APPENDIX A

CONCEPTUAL MODELING OVERVIEW

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TABLE OF CONTENTS

FIGURES

TABLES

ATTACHMENTS

ACRONYMS

ASTM	American Society for Testing and Materials
BCMWLAP	British Columbia Ministry of Water, Land and Air Protection
COPC	Contaminants of Potential Concern
CSR	Contaminated Sites Regulation of the *Waste Management Act*
EPA	United States Environmental Protection Agency
MADEP	State of Massachusetts (USA) Department of Environmental Protection
NAPL	Non-Aqueous Phase Liquid
SWR	Special Waste Regulation of the *Waste Management Act*
WMA	*Waste Management Act*

PREFACE

This document provides an overview of conceptual model development. Conceptual models are valuable analytical frameworks that provide visual summaries of the connections between contaminant sources and receptors and the exposure pathways that join them. Conceptual models are valuable early in the assessment process, but also have value as more detailed analyses are undertaken as well.

INTRODUCTION

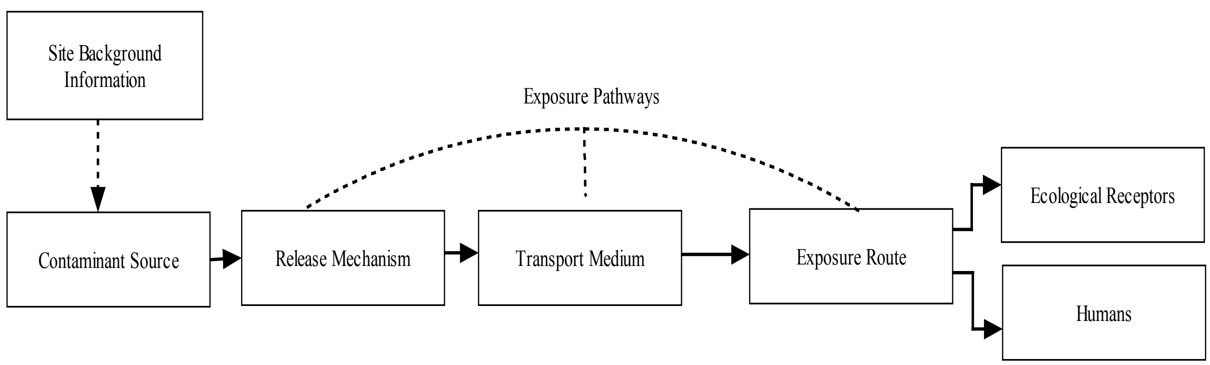
Developing an understanding of complex interactions between contaminants, media impacted by the contaminants, movement of contamination to additional media, and contact between humans and ecological receptors and the contaminants is a difficult process. A conceptual model is a visual display and analytical tool. Often developed early in the assessment process to summarize research issues, conceptual models continue to have analytical and organizational value throughout the assessment process.

Conceptual models provide a summary of the connections among sources, transport and exposure pathways, and receptors at and near a site. Complete exposure pathways exist when linkages between sources, pathways and receptors are found to exist; when such linkages do not exist, the exposure pathways are considered to be incomplete. Complete exposure pathways indicate that receptors can be exposed to the contaminants present in source areas either directly or via the identified exposure pathways. The presence of complete exposure pathways indicates a potential for exposure and risk that may require further evaluation; incomplete exposure pathways indicate that exposures are not occurring and therefore risks to receptors via those pathways are not unacceptable.

Conceptual models are constructed in a number of formats. In this document, a common format, the 'box-and-line' drawing, is presented. In this graphic a box represents a component within each conceptual model category, e.g. transport medium – sediment, surface water, groundwater, receptor – invertebrate, fish, bird, mammal. Lines and arrows are used to illustrate linkages or the flow path of contaminants through a pathway. For example, if a contaminant moves from a source, is released by mechanism A, is transported in transport medium B and enters a receptor via exposure route C a series of arrows will trace the path from each component to the next. The network will be complex because many components are interconnected with each other. Sample conceptual models from common sites in British Columbia (petroleum, mine, highly bioaccumulative compounds) are provided in Attachment 1. For complex sites with many receptors, separate conceptual models for human and ecological receptors may clarify the presentation.

Other conceptual model formats are also commonly employed. In some cases drawings or illustrations of each component of the model are interconnected using arrows. This pictorial conceptual model can simplify the presentation. Tabular conceptual models allow for the presentation of more detail for each component, but are limited in terms of illustrating interrelationships.

The basic structure of a conceptual model, as described in this document, is:



STEPWISE CONCEPTUAL MODEL DEVELOPMENT

The assembly of a conceptual model may be divided into six (6) steps (Figure 1). Information useful for completing each step in the development process is summarized in Figure 2. The steps are described in detail below.

Step 1: Describe the Site

In order to begin developing a conceptual model, a general understanding of the site, contamination and receptors is needed. In Step 1, important site information is collected that will inform completion of the steps that follow. While this Step does not generate specific boxes in the model, a narrative description of site conditions is developed and will provide the information needed to select the components of the conceptual model.

In general, the summary narrative for the site description includes the following information:

> General site information (address, ownership, current status – operational, closed, secure);
>
> Description of the land uses on site and in adjacent areas;
>
> Description of habitats located on site and in adjacent areas (ultimately used to determine the human and ecological receptors expected to use the site); and,

Associated maps and figures used to clarify habitats and land uses.

The determination of which neighboring areas should be included in the analysis is based on the likelihood of exposure to site contaminants. A simple connection to the site may not justify inclusion of adjacent areas. However, if an adjacent area or habitat is functionally connected, such that people or ecological receptors in an adjacent area may move to the site thereby increasing the likelihood that the species will occur in an area, then the adjacent habitat/land uses will be an important consideration. Other factors such as topography, wind directions, soil types and drainage patterns may influence the areas included in the analysis.

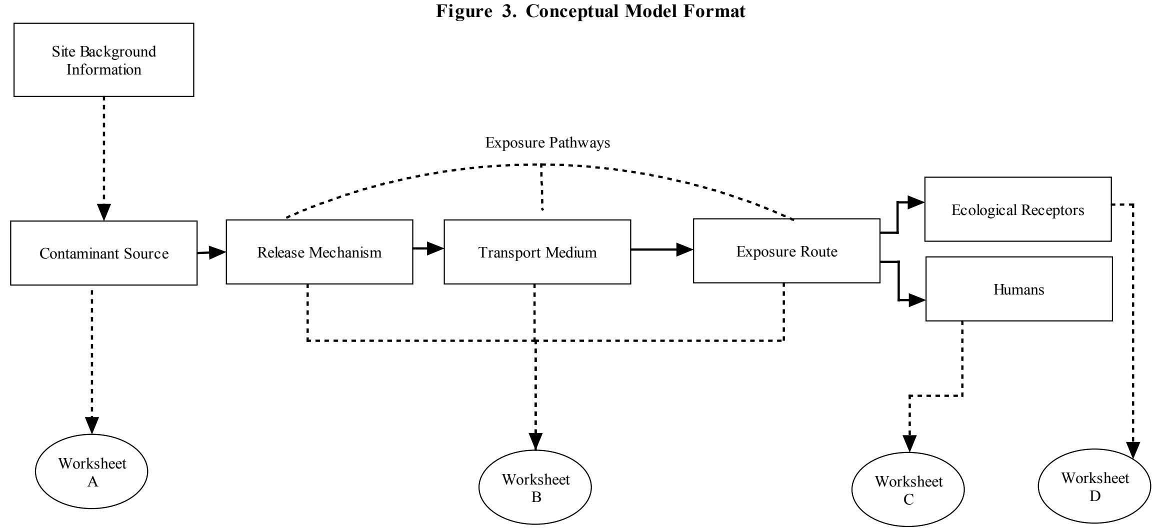
To facilitate the collection of the information required to complete Step 1 and to guide the collection of additional information if needed, a series of worksheets are provided to guide the assessor through the data gathering process (Attachment 2). The content in the worksheets is drawn from a number of widely available guidance documents such as BC Environment (1993), CSR, SWR, BCMWLAP (1998), USEPA (1997), MADEP (1995; 1996; 2003) and ASTM (1995). Data collection and sampling plan design guidance is provided on the British Columbia Ministry of Water, Land and Air Protection website at: http://wlapwww.gov.bc.ca/epd/epdpa/contam_sites/index.html .

These questions may or may not be applicable to a specific site and the numeric cutoffs are provided as examples of parameters that could be quantified. These values do not reflect regulatory requirements.

Each worksheet applies to a component in the conceptual model as illustrated in Figure 3. The worksheets include (Attachment 2):

Worksheet A: Site Historical Background and Contaminant Sources
Worksheet B: Exposure Pathways (release, transport and route)
Worksheet C: Human Receptors
Worksheet D: Ecological Receptors

Figure 3. Conceptual Model Format



Each is briefly described below.

Worksheet A: Site Historical Background and Contaminant Sources

The series of questions presented in Worksheet A focus on understanding the site. The first series of questions in Worksheet A focus on site properties such as site size, habitat types on site and in adjacent areas, distances from the site to various habitat types, and the identification of site and neighboring land uses. Though beyond the scope of this document, habitat quality is also an important evaluation factor. Habitat may be present in an area, however the habitat may be of very poor quality and support few, if any, species. A general determination of habitat quality may be useful at the screening stage to determine presence or absence of particular species groups. When considering site land uses and habitats it is important to not only consider current conditions, but to consider conditions that may occur in the foreseeable future as well. In some cases zoning restrictions or surrounding land uses can be used to confirm that high exposure activities such as residential uses will not occur in the area in the future.

The second series of questions on this worksheet focus on the release of contaminants including the nature of the release, horizontal and vertical (spatial) extent in media, and potential for migration. In addition, the form of the release, whether a point source, spill or a broad and undefined release may also influence decisions regarding the selected pathways. This series also includes questions about the chemical and physical properties of the contaminants because these parameters influence exposure and movement of contaminants.

Worksheet B: Exposure Pathways (Release Mechanism, Transport Media and Exposure Routes)

The second series of questions focuses on the exposure pathways. The worksheet is divided into three groups of questions. The first series of questions is a checklist of the most common release mechanisms. Answering these questions may involve discussions with site engineers, visual observations, a review of the site history, fate and transport modeling and exploratory sampling. The analysis should consider release mechanisms that are occurring as well as those mechanisms that may occur in the foreseeable future.

The second series of questions focus on transport media. Based on a review of site history, fate and transport modeling, discussions, sampling and observations an assessor should be able to determine which media may be transporting site contaminants from the source(s) to receptors. For these questions, it is particularly important to consider pathways that may result in more distant transport of contaminants such as transport in air or dust, transport from soil to flowing water, and transport from soil into groundwater. Other questions explore the potential for preferential pathways such as drainage ditches, sewer systems, swales, and paved areas that might facilitate transport of contaminants from source locations.

The final series on this worksheet focuses on exposure routes and consists of a checklist of the more common routes. This series is closely tied to the receptors that will be identified in Worksheets C and D and the activities that those receptors engage in at or near the site. For example, a security guard may experience different exposure routes than a gardener digging into the soil. In addition to more active exposure routes such as ingestion, dermal contact and inhalation, passive exposure routes such as absorption are also important, especially for ecological receptors.

Worksheet C: Human Receptors

In the third worksheet, potential human receptors are identified. The first step is to identify all of the likely persons who work at the site, might enter the site, live, play or occupy areas near the site where contamination may migrate and humans who could otherwise contact site contamination under current conditions or in the foreseeable future. The general land use categories include: agriculture, residential or recreation, and commercial or industrial (BC Environment, 1993). The questions on this worksheet may be answered using a combination of sources such as employee records, direct observations, security notes regarding illegal trespass, review of maps of surrounding areas and interviews. In addition to identifying the people who may contact site contamination, determining the likelihood or magnitude of exposure is also valuable in understanding human exposures. For example, evidence of trespassers living on site might elicit more concern than evidence of a one time trespassing event. In terms of the screening assessment, describing different types of exposures and any exposures to sensitive populations is more important than listing every potential receptor. This worksheet guides the user through the process of identifying the general receptor categories, assists in highlighting receptor characteristics that might influence exposures and identifies the media to which each receptor may be exposed.

Worksheet D: Ecological Receptors

The final worksheet series is designed to help identify potential ecological receptors at or near the site under current or foreseeable future conditions. Worksheet A provided a starting place for this part of the evaluation as it lists the primary habitat types at or near the site. Species and species associations may often be inferred based on the surrounding habitat types. However, confirmatory observations or other forms of direct identification can help insure that appropriate ecological receptors are included in the conceptual model. The series of questions in this worksheet are designed to evaluate the size and quality of the habitat, identify the species (or representative foraging strategies) that may occur on or near the site and evaluate characteristics of those species groupings that may influence exposure. The number of species that may inhabit any given site may be quite large when invertebrates, plants, mammals, birds, amphibians, fish and reptiles are all considered. For the purposes of the screening, the goal is to identify primary feeding or exposure groups and representatives of those groups. While it will be important to know that a black bear may feed on a site, for the purposes of determining if there are complete exposure pathways on site, it is important to know that a large omnivorous mammal feeds on site or adjacent to the site or that a ground nesting bird is present on site or adjacent to a site. There may also be sensitive species which are found in low numbers (endangered or threatened) or exhibit characteristics that may increase exposure in some situations (such as amphibians absorbing contaminants through the skin). Finally, species important to the community or region due to ecological characteristics or commercial value may also be included if exposure is possible. The series of questions in this worksheet highlight important considerations for ecological receptors in the conceptual model.

More detailed species checklists are provided in BCMWLAP (1998) that list many of the common species found in specific habitat types. Appendix B in BCMWLAP (1998) also provides detailed discussions about determining what plants and wildlife species use a site.

Appendix C in BCMWLAP (1998) provides the primary ecological species selection criteria which include (adapted from Gaudet et al. 1994 in BCMWLAP 1998):

Sensitivity to site stressors;
Threatened or endangered;
Ecologically significant (e.g. keystone species, dominant species);
Good indicator or surrogate;
Aesthetic value; and/or,
Recreational or commercial value.

Step 2: Describe the Source/Release

In combination with characteristics of the site, the type of source/release will determine which media, pathways and even receptors should be included in the conceptual model. The description of the contaminant source (Box 2) will guide the selection of the other components of the conceptual model. The narrative component of this Step includes:

Box 2. Contaminant Source

Contaminant sources may be broadly defined. In general a source is a combination of a location, activity and the associated contaminants. The source may be a specific process occurring on-site, e.g. dry cleaning, petroleum refining, mine tailings, and the contaminants released either through operations or due to an accident. In other cases, a mixture of contaminants may be released and the source is an activity that generates or results in the release, e.g. dredging of contaminated sediments. Often a source may be isolated, but susceptible to external forces. For example, a waste pile of mine tailings may in and of itself be an inhospitable environment, but when exposed to heavy rain, contaminants may also move to more sensitive habitat areas. In this case, mine tailings would be a source of contaminants. The source may be a specific medium, e.g. contaminated soil, contaminated groundwater, or it may be a more general source, such as a release, or waste material.

Description of the source (activity that generates release, history of release location);

Chemical description of the material (e.g. compounds, commercial product);

Physical description of the material (e.g. flowing, solid, NAPL);

Current control measures in place; and,

Unique characteristics of source that may influence the assessment of exposure.

Upon completion of this Step, the first box, or boxes if multiple sources occur, in the conceptual model will be added.

Step 3: List Contaminants of Potential Concern

The contaminants of potential concern (COPC) were selected during completion of the PSI. In general, COPCs are selected using a combination of knowledge about activities occurring at the site, site characterization contaminant sampling and comparison of contaminant concentrations to generic numerical soil and water standards, matrix numerical standards and risk-based standards or background concentrations. Consideration of the following parameters may be useful when selecting COPCs:

Contaminant concentration relative to generic numerical soil and water standards, matrix numerical standards and risk-based standards;

Contaminant concentration relative to background;

Detection frequency;

Toxicity of contaminants; and,

Bioaccumulative characteristics of the contaminants (Canadian Environmental Protection Act, 1999; MADEP, 1995).

In COPC selection, the maximum concentration is compared to the applicable standard. If the concentration exceeds the standard then it may become a COPC or further assessment may be undertaken. If further screening is desired or regulatory criteria are unavailable, but contaminant toxicity is known then contaminant concentrations may be compared to background concentrations (BC Environment, 1993). If the concentration of a contaminant does not exceed the background concentration, then further evaluation of the contaminant is not necessary. The Contaminated Sites Regulation under the *Waste Management Act* defines a background concentration as "the concentration of a substance in an environmental medium in a geographic area, but does not include any contribution from local human-made point sources" (CSR; SWR). In some cases, a background concentration may not be available and a reference concentration may be developed. For contaminants that are retained after the standard screening and background screening, a comparison to conservative, risk-based values specific to the site may be undertaken (BC Environment, 1993). Also, the toxicological properties of a contaminant may also be useful parameters because some contaminants such as highly bioaccumulative or acutely toxic contaminants can be harmful in low concentrations and may accumulate in tissues.

In this Step the COPC list developed during the PSI is reviewed in terms of the characteristics of the COPCs that might impact exposure, e.g. solubility, persistence, bioavailability, bioaccumulation potential. The physicochemical properties of the COPCs influence their fate and transport and the exposure pathways by which receptors might be exposed.

It is also important to understand the toxic mechanism of site COPCs as this can assist in the identification of important pathways (EPA, 1997). Certain COPCs might impact specific species, biological processes or human functions. For example, PCBs may be present in sediment. Because PCBs bioaccumulate, a conceptual model might include transport of PCBs to pore water, invertebrates, fish, fish consuming birds and mammals and persons who consume fish.

Step 4: Characterize Human and Ecological Receptors

Although the last component in a conceptual model, the selection and characterization of human and ecological receptors occurs in Step 4 because the receptors that occur on or near a site will be determined based on the site land uses and available habitats, not exposure pathways. Ultimately, the receptors active on a site will guide the identification of exposure pathways in Step 5.

In order to complete an exposure pathway, it must lead to a receptor; thus a receptor must be present or likely to be present in the foreseeable future. Identifying receptors subject to potential exposure at or near a site is challenging because their presence is influenced by a number of factors. For example, some receptors may follow seasonal or sporadic patterns of visitation to the site. Not all persons visiting the site will be observed. For example, trespassing is a common activity that is difficult to document and track. A well planned survey of site activities, habitats, direct observations and observations of signs of activities will strengthen the receptor identification.

The selection of the receptors is based on a combination of visual observations, knowledge about the activities occurring on a site and expectations of presence based on habitat association. A useful starting point in the selection of receptors is to return to Worksheets C and D in which the series of questions assists users to identify site characteristics, list potential receptors and differentiate between receptors in terms of degree of potential exposure. Also, it is useful to return to the site description completed in Step 1. For humans (Box 3), the summary of on site activities, accessibility of the site and surrounding activities will provide useful insights for receptor selection. For ecological receptors (Box 4), the general description of habitats will provide the assessor with a general understanding of the types of wildlife communities likely to inhabit the site. For example, a dense forest might support a very different community than a fragmented grassland or small pond. In general, receptor selection should

Box 3. Humans

While identification of site workers who may be exposed to site contaminants may be possible using site security logs, the identification of humans who may be exposed outside of the site boundaries or through illegal activities onsite is more challenging. Also, not all sites will be commercial or industrial, therefore site documentation may be limited. In general, a survey of land uses in surrounding/adjacent areas will provide valuable information for the selection of human receptors. For example, some sites may be surrounded by industrial areas, while others may be close to schools and residential neighborhoods. The surrounding land uses provide important clues about who may contact site contaminants. For exposure pathways that lead off site, e.g. groundwater migration, stream discharge, similar recommendations apply. The combination of land use activities and radial distance from the site to which an exposure pathway may extend will assist in selecting the human receptors. In addition, the exposure routes are an important consideration in receptor selection. A receptor who never contacts a site with immobile soil contamination, but may walk close to the site boundary, would not be identified as a receptor of concern, whereas the same receptor walking near a site with volatile contamination may be included based on the potential inhalation exposure. Similar to the selection of ecological receptors, the final set of humans examined for each site should represent the most sensitive subcategory for each type of exposure (i.e. worker, trespasser, resident, recreational user). The most sensitive receptors tend to be younger females because of child-bearing sensitivities as well as those exposed for long durations.

Box 4. Ecological Receptors

For the purposes of the screening, the receptors selected are representatives of the primary feeding groups expected or observed on site. This grouping includes invertebrates, plants, as well as higher order species such as fish, mammals and birds. In addition to representative species, any sensitive, threatened or endangered species are included as long as the species may be part of a complete exposure pathway. British Columbia provides an endangered species identification resource at: http://srmwww.gov.bc.ca/atrisk/red-blue.htm . All species may not be easily observed. Some may only visit the site seasonally, while others may only intersect the site sporadically while moving and foraging over an area larger than the site. Some species such as invertebrates may require excavation for identification, while others may be identified through the use of traps and surveys. Trained wildlife biologists employ observational techniques and can determine species use in an area based on habitat types. Once the species groups are identified, the next step is to connect them to exposure routes. In many cases the exposure route may be ingestion of a lower order species, e.g. bird consuming an earthworm, or large mammal consuming a small mammal.

reflect the range of different behaviors that may result in exposure on a site. Some guidelines to consider when selecting receptors include:

Duration of time spent on-site;

Behaviors likely to lead to exposure (e.g. for ecological receptors – foraging behavior, for humans – tasks involving work with contaminated media);

Sensitivity of the receptor and receptors that might result in disproportionate exposures (e.g. children versus adults);

Status of a population (e.g. rare and endangered species);

Proximity of receptor activities to source or secondary contamination; and,

Availability of evidence of activity (e.g. observations, interviews, predicted based on habitat features).

The result of this Step is a description of the communities active on site. A list of representative humans and ecological receptors that are members of the site communities will be used in the conceptual model figure. In some conceptual models, actual species names are replaced with a foraging or life-history characteristic that influences exposure, e.g. soil dweller, piscivore.

Step 5: Identify and Describe the COPC Exposure Pathways from Source to Receptor

In this step of conceptual model development, the contaminants in the original source area are connected to the receptors through exposure pathways (Box 5). The components of an exposure pathway include release mechanisms, transport media and exposure routes. Worksheet B assembled the information required to complete this Step. However, the worksheet did not link the three components of the exposure pathway. In addition to the information compiled in Worksheet B, the development of the pathways will draw from the site characterization work completed in Step 1 and Step 2. It will also be based on the characteristics of the COPCs identified in Step 3 such as mobility, bioavailability and likelihood to bioaccumulate. Also, knowledge about the presence of site COPCs in non-source media will also assist in the development of exposure pathways. Detailed human health pathway screening frameworks are provided in

> *Box 5. Exposure Pathway*
>
> An exposure pathway traces the contaminant from a source to a location and medium to which a receptor may be exposed. In order for an exposure pathway to be complete, contaminants are released from the source by a particular process, the released contaminants move from the source in another medium and ultimately a receptor is exposed to the contaminants in the medium through a specific route or intake activity. The three components of an exposure pathway are: release mechanism, transport medium and exposure route. Also, receptors may be exposed to the contaminant source directly. At most sites, there will be multiple exposure pathways. Each component is discussed below.

BC Environment (1993) (Figures 5-8A through 5-8C). Combining the information assembled in Steps 1-4, the goals of this Step include:

> Identify release mechanisms based on visual observations, fate and transport modeling, and direct measurements;
>
> Associate transport media with each release mechanism; and,
>
> Associate an exposure route or routes with each transport medium (Box 6).

Ultimately, the exposure routes will connect with human and ecological receptors and Table 1 lists key physical, chemical, and biological considerations for judging the completeness of the potential linkages for a number of key exposure pathways. In addition to contaminant migration through an exposure pathway, some receptors or receptor activities may result in direct contact with the contaminant source. Also, a subset of ecological receptors may receive exposure to site contaminants indirectly through consumption of lower order organisms that were exposed to site contaminants and accumulate COPC concentrations in their body tissues.

It is important to trace the pathway of each arrow through the framework. This can result in a number of linkages. In order to proceed in an orderly fashion it is best to work from the sources through the subsequent boxes on the conceptual model as the model diagrams can become complex.

Box 6

Release Mechanisms

Specific processes, when applied to a source, may result in the release, mobilization and movement of contaminants. Although there are a number of mechanisms, a few of the more common include: leaching, dust generation, volatilization, erosion, biological mixing, dissolution, adsorption, complexation, runoff, and (re)suspension. Each acts on or produces the release of contaminants from the primary source. Physical release mechanisms may also be important, such as transport for disposal, bulk transport from flood, or excavation and grading of a source. Characteristics of the contaminant and source may also govern the impact of release mechanisms. Certain contaminants may associate tightly with organic carbon and may, therefore, not be susceptible to degradation, while other contaminants may be soluble and likely to dissolve in water.

Transport Medium

Often the source medium may not be the only exposure point for receptors. The impact of a release mechanism acting on a source may be to contaminate additional media which may ultimately transmit contamination to receptors. In some cases, contaminants may not be mobile, and although release mechanisms may act upon them, the contaminants will not move into additional media. In other cases, the transport medium and source may be the same medium. For example, a surface water source in a holding basin, may be subject to runoff when rain falls. Contaminated surface water in a basin, may then be transported to a stream or pond as surface water. Preferential pathways may also facilitate the migration of transport media. In the previous example, a storm water sewer line or drainage ditch might increase the likelihood that contaminated source water will end up in nearby surface waters. Typical transport media include: soil, groundwater, surface water, sediment, air (volatile), air (dust), and the food chain.

Exposure Route

The final component of an exposure pathway is the exposure route. The release mechanism resulted in migration of contaminants from the original source to additional transport media. In order to complete an exposure pathway, a route from the original source or transport media into or on a receptor is required. Some common exposure routes include: ingestion of both food and transport media; inhalation of both dust and volatiles; dermal contact with sediment, soil, surface water, groundwater/drinking water, dust; uptake/absorption of dissolved contaminants; and absorption and translocation through roots.

Step 6: Identify Complete Exposure Pathways

After all conceptual model connections are made, a final conceptual model review is completed to identify complete exposure pathways and remove any pathway that may not be complete. A complete pathway contains a source, a connection from the source to an exposure point (release mechanism and transport medium), a route from the transport medium into a receptor (exposure route) and a receptor. A receptor that directly contacts the source will not require a release mechanism and transport medium to be in a complete exposure pathway. Any series of connections that does not include all of the components of an exposure pathway, is not complete and may be excluded from the conceptual model. A pathway may be incomplete because there are no receptors contacting the source or there are no exposure pathways between a source and a receptor. Linkages between sources/releases and human or ecological receptors are influenced by physical, chemical, and biological factors. A number of exposure pathways, if identified as complete in the screening assessment, may indicate a need for a more detailed risk assessment. Table 1 identifies the major physical, chemical and biological considerations that may be useful in judging whether important and common exposure pathways are complete. Because the pathways listed in Table 1 are so important in conveying contaminants to receptors, even in the absence of a receptor, further study may be warranted to confirm the lack of receptors under current and foreseeable future conditions.

For human health exposures, incomplete exposure pathways are present (and an assessor may exit the screening process) if the following occur:

Lack of activity at the site and restricted access to the site;

Release area is spatially isolated with no receptors, air or groundwater releases;

Inaccessible contamination that is not migrating to accessible media or to receptors;

No workers, residents or other persons are present onsite and no other humans work or live in close proximity to the site; and,

No drinking water or air releases are occurring.

Conversely, further analysis may be required if:

The site is an active workplace and/or an attractive resource to the community;

Residential areas are in close proximity to (or on) the site/contamination;

Drinking waters and/or air quality impacts are occurring;

Contamination is accessible and/or migration to additional accessible media is occurring;

Humans are actively working on site and/or humans live/work within the radius of contamination impacts;

Humans are consuming impacted drinking water; and,

Humans are breathing impacted air/dust.

For ecological exposures, incomplete exposure pathways are present (and an assessor may exit the screening process) if the following occur:

Lack of habitat;

Lack of habitat of sufficient size to support wildlife;

Inaccessible contamination that is not migrating to accessible media;

Lack of bioaccumulative contaminants;

Lack of lower order species in contact with contamination;

Lack of higher order wildlife and signs of nesting/feeding;

No evidence of stressed biota; and/or,

No endangered or threatened species present on site.

Conversely, further analysis may be required if:

Habitat of sufficient size is present;

Contamination is accessible, or migrating to accessible media;

Contaminants bioaccumulate;

Higher order receptors are present and food sources are in contact with contaminated media;

Stressed biota have been observed; and/or,

Endangered species are present on site or in locations where exposure could occur.

COMMON CONCEPTUAL MODEL PITFALLS

Even though thorough site research may have been completed, there are a number of common pitfalls in conceptual model development. The goal of this document is to eliminate from further analysis sites and/or exposure pathways that, despite contaminant concentration exceedances of standards, require no further evaluation because they lack complete exposure pathways. Therefore, it is important that the conceptual model only present complete exposure pathways. Table 2 presents a summary of common conceptual modeling problems with potential solutions.

UNCERTAINTY

In an screening assessment, uncertainty will require assessment and management. A screening assessment balances knowledge with efficiency and resources. Early planning and well designed studies will minimize uncertainties, but ultimately the final decision will include some uncertainty. Uncertainty is commonly generated in:

Evaluating the extent of contamination in a screening assessment;

Characterizing site use by ecological and human receptors;

Describing fate and transport pathways;

In most cases the uncertainty can be managed through the collection of additional data. Table 3 provides a more detailed analysis of uncertainties and methods for management.

SUMMARY

A conceptual model is a valuable organizational tool to assist in understanding the linkages between sources of contamination, fate and transport/exposure pathways and receptors and, ultimately, characterizing the site.

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