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Interests and Expectations of the Confederated Tribes of the Umatilla Indian Reservation Regarding Hanford and Hanford-Affected Lands

Confederated Tribes of Umatilla Indian Reservation

Scoping Report 2:

Interests and Expectations of the Confederated Tribes of the Umatilla Indian Reservation Regarding Hanford and Hanford-Affected Lands.

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PREFACE

This document updates the previous document “Scoping Report: Nuclear Risks in Tribal Communities” prepared by CTUIR in 1995. At the time, “no comprehensive or sitewide evaluation of risks and costs has been performed at Hanford.” A decade later, this is still true. It is also still true that “a full risk picture must include addressing the impacts over time.”

This report provides a more docused perspective on how to establish both technically and politically defensible environmental management approach in an era of continued fiscal constraints. This was true in 1995 and is even more constraining in 2006. A major stakeholder-driven document was written in 1996 (Columbia River Comprehensive Impact Assessment, Part II). We believe that an investment by DOE in a more effective and efficient risk assessment approach as well as increased emphasis on integration of NRDA and Stewardship into the CERCLA process will ultimately save DOE money by reducing future maintainence and other costs.

Description of chapters:

Chapter 1 includes an introduction to the CTUIR, a discussion of homeland security, a description of the Hanford ethnohabitat ane associated environmental health concepts, and the CTUIR Hanford Policy. Chapter 2 discussed decision criteria, stewardship and insittional controls. Chapter 3 includes a vision of Hanford endstate that protect environmental health, Treaty Rights, and natural and cultural resources. Chapter 4 presents a risk evaluation framework that describes the information needed by many different stakeholders and decision makers.

CHAPTER 1 - INTRODUCTION

Tribal culture and individual Tribal citizens are embedded within the environment as integral components of an interconnected and interdependent environment. The perspective stands in stark contrast to the predominant view in non-Indian society where humans are viewed as separate from and superior to the environment in which they live. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) rely significantly on the health of natural and cultural resources in their ancestral homelands including prehistoric possessory and usuary areas, historic ceded lands, the Umatilla Indian Reservation, usual and accustomed fishing stations and including the health of the Columbia River and its tributaries. The United States government has a fiduciary responsibility toward protecting the interests of and upholding the rights of CTUIR members provided by Treaty of 1855 in making land management decisions including the regulation and permitting of pollution impacts to natural and cultural resources.

The Umatilla Indian Reservation has been impacted, continues to be impacted and will be impacted in the future by pollution from historic, current, and future sources permitted within of the United States. Pollution impacts, especially those from Hanford, represent a persistent long term presence in the air, ground water, water, and soil that are a direct threat to the health and livelihood of the CTUIR membership. However, Assessments of pollution impacts to human health and environmental risks do not fully include the subsistence lifestyles and reliance on natural and cultural resources by Indian people including the members of the Confederated Tribes of the Umatilla Indian Reservation. The CTUIR, through the Department of Science and Engineering, is actively participating in the federal, state, and local planning and decision making processes to preserve and protect tribal members and treaty reserved natural and cultural resources from pollution.

1.1 History of the CTUIR in the Columbia Basin

The Umatilla and Walla Walla occupied riverine tracts along both shores of the Columbia River and the lower courses of tributary streams, including Willow Creek, the Umatilla River, Snake River, Yakima River, and Walla Walla River. The Cayuse homeland lay along the upper reaches of the Umatilla and Walla Walla Rivers, and the Grand Ronde, Touchet, and Tucannon Rivers, as well as into the Blue Mountains.[1] The environments included the major rivers with salmon, sturgeon, lamprey and other fish, surrounded by shrubsteppe, bunchgrass steppe, and xeric montane areas.

Despite the aridity of the Columbia Basin, it was abundant with resources. Water is the origin of and essential for the survival of all life.[2] Fisheries were the staple of all life in the Basin. Elk, deer and other mammals were abundant, and a family could easily obtain the 20 or 30 deer it needed throughout the year (or 1/3 that number of elk)[3]. Roots, bulbs, nuts, berries, medicine, and fiber plants were seasonally abundant. Survival was not easy, but the tools and resources were available to support Tribal life since time immemorial.

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[1] Stern, T. (1998). “Cayuse, Umatilla, and Walla Walla.” In: Walker, D. (ed.), Handbook of the North American Indian, Vol. 12: Plateau, pages 395-419. Washington, D.C.: Smithsonian Institution.
[2] CTUIR (1996) Comprehensive Plan.
[3] Chatters, J. (1998). “Environment.” In: Walker, D. (ed.), Handbook of the North American Indian, Vol. 12: Plateau, pages 29-48. Washington, D.C.: Smithsonian Institution.

The southern Columbia Plateau was inhabited at least as far back as 11,500 years ago. With evolved ceremonial practices and socio-religious systems. By 11,000 years ago, a broad-spectrum hunter-gatherer subsistence economy with associated technology was well established. Animal remains at these sites include bison, deer, elk, and pronghorn, as well as smaller animals, salmon and other fish, and grinding and milling equipment associated with plant processing. Salmon have been available for that entire time.[4]

Seasonal rounds occurred as foods became available, at first on foot and with dogs, and later with horses. Eventually, a man was considered poor if he had only 20-30 horses. Most foods would be stored for winter use after drying, smoking, or cooking. Hunting, gathering, and procurement of materials on a family or community basis required an organizational strategy and an efficient skilled disciplined source of labor, with division of labor and specialization into various occupations. Without strict adherence to many of these cultural traditions, survival for over 13,000 years would not have been possible. Individuals have a personal relationship with the land and Creator through the sweathouse, and larger groups reinforce this relationship in the longhouse.

[4] Butler, V.L. and O'Connor, J.E. (2004). "9000 Years of salmon fishing on the Columbia River, North America." Quaternary Research 62: 1-8. http://web.pdx.edu/~virginia/pdf%20files/butler%20and%20Oconner%202004.pdf.

1.2 Homeland Security

Like every nation, the CTUIR is very concerned for the safety and integrity of its homeland. Every homeland has certain characteristics:

- Land Base – a secure land with jurisdiction and ownership
- Governance – stable, balanced government that remains vigilant to encroachment, exerts its rights on behalf of the membership, and adheres to the values and the Tribal vision and mission statements.
- Resources – natural, cultural, legal, technical, organizational, and human resources adequate to define and meet threats to stability, self-determination, resources, culture, mental and physical health, religion, economy and security.
- Capital Resources – infrastructure, cyber, and domestic resources designed to respond to threats and protect tribal values and resources with strength and understanding in a traditional manner.
- Security – confidence in natural resource adequacy and quality, confidence in a leadership that looks out for the members and the resources, confidence in adequate economic well-being, and confidence that the tribal culture, language, values, and people will survive.
- Culture – appreciation of individuals, creativity, support of the needy, devotion to the people, justice, and the shared history and blood ties to the land and to each other, according to the teachings of our elders.
- Religion – freedom to choose and practice any religion, or no religion.
- Economy – adequate food, clothing, shelter for individual and tribal needs, both in dollars and barter, but also including riches of the landscape, heritage, and knowledge.

Tribes are not just social organizations of people who happen to live close to each other or who happen to have some historical experiences in common. In order to be healthy, the people have to practice certain traditional spiritual and eco-cultural lifeways that depend on a clean and healthy ecology. This is who the Cayuse, Umatilla, and Walla Walla People are, body and soul. But we can only do this on the Reservation or in limited portions of our ceded area because all the rest of our land was taken. Therefore, any further diminution of the land base or resource quality diminishes the Indianness of CTUIR citizens. This loss of identity, combined with the poverty and termination policies and other physical, legal, economic and psychological assaults from the dominant society, has resulted in the problems we see today on most reservations. The anger and despair and low self esteem are often turned inward or against each other, as the only outlets that are not severely punished (called 'internalized oppression' or 'post-colonial traumatic stress disorder'). This is also why most tribes are encouraging a cultural revitalization, a return of pride and self-determination, a return to traditional lifeways and diets, a return to the language and religion, and why most tribes are taking a stand against further land and resource loss. Henceforth, we will determine our own destiny.

Since time immemorial when the Creator placed our peoples on their homelands, Indian people lived and thrived in the lands of the Columbia Basin. The land and waters provided abundant quantities of high quality fish, game, roots, berries, greens, and other plant foods, firewood, materials for construction and clothing, herbal medicines, ceremonial materials, sacred areas and sacred geographies, and raw materials for crafts and commerce. People were fit and healthy, renown for their athletic ability, long-lived (many elders lived to be 100 years old), and the land provided enough resources that ample leisure time was available for religious observations, recreational competitions, craftsmanship of material culture items, and extended trading trips. The homeland provided bountiful resources to support a rich culture, not just enough to barely survive, as the term 'subsistence' is sometimes misunderstood to mean.[5]

The reservation and Columbia River is also a safe haven to which people can return if they have to live elsewhere for a while. Therefore, the role of Tribal programs is to be the guardians of the places where cultural and personal well-being is attained and renewed, and where children can grow up safe and Indian. This will ensure that the warriors of today and tomorrow will always have a place of renewal between their forays into the battle fields of modern American courts and federal agencies. The Reservation is the last place where we can truly be Cayuse, Umatilla, or Walla Walla. The Umatilla Indian Reservation lands are the only remaining homeland of the Confederated Tribes. Without its land base and natural resources, the Tribes would lose their identity, their culture, and their traditions. Members of the Confederated Tribes use the Reservation and Columbia River for gathering native plants for food, medicine, and ceremonial purposes. Subsistence fishing and hunting hold deep cultural significance, as well as providing food for the family; therefore wildlife habitat is inseparable from cultural use. The Rivers, river banks, mountains, and terraces are religious places. The Reservation as a whole (in fact, the entire aboriginal territory) is a place of spiritual connection with ancestors. Special areas serve as burial sites, arenas for community gatherings, educational settings, socialization, and rites of passage.

1.3 The Hanford Ethno-habitat

Ethno-habitats can be defined as the set of cultural, religious, nutritional, educational, psychological, and other services provided by intact, functioning ecosystems and landscapes. An ethno-habitat refers to the cultural survival of a people within its traditional homeland. A healthy ethno-habitat is one that supports its natural plant and animal communities and sustains the biophysical and spiritual health of its native peoples through time. Ethno-habitats are also eco-cultural landscapes. Ethno-habitats are places defined and understood by groups of people within the context of their culture. They are landscapes with culturally familiar features defined by cultural knowledge and experience.

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[5] Subsistence does not refer to only the bare minimum to keep people alive. A subsistence economy is simply one in which production and consumption are more or less direct, without intervening currency. Individual households as well as communities are self-sufficient, including food production, technology, culture, religion, education, trade of goods, status and labor, and so on (M. Nash, 1966, Primitive and Peasant Economic Systems. San Francisco: Chandler Publishing Company).

These lands serve to help sustain modern Indian peoples' way of life, cultural integrity, social cohesion, and socio-economic well being. These lands encompass traditional Indian homelands, places, habitats, resources, ancestral remains, cultural symbols, and cultural heritage. The presence of and access for traditional use to healthy habitats is fundamental to useable and harvestable levels of resources significant to Indian peoples as well as to healthy ecosystems.

Those ethno-habitats that are places where useable quantities of culturally significant species may be obtained often overlap with ecologically-defined areas, although the species and their number and quality are often defined differently than Euro-American taxonomic systems would define them. Larger ethno-habitats can include multiple interconnected ecosystems, discrete geographic and seasonal use areas, and access corridors all within a collective set of significant places.

The Hanford landscape is a very important part of the Umatilla tribal homelands for several reasons. The basalt outcrops are important in tribal religious history and thus form a sacred landscape, social and cultural activities, and also provide unique food and medicinal plants. The upland portions of Hanford contain a series of interlinked habitats with an abundance of plants and animals important to tribes for many reasons (food, medicine, religion, and ecological functionality). The river corridor is also of utmost importance for cultural, nutritional, religious, social, educational, and other reasons. The continuity between the river and the basalt outcrops form a single system that nourishes its native people spiritually, nutritionally, medicinally, socially, and so on.

1.4 Relation of Environmental Quality to Healthy People 2010

Healthy People 2010 (HP2010) is a federal program designed to serve as a roadmap for improving the health of all people in the United States during the first decade of the 21st century. It is designed to increase quality and years of healthy life, and to eliminate health disparities. HP2010 seeks to increase life expectancy and quality of life over the next 10 years by helping individuals gain the knowledge, motivation, and opportunities they need to make informed decisions about their health. At the same time, HP2010 encourages local and State leaders to develop communitywide and statewide efforts that promote healthy behaviors, create healthy environments, and increase access to high-quality health care.

However, it is important not to destroy a culture in the process. Indeed, the underlying premise of HP2010 is that the health of the individual is almost inseparable from the health of the larger community. That is why the vision for Healthy People 2010 is "Healthy People *in Healthy Communities*" (emphasis added). Quoting from HP2010, "quality of life reflects a general sense of happiness and satisfaction with our lives and environment. General quality of life encompasses all aspects of life, including health, recreation, culture, rights, values, beliefs, aspirations, and the conditions that support a life containing these elements. Health-related quality of life reflects a personal sense of physical and mental health and the ability to react to factors in the physical and social environments."

The CTUIR has modified HP2010 indicators to be more relevant to the unique natural resources and cultural lifeways, as shown in the following table.

Comparison of HP2010 Indicators with CTUIR Goals	
HP 2010 Leading Health Indicator	**CTUIR Metric Related to Indicator**
Physical Activity	Cultural practices can be vigorous. Incorporating data on energy expenditure (funded by another grant) is part of our overall goal, but those activities must be safe, as expressed by risk assessment exposure factors combined with data on contaminants.
Mental Health	"Internalized oppression" or "post-colonial traumatic stress disorder" are widespread in tribal communities. Enhancing the culture reduces stress and associated disorders.
Environmental Health	Nationally, an estimated 25 percent of preventable illnesses worldwide can be attributed to poor environmental quality. Due to their closer environmental contact, this is probably higher for Tribes.
HP 2010 Objective for Improving Health	**Metric Related to Indicator & Objective.**
(3) Cancer	Reduction in exposure to radionuclides and carcinogenic chemicals by identifying the locations and foods to avoid, and the cleanest locations and cleanest native food in each food category.
(5) Diabetes	Increase in physical activities by participation in cultural programs; Improvement in diet through increased availability of clean native foods.
(7) Educational and Community-based programs	Development of educational materials on cleanest locations and foods; Increase in participation in cultural activities program through the Tamastlickt Cultural Institute, with age-specific goals.
(8) Environmental Health – Outdoor Air Quality	Development of regional air quality data through emissions inventories, TRI data, and on-reservation data collection.
(8) Environmental Health – Water Quality, including microbial and fish toxics.	Development of contaminant data for the hazard assessment (see next item)
(8) Environmental Health – Toxics	Complete cumulative risk analysis for fish toxics and other water sources.
(8) Environmental Health – Healthy Homes and Healthy Communities (hazards, sanitation, etc.)	Completion of a hazard assessment and regional picture of contaminants and exposure pathways (sources, water quality, pesticide use, CERCLIS sites, sewer and septic quality, etc.)
(8) Environmental Health – Infrastructure and health surveillance; human resources, information access.	Establish a tracking system for primary health outcomes (to be selected).
(8) Environmental Health – Global	Improved understanding of regional

Environmental Health	environmental health and vulnerability to indicators originating from outside our region.
(10) Food Safety	Identification of foods lower in toxics.
(11) Health Communication	Included in the Education item.
(16) Maternal, Infant, and Child Health	Provision of cleanest and healthiest food to women and children through WIC program and tribal giveaway program.
(18) Mental Health	Overall well-being in community cultural health includes mental health (not to be measured)
(19) Nutrition and Overweight	Improvement in dietary choices, with information about reducing food of poor nutritional quality and food with higher toxics.
(20) Occupational Safety and Health	Provision of information to tribal members who work at toxics sites.
(22) Physical Activity and Fitness	Information about safety of cultural activities at specific sites will be incorporated into recommendations on physical activity.

1.5 Environmental Justice and Health Disparities

Another goal of the federal government is to reduce the disparities in health measures among various subpopulations and the general US populace.

> "Inequalities in income and education underlie many health disparities in the United States. Income and education are intrinsically related and often serve as proxy measures for each other. In general, population groups that suffer the worst health status also are those that have the highest poverty rates and the least education. Disparities in income and education levels are associated with differences in the occurrence of illness and death, including heart disease, diabetes, obesity, elevated blood lead level, and low birth weight." (*from HP2010*)
>
> "There are differences experienced by American Indians and Alaska Natives residing in areas served by the IHS: males can expect to live 6 years less than the average U.S. male and AI/AN females can expect to live 5 years less than the average U.S. female. Infant mortality rates among AI/ANs are 24% higher than the total U.S. population. Mortality rates experienced by AI/ANs are disparate with overall U.S. rates: mortality rates are 67% higher due to alcohol related causes, 318% higher for diabetes, 180% higher due to accidents, 92% higher due to suicide, and 110% higher due to homicide."[6]

The disparities in health measures are magnified in Tribal communities ever more. Many co-risk factors tend to cluster in tribal communities, including poverty, low education, poor housing, poor transportation, poor communication infrastructure, marginal sanitation services, marginal mental health and social services, inadequate daycare and Headstart, less access to health care, and so on.

[6] http://www.qualitytools.ahrq.gov/disparitiesreport/documents/NHDR.pdf

On top of this, Tribes may be advised to reduce their dependence on healthy native foods and cultural practices in order to avoid contaminants. This further magnifies the community impacts of the other co-risk factors.

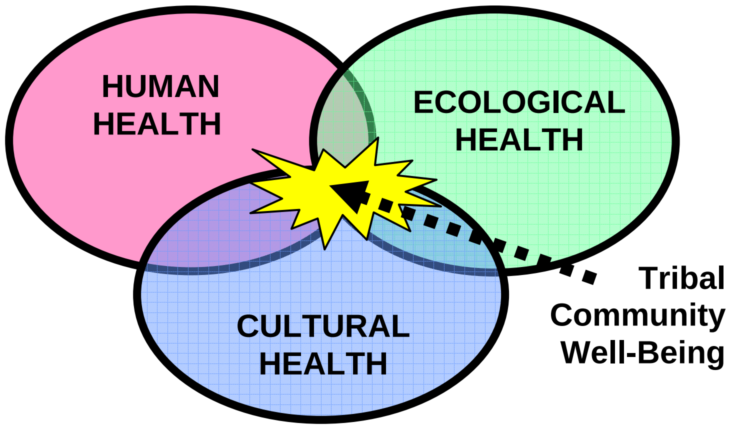
1.6 Expanded Definition of Environmental Health

The Agency for Toxics Substances and Disease Registry (ATSDR) has described several dimensions of human health: Biology, Behavior, Social Environment, Physical Environment, and Policies & Interventions. ATSDR recognizes the importance of the environment, but from a tribal perspective human and environmental health need to be even more integrated. From our perspective, **"Environmental Health"** is defined as individual and community physical, mental, social, cultural, and spiritual well-being achieved in the course of pursuing a tribal lifestyle as an integral part of a clean, intact, and functioning environment in traditional use areas on and off the reservation proper. It combines ecological, cultural, and medical and community health in a single human eco-cultural system.

> "The CTUIR culture, which has co-evolved with nature through thousands of ecological education, has provided its people with their unique and valid version of holistic environmental management. Throughout the year, when the CTUIR traditional American Indian participates in activities such as hunting and gathering for foods, medicines, ceremonies, and subsistence, the associated activities are as important as the end product. All of the foods and implements gathered and manufactured by the traditional American Indian are interconnected in at least one, but more often in many ways. The people of the CTUIR community follow cultural teachings or lessons brought down through history from the elders. Our individual and collective well-being is derived from membership in a healthy community that has access to ancestral lands and traditional resources and from having the ability to satisfy the personal responsibility to participate in traditional community activities and to help maintain the spiritual quality of our resources. This is an ancient oral tradition of cultural norms. The material or fabric of this tradition is unique, and is woven into a single tapestry that extends from far in the past to long into the future."[7]

The following figure illustrates a single eco-cultural system with inseparable human, environmental, and cultural health components. The importance of this concept cannot be overstated. Conventional forms of "intervention" are zero-sum actions – any loss of traditional

[7] Harris, S.G. (1998). CULTURAL LEGACIES. Plenary Address, Society of Risk Analysis Annual Meeting, December 7, 1998, Phoenix, AZ



1.7 Capacity Building

One of the goals of every tribal program is **"Capacity Building"** but it is seldom defined. Many federal programs seek to "build tribal capacity," but suffer from insufficient money, tribal employees who are unable to take advantage of opportunities through inadequate prior education/training, and unstable funding so the program shuts down when the grant is done, often without capturing any knowledge gained or data collected. We are still in our first generation of tribal scientists, but still have relatively few with PhD or MD degrees. While this is slowly changing, one of the long-term goals of the CTUIR Department of Science and Engineering is to mentor students starting in middle school or high school, and keep them in a science pipeline all the way through college and graduate school. A high degree of technical competence combined with cultural understanding is especially important when dealing with Superfund Sites, where we have to deal with EPA, State, Federal facility, and contractor staff on a scientist-to-scientist basis. This is an absolute necessity for dealing with Hanford and similar sites, and is the reason that the CTUIR established the Department of Science and Engineering.

"Capacity" is defined for this project as skills, information, personal knowledge, institutional memory, and professional habits. Building capacity includes:

- ***permanent program-level capability*** – the challenge is to preserve program advances even though training occurs at an individual level, so a process for constructing a tangible legacy of environmental health capabilities is possible.
- ***reports and plans*** - a Hazards Assessment, followed by a public health Needs Assessment;
- ***information and data accessibility*** - gaining the ability to obtain health data and environmental data; ability to access Internet data and other technical information in a timely and efficient manner;
- ***traditional environmental knowledge (TEK)*** – collect existing interview notes and recordings, continue interviewing when opportunity exists, work with Cultural Resources on a TEK archive particularly from the perspective of exposure estimates (resource use, diets, frequency and duration of activities, and information pertaining to quality of life parameters used in a dependency web format;

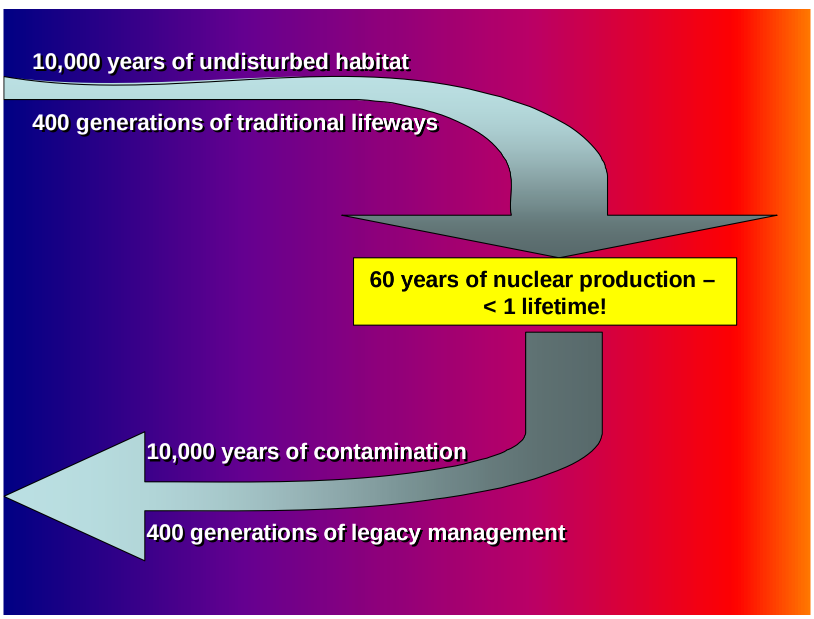
- ***expertise*** – hiring in-house national caliber staff who can provide regulatory-style responses to environmental contamination such as site assessment, exposure evaluation, remediation, incident response, natural resource planning, IHS planning, and so on. It also includes mentoring Tribal interns and public health staff.
- ***integration*** - enabling coordination between policy makers and environmental and health programs, acting at the interface between these programs and between corresponding disciplines;
- ***collegial networks*** – a database of resources and individuals, all centrally organized to provide access by any tribal program;
- ***record-keeping*** – a system for saving written records, meeting notes, tracking documents, and other professional habits;
- ***planning for financial stability*** - part of capacity building is continuity of institutional memory and commitment, which requires stable funding, so seeking additional financial support will be a part of the capacity that is built.

CHAPTER 2

STEWARDSHIP, INSTITUTIONAL CONTROLS, and REMEDIAL DECISIONS

2.1 Stewardship

The mission of the DOE Office of Legacy Management[8] is to manage DOE's post-closure responsibilities and ensure the future protection of human health and the environment. This Office has control and custody for legacy land, structures, and facilities and is responsible for maintaining them at levels suitable for their long-term use. It has taken less than one lifetime to permanently affect the ability to use Hanford and River resources for the next 10,000 years.



[8] http://www.lm.doe.gov/what_is/functions.htm

The temporal aspects of legacy management are unimaginable. EPA requires DOE to set a limit on exposure at the proposed Yucca Mountain facility in Nevada of 15 millirems a year for 10,000 years into the future, and then increase the allowable level to 350 millirems for up to 1 million years. The proposed standards also require that the facility must withstand the effects of earthquakes, volcanoes and significantly increased rainfall while safely containing the waste during the 1 million-year period.[9] Radioactive waste in near-surface disposal at Hanford will also remain radioactive for tens of thousands of years and will require perpetual care.

Radionuclide Half-Lives.

cesium-137	30 years	strontium-90	29.1 years
iodine-129	16,000,000 years	technetium-99	210,000 years
plutonium-238	87.7 years	tritium	12.4 years
plutonium-239	24,000 years	uranium-238	4,500,000,000 yrs

CTUIR goals for long-term legacy management are to maximize benefits within the context of permanent radioactive disposal sites. This will require that CTUIR becomes a primary steward of Hanford and its resources. The DOE definition of stewardship is "***all activities required to maintain an adequate level of protection to human health and the environment from hazards posed by nuclear and/or chemical materials, waste, and residual contamination after cleanup is complete***." and "***long-term care of DOE sites after cleanup is complete."*** To quote from DOE:

> "The mission of the LTS Program is to provide for continuous human and environmental protection, and the conservation and consideration of use of the biological, natural, and cultural resources, both during and following the completion of the cleanup mission. These resources include fish, wildlife, and plant populations and their habitats; minerals, natural gas, surface water, groundwater, land, and other natural resources; prehistoric archaeological sites; Native American sacred and ceremonial places; and historical resources. The interactive system of human cultures, ecology, and natural resources are protected now, and in the future, from the risks associated with the residual contamination. At Hanford the term "long-term stewardship" consists of three elements: management of residual risk, management of Site resources, and reuse. The first element is the management of the risks (human health, ecological, and cultural) associated with any remaining residual contamination. Restoration of contaminated areas to their pre-Hanford condition is often not feasible because of the associated worker and environmental risks, costs, and technical and logistical issues. The second element is the protection of the Site's cultural, biological, and natural resources. Many of these resources have been set aside and protected for nearly 60 years, providing a vital link in the preservation of the biodiversity of the Columbia Basin's ecoregion. The third element is the reuse of the Site's assets as land, facilities, technologies, and skilled personnel are no longer required to support Hanford Site missions. Because the completion of the cleanup mission at Hanford will not result in the complete elimination of all residual contamination (either radiological and/or hazardous), long-term stewardship activities will be required for portions of the Site to ensure protection of human health and the environment. Restoration of contaminated areas to their original conditions (prior to Hanford use) is often not feasible because of the associated worker and environmental

[9] **Proposed Yucca Mountain Standards to Protect Public Health For a Million Years.** Tuesday, August 9, 2005. http://www.newsday.com/news/health/sns-ap-yucca-mountain,0,1699616.story?coll=ny-leadhealthnews-headlines

risks, costs, and technical and logistical issues. At the conclusion of the cleanup program, residual hazardous contamination will remain, both on the surface and subsurface. The length of time over which long-term stewardship activities will be required is not measured in terms of years, or even decades, but rather in terms of hundreds, and in some cases, even thousands, of years. Among the hazards remaining are plutonium, cesium, strontium, and tritium. With half-lives for some of these contaminants ranging from a few years to over 20,000 years long-term stewardship will be required on portions of the Site long after cleanup is complete to protect human health and the environment." [10]

"Except at the Yucca Mountain and Waste Isolation Pilot Plant (WIPP) geologic repositories, wastes will not be buried deep in the earth. They will therefore require even greater efforts to keep them effectively isolated over the long term. Many of the radioactive elements and radioisotopes that DOE manages will remain dangerously radioactive for thousands or millions (in the case of uranium-238, billions) of years. While DOE can undoubtedly control the *foreseeable* future of sites it owns, its reliance on institutional controls to achieve its long-term stewardship goals may not be justified. The history of such controls is checkered at best. The authors find that the statutes and regulations fail to impose effective restrictions on the future use of contaminated property and do not establish the types of institutions that are necessary to manage long-lived wastes."[11]

"Broadly speaking, stewardship refers to physical controls, institutions, information, and other mechanisms needed to ensure protection of people and the environment, both in the short and the long term, after the cleanup of the weapons complex is considered "complete." The likely elements of a stewardship program are

- Site monitoring and maintenance;
- Application and enforcement of institutional controls;
- Information management; and
- Environmental monitoring.

The notion of stewardship carries with it something more, however, than simply a list of tasks or functions to be implemented. It connotes a sacred responsibility to protect human health and the environment for future generations. One key issue, however, is whether DOE should continue to have a major role in stewardship of its sites, or whether responsibility for long-term stewardship should be transferred to another federal agency, or to state agencies, for certain sites. If DOE continues to have responsibility for stewardship activities at its sites, increased external oversight—by EPA, states, or some other agency—will be needed to hold DOE accountable and increase public confidence that important post-closure activities are, in fact, being implemented. EPA, too, bears an important responsibility for addressing these issues. Superfund is one of the primary statutes driving cleanup activities at DOE and many other contaminated sites. The increasingly frequent use of institutional controls as an integral component of site remedies and their potential application at DOE sites demands that the issue of assuring the long-term integrity of institutional controls be addressed. Equally important, federal appropriations specifically earmarked for stewardship activities will be needed, both to fund the program and to confirm the commitment."[12]

[10]GAO (2002) HNF-12254 REV A WORKING DRAFT WORKING DRAFT Hanford Long-Term Stewardship Program: Integrating Accelerated Site Cleanup Completion with Long-Range Post-cleanup Planning.
[11] John S. Applegate and Stephen Dycus (1998) Institutional Controls or Emperor's Clothes? Long-Term Stewardship of the Nuclear Weapons Complex. 28 Environmental Law Reporter 10631-10656.
[12] Probst, K.N. and McGovern, MH (1998) Long-Term Stewardship and the Nuclear Weapons Complex: The Challenge Ahead. Resources for the Future.

2.2 Summary of CTUIR Views on Institutional Controls

Under CERCLA, cleanup has two phases: remediation and natural resource damage assessment. Under DOE's definition, cleanup has two phases: remediation and stewardship. These two mental models have different goals. The CERCLA goal is to make the site whole: remediate the site to protect human health and the environment, and then restore natural resources to the condition prior to the release or establishment of the facility. The DOE goal is to implement remediation and restoration, but then assumes that permanent institutional controls and guardianship of the majority of the Hanford site, with natural resource management of the rest.

When cleanup is completed, most DOE sites will require some level of long-term stewardship (LTS) to ensure protection of human health and the environment from hazards that remain after the cleanup is complete. Long-term stewardship includes all engineered and institutional controls designed to contain or to prevent exposures to residual contamination and waste, such as surveillance activities, record-keeping activities, inspections, groundwater monitoring, ongoing pump and treat activities, cap repair, maintenance of entombed buildings or facilities, maintenance of other barriers and contained structures, access control, and posting signs.[13] DOE uses a layering strategy of mutually reinforcing controls to protect human health and the environment from the hazards associated with residual contamination. Physical and administrative controls are commonly referred to collectively as "institutional controls."

- Engineered barriers are man-made controls (e.g. caps, entombment of facilities, contaminant immobilization) designed to isolate or to contain waste or materials.
- Physical controls provide an additional level of protection when used in conjunction with an engineered barrier to discourage people from reaching the residual contamination.
- Physical controls may include, but are not limited to, signs, warning markers, and fences.
- Environmental monitoring includes groundwater, air, crops, plants, and animals to verify that cleanup remedies remain effective and protective.
- Administrative controls are the administrative set of policies, procedures, and laws that help ensure that activities or uses do not disturb physical controls, engineered barriers, or residual contamination.

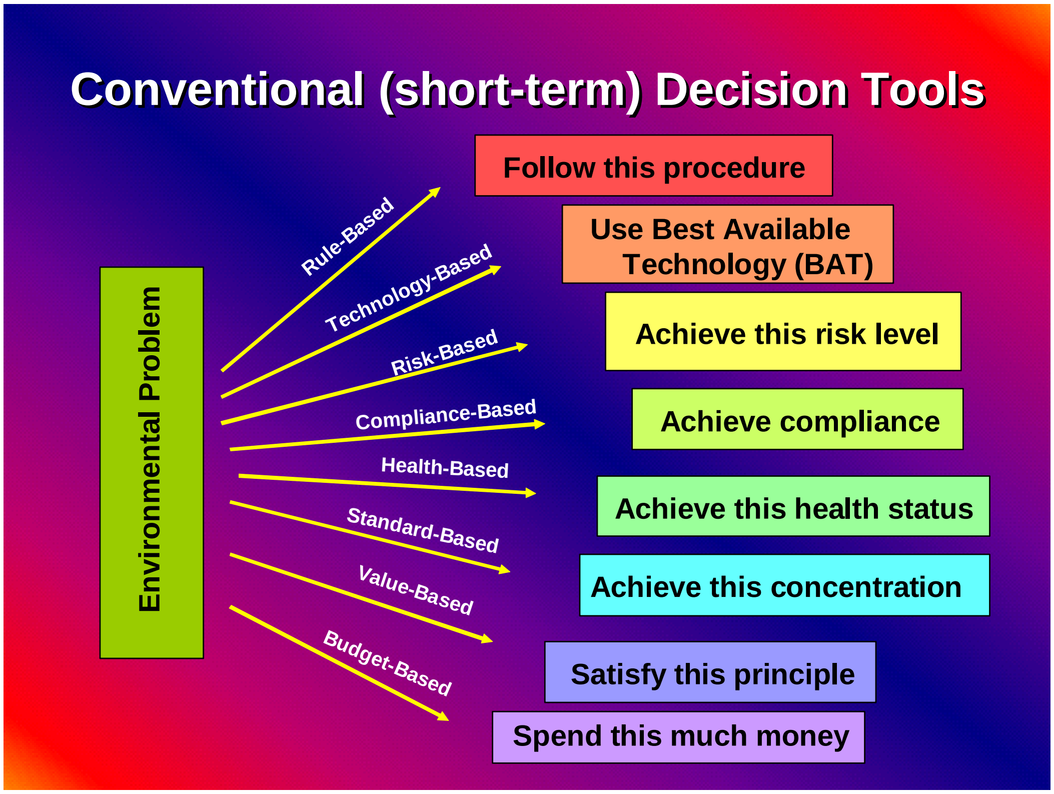
2.3 The CTUIR CERCLA Decision Criteria

As tribal staff, our actions are based on our need to protect our peoples' Trust and Treaty rights. Additionally, we help protect tribal sovereignty, rights, people, individual and community health, values, natural and cultural resources, and a traditional way of life. Our highest goal is "*to protect the continuity and well-being of the people."* Therefore, we evaluate federal actions for their impacts on (1) tribal rights/sovereignty, (2) individual and community health over many generations, (3) ecosystems, ethno-habitats or ethno-ecosystems, natural and cultural resources, and landscapes, and (4)

[13] US DOE (2002). Long-term Stewardship Planning Guidance for Closure Sites (No number); . *A Report to Congress on Long-term Stewardship* (DOE 2001*)*

on the ability to practice traditional religion and the traditional way of life. We evaluate this as a whole package, and not just as thresholds of acceptability for individual metrics. We must also evaluate federal actions for their underlying commitment to meeting federal trust obligations to tribes, to achieving equity and environmental justice, to precautionary decision making, to the restoration, protection and enhance of natural resources, to the sustainability of ecosystems and cultures, and to the health and range of options available to future generations.

The following figure illustrates various decision criteria. They do not all result in the same amount of cleanup. For example, CERCLA cleanups must meet both risk-based levels and concentration standards for individual chemicals. In many situations, meeting individual standards does not result in meeting cumulative risk levels if there are multiple contaminants.



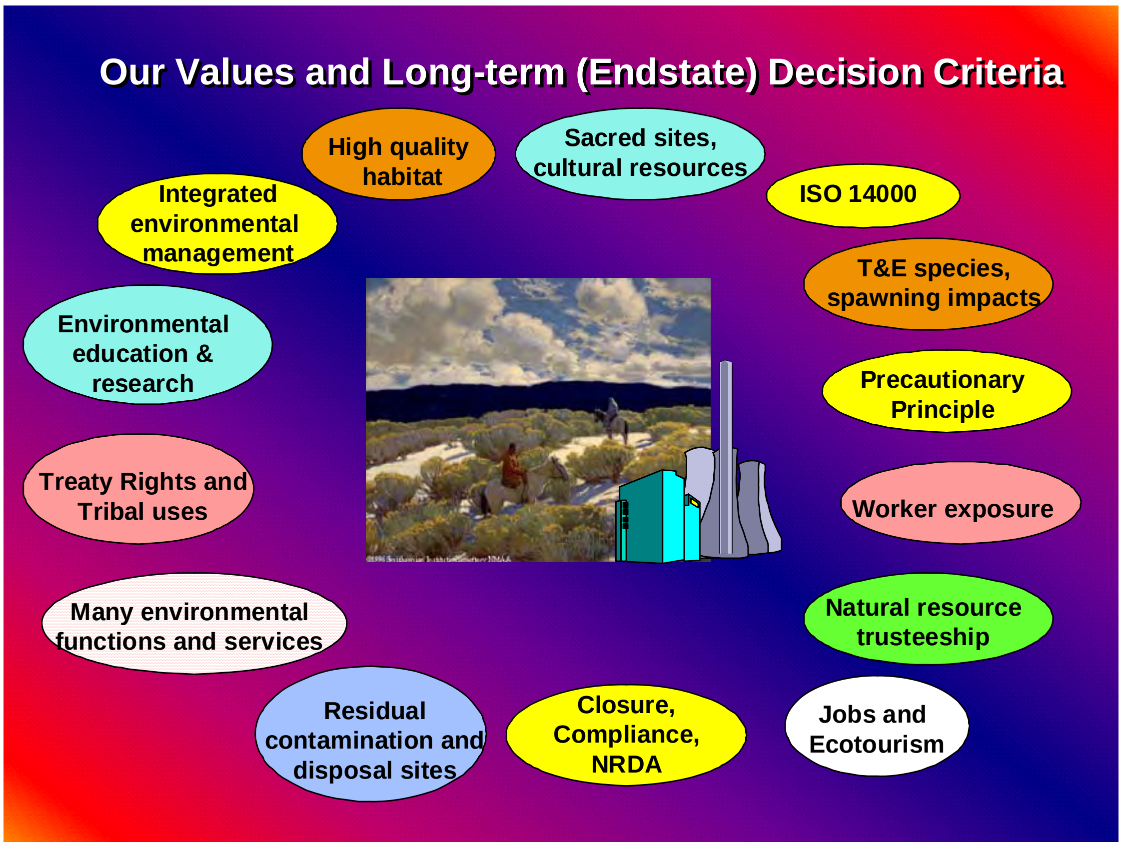
The decision criteria used at Hanford have been confused, resulting in different expectations resulting from undefined terminology. For example, meeting Safe Drinking Water Act MCLs for individual contaminants results in different cleanup goals than cumulative health-based goals. This is a problem at every Superfund site, including Hanford, but it seldom dealt with in a way that the public understands. *Expand this discussion.*

The CTUIR definition of an endstate that is sustainable through an active stewardship or legacy management program, and one that protects human health and the environment is:

1. One that complies with all existing Treaties, ARARs, and Agreements;
2. One that protects natural and cultural resources and the human use of those resources, particularly Tribal health during the exercise of traditional lifestyles as described in our exposure scenario. This is a health-based cleanup, which is different from a standards-based cleanup.
3. One that assesses natural resource injuries, and minimizes, restores, mitigates, or compensates for past injury as well as future injury due to residual

contamination. This includes ecological injury as well as lost human use as quantified through the use of our exposure scenario.

4. One that protects people and resources over thousands of years. Hanford will remain contaminated for a period of time as long as mankind has existed as a species.
5. One that is based on cumulative lifecycle risks and costs and Value-of-Information decision analysis. This includes a wider variety of risks, including cultural risk.
6. One that preserves all future uses, by cleaning, restoring and maintaining all Hanford lands in an original or baseline condition. We consider this to be the highest and best use of the land, and the most valuable status or condition.



This figure depicts our criteria for closure and endstate acceptability. We evaluate each of these, some quantitatively and some qualitatively but nevertheless systematically. Specific metrics are not presented here; they have been transmitted to DOE on many previous occasions.

Natural Resource Trusteeship. This issue has not been adequately factored into DOE planning and closure. All of Hanford is under the oversight of natural resource Trustees. This trusteeship persists even after land ownership is transferred to another federal agency. Thus, the process for taking land away from Trustees and giving it to private owners (such as civic entities) has never been discussed. Can local land use controls honor Trusteeship if local governments are not Trustees? Do Counties have to honor Treaties in their Urban Growth Management Plans? Counties are notorious for ignoring

Tribes and Trusteeship. Who bears the accountability or liability for making equitable decisions?

Reasonably Foreseeable Post-Reclamation Land Use. The Hanford Remedial Action EIS, which became the Hanford Comprehensive Land Use Plan (CLUP), set some land uses for 50 years. The CLUP did not abrogate Treaty Rights, and NEPA cannot "trump" a Treaty. Regardless of the CLUP, our land use is always traditional lifeways across all of Hanford throughout time.

Land uses always change. Today's land use plans do not necessarily reflect what future land use will actually be. All land use controls fail. Local zoning ordinances are easily undone.[14] Land uses that are inconceivable now *will* happen. There are many examples of decisions made less than one generation ago that are forgotten, resulting in schools and houses being built on landfills, and waste sites being inadvertently intruded into. The best solution is to clean up to the highest and best condition, which would allow any future use to be safe.

Time Frame. The time frame of evaluation is at least 10,000 years or as long as the material remains intrinsically hazardous, not 1,000 years, and especially not the mere 50 years discussed in the land use plan. The time frame for institutional control failure is 100, not 150 years. Intruder and residential scenarios must be evaluated starting with current conditions and continuing for 10,000 years or as long as the material remains intrinsically hazardous. The proper way to perform a risk assessment is to evaluate what the risks would be now, and then determine how to deal with access and land use, rather than to restrict access first and then decline to evaluate those risks at all.

Disposal and Waste Reclassification. We oppose the reclassification of waste, including tank waste, to lower designations that might result in near-surface disposal of highly radioactive materials. If reclassification occurs, then the RBE must assume that institutional controls fail within the prescribed time under CERCLA, and intruders intentionally or unintentionally penetrate the caps over the landfills, waste trenches and tanks. If DOE asserts that there will be 10,000 years of monitoring and effective DOE control, then the RBE must describe how this will occur and the likelihood that it will be adequately funded.

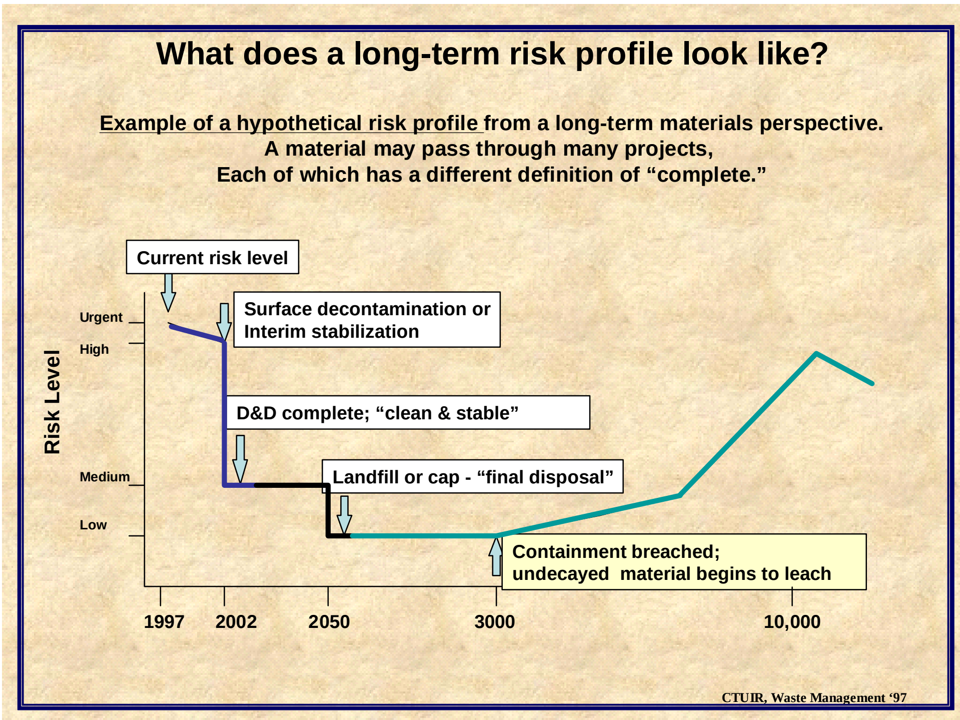
Life Cycle Cost-Benefit Analysis (CBA) and Life Cycle Risk Assessment. We believe that CBA is misunderstood. For example, DOE apparently will compare safety issues to dose-based risks. DOE should not assume that their nuclear transportation drivers have a certain number of accidents per mile based on national DOT highway statistics, nor should DOE assume a certain number of accidents per mile for trucks that are moving waste from one part of Hanford to another. As recognized in the RBE guidance, DOE is required to proceed with its cleanups safely, period. Therefore, the safety requirement is to train nuclear drivers to a much higher standard that the general public so that accidents do not happen at all, and to maintain its equipment at a much higher standard, to maintain road conditions safer, and so on. If DOE assumes a higher number of accidents for its nuclear drivers, then DOE is not meeting safety standards.

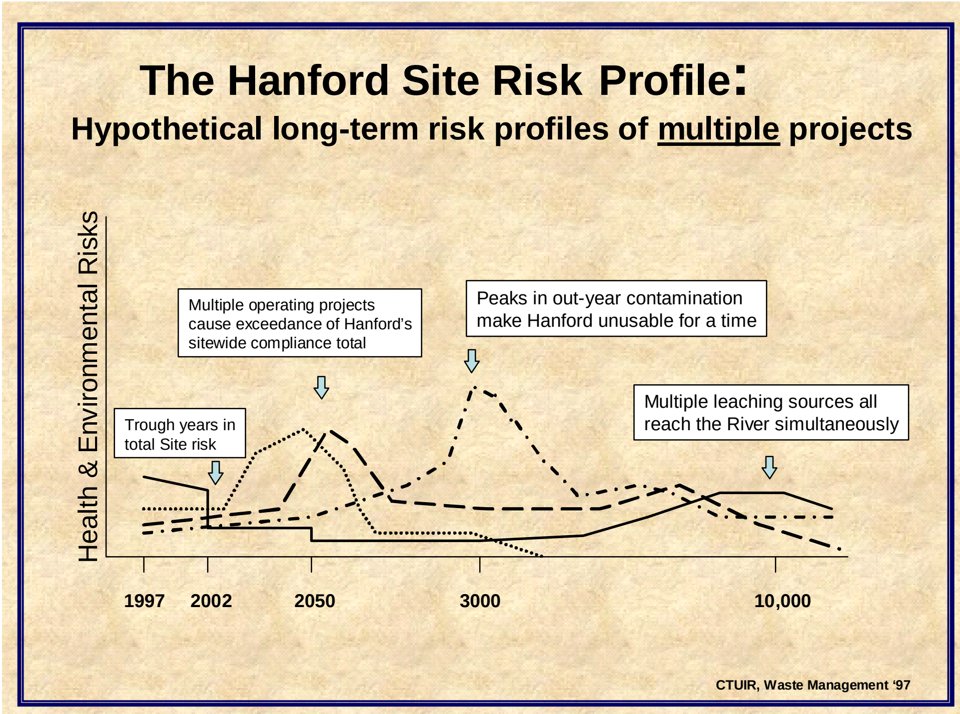
[14] MR English and RB Inerfeld, 1999. "Institutional Controls for Contaminated Sites: Help or Hazard?" Risk: Health, Safety & Environment 10: 121-138.

If life cycle cost/risk comparisons are made to endstates requiring institutional controls, then the life cycle cost must include NRDA damage costs for ecological injury and lost human use to account for the differential between full cleanup and partial cleanup. We believe it is imperative to develop methods to evaluate lifecycle risks and lifecycle costs. The following figures illustrate some of the concepts and show how endstate and legacy planning would benefit from these types of discussions.

What does a long-term risk profile look like? At each stage of material processing, there is an associated risk profile (not shown in the figure above). There is a long-term risk profile if material is not stabilized, and a smaller risk profile associated with material after it has been stabilized. Even landfills and capped sites have risk profiles associated with future breach of containment. If the area under each risk curve is integrated and compared, the differences reflect how much risk is reduced. Sometimes this risk is merely delayed as containment delays release of contaminants. In other instances, containment allows decay before it escapes containment, which is true risk reduction. The magnitude of this risk reduction is what we are "buying" with Hanford cleanup, and if all risks (human, ecological, cultural, economic, and social) are properly evaluated, we can better justify the budgets and benefits of Hanford cleanup. We have presented ways to evaluate all the risks and impacts (dependency webs and risk metrics).

Risk integration and endstate planning would also benefit from evaluating the overlap between the long-term risk profiles of different projects. Even with a great deal of uncertainty about long-term contaminant migration and risks, a value-of-information approach to developing long-term risk information would likely show the cost-effectiveness of developing these risk profiles.





The Hanford Site Risk Profile:
Hypothetical long-term risk profiles of multiple projects
Health & Environmental Risks
Multiple operating projects cause exceedance of Hanford's sitewide compliance total
Peaks in out-year contamination make Hanford unusable for a time
Multiple leaching sources all reach the River simultaneously
Trough years in total Site risk
1997
2002
2050
3000
10,000
CTUIR, Waste Management '97

CHAPTER 3

HANFORD ENDSTATE VISION

Honoring our past, taking responsibility for our future, the CTUIR DOSE will protect the long-term environmental quality of environmental resources on or influenced by the Department of Energy's Hanford site so that Treaty rights can be safely and effectively exercised and so that the health, resources, and rights of the current and future generations of the CTUIR are protected.

This Chapter clarifies the CTUIR endstate vision for Hanford. The Hanford Site is alive with the heritage of Native people. Continuous use of the natural resources reaching back 10,000 years at Hanford is well documented. The Big River, N'chi'wana, remains the lifeblood of tribal culture and traditions, as it has been for generations upon generations. The river sustains and nourishes many interlinked peoples and systems, including the salmon, the deer, the eagle, the human, the sagebrush, and so on. Recognition by native ancestors that all natural and cultural resources, as well as the lives of the native peoples, are linked within a single web has grown into a holistic environmental management science over many millennia of systematic observation and inductive reasoning.

Our most basic natural resource values are cold, clean, uncontaminated water; clean, clear uncontaminated air; uncontaminated soil; clean, vibrant, and uncontaminated biological resources; clean, uncontaminated, and wholesome foods; and clean and healthful medicines.

The goal of the CTUIR is to protect and restore all native species and habitats still remaining at Hanford, to restore particularly sensitive or significant habitats to their baseline conditions, and ensure that the lands and resources are clean enough and whole enough that traditional practices (unlimited use and unrestricted access[15]) are safe.

- To ensure that Tribal natural and cultural resources are protected, preserved, and perpetuated by making certain that Hanford generated pollution is not allowed to further contaminate or in anyway devalue on- and off-site Tribal natural and cultural resources such as those associated with the Columbia River.

- To protect the ecology of the Hanford Site in its entirety by evaluating the effectiveness of clean-up actions at Hanford and pursuing further clean-up where Tribal rights and resources have to been fully protected.

[15] USEPA (2001). Comprehensive Five-Year Review Guidance. EPA 540-R-01-007, OSWER No. 9355.7-03B-P.

Our most basic value might be expressed as ensuring the continuity and well-being of tribal peoples and their homelands. The basis for this value is often cited as a combination of (1) legal documents (Treaties, the U.S. Constitution, environmental statutes), (2) court cases that uphold trusteeship, sovereignty, and treaties, (3) federal policies that recognize and affirm underlying principles and obligations of trusteeship, government-to-government relations, and ecological and environmental health protection, and (4) religious teachings that stress that in return for being given a planet that provides the resources needed for survival, health, and fulfillment there are proportional responsibilities to care for mother earth and fulfill sacred duties.

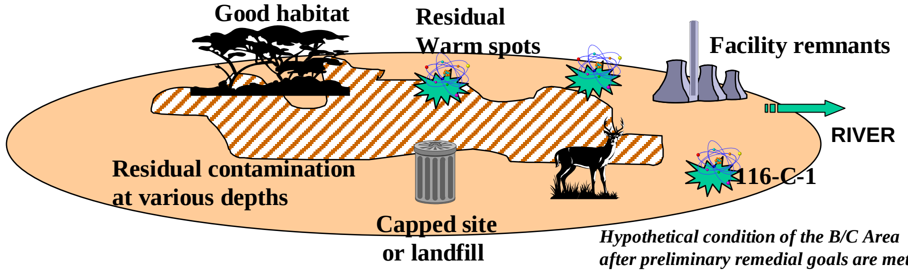
Whether these values are interpreted by the dominant society as common sense, a legal requirement, a philosophy of enlightened self-interest, an environmental religion, or a stewardship ethic, the result is the same - caring for mother earth and all her peoples now and in the future. The single Columbia Basin fabric that includes human livelihood, many cultures, environmental functions and services, and tangible resources and goods can be thought of as a single ethno-habitat (human beings living within and inseparable from the environment).

Of fundamental importance is the fact that cultural identity and integrity depends on being able to protect ancestral, cultural, or heritage areas for hunting, gathering, fishing, ceremonies, teaching, religious observances, and social activities. Thus, the integrity of the overall cultural fabric depends on being able to conduct these activities in a clean and whole environment, and being able to fulfill sacred duties. It should therefore be recognized that, in addition to the sustenance (nutritional services) and everyday implements provided by sites and natural resources, they also provide cultural services.

Framing the Issues about Endstates

Issue: We need to close ecosystems, not facilities or hotspots or parcels of property with artificial boundaries.

Problem: Is it possible to close single sources within a larger multi-source area with widespread shallow, deep or groundwater contamination?
Problem: There may be different contamination at different depths moving at different speeds. Must we close the source to receptor as a single system? Can we "close" horizontal slices of real estate, leaving some layers contaminated?
Problem: *When* and on what *scale* is a "baseline" risk assessment needed?
Problem: Project endpoints must help describe the Sitewide Endstate

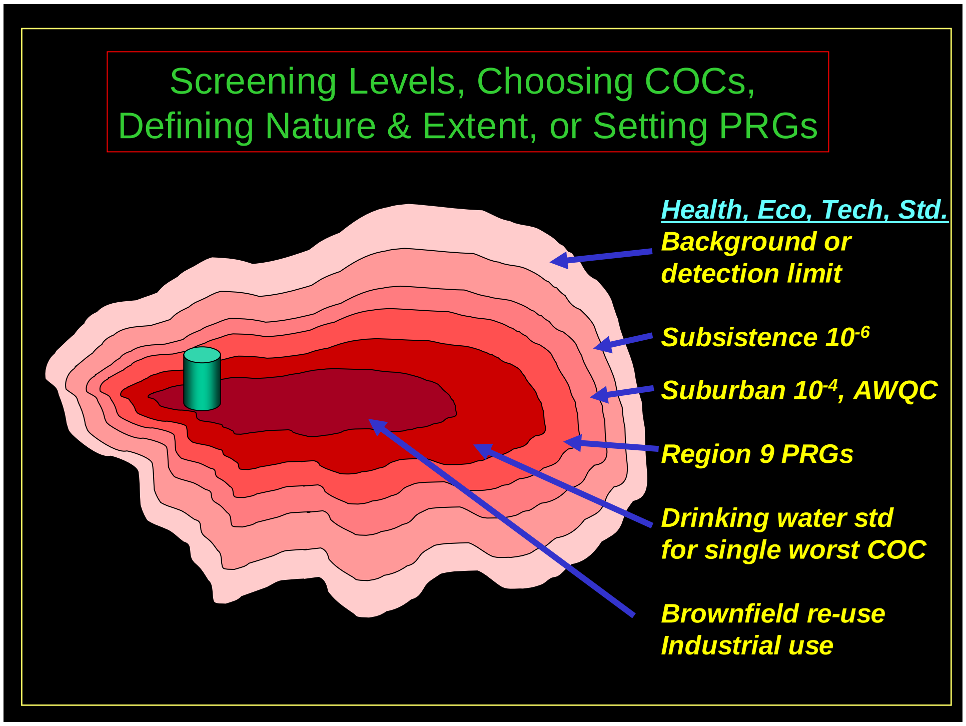


Hypothetical condition of the B/C Area after preliminary remedial goals are met

Hanford Values and Vision

1. Our intention is to regain our use of the Hanford area to fish, hunt, gather traditional foods, and practice our traditional culture, ceremonies, and commerce. The protection of the health and safety of members as they practice their traditional, cultural, and commercial practices at Hanford is paramount.

2. The US government must protect the interests of the CTUIR by ensuring that lands, water, soil, air, biological and cultural resources are clean and safe to use. The US government must also ensure that, after clean-up, human health is not adversely affected from chemical, radiological, and physical impacts that are related to operations or management of the Hanford site.



This figure illustrates the range of possible endstate contaminant levels, based on a combination of acceptable risk, land use, and number of pathways considered. The inner core of this hypothetical groundwater plume consists of institutional controls and a land use that assumes relatively little, if any, contact with groundwater. The next ring requires slightly cleaner levels, and would be suitable for public use only if a drinking water standard for one contaminant at a time is used as the criterion. The third ring, EPA Region 9 Preliminary Remedial Goals, requires slightly cleaner levels, and assumes additional groundwater uses in addition to drinking water. The next ring assumes a suburban lifestyle, multiple water-based exposure pathways, a minimally-protective risk level (1E-4), and individual contaminant ambient water quality standards (actually applies to surface water). A subsistence land use and a more protective risk level require an even cleaner condition. Background conditions, or detection limits.

Form the outermost ring, and is the conditions when truly unlimited use and full restoration of baseline conditions is achieved.

100 Area Summary Statement

The River corridor is very important to CTUIR, including the riparian areas, the upland areas and the River itself. The River, river corridor, and adjacent lands are locations included in our Treaty as locations where we reserved rights of access and use. Additionally, the CTUIR is a Natural Resource Trustee of these areas. We consider the 100 Area and the River Corridor to be part of the same unit. We also consider groundwater and soil sites to be linked, and we believe that they cannot be closed independently even if, for practical reasons, they have been designated as separate operable units and are on separate schedules.

Our land use in the 100 Area is the same year-round lifestyle, with fishing, hunting/livestock, gathering/gardening, pasturing, and sweating that is described in our CTUIR exposure scenario. Our scenario should be used to evaluate risk and set cumulative (multi-pathway, multi-media, and multi-contaminant) health-based remedial goals. If the risks are reduced to acceptable levels as confirmed by the use of the CTUIR scenario, there will be no further lost or restricted use. Setting remedial goals for individual contaminants when multiple contaminants are present results in unprotective remedies due to additive risk. Any institutional controls that are required to reduce health risk are demonstration of lost use (a NRDA issue).

Baseline environmental conditions are defined as good-quality shrub-steppe and riparian habitat that has not been disturbed or contaminated. Regaining that level of habitat quality will support traditional tribal uses. For groundwater, the data for invertebrates in the hyporheic zone (what invertebrates are present, what is their abundance, what is the toxicity of contaminants, and what is the effect of anoxic conditions) is thin.

Criteria for closing the 100 Area as a complete unit have not been developed. Considering the amount of residual contamination that is being left beneath clean fill and the spatial extent of groundwater contamination, it is not clear what are appropriate closure criteria.

It makes sense to allow the entombed the reactor cores to remain where they are for several decades in order that radioactive decay can occur and make subsequent removal less risky and less ecological damaging. However, a bond must be posted to ensure that future removal will occur, or there will be an accumulation of lost use (NRDA damages) while we wait.

We prefer that the pipe outfalls in the river be removed. We believe that the environmental damage done when the pipes were laid is equivalent to new damage that would occur during their removal. However, studies should be done to determine the least damaging means of doing this, or whether circumstances are different now (for instance, whether sediments are so contaminated that any disturbance would mobilize sediments to gravel spawning beds; in this case a shield to deflect sediments or timing to avoid spawning runs would need to be explored). Work on the pipelines may be most practical to do when the river would naturally be at its lowest flow.

The N-Area groundwater plume must be addressed. The CTUIR exposure scenario includes access and use of groundwater. Whatever remedy is selected, the recovery time will be evaluated in the NRDA process. It is important to understand these recovery curves for each plume.

If the 100 Area is ever transferred to another federal agency, we prefer that it be transferred to BIA and USFWS jointly. In any event, federal and tribal national governments take precedence over local civic governments.

Frequently Asked Questions

A final regulatory decision must be made for the 100 Area cleanup. Given the National Monument designation and the Department of Energy Record of Decision on land use, what post-cleanup activities do you see for the 100 Areas?

- Full traditional use, as reflected in the CTUIR exposure scenario, including year-round residence, gathering/gardening, fishing, hunting/livestock, pasturing, and sweating. Cumulative, health-based remedial goals should be used to select a remedy, including groundwater.
- If institutional controls are required because the CTUIR scenario shows excessive risk, this will be lost use under NRDA
- Neither the CLUP nor the HRNM designation can be used to break our Treaty or deny access.
- CTUIR could manage the land areas not in the National Monument and co-manage the land in the HRNM
- We would like excess land returned to us; Tribal governments take precedence over local civic governments. If the land is not returned directly to us, then we would prefer that it be turned over to BIA and USFWS jointly.
- Locations of cultural resources must be protected; adequate staff must be provided.
- Data on the hyporheic zone, including invertebrates, is weak.

Should the reactor blocks be moved to the Central Plateau? If so, now or at the end of an interim storage period?

- Comfortable with leaving for a while but strongly want ultimate removal. Do not implement irreversible remedies, such as monolithic concrete or grout in tanks. OK to wait a little longer if reactors can then be cut and completely removed without too much ecological damage. Post a bond now so those funds will be available in 75 years; otherwise, there will be additional NRDA lost use while we wait.

Are the remedies completed at waste sites in the 100 Area sufficient to be considered final remedies?

- Probably not, but we won’t know until a truly cumulative, multi-pathway, multi-contaminant, integrated risk assessment is done.

- Since rad training and safety training is required to go anywhere on site, and additional training is required to walk around and do work in the operable units, they are clearly not safe now.
- Note on remedy selection: if the only criterion is to reduce human health risk, an institutional control would break an exposure pathway. If both human and ecological risk must be reduced, then an institutional control (which does nothing to reduce ecological risk) is not adequate. If human, ecological, and cultural risk must be reduced, then a more extensive but less intrusive remedy must be chosen.
- Note: there is no such thing as "unrestricted surface use." This is not CERCLA language – land use refers to a site, not just to layers of a site. A "site" extends from deep in the ground to high in the air, and site closure is not done a layer at a time, despite the designation of operable units as soil and water pieces (this is a merely practical measure since the engineering required to remediate soil and groundwater is so different).
- Note: worker dose is not a cleanup issue or a risk tradeoff – workers will not receive an excess dose, period. This is why there is such a strict dosimetry program. Further, rad workers today wear dosimetry badges so their doses can be ensured of remaining within acceptable limits. Tomorrow's workers may not. Tribal members will not be wearing badges as they engage in traditional activities and lifestyles. No one except workers is carefully monitored for dose.

Should the pipelines from the reactors into and under the Columbia River be removed or should they be left in place?

They must be removed. Studies must be done to determine how to do this with minimal ecological damage.

Groundwater in the 100 Area is expected to meet applicable standards by the end of the cleanup mission with the exception of the strontium-90 (Sr-90) plume at 100 N. Is it acceptable to rely on radioactive decay to remediate this plume or are extensive efforts required to perform further treatment?

- No. "Applicable standards" are not cumulative, and were not developed with Tribal usage levels in mind; therefore MCLs or other numerical standards for individual contaminants do not protect tribal health or resources. A health-based remedial goal (as opposed to a standards-based PRG) would use the CTUIR exposure scenario to both estimate risks and set cleanup goals. Any cleanup less than this obviously means that tribal members cannot practice that lifestyle the way that the scenario describes, and restricts our use. This is not a seasonal or visitation scenario – it is a whole-lifestyle scenario, including fishing, sweating, gathering/gardening, pasturing, and hunting/livestock. .
- Natural attenuation comes with high costs of lost use and injured resources. Lifecycle cost estimates will reveal whether it is cheaper to spend more to clean a plume or pay more for the NRDA process and associated court costs.
- Concern about uranium in clam shells and contaminants in tules.
- Tribal staff and Tribal members indicated that the cost of remedy is not a consideration for Tribes (clean it up no matter what the cost). The full lifecycle cost or a remedy must be included (and the full life cycle risk profile), including the

Natural Resource Damages for lost use and injured resources if the remedy leaves residual contamination.

- Note: Tribal members present pointed out that the Tribal members and staff present spoke for themselves and the government-to-government consultation was required to obtain a Tribal position.

200 Area Summary Statement

The 200 Area and Central Plateau are very important to the CTUIR for natural resource and cultural reasons. The upland portions of Hanford are locations included in our Treaty as locations where we reserved rights of access and use. Additionally, the CTUIR is a Natural Resource Trustee of these areas. The mature late-successional sagebrush habitat of the 200 and 600 Areas, along with its wildlife and its cultural uses and history is of paramount importance to preserve both for its uniqueness as the last remnant of mature sagebrush and for its importance as part of the traditional cultural landscape. The upland areas at Hanford are a collection of interlocking habitats based on soil and vegetation characteristics, and the variations in soils and plants results in different plant communities at different locations. Because any of these plant communities is likely to contain plant species of traditional importance, it cannot be assumed that there are local substitutes of comparable quality. Therefore, the size of the impact footprint must be measured, and all types of impact (physical disturbance, airborne deposition, or soil or groundwater contamination) must be evaluated.

There are also unique plant communities on Gable Mountain due to its composition and elevation that, along with its identification as a sacred site, make it important to measure airborne deposition on the mountain. The eco-cultural systems associated with the ALE Reserve and Rattlesnake Mountain are also extremely important to evaluate due to their natural characteristics which made them important food, medicine, and cultural areas over many millennia. The water sources (various springs on ALE, West Lake) in the upland areas are focal points for cultural resource preservation as well as individual species of high importance. Finally, unique geologic features (e.g. islands, dunes, and basalt outcrops) are important not only for their unique habitats but also for their traditional uses and place in the native historical culture.

Our endstate vision and land use in the Central Plateau, including the core zone, is full traditional use. We never agreed to a permanent disposal and sacrifice zone in this area, despite the CLUP. The CLUP cannot be used to deny Treaty rights, either in the core zone or outside of the core zone (or anywhere else on site).

Our land use in the 200 Area is the same year-round lifestyle, with fishing, hunting/ livestock, gathering/gardening, pasturing, and sweating that is described in our CTUIR exposure scenario. Our scenario should be used to evaluate risk and set cumulative (multi-pathway, multi-media, and multi-contaminant) health-based remedial goals. If the risks are reduced to acceptable levels as confirmed by the use of the CTUIR scenario, there will be no further lost or restricted use. Setting remedial goals for individual contaminants when multiple contaminants are present results in unprotective remedies due to additive risk. Any institutional controls that are required are demonstration of lost use (a NRDA issue).

Our baseline condition is good-quality (undisturbed and uncontaminated) shrub-steppe habitat. Our endstate vision is to consolidate waste as much as possible, which will minimize the size of the footprint for which restricted access and lost use (under NRDA) will need to be evaluated.

The best closure of the U-Plant (the first canyon building) is clearly full removal, which is one of the cheapest in short-term project costs, is by far the cheapest in terms of lifecycle costs (monitoring, barrier replacement), allows adjacent waste to be excavated, is most permanent, uses by far the least amount of clean fill (with its associated natural resource injury and associated costs), and protects the tribes and public the most. Since worker doses will not be allowed to exceed permissible limits, this is not a decision factor. The cost and risk data presented in the DOE documents make full removal by far the best remedy.

The tanks should not be filled with grout. We strongly support full removal so that the tanks and associated soil contamination can be removed. If they cannot be removed in the short term, then DOE should not take irreversible interim actions such as filling the tanks with grout. We strongly oppose the reclassification of residual high level waste as low activity waste, which would result in leaving high level waste in near-surface disposal or storage sites, which is prohibited by law.

Contamination from tank leaks has clearly reached groundwater and is moving northwest toward the Columbia River. We may have only decades until it begins to affect the last salmon spawning area in the mainstem Columbia River. The contamination that is in the vadose zone should be excavated to a depth that needs to be negotiated. If residual soil uranium is fairly immobile for the present, this makes it easier to excavate; and immobility is not a valid reason to leave it in place, but fortuitously aids in removal. Associated pipes, trenches, cribs, ditches, electrical lines and other waste should be removed. Any residual contamination in the deep vadose zone may be part of the NRDA injury valuation, since deep soil is also a natural resource under the aegis of the Natural Resource Trustee Council.

Frequently Asked Questions

What range of activities could workers and/or visitors be involved in within the core zone? Outside the core zone? Should other alternatives activities (beyond those consistent with the assumed land uses) be considered for comparison or other purposes?

- CTUIR never agreed to a sacrifice zone where permanent disposal is acceptable. As DOE has stated numerous times, the FSUWG and similar items are "not decision documents." The Land Use Plan EIS cannot be used to deny Treaty-reserved rights. This, again, is de facto evidence of lost use, restricted access and denial of treaty rights,

- These statements apply to the entire site, including the ALE-North Slope buffer areas and the core zone. The full CTUIR exposure scenario must be used to evaluate risks, and the degree to which it is used, or not used, to set remedial goals forms the basis for lost use claims.

- A single large landfill (ERDF) is preferable to many smaller landfills/closures, and reduces the areal extent of lost use (a NRDA issue).

Based on the desired land-use and exposure scenarios, what types of institutional controls are appropriate, and over what time frames?

None. Institutional controls are demonstration of restricted access and lost use, a NRDA issue. Restricted access in the 200 Core zone was never agreed (we cannot agree to give up Treaty-reserved rights for free). If it is not practical to regain full access for unrestricted use in the core zone, then there is room for negotiating how to mitigate that lost use.

Institutional controls do not work, especially over millennia. This is why LTS planning is so important now. The larger the anticipated legacy waste problem, the more money DOE should be sending to Hanford to plan for LTS. Since Hanford is the most contaminated, it should be getting more money for planning.

Does land revert to Tribes? Consultation under Cultural/Historical Resources law with Tribes ongoing for transfer of jurisdiction from DOE to Fish and Wildlife Service. There are many issues here. One solution would be to transfer it to BIA, as is being done in a number of cases across the country. Or, transfer it jointly to BIA and USFWS. In any event, federal and tribal governments take precedence in the government excess process over local civic entities such as towns.

When would you consider leaving waste in place under a barrier? When would you consider removal, treatment, and disposal of the waste? What other options would you consider and when would you consider them? How would these considerations change depending on location inside or outside the core zone and could these decisions affect how the core zone is defined? If data collection activities are purposely focused on defining the highest levels of contamination, how important is additional detailed characterization in making these decisions? How does this change for different end states or hazards?

CTUIR will be providing risk-based decision criteria and decision analysis rules. We have many comments on these topics and a high level of interest, and a short quick answer would not do this topic justice.

The short answer is that any remedy that leaves waste comes with a cost of perpetual barrier lifecycle costs, as well as lost use and ecological injury NRDA damage costs. There has never been an open and honest discussion of this (DOE lawyers prohibit these discussions).

What end-state do the stakeholders envision for the various classes of facilities (such as canyons, plutonium processing facilities, ancillary facilities? Waste storage/treatment facilities, etc.) on the Central Plateau? How do you feel

about leaving facilities in place (i.e. fully standing) versus demolishing them? Under what situations would you think it appropriate to retrieve, treat and dispose of some or all of the waste within and/or under the facility or is consolidation and isolation of waste within the facility a viable option? If a canyon facility is left in place or is partially demolished, can additional waste be placed init? How would the potentially high does rates and hazards to workers encountered during cleanup activities affect these decisions? If data collection activities are purposefully focused on defining the highest levels of contamination, how important is additional detailed characterization information in making these decision? How does this change for different end states or hazards?

CTUIR will be providing risk-based decision criteria and decision analysis rules. We have many comments on these topics and a high level of interest, and a short quick answer would not do this topic justice.

Again, clean closure and/or complete removal is clearly the most cost-effective and health-protective remedy, according to the DOE U-Plant Closure Plan. The option is one of the cheapest remedies, and has no out-year costs (other than ERDF costs), no barrier replacement costs, less damage due to clean fill and barrier capping material needs, a smaller footprint, is permanent, is more acceptable to the community, and similarly meets the rest of the 9 CERCLA criteria better in every case. It is mystifying to us why that option is not being chosen.

<u>300 Area Summary Statement</u>

The 300 Area is very important to the CTUIR for natural resource and cultural reasons. The River, river corridor, and adjacent lands are locations included in our Treaty as locations where we reserved rights of access and use. Additionally, the CTUIR is a Natural Resource Trustee of these areas. Our land use in the 300 Area is the same year-round lifestyle, with fishing, hunting/livestock, gathering/gardening, pasturing, and sweating that is described in our CTUIR exposure scenario. Our scenario should be used to evaluate risk and set cumulative (multi-pathway, multi-media, and multi-contaminant) health-based remedial goals. If the risks are reduced to acceptable levels as confirmed by the use of the CTUIR scenario, there will be no further lost or restricted use. Setting remedial goals for individual contaminants when multiple contaminants are present results in unprotective remedies due to additive risk. Any institutional controls that are required are demonstration of lost use (a NRDA issue).

The 300 Area should remain under federal control, preferably jointly BIA and USFWS. Local civic entities such as towns should not get any further excess land from the 300 Area and northward; in fact, Richland already received Columbia Point and portions of the 1100 and 3000 Areas. The Tribes have received nothing.

In the 300 Area, there may be uncontaminated buildings that could be reused. This is to be encouraged, as long as there is not soil contamination beneath them, and as long as no irrigation or landscaping is added, since this could mobilize the uranium in the soil

The uranium in the soil and groundwater needs to be addressed. If a remedy such as soil flushing is proposed, it must be accompanied by catch-systems (such as a freeze barrier) so that the uranium does not simply get flushed into the river.

Frequently Asked Questions

Based on the possible post-cleanup land uses, the following end state related questions (primarily focused on the time frame of 20 years into the future and beyond) can be discussed:

- **What range of activities could the public, workers and/or visitors be involved in within the region now known as the (industrialized) 300 Area?**
- **Outside the industrialized 300 Area?**
- **Should other alternative activities (beyond those consistent with the assumed land uses) be considered for comparison or other purposes?**
- **Based on the desired land-use and exposure scenarios, what types of institutional controls are appropriate, and over what time frames?**

Tribal Nations will use the area for traditional fishing, hunting, gathering, and sweathouses, as described in our exposure scenario. This is not seasonal or visitational, but whole-life and cumulative. This statement applies everywhere on Hanford and for any time period (past, present and future).

The 300 Area should remain under federal control, preferably jointly BIA and USFWS. Local civic entities such as towns should not get any further excess land; in fact, Richland already received Columbia Point and portions of the 1100 and 3000 Areas.

No additional surface water use should be permitted since this will mobilize the residual uranium.

Groundwater Remediation Alternatives and Technologies

- **Are the alternatives we are considering for the groundwater feasibility study appropriate?**
- **Are you aware of any other potential groundwater technologies which should be considered?**
- **Are there other considerations that should be evaluated?**

Given the possible types of surface uses and the potential groundwater remediation alternatives, what considerations are important for groundwater remedy selection? For example,

- **What is an acceptable period of time to achieve groundwater goals?**
- **Under what surface end states would it make sense to continue with monitored natural attenuation?**
- **Under what surface end states would it make sense to pursue an alternative approach?**
- **Under what circumstances would alternatives that result in near-term increases in uranium contamination in the groundwater and/or increased discharge to the river be appropriate?**

Again, CTUIR has many detailed comments and a high level of interest in groundwater.

As with the other questions, the simple answer is that our resource uses and Treaty-reserved rights are reflected in our exposure scenario, across all of Hanford, and throughout time. This includes groundwater. Whatever remedy is applied to groundwater, including natural attenuation, simply determines what area-under-the-curve is used to estimated recovery times, lost use, and therefore NRDA damages.

Monitoring will be required until sites can be given a clean bill of health, which is why the CTUIR is planning a science center/field station as the future legacy managers of Hanford.

Again, there is no such thing as "surface endstates." The endstate is simply whether the site is restricted or unrestricted (clean enough to allow multipathway subsistence use, and whole enough to support them).

If short-term uranium mobilization (to flush it out of the soil and groundwater) were proposed, it should be combined with a catch system that has a very high probability of success (possible freeze barriers). It should not simply be flushed into the river.

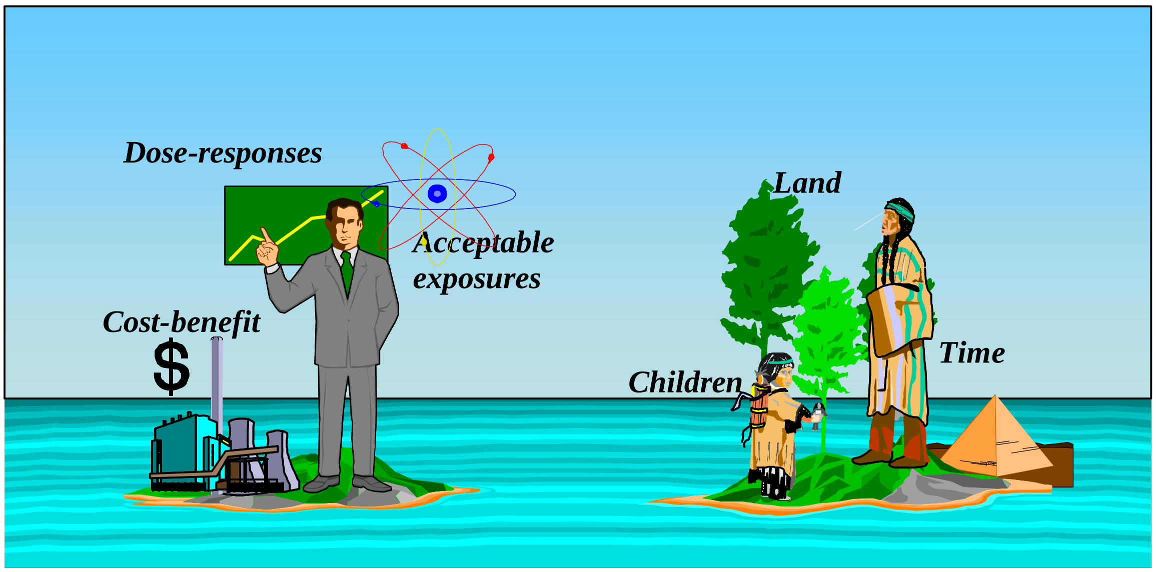
CHAPTER 4

A FRAMEWORK for EVALUATING TRIBAL HEALTH and ECO-CULTURAL RISKS[16]

This chapter provides a framework for evaluating risks in Indian Country. All cultures depend on environmental quality for their survival, but the health of tribal communities and their individual members is so intertwined with their environment as to be inseparable. The foundation of risk assessment, risk characterization, and risk management in Indian Country rests on the federal Trust responsibility to protect the people, their homelands, and their natural and cultural resources. Thus, tribal risk assessments must include the probabilities of adverse health, ecological, and cultural impacts in order to be relevant to the affected tribal community and government. This chapter presents several ecologically based methods for evaluating overall tribal community health risk and eco-cultural health impacts. Elements of this approach include a (1) culturally-sensitive human exposure scenario, (2) ecological risk assessment that includes species of cultural concern, (3) evaluation of impacts to environmental functions and services, (4) measurement of impacts to socioeconomic

[16] ***Modified from:*** Harper, B.L. and Harris, S.G., "Measuring Risks to Tribal Community Health and Culture." In: *Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport*, Ninth Volume, ASTM STP 1381, (F. T. Price, K. V. Brix, and N. K. Lane, Eds.), American Society for Testing and Materials, West Conshohocken, PA, 1999. ***And presented at:*** ASTM 9th Symposium on Environmental Toxicology and Risk Assessment, Seattle, April 19-22, 1999; Paper ID #6035; Committee E47.

and sociocultural health, and (5) a risk characterization step that combines of all these risks and impacts in a way that tells the whole story about impacts to the place or resource from the community's trusteeship perspectives. While these elements are likely to be common to most tribal risk assessments, each tribe's ecology, history, culture, and government are unique, so every tribal risk assessment will be unique. It is hoped that by presenting some initial methods for characterizing and comparing risks that are relevant to tribal cultures and communities an interdisciplinary discussion will be sparked that brings together the disciplines of social impact assessment, comparative risk (quality of life), natural resource valuation, public health, and conventional toxicity-based risk assessment.



4.1 Introduction

As depicted above, the perspective of Tribal Nations and the federal government may be quite different. The challenge is to modify methods developed under the left-hand situation to suit information needs depicted in the right-hand panel. There is a growing recognition that the conventional risk assessment paradigm does not address all of the things that are "at risk" when communities face the prospect of contamination. In addition to human health and local ecological health, the community's social, cultural, and economic health may also be at risk from contamination. For tribal nations, this is especially true. For example, if the natural resources that form the basis for the lifestyle, religion, nutrition, and customs are contaminated, or if access to important areas or resources is restricted, the entire culture suffers. Also, many tribal communities are recovering from years of adversity, and the ability to follow a traditional lifestyle and practice traditional religion, which require a clean and functioning ecosystem, has been identified as crucial for recovery. This is in contrast to a more typical process of evaluating risks to human health and ecological resources within the risk assessment phase and deferring the evaluation of risks to socio-cultural and socioeconomic resources until the risk management phase (National Research Council, 1994, 1996; President's Commission, 1997).

This paper introduces several ways to measure this suite of impacts and a framework within which to work. From an indigenous perspective, risk assessments are often seen as irrelevant due in part to the tendency to divide an evaluation into isolated pieces (e.g., human health that is evaluated entirely separately from ecological risk or socioeconomic impacts) that destroys the system-level functional understanding. The "system" that is an appropriate unit of analysis is the entire human-eco-cultural system, and subdivisions of this system, while necessary for quantification, must be blended together during the risk characterization step. While the emphasis in this paper is on tribal communities, we recognize that the methods may also be relevant, with modification, to non-native communities, and indeed are derived in part from the Comparative Risk discipline which was developed in non-indigenous settings.

At the outset, it must be recognized that American Indian Tribes are sovereign nations, not just the upper tail within a general public exposure and risk range. Many tribes operate under Treaties that they made with the United States government, and since the U.S. Constitution specifically identifies the requirement to honor treaties, Treaties are often referred to as "the supreme law of the land." Tribes are also natural resource Trustees, and metrics relevant to the federal trust responsibility must be included. It must also be remembered that each tribe is different in its resource base, its concerns, and the complexities of its cultural practices, so each tribe must have the opportunity to define its own culture and select the appropriate metrics for evaluating its risk. This paper presents some generic methods while recognizing that they will not be suitable for boilerplate application and do not substitute for intergovernmental consultation or participation in the decision process.

4.2 Legal Drivers for Including Cultural Risk or Quality of Life in Risk Assessment

Drivers or forcing functions (Figure 1) for evaluating cultural risk and quality of life within the risk assessment paradigm and for guiding the development of evaluation metrics includes; (1) Treaties with Indian Nations, (2) federal fiduciary Trusteeship obligations, (3) NEPA (broad welfare and usage impacts), (4) Natural Resource Damage Assessment (natural resource quality and human uses of natural resources), (5) Executive Order 12898 on Environmental Justice (subsistence lifestyles, welfare and economic effects), (6) cultural resource protection laws such as the National Historic Preservation Act (traditional cultural properties, landscapes and sites) and the Native American Graves Protection and Repatriation Act, 7) CERCLA (criteria for community acceptance and protecting sensitive populations), and (8) current standards and practices as recognized by the Presidential and Congressional Commission on Risk Assessment (1997), the National Research Council (1994), and the Environmental Protection Agency (1993).

Evaluating the health of and access to ecological and cultural resources is done in part to restore, protect, and enhance environmental quality so subsistence Treaty-reserved rights can be exercised, cultural wellness can be regained or maintained, and communities can be sustained, all of which requires a healthy functioning environment. The methods presented below can also be used in regulatory decision making, although conventional regulatory-based approaches such as CERCLA risk assessments, while not precluding the use of this information, are often narrowly cited as rationales for improperly deferring the collection and use of this information to the risk management phase. However, it is our premise that if it is not included in the risk assessment step, then complete information will not be available for risk characterization, and the decision may be rejected by the affected community. There are also many misconceptions about Tribal lifestyles and the concept of cultural risk that are typically raised in resistance to including quality of life in risk assessment (Figure 2).

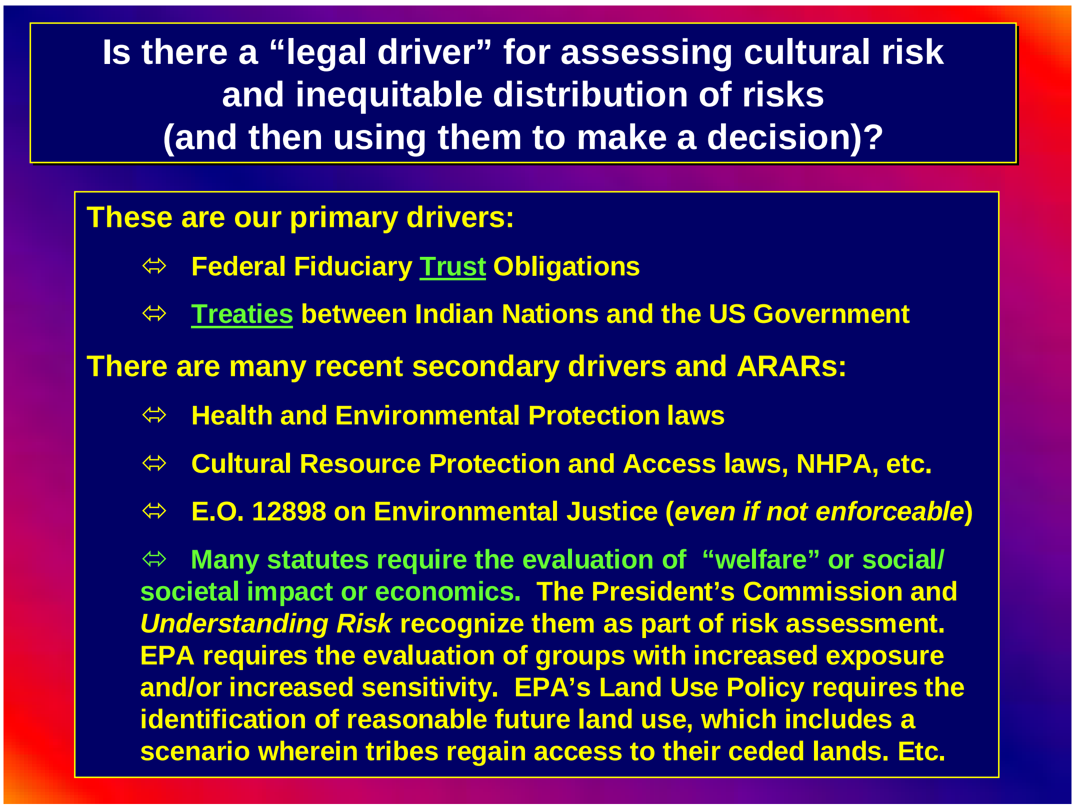


Figure 1. Legal drivers for including sociocultural metrics in risk assessment.

Figure 2. **Some of the barriers and misconceptions about Tribal risk assessment.**

4.3 CRCIA Summary

In 1996 a document, the Columbia River Comprehensive Impact Assessment (CRCIA)[17] Part II, was prepared by Stakeholders, Agencies, Tribes, and Contractors. Its purpose was to describe the methods for river corridor and sitewide assessments that would provide the information needed by all parties to make informed risk-based decisions. Although DOE committed to using it as a template, this has not happened in totality. Many aspects are being incorporated into Hanford risk assessments as conventional standards and practices. Other aspects are being more-or-less met by DQO processes. However, no DQO process has yet adequately identified (a) what do we need to know, and (b) how well do we need to know it. This leads to lengthy discussions, often without resolution, about statistical sampling power, selection of evaluation endpoints, the number and locations of samples, and so on.

In CERCLA remedial decisions, there are 9 criteria; two of these are primary criteria:

- Does the remedy protect human health and the environment?
- Does the remedy meet ARARs?

Like chaos theory, on one level these are simple questions, while on another level, they are not yes/no questions at all, but are exceedingly complex. While they are phrased as yes/no questions, they are not. Within them are embedded many elements that are generally not well-considered.

[17] http://www.hanford.gov/docs/rl-96-16/. Available at http://sesp.pnl.gov/Reports/CRCIA/doe-rl_96-16/crcia03_98.htm

The key elements that CTUIR believes are not being adequately addressed include:

- "What and how well do we need to know it"
- Statistical power as a driver of experimental design
- Temporal integration of risks
- Spatial integration and risk mapping
- Uncertainty analysis within the entire modeling process (how much uncertainty can be tolerated by the decision process)
- Improper use of screening steps that do not consider mixtures or tribal exposure factors.
- Lack of independent review of work plans, data quality, and interpretation.

4.3.1 *"What do we need to know and How well do we need to know it?"*

This question has two components: (1) What is the value of certain technical information at various stages of an assessment (or conversely, what are the consequences of not knowing); and (2) how much statistical power or certainty is needed in order to rely on the information for making decisions? These questions contain embedded questions about data gaps, precision, accuracy, alpha and beta error, and value of information (or cost of missing information). These are seldom if ever systematically discussed with Trustees, Tribes, and other stakeholders when scoping contractor work.

For example,

- How much certainty about geological strata is needed in vadose and groundwater models in order to use the resulting risk information in setting risk-based remedial goals? If the information is not available, what assumptions can be made to protect against that eventuality should it be proven true at sometime in the future?
- Do we need to know the point of maximum flux into the river, or the total flux over time and space, or both? We need to know the point of maximum concentration to protect against localized toxicity, and we need to know total flux because it may reconcentrate (e.g., in the sediment behind McNary Dam). We also need to know what conditions cause maximum concentrations over short periods of time, such as flow rates – bank storage, runoff, or turbidity
- Is there non-random transport and deposition of contaminants in the river (such as laminar flow, sediment deposition pools)? Does this vary with flow regimes? Will we underestimate acute risks if we do not understand this?
- How will we integrate cumulative mutagenicity burdens in small populations over time, as multiple generations are exposed in succession?
- Is a formal data validation step required, including trip blanks, duplicate samples, verification of unknown standards as a laboratory certification step, and so on? If DOE would require stakeholder-generated data to follow procedures for certified laboratory and QAPPs, then so should DOE.

4.4 Community Health and Quality of Life

John M. Last (1998) and other environmental health professionals define individual human health more broadly than the regulatory approach, which tends to equate good health with lack of excessive exposure. Public health definitions focus on positive achievement of a variety of medical and functional measures, but do not specifically call out the fact that the survival and well-being of every individual and culture depends on a healthy environment (Figure 3).

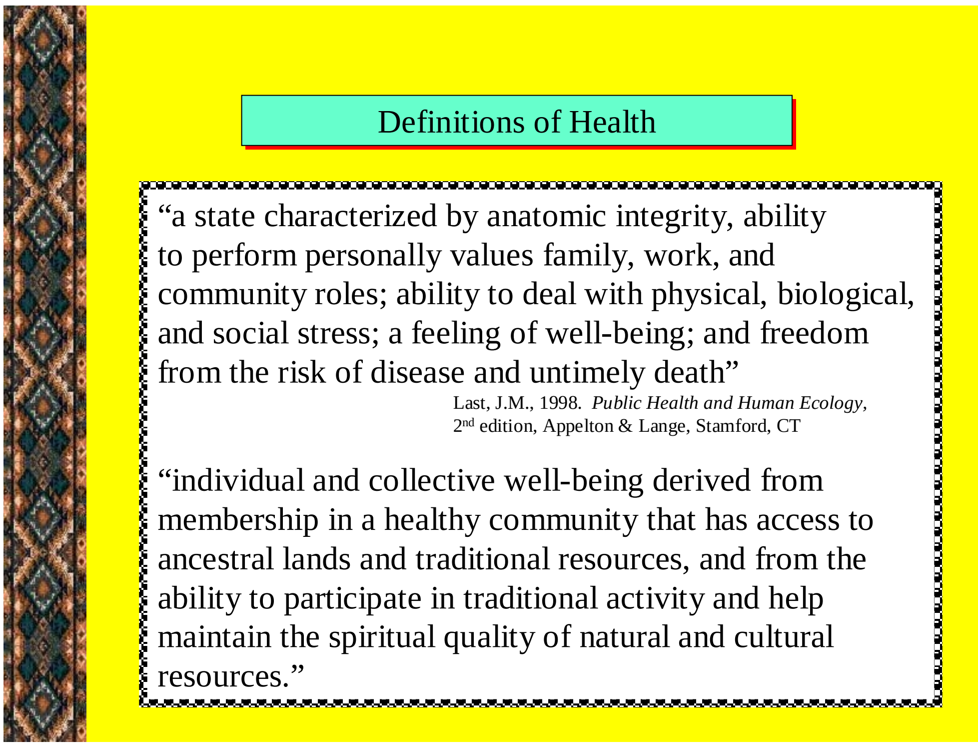


Figure 3. Definitions of health.

Because public health in a tribal setting is almost synonymous with culture, this also needs to be defined. Various definitions of "culture" include social behavior systems, religion, art, material goods, individual and collective health, a land ethic, ways of relating to the environment, and other elements. Since individual tribes are sovereign governments and political entities, each tribe must be able to define its own culture, and these definitions may differ from conventional (western) sociological or anthropological definitions. Indigenous cultures and their environs are intertwined to a degree that is usually not accounted for by western society and scientists when developing risk metrics, since the environment constitutes a cultural homeland where the people (and their genetics) co-evolved with the ecology over thousands of years. The concepts of health and culture can be combined into a concept of cultural health (healthy individuals functioning in healthy social and cultural systems). For indigenous communities that are inseparable from their environment this is best described as eco-cultural health.

The concept of individual and community eco-cultural health risk logically includes evaluating the risk (i.e., the probability of adverse impacts) to community quality of life, to the ability to follow traditional lifeways, to historical and cultural resources, artifacts and landscapes, to human health as cultural and other activity patterns are pursued, and to the health and functionality of the surrounding environment (Figure 4).

Figure 4. The holistic concept for health of the culture.

From the perspective of the affected community or culture, a contaminated site is likely to be only one of many stressors. Therefore, an approach more suitable for Tribal communities is to begin with stressor identification rather than the conventional approach of simply tracking releases into environmental media and then to single receptors (Figure 5).

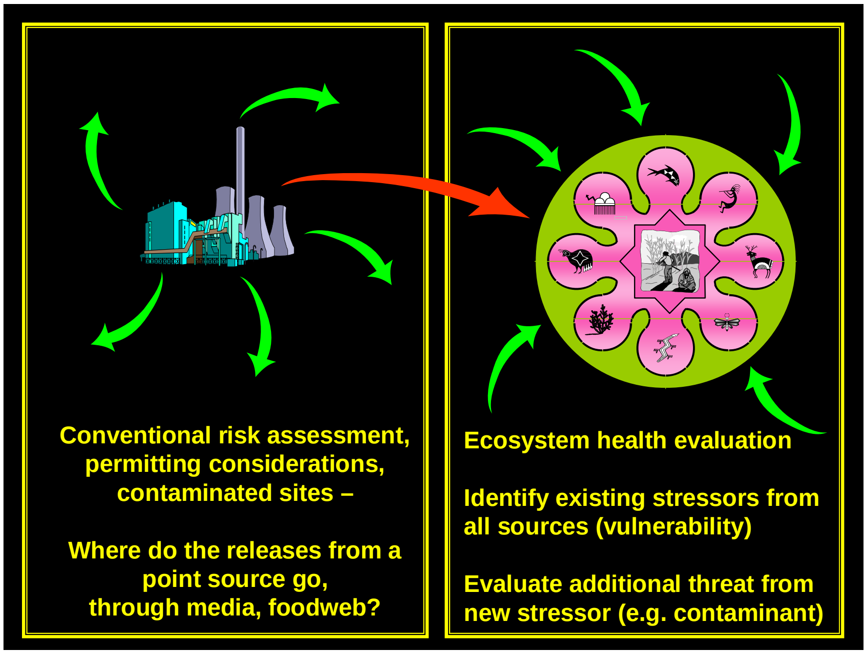


Figure 5. Comparison of site-oriented versus ecosystem-oriented assessment.

4.5 Framework for Organizing Risk Metrics

For simplicity, the dozens of potential metrics that are described later in this chapter can be divided into three types of metrics (human, ecological, and cultural, Figure 6) or four types of metrics (human, ecological, socioeconomic, and cultural, Figure 7).. These figures show ways of organizing the information, as well as indicating what kind of information is needed so data collection can be most efficient. Human health is described in the SCENARIO chapter, while this chapter discusses approaches for ecological, cultural, and the combination (eco-cultural or ethnohabitats).

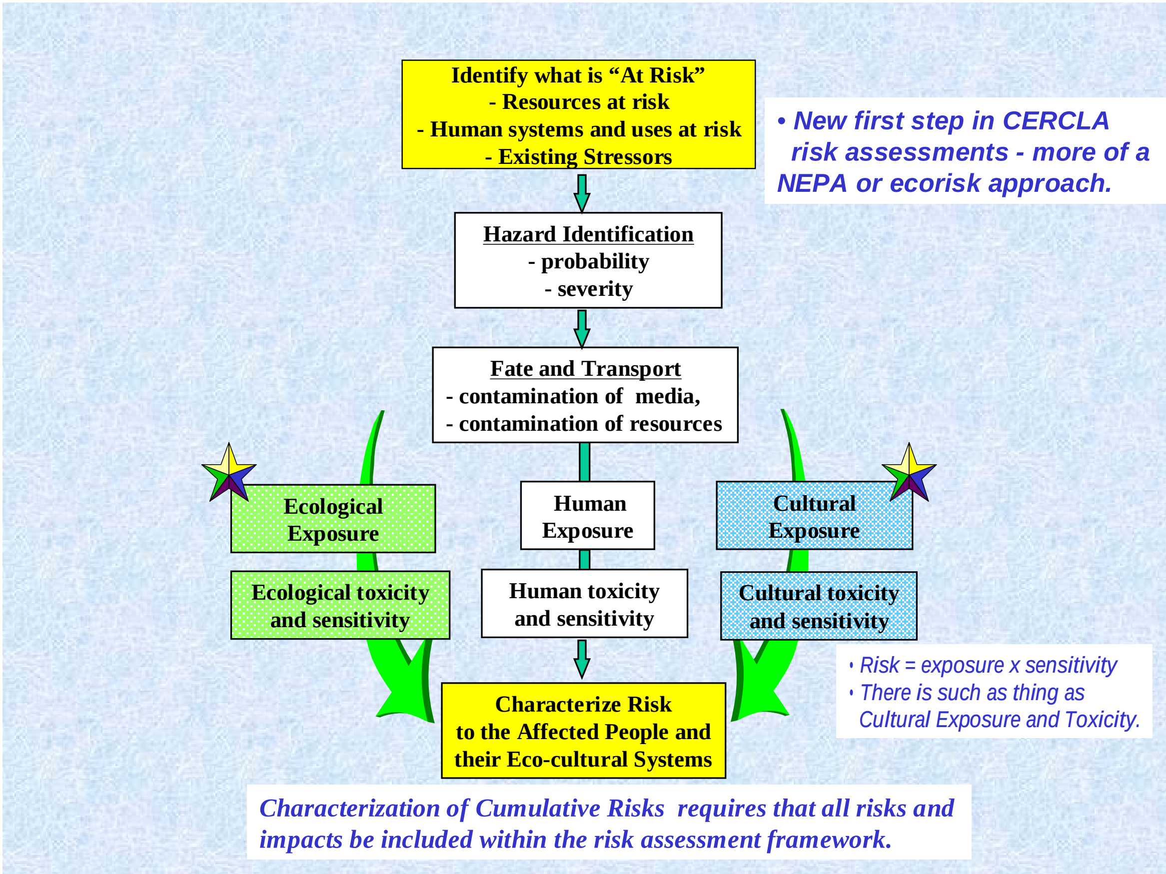


Figure 6. Risk assessment framework with three types of metrics (ecological, human health, and cultural).

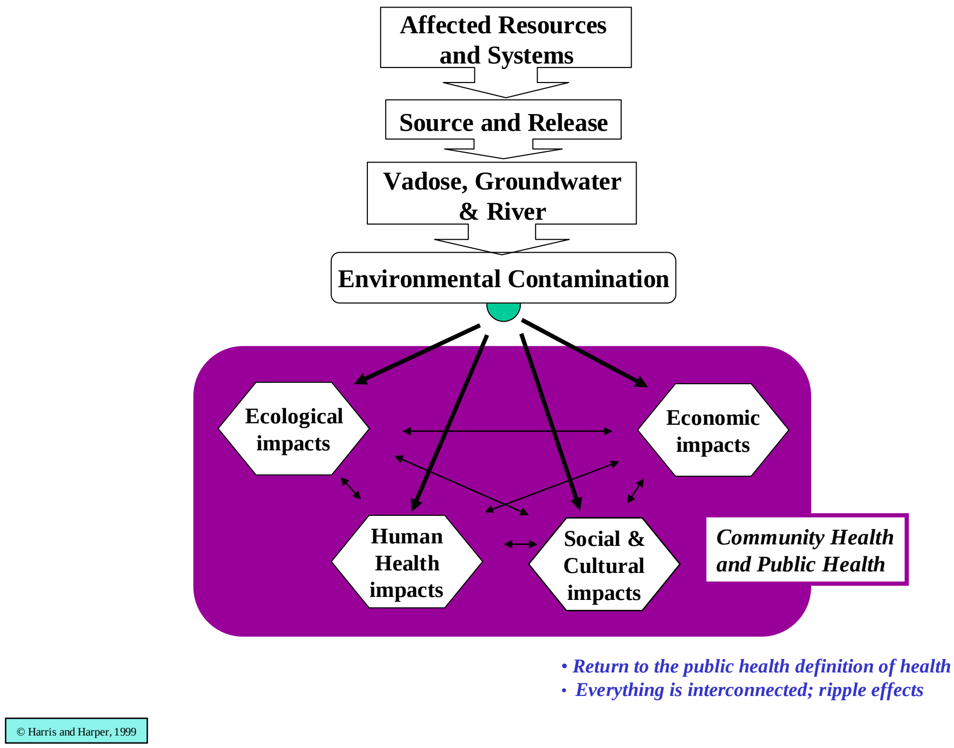


Figure 7. Framework with four categories of risk endpoints.

4.5.1 Traditional Environmental Management Science

The scientific method is the observation, identification, description, experimental investigation, validation, and theoretical explanation of natural phenomena. It typically proceeds from observation to hypothesis, then theory, and finally to law. Native American traditional environmental management science has traveled this exact path. American Indians have been observing natural phenomena, describing them experimentally investigating them, and explaining natural phenomena and complex ecosystems for thousands of years. This tribal environmental knowledge forms the basis of traditional environmental management (Harris, 1998).

Tribal elders have explained that our traditional lifestyle and behavior is a conscious response to environmental observation, and that our behavior is a product of rigorous and proven methodology that has guaranteed our survival through all types of natural cycles (Figure 8). Our lifestyle is resilient and has persisted through floods, droughts, cataclysms, upheavals, and warfare. Our ancestors understood the value of systematic observation and used inductive reasoning to determine the most probable reactions of very complex, interrelated ecosystem functions. The application of this science has been codified into law and has been distilled into daily practice. This knowledge is still transferred between generations. Attention to and application of this knowledge means personal survival and enhancement of our ecology, culture, and religion.

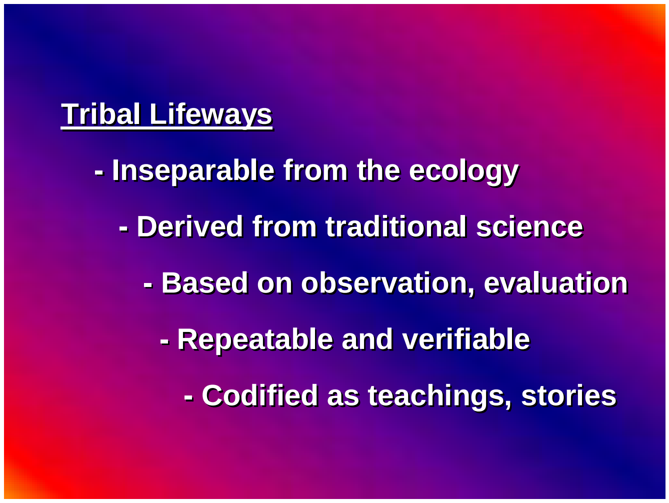


Figure 8. Tribal lifeways.

The individual and collective well-being of CTUIR citizens is derived from membership in a healthy community that has access to ancestral lands and traditional resources and from having the ability to satisfy the personal responsibility to participate in traditional community activities and to help maintain the spiritual quality of our resources. This is an ancient oral tradition of cultural norms. The material or fabric of this tradition is unique, and is woven into a single tapestry that extends from far in the past to long into the future. In order to encompass the wide range of factors directed tied to the traditional American Indians of the CTUIR, a risk assessment has to be designed and scaled appropriately. It must include an evaluation of cultural risk, or the risk to traditional culture and lifeways that is or can be caused by contamination or other stressor. This principle is probably applicable to all communities, and might improve the quality and stability of environmental decisions if it were followed routinely.

4.5.2 Describing the Importance of a Place and Its Resources

A particular place or resource may be important for many reasons, and may be important to different groups of people for different reasons (Figure 9). For example, one group of people may value a place for recreation while another values it for religious reasons (Devil's Butte is a case in point). The purpose of this step is not to judge which use prevails and does not rank any use above another. Its purpose is to explain all the reasons a place or resource is important. This process may identify distinct groups of people that might not otherwise be recognized or given a voice. One method for organizing this information into a coherent picture is to use dependency webs (influence diagrams). This method is based on a joint project between the Tulalip Tribe and EPA.[18] These webs can be developed for individual resources or specific locations. The elements that comprise a web include critical ecological characteristics, existing stressors, and critical human uses, according to the following questions: A Hanford Reach example is presented in Figure 10.

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- What makes the place important (to anyone or any species); What is “at stake” at that location if contamination arrives or is not remediated?
- Who/what lives there or exists there (people and biota; vistas, cultural resources);
- Who/what uses the location and what happens there (ecological migratory stop, human recreation, ceremonies, etc.)
- What is the existing environmental quality or usability; what environmental quality or functions or species have already been lost there; what would be expected there but isn’t; what trends in environmental quality can be described there?)
- Is there a sense of community well-being and social and family cohesiveness maintained through use of the place or resource? Is religious or ceremonial well-being gained through use of the place or resource? Are there other uses of the site or resources such as historical education or migration corridors?
- Are materials derived from the place or resource, and are living and social activities and practices associated with the place or resource?
- Is intergenerational continuity in knowledge, language, traditions, values, and education related to the place or resource?
- How would people be exposed if the place or resource were contaminated?
- How is the place or resource already threatened or stressed?
- What environmental goods, functions, and services are provided by the location and its natural, cultural, economic, and human resources?

[18] T. Williams and G. Mittelstaedt, Tulalip Tribe, personal communication

A Salmon-Specific Dependency Web

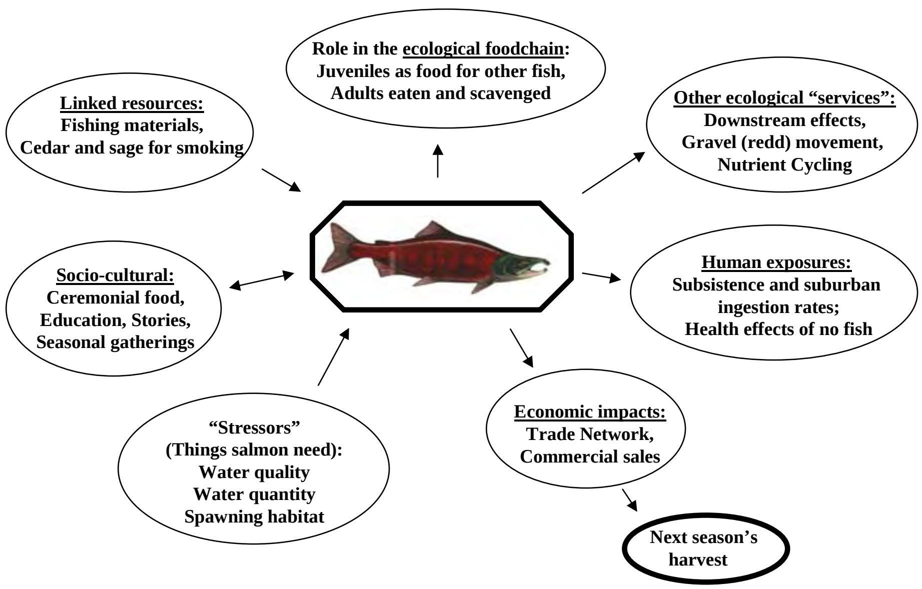
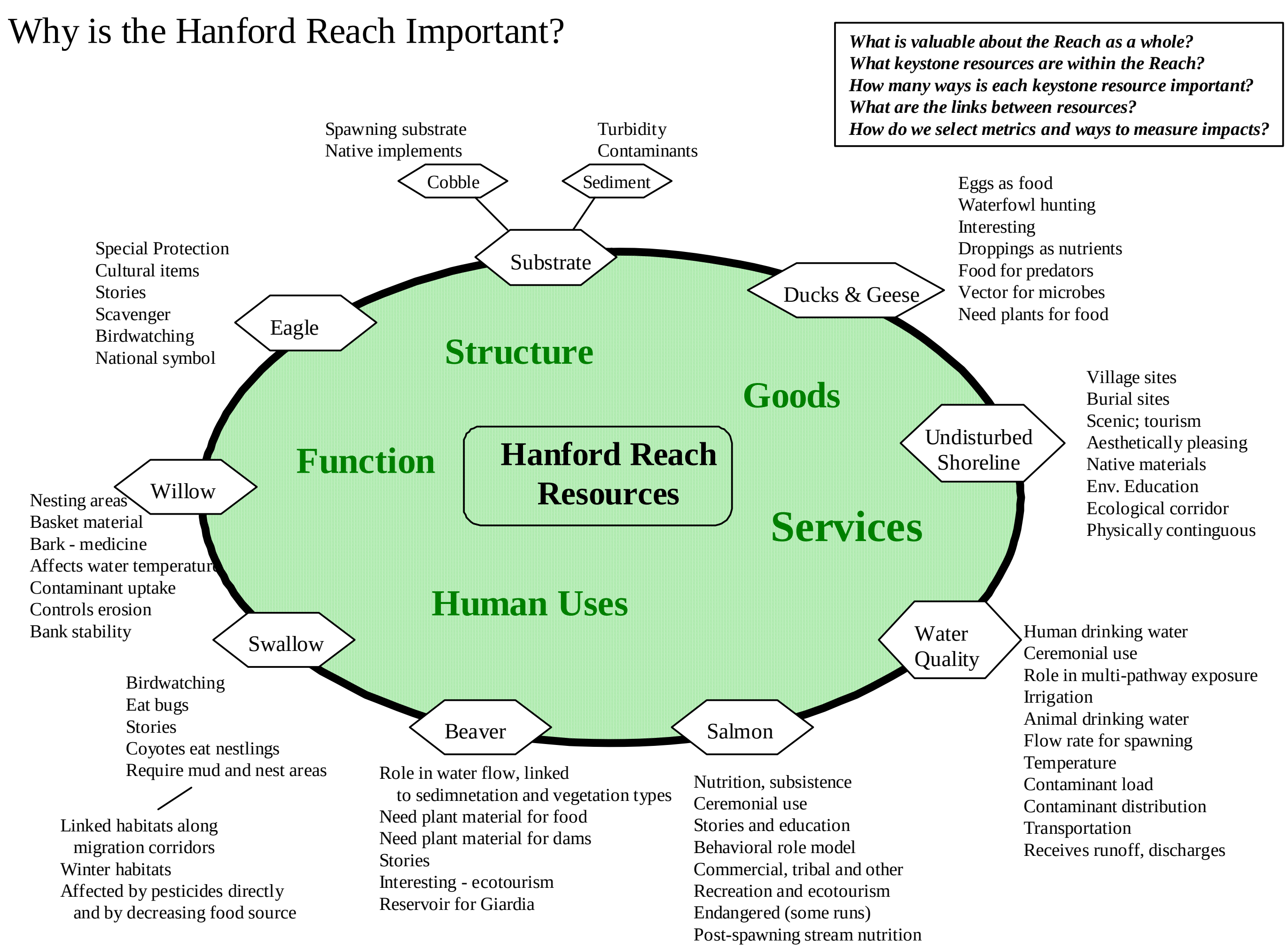


Figure 9. A Salmon-specific dependency web. This example is focused on a dingle natural resources that has many reasons for its importance and is critical to several ecological processes.

Figure 10. Example of identifying the importance of a specific location.



4.5.3 Ethno-Habitats, or Eco-Cultural Systems

For tribal communities, the most logical way to approach a risk assessment or impact evaluation is by understanding the ethno-habitat and the components that are at risk. Ethno-habitats can be defined as the set of cultural, religious, nutritional, educational, psychological, and other services provided by intact, functioning ecosystems and landscapes.[19] A healthy ethno-habitat or ethno-ecosystem is one that supports its natural plant and animal communities and sustains the biophysical and spiritual health of its native peoples. Ethno-habitats serve to help sustain modern Indian peoples' way of life, cultural integrity, social cohesion, and socio-economic well-being. People, their geographic place, resources, culture, health, language, art, religion, trade networks, social and survival activities, and their past and future are all interconnected into a single ethno-habitat. Ethno-habitats are places defined and understood by groups of people within the context of their culture. For tribes, their lands encompass traditional, places, habitats, resources, ancestral remains, cultural symbols, and cultural heritage. They are landscapes with culturally familiar features defined by cultural knowledge and experience, and have also been called eco-cultural landscapes and sacred geographies (Walker, 1991). The presence of healthy habitats is fundamental to useable and harvestable levels of resources as well as to healthy ecosystems. Those ethno-habitats that are places where useable quantities of culturally significant species may be obtained often overlap with ecologically-defined areas, although the species and their number and quality are often defined differently than European taxonomic systems would define them. Larger ethno-habitats can include multiple interconnected ecosystems, discrete geographical and seasonal use areas, and access corridors.

In traditional tribal communities, the people, their geographic place, their resources, their culture, their health, their art, their religion, their trade networks, their social and survival activities, and their past and future are all interconnected (Harris 1998; Cajete, 1999). A healthy **ethno-habitat or eco-cultural system** is one that supports its natural plant and animal communities and also sustains the biophysical and spiritual health of its native peoples. Ethno-habitats are places clearly defined and well understood by groups of people within the context of their culture. These are living systems that serve to help sustain modern Native American peoples' way of life, cultural integrity, social cohesion, and socio-economic well-being. The lands, which embody these systems, encompass traditional Native American homelands, places, ecological habitats, resources, ancestral remains, cultural landmarks, and cultural heritage. Larger ethno-habitats can include multiple interconnected watersheds, discrete geographies, seasonal use areas, and access corridors. This concept is also applicable to suburban communities, which are re-learning about their links to and dependence on the environment.

Ethno-habitats can be defined as the set of cultural, religious, nutritional, educational, psychological, and other services provided by intact, functioning ecosystems and landscapes. Ethno-habitats are also eco-cultural landscapes or sacred geographies (Walker, 1991). They are landscapes with culturally familiar features defined by cultural knowledge and experience. The presence of and access to healthy habitats for traditional uses of useable and harvestable levels of resources is significant to Native American peoples as well as to healthy ecosystems.

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[19] Modified from the Eastside EIS, Appendix 1.

> "Public lands serve to help sustain modern Indian peoples' way of life, cultural integrity, social cohesion, and socio-economic well being. These lands encompass traditional Indian homelands, places, habitats, resources, ancestral remains, cultural symbols, and cultural heritage. The presence of and access for traditional use to healthy habitats is fundamental to useable and harvestable levels of resources significant to Indian peoples as well as to healthy ecosystems. A healthy <u>ethno-habitat</u> is one that supports its natural plant and animal communities and sustains the biophysical and spiritual health of its native peoples through time." *(modified from Eastside EIS, Appendix 1)*

Ethno-habitats are places defined and understood by groups of people within the context of their culture. They are landscapes with culturally familiar features defined by cultural knowledge and experience. Those ethno-habitats that are places where useable quantities of culturally significant species may be obtained often overlap with ecologically-defined areas, although the species and their number and quality are often defined differently than Euro-American taxonomic systems would define them. Larger ethno-habitats can include multiple interconnected ecosystems, discrete geographic and seasonal use areas, and access corridors all within a collective set of significant places.

<u>4.5.4 Description of Environmental Uses, Functions, Goods, and Services</u>

Because tribal communities are inseparable from their environment and because cultural survival depends on a clean and functioning ecosystem, a brief discussion of environmental evaluation is presented. It complements conventional ecotoxicity and assumes that conventional ecological toxicity and ecological population-level indicators also are addressed elsewhere in the assessment. However, the functionality of an ecosystem is usually omitted from conventional risk assessments in favor of simple ecotoxicity. The functions of an intact ecosystem and the ecological and human services that it provides are increasingly recognized as an important part of impact evaluation, the natural resource damage assessment process and cost-benefit analysis.

Methods for quantifying environmental functions are immature, but should probably include estimating recovery periods and the degree of service reduction stemming from the injury to the natural resource(s), including both physical and biological functions. Examples of human uses and services provided by the ecological functions include food, flood control, groundwater recharge, waste assimilation, recreation, religion, aesthetics, identity, and other factors (Walker 1991, Carmichael 1994. These factors are termed "uses" as opposed to intangible externalities or non-use activities in cost-benefit methodology.

Evaluation of these attributes can and should also draw heavily on traditional environmental knowledge and traditional environmental management science. Brief definitions are as follows:

- <u>Goods</u> are tangible items of value to plants, animals, or people, such as food and medicine obtained from the location.
- <u>Functions</u> are dynamic roles that elements of the local area play within the area or within a larger ecosystem. Examples are nutrient production and cover or shelter needed by local fauna and migratory birds.

- Services are process or ends of importance to people, or things people pay for (or don't have to pay for if the ecosystem provides it). These services, especially cultural services, can be impaired at contaminant concentrations well below regulatory standards.
- Uses are things people or animals do at the location that are dependent on natural resource quality, such as recreation, education, traditional cultural activity, public water intake, or seasonal nesting grounds for birds.

These goods, functions, uses, and services can be divided into categories that are typically addressed by different disciplines:

- *Human health-related goods and services.* This category includes water, air, food, and native medicines. In a tribal subsistence situation, the land provided all the food and medicine that was necessary to enjoy long and healthy lives. The clean water provided by groundwater and surface water sources is undervalued but is increasing in recognition.

- *Environmental functions and services.* This category includes environmental functions such as soil stabilization and the human services that this provides, such as erosion control or dust reduction. Dust control in turn would provide a human health service related to asthma reduction. Environmental functions such as nutrient production and plant cover would provide wildlife services such as shelter, nesting areas, and food, which in turn might contribute to the health of a species important to ecotourism.

- *Social and cultural goods, functions, services, and uses*. This category includes many things valued by suburban and tribal communities about particular places or resources associated with uncontaminated and, to a large extent in tribal communities and to a lesser extent in suburban communities, with intact ecosystems and landscapes. Some values are common to all communities, such as the aesthetics of undeveloped areas, intrinsic existence value, environmental education, and so on. However, because all natural resources are cultural resources from a tribal perspective and because of the historic use of the entire continent by native peoples before they were encroached upon, all natural areas are likely to have some tribal significance that is greatly in excess of suburban contingent valuation.

- *Economic goods and services.* This category includes conventional dollar-based items such as jobs, education, health care, housing, and so on. There is also a parallel non-dollar indigenous economy that provides the same types of services, including employment (i.e. the functional role of individuals in maintaining the functional community and ensuring its survival), shelter (house sites, construction materials), education (intergenerational knowledge required to ensure sustainable survival throughout time and maintain personal and community identity), commerce (barter items and stability of extended trade networks), hospitality, energy (fuel), transportation (land and water travel, waystops, navigational guides), recreation (scenic visitation areas), and economic support for specialized roles such as religious leaders and teachers.

Table 1 shows a partial example of the variety of goods, functions, services, and uses of a wetland. The goal of developing such a table is to capture all the reasons a wetland is important to biota and to people, because these are all the things that are “at risk” or “at stake” if the wetland is degraded or contaminated. Table 2 is an example for a specific resource rather than a particular location. In both cases, we see that the location or resource is important to many people/biota for a variety of reasons. Evaluating these impacts (or the probability of each of these impacts happening) to each of these elements is part of the evaluation needed for ethno-habitat or eco-cultural risk evaluation (see next section).

Table 1 – *Evaluation of a hypothetical wetland from a tribal ecological perspective, focus on cattails.*

	Goods produced	**Functions provided**	**Services rendered**	**Uses, Activities**
Human health	Cattails Other species Water		Nutrition. Anti-carcinogens	Fiber, Food
Ecological health	Foodweb Nutrients Energy	Food, Cycling of organic materials, Sedimentation, Biodiversity, Productivity, Other indicators,	Water filtration, Aquifer recharge,	
Social and Cultural health	Basket materials	Solitude, Stability	Social patterns, Cultural activity, Personal renewal	Recreation, Education, Bird watching
Economic health	Vistas, Attractive species			Ecotourism

Table 2 – *Evaluation of salmon from a tribal ecological perspective*

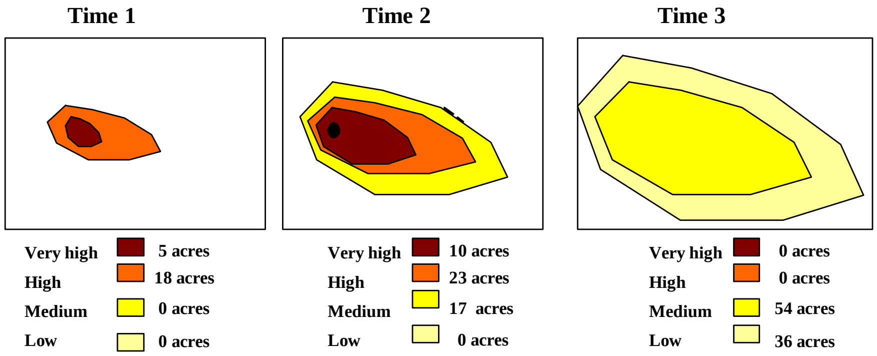
	Goods produced	**Functions provided**	**Services rendered**	**Uses, Activities**
Human health	Protein Belly fat		Nutrition Paint base	Food, Body paint
Ecological health	Juveniles, Carcass	Food, Stream nutrients	Downstream health	
Social and Cultural health	Ceremonial food	Ceremonial resource	Religious health, Socialization	Ancestral village site locations, Heritage and identity, Stories
Economic health	Commercial harvest,		Jobs, Family income (non-job)	

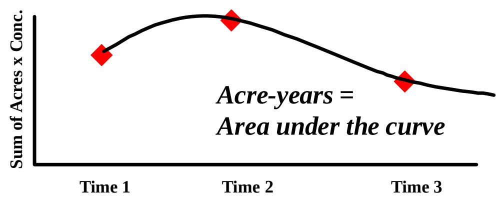
4.4.5 Space-Time Attributes of Environmental Risk: Service-Acre-Years

The characteristics of natural resources within the contamination footprint (the location and areal extent of the plume or spill) include the diversity index of both the specific species and critical habitats as well as environmental functions and services. The functions and services provided by an intact and functioning habitat have been receiving increased attention (Costanza and Folke 1997, Scott et al. 1998, Daly 1996, Daily 1997). Many of the metrics used in natural resource valuation require spatial and temporal descriptors in addition to concentrations at individual points of compliance because they deal with ecosystems. Many of the concerns raised as cultural risk issues are parallel and also related to areas, ecosystems, or landscapes as well as to the duration of the contamination or the effect. Many of the concepts used in natural resource valuation are applicable to the evaluation of cultural risk and the culturally-related goods and cultural services provided by a healthy environment.

The services that an intact, mature, functional environment, provide to humans include erosion control, clean air, recreational opportunities, or scenic vistas. An environmental perspective held by indigenous and other communities may consider that an intact environment also provides a homeland, medicines, religion, and many other things. In an ecological evaluation, major environmental services are identified and evaluated for the extent, magnitude and duration of impairment to give an area under the curve for each service (Figure 11, modified from Friant et al., 1998).

Figure 11. Acre-Years Applied to Groundwater Concentrations. Concentration isopleth definitions can be based on detection limit, regulatory standard, and/or other metrics defined jointly by the community and the decision maker.


Time 1
Time 2
Time 3
Very high
5 acres
High
18 acres
Medium
0 acres
Low
0 acres
Very high
10 acres
High
23 acres
Medium
17 acres
Low
0 acres
Very high
0 acres
High
0 acres
Medium
54 acres
Low
36 acres

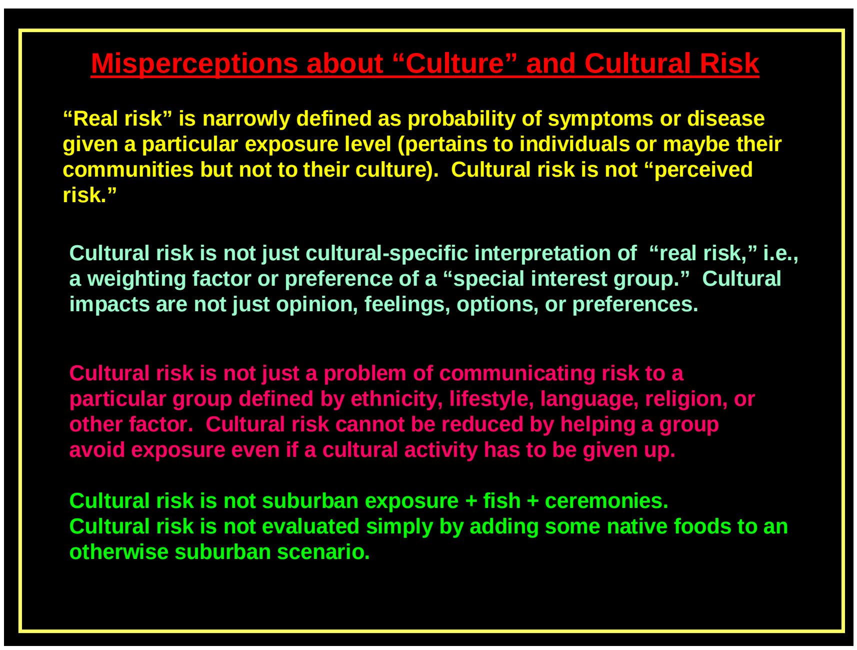

Sum of Acres x Conc.
Acre-years =
Area under the curve
Time 1
Time 2
Time 3

4.6 Cultural Risk Evaluation

Culture is collective knowledge and systematic unity that gives members a sense of personal identity and cultural anchorage (Greaves, 1996). A culture includes time from the past to the future, religious, economic, political, communication, and kinship systems, as it is the whole set of learned behavior patterns common to a group of people, their interactive behavior systems, their art, their material goods, their individual and collective health, and (although this is generally not recognized) the natural resources and environment on which all of this depends. The CTUIR people have genetically adapted to the ecology of their homeland for thousands upon thousands of years, and have had their behavior modified as a result of responding to the flux of the ecology of our land for thousands upon thousands of years. They have produced a viable holistic environmental management system designed for continuously sustainable enhancement of our culture. The fabric of our very existence, including our sounds, medicine, science, art, music, and lifestyle is a reflection of thousands upon thousands of years of site-specific environmental shaping. Any impact to those resources of which we are an inseparable part, is a cultural risk. If tribal members are kept from a sacred site because it has been contaminated, then they cannot transmit traditional teaching to future generations about the life significance of that site and therefore a significant part of their culture will be irreversibly altered.

What cultural risk is not. There are many misconceptions about cultural risk (Figure 12 a and b). Cultural risk is not “perceived risk,” a perception of risk by a culturally defined group, a weighting factor, a risk management consideration, an opinion, or a preference. It is not a culturally-specific interpretation of “real risk.” It is more than merely disturbance of cultural artifacts, and more than an exposure estimate for a particular culturally-defined group. It is not just a byproduct of other risks or a ramification of human exposure or loss of resources.

Figure 12. Misperceptions about cultures and cultural risk.



Cultural Risk Metrics. Since this paper focuses on the cultural aspects of tribal community health, more emphasis is placed on social quality of life, cultural activities, access and use to a site or resource, risk to cultural resources or landscapes, and equity. Figure 13 illustrates a process for translating cultural values or statements into quantifiable metrics. One possible set of risk measures that reflect a typical indigenous perspective toward the land (although this may apply equally to some non-native communities), and which is therefore tied to a specific location/resource is as follows:

- Access to or use of a place or resource (duration of loss, percentile of loss relative to original conditions, residual quality if partially lost or not fully restored)
- Community well-being and social and family cohesiveness maintained through use of the place or resource
- Everyday life and material implements derived from the place or resource, and living and social activities and practices associated with the place or resource
- Exposures received during use of the site or resource (and exposures to the biota)
- Religious, ceremonial well-being gained through use of the place or resource
- Intergenerational continuity in knowledge, language, traditions, values, and education related to the place or resource
- Physical integrity of historical or cultural resources located in the place or associated with the use of the resource

Examples of Cultural Risk Metrics

Principle or Value	*Type of data & metric needed to describe impacts*
Any amount of contamination can cause social or cultural impacts	Acreage above background or detection limit as well as above regulatory standards. x how many years = acre-years or Cultural QALY
All natural resources are cultural resources	Acreage above background; number of species affected; number of individual organisms
Obligation to evaluate impacts to Trust Resources	Mass of soil contaminated; volume of water contaminated (x duration)

Figure 13. Examples of translating cultural principles into evaluation metrics.

Evaluating disproportionate impacts is also embedded in holistic risk assessment. The conventional approach to addressing risk distributions (environmental justice) as recommended by EPA and DOE is solely as a demographic and economic problem (identifying the racial or ethnic profile for an impact zone, and evaluating whether there is a differential impact to jobs, services, and so on for the groups within the impact zone based on the number of people within each demographic stratum). This is not suitable for indigenous communities, which are less market-based and more resource-based, and which tend to value impairment of cultural use as high or higher than commercial utility. Identifying "environmental justice communities" based on suburban demographics (racial profiles) rather than on affected resources is inappropriate for tribal communities. Further, the spatial boundaries of the impact zone extend for as far as the contamination moves (may be greater than 50 miles), and the temporal boundaries of the impact zone extend for as long as the contamination or disposed waste remains intrinsically hazardous, and for as long as the adverse impact persists (e.g., ecological recovery time, the number of generations that are exposed, or the number of generations that a mutation remains in a population after exposure stops).

EPA's Comparative Risk Process includes community concerns and their attributes, such as magnitude (area, numbers of people, etc.), severity, reversibility, and uncertainty (EPA 1993). Table 3 represents an example of a cultural quality of life scale that could be constructed for a Native American Tribe with historical presence in a particular area. The focus is on risks to the community rather than the individual, which is an important distinction. Table 4 is an example of a cultural risk evaluation that parallels the common concept of "risk = probability x severity."

Table 3. Information that can be used to evaluate the distribution of risks and impacts between groups, from a resource-based perspective.

Group specific <u>access, use, and rights</u>. Institutional controls cause lost access and cultural costs. Includes treaties and trusteeship access to or use of a place or resource (duration of loss, percentile of loss relative to original conditions, residual quality if partially lost or not fully restored)
Group specific use of local natural resources. Everyday life and material implements derived from the place or resource, and living and social activities and practices associated with the place or resource, and cultural use of natural resources.
Group specific <u>health</u> concerns or sensitivities. Multi-generational effects, effects on individuals within the group such as children & elders, community-level exposures, total contaminant burden, preexisting health conditions and disease patterns, stressors such as nutritional status or low socioeconomic status. Includes cancer, mutagenic, endocrine, neurological, reproductive, developmental, immunological, and other effects. Applies to both the maximally exposed individual, to the most sensitive individuals, and to the community as a whole (total community contaminant burden).
Group specific <u>ecological</u> concerns and key species. Ecological toxicity at the organism and population level, sublethal effects including mutation, multigenerational effects for long-lived contaminants or persistent effects, biodiversity and ecosystem integrity, environmental functions and services.
Group specific <u>economic/trade</u> impacts. Full set of metrics beyond direct impacts such as jobs and services; costs of lost access, use, etc.; replacement costs; costs of health care or restoration; natural resource valuation, costs of intangibles or externalities; costs of monitoring and surveillance now or in the future; issue of discounting (or not).
Group specific family and <u>social</u> impacts. Community well-being and social and family cohesiveness maintained through use of the place or resource, civic or secular activities dependent on the place or resource, indicators of community health; stability of governance systems.

Elder-defined religious and ceremonial impacts. Religious, ceremonial well-being gained through use of the place or resource.
Cultural & historical sites or properties (NHPA). Physical integrity of historical or cultural resources located in the place or associated with use of the resource; importance of the resources as evaluated by the "owners" of the resource.
Traditional use areas, sites, resources, and landscapes. Other uses of the site or resource such as education or art; intergenerational continuity in knowledge, language, traditions, values, and education related to the place or resource; preservation of future use options; contribution to sustainability; relation to land ethic and self-identity.
Proportion of group affected compared to population at large. Distributions of impacts; determination of any inequities.
Overall community well-being. Psycho-social statistics, health statistics, law enforcement records, current status of community satisfaction (e.g., existing outrage, existing cultural deficit, trends in community wellbeing, etc.

Table 4. Example of Impacts to Cultural Resources, Activities and Values Over Time.

Metric	Maximum Possible Score	Actual score	Comments
RESOURCE IDENTIFICATION			
Likelihood of resource being present within the impact zone	50	50	Known village, burial, ceremonial sites, prime habitat.
Total area impacted	25	25	Entire area river shoreline
Types of sites/resources (estimated max approx 150)	150	150	Multiple types, sites; prime ecological area
Existing condition	25	20	Surface largely undisturbed
DAMAGE POTENTIAL			
Imminence of harm	50	50	High urgency
Severity of harm	100	100	Varies with scenario

Reversibility/duration	100	100	Would be irreversible
CONSEQUENCE POTENTIAL			
Potential to limit access or use over time	25	25	Full loss of use, depending on scenario
Potential resource loss	25	25	Irreplaceable
Potential impact on recreational Quality and use	25	15	Recreational use of the River may be reduced
Proximity to River	25	25	Very close to river
Degree of Trusteeship responsibility	25	25	Multiple ecological, cultural resources
Potential for multigenerational Impacts	25	25	Cumulative health and cultural impacts
Potential for limiting future Land use options	25	25	Depending on scenario, could restrict all future uses
Totals	825	755	Extremely high priority to protect and restore safe access and use.

Summary of Cultural Risk	Score	Comments
Resource Presence Probability	245 out of 250	There are known village, burial, ceremonial sites and prime shoreline and habitat areas. Part of the area is disturbed.
Damage Potential	250 out of 250	Damage to cultural factors would be essentially irreversible; high urgency to prevent harm.
Consequence Potential	255 out of 325	High existing and future impacts to access, resources, River, trusteeship, multigenerational impacts and other Site values and principles.
TOTAL	750 out of 825	

4.7 Risk Characterization: Characterizing All the risks and impacts

This paper and the companion paper have presented several ways to evaluate cultural risk and/or community quality of life. The risk characterization step should bring all the risk attributes together into a single overall risk evaluation.

Depending on the selection of risk attributes (magnitude or severity, probability or likelihood, area of impact, recovery or resiliency, time to impact or initial release event, and so on, one can construct matrices or scales by which overall risks can be ranked. Two examples are shown below (Tables 5 and 6 and Figure 14).

Table 5. Risk Evaluation Matrix, modified from Department of Energy Guidance

		A	B	C	D
LIKELIHOOD defined as either:	Probability that event (i.e. initial release event OR exposure) occurs within a year, leading to eventual adverse impacts (1) or	1 to 0.1	<0.1; >0.01	<=0.01; >0.0001	<= 0.0001
	Time until event (i.e. initial release event OR exposure) leading to eventual adverse impacts is expected to occur	<10 years	>=10 yrs; <100 yrs	>=100 yrs; <10000 yrs	>= 10000 yrs
IMPACTS - Public Safety and Health (2)					
1. Death or injuries/illnesses in one or more people involving permanent, irreversible effects such as permanent total disability or chronic diseases; Extreme overexposures		Very high	High	Medium	Medium
2. Injuries/illnesses involving permanent partial disability or temporary total disability >3 months; Serious overexposure		Very high	High	Medium	Medium
3. Injuries/illnesses that result in reversible impacts of <3 months duration whether the disability is total or partial; Small overexposure		High	Medium	Medium	Low
4. Cumulative exposures are detected or predicted at or below regulatory levels for single or multiple substances, but do not result in illness or other adverse health effects.		Medium	Low	Low	N/A(3)
IMPACTS - Environmental Health					
1. Catastrophic damage (irreversible loss of unique or sensitive environment, or causation of very poor biological condition(4), or a wide geographic impact or >20 years to recovery); environmental contamination exceeding one or more environmental standards for >20 years.		Very high	High	Medium	Low

2. Significant damage (poor biological condition, or intermediate geographic impact, or 5-20 years to recovery); environmental contamination exceeding one or more standards for 5-20 years duration.	High	High	Medium	N/A
3. Moderate damage (fair biological condition, or small geographic impact, or 2-5 years to recovery); environmental contamination exceeding one or more standards for 2-5 years.	Medium	Medium	Low	N/A
4. Minor damage (good biological condition, and negligible geographic impact, or <2 years to recovery); environmental contamination exceeding detection level but below standards..	Medium	Low	N/A	N/A
IMPACTS - Socio-Cultural and Economic Health				
1. Permanent lost access or use of area with permanent reduction in community or tribal quality of life[5]; extreme proportional inequity in the distribution of impacts[6]; major economic impact to surrounding community; irrevocable loss of cultural resource(s)[7].	Very high	Very high	High	Medium
2. Permanent partial restriction on access or use, or temporary total restriction > 10 years in duration; temporary reduction in quality of life >10 years in duration; serious proportional inequity; serious economic impacts; harm to cultural resource requiring major mitigation.	Very high	High	Medium	Low
3. Temporary restriction <10 years in duration with a moderate reduction in usage levels or quality of life; moderate inequity; harm to cultural resources recoverable through moderate mitigation efforts.	High	Medium	Low	N/A
4. Restrictions on access without loss of resources; temporary but reversible impacts on quality of life; minor economic impacts not requiring response efforts; minor impact on cultural resources, traditions that are fully reversible without lost value.	Medium	Low	N/A	N/A

1. If the release event has already occurred and effects are inevitable, probability = 1 because the sequence of events has already started. All of the exposure scenarios are tied to environmental quality, land use plans/promises, and reasonably anticipated onsite access levels.
2. For public health, effects are to be evaluated for one or more people and summed over time, populations, contaminants, and sources (including background). For individuals, concentration x time is evaluated, while for populations and generations, concentration x persistence is evaluated.
3. While N/A is used in this table to indicate risk levels near background, it may also be used to designate projects unrelated to risk reduction, such as administration, management, or research.
4. Biological conditions refers to ecotoxicity, community and habitat impacts, ecosystem functions & services, and impacts on linked systems. The size of the impact area includes both the immediate area and "downstream" or ramifications in linked areas resulting from the initial impact.
5. Quality of life refers to social, religious, recreational, psychological, behavioral, linguistic, and aesthetic aspects of the lifestyle. For tribal impacts, this refers to a traditional lifestyle and access to ancestral lands and resources.
6. Proportional equity refers to the proportion of the affected group that is impacted rather than the absolute number of people affected. Equity refers to the identification of what members of the present generation are most affected, whose resources are affected, whether future generations will have a larger remediation burden than the present generation, and whether the options of future generations are reduced through the choice of irreversible technologies or waste forms.
7. Cultural resources include historical buildings or areas, traditional cultural properties and landscapes, religious use areas, physical artifacts, and cultural traditions associated with particular areas and resources.

Table 6. Summary of metrics

AFFECTED SYSTEMS: Categories of Risk or Impact with Types of Metrics

A. Ecological health (species, system processes, locational attributes, attributes of the whole system)

- Identification of affected environment
  - abiotic resources such as soil, existing water quality, biogeochemical cycles, etc.)
  - biotic resources such as Trust resources, critical habitat, T&E species, cultural species, ecosystem descriptions and linkages
  - Location attributes (unique features, watersheds, traditional cultural properties, landscape, historic districts) and locational qualities (solitude, quiet, pristine, other qualities that are lost with any degree of disturbance).
  - Identification of ecological co-stressors (physical, thermal, radiologic, biological, fragmentation, trends, and so on)
- Ecotoxicity in individual organisms, including tissue-level effects. Toxicity to plants, animals, microbes using simple foodchains.
- Community or population effects, foodweb effects
- Scales: spatial (e.g. trophic levels, overlapping homerange sizes) and temporal (e.g. overlapping lifespans, multigeneration cycling of persistent chemicals or long-lived radionuclides)
- Habitat and Ecosystem indices of diversity, integrity and functionality (several to choose from). Ecological structure (the elements), relationships, and the function of the parts and the system.

B. Impacts to Environmental goods, uses, functions, and services (ethno-habitat)

- **Goods** are tangible items of value to plants, animals, or people, such as food and medicine obtained from the location
- **Functions** are specific roles that elements of the local area play within the area or within a larger ecosystem. Examples are nutrient production needed by local fauna and migratory birds.
- **Services** are process or ends of importance to people, such as soils stabilization provided by intact groundcover which in turn reduces dust and associated visibility reduction and cleaning costs. Cultural services are provided by places, resources, participation in the circle of life, and so on.
- **Uses** are things people or animals do at the location that are dependent on natural resource quality, such as recreation or seasonal nesting grounds for birds.

C. Human Health

- Exposure scenarios relevant to the lifestyles that are at risk
- Cancer and many non-cancer endpoints (hazard index and individual endpoints); synergisms.
- Public health metrics such quality of life-years (QALY), other measures for functionality and quality

- Multigeneration effects, summed over the lifespan of the material
- Community-level effects, summed over spatial and temporal scales
- Co-risk factors (multiple exposures, biochemical genetics – see NIEHS web page, underlying health effects and disease patterns, nutritional status, access to health care, poverty, loss of native food and medicine, loss of language and religion, encroachment on land base and traditional resources)
- Identification of sensitive groups such as children or elders, and groups with unique exposure pathways.
- Proportion of community that is at risk.
- Population structure and changes or trends.

D. Sociocultural Health (system elements, processes, and attributes)

- Social indicators such as social cohesion, recreation, education, learning systems, etc.; availability of opportunities to educate, transfer knowledge, participate in ceremonies (lost opportunity costs are under economics).
- Cultural indicators such as access and use of traditional lands, intergeneration continuities, other ways of defining cultural systems and cultural identity
- Religion (access to and quality of ceremonial and religious areas and resources, …)
- Cultural and historic resources, landscapes, viewsheds, soundscapes
- Treaty rights, Trusteeship, Values and Principles (preservation of future options, sustainability, …)
- Socio-cultural co-risk factors or co-stressors (past history and cultural deficits, ease of access to and responsiveness of decision processes, fairness and openness of institutions, co-ownership of decisions …)
- Metrics for impact evaluation include:
  - (the acres above various thresholds) x (the duration) x (the full duration of any degree of contamination), summed for ALL contaminants over time;
  - (numbers of species/organisms/sites contaminated above various thresholds) x (their importance, or how many ways are they used) x (persistence or duration of contamination);
  - (ecological functions and service-acre-years lost or impaired due to contamination or the response to contamination) x (duration or resiliency or recovery time);
  - (percent or acres of original landscape/soundscape/viewshed affected) x (duration of impact), or more specifically decibels added, visual degrees, etc.;
  - (degree of restricted human access) x (duration of lost access) x (importance of access to the particular location or resource);
  - number of future use options temporarily or permanently lost;
  - lost trust or peace of mind (H-M-L scale);
  - proximity to important locations, ripple effects linked through time, space, resources, history, and so on.

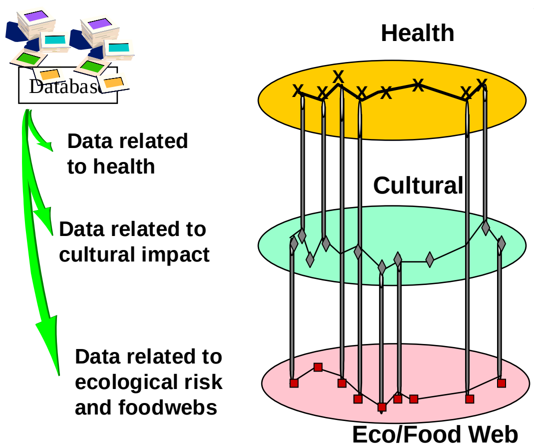
E. Socioeconomic Health (system elements and processes)

- Suburban economic metrics (jobs, services rendered and required, recreation, infrastructure etc.)
- Dollar or non-dollar economies (parallel metrics for value of clean media, tangible goods for food, shelter, barter, spiritual currency, specialization of roles, survival…)
- Cost of lost subsistence practices, lost religious opportunity, lost resources with ripple effects…
- Natural resource valuation; intrinsic value (CVM, etc.); cost of lost or degraded resources and their uses
- Costs associated with avoiding, mitigating or repairing ecological, human, cultural impacts
- Degree of regulatory compliance and Trusteeship (with associated penalties for noncompliance or lost property values or lost land use), litigation potential
- Economic co-stressors (SES status, historical economic deficit, discounting as a stressor by itself)

Figure 14 shows and example of the spatial integration of metrics according to the type of metric and their distribution over a landscape.

Figure 14. Spatial organization of risks and impacts.

Summing impacts across several risk-based data layers to measure total impacts and lost uses



Examples of Metrics:

- **Acres above tribal WQ std.**
- **Number of lost visits**
- **Acres with restricted access**
- **Number of years of reduced use**

- **Number of cultural uses for an affected resource;**
- **Degrees of viewshed affected**
- **Number of NHPA sites contaminated**

- **Number of organisms or species with contamination above detection limit**
- **Number and duration of lost ecological functions and services (acre-years)**
- **Human health risk x number of years above selected risk level x proportion of community affected**

4.8 A Universal Harm Scale for Comparing Risks

The Universal Harm Scale represents one possible way to compare disparate kinds of risks (Bilyard, personal communication[20]; Harper et al. 1995). In this example (Table 7), the constructed point scale in Tables 4 and 5 is used for the socio-cultural element. By anchoring the scales with labels that are in common usage but generally lack numerical standards, a discussion can be triggered in which the affected peoples have as much say as the "experts." If the discussion is guided properly, a discussion of values precedes technical arguments (such as whether lethality occurs at 1000 times the Reference Dose) and the scales are normalized to value judgments about severity. This allows each expert (e.g., a toxicologist, an ecologist, an economist, and a tribal elder) to determine what is catastrophic for him or her or is convention within their discipline. It also recognizes that for some measures low level contamination can indeed perturb the system in a way that may make a difference to the outcome even if regulatory harm (exceedance of a standard) has not occurred. A "No Effect" column would be largely but perhaps not completely synonymous with zero contamination or no elicitation of even an adaptive response.

EPA's Comparative Risk Process includes community concerns and their attributes, such as magnitude (area, numbers of people, etc.), severity, reversibility, and uncertainty (EPA 1993). Table 3 represents an example of a cultural quality of life scale that could be constructed for a Native American Tribe with historical presence in a and cultural resources. It includes three factors for cultural risk: (1) Resource Identification, or likelihood that cultural resources are present within an impact zone or that the site or resource has tribal or community significance, (2) Damage Potential, or the probability and severity of the damage in terms of physical disturbance, contamination or degradation, and (3) Consequence Potential, or the consequences of the damage on cultural activities, resources or values (Harper et al.1995).

- *Resource Identification: description and importance of potentially impacted cultural sites.* The Resource Identification description of a site or area is defined as the probability that a resource of importance being present or being impacted. The description includes the type, extent, uniqueness, and importance of an area or resource, including buffer zones and service areas, as well as impacts on, or from, nearby or linked areas. This includes sacred sites, historical/ archaeological sites, burial sites, and sites containing important traditional cultural materials or with associated cultural uses or history, or general community importance (values recreational areas, physical features by which the community identifies itself, etc.). This step is analogous to the EIS step of describing the affected resources, but includes identifying resources on the basis of their usage and importance as well as simply physical presence.
- *Damage Potential:* Existing condition, existing stressors, and potential for damage due to physical disturbance, contamination, desecration or aesthetic degradation. An estimation of the damage (predicted peak concentrations, time to impact, resiliency of the affected system) is also estimated. Also termed "Degree of Vulnerability" (EPA 1993).
- *Consequence Potential:* This parameter represents the intersection between the first two parameters (the probability of a resource being present and the probability of

[20] G. Bilyard, Battelle Pacific Northwest National Laboratory, Richland, WA, 99352.

damage). The consequences of the first two parameters might include restricted access, desecration or aesthetic degradation. This step can also evaluate other principles, such as potential loss of future use options. Individual metrics might include subscales for lost access or use, or lost services (how extensive and how long) such as acres x years x percent restriction, or probabilities of damage x severity x duration.

Table 7. Universal Harm Scale with hypothetical thresholds for impact severity levels

	Perturbation (some effect above zero)	**Harm (may be de minimis)**	**Injury (may be reversible)**	**Severe or Irreparable Injury**	**Catastrophic Injury**
Public health	<1E-6 cancer HI < 1	1E-6 HI = 1	1E-6 to 1E-4 HI = 1 to 10	1E-4 to 1E-2 HI = 100	Loss of life 1E+0 HI = 1000
Worker health	<TLV or PEL or STEL	TLV, reportable incident	10 x TLV; lost work days	100 x TLV Permanent disability	1000 x TLV Loss of life
Ecotoxicity	Detected but below standard	NOEL, NOAEL, AWQS or other standard	1-10 x std.	10-100 x std.	1000 x std.
Environ-mental Functions and Services	Transient but noticeable effects; adaptive responses in organisms; Detectable body burdens.	Localized ($100m^2$) and short-term (< 1 year to full recovery); few individual organisms; no T&E species; No intervention	Larger ($1000m^3$) and/or longer term (1-3 yrs); Community level effects; Little intervention required.	Widespread (> 10000 m3) and/or long-term (>5 yrs); Population level injuries; Recovery only with significant intervention	Irreversible injury; Permanent loss; Ecosystem level effects; “Important” species irreversibly harmed.
Socio-cultural; points from a proxy scale	0-100	100-250	250-400	400-550	>550
Socio-economic; impact costs and restoration costs	< $1000	$10,000	$100,000	$1M	>$1M; Costs of life, image, studies, penalties, remedies, etc.

In this example there is some consideration of severity, extent, and duration, which would depend on the characteristics of the situation. Similarly, the number of individual measures that are considered in each category is also situation specific. In this example, human health is reduced to a single metric (cancer risk or hazard index), while environmental functions and services considers 4 or 5 attributes, and the sociocultural category sums a score from a proxy scale that includes a dozen different metrics.

There are several potential applications of these methods. One application is to improve risk characterization, which is perhaps the most neglected aspect of risk evaluation. Affected communities expect all of their risks to be characterized, and to be able to understand the whole story about a contamination source or important site or resource. A second application is for the evaluation of risk distributions to determine whether there is a disproportionate or inequitable risk burden from community to community. A third application would be in remedy selection, potentially influencing the preferred remedy if cultural as well as human health risks are evaluated during the risk assessment phase. A similar application is to the NEPA process, as well as environmental planning (which was the origin of some of these concepts as Comparative Risk tools). A final application is to the embryonic national discussions about closure of large or complex or hazardous sites (including landfills and other near surface disposal sites) from a long-term stewardship perspective. Stewardship means much more than simply the maintenance of barriers or monitoring and surveillance devices. This is a discussion that must receive more attention. Finally, risk ethics has been neglected to the detriment of communities that do not have the time or money to participate in risk based decision making discussions. We would like to close by proposing that a national risk ethics forum be established and that curricula be developed to shed light on the topic and level the playing field.

Table 6. Summary of methods for evaluating cultural risk or quality of life

Method	Description
Universal Harm Scale.	A method for normalizing each type of risk/impact so that cumulative risks can be addressed
Socio-Cultural Effects Scales	A method that includes human use potential, damage potential, and consequence potential (to be combined with parallel evaluations for human health and ecological health)
Service-Acre-Years	A method that combines space-time attributes of risks and impacts with specific services provided by the affected area or resource.
Environmental Functions and Services	Descriptions of goods, environmental services provided by the site or resources, human services obtained from the functions, and uses/activities that are dependent on the quality of the site or resource; complements ecotoxicity evaluations.
Ethno-Habitats	Description of the human-ecological system that together defines a culture and sustains it.
Dependency Webs	Influence diagrams as a way to identify concerns about a site or resource, or reasons why it is important to people or biota. Also a way to organize the analysis and communicate results; Also an aid to cumulative risk characterization.
Risk Evaluation Matrix	A tool to help prioritize response actions or budgets based

	on magnitude, severity, imminence, and duration of impacts.

4.9 A Spatial Risk Approach for a Facility with Multiple Waste Sites

Traditional risk assessment typically consists of tables of numerical hazard calculations from a source through a pathway to a specified receptor. This methodology is well established in the regulated community. The traditional model is designed to evaluate limited sources and limited receptors, for which it can be a useful decision tool.

However, it is difficult to perform a risk assessment that is required to describe impacts to entire surrounding public and ecosystems over space and time. It is even more difficult to assess risks over space and time at installations with tens or hundreds of individual waste sites as well as many types of data for multiple media which are, or will be, moving through the environment. These assessments must address different constituents, multiple waste sites, multiple release patterns, different transport pathways (i.e., surface water, groundwater, air, overland soil, and cycling through biological organisms and food chains), different receptor types and locations, various times of interest, and various population distributions and land uses distributed across the landscape in different patterns over time.

Traditional risk assessments are performed via a myriad of calculations, which are based on a combination of equations and input-output parameters. These methods are well standardized, once the assumptions are agreed upon. Even with very complex sites, the difficulty is not in the calculations; it is (a) the overall architecture of the assessment codes, and (b) the translation of hundreds of output tables into spatial and temporal information into a format that truly informs decisions. Additionally, evaluating the sensitivities and uncertainties associated with large impact areas, containing multiple sites, multiple sources, and multiple receptors, is not efficient using conventional inflexible architecture.

4.9.1 Modular Risk Assessment

Although the process is complex, two of the most important difficulties to overcome are associated with (1) establishing an approach that allows for modifying the source term, transport model, and/or exposure component as an individual module without having to re-evaluate the entire installation-wide assessment, and (2) displaying and communicating the results in an understandable and useable manner to interested parties.

An integrated, physics-based, modular approach which is coupled to a Geographical Information System (GIS) can resolve these problems. The Modular Risk Assessment (MRA) allows the user to analyze a wide range of situations (e.g., different closure configurations or land uses) and present the information as spatial visualizations of 1-D, 2-D, and 3-D risk maps.

The MRA is not a new idea (Nazarali,1994), but a proven approach for the risk assessment of large area environmental insults consisting of multiple sources and multiple receptors. This approach has been first used successfully in an evolution consisting of the Hanford Remedial Action EIS (HRA-EIS; DOE/DEIS-0222), the Tank Waste Remedial System Environmental Impact Statement (TWRS-EIS), and the Retrieval Performance Evaluation (RPE). The RPE added a probabilistic method to evaluate the systemic uncertainty for numerous parameters with the risk results. This sequence resulted in the current industry bench mark. Figures 1 and 2 present samples of the output for the MRA approach.

The MRA approach is based on a large scale modular platform that was developed for Hanford. The MRA platform can be updated with available individual site closure data [e.g., the closure verification package (CVP) data] in the initial phases. The MRA can also use other environmental data as it becomes available, and can incorporate the environmental concentrations and GIS coordinates, according to EPA data usability guidelines.

4.9.2 MRA Structure

The MRA structure has many elements in common with conventional risk assessments. They both rely on site specific data, transport and dispersion models (e.g., MODFLOW), and exposure parameters and risk evaluation equations (e.g., RESRAD). Where they differ is in their respective abilities to assess changes and define the specific attributes (e.g., source term, transport, and receptors) that most influence the summation of risk at a closure area.

An integrated physics-based, compartmentalized or cellular structure of the affected areas is coupled to a GIS grid cell system. This system is the key to mapping the initial source term data, the movement of contaminants over time, and the spatial mapping of risk results. This modular GIS based approach overcomes difficulties in analyzing multi-variable scenarios for cumulative pictures of risks over space and time. This type of presentation captures the essence of the assessment in a relatively elegant manner where results are quickly conveyed. Figures 3, 4, and 5 provide examples of the graphic output of the modular platform.

The other primary structural element in the MRA is the unit risk approach. Once the model parameters are determined and approved, risk estimates (with and/or without transport modeling) are evaluated for unit amounts of each constituent present at each source. If additional source term or other environmental data are gathered, they can be easily used a scalar modifications of the pre-calculated results without recalculating the entire analysis. Similarly, the assessment can be easily modified for different groundwater flow pathways, different ecological uptake, or any other parameter differences. Summary displays (graphic and tabular) for various closure configurations, future climate conditions, or land uses are tailored for specific risk criteria, following EPA and State guidelines.

Sensitivity and uncertainty analysis can be included for both reasonable maximum and central tendency risks, depending on the statistical quality of the environmental data. A combination of deterministic and probabilistic methods are often used to provide a sensitivity and uncertainty analysis for over seventy parameters (the RPE methodology).

4.9.3 Use of the MRA Results.

As the updates of the MRA evolve, higher confidence would evolve assuring that priorities remain on target. Should anomalies arise, the MRA could be used to cost-effectively evaluate the specific issues (e.g., new source term data, preferred flow pathways, biological concentrations, or receptor risk), and provide feasible or best fit remedial alternatives.

The MRA data can also be sued to identify alternatives for long-term stewardship and provide confidence in remedial actions already taken.

Events and risks need to be considered over a much larger span of time because decisions being made now will have consequences for thousands of years. Simply put, common sense tells one that as long as something is intrinsically dangerous one must make decisions now so it will be managed appropriately, which in some cases means in perpetuity. Temporal risk profiles (Harris-1997, Harper-1999) can be prepared to show how risks are reduced for different end state configurations, as well as how future risks might coincide in the future if releases from closed waste sites occur in the future, or if groundwater plumes merge.

Figure 15.

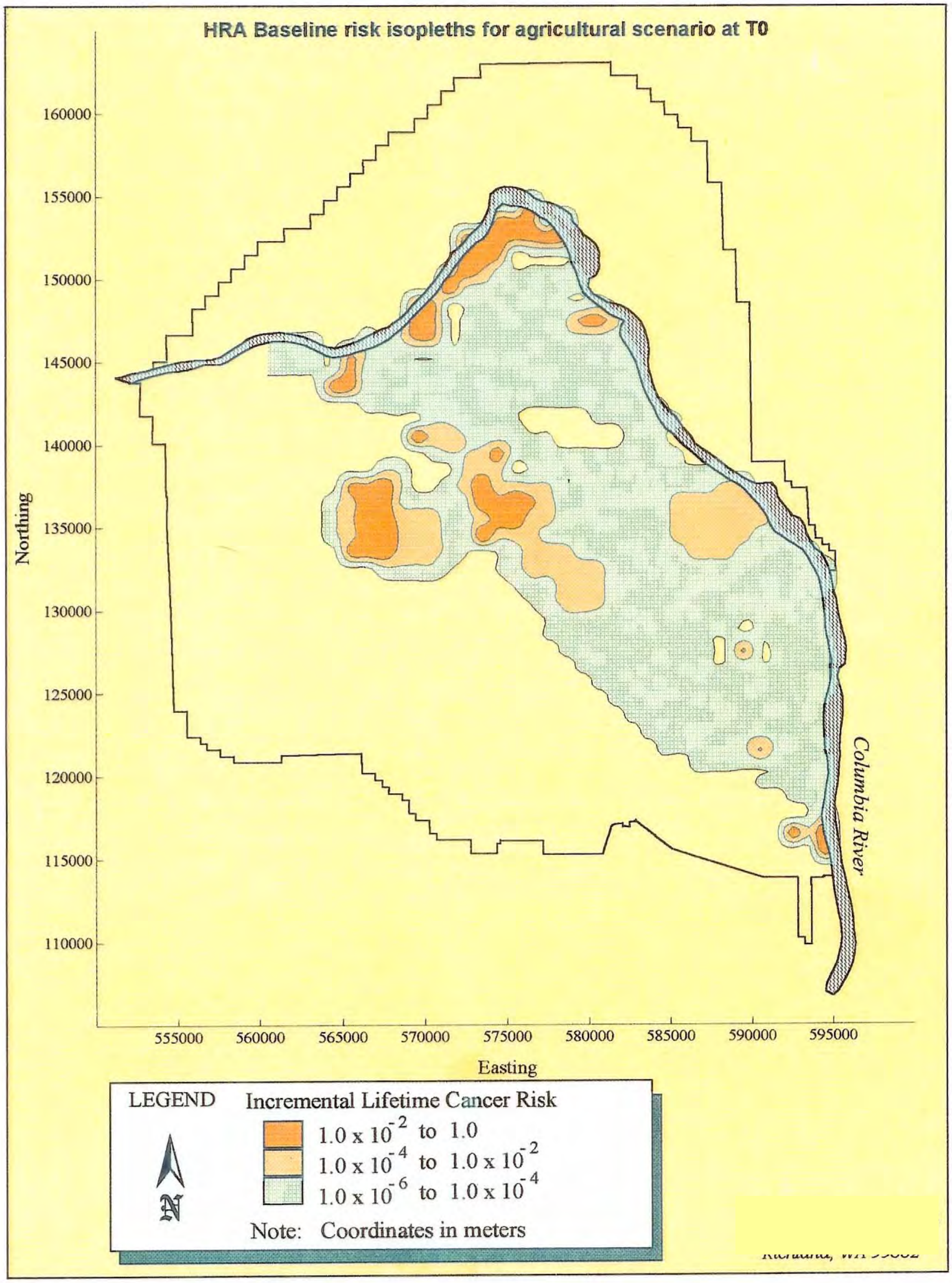

HRA Baseline risk isopleths for agricultural scenario at T0
160000
155000
150000
145000
140000
135000
130000
125000
120000
115000
110000
Northing
555000
560000
565000
570000
575000
580000
585000
590000
595000
Easting
Columbia River
LEGEND
Incremental Lifetime Cancer Risk
1.0 x 10-2 to 1.0
1.0 x 10-4 to 1.0 x 10-2
1.0 x 10-6 to 1.0 x 10-4
N
Note: Coordinates in meters

Figure 16

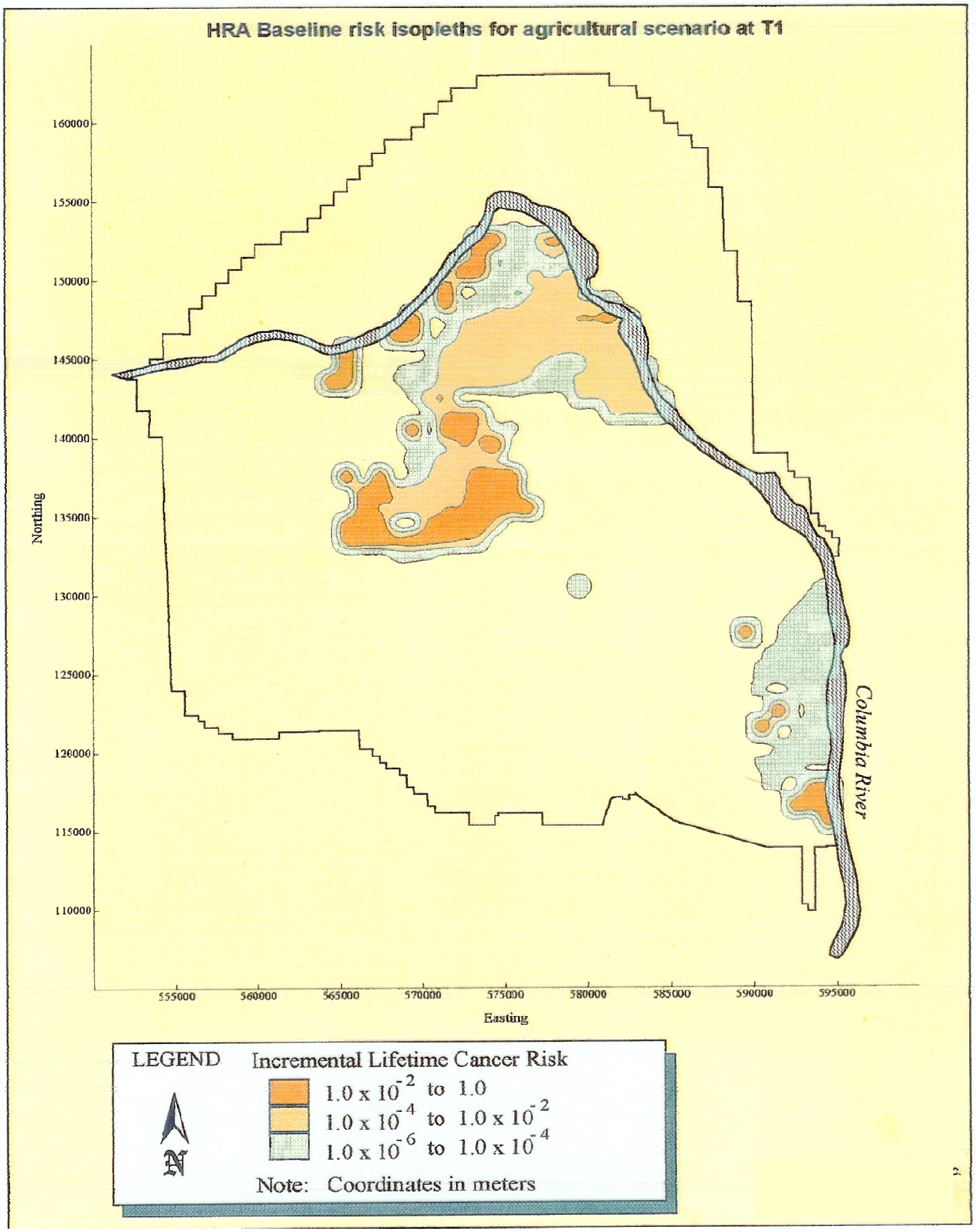
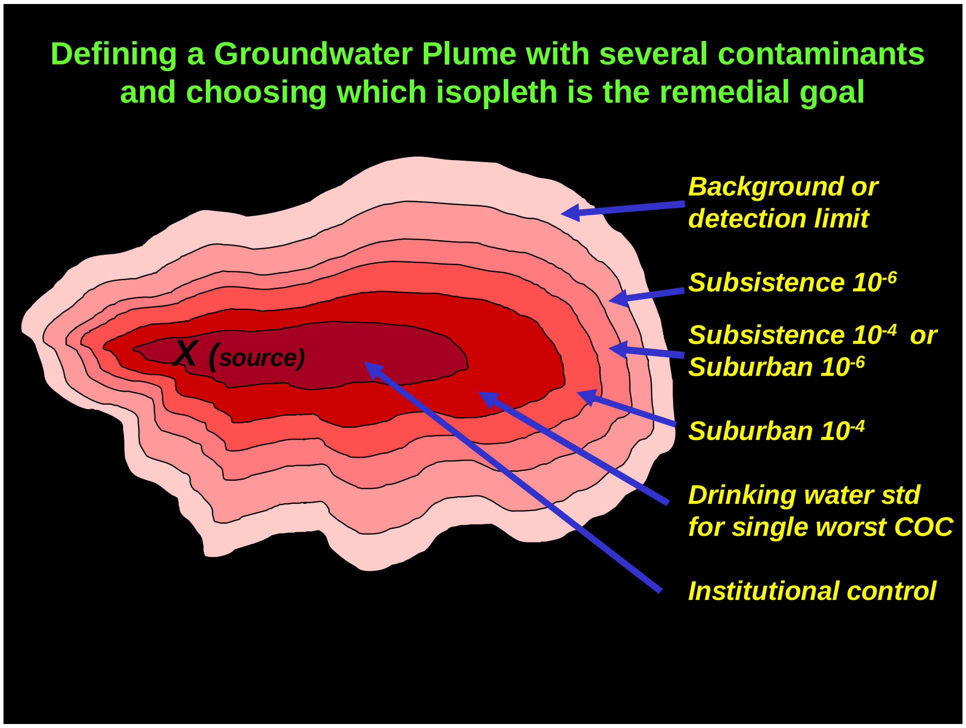

HRA Baseline risk isopleths for agricultural scenario at T1
Northing
160000
155000
150000
145000
140000
135000
130000
125000
120000
115000
110000
555000
560000
565000
570000
575000
580000
585000
590000
595000
Easting
Columbia River
LEGEND
Incremental Lifetime Cancer Risk
1.0 x 10-2 to 1.0
1.0 x 10-4 to 1.0 x 10-2
1.0 x 10-6 to 1.0 x 10-4
N
Note: Coordinates in meters

Figure 17.



Defining a Groundwater Plume with several contaminants and choosing which isopleth is the remedial goal
X (source)
Background or detection limit
Subsistence 10^{-6}
Subsistence 10^{-4} or Suburban 10^{-6}
Suburban 10^{-4}
Drinking water std for single worst COC
Institutional control

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