



**Confederated Tribes and Bands
of the Yakama Nation**

Established by the
Treaty of June 9, 1855

September 7, 2007

Mr. David A. Brockman
U.S. Department of Energy
Richland Operations Office
P. O. Box 550
Richland, WA 99352

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EDMC

Subject: Yakama Nation Exposure Scenario for Hanford Site Risk Assessment *H-0-7*

Dear Mr. Brockman:

This letter is to transmit the Yakama Nation Exposure Scenario for Hanford Site Risk Assessment. Development of this scenario is an initial step to addressing the potential risks to members of the Yakama Nation who may utilize resources at the Hanford Site and surrounding areas, or otherwise be exposed to Hanford contaminants.

The Yakama Nation intends for this information to be used in a manner that comprehensively and completely evaluates all risks posed by Hanford contaminants to Yakama Tribal members. To be scientifically conservative and credible, such a risk assessment must consider the unique risks to Tribal members as additive to the generic maximally exposed individual. In other words, Tribal exposure pathways cannot be limited with non-conservative assumptions, whereas unique Treaty protected lifestyle and diet factors which add incremental risk must be accounted for.

We remain concerned at the many individual risk assessments being conducted for limited portions of the site, for particular management programs or for environmental impact statements. This scattered and fragmented approach will not cumulatively analyze all risk to human health in general or to the Yakama Nation in particular.

Yakama Nation uses will result in unique contaminant pathways and exposure rates from living on the site and using the natural resources. High level, transuranic, low-level and mixed radioactive wastes, nuclear facilities, proposed waste treatment operations, contaminated biota, and polluted water pose threats to the Yakama Nation, the health of our people, and the vitality of our traditional subsistence lifeways. To protect Yakama Nation uses, all contaminant sources and hazards should be identified and assessed comprehensively to make cleanup decisions. We expect that the Department of Energy will consider the total risk to Yakama members and analyze all exposure routes, including potential groundwater consumption, to evaluate cleanup actions.

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As a first step, we request that the Yakama Nation Exposure Scenario be incorporated into the Risk Assessment Report for the 100 Area and 300 Area Component of the River Corridor Baseline Risk Assessment. However, in doing so, we point out that it will not be a complete picture of risk as many geographic areas and contaminant sources are not included in that Assessment. We expect that actual contaminant concentrations in media and biota be used to assess risk, although it is our understanding that site-specific data of that type is not available for many plants and animals that the Yakama Nation uses.

Of major concern is how the Yakama exposure scenario will be utilized to inform cleanup decisions. In this regard, the Yakama Nation has repeatedly asked for technical assistance funding to participate in Hanford risk assessment in an active and meaningful way. We have yet to receive approval or funding of our risk assessment scope of work. We again request the necessary resources to participate effectively, and look forward to meeting with you to address this matter in our upcoming discussions about the FY 2008 Yakama Nation Cooperative Agreement scope of participation.

Sincerely,



Russell Jim
Manager, ERWM Program

Enclosure

Cc: Jane Hedges, WA NWP
Nick Ceto, Hanford EPA

YAKAMA NATION EXPOSURE SCENARIO

FOR HANFORD SITE RISK ASSESSMENT

RICHLAND, WASHINGTON

PREPARED FOR THE

YAKAMA NATION

ERWM PROGRAM

**YAKAMA NATION EXPOSURE SCENARIO
FOR HANFORD SITE RISK ASSESSMENT
RICHLAND, WASHINGTON**

Prepared for the
Yakama Nation
ERWM Program

Prepared by
RIDOLFI Inc.

September 2007

EXECUTIVE SUMMARY

An exposure scenario for risk assessment was developed for the Confederated Tribes and Bands of the Yakama Nation to describe their traditional subsistence lifestyle, including dietary patterns and seasonal activities. This lifestyle may result in exposure to radioactive and hazardous chemical contamination, now and in the future, from the nearby Hanford Nuclear Reservation in southeastern Washington. The Hanford Site is located within the Yakama Nation ceded territory.

This scenario describes the maximum exposure reasonably expected to occur in the Yakama population, who currently subsist on natural resources in the vicinity of Hanford. Upon adequate cleanup, the Yakama hope to regain access to the Hanford Site, which is part of their usual and accustomed use areas. Without compromising confidential information, details of this scenario will be used by the U.S. Department of Energy to complete an exposure assessment to evaluate potential risks to the Yakama Nation from Hanford-associated contamination.

Using ethnographic interview methods, adult Yakama members described fishing, hunting, and gathering practices, sweathouse use, feasts, and ceremonies, all of which remain critical aspects of their subsistence lifestyle and unique culture. These data were compiled to provide a qualitative description of the current and anticipated future Yakama lifestyle and develop quantitative exposure parameters.

This project resulted in a conceptual site model that was developed to illustrate potential exposure pathways from Hanford Site contaminant releases to soil, water, plants, fish and other animals, which may ultimately impact the Yakama people. Surveys found that the Yakama depend heavily on the harvest and consumption of fish from local rivers, including the Columbia River, which passes through the Hanford Site. They also depend upon wild game and an abundance of local native plants, including shoots, roots, leafy material, and berries. These resources provide not only foods and medicines, but also material for tools, shelter, and accessories.

Federal guidance documents currently do not include adequate exposure information pertinent to a Native American subsistence lifestyle. This scenario compiles information specific to the

Yakama Nation to be considered in evaluating potential risk from Hanford Site contamination and to support appropriate cleanup decisions. Exposure parameters were estimated for inhalation, dermal contact, and ingestion of air, soil, water, fish, meat, vegetables, fruit, and milk, and reflect the current and anticipated subsistence lifestyle. The Yakama expect that this scenario will be used to evaluate risk in a comprehensive manner for the entire Hanford Site, incorporating all sources, radiological and chemical contaminants, exposure pathways, and natural resource uses.

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LIST OF ABBREVIATIONS AND ACRONYMS

CERCLA	Comprehensive Environmental Restoration, Compensation, and Liability Act (Superfund)
CRITFC	Columbia River Inter-Tribal Fish Commission
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ERWM	Yakama Nation Environmental Restoration and Waste Management (Program)
NPL	National Priorities List (for Superfund)
RESRAD	Residual Radiation (modeling program)
RME	Reasonable Maximum Exposure
Yakama Nation	Confederated Tribes and Bands of the Yakama Nation

LIST OF UNITS

g/d	grams per day
hr/d	hours per day
L/d	liters per day
lb/d	pound per day
m ³ /hr	cubic meters per hour
mg/d	milligrams per day

1.0 INTRODUCTION

This report describes an exposure scenario developed for the Confederated Tribes and Bands of the Yakama Nation (Yakama Nation) to better understand their traditional Native American lifestyle patterns and seasonal activities. This lifestyle may result in risks from exposure to Hanford Site contamination now and into the future. The material provided herein is intended to serve as a summary of the unique aspects of Yakama lifeways. In order to preserve uses for future generations, the Hanford Site cleanup process should be adequate to protect all natural resources and human populations, both tribal and non-tribal, in the region.

Ridolfi prepared this report on behalf of the Yakama Nation Environmental Restoration and Waste Management (ERWM) Program. The ERWM Program focuses on Hanford impacts to the Yakama people and their culture, and the land and the natural resources on which they depend. This report is based upon research and interviews with a sub-set of the population, qualitatively evaluates the Yakama lifestyle in general, and develops basic quantitative exposure parameters. Information in this scenario is intended to be used by the U.S. Department of Energy (DOE) to complete an exposure assessment for evaluating potential risks to the Yakama Nation from Hanford Site contamination. Identifying immediate and future risks is critical to the cleanup process.

1.1 Background

This section provides an introduction to the Yakama Nation, a summary of Yakama Treaty Rights, a brief summary of the Hanford Site and a description of the federal risk assessment process.

1.1.1 The Yakama Nation

The Yakama Nation is one of four federally recognized tribes in the vicinity of Hanford, along with the Confederated Tribes of the Umatilla Indian Reservation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Nez Perce Tribe. Figure 1 shows the location of the Yakama Nation Reservation, which currently occupies an area of nearly 1.3 million acres in southeastern Washington State, and the nearly 12 million acres of land ceded to the United States

in the Treaty of 1855 (Williams and Babcock, 1983; CRITFC, 2007). By 2006, the total membership of the Yakama Nation reached a population size of 9,872 individuals (ERWM personal communication, 2006-2007).

Unlike many Native American tribes residing on reservations in the United States, the Yakama Nation settled upon the land previously occupied by their ancestors for thousands of years. Although land was ceded to the United States, the Yakama retain for use the ceded area that encompasses the elevation gradient from the eastern Cascade mountain range eastward, which is an area of principle importance to their lifestyle and heritage (Williams and Babcock, 1983).

The Yakama Nation's traditional homeland is an area where ancient cultures have survived for thousands of years. During a long and dynamic tenure, the Yakama Native Americans developed an intimate understanding of the complex relationships between the land and associated natural resources. Resources used by the Yakama are broadly classified as roots, fibers, berries, fish, birds and other animals, minerals, and places of spiritual guidance and strength. As a place, the Yakama Nation's ceded and reserved land offers a multitude of resources important to former, current, and future generations.

1.1.2 Yakama Treaty Rights

On June 9, 1855, a treaty agreement was reached between the Yakama Nation and the United States. Appointees from the Yakama, Palouse, Piquouse, Wenatshapam, Klikatat, Klinquit, Kow'was-say-ee, Li-ay-was, Skin-pah, Wish-ham, Shyiks, Oche-chotes, Kah-milt-pah, and Se-ap-cat tribes and bands of Native Americans were joined by this treaty agreement to be considered as one nation, under the name of "Yakama." Kamiakun was named as "head chief," and all members were to be relocated to the designated reservation. Another regional tribe, the Wanapum (known locally as River People), were not included in the treaty, but many eventually enrolled as members of the Yakama Nation (ERWM personal communication, 2006-2007; Williams and Babcock, 1983).

The treaty was ratified by the United States Senate on March 8, 1859 and signed by the President on April 18, 1859, thus establishing a government-to-government relationship between the two

sovereign powers. According to the treaty, “the exclusive right of taking fish in all the streams, where running through or bordering said reservation, is further secured to said confederated tribes and bands of Native Americans, as also the right of taking fish at all usual and accustomed places, in common with citizens of the Territory, and of erecting temporary building for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed land” (Treaty with the Yakama, 1855, Article 3).

1.1.3 The Hanford Site

The Hanford Site is a 586 square-mile former plutonium production facility located within Yakama Nation’s traditional homeland (ceded area), approximately 20 miles east of the current Yakama Nation Reservation. The site, which has been operated by DOE, its predecessor agencies, and its contractors since its inception in 1943, is located primarily in Benton County (with portions of the site in Grant, Franklin, and Adams counties) along the Columbia River, just north of the city of Richland.

As part of plutonium operations, radioactive and chemical wastes were both intentionally and unintentionally discharged to the air, ground and waters. Contaminants have migrated from the soil vadose zone to the groundwater, ultimately discharging into the adjacent Columbia River. Hanford contaminants have been found in the region’s soils, waters, plants, fish and other animals, affecting the health of these natural resources and area residents. Figure 2 shows the location of the Hanford Site in relation to the Yakama Reservation, as well as the extent of current ground water radionuclide and hazardous chemical contamination at the Hanford Site (WADOE, 2006).

When plutonium production ceased in 1989, DOE, the U.S. Environmental Protection Agency (EPA), and the Washington State Department of Ecology signed a “Tri-Party Agreement.” This agreement effectively transformed the site’s mission from nuclear weapons production to cleanup and environmental restoration. Soon thereafter, specific areas on the Site (100, 200, 300, and 1100 Areas) were listed on the National Priorities List (NPL) for cleanup under the federal Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA); the 1100 Area was later delisted from the NPL in 1996 (Ridolfi, 2006). The

exposure scenario described in this report is not limited to the NPL sites, but includes the entire Hanford Site and any areas where Hanford-associated contaminants have come to be located.

The Yakama Nation, a trustee for the area's natural resources, currently participates in the Hanford cleanup process. The Yakama Nation's goals for the Hanford cleanup center on protecting Yakama Nation Treaty Rights, including the health of the Yakama people and natural resource interests. To accomplish these goals, the Yakama Nation takes a holistic approach to the cleanup, recognizing that all things interrelate. This requires considering the impacts on air, land, water, and all plants and animals. The Yakama Nation believes the cleanup actions conducted or planned by DOE thus far are not adequate to remedy the extensive contamination to attain these goals. It is essential to the Yakama to safeguard human health, and the health of the environment now and for future generations.

1.1.4 The Risk Assessment Process

According to EPA, risk assessment for CERCLA is defined as a "qualitative or quantitative evaluation of the risk posed to human health and/or the environment by the actual or potential presence or release of hazardous substances, pollutants or contaminants" (EPA, 2006). DOE is currently in the process of conducting multiple risk assessments for the Hanford Site, including the Columbia River corridor and central plateau.

An exposure assessment is one of four major components of the risk assessment process, along with hazard identification, toxicity (dose-response) assessment, and risk characterization. According to EPA, "exposure assessment is the process by which potentially exposed populations are identified, potential pathways of exposure and exposure conditions are identified, and chemical intakes/potential doses are quantified" (EPA, 2004a). The primary purpose of an exposure assessment is to estimate potential dose to an exposed individual or population, which can then be used to calculate risk and determine appropriate cleanup levels. Figure 3 illustrates the basic risk assessment process, including the exposure assessment phase.

Exposure scenario development is a key element of an exposure assessment. Using the scenario technique requires information about potential contact time with contaminant concentrations and

other information specific to the potentially exposed population. Physical and behavioral information on the exposed population may be obtained from interviews with individuals representing that population, including assumptions to account for future conditions (EPA, 1992).

Exposure is defined as human contact with a chemical or physical agent, which may occur via inhalation, ingestion, dermal absorption, or irradiation, and is dependent on the intensity, frequency, and duration of contact. Exposure parameters, which are based upon human physiological and behavioral factors, include inhalation rates; consumption rates of soil, water, and foods; skin surface area; body weight; exposure frequency and duration; and any other modifying factors (EPA, 1989 and 2004a). Risk assessments are generally limited to the evaluation of a lifetime of an individual (e.g., 70 years), although many contaminants persist in the environment affecting many generations (e.g., radionuclides with half lives of thousands of years).

The risk assessment process used by government agencies to calculate and manage risk associated with contaminant exposure has generally not been adequate for assessing risks to Native Americans, whose lifestyle and close association with natural resources is not always recognized in a typical evaluation. When conducting a risk assessment, both physical health and traditional cultural practices that are closely tied to individual and community health should be protected (Arquette, et al., 2002). Figure 4 illustrates a holistic view of the many Hanford contaminant sources, including high-level radionuclide waste, reactor facilities, and contaminated media/biota, which pose imminent and chronic threats to the Yakama Nation, their health and the health of their traditional subsistence¹ lifeways.

1.2 Purpose and Scope

The purpose of this project is to develop a Yakama Nation exposure scenario. This scenario will facilitate identification of Hanford Site contaminants that are associated with unacceptable risk to human health for members of the Yakama Nation living a traditional subsistence lifestyle on and in the vicinity of the Hanford Site, now and in the future. The Yakama Nation ERWM Program is working towards the goal of a Hanford Site that no longer threatens the health of the

¹ Subsistence refers to a means of supporting life or sustenance; a living or livelihood.

Yakama people by pollutant releases. The Yakama Nation wants Hanford cleaned up as the law requires, and wants the natural resources properly addressed (Rigdon, 2006).

1.2.1 Objectives

In an effort to develop a Yakama-specific exposure scenario, objectives of this project include: describing the Yakama population; identifying the daily and seasonal activities in which Yakama members participate; identifying potential pathways of exposure associated with the Yakama traditional and/or subsistence lifestyle; and providing exposure parameters that best represent the Yakama people now and in the future using the Hanford Site.

DOE is evaluating other exposure scenarios, such as rural-resident, worker, recreational user, etc., for the Hanford Site risk assessment process. This document is intended to provide summary information for the Yakama Nation exposure scenario, including aspects of the daily life and associated exposure pathways for tribal members. This exposure scenario for Yakama members is a subsistence fisher-hunter-gatherer scenario for an individual living on the site, drinking surface and ground water, harvesting fish from the Columbia River, and using all usual and accustomed places year round.

1.2.2 Scope of Work

The scope of work defined for this project includes producing a conceptual site model, which illustrates exposure pathways for potential risks from Hanford Site contamination to the Yakama Nation, and developing a Yakama-specific qualitative and quantitative exposure scenario. This includes identifying and describing characteristics of the cultural population of interest that is the Yakama Nation, the study area that includes the Hanford Site and all surrounding areas potentially impacted by Hanford that comprise usual and accustomed areas, and the timeframe that accounts for current practices and estimates of future uses.

This exposure scenario describes the traditional Yakama lifestyle now and anticipated for the future, identifies potential exposure pathways of Hanford Site contamination, and quantifies applicable exposure factors. This report also provides recommendations for using these results,

as well as limitations and uncertainties of this study and the risk assessment process in general, and future study needs.

1.2.3 Yakama and DOE Expectations

DOE has produced scoping statements for different land use scenarios during the risk assessment process, including a scoping statement for Native American subsistence scenario. DOE stated that, "each Tribe will be asked to provide their own use scenario for the Columbia River Component risk assessment. Anticipated uses by the Tribes include hunting, fishing, gathering of plants, and religious and ceremonial uses of the land, river, and other natural resources" (DOE, 2004). It is expected that DOE will use the information presented in this report to evaluate potential exposure pathways and risks for Native American traditional uses.

The type of information that is needed to complete an exposure assessment for the Yakama Nation at the Hanford Site is summarized in the following table. The information needed is categorized as descriptive in nature (qualitative) or numerical (quantitative). The lead organization responsible for providing the information, either DOE or the Yakama Nation, is also listed. The information required of the Yakama Nation is provided in this exposure scenario report. Information in the descriptive scenario can be used for DOE's complete exposure assessment, which will include contaminant concentration data.

Exposure Assessment Data Needs

Information Needed	Information Type	Lead
Description of Hanford Site (exposure) setting	Qualitative	DOE
Characterization of site contaminants	Quantitative	DOE
Description of contaminant exposure pathways	Qualitative	Yakama
Characterization of exposed population (current/future)	Qualitative	Yakama
Estimation of exposure parameters (for contaminant transfer)	Quantitative	Yakama
Calculation of current/future dose to estimate potential risk	Quantitative	DOE

A description of the Yakama exposure scenario and specific exposure parameters is being provided to DOE as part of the risk assessment process and to estimate the reasonable maximum

exposure (RME) expected to occur at the Hanford Site. According to EPA and Washington State, site-specific risk assessments must consider the RME, which is "the highest exposure that is reasonably expected to occur at a site under current and potential future site use" (EPA, 1989; WADOE, 2001). It is anticipated that a subsistence lifestyle will have the greatest potential for exposure and thus will represent the RME for Hanford due to regular use of and contact with the natural resources; exposure parameters for the Yakama Nation will likely provide an estimate of one of the most highly exposed populations at the Hanford Site.

Exposure parameters (such as consumption rates) identified and proposed for the Yakama Nation are based upon maximum values to conservatively protect all Yakama individuals. Expectations for using the information provided in this report are provided in more detail in Section 4.

2.0 APPROACH AND METHODS

The approach for identifying the traditional subsistence exposure scenario for the Yakama Nation involved research of available literature and guidance, as well as site visits and interviews with Yakama members, described in the following sections.

2.1 Literature Review

Literature review involved consultation with federal and state guidance documents, examples of previous exposure assessments, and other documents related to evaluating contaminant exposure and risks to Native Americans. All literature obtained and referenced was compiled into a project-specific database using FileMaker Pro 6® for organization and accessibility. Appendix A provides a list of the complete bibliography of resources compiled for this study.

2.2 Ethnographic Interview Approach

To obtain information directly from Yakama members, a population sample was selected for interviews. The primary focus was to obtain information to describe lifestyle patterns and estimate general activity levels rather than to inventory every specific activity and species-specific resource use. Prior to conducting the study interviews, data needs were identified, an approach for collecting the data was established, and procedures for protecting data confidentiality were clarified.

2.2.1 Data Needs

To identify the information to solicit during interviews, Ridolfi worked closely with the Yakama Nation ERWM Program to identify activities common to a majority of Yakama members. Traditional lifestyle activity patterns that were identified for research included fishing, hunting, and gathering, and cultural activities such as sweating, feasts, and ceremonies. Table 1 provides a Yakama Nation lifestyle activity matrix that was developed during the planning process to outline the traditional lifestyle and help identify data needs.

It was determined that information was needed regarding the environmental setting and lifestyle, including the natural resources available for use, such as plants, fish and other animals, and confirmation from Yakama members on the degree of consumption, use, and collection of these natural resources. Determining the daily and seasonal activities and dietary patterns facilitates defining potential contaminant pathways and exposure parameters for the exposure scenario.

2.2.2 Data Collection

Information was collected by direct consultation with the ERWM Program office as well as interviews with Yakama tribal community members, which allowed for a description of daily, seasonal, and lifetime activities of men and women, children and elders from different families and geographical locations. Input was obtained throughout the project from tribal representatives at ERWM, who are acknowledged experts due to their experience working with natural resource issues.

To survey tribal members, ethnographic interview techniques were used to provide a scientific description of the culture (Riley, et al., 2006). These techniques involved establishing community standing and personal credibility, demonstrating cultural sensitivity and an understanding of proprietary information. This was accomplished by working closely with the ERWM Program office, members of which spoke with potential interviewees about the project, as well as publishing informational articles in the local tribal newspaper, the Yakama Nation Review. The published news articles are provided in Appendix B.

2.2.3 Confidentiality

During the interview process, all participants were made aware of the criticality of protecting confidential information, such as names, locations, and species. Both interviewer and respondent signed an Informed Consent Form at the time of the interview to guarantee that no confidential information will be released to anyone outside of the ERWM Program office, where the final record of responses will be permanently secured. Respondents were told that they could skip any question at any time, and elaborate on answers, as they felt comfortable.

2.3 Yakama Member Interviews

The interview process is discussed in the following sections, including development of the questionnaire, a description (without names) of the individuals ultimately interviewed, and details of the interview process.

2.3.1 Questionnaire Development

Development of the questionnaire was an iterative process, based upon initial research of previous tribal interviews, input provided from the ERWM Program office, and input from lessons learned during the interview process itself. The questionnaire was divided into several major categories based upon potential exposure activity type (fishing, hunting, gathering, etc.) to obtain qualitative and quantitative information about the Yakama lifestyle.

A copy of the questionnaire (including plant and animals species on/near the Hanford Site) is provided in Appendix C. The interviews included questions on consumption, use, and harvesting of plants, fish, and other animals from the area to identify the extent to which Yakama members depend upon natural resources that may be impacted from Hanford contamination. Other information regarding daily and seasonal activities was also solicited in an effort to qualitatively describe the Yakama lifestyle, identify culturally important activities and resources, and quantify as best as possible exposure values that may be used for risk assessment.

Photographs of select plant, fish, and other species, some of which were used during the interviews, are provided in Appendix D. Information was also gathered about contact with water and soil in order to identify other potential pathways. Respondents were asked for their opinion on the health of the natural resources that they use, as well as their thoughts and knowledge about potential impacts from Hanford. Questions about future use of the Hanford Site were contingent upon unrestricted use of a theoretically remediated site so that responses were not skewed towards avoidance or other behavior that may intentionally restrict use.

2.3.2 Survey Respondents

Ridolfi worked with the ERWM Program office to prepare an initial list of potential interviewees. Enrolled members of the Yakama Nation must be, as defined by the General Council, individuals who are least one-quarter ethnic Yakama Native American. The goal was to interview enrolled members who could provide adequate information regarding current lifestyle, including daily, seasonal, and dietary patterns, consider changes from past practices, and estimate intended future use of the Hanford Site and surrounding areas. Questions about child lifestyle and consumption patterns were also asked of the adult respondents.

A total of 16 Yakama members were ultimately interviewed from a larger list of candidates. Although 16 interviews (from a membership enrollment of over 9,700) is a small sample population, the selected interviewees provided an adequate cross-sectional representation of the population as a whole for the purposes of this study. The sample group was targeted towards elders for their rich oral traditions and long history with changes in the area over time; younger adults were also interviewed to obtain a broader perspective of the general Yakama population. Respondents were asked consumption questions not only for themselves (direct response), but also for their parents and children to obtain data on additional adult and child patterns, respectively (indirect response).

Potential respondents were contacted directly by ERWM staff by visitation, phone call, and/or email. The 16 respondents, interviewed between February and May 2007, were aged 24 to 75 years; seven were male and nine were female. All respondents were associated with multiple longhouses,² although for some, there was a primary longhouse to which they belonged and others that they attended periodically.

2.3.3 Interview Process

Interviews were conducted by four Yakama Nation members and a Ridolfi risk assessor. A brief introduction to the project and its purpose was given at the time of initial contact, and additional

² Longhouse refers to any Native American communal gathering place.

details about the study were provided at the start of each interview (included in the introduction of the Questionnaire, provided in Appendix C).

Individual interviews lasted between 45 minutes to slightly over 3 hours, depending upon how much an individual chose to elaborate on specific answers or tangentially share oral histories or personal stories. Interviewers generally asked all questions on the survey, except when time was constrained. In few cases, the respondent gave free-form testimony in lieu of the questionnaire. Respondents were asked information about themselves, as well as of their parents (to represent other adults) and children (for child values). Samples of fish, meat, and plants were used for estimating serving sizes, as well as measuring cups. All interviews were tape recorded, with the respondents' permission, to supplement the hand-written notes taken by the interviewer. The interviewer and respondent both signed the disclaimer form ensuring protection of confidential information. All completed forms, hand-written and typed notes, and cassette tapes will be permanently secured at the ERWM Program office.

2.4 Data Analysis and Reporting

Notes taken during the interview were transferred by the primary interviewer into electronic format, and combined with any other notes compiled similarly from secondary interviewers who were present. The notes (text and tables) were edited and formatted, and then sent to the respondent with a cover letter and self-addressed stamped envelope to give them the opportunity to correct any mistaken information or interpretations. Upon receipt of edits, a corrected version of the notes was re-sent to the respondents for their records. The majority of respondents did not provide corrections or additions, however, and the recorded notes and values are assumed to be correct.

Once all data were collected, quantitative values were compiled into a spreadsheet to evaluate exposure rates. When an individual provided a range of values, analysis of the data considered the maximum of this range. Basic statistics (minimum, maximum, and average) values were calculated for all individuals combined. Consumption rates for fish and meat are estimated by the respondents based upon meals; data were not converted to raw tissue values.

During the data evaluation phase, it was discovered that respondents considered children to be through the age of 18 and, consequently, many of the values were comparable to the adult values. Since EPA considers the sensitive child stage as 0 to 6 years, the more broadly defined age group of Yakama-child data are not summarized here. Assumptions are made, however, regarding child exposure values from the literature (discussed in Section 3). This report includes information specific to the Yakama Nation, without compromising confidentiality (i.e., names are not included).

2.5 Potential Sample Bias and Data Uncertainties

Sampling may have been biased by any of the following: small sample size; targeted sampling towards knowledgeable elders; varying degrees of experience with Hanford and hazardous waste contamination issues in general; respondent recollection; use of example servings of a particular size; use of cooked versus raw samples for serving size estimation; survey layout and length; and mistrust of scientific survey methods and/or cultural differences. Also, respondents may have reported higher rates during high consumption months and reported lower rates during relatively lower consumption months. Although likely an insignificant modifying factor, actual body weights were not used for exposure parameter calculations.

This exposure scenario does not take into account variations in population susceptibility that may exist within the Yakama Nation, or Native American populations in general, compared to the general U.S. population. Genetic susceptibility and overall health, for example, may increase risk from contaminant exposure (Arquette, et al., 2002). The risk assessment process in general also does not consider impacts and risks to the social, cultural, and spiritual practices of the Yakama people, which are considered an important link to personal health. These uncertainties, biases, and omissions noted during from this study should be taken into account in future studies.

3.0 EXPOSURE SCENARIO

The exposure scenario presented in this section includes factual data, assumptions, and inferences to describe contaminant exposure pathways, characterize the potentially exposed population, and develop exposure parameters. This section provides the study results, including development of a conceptual site model, description of traditional activities associated with the Yakama lifestyle, and proposal of Reasonable Maximum Exposure parameters for the Yakama Nation.

3.1 Conceptual Site Model

An exposure pathway “describes the course a chemical or physical agent takes from the source to the exposed individual” (EPA, 1989). The Yakama Nation conceptual site model identifies the exposure pathways, linking Hanford Site contamination with population locations and activity patterns by identifying contaminant releases, media in which the contaminant is retained and transported, and the exposure route, such as ingestion and dermal absorption.

A simplified Yakama conceptual site model is shown graphically in Figure 5 as a visual illustration of source contamination from the Hanford Site, potential exposure pathways through site media and biota, and various activities in which Yakama members participate as part of their traditional and cultural lifeways that may lead to contaminant exposure. Table 2 provides a more detailed Yakama conceptual site model as a narrative flow chart.

3.1.1 Target Population

For this study, the Yakama Nation is identified as the potentially exposed population, whose use of and extensive dependence upon local natural resources and close proximity to the Hanford Site place them at risk from exposure to contamination from Hanford Site releases. Federal guidance documents do not include adequate exposure information pertinent to a Native American subsistence lifestyle, such as ingestion rates of wild game, roots, berries, and medicinal plants. The extent and duration of tribal exposure to soil, water, and foods differs from the general population due to unique daily, seasonal, and important cultural activities that should be considered in the estimation of risk (ITRC, 2002).

Categories of information needed for an exposure scenario include consumption patterns, food preparation methods, exposure time, and concurrent exposures from all sources. EPA has acknowledged that, although comprehensive guidance is not currently available, there is a growing trend towards characterization of exposures to an individual throughout their different life stages (EPA, 2004a). All life stages for men and women should be considered, including infant, child, adult, and elder.

3.1.2 Site Use

To determine future use of the Hanford Site with respect to the Yakama people, current uses of natural resources were considered on the Reservation and surrounding areas (since use of the site itself is currently restricted), as well as past uses to provide further insight into traditional lifestyles that occurred previously on the Site. Future site use combined with current uses of modern technologies and lifestyles is the most accurate reflection of Yakama people's intended uses when the Hanford Site is cleaned up. This exposure scenario for Yakama members is a subsistence fisher-hunter-gatherer scenario for an individual living on the site, drinking surface and ground water, fishing at all usual and accustomed places and harvesting plants and animals year round.

3.1.3 Natural Resource Use

Native Americans of the Columbia River Basin, including members the Yakama Nation, depend on the Columbia River, known as *Nch'i-wa'na* ("Big River") for their livelihood. The spring Chinook salmon is considered a "first food," celebrated with a feast each spring to recognize the availability and abundance of food at the start of each growing season (ERWM personal communication, 2006-2007; Relander, 1986). In addition to dependence on fish as a major part of their diet for both nutritional and cultural health, the Yakama also depend on hunting local wild animals and birds for food and materials. They are also extremely dependent on the rich abundance and variety of wild plants, from above and below ground, which are used for food and medicine and some of which are also celebrated as "first foods."

Activities representing the traditional subsistence lifeways of the Yakama people may occur daily, seasonally, or annually, depending upon purpose and availability of the resource. The intensity, frequency, and duration of these activities also vary. Figure 6 provides a generalized illustration of historical seasonal activities based upon natural resource availability. The major activities in which the Yakama participated historically and to this day include:

- Fishing, including the preparation, consumption, and use of fish for food, medicine, and materials;
- Hunting, including the preparation, consumption, and use of meat, organs, and other parts of the animal for food, medicine, and materials;
- Gathering, including preparation, consumption, and use of roots, shoots, stems/stalks, leaves, and berries for food, medicine, and materials;
- Consumption and use of water (surface water and ground water);
- Other daily activities, such as time spent outdoors (for work and recreation, potentially exposed to dust), and natural materials production (handling and using natural resources to make shelter, clothing, tools, and accessories); and
- Cultural activities, including sweating and participating in various celebrations, ceremonies, and memorials.

3.2 Exposure Activities

Qualitative descriptions of the key Yakama lifestyle activity patterns are provided in the following sections, along with quantitative summaries of the exposure parameters obtained from the interviews. These activities are associated with multiple exposure routes, such as inhalation, absorption, ingestion, and irradiation of potentially contaminated air, soil, ground water, surface water sediment, and biota. In cases where individual respondents provided a range of consumption values, maximum values were used for data analysis. Basic descriptive statistics (minimum, maximum, and average values) were calculated for all respondents combined.

3.2.1 Fish Harvest, Use, and Consumption

The harvesting, preparation, consumption, use, and trade of fish are critical components of the Yakama lifestyle. Despite a decrease in fish abundance from historical levels in the Columbia River and the Yakima River (EPA, 2002a), the loss of available fishing sites from dam construction, and concern over fish health from agricultural runoff, Hanford contamination, and human encroachment, the Yakama continue to depend upon fish as a major part of their diet. Fishers generally harvest most of their lives and collect enough fish to feed their extended families as well as communal longhouse feasts and elders who can no longer provide for themselves.

The primary fish of importance is salmon, including spring and fall Chinook, coho, sockeye, and chum salmon, steelhead and cutthroat trout. Other anadromous as well as resident fish species of key importance to the Yakama diet include bass, bull trout, smelt, lamprey (eel), suckers, whitefish, and sturgeon. These and other fish species are harvested from the Columbia River and have been identified specifically at the Hanford Reach. The Yakama fish year round, depending upon the fish reproductive cycles.

Fish are caught using fish gill nets, dip nets, gaffs (large hooks), and poles and lines. The harvested fish are gutted, washed, and depending upon the species, filleted. Fish are preserved by smoking, salting, drying, freezing, and canning. For example, sockeye (red or blueback) salmon is generally canned, fall Chinook (or King) salmon is generally smoked and salted for preservation, and lamprey is generally dried. Cooking methods for all fish include roasting, baking, broiling, pan- and deep-frying, poaching, and boiling in stew.

Adult fish consumption rates calculated for salmon and other species from the survey results are shown in Figure 7. Fish consumption includes whole body (i.e., all fish parts) as well as fillet only. Based upon maximum values provided by respondents, the adult fish consumption rate ranged from 3 grams per day (g/d) to 451 g/d, with an average of 150 g/d. The maximum rate of 451 g/d is equivalent to approximately 1 pound per day (lb/d) or 2 (8-ounce) meals per day. Although respondents were asked about fish consumption rates by children in their family, these data are not provided because exact ages of the children were not identified. Based upon this

study, salmon comprise the majority of fish species consumed by the Yakama, approximating as much as 90% of all fish consumed.

Respondents were asked about consumption patterns of particular species that are known to be found in the Columbia River, particularly the Hanford Reach. Assuming the responses reflect accurate amounts of fish consumed by current (and future) adults, these values may reflect suppressed rates. Other studies of Native American fish consumption have noted that historical consumption rates are generally much higher than current rates. Most of the respondents in this study said they would like to eat as much if not more fish in the future (except for cases where aging is a factor in reduced consumption). Many members, however, expect a reduction in future fish consumption rates, not by choice, but because of decreasing fish availability and decreasing numbers of fishers providing for the communities.

As shown in the conceptual site model (Table 2), potential exposure routes for fishing include inhalation of air, ingestion and dermal absorption of surface water and sediment, and ingestion of fish tissue.

3.2.2 Meat Harvest, Use, and Consumption

Hunting was a common practice historically for the Yakama, and continues to be practiced regularly today, despite the increased availability and consumption of domestic animals. The Yakama hunt year round, and harvest many species of wild mammals³ and birds, primarily deer and elk, but also rabbit, goat, sheep, beaver, pheasant, wild turkey, duck, and (in previous times of food scarcity) chipmunk and squirrel, and (historically) bear. Nearly all parts of the hunted animal are consumed or used; for example, deer/elk antlers and hides are used for tools, shelter, clothing, accessories, and drums; sausage casings are made from intestines and sinew (tendon), and (historically) beaver tail, wild bird eggs, and stewed bear claws were eaten. The Yakama are not constrained by state laws dictating hunting seasons or limited quantities, although the Tribal Council (governing body for the Yakama Nation) does impose harvesting restrictions on female

³ The coyote is the only mammal commonly found on the Hanford Site and surrounding areas that the Yakama do not hunt because this animal is considered a sacred brother to the people.

animals during the breeding and rearing months of January through June in order to sustain the population.

A typical hunt involves primarily hunting of large game. Deer and elk are generally hunted using a rifle; however, some members still use bow and arrow as a test of skill. After a large game animal is killed, it is generally gutted and skinned and the offal left for other animals, while the remaining carcass is hung for several hours or overnight. The meat is then sectioned and processed for immediate consumption (by roasting, baking, boiling, frying, or stewing) or preservation (smoking, drying, freezing, or canning). Organs, such as the heart and liver are also eaten, while the brain has been used for curing the hide. The hide is dried to use for making clothing (moccasins, leggings, chaps, and dresses), shelter (tipis) and accessories (drums), and is traded for other goods. Other parts of the animal are used for decoration, such as the antlers, hooves (during medicine dances), and teeth (earrings, necklaces, and ornaments). Hides have also been used from less commonly hunted animals such as weasel and otter.

Adult meat consumption rates calculated for hunted and domestic meat from the survey results are shown in Figure 8. Based upon maximum values provided by respondents, the adult meat consumption rate ranged from 23 g/d to 704 g/d, with an average of 245 g/d. The maximum of 704 g/d is equivalent to approximately 1.6 lb/d or 3 (8-ounce) meals per day. Although respondents were asked about meat consumption rates by children in their family, these data are not provided because the exact ages of the children were not identified. The current meat diet of many Yakama today includes a high dependence on domestic meat, comprising a total of approximately 60% of the total meat consumed, which is due in part to restricted access to hunting grounds (e.g., Hanford Site) and the physical inability to hunt. This indicates the need for consideration of risk due to consumption of both domestic and wild animal meat, both of which may be impacted by Hanford contamination.

As shown in the Yakama conceptual site model (Table 2), potential exposure routes for hunting and meat consumption include inhalation of air and soil/dust that is suspended during hunting, ingestion and dermal absorption of soil and ground water, and ingestion of animal tissue, including wild and domestic animals on the Hanford Site.

3.2.3 Plant Harvest, Use, and Consumption

Gathering of wild plants for food, medicine, and materials has always been, and remains, a critical component of the Yakama dietary and cultural lifestyle. Plant roots, shoots, stems/stalks, leaves, and berries of more than 70 different plant species are harvested seasonally according to plant lifecycles and availability. Plants commonly used as food include Indian celery, biscuitroot, bitterroot, Indian carrot, yellow bell, huckleberries and choke cherries. Plants are also used for medicine, such as boiled rose bush for health and spiritual cleansing, and materials, such as bulrush for tule mats, Indian hemp for rope, and willow for sweathouse and tool construction.

Natural edible plant parts include tubers, bulbs, roots, and sprouts. Indian celery, which is a “first food” collected in early spring when it first sprouts (the mature plant is not edible), grows in small streams and springs; this plant is eaten during annual feasts and is used medicinally to cleanse the body. Bitterroot and other plants are collected in late spring. The Indian carrot is collected in August for its sweet, white root, and is dried, ground, and re-hydrated into a paste. Certain species of plants in the *Lomatium* genus, commonly gathered by the Yakama, contain a quality that, when dried, ground, and mixed, make ideal dough for bread or candy⁴ (ERWM personal communication, 2006-2007).

Another popular root that is gathered (although not from the Hanford Site) is camas, a small scaly bulb that is dried, ground, and baked for several hours in a hot coal-heated and hot rock-heated pit, layered with willow leaves and covered with earth. Other roots may be baked in a similar fashion, but with water poured down a hole and sealed to create steam. Lichen is collected year round, and acorns are collected in fall and baked underground similar to Camas (Relander, 1986).

Yakama members generally start gathering with their families at a very young age, such as five to seven years old, and continue to do so until they are “too old to walk.” People gather for most of their lives, and generally within the same collection areas. Gathering is a family affair, with

⁴ *Lomatium spp.* plants are identified by flower tops, which become difficult to identify when destroyed, such as may occur from cattle grazing.

mothers and grandmothers teaching their very young sons and daughters the specialized art of plant identification and timing of collection. Although women generally do most of the gathering as adults, some men continue to do so as well. Tools used for gathering include a root digging instrument made of deer or elk antlers or wood, and carrying baskets made of hemp or cedar (or synthetic materials).

Adult plant consumption rates calculated for wild plants (including roots, berries, and stalks/leaves) and garden/domestic plants from the survey results are shown in Figure 9. Based upon maximum values provided by respondents, the total adult plant consumption rate ranged from 33 g/d to 1,208 g/d, with an average of 264 g/d. The maximum is equivalent to approximately 2.7 lb/d or 5 (8-ounce) meals per day. When vegetables and fruits were considered separately, garden plants were estimated to be half vegetable and half fruit, which was then summed with wild roots and stalks/leaves (for vegetable total) and with wild berries (for fruit total); the average vegetable and fruit consumption was 1,118 g/d and 299 g/d, respectively.⁵ Although respondents were asked about plant consumption rates by children in their family, these data are not provided because the exact ages of the children were not identified.

Although many domestic fruits and vegetables are consumed, roots, berries and other wild plant parts generally comprise more than half of the total (and even more so for children). Some members expect a reduction in future plant consumption rates, not by choice, but because of restricted access. Members recognize that access to areas for plant collection (root digging, berry picking) is decreasing because of land disturbed by development and construction, population growth and increasing private land ownership restricting access to historical gathering grounds (including the Hanford Site). Members also cited increased agricultural contamination from pesticide spraying and runoff restricting future use of plants.

⁵ The average total vegetable and fruit rates represent different individuals, which is why together the total does not equal the average total for all plants consumed.

As shown in the Yakama conceptual site model (Table 2), potential exposure routes for gathering and plant consumption include inhalation of air and soil/dust, ingestion and dermal absorption of soil and ground water, and ingestion of plant tissue.

3.2.4 Liquid Ingestion Rates

Other daily intakes that are important to consider for risk assessment include rates of water consumption (surface water and ground water pathways) and milk consumption (biotic pathway). Similar to food consumption rates, child data are not provided because the exact ages of the children were not indicated.

3.2.4.1 Water Consumption

The Yakama drink water on a daily basis, and increase consumption during sweathouse use and active outdoor activities. Adult water consumption rates calculated from the survey results are shown in Figure 10. Based upon maximum values provided by respondents, the adult water consumption rate ranged from 0.2 liters per day (L/d) to 3.0 L/d, with an average of 1.4 L/d. The maximum, which does not account for additional consumption during sweathouse use, is equivalent to approximately 13 (8-ounce) glasses per day. Many respondents noted that ground water wells served as their primary source of drinking water (in addition to tap and bottled water); use of contaminated ground water is an important Hanford exposure pathway.

3.2.4.2 Milk Consumption

Adult liquid consumption rates calculated for milk consumption from the survey results are shown in Figure 10. The adult milk consumption rate ranged from 0.004 L/d to 1.18 L/d, with an average of 0.24 L/d. The maximum is equivalent to five 8-ounce glasses per day. Consumption of milk, which may be from local dairy cows, is a potential exposure pathway for Hanford contamination.

3.2.5 Other Daily Activities

Time spent outdoors in general is an important factor to consider in assessing potential contaminant exposure, as is time spent doing strenuous activities, recreational and otherwise, that may involve increased inhalation rates. The Yakama also spend time handling natural resources, such as animal hides and bone, plant fibers and dyes, to produce various items for shelter, tools, clothing, and accessories, producing additional exposure potential.

3.2.5.1 Outdoor and Recreational Activities

Time spent outdoors in general provides a good indication of potential exposure to contaminated air and soil/dust, particularly time spent doing strenuous activities, during which time inhalation rates are higher than normal resting rates. Based upon maximum respondent data, time spent outdoors (for both work and recreation) ranged from half an hour to 7 hours per day; with an average of approximately 4 hours. Although the extent of time doing strenuous activities varied greatly and according to age, an average of about half of an individual's time spent outdoors was spent being involved in active or strenuous activities (e.g., dancing, running); other recreational activities noted were breaking horses, biking, hiking, and sports.

3.2.5.2 Natural Materials Production

Respondents described a variety of materials that they and other Yakama members make from natural resources. The time spent handling plant materials, for example, creates potential exposures from dermal contact with contaminated soil and inadvertent ingestion. Plant material is used for shelter, such as bulrush used to make tule mats for longhouses. Raos and baskets are

paints made from saprophytic shelf fungus that grow on dying trees. Historically, gorge hooks and three-pronged spears used for harvesting fish were made of hard wood, tied with braided hemp set lines (Relander, 1986). Many of these traditional Yakama materials continue to be made today.

Many items are also made from animal resources, particularly cured/tanned hide. Respondents described the use of deer and elk hide to make drums (for religious services) and suitcases, each of which may take 5 days to produce. Hide is also often used to make moccasins for men, women, and children (10 days to produce, depending on the degree of bead work added), and leggings (or chaps), birch cloth, and vests for men (total of 33 days to produce). Men wear these items along with a shirt, necklace, and blanket during traditional services, while women wear a wing dress, necklace, hair ties, and a blanket. Jewelry and other accessories are crafted by the Yakama from animal teeth and rocks/minerals. Tools, such as the digging sticks used for gathering roots, are made from deer and elk antlers and bone.

Yakama members work with all of the materials just described; some make these items on a regular basis. Consequently, one individual may be exposed to contaminants by handling a variety of plant and animal products throughout their lives. Although these preparation times are not converted to actual exposure quantities (e.g., soil ingestion rate) in this report, it is important to consider these exposure pathways qualitatively in risk assessment.

3.2.6 Cultural Activities

The Yakama participate in various cultural activities that are unique and important to their lifestyle and to maintain a connection to their ancestral past, including sweating, feasting, and participating in other cultural activities. As shown in the conceptual site model, these activities create potential exposure pathways via inhalation of water vapors and soil/dust, dermal contact with water and soils, and ingestion of water, soils, fish, meat, and plants.

3.2.6.1 Sweathouse Use

Use of a sweathouse for physical and spiritual cleansing is an important activity of the Yakama, practiced historically using mobile structures and continuing today with more permanent

structures, which are generally used on a daily basis. Respondents noted the use of willow branches to construct the sweathouse frame, which not only provides the structure, but also releases its medicinal component during the steaming process. Fir boughs and blankets and other materials complete the construction.

A fire is made outside of the sweathouse (avoiding processed wood or orchard wood that may be contaminated with organic compounds) to heat rocks, which are then used inside the sweathouse to create heat and steam within the confinement of the enclosure. Only porous rocks are used, which may be collected from the Columbia River, to avoid heat-induced explosions. Water is poured over the rocks to create water vapor inside the sweathouse and is used to rinse and re-hydrate outside. The source of water is either surface water (river) or ground water (springs, wells, tap water, etc.). Sweathouses were historically situated near a water source (e.g., alongside a river or, at higher elevations, near ground water springs). Rattlesnake Ridge, for example, which is a unique and sacred area on the Hanford Site, has over 100 different springs that could be useful for situating sweathouses.

Based upon interview data, respondents spend varying amounts of time inside of the sweathouse. Maximum time spent inside the confinement sweating ranged from a total of only 90 minutes per year for those individuals who sweat infrequently (e.g., once or twice per year) or for little duration (e.g., no more than 15 minutes per event), to as much as 7 hours per day for those individuals who sweat at least daily or for several hours per event; the average was 5 hours per week inside the sweathouse. Sweathouse use also increases the general water consumption rate in order to replenish water loss during sweating.

3.2.6.2 Celebrations and Ceremonies

The Yakama participate in many different cultural activities, some religious in nature, others strictly festive or recreational. Celebrations include holidays, such as the Indian New Year that is celebrated each year during the winter solstice over a period of two days, as well as other federally-recognized holidays. A very common celebration is the pow-wow that generally occurs multiple times per year (respondents participated an average of approximately 72 hours per year). Treaty day occurs every year on June 9 in celebration of the signing of the Treaty of

1855 between the U.S. government and the Yakama Nation. Other celebrations include rodeos, tournaments, and trade fairs, each of which may last up to three days.

The Yakama also participate in several types of ceremonies. A burial is a very important 3-day ceremony that occurs whenever there is a death, when the body is lowered into the ground, and is attended by friends, family, and anyone paying respects to the deceased. There are at least five Indian cemeteries identified alongside the Columbia River at the Hanford Site, which, some fear, will be disturbed in future investigations and remediation activities. One year following the burial, a memorial is held for one day to remember the deceased and end the mourning period for family members. Ceremonies are also held to recognize one's "first hunt" and traditional "name giving," which are held in honor of an individual's first hunting kill and in honor of officially passing on an Indian name to an individual, respectively. Currently, to accommodate modern work schedules, these events are generally held for a full day on Saturdays. Other less common ceremonies include a medicine dance, which is conducted by a group of people to help heal a sick individual; a war dance, borrowed from more war-like tribes further east; a smoke dance; and a canoe ceremony (practiced with seafaring tribes on the Pacific coast).

The primary cultural activity is religious services and feasts, centered around the longhouse (and, in more recent times, churches), involving prayer, feasting, singing and dancing. Drums are used during ceremonies, the beat of which is considered the heartbeat of the earth and the heartbeat of the children. Religious ceremonies include the traditional *Washat* services held on Sundays. The *Washat* services involve prayer, singing, dancing (often on dirt floors), and feasting. Community gathering places include (alphabetically): Celilo longhouse, Priest Rapids (Wanapum) longhouse, Satus longhouse, Satus Shaker church, Shaker church (of 1910), Shaker church (Independent, of White Swan), Toppenish church, Toppenish community center, Toppenish Creek longhouse (of White Swan), Toppenish longhouse, Wapato longhouse, and the White Swan Community Center. Members also gather at several shorthouses in the area as well as members' homes.

"First food" feasts are extremely important ceremonies conducted several times per year to celebrate a food that has made itself available to sustain the Yakama people for another year, such as the first salmon caught swimming up river, the first celery to sprout from the ground, or

the first berries to form on the bush. These important foods, in addition to being formally recognized during “first food” feasts, are also eaten during weekly *Washat* services, and include salmon, deer or elk meat, and a variety of roots and berries, which are each introduced in the service in that specific order. Feasts also include other food items, such as fry bread.

Historically, Yakamas spent one week before and after the winter solstice feasting at Columbia Point longhouse where the Columbia and Yakima Rivers converge.

Important geographical locations for the Yakama include Signal Peak on the western heights of Toppenish Ridge and Satus Peak. Historically, when tribesmen gathered together for a full week each July in Toppenish, the tribesmen held council, danced, and played stick and bone games. Traditional customs and beliefs, strictly upheld by the Yakama, have been passed on through oral tradition through the generations for thousands of years (Relander, 1986). Rattlesnake Ridge, which is currently part of the Hanford Site, is a very sacred site for the Yakama, providing a wealth of plants to gather for food and medicine, and historically a vision site for children to find their “gift.”

3.3 Yakama Exposure Parameters

Tables 3, 4, 5, and 6 provide published exposure factors for the air pathway, soil / sediment pathway, surface / ground water pathway, and biota pathway, as compiled from the literature, primarily Native American research studies as well as EPA guidance and DOE documents. These tables also include maximum values for the Yakama Nation identified from the interview process, presented in the previous section. Reasonable maximum exposure parameters for the Yakama Nation, developed using results of the ethnographic interviews from this study and published values, are provided in these tables. The proposed exposure values are summarized in Table 7.

3.3.1 Air Pathway

Table 3 lists exposure parameters for the air pathway. Although air inhalation rates are based upon physiology, and generally do not differ among culturally unique populations, a maximum inhalation rate for the Yakama Nation was estimated using EPA’s average activity level rates.

Since interview data for this study only included time spent outdoors (light to moderate activity) and time involved in strenuous activity, the rate was calculated by adding the following: maximum time spent outdoors (7 hours per day [hr/d]) multiplied by the EPA average outdoor worker inhalation rate (1.3 cubic meters per hour [m^3/hr], which falls between the range of light and moderate activity levels), added to the maximum time spent doing strenuous activities (7 hr/d) multiplied by the EPA average rate for heavy activity ($3.2 \text{ m}^3/\text{hr}$), added to an assumed sleeping/resting rate for the remaining hours in a day ($10 \text{ hr/d} * 0.4 \text{ m}^3/\text{hr}$). The sum of all activities at average inhalation rates results in a maximum daily rate of $35 \text{ m}^3/\text{d}$ (assumed for 365 d/yr). This rate cannot likely be maintained for a lifetime of 70 years of exposure.

Consequently, the next highest value reported for strenuous activities, 4 hr/d, was used as a more realistically sustainable rate (multiplied by $3.2 \text{ m}^3/\text{hr}$), resulting in a total rate of $26 \text{ m}^3/\text{d}$. This value, which is physiologically plausible for an active lifestyle, is proposed for the Yakama adult inhalation rate. Since no Yakama-specific child data are available, the average inhalation rate (moderate activity) of young U.S. children (age 3 to 5.9 years) of $16 \text{ m}^3/\text{d}$ is proposed for the Yakama child scenario (Table 7). General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.2 Soil / Sediment Pathway

Table 4 lists exposure parameters for the soil / sediment pathway. The inhalation rate for soil is assumed to be the same as the general inhalation rate calculated in Section 3.3.1, particularly since that rate was calculated based upon time spent outdoors and time involved in strenuous activities, which generally involves exposure to suspended dust particulates. Consequently, the rate for soil/dust inhalation proposed for Yakama adults and children (<6 years) is $26 \text{ m}^3/\text{d}$ and $16 \text{ m}^3/\text{d}$, respectively.

Although data were not collected to estimate Yakama soil ingestion rates in this survey, several lifestyle factors should be noted regarding potential exposure to soil:

- The Yakama Nation traditional subsistence lifestyle involves many hours spent outdoors to fish, hunt, gather, and attend cultural events.

- Weekly *Washat* services held in longhouses usually involve dancing on a dirt floor, creating dust suspension and inhalation.
- Interview respondents spend a maximum of 7 hr/d outdoors.

Based upon these high exposure activities, the upper percentile of soil ingestion rates (calculated from other studies) are appropriate for the Yakama lifestyle. The soil ingestion rates proposed for Yakama adults is 200 mg/d and for children is 400 mg/d (Table 7). General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.3 Surface Water / Ground Water Pathway

Table 5 lists exposure parameters for the water pathway. Similar to the general inhalation rate calculated in Section 3.3.1, the inhalation rate for water vapor was calculated using EPA recommended activity level rates. The maximum time spent inside a sweathouse (7 hr/d) was multiplied by the EPA average moderate activity inhalation rate (1.6 m³/hr), which was added to the EPA recommended upper range of bathing times (15 min/d * 1.6 m³/hr) to account for other water vapor exposures.

The sum of all activities at average inhalation rates results in an RME daily rate of approximately 12 m³/d. This value does not take into account, however, water vapor potentially inhaled during all other uses of warm and hot water (e.g., hand washing dishes, clothes, etc.); nor does it consider increased breathing rates that occur during sweating. Consequently, the general air inhalation rate of 26 m³/d and 16 m³/d for adults and children, respectively (discussed in Section 3.3.1), are proposed for the Yakama water vapor inhalation rate.

The maximum water ingestion rate for all adult Yakama respondents interviewed for this study of 3 L/d (discussed in Section 3.2.4.1) falls within the range of published water ingestion values listed in Table 5. The minimum value listed is 1.4 L/d used by DOE to estimate dose with the RESRAD (RESidual RADiation) modeling program (ITRC, 2002). The maximum value listed is 4 L/d developed for the CTUIR, which accounts for an additional liter per day due to sweathouse use (Harris, 2004). Although respondents for this study were not asked directly

about additional water consumption during sweathouse use, follow up discussions with ERWM confirmed that additional water (up to 1 L) is consumed during sweathouse use. Consequently, a rate of 4 L/d is a more accurate adult Yakama water ingestion rate. The maximum child water ingestion rate reviewed of 2 L/d (Table 5) is proposed for the drinking water ingestion rate for Yakama children (< 6 years); and assumes that children may ingest approximately 50% of adults (Table 7). General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.4 Biota Pathway - Fish

Table 6 lists exposure parameters for the fish ingestion pathway. The maximum consumption value for fish (and shellfish) for all adult Yakama respondents interviewed for this study was 451 g/d (discussed in Section 3.2.1). This value falls within the range of published literature values reviewed for this study. The minimum value listed is 170 g/d, which is the 95th percentile for Native American subsistence populations calculated by the Columbia River Inter-Tribal Fish Commission (CRITFC) and used by the EPA in the Exposure Factors Handbook (CRITFC, 1994; EPA, 1999). The maximum value listed is 1,060 g/d, which is the “high fish diet” ingestion rate (including shellfish) developed for the Spokane Tribe (Harper et al., 2002) and comparable to the rate developed by Walker in 1985 that was based upon a pre-dam estimate for Columbia River Plateau Tribes (Harris, 2004).

The Yakama rate of 451 g/d may be an under-estimation of the RME for Yakama fish consumption for the following reasons:

- Many of the respondents were elders (nearly half were aged 60 years and older), who eat less in general, including less fish because they can no longer fish themselves and depend on friends and family for provisions.
- Many respondents appeared to under-estimate serving size.
- There are sub-sets of the Yakama population who depend more heavily on fish consumption than others, who may not have been reflected in the limited sample set.
- Current rates likely reflect suppressed rates that do not represent a subsistence lifestyle.

Consequently, other published values were considered more closely. In EPA's report, Estimated Per Capita Fish Consumption in the United States (EPA, 2002b), "fish consumers" were evaluated separately from the rest of the population. The 99th percentile of 519 g/d for adults and 363 g/d for children (< 6 years) estimated by EPA for fish consumers (of all fish, uncooked) are proposed as more accurate Yakama adult and child fish consumption rates, respectively (Table 7). General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.5 Biota Pathway - Meat

Table 6 lists exposure parameters for the meat ingestion pathway. The maximum consumption value for meat (hunted and domestic) for all adult Yakama respondents interviewed for this study was 704 g/d (discussed in Section 3.2.2). This value falls within the range of published literature values reviewed for this study. The minimum value listed is 125 g/d developed for the CTUIR, which does not include domestic beef (Harris, 2004), and the maximum value is 935 g/d developed for the Spokane Tribe (Harper et al., 2002). Until additional Yakama-specific meat consumption information can be collected, the respondent data provide in this study is relied upon to develop a Yakama meat consumption value.

The meat ingestion rate of 704 g/d is summarized in Table 7. The only child rate reviewed of 212 g/d, used by the Washington State Department of Health (DOH, 2003), is proposed for the Yakama child meat ingestion rate. General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.6 Biota Pathway - Plants

Table 6 lists exposure parameters for the plant ingestion pathway. The maximum plant consumption rate for all roots, berries, stalks and leaves of gathered wild and garden plants for all adult Yakama respondents was 1,208 g/d (discussed in Section 3.2.3). When the plant consumption data are separated into vegetables (including roots) and fruits (including berries), the maximum values are 1,118 g/d and 299 g/d, respectively (maximums representing different individuals).

The vegetable consumption value falls within the range of published literature values reviewed for this study. The minimum value listed is 7.4 g/d used by DOE to estimate dose with the RESRAD modeling program (ITRC, 2002), and the maximum value is 1,600 g/d developed for the Spokane Tribe (Harper et al., 2002). The fruit consumption value also falls within the range of published values reviewed. The minimum value listed is 125 g/d developed for the CTUIR (Harris, 2004), and the maximum is the EPA rate of 868 g/d, which is the 95th percentile for the general population (EPA, 1999). Until additional Yakama-specific plant consumption information can be collected, the respondent data provide in this study is relied upon to develop a Yakama plant consumption value.

The vegetable and fruit ingestion rates of 1,118 g/d and 299 g/d, respectively, are summarized in Table 7. The only child rates reviewed of 187 g/d and 127 g/d, used by the Washington State Department of Health (DOH, 2003), are proposed for the Yakama child vegetable and fruit ingestion rates, respectively. General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.7 Biota Pathway - Milk

Table 6 lists exposure parameters for the milk ingestion pathway. The maximum ingestion rate for milk for all adult Yakama respondents interviewed for this study was 1.2 L/d (discussed in Section 3.2.4.1). This value falls within the range of published literature values reviewed for this study. The minimum value listed is 0.49 L/d developed for by Harris and Harper (1997), and the maximum value is the EPA rate of 2.2 L/d, which is the 95th percentile for the general population (EPA, 1999). Until additional Yakama-specific milk ingestion information can be collected, the respondent data provide in this study is relied upon to develop a Yakama ingestion value.

The milk ingestion rate of 1.2 L/d proposed for Yakama adults is summarized in Table 7. The only child milk ingestion rate reviewed for this study of 0.5 L/d (Harper et al., 2002) is proposed for the Yakama child rate. General exposure factors associated with all pathways are described in Section 3.3.8.

3.3.8 Other Exposure Factors

Since the maximally exposed Yakama individual is a subsistence fisher-hunter-gatherer living on the Hanford site year round, the maximum exposure frequency proposed for the adult Yakama is 365 days per year.

The exposure duration constitutes an entire lifetime. Although detailed demographic data are not available for the entire Yakama Nation population, nearly half of the respondents were elders (age 60 years and older) and many of these were older than 70 years. EPA's life expectancy for the general U.S. population (projected for 2010) is 78 years. Based upon this information, the adult exposure duration would be 72 years (78 life time minus 6 childhood years); however, the default value of 70 years is adequate as an average lifetime for risk calculations. For children, the exposure lifetime is considered 6 years.

The maximum weight of the respondents was much greater than the U.S. general population adult default value of 70 kg; however, without further demographic information about all members of the Yakama Nation, the average adult body weight of 70 kg should be used as default. Similarly, the default value of 16 kg is proposed for children.

3.4 Exposure Scenario Summary

This exposure scenario for Yakama members is a subsistence fisher-hunter-gatherer scenario for an individual living on the site, conducting daily and seasonal activities on the entire site and surrounding areas, eating local fish and wildlife, drinking local ground water and surface water, breathing local air, and using all usual and accustomed places year round. Dietary habits, natural resource use, and exposure to potentially contaminated media and biota should be considered for the Yakama Nation, which differs from the general population. A safe and healthy subsistence lifestyle should remain an option for the Yakama in their ancestral lands. Potential contaminant exposure from such a lifestyle is expected to be considered when calculating allowable dose and estimating risk from radionuclide and hazardous chemical contaminants from Hanford Site releases.

This exposure scenario provides a compilation of general information about the Yakama Nation traditional and subsistence lifestyle, including cultural practices that intimately connect this Native American population to regional natural resources. It is not, however, all inclusive. Other aspects of the Yakama lifestyle remain to be researched and addressed, such as additional dietary patterns (e.g., grain intake), rate of breast feeding, highly sensitive individuals, and overall general health.

Although a limited sample group was interviewed for this study, these individuals provided information representative of the general Yakama Nation population. These individuals provided information not only about their own dietary and activity patterns, but also those of their parents and children. Although specific daily activity patterns of children (age 0-6 years) are not described here, they were found to participate in many of the same activities as the adults; for example, families often bring their children on plant gathering expeditions about the age of 5 years. Men and women may participate in slightly different daily and seasonal activities, but the general exposure time to environmental media is likely to result in a comparable exposure.

Although this report was divided into various exposure activities, members of the Yakama Nation generally participate in all of the activities described in this scenario. The lifestyle is considered active, with a lot of time spent outdoors. Fishing, hunting, and gathering remain an important aspect of daily life, including the consumption and use of the resources that are harvested and distributed. Items such as tools, shelter, clothing, and accessories continue to be made by hand using raw plant and animal materials. Cultural practices, such as weekly religious services, events to recognize achievement, and memorials for those passed away, are the foundation of the cultural fabric of the nearly 10,000 members who comprise the Yakama Nation.

The Hanford Site is situated within the ancestral lands of the Yakama Nation, members of which spent winters on the site, then dispersed in other seasons to collect food from all areas and all elevations. The Yakamas were restricted from entering the site, however, between 1943 and 1988, when the Hanford Site was an active plutonium production plant, and access remains restricted during the cleanup process. There are areas of the Site, such as Rattlesnake Ridge and

islands in the Columbia River, that are unique and sacred, produce important foods and medicines, and which are revered and used for prayer. It is hoped that all areas will become available as cleanup actions are successfully completed.

The Yakama Nation is determined to ensure that the Hanford Site is cleaned up, efficiently and thoroughly, to protect and preserve the soils, waters, plants, fish and other animals of the area, and the health of the people that depend upon, and have rights to, these natural resources now and for future generations. The Yakama dependence on the consumption and use of natural resources suggests that the Yakama represent a maximally exposed population, potential contaminant exposures to whom should be evaluated during a comprehensive risk assessment of the Hanford Site.

4.0 RECOMMENDATIONS AND DATA NEEDS

This section provides recommendations for data use as well as additional data needs.

4.1 Data Use

It is expected that DOE will use this Yakama Nation exposure scenario and the lifeways described herein to conduct Hanford Site risk assessment. Cumulative risk should be evaluated for all exposure pathways, all contaminants, and all locations (including down wind and down stream of the site boundaries) over an individual Yakama's lifetime. High-level radioactive waste, nuclear reactor facilities, chemical processing operations, contaminated groundwater, polluted sediment, and plants and animals all pose risks to Yakama individuals. Consideration of all sources, areas, and management activities together will provide a more holistic evaluation of the Hanford Site than conducted thus far. The risk assessment should consider qualitative information provided in this exposure scenario, which explains the extent to which the Yakama depend upon the use of the soil and water, plants, fish and other animals, in addition to the quantitative exposure parameters.

During DOE's assessment, contaminant concentration terms should be used that spatially represent the entire Hanford Site. It is vital that DOE use adequate concentration data to evaluate potential risk, without parceling the site or dismissing usable data. Use of appropriate concentration terms together with Yakama Nation exposure parameters and appropriate toxicologic data will facilitate estimating cancer, non-cancer risk, and radiation exposure. These calculations should evaluate the potential exposure to the Yakama Nation as a "receptor group" and should be combined to obtain a cumulative exposure assessment.

Based upon an increased emphasis on the evaluation of chemical mixtures, aggregate exposures, and cumulative risk assessments, it is recommended that DOE use the results of the exposure assessment described in this report to quantify aggregate exposures. These aggregate exposures should combine the exposure of an individual to a specific contaminant by various exposure routes (e.g., summing exposure to an agent via ingestion of water and food, dermal contact, etc.). It should also quantify cumulative risk, which combines the aggregate exposures of multiple

chemical or physical agents (i.e., daily activity patterns combined to evaluate an entire lifetime); and determine cleanup based on a holistic paradigm that evaluates the risk assessment combined with an evaluation of community health and environmental restoration, which are intrinsically linked (Arquette, et al., 2002; EPA, 2004b).

Ultimately, to protect the Yakama Nation, it is expected that DOE will thoroughly investigate and characterize the Hanford Site, utilize available historical information and monitoring data, and incorporate the information into a comprehensive risk assessment for the entire site. Hazards identified during the risk assessment process should be addressed in the cleanup to allow safe use of the Hanford Site and surrounding areas.

4.2 Data Needs

The following additional data needs are recommended for further study and to provide a statistically robust data set to expand upon the Yakama Nation exposure scenario presented in this report:

- Conduct additional interviews to allow a greater sample size.
- Collect additional data regarding child-specific consumption rates, which are likely the most sensitive receptor group.
- Collect additional historic, demographic, and nutritional health information on the entire Yakama Nation population.

These data needs are recommended for future studies and do not discount the exposure scenario presented in this report.

Actual site media and biota contaminant concentrations should be used for exposure point values. For example, concentrations of radionuclide and hazardous chemicals measured in roots and berries from the Hanford site should be used with RME ingestion rates to calculate risks from this pathway. The Yakama Nation hopes to work closely with DOE, EPA, and other stakeholders to ensure the scenario is applied appropriately to the risk assessment process and to

ensure an adequate cleanup of the Hanford Site. Involvement of the Yakama Nation throughout the risk assessment process is critical to ensuring issues are addressed and data are used appropriately in the cleanup process.

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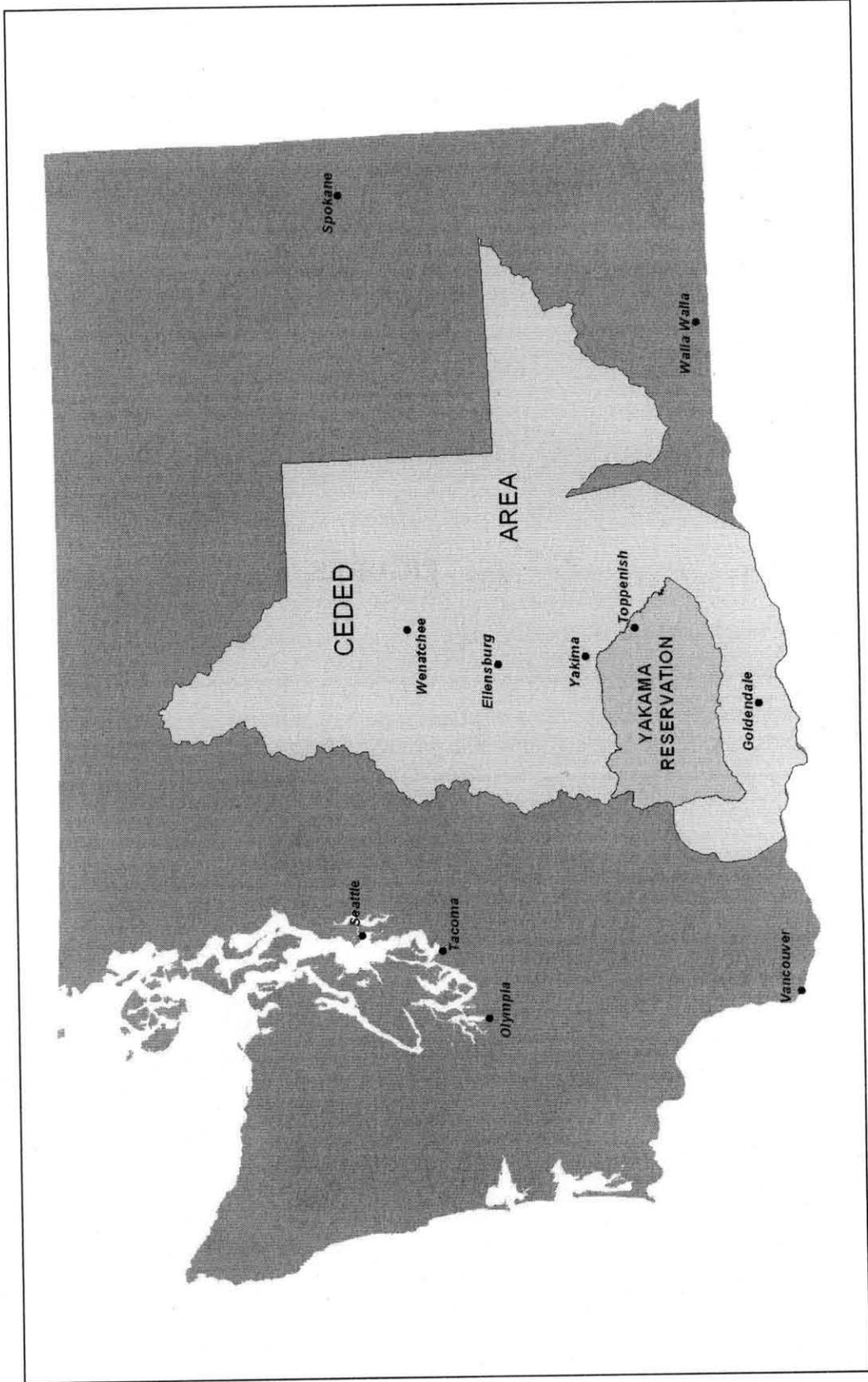
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FIGURES

Figure 1. Yakama Nation Reservation and Ceded Lands



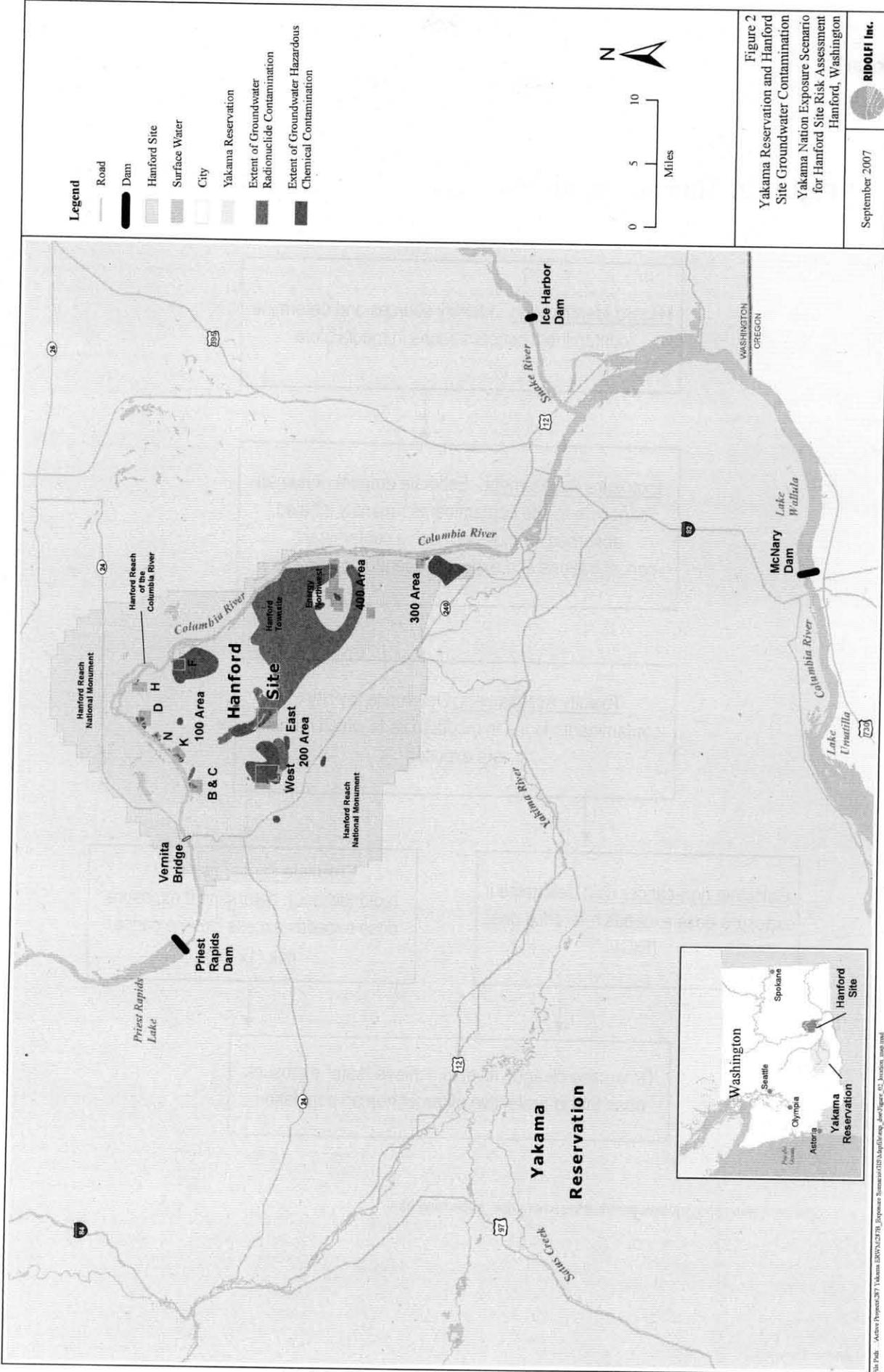
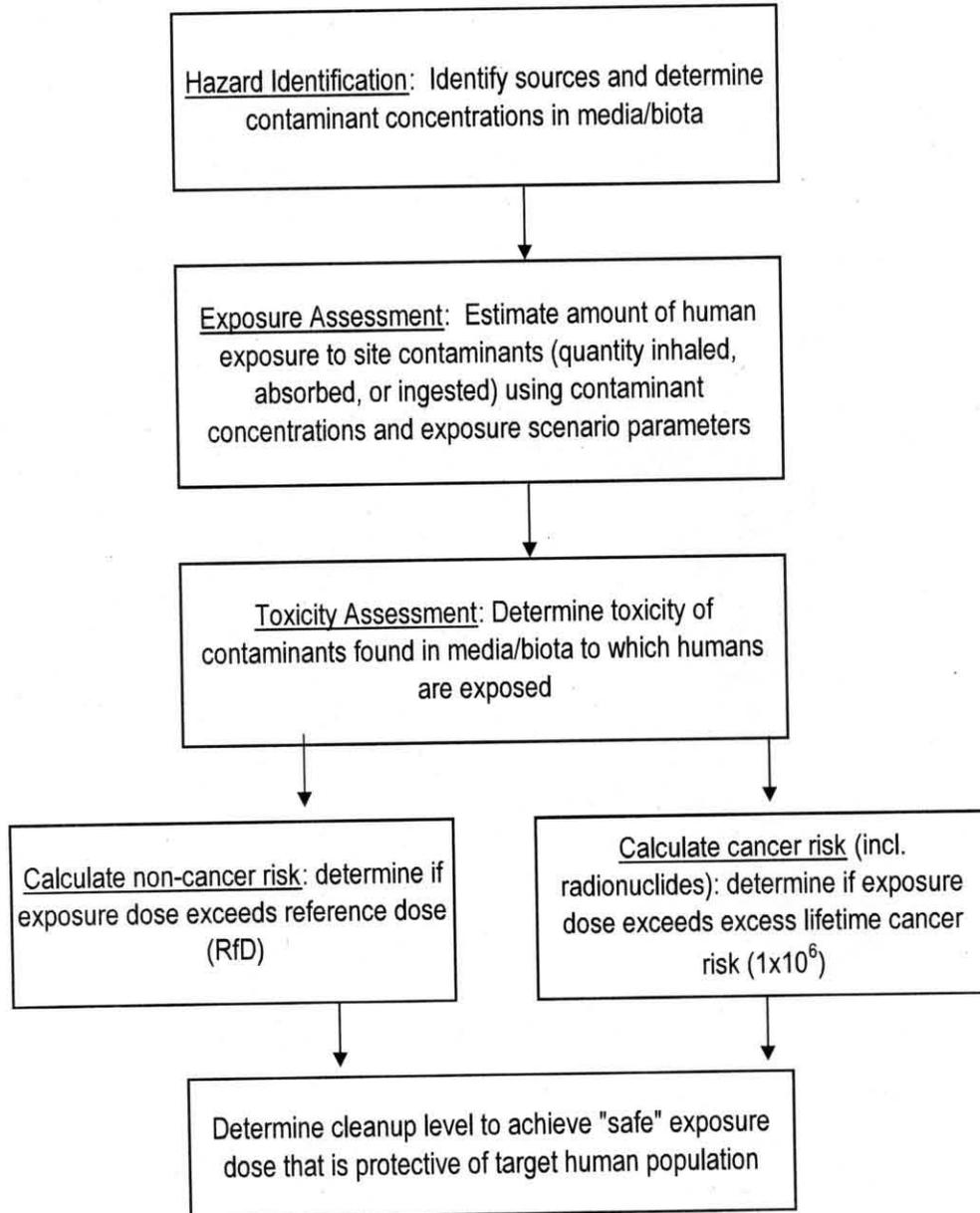
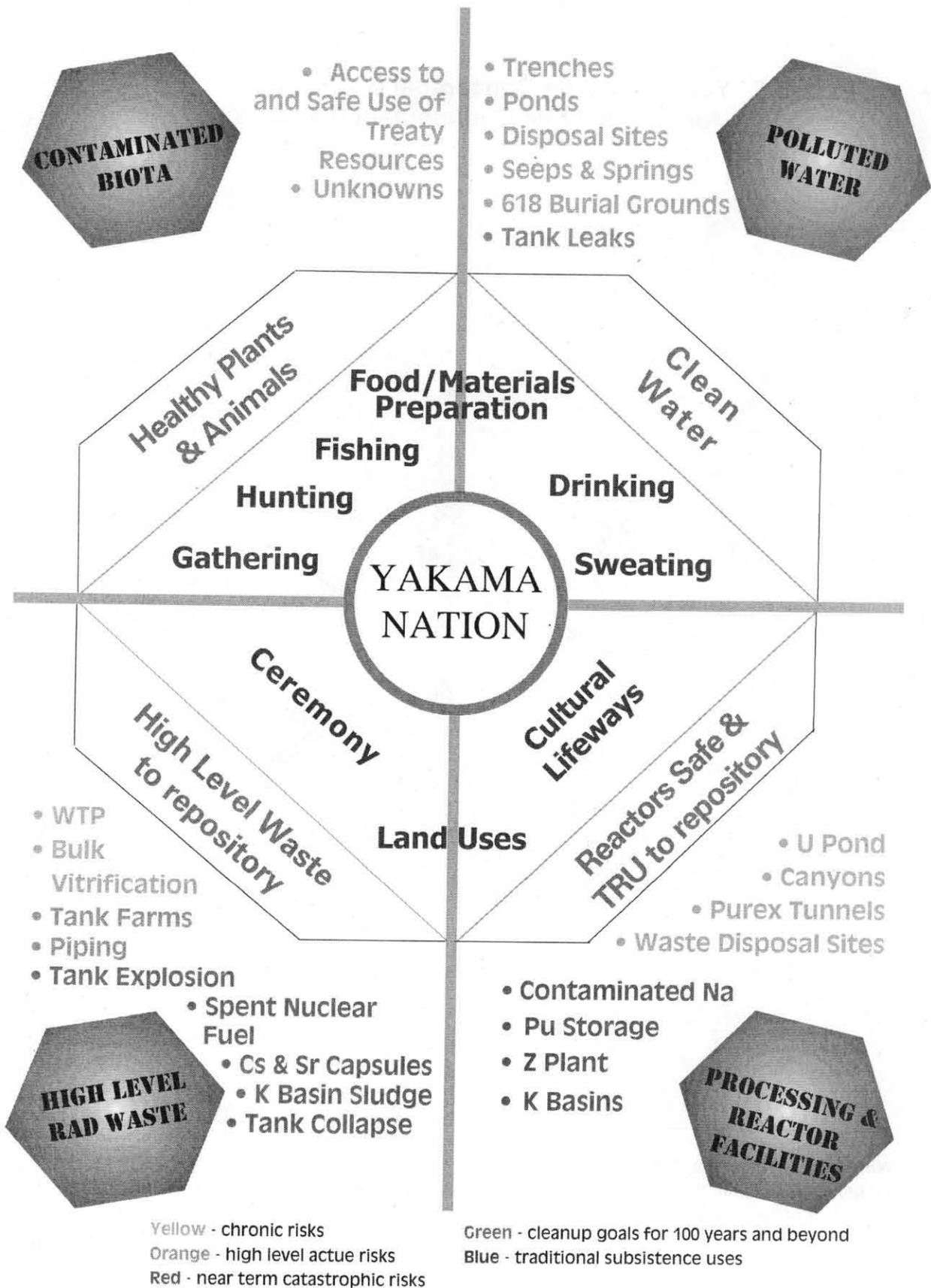


Figure 3. Human Health Risk Assessment Flow Chart

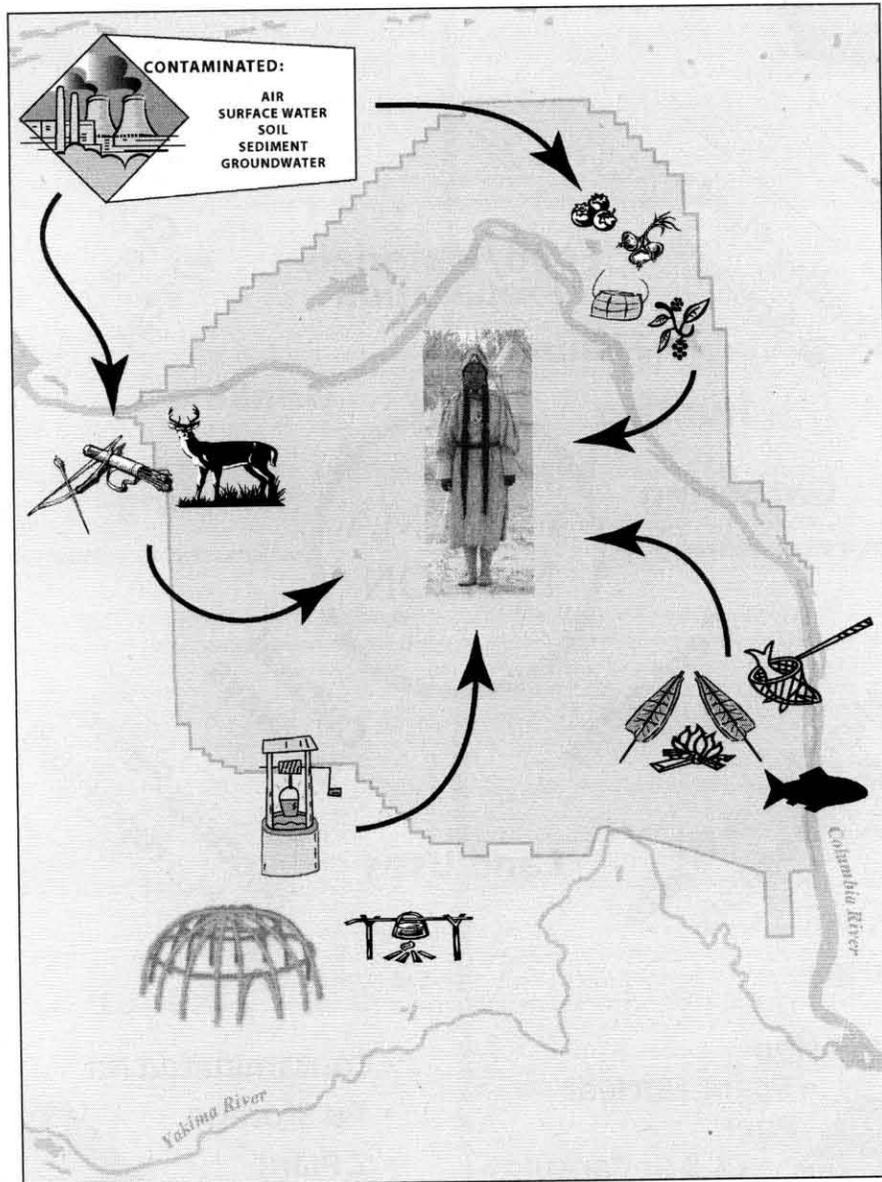


Source = www.epa.gov/oswer/riskassessment/risk_superfund.htm

Figure 4. Holistic View for Cleanup of Hanford Threats



**Figure 5. Yakama Nation Conceptual Site Model
for Hanford Site Contaminant Exposure**



Note: This figure represents a Yakama member conducting all of his or her daily and seasonal activities, including fishing, hunting, gathering, sweating, celebrating, eating local resources, drinking local ground water and surface water, and breathing local air, on the entire Hanford Site and surrounding areas.

Figure 6. Yakama Nation Historical Seasonal Activities

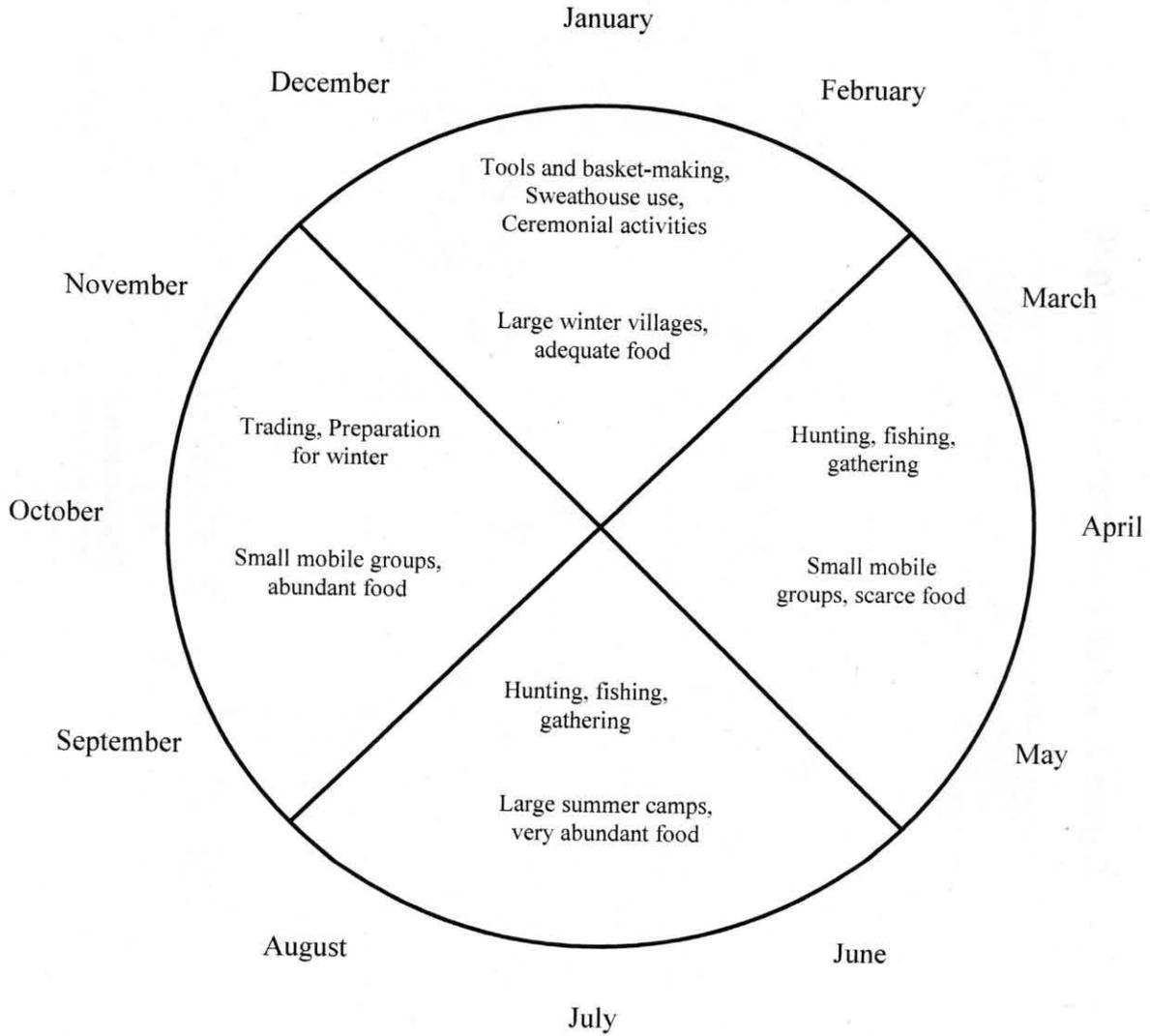


Figure 7. Adult Fish Consumption (g/d)

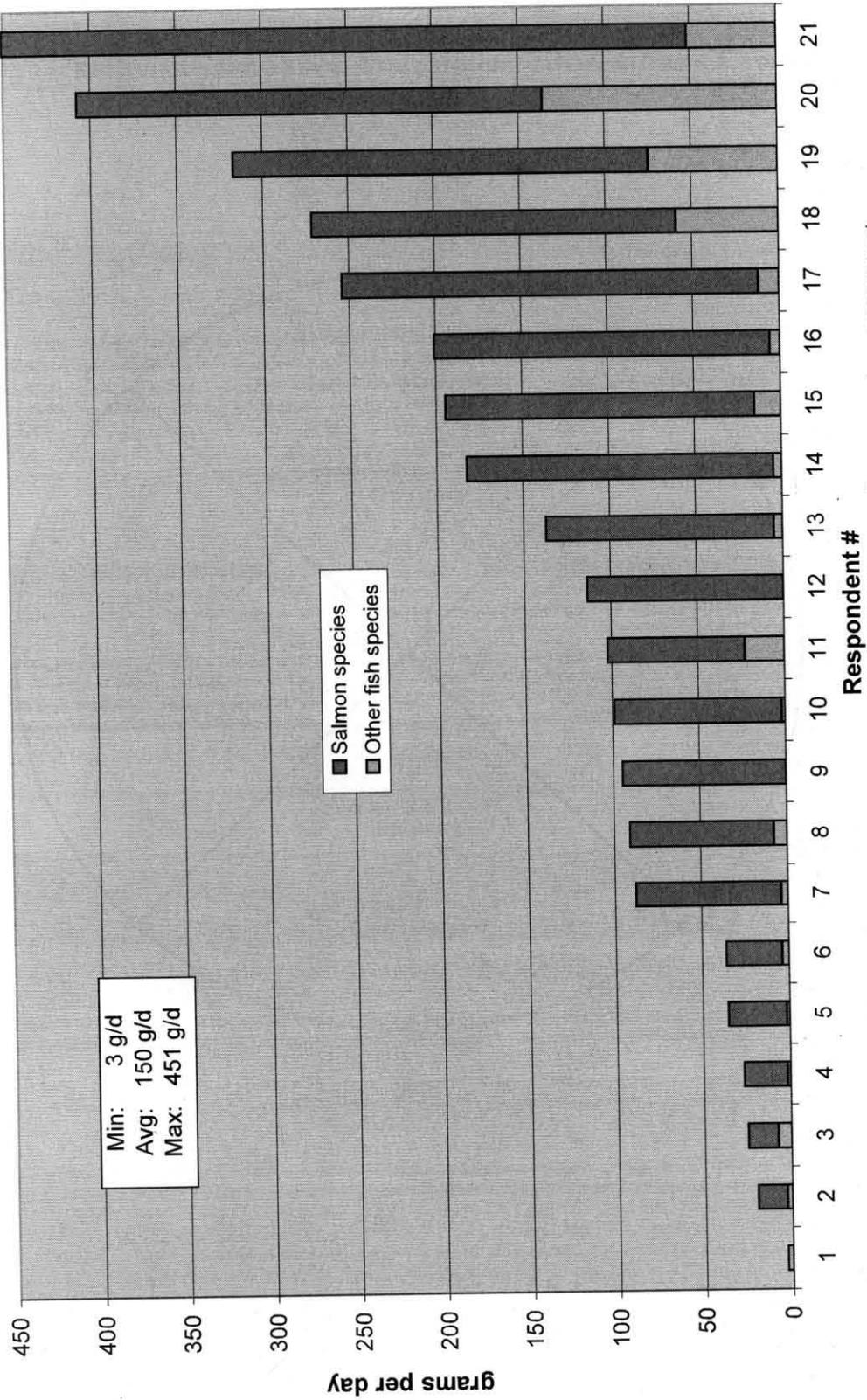
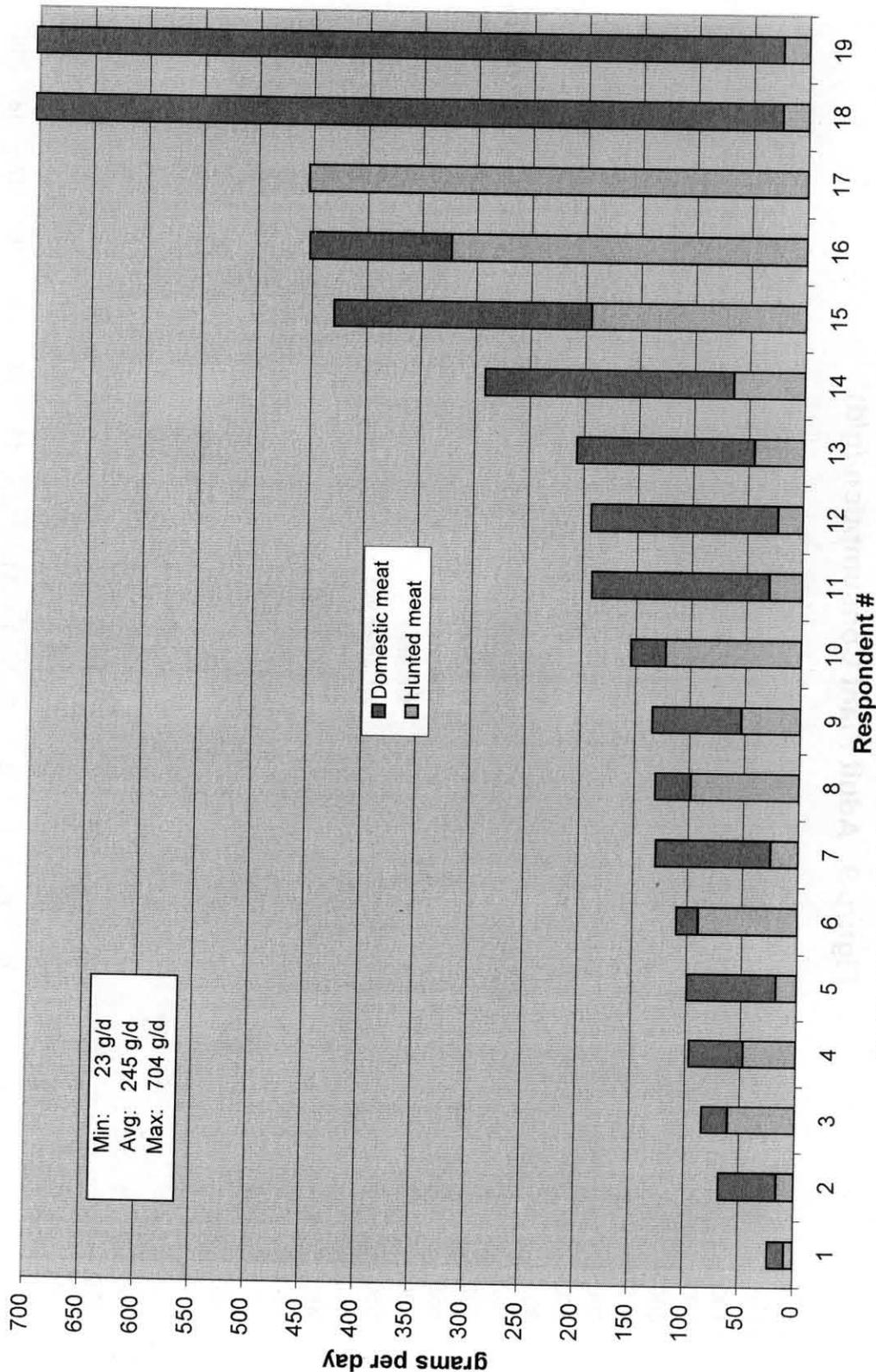


Figure 8. Adult Meat Consumption (g/d)



Based on cooked meat; includes data on respondent and parents; if range was given, max was used

Figure 9. Adult Plant Consumption (g/d)

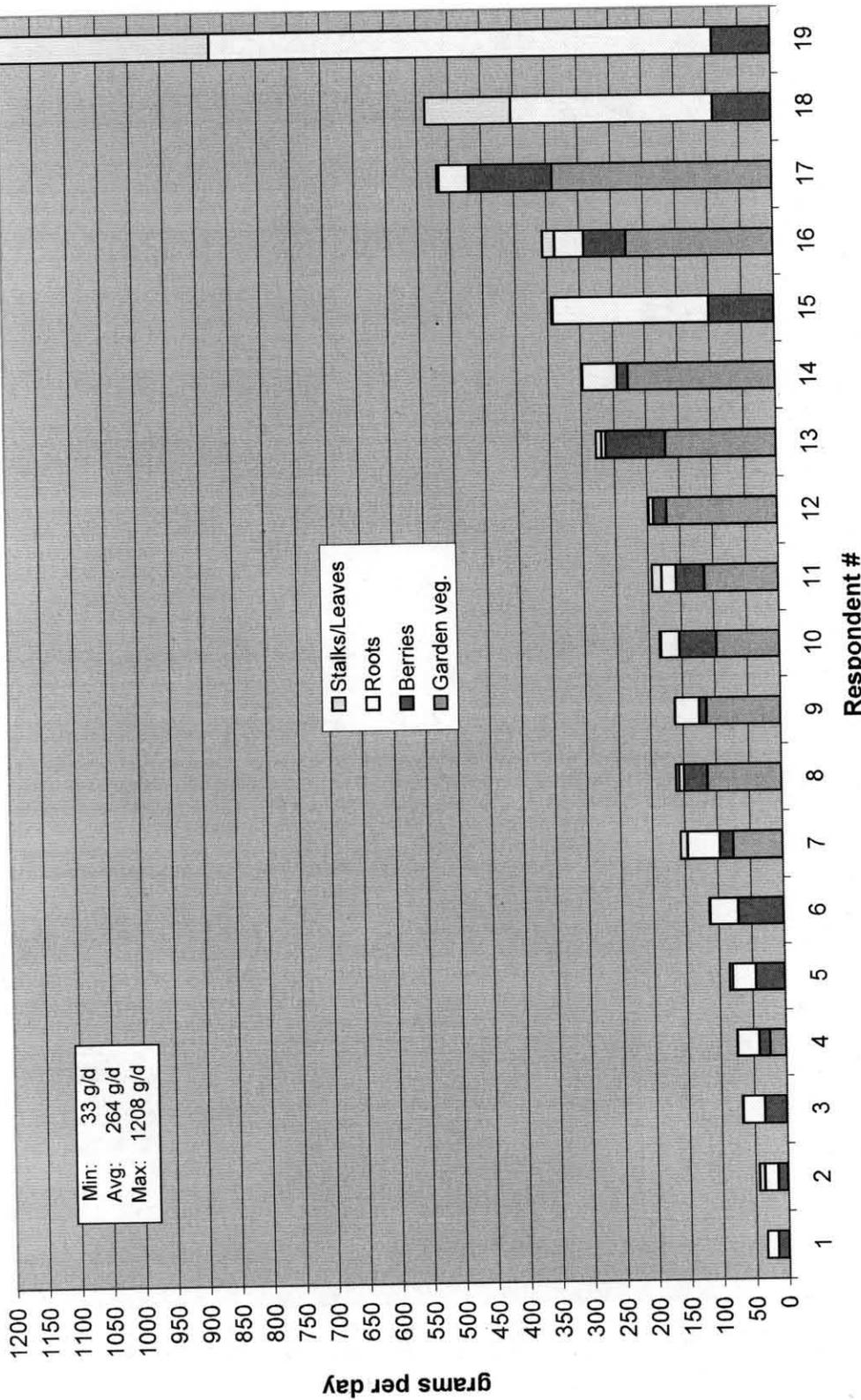
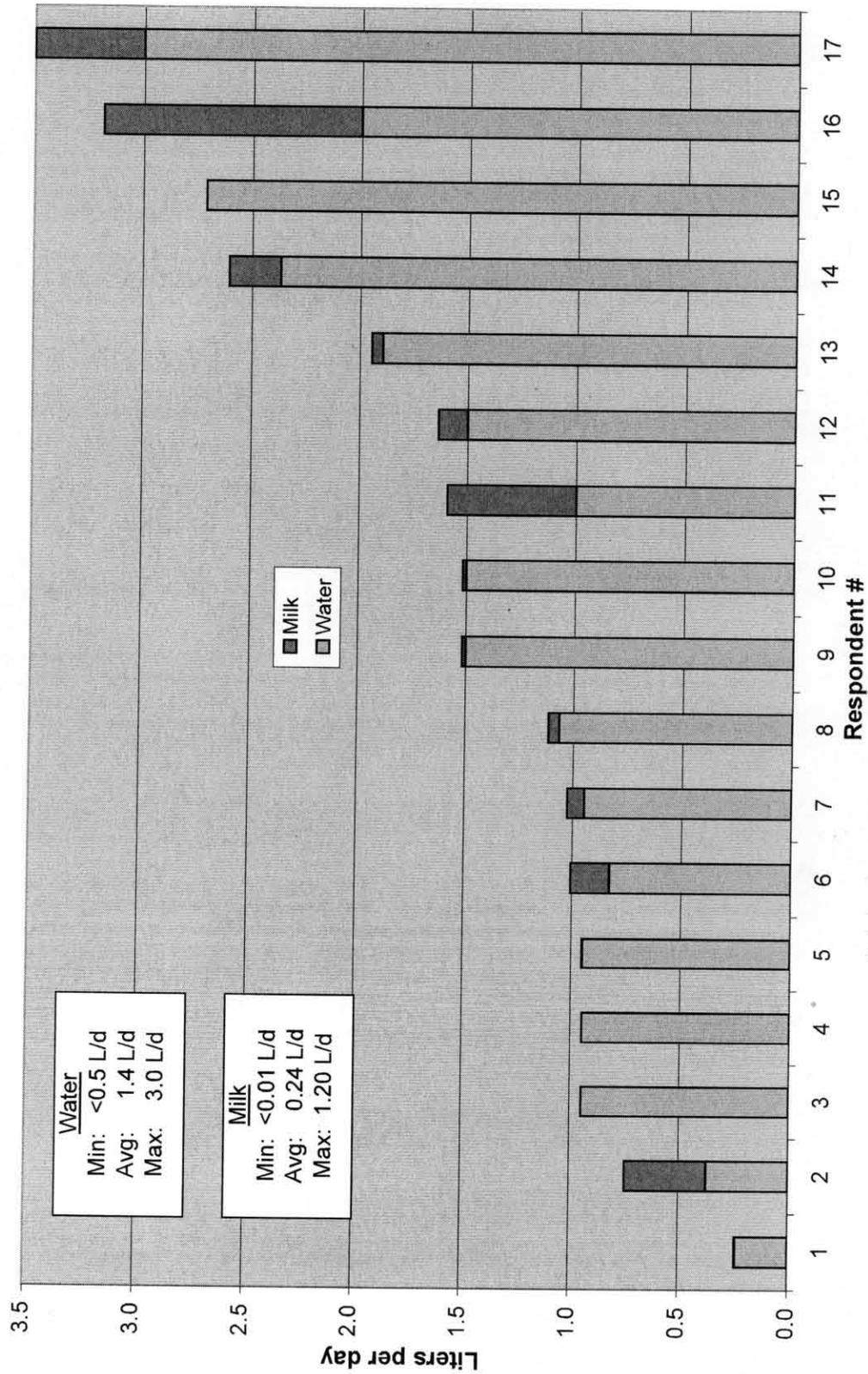


Figure 10. Adult Water and Milk Consumption (L/d)



Includes data on respondents and parents; if range was given, max was used

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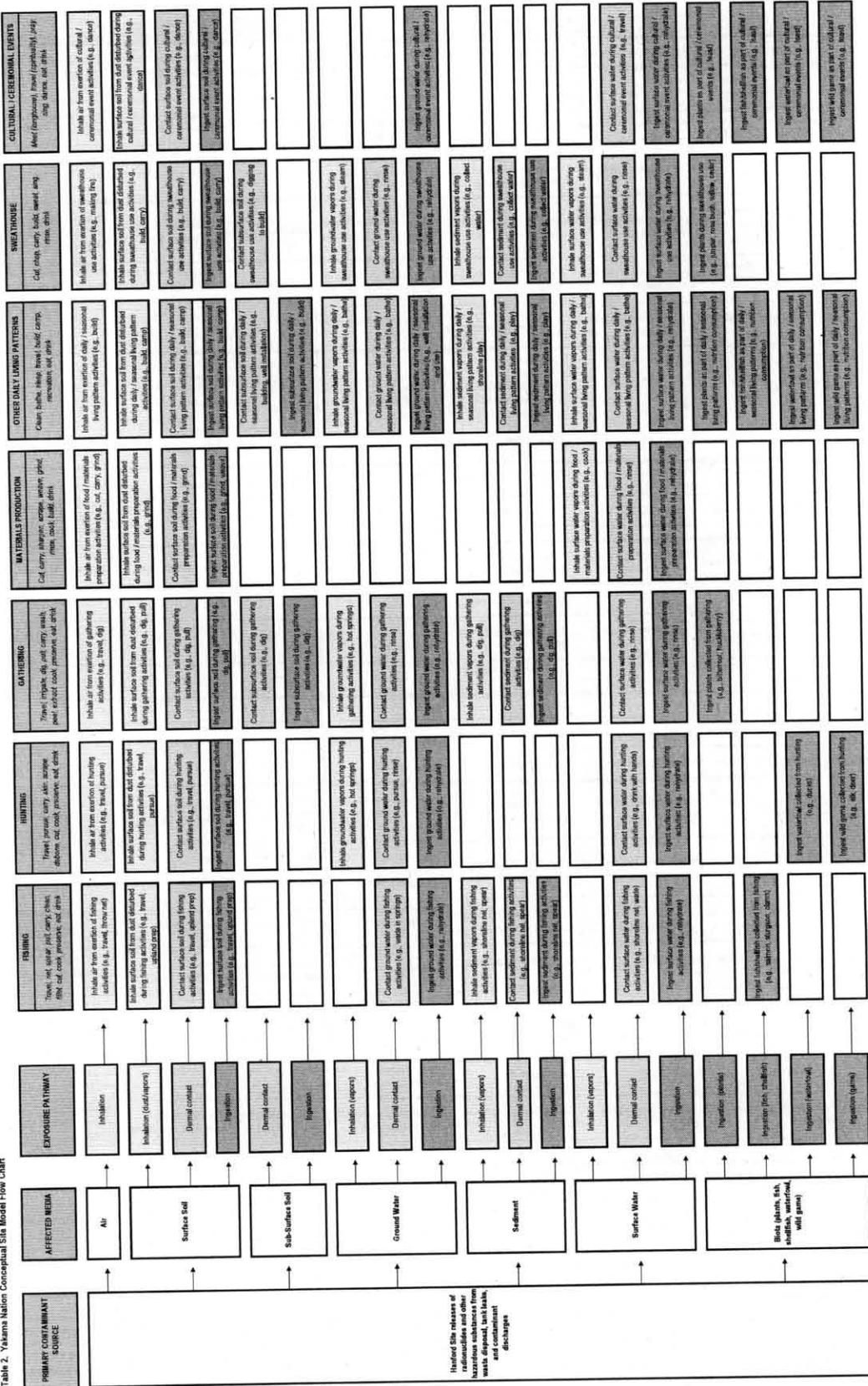
Yakama Nation Exposure Scenario
for Hanford Site Risk Assessment
September 2007

TABLES

Table 1. Yakama Nation Lifestyle Activity Matrix

Questions	Fishing	Hunting	Gathering	Materials Production	Other Daily Living Patterns	Sweathouse	Ceremonial / Cultural Events
WHAT (process)	Travel to fishing area, and actively fish, harvest, and carry out fish	Travel to hunting area, and await, pursue, hunt, and carry out animals	Travel to gathering areas, dig, out, harvest, and carry out plants	Make tools for hunting, including spears, bows and arrows	Bathe and shower	Gather wood and other materials and construct sweathouse	Gather to eat, pray, sing, and dance (including First Feast)
	Eviscerate fish; clean and fillet carcass	Eviscerate animal, skin/scrape hide, debone/quarter carcass	Wash, peel, and process plant parts	Make tools for fishing, including poles, reed nets, dip nets	Rest and sleep	Gather, haul, and chop firewood, and prepare fire	Attend Washat and other religious services
	Separate filets, bones, head, and organs	Cut meat and remove organs	Separate plant roots, stalks, leaves, and berries for food, medicine, or materials use	Make tools for gathering, including digging implements (antlers, sticks)	Work and play	Gather rocks to heat in fire	Attend burials, memorials, first hunt and naming ceremonies
	Cook edible fish parts by roasting/broiling, baking, boiling/poaching, frying	Cook meat and organs for stew, roast, and jerky	Prepare plants by steaming, boiling, frying, and raw	Weave baskets for plants for water, food, and storage	Camp in new locations	Gather water for steam and rinsing	Attend recreational events (pow-wows, tournaments, Treaty Days, etc.)
	Preserve fish by smoking, drying, salting, freezing, and canning	Preserve meat by smoking, drying, freezing, and canning	Preserve plants by drying and grinding to powder	Grind seeds and other plant parts for food and medicines	Recreational activities	Sit in sweat house, create steam, talk, sing, and chant	Send children to mountain for spiritual guidance (historical)
	Clean fish bones for materials use	Tan hide and use antlers/bones for materials use	Extract dyes for materials use	Construct long house, sweat house			
WHAT (species)	<ul style="list-style-type: none"> • Salmon • Trout • Lamprey (eat) • Smelt • Whitefish • Sturgeon • Walleye • Sucker 	<ul style="list-style-type: none"> • Deer • Elk • Rabbit • Otter • Beaver • Pheasant • Duck 	<ul style="list-style-type: none"> • Balsamroot • Bitterroot • Gray's desert parsley • Gairdner's yampah • Indian oshley • Chokecherry • Blue elderberry • Huckleberry 	<ul style="list-style-type: none"> • Willow • Indian hemp • Cedar 	<ul style="list-style-type: none"> • Water • Soil / dust 	<ul style="list-style-type: none"> • Willow • Fir boughs • Cedar • Rose bush • Water • Rocks 	
WHEN (duration, timeline)	Year round, depending on species migration patterns Spring Chinook salmon eaten - March for First Feast	Year round, depending on species migration patterns No female elk/deer Jan to Jun (allowing for reproduction)	Mar - Nov, depending on species growth cycles Spring roots, summer plants, fall berries	Year round; primarily in winter	Jan - Dec Bathe 0.5 hr/d; Sleep 8 hr/d	Year round	Year round Determined by food availability and events
WHERE (location)	Columbia River, Hanford Reach West side of Look Island - salmon spawning area Beyond Hanford Reach, e.g. Yakima River, previously Celilo Falls "Usual and accustomed" fishing areas (Treaty)	Laleek (sacred Rattlesnake Mtn), Arid Lands Ecology Cable Mountain and other upland areas "Open and unclaimed land" (Treaty)	Laleek (sacred Rattlesnake Mtn), Arid Lands Ecology Snively basin (cold creek) Toppenish Mountain (Poisal Butte) "Open and unclaimed land" (Treaty)	All areas	All areas Bathe 0.5 hr/d; Sleep 8 hr/d	Near Columbia River Near upland springs	Look Island - burial site
WHO (bands, sexes, ages)	All (incl. Wanapum) Primarily males, some females Primarily adults, some youth	All Primarily males, some females Primarily adults, some youth	All Primarily females, some males Adults and youth	All Primarily females, some males Adults and youth	All	All	All
HOW (all possible exposure pathways)	Inhale air from exertion of fishing activities Inhale soil from dust disturbed during fishing activities Dermally contact soil / sediment during fishing activities Ingest soil / sediment during fishing activities Inhale water vapors during fishing activities Dermally contact water during fishing activities Drink water during fishing activities Ingest edible fish and shellfish parts collected from fishing	Inhale air from exertion of hunting activities Inhale soil from dust disturbed during hunting activities Dermally contact soil/dust during hunting activities Ingest soil during hunting activities Inhale water vapors during hunting activities Dermally contact water during hunting activities Drink water during hunting activities Ingest wild game and waterfowl collected from hunting	Inhale air from exertion of gathering activities Inhale soil from dust disturbed during gathering activities Dermally contact soil during gathering activities Ingest soil during gathering activities Inhale water vapors during gathering activities Dermally contact water during gathering activities Drink water during gathering activities Ingest plants collected from gathering	Inhale air from exertion of materials preparation activities Inhale soil from dust disturbed during materials preparation activities Dermally contact soil during materials preparation activities Ingest soil / sediment during materials preparation activities Inhale water vapors during materials preparation activities Dermally contact water during materials preparation activities Drink water during materials preparation activities	Inhale air from exertion of living pattern activities Inhale soil from dust disturbed during living pattern activities Dermally contact soil during living pattern activities Ingest soil during living pattern activities Inhale water during living pattern activities Dermally contact water during living pattern activities Drink water during living pattern activities Ingest plants and animals during living pattern activities	Inhale air from exertion of sweathouse use activities Inhale soil from dust disturbed during sweathouse use activities Dermally contact soil during sweathouse use activities Ingest soil during sweathouse use activities Inhale water vapors during sweathouse use activities Dermally contact water during sweathouse use activities Drink water during sweathouse use activities	Inhale air from exertion of ceremonial/ cultural event activities Inhale soil from dust disturbed during ceremonial/ cultural event activities Dermally contact soil during ceremonial/ cultural event activities Ingest soil during ceremonial/ cultural event activities Inhale water vapors during ceremonial/ cultural event activities Dermally contact water during ceremonial/ cultural event activities Drink water during ceremonial/ cultural event activities Ingest plants and animals during ceremonial/ cultural event activities
WHY (survey questions)	Discuss fishing activities What do/would you fish? When do/would you fish? Where do/would you fish? How often/long do/would you fish?	Discuss hunting activities What do/would you hunt? When do/would you hunt? Where do/would you hunt? How often/long do/would you hunt?	Discuss gathering activities What do/would you gather? When do/would you gather? Where do/would you gather? How often/long do/would you gather?	Discuss food/materials preparation activities What materials do/would you make? When do/would you make these materials? Where do/would you make these materials? How often do/would you make these materials?	Discuss daily/seasonal living patterns What are your living patterns? When do/would you do these activities? Where do/would you do these activities? How often do/would you do these activities?	Discuss sweathouse use What sweathouse do/would you use? When do/would you use the sweathouse? Where do/would you use the sweathouse? How often do/would you use the sweathouse?	Discuss ceremonial / cultural activities What ceremonies do/ would you practice? When do/would you practice? Where do/would you practice? How often do/would you practice?

Table 2. Yakama Nation Conceptual Site Model Flow Chart



Note: When a radionuclide is the contaminant released, dermal contact also refers to external radiation.
Air (inhalation) pathway.
Dermal contact (absorption) pathway.
Ingestion (dietary) pathway.

Table 3. Exposure Parameters for Air Pathway

Media Pathway Exposure Parameter	Air									
	Inhalation			Modifying Factors						
	IR	IR _c	Air inhalation rate	ET	EF	ED	ED _c	ED _c	BW	BW _c
Adult m ³ /d	Child m ³ /d	m ³ /d	Adult/Child hr/d	Adult/Child d/yr	Adult yr	Adult yr	Child yr	Adult kg	Child kg	
Native American Rates										
TWRS, 1996	30	15		24	365	64	6	6	70	16
Harris & Harper, 1997	20	-		24	365	70	-	-	70	-
CRCIA, 1998	30	-		24	365	70	-	-	70	-
Harper et al., 2002	30	-		-	-	-	-	-	-	-
DOH, 2003	30	15		24	365	-	-	-	70	16
Harris, 2004	30	-		-	365	70	-	-	-	-
U.S. Residential Rates										
EPA, 1999 and 2002	31 ^a	16		-	365	78 ^c	-	-	72 ^d	-
DOE (RESRAD)	20	-		-	-	30	-	-	-	-
Statistics										
Min	20	15		24	365	30	6	6	70	16
Max	31	16		24	365	78	6	6	72	16
Yakama Nation										
Yakama Max*	26 ^b	n/a		24	365	75	n/a	n/a	145	n/a
Yakama Proposed	26	16		24	365	70	6	6	70	16

Notes

- *Yakama maximum exposure factors are based on data provided by interview respondents from this study.
- a. Rate is mean for outdoor workers of 1.3 m³/hr, recommended by EPA.
- b. Rate is based on maximum time spent outdoors x EPA average population inhalation rate, added to the 2nd-highest time doing strenuous activities x EPA avg heavy activity inhalation rate, added to the assumed sleeping/resting rate for remaining 10 hours of day (max values for all individuals): (7 hr/d * 1.3 m³/hr) + (4 hr/d * 3.2 m³/hr) + (10 hr/d * 0.4 m³/hr).
- c. Exposure duration is life expectancy projected for general U.S. population in 2010.
- d. Body weight is average of general U.S. population.
- n/a = not available (not enough information to calculate).

References

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 EPA, 1999 = Environmental Protection Agency, Exposure Factors Handbook, EPA/600/C-99/001 (mean values for U.S. population).
 EPA, 2002 = Environmental Protection Agency, Child-Specific Exposure Factors Handbook, EPA/600/P-00/002B (average moderate activity [playing] inhalation rate for U.S. children <6 yrs).
 DOE (RESRAD) = U.S. Department of Energy, RESRAD RADIAL dose modeling system, input parameters (cited in ITRC, 2002).
 ITRC, 2002 = Technical and Regulatory Document, Determining Cleanup Goals at Radioactively Contaminated Site, Case Studies. The Interstate Technology and Regulatory Council.

Table 4. Exposure Parameters for Soil / Sediment Pathway

Media Pathway	Inhalation				Ingestion				Soil and Sediment					
	Soil/sediment inhalation rate		IR _c		Soil/sediment ingestion rate		IR _c		Soil exposure time/frequency/duration			Modifying Factors		
	IR	Child	Adult	Child	IR	Adult	Child	IR _c	ET	EF	ED	ED _c	BW	BW _c
Exposure Parameter	m ³ /d	m ³ /d	m ³ /d	m ³ /d	mg/d	mg/d	mg/d	hr/d	d/yr	yr	yr	yr	kg	kg
Abbreviation														
Receptor	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult/Child	Adult/Child	Adult	Child	Adult	Child
Units	m ³ /d	m ³ /d	m ³ /d	m ³ /d	mg/d	mg/d	mg/d	mg/d	hr/d	d/yr	yr	yr	kg	kg
Native American Rates														
TWRS, 1996	30	15	200	200	200	200	200	200	24	365	64	6	70	16
Harris & Harper, 1997	20	-	200	200	200	200	200	200	24	180	70	-	70	-
CRCA, 1998	30	-	200	200	200	200	200	24	365	70	-	-	70	-
Harper et al. 2002	30	-	400	400	400	400	400	-	-	-	-	-	-	-
DOH, 2003	-	-	200	200	200	200	200	24	365	-	-	-	70	16
Harris, 2004	30	-	400	400	400	400	400	-	365	70	-	-	-	-
U.S. Residential Rates														
EPA, 1999 and 2002	-	16	50	400 ^b	-	-	-	-	-	180	78 ^d	-	72 ^d	-
DOE (RESRAD)	20	-	100	-	-	-	-	-	-	-	30	-	-	-
Statistics														
Min	20	15	50	200	200	200	200	24	180	30	30	6	70	16
Max	30	16	400	400	400	400	400	24	365	78	78	6	72	16
Yakama Nation														
Yakama Max ^a	26 ^a	n/a	n/a	n/a	n/a	n/a	n/a	24	365	75	75	n/a	145	n/a
Yakama Proposed	26	16	200	400	200	400	400	24	365	70	70	6	70	16

Notes
^a Yakama maximum exposure factors are based on data provided by interview respondents from this study.
^b Rate is based on maximum time spent outdoors x EPA average population inhalation rate, added to the 2nd-highest time during strenuous activities x EPA avg heavy activity inhalation rate, added to the assumed sleeping/reading rate for remaining 10 hours of day (max values for all individuals): $(7 \text{ hr/d} \cdot 1.3 \text{ m}^3/\text{hr}) + (4 \text{ hr/d} \cdot 3.2 \text{ m}^3/\text{hr}) + (10 \text{ hr/d} \cdot 0.4 \text{ m}^3/\text{hr})$.
^c Child soil ingestion rate is upper percentile of EPA recommended values for children (<6 yrs).
^d Exposure duration is life expectancy projected for general U.S. population in 2010.
^e Body weight is average of general U.S. population.
n/a = not available (not enough information to calculate).

References
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Harris & Harper, 1997 = A Native American Scenario, Risk Analysis, 17(6):789-795 (also cited in DOH, 2003).
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EPA, 2002 = Environmental Protection Agency, Child-Specific Exposure Factors Handbook, EPA/600/P-00/002B (average moderate activity [playing] inhalation rate for U.S. children <6 yrs).
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ITRC, 2002 = Technical and Regulatory Document, Determining Cleanup Goals at Radioactively Contaminated Sites: Case Studies. The Interstate Technology and Regulatory Council.

Table 5. Exposure Parameters for Surface Water / Ground Water Pathway

Media Pathway	Surface Water and Ground Water											
	Inhalation				Ingestion				Modifying Factors			
	Water vapor inhalation rate		Water ingestion rate		Water exposure time/frequency		duration		Body weight			
Exposure Parameter	IR	IR _c	IR	IR _c	ET _{sw}	EF	ED	ED _c	BW	BW _c		
Abbreviation	Adult	Child	Adult	Child	Sweathouse	Adult	Adult	Child	Adult	Child		
Receptor	m ³ /d	m ³ /d	L/d	L/d	hr/d	d/yr	yr	yr	kg	kg		
Units												
Native American Rates												
TWRS, 1996	30	15	3	1.5	1	365	64	6	70	16		
Harris & Harper, 1997	15	-	3	-	1	365	-	-	70	-		
CRCA, 1998	30	-	3	-	1	365	-	-	70	-		
Harper et al., 2002	30	-	4	-	-	-	-	-	-	-		
DOH, 2003	-	-	3	2	-	-	-	-	70	16		
Harris, 2004	30	-	4	-	1	365	64	6	70	-		
U.S. Residential Rates												
EPA, 1999 and 2002	-	16	2.3 ^b	1 ^c	-	365	78 ^d	-	72 ^e	-		
DOE (RESRAD)	20	-	1.4	-	-	-	30	-	-	-		
Statistics												
Min	15	15	1.4	1.5	1	365	30	6	70	16		
Max	30	16	4	2	1	365	78	6	72	16		
Yakama Nation												
Yakama Max*	12 ^a	n/a	3	n/a	7	365	75	n/a	145	n/a		
Yakama Proposed	26 ^{**}	16	4	2	7	365	70	6	70	16		

Notes

- * Yakama maximum exposure factors are based on data provided by interview respondents from this study.
- ** See Tables 3 and 4 (Yakama max. inhalation rate calculation)
- a. Rate is based on maximum time spent in sweathouse x EPA average moderate activity inhalation rate, plus EPA recommended bathing time x same inhalation rate. (7 hr/d * 1.6 m³/hr) + (15 min/d * 1.6 m³/hr); other water vapor exposures not considered.
- b. Rate is 50th percentile of general adult U.S. population.
- c. Rate is approx. 95th percentile of general U.S. population of children (<5 yrs).
- d. Exposure duration is life expectancy projected for general U.S. population in 2010.
- e. Body weight is average of general U.S. population (EPA, 1999).
- n/a = not available (not enough information to calculate).

References

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Table 6. Exposure Parameters for Biota Pathway

Media Pathway	Fish				Meat		Veg.		Fruit		Milk		All Food						
	Ingestion		Ingestion		Ingestion		Ingestion		Ingestion		Ingestion		Food exposure frequency/duration		Modifying Factors		Body weight		
	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	IR _c	EF	ED	ED	BW	BW _c	
Exposure Parameter	Fish/shellfish ingestion rate		Meat/game ingestion rate		Vegetable ingestion rate		Fruit ingestion rate		Milk ingestion rate		Food exposure frequency/duration		Modifying Factors		Body weight		Body weight		
Abbreviation	IR	IR _c	IR	IR _c	IR	IR _c	IR	IR _c	IR	IR _c	IR	IR _c	Adult	Child	Adult	Child	Adult	Child	
Receptor	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	Adult	Child	
Units	g/d	g/d	g/d	g/d	g/d	g/d	g/d	g/d	g/d	g/d	yr	yr	yr	yr	yr	yr	kg	kg	
Native American Rates																			
Hewes, 1973	498	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Walker, 1985	1,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRITFC, 1994 (90th %ile)	389	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toy et al., 1996 (95th %ile)	177	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TWRS, 1998	-	-	34 ^d	-	330	-	330	-	0.6	-	365	-	70	6	70	16	-	-	-
Harris & Harper, 1997	540 ^e	-	275 ^d	-	343	-	330	-	0.49	-	365	-	70	-	70	-	-	-	-
CRCIA, 1998	540	-	337 ^d	-	330	-	330	-	0.6	-	365	-	70	-	70	-	-	-	-
Squamish, 2000 (95th %ile)	798	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Squamish, 2000 (95th %ile)	1,060 ^f	-	935 ^d	-	1,600 ^f	-	1,600 ^f	-	0.5	-	-	-	-	-	-	-	-	-	-
Harper et al., 2002	1,060 ^f	-	348 ^d	-	343 ^d	-	343 ^d	-	-	-	-	-	-	-	-	-	-	-	-
DOH, 2003	620	-	125 ^d	-	1,100	-	1,100	-	-	-	-	-	-	-	-	-	-	-	-
Harris, 2004	620	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
U.S. Residential Rates																			
EPA, 1999 [†]	170 ^g	-	357 ^h	-	700 ⁱ	-	700 ⁱ	-	2.2 ^j	-	365	-	78 ^k	-	72 ^l	-	-	-	-
EPA, 2002 ^{††} (90th %ile)	519	-	363	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
DOE (RESRAD)	-	-	-	-	7.4	-	7.4	-	-	-	-	-	-	-	-	-	-	-	-
Statistics																			
Min	170	-	125	-	7.4	-	7.4	-	125	-	127	-	0.49	-	0.5	-	70	6	70
Max	1,060	-	935	-	1,600	-	1,600	-	868	-	127	-	2.2	-	0.5	-	365	6	72
Yakama Nation																			
Yakama Max*	451	n/a	704	n/a	1,118 [†]	n/a	1,118 [†]	n/a	299	n/a	n/a	n/a	1.2	n/a	n/a	n/a	145	n/a	n/a
Yakama Proposed**	519	363	704	212	1,118	187	1,118	187	299	127	0.5	70	6	70	16	-	-	-	-

Notes

- † All rates represent general U.S. population except the fish consumption rate (see footnotes c).
- †† Fish consumption rates represent fish and shellfish (uncooked) of the general U.S. population of adult & child (<5 yrs) "fish consumers" only.
- * See Table 7 for rationale behind selection of Yakama Nation proposed exposure parameters.
- ††† Yakama maximum exposure factors are based on data provided by interview respondents from this study.
- a. Rate is reasonable subsistence intake, and excludes shellfish.
- b. Rate is for "high fish diet" and includes shellfish (mussele + crayfish = 175 g/d).
- c. Rate is 95th percentile for Native American subsistence population (from CRITFC, 1994)
- d. Includes organ meats at 10x meat concentration, but consumed at 0.1 frequency of meat (organs, eggs).
- e. Rate includes big game, small game, and fowl (small game + fowl = 50 g/d), but does not include beef.
- f. Rate is 95th percentile for general population, assuming body weight of 70 kg.
- g. Vegetable includes gathered (20% above-ground, 40% below-ground, 20% equal) + garden (10% above-ground, 10% below-ground).
- h. Vegetable includes weekly material (178 g/d) and roots (165 g/d).
- i. Vegetable includes 1/2 of garden plants (assume equal ratio veg/fruit+salads/vegs and roots (of gathered plants)).
- j. Yakama vegetable = 1/2 of garden plants (assume equal ratio veg/fruit+salads/vegs and roots (of gathered plants)).
- k. Yakama fruit = 1/2 of garden plants (assume equal ratio veg/fruit+berries (of gathered plants)).
- l. Exposure duration is life expectancy projected for general U.S. population in 2010.
- m. Body weight is average of general U.S. population.
- n/a = not available (not enough information to calculate).

References

- Hewes, 1973 = Indian Fisheries Productivity in Pre-Contact Times in the Pacific Salmon Area (salmon only consumption rate)
- Walker, 1985 = Pre-dam estimate for Columbia Plateau Tribes (cited in Harris, 2004).
- CRITFC, 1994 = Columbia River Inter-Tribal Fish Commission, A Fish Consumption Survey of the Umatilla, Nez Perce, Yakama, & Warm Springs Tribes of the Columbia River Basin (90th percentile of non-subsistence fish consumed)
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- DOH, 2003 = Radiological Risk Assessment (Appendix II) for Final Environmental Impact Statement, Washington Department of Health (www.ecy.wa.gov/programs/hwp/index.html).
- Harris, 2004 = Exposure Scenario for CTUJ Traditional Subsistence Lifestyles, Confederated Tribes of the Umatilla Indian Reservation.
- EPA, 1999 = Environmental Protection Agency, Exposure Factors Handbook, EPA/600/C-99/001 (mean values for U.S. population).
- EPA, 2002 = Environmental Protection Agency, Estimated Per Capita Fish Consumption in the United States (98% for U.S. population).
- DOE (RESRAD) = U.S. Department of Energy, RESRAD RADation dose modeling system, input parameters (cited in ITTC, 2002).
- ITTC, 2002 = Technical and Regulatory Document, Determining Cleanup Goals at Radioactively Contaminated Sites, Case Studies, The Interstate Technology & Regulatory Council.

Table 7. Summary of Proposed Yakama Nation RME Parameters

Pathway	Route	Exposure Parameter	Abbrev.	Receptor	Units	RME	Rationale
Air (see Table 3)	Inhalation	Air inhalation rate	IR	Adult	m ³ /d	26	Yakama calculated value
			IR _c	Child	m ³ /d	16	EPA average child value (<6 yrs) for moderate activity
	Modifying factors	Air exposure time/frequency/duration	ET	Adult/Child	hr/d	24	Max exposure time for all populations
			EF	Adult/Child	d/yr	365	Max exposure frequency for all populations
			ED	Adult	yr	70	Average lifetime (default)
		ED _c	Child	yr	6	Average childhood lifetime (default)	
Soil and sediment (see Table 4)	Inhalation	Soil inhalation rate	IR	Adult	m ³ /d	26	See air inhalation value
			IR _c	Child	m ³ /d	16	See air inhalation value
	Ingestion	Soil ingestion rate	IR	Adult	mg/d	200	Upper percentile adult value (Native American studies)
			IR _c	Child	mg/d	400	Upper percentile EPA child value
	Modifying factors	Soil exposure time/frequency/duration	ET	Adult/Child	hr/d	24	Max exposure time for all populations
			EF	Adult/Child	d/yr	365	Max exposure frequency for all populations
			ED	Adult	yr	70	Average lifetime (default)
			ED _c	Child	yr	6	Average childhood lifetime (default)
Surface and ground water (see Table 5)	Inhalation	Water vapor inhalation rate	IR	Adult	m ³ /d	26	See air inhalation value
			IR _c	Child	m ³ /d	16	See air inhalation value
	Ingestion	Water ingestion rate	IR	Adult	L/d	4	Max Yakama value, plus additional consumption during sweathouse use
			IR _c	Child	L/d	2	EPA child rate, plus additional consumption during sweathouse use
	Modifying factors	Water exposure time/frequency/duration	ET _{sw}	Sweathouse	hr/d	7	Max Yakama value of time spent inside sweathouse
			EF	Adult	d/yr	365	Max exposure frequency for all populations
			ED	Adult	yr	70	Average lifetime (default)
			ED _c	Child	yr	6	Average childhood lifetime (default)
Fish (see Table 6)	Ingestion	Fish/shellfish ingestion rate	IR	Adult	g/d	519	EPA upper percentile for adult "fish consumers"; within range of published rates
			IR _c	Child	g/d	363	EPA upper percentile for child "fish consumers"
Meat (see Table 6)	Ingestion	Meat/game ingestion rate	IR	Adult	g/d	704	Max Yakama value; within range of published rates
			IR _c	Child	g/d	212	Washington DOH estimated child rate
Veg. (see Table 6)	Ingestion	Vegetable/root ingestion rate	IR	Adult	g/d	1,118	Max Yakama value; within range of published rates
			IR _c	Child	g/d	187	Washington DOH estimated child rate
Fruit (see Table 6)	Ingestion	Fruit/berry ingestion rate	IR	Adult	g/d	299	Max Yakama value; within range of published rates
			IR _c	Child	g/d	127	Washington DOH estimated child rate
Milk (see Table 6)	Ingestion	Milk ingestion rate	IR	Adult	L/d	1.2	Max Yakama value; within range of published rates
			IR _c	Child	L/d	0.5	Published child rate (Native American studies)
All Food	Modifying factors	Food exposure frequency/duration	EF	Adult	d/yr	365	Max exposure frequency for all populations
			ED	Adult	yr	70	Average lifetime (default)
			ED _c	Child	yr	6	Average childhood lifetime (default)
General	Modifying factors	Body weight	IR	Adult	kg	70	Average adult body weight (default)
			IR _c	Child	kg	16	Average child body weight (default)

Notes:

DOH - Washington State Department of Health

EPA - United States Environmental Protection Agency

Child is considered age 0-6 years (EPA, 1999)

These exposure parameters are relevant to the entire Hanford Site and beyond, used by Yakama members for all activities (see Figure 5 and Tables 3-6 for details)

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Yakama Nation Exposure Scenario
for Hanford Site Risk Assessment
September 2007

APPENDIX A

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DOE	1995	Native American Working Group, December 1990 - December 1995: Technical Steering Panel on the Hanford Environmental Dose Reconstruction Project, Final Report, Published December 1995			47
DOE	1996	Columbia River Comprehensive Impact Assessment (CRCIA) - Part I, Screening Assessment		DOE/RL-96-16	46
DOE	2004	Columbia River Component of the River Corridor Baseline Risk Assessment: Basis and Assumptions on Project Scope		DOE/RL-2004-49	43
DOE	2004	Risk Assessment Work Plan for the 100 Area and 300 Area Component of the RCBRA		DOE/RL-2004-37	88

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AUTHOR	DATE	DOC_TITLE	DOC_NO	Citation	DocKey
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DOE	2006	100-B/C Pilot Project Risk Assessment Report, Volume 1	DOE/RL-2005-40		42
DOE	2006	CERCLA Five-Year Review Report for the Hanford Site	DOE/RL-2006-20		110
DOE	2006	Ecological Compliance Assessment Management Plan	DOE/RL-95-11		75
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RIDOLFI Inc.

Yakama Nation Exposure Scenario
for Hanford Site Risk Assessment
September 2007

APPENDIX B
Published News Articles

HANFORD NUCLEAR RESERVATION

Radioactive materials discharges accidental, intentional

By RUSSELL JIM

The Hanford Site is a 580-square-mile U.S. Department of Energy (DOE) facility located near Richland, just 20 miles from the eastern border of the Yakama Reservation.

Operations at the site produced plutonium for U.S. nuclear weapons programs for 45 years until the end of the Cold War in 1989. Releases of radioactive materials and toxic chemicals at the site began with the onset of operations in 1944 and continue to this day.

As part of operations, radioactive and chemical wastes were both intentionally and unintentionally discharged to the air, ground and waters at the site. These contaminants can be found in the region's soils, waters, plants, fish and other animals, potentially affecting the health of these natural resources as well as area residents.

When plutonium production ended at the Hanford Site, the focus switched to environmental cleanup. In May, 1989, the DOE, the U.S. Environmental Protection Agency, and the Washington State Department of Ecology signed the Hanford Federal Facility Agreement and Consent Order, better known as the Tri-Party Agreement, which committed DOE to cleaning up the Hanford Site.

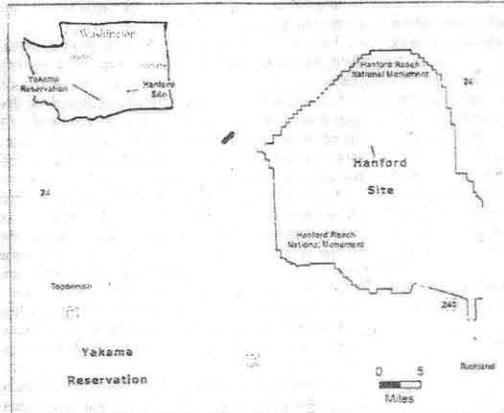
The Confederated Tribes and Bands of the Yakama Nation, a Trustee for the area's natural resources, participates in the Hanford cleanup.

The Yakama Nation's goals for the Hanford cleanup center on protecting Yakama Nation Treaty rights, including the health of the Yakama people and natural resource interests protected by the Yakama Treaty of June 9, 1855.

To realize these goals, the Yakama Nation takes a holistic approach to the cleanup, recognizing that all things interrelate, which requires considering the impacts on air, land, water, and all plants and animals. The Yakama Nation believes the cleanup actions conducted or planned by DOE thus far, will not sufficiently remedy the extensive contamination to attain these goals, and to safeguard human health and the health of the environment in the future.

What is the Hanford problem?

Widespread contamination is present over the Hanford Site as a result of 45 years of plutonium production. During this period over 200 billion gallons of liquid waste containing plutonium, uranium, and other radioactive and toxic chemicals were dumped directly to the ground.



These wastes moved downward to the water table, eventually making 270 billion gallons of ground water over an area of 80 square miles unsafe to drink. Some of this ground water has already reached, and is discharging into the Columbia River.

Additionally, 53 million gallons of some of the most dangerous mixed radioactive and chemical waste in the world is stored in 177 underground storage tanks at the Hanford Site. Several of these tanks have already leaked about one million gallons of this stored waste into the soil.

The potential also exists for catastrophic failure of these aging tanks, which would result in widespread radioactive contamination.

Some efforts are currently underway by DOE to cleanup the most immediate threats at Hanford. These localized efforts are not effective for all types of contamination, however, and only cover a part of a very large site with complex contamination issues.

Why is the Nation involved?

Before Hanford existed, the Yakama people and other Native Americans used the area's natural resources for thousands of years for hunting, fishing, gathering, and religious ceremonies.

In the Treaty of 1855, the Yakama Nation retained their rights to fish in all usual and accustomed places, and to hunt and gather foods and medicines on open and unclaimed land beyond the Reservation.

An effective cleanup of Hanford is critical for protecting the health of the Yakama people, not only physical health, but also cultural and spiritual health, and for protecting the treaty rights of the Yakama Nation.

Natural resources, such as the plants and animals that have been

impacted by Hanford contamination, are critical to the traditional way of life for the Yakama people, who are recognized stewards of the land.

The Yakama Nation is involved in the cleanup process in an effort to protect their people and the land to which they are intimately tied, and to protect the health of all people. The Hanford Site must be cleaned up and the natural resources must be restored to allow future use of the site.

What are the health risks?

Exposure to radioactive and toxic chemicals, such as those released at the Hanford Site, has been shown to impact the health of people as well as plants and other animals. No level of radiation exposure is considered safe. Health effects may include damage to liver and other organs, reduced immune system function, reproductive effects, and cancer.

Wastes in the underground storage tanks, which have been leaking into the soil and migrating to ground water, include radioactive contamination that may pose a substantial health risk for as long as 200,000 years.

Fish, an abundant resource in the Columbia River, are an important part of a healthy diet, and for Native Americans in the Pacific Northwest, an important cultural resource.

Salmon and other fish have been declining in numbers and health in the river over the past century. Some efforts to restore salmon in the river have succeeded (fish hatcheries, etc.), but unsafe levels of contaminants have been found in these fish, potentially affecting the health of the people eating them.

Without effective cleanup, risks from Hanford contamination may result from:

- Harvesting and eating fish and other animals (elk, deer, etc.);
- Gathering and using plants (roots, leaves, berries) for foods and medicines;
- Drinking water or using water for sweat lodge and other cultural activities.

What is the Nation doing?

Both the Yakama Nation's Environmental Restoration & Waste Management (ERWM) Program, and the Department of Natural Resources advocate complete cleanup of Hanford for the protection of all Yakama people and the public.

The Hanford Site is part of the "usual and accustomed" areas retained by the Yakama Nation for fishing, hunting, and gathering, and thus, safe use of the site must be secured for the future.

The DOE is currently conducting risk assessments to evaluate potential threats to human health and the environment from the Hanford Site's radioactive and chemical wastes.

A risk assessment involves consideration of the people that may use the site both now and in the future, and evaluation of their activities that may lead to exposure to contamination. The Yakama people are an important group of land users at the Hanford Site, particularly in practicing their traditional activities.

Yakama Nation uses must be protected. With the objective of assisting DOE to correctly consider Yakama Nation uses in the risk assessments, the ERWM is developing a Native American Exposure Scenario. The scenario will be based on a traditional subsistence lifestyle, with adjustments to take aspects of modern life into account.

The ERWM plans to gather input from Yakama Nation members to describe this subsistence lifestyle from their past experiences, cultural knowledge, and envisioned future uses of the site.

It is hoped that the Hanford Site will eventually be cleaned up and restored to the point where the Yakama people can return to conduct activities, if they so desire, in areas currently too contaminated to use.

Russell Jim is the manager of the Yakama Nation Environmental Restoration & Waste Management Program, a former Yakama Tribal Council member and a practitioner of traditional Yakama beliefs.

[Editor's Note: This is the first in a series, with future articles on the Yakama Exposure Scenario Project and how the public can become involved to help the Yakama Nation promote cleanup and restoration of the Hanford Site.]

ENVIRONMENTAL STEWARDS

Program needs tribal members' input, help with survey

HANFORD NUCLEAR RESTORATION

Hanford — Is it safe for the Yakama People?

By RUSSELL JIM

[This is the second of three articles about chemical releases from the Hanford Site and how exposure to these chemicals may affect the Yakama Nation. In the first article, we described the contamination at the Hanford Site. This article describes some of the work currently being done by the Yakama Nation to assure that chemicals released from Hanford do not pose a risk to people. Imagine the Hanford Site completely cleaned up and safe for you to live there. How would you and your family engage in a healthy and modern subsistence lifestyle?]

How can the health of the Yakama people be protected?

The Yakama Nation's Environmental Restoration and Waste Management (ERWM) program is working with the U.S. Department of Energy (DOE) to ensure that the Yakama people and their ways of life are protected from exposure to environmental contaminants. This includes the safe and unencumbered use of clean natural resources, such as water, plants and animals that are integral to the traditional life ways that make up the Yakama cultural landscape.

The DOE is in the process of cleaning up the Hanford Site. Cleanup decisions are based in part on evaluating threats to people and the environment. With the objective of a protective cleanup, the ERWM is providing input to DOE to ensure that all possible risks to the Yakama people are considered during the cleanup process at Hanford.

To accomplish this, ERWM, with technical assistance from RIDOLFI Inc., would like your help in describing the lifestyle of the Yakama people. We want to document what you consider to be a traditional lifestyle, including hunting, fishing, gathering, cultural activities, and other details unique to the Yakama. We will provide some of the information, only that which is not confidential, to the DOE to help them assess the potential threats that may exist to the Yakama people from



Hanford contamination, with the hope that people may be able to use the Hanford site again in the future.

How will we describe the Yakama lifestyle?

In order to consider all possible ways a Yakama individual may be exposed to Hanford contamination, an "exposure scenario" will be developed that includes present day information about how people live, supplemented with assumptions about the future. This will help to describe how Yakama people can be exposed to potential contaminants in the air, water, soil, plants and animals through their daily activities.

The Yakama "exposure scenario" will include a general description of how the Yakama people live, including estimates of how a sustainable diet was, and is, maintained, how often cultural activities occurred, and may occur, as well as other information that may cause disproportionate impacts from contamination. The Yakama lifestyle needs to be documented and taken into account by the DOE during the cleanup of Hanford.

What information is needed?

All people of the Yakama Nation are traditionally tied to the land and its natural resources, and orally pass their culture and traditions from elders to younger generations. The ERWM hopes to document some of this information, while respecting confidentiality. We would like to reflect the Yakama population as a whole, both now and in the future, including all ages and genders. To do this, ERWM hopes to speak with as many members as possible to gather this information. We will have members interviewed before during the Hanford Environmental Dose Reconstruction Project of the 1990's and the Down Winder Court Cases. Those efforts did not involve a complete "exposure scenario." Information needed includes:

- Hunting
- Fishing
- Gathering (and gardening)
- Materials preparation (tools, baskets, etc.)
- Dietary and living patterns
- Cultural and ceremonial activities (feasts, burials, sweat house, etc.)

How will the information be used?

The DOE needs basic information about the Yakama lifestyle to assess potential risk from Hanford contamination and determine cleanup levels. The DOE requires that information that is used for cleanup decisions be transparent and legally- and scientifically-defensible. However, it is most important that Yakama tribal confidentiality be respected and secured. Only non-proprietary and non-confidential information will be provided to the DOE, all other data will be secured at ERWM.

ERWM staff would like to interview any member with the time and interest to share their thoughts and information. The confidentiality of this information is of the highest importance and no sensitive information (including names of individuals, exact locations of plant and animal collection, medicinal or cultural practices, etc.) will be published or released from the sole care of the Yakama Nation ERWM.

How can you become involved?

The ERWM staff hopes to collect information primarily from personal interviews, through informal conversations with Yakama members or mailed surveys. With this information, ERWM will develop a picture of the Yakama lifestyle now and in the future.

We invite you to participate in this important opportunity to ensure that the Hanford Site is adequately cleaned up to protect the Yakama Nation and the natural resources on which the people so intimately depend. Your lifestyle will be represented, your confidential information will be respected, and your voice will be heard. For information, please contact Russell Jim at the ERWM Program at (509) 865-5121.

[The final article will provide a preview of what the Yakama lifestyle looks like to date based on information gathered from Yakama Nation members.]

Russell Jim is the manager of the Yakama Nation Environmental Restoration/Waste Management Program; is a former Yakama Tribal Councilman; and a practitioner of traditional Yakama beliefs.

Yakama Nation Review

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July 13, 2007

RED FROM COVER TO COVER

Established May 1970

Volume XXXVIII Number 4

Tribe determined to protect usual and accustomed sites

By the Yakama Nation ERWM Program and RIDOLFI Inc.

[Preface: This is the third and final article in a series about radioactive and chemical releases from the Hanford Nuclear Reservation and how exposure to these contaminants may affect the people of the Yakama Nation. In the first article, we described the extent of contamination at the Hanford Site and the potential environmental impacts. In the second article we described work being done by the Yakama Nation to assure that contaminants released from Hanford do not pose a risk the Yakama people now and in the future. In this third and final article, we provide a look at how some Yakama members describe their traditional lifestyle and consider how dietary and cultural activities may lead to exposure to Hanford contamination. The Yakama envision a future where the Hanford Site is completely cleaned up and safe for all Yakama members to live off of the land and engage in a healthy and modern subsistence lifestyle.]

A Yakama woman, gathering roots and berries every year since she was a child, says she will continue to gather traditional plants until she is "too old to walk."

This reflects the determination of the Yakama people to make use of the local resources, just as their an-

cestors have done for thousands of years.

These plants, as well as the fish and the wildlife, provide food and medicine, tools and shelter, which are critical to the survival of the Yakama culture.

Accordingly, feasts are held annually to celebrate the abundance and importance of these natural resources.

Russell Jim, manager of the Yakama Nation Environmental Restoration and Waste Management (ERWM) Program, stresses the importance of "the salmon, the deer, the elk, the food out of the ground, and the berries as necessary medicine, with strong genes, to provide a strong body, heart and life."

The ERWM program has developed an "exposure scenario" that describes what life is like as a Yakama. This portrayal of the traditional lifestyle will be used to help assess potential threats from the nearby Hanford Site.

Aspects of this lifestyle that involve consuming or contacting the soil, water, plants and animals, may result in risks to the Yakama from exposure to radioactive and hazardous chemical contamination that has been released from Hanford over many years.

The Hanford Site lies within the ancestral lands of the Yakama people, who used to spend winters on the site, and then travel in other

seasons to collect food from all areas and elevations.

However, between 1943 and 1988, the Yakama were not allowed on the Hanford Site while it was producing plutonium.

Rattlesnake Ridge, for example, is a unique and sacred area at Hanford with limited access that continues to produce very important foods and medicines for the Yakama, and which is still revered and used for prayer today.

As part of the exposure scenario project, Yakama adults and elders were interviewed and provided information on traditional fishing, hunting, and gathering practices, as well as sweathouse use and ceremonies.

Those interviewed discussed their methods for collecting traditional foods and the amounts of the foods they ate. All of these activities are still critical aspects of Yakama subsistence and culture today, connecting the people to the land for generations to come.

The interviews show that the Yakama depend heavily on the harvest and consumption of fish from local rivers such as the Columbia River, which passes through the Hanford Site; as well as wild game and an abundance of local native plants, including shoots, roots, leafy material, and berries.

Fishing, hunting, and gathering remain an important aspect of daily life - the harvest of which is shared

with others. Tools, shelter, clothing and accessories are made by hand using raw plant and animal materials.

Weekly religious services, memorials for those passed away, events to recognize achievement, and other traditions are weaved into the cultural fabric of the Yakama Nation.

Like previous generations, the Yakama continue to subsist on natural resources in the vicinity of Hanford.

The Yakama envision a future where the Hanford Site, which is part of the Yakama "usual and accustomed" use areas, is cleaned up and they can return.

Without compromising confidential information, results from the "exposure scenario" will be shared with the U.S. Department of Energy to evaluate potential risks to the Yakama from Hanford contamination.

The Yakama Nation is determined to ensure that the Hanford Site is cleaned up efficiently and thoroughly, to protect and preserve the soils, waters, plants, fish and other animals of the area; and the health of the people that depend upon, and have rights to, these natural resources now and for future generations.

For more information, please contact Russell Jim at the ERWM Program at (509) 865-5121.

RIDOLFI Inc.

Yakama Nation Exposure Scenario
for Hanford Site Risk Assessment
September 2007

APPENDIX C
Survey Questionnaire

SURVEY QUESTIONNAIRE

YAKAMA NATION EXPOSURE SCENARIO

Prepared for the
Yakama Nation

Prepared by
RIDOLFI Inc.

April 5, 2007

CONFIDENTIAL – NOT TO BE RELEASED

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INTERVIEW LOG

To be completed by person conducting the interview ("interviewer").

Interviewer Name: _____

Interviewee

Name: _____

Address: _____

Phone #: _____

Interview

Date/Time: _____

Location: _____

Note to interviewers: Text in italics is for your information and does not necessarily need to be stated to the interviewee.

Before begin interview:

- Give them copy of INTRODUCTION page to follow along
- Have them sign the confidentiality Disclaimer Form (2 copies)
- Verify that tape-recording is acceptable
- Have with you: Serving size props (salmon piece/ can, parsley, radishes, measuring cups, and water bottle) and pictures of fish and plants
- Have with you: \$100 check and copy of check to sign upon receipt

1. INTRODUCTION

Thank you for your time today. I am working with the office of the Yakama Nation Environmental Restoration Waste Management program (ERWM). We appreciate your willingness to participate in this survey and share your time and knowledge. As a Yakama member myself, I fully respect the confidentiality of your personal information, and we have a form to sign that guarantees that ERWM will not release any confidential information to anyone outside of our program (one copy of which you can keep for your records). Your information will be compiled with all other responses to produce a summary of the Yakama lifestyle.

The office of the Yakama Nation ERWM is designed to identify, locate, and protect the Yakama Nation cultural and natural resources within the Hanford Site. The Hanford Site is located in the Ceded Area and is subject to the rights of the Yakama Nation Treaty of 1855. Some of the treaty rights extend beyond present day boundaries of reservations or Indian Trust lands. Off-reservation treaty rights may include grazing, hunting, fishing, and gathering rights and other interests, water and subsistence rights.

The U.S. Department of Energy (DOE) is in the process of cleaning up the Hanford Site. Cleanup decisions are based in part on evaluating threats to people and the environment. With the objective of a protective cleanup, the ERWM is providing input to DOE to ensure that all possible risks to the Yakama people are considered during the cleanup process at Hanford.

Your input today will help the Yakama Nation record important aspects of our culture that need to be protected and preserved, such as native foods and medicines, during the cleanup process at the Hanford Site. It is hoped that the Hanford Site will eventually be cleaned up and restored to the point where we, the Yakama people, can return to use the land.

2. BACKGROUND

I will begin with some basic questions.

1. Gender

- a. Male
- b. Female

2. How old are you?

(Age indicates experience and knowledge of traditional lifestyle)

3. With which longhouses and/or churches are you associated?

(To ensure multiple longhouses, and potentially different traditions, are represented)

GATHERING PLACE	(√) IF YES	GATHERING PLACE	(√) IF YES
Celilo Longhouse		Toppenish Longhouse	
Priest Rapids/Wanapum Longhouse		Toppenish Church	
Rock Creek (Goldendale area)		Toppenish Community Center	
Satus Longhouse		Toppenish Creek Longhouse (W.S.)	
Satus Shaker Church		Wapato Longhouse	
Shaker Church (1910)		White Swan (W.S.) Community Center	
Shaker Church (Independent/W.S.)		Other:	

This survey has questions about (1) dietary and living patterns, including fishing, hunting, gathering, and making materials, and (2) cultural activities, including sweats and ceremonies. Please tell me at any time during the interview if you prefer to skip any of the questions.

(This allows interviewee control over which information they want to share)

3. FISH EATEN, USED, AND FISHED

These next few questions are about the fish that you eat, including where you get them, how you prepare them, and how much of them you eat. Then, if you fish for your food, I have a few questions about that.

- 4. I will list different types of fish and ask you some questions about each. These sample serving sizes can help identify the amounts of fish you eat.**
(To identify which fish are important to the Yakama and must be protected, and to identify specific fish consumption rates based on snacks, meals, and feasts)

COMPLETE TABLE #1

NEXT 2 QUESTIONS ONLY APPLY IF THE INTERVIEWEE HAS FISHED

- 5. At what age did you start fishing, and do you still fish today?**
(To quantify average lifetime spent fishing)
- 6. Can you tell me about the kinds of tools you use for fishing?**
(To provide a complete description of fishing)

7. **In regards to the fish you eat today, do you plan on consuming more, less, or the same amount in the future?**
(To identify future fish consumption values)
8. **If you have children/grandchildren, what percentage of fish do your children/grandchildren eat in comparison to you?**
(To identify children consumption values)
9. **Do you think the fish that you eat from the area are clean or unclean, and has your attitude or habits changed towards eating fish and fishing from the area?**
(To identify the existing perception about contamination and its effect on practices)
10. **How has Hanford changed your fish eating or fishing practices, and what should be done about it?**
(To ensure future uses of the Hanford Site are considered during cleanup)

4. MEAT EATEN, USED, AND HUNTED

These next few questions are about the meat that you eat, including where you get it, how you prepare it, and how much of it you eat. Then, if you hunt for your food, I have a few questions about that.

- 11. I will list different animals and ask you some questions about each. These sample serving sizes can help identify the amounts of meat you eat.**

(To identify which animals are important to the Yakama and must be protected, and to identify specific consumption rates based on snacks, meals, and feasts)

COMPLETE TABLE 2

NEXT 2 QUESTIONS ONLY APPLY IF THE INTERVIEWEE HAS HUNTED

- 12. At what age did you start hunting, and do you still hunt today?**

(To quantify average lifetime spent hunting)

- 13. Can you tell me about the kinds of tools you use for hunting?**

(To provide a complete description of hunting)

14. In regards to the meat you eat today, do you plan on consuming more, less, or the same amount in the future?

(To identify future meat consumption values)

15. If you have children/grandchildren, what percentage of meat do your children/grandchildren eat in comparison to you?

(To identify children consumption values)

16. Do you think the meat that you eat from the area is clean or unclean, and has your attitude or habits changed towards eating meat and hunting from the area?

(To identify the existing perception about contamination and its effect on practices)

17. How has Hanford changed your meat eating or hunting practices, and what should be done about it?

(To ensure future uses of the Hanford Site are considered during cleanup)

5. PLANTS EATEN, USED, AND GATHERED

These next few questions are about the plants, roots and berries that you eat, including where you get them, how you prepare them, and how much of them you eat. Then, if you gather your food, I have a few questions about that.

- 18. I will list different types of plants and ask you some questions about each. These sample serving sizes can help identify the amounts of roots and berries you eat.**
(To identify which plants are important to the Yakama and must be protected, and to identify specific consumption rates based on snacks, meals, and feasts)

COMPLETE TABLE 3

NEXT 2 QUESTIONS ONLY APPLY IF THE INTERVIEWEE HAS GATHERED

- 19. At what age did you start gathering, and do you still gather today?**
(To quantify average lifetime spent gathering)

- 20. Can you tell me about the kinds of tools you use for gathering?**
(To provide a complete description of gathering)

21. In regards to the plants you eat today, do you plan on consuming more, less, or the same amount in the future?

(To identify future plant consumption values)

22. If you have children/grandchildren, what percentage of plants do your children/grandchildren eat in comparison to you?

(To identify children consumption values)

23. Do you think the plants that you eat from the area are clean or unclean, and has your attitude or habits changed towards eating plants and gathering from the area?

(To identify the existing perception about contamination and its effect on practices)

24. How has Hanford changed your plant eating or gathering practices, and what should be done about it?

(To ensure future uses of the Hanford Site are considered during cleanup)

6. OTHER DAILY / SEASONAL ACTIVITIES

These next few questions are about drinking and using water, other dietary habits, and daily activity patterns.

25. I will ask you some questions about drinking water and milk.

(To determine drinking water consumption and rates and milk consumption rates)

COMPLETE TABLE 4

26. Do you think the water that you drink from the area is unclean, and if so, has this changed your attitude or habits towards drinking and using water from the area?

(To identify the existing perception about contamination and its effect on practices)

27. How has Hanford changed your water drinking and use practices, and what should be done about it?

(To ensure future uses of the Hanford Site are considered during cleanup)

28. How many hours do you spend outdoors each day (or week)?
(To identify contact rates with outdoor air and soil/dust)

29. How much time do you spend doing strenuous activities each day (or week), such as chopping, grinding, running, dancing, weaving, chasing horses, etc.?)
(To identify frequency of activity levels that cause greater inhalation and contact rates)

30. Do you use a sweathouse, and if so, for what purposes in general?
(To determine physical, emotional, or spiritual purposes of sweating)

If answer is NO, skip to the next section.

31. How often do you sweat?
(To determine frequency of sweathouse use per day, week, or month)

32. Each time you sweat, how long do you spend in the sweathouse?

(To determine duration of time spent actually sweating)

33. With whom do you generally sweat?

(To identify which groups and genders sweat together)

34. Since what age have you been sweating?

(To identify age groups that sweat)

35. Where is the sweathouse located that you use most often?

(To identify sweathouse locations)

36. How is the sweathouse constructed that you use most often?

(To identify natural resources used in the physical construction of sweathouse)

37. What is the source of water you use during your sweats?

(To identify the source of surface or groundwater used for steam, washing, and drinking)

38. Is there anything added to the water you use during a sweat?
(To identify additives used, such as rose water, etc.)

39. Could you imagine building and using a sweathouse on the Hanford Site?
(To ensure future uses of the Hanford Site are considered during cleanup)

40. Is there anything else you can describe about sweating, including past experiences, changes you've seen over time, or future hopes or concerns?
(To describe sweating practices)

8. MATERIALS PREPARATION

These next few questions are about making items from natural resources.

41. If you make anything by hand from natural materials, please tell me what items you make, such as baskets, blankets, clothing, accessories, drums or tools. For each item, please describe what it is made from, what it is used for, how often you make it, and how much time it takes you to make it.

(To identify types of materials made from natural resources and contact frequency and duration with the materials)

ITEM	INFORMATION
Baskets	
Blankets	
Moccasins	
Leggings	
Vests	
Woven hats	
Necklaces	

ITEM	INFORMATION
Drums	
Tools	
Other	

42. How many years in your lifetime will you be making these items?
(To quantify average lifetime spent making materials)

43. What age groups and genders generally make these items?
(To identify which genders and ages may prepare materials)

44. Do you think the materials that you use from the area are unclean, and if so, has this changed your attitude or habits towards making item from materials from the area?
(To identify the existing perception about contamination and its effect on practices)

45. How has Hanford changed your materials making practices, and what should be done about it?
(To ensure future uses of the Hanford Site are considered during cleanup)

7. CULTURAL ACTIVITIES

Please tell me if you participate in any of the following cultural activities. For each activity, I will ask you where and when it occurs, and how long it generally lasts.

(To identify what cultural activities are practiced)

CEREMONY	(√) IF YES	PURPOSE	WHERE	WHEN	HOW LONG
First food feasts (salmon, root, and berry)					
Washat service					
Other religious services					
Powwows					
Trade fairs					
Rodeos					
Holidays					
Name giving celebration					
First hunt celebration					
Medicine dances					
Burials					
Memorials					
Treaty days					
War dance / other					

- 46. Who participates in these cultural activities?**
(To identify what ages and genders participate in ceremonies)
- 47. Would you imagine practicing these cultural activities on the Hanford Site?**
(To ensure future uses of the Hanford Site are considered during cleanup)
- 48. Do you have anything else to share about cultural activities, including past experiences, changes you've seen over time, or future hopes or concerns?**
(To describe cultural activities)

49. Is there anything else you can describe about your typical day, week, or year in your life that I haven't covered today?

(To identify daily, seasonal, and unique activities)

50. Do you expect these lifestyle activities to change in the future and if so, particularly as related to a clean Hanford Site?

(To estimate future activities based on current ones)

9. CONCLUSION

This concludes our survey today. Thank you very much for sharing your time and information. Your participation will significantly contribute to documenting and protecting the important activities that make up the Yakama lifestyle.

I will send you a draft copy of my notes from today so that you can make any edits to my interpretation of your responses, if you choose. We will then send you a final copy of the notes for your record (and, if you request, a copy of the recording). Again, the confidential information will remain in the custody of the office of the Yakama Nation ER/WM. A summary of the combined results from all surveys will be compiled, provided to the DOE to help the Hanford cleanup process, and eventually reported in the Yakama Nation Review.

Lastly, I would like to offer you compensation in various forms: a blanket, jewelry, gift card, or cash. What would you prefer?

After the interview:

- *Be sure they have copy of Disclaimer Form*
- *Give them \$100 check and have them sign check receipt*
- *Verify address to send them a copy of draft notes with return/stamped envelope*

ADDITIONAL NOTES

Interviewee Name:

Table 1. Fish Eaten, Used, and Fished

English Name	Sahaptin Name**	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You fish?	When fish?	Where fish?
		present, past	# times per wk, mo, yr	# oz at each serving	fillet only, fillet w/skin, head, organs, eggs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories	(<input checked="" type="checkbox"/>) if Yes	months or seasons	Hanford Reach?
Chinook (King) salmon *	(Not shown here)	Now Childhood Parents								
Blueback (Sockeye, Red) salmon *	(Not shown here)	Now Childhood Parents								
Silver (Coho) salmon *	(Not shown here)	Now Childhood Parents								
Dog (Chum) salmon	(Not shown here)	Now Childhood Parents								
Pink (humpy) salmon	(Not shown here)	Now Childhood Parents								
Steelhead/Rainbow trout *	(Not shown here)	Now Childhood Parents								
Bull trout	(Not shown here)	Now Childhood Parents								

Interviewee Name:

Table 1. Fish Eaten, Used, and Fished

English Name	Sahaptin Name**	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You fish?	When fish?	Where fish?
		present, past	# times per wk, mo, yr	# oz at each serving	fillet only, fillet w/skin, head, organs, eggs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories	(^) if Yes	months or seasons	Hanford Reach?
Cutthroat trout *	(Not shown here)	Now Childhood Parents								
Bass *	(Not shown here)	Now Childhood Parents								
Carp *	(Not shown here)	Now Childhood Parents								
Catfish *	(Not shown here)	Now Childhood Parents								
Chisel-mouth *	(Not shown here)	Now Childhood Parents								
Chub / peamouth *	(Not shown here)	Now Childhood Parents								
Crappie *	(Not shown here)	Now Childhood Parents								

Table 1. Fish Eaten, Used, and Fished

Interviewee Name:

English Name	Sahaptin Name**	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You fish?	When fish?	Where fish?
		present, past	# times per wk, mo, yr	# oz at each serving	fillet only, fillet w/skin, head, organs, eggs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories	(✓) if Yes	months or seasons	Hanford Reach?
Dace *	(Not shown here)	Now Childhood Parents								
Lamprey (eel) *	(Not shown here)	Now Childhood Parents								
Perch *	(Not shown here)	Now Childhood Parents								
Sculpin *	(Not shown here)	Now Childhood Parents								
Shiner *	(Not shown here)	Now Childhood Parents								
Smelt	(Not shown here)	Now Childhood Parents								
Squawfish (minnow) *	(Not shown here)	Now Childhood Parents								

Interviewee Name: _____

Table 1. Fish Eaten, Used, and Fished

English Name	Sahaptin Name**	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You fish?	When fish?	Where fish?
		present, past	# times per wk, mo, yr	# oz at each serving	fillet only, fillet w/skin, head, organs, eggs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories	(✓) if Yes	months or seasons	Hanford Reach?
Sturgeon *	(Not shown here)	Now Childhood Parents								
Sucker *	(Not shown here)	Now Childhood Parents								
Walleye *	(Not shown here)	Now Childhood Parents								
Whitefish *	(Not shown here)	Now Childhood Parents								
Crayfish	(Not shown here)	Now Childhood Parents								
Clams / mussels	(Not shown here)	Now Childhood Parents								
Other?		Now Childhood Parents								

Notes:
 * Confirmed in Hanford Reach, Columbia River (Gray and Dauble, 1977).
 ** Sahaptin names removed to preserve confidentiality.

Interviewee Name:

Table 2. Meat Eaten, Used, and Hunted

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You hunt?	When hunt?	Where hunt?
		present, past	# of times per wk, mo, or yr	# oz at each serving	meat only, meat w/skin, head, organs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	() if Yes	months or seasons	Hanford?
Elk	(Not shown here)	Now Childhood Parents								
Deer	(Not shown here)	Now Childhood Parents								
Antelope	(Not shown here)	Now Childhood Parents								
Bighorn Sheep	(Not shown here)	Now Childhood Parents								
Mountain Goat	(Not shown here)	Now Childhood Parents								
Badger	(Not shown here)	Now Childhood Parents								
Beaver	(Not shown here)	Now Childhood Parents								

Interviewee Name:

Table 2. Meat Eaten, Used, and Hunted

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You hunt?	When hunt?	Where hunt?
		present, past	# of times per wk, mo., or yr	# oz at each serving	meat only, meat w/skin, head, organs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(N) if Yes	months or seasons	Hanford?
Otter (river)	(Not shown here)	Now Childhood Parents								
Jackrabbit	(Not shown here)	Now Childhood Parents								
Rain-maker Rabbit	(Not shown here)	Now Childhood Parents								
Cottontail Rabbit	(Not shown here)	Now Childhood Parents								
Raccoon	(Not shown here)	Now Childhood Parents								
Chipmunk	(Not shown here)	Now Childhood Parents								
Porcupine	(Not shown here)	Now Childhood Parents								

Interviewee Name:

Table 2. Meat Eaten, Used, and Hunted

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You hunt?	When hunt?	Where hunt?
Gopher (Townsend's Ground Squirrel, Prairie dog)	(Not shown here)	present, past Now Childhood Parents	# of times per wk, mo, or yr	# oz at each serving	meat only, meat w/skin, head, organs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(\) if Yes	months or seasons	Hanford?
Marmot, yellow-bellied (groundhog)	(Not shown here)	Now Childhood Parents								
Gray or tree squirrel	(Not shown here)	Now Childhood Parents								
Beldings ground squirrel	(Not shown here)	Now Childhood Parents								
Golden mantled squirrel	(Not shown here)	Now Childhood Parents								
Larger ground squirrel	(Not shown here)	Now Childhood Parents								
Weasel	(Not shown here)	Now Childhood Parents								

Interviewee Name: _____

Table 2. Meat Eaten, Used, and Hunted

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You hunt?	When hunt?	Where hunt?
		present, past	# of times per wk, mo, or yr	# oz at each serving	meat only, meat w/skin, head, organs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(<input type="checkbox"/>) if Yes	months or seasons	Hanford?
Bobcat	(Not shown here)	Now								
		Childhood								
		Parents								
Cougar	(Not shown here)	Now								
		Childhood								
		Parents								
Fox	(Not shown here)	Now								
		Childhood								
		Parents								
Duck	(Not shown here)	Now								
		Childhood								
		Parents								
Pheasant	(Not shown here)	Now								
		Childhood								
		Parents								
Sage Grouse/hen	(Not shown here)	Now								
		Childhood								
		Parents								
Wild turkey	(Not shown here)	Now								
		Childhood								
		Parents								

Interviewee Name:

Table 2. Meat Eaten, Used, and Hunted

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You hunt?	When hunt?	Where hunt?
Beef / steak	(Not shown here)	present, past Now Childhood Parents	# of times per wk, mo, or yr	# oz at each serving	meat only, meat w/skin, head, organs	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(✓) if Yes	months or seasons	Hanford?
Chicken & turkey	(Not shown here)	Now Childhood Parents								
Other?		Now Childhood Parents								

Notes:

* Sahaptin names removed to preserve confidentiality.

Table 3. Plants Eaten and Gathered

Interviewee Name: _____

English Name	Sahaptin Name*	Time period	How often eat? # of times per wk, mo, or yr	How much eat? # oz at each serving	Which parts eat?	How prepare? raw, dry, can, smoke, roast, bake, stew, fry	Other uses? tools, accessories, clothing, shelter	You gather? (✓) if Yes	When gather? months or seasons	Where gather? Hanford?
Indian celery (Gray's desert parsley, a Lomatium)	(Not shown here)	present, past Now Childhood Parents			root, stalk, leaf, flower, fruit			(✓) if Yes	months or seasons	Hanford?
Biscuitroot (Lomatium)	(Not shown here)	Now Childhood Parents								
Bitterroot	(Not shown here)	Now Childhood Parents								
Arrowleaf balsamroot "sunflower"	(Not shown here)	Now Childhood Parents								
Carey's balsamroot	(Not shown here)	Now Childhood Parents								
Camas	(Not shown here)	Now Childhood Parents								
Indian carrot (Gairdner's yampah)	(Not shown here)	Now Childhood Parents								

Table 3. Plants Eaten and Gathered

Interviewee Name: _____

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr.	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(^) if Yes	months or seasons	Hanford?
Indian potato	(Not shown here)	Now Childhood Parents								
Mariposa lily	(Not shown here)	Now Childhood Parents								
Piper's desert parsley	(Not shown here)	Now Childhood Parents								
Choke cherry	(Not shown here)	Now Childhood Parents								
Huckleberry	(Not shown here)	Now Childhood Parents								
Blueberry	(Not shown here)	Now Childhood Parents								
Blue elderberry	(Not shown here)	Now Childhood Parents								

Interviewee Name:

Table 3. Plants Eaten and Gathered

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(\) if Yes	months or seasons	Hanford?
Goose berry	(Not shown here)	Now Childhood Parents								
Golden currant	(Not shown here)	Now Childhood Parents								
Lichen	(Not shown here)	Now Childhood Parents								
Cedar	(Not shown here)	Now Childhood Parents								
Juniper	(Not shown here)	Now Childhood Parents								
Indian hemp	(Not shown here)	Now Childhood Parents								
Bitter white dogwood	(Not shown here)	Now Childhood Parents								

Interviewee Name: _____

Table 3. Plants Eaten and Gathered

English Name	Sahaptin Name*	Time period	How often eat? # of times per wk, mo, or yr	How much eat? # oz at each serving	Which parts eat?	How prepare? raw, dry, can, smoke, roast, bake, stew, fry	Other uses? tools, accessories, clothing, shelter	You gather? (^) if Yes	When gather? months or seasons	Where gather? Hanford?
Bulrush (tule)	(Not shown here)	Now Childhood Parents			root, stalk, leaf, flower, fruit					
Greasewood	(Not shown here)	Now Childhood Parents								
Rose bush	(Not shown here)	Now Childhood Parents								
Yellowbell	(Not shown here)	Now Childhood Parents								
Western serviceberry	(Not shown here)	Now Childhood Parents								
Willow	(Not shown here)	Now Childhood Parents								
Garden plants - fruits & vegetables	(Not shown here)	Now Childhood Parents								

Interviewee Name: _____

Table 3. Plants Eaten and Gathered

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(\) if Yes	months or seasons	Hanford?
Apple	(Not shown here)	Now								
		Childhood								
		Parents								
Asparagus	(Not shown here)	Now								
		Childhood								
		Parents								
Black hawthorn	(Not shown here)	Now								
		Childhood								
		Parents								
Bracken fern	(Not shown here)	Now								
		Childhood								
		Parents								
Brodiaea	(Not shown here)	Now								
		Childhood								
		Parents								
Burdock	(Not shown here)	Now								
		Childhood								
		Parents								

Table 3. Plants Eaten and Gathered

Interviewee Name: _____

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(N) if Yes	months or seasons	Hanford?
Cattail	(Not shown here)	Now Childhood Parents								
Cherries, peaches, etc.	(Not shown here)	Now Childhood Parents								
Dock, sorrel	(Not shown here)	Now Childhood Parents								
Evening primrose	(Not shown here)	Now Childhood Parents								
False mountain dandelion	(Not shown here)	Now Childhood Parents								
Goldenrod	(Not shown here)	Now Childhood Parents								
Himalayan blackberry	(Not shown here)	Now Childhood Parents								

Interviewee Name: _____

Table 3. Plants Eaten and Gathered

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(N) if Yes	months or seasons	Hanford?
Indian paintbrush	(Not shown here)	Now Childhood Parents								
Licorice	(Not shown here)	Now Childhood Parents								
Miner's lettuce	(Not shown here)	Now Childhood Parents								
Oat	(Not shown here)	Now Childhood Parents								
Onion	(Not shown here)	Now Childhood Parents								
Red columbine	(Not shown here)	Now Childhood Parents								
Russian thistle	(Not shown here)	Now Childhood Parents								

Interviewee Name:

Table 3. Plants Eaten and Gathered

English Name	Sahaptin Name*	Time period	How often eat?	How much eat?	Which parts eat?	How prepare?	Other uses?	You gather?	When gather?	Where gather?
		present, past	# of times per wk, mo, or yr	# oz at each serving	root, stalk, leaf, flower, fruit	raw, dry, can, smoke, roast, bake, stew, fry	tools, accessories, clothing, shelter	(\N) if Yes	months or seasons	Hanford?
Silver maple	(Not shown here)	Now Childhood Parents								
Smooth sumac	(Not shown here)	Now Childhood Parents								
Stinging nettle	(Not shown here)	Now Childhood Parents								
Thistle	(Not shown here)	Now Childhood Parents								
Wheat	(Not shown here)	Now Childhood Parents								
White mulberry	(Not shown here)	Now Childhood Parents								

Notes:

* Sahaptin names removed to preserve confidentiality.

Interviewee Name: _____

Table 4. Drinking Water and Milk

Liquid	Time period	How often drink? # of times per wk, mo, or yr	How much drink? # oz at each serving	Other uses? wash, bathe	Sources? city water, groundwater wells, rivers/ponds
Water	present, past				
	Now				
	Childhood Parents				
Milk	Now				
	Childhood				
	Parents				

RIDOLFI Inc.

Yakama Nation Exposure Scenario
for Hanford Site Risk Assessment
September 2007

APPENDIX D
Photographs

INDEX

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Golden Currant	30
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Indian Carrot	32
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Cedar	36
Greasewood	37

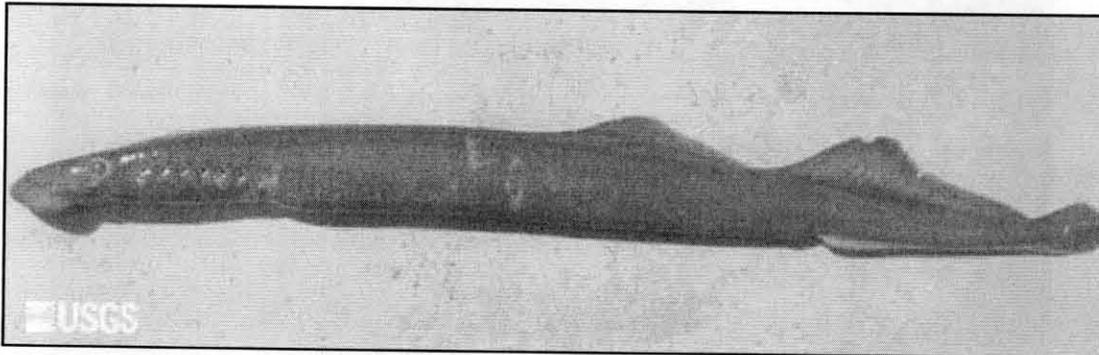


Photo 1. Lamprey (eel)

<http://wfrf.usgs.gov/research/fish%20behavior/images/pcladultss.jpg>

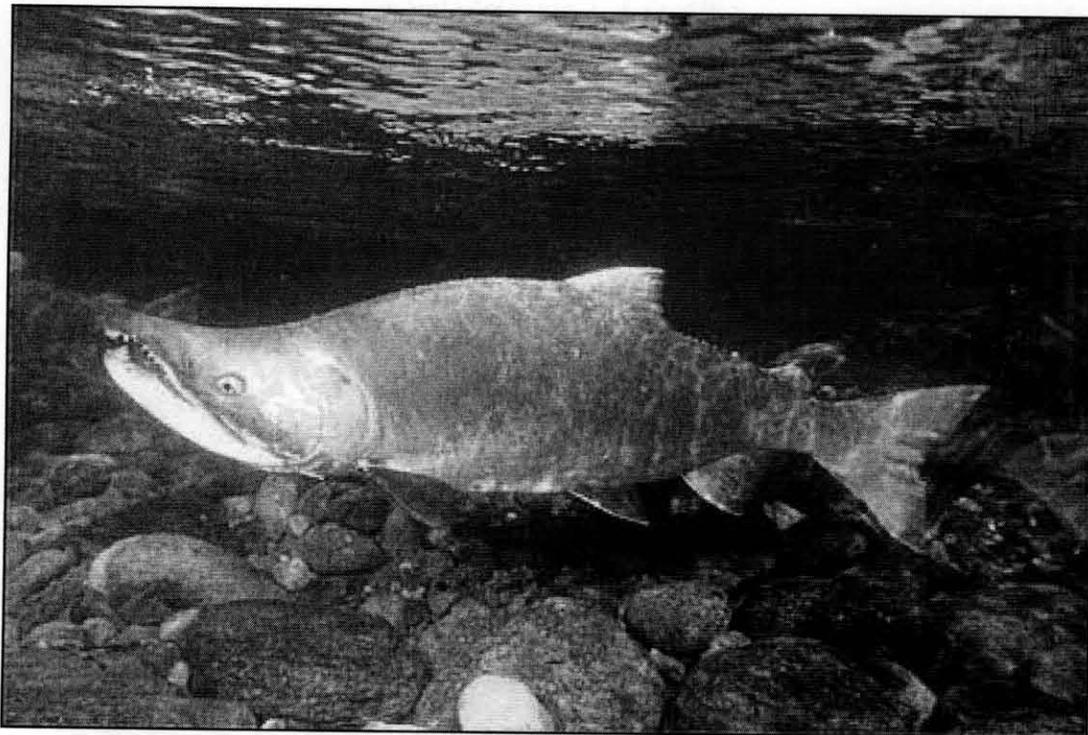


Photo 2. Blueback (Sockeye) Salmon

<http://cache.eb.com/eb/image?id=65380&rendTypeID=4>

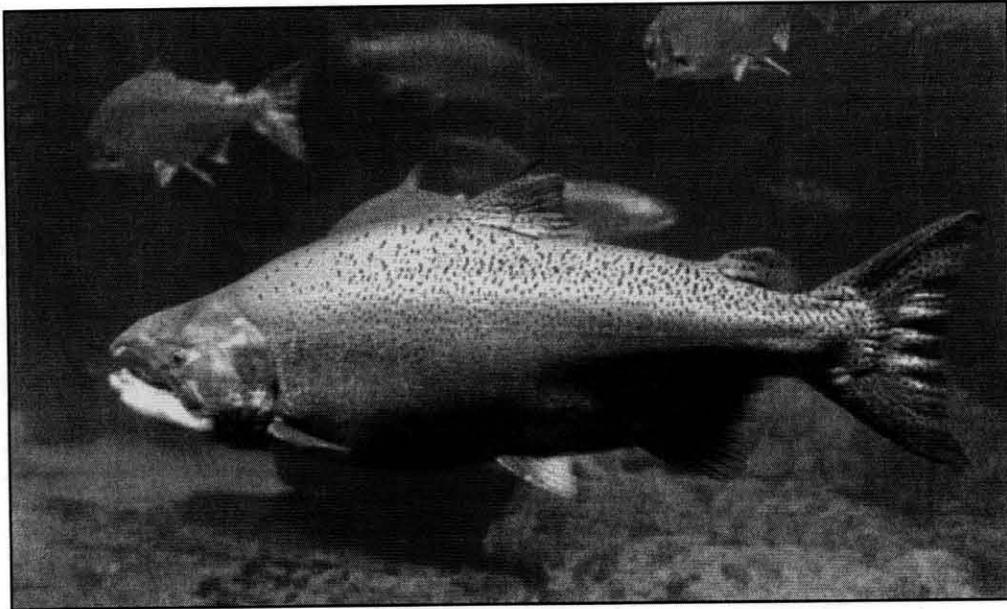


Photo 3. Chinook Salmon

http://wildernessclassroom.com/superior/Chinook_Salmon.gif

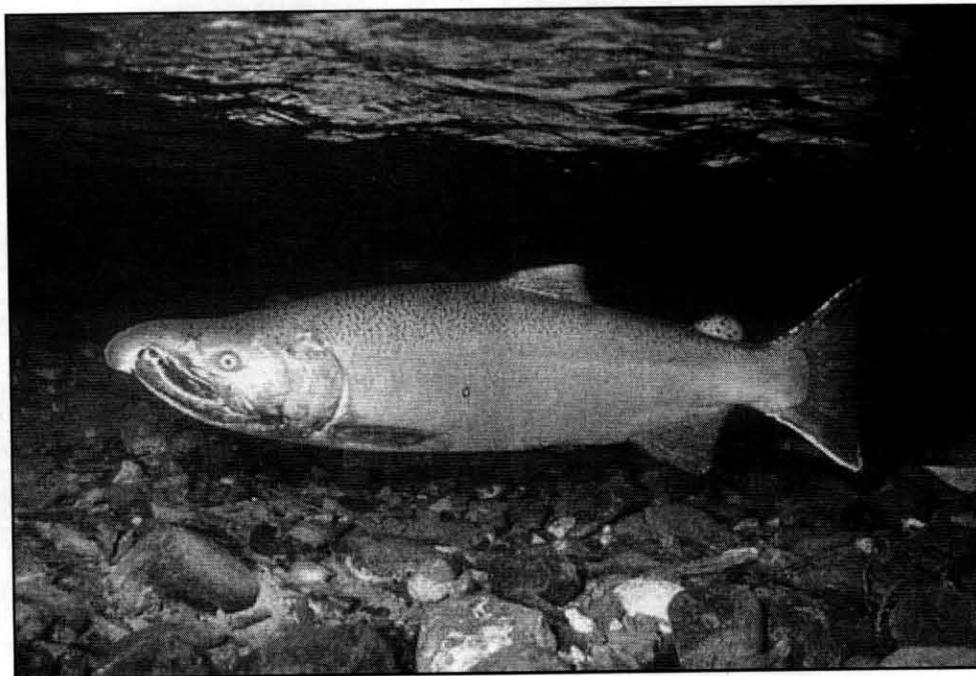


Photo 4. Silver (Coho) Salmon

<http://www.nmfs.noaa.gov/pr/species/fish/cohosalmon.htm>



Photo 5. Sculpin

<http://www.divephotos.com/images/65Sailfin.jpg>

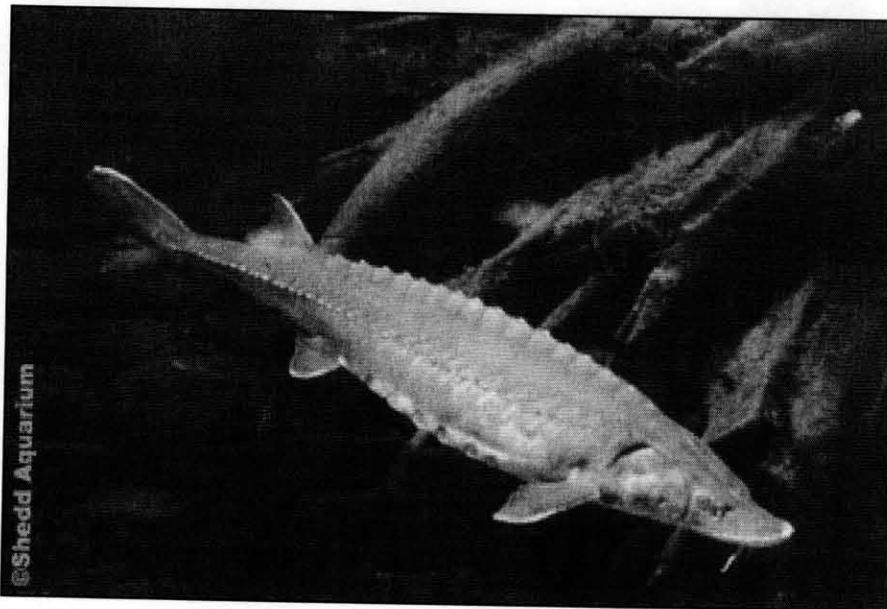


Photo 6. Sturgeon

<http://wildernessclassroom.com/superior/LakeSturgeon.gif>

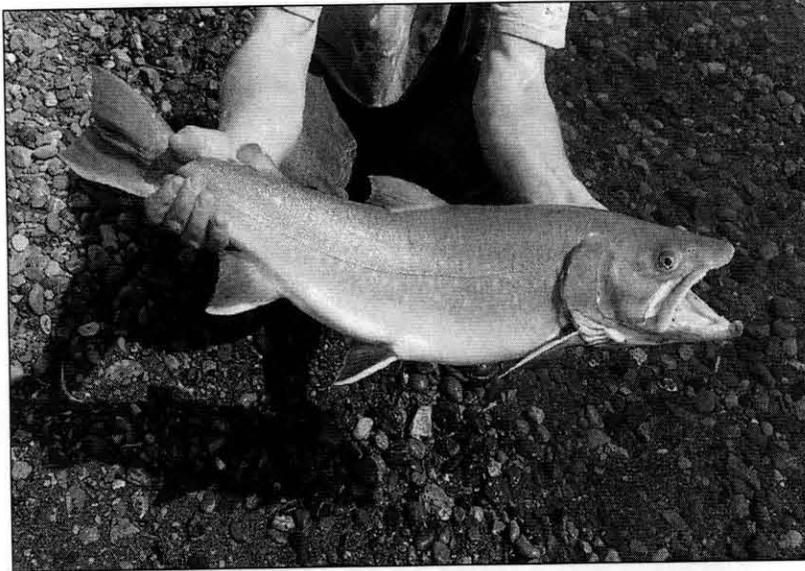


Photo 7. Bull Trout

<http://www.skeenaguidesassociation.ca/photo-gallery-page/web-gallery-mar-14-2006/web-Ruud-2-2005-May-135.jpg>



Photo 8. Cutthroat Trout

http://www.fws.gov/columbiariver/programs/native_trout/adultcct.JPG

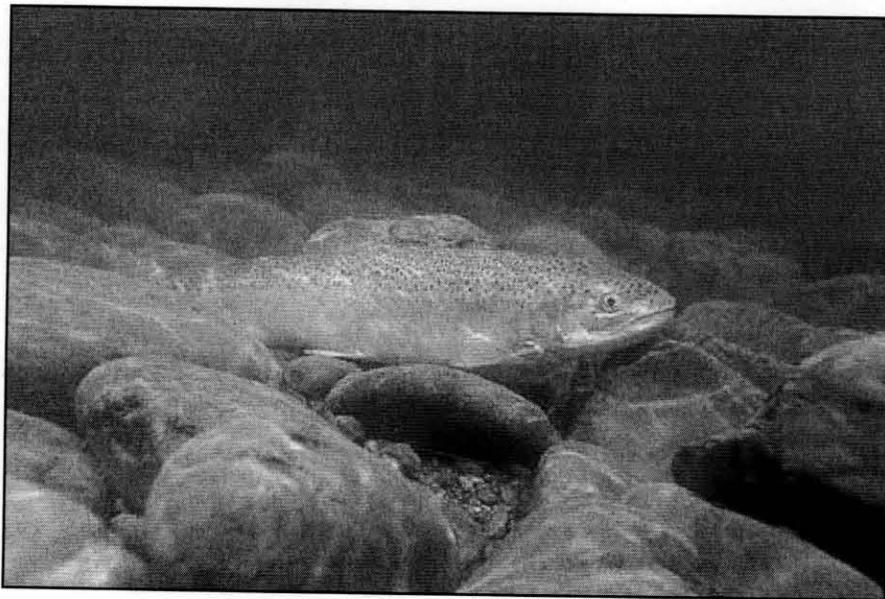


Photo 9. Steelhead Trout

http://www.nwf.org/nationalwildlife/images/062003/rainbow_trout.jpg



Photo 10. Mule Deer

<http://picturethis.pnl.gov/picturet.nsf/by+id/SMAA-4CGU3T>

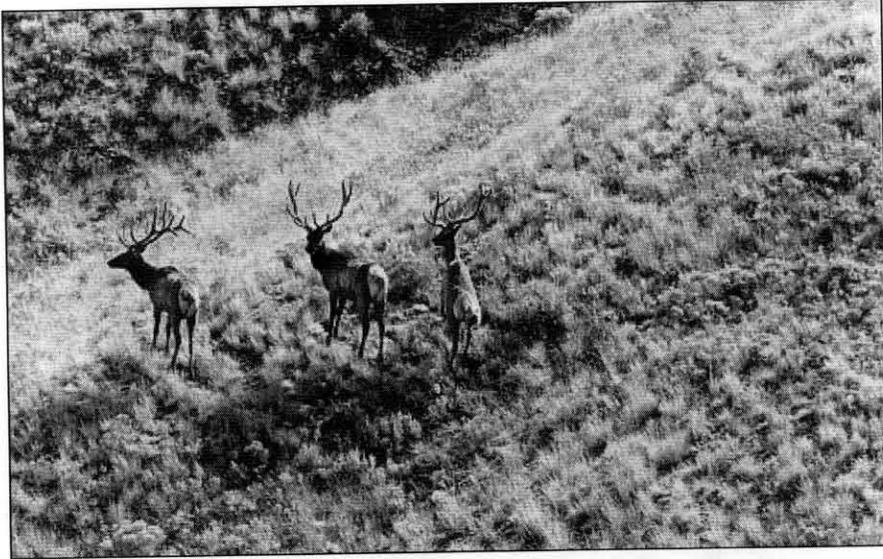


Photo 11. Elk

<http://picturethis.pnl.gov/picturet.nsf/by+id/PNLM-3U2T4V>

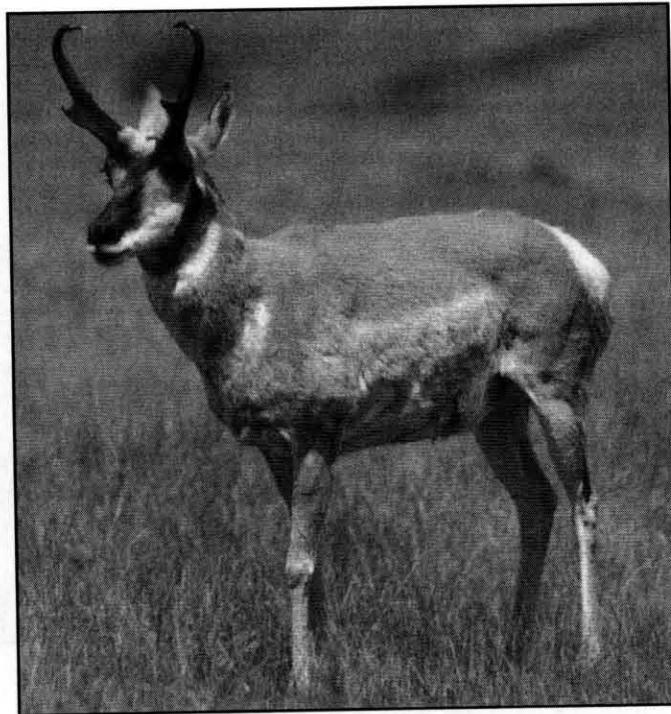


Photo 12. Antelope (Pronghorn)

http://www.fws.gov/huronwetlands/Photos/Wildlife/images/Pronghorn%20Antelope_jpg.jpg

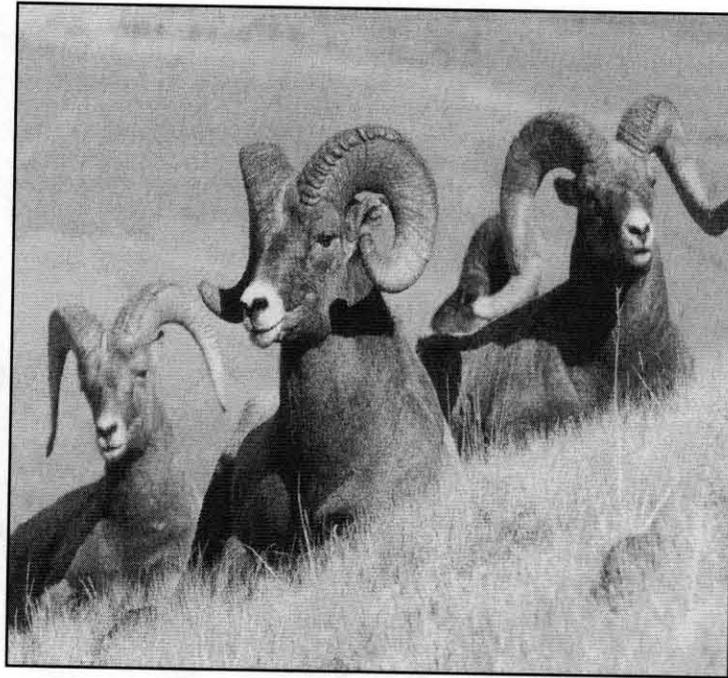


Photo 13. Bighorn Sheep

<http://www.nrel.colostate.edu/projects/bighorn/bighorn-sheep.jpg>

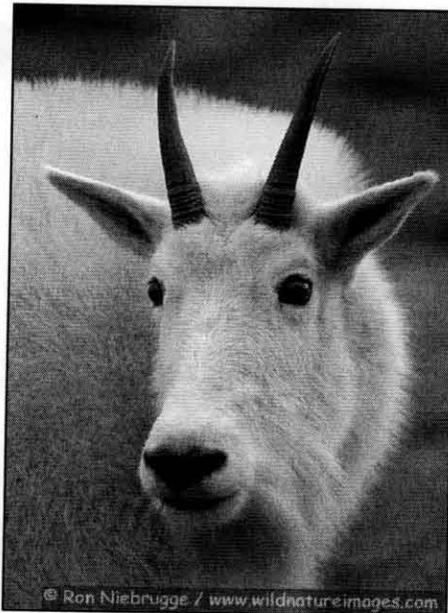


Photo 14. Mountain Goat

http://www.wildnatureimages.com/search/index.php?pageId=100&id=11319&start=0&lightbox_page=&search_mode=search



Photo 15. Beaver

http://www.kdwp.state.ks.us/var/news/storage/images/hunting/fur_harvest/furbearer_gallery/beaver_castor_canadensis/11744-2-eng-US/beaver_castor_canadensis_imagelarge.jpg



Photo 16. River Otter

http://www.lilythere.com/Copy_of_Otter_river_photo.jpg



Photo 17. Rabbit (cottontail)

<http://picturethis.pnl.gov/picturet.nsf/by+id/SMAA-4CGUYC>



Photo 18. Townsend Ground Squirrel

<http://www.washington.edu/burkemuseum/collections/mammalogy/mamwash/Images/tgs.jpg>



Photo 19. Blue Grouse

<http://www.nhptv.org/natureworks/graphics/bluegrouse.jpg>

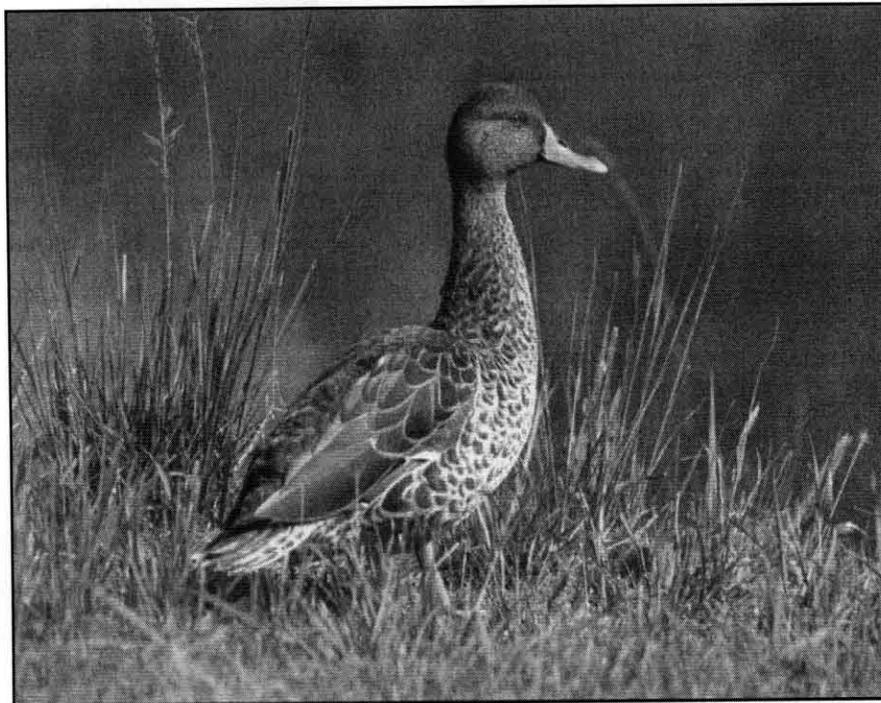


Photo 20. Duck

<http://www.exzoobrance.com/virtual%20zoo/they%20fly/duck/Yellowbilled%20Duck%20268012.jpg>



Photo 21. Pheasant

http://sdakotabirds.com/species/ring_necked_pheasant_info.htm



Photo 22. Wild Turkey

<http://www.bentler.us/eastern-washington/animals/birds/wild-turkeys.aspx>

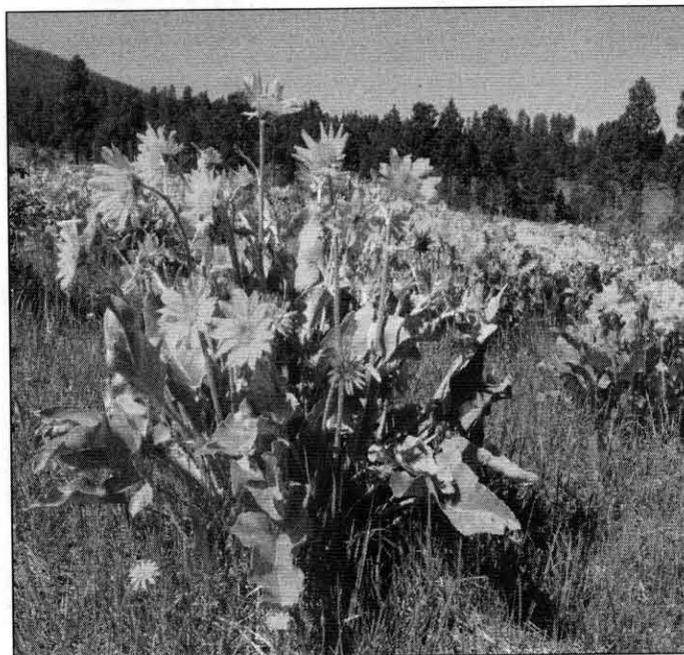


Photo 23. Arrowleaf Balsamroot

http://www.fs.fed.us/wildflowers/regions/intermountain/Greendale/images/arrowleaf_balsamroot_lg.jpg



Photo 24. Carey's Balsamroot

<http://biology.burke.washington.edu/herbarium/imagecollection.php?ID=1034>

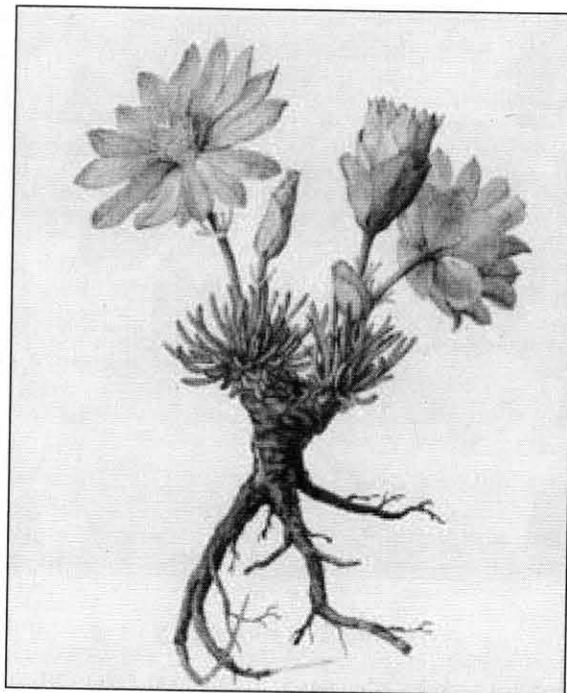


Photo 25. Bitterroot

http://www.nationalgeographic.com/lewisandclark/record_species_260_18_4.html



Photo 26. Blue Elderberry

http://www.boskydellnatives.com/graphics/blue_elder_skinny.jpg



Photo 27. Blueberry

http://calphotos.berkeley.edu/imgs/512x768/0000_0000/1203/0185.jpeg



Photo 28. Camas

<http://www.nps.gov/lecl/naturescience/images/camas-combo-pic.jpg>



Photo 29. Choke Cherry

http://www.statestreetgallery.com/exhibits/Botanical_Art/images/rhonda_nass-chokecherry.jpg



Photo 30. Golden Currant

<http://www.cwnp.org/lgphoto/rlg/ribesaureum.jpg>



Photo 31. Huckleberry

<http://www.mnh.si.edu/lewisandclark/images/rah03399.jpg>



Photo 32. Indian Carrot (Gairdner's Yampah)

<http://food.oregonstate.edu/images/native/carrot.jpg>



Photo 33. Indian Celery

<http://k43.pbase.com/g3/14/98514/2/57483782.OlyD540010.jpg>



Photo 34. Bitter White Dogwood

<http://www.bentler.us/eastern-washington/plants/red-osier-dogwood3.jpg>

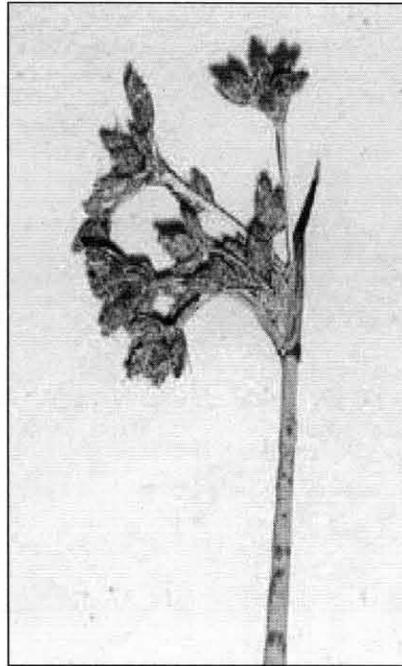


Photo 35. Bulrush (tule)

http://www.outsideeducators.com/Images/tule_mat/tule_seeds.jpg



Photo 36. Cedar (part of trunk)

<http://www.loc.gov/exhibits/lewisandclark/images/ree0097s.jpg>



Photo 37. Greasewood

<http://www.fs.fed.us/database/feis/plants/shrub/sarver/habitat.jpg>