Health Consultation

Technical Review
Inhalation Pathway Interim Measure Approach
Groundwater to Indoor Air Pathway
Philip Services Corporation – Georgetown Site
Seattle, King County, Washington

August 9, 2005

Prepared by

The Washington State Department of Health
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

DOH 333-094 August 2005

Foreword

The Washington State Department of Health (DOH) has prepared this health consultation in cooperation with the Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR is part of the U.S. Department of Health and Human Services and is the principal federal public health agency responsible for health issues related to hazardous waste. This health consultation was prepared in accordance with methodologies and guidelines developed by ATSDR.

The purpose of a health consultation is to identify and prevent harmful human health effects resulting from exposure to hazardous substances in the environment. Health consultations focus on specific health issues so that DOH can respond to requests from concerned residents or agencies for health information on hazardous substances. DOH evaluates sampling data collected from a hazardous waste site, determines whether exposures have occurred or could occur, reports any potential harmful effects, and recommends actions to protect public health. The findings in this report are relevant to conditions at the site during the time of this health consultation, and should not necessarily be relied upon if site conditions or land use changes in the future.

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Purpose

The Washington State Department of Health (DOH) conducted this health consultation at the request of the Washington State Department of Ecology (Ecology). The purpose of the health consultation is to evaluate whether the inhalation pathway interim measure (IPIM) approach developed by Philip Services Corporation (PSC) in 2002 provides a reasonable long-term approach for protecting residents and workers in the nearby Georgetown community where indoor air might be affected by chemicals volatilizing from the underlying or adjacent shallow, contaminated groundwater while the site undergoes cleanup. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background and Statement of Issues

The PSC facility is located at 734 South Lucile Street in the Georgetown community of Seattle, King County, Washington. Various companies have operated at this property from at least the mid-1930s, the last being PSC. Only minor chemical releases have been documented at the property. However, PSC acknowledges that undocumented releases might have occurred at the facility (e.g. releases from tanks and associated piping, container handling, and chemical transfer operations).[1] Releases such as these are the likely source of the volatile organic compounds (VOCs) detected in soils on and immediately adjacent to the PSC property and groundwater on and down-gradient of the PSC property.

Groundwater generally flows from the PSC facility to the west/southwest toward the Duwamish River. The water table fluctuates seasonally and ranges from 6 to 10 feet below ground surface (bgs) in the wetter months of the year and drops about 5 feet during the drier months of the year.[2] Owners of the facility have been investigating the nature and extent of groundwater contamination since the late 1980s. VOCs and other contaminants were discovered in groundwater during these investigations. A portion of the Georgetown community overlies this contaminated groundwater. Land use in the Georgetown community near and down-gradient of the PSC facility is mixed residential, commercial, and industrial.

PSC installed a subsurface hydraulic barrier wall and well system in early 2004, which is designed to contain contaminant sources at the PSC facility and prevent contaminated groundwater from further moving off the facility property. PSC is currently monitoring this system to confirm that it is working as designed. Some contaminated soils associated with the former PSC facility exist beyond the PSC property and barrier wall. These additional soil contaminants will be addressed by PSC and Ecology as part of the feasibility study, in the near future, if the concentrations are above cleanup levels (Ed Jones, Ecology, personal communication, August 31, 2004, and September 16, 2004).

Groundwater in the Georgetown community is not used as a drinking water source. The City of Seattle, which obtains its water from the Cedar River watershed, provides drinking water to the Georgetown community. Therefore, the drinking water supply is not threatened. The shallow portion of the contaminated groundwater, however, does pose an indoor air health threat. VOCs can evaporate from shallow contaminated groundwater, move through the overlying soil column, and can enter buildings through cracks or other openings in the foundations overlying or near the

plume of contaminated groundwater. Basements, crawlspaces, and slab-on-grade buildings are all vulnerable.

DOH conducted indoor air sampling in 2000 and 2001 at some buildings (residences and businesses) that were determined to be the most vulnerable to the migration of VOCs from shallow groundwater underlying the Georgetown community. PSC also conducted some indoor air sampling during that time. DOH evaluated this data as it became available and determined that the levels detected in these sampled buildings did not pose an immediate or short-term health risk. DOH did note, however, that the VOCs detected in indoor air at some of the buildings were above those normally found in indoor air and that some of the VOCs were also found in groundwater and soil gas. DOH also evaluated the long-term health effects associated with the indoor air levels obtained in 2000 and 2001 and determined that levels detected in the buildings only slightly increased the estimated risks for cancer and non-cancer health effects. However, because of the complexity and uncertainty associated with the groundwater to indoor air pathway, DOH recommended that further evaluation of the pathway be conducted.[3]

Although DOH determined that no immediate or short-term indoor air health risk existed, PSC did move forward to develop an inhalation pathway interim measure (IPIM) approach in 2002. That IPIM approach provided a means to evaluate the potential indoor air health threat posed by the shallow VOC contaminated groundwater at residences and businesses overlying or near the shallow VOC contaminated groundwater. The approach relies on making predictions about indoor air quality using VOC results obtained during groundwater monitoring.[2] The IPIM approach was approved by Ecology in August 2002. DOH understands that PSC's IPIM approach will likely continue to be used until Washington State Model Toxics Control Act (MTCA) groundwater cleanup levels protective of indoor air quality have been achieved.

The groundwater to indoor pathway is complex because many factors can influence the movement of VOCs from groundwater into an overlying building. The amount of VOCs evaporating from contaminated groundwater and traveling through the soil column into indoor air can be influenced by meteorological (e.g. temperature, barometric pressure, rainfall, wind) and hydrogeological factors (e.g. soil characteristics, soil moisture content, soil permeability, groundwater levels). Building characteristics (e.g. cracks and openings in foundation, heating and ventilation system operation, air exchange rates between indoor and outdoor air) can influence the movement of contaminants from the subsurface into indoor air. Permeable soils along utility lines can act as preferential pathways or conduits for VOC migration and could be an additional VOC source for buildings overlying shallow VOC contaminated groundwater. VOCs moving along utility lines could also potentially affect indoor air quality at buildings in areas where groundwater VOC levels are low or not detected. VOCs found in ambient air and common household products (e.g. cleaning products, paints, solvents); dry cleaned clothes, and other household materials (e.g. rugs) can affect indoor air quality adding to the complexity of the groundwater to indoor air pathway evaluation.

Because of this complexity, only very limited guidance was available for evaluating the groundwater to indoor air pathway until the late 1990s when EPA and some state environmental agencies began developing guidance to address this pathway and assess the potential indoor health risks. In November 2002, three months after Ecology approved PSC's IPIM approach, EPA released an expanded version of its vapor intrusion guidance.[4] EPA also released an

updated version of its Johnson & Ettinger (J&E) model in June 2003. The J&E model provides a means for predicting non-carcinogenic and carcinogenic indoor air health risks associated with VOC contaminated groundwater and soil.[5] In addition, substantial work was undertaken by various states regarding the groundwater to indoor air pathway since the PSC IPIM approach was developed (e.g. California, Colorado). Washington State has no specific guidance for addressing the groundwater to indoor air pathway. However, its Models Toxics Control Act (MTCA) cleanup regulation does address the need to develop groundwater cleanup levels that "eliminate or minimize the potential for the accumulation of vapors in buildings or other structures"[6]

Discussion

Sites, like the PSC site, where shallow VOC contaminated groundwater is expected to remain for many years while undergoing remediation, require a comprehensive, long-term approach to continue evaluating whether the groundwater poses an indoor air health threat. PSC's IPIM approach, which was developed as an interim approach, is now being considered as part of a long-term cleanup strategy by Ecology and PSC. The IPIM approach was used to developed groundwater action levels that can trigger building specific sampling and installation of mitigation systems, where necessary, to reduce potential exposures to VOCs migrating from groundwater into indoor air. PSC reports that it attempted to minimize the uncertainty with its approach so that decisions are biased toward taking interim measures when such measures are not necessary as opposed to not taking measures when they are necessary.[7] Site-specific groundwater cleanup levels that are protective of indoor air were also developed using this approach (information communicated by PSC at a meeting with Ecology and DOH, February 11, 2005).

PSC's IPIM approach consists of two main steps:

- Step One
    - Develop site-specific groundwater to indoor air volatilization factors (GIVFs) to represent the relationship between the levels of VOCs found in the contaminated groundwater and indoor air, and
    - Develop inhalation pathway interim measure actions levels (IPIMALs), which are levels of chemicals that are intended to be protective of human health
- Step Two
    - Use the GIVFs and IPIMALs developed in Step 1 along with a 4-tiered decision tree (Figure 1) to determine if indoor air levels of VOCs at buildings located hydraulically down-gradient of the PSC facility could potentially be above levels of health concern. The approach relies on comparison of quarterly groundwater monitoring well or direct push data to the groundwater IPIMALs. This comparison is used to determine whether interim actions, further study, or no actions are warranted at buildings overlying the VOC contaminated groundwater.[7]

PSC reports that 73 buildings overlie the shallow VOC contaminated groundwater plume. Thirty buildings are commercial/industrial and 43 are residential. Some of the commercial/industrial buildings have multiple tenants. Some of the residential buildings are used for commercial purposes (e-mail communication with Chris Waldron, Pioneer Technologies, February 23, 2005.)

Since PSC implemented its IPIM approach in 2002, all 73 buildings have gone through the decision tree evaluation and PSC has installed a number of mitigation systems where indoor air quality appeared to be affected by the underlying contaminated groundwater at levels of concern to Ecology. PSC also installed some mitigation systems where there was no clear evidence that indoor air was being affected by underlying contaminated groundwater but the groundwater contaminant levels suggested there could be a problem. In some cases, PSC offered mitigation systems simply because they offered similar systems to other homeowners on a block (e-mail communication with Ed Jones, Ecology, April 8, 2005).

Vapor mitigation system installations were completed at 30 of the 73 buildings as of June 2, 2005, (e-mail message from Ed Jones, June 2, 2005). Most of those installations occurred at residential buildings. However, some systems were installed in commercial buildings. This work was conducted with Ecology approval and oversight. Some of the remaining 43 buildings are in the process of having mitigation systems installed or PSC is trying to obtain access agreements to install the systems (vapor installation information provided by PSC at a meeting with Ecology and DOH, February 11, 2005). In some cases, PSC offered to install a mitigation system but the property owner declined the offer. In other cases, property owners would not allow PSC access to conduct indoor air sampling (e-mail communication with Ed Jones, June 2, 2005). Other buildings are located in areas above the contaminated groundwater where it is was not predicted to pose an indoor air health threat (e-mail communication with Ed Jones, June 2, 2005).

PSC developed a plan in 2004 for monitoring the installed vapor mitigation systems to ensure that they continue to operate as designed, which was also approved by Ecology. DOH reviewed and commented on draft versions of this vapor mitigation system monitoring plan because these systems can pose potential health concerns if not maintained and monitored properly.

While evaluating whether PSC's IPIM approach was suitable as part of final site cleanup strategy, DOH identified some areas of concern regarding the approach, which are summarized below. These areas of concern should be addressed by Ecology and/or PSC before selecting the IPIM approach as part of the final cleanup strategy.

GIVF Development

A sub-area of the Georgetown community where high concentrations of chloroethane, trichloroethylene (TCE), and vinyl chloride were detected in shallow groundwater was selected for collecting co-located indoor air, groundwater, soil gas, and ambient air samples to be used for developing GIVFs. Some geotechnical samples were also collected. The samples were collected the week of August 19, 2002 at 11 buildings locations. Some additional indoor air sampling was conducted the last week of August 2002. Basic information about 10 of the 11 sampled building locations was collected by PSC as part of a building survey conducted prior to the August 2002 sampling.[7] The following items summarize DOH's concerns with the GIVF development:

- PSC conducted the sampling for the GIVF study in August 2002 but provided no rationale to support why sampling at this time of year would result in the best data set for developing GIVFs.

Recommendation: PSC and Ecology should address how sampling in August versus other times of the year could affect GIVF values.

- Indoor air, ambient air, and soil gas were supposed to be collected over 24 hours using 6-liter Summa canisters. However, indoor air sampling intervals ranged from 15.9 to 25.9 hours while ambient air sample intervals ranged from 17.7 to 24.7 hours. Only about a quarter of the indoor air samples were collected over more than 20 hours and only two indoor air samples were collected for about 24 hours (one was collected for 23.9 and another for 25.9 hours). Duplicate samples were collected at each building. In some cases, there were considerable differences between the cumulative times for the duplicate sample collection. For example, duplicate samples collected on August 27 at a South Lucile Street apartment ran for 15.9 hours and 22.8 hours.[7]

  Five of 6 ambient air samples were also collected over less than 20 hours. In a number of cases, the ambient air sampling intervals were longer (up to 6 hours longer) than the corresponding indoor air sample. In other cases, the ambient air sampling interval at the building location was shorter than the corresponding indoor air sampling intervals.[7]

  Recommendations:

  - The sampling interval problems, described above, reduce the certainty of the IPIM approach. However, the levels of chemicals detected in groundwater, indoor air, and ambient air are relatively low so the problems with the sampling intervals probably will not significantly affect the calculated GIVFs values. DOH, however, recommends that Ecology and PSC explore this issue further since the IPIM approach is being considered as part of the final cleanup strategy for the site.

  - Ambient air sampling results were often elevated above indoor air results. It is unknown whether this is because of the sampling interval discrepancies described above. Ecology and PSC should re-consider whether subtracting ambient air results from the indoor air results when calculating GIVFs is appropriate where there is a significant difference between indoor air and ambient air sampling intervals or whether background literature values should be used instead.

  - The purpose of duplicate samples is to verify the quality of the sampling procedure. This verification cannot be accomplished using indoor air samples that were collected side-by-side but over different cumulative times, which is what occurred in some cases during the GIVF study. PSC averaged duplicate results during the GIVF study. Such an approach is not appropriate when there are significant differences in duplicate cumulative sampling intervals. DOH recommends that Ecology re-evaluate the duplicate results to determine whether averaging is appropriate.

- Only one soil gas sample was collected near each building during the GIVF study.[7] The locations of these soil gas samples, however, might not be representative of soil gas conditions below homes. Soils below buildings are generally drier than soils beyond the

building footprint, allowing VOC vapors to more readily move upward through the soil column, and posing a greater indoor air health threat. However, the soil gas results were only used qualitatively by PSC during the GIVF development. [7]

Recommendation – Soil gas samples for future GIVF studies, if any, should be collected below rather than near buildings to provide more representative results. Soils below buildings can be heterogeneous, which can affect the movement and concentration of VOCs in soil gas. Ecology and PSC should also consider collecting multiple soil gas samples below buildings if future GIVF studies occur.

- The samples collected for the GIVF evaluation were analyzed for target compounds, which are a subset of the groundwater chemicals of potential concern (COPC). Target compounds are considered by PSC as being the most reliable chemicals to represent volatilization from groundwater to indoor air. DOH understands the rationale for selecting target compounds. However, it does add some uncertainty to PSC's approach particularly since chemicals like trichloroethylene (TCE), which is significant groundwater COPCs for this site, was not considered a target compound.

  Recommendation: Ecology should calculate a GIVF for TCE and other COPC using data from buildings, where both indoor and ambient air were sampled over the same interval, to determine if this is a significant issue.

- The IPIM plan indicates that prior to calculating GIVFs, the indoor air results for the target compounds were adjusted for contributions from background. The highest of either the measured ambient levels of the target compounds or peer-reviewed literature values for indoor air levels of the target compounds were subtracted from the target compound analytical results. The mean of the 25^{th} or 75^{th} percentile or the median, whichever was lower, was used when literature values were selected as background.[7] Ecology reports, however, that this element of the IPIM plan was not approved or implemented (E-mail message from Ed Jones, Ecology to Barbara Trejo, DOH, June 2, 2005).

  Recommendation: Although the proposed approach for adjusting for background contributions was not approved by Ecology, DOH recognizes that some adjustment to indoor air levels is necessary to account for indoor VOC levels found in a typical urban home, which are typically higher than ambient air levels.

- To help evaluate the uncertainty associated with developing target compound GIVFs, PSC also calculated target compound GIVFs and attenuation coefficients (ACs) using the J&E model. This appears to be a reasonable approach for addressing some of the uncertainty. The J&E model, however, has been revised since PSC conducted its modeling in early 2002.

  Recommendation: Ecology and PSC should evaluate the changes to the J&E model and determine whether these changes could significantly alter the modeling results obtained by PSC. It should be noted that the J&E model is only applicable for basement and slab-

on-grade structures so its use for evaluating crawlspace homes is not appropriate.

Groundwater Inhalation Pathway Interim Measure Action Levels (IPIMALs)

PSC selected the maximum target compound GIVF obtained in the GIVF step, described above, to help develop groundwater IPIMALs. This target compound GIVF was used to derive a GIVF for the all the groundwater COPCs based on the physical/chemical relationship of the maximum target compound to each COPC.[7] Such an adjustment appears reasonable and appears consistent with an approach used by the state of Colorado in its vapor intrusion guidance.[8] Groundwater IPIMALs were then calculated for each COPC by dividing the indoor air IPIMAL by its corresponding GIVF. Indoor air IPIMALs were based on a 1E-06 cancer risk and a hazard quotient of 0.1 for individual chemicals for residential and commercial/industrial exposures.[7] It should be noted that using a HQ of 0.1 results in non-carcinogenic IPIMALs an order of magnitude lower than typical indoor air cleanup levels where an HQ is equal to 1.[6]

PSC's approach for calculating groundwater IPIMALs appear reasonable if VOC contaminated groundwater below the buildings is the only source of VOCs moving from the subsurface into indoor air. These values may not be protective of indoor air, however, if contaminants are also moving along utility lines from other areas of the site, or other preferential pathways, and contributing contaminants into indoor air. Utility lines acting as preferential pathway has been recognized by the US Environmental Protection Agency (EPA) as well as a number of states (e.g. California, Wisconsin, Colorado, Massachusetts, New York) as a pathway that needs to be assessed when evaluating whether VOC contaminated groundwater poses an indoor air health threat.[4, 8, 9, 10, 11, 12, 13]

No formal assessment of utility lines acting as preferential pathways for VOC contaminated soil gas has been conducted at the PSC site although a number of underground utilities were identified by PSC in the Georgetown area during the RI.[1] However, it appears that PSC did consider utility lines acting as preferential pathways when selecting groundwater monitoring wells for the Tier 3 and Tier 4 IPIM evaluations (e-mail message from Marcia Bailey, June 3, 2005). In addition, Ecology indicates that they have discussed utility lines acting as preferential pathways with PSC and determined that this is not a significant issue for this site (personal communication with Ed Jones, Ecology, April 19 2005). However, none of this information about the utility lines is documented, which makes it difficult for DOH to fully evaluate whether utility lines are acting as preferential pathways and posing a possible health concern.

There is some evidence that desiccation and cracking of the barrier wall material occurred in the vadose zone after the wall was installed.[14] This could be a possible pathway for VOCs to migrate through the wall and possibly enter nearby utility trenches and migrate to areas where mitigation systems have not been installed.

Recommendation: PSC or Ecology need to document the process it used when determining that utility lines are not acting as preferential pathways as well as the process it is using to monitor any contaminants that might move along utility corridors. Ecology and PSC should also address whether vapors could be migrating through the barrier wall and entering nearby utility trenches.

Decision Tree Evaluations

Tier 1

Groundwater results obtained from individual monitoring wells and direct push borings were divided by groundwater IPIMAL to obtain an exceedance factor (EF). Mainly groundwater monitoring wells screened across the water were used for this evaluation. In some cases, however, wells screened in the shallow aquifer but screened below the water table were used.

The EFs were then summed for each location to obtain cumulative cancer and non-cancer EFs (CCEFs and NCEFs, respectively). The cumulative EFs (CEFs) were then plotted and contoured to determine potential areas that could be affected by the groundwater. PSC selected residential buildings within the contours exceeding10 CEFs for Tier 3 evaluation or to proceed directly to Tier 4, where interim actions (e.g. vapor vacuum systems) are designed and implemented. Commercial/industrial buildings within contours exceeding 10 CEFs or greater were considered for Tier 2 evaluation. A CCEF and NCEF of 10 indicate that exposure to indoor air concentrations near the sampling location could potentially result in a cumulative risk of 1E-05 or a hazard index (HI) of 1. Locations where CEFs were less than 10 were sampled during subsequent quarterly groundwater monitoring events.[7]

PSC's Tier 1 approach seems reasonable if the following recommendations are addressed by Ecology and PSC.

Recommendations:

- Ecology and PSC should address whether the number and distribution of wells or other groundwater sampling points (e.g. new direct push) are adequate for conducting the Tier 1 evaluation since this approach is being considered as part of the final actions at the site. If the monitoring network is inadequate, it should be expanded as appropriate.

- Some indoor air sampling should be conducted by PSC at buildings where CCEFs and NCEFs are less than 10 to confirm that PSC's approach is correctly identifying buildings where VOC contaminated groundwater poses an indoor air health threat. Ecology and PSC should consider a subset of vulnerable subset of such buildings, based perhaps on structural characteristics, for this confirmation sampling.

- Some wells screened below the water table were used for the Tier 1 evaluation where no water table wells existed. DOH recommends that Ecology and PSC consider adding water table wells or other types of water table sampling points (e.g. direct push) at these locations if these are appropriate monitoring points and it is likely that water table COPC concentrations exceed levels measured at the lower depths.

- Ecology and PSC should conduct a building survey at all buildings where no vapor mitigation systems have been installed, and the buildings overlie or are located near the shallow VOC contaminated groundwater, to ensure that there are no buildings that are

particularly vulnerable to the migration of VOCs from the groundwater to indoor air (e.g. crawlspace homes where crawlspace vents are blocked off or no crawlspace vents exist; homes with exposed soils in the basements).

Tier 2

Commercial/industrial locations that exceeded a groundwater CEF of 10 were evaluated again in Tier 2. However, the steps appear to be the same as Tier 1 except that PSC notes that locations exceeding a CEF exceeding 10 will be further evaluated under Tier 3 of the IPIM decision tree.[7]

Recommendation: None

Tier 3

The purpose of Tier 3 is to collect property specific data (e.g. indoor air, soil gas, groundwater, and/or soil) at locations where groundwater CEFs exceeded 10 in Tier 1 or 2 to determine if interim measures are necessary. As done in the GIVF step above, indoor air sample results are adjusted for background contributions. These adjusted results are then divided by residential and commercial/industrial indoor air IPIMALs to obtain EFs and CEFs as described in Tier 1, above. Only COPCs detected in groundwater and soil gas are included in the Tier 3 evaluation because it is assumed that this represents a completed pathway.[7] This appears to be a reasonable approach if groundwater and soil gas sampling are conducted appropriately. However, it was determined in early 2005 that there are some problems with PSC's soil gas sampling method, resulting in an underestimation of the contaminant levels in soil gas.

Ecology reports that it re-evaluated Tier 3 decisions made prior to discovering that there were some problems with sub-slab soil gas sampling and determined they had not erroneously concluded that a vapor mitigation system was unnecessary at any location (E-mail message from Ed Jones, Ecology to Barbara Trejo, DOH, June 2, 2005).

Recommendation: Ecology and PSC should resolve the soil gas sampling problems for future evaluations. In addition, Ecology and PSC should ensure that sampling intervals for indoor air and ambient air are consistent with planned sampling intervals (e.g. 24 hour samples for residential structures).

Tier 4

The purpose of Tier 4 are property is to collect property specific information (e.g. building evaluations) for designing and installing a vapor mitigation system.[7]

Recommendation: None

Child Health Considerations

Children could potentially be exposed to contaminants migrating from contaminated groundwater into indoor air if measures are not taken to reduce such exposures. Children can be uniquely vulnerable to the hazardous effects of environmental contaminants. When compared to adults, pound for pound of body weight, children drink more water, eat more food, and breathe more air. These facts lead to an increased exposure to contaminants. Additionally, the fetus is highly sensitive to many chemicals, particularly with respect to potential impacts on childhood development. For these reasons, DOH considers the specific impacts that cleanup strategies addressing the groundwater to indoor air pathway might have on children, as well as other sensitive populations.

Conclusions

Shallow VOC contaminated groundwater migrating from the PSC property appears to be affecting indoor air quality at some Georgetown buildings located above the plume, posing a possible long term health risk at some locations. PSC's inhalation pathway interim measure (IPIM) approach provided an interim means to monitor and identify buildings where groundwater VOCs could be migrating from groundwater to indoor air at levels that could pose a possible health threat. Over the last few years, PSC's IPIM approach has resulted in the installation or offer to install vapor mitigation systems at over half the buildings in the Georgetown community underlain by shallow VOC contaminated groundwater. These vapor mitigation systems are intended to reduce or eliminate building occupants' potential exposures to VOC evaporating from groundwater and entering indoor air.

PSC's IPIM approach is now being considered by Ecology and PSC as part of the final cleanup strategy for the Philip Services – Georgetown site. Given the complexity and uncertainty associated with the groundwater to indoor air pathway, PSC IPIM approach would appear to be part of a health protective, long-term cleanup strategy for the site if the issues and recommendations identified by DOH, summarized above, are addressed.

Recommendations

1. Recommendations regarding PSC's IPIM approach are summarized in the discussion section, above.

2. Residents living and working above the shallow contaminated groundwater should continue to be educated about the groundwater to indoor air pathway. This effort should include information about ways to reduce or prevent exposure to VOCs migrating from groundwater. For example, residents should be reminded that covering crawlspace vents could increase their potential exposure to VOCs migrating from groundwater.

Public Health Action Plan

1. DOH will provide copies of this health consultation report to Ecology and EPA.

2. DOH is available to review new data and information to support PSC's approach.

3. DOH is available to assist Ecology and PSC with education and outreach to residents potentially impacted by groundwater contaminants at the PSC site.

4. DOH will post this health consultation report on its web site to make it available to the general public.

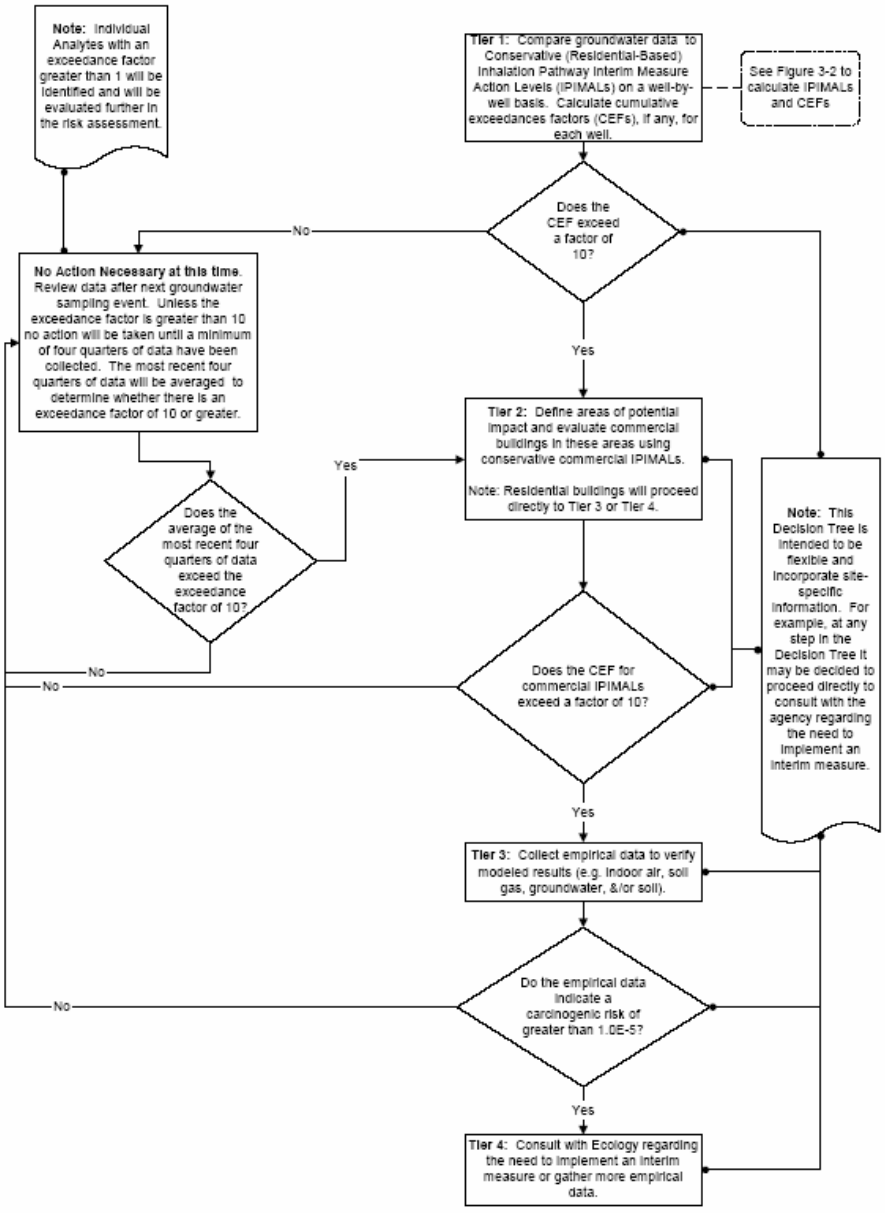

Figure 1: IPIM Decision Tree[7]
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Certification

This Health Consultation was prepared by the Washington State Department of Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation were begun.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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