Assessing and Communicating Risk: A Partnership to Evaluate a Superfund Site on Leech Lake Tribal Lands

ECOLOGICAL RISK ASSESSMENT PANEL REPORT

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Introduction

This report describes and summarizes discussions of the Ecological Risk Assessment Panel concerning ecological impacts and risks posed by previous and continuing contamination at the St. Regis/Wheelers Superfund site at Cass Lake, Minnesota. These discussions occurred during an expert panel review held in Cass Lake on May 13–15, 2002, as part of an Environmental Justice (EJ) project, organized through the University of Minnesota Sea Grant in partnership with the Leech Lake band of Ojibwa and funded by the US EPA.

The purpose of the review was to examine and evaluate the results of previous and ongoing studies directed towards a quantitative understanding of potential adverse impacts to ecological resources in the vicinity of the site. The review addressed the probable impacts of chemical contamination associated with previous site operations and continuing remediation activities. While not tasked with completing an ecological risk assessment, the review was organized and directed using ecological risk assessment principles and guidelines. This approach greatly facilitated evaluation of existing information and identification of information and data gaps. Ecological risk assessment focuses on the inherent value of the life-sustaining ecosystems, as well as the economic value of selected ecological resources to individuals inhabiting the region.

The primary objectives of the Ecological Risk Assessment Panel discussions were to (1) evaluate existing information for assessing the ecological impacts of site-related contamination, and (2) determine if previous clean-up efforts have resulted in conditions that are protective of ecological resources. The purpose of the panel was not to directly assess ecological risks posed by site-related contamination (i.e., conduct a risk assessment). Rather, the panel examined current ecological conditions, evaluated the nature and quality of existing data, and recommended additional studies that might be undertaken to collect additional data and information in support of a comprehensive and quantitative ecological risk assessment for the St.Regis/Wheelers Superfund site.

As stated in the companion report from the Human Health Risk Assessment Panel (Bartell et al. 2002), the interrelationship between human health and ecological concerns are fundamentally inseparable for the tribe, who is the primary stakeholder with ancient ties, both physical and spiritual, to the local ecology. Several important issues raised during the human health panel discussions re-emerged during the discussion of ecological risks. While this report focuses on ecological impacts, any meaningful remediation and/or restoration of the Leech Lake site will necessarily require an effective integration of human health and ecological perspectives in defining appropriate objectives and approaches for site clean-up.

Review Participants and Ecological Risk Assessment Panel

The review included the following participants and was facilitated by an Ecological Risk Assessment Expert Panel:

Groundwater Panel Representative

The review discussions concerning the role of groundwater in determining the transport and fate of site-related contaminants were greatly facilitated by the participation of Dr. Howard Mooers, Department of Geology, University of Minnesota Duluth, who participated in the Groundwater Panel (McDonald et al. 1999).

Environmental Justice Project Principal Staff

Leech Lake Band (Cass Lake, MN)

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Other Participants

The following individuals participated in the May 2002 review and contributed to the preparation of this summary report:

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Environmental Justice (EJ) Project staff prepared a 3- ring binder of reports, data summaries and other written materials that was distributed to the Human Health and Ecological Risk Assessment panel members prior to the May 2002 meeting at Cass Lake, MN. This binder is cited in this report as NRRI 2001 (Risk Information Packet) and its Table of Contents is attached as Appendix 1. EJ staff has also compiled a list of essential references" (Appendix 2) from the period 1985-2002 pertinent to any assessment of the current or historical environmental issues at the St. Regis/Wheelers Superfund site at Cass Lake, MN. It is important to note that there are many additional, potentially important, documents and data that may also be relevant to future assessments of the Site which are not included in these lists.

Background

The Cass Lake region is ecologically distinct and reasonably unimpacted except for the Superfund site. This region provides a relatively unique intersection of different ecological biomes in North America and features four large lakes that are integral components of the Mississippi River headwaters. Diverse wetlands define an ecologically valuable land:water interface within the region. The avian, terrestrial, and aquatic communities within the Cass Lake region are diverse and highly productive.

The Cass Lake area includes a variety of valuable ecological resources, for example, wild rice, fish, birds, and mammals. Additionally, the wild rice beds provide nursery habitat for northern pike, perch, and walleye. Lake tributaries such as Fox Creek are ecologically important for suckers and other species of fish. Cass Lake also has comparatively abundant populations of rare unionid mussels. The proximity of this area to the Mississippi River may carry broader implications for ecological risks posed by chemical contamination of the Cass Lake area. Impacts in this region might affect the ecology of the headwaters of this large and nationally important river system.

Cass Lake derives from the melting of a large block of ice following the last glacial period. The deep pool (90 feet) in Pike Bay is below the till confining layer that separates the upper and lower aquifer in this region. Groundwater likely flows into the west side of Pike Bay and Cass Lake and flows out the east side of the lakes. Surface water can flow in either direction through the channel between Pike Bay and Cass Lake, although the natural flows are to the north from Pike Bay into Cass Lake.

Ecological Risk Assessment Framework

A formal ecological risk assessment has not yet been conducted for the St. Regis/Wheelers Superfund site, although some preliminary screening-level calculations have been completed (EPA 2002). Analogous to the human health risk assessment paradigm (e.g., National Research Council 1983), assessing ecological risks includes the following steps (EPA 1997, 1998): (1) problem formulation, (2) assessment of ecological effects, (3) analysis of exposure, and (4) risk characterization. To assist in understanding

the current conditions of ecological resources and in determining additional data needs, the expert panel discussions have been summarized according to the framework and guidelines for performing an ecological risk assessment.

An ecological risk is the probability of an adverse ecological impact occurring, combined with some statement concerning its consequences (Kaplan and Garrick 1981). An ecological risk assessment attempts to answer three basic questions: What can go wrong? How likely is it to go wrong? So what if it does go wrong?

Problem Formulation

The problem formulation step essentially encapsulates the ecological risk assessment process. A conceptual model is developed that defines the ecological stressors (e.g., toxic chemicals in this case), identifies ecological receptors that might be at risk, defines the ecological responses of interest, identifies needed exposure-response relationships, and delineates the methods for characterizing risk.

An important component of problem formulation is the identification of *assessment endpoints* in the vernacular of risk assessment. These are "explicit expressions of the actual environmental value that is to be protected, operationally defined by an "ecological entity and its attributes" (EPA 1997, 1998). *Measurement endpoints* (EPA 1997) or the measures of effects (EPA 1998) are "measurable changes in an attribute of an assessment endpoint or its surrogate in response to a stressor." These measures of effect could be distinguishable from the assessment endpoint. The panel and review participants suggested several categories of ecological risk assessment endpoints, measures of exposure, and measures of ecological effects for the St. Regis/Wheelers Superfund site:

Assessment endpoints

- Undesirable or unsustainable changes in the production dynamics of ecologically and economically important species (e.g., leeches);
- Impairment of ecological processes (e.g., energy flow, material cycling); and
- Adverse impacts on natural goods and ecosystem services provided to humans.

Measures of exposure

- Endocrine levels in key species; and
- Metabolites in bile, fish tumors, and chemical residues in livers.

Measures of effects

- Reproductive impairment in key species (e.g., bald eagles);
- Oxygenase functions in fish, polycyclic aromatic hydrocarbons (PAH) reactivity, phototoxicity;
- Alteration of plant community structure and associated fauna;
- Impacts on bacterial communities in groundwater, soil invertebrate communities, hyporheic communities;
- Modification of the natural seasonal progression of species assemblages;
- Degradation and loss of habitat; and
- Alteration in food web structures.

In delineating assessment endpoints, the principal communities occupying the site and nearby areas should be described and representative species selected from each community. Tribal participants identified the wild rice community, stream/beaver community, wetland community, lake community, and upland community as important components of the local and regional landscape. The risk assessment should address both changes in the composition of potentially impacted communities and alterations in the temporal progression of species compared to reference sites.

Impacts on threatened and endangered species should be considered as possible endpoints in the risk assessment. There are tribally-sensitive species of plants and animals that should be evaluated as well. Risk assessment should consider these species or taxonomic/functional analogs for them.

Phototoxicity (significantly increased potency triggered by solar radiation) associated with exposures to PAHs might also be of concern for sensitive aquatic organisms. Perhaps the greatest likelihood of phototoxicity will be in the fish nursery area where larvae are fairly well confined. In situ bioassays using caged benthic organisms at different levels in the water column, with appropriate controls, could potentially be a useful alternative to a more comprehensive and expensive field study.

Site Characterization

A credible assessment of ecological risks posed by site contamination requires a comprehensive and accurate characterization of the distribution and fate of chemicals of concern (COCs). Existing reports pertinent to site characterization underscore the absence of any organized and comprehensive sampling of the site prior to 1997 (e.g., MJ 1997; MPCA 1995; MDH 1995, 1993; ATSDR 1989). This includes a lack of any

terrestrial soil or aquatic sediment data. The MJ (1997) report provides a useful summary of the chronology of site remediation and a general review of monitoring data through 1996. The reports were interpreted as recommending extensive sampling of soils, sediments, and biota to determine the nature and extent of contamination. The St. Regis/Wheelers site was never formally listed as a Superfund site. In the absence of this federal oversight, the Minnesota Pollution Control Agency (MPCA) served as the leading governmental unit onsite until 1996. However, the USEPA became the responsible governmental unit in 1996 at the request of the Leech Lake Tribal Council. At that time, EPA began to discuss additional sampling of the site with the Leech Lake Band. The sampling effort was finally implemented in October 2001, and the data became available in draft form (EPA 2002) less than two weeks prior to the EJ Risk Assessment Panel meetings in May 2002. This data report was finalized in August 2002 without changes to the data (L. Kern, EPA Region 5, Chicago, IL, pers. comm.).

Review participants offered historical accounts of alleged off-site disposal of contaminants. However, minimal sampling for assessing ecological risks has been accomplished thus far. Prior to the EJ Project study (section 19 in NRRI 2001, which includes the data collected through the EJ Project grant) the major, if not only, biological data collected for the site or nearby aquatic systems were the biennial (every other year) analyses of a single, pooled composite of six northern pike and a single, pooled composite of six tullibee fish samples from Pike Bay in Cass Lake and nearby Lake Andrusia (as a "possible" reference) that were analyzed for hexachlorodibenzo-p-dioxin (HxCDD) as required by National Pollution Discharge Elimination System (NPDES) MN State Discharge System (SDS) Permit No. MN0056537. Apparently, no other biological samples associated with the St. Regis/Wheelers site were collected and analyzed for COCs until 1998–1999, when the EJ Project partnership conducted a limited baseline sampling program.

As part of the EJ Project partnership, the University of Minnesota Natural Resources Research Institute (NRRI) set up transects into Pike Bay and Cass Lake and collected and analyzed a very limited set of fish, invertebrate, and sediment samples. Semi-permeable membrane devices (SPMD), also known as lipid bags, were used to simulate bottom dwelling localized fish (Huckins et al. 1993). Sediments were analyzed for a suite of PAHs, pentachlorophenol (PCP), pentachloroanisol (PCA), copper (Cu), chromium (Cr), and arsenic (As). Additional soil samples were also screened for PAHs (Peterson et al. 2002) and Microtox toxicity (e.g., Day et al. 1995, Microbics 1994).

Review participants emphasized the need for a comprehensive characterization of on-site and off-site contamination to provide the basis for a quantitative ecological risk assessment. The panel concluded that the draft screening-level assessment (EPA 2002) indicates unacceptable exposures of wildlife to COC, particularly copper and semi-volatile organic chemicals (SVOC), in upland areas and in locations within the City of Cass Lake dump/landfill near Fox Creek. Data describing the concentrations of various COCs in soils, sediments, surface waters, groundwater, and biota that were obtained for the human health assessment are also useful in assessing ecological impacts (e.g., EPA 2002). As in the discussions of human health risks, it would prove useful to apply a mass

balance approach to estimate releases of selected COCs, determine how much has been removed (e.g., by COC extraction and treatment), and how much contamination remains to pose future risks. As noted in the Human Health Risk Report (Bartell et al. 2002), the panel also surmises that the COC list and the spatial and temporal sampling design may be incomplete. Further site characterization based on a mass balance approach might be facilitated by

- obtaining information that defines the chemical composition of the raw materials used at the facility, as well as products. For example, knowledge of pentachlorophenol (PCP) sources might permit inferences concerning dioxin content;

- acquiring company records concerning site operations and maintenance, NPDES permits, permits to haul wastes off-site, railroad shipping and delivery documents;

- collecting and cataloging historical references and recollections of possible contaminant releases or "events" that could indicate locations, COCs, and amounts released;

- reviewing old newspapers (Cass Lake Times), obtaining existing aerial photographs (e.g., University of Minnesota library) taken during site operations, requesting assistance in obtaining remotely sensed data (e.g., infrared photographs) from USEPA as part of the 5-year review process;

- interviewing previous employees (e.g., 40–50 St. Regis employees; Chippewa National Forest Service employees) and long-time residents to learn of detailed operating procedures and waste disposal practices;

- setting up one or more permanent environmental grids that can be monitored using digital or film cameras;

- collecting (including Global Positioning System coordinates) and archiving for future analysis samples from areas of suspected historical releases or dumping of site-related chemical wastes (i.e., ditches near back roads);

- using ground penetrating radar to thoroughly characterize groundwater light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs) and possibly plumes of dissolved components (A recent preliminary ground penetrating radar survey by the University of Minnesota-Duluth has confirmed the site's hydrogeological complexity (Mooers 2002, Appendix 3);

- understanding the degradation compounds of parent COCs to assist in identifying compounds to analyze in any additional environmental samples (i.e., media, biota), for example, the PCP recovered from the extraction wells could be

analyzed for constituent compounds before being shipped to South Dakota for reuse; and

- training several people from the Leech Lake Band Division of Natural Resource Management (or from another local agency) with chain of custody, collecting samples, quality assurance/quality control, etc., to provide assistance if there is an important episodic event that should be characterized in terms of site risks. This expertise might be obtained from the Minnesota Chippewa Tribal Laboratory directed by John Persell.

Reference Site

Ecological risk assessment requires the identification of one or more reference sites. The ecological conditions of the selected reference site(s) should be characteristic of regional ecological systems that remain comparatively less impacted by human activities. In some instances, ecological risks are inferred from comparisons of ecological conditions at reference and impacted sites. Conditions at reference sites can also be used to assess the likely magnitude of ecological impacts projected from comparisons of chemical exposures at contaminated sites to toxicity benchmark data for ecological receptors of concern. Clearly, sites that have been impacted by the chemicals of concern (or other similar stressors) should not be chosen as reference sites.

Quantitative description of ecological conditions at the reference site(s) should provide acceptable values of structural and functional measures (i.e., baseline conditions) for comparison with corresponding ecological measures obtained from potentially impacted ecosystems surrounding and including the St. Regis/Wheelers site. These measures of ecological structure and function define the *measurement endpoints* in an ecological risk assessment. Characterization of the reference (and impacted) sites should include quantification of spatial and temporal variability in the values of the measurement endpoints.

Additional Chemicals of Concern

A standard Superfund list of possible COCs seems to have been used thus far to identify contaminants of concern for the Cass Lake site. The COC list is not consistent throughout the various media. Selection of COCs needs to support a cumulative risk assessment and the panel recommends consideration of additional contaminants. For example, fuel oil – e.g., alkyl PAHs and retene would be expected because of all the wood, but these possible COCs were not measured. Polychlorinated biphenyls (PCBs) might reasonably receive additional attention. Ketones were likely used to make hydrophobic compounds (e.g., many PAHs) more soluble. Cutting oils, gasoline and other chemicals might have been routinely used to clean up creosote-laden tools and machinery. Chemicals in creosote might not have been adequately represented in the current list of COCs. There are additional COCs of concern to the tribe as well, including mercury. Copper, arsenic, and zinc appear as additional metals of concern for the ecological risk assessment.

In addition, metabolites and reaction products of PAHs were not measured. Similarly, PCA, a degradation product of PCP, should have been analyzed in environmental and biological samples.

Exposure Analysis

As in human health risk assessment, pathways of exposure are identified that functionally link ecological receptors of interest to sources of contamination. Not surprisingly, many of the pathways are similar to human health exposure analysis: inhalation of contaminated air or dust; dermal exposure; ingestion of contaminated water, soils, and sediments; and ingestion of contaminated food or prey (i.e., bioaccumulation, bioconcentration, and biomagnification). Estimating exposure for the St. Regis/Wheelers Superfund site will necessitate characterization of on-site and off-site contamination. Participants were concerned that on-site contamination might result in a "sink" for organisms that immigrate on-site and accumulate sufficient contaminants to either die or become easy prey for local raptors and other predators. Movements of contaminants off-site may imperil valued terrestrial and aquatic species, as well as impact wetlands and other important ecological systems.

The expert panel and review participants addressed several issues regarding the quantity and quality of existing information for performing an ecological risk assessment. Further, the panel, as well as the EJ Project partnership, remains confused concerning the status of the Quality Assurance Project Plan (QAPP) for Barr/Champion/International Paper routine monitoring activities at the site. It appears that there has never been a Asigned off@ certified Quality Assurance Project Plan (QAPP) for the Champion/Barr annual monitoring program. The QAPP was apparently either not available or not used to standardize analytical methods and/or levels of detection since the inception of the Remedial Action. Our understanding is that an unsigned draft dated January 24, 1995, with a Revision 2 February 1999 note was sent to the Band with a March 10, 1999, date stamp, but it remains unclear if it was ever carefully reviewed by regulatory agencies, accepted and implemented.

The panel was also concerned that vegetation growing in the wetlands just off site, between the extraction wells and channel, is directly exposed to groundwater. This vegetation should be sampled to determine possible contamination. Soils in this area should also be characterized for COCs, despite the operation of the extraction wells. Even though the wells have been in operation since 1987, LNAPLs are still being encountered on the other side of the channel.

More meaningful site characterization to support an exposure analysis would result from additional sampling north of the channel near the residential area. The presence of a pipeline and the measurement of PCP and PAHs in Well 118 suggest that sampling should not have been terminated in the well located north of the site. In addition, the possible contamination of aquatic organisms from SVOCs associated with the railroad should be investigated. The railway bed might act as an efficient conduit for the transport

of COCs to the lake; contamination from treated railroad ties should also be examined as a possible confounding factor in understanding PAHs released from the site.

The higher molecular weight PAHs are more than likely bound in the sediments and not readily entering into solution. Measurement of PAH concentrations in sediment pore waters appears justified in determining exposure of organisms inhabiting the sediments as well as in quantifying exposures to fish.

Effects Assessment

The nature of effects assessment distinguishes ecological risk assessment from the assessment of human health risks. Ecological risk assessment includes a diverse set of potential ecological impacts of concern rather than the cancer and toxicity endpoints of health risk assessment. Potential effects of concern in ecological risk assessment include, for example, mortality and sublethal impacts (e.g., reduced growth, reproductive impairment, susceptibility to disease and vulnerability to parasites) on individual organisms, alterations in survivorship and fecundity of populations, changes in the structure of ecological communities (e.g., biodiversity), and impacts on ecosystem structure and function (e.g., energy flow, nutrient cycling, stability).

Effects assessment also establishes exposure- or dose-response relationships for the assessment and measurement endpoints. In some instances, the relationship might be defined by a single toxic benchmark concentration (e.g., LC_{50} or EC_{50}). Alternatively, more complex nonlinear dose-response functions with threshold values can define such relationships. Ecological risk assessments of complex sites involving multiple contaminants and many endpoints, such as the situation at Cass Lake, typically use combinations of these different relationships to estimate risks.

As the result of the expert panel review, several issues were raised in relation to assessing ecological effects and obtaining data sufficient to perform a baseline ecological risk assessment for the St. Regis/Wheelers site and areas surrounding Cass Lake. Importantly, a thorough evaluation of available toxicity benchmark databases should be undertaken to determine which, if any, of these data might prove applicable to the endpoints of interest in this assessment. In addition to the toxicity data used in the screening assessment, benchmark data developed at Oak Ridge National Laboratory, Los Alamos National Laboratory, and relevant data published in the peer-reviewed technical literature should be examined and evaluated for application in the Cass Lake assessment. Data developed for the Great Lakes Initiative may prove useful in this assessment and should be examined. The relevant data should be used to construct and manage a database of known quality designed specifically to support the Cass Lake ecological risk assessment.

It is important that toxic equivalency factors (TEFs) be used correctly and consistently throughout the assessment. The assessment should be based on TEFs established by the World Health Organization (WHO, e.g., van den Berg et al. 1998). However, the TEFs

used in assessing dioxins and furans do not appear to be the WHO 1998 values. Existing exposure data (i.e., fish data) should be reevaluated using the appropriate TEFs. For samples where detection levels are in question, a range of TEFs should be used to assess the possible ecological ramifications of contamination.

Risk Characterization

In contrast to the emphasis on excess cancer risks and hazard quotients that characterize the estimation of human health risks, ecological risk assessment commonly involves a complex set of measures and models for quantifying risk. Methods for characterizing risks posed by toxic chemicals may include extrapolation of existing data for similar compounds and organisms, controlled experimentation under laboratory conditions, experiments performed under field conditions (e.g., mesocosms), field monitoring, ecological modeling (e.g., Pastorok et al. 2002, Bartell et al. 1992), and expert elicitation; wherein, standardized and generally accepted methods are used to characterize risks on the basis of professional judgment and informed opinion (Ayybub 2001). Usually, several of these methods are combined in an overall weight of evidence approach for estimating ecological risks (Bartell 1996, Suter 1992).

The screening-level assessments performed thus far have been based on simple quotient calculations analogous to the human health hazard quotients. Concerns were expressed that there were inconsistencies in the use of screening-level criteria (e.g., for sediments).

Uncertainties

Many sources of uncertainty are inherent in assessing risks posed by toxic chemicals in complex ecological systems. In addition to the kinds of uncertainties also associated with quantifying exposures in human health assessment (e.g., multiple pathways, spatial-temporal variability, environmental heterogeneity), ecological risk assessments must address uncertainties that result from the incomplete understanding of ecological systems (structural and functional), variability among individual organisms in their response to exposure to multiple chemical stressors, and the natural variability or heterogeneity in other environmental factors that determine the distribution and abundance of species of concern.

The design of sampling programs to collect additional data for an ecological risk assessment should address the above mentioned sources of uncertainty. Uncertainties should be characterized to the extent possible and propagated through the assessment. The estimated ecological risks should be expressed in probabilistic terms (e.g., based on statistical distributions of expected impacts), fuzzy sets, or other means (e.g., intervals) that convey the implications of ecological and toxicological uncertainties in assessing ecological risk.

Habitat-based Approach

Much of the review discussion focused on the kinds of studies that might be performed in specific habitat areas potentially impacted by site wastes. Importantly, the results of such studies, if properly designed and implemented, could provide data and information to support an ecological risk assessment of the site-related contamination.

The following sections briefly outline studies proposed by the panel and review participants for five habitats important to the St. Regis/Wheelers site: (1) the on-site field, (2) local wetlands, (3) the channel area between Pike Bay and Cass Lake, (4) Fox Creek, and (5) lands managed by the U.S. Forest Service. Special consideration was given to the definition of technically defensible studies that could be carried out by tribal staff members following a reasonable investment in training, supplies, and equipment. The list of studies is by no means exhaustive given the comparatively short duration of deliberations by the panel and review participants. In envisioning the proposed studies, the panel focused on three basic questions: what should be done? what can be done? and why should it be done? Refinements and additions to these suggested studies are anticipated.

On-site Field

Interest was expressed in obtaining measurements of the body burdens of organic contaminants in rodents inhabiting, foraging, or otherwise utilizing the large on-site field. The generalized foraging behavior of these organisms might provide an integrated measure of exposure to organisms at lower trophic levels. Impacts of contamination (e.g., increased mortality, reduced fecundity, poor growth) that reduce population sizes of rodents can indirectly affect populations of predators (e.g., raptors) that prey upon these organisms. Ingestion of contaminated rodents may also be an important exposure pathway for such higher level consumers. If possible, different sub-populations should be compared for this site.

Actual body burdens or evidence (i.e., biomarkers) of exposure to PAHs, dioxins, and PCP would be extremely valuable in characterizing risks to rodents and ecologically similar organisms. Many TEFs are derived from studies using rodents. Additionally, description of population sizes or at least determination of the age/sex profile would be useful, as well as observations concerning gonad development. Initial discussions focused on the feasibility of monitoring voles, deer mice, and white-footed mice, although it remains unclear whether these rodents inhabit the area of concern. It appears more likely that gophers could be collected at this site. If such organisms cannot be sampled reliably and in sufficient numbers, studies using caged animals might be conducted to obtain this valuable exposure information, despite the potential logistical problems associated with caged animal studies.

With corresponding sampling and analysis of soils and vegetation from this site, it would be possible to estimate soil-to-gopher or vegetation-to-gopher bioaccumulation factors. These factors would be useful for food chain modeling directed at estimating exposures

to higher-level consumers (e.g., raptors) for which direct measures of exposure may prove difficult or infeasible.

Review participants also discussed the value and feasibility of characterizing the impacts of contaminants on plants that occupy this field. Previous observations suggest that many trees, especially pines that grow in this field are stunted. A comprehensive search of the literature for phytotoxicity (including root toxicity) data was recommended in relation to the COCs. Root toxicity could make it impossible for valued plants to grow and survive; surviving individuals may exhibit a reduced ability to resist disease or other stressors (e.g., drought). Concentrations of toxic metals could also be measured in these trees. Toxicity databases, including the USEPA ASTER (Assessment Tools for the Evaluation of Risk) database, should also be examined for existing and relevant phytotoxicity data. The ASTER database is located at the USEPA-MED laboratory in Duluth, Minnesota, and can be accessed through the Internet.

In addition to impacts on populations of plants and consumer organisms, the panel and review members discussed the feasibility of assessing possible impacts of chemical contamination on the ecological functioning (e.g., total respiration) of the soils in this field. Participants remarked that measures of soil respiration have not worked well and perhaps attention might be focused on some measure of nutrient cycling, for example, soil nitrogen. Other tests, such as the earthworm toxicity test, plant toxicity tests, and soil community evaluations, might provide insights regarding functional impacts of soil contamination.

Several participants mentioned the ubiquitous distribution of ground beetles and suggested that these organisms might provide an opportunity (i.e., "sentinel" species) for further examination of the possible impacts of contamination. Demonstrated absence of these organisms from areas known to provide favorable habitat might be indirect evidence of an impact.

One perhaps novel idea was to monitor the body burdens of local pets, particularly dogs and cats that use the site. In addition to direct dermal exposure, these domestic animals might ingest field soils and water, as well as prey upon organisms inhabiting the field.

Wetlands (spray/irrigation area)

Considerable emphasis and concern was expressed regarding the degree of contamination of the wetlands area located to the east of the major on-site field and extraction wells. Measurement of contaminants in soils, sediments, and surface water in this area should receive high priority. The spatial extent of contamination is poorly known because of the absence of samples collected from the fringe areas of the wetlands. This high priority is further justified given that the soils and sediments in this area are subject to groundwater discharge. The high organic content of these soils and sediments also suggests the potential for accumulation of hydrophobic chemical contaminants; the organic layers of wetlands soils (peat) should be sampled for organic COCs.

Samples should be collected in relation to major precipitation events. The existence of a seep along the site is evidence of the possible importance of storm water in the transport of contaminants off-site, possibly into the wetlands adjacent to the site.

In addition to samples of environmental media, the expert panel discussions led to the identification of possible studies and sampling of relevant organisms to further characterize the nature of contamination and potential ecological impacts in the wetlands. Measurements of short-term exposures to PAHs, metals, and PCBs, for example, might be obtained from samples of benthic invertebrates, crayfish, and amphibians. Exuvia from benthic invertebrates and amphibian eggs or tadpoles might provide good indication of exposure. Water beetles might also be collected and analyzed for selected COCs. Samples of vegetation, for example alders, might be obtained to determine if these plants accumulate COCs from contaminated groundwater that has moved off site.

Nesting habitat might be provided to attract tree swallows to the fringes of the wetlands. Sampling and analysis of eggs and nestlings of these birds could provide useful information concerning body burdens of selected COCs, as well as indicate diet composition, including potentially contaminated food items.

Channel Area

Considerable attention was devoted to identifying sampling efforts and studies that might be performed to better characterize contamination and evaluate possible ecological impacts in the channel that connects Pike Bay and Cass Lake. Several of the concerns and recommendations, similar to those outlined for the wetland areas, are directed towards better characterization of contaminants in water and sediments, as well as, sample collections for improved description of possible impacts on selected aquatic and riparian species.

The assessment of ecological risks posed would be greatly facilitated through better characterization of locations of possible inputs of contaminants in the channel. Discharge locations, areas of surface water runoff and groundwater flows into the channel might be identified through examination of existing aerial photographs or analysis of water temperatures, although the patterns of flow might be fairly diffuse. The major mechanisms of transport appear to be groundwater flow and surface runoff. It is important to note that groundwater which is pumped and treated enters the channel as surface water runoff following treatment. Contaminants not captured by the treatment process can readily enter the channel. It should be further noted that the NPDES permit for the surface discharge from the treatment facility to Pike Bay expired in 1997. Its renewal should only occur within the context of the ecological and human health risk assessments suggested by the EJ Panels (this report, Bartell et al. 2002, and McDonald et al. 1999).

High priority should be given to obtaining additional samples of sediments and organisms inhabiting the sediments, for example amphipods, as well as crayfish and other selected benthic invertebrates. At the same time, it was recognized that the interpretation of data

developed from additional sediment samples might be difficult because of channel dredging that occurs every few years. These samples of sediments and biota should be analyzed to assess exposures to PAHs; PAH concentrations in sediment dwelling organisms may be in equilibrium with PAHs adsorbed to sediments (or in pore waters). SVOCs are also apparent in the channel sediments, but are not in the water column. Sediment toxicity testing was suggested, along with some simple experiments to assess phototoxicity. Sampling and analysis of larval fish for PAHs and other SVOC were also strongly recommended by the expert panel. Some additional data were collected according to EPA standard protocols (NRRI 1999) by NRRI staff in 1998 (Section 19 in NRRI 2001). These data also should be included in discussions of survey design and final assessment.

As suggested for the wetlands, tree swallow nest box studies could be performed to quantify body burdens of contaminants, including contaminants in tree swallow eggs and nestlings. Diet composition can be ascertained for these birds, and observations of nesting success can be made. The results might extrapolate to functionally similar bird species that inhabit or forage at the site.

Tribal participants expressed concerns that contaminants might be impacting the production of wild rice or perhaps contaminating the rice. As a result of these concerns, contamination should be evaluated in sediments that provide habitat for wild rice.

Fox Creek

Another major area of concern in assessing ecological risks is Fox Creek. One reason for concern is the proximity of the creek to the location of the Cass Lake city dump. LNAPLs have been reported in groundwater samples from the city dump area. In addition, sludge potentially contaminated with organics and metals has been disposed at the dump. As a result, there is considerable potential for contamination of Fox Creek surface waters and sediments. In fact, high concentrations of dioxins have been reported from samples collected at the mouth of Fox Creek and this contamination might well have resulted from dumping. The creek sediments contain high concentrations of metals. Apart from direct ecological considerations, concerns were expressed because local residents fish in Fox Creek. Thus, more comprehensive sampling and analyses of the nature (metals, PAHs, SVOC, and other COCs), distribution, and amounts of contaminants in Fox Creek are warranted. Sampling design should address the possibility of a gradient (i.e., upstream-downstream) of contamination in sediments and riparian soils. For example, organic COCs (e.g., PAH) will accumulate differentially in creek sediments that are enriched with organic carbon; thus, a gradient in the distribution of sediment organic carbon might produce a corresponding gradient in contaminant concentrations and exposure to sediment dwelling organisms. As in the channel connecting Pike Bay and Cass Lake, samples of contaminants in benthic invertebrates, crayfish, amphibians (eggs, tadpoles), and larval fish may provide valuable data for characterizing exposure to COC. Data should be developed and used to estimate sediment-to-fish and sediments-to-cattails bioaccumulation factors.

As in other site-related areas, studies of tree swallow diet composition, measures of body burdens (eggs and nestlings) for selected COCs, and observations of reproductive success can provide additional data and information for risk estimation, including a weight-of-evidence approach to risk characterization.

Food chain models should be constructed to address the accumulation of selected toxic chemicals by wildlife that inhabit or forage within the Fox Creek area, including mink, otter, raccoon, muskrat, and beaver. Contamination (i.e., dioxin) of creek chubs or larval and juvenile bluegill could serve as a source of contamination to fish-eating wildlife and should be evaluated. Additional exposure pathways include ingestion of water, soils, and sediments, as well as dermal exposures.

In addition to better quantifying the distribution of COCs in Fox Creek, more information concerning the toxic effects of site-related contamination on creek biota are needed to support a baseline ecological risk assessment. Clearly, the nature of the contamination argues for performing toxicity tests with Fox Creek sediments. Simple experiments can be performed to determine the relevance of phototoxicity in Fox Creek; samples of benthic invertebrates can be raised in the water column and subsequent mortality reported. Benthic community structure in Fox Creek could also be compared with communities in reference sites. Toxicity studies using surface soils in the Fox Creek watershed can be performed with earthworms, rodents (if available) and perhaps voles or shrews.

Forest Service Area

Discussions of the lands near the site that are managed by the U.S. Forest Service focused on identifying possible sites of historic chemical disposal.

Conclusions and Recommendations

Based on the results of the expert panel review, the Ecological Risk Assessment Panel arrived at the following conclusions and offers several recommendations concerning ecological risks posed by the St. Regis/Wheelers Superfund site.

Conclusions

The essential issues of concern for assessing ecological risks are similar to those expressed in relation to the human health assessment (Bartell et al. 2002).

1. An incomplete screening-level assessment has been completed and the results of the screening indicate that a more comprehensive risk assessment is justified (Tables 1–4).

2. The characterization of on-site and off-site contamination is inadequate to support a meaningful examination of impacts and risks posed by site-related contamination.

3. Evaluation of the quantity and quality of existing data is difficult given current levels of data reduction, analysis, and summarization.

4. Pathways of exposure have not been comprehensively investigated for the diverse assemblages of species potentially at risk.

If the contaminated groundwater plume continues its suspected pattern of movement toward Cass Lake, risks posed by the COCs in the plume to fish and other aquatic organisms could increase markedly in the future.

Limited efforts in ecological assessment at the Leech lake site to date have focused on dioxin and fish. As a result of reviewing existing information and panel discussions, the Panel concludes that the assessment needs to be expanded in terms of ecological endpoints and COCs. The selection of additional species as assessment/measurement endpoints should be guided by cultural practices involving plants and animals valued by the tribe, as well as by the ecological uniqueness of the region.

Recommendations

The panel recommends the following actions to facilitate the necessary ecological risk assessment for the St. Regis/Wheelers Superfund site:

1. Based on the preliminary screening-level results, a scientifically credible and technically defensible assessment of ecological risks should be performed.

2. A more comprehensive ecological assessment will require the collection of additional samples to characterize exposure and additional toxicity benchmark data.

3. The collection and processing of additional samples should be coordinated to improve the characterization of site contamination and provide data and information relevant for both the human health and ecological risk assessments.

4. An important component in improving the site characterization necessary to support an ecological risk assessment involves the derivation of bioaccumulation factors across media, COCs, and species at risk. For hydrophobic organic contaminants, measures of organic carbon in soils and sediments are unavoidable. Lipid concentrations in species of concern are also necessary to evaluate the potential for bioaccumulation of organic contaminants.

5. In contrast to the EJ Human Health Risk Assessment Report (Bartell et al. 2002), the identification of appropriate reference sites will be necessary to complete a meaningful ecological risk assessment. The reference sites should be selected to reflect ecological similarities to the conditions that existed at the St. Regis/Wheelers site prior to the onset of commercial activities.

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Table 1. Summary of ecological screening of surface soils exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

Area	Dioxin/furan	SVOC	VOC*	Pesticides	Metals
N. Storage	5/20	20/20	Not included	-	0/20
Pond A	-	2/2	"	-	0/2
Pond B	-	1/1	"	-	0/1
Pond C	-	1/1	"	-	0/1
Spray/irrig Landfill	-	2/2	"	-	0/2
Residential	0/20	17/20	"	-	1/20
Seep location	0/1	1/1	"	-	0/1
SW/hatchery	1/6	6/6	"	-	0/6
City dump/Fox Creek	-	1/1	"	-	0/1
Other-reference	0/2	2/2	"	-	0/2

*VOCs not evaluated in this report at the request of USEPA, although data are reported.

Table 2. Summary of ecological screening of sediments exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

Area	Dioxin/furan	SVOC	VOC*	Pesticides	Metals
City Dump/Fox Creek	9/13	9/13	Not evaluated	0/5	6/13
Channel	4/4	9/9	"	-	2/9
Reference	3/6	0/6	"	0/6 [DDT/DDE]	2/6
Cass Lake – deep	1/1	1/2	"	0/4 [DDT,DDE]	0/2
Pike Bay – deep	1/1	0/2	"	-	0/2
Pike Bay Shoreline	0/3	0/5	"	-	0/5

*VOCs not evaluated in this report at the request of USEPA, although data are reported.

Table 3. Summary of ecological screening of surface water exceedences for St. Regis/Wheelers Superfund site (EPA 2002). Fractions indicate number of exceedences over number of samples.

Area	Metals	SVOC	VOC*
City Dump/Fox Creek	2/3	0/4	Not evaluated
Channel	3/3	0/4	"
Reference	2/2	0/2	"
Cass Lake – deep	2/2	0/2	"
Pike Bay – deep	2/2	0/2	"
Pike Bay Shoreline	1/1	0/1	"

*VOCs not evaluated in this report at the request of USEPA, although data are reported.

Table 4. Summary of St. Regis/Wheelers Superfund site ecological exceedences used for screening fish tissue concentrations. In the absence of an "accepted" screening level for dioxins/furans, mammalian and avian "benchmarks" were used for fish tissue (EPA 2002). Fractions indicate number of exceedences over number of samples. Note that units specified for screening levels for PCBs and dioxins/furans in Table C-7 of EPA (2002) appear to be erroneously reported as "micrograms per kilogram of body weight per day."

	Dioxins/furans		PCBs	
Areas	Mammalian	Avian	Mammalian	Avian
Ball Club Lake	3/3	0/3	3/3	3/3
Cass Lake	5/5	0/5	5/5	5/5
Pike Bay	5/5	0/5	5/5	5/5

*VOCs not evaluated in this report at the request of USEPA, although data are reported.