BIOLOGICAL CHARACTERIZATION

List and describe all wildlife habitats potentially affected by the site. The nature of the habitat should be detailed including cyclic changes. The rationale for excluding any nearby wildlife habitat from evaluation should be provided.

List all special species potentially affected by the site and identify any endangered or special status species. State if any of these species have been observed on the site. Note if a species is particularly sensitive to any chemicals of concern found on site.

3.2.9.3 PATHWAY ASSESSMENT

Describe the onsite contamination and the exposure pathways for which there may be contact between biota and chemicals of concern in any medium. Use a CSM to illustrate general potential exposure pathways, then a more detailed exposure pathway analysis table can be used for each habitat. Include a discussion on whether this exposure is onsite or offsite and describe the potentially affected species. Any past documented or observed impacts to wildlife habitats or special species from the site should be described in this section. Also, describe any interim remedial measures that may abate potential impacts to the environment from the chemicals of concern.

3.2.9.4 QUALITATIVE SUMMARY

Provide a qualitative description of the magnitude, duration, and frequency of exposure for the various biological receptors, representing multiple trophic levels, for each contaminant and area of contamination. A site-wide habitat map and maps showing historical and current land use should be included. Conclusions regarding current or potential environmental impacts should be included. If the site contamination does not affect biota, a qualitative statement to that effect and supporting rationale should be provided. If the site contamination has the potential or can be reasonably assumed to affect wildlife or wildlife habitats, either onsite or offsite, further investigation and assessment may be necessary.

3.2.10 COMMUNITY PROFILE

This section should be a summary of the public participation activities conducted as part of the PEA investigation. The summary should highlight the assessment of community concern and the public participation actions taken. Also, include any recommendations for future public participation activities, if any.

3.2.11 OPINION OF ENVIRONMENTAL PROFESSIONAL (REQUIRED BY AAI)

For PEAs that include AAI requirements, the Environmental Professional's opinion(s) as to whether the inquiry identified conditions indicative of releases or threatened releases of hazardous substances on, at, in, or to the subject property must be included (see final rule at 40 CFR §312.21(c)(1)) The Environmental Professional also must include an opinion regarding additional appropriate investigation to detect the presence of contamination at the property, if the Environmental Professional has such an opinion.

3.2.12 CONCLUSIONS AND RECOMMENDATIONS

3.2.12.1 SUMMARY AND CONCLUSIONS

The conclusions of the PEA report need to address three main questions:

- Have current or past practices of handling hazardous waste/substances/materials resulted in a release or threat of release at the site?

- If a release has occurred or a threatened release exists, does it pose a significant threat to public health or the environment?

- Does the release pose an immediate potential hazard to public health or the environment which would require the implementation of an expedited response action?

In answering the above questions, the conclusions should be specific, concise, and supported by information presented in the body of the report. All conclusions presented in this section must be consistent with the data and analysis presented elsewhere in the PEA report.

If a release or threatened release does not exist, this section should include a statement to that effect and reference the information contained in the body of the report which supports the statement.

3.2.12.2 RECOMMENDATIONS

Based on the conclusions presented in the previous section, the Environmental Professional will make a recommendation(s) regarding the need for further action at the site. In its simplest form the recommendation will either be "no further action (NFA)" or "additional action required".

A NFA recommendation can be made in cases when no release of hazardous substances/materials has occurred and in cases when levels of contamination are determined to be insignificant. Any recommendations for NFA at sites where a release has been documented must be supported by information provided in the human health and environmental threat evaluation portion of the report.

At sites with significant contamination, a recommendation for further action to investigate or remediate the site must be made. This recommendation should not simply state that "further action is required". The recommendation should identify additional investigation and/or remediation needs and strategies to address them.

In addition to the recommendations above for long term actions, this section must include recommendations for expedited response actions necessary to mitigate any immediate potential hazards to public health or the environment. These actions can take a number of forms, including but not limited to: removing highly contaminated soils to prevent further migration; placing a polymer coating onto soils to prevent dispersion and runoff; placing a fence and warning signs around contaminated areas to prevent direct contact; and/or providing alternative drinking water sources to residents near sites where drinking water supplies are contaminated. When determining if expedited response actions are required, consider the following:

- Does the site have unrestricted access?

- Are there hazardous substances in surface impoundments, unsealed or improper containers, piles, leaking tanks, or other unapproved storage?

- Have the substances been spilled on the ground or other surfaces accessible to humans or animals?

- Does the toxicity of the hazardous substances at the site pose an immediate public health or environmental endangerment?

- Are unsafe levels of soil vapor migrating or have the potential to migrate into indoor air?

- What is the most immediate exposure threat facing nearby populations?

- How many people live or work around the site and what is the distance of that population from the site?

- Is there a confirmed instance in which exposure to hazardous substances/materials at a site has caused injury, illness, or death to humans, domestic or wild animals, or plants?

- Can it reasonably be inferred from the geology and hydrology of the site and surrounding area and the nature of the contaminants that there is the potential for offsite migration?

- Is there evidence of offsite migration?

- Are there active wells in the suspected pathway of migration?
- Is there a potential for the contaminant to become airborne?
- Can a reasonable inference be made that taking an immediate action could significantly reduce continued or potential hazardous substance migration from the site through air emissions, surface water runoff, groundwater migration, or subsurface gas migration?

3.2.12.3 DATA GAPS (REQUIRED BY AAI)

As required in 40 CFR §312.21(c)(2) of the final rule, the report should document and discuss significant data gaps that affect the ability of the Environmental Professional to identify conditions indicative of releases or threatened releases.

3.2.12.4 PRELIMINARY SCOPING RECOMMENDATIONS

For sites that will continue in the cleanup process, the next step after completing the PEA is the Remedial Investigation/Feasibility Study (RI/FS). The RI is conducted to characterize the full extent of contamination at the site and to obtain information needed to identify, evaluate, and select cleanup alternatives. The FS includes an analysis of remediation alternatives based on the nine National Contingency Plan evaluation criteria (USEPA, 1988).

The first step of the RI/FS is the planning or scoping of the project to focus activities and streamline the process, thereby preventing needless expenditures and loss of time in unnecessary sampling and analysis. Ideally, all sites would begin the RI/FS immediately upon completion of the PEA. This section includes steps to scope the RI/FS upon completion of the PEA. These steps will serve to identify potential data gaps, keep information on site conditions current, and help establish priorities for future remedial actions. Upon approval of the PEA report, the parties responsible for the site should initiate the implementation of the scoping activities identified in the report.

Specific activities that may be conducted during project scoping include:

- Evaluating the PEA data to update the CSM and identify data gaps.
- Initiating limited field investigations if available data are inadequate to develop an updated CSM and adequately scope the project. An example of limited field investigation would be installation of monitoring wells and/or collecting samples from existing wells on a quarterly basis to monitor for the chemicals of concern or hydrological studies.

- Identifying preliminary remedial action objectives (RAOs) and likely response actions for the specific projects, including presumptive remedies. This may include identifying the need and a schedule for treatability studies to better evaluate potential remedial alternatives.

- Conducting treatability studies identified in scoping.

Full project scoping activities can be found in the USEPA's *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (USEPA, 1988). Potential scoping needs applicable to baseline risk assessment data collection can be found in USEPA's *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* (USEPA, 1989a). DTSC's Proven Technologies and Remedies documents are also available and are designed to help streamline remedy selection and site cleanup while ensuring full protection of public health, safety and the environment without diminishing public input. These documents are available on DTSC's web site at http://www.dtsc.ca.gov/SiteCleanup/PTandR.cfm, and are intended to be one of many options that may be used in the cleanup process and are not necessarily applicable to every site.

3.2.13 SIGNATURE(S) AND QUALIFICATIONS OF ENVIRONMENTAL PROFESSIONAL(S), INCLUDING STATEMENTS (REQUIRED BY AAI)

The signature(s) of the Environmental Professional(s) and the statements as required by 40 CFR §312.21(d) need to be included if an AAI is being conducted. Geologic or engineering plans, specifications, drawings, and reports must be prepared by, or under the direct supervision of a California professional geologist or civil engineer, as appropriate, who will review and sign all such documents indicating responsibility for their content.

GLOSSARY

CALIFORNIA HUMAN HEALTH SCREENING LEVELS (CHHSLS). CHHSLs were developed by the Cal/EPA Office of Environmental Health Hazard Assessment (OEHHA) in 2005 using California toxicity criteria, assuming default exposure pathways and default conservative exposure parameters. CHHSLs are not generally recommended for use in a PEA evaluation, because they are not reviewed and revised on a regular basis. Consult with a DTSC toxicologist for further information.

COMMUNITY ASSESSMENT. A series of interviews with local community members which will aid in characterizing and determining the informational needs and desires of the community.

COMMUNITY PROFILE. A written presentation of information gathered through the community assessment regarding community concerns that form the basis for determining public notification and public participation needs.

CONCEPTUAL SITE MODEL (CSM). A "model" of a site developed at scoping using readily available information. In its simplest form, the CSM identifies all potential or suspected sources of contamination, types and concentrations of contaminants detected at the site, potentially contaminated media, and potential exposure pathways, including receptors.

EXPEDITED RESPONSE ACTION. A removal action which occurs during or soon after the site evaluation phase. These removals generally consist of removing leaking drums/tanks, fencing the site, and placing caps of protective covering over known areas of contamination. Also known as: interim remedial measures (IRMs), time-critical removal actions (TCRAs), or non-time-critical removal actions.

EXPOSURE POINT. A location of potential contact between an organism (or receptor) and a chemical or physical agent. (USEPA, 1991)

EXPOSURE ROUTE. The way a chemical or physical agent comes in contact with an organism (i.e., by ingestion, inhalation, dermal contact). (USEPA, 1991)

FIELD DUPLICATES. Independent samples which are collected as close as possible to the same point in space and time. They are two separate samples taken from the same source, stored in separate containers, and analyzed independently. These duplicates are useful in documenting the precision of the sampling process. (USEPA, 1986)

HAZARD INDEX (HI). The sum of two or more hazard quotients (HQs) for multiple substances and/or multiple exposure pathways. (USEPA, 1991)

HAZARD QUOTIENT (HQ). The ratio of a single substance exposure level over a specified time period to a reference dose for that substance derived from a similar exposure period. (USEPA, 1991)

INHALATION UNIT RISK (IUR). The upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 μg/m^3 in air.

QUANTITATION LIMIT. The lowest level at which a chemical can be accurately and reproducibly quantitated. Usually equal to the instrument detection limit multiplied by a factor of three to five, but varies for different chemicals and different samples. (USEPA, 1991)

REFERENCE CONCENTRATION (RfC). An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of adverse non-cancer effects during a lifetime. Expressed as a concentration of contaminant in air (mg/m^3). (Adapted from IRIS database)

REFERENCE DOSE (RfD). An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of adverse non-cancer effects during a lifetime. Expressed in mg/kg of body weight per day. (Adapted from IRIS database)

REGIONAL SCREENING LEVELS (RSLS). Initial screening levels that are protective of human health. RSLs are used in the screening level human health evaluation. RSLs were developed by the USEPA using toxicity criteria derived by the USEPA, assuming default exposure pathways and default conservative exposure parameters. They are reviewed and revised at least twice a year.

REMEDIAL ACTION. (a) Those actions which are consistent with a permanent remedy, that are taken instead of, or in addition to, removal actions in the event of a release or threatened release of a hazardous substance into the environment. (Adapted from California Health and Safety Code, Division 20, Chapter 6.8)
(b) Those actions which are necessary to monitor, assess, and evaluate a release or a threatened release of a hazardous substance. (Adapted from California Health and Safety Code, Division 20, Chapter 6.8)

REMOVAL (ACTION). Includes the cleanup or removal of released hazardous substances from the environment or the taking of other actions as may be necessary to prevent, minimize, or mitigate damage which may otherwise result from a release or threatened release. (Adapted from California Health and Safety Code, Division 20, Chapter 6.8)

Slope Factor (SF). A plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure at a particular level of a potential carcinogen. (USEPA, 1991)

Split Samples. Aliquots of a sample taken from the same container and analyzed independently. These are usually taken after homogenizing the sample and are used to document intra- or inter-laboratory precision. (USEPA, 1986)

Vadose Zone. The unsaturated zone between the land surface and the water table.

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APPENDIX A

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TABLE 1 SCREENING LEVEL DERMAL ABSORPTION FRACTIONS (ABS) FROM SOIL

Compound Class	Absorption Fraction[1]	References
Chlorinated Insecticides	0.05	Wester, et al., 1990a; Wester, et al., 1992a
Polynuclear Aromatic Hydrocarbons	0.15	Wester, et al., 1990a
Organophosphates	0.25	Cal/EPA Office of Environmental Health Hazard Assessment
Pentachlorophenol	0.25	Wester, et al., 1993b
Polychlorinated Dibenzo-p-dioxins and Dibenzofurans	0.03	USEPA, 1992
Polychlorinated Biphenyls (PCB)	0.15	Wester, et al., 1993c
Other Organic Chemicals	0.10	SCAQMD, 1988
Cadmium	0.001	Wester, et al., 1992b
Arsenic	0.03	Wester, et al., 1993a
Hexavalent Chromium	0%	Not shown to be a systemic carcinogen via dermal exposure
Other metals and complexed cyanides	0.01	SCAQMD, 1988
Free Cyanide	0.10	SCAQMD, 1988

1. Dermal absorption values from soil are based on, in order of preference: in vivo, animal studies on dermal absorption from soil; in vivo, animal studies on dermal absorption from an applicable cosolvent; in vitro, human skin dermal absorption studies; in vitro animal skin dermal absorption studies. Actual dermal absorption from soil may vary from these estimates due to exposure conditions or soil characteristics which differ from the experimental conditions.

TABLE 2 SAMPLE EXPOSURE PATHWAY ANALYSIS FOR AN ECOLOGICAL SCREENING EVALUATION

Habitat Type[67]	Potential Contaminants or Classes of Contaminants of Concern[68]	Contaminated Media[69]	Food Web Exposure[70]	Potential Exposure Pathway[71]	Complete Exposure Pathway
Chaparral	**DDT**	**Soil**		**Direct Ingestion**	**Yes**
	DDT	**Soil**	**Invertebrates to Mouse**	**Ingestion of Prey**	**Yes**
	Chloroform	**Groundwater**		**Inhalation of Soil Gases**	**Yes**
	Chloroform	**Groundwater**		**Direct Ingestion**	**No**

[67] Examples of habitat types include freshwater wetland, conifer forest, oak woodland and riparian.

[68] Indicate the specific chemical or family of chemicals, based on potential significance to the risk assessment. Physical or chemical properties such as volatility, bioaccumulative potential, tendency to sorb to soils or sediments and water solubility may be important.

[69] Indicate the food web transfers for those indirect exposures through the food web.

[70] Indicate the potential exposure pathway such as inhalation of volatile compounds from surface or subsurface contamination, incidental soil or sediment ingestion, ingestion of contaminated food items, or dermal contact with contaminated media.

[71] Indicate whether the potential exposure pathway is complete given site-specific characteristics.