

HEALTH CONSULTATION

Washington State Department of Ecology, Toxics Cleanup Program
Draft Guidance Document
Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation

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

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 on if site conditions or land use change in the future.

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Summary and Statement of Issues

The Washington State Department of Ecology (Ecology) is developing guidance to assist its project managers and others who are considering using natural attenuation as an option for contaminated site cleanup. A draft version of the guidance document, *Guidance on Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation*, was provided to the Washington Department of Health (DOH) on July 2, 2004. The purpose of the Ecology document is to provide guidance on the appropriate use of natural attenuation as a cleanup option under the Washington State Model Toxics Control Act (MTCA) Cleanup Regulation (Chapter 173-340 WAC) and on evaluating the feasibility and performance of natural attenuation as a cleanup option for petroleum contaminated groundwater.¹

This health consultation report summarizes issues and concerns identified by the Washington State Department of Health (DOH) during a limited review of the Ecology draft guidance. DOH prepares health consultations under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR).

Background

Natural attenuation alone or in combination with engineered cleanup options is increasingly being considered and used to cleanup contaminated sites. Natural attenuation includes a variety of physical, chemical, and biological processes that act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants. Examples of these processes include biodegradation, dispersion, dilution, sorption, volatilization, chemical transformation, and contaminant destruction.

Although there are some benefits to using natural attenuation at some sites, such as reduced cleanup costs, limitations exist that could make the use of natural attenuation a public health concern. For example, although being used increasingly at sites with a variety of contaminants, natural attenuation is only well established for a few types of contaminants, primarily the petroleum related compounds benzene, toluene, ethylbenzene, and xylene (BTEX). In some cases, natural attenuation can result in the formation of breakdown products that are more hazardous than the original contaminants.^{2,3} If limitations such as these are not considered when evaluating the feasibility and performance of natural attenuation, the public may be exposed to contaminants at levels of public health concern.

To reduce the chance of exposing the public to contaminants at sites where natural attenuation is planned or being used, guidance is necessary to address issues such as those described above. Since the late 1990s, the U.S. Environmental Protection (EPA) and others have developed some natural attenuation guidance. The draft guidance Ecology is developing references much of this work.

Discussion

The May 2004 Ecology draft *Guidance on Remediation of Petroleum-Contaminated Ground Water by Natural Attenuation* provides a good start for developing natural attenuation policy and guidance for evaluating the feasibility and performance of natural attenuation for petroleum contaminated groundwater for Washington State. However, DOH identified some policy and technical issues during its limited review of the draft guidance that could affect public health either directly or indirectly when natural attenuation is being considered or used as a cleanup option. The bulleted items below summarize general issues and concerns DOH identified during its review. The numbered items summarize issues and concerns associated with specific sections of the draft guidance.

General Comments

- Comment 1 – Combining policy on the appropriate use of natural attenuation as a cleanup option under MTCA and technical guidance for evaluating the feasibility and performance of natural attenuation for petroleum-contaminated groundwater makes the document somewhat confusing. Both are important for ensuring protection of public health.

Recommendation - For clarity, DOH suggests that Ecology separate the policy portion of the guidance, which is embedded throughout the draft document, from the technical guidance on petroleum-contaminated groundwater. This approach is consistent with what EPA uses when it discusses its monitored natural attenuation policy in a document that is separate from its technical guidance documents on natural attenuation.³

- Comment 2 - Many of the important issues identified, and appropriately addressed, in the EPA monitored natural attenuation policy, such as addressing residual contamination, are not included in the draft Ecology guidance. This could affect how natural attenuation is applied at sites where human exposures could potentially occur.

Recommendation - DOH recommends that Ecology consider adopting the EPA policy with caveats as the Massachusetts Department of Environmental Protection and Kansas Department of Health and Environment did or incorporate relevant portions of the EPA policy into Ecology natural attenuation policy as the Alaska Department of Environmental Conservation did.^{4,5,6} Either approach will provide more substantive information than is presented in the draft guidance.

- Comment 3 - The National Research Council (NRC) notes that in some cases removing contaminant sources can interfere with natural attenuation if the source is serving as a “critical fuel” for the natural attenuation process.² Section 3.3.1 of the Ecology draft guidance, for example, indicates “[s]ource control must be conducted to the maximum extent practicable before relying on natural attenuation to achieve cleanup standards.”

Recommendation – DOH recommends that the point NRC raises, as noted above, be included in the Ecology guidance because removing the contaminant source could reduce the effectiveness of natural attenuation processes, which could cause human health concerns.

- Comment 4 - DOH understands that much of the draft guidance focuses on the use of natural attenuation for petroleum-contaminated groundwater. However, as the NRC notes, delineating the contaminant source (e.g., residual contamination in soil, non-aqueous phase liquids (NAPLs)) is an important element when evaluating natural attenuation as a cleanup option for remediating groundwater.² Source delineation provides information to determine contaminant mass and estimate contaminant flux into the plume. The draft guidance only *recommends* that source delineation occur.

Recommendation - DOH suggests that Ecology indicate that source delineation is *necessary* when using natural attenuation as a cleanup option.

- Comment 5 - Performance monitoring is a critical element when natural attenuation is chosen as a groundwater cleanup option to ensure that natural attenuation is working as planned and ensure that people are not being exposed to contaminants while natural attenuation is occurring. Therefore, a well thought out performance monitoring plan, which includes performance monitoring system design, sampling requirements, data analysis methods, and application of the monitoring data to remedial decisions, is essential. The performance monitoring plan information included in the draft Ecology technical guidance (e.g., Section 3.6) provides some information about monitoring system design, sampling requirements, and data analysis. However, this information is very limited. In addition, no information is provided about how monitoring data should be used to make site decisions.

Recommendation - DOH recommends that Ecology consider using EPA's April 2004 guidance titled *Performance Monitoring of MNA [Monitored Natural Attenuation] Remedies for VOCs in Groundwater* to revise and expand the performance monitoring section of the guidance. This EPA document is an example of the level of detail that is necessary when providing guidance for performance monitoring.

- Comment 6 – Several references for evaluating the feasibility and performance of natural attenuation are included throughout the draft guidance. However, no indication is given whether Ecology concurs with all the information contained in these documents. For example, 11 methyl tertiary butyl ether (MTBE) references are cited in Section 2.3 as sources of MTBE information – more than half of these are American Petroleum Institute (API) documents – but no information is provided to indicate what information about MTBE is consistent with Ecology's policy or regulation.

Recommendation - Because use of these referenced documents could affect decisions about the feasibility and performance of natural attenuation, DOH recommends that Ecology briefly summarize any potential limitations associated with these documents.

- Comment 7 - EPA notes in its monitored natural attenuation policy that, when relying on natural attenuation for remediating contaminants, it prefers those natural attenuation processes that degrade or destroy contaminants.³ This EPA preference is similar to the MTCA cleanup action requirement to use permanent solutions to the maximum extent possible (WAC 173-340-360(2)(b)(i)).

Recommendation - DOH recommends that Ecology's natural attenuation policy include a statement about the MTCA cleanup action requirement to use permanent solutions to the maximum extent possible.

- Comment 8 - EPA's monitored natural attenuation policy notes that decision makers need to ensure that natural attenuation is appropriate for addressing all contaminants that represent a threat or potential threat to human health because engineering controls are typically not used to control plume migration during natural attenuation.³

Recommendation - DOH recommends that to help ensure protection of public health Ecology add to its natural attenuation policy a statement similar to EPA's about the need to ensure that natural attenuation is appropriate for all contaminants where no engineering measures are used to control plume migration.

Section Specific Comments

1. Section 2.2, Potential Limitations – The guidance notes the “[p]otential for continued migration of contaminants and cross-media transfer of contaminants to surface water and sediments.” However, the potential also exists for the transfer of contaminants from groundwater to air.

Recommendation – DOH recommends that the groundwater to indoor air pathway also be noted in the guidance because this pathway can pose a potential health concern.

2. Section 2.2, Potential Limitations – The draft guidance states that “[t]here exist some petroleum contaminated sites where natural attenuation can not be effectively assessed and where active cleanup alternatives are either not effective or not practicable. Long-term monitoring of the contaminated media may be appropriate response at those sites after ascertaining the human health and environment are well protected during the monitoring time. However, monitoring by itself is not a cleanup action. Long term monitoring may need to continue until new cleanup technologies are available to address the contamination.” However, no examples are provided to indicate what type of sites this would apply to, so it is impossible to know whether these types of sites could pose possible health threats.

Recommendation – DOH suggests that Ecology include some examples where neither natural attenuation nor active cleanup options would be effective or practicable.

3. Section 2.3, Consideration of MTBE and Other Oxygenates to Fuels - The draft guidance indicates that MTBE, which is often mixed with gasoline (at up to 15% by volume), has been added to gasoline sold in Washington State although at relatively lower percentages. MTBE is a possible human carcinogen.⁷ No reference was provided regarding the volume of MTBE added to gasoline nationally or in Washington although this is important information as stated in the ATSDR MTBE toxicological profile:

The behavior of a plume of MTBE mixed with gasoline and other organic hydrocarbons such as the BTEX series (benzene, toluene, ethylbenzene, and xylene) in contact with water in an aquifer can

become very complicated. A key factor is the percentage of MTBE in the original fuel mixture. Since 1979, EPA has allowed progressively higher percentages of MTBE in reformulated gasolines, the percentage has risen from 7% in 1979 to 11% in 1981, and then to 15% in 1988 (Lorenzetti 1994). Below levels of about 5%, the pollution chemistry of a reformulated gasoline plume mixing with fresh groundwater will be driven mostly by the effects from the BTEX components. At higher MTBE levels, however, studies based on theoretical considerations and modeling exercises suggest that MTBE may increase the partitioning of the BTEX toxics into groundwater (Mihelcic 1990; Poulsen et al. 1992). These impacts will be minor when the levels of MTBE in a reformulated gasoline mixture are less than 10% (by volume), with BTEX solubilities in water increasing by 10% or less. At higher MTBE mixture ratios, however, increases in the MTBE mixture percentage can increase the BTEX water solubilities to a higher degree. For instance, a reformulated gasoline mixture containing 0.1% MTBE by volume could increase BTEX water solubilities by only around 1%; a 10% MTBE mixture could result in a 100% increase in BTEX water solubilities (Mihelcic 1990). The MTBE co-solvent can also change the sorption/desorption characteristics of other hydrocarbons, thus increasing their mobility.

Recommendation - DOH recommends that Ecology add the appropriate references regarding volume of MTBE added to gasoline because this is critical information for estimating potential health risks and evaluating natural attenuation as a cleanup option.

4. Section 2.3, Consideration of MTBE and Other Oxygenates to Fuels - Tertiary butyl alcohol (TBA) is a breakdown product of MTBE.⁸ However, it is not mentioned in this section of the report although TBA would be considered a contaminant of potential concern and a possible parameter to be monitored when evaluating the feasibility and performance of natural attenuation of MTBE.

Recommendation – DOH recommends that Ecology add information about TBA to its technical guidance.

5. Section 3 – EPA, in its monitored natural attenuation policy, briefly discusses natural attenuation and petroleum related contaminants and notes how some heavier petroleum constituents may remain after natural degradation of benzene, toluene, ethylbenzene, and xylene (BTEX), which could pose health concern.

Recommendation - DOH recommends that Ecology add statements similar to EPA's to its natural attenuation policy as well as to its technical guidance document as a reminder about petroleum contaminants like polycyclic aromatic hydrocarbons that could pose a human health risk after the natural attenuation is completed.

6. Section 3.4, Conduct Remedial Investigation - The draft guidance states that “[t]he purpose of the remedial investigation (RI) is to collect the data necessary to adequately characterize the site for the purpose of developing and evaluating cleanup action alternatives, including alternatives relying (solely or in part) on natural attenuation.” Another purpose of the remedial investigation is to assess health risks posed by site contamination.

Recommendation – DOH suggests that language be added to the guidance about assessing risks during the remedial investigation.

7. Section 3.4, Conduct Remedial Investigation – The guidance contains several steps for conducting a RI. However, it does not include developing a preliminary conceptual site

model although this is a very important preliminary step for effectively planning and conducting a RI.

Recommendation – DOH suggests that language be added to the guidance about developing a preliminary conceptual site model at the start of the RI process. Conceptual models include elements such as primary and secondary sources, environmental media, point of exposure (e.g., tap water), route of exposure (e.g., inhalation, dermal contact, ingestion), receptors, and time (e.g., current or potential future exposure). The preliminary conceptual site model should be refined, as appropriate, after new information is obtained during the RI to ensure an accurate understanding of potential health concerns. This should also be noted in the guidance.

8. Section 3.4.1. Determine Scope of Investigation – The draft guidance states that “[t]ypically, natural attenuation sites will require more thorough site investigation than sites where only active cleanup actions are applied.” This is a reasonable statement. However, the next sentence in the guidance states that “[a]t a minimum, the user must collect sufficient information that is to characterize the nature and distribution (the degree and extent of contamination) of hazardous substances at the site, and the threat posed by those substances to human health and the environment and lays the basis for assessing natural attenuation processes,” which seems like a typical RI step but is inconsistent with the previous statement.

Recommendation – DOH suggests that Ecology remove the second statement or revise it to include things such as documenting plume behavior, which might not be done at some petroleum contaminated sites.

9. Section 3.4.1. Determine Scope of Investigation – The draft guidance recommends that information about potential receptors be included when evaluating the feasibility of natural attenuation including “[b]asements and other subsurface enclosed building structure within 100 feet of the contaminated site.” This approach is consistent with EPA vapor intrusion guidance. However, buildings with basements are not the only vulnerable structures overlying contaminated groundwater plumes, particularly with volatile contaminants like those found in petroleum. Homes with crawlspaces as well as slab-on-grade structures are also vulnerable under certain conditions.

Recommendation – DOH suggests that Ecology also mention homes with crawlspaces and slab-on-grade structures in the guidance to ensure that these structures are also considered when evaluating feasibility of natural attenuation.

10. Section 3.4.1. Determine Scope of Investigation – The U.S. Department of Energy (US DOE) web page on data quality objectives is cited in the draft guidance as a place to obtain information about data quality objectives, but data quality objective documents developed by EPA are not mentioned. The rationale for this decision is not provided. Ecology guidance on data quality objectives is also not mentioned.

Recommendation – DOH suggests that Ecology consider the data quality objective documents developed by EPA and Ecology rather than those of US DOE unless some specific reason exists why the US DOE guidance is more appropriate.

11. Section 3.4.1. Determine Scope of Investigation – A 1998 American Petroleum Institute (API) document and a 2001 EPA document are cited as two references containing groundwater sampling information. It should be noted, however, that EPA does not reference the API document in its 2001 document. The API document is also not referenced in EPA’s 2002 groundwater sampling guidance, which is not mentioned in the Ecology draft guidance.⁹ This lack of reference suggests that the API methods might not be consistent with EPA groundwater sampling guidance, which could result in an underestimation of human health risks.

Recommendation – DOH suggests removing the API guidance as a reference for groundwater sampling.

12. Section 3.4.1. Determine Scope of Investigation – The draft guidance recommends a no purging approach as one method for groundwater sampling. However, no scientific evidence exists to suggest that a no purging approach would result in the collection of representative groundwater samples.

Recommendation – DOH suggests that Ecology remove the no purging approach from the guidance.

13. Section 3.4.2, Conduct Investigation – The draft guidance states that “[d]ata collected from the monitoring network is then used to assess plume behavior and to extract the rate constants of attenuation, to identify major attenuation mechanisms.” However, the specific types of data are not mentioned.

Recommendation – DOH recommends that Ecology specify the data that are needed to assess the plume behavior and determine the attenuation constants so no confusion exists about what is needed to identify the major attenuation mechanisms.

14. Section 3.4.2, Conduct Investigation – The NRC indicates that inorganic carbon can be produced at petroleum sites where natural attenuation is occurring under aerobic conditions or under denitrifying or sulfate reducing conditions. However, it has not been included as a geochemical indicator in the draft guidance.

Recommendation – DOH recommends that Ecology consider adding inorganic carbon as an indicator chemical.

15. Section 3.4.2, Conduct Investigation – Five monitoring wells are the minimum number recommended in the draft guidance to assess the feasibility of natural attenuation during the RI. It is recommended that two of the five wells be installed in the dissolved portion of the plume and one “sentinel” well is recommended downgradient of the plume. No information is provided in the guidance to indicate the purpose of the sentinel well. However, it is

assumed to help define the plume boundaries and help monitor whether the plume is advancing toward potential receptors. It is also assumed that the two wells installed in the dissolved portion of the plume are meant to help characterize the plume and groundwater flow.

Recommendation – DOH suggests that a minimum of two monitoring wells be installed downgradient of the plume to ensure that the sentinel wells are representative of groundwater moving away from the plume. More than two wells may be necessary when characterizing the dissolved portion of the plume. DOH recommends that the number recommended in the guidance should be selected on the basis of plume length and width and the concentration of dissolved contaminants across the plume.

16. Section 3.5, Evaluate Feasibility of Natural Attenuation as a Cleanup Action Alternative – The draft guidance states that “[a] statistical evaluation of the rate constants estimated from remedial investigation of natural attenuation of ground water contamination often reveals that the estimated rate constants contain considerable uncertainty (US EPA 1992a, 1998, 1999b, 2000; Washington State Department of Ecology, 1995). Due to variability resulting from sampling and analysis, as well as plume variability over time, statistical confidence interval needs to be estimated for the calculated attenuation rates that are based on historical trend data. Ecology recommends use 85% or higher level of confidence as decision criteria for all evaluation of feasibility of natural attenuation at where applicable. At other sites a more stringent confidence level (e.g., 95%) may be more appropriate, depending on the level of health risk that is acceptable.” However, this discussion does not provide any information or criteria to help decide what is an appropriate level of confidence.

Recommendation – DOH recommends that Ecology expand this discussion to include information or criteria in the draft guidance so people can make sound decisions when selecting confidence levels.

17. Section 3.5.2, Evaluate Ability to Reduce Contaminant Mass – The draft guidance states that “[t]o demonstrate compliance with this threshold criterion, the user needs to demonstrate that natural biodegradation is occurring at the site. To make that demonstration, the user must evaluate changes in the geochemical indicators associated with the degradation process and determine the assimilative capacity of the medium. Or, calculate the biodegradation rate constant where there are no clear changes in the geochemical indicators.” The first two sentences from the draft guidance are consistent with the NRC recommendation that clear evidence be used to demonstrate that natural attenuation is occurring. Therefore, calculating a biodegradation rate appears inappropriate where no clear evidence indicates that biodegradation is occurring, which is suggested in the third sentence.

Recommendation – DOH suggests that the demonstration supported by the NRC be added to the guidance.

18. Section 3.5.2, Evaluate Ability to Reduce Contaminant Mass – The draft guidance states that “[t]he biodegradation of BTEX (major petroleum constituents in ground water plume) constituents is well documented and separate microcosm studies are not typically necessary

for a petroleum-contaminated site.” However, BTEX are not the only compounds associated with petroleum sites that can affect groundwater quality. Therefore, microcosm studies might be appropriate.

Recommendation – DOH recommends that the draft guidance be revised to include a statement that microcosm studies might be appropriate.

Conclusions

While policy and guidance regarding the use of natural attenuation as a cleanup option can result in more effective remediation, full consideration of site-specific factors is important before remedial decisions are made. The draft natural attenuation guidance developed by Ecology provides a good start for developing natural attenuation policy and guidance for Washington State. However, some issues and concerns regarding this draft document could result in potential health concerns if used “as is” when evaluating cleanup decisions at contaminated sites.

Recommendations

Health consultation recommendations follow each comment in the discussion section above.

Public Health Action Plan

DOH will continue working with Ecology on future versions of the natural attenuation policy and technical guidance for Washington State.

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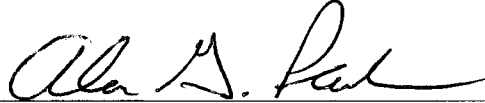
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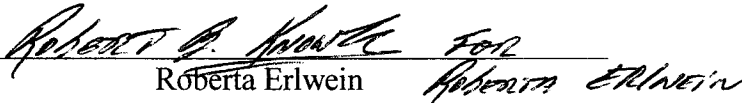
Certification

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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