New Mexico
Environmental Law Center
TM

May 1, 2014

Mr. David Cobrain, Program Manager
Hazardous Waste Bureau
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg. 1
By email to: Dave.Cobrain@state.nm.us

RE: CCNS, Tewa Women United and H.O.P.E. - Second Set of Comments on Los Alamos National Laboratory (LANL) TA-016-399 Draft Closure Plan

Dear Mr. Cobrain:

Below are the second set of comments following the of comments and hearing requests filed December 13, 2013, on the above referenced closure plan as required under the federal Resource Conservation and Recovery Act (RCRA), implementing regulations contained in Title 40 of the Code of Federal Regulations, and the New Mexico Hazardous Waste Act (NMHWA), NMSA 1978 Section 74-4-1 et seq., which incorporates RCRA by reference and under regulations promulgated as 20.4.1.600 NMAC. I incorporate herein by reference the statements of the nature and scope of interest of the commenters, Concerned Citizens for Nuclear Safety (CCNS), Tewa Women United (TWU) and Honor Our Pueblo Existence (H.O.P.E.), as well as the other requisite information contained in the first set of comments and hearing requests, and set forth as follows:

SECOND SET OF COMMENTS OF CCNS, TWU AND H.O.P.E

1. The November 19, 2013 draft Closure Plan allows the Permittees to leave the concrete pad, fence and electrical box in place. TA-16-399 was used for burning hazardous waste on the bare ground (1951 to 1980) before the concrete pad was installed. The Permittees have been unable to provide any documentation about the volumes and type of waste burned at the unit for the period 1951 to 1980. Without drilling through the concrete pad and taking samples beneath it, there is no way to determine if there is soil contamination below the concrete pad. NMED

has not required additional sampling below the pad. Soil contamination below the concrete pad could provide a pathway for RCRA pollutants to migrate into the vadose zone and into the regional aquifer.

CCNS, TWU and H.O.P.E. state that as the investigation requirements in the draft Closure Plan are an incomplete and/or inadequate basis for NMED allowing waste to be left in place. By law, in order to leave waste in place, the Permittees are required, pursuant to 40 CFR 265.117, et seq., to submit a Post-Closure Plan. Moreover, NMED has not required LANL to drill through the concrete pad to demonstrate ascertain whether there is contamination below it--even though NMED has required such an investigation in previous open burn/open detonation closure plans. *See*, *e.g.*, LA-UR-99-6216, Closure Plan for the TA-16-394 Burn Tray, Rev. 1 at 13, 15 (February 7, 2001) ("samples will be collected from locations immediately adjacent to, and beneath, the removed burn tray structure" and "[s]ampling locations beneath the removed structure" -- although removal of the structure was part of the closure plan for 16-394, for 16-399, where the structure is to remain in place, there is all the more reason for requiring sampling by boring holes into the concrete to allow augering samples beneath the pad).

Further, the neighboring TA-16-388 Flash Pad will continue operations and, as a result, have a continuing impact upon the soils at TA-16-399 through the air (and perhaps some other) pathway. It is neither reasonable nor in accordance with law and regulations under RCRA and the New Mexico Hazardous Waste Act for NMED to allow the Permittees to leave contamination underneath the concrete pad without additional investigation or--in the event NMED allows the concrete pad, fence and electrical box to be left in place at site closure--submission of a Post-Closure Plan *at the same time* as the Closure Plan.

Early in the decade of 2001, during their initial involvement in the open burning permit for these sites, TWU and CCNS representatives recall seeing staining on the TA-16-399 concrete pad when they toured the TA-16 Burn Grounds. Staining indicates that there may be substances in the ground below the concrete pad, as the pad was not one continuous piece. Moreover, as the same site and location was used for burning on bare ground prior to installing the concrete pad, there is a reasonable basis to infer that contamination is likely under the concrete pad.

2. CCNS, TWU and H.O.P.E. agree with the Permittees' (LA-UR 13-29409) December 19, 2013 comments on the draft Closure Plan, except:

A. Comment 3 and Comment 30. List of Figures and Figure 5. Figure 5 should remain in the Closure Plan, as it shows the watershed where the TA-16-399 Burn Tray is located. It also shows the Individual Storm Water Permit sampling point for CDV-SMA-2.5, of which Solid Waste Management Unit 16-010(d) (the TA-16-399 Burn Tray) is a part.

B. Comment 17 and Comment 21. Sec. 5.5 and Sec. 6.1.1. More than one high explosives (HE) spot test should be required for the burn tray, metal cover, tracks and rims. Requiring multiple samples would be consistent with past practices cited above and below.

C. Comment 17. Sec. 5.5. Do the fire bricks need to have HE spot tests? How about the sand bed? *See* Sec. 2.1. The sand bed is not mentioned. What is the disposition pathway for the sand bed? Testing of fire bricks, sand and gravel adjacent to and below the site, and the surface as well as below the concrete was done in the case of the pre-closure (site characterization) and closure activities associated with TA-16-394 cited above at Comment 1. The same requirements should apply to the TA-16-399 Burn Tray.

D. Comment 27. Table 2. Diesel Range Organics (DROs) and Nitrates and their EPA HazWaste Numbers should be listed in separate rows. There are no EPA HazWaste Numbers for the "Other constituents of concern. " Putting all three categories in one row is likely to confuse persons reviewing the requirements.

3. The following comments apply to NMED's draft Response to Comments on this draft permit:

A. Response 32. Figure 5 in the draft Closure Plan is helpful in that it shows the watershed area. It should not be removed and should appear in the plan(s).

B. Response 34. Please provide cites the document(s) where NMED is requiring surface and ground water sampling activities for TA-16 Burn Grounds (CDV-SMA-2.5) to include dioxins/furans in the analytical suite.

C. Response 35. It is not correct to state that, "additional surface and ground water sampling would be duplicative of work already performed continuously under the

[Individual Permit] IP." There is no direct investigation of the ground water below the TA-16-399 site. The Permittees are unable to document the waste burned on the bare ground from 1951 to 1980. NMED must require groundwater investigation at the TA-16-399 site, and specifically within the site perimeter.

In addition to testing groundwater, there is a need for extensive soil testing. A recent study which tested soils in a garden plot in Española, revealed that the soils contain RDX, perchlorates and Chromium, including Chromium VI (Cr-VI). The researcher attributed these sources to LANL's emissions entering the water. *See* M. Drewniany, "Red Dust: A Soil Scientist's Journey Through the Political and Environmental Chemistry of Northern New Mexico" at 126-141, 148-153 (Hampshire College, Amherst, MA: May 3, 2013) (Drewniany found these substances in soil samples and hypothesized deposition from watering; absent water testing it is possible the source of contamination was airborne material from LANL open burning and open detonations). A PDF copy of the thesis is provided as Appendix A to these comments. *See also*, M. Kaltofen, P.E., T. Carpenter, "Citizen Environmental Monitoring and Technical Assessment: Analysis of Radiochemical Contaminants in Los Alamos Region Biota and Environmental Materials At The Perimeter of the Los Alamos National Laboratory" at 14-17 (June 2007) (report showed that airborne deposition of LANL materials was taking place and detectable off-site in dust, soil and sediments). A PDF copy of this report is provided as Appendix B to these comments.

Under the Individual Permit, the surface water monitoring point is CDV-SMA-2.5. NMED states that it does not want to duplicate sampling. However, the Permittees, under the Individual Permit, discontinued CDV-SMA-2.5 sampling. In the case of surface water, EPA is the regulator and may approve changes without notifying NMED. For that reason, NMED *must* require surface water sampling under the draft Closure Plan, <u>and</u> any Post-Closure Plan. , The following excerpts from the *Storm Water Individual Permit Annual Report, Reporting Period: January 1 – December 31, 2013, NPDES Permit No. NM0030759,* LA-UR-14-20839, March 2014, EP2014-0055 demonstrate that this assertion is correct:

(i) Section 8.1.1 Baseline Monitoring Extended - "Samples from CDV-SMA-2.5 collected in 2012 indicated no TAL exceedances, but the semivolatile analyses did

not meet minimally acceptable quality criteria so the results were not accepted for confirmation monitoring. During 2013, confirmation monitoring sample was collected and analyzed. No TAL exceedances were observed."

In relation to the reported sampling, there is another significant problem with the Permittee's programs for collecting and analyzing the samples: the lack of an error rate analysis. In order to have meaningful data, NMED must require the Permittees to conduct an error rate analysis of their sampling program. The results will provide a window on the number of problems LANL encounters in fulfilling the compliance requirements in its operating permits. This would demonstrate that these environmental safety sampling programs were consistently conducted within a reasonably conservative range of errors. That is important information to have given that the DOE report on the causes of the recent fire and radiation release at the DOE Waste Isolation Pilot Plant (WIPP) cites, a prime factor in the accident, *erosion of key safety programs, including the sampling program*. http://www.wipp.energy.gov/pr/2014/Radiological_Event_Report.pdf

(ii) Section 9.2 2013 Compliance Status Changes - "The Laboratory has discontinued monitoring at 10 SMAs based on the above criteria: 2M-SMA-2.5, A-SMA-3.5, ACID-SMA-1.05, CDV-SMA-1.2, **CDV-SMA-2.5**, M-SMA-13, PJ-SMA-14.8, PJ-SMA-16, R-SMA-2.3, and W-SMA-9.05. Inspection of the Sites and installed controls will continue in accordance with Part I.G of the Permit, and all control measures will be maintained in effective operating condition as required by Part I.B.2 and E.5(c)." [Boldface and underline emphasis added.]

NMED states that it does not want to duplicate sampling requirements in the draft Closure Plan. However, the Permittees are no longer sampling at the CDV-SMA-2.5. To comply with RCRA and the New Mexico Hazardous Waste Act, monitoring requirements at CVD-SMA-2.5 must be added to the draft Closure Plan, as well as the draft Post-Closure Plan.

(iii) Table 6-10 Inoperable Triggered Sampler Equipment – "The [CDV-SMA-2.5] sampler was activated for MEx monitoring on 4/17/2013 at 10:50 AM. The sampler attempted but was unable to collect a sample on 7/12/2013 at 12:12 PM and was reset on 7/16/2013 at 2:30 PM (inoperable 4 days). The sampler was shut down on 7/26/2013 at 5:54 PM after sample collection." Id., p. 147.

Sampling requirements under the Individual Permit are not the same as required for the RCRA Hazardous Waste permit. Thus, the sampling is not duplicative. In fact, requiring sampling under different permits has at least two salutary effects: supporting the public's right to know by providing more than one source of information, and, potentially, providing independent, confirmatory results.

(iv) Table B-12 Results for Organic Analytes lists non-detect hits of benzo(a)pyrene, hexachlorobenzene, and pentachlorophenol at CDV-SMA-2.5. Significantly, however, these are, nonetheless, hits. Id., pp. B-61, B-73. These hits demonstrate the need for more, *not less*, sampling.

D. Response 36. The soil sampling required under "Section 6.1.2 Soil Sampling" is *not* adequate. "A minimum of ten soil samples must be collected from the top two inches of soil and two samples must be collected for a 6 to 10 inch depth" is not sufficient, given that the Permittees cannot provide any documentation about the use and volume of waste burned at the site from 1951 to 1980. RCRA and the New Mexico Hazardous Waste Act require more investigation is to adequately characterize and determine the pollution pathways to and from TA-16-399.

In the TA-16-394 Closure Plan cited above, sampling was conducted at 0 to 1 ft, 1 to 1.5 ft, and 3 to 4 ft depths. TA-16-399 has been the site of open burning for longer than TA-16-394. Unlike TA-16-394, TA-16-399 lacks documentation of the site uses and types of materials disposed of at the site between 1951 and 1980. Testing which merely "scratches the surface" is not sufficiently protective of human health and safety under RCRA and the New Mexico Hazardous Waste Act. Despite the claimed incomplete documentation of the site uses and materials incinerated at TA-16-399, DOE/LANL and NMED know that kerosene was poured on bare earth to ignite fires on the site for almost 30 years. Given that fact, requiring sampling solely of the near surface and not requiring sampling beneath the concrete pad (which LANL installed over the place where kerosene was poured for some 30 years) will produce neither an adequate characterization of the site nor the remediation RCRA and the New Mexico Hazardous Waste Act require.

The Drewniany thesis cited above raises serious concerns about the sources and extent of depositions of RDX, perchlorate and Cr-VI in the soils of a garden in Española approximately 20 or more miles downwind from the LANL open-burning and open detonation sites. The testing conducted formed the basis of an

hypothesis in the thesis that, "[T]he locations of the contaminants indicate that perchlorate and RDX are travelling into the garden through the [acequia] water and concentrating in areas where irrigation water pools." Id. at 148. Absent soil, air and water sampling at a scientifically significant number of other locations downwind of TA-16-399, neither LANL nor NMED can be certain that there is not an imminent and substantial endangerment to the environment and human health from off-site depositions due to long-term LANL emissions of toxic chemicals.

NMED must require that DOE/LANL initiate and fund an independent testing program to ascertain whether (and, if so, where) RDX, perchlorate and Cr-VI have been deposited in soils and have entered the ground and surface water at sites downwind of the TA-16 open burn/open detonation unit. NMED also needs to require LANL to sample below the concrete pad at all points where post-1980 material could have migrated and where it is likely pre-1980s material would have been deposited. In addition, NMED must require that LANL conduct soil sampling in and about the area, particularly in all drainage areas, in the number and at the range of depths utilized in the TA-16-394 closure plan. RCRA, the New Mexico Hazardous Waste Act, and the Presidential Executive Order 12898 "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations" (February 11, 1994) require no less.

E. Response 37. Please provide NMED's review of "the potential for contamination in the alluvial groundwater well in Fishladder Canyon and Lower Water Canyon." What is the potential for contamination in the alluvial groundwater below the TA-16-399 site? Pursuant to RCRA and the New Mexico Hazardous Waste Act that is information NMED need to ascertain, as the nearest alluvial well is outside the TA-16-399 site boundaries.

F. Response 38. Please provide NMED's review of "the potential for intermediate-perched groundwater contamination." As the Permittees are not able to provide information about the waste that was burned on the bare ground from 1951 to 1980, a RCRA groundwater well for TA-399 is required to be located in a proper, down-gradient location near the site. The potential for contamination in the intermediate-perched ground-water below the TA-16-399 site cannot be ascertained without such a well. Such an investigation must be undertaken, pursuant to RCRA and the New Mexico Hazardous Waste Act, because the nearest intermediate-perched groundwater well is outside the TA-16-399 site boundaries.

It is significant that this interim status unit accepted waste after July 26, 1982, and is therefore a regulated unit that is subject to high level protection of groundwater. 40 CFR 264.90.

G. Response 39. Please provide NMED's review of "the potential for contamination of springs." There are springs downstream of the TA-16-399 site. Therefore, an investigation for contaminants in those springs must be conducted.

H. Response 40. Sampling under the concrete pad is required. Otherwise, it is reasonable to assume that waste will be left in place after closure. Under RCRA and the New Mexico Hazardous Waste Act, NMED is, therefore, also required to order the Permittees to submit a Post-Closure Plan for the site. Under RCRA and the New Mexico Hazardous Waste Act, a draft Post-Closure permit is subject to public review and comment.

4. The following changes should be made to the draft Closure Plan (11/19/2013):

A. There are places in the draft where reference is made to "units" rather than the one unit, e.g., Sec. 1.0 Introduction. This should be changed to "unit" throughout.

B. It appears that the Permittees plan to amend the Closure Plan. The EPA's RCRA regulations codified at 40 CFR 270.42 anticipate that such amendments will only be Class 1 permit modification. Characterization of amendments to this Closure Plan as Class 1 modifications is unacceptable. Because of the significant level of public interest in this site for over a decade, we contend that both RCRA and the New Mexico Hazardous Waste Act require that any amendment of the Closure Plan requires a Class 2 or Class 3 permit modification request, with public notice and opportunity for public review, comment and hearing requests before NMED makes a final decision.

C. The draft permit must require the sampling of flora and fauna in the area down-gradient and downwind of TA-16-399, including all off-site area that TA-16-399 emissions have, potentially, contaminated. This permit requirement is of particular concern for the Native American non-governmental organizations for at least two primary reasons. First, the flora and fauna, used for traditional and cultural purposes, must be protected. Second, off-site, downwind sampling is necessary because the Drewniany thesis demonstrates that open burning/open

detonation byproducts are at toxic levels in garden plots approximately 20 miles downwind of LANL. Native Americans, in addition to traditional and ceremonial purposes, gather local flora and fauna as part of their diets. The Drewniany data raises serious issues concerning the potential impacts of the legacy (and continued practice) of LANL's open burning and open detonations upon the air, soils and water within which wild plants and animals exist and within which domestic gardens are cultivated. Pursuant to RCRA and the New Mexico Hazardous Waste Act, and international treaties--to which the United States is a signatory--which are intended to protect the health and safety of the indigenous peoples of the United States, NMED must require the Permittees to facilitate and fund independent testing of off-site, downwind soils, flora and fauna. This is necessary to ascertain whether there are dangerous levels of contamination due to substances released during LANL's historic and continuing opening burning and open detonations.

5. Sampling for beryllium, cyanide and barium must be included in the draft Closure Plan. Beryllium, cyanide and barium sampling must also be included in any draft Post-Closure Plan, if NMED allows the Permittees to leave the concrete pad, electrical box and fence in place or fails to require LANL to conduct a complete investigation of the impacts of operations on groundwater zones and soils. *See* below for examples from NMED 's own documents demonstrating the need for such sampling; *see also* the list of substances that were required to be assayed in the Closure Plan for TA-394, *supra* at 12-14.

A. Paragraph 12 of the 2002 NMED *Determination of an Imminent and Substantial Endangerment to Health and the Environment,* issued to DOE/LANL: "The Facility Operators have conducted dynamic testing at firing sites, which used a variety of high explosive compounds ("HE"), **<u>barium, beryllium</u>,** lead, mercury, and other metals. (DOE 1979)." [Emphasis in boldface and underlining added.]

B. Paragraph 23 of the 2002 NMED *Determination of an Imminent and Substantial Endangerment to Health and the Environment,* issued to DOE/LANL: "The Facility Operators have disposed of hazardous wastes, hazardous constituents, and other solid wastes at the Facility. These wastes include chlorinated and non-chlorinated solvents such as carbon tetrachloride, methylene chloride, trichloroethane, trichloroethylene, tetrachlorethylene, benzene, toluene, acetone, chloroform, and methyl ethyl ketone ("MEK"); high explosive compounds ("HE") such as trinitrotoluene ("TNT"), dinitrotoluene compounds, octahydro-1357-tetranitro-1357-tetrazocine ("HMX"), and cyclonite ("RDX"); corrosive and toxic gases; metals such as arsenic, **<u>barium, beryllium</u>,** cadmium, chromium (including Cr-VI),

copper, lead, mercury, molybdenum, silver, and zinc; **cyanide;** polychlorinated biphenyls ("PCB's"); pesticides such as 2,4-D; perchlorate; other inorganic contaminants such as nitrates, ammonia, and fluoride; various radionuclides such as tritium; and other wastes. (E.g., DOE 1979, 1987 and 2001; LANL 1981, 1998c, 1998e, 2000a, and 2001a; CDCP 2002)." [Emphasis added.]

C. Paragraph 54 of the 2002 NMED *Determination of an Imminent and Substantial Endangerment to Health and the Environment,* issued to DOE/LANL: "Contaminants that have been released into, and detected in, soils and sediments at the Facility include HE compounds; metals such as arsenic, **barium, beryllium,** cadmium, chromium, copper, lead, mercury, molybdenum, silver, and zinc; PCB's; various radionuclides such as tritium; and other contaminants. (E.g., DOE 2001; LANL 1998b, 1998c, 2000a, 2001a, and 2001c; CDCP 2002)." [Emphasis boldface and underlining added.]

D. Paragraph 55 of the 2002 NMED *Determination of an Imminent and Substantial Endangerment to Health and the Environment,* issued to DOE/LANL: "Contaminants that have been released into, and detected in, ground water beneath the Facility include HE compounds; volatile organic compounds such as trichloroethylene, dichloroethylene, and dichcloroethane; metals such as molybdenum, manganese, **beryllium,** lead, cadmium, and mercury; perchlorate; other inorganic contaminants such as ammonia, nitrate, and fluoride; radionuclides such as tritium; and other contaminants. **Contaminants have been detected beneath the Facility in all four groundwater zones.** (*e.g.*, Purtymun 1975; LANL 1981, 2001a, 2001c, and 2002; CDCP 2002). [Emphasis in boldface and underlining added.]

E. Paragraph 56 of the 2002 NMED *Determination of an Imminent and Substantial Endangerment to Health and the Environment,* issued to DOE/LANL:

"HE compounds and metals have been detected in ground water beneath the Facility at levels in excess of maximum contaminant levels ("MCLs") set by the EPA under the federal Safe Drinking Water Act, 42 U.S.C. §§ 300f to 300j-26. (EPA 2000; LANL 1981, 1998b, 1998c, and 2002; NMED 1996)."

Clearly, it is consistent with NMED's and LANL's prior permits and practices at similar sites that additional sampling of air, water and soil be required in for the TA-16-399 Closure Plan.

6. Declarations Acknowledging Our Government's Occupation and Pollution of Sacred Places.

In the support of our comments, we cite the following Declarations of Indigenous Women that have been written by *Las Mujeres Hablan*, located in Northern New Mexico, as well as *Declarations of Indigenous Women* that have submitted to the United Nations.

The Declarations state the threats and harms from dangerous industries, such as is the Permittees' nuclear, chemical and biological weapons complex. Recommendations are made and references to actions being taken to restore justice and well-being to Indigenous communities. The full Declarations are attached to these comments in Appendices C through G. The information therein documents environmental justice aspects of the draft Closure Plan and support for NMED to require a Post-Closure Plan for the site.

Las Mujeres Hablan: The Women Speak - Women's Declaration for New Mexico 2010 at paragraph 9:

> Be it further resolved that we will support the work of **Las Mujeres Hablan.** (New Mexico Acequia Association **(**NMAA); Honor Our Pueblo Existence (H.O.P.E.), Tewa Women United (TWU); Concerned Citizens for Nuclear
>
> Safety (CCNS); Embudo Valley Environmental Monitoring Group (EVEMG); New Mexico Conference of Churches (NMCC); Community Service Organization (CSO) Del Norte.
>
> **Mission**: To address past, present and future issues arising from the nuclear industry's releases of toxic chemicals and radioactive materials that cause contamination to our land, air, and water; demand clean-up of these sites; question the continued manufacturing of nuclear weapons; and restore justice to the Peoples who have been impacted by this industry. And, address other activities that violate and cause harm to our environment and well-being within the Sacred Mountains of New Mexico and other places in the world,

A PDF copy of this Declaration is provided as Appendix C to these comments.

> *Indigenous Women and Environmental Violence,* A Rights-based approach addressing impacts of Environmental Contamination on Indigenous Women, Girls and Future Generations. Submitted to the United Nations Permanent Forum on Indigenous Issues Expert Group Meeting *Combating Violence Against Indigenous Women and Girls*, January 18 – 20, 2012, United Nations Headquarters, New York, by Andrea Carmen, International Indian Treaty Council and
>
> Indigenous Women's Environmental and Reproductive Health Initiative, and Viola Waghiyi, Native Village of Savoonga, St. Lawrence Island, Alaska and Alaska Community Action on Toxics – Theme 2: *Contextualizing Violence.*
>
> *From a traditional perspective, the health of our Peoples cannot be separated from the health of our environment, the practice of our spirituality and the expression of our inherent right to self-determination, upon which the mental, physical and social health of our communities is based.*
>
> --- IITC Oral Intervention presented by Faith Gemmill, Gwich'in Nation Alaska United Nations Working Group on Indigenous Populations, Geneva July 31, 1996.

A PDF copy of this Declaration is provided as Appendix D to these comments.

Report of the International Indigenous Women's Environmental and Reproductive Health Symposium, April 27th – 29th, 2012, Chickaloon Native Village, Alaska. Co-hosted by the International Indian Treaty Council (IITC) and Indigenous Women's Initiative for Environmental and Reproductive Health, Alaska Community Action on Toxics (ACAT), Chickaloon Native Village an International Indigenous Women's Forum (FIMI). Submitted to the 11th Session of the United Nations Permanent Forum on Indigenous Issues as a Conference Room Paper by the International Indian Treaty Council, Indigenous Non-governmental Organization in General Consultative Status to the United Nations Economic and Social Council**.** May 5th, 2012. Kathy WanPovi Sanchez of TWU and Marian Naranjo of H.O.P.E. participated in the Symposium and signed the Report.

Based on these shared understandings, we adopt by consensus this ***2nd DECLARATION for the Health, Survival and Defense of OUR LANDS, OUR RIGHTS and our FUTURE GENERATIONS and make the following recommendations:***

That Indigenous Peoples, Nations and Communities:

1) Identify and document the disproportionate impacts of environmental toxins on Indigenous women and children as "environmental violence" for which States and corporations can be held accountable.

2) Provide community capacity-building and training linking reproductive and environmental health and human rights.

3) Maintain, support, strengthen and assert traditional systems of law, community organization, decision-making, leadership and representation.

A PDF copy of this Declaration is provided as Appendix E to these comments.

Sovereignty: Long Live Mother Earth – Women's Declaration 2012: Year of Indigenous Women, by Las Mujeres Hablan: The Women Speak, which include H.O.P.E., TWU, and CCNS, paragraphs 20-31:

Be it further resolved that we will work in solidarity with each other in our struggles to defend the air, land, and water from contamination, exploitation, and militarization,

Be it further resolved that we honor, respect, and recognize the dignity of women and their families throughout the world and here at home who are subjected to exposure to toxins through their work, their food, or their proximity to pollution and that we resolve to speak and act in solidarity with them in efforts to defend the health of their families and communities,

> Be it further resolved that we will continue to play an important role in reshaping our communities to achieve a vision of safe, healthy, and joyful lives for our families and communities with good, healthy and locally grown food, good livelihoods that honor the dignity of every human person, and a meaningful and spiritual relationship with Mother Earth.

A PDF copy of this Declaration is provided as Appendix F to these comments.

> *References to Indigenous Women in the ALTA Outcome Document,* Compiled and submitted to the World Conference of Indigenous Women, October 28 – 30, 2013, Lima, Peru, by Andrea Carmen (North American Region) and Mililani Trask (Pacific Region).
>
> *Recommend* that States uphold and respect the right of self determination and the free, prior and informed consent of Indigenous Peoples who do not want mining and other forms of resource extraction, "development" and technologies deemed as degrading to their human, cultural, **reproductive** and ecosystem health. Where mining and other forms of resource extraction are already occurring, States shall develop mechanisms with the full and effective participation of Indigenous Peoples to develop a comprehensive strategy for ecologically sustainable and equitable development to end and prevent uncontrolled and unsustainable industrial contamination and degradation with plans for clean-up, remediation and restoration. Such as strategy shall incorporate strengthening the capacity of Indigenous youth in relation to sustainable development practices based on Indigenous knowledge and the relationship with the land as well as the protection and promotion of the important role of traditional knowledge holders including Indigenous Elders and **women**; ***(Theme 1: Indigenous Peoples' lands, territories, resources, oceans and waters, Paragraph 6)***

A PDF copy of the ATLA Outcome document is provided as Appendix G.

The documents cited above (and attached hereto in the Appendices C through G) are consistent with the treaty obligations of the United States government that are binding upon the State of New Mexico. Specifically, the Convention on the Prevention and Punishment of the Crime of Genocide, 78 U.N.T.S. 277, *entered into force* Jan. 12, 1951, which applies to acts that destroy a People, such as the expropriation of their lands, poisoning them, poisoning the flora and fauna upon which they rely for sustenance and cultural and ceremonial purposes, keeping them from and/or poisoning substances they utilize for ceremonial purposes such as clays and water, and making it impossible for them to maintain their ancestral way of life. That is the essence of genocide. The United States government and its agencies and contractors have done this by instituting and maintaining the Los Alamos National Laboratory which has taken the ancestral lands and poisoned the Indigenous People--as well as the flora, fauna, water, clays and

sacred places they rely upon to maintain their ancestral way of life. NMED, under state and federal law (which includes such treaties and conventions) has a special obligation to assure the health and safety and protect the Indigenous Peoples whose ways of life have been diminished by the continuing acts of the United States government, and who have been--and continue to be--exposed to LANL's toxic, hazardous pollutants and the disturbances from burning and detonations of toxic materials. This duty is heightened as such people are also citizens of the State of New Mexico

Thank you for your careful consideration of this Second Set Of Comments. CCNS, TWU and H.O.P.E. are dedicated to ensuring that the Pajarito Plateau is thoroughly and completely cleaned up for all time.

Respectfully submitted:

Jonathan M. Block, Staff Attorney
Counsel for CCNS, TWU and H.O.P.E.

Attachments (in PDF):

Appendix A. M. Drewniany, "Red Dust: A Soil Scientist's Journey Through the Political and Environmental Chemistry of Northern New Mexico" (Hampshire College, Amherst, MA: May 3, 2013).

Appendix B. M. Kaltofen, P.E., T. Carpenter, "Citizen Environmental Monitoring and Technical Assessment: Analysis of Radiochemical Contaminants in Los Alamos Region Biota and Environmental Materials At The Perimeter of the Los Alamos National Laboratory" at 14-17 (June 2007) (report showed that airborne deposition of LANL materials was taking place and detectable off-site in dust, soil and sediments).

Appendix C. *Las Mujeres Hablan: The Women Speak - Women's Declaration for New Mexico 2010*

Appendix D. *Indigenous Women and Environmental Violence,* A Rights-based approach addressing impacts of Environmental Contamination on Indigenous Women, Girls and Future Generations. Submitted to the United Nations Permanent Forum on Indigenous Issues Expert Group Meeting *Combating Violence Against Indigenous Women and Girls,* January 18 - 20, 2012, United Nations Headquarters, New York, by Andrea Carmen, International Indian Treaty Council and Indigenous Women's Environmental and Reproductive Health Initiative, and Viola Waghiyi, Native Village of Savoonga, St. Lawrence Island, Alaska and Alaska Community Action on Toxics - Theme 2: *Contextualizing Violence.*

Appendix E. *Report of the International Indigenous Women's Environmental and Reproductive Health Symposium,* April 27th – 29th, 2012, Chickaloon Native Village, Alaska. Co-hosted by the International Indian Treaty Council (IITC) and Indigenous Women's Initiative for Environmental and Reproductive Health, Alaska Community Action on Toxics (ACAT), Chickaloon Native Village and International Indigenous Women's Forum (FIMI). Submitted to the 11th Session of the United Nations Permanent Forum on Indigenous Issues as a Conference Room Paper by the International Indian Treaty Council, Indigenous Non-governmental Organization in General Consultative Status to the United Nations Economic and Social Council**.** May 5th, 2012.

Appendix F. *Sovereignty: Long Live Mother Earth – Women's Declaration 2012: Year of Indigenous Women,* by Las Mujeres Hablan: The Women Speak.

Appendix G. *References to Indigenous Women in the ALTA Outcome Document,* Compiled and submitted to the World Conference of Indigenous Women, October 28 – 30, 2013, Lima Peru, by Andrea Carmen (North America Region) and Mililani Trask (Pacific Region).

Appendix A

M. Drewniany, "Red Dust: A Soil Scientist's Journey Through the Political and Environmental Chemistry of Northern New Mexico" (Hampshire College, Amherst, MA: May 3, 2013).

Red Dust

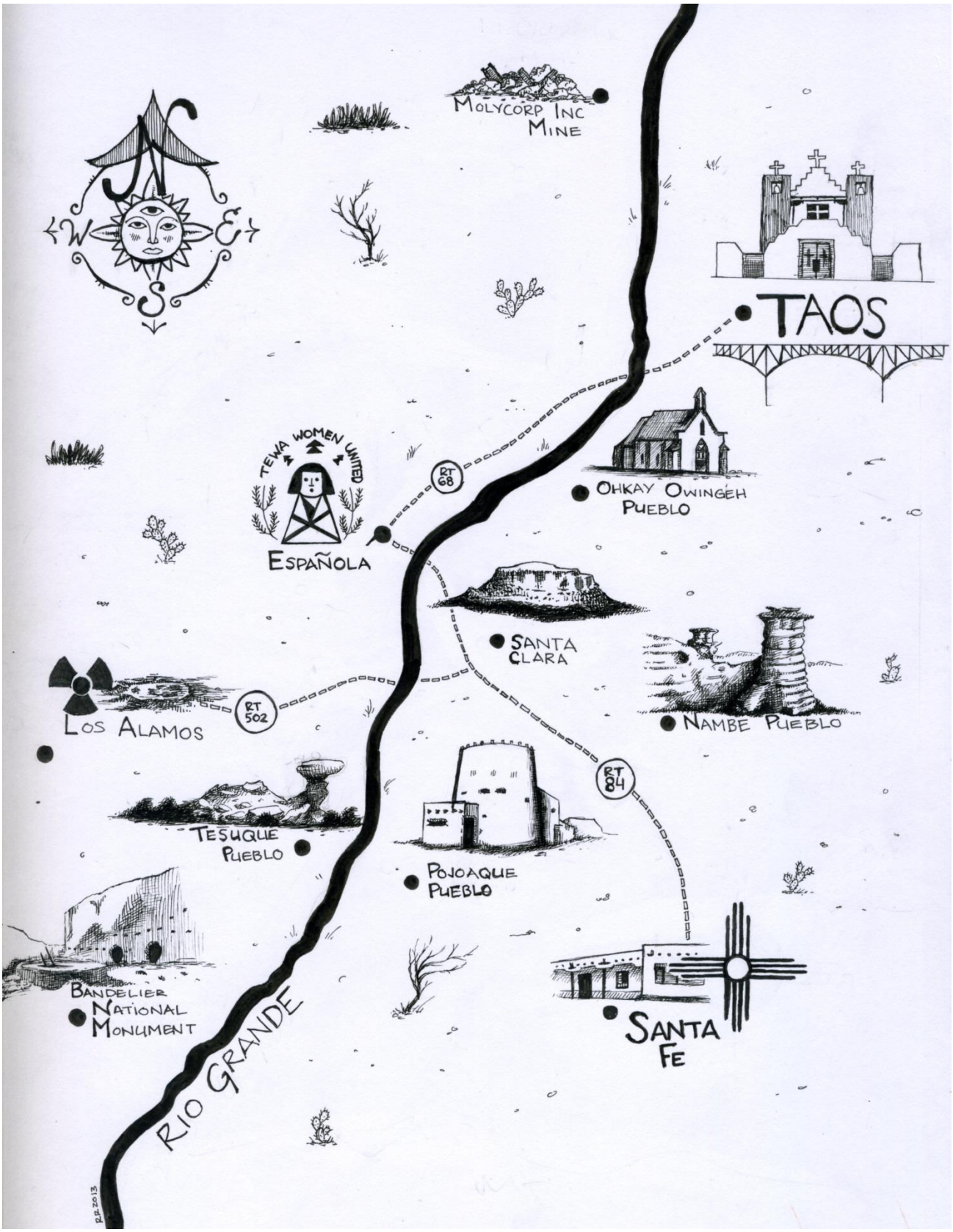
A Soil Scientist's Journey Through the Political Climate and Environmental Chemistry of Northern New Mexico

Red Dust

A Soil Scientist's Journey Through the Political Climate and Environmental Chemistry of Northern New Mexico

An NS Division III by Morgan Drewniany

Co-Chairs: Pamela Stone and Rayane Moriera


N
W
E
S
MOLYCORP INC
MINE
TAOS
TEWA WOMEN UNITED
RT 68
OHKAY OWINGEH
PUEBLO
ESPAÑOLA
SANTA
CLARA
LOS ALAMOS
RT 502
NAMBE PUEBLO
RT 84
TESUQUE
PUEBLO
POJOAQUE
PUEBLO
BANDELIER
NATIONAL
MONUMENT
SANTA
FE
RIO GRANDE
RP 2013

This work is dedicated to:

Everyone I worked with at Tewa Women United, and in the larger Rio Arriba Valley. You have framed my work for me and truly changed my thinking about health and environmental justice, and these experiences will lead me through my life and career.

The community of Los Alamos and my Starbucks family who welcomed me in as an outsider exploring issues that claimed the lab that sustains their livelihood on the hill was a source of suffering. Through work and play in the Atomic City, I saw firsthand that we cannot categorically point to a place and blame everyone in it- it's the few people at the top.

Don, Kelly, Lucy, Pip and Princess Sofie. You truly provided not just a house, but a home for me in New Mexico.

Pam and Rayane, my brilliant co-chairs and editors. Without you, this piece would still be a jumble of words, and I would still be a jumble of thoughts.

Sarah Steely. You were so imperative to my lab work, through setting up hundreds of tests, to looking at the pretty colors all my tests made.

My incredible friends at Hampshire and in Westfield. Rachel, your endless supply of jelly beans and your willingness to listen to my whining kept me going when I didn't know if I could. Your map is beautiful and adds an incredible amount to my work. Andrew, you have been here for me through it all, and I'm glad I've finally learned to take your advice; I wouldn't have found nearly as much drive without you nudging me along.

Mom and Dad. Thank you for your love, neverending support, and constant reminder that you are proud of me. There were days that you called that I needed nothing more than to hear from you.

A special thanks to the generous funding by : The Reproductive Rights Activist Service Corps at the Civil Liberties and Public Policy Program, Denice O'Neill Scholarship Fund, Samuel Morris Sustainability Endowment Fund, Tara Nelson Award, and Justine Salton Memorial Fund.

"Science loves order, simplicity, the manipulation of a single variable against a background of consistency. The tools of science do not work well when everything is changing at once."

- Steingraber, 1998

Table of Contents

Tables and Figures

List of Tables

List of Figures

Abstract

Experiments were performed to investigate the presence of health-threatening contamination in the soils of a food producing community garden in the Pueblos of Espanola, NM, downhill and downwind from Los Alamos National Labs (LANL). Soil samples were collected during an internship with the Indigenous women's group Tewa Women United in the Rio Arriba Valley of New Mexico. Over 100 samples were tested for arsenic, perchlorate, RDX, and hexavalent chromium using quantitative or semi-quantitative colorimetric methods. All four contaminants were found to be elevated, with levels above or closely approaching established health-protecting quality limits. It is clear that with levels this high, the health of those exposed is threatened as are the surrounding waterways. These findings indicate that LANL has polluted the lands inhabited by Indigenous communities. The nature and high levels of contaminants has also created an area in which health disparities are disproportionately high. Suggestions for bioremediation and behavioral change to protect public health and environmental justice while still utilizing the garden are recommended in the paper.

Introduction

Beyond the Ridge to the West

The drive from Los Alamos to Santa Fe is forty minutes long, down a highway that winds through towering mesas and long red stretches. It is just long enough to listen to *In the Reins* by Iron and Wine and Calexico, an album I found myself repeating throughout my summer. The initial descent from the secret city is steep and dangerous, 2000' in 10 minutes. As I departed Los Alamos and drove into the valley, houses became further and further apart and cars passed less frequently. After "Red Dust", the fourth track, drew to an end, I reached Pojoaque Pueblo with its scattered casinos and gas stations. From Pojoaque to Santa Fe, a gentle ascent is spread over the next three songs, where buildings and stores become more concentrated. Entering Santa Fe to the last chords of "Burn that Broken Bed," feels warm after the long ride through the country.

Santa Fe is lively and feels youthful, though it is one of the oldest cities in the United States. The separation between young and old is located somewhere between the shops hawking modern art and the local people of the pueblos with their crafts spread on wool blankets in the Plaza. Buildings crafted of adobe are nestled in with towering metal sculptures and vibrant murals. Greying women with turquoise jewelry bustle through crowds of laughing twenty-somethings waiting for the train to Albuquerque.

After a day of work, I would get into my Volvo once again to make the drive back to Los Alamos. Nothing stirred, the road was calm and straight, it was just me, the car and the road. No police waited with radar guns, no deer grazed on the side of the highway. A lonely sign explaining the Jemez Mountains was always a reminder that I was getting closer to the Atomic City. Driving back to Los Alamos after a day in Santa Fe, the beauty of the landscape is illuminated in as the sun sets over the Jemez mountain range. The mountains steal the climax of the show, shading the reds, purples and yellows of the sunset away from sight.

After crossing once again through Pojoaque, the wide open reservations housing the pueblos of Santa Clara and San Ildefonso are striking. I can feel that they have seen thousands of years. The ragged mesas that populate the land were sculpted by an ancient ocean that washed away rock and dirt incrementally to create ridges on their sides. Fossils of prehistoric sea creatures found in the mesas have been written about in petroglyphs and on old maps. Stretches of red land are scarred with the evidence of recent wildfire. All that remains on the majority of the land is scrub brush and tumbleweed, both quick growing and invasive, telling the story of these fires. Over the dry land spring dust devils creating tiny tornadoes of orange and brown on the sides of the highway. Small pockets of adobe homes, some crumbling back into the earth, follow rocky dirt roads.

Crossing the Rio Grande each day was also a cue of what the land has seen. The rapidly flowing river reminded me daily that water is precious in this place. It is thick with clay which gets washed up by the current. As monsoon season approached, the river often

became angry and unruly. Rain rushed down the sides of the surrounding mesas, stirring up the river and quickly creating rapids that seemed to disappear as quickly as they were made. More than once, the rain became so intense that the river overreached its banks, rushing into back yards, into kitchens and living rooms and devastating communities.

After the long drive each day, I would arrive back in Los Alamos, where I lived for the summer. Los Alamos today is a white-collar version of a factory town. One grocery store, three gas stations, two garages, a coffee shop and a handful of independently owned stores populate the plateau. A sole employer, the US Government, owns the majority of the community. Ashley Pond is a beautiful plot of land in the center of town across from the old communal lodge, land with plenty of well-manicured green Kentucky Bluegrass, and a reflective pond, both out of place in the dry Southwest. Though the view from the plateau contains a full New Mexican palette, the town itself feels like Anytown, USA.

The more time I spent in Northern New Mexico, the more I became aware of the divides between Los Alamos and Santa Fe, and the Espanola Valley. Not only was the land different, but the way of life was different in a way that I never would have realized had I not created relationships in both places. Social dynamics have sculpted Northern New Mexico just as much as the ancient seas and wildfires, and they have divided populations. Driving from place to place quickly changed from looking at landscapes to looking at people, and how they live.

I took the drive between Santa Fe and Los Alamos or Los Alamos and Espanola nearly every day, and it provided me a time in which I could reflect upon the work that I have done thus far in my academic career as well as where I wanted to go with that knowledge. I spent the majority of time in the car considering privilege, what it meant for me as a white person to be working with the Indigenous people in Northern New Mexico, and what it meant for me to be taking my experiences and writing about them as my Division III. During my time there, I discovered a love for understanding the community, their needs, and how I could do the work I want to do in a way that works *with* the people, not for them. My Division III stands as an attempt at bridging the gap between communities as well as those between environmental justice, social justice and science together.

My Division III

I began my journey in Northern New Mexico through a summer internship with Tewa Women United (TWU). Mine was an internship set up through a civil liberties organization I had worked for before, the Civil Liberties and Public Policy Program (CLPP), through a program called the Reproductive Rights Activist Service Corps (RRASC). I applied for the internship in hopes of gaining experience in an environmental justice setting. I met my supervisor at a conference the spring before I left and she was wonderful and inspiring; however, when I set out from Massachusetts to New Mexico in the summer, I had little knowledge of what to expect out of my time at TWU.

Tewa Women United is an organization whose mission is "to provide safe spaces for Indigenous women to uncover the power, strength and skills they possess to become positive forces for social change in their families and communities," (TWU, 2013). They were formed in 1989 as an indigenous women's support group, focusing on struggles women were experiencing in the community such as alcoholism, depression, and domestic and sexual violence. In 2001, Tewa Women United became an official nonprofit with 501c3 status and grew rapidly into a multi-departmental organization which still focuses on the community. They are located in the city of Espanola in the Rio Arriba Valley of Northern New Mexico. Rio Arriba is North of Santa Fe and Southeast of Los Alamos Counties. Programs at TWU include: Valuing Our Integrity with Courage, Empowerment, and Support (VOICES), a culturally appropriate response to sexual violence and trauma, the Indigenous Women's Health and Reproductive Justice Program, offering doula services in the Rio Arriba Valley, and the Environmental Justice (EJ) Program, addressing education and awareness of local environmental concerns. There are a number of other, smaller, programs within Tewa Women United which also aim to engage women in the communities as well.

All of the departments of Tewa Women United are interrelated and work closely together, and all of the employees are women from surrounding communities, mostly indigenous women from the Pueblos. The concerns of the community are the concerns of everyone who works in this small organization and I was embraced closely by the family of TWU throughout my time with them. Women in TWU come from all of the surrounding

Pueblos, but concentrate on serving women in the Tewa speaking Pueblos of Northern New Mexico: Nambe, Pojoaque, Santa Clara, San Ildefonso, Okeh Owingeh, and Tesuque (Edelman, 1986).

I worked in the environmental justice (EJ) department, which focuses more specifically on "taking care of our Mother Earth and all our relations," (TWU, 2013). The larger picture of Mother Earth is taken into account in the environmental justice department, but the EJ Program focuses mainly on local environmental risks. The great majority of work done in the EJ department is done regarding neighboring LANL, with the website stating that "LANL has been discharging its toxic and radioactive wastes onto Tewa ancestral land" (TWU, 2013). There are efforts through the EJ program to inform the community of happenings on the hill, such as the newly proposed Chemistry and Metallurgy Research Replacement (CMRR) Building, wastes at Area G or simply new reports coming out of the labs.

In my first few weeks of the internship, I worked on pre-existing projects such as working in the community garden, doing research on pesticide use in Espanola and the movement to raise funds for a terrace garden. Quickly, I realized that the thick, academic documents coming out of LANL outpaced the ability of TWU's EJ staff to digest the information by far. My privilege as a science student allowed me to delve into official documents and through the summer, I summarized over 1,000 pages of Department of Energy (DOE) and LANL reports for the community to access. The reports were written to

inform the community, but were not accessible in the least. I also attended official DOE and LANL meetings in Santa Fe and Albuquerque that were scheduled at times when the women leading the EJ department were with their families, and I made public statements in their respect. These experiences highlighted the class gap between people on the hill and people in the valley which played itself out over and over.

Parallel to my work in the Rio Arriba Valley with women from the surrounding Pueblos, I lived atop the Pajarito Plateau in Los Alamos because that was where I found housing. I lived with Don and Kelly, a couple who had worked in and around the labs for years. They gave me more than I could have ever asked for during my stay in Northern New Mexico. I also worked at a coffee shop atop the Plateau and met hundreds of the people who work in the labs. My experiences certainly framed the issues in Northern New Mexico for me in a way which they would have not been had I been an outsider in the Los Alamos community. I do not see the people who work at the labs as greedy or ill-intentioned. I believe that there are a few powerful people at the top who have made decisions at LANL that have caused devastating environmental results, but the poor decision making of a few does not reflect the vibrant community atop the Plateau.

The split of my time between the two places was nearly even. I had a full time job at Tewa Women United and spent time outside of work gardening, and going to special events like infant massage clinics or water blessing ceremonies before and after work in Espanola and the surrounding towns. Outside of that job, I worked around 10 hours a week in a coffee

shop in Los Alamos and spent time at "home" in Don and Kelly's house, as well as with friends I made in the Atomic City who were closer to my age than my coworkers at TWU. I could have, perhaps, used a bit more sleep some days but I feel like I took every opportunity that came to me.

Through my three months in New Mexico, I discovered a love for the history and current day Los Alamos and Rio Arriba Valley, and the communities in both places. My background lies in soil chemistry and environmental justice and putting all these pieces together, I unearthed my Division III. Throughout my DIII, I will give a layout of Northern New Mexico as it stands today, the history of the places I was in, environmental health in the region, and contaminant origins and movement in both the greater NNM area as well as the North Railroad Avenue garden in Espanola I focus on in my soil sampling. These sections serve as a lead-up to my independent experimental research.

For my own research, I collected around a hundred soil samples from a community garden overseen by the EJ department at TWU. It is located on North Railroad Avenue in Espanola and I tested the soil samples for arsenic, RDX, perchlorate, and hexavalent chromium. These are all contaminants discussed abundantly in the documents I reviewed during my work at TWU as health-threatening chemicals sourced from local industry. The garden is used for crops that are consumed by the local communities. Contamination of the garden soil by surrounding industry implies a larger contamination of Pueblo lands and the Rio Arriba Valley.

In my work, I concentrate a lot on the tenets of environmental justice, which I will later explore more deeply. The core of environmental justice, as defined by Tewa Women United, is "teach[ing] traditional Indigenous forms of healing medicines and foods to counteract the negative impacts that pollution and nuclear contamination ha[s] on our bodies, minds, spirits, lands, air, and water" (TWU, 2013). In a larger framework, I employ the definition Bullard uses to define EJ as "embracing the principle that all people and communities are entitled to equal protection of environmental and public health laws and regulations" (Wakefield et al., 2010: n.p.). The sources I have chosen to incorporate in my research rely heavily on the integration of environmental and social justice frameworks.

Through my experiences at Tewa Women United as well as the frameworks I have used to create my Division III, I aim to make my piece as accessible as possible. This accessibility is part of my journey to make science socially sensitive. The language I use is meant to be understandable by everyone, not just academics and scientists. My results are to be returned to the communities in the Rio Arriba Valley and therefore, I have tried to stray away from isolating rhetoric.

Chapter 1 introduces the New Mexico landscapes and first, aims to place the reader in the place. I use personal experiences from my time in Los Alamos and the Rio Arriba Valley. My narrative is important to paint a picture for the rest of the scenes I describe in the piece. I continue on to recount a short history of Northern New Mexico and how historical situations have informed the present, focusing on the Labs.

Chapter 2 explores environmental health in the region as it has been presented in local and regional studies, as well as the social dynamics between areas of Northern New Mexico. The chapter identifies where these two things meet and cause each other, as well as explaining why the environment informs health and sickness.

Chapter 3 looks at contaminant origins and movement in the larger region of Northern New Mexico. The specific geology and geochemistry of the region and possible sources/routes of contamination are presented. It wraps up with a focus on the largest polluter in the region: Los Alamos National Laboratory.

Chapter 4 presents contaminant information in the context of the gardens, and specifically, the North Railroad Avenue garden. It provides information as to why soil and agricultural science is important to Northern New Mexico and applies this information to my experimental research. It also details the choices I have made in contaminants to research in experimental analysis and their health implications.

Chapter 5 contains all of my personal experimental research, methods, data and analysis. This section provides information on the specific contaminants which were detected in the garden, where, and at what levels. The tone of this chapter shifts drastically from the rest of the Division III, due to the technical nature of the results provided, but I have tried to make this portion understandable and straight forward.

Three appendices are provided. The first, Appendix A, provides an index of all tables and figures provided throughout this paper. Appendix B provides detailed maps with scale in order to orient you, the reader, with the area. Appendix C contains all of my raw experimental data. In addition, there is a hand-drawn map in the very beginning of my Division III, before the Table of Contents, which has been lovingly provided in the hopes that it will help you find your place in my work as I found my place in Northern New Mexico.

As with all research, my work, and the sources I have chosen to integrate into my work, is informed by the experiences I have had in Northern New Mexico. The implications of the contaminants I have found in the soil of the community garden are huge, and can certainly be tied back to the history of Los Alamos and the Rio Arriba Valley, as well as where Northern New Mexico stands today.

Chapter 1: The Land of Enchantment

Through snapshots of the time I spent in the Rio Arriba Valley, Los Alamos and surrounding places, I aim to paint a picture of the region as it is today. An image of the area is important because my research depends so much upon the specific social and cultural dynamics of the area alongside the unique landscapes of Northern New Mexico. The people I met and the places I went shaped the direction of my research and I feel as though it is important to provide some of these stories in order to connect you, the reader, to this incredible setting.

1.1 New Mexico Today

Arriving in Los Alamos

My first day in Los Alamos began with a six hour drive from the Cactus Inn in McLean, Texas. The motel was cozy; overnight, cherry-sized hail fell from an impromptu thunderstorm. The sound of it falling on the rooftop concerned me, but was apparently "normal" in the southwest. My partner and best friend, Andrew, had accompanied me for the five-day drive from Massachusetts to New Mexico, after months of coaxing. He woke me at six in the morning so we could get a head start on our last day of travel. I let him drive and settled into the passenger seat with my pillow. Quickly, as the sun had not yet risen, I fell back to sleep against my seat belt. A couple hours later I woke up to the New Mexico state line, and a coffee, and took over in driving the remaining four hours.

Figure 1: View of the Jemez Mountain range from Route 502 between Santa Fe and Los Alamos. (Drewniany, 2013)

It took far longer than I expected to reach Los Alamos. Tension built in my body as we drove closer, not knowing what I should expect from the experience ahead. Countless possibilities existed in this new place. I fiddled with the radio, trying to find a station, trying to distract my mind from what was in front of me. Andrew sat next to me driving, trying to crack a joke in the silence between us while I drove up the hill to the Atomic City. Driving past the small airport, Ashley Pond, and the hospital, Andrew noticed my anxiety and exclaimed, "you're going to fucking love it here." I responded in my usual sarcasm, "how do you know?" He rebutted, explaining that he knew me as we pulled down Diamond Drive and drove closer to my home for the summer.

The population of Los Alamos today is far removed from general American society. The city feels like a small utopia atop the Pajarito Plateau. As you drive around you learn that the wealthy LANL staff live in beautiful neighborhoods with green lawns or extensive dry landscaping. Fruit trees abound in yards, offering up apricots, plums, and peaches all summer long. Traditional adobe styles are used to create "sustainable" "solar heated" spaces. On the parts of the plateau which have housed Los Alamosans for the longest, including the government-issue clapboard homes and dormitories, lower income housing gives college interns and low-paid LANL employees a place to live. These scenes differ immensely from those down the hill in the Pueblos.

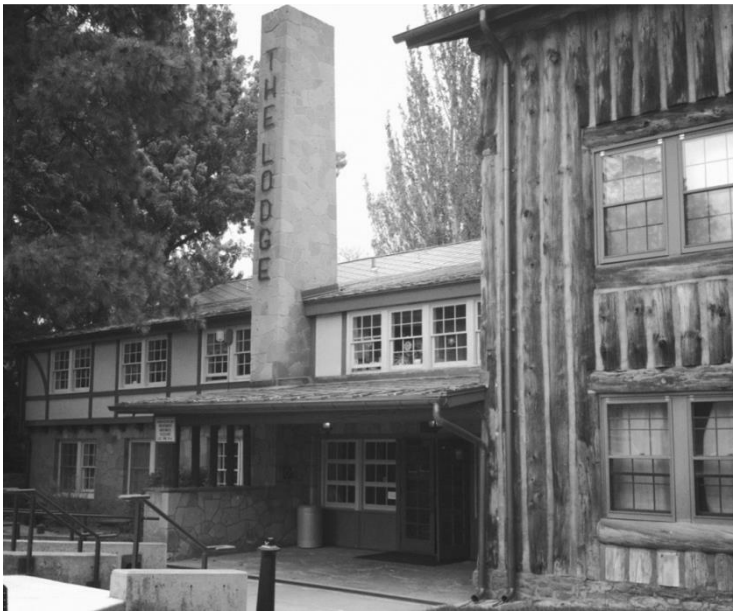


Figure 2: Fuller Lodge in Los Alamos, NM, the former home of the Los Alamos Ranch School and now, home to the Los Alamos Historical Museum. (Drewniany, 2013)

As I pulled into the driveway of one of the beautifully built adobe homes, Don waved and motioned for me to park in the corner of their driveway. I was lucky to make it up

through the tall stucco walls - designed for privacy but in practice, just a threat to car bumpers and mirrors. I shook his and Kelly's hands, unsure how to thank them for opening their house to me without even meeting me first. I looked at the Jemez mountain range visible from their deck, scorched and brown from the Las Conchas fire a year prior. They helped me unload my tightly-packed car and invited me to a beer festival later on in the day at Pajarito Mountain Ski Area just a bit further up the hill. Andrew reminded us that he needed to take a flight out of Santa Fe in a short two hours. We left the driveway as quickly as we had driven in.

Figure 3: Fire-scarred mountains of the Jemez Mountain Range from Don and Kelly's driveway.(Drewniany, 2013)

The drive back to Santa Fe felt all too short as I left the one person I knew in the lobby of the airport. I turned around to drive back to my summer home and tears welled up in my

eyes. I made it back up the steep stucco driveway once again, realizing I was home alone since Don and Kelly had gone to the festival. Not knowing quite what to do, I took a shower, trying to wash off the sharp feeling between my shoulders and the dry heat of the plateau. Rubbing my face hard with a towel after I stepped out, I realized I had a nosebleed from the drastic altitude change I was experiencing, with Los Alamos standing at an impressive 7,500' as compared to my sea level home in Massachusetts. I wiped it off, took a breath in and decided I needed to get out and go to the beer festival.

Figure 4: Route into Los Alamos on 502, with monsoon clouds rolling in. (Drewniany, 2013)

Pajarito Mountain is a ridge of the Pajarito plateau, and the access road leading up to it travels through the gates of Los Alamos National Labs. I stopped at the gates, thinking my car would be searched, and instead just got a glare from the guard inside. A winding road

through the national park led me to the summit. The forests, much like the ones I had seen from the deck at my summer home were badly burned with only stumps standing in some areas. All the blood rushed to my head, making me dizzy as I kept climbing. I reached the parking lot and took a deep breath of dry air before ascending the stairs to the ski lodge patio.

Music from a local ska band blasted from beneath the patio that held rows of local brewers. I'm a beer lover myself, but a huge and unexpected smile spread across my face as I scanned over how many people were there, dancing, laughing and talking about the brews. Even in my lightheadedness, I knew Andrew was right, that this place would be home to me. After some shuffling through the crowds, I found Don and Kelly. They introduced me to their friends, all outdoorspeople who told me their tales of hiking, kayaking and rock climbing in the Southwest. They welcomed me to the Pajarito Plateau with excitement.

That day I met the modern-day Los Alamos, which has a dynamic and diverse population. Over my next few months working in the Pueblos, visiting local museums, reading books and talking to the inhabitants of Los Alamos who worked in and lived near the labs, I learned so much. From all of my experiences, I gleaned that history at the labs is not always as it seems.

The Pueblos Today

Down the hill from Los Alamos lie several Pueblos including Santa Clara and San Ildefonso, which were where I spent most of my time. These communities lie on government-sanctioned reservation land now, but these communities have been in existence for thousands of years, practicing the same traditions and worshiping the same Mother Earth. I learned a lot about the people and culture in this area through my internship at Tewa Women United (TWU).

During my first week at TWU, I was invited to an event everyone at the office referred to simply as "feast." Still feeling uncomfortable in my new surroundings, I quickly accepted, excited to have somewhere to go on the weekend. Before gathering my things from the office, I walked to my supervisor's desk and timidly asked her if she could give me directions to the feast. She said we would be going to a coworker's aunt's house and she would gladly drive me there. We packed up, walked to the parking lot together and I began to follow behind her in my car from Espanola to Santa Clara Pueblo.

I had driven through a number of pueblos between Santa Fe and Los Alamos as well as from Los Alamos to Espanola, but had not been into the villages yet. Adobe homes of similar shapes were built off of narrow, dry dirt roads that engulfed my car in red dust. Spiky barbed wire lined the roads in some places and grates allowed me to cross a small, parched riverbed,

originally placed there to keep cattle in their pastures. Most Pueblos in the area follow the same design: off secluded dirt roads, surrounded by open, seemingly empty desert land.

The two Pueblos where I spent most of my time were San Ildefonso and Santa Clara. San Ildefonso is located 22 miles Northwest of Santa Fe and is known for its beautiful black glazed potteries (Edelman, 1986). Los Alamos National Labs (LANL) resides on traditional San Ildefonso land and the pueblo shares its boundaries with LANL to this day. San Ildefonso land is large and sprawling, containing the least amount of people per square mile of the six Tewa Pueblos in the area. All of the Pueblos are legally sovereign nations within the United States and have their own laws and regulations.

Riding through San Ildefonso on the way to Santa Fe from Espanola, I asked my work supervisor about a tall, dark mesa I drove by each day. Every morning my eyes would focus on it, approaching slowly as I descended into the Espanola valley from Los Alamos. It felt different from the other mesa tops, somehow more compelling. The red clay at the base of the mesa gradually became darker up and up the side, fading into a steel grey at the top where a handful of trees had planted their roots. She explained that it was Black Mesa, a mesa on which Natives from San Ildenfonso stood their ground against the Spanish and forced them out of the area in the Pueblo Revolt. Black Mesa stands for independence and the fight against colonization by the Spanish, something not often mentioned in the Spanish-strong and proud cities surrounding the mesa. Her short history lesson brought to my eyes

how connected the people on Northern New Mexican land still are to their history and how it has shaped their lives.

Figure 5: Black Mesa at Sunset, located in San Ildefonso Pueblo alongside the Rio Grande. (Drewniany, 2013)

Santa Clara is on the side of Black Mesa away from Los Alamos. The present village site is around four hundred years old and contains Puye Cliffs. Puye is home to astonishing cliff dwellings carved out of the stone on the side of the mesas of the Pajarito Mountains. The cliffside dwellings were home to the direct ancestors of Pueblo Indians that live in Northern New Mexico today. For the women who now live in the Pueblos, 28% have lived in the area their whole life and another 15% for more than twenty years (Berkowitz, 2010). The ties communities have to the land is long and enduring in Northern New Mexico. Roots in this

region are incredibly deep and it is uncommon for people to move out of the community (Berkowitz, 2010).

The feast I attended was in Santa Clara Pueblo and I had no idea what to expect walking in. I had been told there would be food and dancing performances in the commons, which seemed good enough to me, but I vastly underestimated the experience. As I parked my car on that day, I walked through rows and rows of vendors selling their art, the majority of which was intricate jewelry carved from local stones. I walked closer to the center of the village and heard the rhythmic beat of huge drums.

When the center came into my sight, I lost my breath. Around fifty people from the Pueblo of all ages were dancing together to the heartbeat of the drums. They wore beautiful costumes made of leather and feathers that I later learned were a gift from the Natives of the Midwestern United States. The dancers kept on for hours in the midday heat and sun, dancing, this time, for crops to grow. They moved from place to place, shaking shells on their ankles filled with pebbles that made a beautiful clink in time with the drums and rattles filled with corn. Sweat beaded on some dancers' foreheads, washing the paint from their faces while they kept on. Different traditional dances, with different steps, music and costumes are performed at each feast day to celebrate and show thanks.

Feast days are held in each Pueblo, often several each year. One large feast is held in each Pueblo on the day sacred to its Roman Catholic patron saint, brought in by influence of the Spanish in the 15th and 16th centuries. The saints were assigned to each Pueblo by the Spanish

missionaries so that each Pueblo's respective feast day would coincide with a traditional ceremony (Horgan, 1954).

I was led away from the center by co-workers to eat lunch in a Pueblo home. I sat down at the table inside and looked across the spread of food, not sure where to start, or even what most of the food was. Old dishes such as posole shared space with green-and-red-chile laden meats and fry bread to pile it all onto. The tradition of inviting people into the home and feeding them has been a long standing sign of thanks and celebration during feast days. It also provides a time in which the community bands together, which was important in the past when days were spent farming and hunting, but now is equally so to keep tradition alive.

Figure 6: The branching together of the Rio Grande, from Cochiti, NM. (Drewniany, 2013)

Through colonization and the change from a land-based economy, much of traditional Pueblo agriculture was abandoned; however, a modern movement back towards traditional agriculture is vibrant in the Rio Arriba valley. A farmer's market takes place twice a week in Espanola thanks to a few individuals' unrelenting work. I not only watched these markets, but bought amazing food at them each and every week. I bought pounds of blue corn masa and ground red chile to make recipes I learned throughout my time there. Farmers would back in their dust-covered pick-up trucks and unload the back onto a table. The parking lot which was empty when I arrived at 9 AM would transform quickly to rows and rows of tables, covered in baskets with crops changing from week-to-week like peas, cherries, squash blossoms and plums. Natural remedies like *cota*, a tea made from the greenthread plant promising to aid the kidneys in filtering were set alongside the other goods. In Espanola, the market is one of the only places to buy fresh foods. The farmers market, to me, truly represents community: specifically, a community weaving together for the well-being of each individual. The heart of the community, connection to the land and tradition are some of the things I would put forth to define the Pueblos, though it is something that cannot be described accurately in words.

During my time working at Tewa Women United, I spent a fair amount of time tending to the community garden in Espanola, which is connected to an *acequia*, a traditional irrigation system fed by the Rio Grande. The garden on North Railroad Avenue is part of the mission of the TWU EJ program, to bring people back to Mother Earth. Community

members are welcomed to come and participate in gardening and crops are distributed throughout the Tewa Women United staff and from there, their families and neighbors.

Figure 7: Rows of crops in the North Railroad Avenue Garden in Espanola, NM. This garden is tended to by community members and overseen by the Environmental Justice program through Tewa Women United. (Drewniany, 2013)

In the early morning, I would wake up and put on my wide brimmed hat and sunscreen to weed the garden before the sun got too hot in our plot. I tended to rows of crops that ranged from amaranth to arugula, as well as traditional corn, beans and squash which have

been planted for thousands of years, due to their resiliency through drought. These are the same gardens I collected soil from and tested in my Division III, and I ate from the plots nearly every day. The chemicals found in the soil the vegetable plants are growing in are extremely threatening to health, but in my embracing of the culture and community I was living in, it felt right to eat these crops. It is insulting that the vegetables that should be a source of health and well-being are the very sources of illness.

Figure 8: The main acequia in the garden, leading water to the individual rows of plants. Water does not flow into the garden unless the connection to the acequia madre is opened. As water flows into this main acequia in the garden, each row of the garden is watered

individually and then blocked off with a mound of clay. This allows water to reach each row without drowning plants. (Drewniany, 2013)

One day, after a rough time clearing the acequia of weeds to ensure a good flow of water the following morning, I sat down with a fellow gardener and talked for hours about the surrounding cultures, community and history. He brought a bag of cherries from his backyard and while spitting pits into the tall grass, we talked about the interwoven histories of people on these same lands that have shaped contemporary attitudes and actions.

1.2 History of Northern New Mexico

The history of Northern New Mexico is complex and multi-layered, but imperative to understand in order to frame my Division III. The land which a number of cultures have claimed as their own through history is vast and beautiful, with hot summers and cold, snowy winters, with a wet "monsoon" season between. Native Americans were the first people to have lived on the Pajarito Plateau and in the Rio Arriba Valley, followed by Spanish conquistadors, Anglo homesteaders and then the scientists of the atomic age. The stories of people throughout history will attempt to describe the situations that people of Northern New Mexico now face.

My reporting of the history and landscapes of the Pajarito Plateau and the Rio Arriba Valley, and events that occurred on them, are heavily informed by the histories published by Hal Rothman (1997) in his book, "On Rims and Ridges", Cold War anthropologist Joseph

Masco (2006) in his book "The Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico," and Ruben Martinez (2012) in his narrative of experiences in Northern New Mexico, "Desert America." In addition to these texts, I rely on my own experiences in this region of the American Southwest and aim to paint a picture of the region, and offer a brief narrative of the history of places and people here.

History of Northern New Mexico

The Pajarito Plateau, home to Los Alamos, has a traceable human history that reaches back further then all of the cities in the United States, and certainly those in the Southwest. Signs of human occupation going back nearly ten-thousand years have been found here. The region is a section of the Eastern slope of the Jemez Mountain Range, which is located in a thirty-mile stretch between Santa Clara and Cochiti Pueblos. The Plateau stands out in the landscape and can be seen from most of the Northern Pueblos. Indigenous peoples throughout the Southwest have collected spring water, medicinal plants, minerals, and clay from the Jemez range for a long time. The plateau has spiritually important ruins, shrines, and powerful natural elements as well as sites of ancient mythohistorical emergence. Its soft, erodible surface created from volcanic ash spewed by the Valles Caldera gives way to a hard granite core underneath.

The land around the Pajarito Plateau is varied with low points filled with sage brush and hills of pinon and juniper rising out of it up as high as thirteen thousand feet.

Geologically, it looks like desert. The loamy soils, mesas, buttes, and long, snowy winters dispute the first impression of barrenness, providing a challenging but rewarding agricultural area that has been inhabited for thousands of years by some of the oldest tribes known to anthropologists in the United States, often referred to as the Pueblo Indians.

There is evidence in and around the Pajarito Plateau proving that people have inhabited the plateau and surrounding lands land in large-scale settlements since 900 AD. Populations grew and fell as communities learned to adapt to their lands and live in one area rather than roam. Cultural beliefs, along with climate change and drought, forced groups of Puebloan peoples to move throughout the region. By 1800, the lowland pueblos of San Ildefonso, Santa Clara, Pojoaque, and Cochiti were defined centers of Native American life in what is now Northern New Mexico.

Between the 1500s and 1880s, Pueblo life was relatively stable. Subsistence was the center of most activities, taking advantage of the fertility of the alluvial soils and the water available for irrigation from the Rio Grande. Some dry farming was also practiced, with beans, squash and corn (also known as maize) as the main crops. Livestock was kept on the land, and the plateau was used as a place to graze animals when the valley became uncomfortably hot in the summer.

The Pueblo Indians have not only one of the longest histories of land use in the United States, but also an unusually robust set of cosmological ritual and beliefs. Much of the knowledge of beliefs is protected within Pueblo societies, but some mythohistory is known.

The main story within the Pueblos is that of creation. It begins with the emergence from the earth, much like a plant seedling. Each of the tribes left a dark underworld, and with the help of supernatural and animal guides, pushed up toward the daylight to inhabit the surface of the earth. Each of the Northeastern Pueblos has a slightly different creation story that ties the people to the earth and ultimately creates a spiritual bond with a very specific geographic area. Some creation myths begin underwater, and they are led with different types of animals (Ortiz, 1969). Lakes, springs and caves become extremely sacred sites because they are all points of connection to the underworld as told in the creation story. The Puebloan people have elaborate systems of sacred shrines connected to creation spread throughout the landscape (Ortiz, 1969).

Often, Pueblo cosmologies also argue that the people are inseparable from the specific geographical space where their ancestors are buried and where the channels of power connecting the different levels of existence line up to focus life energy on their communities (Ortiz, 1969). The cosmology creates a culture where specific landmarks and places in the landscape are incredibly important, but are all interconnected. As Rita Swintzell of Santa Clara Pueblo explains:

> Differences among the elements of the life force are recognized and accepted, but essential characteristics are known to be the same. For example, a lump of clay is identical to that which determines human beings. The Tewa word "nung" is translated to mean "us" or "clay" depending on the context. There is direct cross-communication possible between all elements of nature – humans, plants, animals and even natural phenomena. (as cited by Masco, 2006: 103)

Tewa, the language which is spoken by some, shows the direct connection the communities have with their land. Tradition and beliefs are all tied to place in Pueblo culture.

Pueblo life and tradition is also set on a strict cyclical movement through a specific physical space; for example, the agricultural cycle. Rituals including dance are performed on a cyclical scale to focus cosmic energy: to grow crops or bring fertility and health, for example. Northeastern Pueblo people have lived on the same land, tended the same shrines and successfully reproduced the natural order for more than a millennium. They uphold a system that flawlessly connects space, ecology, power and action, placing humans within the center of an order in which every being has a specific role to play. The connectedness is exactly why pollution of land, water, and air is so very devastating to Pueblo populations to this day.

Cities of Gold

Again drawing on Martinez (2012), the region was first colonized by the Spaniards who arrived in what is now New Mexico in 1598, led by the myth of the Cities of Gold. The conquistadors blazed a trail into the area expecting bars of silver and gold to be scattered on the ground for the taking, a literal symbol of their colonial idea of wealth and power. As they arrived in the area the Spaniards quickly realized there was no treasure, only wide open valleys and tall mesas. After spending more time in the area, the Spaniards realized that maybe they had found a treasure after all. In meeting with the Natives, Spaniards realized

the land was good for farming, especially in the Espanola Valley, where the local communities kept vast stores of maize over the winter months. They began a culture of agriculture, but were challenged again when they realized that even though the land was rich, farming certainly wasn't effortless. Freezes stayed late into the spring and began early in the fall; rain was unpredictable at best, flooding occurred during monsoon season and gardens withered in long dry spells in the spring and summer.

But the Spaniards claimed more than agriculturally rich lands. Missionaries moved into the area to spread the word of their god. Towering church and mission structures were quickly put up, much larger than were needed (Swentzell, 2012). The Spanish buildings quickly became the dominant focal point of Pueblo landscapes as missionaries pressured Puebloan people away from their ideas of earth, sky, and water and towards a more Christian view of heaven (Swentzell, 2012).

To reward Spanish missionaries and other individuals who helped in the conquest of Northern New Mexican lands, the Mercedes Land Grants were founded in the sixteenth century. The grants pushed Puebloan people off their lands to give to the Spanish as rewards, which were then largely used for agriculture. The Spanish grants created buffers between communities of Natives and Hispanos and were often used as tools of colonization and conquest. Lands historically used by the Pueblos were taken for the grants as the Spanish's own and then granted to those who helped in the conquest; over five million acres for

farming and homesteading were given away. The Natives who no longer had a claim on the land were left with few resources, but ample anger towards the Spaniards.

To irrigate their newly-claimed lands and create more agricultural opportunities, the Spaniards brought acequia culture to Northern New Mexico. Acequias consisted of small waterways that moved water for miles from the main rivers through ground and wooden ditches accompanied by complicated systems of management through *mayordormos* (Swentzell, 2012). Mayordormos were community members in charge of looking over the acequia to ensure that no one farm was taking an unfair amount of water and leaving the farm down the ditch dry. The ditches required a fair amount of upkeep, being made of dirt and wood and constantly filled with water (Swentzell, 2012).

Each spring, the *acequia madre*, the "mother" acequia fed directly by the river, was cleared out by the Spanish in a big village ritual. Water rights became an integral part of land deals, because without water, there was no chance of subsistence living. Because the Rio Grande rises and falls with no outside control, acequias introduced a communal intimacy with the specific ecology of the valley that Hispanos had not connected to before.

Prior to Spanish intervention, Puebloan people used some irrigation from the Rio Grande, but mainly practiced "dry farming" with main crops consisting of corn, beans, and squash, none of which required irrigation. The communities talked with the clouds and used the water coming from the skies to nourish their plants (Swentzell, 2012). The introduction of acequias to Pueblo communities meant that yet another traditional practice, connecting

with the living watershed, was replaced with practices from the European system (Swentzell, 2012).

Land and Water

After eighty-two years of epidemic disease, loss of water rights, and unfair rule brought into Northern New Mexico by the Spanish, the Pueblo Indians fought back in the Pueblo Revolt of 1680. They banded together to force the Spanish South of the Rio Grande. The Revolt, celebrated to this day as an important point in Pueblo independence, resulted in twelve years without conflict between the Pueblos and Spaniards, an impressive length of peace during the Spanish colonial period.

In the time after the Revolt, Anglo homesteaders began to move into the area, with their own vision of the treasure New Mexico had to offer. They craved large lots of property with their name on the bill, for in their culture, land measured wealth. On the Pajarito Plateau, land was available and was claimed by Anglos who guarded it with all of their lives. They formed large ranches and farms where they could create their own prosperity.

Homesteaders were not part of an intricate social structure like their Hispano and Native neighbors and therefore lacked an overall sense of community. The land they owned was their home, but "home" did not mean the same generations of traditions on the plateau as it did for their neighbors. This connotation, that "home" meant success, contributed to the first significant divides within the region.

The Treaty of Guadalupe Hidalgo in 1848 integrated New Mexico into the Union. Old Spanish land grants were seen as obstacles to expansion, as they took up extensive plots of valuable land. In the favor of national expansion, Hispano land grants were taken away by the US government. This was an interesting imitation of the chain of events which occurred when the original conquistadors claimed Native lands. Without ownership of the acequias, many Hispanos found themselves with no livelihood. The reclamation of New Mexican lands was so extensive that only 300,000 acres of land belong to their "original" owners out of the whole state- 3/1,000 of the state's acreage.

As the traditional, land-based economy faded in favor of agriculture for profit, degradation of lands began along with the degradation of culture. Drought in a dry Southwestern place, along with overgrazing and monocropping, resulted in massive erosion. Some efforts were put in place in the 1930s by soil conservationists to restore eroded lands; including regulating grazing times, reseeding, and using vegetative cover to prevent future degradation by wind and heavy rains. People living off of the land were afraid of change because of the historical changing-of-hands of the land that had occurred throughout the previous 200 years, and therefore did not follow many of the soil conservation efforts. These events resulted in even further erosion that continuously degraded agricultural lands, resulting in areas today that have massive rifts or virtually no topsoil.

From the transition of Native American-dominant communities, through Spanish conquistadors and eventually Anglo homesteaders, there were many conflicts. However,

none were as severe as the arrival of Los Alamos National Labs, which changed the face of Northern New Mexico forever.

1.3 History of Los Alamos National Laboratory

Los Alamos National Laboratories is perhaps the most important complex in Northern New Mexico, providing jobs and security for the majority of people in the region. Its history begins in the 1940s and stretches to current day, eclipsing the history of Pueblos and conquistadors in the region. This history is important to consider because it shaped how the labs operate now and the historical practices of the labs have shaped health in the region. Information in this section relies on the histories written by Masco (2006) and Rothman (1997), as well as several personal experiences I had while in the Southwest and official reports from throughout the lab's history.

Siting the Labs

With the introduction of the Manhattan Project in 1939, the US Government became increasingly interested in formulating a nuclear weapon for military use. The project was a research and development program by the government to produce an atomic bomb, run by Robert Oppenheimer with Major General Leslie Groves as the director of the facility. With the project in place there was a search for a proper location for the laboratories creating the bomb. In 1942, Oppenheimer proposed Los Alamos and claimed that the area would inspire scientists working on the project and bring their work to fruition. Oppenheimer had spent

time at a boys' school in Northern New Mexico, and thanks to his experiences, the area represented freedom and a vigilant spirit to him that he hoped would also find the scientists. Major Groves was in favor of the location due to its seclusion; with only one road into and out of Los Alamos, the area could be secured without fences or barracks. In addition, a majority of the land proposed for the use of the labs was already owned by Federal agencies through the Park and Forest Services. However, there was still a great expanse of land known as home to many people at the site.

Los Alamos was home to the Los Alamos Ranch School in 1942 also. The Ranch School was similar to the one which Oppenheimer had attended himself. The school took up a small amount of space on the tablelike plateau, surrounded by land which was homesteaded by poor Hispano and Anglo farmers who had been there for years. Their ranches spread across the outer edges of the plateau, where their animals could graze freely. San Ildefonso Pueblo, which laid claim to the surrounding land for thousands of years, was located down the hill. In fact, most of present-day LANL resides on land historically belonging to San Ildefonso.

Very shortly after Oppenheimer's proposal the government decided that Los Alamos would be the official site, despite the land being occupied by farmers, ranchers, and local Puebloan people. Groundbreaking began in late 1942. The government seized the land from the Los Alamos Ranch School, as well as the poor homesteaders who didn't have legal rights to land protection. To this day, seizure of land is a sore point for many people who were

forced off their property in order for the labs to be built and never got what they were promised in return.

Once the ground was broken, the labs were built under a shroud of military secrecy. Mail was sent to all scientists on the plateau at PO Box 1663, regardless of their actual address in Los Alamos. The people who lived there generally called the city Los Alamos or "the mesa." People in Santa Fe referred to it as the Hill. In government and military speak, it was sometimes known as Site Y, or the Zia Project, neither of which caught on (Wilson and Serber, 1988).

Wilson and Serber (1988) recount through interviews with local women that the Los Alamos National Labs were actually formed as a group of laboratories focusing on different aspects of the formulation of an atomic weapon, with each specific laboratory known as a technical area, tech area, or more casually, tech. They were overseen in the beginning by Oppenheimer and a group of handpicked young and brilliant theoretical physicists. Special passes and badges were required for admission into the technical areas, which were manned by military guards.

A piece from Rothman's history (1997) of the Pajarito Plateau accurately captures the immediate shock Los Alamos National Labs brought to Northern New Mexico:

> Los Alamos had been dropped into a world to which it bore no relation. Not only were the physicists immersed in the realm of science… lonely and isolated in an aesthetically beautiful place, but they were also light years away from their predecessors in the way that they perceived institutions, in their reliance on the

> sociocultural infrastructure and in their level of integration into mainstream American society. (Rothman, 1997: 209)

The Pajarito Plateau, which had only been part of the industrial world for sixty years before the introduction of the labs, was dropped into a place of subservience to people who would ultimately shape the future of the world. The deep history of the plateau was quickly lost under the news about exciting new nuclear technologies and the scientists' interests.

After the War was Won

When World War II ended and Los Alamos National Labs was done celebrating, the encampment on the isolated Pajarito Plateau went into a brief period of decline. Oppenheimer, the brilliant young physicist who had opened the lab, was no longer director, having passed the torch to Norris Bradbury, who brought a new sense of urgency to weapons science at the labs. At this point in history, there was seemingly no more need for atomic science. Some thought the labs should shut down operations and abandon the installation high up on the plateau. LANL was rescued from this grim future by the uprising of the Cold War. In 1950, Bradbury explained his position on keeping the labs open, stating that the US truly "had, to put it bluntly, lousy bombs" (Fradkin, 1989, p 81) and that weapons science had a long way to go.

Bradbury (as cited by Fradkin, 1989) suggested that Los Alamos stay open to improve the reliability, versatility, size and weight of the weapons currently in the US stockpile. He insinuated to President Truman that there were actually no bombs in the current arsenal that were immediately usable. When the President received the news of ineffective bombs, he

immediately committed to expand the weapons program; by the following year, LANL had produced fifty more weapons for the stockpile. The decision to continue research and develop the hydrogen bomb in 1950 further increased nuclear science at LANL (Fradkin, 1989).

Shortly after this point, with the labs pumping out a seemingly endless supply of weapons, Bradbury realized what a monstrous new weapons laboratory he had created, stating in 1955:

> The future beyond [this] point looks somewhat unrewarding. Fissionable material will go on and on being made until the efficiency of atomic weapons will become of academic interest. Everyone will ultimately have all the weapons in all the variety wanted and the number will probably be more than the world can safely tolerate being used. (as cited in Fradkin, 1989: 81)

Bradbury's statement is shockingly accurate in regards to the US nuclear weapons arsenal today. The exact number of weapons in the stockpile is not publicly available, but is thought to be 5,113 warheads, in comparison to Russia with over 1,300 and France at around 300 (Arms Control Association, 2012). It can be stated, however, that the quantity of weapons globally is more than enough to validate Bradbury's foreshadowing of "more than the world can safely tolerate…" (Fradkin, 1989:81).

In 1963, the Nuclear Test Ban Treaty was passed by the United States, banning all above-ground testing of nuclear weapons. Underground testing was allowed, and was practiced as new technologies of weapons were released. The development of nuclear science was so rapid that a group of scientists would spend six to eight years creating a weapon that

they acknowledged would be replaced with new technology within ten years (Fradkin, 1989). In 1993, the world of nuclear science was shattered when the Comprehensive Test Ban Treaty was passed. No longer was any testing of nuclear weapons allowed, with surveillance by seismographs kept at all hours of the day to monitor violations.

The Labs Today

Fuller Lodge, the main building of the former Los Alamos Ranch School and the public hall of Los Alamos National Labs (Figure 2), now operates as the Los Alamos Historical Museum. The Bradbury Science Museum, located down the road from the Historical Museum, named after Norris Bradbury, is the public science museum related to LANL. Entering these museums on my second day in Los Alamos was a strange experience. Both museums glorify the short history the city has had in the past seventy years, with a scarce shred of history mentioned pre-1942. Fallout shelter signs in assorted colors line the walls next to plexiglass sheets protecting a small 1950s kitchen, complete with pastel toaster and replicas of atomic-era canned foods.

It seemed strange that a historical museum would concentrate so strongly on the present and future rather than the past. It seemed even stranger that the science museum glorified atomic weapons so single-mindedly and strongly, citing them as responsible for saving our society from violence and war. Both spaces gave the aura of containing the ultimate truth and refuting anyone who had an alternative story or opinion. Black and white photos and old

radiation badges boast how brave Los Alamosans had been, but ignore how many people had been hurt in the process. This was a theme that followed me throughout my time in the area: a lack of history in Los Alamos versus the deep, meaningful history that exists in the surrounding Pueblos.

The physical facilities of the labs are aging buildings reminiscent of the 1950s government style. Some new buildings have been constructed, but a huge budget is required to put up new laboratories with the required safety equipment. A map of the labs from above (see Appendix B) shows that the land is split up with atomic era names of "Technical Area (TA)" 1 through 74. The technical areas contain everything from shooting ranges to waste management to plutonium labs. Certain areas within TAs gain a letter as well, such as Technical Area 54 which contains the largest waste dump, more commonly known as Area G. Huge new scientific complexes are consistently proposed in order to further science in more modern settings.

Current day LANL is a different creature than it was in the past. The US still continues to spend over $6 billion a year at the three national laboratories (including LANL) on nuclear weapons science (Masco, 2006). This is actually a greater monetary total than during the Cold War, which averaged at $3.7 billion a year, adjusted for inflation (Masco, 2006). Unlike during the Cold War, the majority of LANL's money now is devoted to maintaining nuclear expertise, upgrading the nuclear arsenal and watching Cold War-era bombs age.

Other scientific ventures now occur at Los Alamos National Labs, and receive approximately 4% of the LANL budget (LANL, 2012). "National security," National Nuclear Security Administration (NNSA) Weapons Programs, NNSA Safeguards and Security, NNSA Nonproliferation and DOE Science receive the majority of the remaining budget (LANL, 2012). LANL's other areas of research occur in a multidisciplinary manner including space exploration, renewable energy, medicine, nanotechnology, and supercomputing, all upcoming fields of science. Non-nuclear fields of research have afforded LANL a respectable name in the larger scientific world.

LANL is still part of the Department of Energy, and therefore receives its budget through the DOE alongside the National Nuclear Security Adminstration (LANL, 2012). It also, from time to time, receives funding from the Department of Defense. Specific line budgets are not required to be passed through Congress, due to the military secrecy and national defense claims LANL boasts. The labs maintain a complex relationship with each branch of the US military as well as corporations and industrial suppliers because its work spans so many governmental concerns.

The money that is spent at Los Alamos National Labs today go into a program known as "stockpile stewardship," ushered in after the Comprehensive Test Ban Treaty (LANL, 2012). Stockpile Stewardship falls into two specific areas: the application of physics and engineering to the whole "cradle to grave" lifetime of a nuclear weapon and the use of

nuclear weapons in science and technology to support national objectives of a number of areas including environmental restoration and nonproliferation (Masco, 2006; LANL, 2012).

Stockpile stewardship is a program which covers most of the new buildings and administration of the laboratory. Taking care of aging bombs is proving to be more challenging to scientists than creating them. New engineering is being used in "bomb hospitals" to peer inside of the mechanisms of existing weapons to ensure their reliability and potency. So much pressure was put onto initially developing a weapon, and then creating exciting new technology that the microscopic, microsecond-by-microsecond phases atomic weapons go through were never studied. This is what nuclear scientists at LANL study now.

Stewardship is a controversial topic because billions and billions of dollars are poured into diagnostic technologies. Through the Cold War, as thousands of warheads were put together, safeguards were put into place to make sure that the bomb would not detonate if it fell into the wrong hands. Switches, locks and controls were put on each and every weapon in the name of protection.

These weapons, in their guarded state, are almost certainly inert, sitting on a shelf in a storage facility; this is why the billions of dollars poured into extensive testing of weapons are contested (Masco, 2006). All of the x-rays and diagnostic tools used to monitor aging bombs may realize a 10% decrease in power, but the weapon would still level an entire city (Masco, 2006). If the goal of stockpile stewardship is to ensure the well-being of the nuclear arsenal such that the weapons can be used in future wars, perhaps less intensive monitoring

is needed. The idea of complete nuclear non-proliferation also comes into play in the conversation. Activists claim that if the United States is committed to eliminating nuclear weapons, Stockpile Stewardship money should be spent on dismantling and recycling materials from the 5,113 weapon currently in the arsenal (LANL, 2012).

The histories of Northern New Mexico at large, including the Pueblos and the Spanish Conquest, land grants, and the Treaty of Guadalupe Hidalgo have created an area with profound roots in the specific geography of the region. Colonization and politics have shaped both land use practices and social dynamics to this day. Social dynamics exaggerated with the arrival of LANL have shaped communities in the area. The initial mission of the labs goes directly against the core beliefs of the Pueblos, as seen in their histories, and has ultimately led to a decline in spiritual, emotional and physical illness, as I will move on to explore.

Chapter 2: More Than the World Can Safely Tolerate

The split of cultures and wealth throughout Northern New Mexico is vast. It is a place in which the most exaggerated extremes of wealth and poverty are seen within an hour's drive. Los Alamos County, atop the Pajarito Plateau, has been rated as having the number one living conditions in the country, while Rio Arriba County down the hill, which holds both San Ildefonso and Santa Clara Pueblos, is rated 2,303 out of the 3,141 counties rated (Berkowitz, 2010). Santa Fe and Taos rate extremely high on the list as well, creating a nearly perfect triangle of living conditions on a map. The correlation of ethnicity to poverty is almost linear here. Los Alamos, the county with the highest rated living conditions is the most white. The relationship between ethnicity and poverty has created extreme social dynamics, which I will discuss leaning heavily on personal experience speaking and interacting with people across Northern New Mexico throughout my summer. These correlations side-by-side with health disparities prove the conditions of environmental injustice.

2.1 Pueblo/LANL Relations

Land

Los Alamos National Labs itself is located right on the foot of a volcano. Within Pueblo cosmology and beliefs, the caldera is a place of fire and one of the most sacred sites

that exists. It is not seen as coincidence that the place that released the "eternal fire" (Masco, 2006, p 107) is surrounded by volcanic sacred sites. In the beginning years of the labs when environmental impact statements weren't required, buildings and even dumps were put up quickly on sacred areas.

The Department of Energy (DOE) generally does not validate the sites which they have built upon as being sacred, claiming no important ruins existed on the land (Masco, 2006). What the DOE does not understand is what sacred truly means in a culture where mountains, caves, cliffs and even open swaths of land are sacred. "Sacred"ness of a place should never have to be defined. Dumps and buildings have, throughout the lab's history and even present-day, been constructed on sacred sites with little to no acknowledgement.

As the labs were built, the local people were not brought into the decision-making processes or planning due to "national security" and time concerns (Masco, 2006). The surrounding communities weren't told what type of industry was being forced into their homeland, but assumed the best of intentions. This was, perhaps, not the case, as Gregory Cajete of Santa Clara Pueblo states:

> As I was growing up, we used to talk and wonder about what was going on at Los Alamos. And we would reflect on how different the people from Los Alamos were, not only in terms of students and people that were up there but also the kinds of things that were part of the whole community, because largely Los Alamos kept to itself. It began as a scientific city, a secret city. There are so many stories as to why the lab was located at Los Alamos. One of them, of course, was because of its isolation… but I also think because of the fact that it was being put in a place where if something did indeed go wrong it wouldn't affect too many people. And the people it

> would affect, in a sense, in that time and place, were considered, I think, in some ways of thinking, almost expendable. (as cited by Masco, 2006: 132)

It is common discourse that the placement of the labs on the Pajarito Plateau was an intentional decision based on the "disposable" surrounding communities. Disposability is recognized more frequently when referred to as the "National Sacrifice Zone," a term coined in the WWII era to concrete that it was the citizen's duty in wartime to allow the government to do what was needed, in order to be a good patriot (Masco, 2006). This concept has caused millions of lives to be affected by ill-informed lab decisions during wars.

Much like the sacred spaces on the mesa top, Natives in the area were often seen not as people, but as part of the "national sacrifice zone" in the atomic age. They were, as Cajete says, expendable and without data and analysis to support his claim, the DOE would do what it thought was best. Natives were moved from their homes, and used as a low-paid workforce at the labs, cleaning up after the scientists and handling a great majority of the waste on the land.

Health and Sickness

LANL has contaminated millions of resources in the Rio Arriba valley, some of which are sacred and roped off, but most of which are contained within reservation land, water, and air. These are resources used by the general public, but under the guise of secrecy and national security, many of the contaminant releases by the labs are not made known to the general public, especially those from the past.

When the Cold War ended and the information flow was opened, many public forums were held by LANL to try and integrate itself into the communities as trustworthy. At the public meetings, the first concerns about health issues caused by the labs surfaced. In the early 1990s, San Ildefonso, located closest to the labs, announced they had determined increased rates of cancer going back to the founding of the Manhattan project (Masco, 2006). Pueblo members attended meetings pleading to know why they had so many cancers (Berkowitz, 2010).

Native Americans in New Mexico currently experience significantly higher rates of cancer than other ethnic groups (RACHC, 2008). The rise in illness is a starling change from the first decades of the 19th century, when prevalence of cancer in Natives was so low, they were thought to be "immune" to the disease (Masco, 2006, p 140). Some initial scientific studies have begun to correlate environmental releases of hazardous chemicals to elevated disease in New Mexico (see: Lemstra, 2009; Makhijani et al., 1995), but they are often overlooked or swept under the rug (Masco, 2006). Environmental contaminants and hazards through LANL are not known because they are not required to be published, or simply because the labs don't know the releases themselves due to poor past laboratory conduct. Contamination is unacceptable because pollutants likely have direct impacts on the health of surrounding communities.

The relationship between contamination of sacred land and sickness is often held as the common thread between Pueblos. Tewa Women United published on their Environmental Justice page:

> LANL has been dumping and discharging its toxic and radioactive wastes onto Tewa ancestral land. This land is revered as sacred to our people. LANL is surrounded by four pueblos; San Ildefonso and Santa Clara sit adjacent to LANL, both downwind and downstream. This contamination from dumping and discharging has been devastating to our land, water, air, food and the overall well-being of our people and ways of life. (TWU, 2011)

The labs have not only taken away sacred sites from Pueblo access, but have contaminated them with toxic chemicals. Taking away the places most sacred to the people and therefore, their spiritual connection causes even further physical strain as well in the form of stress and anxiety (Berkowitz, 2010).

2.2 Environmental Health

Health in Northern New Mexico is a contentious topic. Many of the women I worked with over the summer felt very strongly about the topic, attributing elevated rates of sickness, and more specifically, cancer, to the introduction of Los Alamos Laboratory in the 1940s. Many conversations I had which included local people, including members of the Pueblo communities, all reflected the fact that everyone knew someone who got sick from the labs. While most of the voiced concerns were focused on issues of radioactivity, the labs, and how they have impacted health here, it is the hazardous and toxic chemicals that I primarily focused on for my Division III. In fact is it non-radioactive chemicals which are

the sleeping dragon of the valley, slowly making their way into the water that is the lifeblood of these communities.

In this section I focus on first the role of environmental health and justice movements in defining health issues for economically stressed populations. I then incorporate health disparities in New Mexico, which include my observations and personal conversations with people from the region including Pueblo members as well as scientists up "on the hill." To further understand the complicated relationships of health, sickness, and the role of the labs in exacerbating issues Northern New Mexico, I will also utilize Maya Weiner Berkowitz's Division III from 2010. Her work explores issues of environmental justice, health and sickness in the Rio Arriba Valley through personal experience and independent research while also working with Tewa Women United. I also make extensive use of the environmental justice work by Nia Robinson (2008) and Robert Bullard (2010) and the environmental health work done by Sandra Steingraber in her book "Living Downstream" (1998).

Environmental Health and Justice

Environmental health is an important field of research which attempts to address public health as it relates to the environment a person is living in, whether it is a city street, down the road from a factory, or in the forest (Schapiro, 2007). More succinctly, it looks at the environment, both natural and built and how it affects the health of communities.

However, environmental justice (EJ) is separate from environmental health and in some circles is considered a branch of social justice where physical environmental degradation and social environmental arrangements are involved. Bullard, one of the leading voices in the EJ movement, is cited in Wakefield et al. (2010:n.p.) as defining environmental justice as something fundamental, "embracing the principle that all people and communities are entitled to equal protection of environmental and public health laws and regulations." Bullard's statement, of course, assumes that the state in question has environmental and health regulations in place.

An important part of the environmental health and environmental justice movements is that they both look at how multiple sources put people's health at risk (Wakefield et al., 2010). In areas like the American Southwest this is particularly important as many communities live on the margins. Compounded disadvantage is an environmental health term that takes into account several levels of health risk, adding environmental insults such as contaminants and stress which all result in elevated rates of disease (Schapiro, 2007). Compounding is an additionally important aspect to consider in Northern New Mexico as there are high rates of potential environmental exposures that put disadvantaged communities at risk.

The combination of health risks that are faced by communities may not be tied directly to specific, single, environmental contaminants and disease outcome (Wakefield et al., 2010). It is more probable that a slew of contaminants result in a "slow drip," that is more

likely to affect health, resulting in chronic and heavy bio-loads on the human system. Thus, the constant exposure to chemicals at low levels and in compounding amounts causes a great amount of scientific uncertainty as to what actually causes the diseases within a certain environment. Often the direct links of toxins in the environment to human health issues are confounded by other toxins as the result of widespread introduction of suspected chemical carcinogens; this is seen as a kind of uncontrolled experiment (Steingraber, 1998). The result of the experiment is complicated because each environment has different issues and chemicals which impact the specific area. A society which remains without any chemical exposure and would have a "natural" rate of disease no longer exists (Steingraber, 1998).

While there is no "control society," exposures to chemicals in the environment are unimpeded and multiple, as mentioned before (Steingraber, 1998). Chemicals are poured into the environment, exposing communities daily to small amounts through many different routes. For example, in the Southwest, a community member living in the desert may be exposed to arsenic through their water supply, through soil on their hands after gardening, as well as through inhalation of airborne dusts, all at small levels. This is in combination with hundreds of other single exposures throughout the day in the same and different exposure pathways. From a scientific point of view, such combinations are especially dangerous because they have the capacity to do immense harm while yielding meaningless data (Steingraber, 1998). The problem with the majority of contaminants is not longevity, but the

fact that we are continuously exposed to them through multiple routes (Steingraber, 1998). This is the case for all four chemicals I have investigated.

When we turn to the environmental justice movement after looking at the main issues of environmental health, they are framed differently. Environmental justice addresses the disparities that are often the result of racism, coined "environmental racism." Racism in the environmental sense manifests itself in unequal distribution of toxic wastes, wealth, resources and industrial sites (Cole and Foster, 2001). Furthermore, the framework of environmental justice recognizes that communities which bear heavier toxic burdens are often poor communities and as such bear the weight of pollutants from around the globe (Cole and Foster, 2001). Environmental racism is of particular interest here as my work covers reservation lands and regions where the local populations are some of the poorest in the United States.

These populations of Pueblo Indians are emblematic of issues of institutionalized racism in the United States, which is an "overarching institution of power that acts as a force for inertia, blocking progress…" (Hoerner and Robinson, 2008, p 42). These institutions have powerful hold and are now resulting in environmental legislation, including funding decisions on superfund cleanup sites, locations of government military installations and laboratories, as well as some threshold cleanup levels of contamination which all foster issues of racist ideology (Cole and Foster, 2001).

In the desert southwest, the locations of toxic sites such as incinerators, landfills, and chemical factories have been shown to increase in communities who have less political power; often poor communities of color who are then disproportionately affected (Hoerner and Robinson, 2008). In New Mexico, there are fifteen sovereign Indigenous nations within a fifty mile radius of Los Alamos National Labs (Masco, 2006). On the national scale, the disproportionate burden also been seen, with unequal distribution of toxic waste facilities targeting Indian land (Cole and Foster, 2001).

Indigenous Environmental Health

The Puebloan people have been on their lands for hundreds, if not thousands, of years, carrying on the same traditions, but they are now exposed to environmental contaminants through newly, disproportionally spread toxic sources. This is devastating to the health of communities which have deep traditions with the land and their bodies, as Tom Goldtooth, the leader of the Indigenous Environmental Network (IEN) stated:

> It's not as simple as telling… a mother not to breastfeed, because the original instructions are not man made. These are original instructions that are part of our spiritual being. (as cited by Cole and Foster, 2001, p 137)

Taking away the ability of Indigenous peoples to practice traditional living, including farming and water usage, as well as spiritually connecting to their ancestral lands, is environmental injustice. Forcing Pueblo communities away from their land and tradition due to widespread contamination not only affects health in the direct contaminant way, but also spiritually, contributing to stress and further sickness (Cole and Foster, 2001).

In the Rio Arriba Valley, water is what led people to settle. Now, the same water is contaminated and is seemingly responsible for significantly elevated rates of sickness in the community (Travers et al., 2009). Changes in the local environment as well as the severe lack of healthcare in the Rio Arriba Valley have vastly altered the life course and health of many community members (RACHC, 2008). No longer are many of the traditions, which have existed for hundreds of years, practiced, due to these changes. For example, the potteries created in the Pueblos: both black volcanic ash sand and red clay from the plains are collected in order to create the unique ceramic style of Santa Clara and San Ildefonso. They are traditionally combined with blessed water from a spring or river while reciting prayers or song. These potteries, once fired, are used for cooking and also for eating and drinking directly. If the soils are contaminated, then so are the potteries, and therefore there is a direct exposure from soil to mouth. Pottery has a very specific contamination route in the Pueblo community, but there are also many others which connect back to tradition.

Multiple routes of contamination were also a large part of the community I was working in and must be considered in the larger health picture. Water is used for drinking, cooking, showering, brushing teeth, and to water gardens, which produce crops that are then consumed. The soil, which those crops grow in, also is kicked up and inhaled in dust devils or during heavy monsoons. If the water is contaminated, this creates countless other ingestion routes. Even if a community member were to drink and brush their teeth with

only bottled water, but ate tomatoes from the community garden in an attempt to be healthy, they could be inadvertently ingesting the same amount of contaminants.

The "Most Sensitive Population"

Women are often the most sensitive to environmental toxins, and as such, one would think that women's health should be included in all public health evaluations, considering women make up 46% of the US public (Vahter et al., 2007). It is alarming to realize that in a survey of 1233 published epidemiologic studies on occupational cancer, only 7% concentrated on women, and only 1% on nonwhite women (Wakefield et al., 2010). The effects of sex have largely been overlooked in epidemiology and toxicology and therefore have not been incorporated into formation of public health standards (Vahter et al., 2007).

While much of the past research concerning epidemiology and environmental health has mainly involved occupationally exposed males who were considered to be representative of the population in general, recent research reveals that this is not so. The elderly, women, and children have significantly different health profiles (Vahter et al., 2007). However it is the studies on men which have determined maximum contamination levels (MCLs) in drinking water and other EPA limits in the US (Wakefield et al., 2010). A focus on men in formulation of MCLs has led to potentially dangerous limits which do not consider the biological factors which may influence the kinetics and toxicity of chemicals in the bodies of women differently than they do in men (Vahter et al., 2007). While research is still needed

on women's specific health, some differences seen are the result of larger muscle mass and body weight in men, differing hormones, and also potential exposure differences during menstruation (Vahter et al., 2007). Newly published health studies are moving towards including explicitly separate health assessments of women and men biologically, which is encouraging.

While biological factors are important, lifestyle can largely determine exposure to occupational and environmental chemicals, also adding to the disparities between the sexes, and for different age groups. Lifestyle factors include: smoking, dietary and nutritional inputs, physical activity, cosmetics and fashion as well as stress (Vahter et al., 2007). Exposure may increase exponentially between men and women in the case of some trace chemicals which are found in certain materials specific to daily activities (Wakefield et al., 2010). This also must be integrated into health studies in order to ensure true protection of health of all populations.

Alongside women, children are also ignored to a great degree in health studies, and if they are integrated, it is often as "small adults," (Wakefield et al., 2010). However, exposure to environmental toxicants early in life has completely different implications than adult exposure (Vahter et al., 2007). For example, endocrine (hormone) disrupting chemical exposure in childhood can devastate development both physically and mentally (Smith, 2006). Children have different behaviors and physiology from adults and thus "adult" levels of exposure throughout their growth and development results in higher bio-loads over the

course of a lifetime (Smith, 2006). The toxic exposures of children in the American Southwest have been seen to have hormonal influences on the brain (see: Vahter et al., 2007). These are pathways that add to total exposure and cannot be ignored.

Turning an eye to children and soil ingestion specifically, the factors change somewhat. Inhalation must still be taken into account, but so must ingestion through hand-mouth routes as well as play on the ground (Smith, 2006). Generally speaking, children ingest soil in ways that adults do not. The dust-hand-mouth pathway is one which is astoundingly common in many children who spend their time crawling on the ground or playing outdoors (Abrahams, 2002). The intakes through play are not insignificant amounts, with a mean ingestion amount of 184 mg per day of children aged 1 to 12 years old (Calabrese et al., 1994). Children 6-12 years old ingest only 25% the amount of soil a 1-6 year old does (Calabrese et al., 1994), which is alarming due to the important developmental stages in the ages of 1-6 years old. Exposure to endocrine disrupting chemicals at a young age may have devastating effects.

Additionally, 30% of indoor dust is made up of tracked-in soil from outdoors (Calabrese et al., 1994), which contains all contaminants that outdoor soils do. Children often play on floors, with their faces close to the ground, increasing risk of ingestion via mouth or inhalation (Smith, 2006). Play is a way in which contaminated soil may then affect children in a way that it does not affect adults.

Women and children have not been acknowledged in health studies and this is seen very clearly in Northern New Mexico, and the decisions which have been made there to protect citizens. Los Alamos National Labs, in their health assessments, specifically uses dose conversion factors for a 154 pound male, known as 'reference man,' because "dose conversion factors for populations other than adult workers have not been published by the DOE," (Smith, 2006). The use of a "reference man" is a sweeping generalization and may be putting thousands of people at risk for serious illness, because in some cases, protective drinking water limits are lowered by ten-fold in order to protect all women and children.

From here, in my discussions of health, I will concentrate largely on the effects of contaminants on women and children because they are truly the most sensitive population and have been ignored by Los Alamos National Labs health studies. I will also take into account the specific exposure routes that are experienced by Pueblo communities, because I believe an integrated approach is completely necessary to ensure health for all people. I believe that health is a human right and that the population of Rio Arriba Valley deserves nothing less than this treatment.

Regulatory Limits in the US

"Maximum contaminant levels," also known as MCLs, are limits set by the US Environmental Protection Agency (EPA) as the legal threshold limit of a certain contaminants that are allowed in drinking water. Threshold limits developed by the EPA are

done so in the name of protecting public health; however, MCLs are not simply a health based standard- they also take into account cost and the availability of technology to reduce contaminants to particular levels (Steingraber, 1998). Often the limits set by the EPA are further restricted by states, which set lower limits in order to protect the most sensitive populations: women and children. Lack of further restriction leaves citizens in states without more stringent guidelines in a potentially threatening situation.

In Maya Wiener-Berkowitz's Division III (2010), she talks about a woman at Tewa Women United who referred to MCLs as "allowable harm." Ideally, we want none of these contaminants in our bodies at all, and most of them do cause harm at trace levels, though the effects are often not known. The system put out by the EPA of regulating one contaminant at a time also brings back the question of how combinations of chemicals may act in concert to harm the body (Steingraber, 1998). Combinations of contaminants may cause more disease or completely different disease than are being predicted by EPA models.

In the research that I conducted on contaminants (see Chapter 5) I rely on established maximum contaminant levels. Previously established MCLs help to frame my analysis of the health effects of the contaminants I investigate and to tie my research into the current literature. However, I do not believe that EPA standards accurately reflect the real health risks and potential bio-loads that people are being confronted with. In addition, it is clear that the EPA system of evaluating contamination needs a lot of work; therefore I will also be

keeping a close eye on also integrating non-governmental research which looks at contamination with a more critical lens.

2.3 The Rio Arriba Valley and Health

As I have reviewed, specific health risks may be attributed to every community, especially those subject to an unequal burden of environmental toxicants such as Rio Arriba County. Rio Arriba is an extremely disadvantaged community and this, in combination with high risk, has created a situation of elevated sickness. Knowledge and understanding of local contamination is low due to access barriers, which in return creates more risk of sickness. It is important to understand and review these statistics and understand what creates risk in the valley to assess overall health.

Elevated Sickness in the Valley

Health studies published by LANL are generally predicated on a theoretical basis. Data is gathered from surrounding hospitals and clinics and condensed down into a general statement regarding health. This would be a relatively reliable manner of conducting health studies, if healthcare was reliable in the Valley (Berkowitz, 2010). There is a desperate lack of access and limited number of clinics in the area (Berkowitz, 2010). The main health service, provided to people living on the reservations, is known as Indian Health Services (IHS). But many Pueblo members do not trust IHS, especially in the context of accurately recording causes of death, which would give better statistics on health risks. Many claim that often

when people died of cancer, IHS lists other causes of death on their death certificate, which has skewed the official cancer rates (Masco, 2006). Furthermore, inaccurate recording may be affecting overall studies in the area, or hindering appropriate knowledge of health needs in these communities (Berkowitz, 2010). Outside the Pueblos, like in Espanola, Santa Fe and Los Alamos, clinics and hospitals are often too expensive, and thus there is an overwhelming lack of health care in the whole region (RACHC, 2004). Lack of health care results in a lack of studies of cancer rates and causes in the region, and as support relies on high levels of need, the statistical portraits drawn are irreconcilable with the small scale of communities in the Rio Arriba Valley (Masco, 2006).

Beyond the larger health support and reporting issues that populations in the area face, a lack of access to clinics, specifically to reproductive healthcare practitioners, has a direct impact on women's health. A gap in care may be contributing to the overall elevated cancer rates for women, which have been found to be twice the state average in breast and cervical cancer (Berkowtiz, 2010). Female reproductive cancers in Rio Arriba County are 75.03 for Native women, 32.04 for Hispanic and 31.19 for Anglo women per 100,000 (Berkowitz, 2010). This is a significant difference, and since there are no empirical or national health studies, the root causes of high rates of cancer in Native communities are not understood, but it is proposed it is due to toxic environmental exposure.

One study published in 2004 by the Rio Arriba Community Health Council (RACHC) about health in the Rio Arriba valley, involved surveys, focus groups, community meetings

and town hall forums to investigate health disparities in the region. It was found that the rates for general cancers in Rio Arriba County are elevated when viewed in contrast to New Mexico's average rates. It was found that for 191.1 per 100,000 people cancer was the cause of death in Rio Arriba County, versus the New Mexico rate of 159.2/100,000 (RACHC, 2004). Among males, the rate was 260.0/100,000 versus the state average of 188.5/100,000, with significantly higher rates of stomach, kidney and renal cancer. For women, the rate was 139.2/100,000 against the rate average of 137.3/100,000, with fairly similar rates of all cancers (RACHC, 2004).

It is hard to trace the root of elevated rates of cancer, because there are so many causes, including stress, exposure to industrial chemicals, and genetic factors (Fradkin, 1989). This is reality and is what the field of environmental health seeks to investigate. Environmental exposure and linkage to disease is hard to prove due to compounded disadvantage, which in Rio Arriba valley involves the lack of healthcare access as mentioned above, as well as stress from living in an economically depressed area in the shadow of an atomic laboratory. The causes of the cancer are somewhat unclear, but the numbers are straightforward. The valley is an area with high rates of cancer.

It is also clear that this situation is a direct example of environmental injustice. Rio Arriba Valley is a poor community of color which has been exposed to contaminants through many different sources over an extended period of time without their permission or knowledge. The figures on elevated cancer in Native American and Hispano communities as

well as elevated cancer in the Rio Arriba Valley as compared to Santa Fe are direct. If one can afford to leave the community to avoid potential contamination from the labs, or can afford to leave the community to receive better healthcare, they will most likely have less compounded disadvantage, but leaving isn't an option for many people in the community. The class dynamics, which were discussed earlier, have created a valley in which health is determined by social standings.

Access to Health and Science

Through my experiences in Northern New Mexico, working to look at health, I read through thousands of pages of LANL documents regarding contamination, possible chemical releases and health. Specifically, I reviewed the Final Supplemental Impact Statement for the Chemistry and Metallurgy Research Replacement Project at LANL, the Final Long Term Management and Storage of Elemental Mercury Environmental Impact Statement, Plans and Practices for Groundwater Protection at LANL, the Corrective Measures Evaluation for Material Disposal Area G at LANL and the Draft Environmental Impact Statement for the Disposal of Greater-Than-Class-C (GTCC) Low Level Radioactive Water and GTCC-like Waste at LANL. LANL and DOE documents are incredibly hard to read due to their thick, academic language. For every proposal for cleanup, new operations or new buildings, the labs are required to put out an environmental impact statement (EIS) which informs the public of all options being considered as well as the potential impacts those options will have on the surrounding flora and fauna, as well as social and cultural impacts. In total, the five

documents I summarized contained over 1,000 pages, with complicated graphs and charts, and took me the entire summer to review and consolidate in order to share with the community.

The EIS documents I reviewed were challenging to read and I found myself taking breaks every twenty minutes or so in order to clear my head. The women in my office told me that they had never been able to keep up with the documents and clearly understand what was being said, which is why I took on summarizing them with complete definitions as one of my main projects. EIS documents are released at least once a month through different departments at the labs, either summarizing the environmental impacts of a proposed building, reviewing environmental conditions or looking at citing waste disposal on the plateau. This rapid pace is the most challenging part of processing and understanding the documents coming out of the institutions.

LANL's impact statements and even the public notices announcing open forums are intended to include the public in decisions which use their tax money, but are not accessible in the least. Often times, they include no background information, history or appendices to aid the reader in understanding the data being presented. Some at the labs claim that the solution to fixing the problem of access is more science education, to provide knowledge. What I believe is more important is common language and open discourse.

It clicked that the thick language and constant release of official documents was a mechanism that was being used by the labs to further isolate themselves from the

surrounding communities. The labs are required to put out statements, but they are not required to release them in language that is accessible to non-scientists. As the Pueblo communities have become more frustrated with trying to understand institutional scientific language, they have stopped reading them as reliably; it's impossible to stand up to something you can't comprehend. Barriers to access have effectively achieved some apathy in communities surrounding LANL which feel that they are up against an unapproachable institution.

There have been several documents published by LANL and contractors working for LANL that look at contamination on the Pajarito Plateau and in the Rio Arriba Valley (see: EHC, 2007; Ferenbaugh et al., 1982; Hopkins, 2007). Official documents and reports have been incredibly important in my work, but they are not accessible to the communities I worked with due to their isolating language. Because of this the labs remain to be largely a mystery danger up on a hill. Knowledge is important, and having the knowledge of what contaminants are in their land could help Pueblo communities protect their health, or at the very least, inform them of the possible risks.

It is a common thread through environmental injustice- that the institutions causing health disparity put out what they refer to as "public" or "common" documents. This allows them to be able to claim that they gave communities a chance to voice their opinion. In communities with a lack of political power to begin with due to their class status, assuming understanding is an inherent mistake. The example of the interactions between LANL and

the Pueblo communities fits this mold perfectly. In order to honestly include the most disadvantaged, minority voices, LANL needs to step up and put out clear statements that cater to everyone, not just everyone who lives in academia.

Chapter 3: Toxic Origins and Movement in Northern New Mexico

The Rio Arriba Valley is a complicated space when it comes to looking at pollutants, due to numerous potential sources and unknown geochemistry of the landscape, that make up the mesas and canyons as they cut through by the Rio Grande. To predict and ultimately avoid health issues associated with contaminated water and soil, it is important to first understand the intricacies of the pathways contaminants may travel from sources into surrounding environment and subsequently impacting the local communities.

Northern New Mexico has a history of thousands of years of people living on the land with little impact (Rothman, 1997). As industry was introduced in the 1800s and then the atomic mission in the 1940s, waste was dumped into the rivers and mesa tops with no consideration of where it would go or who it would affect in the future (Masco, 2006). The disposal of toxic waste was in part due to a lack of knowledge of the impact it could have, and the result of a small group of people who held all of the power of decisions regarding waste disposal at Los Alamos National Labs (LANL). This chapter focuses mainly on toxic waste from LANL, what was done with it, and tracking where has gone and will continue to go. I rely heavily on the presentations I saw and conversations I had with Dr. Michael Barcelona from Western Michigan University about his research on accountable groundwater monitoring at Los Alamos National Laboratory, as well as two large watershed management plans by Environmental Health Consultants (EHS) and the National Research

Council (NRC). In addition, my personal experiences and conversations in the Rio Arriba Valley and Los Alamos have informed this chapter.

3.1 The Place and the Sources

Geochemistry and Geology

The geology of Northern New Mexico is impressive, with mesas flowing down into deep canyons and back up again. The mountains are truly towering, which I realized when I first drove into New Mexico and felt so small. Roads and riverbeds once filled with water weave into and out of canyons, now filled with red clays and rocks. Elevations range from 5,600 to a staggering 11,403 feet (Smith, 2006). These geological formations including mesas, rocks, and clays all contribute to contaminant pathways from the mesa tops and upstream sources to the Rio Arriba Valley. Different soil and rock types allow varying mobility of contaminants, ultimately resulting in differentiation of what gets to surrounding communities through the water and what stays planted in the ground.

The valleys in the area are cut into rocks which were deposited between approximately 1.8 billion and 3 million years ago, carved out by ancient streams (Smith, 2006) The rocks in this area are a mix of shale, sandstone and limestone with embedded shells, telling the story of an old ocean (Smith, 2006). The North-South mountain range has a granite core, generally flanked by the same sedimentary sandstones (Smith, 2006).

In contrast, most of the rocks that make up the Pajarito Plateau are volcanic rocks, and lie on top of the sedimentary rocks (Smith, 2006). This volcanic rock is known as tuff, which was a very important volcanic rock in the formation of the Pajarito Plateau. For years, tuff was believed to be impermeable and that it could block the flow of water (NRCS, 2008). We know now that tuff is made up of broken pieces of volcanic glass and sand fused together by the heat of magma released thousands of years ago (PEEC, 2012), and it is, in fact, not impermeable- dumps built atop tuff may be leaching into groundwater (Hopkins, 2007). This is very important in the discussion of toxic contaminants, especially in the context of LANL.

While the rock bases are complex, the topsoils in the area are mainly silty clay loam from 0-17 inches, clay loam down to 35 inches and cobbly clay loam beneath that (Austin, 1982). These clays have the capacity to bind to metals and ionic contaminant species due to their effective negative charge. The initially negatively charged clay layers will act like a magnet and attract positively charged ions, such as metals, then hold them in tightly to achieve a favored neutrally charged state. This means that the clay soil will hold on to the metals, not enabling contaminants to wash away with rainwater but often still allowing plant uptake. Clays, with a particle size of less than 2 micrometers, are not easily permeable- that is, they do not allow water to flow through them. Impermeability creates pools of surface water that sit on top of the soil, increasing exposure time to the clay resulting in more binding, and then eventually slow travel to groundwater. Clays that are more impermeable,

and have a more negative charge, result in the least amount of transfer of contaminants to groundwater, but the most contaminants bound to the soil.

The majority of the soil consisting of clays also means that the soils shrink and swell with moisture content (Austin, 1982). The presence of sand in the soils somewhat lessens the drastic effect because sand particles compact well, with a larger particle size of up to 1 millimeter. The following descriptions of specific clay types are important to understanding exactly how much of a contaminant and what types of contaminants are contained within the soil; however, the exact details of clay hydration and absorption are not necessary to understanding the overarching concept. I provide these details for enrichment and perhaps, further insight into soil science.

The clays found in Northern New Mexico are generally of the smectite family with a 2:1 structure (Manley, 1978). Clay minerals are fundamentally built of tetrahedral and octahedral oxide sheets which nestle on top of one another, held together by a total ionic charge. A 2:1 clay, such as smectite, is made up of one octahedral sheet sandwiched between two tetrahedral sheets. The interlayer between the sheets is hydrated, that is, it holds water, and may attract cations such as Mg^{2+} from solution outside of the clay, to be attached to the clay. It is through the mechanism of hydration that ionic contaminants may be bound to soils in the Southwest (Austin, 1982). These clays, which make up the majority of soils in Northern New Mexico, result in relatively high rates of contaminant retention (Manley, 1978).

In comparison, there are kaolinite clays available in the mountains close to the caldera. Kaolinites are 1:1 clays, with only one tetrahedral sheet for each octahedral sheet (Manley, 1978). In these clays, very little hydration is kept due to the lack of space between the two layers, which stack well. Kaolinite clays have been sought after for centuries, for potteries in the Pueblos. Because they contain very little moisture, when they are fired, they do so quickly and do not develop the cracks that 2:1 clays may when going through a rapid drying process (Austin, 1982). 1:1 clays are far more rare and do not represent the majority of soils in the region.

Average monthly precipitation ranges from 1.10 inches in June, the dry season, to 2.88 inches in August, during "monsoon" season. During this span of June-August, the average number of days with rainfall of 0.1 inches or more jumps from just 3 days to 7 days (NRCS, 2008). 0.1 inches may not appear to be a significant amount of rainfall over 24 hours, but the storms that appear in Rio Arriba Valley roll in and out within an extremely short period of time, releasing massive amounts of rainfall at once.

"Monsoon" season storms create large amounts of runoff water that can transport contaminants along the canyons, resulting in soil erosion that then enables more runoff during the next storm. The canyons off of the Pajarito Plateau all feed into the Rio Grande, whether it be directly or through another canyon. During large storm events on the flat mesa tops of the Pajarito Plateau, significant amounts of soil and debris are washed down into the

Rio Grande, smaller dry riverbeds and surrounding communities. This is an important route for contaminants making their way from the mesa top into the valley.

Groundwater under the Pajarito Plateau occurs in three forms: surface water in shallow rock beds in the canyons, sub-terrainian perched "pockets" of water and the main aquifer (EHC, 2007). Surface water, as well as the perched waters, flow through to the main aquifer at a very, very slow pace. The aquifer located in the Tesuque Formation 600-1,200 feet beneath Los Alamos provides the only municipal water for Los Alamos and White Rock (EHC, 2007). It discharges partially into the Rio Grande as well as neighboring aquifers that serve the Rio Arriba Valley (Travers et al., 2007).

Unfortunately, the exact details of geochemistry beneath the Pajarito Plateau are not understood. Los Alamos National Labs does not have good models to understand the pathways for transport of liquid and even fewer for solid contaminants that were buried over their years of operation (Hopkins, 2007). Several waste sites with unlined pits may be leaching into the various forms of groundwater all over the plateau. Pathway understanding is absolutely necessary for planning sampling well locations, sampling frequencies and analysis. For example, the presence or absence of perched groundwater under active waste sites may determine how quickly contaminants reach the main aquifer, if at all (Hopkins, 2007).

Fire

Fire in the Southwest has long been a natural process that cleared the forest of debris and activated new seeds to allow growth. As a natural, regular occurrence, historical fires burned at a low temperature, allowing a long smoldering of the forest floor (Rothman, 1997). Creation of and changes in fire policy in Northern New Mexico in the early 1900s with the development of National Parks allowed fire suppression causing the forests to become clogged with excess debris (Rothman, 1997). The result of this is that when fire did break out, it burned out of control and at a very high temperature. These fires in the 20th century burned so hot that they killed important microorganisms through the soil and indiscriminately took down stands of juniper, pinon and white pine (Rothman, 1997). In addition we are learning that the damage from these hot-burning fires may take more than one hundred years to heal, especially if the area is re-burned a short amount of time later (EHC, 2007).

The main problem that springs from the 20th century fires was explained to me in my pottery lessons in a simple allegory that links the ceramic traditions of the Pueblos to the natural occurrence of fires. Most of the soils in the area are comprised of clays, which are often used for pottery-making in the Pueblos. In the last step of processing, mugs and bowls are "fired" to close all of the micropores on the surface and make the piece suitable for holding liquids. As extremely hot fire spreads across the mesas, the same phenomenon occurs, and now the sides of the mesas are essentially glazed over. The glazing, with the lack

of trees after fire, makes water runoff into the canyons dangerous, and when large storm events move into fire-scarred areas, there is nothing to keep water from streaming down rapidly and all at once to the rivers and villages.

There were two major fires in Northern New Mexico over the past 15 years that have impacted the movement of contaminants. The first was the Cerro Grande fire of 2000, which burned hot and fast for nearly two months, and consumed a total of 48,000 acres of land, 27,000 of which were Los Alamos National Labs property (EHC, 2007). The area burned can be seen in Figure 9 below. The fire moved a lot of contaminated soil and mobilized contaminants as well as creating increased runoff towards the Rio Grande (CCNS, 2011). In fact, the impact of this fire resulted in flooding never seen before.

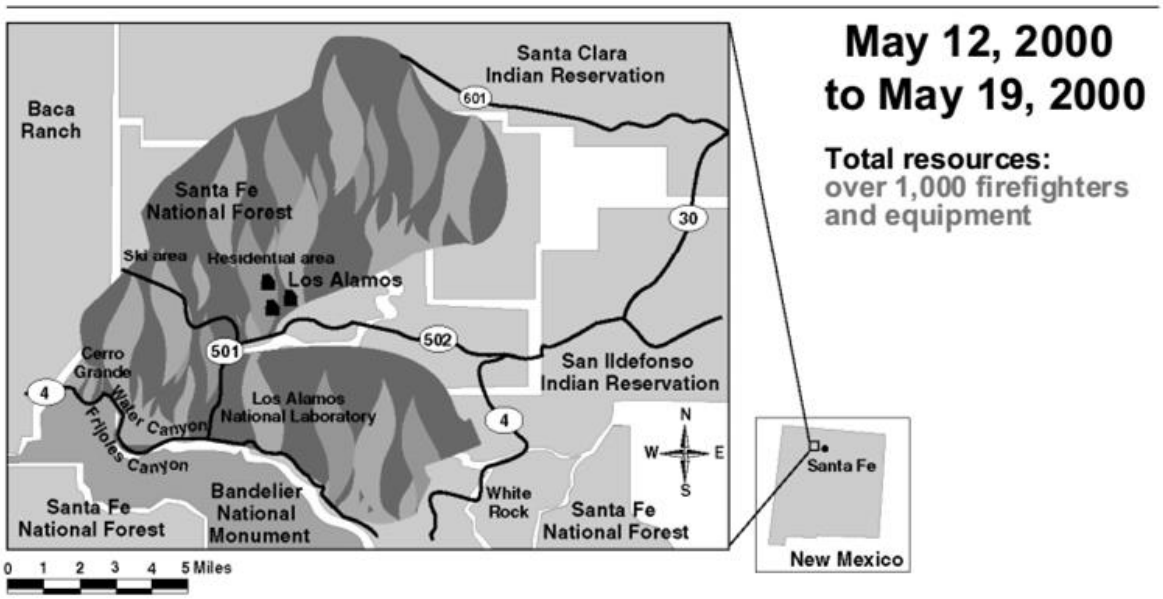


Figure 9: The land scorched in the Cerro Grande fire of 2000. Almost 48,000 acres of land were burned, about 280 homes were burned and 40 laboratory structures were damaged. From the fire, over 400 families were displaced and the overall damages were estimated at $1 billion (GAO, 2000).

The second major fire, the Los Conchas fire of 2011 was even more disastrous, burning 150,000 acres of land in about a month, as seen in Figure 10 below (LANL, 2011). It did not burn on LANL property, but re-burned several surrounding mesas in the Jemez range that had been previously scarred by the Cerro Grande fire. Sixteen thousand acres of Santa Clara land were burned, including several sacred sites. This process of re-burning and clearing of land under the mesas made effects from runoff from subsequent storm events even more drastic (CCNS, 2011).

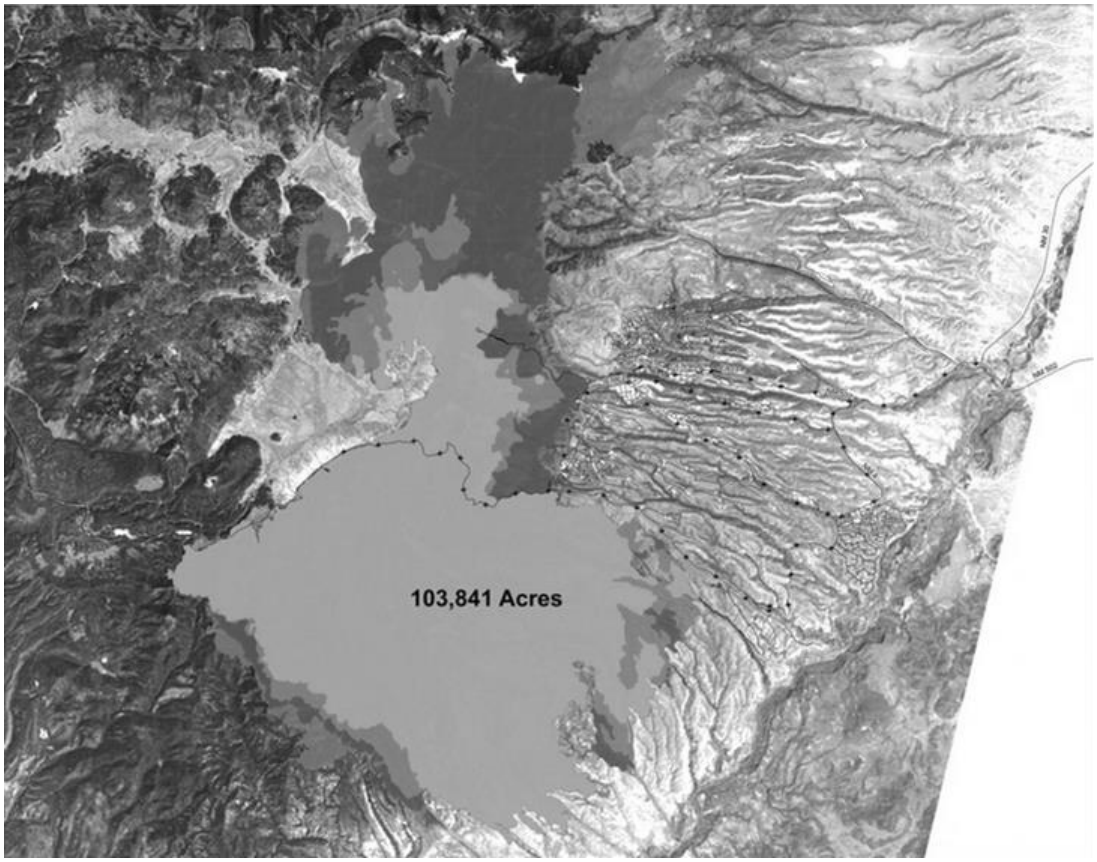


Figure 10: The area burned by the Los Conchas fire of 2011, which burned close to Los Alamos following the Cerro Grande fire of 2000. A great area of the same land was re-burned in this process, damaging forests deeply. This map shows where the fire started (light) out to where the fire was at its largest (dark) (LANL, 2011).

In the summer of 2012, massive flooding in Santa Clara Pueblo resulted in $3.7 million of property damage (Cabrero and Romero, 2012). The damage occurred after a fast-moving, high-volume storm on the Pajarito Plateau raced down the mesa sides and into small tributaries of the Rio Grande. A small dike put into place on one of the rivers broke completely, releasing millions of gallons of water into the community's homes, streets and businesses. The water from the broken dike was contaminated with potentially dangerous soil from the mesa tops and riverbeds (Cabrero and Romero, 2012). The combination of damages creating flooding proves that the "glazing over" resulting from massive fires is important.

Fires have contributed to contamination in the Rio Arriba Valley by creating pathways for water runoff to transport contaminants located in the soils of the mesas into the canyons, as well as through direct flooding. Fire-scarred land is one of many historical sources of contamination which have also affected the valley for hundreds of years, contributing to an area of intense concentration.

Sources of Contamination

There are several different routes by which pollution may enter the Rio Arriba Valley but it is industry that, in the past, used extremely hazardous chemicals in careless ways along these exposure routes. Industries include mining and agriculture across the Northern part of the state and science on top of the Pajarito Plateau. Potential sources of pollution need to be

explored in order to understand their impact on the communities in the Rio Arriba Valley as well as on top of the plateau.

While there are few natural inputs of contaminants threaten human health in Northern New Mexico, there is one notable exception: the Valles Caldera, a twelve mile wide volcanic caldera in the Jemez Mountains, one of only six known land-based supervolcanoes worldwide. The presence of a volcanic stand drastically increases the natural arsenic levels in the Rio Arriba Valley and on the Pajarito Plateau due to high arsenic levels in volcanic rock (EHC, 2007).

Although natural inputs of contamination are limited, industrial contamination sources have expanded since colonization of New Mexico. Industry was introduced into the area in the 1800s along with the railroad, and mining took a prominent role with many sites developed along the rivers which provided a good source of water for processing. Molycorps Inc., who now owns the largest developed mines in the area, located outside of Taos, has residual waste rock and tailings that have contributed heavy metals to the Red River, which merges with the Rio Grande (ASTDR, 2005). Molycorps actively mines molybdenum in an underground mine. Old Molycorps mines are listed as an EPA Superfund cleanup site (EPA, 2009). Tailings were used to backfill water lines in the municipal system in Taos developed in 1968. They contaminated the river and adjoining acequias, as well as the air as dust from the empty water lines was spread by the wind (ASTDR, 2005). Private wells around the mines have recorded elevated levels of arsenic, cadmium, iron, magnesium, manganese,

molybdenum, zinc, fluoride, and sulfate, all chemicals used industrially in the mines (ASTDR, 2005). While the impact of pollution from Molycorps' mines is still being explored, the tailings washed out into the Rio Grande may be settling in the riverbed, threatening future water use for drinking and agricultural use (ASTDR, 2005).

Agriculture has also been a huge focus of the communities of Northern New Mexico even farther back than mining and other industry (EHC, 2007). Large-scale agricultural farms built by homesteaders along the Rio Grande carelessly used the land, often discarding garbage and byproducts of farming such as manure or fertilizers directly into the river (EHC, 2007) in the name of moving towards the cash economy. Massive erosion due to monocropping and unregulated grazing on farmland also was commonplace on Northern New Mexican lands, and combined with unregulated dumping, contributed to pollution of the riverbeds and water (EHC, 2007).

Historical industries along the Rio Grande are more generally scattered across Northern New Mexico, and have created a dangerous mix of potential contaminants and routes to human health issues. But the largest single source of contamination, LANL, did not come into the picture until much later than agriculture and mining. In no way does their later emergence mean they have not had as much of an impact.

3.2 Contamination from the Los Alamos National Laboratories

As far as contaminant sources in Northern New Mexico go, Los Alamos National Labs is the main threat, because of the pure number of potential chemical releases and the nature of the contaminants as well as the general mystery surrounding what exists on the Pajarito Plateau. The records are loose, thinly recording the chemicals put into dumps in the past, making it complicated to track their releases. For example, reported in a study in 1993, a number of volatile organic compounds have been found under the labs including acetone, benzene, carbon disulfide, carbon tetrachloride, chloroform, chloromethane, 1,1-dichloroethane, 1,1-dichloroethene, methylene chloride, PCE, toluene, TCA, TCE, Freon 11, Freon 13 and xylene (as cited by Hopkins, 2007). Hexavalent chromium, nickel, high explosives, perchlorate, pentachloropenol, tritium, americium, cesium, nitrate, RDX and strontium-90 have also all been detected in local drinking water wells (CCNS, 2011). Understanding the vast number of waste outputs in scale and magnitude at LANL as well as the serious nature of the contaminants released is important to understanding potential health risks in communities surrounding the labs.

Solid Waste at Los Alamos National Labs

Waste disposal at Los Alamos has historically been unsystematic and without consideration of safety or permanence. Major canyons were used as waste release sites, connecting the top of the plateau to the Rio Grande (Travers et al., 2009). Waste, and the

way it has been handled at the labs, is a controversial topic. LANL has discharged waste on surrounding mesa tops and into canyons with little or no documentation (Masco, 2006). They had no consistent way of disposal in the past, due to lack of regulations, so the mountains became the dominant receptacle. Waste in the form of liquids, drums and cardboard boxes were released into the canyons or deposited into holes dug in the ground completely untreated; poor records were maintained about the volumes and activities of waste releases (Masco, 2006). A former LANL scientist stated that, "during the War years, partly because of ignorance, and partly because of the stress of wartime conditions, operations with plutonium were conducted with greater laxity than has ever been tolerated since." (Travers et al., 2009)

In the process of creating the atomic bomb, millions, perhaps billions, of gallons of waste in liquid form were produced, not to mention solid wastes. Between just 1944 and 1952, 2-3 million gallons of highly contaminated toxic radioactive waste was dumped into Acid Canyon, which leads directly to the Rio Grande (Masco, 2006). Solid waste such as contaminated instruments, gloves, jackets and equipment, and even spent nuclear fuel rods were buried in unlined pits and then covered with thin layers of soil (Masco, 2006). These sites have attracted some attention and have begun to be cleaned up (see: LANL, 2011; NRC, 2007).

For example, Area 21 is one of the most famously "mysterious" waste dumps from WWII that has been declassified and clean up begun (NRC, 2007). Area 21 is located across from the airport on the main road into Los Alamos, bordering Los Alamos Canyon. Since the

soil is regularly exposed to local citizens and visitors, it was a priority for cleanup. LANL documents show photos of scientists cleaning up the forty-year old landfill to uncover things they never expected, like an old truck with its trunk full of cardboard boxes packed with contaminated lab gear. Cleanup of LANL's scattered dumps is taking place slowly, and is complicated by the very limited records of what the sites contain (Masco, 2006). The consolidated wastes from various sites being cleaned up on the plateau are documented and moved to material disposal areas (MDAs).

Another site, known as Material Disposal Area G, is the most well-documented and largest MDA at LANL currently, expected to receive 54,000 drums worth of waste each year to be placed in permanent pits and shafts covered with dirt (Hopkins, 2007). Area G is located on a fingerlike mesa with its sides draining into Canada del Buey and Pajarito Canyon, directly into the Pueblo de San Ildefonso (LASG, 2011), covering a total area of 63 acres and containing 334 active and inactive waste management units (Hopkins, 2007).

During active operations while waste is received, pits and trenches at Area G have been open to the atmosphere, allowing dust and debris to be kicked up. Pits and shafts that are covered only by soil allow for infiltration by water and leaching of contaminants to groundwater (Hopkins, 2007). The groundwater chemistry under MDA G is not known, but it is possible that the groundwater, which is in layers of granite beneath the site, has the potential to push contaminants into the regional aquifer, which is used for drinking water (Hopkins, 2007).

In addition, channel soils beneath Area G have measurable amounts of beryllium, cadmium, cobalt, mercury and silver, all considered chemicals of potential concern due to their status as man-made only chemicals and their hazard to human health (Hopkins, 2007). While these are not the only chemicals of concern; they are simply the chemicals that can be traced back directly to Area G (Hopkins, 2007). All of the chemicals mentioned in this chapter as detected in groundwater may possibly be from Area G, but tracing chemicals to their origin is difficult due to the lack of geochemistry knowledge and documentation of waste.

In other areas the materials are documented and different from Area 21 and Area G, but this does not mean they don't have the potential for problematic impact on the environment and the communities in the region. Material disposal area S contains mostly explosives and it is currently being used for an active study on how weather and sediment affect the decomposition of explosives and therefore, is not being actively contained (Travers et al., 2009). Material disposal area H contains an even larger amount of high explosives; an estimated 50,000 pounds were disposed in it each year it was open from 1960 to 1986. Technical area 16 is estimated to have burned 96,300 pounds of explosives waste each year since it was opened, as reported by a 1981 LANL memo (as cited by Travers et al., 2009).

Material disposal area B is one of the oldest on the plateau and needs a more modern cleanup. It consists of several unlined disposal trenches, 90% of which are estimated to be holding contaminated laboratory debris in cardboard boxes sealed with nothing but masking tape. It also contains at least one truck which was buried after contamination resulting from

exposure at the Trinity test. In its current state, MDA B has a high probability of pollutant mobilization and release to surrounding groundwater (Travers et al., 2009; LASG, 2011).

In total, 1,405 solid waste dumps located on the Pajarito Plateau are considered hazardous by the New Mexico Environmental Department (NMED) (EHC, 2007). LANL considers 9,125 total individual sites to have the capability to contaminate groundwater (EHC, 2007). Some of the sites are contained within the dumps, or material disposal areas, while some are scattered and stand alone across the landscape. The number of sites gives some perspective on the massive scale at which waste was generated at LANL as well as the gravity of contamination. Even if a massive cleanup effort were undertaken immediately, it would take years to unearth and consolidate waste in individual sites, which would still have contaminated soils and likely irreversible groundwater contamination.

Liquid Waste

Liquid discharges are direct waste streams that travel from the labs in rivers down canyons. Discharges traveled out of the labs completely untreated in the past, bathing local canyons with radiation that is still detected in soils and plants (Travers et al., 2009). Disposal has changed somewhat since water treatment plants were installed at the labs, cleaning up the wastewater before releasing it into discharges (NRC, 2005). Between 1993 and 2006, LANL decreased the number of active discharges from 141 to 17, with only two considered contamination sources by the New Mexico Environmental Department (NRC, 2005). The release of such volumes of liquid is concerning because the liquid is dumped into canyons

that feed directly into the Rio Grande. Water from release sites may also act as a liquid driver, pushing contaminants present in soil or in solid form closer to the Rio Grande or into the groundwater. The liquids are treated before release, following strict DOE guidelines which regulate some chemicals more strictly than EPA drinking water limits (see: Del Signore, 2011), however, only a handful of heavy metals and radionuclides are regulated (EHC, 2007).

Equally concerning are the explosions that have occurred in the surrounding mountains. Between 1944 and 1962, 254 nuclear explosives tests were completed in the Bayo Canyon site (TA-10), 3 miles from LANL (Ferenbaugh, 1982). Procedures were set up so that the wind had to be blowing north east, away from Los Alamos and instead towards the Pueblos (Ferenbaugh, 1982). The test assemblies in Bayo Canyon explosions usually included components made from natural or depleted uranium and a radiation source for tracking the efficiency of the bomb (Ferenbaugh, 1982). Detonation of these bombs resulted in a wide spreading of radioactive materials as well as nonradioactive materials in the form of aerosols and solid debris. Explosives wastes not only traveled through the air towards local pueblos but settled into the soils to remain for decades to come (Ferenbaugh, 1982).

Total fallout from the Bayo Canyon tests is unknown, but suspected to be some of the highest accumulated fallout in the country when compared to other testing sites (Ferenbaugh, 1982). Hundreds of other explosives tests, including non-nuclear tests, happened after the Bayo Canyon tests, as cited by local citizens. In fact, I heard many stories of people from San Ildefonso, White Rock and Santa Clara, who were woken in the morning

or startled during an afternoon walk by the echoes of bombs off of the mountains as late as the early 1990s, when the Comprehensive Test Ban Treaty was passed.

Monitoring of Contaminants

LANL has installed a series of monitoring wells along their boundaries, near the Rio Grande and in the land surrounding the plateau due to requests by the community as well as requirements by the New Mexico Environmental Department (NMED) and US Environmental Protection Agency (EPA) to ensure that no contaminants are leaching from waste dumps. Unfortunately both the placement of the wells as well as the methods used for drilling and sampling do not provide for the most accurate representation of pollution in the region.

Many assumptions have been made in the drilling of the wells, most importantly, the direction of the flow of groundwater under the labs. Wells have been installed on one side of Area G, but not the other (Barcelona, 2012). If the flow of groundwater is towards the wells, as LANL assumes it to be, the monitoring wells will read accurate levels of contamination, but if the flow of groundwater is perpendicular, the wells will read as having no contamination, risking health of surrounding inhabitants. The alternative flow of water under Area G is likely (Barcelona, 2012) and without more intensive geological investigation, it will not be known.

Placement of the testing wells both up and downwind is lacking (EHC, 2007). The communities located here have been potentially exposed to LANL contaminants since its

inception and have been requesting information on possible contaminants since the labs became public (Masco, 2006). Testing wells on the surrounding lands are placed in seemingly random locations, with little representation of the communities close by (EHC, 2007). A reconsideration of location as well as an increase in number of testing wells in surrounding communities is needed before the monitoring sites may be considered representative of overall contamination.

Bentonite clays as drilling muds have also been used in the creation of the monitoring wells in and around the labs (EHC, 2007). Use of additives in the drilling of wells has been condemned by many leading scientists, as they bind to metals that could be present as active contaminants in the groundwater supply. Bentonite clays will bind to and mask the presence of numerous contaminants and once they are introduced, the contaminants will continue to be covered up (EHC, 2007). Wells drilled with additives are almost definitely ruined and must be re-drilled to ensure complete accuracy in testing (CCNS, 2011).

Poor sampling and analysis of well readings as well as inefficient reporting of monitoring information to the public also prove that LANL's groundwater well network is inefficient and not representative of current contamination in the aquifer (CCNS, 2011). Accurate sampling and reliable reporting to the public are basic scientific tenets that the lab must follow to protect health and instill confidence in their capabilities to monitor contaminants they have released. It is probable at this point that millions of gallons of waste have leached to surrounding communities without their knowledge (Masco, 2006), due to a deficient groundwater testing network and across-the-board lack of documentation of

contaminant location and migration. Without accurate readings, the unsustainable pattern of waste disposal at LANL could continue on and pollute surrounding lands, affecting health in all of Northern New Mexico.

Chapter 4: Contamination in the Gardens

As I have established, chemical contaminants are widespread in Los Alamos and the Rio Arriba Valley from historical and ongoing surrounding industry. I reviewed the range of chemicals which have been detected in drinking water and otherwise in the area, and for my experimental research, chose to narrow the breadth of contaminants to four chemicals to achieve a greater depth of understanding as to what is actually in the soils, and in the gardens. In this chapter, I will discuss the specific chemical characteristics, toxicity and remediation possibilities of four main chemicals: arsenic, RDX, perchlorate, and hexavalent chromium. I rely on many different sources of background information, but have made a conscious effort to use scientific case studies which take into account women and children in their health assessments.

I have chosen to examine arsenic, RDX, perchlorate, and hexavalent chromium specifically because of their differences; however, they all carry a common thread of high toxicity. These are all contaminants which have been detected in and around the Rio Arriba Valley (EHC, 2007; NRC, 2005), but have never been determined to be present in community gardens because there has never been testing such as my own. Perchlorate and RDX are both explosives which would have been used in open-air testing at LANL, and could easily be leaching out of waste dumps on the hill into surrounding canyons and groundwater (Hopkins, 2009). Arsenic is a naturally found element, but is also used in many different

industries and could be associated with historical mining, polluting the river, or coming from waste buried in Los Alamos with a toxic slew of chemicals (EHC, 2007). Hexavalent chromium is most probably leaching from legacy waste at the labs as well, and is frequently known for its mobility in water from industrial sites (EHC, 2007).

4.1 Soil and its Importance

Soil is absolutely fundamental in looking at the world of all living and non-living things. It is a complex mixture of inorganic and organic matter, air, water, and living organisms. Most essential nutrients for life are provided through soil and interactions that take place in soil (Kang, 2002). In short, soil perpetuates life. The productivity of soil in determining plant growth is fundamental in providing food resources (Kang, 2002).

Soil as a Route of Exposure

Because soil has many different uses and contains a delicate balance of many components, pollution and contamination of soil is frequent. Soil is the ultimate and most important sink of contamination in the environment (Adriano, 1986). Plants buffer human exposure somewhat through the plant-soil system in which plants take up trace elements which exceed soil capacity (Adriano, 1986). Uptake varies plant-to-plant and depends on the element. With the drastic increase in anthropogenic (human-made) pollutants due to industry, severe soil pollution has occurred, resulting in barren areas (Kang, 2002). These are

areas in which the levels of contamination are so high that all surrounding plants die, leaving empty patches of soil which are then exposed to humans (Kang, 2002).

Soil is often overlooked in the field of public health; however, it is imperative to include soil in health assessments because soils reflect all of the activities that have taken place in the course of their existence (Mielke et al., 1999). For example, this includes all the historical contamination as well as the human activities that rely on the soils from gardening to pottery. The soils literally make up the land. While ownership of land and lifestyles has been renegotiated over the past centuries, the effects of contaminants present in the area are on a multi-century trajectory due to their presence in the soil and water (Masco, 2006).

The transfer from soil to human is for many elements an important and indirect route for people to consider in health assessment (Mielke et al., 1999). Inhalation is the first exposure, and when gusts blow the dry desert soils up outdoors, mineral dusts are inhaled by humans, trapped in their lungs and sinuses and subsequently ingested, passing through the gastro-intestinal tract (Abrahams, 2002). Ingestion rates are often determined by degree of grass cover because without sufficient grass cover, soil is exposed to the open air and more likely to be blown up (Calabrese et al., 1994). In the Rio Arriba Valley, there is massive erosion due to overgrazing, monocropping, and fire (Masco, 2006). Erosion results in a high level of direct ingestion through suspended dusts.

There have not been many studies on soils or in gardens in general, despite their obvious importance in communities on the margins and in particular in the Northern New

Mexican communities I worked with. The uptake of crops in Los Alamos have been the subject of a single study, after much request from the surrounding communities (Masco, 2006). There was a study that undertook very limited testing on the soil, fruits, stems, and leaves of pinto beans, squash and sweet corn. Each was planted and then analyzed for tritium, cesium, strontium, plutonium and total uranium (Fresquez et al., 1998). All plants were found to contain radionuclides, well under the official permissible dose limit of 100 mrem/year within an assumed maximum ingestion rate (Fresquez et al., 1998). No hazardous chemicals were analyzed, but the insistence of the community on completing the study in Los Alamos shows the interest in knowledge, as well as the value placed on gardens and food.

3.2 Contaminants Being Tested

In this section I will lay out the basic chemical structures, properties, bioavailability in different types of soils and plants, health effects and potential remediation techniques. These will inform my research on the four chemicals of concern and why they are important in the context of the communities I have discussed.

Arsenic

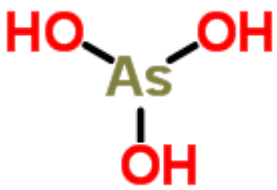
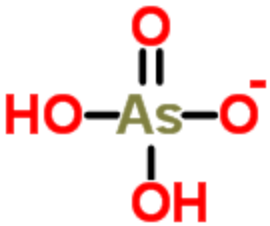
	Arsenite – As^{+3} as $As(OH)_3^0$	Arsenate – As^{+5} as $H_2AsO_4^-$
	 (ChemSpider, 2013)	 (ChemSpider, 2013)
Solubility	3.7g/100 mL H_20 at 20C (ChemSpider, 2013)	.0059 mg/L H_20 at 20C (ChemSpider, 2013)
Mobility	More mobile (Sengupa et al., 2008)	Less mobile (Sengupta et al., 2008)
Behavior in Soils	Present in anoxic soils (Fayiga et al., 2007) Much less prevalent (Martinez-Sanchez et al., 2011)	Present in aerobic/oxic soils (Fayiga et al., 2007) Sorbed to clays (Fayiga et al., 2007) Forms stable surface complex (Nagajyoti et al., 2010)
Water Quality Limits	10 ug/L (EPA, 2012)	
Regional Screening Level	0.39 mg/kg (EPA, 2012)	
RFD_0	$3.0x10^{-3}$ mg/kg.day (EPA, 2012)	
SFO	1.5 $(mg/kg.day)^{-1}$ (EPA, 2012)	

Table 1: Arsenic properties

Arsenic (As) is an element which has been studied over hundreds of years to understand its toxicity. It is a heavy metal found commonly in soils and plants at low levels; however, as the industrial age came about, its prevalence in soil and water rose quickly. Arsenic is used in many chemical processing industries as well as mining and electroplating

(Nagajyoti et al., 2010). It is now known to cause a broad spectrum of health effects known overall as arsenicosis, which is linked to Bowen's disease, squamous cell carcinoma and basal cell epithelioma, all ailments of the skin (Sengupta et al., 2008). Some cancers of the liver, lung, bladder and kidney have also been hypothesized to be linked to arsenic poisoning (Chen et al., 1992). Chronic exposure to arsenic has also been seen to have adverse obstetrical outcomes in women such as miscarriage and premature birth (Ahmad et al., 2001).

Arsenic can find its way into food systems through agriculture, as the soils that are most affected by its natural occurrence are found in the desert southwest of the United States such as New Mexico, Utah, Nevada and California. The reason this region is a natural ground for arsenic is that geologically, there were alkaline brines trapped in closed basins. The result is that the rocks in this region are naturally high in As and contact with alkaline waters results in soil contamination around 10 ug/L, the current defined EPA drinking water limit (Tollestrup et al., 2005; Longmire et al., n.d.). Unfortunately, As also makes its way into soils from mining companies and chemical industries along rivers such as those located along the Rio Grande upstream of Los Alamos. The As does not immediately bind to soils and may make its way down the river until it is used to water a farm, where it may build up with repeated watering, also known as "compounding."

In the environment, arsenic is found in two forms: trivalent arsenite and pentavalent arsenate. Arsenite causes the most immediate medical effects but is somewhat less prevalent

than arsenate in soils and plants. Arsenate is still very toxic to biota and is found widely. Generally arsenic is consumed in arsenate in food and water (Sengupta et al., 2008).

In soils with high levels of organic matter (OM), mobile or available As is lowest in both of its forms. The lack of mobility is due to the high cation exchange capacity and metal sequestering ability of OM. The same type of restriction in mobility is seen in high clay areas due to clay's similar ability to bind As. Clay carries an effective negative charge between sheets which easily attracts As with a positive 3/5 charge. pH is also negatively correlated with total As (Martinez-Sanchez et al., 2011). High pH soils with a high sand content are found to be the highest in bioavailable As. Presence of iron, aluminum and manganese also affect available As in the soil. These are metals highly competitive for binding sites on organic matter and clay and as other metals increase in the soil, more mobile arsenic may occur (Fayiga et al., 2007).

Absorption by plants is restricted by how much As is mobile in the soil, but also by several other factors. Arsenate is the main form taken up by plants, due to its prevalence in the environment (Martinez-Sanchez et al., 2011). Arsenate is an analog of phosphate and carries the same charge. It competes for the same uptake carriers in the roots of plants where it is taken up and translocated throughout the plant. (Nagajyoti et al., 2010). Uptake of arsenic is a much studied mechanism and has been confirmed in a number of studies and it is shown Figure 11 below from Zhao (2010).

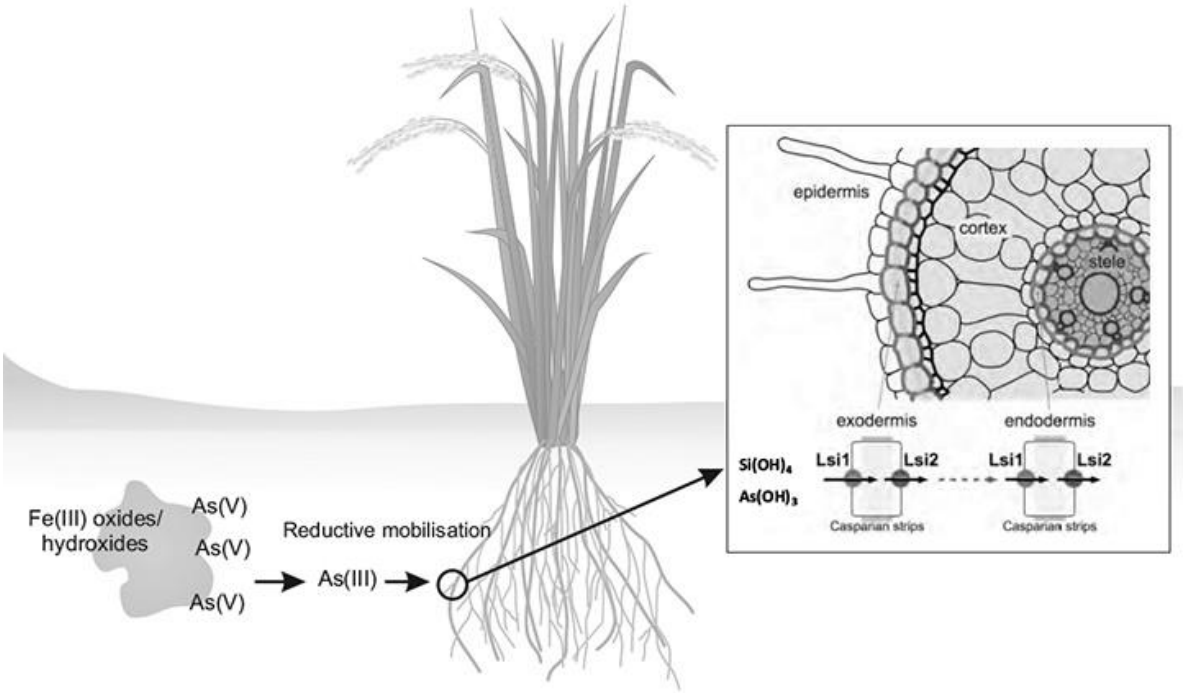


Figure 11: Uptake of As in plants. Arsenate (As^{+5}) is the prevalent form of arsenic found in the soil. Arsenate is readily taken up by phosphate transporters and translocated to shoots. In reducing environments, arsenite in the predominant form of arsenic found. A number of the aquaporin nodulin26-like intrinsic proteins (NIPs) in the root are also able to transport arsenite through the highly efficient silicon (Si) pathway of entry to root cells and move towards the xylem. (Zhao et al., 2010)

Health effects from arsenic are also a very well-studied field that has shown a wide variety of connected disorders and disease. Arsenicosis, which is noted as a disease linked to arsenic, may take 2-20 years to develop depending upon exposure rate as well as physiology (Ahmad, 2004) such as the physical differences discussed between men and women. With a time frame this large, it has often been seen that patients are unaware of any relevant causal exposure (Watson et al., 2004). Large-scale arsenicosis has been seen in Japan, India, Chile and Vietnam; however, it is also a significant problem in the United States. As many as 1/8 of dermatologists in the Southwest see at least one patient with arsenical skin problems in a one

year period, a number which doubles over a 10 year period to ¼ of dermatologists. This figure may even be low, due to the poor healthcare in parts of the US Southwest (Tollestrup et al., 2005).

As mentioned above, arsenate is the most commonly consumed form of arsenic, while arsenite is more toxic. When ingested through food or water, arsenate is slowly reduced to arsenite by glutathione, an antioxidant tripeptide in the body, seen in Figure 12 (Sengupta et al., 2008). The transformation mechanism of arsenic somewhat lessens the importance of speciation taken in to the body.

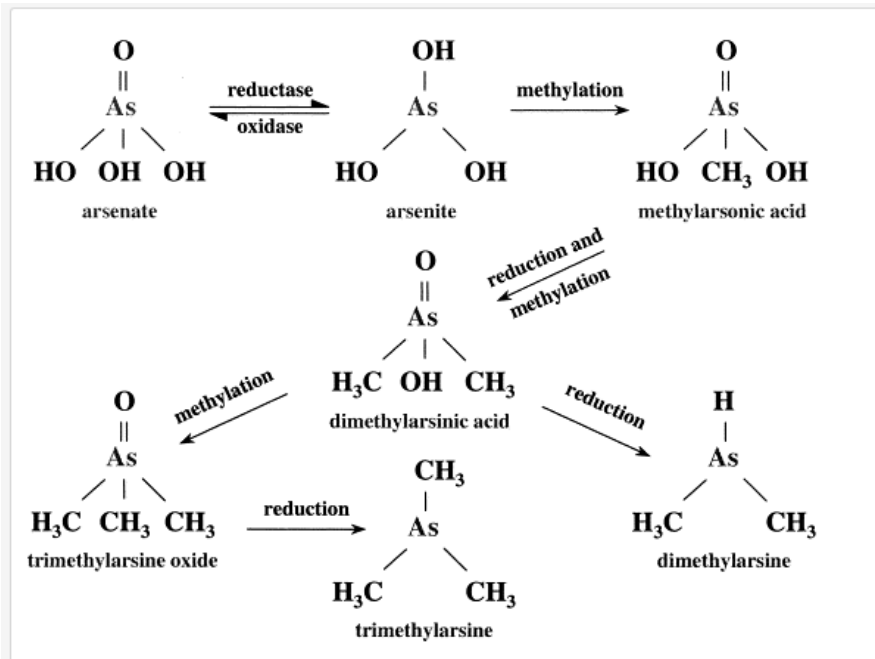


Figure 12: Arsenic is known to sorb to mineral phases, which can impact its environmental mobility. Arsenite, on the other hand, sorbs less strongly to some key mineral phases. This might result in the mobilization of the more mobile arsenite, also more toxic than arsenate. (Mukhopadhyay et al., 2002)

It has been shown that arsenite will widely distribute throughout the body, concentrating in the skin, hair, nails, stomach and small intestine by binding to sulfhydryl

groups in keratin filament and other essential compounds (Sengupta et al., 2008). When it binds with a functional group, it inactivates that group. In this way, arsenic inhibits DNA repair process and alters tumor suppressor gene p53 by DNA methylation (Hasnet et al., 2005). Methylation of DNA is essential to organisms because it helps cells remember where they have been and what they have done in the past. Hypermethylation of DNA, which is induced by arsenic, inactivates tumor suppression genes involved in repairing DNA, leading to uncontrolled cell proliferation. (Sengupta et al., 2008). The uncontrolled proliferation may lead to cancer. Diets low in protein have been hypothesized to increase As toxicity due to lower methylation capacity (Smith et al., 1992). This connection is important for poor communities who may not have proper access to nutritionally rich foods.

Arsenic is excreted mainly through urine, passing through the kidneys as a mixture of inorganic, monomethylated, and dimethylated forms (ASTDR, 2007), all of which can be seen in Figure 12 with the transition between the three. Arsenic is rapidly removed from the blood and may be normal even when urine levels remain elevated; most arsenic is cleared through urinary excretion within 2 days (ASTDR, 2007). Excretory mechanisms point to acute and high levels of repeated exposures as the most important in health studies.

Arsenicosis is linked to skin cancers including Bowen's disease, squamous cell carcinoma, and basal cell epithelioma, which are often first seen as keratotic lesions on the palms and soles or hyperpigmentation scattered across the body (Sengupta et al., 2008). Skin cancers may also arise with no early indication at all (Watson et al., 2004). Populations in

Taiwan, Mexico, India, and Chile that consumed drinking water with high levels of As had high rates of skin cancer, up to 25%, in areas with drinking water levels between 10 and 50 ug/L (Sengupta et al., 2008). The lifetime risks of skin cancer from As has been calculated with be 1.3/1000 in males and 0.6/1000 in females per microgram of As per day. Thus, in an area with a drinking water level of 50 ug/L, lifetime risk of dying from arsenicosis is 21/1000 on average, as compared to a lifetime cancer risk of 10/1000 for a smoker (Smith et al., 1992).

In addition to skin cancer, significant dose-response relationship has been observed between ingested As level and mortality from cancer of the liver, lung, bladder, and kidney in most age groups (Chen et al., 1992, Smith et al., 1992, Sengupta et al., 2008). As age increased, mortality rates significantly increased (Chen et al., 1992), most likely due to As binding with metallothionen, a metal sequestering protein which shuttles metals to the kidney, liver and bladder for excretion (Hasnat et al., 2005).

Adverse obstetrical outcomes are somewhat less studied in the field of arsenic poisoning, but are still fairly well understood. Outcomes include increased stillbirth occurrence, increased spontaneous abortion and preterm births. In women of childbearing age exposed to drinking water 0.1 ppm or higher (as compared to the EPA drinking water limit of 0.01 ppm), all three outcomes were significantly higher than the control group (Ahmad et al., 2001). Risk of miscarriage and stillbirth increased exponentially as drinking water levels of As increased (Hasnat et al., 2005). Transplacental transfer of As is therefore, a major concern. It has been seen that As concentration is the same in maternal and cord

blood, indicating free transfer across the placenta (Sengupta et al., 2008). Maternal toxicity due to sequestering of As in the liver that redistributes zinc has been seen in pregnant rats exposed to arsenate (Hasnat et al., 2005). The relationship between arsenic and zinc is not well studied and should be a point of future research. Currently, the US EPA maximum contaminant level (MCL) is 0.01 ppm, however, 8% of public water supplies in the US exceed the MCL (Tollestrup et al., 2005) and considering the serious implications of arsenic poisoning, the "safe" level may not be protecting everyone.

Some promise for phyotoremediation of As has been seen with a number of plants. High As tolerance has been seen in a number of species including grasses due to their ability to suppress a high affinity P system and take up As instead, as seen in Figure 11 above. This suppression reduces As influx to a level where a plant can easily detoxify by constructive mechanisms (Nagajyoti et al., 2010). *Pteris vittata*, the Chinese Brake Fern, is a strong bioaccumulator of As. After 8 weeks of growth in a study, it took up 24.4 mg As out of a 131 mg As/kg soil contaminated field. The control only took up 6.7-19.3 mg As in the same amount of time (Fayiga et al., 2007). Since the fern is a small species that grows quickly, phytoremediaton in this manner would require little commitment time to cleanup and may be suitable for small fields.

RDX

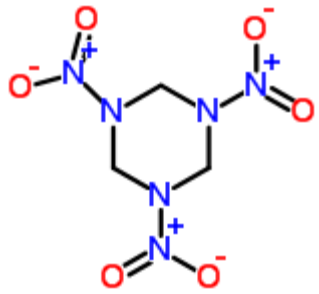
	RDX – cyclo-1,3,5-trimethylene-2,4,6-trinitramine, $C_3H_6N_6O_6$  (ChemSpider, 2013)
Solubility	$1x10^{-6}$ mg/L at 25C (ChemSpider, 2013)
Mobility	Mobile (Falone et al., 2007)
Behavior in Soils	Adsorbs to clays (Townsend et al., 1996) Will leach to groundwater if not taken up by plants (Chen et al., 2011) Will not break down in soil (Chen et al., 2011)
Water Quality Limits	0.1mg/L for one day (EPA, 2012), 0.002 mg/L lifetime (EPA, 2012)
Regional Screening Level	5.6 mg/kg (EPA, 2012)
RFD_0	$3.0x10^{-3}$ mg/kg.day (EPA, 2012)
SFO	$1.1x10^{-1}$ $(mg/kg.day)^{-1}$ (EPA, 2012)
Adsorption Coefficient	24.88 – moderate adsorption, will leach (Falone et al., 2007)

Table 2: RDX Properties

Cyclo-1,3,5-trimethylene-2,4,6-trinitramine, more commonly known as RDX (research department explosive), or C4, is a chemical with widespread application in munitions (Chen et al., 2011). It is used as a component in propellants, detonators, bombs, grenades and a wide variety of other military ordinance (Murnyak, 2011). The first widespread use of RDX was during World War II. In this time, open air testing at military

bases was commonplace, as well as packing of explosives outdoors (Hundal et al., 1997). Consequently, accidental environmental contamination of soils and groundwater has occurred at military bases and the surrounding communities. It is estimated by the US Defense Science Board that more than 15 million acres of closed sites containing RDX and other explosives contamination exist (Ryloh et al., 2008) where concentrations can exceed thousands of milligrams per kilogram of soil (Zhang et al., 2009). It has been known for a long time that RDX is neurotoxic, and it is classified by a possible carcinogen by the US EPA due to early animal studies (Zhang et al., 2009). Cleanup is required in communities where RDX levels are high because it is toxic not only to humans, but to aquatic and terrestrial organisms as well (Hundal et al., 1997).

RDX is especially concerning as a military waste because it is mobile in soil and therefore poses a risk of groundwater contamination when present at high levels. In fields where TNT and RDX are present together, RDX is comparatively much more mobile and is taken up into plants much more easily. It also degrades at a much slower rate than TNT (Chen et al., 2011; Ryloh et al., 2008). Knowledge of the soil binding properties and plant metabolism of RDX is limited. It is a concern that high levels of RDX in the environment may enter the food chain through accumulation in plants.

Though studies on RDX in soil are sparse, some information is known around its behavior in groundwater systems. Sorption studies with RDX have indicated it has low affinity for soil surfaces and is significantly mobile (Lewis et al., 2004; Townsend et al., 1996).

Sorption varies with soil types, and adsorption coefficients of 24.88 (Falone et al., 2007) indicate that RDX is only ever moderately adsorbed to soil and may leach to groundwater (Chen et al., 2011). Sorption values on bentonite clay are similar to sorption values on natural sediment, indicating clay content is important to sorption of RDX. Areas with high clay content will sequester more RDX than a sandy or loamy field because sand and loam do not provide a charged surface for RDX to adsorb to (Townsend et al., 1996). RDX sequestered by soils does not degrade appreciably until it reaches groundwater or air where it degrades at a more rapid rate (ASTDR, 2011). In addition, RDX is resistant to microbial degradation in soils and its structure will remain stable in that medium (Chen et al., 2011). In soil, the half-life of RDX is 2,100 days in winter conditions and 465 days in summer conditions, as compared to 9-13 hours in water (ASTDR, 2011).

As stated above, not much is known about the specific metabolism of RDX in plants either. Roots readily take up RDX and translocate it to aerial organs. The roots-shoots mechanism happens quickly; RDX has been found at high levels in the youngest plant organs (Best et al., 1999). In several studies, it has been seen that total concentration of RDX per unit of plant tissue is always higher than that in the soil, showing an impressively high uptake rate of RDX (Chen et al., 2011). The accumulation of RDX in plant tissue is concentration-dependent, with plants such as maize taking up 3,267 ug RDX from soil in 4 weeks in a pot containing 100 mg/kg RDX in soil (Chen et al., 2011). Wheat was able to take up 2,800 ug per gram dry biomass (Chen et al., 2011).

Despite high uptake rates, plants have a low ability to degrade RDX and accumulation may occur. RDX is returned back into the food chain through the soil as plants die or leaf drop occurs or through animals eating the plants (Ryloh et al., 2008). Some plants are capable of transforming RDX into polar compounds such as formaldehyde and methanol within 1-7 days of incubation (Best et al., 1999). Transformation is promising for in-situ bioremediation prospects, though formaldehyde and methanol are both very toxic as well. Plants would need to be removed completely from the site after remediation for offsite disposal.

RDX has been proven relatively toxic to all plants at both high and low levels (Chen et al., 2011). Brown tips of leaves, browning lesions, necrotic spots and defoliation are the most common symptoms of RDX toxicity, increasing with increasing concentration. Dry biomass of plants affected by RDX toxicity have been found to be comparatively lower than that of control plants, but RDX does not halt reasonable growth in any plants (Chen et al., 2011). It begins to stunt growth as low as 100 mg/kg and halts growth at 500 mg/kg RDX (Rylott et al., 2008).

Acute health effects of RDX have been known for a very long time, involving the central nervous system (CNS), gastro-intestinal system (GI), and renal system. Acute effects include hyperirritability, nausea, vomiting, generalized seizures, and prolonged amnesia. All of the health effects were first seen in men working on military bases or in the field with explosives, and were considered to all be reversible (Etnier, 1989). A very clear causal relationship between RDX and seizures was drawn, eventually linking RDX to neurotoxicity

in the cases of inhalation, oral or dermal exposure (Zhang et al., 2009). The following Figure 13 summarizes existing health studies and shows how many gaps exist.

Longer term studies on chronic low-level RDX exposure are less available than acute studies, due to the military limiting information on the explosive during wartime. RDX is slowly absorbed in the GI after ingestion and does not accumulate appreciably. In rat studies (Etnier, 1989) over 2 years with dosages ranging from 1 to 25 mg/kg, long-term effects of RDX exposure include anemia with secondary splenic lesions, hepatotoxicity, cataracts, and urogenital lesions. No developmental or reproductive toxicity has been found (Etnier, 1989). No studies including children or mothers have been carried out, but it is assumed that children are more susceptible to the effects of RDX than adults due to their developing systems as well as smaller size and weight. In rat studies, RDX passed through the placenta and into breast milk. No birth defects were seen in animal studies, but babies of a smaller weight and length were recorded (ASTDR, 2011).

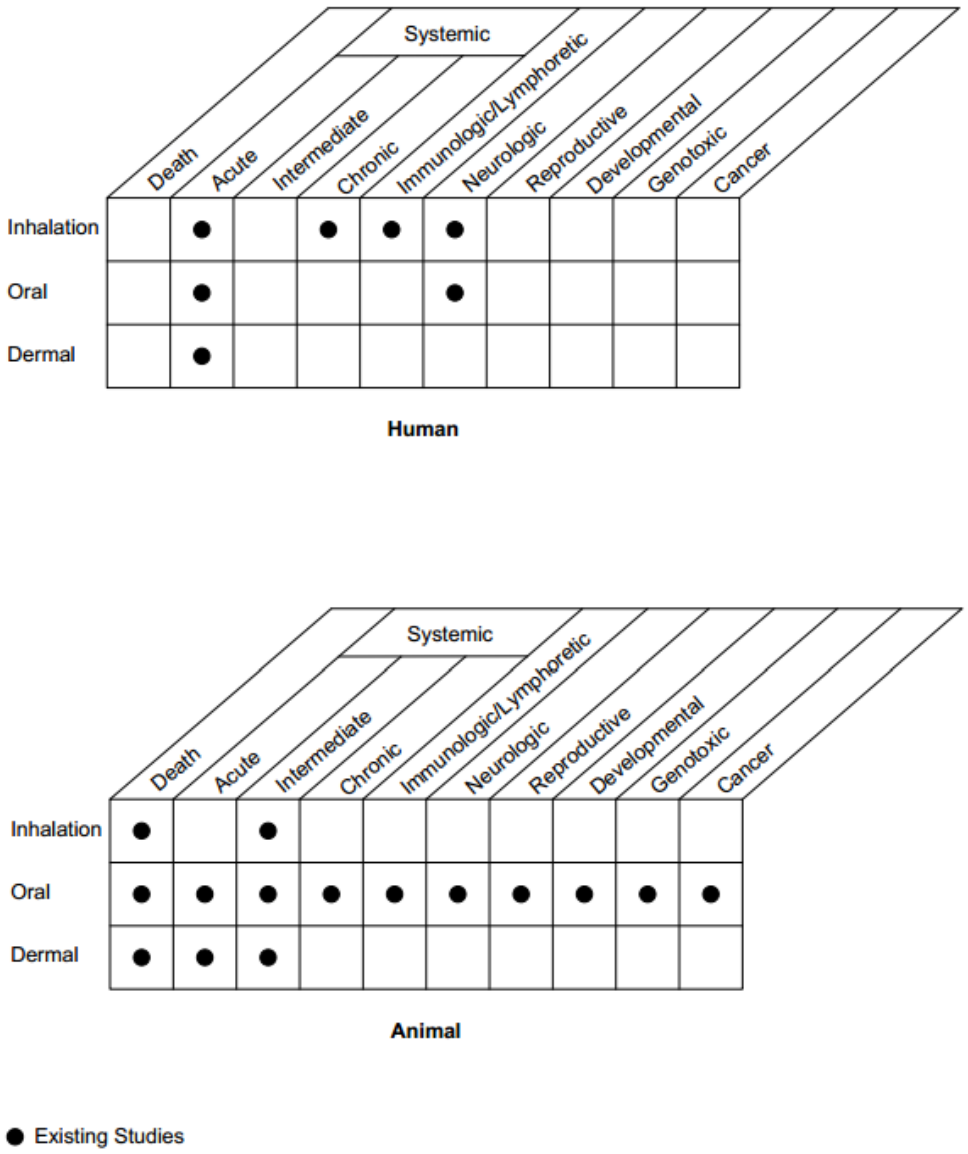


Figure 13: Existing Information on Health Effects of RDX (ASTDR, 2012). Case studies are available regarding systemic effects in humans following acute exposures to RDX via all three routes. One study in the workplace provides information on immunological and neurological effects following inhalation exposure for chronic periods (Hathaway and Buck 1977). Neurological effects have also been described following acute oral exposures to RDX (Hollander and Colbach 1969; Kasuske et al. 2009; Ketel and Hughes 1972; Küçükardalĭ et al. 2003; Merrill 1968; Stone et al. 1969; Woody et al. 1986). Animal data on inhalation exposure is limited to one study. Oral animal data are available for all exposure durations and for all end points. Dermal data on death and systemic effects are available for animals exposed to RDX for acute and intermediate exposure periods. (ASTDR, 2012)

Exposure to RDX has significantly altered miRNA expression profiles in the brain and liver in mice, suggesting carcinogenicity and toxicity. The aberrant expression of miRNA in the brain was greater. In both cases, many cancer-related miRNAs were significantly affected by RDX, suggesting a potential cause of RDX carcinogenicity. The miRNA-206 targets the BDNF gene, which is one of the most important members of neuronal function. Decreasing BDNF levels have been linked with Alzheimer's and Parkinson's diseases. This may be the mechanism in which RDX is neurotoxic, but more studies are required in both cases to confirm carcinogenicity and toxicity though miRNAs (Zhang et al., 2009). Following is a proposed model of the miRNA/RDX mechanism from the Zhang et al. 2009 study (Figure 14).

Currently the US EPA's water quality criterion "for protection of human health and sensitive population through drinking water and aquatic foodstuffs" is 105 ug/L RDX. The water quality limit is based on toxicity data that, as discussed above, are far from complete. The level also does not take into account any RDX exposure through foods or through airborne particulate. No health information is known specifically for pregnant women or children, and therefore the EPA protective level may not truly be protecting the most sensitive population.

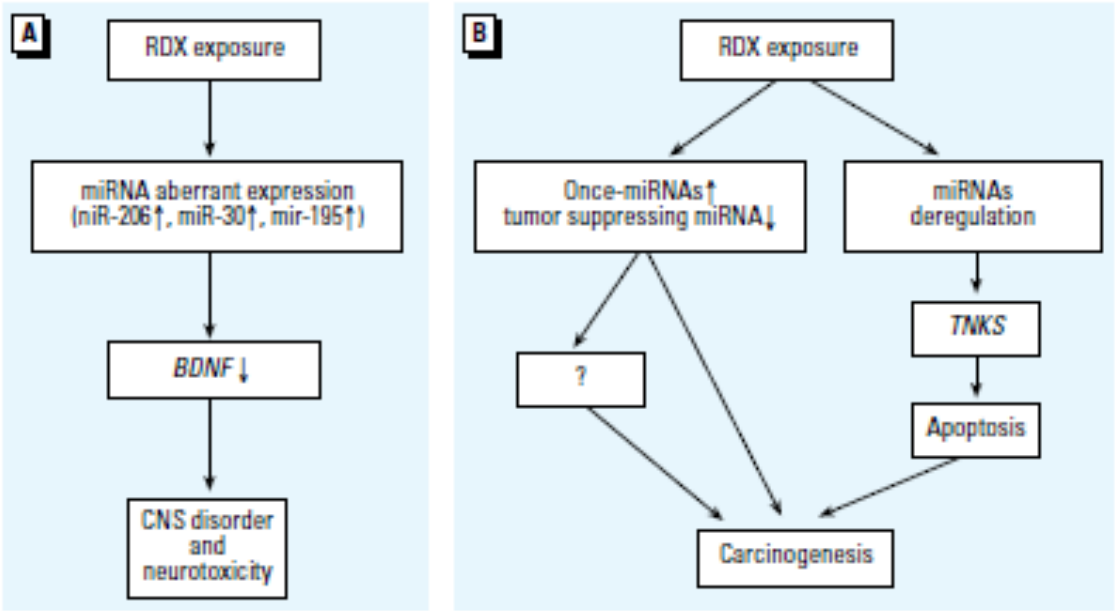


Figure 14: A proposed model showing the mechanisms of RDX-induced CNS disorder and carcinogenesis. RDX exposure caused abberant expressions of many miRNAs. Some of them, as shown (miR-16, miR-20 and miR-195) target BDNF, one of the most important members of the neurotrophin family in mammals. RDX-induced overexpression of these miRNAs inhibits the expression of BDNF, leading to neurotoxicity and CNS disorder. RDX also induced aberrant expressions of tumor suppressing miRNAs which would lead to tumor pathogenesis or target genes related to cell cycles which regulate cell apoptosis. These proposed molecular changes eventually cause RDX induced carcinogenesis and CNS disorder. (Zhang et al., 2009)

Phytoremediation of RDX has seen a lot of attempts, since the majority of RDX contaminated fields are wide, open spaces. Most plants take up RDX in extremely significant amounts at a rapid pace, as reviewed before, which is promising for phytoremediation. If leaves are cut off of large plants before leaf drop, RDX may be removed from soil at a steady pace. If the plants are left to be and leaf drop occurs, RDX will simply be returned to the environment in a more concentrated form (Chen et al., 2011). Few plants have been identified as being capable of degrading RDX, however, they do exist (Best et al., 1999). RDX

is taken up in these plants and reduced to MNX and DNX. Subsequent mineralization of the heterocyclic ring occurs with the aid of light, yielding methanol and formaldehyde, both benign products (Ryloh et al., 2008). Phytoremediation is certainly possible in a short timeframe if care and time is taken to carry it out properly. The exact mechanism of the biodegradation of RDX in order to clean up land follows in Figure 15, showing the transformation of RDX all the way to methanol.

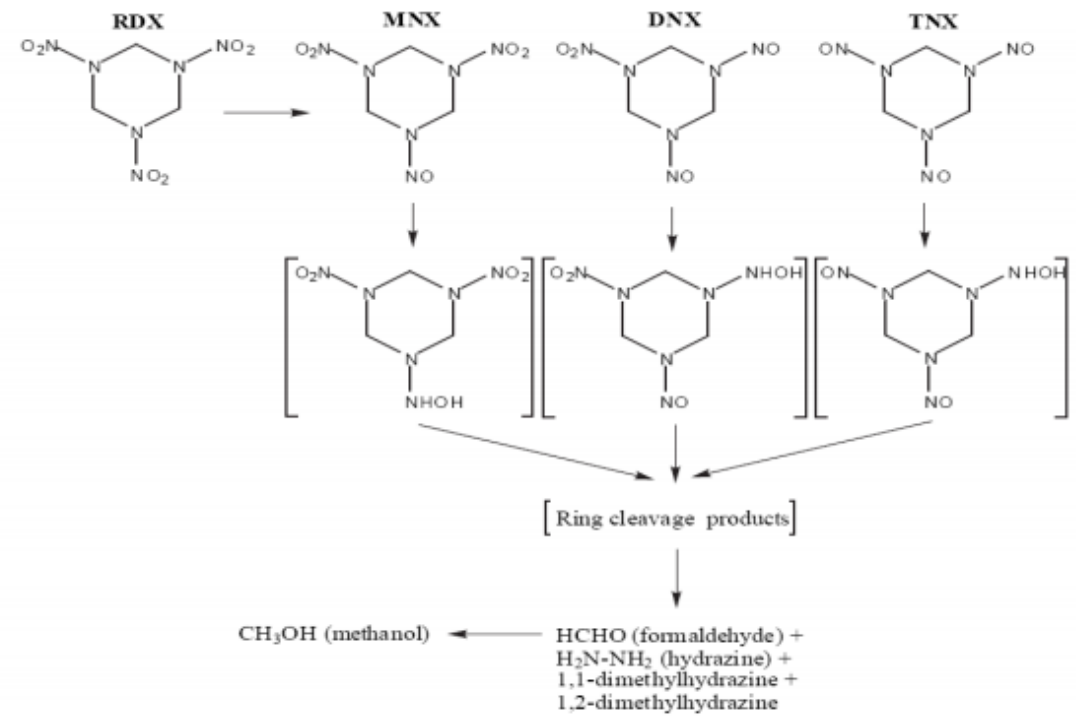


Figure 15: Mechanism of biodegradation of RDX within plants (Sanka, 2009). One pathway of RDX biodegradation in plants involves the production of mono, di, and tri nitroso intermediates from RDX, through sequential reductions of the nitrogroups. Another proposed mechanism of RDX degradation occurs with cleavage of the ring and further break down to formaldehyde and nitramine (NO2-NH2). These are finally converted to carbon dioxide, methane (CH4) and nitrous oxide by microorganisms in the soil (Sanka, 2009).

Perchlorate

	Perchlorate – ClO_4^-  (ChemSpider, 2013)
Solubility	1.5g/100 mL H_20 at 25C (ChemSpider, 2013)
Mobility	Very mobile in soils through water (Ting et al., 2006)
Behavior in Soils	10% perchlorate will attach to clay layers (Brown and Urbansky, 2003)
Water Quality Limits	No EPA limit, 2 ug/L (MA DEP), 18 ug/L (CA DHS) 24.5 ug/L (NAS)
Regional Screening Level	550 mg/kg (EPA, 2012)
RFD_0	$7.0x10^{-4}$ mg/kg.day (EPA, 2012)
SFO	none

Table 3: Perchlorate Properties

Perchlorate is an anion derived from perchloric acid ($HClO_4$) and found commonly in groundwater as a result of military contamination. Due to its unique combination of solubility, stability and mobility, it has a huge potential for localized contamination and high compounded concentrations (Crawford-Brown et al., 2006). Perchlorate also has a similar ionic radius and charge to iodide, a necessary thyroidal signaler, giving it the ability to block iodide in the thyroidal system (Irizarry et al., 2011). Iodide blocking may lead to disruption of hormones and thyroidal problems. Fetuses and newborns are the most susceptible to

hormonal problems, as the only source of iodide in utero and during infancy is from the mother, and iodide is crucial during development (Irizarry et al., 2011).

Perchlorate is formed naturally by unspecified heterogeneous photochemical reactions in the atmosphere (MADEP, 2006). High concentrations of perchlorate are used industrially in systems that require a rapid exothermic release of oxygen, such as fireworks or solid rocket fuel (Crawford-Brown et al, 2006). Perchlorate is highly water soluble and stable at ambient temperature and pressure, making it extremely likely to contaminate waters when disposed of improperly (Ting et al., 2006). Military contamination is generally the main point of concern in perchlorate contamination. Perchlorate salts and perchloric acid are used in over 250 types of munitions at military bases. The structure of perchlorate, as discussed above, allows it to easily contaminate water supplies near military bases (MADEP, 2006).

The transfer of perchlorate to soil is relatively low, at around 10% (Brown and Urbansky, 2003). Perchlorate's transfer properties mean that highly contaminated water sources which may be used to irrigate agricultural fields will transfer 10% of the perchlorate to clay layers. When considering highly contaminated waters not treated to any drinking water standard, this is a concern (Brown and Urbansky, 2003).

Uptake of perchlorate by plants in contaminated soil has not been deeply studied. It has been determined that perchlorate uptake is highly variable plant-to-plant due to individual traits (Yu et al., 2004). Uptake is also limited by the presence of external nutrients in the soil. If plants are well-fed, they take up significantly less perchlorate (Yu et al., 2004).

Ion transport is the route by which perchlorate enters plants, passing from soil solution into xylem. A diagram of the mechanism of plant uptake is provided below in Figure 16.

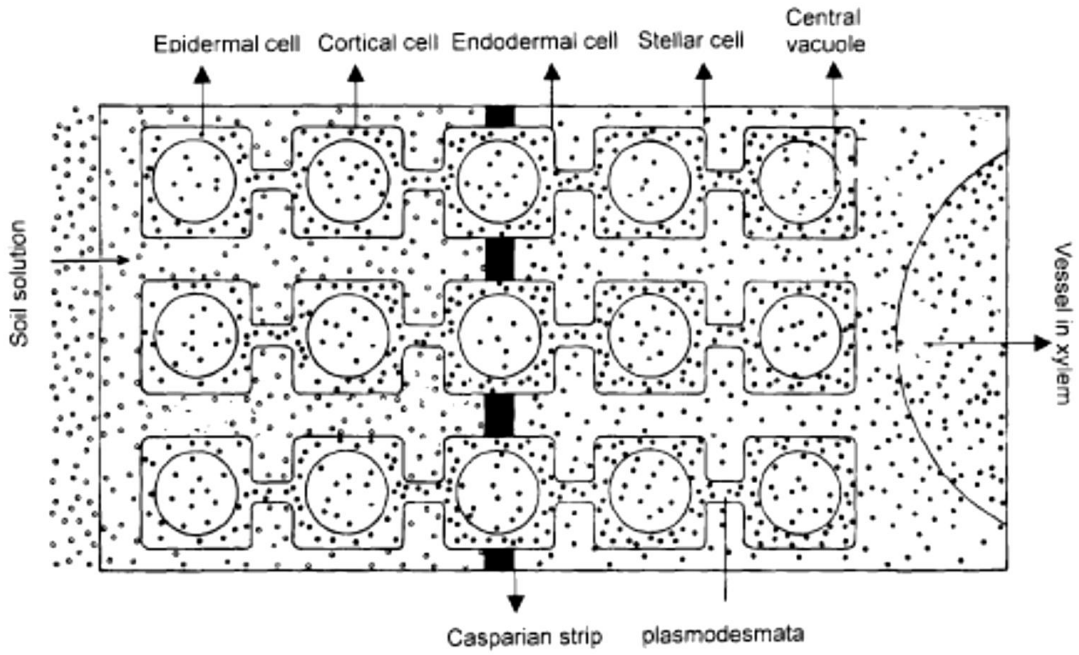


Figure 16: Ion transport model of perchlorate from soil water into the vessels of the root (Yu et al., 2004). The perchlorate enters the root through soil solution, trapped in the pockets between particles of soil. Perchlorate is more likely to exist in solution than in soil, making this pathway particularly important. The exact mechanism of perchlorate uptake is not established, but it is hypothesized that perchlorates are taken up by the root system as an ion in solution, transported up the stem via the xylem and into the leaves and stem (Yu et al., 2004).

Perchlorate contaminated waters are a public health issue because perchlorate attacks the thyroid gland, reducing uptake of iodine (Zewdie et al., 2010). It competes with iodide at the thyroid and can reduce or completely block uptake of iodide into thyroid, and synthesis and secretion of hormones can be impaired due to the blockage of iodide. Perchlorate is very readily absorbed from the gastro-intestinal (GI) tract and distributed systemically with total

body water (Ting et al., 2006). Iodide is a key component of thyroid hormones including thyroxine (T3) and triiodothyrodine (T4), both used to regulate cell replacement, energy production and growth and maturation of body tissues. The half-life of T4 is 5-7 days and the half-life of T3 is about 1 day in adults with no thyroidal issues. This requires a fairly high and regular turnover of thyroidal hormones to keep the hormone supply regular (Irizarry et al., 2010). Role of T3 and T4 in the thyroid is seen in the following diagram, Figure 17.

The simplest mode of action for perchlorate in thyroid involves inhibition of iodide transport into the thyroid by substitution. Substitution is possible due to perchlorate's similar ionic radius and charge. Without competition, perchlorate may then transport into the thyroid follicle and thyroid lumen against a concentration gradient where it again blocks iodide from entering into the thyroid. Here, normal thyroidal hormone production is affected. From the thyroid, perchlorate diffuses back into the bloodstream and is excreted from the body (Clewell et al, 2004).

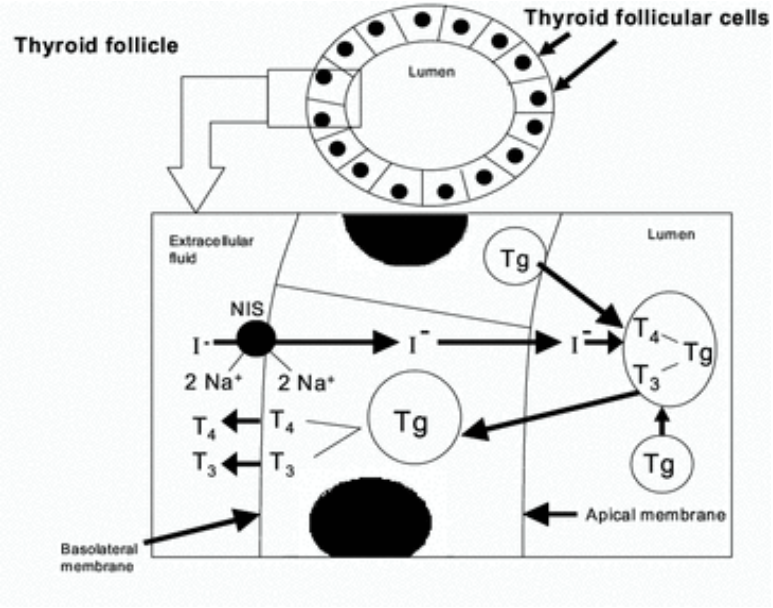


Figure 17: Role of T3 and T4 in the thyroid (NRC, 2005). Thyroid hormones (T4 and T3) are produced by the follicular cells of the thyroid gland and are regulated by TSH made by the thyrotropes of the anterior pituitary gland. The effects of T4 are mediated via T3 (T4 is converted to T3 in target tissues). T3 is 3- to 5- fold more active than T4. T4 is produced by follicular cells of the thyroid gland. It is produced as the precursor thyroglobulin (Tg) which is cleaved by enzymes to produce active T4 (NRC, 2005).

When thyroid hormones in the system are low because of impaired production, the hypothalamus reacts, promoting more hormone production (Zewdie et al., 2010). Prolonged hormone deficiency and hypothalamus stimulation can cause thyroid enlargement. This condition causes a large growth in the neck (known as a goiter), making breathing and swallowing difficult. If left untreated, the patient may not only go through significant pain, but may have to undergo hormone therapy to reverse the problem. If the source of the problem is not removed from the patient's life, the problem will only return regardless of treatment (Ting et al., 2006).

Iodine deficiency disorders (IDDs) were considered a public health concern in the past, but as iodine supplements, such as iodide-supplemented salts, increased in the US, the public health issue dissipated. As environmental perchlorate levels are beginning to rise and affect iodine absorption, IDDs are once again becoming a concern. (Crawford-Brown, 2006)

Although adults are clearly affected by perchlorate, they are not the most sensitive population to be considered. The Ting et al. study (2006) determined that pregnant women and their fetuses are the most sensitive cohort, especially babies in utero and infants. In utero, babies are extremely sensitive because perchlorate exposure limits iodide transport into the womb as well as later on, in breast milk, the only source the infant will have of iodide. Gestation can be a vulnerable period in regards to perchlorate exposure because the mother has increased nutritional demands for iodide. If iodide levels are depressed due to overexposure to perchlorate, thyroid hormones will not be produced at high enough levels. These thyroid hormones are critically important for fetal brain development. Therefore, at low levels, the fetus is at risk.

In utero, the fetal brain undergoes many stages supported by maternal T4 (Clewell et al., 2004). The mother is the only source of thyroid hormone during the first trimester, and the hormone is critically important during the first trimester when the brain first begins to form. If T4 is not supplied in high enough levels, brain development in neonates is significantly retarded, varying within populations due to a number of different factors (Zewdie et al., 2010; Ting et al., 2006). The majority of the supply of T4 comes from the mother's breast milk and therefore, the mothers supply needs to be abundant. The mother's

production of T4 is completely dependent upon her iodide supply in the thyroid. If her production is slowed or halted by perchlorate competition, T4 levels can easily be compromised (Ginsberg et al., 2005).

Perchlorate may also impair iodine excretion into breast milk in humans, suggested by data showing an inverse correlation between perchlorate and iodide concentration in breast milk in a small number of US samples that contained greater than 10 μg/L perchlorate. Iodide limitation in breast milk harms the baby in the way that any thyroid production it may have is not completed because of low iodide levels (Zewdie et al., 2010).

Both iodide levels and T4 levels have been correlated to lower IQ scores later in life. In the same study discussed above, carried out by Zewdie et al. (2010), it was shown that children born to iodine-deficient mothers have IQ levels 5-13 points lower than their iodine-sufficient peers. Iodide deficiency was associated with a four-fold increase in a risk of a low IQ. In an area with known low to moderate iodide uptake in the gestational and infant period, significantly lower IQ levels were recorded (Zewdie et al., 2010).

The main route for perchlorate intake in humans is through drinking water and currently, the United States Environmental Protection Agency (USEPA) recommends a perchlorate drinking water limit of 23.5 μg/mL (Mwegoha et al., 2007), adopted from the National Academy of Sciences (NAS) recommendation. The current EPA limit is not an enforceable limit under the Safe Drinking Water Act and is therefore not required to be reported to communities. The recommended level was determined by a number of studies monitoring hormonal levels and changes through a large population. However, there are

many other methods of determining the safe drinking water level to protect even the most sensitive subpopulation of pregnant women and their fetuses. The USEPA health advisory level prior to the NAS study was 15 μg/mL.

In areas where perchlorate levels in bodies of water are elevated, the soil which is used for agriculture is often polluted as well, requiring cleanup to protect health (Mwehoga et al., 2007). Native species can often be used to remediate perchlorate, such as the *Salix* genus. Phytoremediation has been the most successful method of in-situ bioremediation for perchlorate thus far. *Salix* is planted into the contaminated area and then takes up the perchlorate. Uptake has been seen at greater than 95% in humic soils (Mwegoha et al., 2007).

Animal manure extract can be injected through the soil into the groundwater alongside *Salix* to reach the root location and location of remediation to enhance the conversion of perchlorate to chlorite as much as possible. Dissolved organic carbon (DOC) is often a limiting factor in the breaking down of perchlorate by *Salix* and addition of animal manure speeds the removal rate. Since the DOC is being added by an organic source, it is completely safe to add to areas with groundwater (Mwegoha et al., 2007). After uptake, the plants must be removed and disposed of elsewhere.

Remediation by phytodegration could reduce the amount of perchlorate in the area, and it would not be cost efficient whilst preserving the natural environment. It is a public health concern that perchlorate must be reduced. If perchlorate is not reduced in the environment, adults are at risk for thyroid problems and children are at risk for impeded brain development and future mental issues.

Hexavalent Chromium

	Hexavalent Chromium ($Cr^{+6,}$ as chromate, CrO_4^{2-})  (ChemSpider, 2013)
Solubility	2298 mg/L at 25C (ChemSpider, 2013)
Mobility	Relatively mobile
Behavior in Soils	Weakly sorbed to soils, easily displaced by other ions (Balistrieri and Chao, 1987) Sorption decreases with pH (Bartlett, 1991) Reduces to CrIII in presence of high OM levels (Bloomfield and Pruden, 1980)
Water Quality Limits	0.05 mg/L (EPA, 2012)
Regional Screening Level	550 mg/kg (EPA, 2012)
RFD_0	$3.0x10^{-3}$ mg/kg.day (EPA, 2012)
SFO	$5.0x10^{-1}$ $(mg/kg.day)^{-1}$ (EPA, 2012)
Adsorption Coefficient	52 L/kg, will desorb easily (Stollenwek and Grove, 1985)

Table 4: Hexavalent Chromium Properties

Chromium VI (Cr VI) is a well-documented human carcinogen, first suspected in the 1800s as a group of Scottish pigment workers were found with an abnormally high incidence of lung cancer (Finley et al., 1997). It is commonly seen as a contaminant related to occupational cancer and is also the second most prevalent cause of contact dermatitis in the United States (Kimbrough et al., 1999). Naturally occurring chromates are very rare and found only in highly oxidizing environments; their presence in soils and water is almost

always the result of human activities such as electroplating and other industrial activities (Finley et al., 1997).

Chromium can travel from industrial sites to be deposited elsewhere by either wet deposition or dry deposition, alongside transport by water and dumping in soils. Chromium emitted into the atmosphere can be particle bound or dissolved in droplets, staying airborne for 7-10 days, allowing long distance transport by wind and in dry deposition, these particles settle and are captured by soil or surface waters (Kimbrough et al., 1999). Wet deposition involves the particles becoming entrained within atmospheric moisture like snow and rain, then falling to earth where it settles on soil and surface waters (Kimbrough et al., 1999). After settling down, chromium can also be introduced or reintroduced into the environment via wind resuspention of chromium-contaminated soil particles.

CrVI is seen as a dangerous carcinogen, but its trivalent form, CrIII, is not nearly as toxic for a number of reasons. These are the two stable forms of chromium and are interchangeable under different reducing and oxidizing environments. CrVI usually occurs with oxygen as CrO_4^{2-} or $Cr_2O_7^{2-}$ in the environment. Which oxyanion exists depends strongly on pH and concentration with CrO_4^{2-} predominating (Urbano et al., 2012). CrIII is less mobile and is mainly bound to organic matter in soil and aquatic environments (Shanker et al., 2005). Unike CrVI, CrIII forms positively charged compounds like $[Cr(OH)]^{2+}$which absorb easily to negatively charged layers of clay and organic matter in soil. It is much less

bioavailable than CrVI also due to this sequestration and its lower water solubility (Urbano et al., 2012).

CrVI in soils poses a risk not only of contact dermatitis and inhalation of particles, but also ingestion of CrVI through agricultural crops. As mentioned above, both CrVI and CrIII may be found in agricultural soils, but CrVI is a much more concerning species. CrVI sorption in soil is limited to the number of available positive surface exchange sites. Sites quickly disappear at increasing pH in soils, but at acidic and neutral pH, Fe and Al2O3 sites easily absorb CrVI in either anionic form (Saha et al., 2011). Soil has a limited reducing capacity to change CrVI to CrIII, which will bind to available organic matter. High concentrations of CrVI introduced quickly may exhaust the reducing capacity of that soil and excess CrVI may persist for years. The reducing capacity of soil has been seen to increase with decreasing pH (Kimbrough et al., 1999). A neutral to acidic soil is best for sequestering CrVI, while basic soils generally have more available Cr.

It is unknown whether or not chromium is a necessary compound to plant growth and well-being, however, CrVI uptake in plants is a metabolically meditated process. It is absorbed through the roots via the sulfate pathway, which is ionically similar (Saha et al., 2011). It is then transmitted throughout the plant, concentrating in roots. Small amounts have been seen in above ground portions of plants, with leaves containing more CrVI than grains (Kinbrough et al., 1999). CrVI competes with Ca, K, Mg, P, B and Cu for transport binding and decreases these nutrients in the final plant, as seen in soybean trials. CrIII, on

the other hand, is passively taken up and retained in cation exchange sites. It can enter the plant system if organically complexed at this point and transported in (Shanker et al., 2005).

Both forms of chromium are highly toxic to plants at high levels as well. Toxicity is seen at multiple levels, from reduced yield, through effects on leaf and root growth, to inhibition of enzymatic activities. Chromium toxicity is hypothesized to be due partially due to the competition that blocks out necessary elements from entering the plant at the root. Uptake of chromium is not seen to be particularly high in any plant due to its toxicity (Shanker et al., 2005).

As mentioned above, chromium VI is a known carcinogen. Cancer from chromium shows mainly in the lungs, but it is also a possible oral, intestinal and stomach carcinogen as well (Holmes et al., 2008). The difference in toxicity of CrVI and CrIII has been rationalized due to their geometries. CrVI has a tetrahedral structure that resembles phosphate and sulfate ions. This tetrahedral complex may enter cells via nonspecific anion exchangers that are generally used for uptake of phosphate/sulfate. CrIII is octahedral and cannot enter through nonspecific exchangers in the same manner. They are toxic only by nonspecific mechanisms when administered close to solubility in aqueous solution (Urbano et al., 2012). CrIII may enter cellular membranes, but at a rate exponentially slower than CrVI (Kimbrough et al., 1999).

The mechanism that causes carcinogenicity of chromium is relatively well studied, but not certain, as seen in Figure 18. It is hypothesized that as CrVI centers a cell by

nonspecific anion exchangers, it is reduced quickly to CrIII. Gluthathione reacts with CrVI, leading to the stepwise reduction to CrIII through one electron transfer. During the one electron transfer steps, different free radicals are generated (Saha et al., 2011). These free radicals cause DNA double strand breaks, misrepair of breaks, neoplastic transformation and cancer (Holmes et al., 2008).

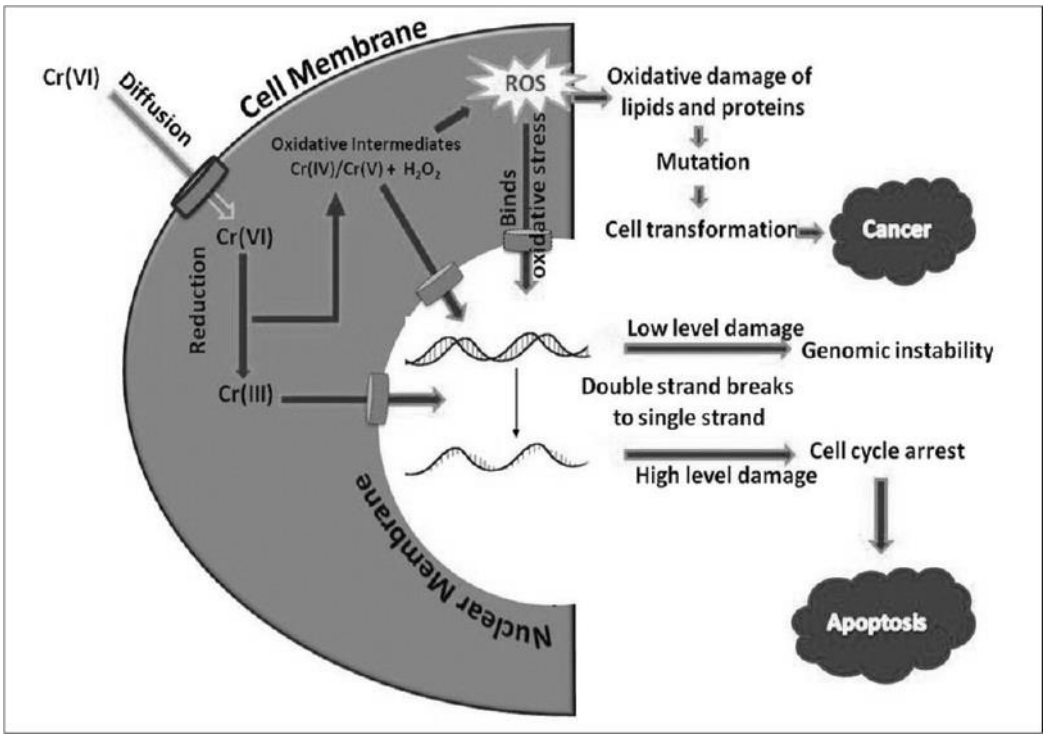


Figure 18: Possible mechanism of hexavalent chromium carcinogenicity (Das and Singh, 2011). Hexavalent chromium is transported into cells via the sulfate transport mechanisms, taking advantage of the similarity of sulfate and chromate's structure and charge. Inside the cell, Cr(VI) is reduced first to pentavalent chromium (Cr(V)), then to trivalent chromium (Cr(III)). The damage and therefore, the cancer, is caused by hydroxyl radicals, produced during reoxidation of pentavalent chromium by hydrogen peroxide molecules present in the cell. (Das and Singh, 2011)

Ingested chromium is reduced most often in the stomach, where the pH is around 1. Reduction happens up until 10 mg/L (Finley et al., 1997). After this point, CrVI continues to

the intestine where it is readily absorbed and then reduced. Heightened levels of stomach and intestinal cancer have been seen in chromium exposed populations, but more research is needed to conclusively determine the carcinogenicity (Kimbrough et al., 1999). Liver and kidney damage from chronic chromium is also commonly seen. Damage is not due to the reduction mechanism, but simply due to the fact that these are the excreters of chromium in the human body (Kimbrough et al., 1999). Recent research has also shown that oral and intestinal cancers are seen in populations exposed to CrVI, and that ingestion may pose a more serious risk than previously thought (Holmes et al., 2008). Additionally, in recent research, an increase in mental, psychoneurotic and personality disorders among all race groups has been seen related to chromium exposure in rodents. This raises the possibility that CrVI is also neurotoxic (Urbano et al., 2012).

The US EPA's maximum contaminant level for chromium VI is 0.05 mg/L and 2 mg/L for chromium III. At these "safe" doses under environmental conditions such as ingestion by tapwater, measureable increases in excreted chromium are seen as opposed to controls (Finley et al., 1997). These levels do not take into account women, children, or people who may be exposed to chromium through sources other than tapwater.

Phytoremediation has been relatively unsuccessful in cases of chromium due to the toxicity is has on plants. Translocation from roots to shoots is also extremely slow, or nonexistent, in some species, limiting how much chromium could be taken into a plant. In species where leaves or branches with concentrated contaminant may be cut off, the

remediation capacity is much higher (Shanker et al., 2005). Most successfully seen is a remediation technique capitalizing on oxidized manganese-rich soils. Addition of organic matter to these Mn-rich soils results in unstable Mn III compounds that temporarily prevent Cr III oxidation to Cr VI and promote reduction of CrVI to CrIII (Kimbrough et al., 1999).

Chapter 5: Experimental Determination of Contaminant Levels in a Food Producing Community Garden

This chapter aims to explain the details and results of soil analyses I conducted and the procedures I used to test the soil of the North Railroad Avenue Community Garden in Espanola, NM for: arsenic, perchlorate, RDX, and hexavalent chromium. I was most interested in these chemicals, which not only seriously threaten public health, but have been detected as being released by industrial or military activity in Northern New Mexico.

The soil was collected from the community garden in Espanola, NM on North Railroad Avenue with the permission of garden leaders. I then tested these soils at Hampshire College in Amherst, Massachusetts. The goals of the soil testing were as follows:

1. To determine presence and levels of contaminants in the soil in the gardens
2. To determine the health risk of contaminant constituents in the gardens
3. To determine methods of reducing contaminant risk that take into account specific soil conditions

From the garden, soil samples were collected on a grid system aligned to both edges of the field to assess places where levels of contaminants were highest and lowest. They were then assessed for measures of soil quality including pH, conductivity and redox potential, which all indicate availability, interaction and fate of contaminants in the soil and soil solution. Colorimetric methods were utilized in order to test for arsenic, perchlorate, RDX, and hexavalent chromium due to restrictions on laboratory equipment. An in-depth literature

study was taken on in order to find the most reliable and well-tested colorimetric methods which could be completed using the materials available.

5.1 Experimental Results and Discussion

All experiments were performed in the laboratories at Hampshire College in the 2012-2013 academic year by Morgan Drewniany, with the assistance and guidance of Rayane Moreira, Assistant Professor of Organic Chemistry, Sarah Steely, Laboratory Technician, and the staff of the Natural Science department. Throughout this section, samples will be referred to by their position in the garden, (column#, row#). A table of all results with average, standard deviation, minimum and maximum values may be seen in Table 5. All experimental methods with details are available following this results section for the interested scientist, but are not necessary to understand the results and meaning of the results.

The levels of RDX do not have a label due to the inability to test quantitatively. RDX is not commercially available as a standard solution, and therefore, a standard curve to match up against the measured amounts was not obtainable. The amounts given in the table are relative levels seen in the field. One sample, which is seen as “4”, was the absolute highest recorded due to instrumental limits. The samples which did not test positive in the first spot test read as “0”. This gave information on where RDX was spatially located in relative amounts. A regression to get exact values for remaining samples was not completed due to lack of information on the correlation.

	ORP (mV)	pH	Conductivity (uS/cm)	RDX (qualitative – to scale)	Arsenic (ppm)	Perchlorate (ppm)	Cr(VI) (ppm)
Average	203.4	6.086	101.3		0.0277	6.961	0.219
Standard Dev	0.0273	0.2164	29.20	0.7797	0.010	3.124	0.0117
Max	209.2	6.5	158.7	"4" (see justification)	0.05	15.28	0.2418
Min	199.4	5.44	41.1	0	0.005	1.571	0.199
MCL (ppm)				105	0.01	0.02	0.05
RSL (mg/kg soil)				5.6	0.39	550	0.29
RFD_0 (mg/kg.day)				0.003	0.0003	0.0007	0.003
SFO $(mg/kg.day)^{-1}$				0.11	1.5	None	0.5

Table 5: Average, standard deviation, maximum and minimum values for all contaminants tested. The measurements of RDX are not quantitative like the rest, but qualitative and therefore there is no measurable average value. Average measured values, water quality limits and toxicity threshold limits for all measured contaminants are also listed. All information from EPA, 2012.

For the garden, average contaminant concentrations are compared to relevant "health protecting" standards set by the EPA. These are guidelines used across the United States and should cover the contamination in the Railroad Avenue garden, especially since it is used for crops which are eaten and pregnant women and their children are exposed to these soils. Water quality limits (MCL) are given with the assumption that soil leaches to groundwater, and levels appearing in soil solution will exist in groundwater. Regional screening levels (RSL) are soil cleanup benchmarks used in EPA Superfund sites, all given at the 'residential' level, which aim to protect citizens using soil for average residential purposes such as gardening and outdoor play. The reference dose (RFD_0) is "an estimate… of a daily oral exposure (including sensitive subgroups) that is likely to be without an appreciable risk of

deleterious effects during a lifetime" (EPA, 2012). This is the most general health-protecting standard the EPA puts out and is assumed to be the dose below which no adverse carcinogenic health effects should occur. A high reference dose indicates a contaminant which is of less concern. Oral slope factors (SFO) define the cancer risk due to ingestion, and are given due to the nature of contaminants in soil. An SFO of 1.5, such is for arsenic, represents 1.5 "extra" cases of cancer per person ingesting 1 mg of a chemical per kilogram of body mass per day. Both the MCL and the RSL take RFD_0 and SFO into account in their assessments of risk. All averages given are in the form of parts per million (ppm), which also may be interpreted as milligrams contaminant per kilogram of soil.

It may be easily seen that all four contaminants exceed the water quality limits defined by the EPA. Hexavalent chromium closely approaches the RSL limit, indicating that there is an immediate health risk resulting from the presence of these contaminants. This trend may be seen in Figures 19-22 below.

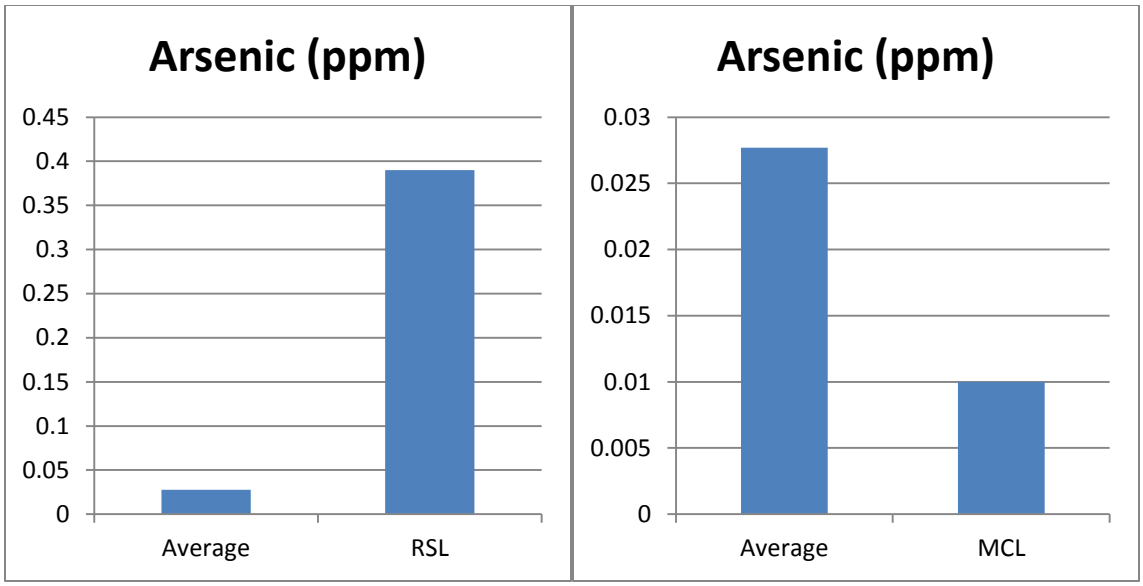


Figure 19: Arsenic Average found versus EPA RSL, MCL

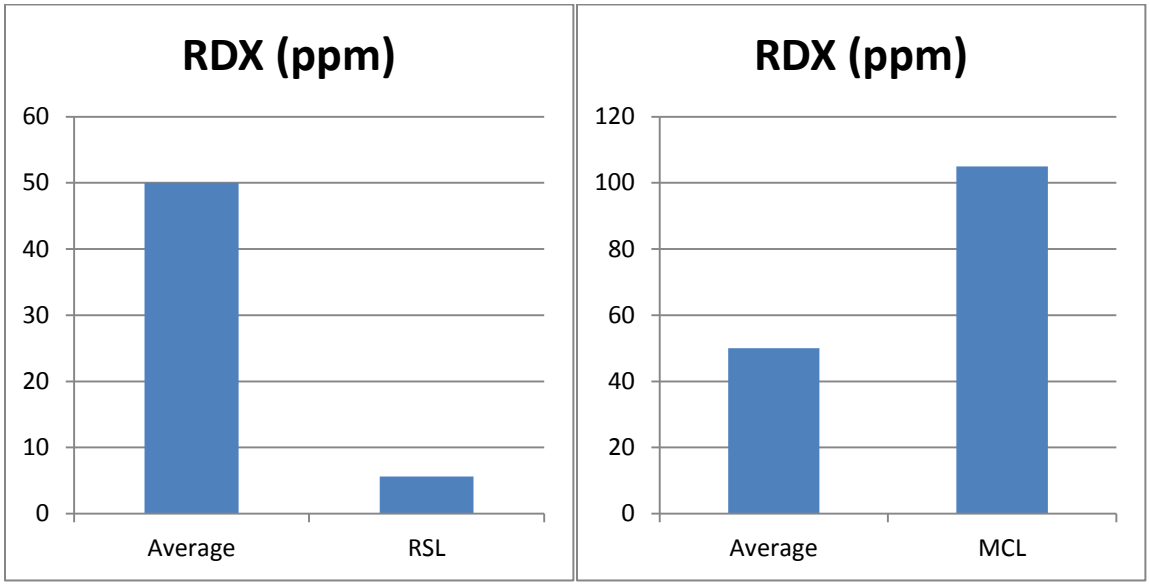


Figure 20: RDX average found versus EPA RSL, MCL

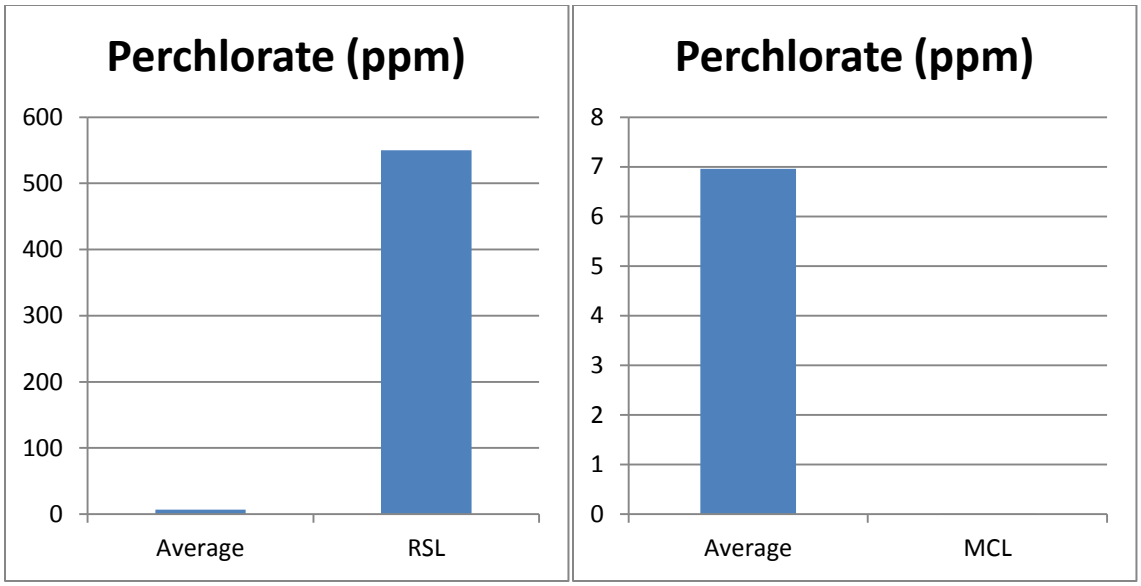


Figure 21: Perchlorate average found versus EPA RSL, MCL

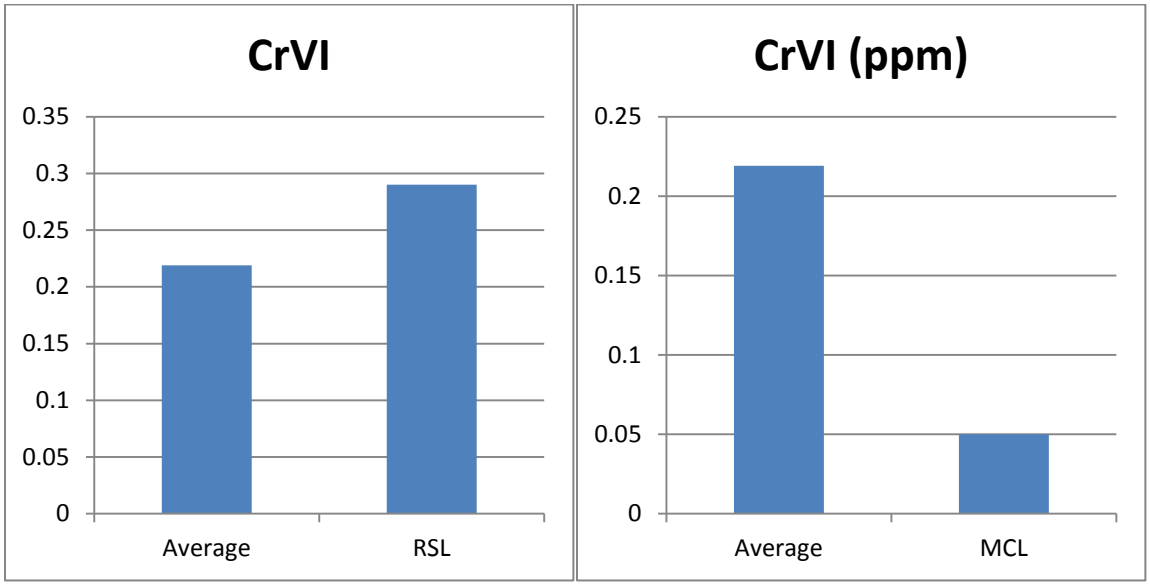


Figure 22: CrVI average found versus EPA RSL, MCL

Soil Electrochemical Properties

The soil pH, conductivity and redox potential were all measured using a water quality meter. These are important measures of the availability, interaction, and fate of elements in the soil and soil solution. pH determines both plant growth and mobility of contaminants,

conductivity determines the flow of electrons in a solution and therefore the amount of ion activity, and redox potential which determines mobility of contaminants.

In these samples, it can be seen that pH and ORP have low standard deviations, indicating a relatively stable average throughout the field. Conductivity, on the other hand, varies drastically, with the highest levels laying along row 1 and decreasing in columns 4 and 5, where water is least likely to pool.

The average pH levels ranged from 5.44 to 6.5, with an average of 6.09. This is in the range of 5.5-7.5, the range which indicates dominance and presence of hydroxyl-aluminum ions, which buffer soil acidity (Thomas, 1996). At this pH range macronutrients in the soil like metals are at their highest availability. Also within this pH range, toxic trace ions with a positive charge, such as arsenite (3+) and arsenate (5+) are least mobile and therefore, less available to plants. Because of this, human exposure through eating produce from the gardens is less likely, but exposure through dust and ion transport into water is still likely.

The redox potential (ORP) in the garden ranged from 199.4 mV to 209.2 mV, with an average of 203.4 mV. At these levels, with an average pH around 6, arsenite, AsO_4^{3-}, with As^{3+}, is more soluble and mobile in soils than arsenate, As^{5+}. Overall, the samples were slightly reduced (ORP=~200 mV) and slightly acidic (pH=~6), which are favorable soil conditions for low trace metal solubility, and therefore contaminants will bind well to the soil.

Contaminants: RDX, Perchlorate, Hexavalent Chromium and Arsenic

Garden soil contaminant concentrations were determined for arsenic, RDX, hexavalent chromium and perchlorate. There was no acceptable control sample readily available in Northern New Mexico, and therefore, the levels of contaminants found were compared to EPA recommended limits due to the high exposure the garden causes to local communities.

The levels of RDX, perchlorate, hexavalent chromium and arsenic found were elevated to possible risk levels. Arsenic levels in the Southwest, and in New Mexico specifically, are naturally elevated due to the soil types and in this specific instance, a nearby caldera, as discussed in chapter 3. This distribution may be seen in the USGS soil arsenic map below (Figure 23). It is difficult to tell how much arsenic is coming from man-made sources as opposed to naturally high levels. Despite this, the total level of arsenic must be considered in order to protect health. RDX and perchlorate are both man-made explosive chemicals, and therefore, they have no naturally occurring levels and are not assumed to be present except in the case of external input. The amounts found are all assumed to be enhanced by surrounding human activities.

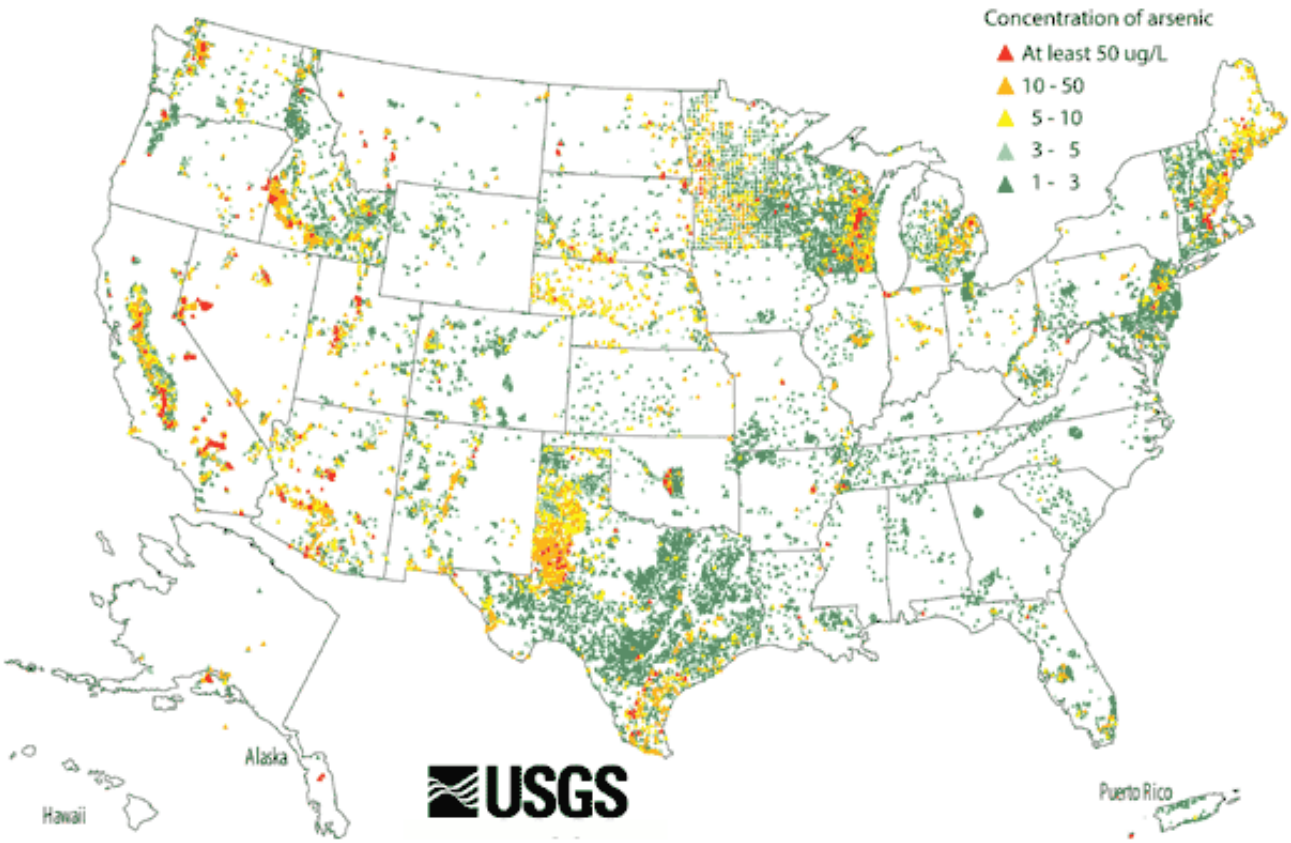


Figure 23: Map of the US by arsenic distribution in soil. Northern New Mexico can be seen on this map to have high points near the Pajarito Plateau, spiking at "at least 50 ug/L." This is listed as the US Drinking Water upper limit. (USGS, 2012)

The distribution of RDX, perchlorate, hexavalent chromium and arsenic were analyzed by placing the rows and columns on a 3D scale (Figures 24-27). This aids in visualizing where the highest concentrations of each contaminant lies.

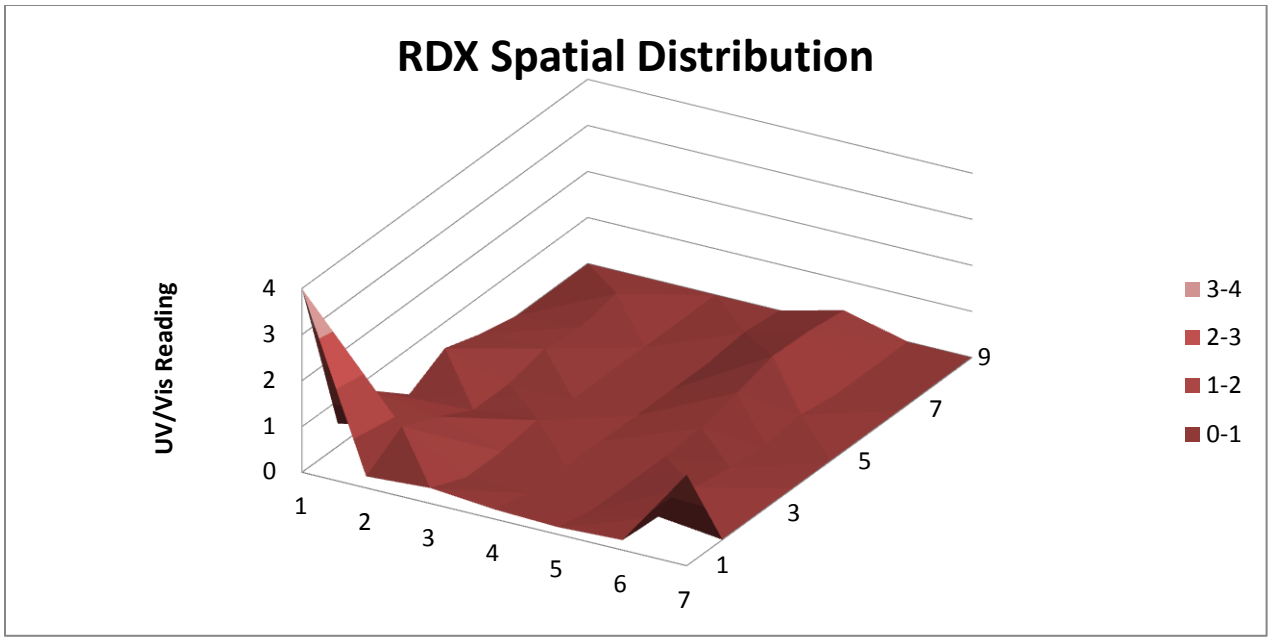


Figure 24: Distribution of RDX within the North Railroad Avenue garden. The high point, listed as "4" is estimated to be 50 ppm and "0" values are 0 ppm.

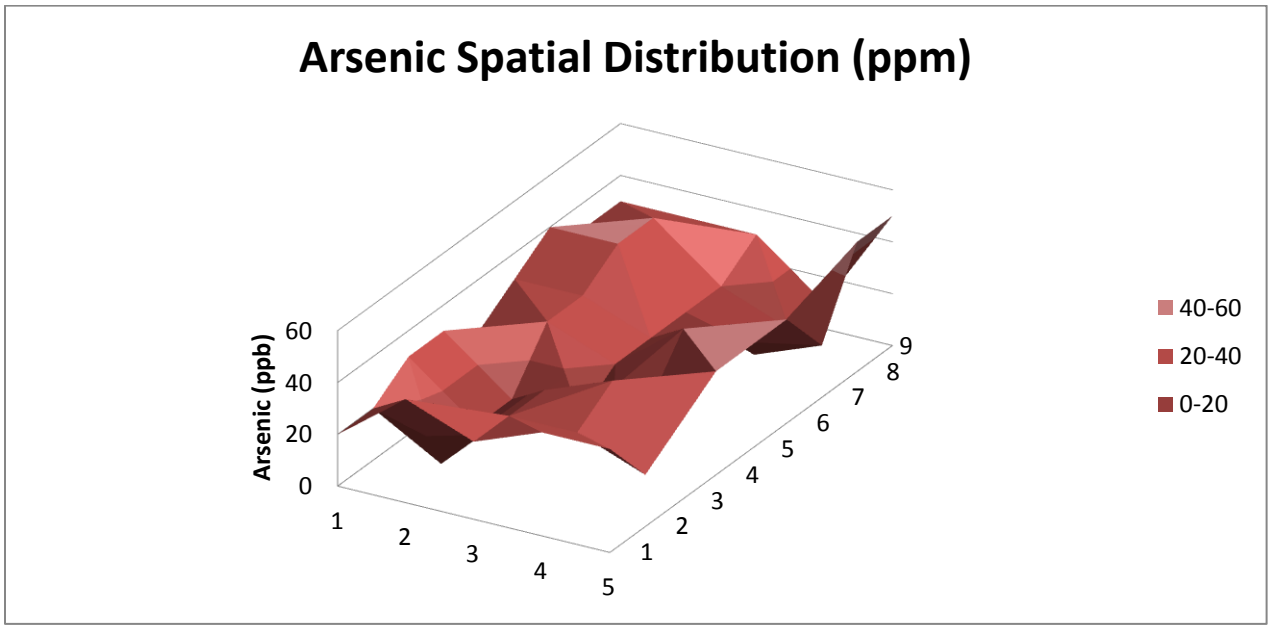


Figure 25: Distribution of Arsenic within the North Railroad Avenue garden.

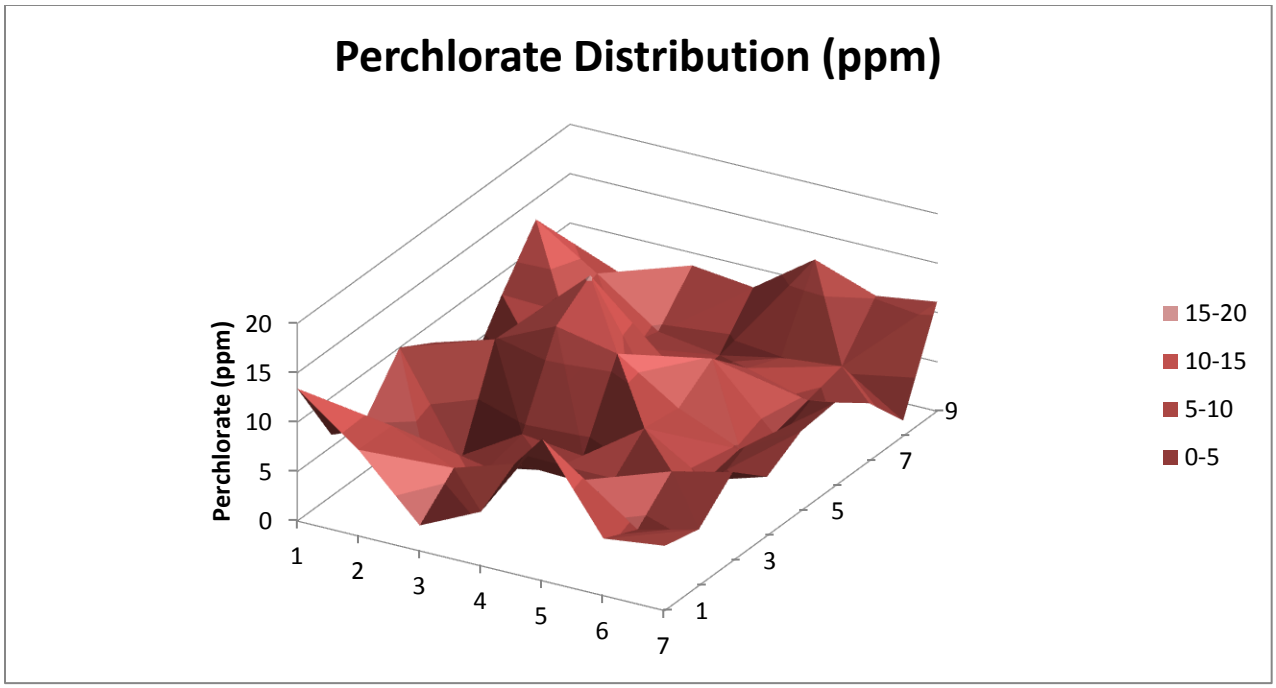


Figure 26: Distribution of Perchlorate within the North Railroad Avenue garden.

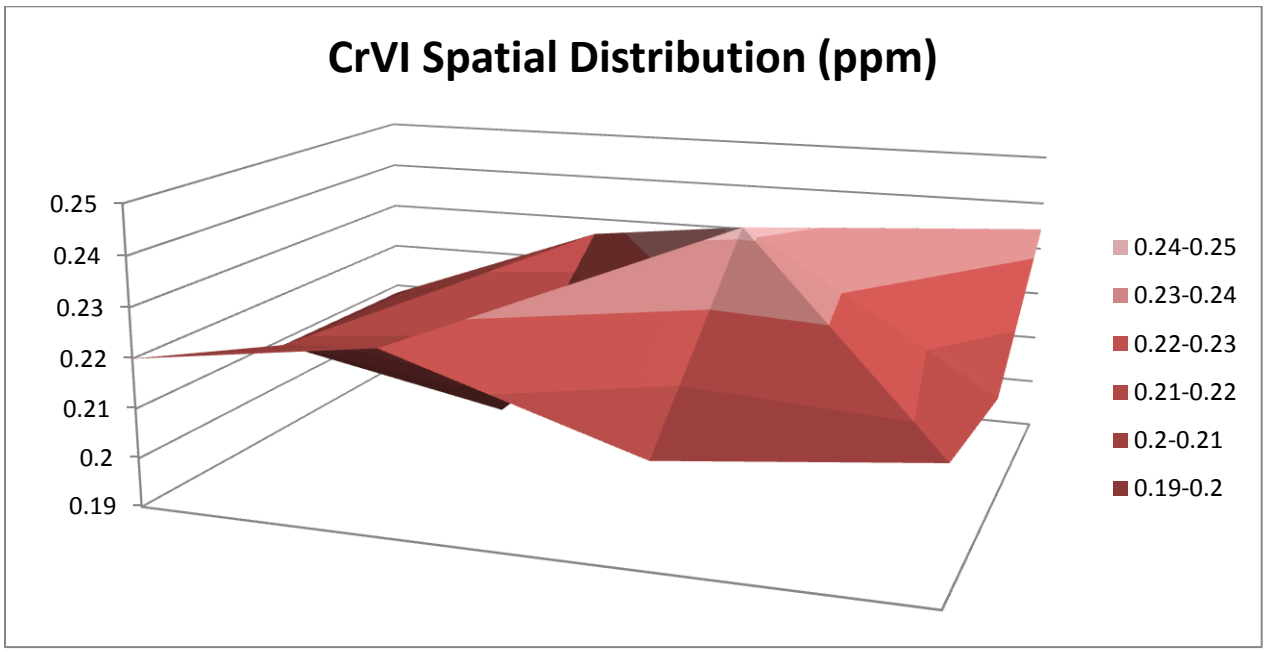


Figure 27: Distribution of CrVI within the North Railroad Avenue garden.

It can be seen that the distribution of RDX is very clear, with highest levels pooling at the inflow of water and the end of the irrigation ditch, where water often sits for extended periods of time. Its solubility of $1x10^{-6}$ mg/L (ChemSpider, 2013) explains this behavior, as does its' tendency to adsorb to clays (Townsend et al., 1996). With this combination of RDX behaviors, the contaminant, which travels easily with water, will accumulate in places where water pools, then attach to the clays in these areas. It is likely that the highest levels of RDX seen in the soil proves the presence of RDX in the waterways, and is approaching the groundwater if it is not yet there.

The distribution of arsenic is varied throughout the field, most likely due to natural variation. Soil was crushed and then analyzed, but the variation seen is most likely due to small "clobs" of soil with varying levels of arsenic. Arsenic is naturally high in this area due to a neighboring caldera, so this variation is not unexpected. The arsenic that is in this soil is not likely to leach significantly to groundwater, but due to the overall high levels found, it is possible for it to accumulate in groundwater in appreciable amounts.

Perchlorate levels also pool at the inflow of water and the end of the irrigation ditch, as well as the end of the columns where water also pools at the end of watering days. This shows that much like RDX, it is concentrating where water most often sits. Perchlorate is also mobile, with a solubility of 150 mg/L (ChemSpider, 2013), and sorbs around 10% to clay layers (Brown and Urbansky, 2010). This explains the relative high spots at the ends of the rows and columns, as well as the high spots in the middle of the field. The ends of the rows

and columns are likely due to the mechanism that RDX utilizes, in which the contaminant builds up with pooling of water. The spots in the middle which contain high levels of perchlorate are most likely due to points with more organic matter which attracts perchlorate much like a magnet. Much like RDX, perchlorate is also likely present in high levels in waterways and approaching the water table. Looking at the figure that 10% of perchlorate in the groundwater sorbs to clay, we may assume that the levels of perchlorate in local waterways is approximately 90% higher than the elevated levels already found in the soil. This is alarming because the soil levels of perchlorate already exceed water quality limits.

The distribution of CrVI found in the soil is not very clear. There is a high point of 0.241ppm, but this is not a drastic difference when compared to the minimum value found of 0.199 ppm. It appears as though the distribution throughout the field is consistent when looking at the average, maximum, and minimum values found. It is likely that the source of hexavalent chromium is through the waterway, but this cannot be confirmed with the data available.

The quantities of each contaminant were also plotted against pH to investigate any relationship which could be solved by adjusting the pH of the soil. There was no correlation found.

Uptake by Plants and Total Exposures

The plant uptake mechanisms for perchlorate and RDX are not well-understood enough to extrapolate the amounts of which each contaminant may be contributing to the diet of the community through the garden. It is known that the uptake mechanisms are highly variable from plant-to-plant (Best et al., 1999; Yu et al., 2004). It is known, however, that plants take up a very significant amount of RDX at a rapid pace, and do not degrade RDX at all (Chen et al., 2011). This creates an environment in which plants accumulate RDX, and from these plants, the RDX is taken up by the plants and eaten by the community, or recycled back into the soil as the plants compost in the fall (Chen et al., 2011). It may easily be assumed that a significant amount of RDX is being ingested through fruit and vegetables from the garden alongside inhalation of soil particulate and the groundwater, which invariably contains some RDX, as is seen in the soil. As stated before, perchlorate uptake by plants is a gap in the field and requires further research, but at the levels found in the soil, is likely a risk through the aforementioned pathways.

The uptake of arsenic by plants is limited to the type of arsenic available in the soil (Martinez-Sanchez et al., 2011), which was not measured in this study. It is known that in both forms, it readily translocates to the fruit of the plant, which is the portion that is eaten. In this specific garden, it may be assumed that a large amount of the average 0.0277 ppm measured is taken up by the plants, especially if the arsenic is coming in through the water and they are bathed with it twice a week. Again, along with the inhalation of soil particles

and intake of arsenic through high measured drinking water levels, this poses a large health risk.

Plant uptake of CrVI is through established sulfate pathways. These are pathways the plant uses to take up a nutrient it needs, and arsenic "tricks" the plant to be absorbed through this route. CrVI has been found to be extremely toxic to plants at low levels. Roots-shoots mechanisms are slow to nonexistent due to the extreme toxicity of the contaminant (Kimbrough et al., 1999). It is likely that before the plant becomes a very serious threat to health, that plants suffer reduced yield and slowed leaf and root growth (Shanker et al., 2005).

Experimental Methods

This section aims to inform the interested scientist of my methodology in soil testing through colorimetric means. It is not necessary to understand the larger piece, and stands simply as a testament to the work I completed in the lab.

Soil Sample Collection

Soil samples were collected at the North Railroad Avenue community garden following all protocol laid out in the US Environmental Protection Agency's (US EPA) surface soil guidelines (US EPA, 2000). The number of samples that were taken followed the guidelines set forth in the Environmental Monitoring and Support Laboratory's "Preparation

of Soil Sampling Protocols: Techniques and Strategies" (Mason, 1983). Samples were taken at regular intervals on a grid system aligned to the edges of the garden to avoid bias in collection. These procedures for sampling the lots take into account the variation in the material itself by sampling the entire site (Van Ee, 1990). In this experiment, soil was be taken from horizon A, the surface soil, avoiding soil that is in immediate contact with the air and sunlight. Tools were rinsed in the field but complete decontamination of tools was not a concern due to the nature of the contaminants being investigated. The grid system set up included taking a sample in each 10 m^2 at both sites. This layout is shown in Figure 33. A marked tape measure was used to lay out the exact grid system.

Figure 33: The North Railroad Avenue Garden. This middle section of the field (480 ft^2) was the plot gardened by Tewa Women United in the summer of 2013.

1 cell in grid = 10 ft x 10 ft, 1 sample taken in each cell = 48 samples total

At each square, the top layer of soil and debris was first removed to 1/2" with a spade rinsed with DI water. Using a pre-cleaned scoop, a generous amount of soil was placed into one pre-labelled zip lock bag. The container was closed tightly and placed aside. This routine was repeated until all samples were collected. All labeled samples were then transported to a cool, dry, dark place to rest until procedures were completed.

Soil Electrochemical Properties

To prepare for pH, ORP and conductivity testing, samples were first removed from storage. 2.000 g of crushed soil chosen randomly from the bag, to avoid bias, was measured out on an accurate scale. Exact weight was noted in a logbook. The 2.000 g sample was transferred to a 20 mL plastic test tube, then 10 mL of distilled deionized water was added, a cap was screwed on, and the sample was vortexed to mix thoroughly. The sample was allowed ample time for settling. After settling, the clear liquid was poured off of the samples into new, labeled 20 mL plastic tubes. This procedure was completed for each sample for these three tests.

pH, DO and ORP testing was completed with a water quality meter. The water quality meter was turned on and warmed up for approximately 30 minutes. Using prepared 4, 7 and 10 pH standards, the meter was calibrated under the pH setting. One sample at a time, pH was measured and recorded, rinsing with DI water between samples until all samples were complete. Next, the meter was set to the DO setting. One sample at a time, DO

was measured and recorded, rinsing with DI water between samples until all samples were complete. Finally, the meter was set to the conductivity setting. One sample at a time, conductivity was measured and recorded, rinsing with DI water between samples until all samples were complete. All tests were done in the same day to avoid bias and variation between samples.

Arsenic Testing

To test for arsenic, all samples were measured to 2.000 g with an accurate scale, placed into a 50 mL plastic tube and vortexed with 20 mL DI water. The samples were allowed ample time to settle. All tests were carried out following explicit instructions from the Hach Arsenic Low-Range Test kit. Two samples were analyzed at a time and recorded in a logbook. Between tests, the test vessels were cleaned vigorously to avoid contamination. Samples were randomly re-tested to ensure accurate readings.

RDX Testing

To test for RDX levels, a quantitative test was first completed, followed by a qualitative test for samples which showed positive results for RDX. All tests were completed according to the procedures laid out in Haas et al (1990) "Conception for the Investigation of Contaminated Munition Plants." An oxidation/reduction step is utilized through use of diphenylamine, which produces dark blue N,N'diphenylene-diphenoquinone-diimene in the presence of nitramenes such as RDX (Haas et al., 1990).

For the rapid quantitative test, a few milligrams of dry, crushed soil were placed in a clean, labeled test tube. A drop of prepared 1% diphenylamine in 88% sulfuric acid was added. In the presence of RDX, the sample will turn dark blue. In the absence, the sample will turn black. This was repeated for each sample and results were recorded.

All positive samples were then prepared for qualitative assessment of RDX. 2.5000 g of soil were measured into a clean, labeled test tube. 6.25 mL of concentrated acetone was added, and the sample was vortexed. After ample time for settling, the sample was filtered through filter paper into a flask, fed only by gravity, leaving soil behind. The filter and soil were disposed of. 2.5 mL of the filtered acetone solution were pipetted into a new, labeled test tube. The filter, flask and pipette were then rinsed. This procedure was repeated for all positive samples. After all samples were filtered and in new test tubes, all tubes were uncapped and left in the hood overnight to allow drying, until all acetone was evaporated. In the morning, the residue in each tube was dissolved in 2 mL of the 1% diphenylamine in 88% sulfuric acid solution. The reaction was allowed to proceed for 5 minutes, then the sample was measured with a spectrometer in a 5 mm quartz cuvette at 596 nm. All samples were measured and the results were recorded.

Perchlorate Testing

To test for levels of perchlorate, samples were first measured to 2.000 g with an accurate scale, placed in a 50 mL plastic tube and vortexed with 20 mL DI water. The samples

were allowed ample time to settle. The clear solution was poured off into new, labeled, 20 mL plastic tubes. All tests were carried out according to the procedures laid out in The US Army Corps of Engineers "Field Screening Method for Perchlorate in Water and Soil." This method separates the chlorate from perchlorate in soil solution through use of a solid phase extraction manifold conditioned with a perchlorate-specific ion-pair reagent. An ion pairing dye is then added. The dye pair is extracted with xylene and then the positive pink xylene layer is measured by spectrophotometry (Thorne, 2004).

A solution of 2.5 mM DTAB in 15% acetone was prepared by placing 0.3854 g DTAB into 75 mL acetone and 425 mL DI in a 500 mL Erlenmeyer flask. A solution of 25 mM DTAB was prepared by placing 3.854 g DTAB into 500 mL DI in a 500 mL Erlenmeyer flask. 1500 mg/L BG stock in 95% acetone/water was prepared by placing 15 mg BG into 9.5 mL acetone/0.5 mL water in a 25 mL Erlenmeyer. Calibration curve standards for perchlorate were created using a 1000 ug/mL perchlorate stock. A blank, 1 ug/mL, 2 ug/mL, 5 ug/mL, 10 ug/mL and 20 ug/mL were all created in clean test tubes with DI from the 1000 ug/mL stock. All solutions were refrigerated until use.

3 mL Phenomenex STRATA X styrene/divenylbenzene (SDVB) solid phase extraction (SPE) cartridges were set up on a manifold and conditioned with 1 mL of the 25 mM DTAB solution into a waste container. The waste container was replaced with a clean test tube. 4 mL of prepared soil solution sample was fed into the conditioned SPE cartridge, which was then rinsed with 2 mL 2.5 mM DTAB solution into the clean test tube to elute any retained

chlorate ions. The SPE cartridge was then rinsed with 1 mL acetone to pick up any residue into the clean test tube. A separate new test tube was prepared with 2 drops of BG solution. 1 mL of water was added to the BG solution to reconstitute the BG. 2 mL of the sample fed through the SPE cartridge was added. 1 mL of xylenes was added to the BG/sample solution and shaken vigorously to mix. Five drops of acetone was added to clear cloudiness. 1 mL of the sample from the xylene layer was absorbed at 640 nm in a spectrophotometer using a 5 mm quartz cuvette. This procedure was repeated for all samples into clean, labeled test tubes and all amounts were recorded.

Hexavalent Chromium Testing

To test for levels of hexavalent chromium in the soil, the US Air Force IERA Hexavalent Chromium (CrVI) Field Analytical Method for Bioenvironmental Engineers (1999) was followed. This method takes advantage of a strong anion solid extraction (SPE) apparatus to first separate CrIII from CrVI. The SPE traps the CrVI which CrIII is eluted and removed. A strong buffer solution of ammonium hydroxide and ammonium sulfate is used to elute CrVI. Before spectrophotometric analysis at 540 nm, HCl and diphenylcarbazide solution were added and complexed with CrVI to produce a measurable pink color (US IERA, 1999).

Soil samples were prepared by measuring 2.000 g soil from each of 12 “blocks” consisting of 4 single points in the field, to reduce number of samples. These samples were

placed in clean, labeled test tubes and vortexed with 20 mL DI water. Solutions to be used in the experiment were then prepared. First, a strong buffer solution of 0.5M ammonium sulfate/0.1M ammonium hydroxide was mixed. A complexation reaction solution of diphenylcarbazide (DPC) was mixed in amber glass and dissolved in acetonitrile. CrVI stock was mixed to create calibration solutions at 0, 0.1, 1.0, 2.0, and 3.0 ppm, all with HCl, strong buffer, and DPC solution to imitate the conditions samples would be measured under.

Phenomenex X-A anion SPE tubes were set up on a manifold and 3 mL of samples were fed through to elute CrIII, into a waste container. Each tube was then rinsed with DI water to elute any residual CrIII. 3 mL of strong buffer was fed through each tube three times into clean, labeled test tubes to then elute CrVI. Before measurement, 0.1 mL HCl and 2 mL DPC solution were added to each labeled tube and allowed to react for 10 minutes to produce the quantifiable pink color. After creating a calibration curve with the calibration solutions, all the samples were absorbed at 540 nm in a spectrophotometer in a 5mm quartz cuvette. This was repeated until all samples were measured and recorded.

Conclusions

The Rio Arriba Valley and the Pueblos it contains are communities I care deeply about. From my first day driving through the dry, red land between Santa Fe and Los Alamos, to the day I left with tears in my eyes and turquoise around my neck, I felt connected to the land and people who welcomed me as family. I collected my soil samples for analysis in a sundress, wide-brimmed hat, and bare feet, feeling the clay between my toes, and ate vegetables from the community garden all summer long. The implications of this work are personal, and I intend to make them accessible and give not simply information, but hope for remediation, back to the community.

The average levels of RDX, perchlorate, arsenic, and hexavalent chromium found in the soils of the Railroad Avenue Community Garden in Espanola, NM, were all found to be significantly higher than institutionally-set public health standards. The locations of the contaminants indicate that perchlorate and RDX are travelling into the garden through the water and concentrating in areas where irrigation water pools. These levels are assumed to be anthropogenically enhanced due to their status as a man-made contaminant, and are likely sourced from explosives at Los Alamos National Labs. The presence of arsenic may be due to either natural or man-made sources, but are regardless at a high enough level to warrant concern for public health. CrVI is nearly always anthropogenically enhanced in the environment, where found. At the levels which have been found, it is certainly threatening

to health. When considering exposure to these contaminants through regular soil exposure pathways (inhalation, direct ingestion) as well as intake through food grown in the gardens, the levels ingested may be very significant and a risk to the community.

Outcomes of Soil Testing

Arsenic

Health risks posed by arsenic at the levels found include arsenicosis, which commonly leads to skin cancer, as well as cancers of the liver, lung, bladder, and kidney (Chen et al., 1992). In women, chronic exposure to arsenic, as is most likely occurring in the Rio Arriba Valley community, leads to adverse obstetrical outcomes including stillbirths and miscarriages (Ahmad et al., 2001). Arsenic also readily transfers across the placenta, putting unborn children at risk if mothers are exposed to high levels (Sengupta et al., 2008). These effects have already been seen in the Southwest, which is known to be an area with high natural arsenic levels in groundwater (Tollestrup et al., 2005), but Northern New Mexico has not been a center of focus. The levels found are certainly concerning, and are causing a direct risk to the community eating from and working in the area.

As mentioned above, it is difficult to differentiate if the high arsenic levels in the soil are natural or anthropogenically enhanced. It is most likely that the arsenic levels in the soil of the garden are elevated due to the close-by caldera. Though these levels are extremely elevated as compared to the average soil in the United States, they are not unusually elevated

as compared to other soils in the Southwest (Tollestrup et al., 2005). It is possible that some anthropogenic sources of arsenic are located upstream in the old mines or abandoned industrial sites, but the proximity of the caldera is the largest source.

Since the arsenic found is a natural non-point source, cleanup or containment will be extremely difficult, or close to impossible. There are several options for bioremediation with plants that are well studied and proven to work (see: Fayiga et al., 2007; Nagajyoti et al., 2010), but if the soil continues to be exposed to the arsenic through water, it will continue to be contaminated. The most effective cleanup method would require ongoing work. In a study completed by Fayiga (2007) brake ferns were planted across a field contaminated with arsenic and took up a significant amount of the contaminant. Brake ferns are a small species which grow quickly and could easily be integrated into the community garden, between rows or even between plants. However, commitment to cleanup would be necessary, because if plants were left to take up arsenic, then composted back into the field, it would simply concentrate into the topsoil and create a more threatening environment because the fern does not degrade arsenic into a less threatening chemical species.

RDX

Risks posed by the presence of RDX are far less studied than arsenic, but some information is known due to military studies. RDX is a man-made chemical used widely in munitions, and pre-World War II, was used abundantly in open-air testing of explosives

(Hundal et al., 1997). Looking at the surrounding area, it is clear that Los Alamos National Laboratory, where many munitions were produced before World War II and open air testing was common practice, is most likely the source of RDX. It is not a chemical commonly used in other industry.

Chronic exposure to RDX has been seen to cause neurotoxicity, CNS disorders, hepatotoxicity, and brain and liver cancers (Etnier, 1989). It is officially classified as a "possible human carcinogen" by the EPA. No studies have been specifically completed on mothers and children, however, in rat studies, RDX has been seen to pass easily through the placenta and into breast milk. No direct birth defects were seen in these studies, but smaller babies were recorded (ASTDR, 2011). The levels at which RDX is assumed to be present at in these fields certainly contribute to chronic exposure symptoms and may be casing an unacceptable health risk, especially since plants take up a very significant amount of RDX.

Fortunately, there are a handful of plants which are known to not only take up RDX appreciably, but also break it down into benign products and eventually methanol (Ryloh et al., 2008). These are small plants which could be easily incorporated into the community garden and with care, phytoremediation is possible. The problem with remediation through biodegradation is similar to that of arsenic, even if RDX is cleared out of the garden, the source is the incoming water as seen by distribution of RDX in the field, and thus, the soil will continue to be contaminated.

Perchlorate

Perchlorate, much like RDX, is also a man-made chemical which has commonly been found in groundwater around the United States as a result of military contamination. It is used as an industrial additive in systems that require quick exothermic releases of oxygen, such as munitions (Crawford-Brown et al., 2006). It has been seen to have contaminated hundreds, if not thousands, of military bases across the United States which practiced explosives testing (MADEP, 2006). Looking at these facts, it is also likely that perchlorate is coming from LANL's legacy waste dumps and abandoned explosives testing sites, washing down "glazed" canyonsides during storm events, or from old explosives testing particulate.

The risks of perchlorate exposure are largely connected to perchlorate's tendency to reduce iodide uptake at the thyroid (Irizarry et al., 2010). Iodide reduction leads to hormone deficiency and thyroid enlargement in adults, but more serious developmental effects in children (Ting et al., 2006). Babies exposed to perchlorate in the womb and then through breastmilk in their infancy will not have sufficient hormones and fetal brain development is at risk (Ting et al., 2006). Perchlorate exposure has been seen to cause retardation in brain development and later on in life, low IQ (Zewdie et al., 2010).

Phytoremediation is possible in the case of perchlorate. Plants have been found which reduce perchlorate to a far less threatening produce, chlorate. In-situ remediation has been extremely successful in these studies, but most of the plants which reduce perchlorate grow

slowly and take years to reduce a significant amount of the contaminant (Mwehoga et al., 2007). Once again, though perchlorate may be able to be reduced and removed from the soils in the Railroad Avenue garden, it will still remain due to the constant input of the contaminant.

Hexavalent Chromium

The risks put forth by hexavalent chromium are very well known in the public health sphere as it is one of the most studied anthropogenic and industrial contaminants. It clearly causes carcinogenicity, but mechanisms are still being figured out. Through this route of exposure, risk of possible oral, intestinal, and stomach cancer is elevated highly (Holmes et al., 2008). Ingested chromium is reduced in the stomach and in exposed populations, and causes these cancers (Kimbrough et al., 1999).

Unfortunately, phytoremediation is not feasible for CrVI due to the low level of tolerance plants have for the contaminant. However, because roots-shoots translocation is extremely slow in the case of CrVI (Shanker et al., 2005), edible non-root vegetables pose lower risk. Addition of organic matter to soils has been seen to promote the reduction of CrVI to CrIII, a more benign species, and gives the most promise for in situ remediation (Kimbrough et al., 1999).

How to Begin to Think About Cleanup and Justice

Looking at the overarching implications of my study, it is clear that there are at least three dangerous chemicals coming into the community of Espanola from Los Alamos National Labs and contaminating the soil. Contamination is unacceptable, especially coming from a community of wealth into a community with a population which consists of low-income, Native peoples. The unequal burden of health risks to the Rio Arriba Community seen in my study is a picture of environmental injustice.

The contaminants which are present in the garden are more likely than not leaching to the groundwater, especially when considering the high mobilities of perchlorate and RDX, as well as their tendency not to accumulate in soils. The fact that they were detected in such high levels in the soil implies that the amount of both contaminants in the water flowing into the garden is significantly higher, as much as 90% in the case of perchlorate. More research is needed specifically in the Rio Arriba Valley, especially on exactly what contaminants are leaching to the communities surrounding LANL, not just in Los Alamos. The contamination also begs the conclusion that better testing wells in more locations are needed to monitor water quality in the area to protect all health. If contaminants are present at this time, there is certainly more on its way, because the legacy waste from LANL is just beginning to surface in water sources.

Some phytoremediation can be put into place in the gardens and more widely, surrounding the Rio Arriba Valley, but proposals of bioremediation are not enough. Regardless of cleanup in the garden, contaminants will continue to accumulate due to their presence in the water, which is necessary for repeated irrigation. Cleanup at LANL to remove the sources of these contaminants is imperative for the ongoing health of communities downhill and downstream from the labs, as is trustworthy and transparent testing and monitoring of water and soil so risks are assessed and understood. I highly recommend further testing of the garden. Though I will put forth a recommendation, and believe that the plants are probably safe, testing and more data on measured levels in the plants, not just the soil, should be collected first.

Though the garden soil has been found to be contaminated, I do not believe it is advisable to stop eating vegetables from the garden entirely. I think, because of the deep-rooted traditions in the Pueblo communities in agriculture and of cultivating Mother Earth at large, it is beneficial overall to continue eating from the garden. I ate from this very garden, understanding my risk due to my interest in sampling from the garden. This being said, I do believe that intake of certain vegetables should be limited. Leafy green vegetables generally contain the highest concentration of contaminants, which tend to translocate to plant leaves (Fayiga et al., 2007). Intake of these plants specifically should be very limited. As stated in my study, specific uptakes of perchlorate and RDX are not known for many plants, but it does vary species-to-species. Because of species variation, intake of each individual

vegetable should be limited. A variety of plants should be eaten rather than just a few to limit exposure. The process of limitation not only will protect physical health, but nourish emotional and spiritual health as well.

The fact that there are chemicals which have been detected in the soil of the North Railroad Avenue community garden and traced back to the labs concretes the historical trauma which has taken place on this land. Communities in the Pueblos de San Ildefonso and Santa Clara have been on the land of Northern New Mexico for hundreds, if not thousands of years, respecting and taking care of their Mother Earth. As the Spanish conquistadors moved in, the Pueblos got pushed aside, and when the labs came in, so went the last threads of the traditional land-based economy. These are peoples who still live and thrive on the lands and the labs absolutely need to clean up land that is not theirs to begin with, regardless of whether they intend to continue using the land. Contamination in the garden not only resurfaces historical trauma, but perpetuates harm to communities in the Rio Arriba Valley and deserves further research, monitoring and remediation to right what has been wrong and protect health in the highest order.

This garden is a testament to the brilliant movement back to traditional methods of living. The ruby red beets and kale that shines in the dewy morning should be a source of health, as they have been for thousands of years. Tomatoes, peas, and squash should not be seen as an increase in cancer risk, yet this is the point at which we are standing. Each person I weeded the garden with has a passion for the well-being of their community, rightfully so,

and I hope that this Division III will aid in their journey to feed and nourish people. The stunning red landscapes of Northern New Mexico have weathered many times through conquest and contamination, and I have the utmost hope that the people, who depend on this land, including those on the hill in Los Alamos, will protect the wealth it contains and best serve environmental justice.

Appendix A: Maps

Figure 28: Regional Map of Espanola, NM. Red boxed area indicates N. Railroad Avenue Community Garden surveyed, and its relative distance to the Rio Grande (~1,000').

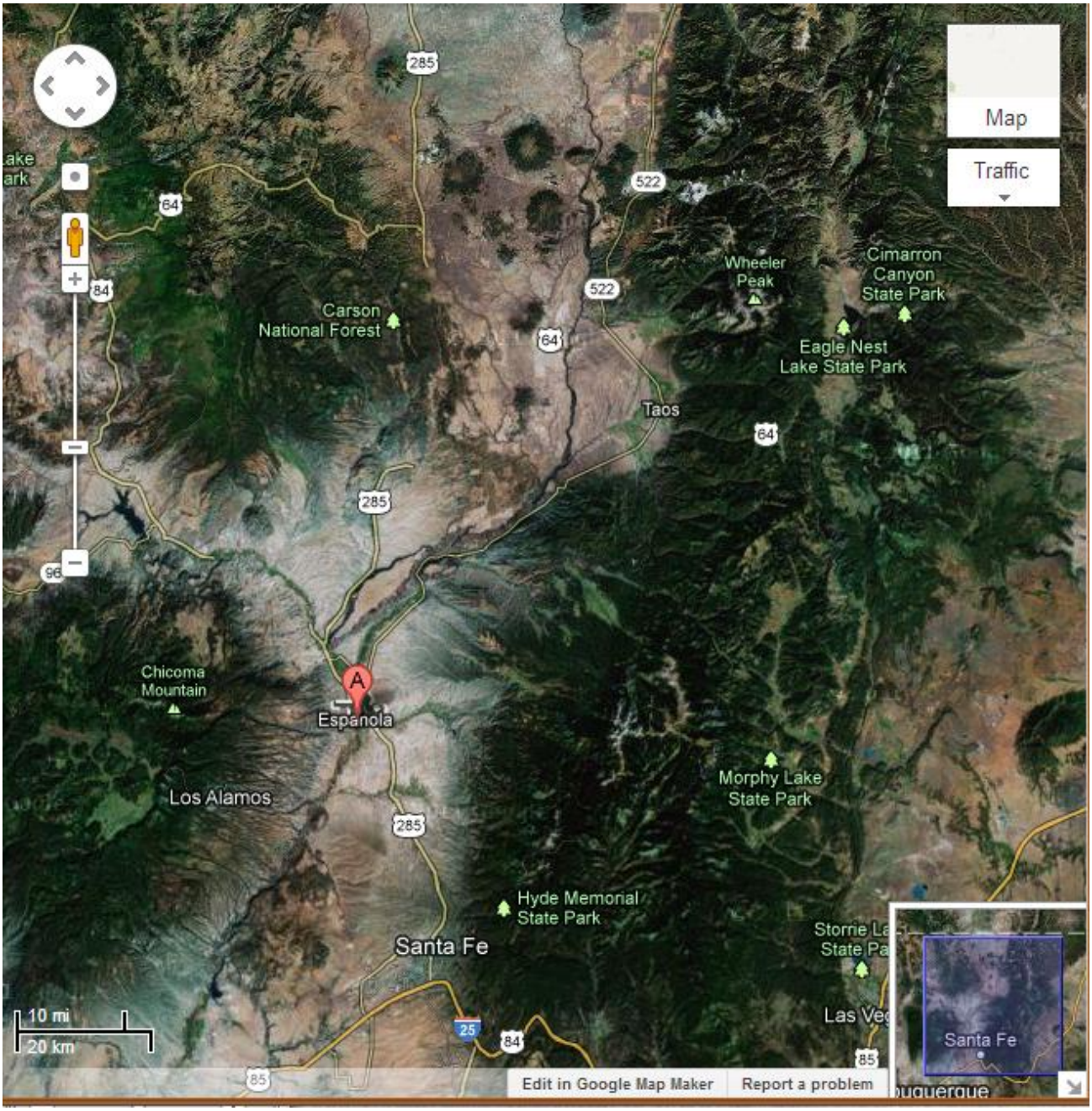


Figure 29: Regional map to show orientation and geological structures between Santa Fe, Los Alamos, Espanola, and Taos, NM. The Rio Grande may be seen travelling from west of Taos, into Espanola, and east of Los Alamos.

Figure 30: State map of New Mexico. The Rio Grande may be seen travelling through the center of the state. Los Alamos is seen as green due to the surrounding national parks, as is the outskirts of Santa Fe into Taos.

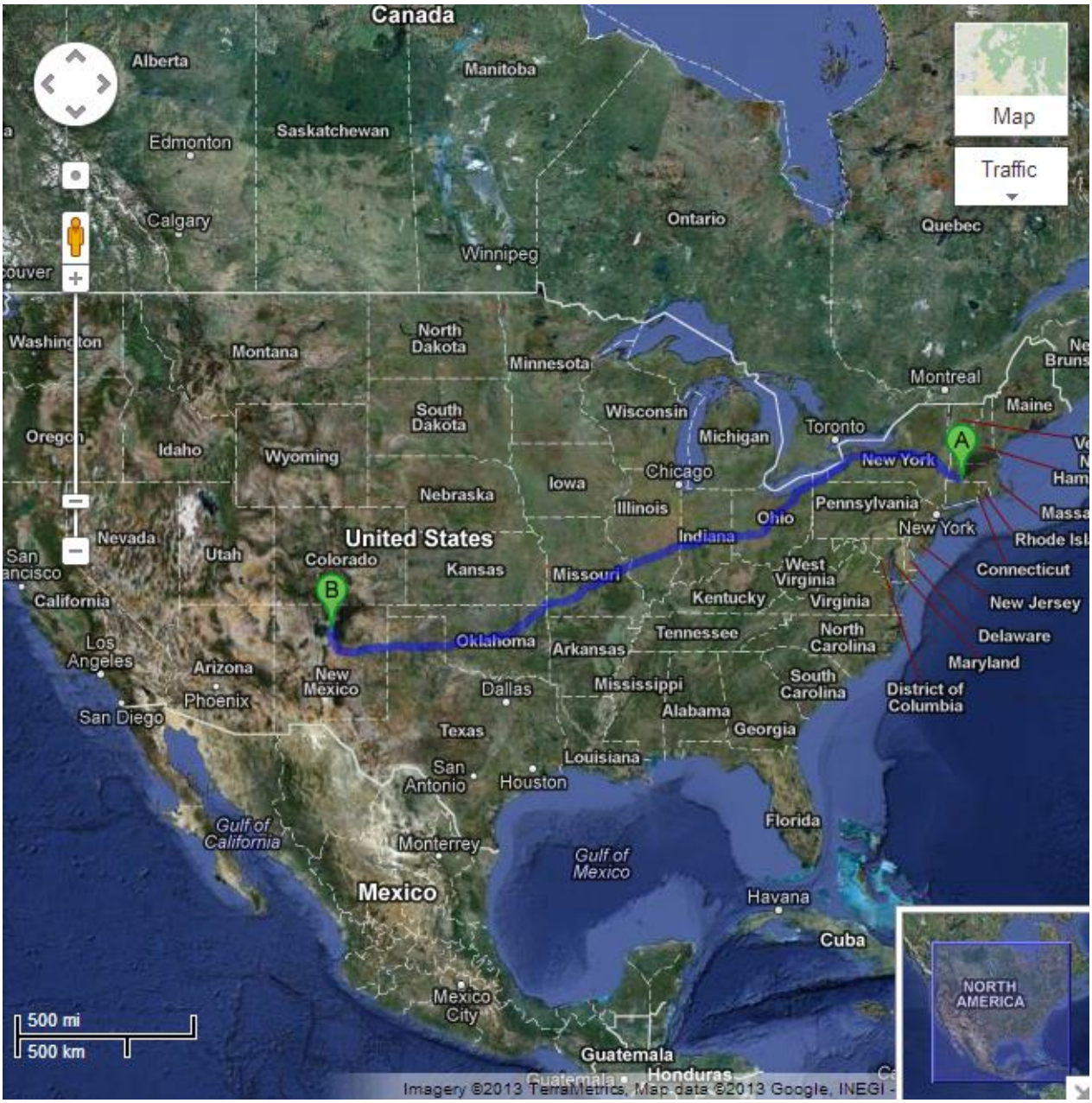


Figure 31: National map showing the route from Amherst, Massachusetts to Espanola, NM.

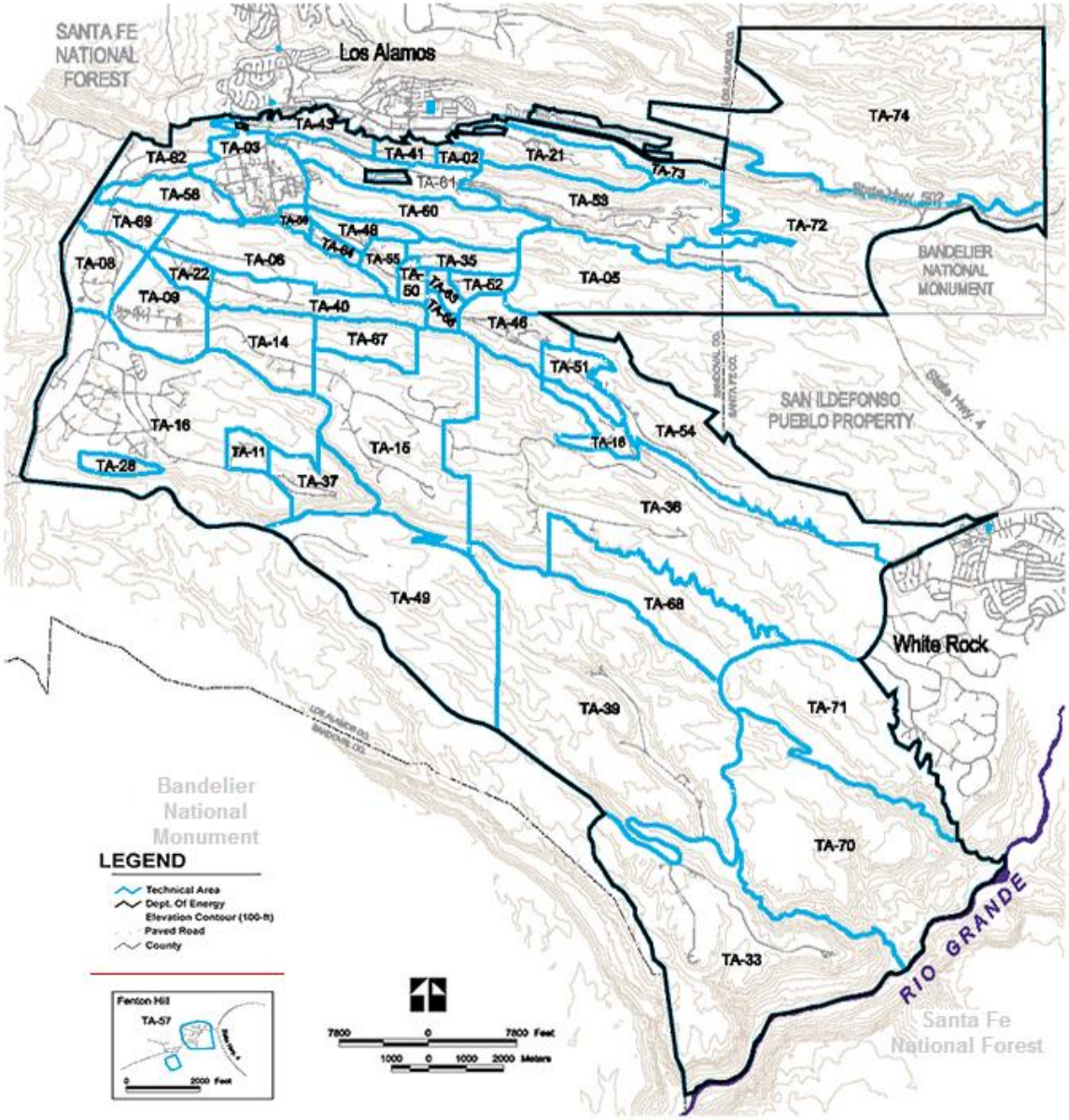


Figure 32: Technical Areas at Los Alamos National Labs. (LASG, 2004).

Appendix B: Raw Experimental Data

	ORP	pH	Conductivity	RDX (quant)	Arsenic (ppb)	Perchlorate ppm
BLANK		6.78	79	0.002		-1.60452
11	2.038	6.11	150.8	4	40	13.42344
12	2.071	6.2	158.7	0.5		6.216288
13	2.036	5.91	130.8	0.644	30	5.292152
14	2.083	5.86	122.7	0	30	10.00691
15	2.06	5.66	131	0.436	30	7.985077
16	2.068	5.65	134	0.179	20	2.14517
17	1.997	5.61	124	0	20	7.803581
18	2.023	5.44	128.5	0	30	12.88927
19	2.023	6.21	112.3	0	5	3.266667
21	2.002	6.04	117.4	0.251	30	8.73914
22	2.028	5.85	126.1	0.778	30	8.624912
23	2.029	5.76	136.6	0.421	40	1.854999
25	2.075	6	122.5	0	30	9.829542
26	2.088	6.09	124.6	0.201	30	6.753159
27	2.02	5.94	111.9	0.0993	30	7.538477
28	1.995	5.92	116.3	0.257	30	8.926506
29	2.011	5.96	120.4	0	10	5.724949
31	2.049	5.92	117.4	0.338	20	2.575112
32	2.002	5.86	120.2	0	20	5.880267
33	2.025	6.4	115.6	0	30	3.418178
34	2.044	6.48	106.9	0.12	30	4.267273
35	2.092	6.43	102.3	0	20	12.6524
36	2.04	6.25	102.1	0	30	15.27758
37	2.052	6.12	110.7	0	40	5.567727
38	2.058	6.1	105.8	0	30	4.553636
39	1.994	5.92	121.1	0	30	8.72502
41	2.007	6.12	98.3	0.21	40	5.481738
42	2.04	6.15	98.4	0	5	7.864979
43	2.07	6.18	88.5	0	10	4.611384
44	2.011	5.97	100.7	0	10	3.545098
45	2.019	5.93	104.5	0	30	11.38891
46	2.037	6.42	91.1	0	30	5.381789

47	2.038	6.5	68.8	0	40	3.425476
48	2.031	6.39	79	0.0933	40	3.652821
49	2.045	6.08	97.6	0	30	8.016965
51	2.007	6.09	83.1	0.159	30	14.36852
52	2.06	6.16	72.4	0	30	7.626052
53	2.016	6.2	86.3	0	30	4.609639
54	2.08	6.47	56.9	0	10	7.890363
55	2.076	6.35	63.3	0.0706	20	7.364121
56	2.026	6.26	58.3	0.259	20	9.880468
57	2.019	6.07	60	0.487	20	6.399687
58	2.013	5.93	65.2	0.456	20	4.931381
59	1.999	5.96	60.3	0.347	30	12.34716
61	2.005	6.15	61.9	0.219	40	5.789202
62	2.012	6.11	59.3	0.163	30	4.175731
63	2.071	6.17	48.6	0.235	40	7.552438
64	2	5.94	50.4	0.102	20	4.114334
65	2.067	5.99	41.1	0	40	4.768289
66	2.065	6.24	43.2	0.122	30	3.755944
67	2.016	6.44	41.1	0	10	4.64835
68	2.008	6.11	130.3	0	10	5.567727
69	2.022	6.05	131.2	0	10	10.17921
71	2.002	6.01	122.2	1.99	40	6.569125
72	1.998	6.01	114.7	0	20	5.708766
73	1.999	6.06	117.6	0	30	8.985048
74	2.057	6.19	123.9	0	40	5.985928
75	2.067	6.24	126.6	0	40	8.070906
76	2.036	6.26	123.5	0	40	8.448335
77	2.055	6.25	113.8	0	20	5.864243
78	2.005	6.09	108.6	0	50	1.571016
79	2.029	6.15	118.4	0	50	11.07828
Average	2.03405	6.0868	101.2870968	0.21189032	27.70491803	6.960594
Standard Dev	0.0274	0.2164	29.19616901	0.56830983	10.73426299	3.124206
Max	2.092	6.5	158.7	4	50	15.27758
Min	1.994	5.44	41.1	0	5	1.571016
	ORP	pH	Conductivity	RDX (quant)	Arsenic (ppb in 10% sol'n)	Perchlorate ppm

CrVI		
	UV/Vis	ppm
block 1	0.12016	0.216171
block 2	0.083681	0.210958
block 3	0.19324	0.226614
block 4	0.14738	0.220061
block 5	0.088339	0.211624
block 6	0.29973	0.241831
block 7	0	0.199
block 8	0.067815	0.208691
block 9	0.24685	0.234275
block 10	0.18237	0.225061
block 11	0.19167	0.22639
block 12	0.064316	0.208191
	Average	0.219072
	Standard Dev	0.011744
	Max	0.241831
	Min	0.199

Works Cited

Adriano, DC. *Trace Elements in the Terrestrial Environment*. New York, NY: Springer-Verlag (1986).

Ahmad, S., Sallim Ullahsayed Akhtar, MH Barua, Haque Shampa, Mauzurul Kahn, S. Kabir, Abdul Hadi Abdul, and MH Jalil. "Arsenic in Drinking Water and Pregnancy Outcomes." *Environmental Health Perspectives* 109.6 (2001): 629-31.

Ahmad, Yusra. "The Largest Mass Poisoning in Recorded History." *International Health* 82.1 (2004): 57-58.

Akesson, Agneta, Marika Berglund, Andrejs Bjellerup, Katarina Bremme, and Marie Bahter. "Cadmium Exposure in Pregnancy and Lactation in Relation to Iron Status." *American Journal of Public Health* 92.2 (2002): 284-87.

Arms Control Association. "Nuclear Weapons: Who Has What at a Glance." *Armscontrol.org*. Arms Control Association, Nov. 2012.

ASTDR. "ASTDR Public Health Assessment for Molycorp, Inc, Questa, Taos County, NM." (2005). Web.

ASTDR. "ASTDR Toxological Profile for RDX." (2011). Web.

Austin, George S. "Clay Deposit Adjacent to NM-44 North of Bernalillo." *Open File Report 404*. (1982).

Balistrieri, L. S. and T. T. Chao. "Selenium adsorption by goethite." *Soil Sci. Soc. Am. J.* 51 (1987):1145-1151.

Barcelona, Michael. "Groundwater Flows from Area G to the Buckman Projects." Communities for Clean Water Conference. Northern New Mexico College, Espanola, NM. 26 July 2012. Lecture.

Barth, Delbert S, Benjamin J Mason, Thomas H Starks, and Kenneth W Brown. *Soil Sampling Quality Assurance User's Guide, Second Edition*. Las Vegas, Nevada: Environmental Monitoring and Support Laboratory, US Environmental Protection Agency, 1989.

Bartlett, R. J. "Chromium cycling in soils and water: links, gaps, and methods." *Environ. Health Perspective* 92 (1991):17-24

Berkowitz, Maya. "Nurturing Resistance: Landscapes of Northern New Mexico's Environmental and Political Fight for Autonomy." (2010).

Best, Elly PH, Susan L. Sprecher, Steven L. Larson, Herb L. Frederickson, and Darlene F. Bader. "Environmental Behavior of Explosives in Groundwater From the Milan Army Ammunition Plant in Aquatic and Wetland Plant Treatments. Uptake and Fate of TNT and RDX in Plants." *Chemosphere* 39.12 (1999): 2057-072.

Bloomfield, C. and G. Pruden. "The behavior of Cr(VI) in soil under aerobic and anaerobic conditions." *Environ. Pollut. Ser. A.*(1980): 103-114.

Cabrero, Alex and McKenzie Romero. *Santa Clara Flood Caused at Least $3.7M in Damage*. Salt Lake City, UT: Deseret News (2012).

Calabrese, Edward J and Edward J Stanek. "Soil Ingestion Issues and Recommendations." *J Environ Sci Health* 29 (1994): 517-530.

Carson, Rachel. *Silent Spring*. Boston, MA: Houghton Mifflin Harcourt, 1962.

CCNS. "Protecting Regional Groundwater, Surface Water, and Drinking Water." (2012). Web.

Chen, Diejun, Z Lewis Liu, and Wayne Banwart. "Concentration Dependent RDX Uptake and Remediation by Crop Plants." *Environmental Sci Pollut Res* 18 (2011): 908-17.

CDC. "National Report on Human Exposure to Environmental Chemicals- Perchlorate." *Centers for Disease Control and Prevention*. (2007). Web.

Chaney, R.L., J.A. Ryan, Y.M. Li, and S.L. Brown. "Soil Cadmium as a Threat to Human Health." *Cadmium in Soils and Plants* (1999): 219-46.

Chen, CJ, CW Chen, MM Wu, and TL Kuo. "Cancer Potential in Liver, Lung, Bladder and Kidney Due to Ingested Inorganic Arsenic in Drinking Water." *British Journal of Cancer* 66 (1992): 888-92.

Chen, Diejun, Z Lewis Liu, Wayne Banwart. "Concentration-Dependent RDX Uptake and Remediation by Crop Plants." *Envionmental Sci Pollut Res* 18 (2011): 908-917.

Clewell RA, Merrill EA, Narayanan L, Gearhart JM, Robinson PJ 2004. Evidence for competitive inhibition of iodide uptake by perchlorate and translocation of perchlorate into the thyroid *Int J Toxicol* 23:17–23.

Cole, Luke W and Sheila R. Foster. *From the Ground Up: Environmental Racism and the Rise of the Environmental Justice Movement.* New York, NY: New York University Press, 2001.

Crawford-Brown, Doug, Bob Raucher, and Megan Harrod. "Intersubject Variability of Risk from Perchlorate in Community Water Supplies." *Environmental Health Perspectives* 114.7 (2006): 975-79.

Crump, C., P. Michaud, R. Tellez, C. Reyes, G. Gonzalez, and EL Montgomery. "Does Perchlorate in Drinking Water Affect Thyroid Function in Newborns or School-Age Children?" *Journal of Occupational Environmental Medicine* 42 (2000): 603-12.

Das, AP and S. Singh. "Occupational Health Assessment of Chromite Toxicity Among Indian Miners." *Indian J Occup Environ Med* 15 (2011): 6-13.

Del Signore, John C. "Radioactive Liquid Waste Treatment Facility Discharges in 2011" *Los Alamos National Laboratory Report LA-UR -12-21423* (2011).

Dimick, Paul S., Arthur Kney, Javad Tavakoli, Steven E. Mylon, and Dongye Zhao. "A Comparison of Metal-Loaded DOW3N Ion Exchangers for Removal of Perchlorate from Water." *Separation Science and Technology* 43 (2008): 2343-362.

Drewniany, Morgan. *Photos from Northern New Mexico*. 2013. N.p.

Edelman, Sandra A. *Summer People, Winter People: Indian Pueblos in the Santa Fe Area*. Santa Fe, NM: Sunstone, 1986.

Edmunds, WM and PL Smedley. "Groundwater Geochemistry and Health: An Overview." *Geological Society, London, Special Publications* (1996): 91-105.

Environmental Health Consultants (EHC). "Upper Rio Grande - La Jicanita through Embudo Valley Watershed Management Plan." (2007). Web.

Environmental Protection Agency (EPA). "Record of Decision: North Railroad Avenue Plume Superfund Site, Espanola, New Mexico." (2001). Web.

Environmental Protection Agency (EPA). "Molycorp, Inc. Site Proposed Cleanup Plan." (2009). Web.

Environmental Protection Agency (EPA). “Regional Screening Level Summary Table.” (2012). Web.

Etnier, Elizabeth L. "Water Quality Criteria for Hexahydro-1,3,5-trinitro-1,3,5-triazine." *Regulatory Tox and Pharmacology* 9 (1989): 145-57.

Eriksson, Jan, Ingrid Oborn, Gunilla Jansson, Arne Andersson. “Factors Influencing Cadmium Content in Crops.” *Swedish Journal of Agricultural Research* 26.3 (1996): 125-133.

Fair, Jeanne M., Orrin B Meyers, and Robert E Ricklefs. "Immune and Growth Response of Western Bluebirds and Ash-Throated Flycatchers to Soil Contaminants." *Ecological Applications* 13.6 (2003).

Falone, Sandra Zago, Eny Maria Vieira and Francis I Onuska. "Adsorption Study of RDX and TNT Explosives in Soil by HPLC." *J of Liquid Chromatography and Related Technologies* 29,11 (2006): 1645-1662.

Fayiga, Abioye O., Lena Q. Ma, and Qixing Zhou. "Effect of Plant Arsenic Uptake and Heavy Metals on Arsenic Distribution in an Arsenic Contaminated Soil." *Environmental Pollution* 147 (2007): 737-42.

Ferenbaugh, Roger W, Thomas E Buhl, Alan K Stoker and Wayne R Hansen . "Environmental Analysis of the Bayo Canyon (TA-10) Site, Los Alamos, New Mexico." *Los Alamos National Laboratory Report LA-9252-MS* (1982).

Fradkin, Philip L. *Fallout: An American Nuclear Tragedy.* Tuscon, AZ: The University of AZ Press, 1989.

Fresquez, PR, DR Armstrong, MA Mullen and L Naranjo Jr. "The Uptake of Radionuclides by Beans, Squash, and Corn Growing in Contaminated Alluvial Soils at Los Alamos National Laboratory." *J Environmental Sci Health B* 33.1 (1998): 99-121.

General Accounting Office (GAO) of the US. "Fire Management: Lessons Learned from the Cerro Grande (Los Alamos) Fire." *General Accounting Office Report GAO/T-RCED-00-257* (2000).

Ginsberg, Gary, and Deborah Rice. "The NAS Perchlorate Review: Questions Remain about the Perchlorate RfD." *Environmental Health Perspectives* 113.9 (2005): 1117-119.

Ginsberg, Gary, Dale B. Haitis, R. Thomas Zoeller, and Deborah C. Rice. "Evaluation of the U.S. EPA/OSWER Preliminary Remediation Goal for Perchlorate in Groundwater: Focus on Exposure to Nursing Infants." *Environmental Health Perspectives* 115.3 (2007): 361-69.

Gottlieb, Robert. "Linking Environmental Justice and Pollution Prevention: Livable Communities and Cleaner Production." *Pollution Prevention Review* (2001): 15-28.

Greer, MA, G. Goodman, RC Pleus, and SE Greer. "Health Effects Assessment for Environmental Perchlorate Contamination: The Dose-Response for Inhibition of Thyroidal Radioiodine Uptake in Humans." *Environmental Health Perspectives* 110 (2002): 927-37.

Haas, R., I. Schreiber, E.V. Low and G. Stork. "Conception for the Investigation of Contaminated Munitions Plants." *Fresnius' Journa of Analytical Chemistry* 338 (1990): 41-45.

Halasz, A., C Groom, E Zhou, L Paquet, C Beaulieu, S Deschamps, A Corriveau, S Thiboutot, G Ampleman, C Dubois, and Jalal Hawari. "Detection of Explosives and Their Degradation Products in Soil Environments." *Journal of Chromatography A* 963 (2002): 411-418.

Hasnat, Milton Abul, Wayne Smith, Bayzidur Rahman, Ziaul Hasan, Ume Kulsum, Keith Dear, M. Rakibuddin, and Azahar Ali. "Chronic Arsenic Exposure and Adverse Pregnancy Outcomes in Bangladesh." *Epidemiology* 16.1 (2005): 82-86.

Helmke, P.A. "Chemistry of Cadmium in Soil Solution." *Cadmium in Soils and Plants* (1999).

Holmes, AL, SS Wise, and JP Wise, Sr. "Carcinogenicity of Chromium VI." *Indian Journal of Medicine* 128 (2008): 353-72.

Holmgren, GGS, MW Meyer, RI Chaney and RB Daniels. "Cadmium, Lead, Zinc, Copper and Nickel in Agricultural Soils of the US of America." *J Environ Quality* 22 (1993): 335-348.

Hopkins, John, Susan G Siger and David R Gregory. "Corrective Measures Evaluation Plan for Material Disposal Area G at Technical Area 54." *Los Alamos National Laboratory Report LA-UR-07-4591* (2007).

Hundal, LS, J. Singh, EL Bier, PJ Shea, SD Comfort, and WL Powers. "Removal of TNT and RDX from Water and Soil Using Iron Metal." *Environmental Pollution* 1.2 (1997): 55-64.

Irizarry, Lisandro. "Thyroid Hormone Toxicity." *Medscape Reference*. Ed. Asim Tarabar. Apr. 2010.

Jankiwicz, B., B. Ptaszynski, M. Wieczorek. *Spectrophotometric Determination of Cadmium(II) in Soil of Allotment Gardens of Lodz.* Lodz, Poland: Inst of General and Ecological Chemistry, Polytechnical University, 1999.

Kesterson, Karen E., Penny S. Amy, and Jacimaria R. Batista. "Limitations to Natural Bioremediation of Perchlorate in a Contaminated Site." *Bioremediation Journal* 9.3-4 (2005): 129-39.

Kimbrough, David Eugene, Yoram Cohen, Arthur M Winer, Lynn Creelman, Clayton Mabuni. "A Critical Assessment of Chromium in the Environment." *Critical Reviews in Environmental Science and Technology* (1999): 1-29.

Kinley, Brent L., and Dennis J. Paustenbach. "Using Applied Research to Reduce Uncertainty in Health Risk Assessment: Five Case Studies Involving Human Exposure to Chromium in Soil and Groundwater." *Journal of Soil Contamination* 6.6 (1997): 649-705.

Kang, Daniel H. "Soil Quality of Nuestras Raices' Urban Community Gardens: A Trace Metal Study in Holyoke, MA." *Natural Science Department, Hampshire College* (2002).

Klang-Westin, Erika, and Jan Eriksson. "Potential of Salix as a Phytoextractor of Cadmium on Moderately Contaminated Soils." *Plant and Soil* 249 (2003): 127-37.

Krauter, Paula, Bill Daily, Valerie Dibley, Holly Pinkart, and Tina Legler. "Perchlorate and Nitrate Remediation Efficiency and Microbal Diversity in a Containerized Wetland Bioreactor." *International Journal of Phytoremediation* 7 (2005): 1522-6514.

LaDuke, Winona. *All Our Relations: Native Struggles for Land and Life*. Cambridge, MA: South End Press, 1999.

LeBlanc, Denis R., and Don A. Vroblesky. "A Comparison of Pumped and Diffusion Sampling Methods to Monitor Concentrations of Perchlorate and Explosive Compounds in Groundwater, Camp Edwards, Cape Cod, MA, 2004-2005." *US Department of the Interior, US Geological Survey* (2008).

Lemstra, M. " Exposure to Radiation and Health Outcomes." Canadian Center for Policy Alternatives, 2009. Web.

Levy, Joel. *Poison: An Illustrated History*. Guilford, CT: Lyons, 2011.

Lewis, Thomas A., David A. Newcombe, and Ronald L. Crawford. "Bioremediation of Soils Contaminated with Explosives." *J of Environmental Management* 70 (2004): 291-307.

Llyod, Jonathan R and Ronald S Oremland. "Microbial Transformations of Arsenic in the Environment: From Soda Lakes to Aquifers." *Elements* 2 (2006): 85-90.

Longmire, Patrick, Dale Counce, and Elizabeth Keating. "Aqueous Geochemisry of Uranium and Arsenic: Los Alamos and Surrounding Areas, New Mexico." Los Alamos National Laboratory. *Identifying Technologies to Improve Regional Water Stewardship: North-Middle Rio Grande Corridor* (n.d): 189-194.

Los Alamos National Laboratory (LANL). "Environmental Monitoring Compliance and Risk Reduction." Los Alamos National Laboratory, 2011. Web.

Los Alamos National Laboratory (LANL). "Fire Progression: Las Conchas." Los Alamos National Laboratory, 2011. Web.

Los Alamos Study Group. "Area G Nuclear Waste Disposal Site." 2011. Web.

MADEP. "The Occurrence and Sources of Perchlorate in MA." *Massachusetts Department of Environmental Protection* (2006).

Makhijani, A., H. Hu, and K. Yih. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and its Health and Environmental Effects.* Cambridge, MA: MIT Press, 1995.

Martinez-Sanchez, MJ, S Martinez-Lopez, ML Garcia-Lorenzo, LB Martinez-Martinez, and C Perez-Sirvent. "Evaluation of Arsenic in Soils and Plant Uptake Using Various Chemical Extraction Methods in Soils Affected by Old Mining Activities." *Geoderma* 160 (2011): 535-541.

Masco, Joseph. *The Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico.* Oxford: Princeton University Press, 2006.

Mason, BJ. *Preparation of Soil Sampling Protocols: Techniques and Strategies.* Las Vegas, NV: Environmental Monitoring and Support Laboratory, 1983.

Mendoza, Jose, James Botsford, Jose Hernandex, Anna Montoya, Roswitha Saenz, Adrian Valles, Alejandro Vazquez, and Maria Alvarez. "Microbial Contamination and Chemical Toxicity of the Rio Grande." *BMC Microbiology* 4.17 (2004).

Mielke, HW, CR Gonzales, MK Smith and PW Mielke. "The Urban Environment and Children's Health: Soils as an Integrator of Lead, Zinc, Cadmium in New Orleans, LA." *Environmental Research Section A* 81 (1999): 117-129.

Mukhopadhyay, Rita, Barry P Rosen, Le T Phung, and Simon Silver. "Microbial Arsenic: From Geocycles to Genes and Enzymes." *FEMS Microbiology Reviews* 26.3 (2002): 311-325.

Murnyak, George, John Vandenberg, Paul J. Yaroschak, Larry Williams, Krishnan Prabhakaran, and John Hinz. "Emerging Contaminants: Presentations at the 2009 Toxicology and Risk Assessment Conference." *Toxicology and Applied Pharmacy* 254 (2011): 167-69.

Mwegoha, William, Odemari S. Mbuya, Amita Jain, Ngozi H. Ugochukwu, and Michael D. Abazinge. "Use of Chicken Manure Extract for Biostimulation and Enhancement of Perchlorate Rhizodegradation in Soil and Water Media." *Bioremediation Journal* 11.2 (2007): 61-70.

Nagajyoti, PC, KD Lee and TVM Sreekanth. "Heavy Metals, Occurrence, and Toxicity for Plants: A Review." *Environ Chem Letters* 8 (2010): 199-216.

Nishijo, Muneko, Soisungwan Satarug, Ryumon Honda, Ikiko Tsuritani, and Keiko Aoshima. "The Gender Differences in Health Effects of Environmental Cadmium Exposure and Potential Mechanisms." *Molecular and Cellular Biochemistry* 255 (2004): 87-92.

National Research Council (NRC). "Health Implications of Perchlorate Ingestion." (2005). Web.

National Research Council (NRC). "Plans and Practices for Groundwater Protection at LANL." (2007). Web.

Natural Resources Conservation Service (NRCS) and United States Department of Agriculture (USDA). "Soil Survey of Rio Arriba Area, New Mexico, Parts of Rio Arriba and Sandoval Counties." (2008).

Olsson, Ing-Marie, Jan Eriksson, Ingrid Skerfiving, and Agneta Uskarsson. "Cadmium in Food Production Systems: A Health Risk for Sensitive Population Groups." *AMBIO: A Journal of the Human Environment* 34.4 (2005): 344-53.

Rothman, Hal K. *On Rims and Ridges: The Los Alamos Area Since 1880.* Lincoln, Nebraska: University of Nebraska Press, 1992.

Rylott, Elizabeth L., and Neil C. Bruce. "Plants Disarm Soil: Engineering Plants for the Phytoremediation of Explosives." *Trends in Biotechnology* 27.2 (2008): 73-81.

Ryu, Hyerim, Joon Kyoung Han, Jae Woong Jung, Bumham Bam and Kyoungphile Nam. "Human Health Risk Assessment of Explosives and Heavy Metals at a Military Gunnery Range." *Environ Geochem Health* 29 (2007): 259-269.

Saha, Rumpa, Rumpa Nandi, and Bidyut Saha. "Sources and Toxicity of Hexavalent Chromium." *Journal of Coordination Chemistry* 64.10 (2011): 1782-806.

Sanka, Sameera. "Uptake, Distribution, and Fate of RDX and MNX in Dark Green Bulrush Plants: A Thesis in Civil Engineering." *Graduate Department of Texas Tech University*, 2009.

Schapiro, Mark. *Exposed.* White River Junction, VT: Chelsea Green Publishing, 2007.

Schmidt, Charles W. "The Price of Preparing for War." *Environmental Health Perspectives* 112.17 (2004): A1004-1005.

Schoeters, Greet, Elly Den Hond, Moniek Zurbier, Rima Naginiene, Peter Van DenHazel, Nikolas Stilianakis, Roberto Ronchetti, and Janna G. Koppe. "Cadmium and Children: Exposure and Health Effects." *Acta Paediatrica* 95 Suppl.453 (2006): 50-54.

Selinus, Olle., Jose A Centeno, Brian Alloway, Robert B Finkelma, Ron Fuge, Ulf Linh, Pauline Smedley. *Essentials of Medical Geology*. Oxford, UK: Elsevier Academic Press, 2005.

Sengupta, Sujit Ranjan, Nilay Kanti Das, and Pijush Kanti Datta. "Pathogenesis, Clinical Features and Pathology of Chronic Arsenicosis." *Indian J of Dermatol Venereol Leprol* 74 (2008): 559-570.

Shanker, Arunk, Carlos Cervantes, Hermina Loza-Tavera, and S. Arudainayagam. "Chromium Toxicity in Plants." *Environmental International* 131 (2005): 739-53.

Shaper, AG, ML Straf, and RMS Perrin. "Epidemiology for Geochemists." *Philosophical Transactions of the Royal Society of London* 288, 1026 (1979): 127-136.

Singh, R., and M.J. McLaughlin. "Cadmium and Soils and Plants - Summary and Research Perspectives." *Cadmium in Soils and Plants* (1999): 257-65.

Smith, Allan H., Claudia Hopenhayn-Rich, Michael N Bates, Helen M Goeden, Irva Hertz-Picciotto, Heather M Duggan, Rose Wood, Michael J Kosnett and Martyn T Smith. "Cancer Risks from Arsenic in Drinking Water." *Environmental Health Perspectives* 97 (1992): 259-267.

Smith, Bryce. "Soil Cleanup at Los Alamos National Laboratory." *Science for Democratic Action* 14, 1 (2006).

Stanbury, JB, and JB Wyngaarden. "Effect of Perchlorate on the Human Thyroid Gland." *Metabolism* 1 (1952): 533-39.

Staessen, Jan A., Harry A. Roels, Dmitri Emelianov, Tatyana Kuznetsova, Lutgarde Thijs, and Jaco Vangronsveld. "Environmental Exposure to Cadmium, Forearm Bone Density, and Risk of Fractures: A Prospective Population Study." *The Lancet* 353 (1999): 1140-144.

Steingraber, Sandra. *Living Downstream: An Ecologist Looks at Cancer and the Environment*. Reading, MA: Addison-Wesley, 1997.

Stollenwerk, KG, and DB Grove. "Adsorption and Desorption of Hexavalent Chromium in an Alluvial Aquifer Near Telluride, CO." *J of Env Qual* 14.1 (1985): 150-155.

Thorne, Philip G. "Field Screening Method for Perchlorate in Water and Soil*." US Army Corps of Engineers*, 2004.

Ting, David, Robert A. Howd, Anna M. Fan, and George V. Alexeeff. "Development of a Health-Protective Drinking Water Level for Perchlorate." *Environmental Health Perspectives* 114.6 (2006): 881-86.

Tischler, Doris. *Soil Contamination in the South Valley of the Albuquerque Basin,* 2010.

Tollestrup, Kristine, Floyd J Frost, Michelle Cristani, Garnett P McMillan, Rebecca L Calderon, R Steven Padilla. "Arsenic-Induced Skin Conditions Identified in Southwest Dermatology Practices: An Epidemiologic Tool?" *Environmental Geochemistry and Health* 27 (2005): 47-53.

Townsend, Dan M., and Dean D. Adrian. "RDX and HMX Sorption in Thin Disk Soil Columns." *US Army Corps of Engineers Installation Restoration Research Program* (1996).
Traina, S.J. "The Environmental Chemistry of Cadmium." *Cadmium in Soils and Plants* (1999): 11-33.

Travers, Jackie, Ekaterina Alexandrova and Marvin Resnikoff. *An Assessment of Los Alamos National Laboratory Waste Disposal Inventory.* New York, NY: Radioactive Waste Management Associates, 2009.

United States Environmental Protection Agency (US EPA). "Superfund Information Systems: Site Progress Profile North Railroad Avenue Plume." *Superfund Information Systems*. Web.

Urbano, AM, LMR Ferreira, and MC Alpoim. "Molecular and Cellular Mechanisms of Hexavalent Chromium Induced Lung Cancer: An Updated Perspective." *Current Drug Metabolism* 13 (2012): 284-305.

Urbansky, Edward Todd and Stephanie K Brown. "Perchlorate Retention and Mobility in Soils." *J Environ Monitoring* 5 (2003): 455-462.

Vahter, Marie, Agneta Akesson, Carola Liden, Sandra Ceccatelli and Marika Berglund. "Gender Differences in the Disposition and Toxicity of Metals." *Environmental Research* 104 (2007): 85-95.

Van Ee, J Jeffery, Louis J Blume, and Thomas H Starks. *A Rationale for the Assessment of Errors in the Sampling of Soils*. Las Vegas, NV: Environmental Monitoring Systems Laboratory, 1990.

Von Oettingen WF, DD Donahue, H Yagoda. "Toxicity and Potential Dangers of RDX." *J Ind Hygene Toxicol* 31 (1949): 21-31.

Wakefield, Sarah EL and Jamie Baxter. "Linking Health Inequality and Environmental Justice: Articulating a Precautionary Framework for Research and Action." *Environmental Justice* 3,3 (2010): 95-102.

Watson, K and D Creamer. "Arsenic-Induced Keratoses and Bowen's Disease." *Clinical and Experimental Dermatology* 29 (2004): 46-48.

Welch, R.M, and W.A. Norvell. "Mechanisms of Cadmium Uptake, Translocation, and Deposition in Plants." *Cadmium in Soils and Plants* (1999): 125-44.

Welinder, H., S Skerfving, O Henriksen. "Cadmium Metabolism in Man." *British Journal of Industrial Medicine* 34, 3 (1977): 221-228.

Yinon, Jehuda and Shmuel Zitrin. *Modern Methods and Applications in Analysis of Explosives*. New York, NY: John Wiley and Sons, 1993.

Yu, L, JE Canas, GP Cobb, WA Jackson, and TA Anderson. "Uptake of Perchlorate in Terrestrial Plants." *Ecotoxicol Environ Safety* 58,1 (2004): 44-49.

Zahm, Shelia Hoar, and Joseph F Fraumeni. "Racial, Ethnic and Gender Variations in Cancer Risk: Considerations for Research." *Environmental Health Perspectives* 103 (1995): 283-286.

Zewdie, Tsedash, C. Mark Smith, Michael Hutcheson, and Carol Rowan West. "Basis of the Massachusetts Reference Dose and Drinking Water Standard for Perchlorate." *Environmental Health Perspectives* 118.1 (2010): 42-48.

Zhang, Baohong, and Xiaoping Pan. "RDX Induces Aberrant Expression of MicroRNAs in Mouse Brain and Liver." *Environmental Health Perspectives* 117.2 (2009): 231-40.

Zhao, Fang-Jie, Steve P McGrath, and Andrew A Meharg. "Arsenic as a Food Chain Contaminant: Mechanisms of Plant Uptake and Metabolism and Mitigation Strategies." *Annual Review of Plant Biology* 61 (2010): 535-559.

Zheng, Weixi, Joseph Lichwa, Matteo D'Alessio and Chittaranjan Ray. "Fate and Transport of TNT, RDX, and HMX in Streambed Sediments: Implications for Riverbank Filtration." *Chemosphere* 76 (2009): 1167-1177.

Appendix B

M. Kaltofen, P.E., T. Carpenter, "Citizen Environmental Monitoring and Technical Assessment: Analysis of Radiochemical Contaminants in Los Alamos Region Biota and Environmental Materials At The Perimeter of the Los Alamos National Laboratory" (June 2007).

CITIZENS MONITORING AND TECHNICAL ASSESSMENT - JUNE 2007

ANALYSIS OF RADIOCHEMICAL CONTAMINANTS IN LOS ALAMOS REGION BIOTA AND ENVIRONMENTAL MATERIALS AT THE PERIMETER OF THE LOS ALAMOS NATIONAL LABORATORY

PREPARED BY:

BOSTON CHEMICAL DATA CORP.
MARCO KALTOFEN, PE

GOVERNMENT ACCOUNTABILITY PROJECT
TOM CARPENTER

Executive Summary

- The Government Accountability Project (GAP) is a non-profit organization based in Washington, D.C. with a branch office in Seattle, Washington. GAP's Nuclear Oversight Program is based in the Seattle Office. GAP's website is www.whisteblower.org. Boston Chemical Data, Inc. is a privately-owned laboratory that specializes in environmental sampling and analysis. Boston Chemical Data, Inc. has posted the report and associated data at its website at www.labs.pro/gap.

- The samples were collected by Marco Kaltofen, of Boston Chemical Data, Inc., and Tom Carpenter, of GAP, from November 14 - 19, 2006. Eighty environmental and indoor samples were taken from homes, farm fields, plants, next to roads, in a park, from vacuum cleaners and in local businesses. Many of the samples were collected in cooperation with various organizations and people, including tribal governments and organizations, the State of New Mexico, the Los Alamos Monitor, Concerned Citizens for Nuclear Safety, the Embudo Valley Environmental Monitoring Group and many individual homeowners. The environmental samples were analyzed by Mr. Kaltofen, and some of the samples were sent for laboratory assay, using a high level of quality assurance. The lab work was conducted by Pace Analytical, Walter Miltz Laboratory.

Findings

- The study found that indoor dust samples had higher radiation levels than surrounding soils. Seven of the eight samples with the highest radiation levels were dusts. Dusts made up only 20 out of the total of 79 samples examined in this study. All six of the highest total alpha screening samples were dust samples.

- Residential dusts from the Picuris Pueblo and from the San Ildefonso Pueblo were among the more elevated radiation levels in the set of residential samples studied.

- Significant Plutonium 239/240 detections were found. Three of the test sites exceeded sediment reference values for Plutonium 239/240 cited by the New Mexico Department of Environment. These and other detections cited in this report were above laboratory uncertainty levels. Portrillo Canyon sediment slightly exceeded the reference value. A sample of wood ash from the San Ildefonso Pueblo was double the reference value (wood burning can concentrate existing radionuclides in the resulting ash). A soil sample from downtown Los Alamos was more than 200 times the reference value, at 2.86 pCi/g +/- 0.43 pCi/g. This sample was collected next to the parking lot of the Los Alamos Inn.

- Uranium 235 levels were very similar to those in a recently published New Mexico Environment Department report.

- Uranium 234 levels exceeded the reference value of 1.4 pCi/g at the San Ildefonso Pueblo (2.0 pCi/g), the NMED bathroom dust (1.64 pCi/g) and in Ancha Canyon (3.13 pCi/g).

- In a comparison of tree rings and in a lichen sample, the South Fork of Acid Canyon in the County of Los Alamos and a cedar juniper from Portrillo Canyon showed significant differences between unexposed and potentially exposed biota samples.

- The number of samples collected and analyzed annually by LANL and NMED on the LANL site is much larger than the number of samples collected in this study. This study serves to supplement, not to replace, the larger data set. GAP's sampling sites are uniformly from offsite and fence line locations, rather than from onsite locations or locations undergoing active remediation. These samples are materials which members of the public have routine contact. Offsite concentrations of radionuclides necessarily are below onsite radionuclide concentrations, since LANL is the source of the bulk of the uncontrolled contamination.

Implications of Study

- Overall, the findings of the study, particularly in dust samples and plant materials, suggest that efforts to reduce airborne transport of radionuclides are not as complete as those for sediments.

- Human exposure to these dusts is significant, as dusts are easily inhaled. Scanning electron microscopy of residential dusts collected by Boston Chemical Data found that the median dust particle size was between 12 and 14 microns, based on 27 samples. The median dust particle size means that they are more readily inhaled.

- For area residents, low offsite levels of radioactivity can translate into higher human health risk levels than onsite materials. Radioactive contaminants collect in residential dusts, and will remain there for long periods unless additional mitigation measures are put in place. LANL employees, who may also experience direct contact with onsite materials, can receive additional exposures from offsite materials.

Recommendations

- Further independent environmental sampling is needed in order to fully understand the off site exposure. Additional biological samples, such as outwash area evergreens, lichens, and crops should be targeted in the next phase of

analyses. Lichens are an excellent sample specimen, as they do not receive inputs from contaminated ground, whereas deeper-rooted plants may receive both.

- Radionuclide movement via airborne particulates should be minimized, in the same fashion that previous studies have suggested that soil and sediment erosion prevention measures could reduce water-borne radionuclide movement, such as the NMED reports for the Los Alamos and Pueblo Canyon system.

- Investigation, cleanup and remediation activities should address the results of this study and provide more occupational and residential protections from exposure to LANL offsite contaminants.

Acknowledgements:

GAP wishes to acknowledge the support of the following foundations for this work:

The Ploughshares Fund

The Public Welfare Foundation

The Winslow Foundation

The Colombe Foundation

The CS Fund

Naomi and Nehemiah Cohen Foundation

The Fund for Constitutional Government

Indoor Dusts and Environmental Materials The objective of this study was to compare levels of radioactivity between indoor dusts and environmental samples. Indoor dusts were collected from residential and workplace locations in the Los Alamos, New Mexico area. Sampling sites included Los Alamos, White Rock, San Ildefonso Pueblo, Picuris Pueblo and surrounding rural locations. Environmental samples were collected from areas known to have elevated radioactivity levels due to operations at the Los Alamos National Laboratory (LANL), as well as from areas reported to be outside the impact zone of the LANL facility. The materials sampled include sediments, biological material and ash.

Indoor dusts were collected in bulk from vacuum cleaner bags and from air handler filters found in appliances including space heaters, fans, and refrigerators. Dust accumulations from various sources collect fine particulates over extended time periods, allowing for a retrospective look at past airborne particulate content.

Figure 1 below is a magnified view of refrigerator dust with an 800 micron field width. The white particle's length is shown compared to the 150 micron, equal to 0.15 millimeters), long scale. Refrigerators collect airborne particulates in a greasy fibrous matrix on the active cooling coils, trapping potentially radioactive airborne particulates.

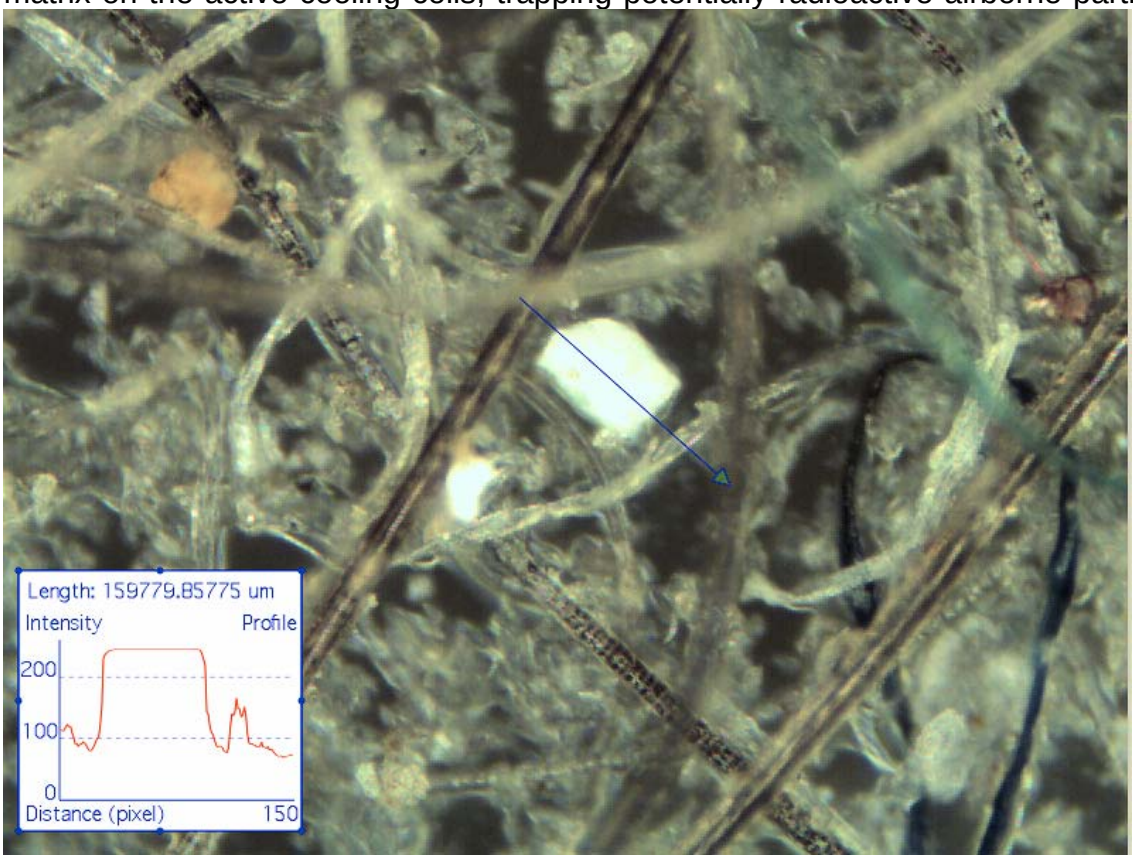
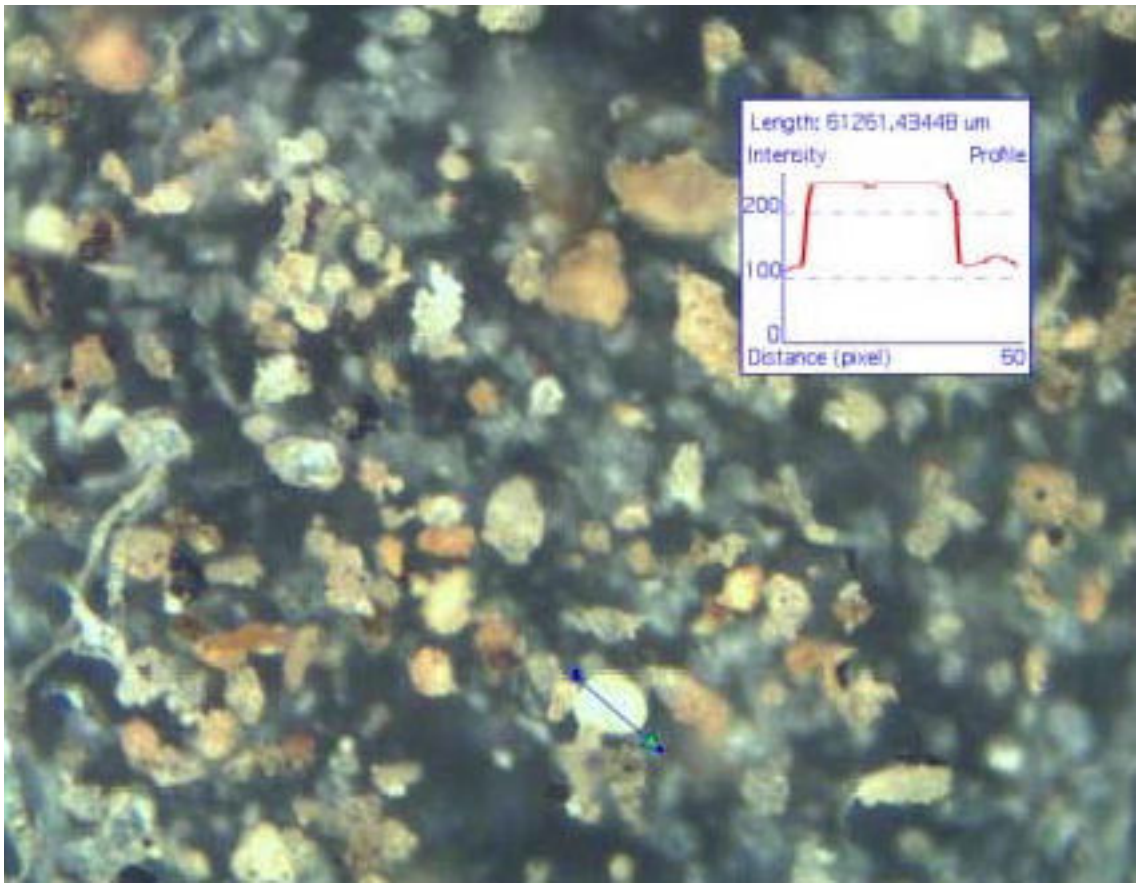


Figure 2 below is a magnified view of fan dust from a private residence, sample number LA0046. As in figure 1, the field width is 800 microns. The white biological artifact is under 50 microns in size. Fan dust samples in the study were generally less fibrous, with smaller median particle sizes. As with the refrigerator dust samples, the fan dust samples represent an accumulation of formerly airborne particulates over time.

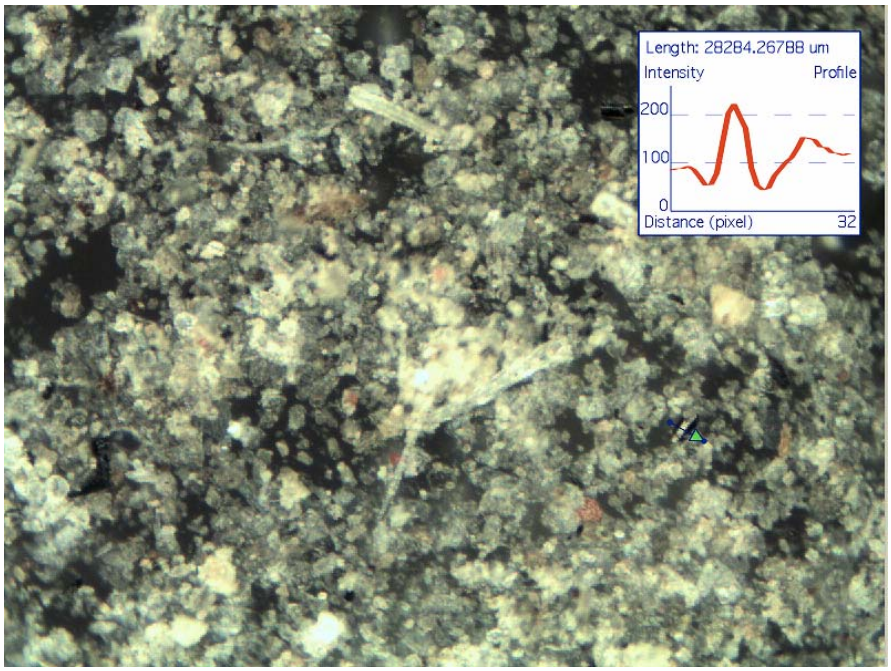


Vacuum cleaner bag dusts were collected at multiple locations. This type of dust is likely accumulated over a shorter period than appliance dusts. A large fraction of this type of dust originates from nearby outdoor soils (ref. 3).

As with other dust samples in the study area, particle sizes were generally small. The samples contained some larger grained material. In order to achieve comparability with existing studies and with other samples collected, vacuum cleaner bag samples were sieved to sizes below 250 microns, eliminating some material which was unlikely to have traveled as airborne particulates. Sediments were also sieved to the same size prior to analysis.

Material tracked-in on footwear is not necessarily eliminated by sieving, thus these samples include both airborne particulates and some outdoor soils. Appliance dusts may well include re-suspended tracked-in soils, but nevertheless still give a measure of airborne particulate-bound radiation exposures.

Figure 3 below, a sample of vacuum cleaner bag dust from a private residence, ID number LA0065, with an 800 micron field width.



Dust samples analyzed are representative of accumulations of airborne exposure. The dust samples selected in this study yield a summation of airborne particulates, house dusts, and tracked-in dusts, as well as dusts and ashes generated by indoor activities. Some of the samples were from residences with dust sources such as indoor wood burning, or from homes of agricultural workers.

Section 1 - White Rock, New Mexico Results

Samples at this location include one interior dust sample, a biota sample, and four sediment samples. The notable sample from this group is the interior dust sample collected from 134 State Road, at the New Mexico Environment Department, LANL Oversight Bureau offices. The sample is of fan dust from a washroom. While sediment and biota samples had elevated radiation levels compared to reference samples (see below), the dust levels were significantly elevated by these measures compared to references and local reference conditions.

These elevated dust levels may reflect bias related to dust particle size compared to soils and potentially the LANL-related activities of building occupants. This result may indicate the need to test other indoor dusts to look for similar results in the homes of others who work on the LANL site.

The measured activity from this interior dust sample was the highest of the entire study set. Total beta activity was measured at 397 disintegrations per minute per gram of material (DPM/g), alpha activity at 21 DPM/g, total activity at 30.5 microRem per hour per gram of material (uR/hr-g). Testing by PACE Analytical, Walter Miltz Laboratory found Strontium-90, Uranium-234, and Uranium-238 all reported in the 1 to 2 picoCuries per gram (pCi/g) range, and all of these exceeding the 2 sigma uncertainty

range (see Cesium-137 in ref. 13)The total activity in the dust sample exceeded that in reference dust and bedrock samples. All total activity counts are performed with a screening alpha, beta, gamma probe calibrated to Nickel-63, and corrected to grams dry weight with a constant area. Total alpha and beta DPM were recorded using a Ludlum model 3030 alpha, beta two channel sample counter. Individual radionuclides were analyzed by Pace Analytical, Walter Miltz Laboratory of Madison, PA.

White Rock Area Samples by ID no.	Total Counts (blank corrected) nR/g-120s	alpha DPM/g	beta DPM/g
LA002 NMED fan dust	1,075	21	397
LA003 Parajito Canyon sediment	389	1	49
LA004 Parajito Canyon outwash soil	467	ND	51
LA005 Parajito Canyon purslane	98	ND	26
LA006 Parajito C. C. Juniper	157	1	85
LA007 Buey Canyon, creekbed	340	1.5	66
Bedrock Outcrop -basaltic	ND		
Urban reference dust	ND		
New Mexico reference dust	ND		
Sante Fe River sediment	242	ND	29
USA reference dusts avg.	ND		
Uncorrected detector blank	343	ND	ND

Other studies have found that interior surfaces will have dust loadings of about 1.3 grams per square meter, with levels reaching 20 grams per square meter in very dusty locations such as window channels and entryway floors (reference 7).

These numbers translate to loadings of 1.4 to 21 pCi/square meter of Strontium 90, 2.1 to 30 pCi/square meter for Cesium 137, 2.1 to 33 pCi/square meter for Uranium 234, and 1.5 to 23.6 pCi/square meter for Uranium 238.

Section 2 - San Ildefonso Pueblo and Picuris Pueblo

This sample set includes dusts and agricultural materials from San Ildefonso and Picuris Pueblos. These sample sets are more distant from LANL, and generally downstream of the impacted watershed. Dust samples generally yielded higher levels than non-dust samples.

The highest of the Strontium 90 result in the Boston Chemical Data Corporation (BCD) study came from a sample of dust on the Picuris Pueblo, yielding 1.54 pCi/g as Stronium-90 +/- 0.42 pCi/g. This sample yielded 70 % of the total counts per unit mass of sample as the dust from the NMED offices in White Rock.

Ashes from a residential interior wood-burning stove had detectable Plutonium 239/240 (0.024 pCi/g) and Strontium-90 (0.81 pCi/g). Both were about twice the 2 sigma uncertainty level.

A sample of refrigerator coil dust from the San Ildefonso Pueblo had 0.63 +/- 0.45 pCi/g of Strontium-90. More importantly, this sample yielded levels of alpha and beta disintegrations which were exceeded only by the dust sample from the NMED offices in White Rock. The sample was ranked 2nd of 77 total samples by both alpha (9 times the study average) and beta counts (3.6 times the study average).

Unlike the White Rock office sample, where employees are anticipated to come into contact with contaminated materials, there is no obvious similar explanation for the elevated radiation levels in this residential dust sample (Note: The NMED dust's radionuclide content may represent the results of particulate track-in by the building's occupants).

San Ildefonso Samples Screening results	Total Counts by nR/g-120s Blank corrected	alpha DPM/g	beta DPM/g
LA047 - Vacuum bag dusts - resid.	309	1	47
LA051 - Squash field top soil	344	3	67
LA052 - Dried tomatoes	243	ND	28
LA053 - Peppers, yellow hots	425	ND	77
LA054 - Peppers -bell	314	ND	68
LA055 - Fan & countertop dust	181	ND	105
LA056 - Refrigerator dust - resid.	217	15	231
LA057 - Topsoil	331	ND	41
LA058 - Vacuum bag dusts - resid.	256	1	63
LA059 - Clay	274	2	51
LA060 - Mica (silicate) clay	521	4	93
LA061 - Horse manure	80	ND	13
LA062 - Wood stove ash	195	ND	53
LA063 - Cow manure	93	ND	91
LA064 - Volcanic ash	446	ND	81

LA065 - Vacuum bag dusts - resid.	146	ND	12
LA072 - Sediment	155	1	55

Picuris Samples

LA073 - Vacuum bag dusts - resid.	181	7	79
LA074 - Attic dust	102	ND	48
LA075 - Wood ash	203	ND	50
LA076 - Bulk dust - residential	217	ND	41
LA077 - Bulk dust - residential	757	2	129
LA078 - Bulk dust - residential	146	1	32
LA079 - apples	128	ND	108

Additional analyses were performed by PACE Analytical in order to follow up on the initial screening results and to identify which radionuclides were the source of the elevated total radioactivity results.

Additional Laboratory Results in pCi/g:

LA051 - soil 0.008 +/-0.005 Pu239/240
LA056 - dust 0.63 +/- 0.45 Sr90
LA060 - clay 0.005 +/-0.004 Pu239/240 LA062 - ash 0.026 +/-0.014 Pu239/240, 0.81 +/-0.48 Sr90
LA064 - ash 0.074 +/-0.050 U235, 2.00 +/- 0.442 U234, 1.94 +/- 0.43 U238 LA077 - dust 1.54 +/- 0.42 Sr90 *****
LA077 - dust 0.080 +/-0.057 U235, 1.21 +/- 0.311 U234, 0.256 +/-0.109 U238

Section 3 - Los Alamos Canyons and Watershed

Samples from the Los Alamos area watershed and its canyons were collected from Ancho, Water, Sandia, Mortendad, Portrillo, and Los Alamos Canyons.

For comparison, those LANL data which were significantly above background for many of these same sites are listed in the Maps and Notes section (Source: Los Alamos National Laboratory 2005 Environmental Surveillance Report, http://www.lanl.gov/environment/eco/reports.shtml. These represent only the high values among a much larger set of LANL data).

Watershed/Canyons Samples Screening results	Total Counts by nR/g-120s Blank corrected	alpha DPM/g	beta DPM/g
LA008 - Portrillo C. sed. @ Rte. 4	470	3	68
LA028 - Soil - Tech Area 2/41	168	ND	32
LA029 - Frijoles bulk indoor dust	168	ND	52
LA030 - Frijoles C. soil	415	2	35
LA031 - Frijoles Ridgetop soil	367	1	59
LA032 - Jemez Ridge	105	3	14
LA033 - Natural fire debris	168	ND	86
LA034 - Rte. 4 parking lot soil	344	1	64
LA035 - Rte. 4 white tree fungus	124	ND	85
LA044 - Los Al. C. juniper berries	159	ND	51
LA045 - Los Al. C. sediment	384	1	29
LA048 - Mortandad C. Juniper	80	1	23
LA049 - Mortandad C. Sage	115	ND	60
LA050 - Mortandad C. Sediment	569	2.5	58
LA066 - Ancho C. Juniper	98	ND	29
LA067 - Ancho C. @ Rte. 4 sed.	687	2	79
LA068 - Water C. Sediment	164	1	69
LA069 - Mortandad C. Sage	120	ND	57
LA070 - Sandia C. Sediment	309	1	48
LA071 - Sandia C. Juniper	27	ND	54

Additional Laboratory Results in pCi/g:

LA008 - sed. 0.088 +/-0.060 U235, 1.03 +/- 0.274 U234, 0.967 +/-0.261 U238
LA030 - soil 1.13 +/- 0.301 U234, ND U235, 1.54 +/-0.382 U238
LA033 - ash ND U235, 0.477 +/-0.145 U234, 0.426 +/-0.133 U238
LA050 - sed. 0.118 +/-0.062 U235, 1.38 +/- 0.30 U234, 0.948 +/- 0.237 U238
LA067 - sed. 0.125 +/-0.070 U235, 3.13 +/- 0.668 U234, 1.86 +/- 0.428 U238
LA067 - sed. 0.006 +/-0.004 Pu239/240

Section 4 - Los Alamos & Santa Fe Proper

A total of 25 samples were collected from within the County or Town of Los Alamos, including 4 samples from the City of Santa Fe. The 25 samples include 11 sediment and biota samples from the South Fork of Acid Canyon, 7 dust samples, 3 biota samples, and 6 soil and sediment samples beyond those taken from the South Fork of Acid Canyon.

SOUTH FORK OF ACID CANYON - The South Fork of Acid Canyon samples were taken from the stream bed and from surrounding vegetation. Total alpha counts ranged from ND (in wood samples) to 4 DPM/g in a sample of dry moss. Total beta counts ranged from 13 (in wood) to 79 DPM/g in lichen.

The Acid Canyon wood samples were from a fallen tree in the bank of Acid Canyon, near the former radioactive effluent outfall location at Technical Area 1. The wood was cross-sectioned and divided into heartwood, inner sapwood, and outer sapwood samples, the heartwood being the oldest, and the outer sapwood being the newest wood material. The following screening values were noted in these three samples.

Sample	Total Counts blank cor.'d	Alpha DPM/g	Beta DPM/g	Approx. dates *
Heartwood	0	ND	13	pre-1911
Inner sapwood	81	ND	72	1961 to 1937
Outer sapwood	67	3	36	pre-2006 to 1978

The values are consistent with periods of no added radionuclide content in the oldest period of wood-formation, followed by accumulation of beta emitters, and finally alpha emitters. Strontium 90 is a common source of beta emissions. Alpha emitters include Cesium 137, Plutonium and others. Based on these screening values, there appear to be significant differences between differing portions of the tree's cross-section. Future sampling events should include more tree cross-sections for analysis.

Above: Location of wood samples in fallen tree cross section.

- Dates are approximate based on ring counts and are provided for conceptual purposes only, as the date of tree fall is unknown.

DOWNTOWN - Soils in a publicly-accessible portion of Downtown Los Alamos were found to have the highest Plutonium 239/240 of the entire study sample set, at 2.86 pCi/g +/- 0.43 pCi/g. This value is more than two orders of magnitude above the expected value. Interestingly, other samples did have higher alpha DPM values per gram, but were not among the samples originally targeted for direct Plutonium 239/240 analysis.

DUSTS - The residential and commercial building dust samples showed significant variation based on location sampled. The highest total counts, alpha and beta DPM were found in a commercial building dust sample just East of Los Alamos (LA023, 2.3 uR/g-120s, 10 DPM, and 145 DPM respectively).

Los Alamos/Santa Fe Samples Screening results	Total Counts by nR/g-120s Blank corrected	alpha DPM/g	beta DPM/g
LA001 - Santa Fe River bed	242	ND	29
LA009 - Acid Canyon lichen	371	1	54
LA010 - Acid Canyon moss	213	4	77
LA011 - Acid Canyon lichen	252	2	33
LA012 - Acid Canyon heartwood	ND	ND	13
LA013 - Acid Canyon middle wood	81	ND	72
LA014 - Acid Canyon sapwood	67	3	36
LA015 - Acid Canyon lichen	239	3	79
LA016 - Los Alamos vac. bag dust	174	1	51
LA018 - Home - refrigerator dust	181	ND	67
LA019 - Residence - vac. bag dust	313	2	52
LA020 - soil from LA019 location	133	1	11
LA021 - Yew Los Alamos fmr. gate	27	ND	58
LA023 - Los Alamos - bath fan dust	1,050	1	145
LA024 - Santa Fe -heater duct dust	230	8	123
LA025 - Residence - bath fan dust	137	5	86
LA026 - Fenceline soil	433	3	64
LA027 - Fenceline animal scat	133	ND	15
LA036 - Los Alamos - vac. bag dust	195	1	35
LA037 - Acid Canyon downstream sed.	402	1	40
LA038 - 20 ft. upstream of LA037	380	1	54
LA039 - 20 ft. downstream of LA037	287	1	63
LA041 - berries	120	ND	12
LA042 - soil 0.5 ft. bgs	300	1	53
LA043 - soil - surface	336	ND	43
LA046 - Santa Fe air filter archived	133	2	65
Instrument Blank	NA	ND	ND

Additional Los Alamos/Santa Fe Sample Laboratory Results in pCi/g:

LA016 - dust 0.28 +/- 0.20 Sr90
LA026 - soil 2.83 +/- 0.43 Pu239/240
LA026 - soil 0.075 +/-0.067 U235, 1.57 +/- 0.422 U234, 1.52 +/- 0.413 U238
LA036 - dust 0.24 +/- 0.19 Sr90

Section 5 - Reference Data and Los Alamos Study Results

Radiation levels detected in this sample set have not generally been converted into doses. However, some comparisons help put potential exposures into perspective. For one of our higher level samples, the dust found at the NMED office in White Rock, we assumed a 200 day per year exposure at 8 hours per working day. This translates into an annual exposure of just over 48 millirems per year/per gram of dust.

The site of radiation exposure can be as important as the quantity of exposure. For dusts, the site of exposure is likely to be the respiratory tract as well as the digestive tract. Inhalation of dust is likely as the dust sample itself would have had to travel by air to become trapped on the intake vent, from whence the sample was collected. Digestive system exposures are possible if dusts are ingested from hand-to-mouth activity.

Assuming the same number of exposure hours as the example above, (200 days at 8 hours per day), and further that respiration rates are at 0.45 cubic meters per hour, yields an annual air intake of 720 cubic meters per person. Residential indoor air contains 10 to 100 micrograms/cubic meter of respirable particulates. For example, airport waiting areas, conference center meeting rooms, and bars have been found to contain levels greater than 500 mcg/cubic meter (reference 8).

Using the 100 mcg/cubic meter figure, respiratory dust intake is 0.072 grams per year. At 500 mcg/cubic meter, dust intake is 0.36 grams per year. Using the higher figure and assuming conservative cumulative exposure, in three years one would have breathed in more than a gram of this dust, and would experience a 51 millirem per year dose rate.

This example assumes no radioactive decay, and that no dust, or the radionuclide burden in the dust, is cleared from the body. In fact there will be some decay and clearance, so the true cumulative exposure number will be lower. Average medical radiation exposures are about 54 millirem per year/per person, the exposure to dusts at this location results in a measurable increased radiation dose, which is significant compared to other typical exposures for the general population.

LANL calculates that the 2005 maximum individual annual radiation dose from onsite activities is about 6.5 millirem (vs. 1.68 in 2004, a 280% increase - see reference 4). It would be useful to recalculate this dose using New Mexico State workers' indoor dust exposures, as New Mexico State workers could exceed this level with quite

modest dust levels of 64 mcg/cubic meter in office air.

For comparison, historic nuclear testing adds 2 mrem per capita. Nuclear power plants generally add about a millirem per year, cosmic rays add 27 millirems per year. The total from all sources is about 360 mrem per year per person, but this is mostly from radon gas, which varies considerably per person (reference 9).

In the region around LANL, the 2005 average combined dose to the 280,000 people within 80 kilometers of Los Alamos is 2.46 person-rems, a 46% increase over the 2004 total population dose.

This additional dose is incomplete, as the number of offsite investigations is limited. For example, LANL collected only two soil samples and no indoor dust samples on the San Ildefonso Pueblo. This is a fairly small number for producing a radiation exposure dose estimate, especially since LANL uses average background plus three standard deviations as reference level. With small sample sets, standard deviations rise, and it is more difficult to detect increases in exposure.

Section 6 - Summary and Future Follow up

6.1 - Indoor dust samples had higher radiation levels than surrounding soils. Seven of the eight samples with the highest radiation levels were dusts. Dusts made up only 20 out of the total of 79 samples examined in this study. All six of the highest total alpha screening samples were dust samples.

6.2 - Human exposure to these dusts is significant, as dusts are fine and respirable. Scanning electron microscopy of residential dusts collected by Boston Chemical Data found that the median dust particle size was between 12 and 14 microns, based on 27 samples.

6.3 - Residential dusts from the Picuris Pueblo and from the San Ildefonso Pueblo were among the more elevated radiation levels in the set of residential samples studied.

6.4 - Significant Plutonium 239/240 detections were found. Three of the test sites exceeded sediment reference values (0.013 pCi/g) for Plutonium 239/240 cited by the New Mexico Department of Environment. These and other detections cited in this section, were above laboratory uncertainty levels (reference 10).

Portrillo Canyon sediment slightly exceeded the reference value. A sample of wood ash from the San Ildefonso Pueblo was double the reference value (wood burning can concentrate existing radionuclides in the resulting ash). A soil sample from downtown Los Alamos was more than 200 times the reference value, at 2.86 pCi/g +/- 0.43 pCi/g. The sample was located at N 35 52.706 W 106 18.241.

6.5 - Uranium 235 levels were very similar to those in the NMED report, with a maximum of 0.125 pCi/g for Ancha Canyon in the BCD study versus 0.126 pCi/g in the NMED Ancha Canyon maximum sample. A BCD study sample also found a similarly elevated level of 0.118 pCi/g of Uranium 235 in Mortandad Canyon surficial sediment. The NMED reference level was 0.07 pCi/g.

6.6 - Uranium 234 levels exceeded the reference value of 1.4 pCi/g at the San Ildefonso Pueblo (2.0 pCi/g), the NMED bathroom dust (1.64 pCi/g) and in Ancha Canyon (3.13 pCi/g).

Testing results released on May 18, 2007 by the New Mexico Environment Department showed that, "239/240 plutonium was the most persistent radionuclide found in terraces downstream of LANL. By far, the largest concentrations were found at the Cañada Ancha site followed by the Frijoles site, and then the Water Canyon site. Elevated 137cesium and uranium isotope concentrations were also found at Cañada Ancha, followed by the Frijoles Site. Strontium-90 was found to be elevated at the Cañada Ancha site and 241americium was elevated at the Frijoles site." The NMED study found that contaminant measurements at the Pajarito and Rio Grande sites were below background references (reference 10).

6.7 – The South Fork of Acid Canyon in the Town of Los Alamos and a cedar juniper from Portrillo Canyon showed significant differences between unexposed and potentially exposed biota samples, particularly in a comparison of tree rings and in a lichen sample. Additional biological samples such as outwash no area evergreens, lichens, and crops should be targeted in the next phase of analysis. Lichens are a good target, as they do not receive inputs from contaminated ground, whereas deeper-rooted plants may receive both.

6.8 - Radionuclide movement via airborne particulates should be minimized in the same fashion that previous studies have suggested that soil and sediment erosion prevention measures could reduce water-borne radionuclide movement (ref. 11).

The number of samples collected and analyzed by LANL and NMED on the LANL site is much larger than the number of samples collected in this study. This study serves to supplement, not to replace, the larger data set. BCD's sampling sites are uniformly from offsite and fence line locations, rather than from onsite locations or locations undergoing active remediation. These samples are materials which members of the public have routine contact. Offsite concentrations of radionuclides necessarily are below onsite radionuclide concentrations, since LANL is the source of the bulk of the uncontrolled contamination.

Overall, the findings of BCD's study, particularly in dust samples and plant materials, suggest that efforts to reduce airborne transport of radionuclides are not as complete as those for sediments. Future sampling efforts should concentrate on tree ring, dust, residential ash, and food chain samples. For area residents, low offsite levels of radioactivity can translate into higher human health risk levels than onsite

materials. LANL employees, who may also experience direct contact with onsite materials, can receive additional exposures from offsite materials.

Radioactive contaminants remain in residential dusts, and will remain there for long periods unless additional mitigation measures are put in place. Investigation, cleanup and remediation activities should address this issue.

References:

Additional data and laboratory test results are available for free download at: www.labs.pro/gap

1) CITIZENS MONITORING AND TECHNICAL ASSESSMENT - ANALYSIS OF CHEMICAL CONTAMINANTS IN HANFORD REACH BIOTA AND ENVIRONMENTAL MATERIALS AT THE PERIMETER OF THE HANFORD NUCLEAR RESERVATION AND ON THE COLUMBIA RIVER, Marco Kaltofen, Boston Chemical Data Corp., url: www.labs.pro, Tom Carpenter, Government Accountability Project, url: www.whistleblower.org, June 2005

2) Environmental Restoration Project, A Citizens Guide, Los Alamos National Laboratory, LALP 01-181, 2002, url: erproject.lanl.gov

3) Agency for Toxic Substances and Disease Registry, Health Consultation, Chestnut Street Property near Abex Lead Site, Portsmouth, Virgina, Background and Statement of Issues. June 5, 1998

4) Environmental Surveillance at Los Alamos During 2005, Ex. Sum. p.7, LA14304-ENV

5) Attics as Archives for House Infiltrating Pollutants: Trace Elements and Pesticides in Attic Dust and Soil from Southern Nevada and Utah, James V. Cizdziela, Vernon F. Hodge, Environmental Science and Health Program 199, University of Nevada Reno, Reno, NV 89557-0187, USA, Department of Chemistry, University of Nevada Las Vegas, 4505 Maryland Pkwy, Las Vegas, NV 89154-4003, USA , Microchemical Journal 64 2000 85 92

6) Use of Olive Oil for Soil Extraction and Ultraviolet Degradation of Polychlorinated Dibenzo-p-dioxins and Dibenzofurans. Pirjo Isosaari, Environmental Science and Technology 2001, 35, 1259-1265.

7) Dust: A Metric for Use in Residential and Building Exposure Assessment and Source Characterization, Paul J. Lioy, Natalie C.G. Freeman,1and James R. Millette, Environmental and Occupational Sciences Institute, University of Medicine and Dentistry of New Jersey-Robert Wood Johnson Medical School, Piscataway, New Jersey, USA; 2MVA, Inc., Norcross, Georgia, USA

8) AAO-HNS, American Academy of Otolaryngology, Head and Neck Surgery, Indoor Air Pollution and Health, Environment Committee article, Steven T. Kmucha, MD, MS, Chair, http://www.entnet.org/education/resources/airpollution.cfm

"The current EPA standard is 75 mcg/m3. The 24 hour EPA maximum allowable is 265mcg/m3. The average home level of particulates is 10-100mcg/m3. Airport waiting areas, conference center meeting rooms, and bars have been found to have levels greater than 500mcg/m3."

9) . Stephen Cass and Corrina Wu, *Discover: Science, Technology, and the Future,* June 2007, p. 76 (general science publication)

10) *Distribution of Radionuclides in Northern Rio Grande Fluvial Deposits near Los Alamos National Laboratory, New Mexico,* David Englert, Michael Dale, Kim Granzow, and Richard Mayer, Department of Energy Oversight Bureau New Mexico Environment Department, 2905 Rodeo Park Drive East Santa Fe, New Mexico 87505, April 2007

11) *Post Cerro Grande Fire Channel Morphology in Lower Pueblo Canyon, Reach P-4 West: and Storm Water Transport of Plutonium 239/240 in Suspended Sediments, Los Alamos County, New Mexico*, by Dave Englert, Ralph Ford-Schmid, and Kenny, Department of Energy Oversight Bureau New Mexico Environment Department, October 2004

12) Map of sample locations prepared by Xiaoxiao Peng for the Government Accountability Project, Seattle, WA, May 2007, www.whistleblower.org

13) Pace Analytical, Laboratory test data, Walter Miltz Laboratory, method PGHR-023-B, Cs137 detected above MDL but below PQL. Feb. 2, 2007.

Maps and Notes

Following page - The first of two site photographs (top photo) is from the boundary of the LANL facility, illustrating the lack of physical access to certain washes and other locations. Some of these locations would be likely to have generated radionuclide levels above those cited in this study.

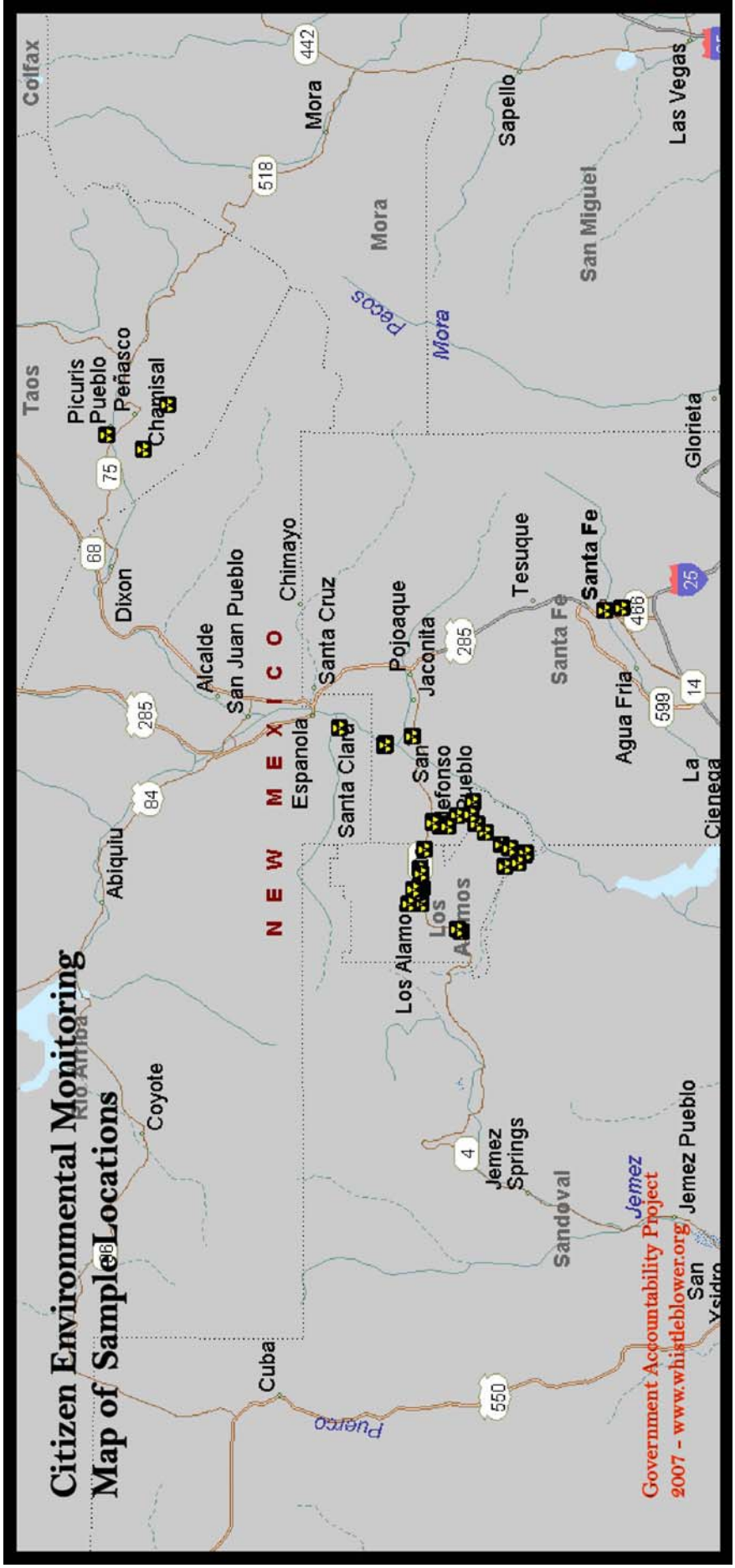
The lower photo is a typical depiction of the semiarid landscape with varying degrees of vegetation available to reduce wind erosion of surface soils and sediments, both of which contribute to the formation of airborne particulates.

This view is the location from which sample LA057 was collected.

Second page following - Map of the sampling locus (See reference 12). Produced by Xiaoxiao Peng, GAP 2007.

For additional data including GIS fields, original laboratory analyses, and screening data, please see www.labs.pro/gap.


No Trespassing
United States
Department Of Energy


Citizen Environmental Monitoring
Map of Sample Locations
Government Accountability Project
2007 - www.whistleblower.org
NEW MEXICO
Colfax
Taos
Mora
San Miguel
Santa Fe
Los Alamos
Sandoval
Rio Arriba
Picuris
Pueblo
Peñasco
Chamisal
Mora
Sapello
Las Vegas
Glorieta
Dixon
Alcalde
San Juan Pueblo
Chimayo
Santa Cruz
Pojoaque
Jacona
Tesuque
Santa Fe
Agua Fria
La Cieneguita
Espanola
Santa Clara
San Ildefonso Pueblo
Los Alamos
Abiquiu
Coyote
Jemez Springs
Jemez Pueblo
San Ysidro
Cuba
Pecos
Mora
Jemez
Puerco
442
518
75
68
285
84
4
550
25
466
14
599

Radionuclide Concentrations Above Background Levels - 2005
LANL Environmental Surveillance Report, Table S6-5.

Location Name	Date	Analyte	Std Result	Std Uncert
DP above Los Alamos Canyon	7/7/05	Cs-137	1.39	0.0585
Mortandad west of GS-1	7/11/05	Cs-137	0.792	0.0535
Mortandad below Effluent Canyon	7/11/05	Cs-137	10.6	0.436
Mortandad at MCO-8.5	7/11/05	Cs-137	2.63	0.122
Pajarito above SR-4	7/5/05	Cs-137	5.87	0.249
Pajarito above SR-4	7/5/05	Cs-137	3.91	0.179
Acid above Pueblo	7/6/05	Pu-238	0.0461	0.0159
Mortandad west of GS-1	7/11/05	Pu-238	0.282	0.0337
Mortandad below Effluent Canyon	7/11/05	Pu-238	3.06	0.171
Mortandad at MCO-8.5	7/11/05	Pu-238	0.845	0.0606
MDA G-8	7/13/05	Pu-238	0.233	0.0275
MDA G-6 Retention Pond Lower	7/13/05	Pu-238	0.0509	0.0121
MDA G-7	7/19/05	Pu-238	0.133	0.0217
Rio Grande at Otowi Upper (bank)	7/27/05	Pu-239,240	0.0894	0.0203
Cochiti Upper	8/3/05	Pu-239,240	0.0311	0.008
Cochiti Middle	8/3/05	Pu-239,240	0.0279	0.00766
Guaje Canyon	7/26/05	Pu-239,240	0.0548	0.0149
Guaje above Rendija	7/26/05	Pu-239,240	0.0508	0.0162
Acid above Pueblo	7/6/05	Pu-239,240	12.5	0.477
Hamilton Bend Spring	7/6/05	Pu-239,240	1.98	0.102
Hamilton Bend Spring	7/6/05	Pu-239,240	1.99	0.103
Pueblo above SR-502	7/6/05	Pu-239,240	0.3	0.0307
Los Alamos above DP Canyon	7/7/05	Pu-239,240	0.261	0.0326
DP above Los Alamos Canyon	7/7/05	Pu-239,240	0.236	0.0278
Los Alamos above SR-4	7/7/05	Pu-239,240	0.138	0.0218
Mortandad west of GS-1	7/11/05	Pu-239,240	0.163	0.0243
Mortandad below Effluent Canyon	7/11/05	Pu-239,240	5.56	0.289
Mortandad at MCO-8.5	7/11/05	Pu-239,240	2.98	0.163
Mortandad at SR-4 (A-9)	7/27/05	Pu-239,240	0.0474	0.0224
MDA G-8	7/13/05	Pu-239,240	1.18	0.0717
Twomile above SR-501	6/28/05	Pu-239,240	0.0252	0.00747
Twomile above SR-501	6/28/05	Pu-239,240	0.0356	0.00709
Pajarito below SR-501	6/28/05	Pu-239,240	0.0274	0.00783
MDA G-6 U West	7/13/05	Pu-239,240	0.076	0.0157
MDA G-6 U West	7/13/05	Pu-239,240	0.102	0.0172
MDA G-6 Retention Pond Lower	7/13/05	Pu-239,240	0.0621	0.014
MDA G-7	7/19/05	Pu-239,240	0.737	0.0548
Pajarito above SR-4	7/5/05	Pu-239,240	0.174	0.0187
Pajarito above SR-4	7/5/05	Pu-239,240	0.202	0.0192
Canon de Valle above SR-501	6/28/05	Pu-239,240	0.0309	0.00952
Sandia above SR-4	6/28/05	U-234	2.71	0.169
Sandia above SR-4	6/28/05	U-238	2.66	0.166

GOVERNMENT ACCOUNTABILITY PROJECT

SEATTLE OFFICE
1511 3RD AVENUE, SUITE 321
SEATTLE, WASHINGTON 98101
Tom Carpenter
206-292-2850
TOMC@WHISTLEBLOWER.ORG

D.C. OFFICE
1612 K STREET, NW
SUITE 110O
WASHINGTON, DC 20006
202-408-0034

BOSTON CHEMICAL DATA CORPORATION

2 Summer Street
Suite 14
Natick, MA 01760
Marco Kaltofen
508-651-1661
Kaltofen@aol.com

Appendix C

Las Mujeres Hablan: The Women Speak - Women's Declaration for New Mexico 2010

Las Mujeres Hablan: The Women Speak

Women's Declaration for New Mexico 2010

Preamble

The Earth community stands at a defining moment in time. Injustices, poverty, ignorance, corruption, crime and violence have deepened and our Earth Mother is suffering. These offenses have lead to values that have become hurtful and a destructive way of living.

We believe that women are sacred unique human beings of the Earth. We believe that female and male energy is found within the other. We believe that all people belong to one earth community as a human family.

We, therefore, declare the following:

1. Whereas, women are the nurturers of the human seed within their wombs and bearers of the blessing of creation through the process of giving birth,

2. Whereas, because of the profound role of women in creation, ancient cultures and civilizations throughout human history and today have revered the earth as our Mother, the source of all life,

3. Whereas, women's bodies are intimately connected to Mother Earth as reflected in our moon cycles that are the basis for procreation and birthing of children,

4. Whereas, mothers and grandmothers continue to be the primary caregivers of children through breastfeeding, feeding, and nurturing, from infancy through all the stages of our human lives,

5. Whereas, women have also nurtured other women historically and traditionally serving as midwives and helping one another raise their children along with their extended families,

6. Whereas, women are believed to have been the first seed savers and contributed to the cultivation of crops in a way that transformed human existence and, today, in our families and communities mothers and grandmothers have continued to be the primary caretakers of seeds,

7. Whereas, women have a special relationship with food in their role as farmers, nurturers, seed savers, and cooks and, therefore, they are the holders of culturally significant recipes and methods for storing and preparing food,

8. Whereas, many of the increasing numbers of small scale, independent farmers are women farmers from various backgrounds who are dedicated to growing clean, healthy, and fair food and to restoring harmony to the earth,

9. Whereas, women provide an important support system for all the activities of operating our *ranchitos*, the family farms and ranches, including serving as part of the labor essential to the process, providing meals for other laborers, and teaching children the values of land-based culture and way of life,

10. Whereas, women are often the teachers of life skills to their children and are therefore important to ensuring that traditional knowledge is passed from generation to generation.

11. Whereas, women play important roles in our communities as spiritual leaders who offer blessings at important times in our lives and who offer guidance on important life decisions,

12. Whereas, women in traditional communities hold essential traditional knowledge including teachings about medicinal plants, where they can be harvested, and how they should be used,

13. Whereas, historically, women's role as homemakers was broad and included helping one another to build, periodically plaster and re-plaster, and maintain their homes,

14. Whereas, for millennia, women have harvested foods such as *piñon*, *quelites*, *tsimaja*, asparagus, *verdolagas*, *chocoyole*, and many varieties of berries, which we regard as special gifts and blessings,

15. Whereas, historically and traditionally, women's roles in families and communities were highly valued and the equally important role of men included providing the needed support system in order to raise healthy families,

16. Whereas, historically and in modern times, women have, out of the love of their children and men in their families, been at the forefront of resisting all forms of violence, including war,

17. Whereas, women today are often not respected as they were traditionally and are often subjected to violence in their own homes by those closest to them,

18. Whereas, because of the nature of women's bodies related to procreation and our intimate relationship with the earth through farming, herb gathering, and earthwork, we are particularly sensitive to exposure to pollutants from various sources,

19. Whereas, the parts of our bodies meant to nurture and nourish our children are also most susceptible to disease and cancer considering that elevated levels of breast cancer, ovarian cancer, and other deadly diseases result from exposure to toxins,

20. Whereas, mothers and grandmothers who feed and nurture their children are concerned about the existence of synthetic hormones and pesticide residues in foods resulting in unprecedented effects on boys and girls such as premature puberty, cancer, and other long-term effects that are unknown,

21. Whereas, our families are also threatened by the unknown health and ecological effects of genetically engineered seeds, plants, and animals, and we are gravely concerned about the patenting of human life which could have unintended consequences for our families and future generations,

22. Whereas, New Mexico is home to various polluting industries, mining operations, power plants, and nuclear facilities that, although serve as a source of financial income for some of our families, also are responsible for pollution that harms all of our families and are part of a pattern of economic development that displaces traditional peoples from the land,

23. Whereas, women are often low-wage workers in these same polluting industries exposed to certain toxins and women are often low-wage agricultural workers who are exposed to pesticides and herbicides in industrial agriculture,

24. Whereas, women have played a key role along with men in social movements to achieve social, economic, and environmental justice by voicing concerns about the threats of toxins to our families and by calling for livelihoods for ourselves and our families that are clean, healthy, and dignified,

Be it resolved;

1. That we are gathered to declare our reverence for our women ancestors that nurtured generation upon generation so that we could be given the blessing of life,

2. Be it further resolved that we will collectively and intentionally work to carry on the seed saving, farming, and ranching traditions of our ancestors and to pass these teachings on to the younger generations,

3. Be it further resolved that we will resist the genetic engineering and patenting of life so that we may maintain the integrity of our seeds, our right to grow our own food, and the sacredness of life itself,

4. Be it further resolved that we will raise our children to be conscious human beings mindful of the sacred gift of life we have been granted by the creator, to be reverent of our Mother Earth, and to be respectful in their relations,

5. Be it further resolved that we will work in solidarity with each other in our struggles to defend the land, air, and water from contamination, exploitation, and commoditization,

6. Be it further resolved that we honor, respect, and recognize the dignity of women and their families throughout the world and here at home who are subjected to exposure to toxins through their work, their food, or their proximity to pollution and that we resolve to speak and act in solidarity with them in efforts to defend the health of their families and communities,

7. Be it further resolved that we will continue to play an important role in reshaping our communities to achieve a vision of safe, healthy, and joyful lives for our families and communities with good, healthy, locally grown food, good livelihoods that honor the dignity of every human person, and a meaningful, spiritual relationship with Mother Earth.

8. Be it further resolved that we will support the work of the **New Mexico Food and Seed Sovereignty Alliance**. (New Mexico Acequia Association (NMAA); Traditional Native American Farmers Association (TNAFA); Tewa Women United (TWU); Honor Our Pueblo Existence (HOPE); Agriculture Implementation, Research and Education (AIRE).

Mission: To continue, revive, and protect our native seeds, crops, heritage fruits, animals, wild plants, traditions, and knowledge of our indigenous, land- and acequia- based communities in New Mexico for the purpose of maintaining and continuing our cultural integrity and resisting the global, industrialized food system that can corrupt our lives, freedom, and culture through inappropriate food production and genetic engineering.

9. Be it further resolved that we will support the work of **Las Mujeres Hablan.** (New Mexico Acequia Association **(**NMAA);Honor Our Pueblo Existence (HOPE), Tewa Women United (TWU); Concerned Citizens for Nuclear Safety (CCNS); Embudo Valley Environmental Monitoring Group (EVEMG); New Mexico Conference of Churches (NMCC); Community Service Organization (CSO) Del Norte

Mission: To address past, present and future issues arising from the nuclear industry's releases of toxic chemicals and radioactive materials that cause contamination to our land, air, and water; demand clean-up of these sites; question the continued manufacturing of nuclear weapons; and restore justice to the Peoples who have been impacted by this industry. And, address other activities that violate and cause harm to our environment and well-being within the Sacred Mountains of New Mexico and other places in the world,

10. Be it further resolved that we will honor and respect the women in our lives including our mothers, grandmothers, and great-grandmothers by thanking them for giving us life and for nurturing us throughout our lives,

AND:

May it be further resolved that we the undersigned, have read this document and are in support of Las Mujeres Hablan: The Women Speak; Women's Declaration for New Mexico 2010. We find it to be true and will assist wherever possible to learn and teach the children, boys and girls, the importance of living close to the land, having respectful relations with one another and act with dignity and respect to protect Mother Earth, so she in turn can continue to care for us.

Appendix D

Indigenous Women and Environmental Violence, A Rights-based approach addressing impacts of Environmental Contamination on Indigenous Women, Girls and Future Generations. Submitted to the United Nations Permanent Forum on Indigenous Issues Expert Group Meeting *Combating Violence Against Indigenous Women and Girls*, January 18 – 20, 2012, United Nations Headquarters, New York, by Andrea Carmen, International Indian Treaty Council and Indigenous Women's Environmental and Reproductive Health Initiative, and Viola Waghiyi, Native Village of Savoonga, St. Lawrence Island, Alaska and Alaska Community Action on Toxics – Theme 2: *Contextualizing Violence.*

"Indigenous Women and Environmental Violence"

A Rights-based approach addressing impacts of Environmental Contamination on Indigenous Women, Girls and Future Generations

Submitted to the United Nations Permanent Forum on Indigenous Issues Expert Group Meeting *"Combating Violence Against Indigenous Women and Girls"*, January 18 – 20, 2012, United Nations Headquarters, New York by Andrea Carmen, International Indian Treaty Council and Indigenous Women's Environmental and Reproductive Health Initiative, and Viola Waghiyi, Native Village of Savoonga, St. Lawrence Island, Alaska and Alaska Community Action on Toxics

Theme 2: "Contextualizing Violence"

***"From a traditional perspective, the health of our Peoples cannot be separated from the health of our environment, the practice of our spirituality and the expression of our inherent right to self-determination, upon which the mental, physical and social health of our commu*nities is based."**

--- IITC Oral Intervention presented by Faith Gemmill, Gwich'in Nation Alaska
United Nations Working Group on Indigenous Populations, Geneva July 31, 1996

"We have listened to each other's stories, and have seen the tragic effects within our own families, communities, and nations of the environmental, economic, social and cultural impacts of toxic contamination. These imposed, deplorable conditions violate the right to health and reproductive justice of Indigenous Peoples, and affect the lives, health and development of our unborn and young children. They seriously threaten our survival as Peoples, Cultures, and Nations."

--- Declaration for Health, Life and Defense of Our Land, Rights and Future Generations", 1st International Indigenous Women's Environmental and Reproductive Health Symposium, June 30 – July 1, 2010, UN Permanent Forum's 10th session [E/C.19/2011/CRP. 9]

Above: Annie Alowa, Yupik elder and community health aide stands among toxic waste at the formerly used defense site, Northeast Cape, St. Lawrence Island, Ak *photo: ACAT*
Right: Three generations of women and girls from a Yaqui family affected by pesticides: Potam Pueblo, Rio Yaqui, Sonora Mexico, June 2006. *Photo: Jeff Conant*

I. Introduction

The severe and ongoing harm caused by environmental toxics to Indigenous women, girls, unborn generations and Indigenous Peoples as a whole, requires immediate attention. These toxics include pesticides and other Persistent Organic Pollutants, as well as chemicals produced by extractive industries (coal, oil, tar sands etc.), military installations and weapons testing, waste dumping and incineration, industrial processes, all phases of uranium mining, milling and waste storage.

The production, use, dumping, and general proliferation of environmental toxics adverse effect the collective and individual rights of Indigenous Peoples, and Indigenous women and children specifically, to free prior and informed consent, health, well-being, culture, development, food and subsistence, life and security of person. The lack of accountability by corporations and States is resulting in devastating health impacts that continue to release environmental toxics into the environment. Of more than 80,000 chemicals in commerce, more than 85% of these chemicals have never been assessed for possible effects on human health in general, let alone their specific impacts on Indigenous women as a uniquely vulnerable group.

States and industry knowingly permit, produce, release, store, transport, export and dump hazardous chemicals that impair the endocrine and immune systems, adversely affect neurodevelopment and reproduction, and cause disease including all forms of cancer with few consequences. This is an egregious example of impunity. Unlike infectious diseases, environmental contaminants that cause disease and death are either deliberately released into the environment specifically *because* they are toxic to living things (i.e. pesticides), or they are a result of manufacturing from industrial or military processes that are judged by States and corporations to pose an "acceptable risk" as compared to their purported economic or military "benefits" to society as a whole. States and corporations deny "provable" impacts despite the clear evidence that these environmental toxics cause a range of serious, well documented health impacts, including harm to reproduction, health and fetal development which disproportionately affect Indigenous women.

Indigenous Peoples live in some of the most remote areas in the world: the deserts, mountains, forests and Arctic tundra. Indigenous families subsist off the land and waters through farming, herding, hunting, fishing and gathering for their main food supplies. Many of these regions are heavily exposed to toxic contaminants as a result of mining and extractive industries as well as industrial agriculture and "green revolution" programs which rely heavily on the use of toxic pesticides. Many chemicals are also transported atmospherically and through ocean currents, and heavily contaminate Indigenous lands and foods far from the points of production and use.

Indigenous women play a key role in farming, food gathering and preparation. They are also cultural practitioners, healers, teachers and knowledge holders who have a central role in the transmission of language and culture to younger generations. Indigenous women have a central role in food gathering and preparation and in a range of traditional cultural practices inextricably linked to the natural environment. These everyday practices increase their exposure and makes them particularly vulnerable to absorbing environmental contaminants, which are increasingly affecting their health, livelihoods and reproductive capacities.

The particular health effects of toxic contaminants on Indigenous women are well documented, and are further affirmed through a range of testimonies from the communities most affected, some of which have been included in this paper. Multiple studies confirm that alarmingly high levels of toxics are found in Indigenous women's breast milk, placental cord blood, blood serum and body fat. Devastating impacts on maternal health include sterility, reproductive system cancers, decreased lactation and the inability to produce healthy children. Research also demonstrates the link between chemical exposures and intellectual and neurological

development of children, impacting their ability to retain and pass on culture, ceremonies, stories, language, songs -- a primary concern of Indigenous women.

Participants in the **1st International Indigenous Women's Environmental and Reproductive Health Symposium** from the North America, Latin America, Pacific, and Arctic and Caribbean regions summarized the impacts:

"Indigenous Peoples, and in particular women and children, are suffering the detrimental, devastating, multi-generational and deadly impacts of environmental toxins and contaminants that were unheard of in our communities prior to industrialization, including:

- *Contamination of mothers' breast milk at 4 to 12 times the levels found in the mother's body tissue in some Indigenous communities;*
- *Elevated levels of contaminants such as POPs and heavy metals in infant cord blood; Disproportionate levels of reproductive system cancers of the breasts, ovaries, uterus, prostate and testicles, including in young people;*
- *Increasing numbers of miscarriages and stillbirths, and;*
- *High levels of sterility and infertility in contaminated communities."*[1]

The disproportionate impacts of environmental contamination on Indigenous Peoples and communities of color are the basis of the now well-accepted concept "environmental racism". The concept of "gender-based environmental violence" is not yet as common. Through this paper, we hope to lay some initial groundwork for the continuing development of this concept, and the development of solutions through implementation of human rights accountability. We will demonstrate why Indigenous women, and the unborn children that they carry, are disproportionally affected by environmental toxics for a number of cultural and biological reasons. We will also address some of the associated pervasive human rights violations that impact Indigenous women, girls, and the cultural health, viability and survival of Indigenous Peoples as a whole.

II. Environmental Violence Against Indigenous Women and Children: Human Rights Framework

"The protection of our health, lands, resources including air and water, languages, cultures, traditional foods and subsistence, sovereignty and self-determination, and the transmission of our traditional knowledge and teachings to our future generations are inherent and inalienable human rights. These rights are affirmed in the ***UN Declaration on the Rights of Indigenous Peoples*** *and other international standards, and must be upheld, respected and fully implemented."* [2]

"Human rights are integral to the promotion of peace and security, economic prosperity and social equity… A major task for the United Nations, therefore, is to enhance its human rights programme and fully integrate it into the broad range of the Organization's activities". [3]

The fundamental link between human rights and environmental contamination is a relatively new and evolving concept in the UN system. It has yet to be fully recognized and effectively integrated in international Convention

---

[1] Declaration for Health, Life and Defense of Our Land, Rights and Future Generations", *1st International Indigenous Women's Environmental and Reproductive Health Symposium, June 30 – July 1, 2010*, submitted to the UN Permanent Forum's 10th session as Conference Room Paper [E/C.19/2011/CRP. 9]

[2] Ibid

[3] "Human Rights in the Report of the Secretary-General on Renewing the United Nations: a Programme for Reform, Extracts from the report of the Secretary-General to the General Assembly, A/51/950, para. 78 and 79, 14 July 1997

processes addressing toxic contaminants. Many States continue to resist addressing this fundamental inter-relationship in the context of UN Environmental Convention processes, despite the fact that a number of existing international human rights norms and standards provide a clear and compelling case for doing so.

A central factor of the proliferation of environmental toxics is the conscious and deliberate nature of their production, marketing, export and release despite their well-known and well documented risks and impacts. Identifying the disproportionate and often devastating impacts on Indigenous women as "environmental violence" for which States and corporations can be held accountable is an even newer concept. A review of some of the inter-related human rights affirmed in international standards can begin to provide the elements and framework for the development of this emerging concept. These include, inter alia:

1. The rights of all individuals to health, food and well-being (Article 25), and life and security of person (Article 3) as per the Universal Declaration on Human Rights.
2. The rights of Indigenous Peoples to self-determination and free prior informed consent, regarding matters which affect them including the use of hazardous materials on their lands, to determine their own priorities for development, and to maintain the productive capacity of their lands[4], in particular, in this context, as applies to the economic, subsistence and cultural activities to which Indigenous women are directly tied.
3. The rights of Indigenous Peoples to attain the highest levels of health.[5]
4. The rights of Indigenous Peoples to practice and transmit their cultures and traditional knowledge to future generations.[6]
5. The rights of Indigenous women and children to special protection.[7]
6. The obligation of States to implement, promote and monitor the enjoyment of these rights, to implement effective solutions, remedies and mechanisms in conjunction with Indigenous Peoples and monitor the human rights impacts of corporations which they license as specifically recommended by the UN CERD in its periodic reviews of Canada and the US. (2007 and 2008)

The ongoing resistance of States to the mainstreaming of human rights into international environmental standard-setting processes may be directly related to their resistance to consider accountability mechanisms for the egregious and ongoing violations of human rights resulting from the deliberate production, sale and use of toxic substances with well-known and well-documented harmful effects on human health and development.

Specific relevant Human Rights Standards which can provide a useful framework for the UNPFII's consideration of "environmental violence" as new area of human rights include:

A. The United Nations Declaration on the Rights of Indigenous Peoples in its preamble affirms the principle of non-discrimination as well as the rights of Indigenous People to maintain their traditional economic, cultural and subsistence activities, protect their health and exercise free prior informed consent regarding decisions and activities affecting them, including the release of environmental toxics in their lands. These rights have been directly threatened and violated, both on an individual and collective level, by State policies and corporate activities which promote, allow and impose unsustainable economic development, including resource extraction and industrial agriculture.

---

[4] Article 29, UN Declaration on the Rights of Indigenous Peoples as well as CERD General Recommendation XXIII

[5] UNDRIP Article 24

[6] various Articles of the UNDRIP as well as UNESCO, the Convention on the Rights of the Child and others

[7] affirmed in both the UDHR Article 25 and UNDRIP Articles 21 and 22

A number of Preambular paragraphs and Articles of the UN Declaration on the Rights of Indigenous Peoples directly address the rights of Indigenous Peoples, and Indigenous women, as well as State obligations to take both preventative and restorative action. These include:

- Article 3 - Right to Self-Determination
- Article 7 – the Right to Life, physical and mental integrity and the security of person; right to live as distinct Peoples
- Article 8 - Right to not be subjected to destruction of culture
- Article 13 - Right to revitalize, use, develop and transmit histories, languages and oral traditions to future generations
- Article 19 – Free Prior and Informed Consent regarding legislative and administrative measures by states
- Article 20 - Right to be secure in subsistence and development
- Article 21 – Right to the improvement of their economic and social conditions, including, inter alia, health
- Article 22 - Attention to the rights and special needs of indigenous elders, women, youth, children and persons with disabilities
- Article 24 - Right to the highest attainable standard of health and the conservation of vital plants and animals
- Article 25 – Right to maintain spiritual relationships to land and resources for future generations
- Article 26 – Right to traditional lands, territories and resources
- Article 29 - Right to conservation and protection of the environment and productive capacity of lands, territories and resources; right to free prior and informed consent regarding hazardous materials and the obligations of States to take action to restore the health of the Indigenous Peoples affected
- Article 31 - Right to maintain, control, protect and develop cultural heritage, traditional knowledge and cultural expressions including genetic resources, seeds and medicines
- Article 32 - Right to determine and develop priorities and strategies for development including the right to free, prior and informed consent
- Article 37 – Treaty Rights
- Article 42 - Obligation for implementation and follow-up by States and UN agencies and processes

Article 29, paragraphs 2 and 3 are of particular relevance to this discussion with regards to the rights of Indigenous Peoples and the related obligations of States:

2. States shall take effective measures to ensure that no storage or disposal of hazardous materials shall take place in the lands or territories of indigenous peoples without their free, prior and informed consent.
3. States shall also take effective measures to ensure, as needed, that programmes for monitoring, maintaining and restoring the health of indigenous peoples, as developed and implemented by the peoples affected by such materials, are duly implemented.

B. The International Covenant on Civil and Political Rights (ICCPR)

Article 27 of the ICCPR states:

"In those States in which ethnic, religious or linguistic minorities exist, persons belonging to such minorities shall not be denied the right, in community with other members of the group, to enjoy their own culture, to profess and practice their own religion, or to use their own language."

General Comment 23 of the Human Rights Committee is meant to serve as guidance to the States in their compliance with Article 27:

"With regard to the exercise of the cultural rights protected under article 27, the Committee observes that culture manifests itself in many forms, including a particular way of life associated with the use of land resources, especially in the case of Indigenous Peoples. That right may include such traditional activities as fishing or hunting, and the right to live in reserves protected by law. The enjoyment of those rights may require positive legal measures of protection and measures to ensure the effective participation of members of minority communities in decisions that affect them."[8]

C. The Right to Food, Food Security, Subsistence and Food Sovereignty

"…In no case may a people be deprived of its own means of subsistence."

-- Article 1 in Common, International Covenants on Civil and Political Rights and on Economic, Social and Cultural Rights

The Rights to Health and Culture for Indigenous Peoples are closely linked to the Right to Food and Subsistence. It is well documented that environmental toxins have a serious impact on traditional foods, creating a false and forced choice for Indigenous Peoples, in particular, pregnant and nursing mothers. They are often forced to choose between the cultural and nutritional value of their traditional foods and subsistence way of life, and the health and development of their unborn children, as well as their ability to have children at all.

In 1997 the United Nations Rapporteur on the Right to Food, Jean Zeigler responded to a submission by the International Indian Treaty Council on behalf of Indigenous Tribes and Peoples in Northern California addressing mercury contamination and St. Lawrence Island, Alaska regarding military toxics and the impacts of this contamination on their traditional subsistence foods.

"The Special Rapporteur believes that the contamination of indigenous peoples' land and water affecting their livelihood (traditional fishing) may contribute to a violation of the Government's obligation to respect the right to food." [9]

Indigenous Peoples have consistently identified toxic contaminants as one of the primary obstacles to their food sovereignty, also affirming the inter-related links to the health impacts on Indigenous women and children. The **"DECLARATION OF ATITLÁN"** from the **1st Indigenous Peoples' Global Consultation on the Right to Food** in Atitlán, Sololá, Guatemala, April 17 - 19, 2002, identified toxic chemicals, in particular those used in industrial agriculture as a primary obstacles to their Food Security and Food Sovereignty, also noting the effects on women's and children's health, as follows:

"The growing imposition of the use of pesticides and chemical fertilizers that poison Mother Earth, the communities that work with the Earth, and the food resources on which Indigenous Peoples depend worldwide, affecting food production and hence nutrition and health, and increasing morbidity and mortality rates, in particular for our women and children;"[10]

---

[8] General Recommendation No. 23, the rights of minorities (article 27), CCPR/C/21/Rev.1/Add.5, 08/04/1994

[9] UN Special Rapporteur on the Right to Food Jean Ziegler, report to the 4th session of the UN Human Rights Council [A/HRC/4/30/Add.1, 18 May 2007]

[10] **"DECLARATION OF ATITLÁN"** from the 1st Indigenous Peoples' Global Consultation on the Right to Food, Sololá, Guatemala, April 17 - 19, 2002,

D. The United Nations Convention on the Rights of the Child (November 20, 1989) is the international instrument that directly addresses the rights of all children, including the female child. Significantly, it is the only human rights Convention which specifically mentions environmental pollution as a human rights concern affecting the health of children, as well as the closely interrelated issues of maternal and prenatal health:

Article 24
1. States Parties recognize the right of the child to the enjoyment of the highest attainable standard of health and to facilities for the treatment of illness and rehabilitation of health. States Parties shall strive to ensure that no child is deprived of his or her right of access to such health care services.
2. States Parties shall pursue full implementation of this right and, in particular, shall take appropriate measures:
(a) To diminish infant and child mortality;
(c) To combat disease and malnutrition, including within the framework of primary health care, through inter alia, the application of readily available technology and through the provision of adequate nutritious foods and clean drinking-water, taking into consideration the dangers and risks of environmental pollution;
(d) To ensure appropriate pre-natal and post-natal health care for mothers;

General Comment 11 of the Committee on the Rights of the Child [CRC/C/GC/11, 2009] further elaborates and underscores State parties' obligations under the Convention specifically with regards to Indigenous children. It also addresses the issue of maternal and family health and the impacts of environmental contaminants, specifically mentioning pesticides and herbicides:

Regarding "Right to Life, Survival and Development"
35. The Committee reiterates its understanding of development of the child as set out in its general comment No. 5, as a "holistic concept embracing the child's physical, mental, spiritual, moral, psychological and social development". The Preamble of the Convention stresses the importance of the traditions and cultural values of each person, particularly with reference to the protection and harmonious development of the child. In the case of indigenous children whose communities retain a traditional lifestyle, the use of traditional land is of significant importance to their development and enjoyment of culture. States parties should closely consider the cultural significance of traditional land and the quality of the natural environment while ensuring the children's right to life, survival and development to the maximum extent possible.

Regarding "Basic Health and Welfare"
53. States should take all reasonable measures to ensure that indigenous children, families and their communities receive information and education on issues relating to health and preventive care such as nutrition, breastfeeding, pre- and postnatal care, child and adolescent health, vaccinations, communicable diseases (in particular HIV/AIDS and tuberculosis), hygiene, environmental sanitation, and the dangers of pesticides and herbicides.

E. The United Nations Committee on the Elimination of Racial Discrimination (CERD)

Of particular relevance to the human rights framework pertaining to the theme and concerns of this Expert Seminar is General Recommendation No. XXIII on Indigenous Peoples, adopted by the 51st session of UN Committee on the Elimination on Racial Discrimination. [11]
General recommendation XXIII, Paragraph 4 states as follows:

[11] CERD, the Treaty Monitoring Body for the International Convention on the Elimination of All Forms of Racial Discrimination, ICERD, adopted August 18th, 2007

4. The Committee calls in particular upon States parties to:

(c) Provide indigenous peoples with conditions allowing for a sustainable economic and social development compatible with their cultural characteristics;

(d) Ensure that members of indigenous peoples have equal rights in respect of effective participation in public life and that no decisions directly relating to their rights and interests are taken without their informed consent.

(e) Ensure that indigenous communities can exercise their rights to practice and revitalize their cultural traditions and customs and to preserve and to practice their languages.

F. The Universal Declaration of Human Rights (1948) firmly establishes that health and well-being are human rights, and also recognizes that "Motherhood and childhood are entitled to special care and assistance"[12]

G. One of the **5 objectives for the Plan of Action for the 2nd International Decade the Worlds Indigenous Peoples adopted by the UN General Assembly in January 2005 is** "is "*promoting full and effective participation of indigenous peoples in decisions which directly or indirectly affect their lifestyles, traditional lands and territories, their cultural integrity as indigenous peoples with collective rights or any other aspect of their lives, considering the principle of free, prior and informed consent".* This objective is of direct relevance in challenging activities related to environmental contamination which violate Indigenous Peoples' human rights, and provides a framework and criteria by which effective solutions and responses can be developed in full partnership with Indigenous Peoples.

H. UN Convention on the Elimination of Discrimination Against Women (CEDAW)

Although CEDAW does not specifically mention Indigenous women or impacts of environmental toxins, its provisions that address employment and rural women are relevant to these concerns:

Article 11
1. States Parties shall take all appropriate measures to eliminate discrimination against women in the field of employment in order to ensure, on a basis of equality of men and women, the same rights, in particular:
(f) The right to protection of health and to safety in working conditions, including the safeguarding of the function of reproduction.

Article 14
1. States Parties shall take into account the particular problems faced by rural women and the significant roles which rural women play in the economic survival of their families, including their work in the non-monetized sectors of the economy, and shall take all appropriate measures to ensure the application of the provisions of the present Convention to women in rural areas.
2. States Parties shall take all appropriate measures to eliminate discrimination against women in rural areas in order to ensure, on a basis of equality of men and women, which they participate in and benefit from rural development and, in particular, shall ensure to such women the right:
(a) To participate in the elaboration and implementation of development planning at all levels
(b) To have access to adequate health care facilities

[12] Article 25

I. Nation to Nation Treaties between States and Indigenous Nations and the consensual relationships they are based on, if honored, respected and put into practice by all Parties, can be the foundation and model for respectful partnerships addressing this and a range of other issues. This is true, in particular, when there is an urgent need for joint and or/shared decision-making in order to correct current injustices, respond to critical violations and redress historic and ongoing wrongs.

The following and other preambular paragraphs, along with Articles 3, 18, 19, 27, 28, 32, 37 and 40, inter alia, of the UN Declaration on the Rights of Indigenous Peoples make important contributions to a human rights framework incorporating Treaty rights and relationships based on FPIC and full participation in decision-making:

"Considering also those treaties, agreements and other constructive arrangements, and the relationship they represent, are the basis for a strengthened partnership between indigenous peoples and States"

Indigenous Peoples have also affirmed the **"Treaty Right to Health"** as a legally binding and sacred obligation of the Colonial governments, including the British Crown, which entered into Treaties with Indigenous Nations: *"That the medicine chest clause binds the federal government to provide medicines and all that is required to maintain proper health."* [13]

III. Case Studies: Environmental Toxics and their impacts on Women and Girls in Indigenous Communities

A. Rio Yaqui, Sonora Mexico: Threats to women's, girl's and future generations' health and development

In 1997, Dr. Elizabeth Guillette, a scientist from the University of Arizona carried out a study of the health effects of industrial agricultural pesticides in the homelands of the Yaqui Indians in Sonora, Mexico,[14] a few hours south of the US/Mexico border. Yaqui Indigenous communities in the agricultural areas have been exposed to frequent aerial and ground spraying of pesticides since the government's implementation of the "Green Revolution" in the late 1940's. For some, their only source of water is contaminated irrigation canals.

In addition to the impacts of pesticides sprayed from airplanes affecting the entire community, Yaqui farm workers who are not provided by growers with any protective gear in the fields. Workers unintentionally carry poisons home in pesticides-soaked clothing and skin, unknowingly spreading the contamination to their families. The maternal health of Yaqui women working in the fields or living nearby, or whose husbands bring the contamination home on their clothing, is particularly impacted. Dr. Guillette's study documented the resulting high levels of pesticides found in the cord blood of newborns and in mother's milk (see table below).

Table 1: Mean concentrations in the cord blood at time of birth and in mothers milk one month post partum from women, Pueblo Yaqui, Sonora, Mexico. [Data from Garcia and Meza, 1991[15]]

[13] "Treaty Right to Health" resolution adopted by the Chiefs in Treaty No. 6, No. 7 and No. 8, March 16-17, 2005, reaffirmed at the International Indian Treaty Council Conference, Ermineskin Cree Nation, Alberta Canada (Treaty No. 6 Territory) August 7th 2005

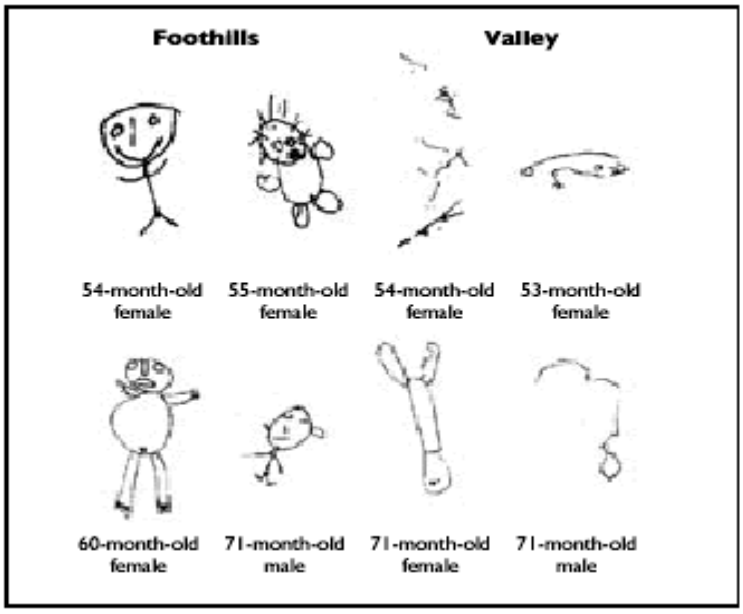
[14] "An Anthropological Approach to the Evaluation of Children Exposed to Pesticides in Mexico", Elizabeth A. Guillette, María Mercedes Meza M. Maria Guadalupe Aquilar A, Alma Delia Soto A., and Idalia Enedina Garcia C., Bureau of Applied Research in Anthropology, University of Arizona, Tucson, AZ, U.S.A. and Direccion de Investigacion y Estudias de Postgrado, Instituto Tecnológico de Sonora, Cd. Obregón, Sonora Mexico, published in *Environmental Health Perspectives* Volume 106, Number 6, June 1998

[15] Ibid

Pesticide	Cord Blood (ppm)	Milk (ppm corrected for fat)
N	19	20
α-HCH	0.030 ± 0.03	0.8599 ± 2.75
β-HCH	0	0.3791 ± 1.08
Lindane	0.084 ± 0.06	0.6710 ± 0.59*
Δ-HCH	0.0039 ± 0.1	0.4432 ± 0.84
Heptachlor	0	1.269 ± 1.65*
BHC	0.003 ± 0.002	0.6270 ± 0.66*
Aldrin	0	0.2363 ± 0.59*
Dieldrin	0.159 ± 0.12	0.0487 ± 0.08
Endrin	0.022 ± 0.02	0.5238 ± 1.1*
p,p′-DDE	0.03 ± 0.03	6.31 ± 5.9
ℜDDE	0.0434	6.52*

*All exceed FAO/OMS established limits

This study also found birth defects, learning and development disabilities, leukemia and other severe health problems in Yaqui children. Combined with personal testimonies from community members collected over years, it also provides strong and compelling evidence of the detrimental impacts of pesticide exposure on the development of exposed Yaqui children. The comparison of Yaqui children in the valley (where pesticide use is heavy) with Yaqui children in the foothills of the Sierra Madre Occidental mountains (where pesticide and insecticide use is minimal to none) showed dramatic differences in motor skills—eye-hand coordination and balance. It showed marked developmental differences included in cognitive skills which were observed in recall, simple problem solving and ability to draw simple stick figures of people:



Her study also found that Valley children had significantly less stamina and hand-eye coordination, poorer short-term memory and were less adept at drawing a person (right) than were children in the foothills (left) where traditional methods of intercropping control pests in gardens and insecticides are rarely used.[16]

Of particular significance to the issues addressed at this EGM is a follow-up study carried out by Dr. Elizabeth Guillette et al examining impacts of in utero pesticides exposure on breast development among girls in Rio Yaqui Sonora Mexico, **"Altered Breast Development in Young Girls from an Agricultural Environment"** published in 2006. This second study was designed to test the hypothesis that abnormal breast development was caused by in utero exposure to agricultural chemicals with endocrine action. The principal difference between the two groups of girls studied was parental exposure to agricultural chemicals which are known to cause endocrine disruption in utero. The study noted that "Various pesticides, mainly organophosphates and organochlorines, were used extensively in the agricultural areas of the Yaqui Valley near the time of the girls' birth (1992–1994), and many of these compounds are known to cross the placenta. A study of newborn children from the Yaqui Valley performed close to the period these children were conceived reported elevated pesticide levels, with cord blood values of lindane, heptachlor, benzene hexachloride, aldrin, and endrin all exceeding World Health Organization established limits (International Programme on Chemical Safety 2005)"[17]

This study was carried through medical examinations (with parental permission) of 50 girls ages 8 – 10 and noted an accelerated rate of breast size development (fatty tissue) in the girls from the high-pesticide use agricultural (valley) areas where their mothers had been exposed to greater levels of pesticides during pregnancy as compared to the girls in the foothill regions where exposure was minimal. Of particular concern to the scientists was the relative lack of and/or abnormal mammary gland development noted in the girls from valley communities, which could have an impact on lactation (breast feeding) later in life as well as a potential links to breast cancer. This first-of-its-kind study (as per Dr. Guillette) examining the relationship between human breast development and environmental contaminants is a unique and alarming confirmation of the impacts of pesticides exposure on the health and development of Indigenous women and girls.

Since 2002, the IITC's **"North-South Indigenous Network against Pesticides Project"** collected and submitted over 50 testimonies from Yaqui community members in Sonora Mexico documenting cancer and leukemia, other illnesses, birth defects and deaths including many from mothers, community midwifes and healers ("curanderas"). These community testimonies have been submitted consistently to the UN Rapporteurs on the adverse effects of the illicit movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, the Right of everyone to the enjoyment of the highest attainable standard of physical and mental health, Right to Food and Rights of Indigenous Peoples. However, this issue has yet to be addressed as a specific area for in depth investigation by any of the UN mandate holders.

Following are translations into English of two of the most recent testimonies submitted to IITC by Yaqui community mothers and a midwife addressing women's and girl's health impacts, which have not as yet been submitted to any other UN body:

Mrs. Flor Reyna Osuna, (mother of the young woman)
Young woman, Flor Osuna García.
Jesús Gonzales, (midwife)

---

[16] Ibid

[17] "Altered Breast Development in Young Girls from an Agricultural Environment" by Elizabeth A. Guillette, Craig Conard, Fernando Lares, Maria Guadalupe Aguilar, John McLachlan, and Louis J. Guillette Jr.

Interviewer: Francisco Villegas Paredes

DECEMBER 15, 2011.

Mrs. Flor Reyna, the mother of a young woman who was born with deformities. Currently the young woman is 30 years old and is 1.20 meters [3'11"] tall. She says that when her daughter was born, the child's body was WATERY and JELLY-LIKE. The girl, due to her scant growth, is unable to move her legs. She can only move her arms. Her vital organs are atrophied. Studies conducted on her reveal that the girl developed deformities while in her mother's womb.

The physicians, as an important conclusion of the studies conducted, consider that the young woman's housing location, on the periphery of agricultural lands and exposed to spraying with agrochemicals, quickly leads to CONGENITAL DISEASES. Also, some biochemists specializing in clinical analysis have analyzed certain products. As a result they have reached important conclusions: mixtures of two or more chemicals applied in inhabited areas also lead to CANCERS.

The midwife, Jesús made the following comments: These deformities are the product of tumors produced by chemicals when young women are exposed to their application while working in the field without personal safety measures or other similar protection.

Mrs. Xóchitl Valdés, (mother of the girl)
Girl: Mariana López Valdés
Interviewer: Francisco Villegas Paredes

DECEMBER 20, 2011.

The girl's mother, Mrs. Mariana López Valdés stated that her pregnancy was very delicate. She was constantly going to the doctor. Even some midwives told her that her girl was not developing well. When the girl was born, she had deformities on her face, principally to her lips. She also stated that the girl's grandfather, Mr. Manuel Valdés works in agriculture and would generally leave chemical residues behind at his house. Some doctors told him, based on studies conducted on the girl that the agro-chemicals are having a direct effect.

The contact she had with the residues while still young caused deformations to some parts of her body when she was a fetus. The girl is alive. She is 1 year 6 months old and her deformities are growing.

The testimonies of these Indigenous women translated from Yaqui into Spanish and then into English, are tragically typical in the highly-impacted Yaqui communities of Sonora Mexico.

B. California, USA

"Indigenous women are life givers, life sustainers and culture holders. Our bodies are sacred places that must be protected, honored and kept free of harmful contaminants in order for the new generations of our Nations to be born strong and healthy."[18]

Data on health impacts of pesticides and the particular danger to maternal health and unborn generations is also well-documented in other regions, including in "developed" countries. For example, results of a 12 year

[18] "The Declaration for Health, Life and Defense of Our Land, Rights and Future Generations", *International Indigenous Women's Environmental and Reproductive Health Symposium,* Alamo, CA in June 30 – July 1, 2010 [E/C.19/2011/CRP. 9

study by the University of California and other agencies of over 600 mothers and their children in the California's Central Valley exposed to pesticides during pregnancy was published in December 2010. The study confirmed that that at age 2, the children of mothers who had the highest levels of organophosphate metabolites in their blood had the lowest levels of mental development in the group. They also had the most cases of pervasive developmental disorders. Prenatal exposure to pesticides has been consistently linked to ADHD and other developmental defects as well as cancers in children such as leukemia. [19]

This work, led by University of California Public Health Professor Brenda Eskenazi, served as a model for a recently launched National Children's Study by the National Institutes of Health (USA), which seeks to examine the effects of the environment on 100,000 children, tracking them from before birth until age 21
It is apparent that the continuing tragic impacts if pesticides on Indigenous women, girls, babies including coming generations is finally beginning to generate greater attention among scientists and policy makers.

Indigenous women in California and elsewhere have stressed the cultural effects of pesticides, which are closely related to health impacts of Indigenous women, and produce a double impact. Traditional cultural activities carried out specifically by Indigenous women, which include food gathering, preparation and production as well as the activities related to the creation of traditional cultural items and art forms, create additional expose to environmental toxins. The following testimony was presented by Monique Sonoquie, Chumash, of the Traditional California Indian Basket Weavers and Indigenous Youth Foundation at the Native Forum preceding the North America Indigenous Peoples preparatory session for UPFII10, March 18th 2011, in Arcata California:

"Pesticides are particularly dangerous to traditional native basket weavers. The Forest Service, Caltrans, governmental agencies, as well as the general public spray pesticides without thought to the natural environment, plants and animals, as well as those of us that work in the forests, parks, rivers, lakes, and oceans. Weavers are affected when gathering in areas sprayed with pesticides, we are constantly at risk as we breathe in, handle and ingest these toxins as we gather, weave and split reeds with our teeth. These pesticides also affect the life and quality of the plants, making them less bug resistant, more fragile, smaller and harder to find, as well as food sources for animals, and traditional medicines for practitioners"

Indigenous women have also expressed concerns regarding the developmental and neurological impacts of neurotoxins such as mercury, many pesticides and industrial chemicals, on the long-term ability of Indigenous peoples to retain and pass on their complex cultural systems which include oral histories, stories, songs language and ceremonies to the next generations. This is a primary responsibility of Indigenous women for girls and young women throughout their learning years, and for young children of both sexes.

It is clear is that the use toxic pesticides in these and other regions causes widespread suffering, injury and death, specifically impacting Indigenous women and girls on a level that constitutes "environmental violence" with a pattern of pervasive and brutal human rights violations that remain, by and large, unchallenged.

C. St. Lawrence Island, Alaska and the Arctic: Military Contamination and Global Transport of Persistent Chemicals

The Yupik Indigenous People of St. Lawrence Island, Alaska (USA) have been harmed and displaced by contamination from formerly used US military bases, with particular effects on women whose breast milk and adipose tissues concentrate chemical contaminants. The US military and Department of Defense disposed of

[19] "Study by the Center for Health Assessment of Mothers and Children of Salinas, a joint project of UC Berkeley, the Natividad Medical Center, Clinica de Salud Del Valle de Salinas and other community organizations, December 2010.

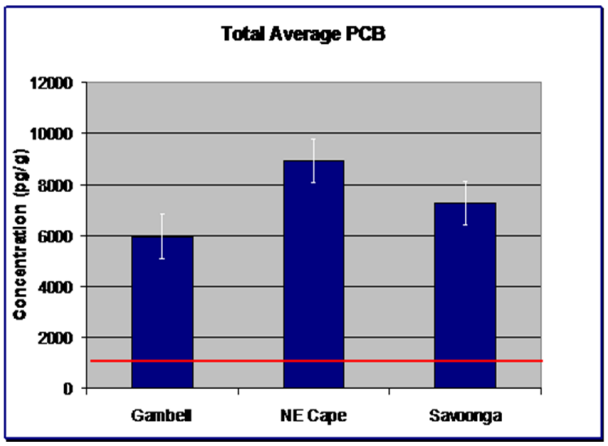
toxic waste on the Island, located in the Arctic Circle between Alaska and Russia, including massive amounts of fuels, solvents, PCBs, PAHs and, mirex (flame retardant), unexploded ordnance, and other persistent pollutants.

Annie Alowa, a respected elder and community health aide from the village of Savoonga, begin to raise concerns in the late 1970's about the adverse health effects she attributed to contamination from the abandoned military site at Northeast Cape, including particular effects on women and children. These included miscarriages, cancer, low-birth weight, and other reproductive health problems. Cancer deaths among the people of St. Lawrence Island are nearly ten times higher than in the general population in Alaska. Contamination from the military sites, which were closed in 1972 but which the US government never removed or adequately cleaned up, continues to adversely affect the health and well-being of the Islands' Indigenous Peoples to this day.

As a result of its strategic importance to the U.S. military during World War II and into present times, Alaska now has 700 formerly used defense sites (FUDS). Two of the most contaminated are located on St. Lawrence Island. The village of Gambell was used as a base for the military beginning in 1948. Hazardous wastes, military debris, unexploded ordnance and spills remain in the soil and groundwater beneath the village. The vulnerability of the drinking water source in Gambell is heightening due to increasing storm surges that accompany rapid climate warming. Northeast Cape is a former U.S. Air Force Base and was also used as a "White Alice" site, part of a military communications network established during the Cold War. Northeast Cape is a traditional food gathering and hunting camp for the residents of Savoonga. A village at Northeast Cape was displaced.

The military installed and later abandoned major facilities at Northeast Cape and Gambell with little or no consideration for the impact on the Island's residents. The Yupik People of St. Lawrence are doubly impacted because the Arctic has become a hemispheric sink for persistent chemicals that travel hundreds of miles into the region and accumulate in the bodies of wildlife and humans.

Hazardous chemicals from military waste sites combined with global transport of POPs to the north contaminate traditional subsistence foods, water supplies, medicinal and food plants (berries, herbs, greens, roots, etc.) that women use, gather and prepare, further exposing them in particular. This double source of toxic contamination undermines the health, cultural practices and development of the Yupik People of St. Lawrence Island, the reproductive health of Yupik women, and the right to survival of their future generations. This pattern is repeated in many other Arctic Indigenous communities.



Levels of PCBs in the blood of St. Lawrence Island Yupik people are ***6-9 times higher*** *than the average in the continental United States populations (indicated by the red line).*

Tribal members from the Villages of Savoonga and Gambell on St. Lawrence Island have levels of PCBs in their blood serum that are 6-9 times higher the average levels in people living in the continental United States due to global transport, with discernibly higher PCB levels among the people who lived or worked at the military base at Northeast Cape. Community health researchers on the island have documented health outcomes of concern including cancers, thyroid disease, learning and developmental problems, diabetes, heart disease, and reproductive health problems. As stated by Dr. David Carpenter, Director of the Institute for Health and the Environment at the University at Albany: "The evidence that there are health hazards from exposures to PCBs in the range of 6-9 ppb is very strong, with disease outcomes ranging from cancer to neurobehavioral effects to endocrine disruption and immune suppression."

Temperatures in the Arctic are warming 5-10 times faster than elsewhere in the world. These outcomes of climate change also cause more rapid dispersal of contaminants into freshwater and marine environments, affecting the health of fish and marine mammals that serve as the main traditional foods for Arctic and northern Indigenous Peoples. Atmospheric loading of contaminants to the ocean surface is increased as sea ice retreats.

D. Global Transport of Persistent Organic Pollutants (POPs) and Impacts on Arctic Indigenous Peoples

Persistent organic pollutants (POPs) are long-lasting pesticides and industrial chemicals that bioaccumulate through the food web, are capable of long-range transport and are toxic to humans and wildlife.[20] The highly toxic organochlorine (OC) pesticides DDT, toxaphene, chlordane, endosulfan, and lindane, and other POPs such as PCBs have been found in human and animal tissue as well as human breast milk in the Arctic at levels several times higher than in the rest of the world. The levels keep rising long after certain of these substances have been banned. For instance, even though DDT agricultural uses have been banned for 30 years in the U.S, it is still accumulating in the Arctic in peregrine falcons, orcas, and human beings

Through a well-known process known as 'global distillation' POPs travel northward and bioaccumulate in high quantities in the bodies of fish, marine mammals and other components of the traditional diets of the Indigenous Peoples in the Arctic. Prevailing ocean and wind currents bring contaminants to the Arctic where they are subsequently trapped by the cold climate. This process is often referred to as the "grasshopper effect", as chemicals repeatedly evaporate and condense while in their journey toward the Arctic. The Arctic is known as the ultimate sink because these contaminants concentrate in the cold environment and fat-based food web.

Levels of OC pesticides such as DDT, chlordane and endosulfan have been increasing in the Arctic. DDT in people is higher in the Arctic than in the rest of the world. PCB levels are 8 to 12 times higher than in the "lower 48 states" of the U.S. and Chlordane levels are 8 to 10 times higher in the people of St. Lawrence Island. Yupik women of the Yukon-Kuskokwim Delta region of Alaska have the highest levels of the POPs chemicals known as PBDEs (polybrominated diphenyl ethers) used as flame retardants in furniture, mattresses and electronics.[21]

POPs chemicals are causing changes in the very DNA of the people living in these areas, which has implications related to intergenerational health effects. The health impacts of POPs on Indigenous Peoples are well-documented on St. Lawrence Island. Much of the contamination by PCBs and other POPs is attributed to past

[20] Stockholm Convention on Persistent Organic Pollutants. http://chm.pops.int/Convention/ThePOPs/tabid/673/Default.aspx accessed November 2011.

[21] Alaska Community Action on Toxics. 2009. Persistent Organic Pollutants in the Arctic: a report for the delegates of the fourth conference of parties of the Stockholm Convention; http://www.akaction.org/Publications_FactSheets_and_Video.htm

and present U.S. military base operations. [22],[23] However, POPs pesticides also continue to build up in Indigenous Peoples' and animals' bodies as these chemicals move northward.

In 1991, the United States joined several other Arctic States in adopting the Arctic Environmental Protection Strategy (AEPS). The AEPS addresses the monitoring, assessment, protection, and conservation of the Arctic zone. The U.S. and the other signing countries made a commitment to, among other things, "monitor the levels of, and assess the effects of, anthropogenic pollutants in all components of the Arctic environment" and "take preventive and other measures directly or through competent international organizations regarding marine pollution in the Arctic irrespective of origin."

In a statement made to U.S. officials of the Environmental Protection Agency, St. Lawrence Island tribal leaders asserted: "The Indigenous Arctic peoples are suffering the most from these chemicals because the chemicals – DDT, endosulfan, lindane, perfluorinated compounds and toxic flame retardants, to name a few—are long lasting, and drift North on wind and water currents from where they are applied in the Southern latitudes. That means these chemicals are also in our traditional foods and affecting our health and the health of our children."

The Arctic is home to approximately half a million Indigenous Peoples, who face significant cultural, food security/subsistence and human health threats from global contaminants combined with climate change which also threatens their food security and traditional subsistence food sources. Indigenous communities of the north are reliant on a traditional diet of foods from the land and ocean for their physical, cultural, and spiritual sustenance. In a 2010 study, researchers found levels of PCBs in the traditional foods of the Yupik people of St. Lawrence Island at 200-400 times the levels considered safe for consumption, particularly in the rendered oils that are so vital for survival in the cold Arctic environment.

The cost of store-bought food is almost six times higher for the same products in rural Alaska compared to other U.S. states. Loss of subsistence foods causes an unbearable economic and nutritional hardship for Arctic Indigenous Peoples and undermines cultural practices handed down through generations.

Specific impacts on women, children and maternal health are well documented. Disparities of health problems in the Alaskan Arctic include high levels of birth defects and neonatal deaths among Alaska Native infants that cannot be explained by the usual risk factors of maternal use of tobacco or alcohol. Data from the Alaska Birth Defects registry shows that the prevalence of birth defects in Alaska is twice as high as in the United States as a whole and that Alaska Native infants have twice the risk of birth defects as white infants born in Alaska. Mothers residing in villages with high hazard ranking are 43% more likely to have a low birth weight baby, 45% more likely to give birth prematurely and more likely to have babies afflicted with intrauterine growth retardation.[24]

IV. Scientific Evidence: Impacts of these Environmental Contaminants Women, Children, and Maternal Health

"We must never forget that it is at this most critical window of development in the mother's womb, the child's first environment and first relationship, where the embodied wealth of indigenous nations is determined."[25]

---

[22] Henifin, Kai A. 2007. Toxic Politics at 64N, 171W: Addressing Military Contaminants on St. Lawrence Island. (Graduate thesis) http://ir.library.oregonstate.edu/dspace/bitstream/1957/4531/1/Henifin_Thesis_Revised.pdf

[23] Christopherson, S., M. Hogan, & A. Rothe. 2006. Formerly Used Defense Sites in the Norton Sound Region: Location, History of Use, Contaminants Present, and Status of Clean-up Efforts. Prepared for Alaska Community Action on Toxics

[24] Gilbreath, S. and Philip Kass. 2006. Adverse birth outcomes associated with open dumpsites in Alaska Native villages. American Journal of Epidemiology 164(6):518-528.

[25] ---Tekatsitsiakwa Katsi Cook, Akwesasne Mohawk: "Protecting the Child in the First Environment: Preconception Health To Save Native Future": Journal of the National Museum of the American Indian, Winter, 2011, 24-27

---Tekatsitsiakwa Katsi Cook, Akwesasne Mohawk: "Protecting the Child in the First Environment: Preconception Health to Save Native Future": Journal of the National Museum of the American Indian, Winter, 2011

A growing body of scientific evidence demonstrates that harm to women's health, particularly reproductive health, is closely associated with exposure to endocrine-disrupting chemicals, which include many POPs and pesticides, often at extremely low levels. In 2009, the Endocrine Society, a medical association of 14,000 endocrine researchers and specialists from more than 100 countries, warned that "even infinitesimally low levels of exposure [to endocrine-disrupting chemicals]–indeed, any level of exposure at all– may cause endocrine or reproductive abnormalities, particularly if exposure occurs during a critical developmental window. Surprisingly, low doses may even exert more potent effects than higher doses."[26] Studies from various fields are converging to implicate endocrine disrupting chemicals as a significant concern to public health. These are substances in our environment, food, and consumer products that interfere with "hormone biosynthesis, metabolism, or action resulting in a deviation from normal homeostatic control of reproduction. Effects of endocrine-disrupting chemicals may be transmitted to further generations through germline epigenetic modifications or from continued exposure of offspring to the environmental insult."[27]

"On top of our basic genetic inheritance lies epigenetics, or those environmental influences that drive changes in the gene function of the developing fetus. Many external agents during critical windows of a child's development, including maternal stress during pregnancy, maternal behaviors, exposures to toxic chemicals, radioactivity, cigarette smoke, diesel exhaust, heavy metals, and persistent organic pollutants like PCBs have lifelong effects on the child's physical, mental and emotional health and well-being. These epigenetic effects and their "reprogramming" of our mammalian physical functions during fetal development and through the end of adolescence can persist across generations."[28]

A 2005 peer-reviewed study by the Environmental Working Group found an average of 200 industrial chemicals and pollutants in the umbilical cord blood of ten babies born in U.S. hospitals.[29] In a study of infants born in 2007 and 2008, the Environmental Working Group commissioned five laboratories in the U.S., Canada, and Europe to analyze umbilical cord blood collected from 10 "minority" infants born in 2007 and 2008. "Collectively, the laboratories identified up to 232 industrial compounds and pollutants in these babies, finding complex mixtures of compounds in each infant. This research demonstrates that industrial chemicals cross the placenta in large numbers to contaminate a baby before the moment of birth." The developing child is particularly vulnerable. Exposures in the womb can result in immediate harm to the child's development; however "some adverse effects may not manifest themselves for years or decades. Scientists refer to this phenomenon as the "fetal basis of adult disease."[30]

---

[26] Diamanti-Kandarakis, Evanthia. Jean-Pierre Bourguignon, Linda C. Giudice, Russ Hauser, Gail S. Prins, Ana M. Soto, R. Thomas Zeller, Andrea C. Gore. 2009. Endocrine-Distrupting Chemicals: An Endocrine Society Scientific Statement. *Endocrine Reviews* 30(4):293-342. http://www.ncbi.nlm.nih.gov/pubmed/19502515

[27] Diamanti-Kandarakis, Evanthia. Jean-Pierre Bourguignon, Linda C. Giudice, Russ Hauser, Gail S. Prins, Ana M. Soto, R. Thomas Zeller, Andrea C. Gore. 2009. Endocrine-Distrupting Chemicals: An Endocrine Society Scientific Statement. *Endocrine Reviews* 30(4):293-342. http://www.ncbi.nlm.nih.gov/pubmed/19502515

[28] Cook, Tekatsitsiakwa Katsi. 2011. Protecting the Child in the First Environment: Preconception Health to Save the Native Future. Journal of the National Museum of the American Indian Winter 2011:24-27.

[29] Environmental Working Group Report Industrial Pollution Begins in the Womb, a Benchmark Investigation of Industrial Chemicals, Pollutants, and Pesticides in Human Umbilical Cord Blood. 2005. Accessed at: www.ewg.org.

[30] Environmental Working Group Report Pollution in Minority Newborns. 2009. Accessed at: www.ewg.org.

Exposure to chemicals can damage women's reproductive health by causing structural malformations and disease, adversely affect tissues or cells of the reproductive organs, and interfere with the endocrine system. Exposure to chemicals is linked with impaired fertility and ability to carry a baby to term. Chemical exposures also confer a higher risk of cancers and disorders of women's reproductive system. Some examples include:

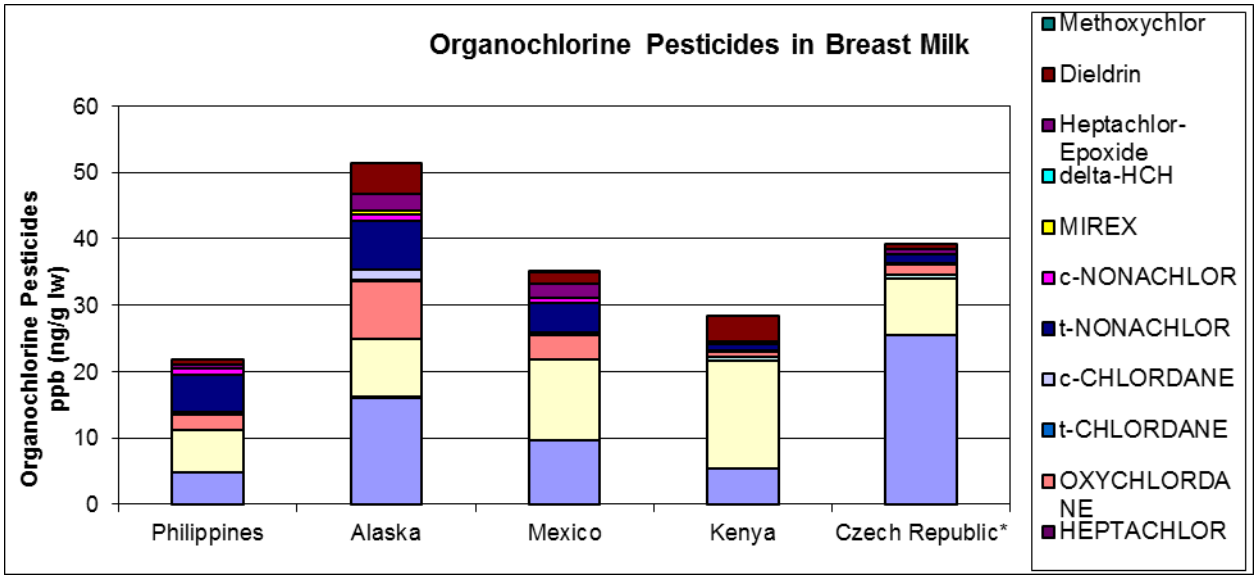
- Uterine fibroids—these noncancerous tumors of muscle lining of the uterus occur in 50% or more of women and are the major cause of hysterectomy in women of reproductive age. They can cause pain, abnormal bleeding, infertility and complications in pregnancy. Although all of the causes are not well understood, exposure to endocrine-disrupting chemicals (xenoestrogens) may cause fibroids. For example, researchers have found that exposure to the chemical bisphenol-A (BPA), found in certain hard plastics and the material lining canned foods and beverages is associated with fibroid development in laboratory studies.
- Endometriosis—is a painful disease occurring when the endometrium, tissue lining the inside of the uterus, grows outside of the uterus into the abdomen, pelvis, or ovaries. Endometriosis affects 10-20% of women of reproductive age and is a leading cause of infertility and hysterectomy. Dioxins and PCBs are among the chemicals associated with endometriosis in animal and human studies. Higher levels of phthalates (an endocrine-disrupting chemical found in personal care products and soft plastics) were found in women with endometriosis.
- Reproductive tract development and disease—exposure to certain xenoestrogenic chemicals such as BPA and the pesticide methoxychlor can interfere with the implantation of fertilized eggs in the uterus or harm the developing bones and uterus of developing babies.
- Effects on ovarian follicles—exposure to endocrine-disrupting chemicals during fetal development can adversely affect the quality and quantity of ovarian follicles. A recent study found that when laboratory animals are exposed to bisphenol-A at levels commonly measured in people, that high percentages (nearly 50%) of their eggs have chromosomal abnormalities. This genetic defect is then also found in the embryos that develop from these eggs. Chromosome abnormalities are the leading cause of miscarriages, birth defects, and mental retardation in people. Bisphenol-A is also associated with re-current miscarriages in humans.
- Early puberty—research demonstrates that exposure to chemicals such as PCs, PBDEs (polybrominated diphenyl ethers), dioxins, and phthalates is associated with earlier onset of puberty in girls.
- Breast cancer—more than 200 chemicals, including a number of endocrine-disrupting chemicals, are associated with increased incidence of breast tumors. Breast cancer incidence rates increased in the U.S. more than 40% between 1973 and 1998, a period that coincides with increasing production and use of pesticides and other industrial chemicals. A woman's lifetime risk of breast cancer is one in eight, as of January 1, 2006 (the most recent point in time for which data are available).
- Miscarriages—exposures to BPA and pesticides such as DDT are associated with miscarriages. Miscarriages affect 21% of known pregnancies and although there are a variety of factors, there is strong evidence that toxic chemicals are significant risk factors.
- Shortened lactation—PCBs and pesticides such as atrazine are associated with a reduction in the length of time that women can breastfeed her baby. Shortened lactation is a critical problem because it has long-term consequences for the development of a healthy child, including increased risk for infection and impaired immunity, obesity, and learning disorders.[31]

V. Contamination of Breast Milk Threatens Current and Future Generations

[31] Information in this section from the report *shaping Our Legacy: Reproductive Health and the Environment*. 2008. A report by the Program on Reproductive Health and the Environment, Department of Obstetrics, Gynecology, and Reproductive Sciences, National Center of Excellence in Women's Health, University of California, San Francisco.

Levels of contaminants found in breast milk demonstrate disproportionate effects in Indigenous communities. Human breast milk is a bioresource at the foundation of subsistence economies and traditional food ways of Indigenous communities. Biomonitoring of human breast milk has shown the ubiquity of persistent organic pollutants in the environment.[32] One study noted that in the Akwesasne Mohawk population with lifetime exposures to consuming fish near contaminated sites, women produced breast milk with higher concentrations of PCBs; yet when later generations of Akwesasne Mohawk mothers heeded fish advisories and did not have such lifetime exposures, the breast milk concentrations of PCBs went down.[33] Unfortunately, in many tribal jurisdictions, where subsistence foods provide an economic and healthy means to eat, and where other sources of food are less available and less desirable, tribal women may not have such a choice.

In a more recent study looking at body burdens of persistent organic pollutants in the Akwesasne Mohawk youth ages 17 to 21 years old, significantly higher levels of PCBs were found among individuals who were breastfed as infants, were first born, or had consumed local fish within the past year. [34]Comparing levels of various persistent organic pollutants (POPs) reported by the U.S. Centers for Disease Control (CDC) for youth between the ages of 12 and 19 years old, the geometric mean of several congeners was significantly higher than the reported CDC 90th percentile. This suggests continued higher than acceptable exposures and body burdens in Indigenous communities either through diet or other sources. Of five women tested from Czechoslovakia, Kenya, Mexico, Philippines and Alaska, levels of pesticides and the industrial chemicals PBDEs (polybrominated diphenyl ethers—used as flame retardants in furniture, mattresses and electronics) were highest in the breast milk of a Yupik woman from Arctic Alaska (see charts below).[35]



Contamination of human milk in Arctic mothers by POPs has been documented at levels considered unsafe. Impacted Indigenous Peoples have stated that they consider the contamination of breast milk as a clear human rights violation, making the most nutritious food for infants poisonous and contaminated in the pursuit of profit.

---

[32] Fitzgerald, E. Hwang, S. et al. 1998. Fish Consumption and Breast Milk PCB Concentrations among Mohawk Women at Akwesasne, American Journal of Epidemiology 148:164-172.
[33] Fitzgerald et al. 1998.
[34] Gallo et al. 2011. Levels of persistent organic pollutant and their predictors among young adults. Chemosphere 03/2011; DOI: 10.1016/j.chemosphere.2011.02.071.
[35] Commonweal. 2009. Report: Monitoring Mother Earth by Monitoring Mother's Milk. www.ipen.org.

Indigenous women continue to strongly encourage breastfeeding for a number of nutritional, spiritual, social, cultural, health and economic reasons. However they demand an immediate halt to all activities which cause it to be contaminated.

VI. State and International Complicity: the Manufacture and Exportation of Banned Pesticides from the United States to Mexico and others countries

"Just because something is not illegal, it may still be immoral. Allowing the export of products recognized to be harmful is immoral."

- UN Special Rapporteur on Adverse effects of the illicit movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, Ms. Fatma-Zohra Ouhachi-Vesely on her first official country visit to the United States, 2001

In 2001, the Special Rapporteur on Adverse effects of the illicit movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, Ms. Fatma-Zohra Ouhachi-Vesely visited the United States. She found that the United States allowed the manufacture and exportation of pesticides that were banned for use in the United States to other, primarily developing, countries. She cited a report on the alarming levels of this exportation:

"United States Customs records reveal that 3.2 billion pounds of pesticide products were exported in 1997-2000, an average rate of 45 tons per hour. Nearly 65 million pounds of the exported pesticides were either forbidden or severely restricted in the United States […]. In the 1997-1999 periods, shipments of banned products were found in Customs Records […] 57 per cent of these products were shipped to a destination in the developing world. Nearly half of the remaining 43 per cent were shipped to ports in Belgium and the Netherlands. Though it is not possible to make a final determination from available data, it is likely that the final destinations of a large number of these shipments were also developing countries." [36]

The same report further stated that:

"[B]etween 1996-2000, the United States exported nearly 1.1 billion pounds of pesticides that have been identified as known or suspected carcinogens, an average rate of almost 16 tons per hour […]"[37]

These figures have particular importance in regard to girls and boys in developing countries. According to the International Labor Organization, 65 to 90 per cent of the children estimated to be working in Africa (80 million), Asia (152 million) and Latin America (17 million) are working in agriculture. Evidence that children have heightened susceptibility to the carcinogenic effects of pesticides has even greater significance for developing countries. There, children live and work in conditions that involve almost continuous exposure, ranging from contact in fields to contaminated water, pesticide-contaminated clothing, and storage of pesticides in homes.

A more recent report based on US Government Custom Service Records, "*Pesticide Exports from U.S. Ports, 2001–2003*" states that:

[36] Carl Smith, "Pesticide Exports from US ports, 1997-2000", vol. 7 *International Journal of Occupational and Environmental Health* (2001), 266-274.
[37] Ibid

"Analysis of U.S. Custom Service records for 2001-2003 indicates that nearly 1.7 billion pounds of pesticide products were exported from U.S. ports, a rate >32 tons/hour. Exports included >27 million pounds of pesticides whose use is forbidden in the United States. WHO Class 1a and 1b pesticides were exported at an average rate of >16 tons/day. Pesticide exports included >500,000 pounds of known or suspected carcinogens, with most going to developing countries; pesticides associated with endocrine disruption were exported at an average rate of >100 tons/day."[38]

The United Nations Declaration on the Rights of Indigenous Peoples as well as CERD General Recommendation XXIII requires the Free Prior Informed Consent by Indigenous Peoples who are exposed and detrimentally affected by exposure these highly toxic substances. The IITC has received extensive documentation from many such communities, in particular in Mexico and Guatemala, affirming that this is, in fact, not the case.

During her visit to the United States Mme. Vesely also met with government officials, reporting that "US officials told me that pesticides banned in the United States but exported cannot be regulated if there is a demand overseas, because of free-trade agreements."[39] The Rapporteur, Ms. Vesely justifiably found that the US policy is based upon, among other unacceptable premises, "… on an untenable premise that pesticides deemed unacceptable for the residents and environment of the United States are somehow acceptable in other countries. Clearly, countries such as the US often choose to offer their citizens a higher degree of protection than they insure for others in other countries and fail to monitor the human rights impacts of this practice by US corporations. One of the most common reasons for doing so is to acknowledge different levels of economic and social development among States. However this disparity is difficult to justify in respect of pesticides found to be so dangerous that they are banned from sale or use." [40]

As one farm worker who is a member of a Yaqui community in Mexico expressed in a meeting with the US's Environmental Protection Agency in the San Diego, California USA in 2001, commenting on the US's policy of banning pesticides for use in the US but still permitting their production for export, "Why are the lives of our Yaqui children in Mexico worth less than the lives of your children here in the US?"

There are a great many difficulties in tracing the use abroad of banned pesticides manufactured in the US. In Mexico and Guatemala, for example, there is no labeling of origin or content of pesticides. They are given names like "Veloz" (speedy), or "Ninja" in Guatemala. As the Special Rapporteur pointed out, "Even if something is marked 'poison' it tends to be shipped in large amounts, and then transferred to smaller containers without proper labeling for local sale and use. And the people actually using the products often cannot read anyway."[41]

In an investigation conducted by the International Indian Treaty Council in Sonora, Mexico, on Indigenous Yaqui ancestral lands received testimony from an indigenous agricultural worker who was told by the agricultural companies involved in aerial spraying to bury large pesticide canisters because they knew that the pesticide was banned. As stated above, many Yaqui family members, farm workers and midwives and mothers have presented testimonies about increasing levels of birth defects, cancers and deaths due to toxic exposure from

---

[38] Pesticide Exports from U.S. Ports, 2001–2003 CARL SMITH, KATHLEEN KERR, MD, AVA SADRIPOUR, ESQ. International Journal of Occupational and Environmental Health ,VOL 14/NO 3, JUL/SEP 2008

[39] U.N. Deems Export of Banned Pesticides Immoral, U.S. Newswire, 202-347-2770/ 12/17 16:09

[40] Special Rapporteur on Adverse effects of the illicit movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, Ms. Fatma-Zohra Ouhachi-Vesely , Mission to the United States, UN Doc. E/CN.4/2003/56/Add.1.

[41] U.N. Deems Export of Banned Pesticides Immoral, U.S. Newswire, 202-347-2770/ 12/17 16:09,

indiscriminate aerial spraying, storage and use of highly toxic pesticides in communities and unsafe working conditions with no safely precautions or information about the dangers provided.

The export of banned and dangerous toxics from the "developed/industrialized" to the "developing" countries continues, with impacted Indigenous and other communities at the bottom end uniformed, sickened and killed. It should be noted with concern that the production and export of banned pesticides by the US is permitted under federal law (the Federal Insecticide, Fungicide, and Rodenticide Act, FIFRA) as well as under the International Rotterdam Convention, as long as the receiving country is informed of this status. Unfortunately no one informs the Indigenous communities "on the ground" who suffer grave human rights consequences.

VII. Holding States and Corporations Accountable

"The agrochemical industry is valued at over $42 billion and operates with impunity while, according to the World Bank over 355,000 people die from pesticide poisoning every year."[42]

On December 3rd 2011, 27 years later after the Bhopal disaster caused by the release of toxic pesticides from the Union Carbide factory in Bhopal India killed over 25,000 people, the **Permanent Peoples Tribunal** convened in Bangalore India with an international panel of 5 judges. Based on testimonies and statements about health and other human rights violations caused by pesticides from communities around the world, including Indigenous communities from Alaska, Mexico, Peru and elsewhere, the Tribunal delivered a scathing indictment of the pesticide industry. It focused on the "Big 6" agrochemical giants, the Multi-national Corporations (MNC's) Monsanto, Syngenta, Dow, DuPont, Bayer, and BASF (Dow bought Union Carbide in 2001).

Blame for the agrochemical industry's human rights abuses was also assigned to the three States where these corporations are headquartered—the United States, Switzerland, and Germany. As stated in the PPT's findings, these countries "*failed to comply with their internationally accepted responsibility to promote and protect human rights, especially of vulnerable populations."*

Other findings included:

"The Tribunal makes the following declaration of responsibility for the six indicted MNCs and three Governments in particular and further also declares the responsibilities of all States, international organizations, UN Specialist Agencies, all other institutions of global governance."

"*AS CONCERNS THE INDICTED SIX CORPORATIONS (BASF, BAYER, DOW CHEMICAL, DUPONT, MONSANTO*

-- The Tribunal finds on all evidence presented before it the six MNCs responsible for gross, widespread and systematic violations of the right to health and life, economic, social and cultural rights, as well as of civil and political rights, and women and children's' rights.

-- The Tribunal also finds these corporations responsible for their systematic conduct resulting in violation of indigenous peoples' human rights and other entitlements.

AS CONCERNS THE THREE SPECIFICALLY INDICTED STATES:

[42] Pesticides Action Network North America, January 10th, 2012

"The United States of America (USA), the Swiss Confederation (Switzerland) and the Federal Republic of Germany (Germany) have failed to comply with their internationally accepted responsibility to promote and protect human rights, especially of vulnerable populations and their specific customary and treaty obligations in the sphere of environment protection…" [43]

The Permanent Peoples tribunal was convened by Non-Governmental organizations and its findings are considered non-binding upon the States and corporations in question. However similar conclusions were reached by a legally binding UN Treaty Monitoring body process, the UN Committee on the Elimination of Racial Discrimination in its Concluding Observations for the periodic review of the United States which took place in February 2008. The International Indian Treaty Council coordinated a joint Indigenous Peoples shadow report which includes testimony and documentation addressing the human rights impact of the production and export of toxic pesticides, including tons of pesticides banned for use in the US due to amble proof of severe health impacts including cancers and birth defects.

In response, the CERD issued the following recommendation to the US, following up on a similar recommendation to the Canadian government during its periodic review the previous year (March 2007):

"30. The Committee notes with concern the reports of adverse effects of economic activities connected with the exploitation of natural resources in countries outside the United States by transnational corporations registered in the State party on the right to land, health, living environment and the way of life of indigenous peoples living in these regions.

> **In light of article 2, paragraph 1 (d), and 5 (e) of the Convention and of its general recommendation no. 23 (1997) on the rights of indigenous peoples, the Committee encourages the State party to take appropriate legislative or administrative measures to prevent acts of transnational corporations registered in the State party which negatively impact on the enjoyment of rights of indigenous peoples in territories outside the United States. In particular, the Committee recommends that the State party explore ways to hold transnational corporations registered in the United States accountable. The Committee requests the State party to include in its next periodic report information on the effects of activities of transnational corporations registered in the United States on indigenous peoples abroad and on any measures taken in this regard."** [44]

The IITC Shadow report submitted to the CERD for the US review specifically documented the export of banned pesticides by the US to Mexico. The issue of Mexico's continuing IMPORT and use of dangerous and banned pesticides and their use in agricultural area of Mexico as impacting Indigenous communities (Yaqui and Huichol) was also submitted by IITC and addressed in the recommendations of the UPR review of Mexico by the UN Human Rights Council in September 2008.

Clearly, United States policies and laws as well as International Conventions allowing banned pesticides to be manufactured and exported by US based corporations are immoral and wrong, and violate the human rights of the impacted Indigenous communities where they are applied without their free, prior and informed consent,

---

[43] DRAFT FINDINGS AND RECOMMENDATIONS, PERMANENT PEOPLE'S TRIBUNAL ON AGROCHEMICAL TRANSNATIONAL CORPORATIONS, Bangalore, India, 3-6 December 2011

[44] Concluding Observations of the UN Committee on the Elimination of Racial Discrimination, United States of America [CERD/C/USA/CO/6 May 8th 2008]

and also where they travel as a result of global transport. As Mme. Ouachi-Veseley stated in her report to the Commission of Human Rights, "[i]n particular, the right to life, the right to health, the right to found a family, the right to a private life are most commonly violated by the effects of pesticide use."[45]

The National Congress of American Indians also affirmed the human rights impacts on Indigenous Peoples of the export of banned pesticides by the United States and US based corporations in a resolution adopted by consensus at its annual conference in November 2007:

"WHEREAS, the production, export and unmonitored use of banned, prohibited and dangerous toxics including pesticides violates a range of human rights for Indigenous Peoples around the world including the Rights of the Child, Right to Health, Food Security, Development Life, Physical Integrity, Free Prior Informed Consent, Cultural Rights, the Right to be Free from all Forms of Racism and Racial Discrimination and the Right of All Peoples not to be Deprived of Their Own Means of Subsistence." [46]

This NCAI resolution also called for a formal Hearing by the United States Senate to further address this matter.

VIII. Advances and Challenges in International Environmental Standards Regarding Environmental Toxics: An opportunity for the UNPFII to exert pressure in support of Indigenous Women and communities' voices, rights and participation

A. The Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention was adopted by States from around the world in 2001 and entered into force in 2004 when 50 States had ratified it. Currently, the Convention includes 176 State parties that agree to work together toward global elimination of the world's most dangerous chemicals. The Stockholm Convention is a living Treaty that includes provisions to add new chemicals that meet scientific criteria for persistence, long-range transport, adverse effects, and bioaccumulation. In addition to the initial list of twelve chemicals including nine pesticides, which were included in the Convention, the "dirty dozen" (aldrin, chlordane, DDT, dieldrin, endrin, heptachlor, mirex, toxaphene, hexachlorobenzene, PCBs, dioxins, and furans), the Parties agreed to add 9 new substances in 2009 and an additional pesticide, endosulfan, in 2011. The scientific committee of the Stockholm Convention, the POPs Review Committee (POPRC), works to determine whether chemicals that are nominated for inclusion under the Convention meet the scientific criteria and warrant global action.

The Preamble of the Convention recognizes the serious health concerns including "*particular impacts upon women and children and, through them, upon future generations*;" and that "*Arctic ecosystems and indigenous communities are particularly at risk because of the biomagnification of persistent organic pollutants and that contamination of their traditional foods is a public health issue*." Because exposure to even low levels of POPs can harm human health and development, the Convention is strongly based on the Precautionary Principle.

However major challenges remain. The chemical industry remains a strong political force in this process, exerting constant and well-funded pressure on States to avoid or delay adding new chemicals. Despite the recognition of impacts on health of women, children and Indigenous Peoples in the Convention's preamble,

---

[45] Special Rapporteur on Adverse effects of the illicit movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights, Ms. Fatma-Zohra Ouhachi-Vesely , Mission to the United States, UN Doc. E/CN.4/2003/56/Add.1, para 39.

[46] National Congress of American Indians Resolution #DEN-07-050, "Impacts on the Contamination of Subsistence Food Resources, Health, Human Rights and Development of Tribes and Indigenous Communities

Human rights including the Rights of Indigenous Peoples most often take a back seat to industry concerns or are not addressed at all in the States' deliberations. Also, there is no formal mechanism for the participation of Indigenous Peoples in the implementation of the Convention. This continues to be a key demand of Indigenous Peoples participating in this process, along with unqualified recognition of human rights.

In the closing statement of the Global Indigenous Peoples Caucus at the 2011 4th Conference of the Parties to the Stockholm Convention (April 6 – 10, 2011, Geneva), these ongoing concerns were emphasized:

"*For Indigenous Peoples, the impacts of the production, export and use of dangerous toxics violates and threaten human rights protected under International Laws, norms and Conventions, including the UN Declaration on the Rights of Indigenous Peoples. Reproductive health and justice, which includes our right to bear and raise healthy children, also continue to be undermined for Indigenous Peoples living at the source of application as well as in Arctic communities, far from the original point of exposure. Indigenous Peoples reiterate our call for formal participation in this process so that we are able to work more effectively with the State parties for the realization of the Stockholm Convention's goals."* [47]

B. The Rotterdam Convention

The **Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade** is an important tool to protect human health and the environment by controlling trade in hazardous chemicals and pesticides that meet the requirements of the Convention. However, as with the Stockholm Convention, there is no formal mechanism for the participation of Indigenous Peoples or to address the human rights abuses caused by the export of hazardous substances when they are used in the lands and territories of Indigenous Peoples without their free prior and consent.

In fact, the Rotterdam Convention specifically allows for the export of pesticides and other chemicals that have been banned for use in the producing State as long as the receiving (importing) State is properly notified. There is no provision to ensure that Indigenous Peoples are afforded the right of Free Prior Informed Consent as stipulated by Article 29 of the UN Declaration of the Rights of Indigenous Peoples, CERD General Recommendations XXIII and other human rights standards. Also, there is no formal process for consideration by State parties of the widespread, brutal Human Rights impacts caused by this practice as have been documented in this paper, putting this UN Convention directly at odds with a number of existing UN human rights standards.

C. Agenda 21 and Rio + 20, the World Conference on Sustainable Development, June 2012

In 1972, the United Nations held the World Conference on the Human Environment in Stockholm, Sweden. The resultant Declaration of the United Nations Conference on the Human Environment was the first pronouncement by the international community on the world's environment. Calling for an environment of a quality that permits a life of dignity and well-being, the Conference established the United Nations Environmental Programme (UNEP).

The Stockholm Declaration addressed the issue of the environment and development but left it up to the States to deal with the growing problem of environmental degradation as a result of development throughout the

[47] United Nations Stockholm Convention on Persistent Organic Pollutants , 5th Conference of the Parties, April 25th 29th, 2011, Geneva Switzerland , Global Indigenous Peoples Caucus Closing Statement , Presented by Monique Sonoquie, International Indian Treaty Council l

world. The Stockholm Declaration did recognize the connection between human right and the environment, but in its formulation of a right to the environment, it framed this right as an individual right even though the right to the environment, like the rights of self-determination, development, and peace, are all so-called "third generation" collective rights of peoples.

The World Conference on the Environment and Development (Rio) was held twenty years later, in 1992, in Rio de Janeiro, Brazil, leading to an explosion of international activity, including development of international conventions addressing the environment.

Principle 22 of the Rio Declaration recognizes that:

Indigenous Peoples and their communities… have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity, culture and interests and enable their effective participation in the achievement of their sustainable development.

Indigenous Peoples are addressed in Agenda 21, Chapter 26 which calls for a "full partnership" with Indigenous Peoples in the accomplishment of the goals of Agenda 21. Chapter 26.3 calls upon the States to "strengthen and facilitate" Indigenous Peoples' participation in their own development and in external development activities that may affect them.

Another important advance, which was also included in the Stockholm Convention, was the key concept of the "Precautionary Principle" placing the burden of proof on the corporation or State that chemicals are safe for human and environmental health BEFORE they are produced, used or released. This formula stands as a rights-based alternative to current practices supported by governmental regulatory models such as "risk assessment", "safe management", and "acceptable risk" which allow the continued use and proliferation of chemicals known to be dangerous if their impacts can be "controlled" or limited to low or "acceptable" rates of illness and death.

Agenda 21 Section I, Chapter 6: "Protecting & Promoting Human Health, E. Reducing health risks from environmental pollution and hazards" recognizes that pesticides pose a serious threat to human health. Although Agenda 21 also endorses partnership with Indigenous Peoples, the Precautionary Principle and Free Prior and Informed Consent, in Chapter 19 and 20 it endorses another model altogether regarding the Management of Chemicals and Hazardous Wastes.

In Chapter 19 it states that "the principle of the right of the community and of workers to know those risks [of chemicals] should be recognized. However, the right to know the identity of hazardous ingredients should be balanced with industry's right to protect confidential business information". [48] In other words, it proposes that the fundamental right of exposed communities to FPIC be "balanced" with corporate business interests. Chapter 19 paragraph 52 f) also allows for the "export of chemicals that are banned, severely restricted, withdrawn or not approved for health or environmental reasons, except when such export has received prior written consent from the importing country"[49] This provides the basis for similar provisions in the Rotterdam Convention.

[48] Agenda 21, Chapter 19 paragraph 8

[49] Agenda 21 Chapter 19, "Environmentally Sound Management Of Toxic Chemicals, Including Prevention Of Illegal International Traffic In Toxic And Dangerous Products", paragraph 52) f

Indigenous Peoples have challenged these provisions of Agenda 21, and the health and human rights threats they pose, in their statements in preparation for the upcoming World Conference on Indigenous Peoples, "Rio + 20" in June 2012, based on the minimum standard in the UN Declaration on the Rights of Indigenous Peoples, in particular Article 29, in this regard. Indigenous Peoples are optimistic regarding the inclusion of the UN Declaration on the Rights of Indigenous Peoples in the "Zero-draft outcome document" for Rio+20 as drafted by the United Nations Secretary General[50] and encourage the UNPFII to urge that this reference remain or be strengthened in the final outcome document.

D. The United Nations Legally-Binding Instrument on Mercury: A Current International Standard-setting opportunity to incorporate the right to health for Indigenous Women, Girls and Future Generations

Mercury is highly toxic. Some levels of inorganic mercury are found in nature. Metallic mercury is used in batteries, thermometers and dental amalgams. The largest amounts of mercury are released into the environment by coal-fired power plants, paper milling, mining and other industrial processes. The most toxic form is "methylated mercury", created when mercury is exposed to decaying plant matter, for example in marshes or lakes created by dams. This form of organic mercury "bio-accumulates" or builds up in the cells of fish and other animals, moving up the food chain in higher and higher concentrations. Humans are most commonly exposed by eating contaminated fish. Mercury contaminates our air, water, lands and traditional foods, in particular the fish upon which so many Indigenous communities depend, producing serious health impacts for persons of all ages. But the gravest danger is to the health and development of our children. Exposure to mercury impairs the neurological development of infants, babies and children, including those still in those mothers' wombs.

The Second Ministerial Meeting of the Arctic Council met in Barrow, Alaska in 2000. Participants were concerned about effects to human health and the environment of mercury and its impacts globally, particularly the Arctic. The Arctic Council asked UNEP to complete a global assessment of mercury to provide information for next steps. UNEP released "Global Mercury Assessment" report in 2002. In summary the report acknowledged that mercury, due to its long range transport, its ability to bioaccumulate in the environment, its persistence and its harm to human health and the environment, is of global concern. In 2009, UNEP agreed to negotiate a global, legally binding mercury-control Treaty. The Treaty was to be drafted in five "Intergovernmental Negotiating Committee" or INC meetings to begin in 2010 and to be completed in early 2013. The first three took place in Japan, Sweden and Kenya. The next session, INC 4, is scheduled in Uruguay in June 2012.

About two-thirds of the mercury released in the environment can be attributed to human activity. The largest source of global mercury pollution comes from burning fossil fuels, primarily coal. The second largest source appears to be artisanal and small scale gold mining, as well as continued run offs from abandoned gold mines. Mercury can also be found in a number of products (batteries, dental fillings, cosmetics etc.)

Mercury contamination is bound to the protein tissue rather than the fatty tissue, unlike contamination from POPs. Although mercury can travel far from the source, contamination is of particular concern for waterways that are near coal-fired power plants, waste dumps, pulp and paper mills, cement kilns, gold mines, sites of fossil fuel extraction for oil, coal and tar sands and chlor-alkali facilities.

[50] "The Future We Want", Zero-Draft text for Rio+20, January 10, 2012, para. 21

Abandoned mercury and gold mines in areas such as California, South Dakota and Alaska continue to emit mercury. Current gold mining and processing taking place in many countries in Latin America, Asia and Africa as well as North America produce new mercury contamination. For example, in 2003, gold mining and processing at Placer Dome's Cortez mine and Barrick's Gold strike in Northern Nevada released 2435 pounds of mercury into the environment.

Methylmercury is known to affect the neurological system of both the developing as well as the adult brain. Prenatal exposure can cause irreversible damage to the developing nervous system resulting in reduced IQ, abnormal muscle tone and losses in motor function and attention. Heart disease and high blood pressure have also been associated with methylmercury consumption as well as damaged immune systems kidney damage and reproductive effects.

As a mother accumulates mercury in her body she can then pass this pollution onto her unborn child. Babies can be exposed by consuming breast milk with high levels of mercury. Indigenous Peoples that rely primarily on fish for their physical, economic and cultural survival are at highest risk. In 2000, the National Academy of Sciences estimated that 60,000 babies born each year in the US are at risk for learning disabilities and other kinds of neurological damage due to mercury contamination. The Academy concluded that there is "little or no margin of safety" for consumption of mercury by women of childbearing age. In 2004, the US Environmental Protection Agency estimated that over ten times that many babies may actually be at risk. Umbilical cord blood has been found to contain almost twice the level of mercury than that found in the mothers' blood, further increasing the risks to unborn generations.

Mercury is an international problem affecting Indigenous Peoples around the world. In British Colombia Canada, the dam holding Teck Cominco's mercury mine tailings burst in 2004, releasing large amounts of mercury into water used for traditional subsistence fishing. In Northern Ontario, paper mill emissions containing mercury had devastating effects on the health and subsistence fishing of the Grassy Narrows First Nation Peoples. The UN Environmental Programme estimates that over one million people in Latin America, including many women and children, are currently involved in small-scale mining activities in which mercury is used.

Indigenous Peoples participating in the INC sessions have proposed including references to Indigenous Peoples in several places in the current Treaty negotiating text, in addition to the current language recognizing "vulnerable populations" as well as a new operative article addressing specific impacts for Indigenous Peoples. The Indigenous Peoples' Global Caucus at INC 3 in Nairobi Kenya (31 October – 4 November 2011) also strongly supported the inclusion of a new operative paragraph on "Health Aspects" currently proposed as Article 20 bis by the GRULAC (Latin American) countries . Their statement to the INC3 plenary linked health impacts to cultural concerns and also called for better data regarding specific impacts on Indigenous women and children.

"Harms from all mercury releases and a need for more and better data on impacts to Indigenous Peoples and vulnerable populations, such as pregnant women, the developing fetus, children, and workers, need to be better tracked and communicated. For us, these harms are linked to traditional foods and diets, and cultural values. This expanded definition of vulnerability includes other factors of poverty, poor nutrition, reproductive concerns of our women, learning disabilities of our children, and the retention of our languages."[51]

Indigenous Women have taken a strong stand regarding the continued release of mercury into the international environment, the lack of political will by States to conduct effective cleanup of lands and waterways that are

[51] Indigenous Peoples Global Caucus intervention on Health Aspects, INC 3, Nairobi Kenya, November 3rd, 2011

contaminated and the need for a strong international instrument on mercury guided by health and human rights concerns rather than priorities set by industry.

The "Indigenous Mothers against Mercury Open Letter to National, State and regional Policy- Makers", was finalized on May 18th 2011 and has received over 1000 signatures from Indigenous mothers around the world. It reiterates the health impacts of mercury as a neurotoxin which most severely damages the developing fetus. It reminds policy makers that this represents "*a violation of our human rights to health, cultural practices, Treaty rights, subsistence, Rights of the Child, and our Right to Free Prior and Informed Consent as recognized by the UN Declaration on the Rights of Indigenous Peoples and other international human rights instruments, norms and standards.*"[52]

Regarding the international standard setting process currently underway, the letter stresses the need for full and effective participation of Indigenous Peoples, including women, and for a strong and effective outcome. The letter concludes with the following 3 proposals to policy-makers:

As policy-makers, we call upon you to take a strong stand for the development of the Global Mercury Treaty, and through policies on the national and international levels that will:

1. *Halt emissions of mercury into the environment from all sources, including the burning of coal, current and past gold mines and production and disposal of medical products that use mercury*
2. *Commit to thorough cleanup of sources of current contamination including legacy mine sites, working in full collaboration with Indigenous Peoples when their homelands, waters, sacred areas and subsistence foods have been impacted.*
3. *Ensure the full, formal and effective participation of Indigenous Peoples, including Indigenous women, in the development of a Global Mercury Treaty and in measures to implement its provisions on the national, regional and local levels.*"[53]

IX. RECOMMENDATIONS

In light of the information and concerns presented in this paper, we suggest that the following recommendations be included in the report of this Expert Group Meeting of the UN Permanent Forum on Indigenous Issues, and be considered for inclusion in the final report of the UNPFII 11th Session in May 2012. These include support for relevant recommendations that have already emerged from a number of consensus documents and processes agreed to by Indigenous Peoples in response to the concerns raised in this paper:

1. This EGM calls upon States to eliminate the production and use of pesticides, industrial chemicals and toxic byproducts that disrupt the endocrine system, affect learning and neurological development, cause cancers and other illnesses, undermine women's and maternal health, contaminate lands, waters and traditional food sources, cause harm to reproduction and affect any aspect of the health and development of our future generations. This EGM also calls upon States to take responsibility for

[52] "Indigenous Mothers against Mercury Open Letter to National, State and regional Policy- Makers", International Indian Treaty Council and the Indigenous Women's Environmental Justice and Reproductive Health Initiative
May 18th 2011

[53] "INDIGENOUS MOTHERS AGAINST MERCURY OPEN LETTER TO NATIONAL, STATE AND REGIONAL POLICY-MAKERS", MAY 8TH, 2012, Submitted by the International Indian Treaty Council and the Indigenous Women's Environmental Justice and Reproductive Health Initiative, May 8th 2011

effective and immediate clean-up of contaminated sites created by activities which it either permitted or approved, in collaboration and coordination with the impacted Indigenous Peoples.

2. The EGM calls upon States to report on their progress at the 12th session on the UNPFII towards full and effective implementation of Article 29 of the UN Declaration on the Rights of Indigenous Peoples, in particular paragraphs 2 and 3 regarding their obligation to ensure free prior and informed consent regarding hazardous materials and to implement programs to restore the health of impacted Peoples in conjunction with these Peoples, ensuring the participation of Indigenous women.

3. We recommend that the "precautionary approach" (principle 15 of the Rio Declaration on Environment and Development) be reaffirmed at Rio + 20, together with a renewed commitment by States to eliminate the production, use and dumping of chemicals that are toxic, persistent and hazardous that pose dire threats to the health of impacted communities and ecosystems, and most of all violate human rights; including the rights of Indigenous Peoples to free, prior and informed consent as stated in Article 29 of the UN Declaration on the Rights of Indigenous Peoples. We call upon States to make a commitment to utilize and implement the Precautionary Principle as an alternative to the models of "risk assessment" and "management" of toxic chemicals presented in sections 19 and 20 of Agenda 21. In addition, we recommend that agricultural methods and practices used traditionally by Indigenous communities based on safe alternatives to toxic pesticides be recognized and supported.[54]

4. The EGM calls upon the UNPFII to urge States and the UN Secretary General to ensure that the reference recognizing "the importance of the UN Declaration on the Rights of Indigenous Peoples in the global, regional and national implementation of sustainable development strategies"[55] be maintained and strengthened in the final Rio + 20 Outcome Document.

5. We recommended that the practice of exporting banned pesticides and other chemicals by the USA and other States cease immediately. We also recommend that the provisions within UN Conventions and national laws which permit this practice without the free, prior and informed consent of the Indigenous Peoples and communities who may be impacted at the source of exposure as well as through global transport, be reviewed immediately and revised. [56]

6. The EGM calls upon the United Nations, its agencies and members to ensure that Human Rights principles and standards must be mainstreamed in all international standard setting processes addressing environment and development, including, interalia, including the Rights to Health, Free Prior Informed Consent, Food and Subsistence, Treaty Rights, Rights of Women and Children and Right to Life, and all rights affirmed in the United Nations Declaration on the Rights of Indigenous Peoples.

7. The EGM recommends that all relevant national and international bodies and processes respect the traditional knowledge of Indigenous women regarding sustainable development, environmental protection, cultural practices, food production and health and take action to strengthen their roles as participants, leaders, and experts in all levels of discussions and decision-making on these matters.

---

[54] Conclusions and recommendations, from the "Rio + 20: Indigenous Peoples in Route to the Rio +20 Conference" from the Global Preparatory Meeting of Indigenous Peoples on Rio +20 and Kari-Oca 2, August 22 - 24, 2011, Manaus, Amazonia, Brazil"

[55] "The Future We Want", Zero-Draft text for Rio+20, January 10, 2012, para. 2121

[56] Conclusions and recommendations, from the "Rio + 20: Indigenous Peoples in Route to the Rio +20 Conference" from the Global Preparatory Meeting of Indigenous Peoples on Rio +20 and Kari-Oca 2, August 22 - 24, 2011, Manaus, Amazonia, Brazil"

8. The UN Permanent Forum on Indigenous Issues, the UN Special Rapporteur on the Situation of Human Rights and Fundamental Freedoms of Indigenous Peoples and other UN bodies and mechanisms addressing Indigenous Peoples' rights are requested to focus attention and collect information from Indigenous Peoples, in particular Indigenous women, on the links between environmental contamination and reproductive health and justice, for the purpose of recommending effective solutions and remedies at the international level. [57]

9. States and their Territories must be accountable for the implementation, with the full and effective participation of Indigenous Peoples of all international Treaties, Standards and Conventions entered into including the Nation to Nation Treaties with Indigenous Peoples and Nations. Processes and mechanisms to ensure accountability must be put in place, with the full participation of affected Indigenous Peoples.[58]

10. Women, children and families who have suffered the impacts of toxic contaminants require special care. States and corporations which have allowed contamination to damage our communities must be held accountable to cover the costs and ensure that adequate care and services are provided, with the full participation and collaboration of the affected Indigenous Peoples.[59]

11. We encourage the development and dissemination of educational materials explaining the links between environmental toxics and reproductive health and justice. We also encourage the development of training programs to inform Indigenous women of opportunities for their participation locally, nationally and internationally, and to build their capacity as strong voices for their families and Nations. [60]

12. Regarding the current process being carried out by UNEP for the development of a legally-binding International Treaty on Mercury, we support the recommendations proposed by the "Indigenous Mothers Against Mercury" open letter, representing the voices of over 1000 Indigenous women worldwide regarding the development of strong language to: *halt emissions of mercury into the environment from all sources, including the burning of coal, current and past gold mines and production and disposal of medical products that use mercury; to commit to thorough cleanup of sources of current contamination including legacy mine sites, working in full collaboration with Indigenous Peoples when their homelands, waters, sacred areas and subsistence foods have been impacted; to Ensure the full, formal and effective participation of Indigenous Peoples, including Indigenous women, in the development of a Global Mercury Treaty and in measures to implement its provisions on the national, regional and local levels."*[61]

    Further, we fully support the proposal of the Global Indigenous Peoples Caucus made at INC3 to include an operative paragraph addressing the health impacts, aspects and concerns regarding mercury in the context of human rights and the health of Indigenous women, children and unborn generations.

---

[57] Declaration for Health, Life and Defense of Our Land, Rights and Future Generations", 1st International Indigenous Women's Environmental and Reproductive Health Symposium, June 30 – July 1, 2010, UN Permanent Forum's 10th session Conference Room Paper [E/C.19/2011/CRP. 9], "Recommendations to the United Nations System and International bodies"

[58] Ibid, "Recommendations to States and their Territories"

[59] Ibid, "Recommendations to States and their Territories"

[60] Ibid, "Recommendations to Indigenous Peoples, Communities, Nations, Tribal Governments and Organizations"

[61] "INDIGENOUS MOTHERS AGAINST MERCURY OPEN LETTER TO NATIONAL, STATE AND REGIONAL POLICY-MAKERS", MAY 8TH, 2012, Submitted by the International Indian Treaty Council and the Indigenous Women's Environmental Justice and Reproductive Health Initiative, May 8th 2011

13. We call for disaggregation of data and studies carried out with the consent and full participation of Indigenous women and communities, to provide better information about specific impacts of environmental toxics, including pesticides, mercury, mining runoffs, uranium mining and processing, waste dumping, and Persistent Organic Pollutants, on the health of Indigenous women, girls and children.

14. States, international financial institutions, United Nations programmes and actions, as well as private investors and corporations must do due diligence and fully disclose to all Indigenous Peoples, Nations, tribes, and communities, their activities and potential risks. Peoples and individuals who may be affected by or exposed to pesticides, mining, dumping, incineration and other forms of toxic chemical production, the complete known or suspected effects of the chemicals in question, the location and names of corporations producing them, any current or prior legal sanctions or cases filed against them, the Indigenous Peoples in the same or other countries who have experiences with the given process or corporation, so that informed decisions can be made as part of Indigenous Peoples right to free, prior and informed consent.[62]

15. Based on paragraph 33 of the report of the UN Permanent Forum on Indigenous Issues 10th session affirming that "the Permanent Forum notes the intention of the International Indigenous Women's Environmental Justice and Reproductive Health Initiative to organize an expert group meeting on the environment and indigenous women's reproductive health and requests that the organizers invite members of the Permanent Forum to participate in the meeting…" [63] that this EGM requests the Symposium, scheduled for April 2012 in Alaska, to collect additional data, testimonies and case studies to submit to the UNPFII at its 11th session documenting environmental violence against Indigenous women.

16. We affirm that the rights and relationships affirmed in the legally-binding Nation-to-Nation Treaties between States and Indigenous Peoples, including self-determination, free prior and informed consent, partnership, mutual respect, full and effective participation in decision-making and the "Treaty Right to Health" are fundamental for developing solutions to critical problems affecting Indigenous Peoples, including all forms of violence against Indigenous Women.

_____

[62] From "Contributions to the UN Secretary General for preparation of the Rio + 20 "Zero-draft outcome document", submitted by the International Indian Treaty Council (IITC), Dene Nation (Northwest Territories, Canada), Nishnawbe Aski Nation (Thunder Bay, Ontario, Canada), Indigenous Environmental Network (IEN), Indigenous Peoples Council on Biocolonialism (IPCB), Indigenous World Association (IWA), Alaska Community Acton on Toxics (ACAT), and Ms. Mirna Cunningham, President, UN Permanent Forum on Indigenous Issues and CADPI (Nicaragua), October 31, 2011

[63] United Nations Permanent Forum on Indigenous Issues Report on the tenth session (16-27 May 2011), Economic and Social Council Official Records, 2011, [E/2011/43-E/C.19/2011/14]

Andrea Carmen and Vi Waghiyi wish to thank:
Pamela K. Miller, Executive Director, and Karla L. Brollier, Environmental Health and Justice Organizer, Alaska Community Action on Toxics; Monique Sonoquie, California Traditional Basket Weavers; Jaquelynn Warledo, IITC Environmental Health Program Coordinator; Dr. Elizabeth Guillette; Tekatsitsiakwa Katsi Cook; the participants in the 1st International Indigenous Women's Environmental and Reproductive Health Symposium; the community members of Savoonga and St. Lawrence Island, Alaska; Francisco "Paco" Villegas Paredes, Jittoa Bat-Natika Weria, traditional curanderas, midwives and traditional authorities of the Yaqui Pueblos of Rio Yaqui, Sonora Mexico; Kathryn Gilje, Pesticides Action Network North America; and Sherri Norris and Angela Berry-Phillip, California Indian Environmental Alliance for their invaluable contributions to this paper.

We also wish to thank the UNPFII for its interest and attention to this critical issue in the context of the theme "Violence against Indigenous Women". This context provides an innovative approach for consideration of the urgent issues presented in this paper, bridging several areas of the UNPFII's mandate and priority focus areas, including human rights, environment, health, development, indicators of well-being and the specific situations affecting Indigenous women and girls.

Participants in the 1st International Indigenous Women's Environmental and Reproductive Health Symposium
June 30 – July 1, 2010

Appendix E

Report of the International Indigenous Women's Environmental and Reproductive Health Symposium, April 27th – 29th, 2012, Chickaloon Native Village, Alaska. Co-hosted by the International Indian Treaty Council (IITC) and Indigenous Women's Initiative for Environmental and Reproductive Health, Alaska Community Action on Toxics (ACAT), Chickaloon Native Village and International Indigenous Women's Forum (FIMI). Submitted to the 11th Session of the United Nations Permanent Forum on Indigenous Issues as a Conference Room Paper by the International Indian Treaty Council, Indigenous Non-governmental Organization in General Consultative Status to the United Nations Economic and Social Council. May 5th, 2012

REPORT OF THE INTERNATIONAL INDIGENOUS WOMEN'S ENVIRONMENTAL AND REPRODUCTIVE HEALTH SYMPOSIUM

APRIL 27TH – 29TH 2012, CHICKALOON NATIVE VILLAGE, ALASKA

Co-hosted by the International Indian Treaty Council (IITC) and Indigenous Women's Initiative for Environmental and Reproductive Health, Alaska Community Action on Toxics (ACAT), Chickaloon Native Village and International Indigenous Women's Forum (FIMI).

Submitted to the 11th Session of the United Nations Permanent Forum on Indigenous Issues as a Conference Room Paper by the International Indian Treaty Council, Indigenous Non-governmental Organization in General Consultative Status to the United Nations Economic and Social Council
May 5th, 2012

THE 2nd DECLARATION FOR HEALTH, LIFE AND DEFENSE OF OUR LANDS, RIGHTS AND FUTURE GENERATIONS

We, Indigenous women from North America, Latin America, the Arctic and the Pacific, gathered April 27th - 29th, 2012 at the ***2nd INTERNATIONAL INDIGENOUS WOMEN'S ENVIRONMENTAL AND REPRODUCTIVE HEALTH SYMPOSIUM,*** at the Yah Ne Dah Ah Tribal School, Chickaloon Native Village in Alaska.

We express our heartfelt thanks to the Native Village of Chickaloon and the Ya Ne Dah Ah Tribal School for their warm hospitality. We heard their stories, songs and language and learned about the devastating environmental, cultural, and social impacts of coal mining by the US Navy in Chickaloon traditional lands from 1914 to 1922. We stand in strong solidarity with Chickaloon Village's current fight to prevent new coal mining in their traditional lands which would drastically impact the health of the children, the environment and Community as a whole.

We thank the UN Permanent Forum on Indigenous Issues for recognizing the 1st International Indigenous Women's Symposium on Environmental and Reproductive Health at its 10th session, and receiving the report of the 2nd Symposium at this session. We also thank the UN Special Rapporteur on the Rights of Indigenous Peoples James Anaya for visiting the 2nd Symposium in conjunction with his US Country Visit on April 28th, 2012, and for his commitment to include the concerns expressed by participants his report to the UN Human Rights Council.

We have shared our stories and the experiences of our Peoples. We express our collective outrage that current federal and international laws permit industry, military and all levels of government to knowingly produce, release, store, transport, export, import and dump hazardous chemicals and radioactive materials, and expand contaminating activities such as fossil fuel development, hydraulic fracturing, uranium mining and milling, introduction of genetically modified seeds and animals, bio-fuel production and high-pesticide agriculture.

As Indigenous mothers and grandmothers, youth and elders, traditional healers, tribal leaders, human rights and environmental activists, we express our profound concern for the life and health of our communities, children, ecosystems and Mother Earth due to the proliferation of environmental toxins.

In response, we affirm, and reaffirm, the following:

1) We steadfastly reaffirm the 1st "***DECLARATION FOR HEALTH, LIFE AND DEFENSE OF OUR LANDS, RIGHTS AND FUTURE GENERATIONS"*** adopted by consensus at the International Indigenous Women's Symposium in Alamo, California on July 1st, 2010.

2) We acknowledge the sacredness of the life-giving force of our birthing places. Many are under attack from toxic contamination, extractive industries and other industrial processes. These include salmon spawning, caribou and moose birthing places, as well as women's wombs.

3) Our health and well-being, lands and resources including air and water, languages, cultures, traditional foods and subsistence, sovereignty and self-determination, life and security of person, free prior and informed consent and the transmission of traditional knowledge and teachings to our future generations are inherent and inalienable human rights. They are affirmed in the UN *Declaration on the*

Rights of Indigenous Peoples and other international standards, and must be upheld, respected and fully implemented by States, UN bodies, corporations and Indigenous Peoples of the world.

4) Our bodies are sacred places that must be protected, honored and kept free of harmful contaminants so that new generations of our Nations are born strong and healthy. The right to self-determination for Indigenous Peoples includes our Indigenous identities, our sexualities and our reproductive health for the future of our Nations.

5) The detrimental health effects of toxic contaminants on Indigenous women are well documented, and are affirmed through testimonies presented in this Symposium. These include high levels of toxics in Indigenous women's breast milk, placental cord blood, blood serum and body fat infertility, miscarriages, premature births, premature menopause, early menses, reproductive system cancers, decreased lactation and inability to produce healthy children. This causes severe psychological, relational, emotional and economic damage to mothers, families and communities.

6) Environmental toxins also have severe negative impacts on the health and development of our children and unborn generations. Many toxic chemicals impair the endocrine and immune systems in utero, affecting health and reproductive capacity of future generations. The intellectual and neurological development of our children are also affected, impacting their ability to retain and pass on our culture, ceremonies, stories, languages and songs.

7) The individual and collective impacts of intergenerational trauma and the legacy of removal and violence are passed on to future generations. Intergenerational trauma amplifies and reinforces impacts of extractive industry, military and environmental degradation in our communities. Addressing intergenerational trauma is a core component of rebuilding reproductive health for our communities.

8) Environmental contaminants causing disease, birth defects and death are deliberately released into the environment *because* they are toxic to living things (i.e. pesticides), or as a result of industrial or military processes that are judged by States and corporations to pose an "acceptable risk" and "allowable harm." States and corporations deny "provable" impacts despite the clear evidence that they cause a range of serious health and reproductive impacts which disproportionately affect Indigenous women and children. This constitutes "environmental violence" by States and corporations and must be identified as such by Indigenous Peoples and human rights bodies.

9) Environmental contamination infringes on the cultural practices of Indigenous Peoples including women's coming of age, rites of passage and other ceremonies for the continuation of life. The use of pesticides on materials used for baskets and cradle boards has resulted in increased rates of cancer for basket makers. Plants, herbs, and traditional medicines vital to Indigenous Peoples' maternal and child health are often outlawed, prohibited, contaminated or are becoming extinct.

10) Land privatization, corporatization and militarization divides our collective land bases, facilitating resource extraction, displacement, forced removal and environmental contamination, impacting Indigenous women's economic, cultural and social practices and reproductive health.

11) We recognize the links between our concerns and struggles. Coal mining contaminates water and decimates fish, wildlife and traditional medicines. Burning coal is also a primary source of mercury emissions and climate change, affecting Indigenous communities globally. Pesticides used in Mexico and other countries contaminate Indigenous communities at the source of exposure, and then enters the

environment and food chain, traveling to the Arctic and concentrating in traditional food, bodies, and breast milk. Likewise, introduction of extractive industries near our communities often results in increased levels of sexual exploitation and violence for our Indigenous women and girls.

12) We will continue to use our own languages and ways of knowing. Our understandings cannot always be expressed in the language of modern science and law. Our Peoples, especially our traditional knowledge holders, spiritual leaders and elders are the experts. We affirm their teachings that we are now in a time that will determine our survival, depending on the choices we make.

13) We affirm the use of our own Indigenous justice and legal systems, including Treaty-Based justice systems to hold those accountable for environmental violence.

14) We recognize the importance of continuing to educate our own Peoples and communities about the links between reproductive health, environmental contaminants and their human rights as affirmed in the UN Declaration, Nation-to-Nation Treaties and other international standards. When Indigenous communities understand these links, they become active participants in resisting environmental violence and violations of their rights.

15) We firmly denounce the continued impunity of States and corporations for the environmental violence they carry out or permit affecting Indigenous Peoples ecosystems, traditional foods, health, well-being and ways of life.

16) While we recognize the impacts and tragedies that have occurred as a result of environmental violence, we also celebrate our struggles, victories and our continued strength, resilience and resistance.

Based on these shared understandings, we adopt by consensus this ***2nd DECLARATION for the Health, Survival and Defense of OUR LANDS, OUR RIGHTS and our FUTURE GENERATIONS and make the following recommendations:***

That Indigenous Peoples, Nations and Communities:

1) Identify and document the disproportionate impacts of environmental toxins on Indigenous women and children as "environmental violence" for which States and corporations can be held accountable.

2) Provide community capacity-building and training linking reproductive and environmental health and human rights.

3) Maintain, support, strengthen and assert traditional systems of law, community organization, decision-making, leadership and representation.

That States and their subsidiary governments (Territories, provinces/states, municipal etc.):

1) Fully implement and uphold, without qualification, the UN Declaration on the Rights of Indigenous Peoples, including Article 29 regarding the right of Indigenous Peoples to the protection of their environments and the State obligation to ensure free prior and informed consent regarding hazardous materials. We also call for the full and unqualified implementation of Articles 23 and 24 affirming our collective rights to health and use of traditional medicines.

2) Eliminate the production and use of pesticides, industrial chemicals and toxic by-products that disrupt the endocrine system, affect learning and neurological development, cause cancers and other illnesses, undermine women's reproductive and maternal health, contaminate lands, waters and traditional food sources and affect any aspect of the health and development of our future generations.

3) Take responsibility for effective and immediate clean-up of contaminated sites created by activities which they permitted or approved in collaboration and coordination with impacted Indigenous Peoples.

4) Implement programs to restore the health of Indigenous Peoples, including women and children who have been negatively impacted by environmental toxins, including their export and import in collaboration and coordination with the affected Indigenous Peoples including Indigenous women.

5) Immediately cease the practice of exporting and importing banned pesticides, toxic wastes and other chemicals in particular from the United States. .

6) Implement and mandate culturally relevant gender based analysis in all impact statements regarding mining and other industries, also ensuring FPIC.

7) Recognize the knowledge and practices of Indigenous women's health, birthing, traditional midwifery, and the use of Indigenous medicinal knowledge on equal footing with other health systems and methods, and the right of Indigenous healers to protect and use this knowledge as they so choose.

8) Prosecute companies and hold military accountable for the full extent of their violations to the rights of Indigenous Peoples pertaining to the contamination of lands, territories and resources, and respect Indigenous Peoples' legal and judicial systems in accordance with Article 27 of the UN Declaration in their efforts to hold government and corporations accountable.

9) We call in particular upon Canada and the United States to implement the recommendations made in 2007, 2008 and 2012 by the UN Committee on the Elimination of Racial Discrimination (CERD) calling upon them to take appropriate legislative measures to prevent the transnational corporations they license from negatively impacting the rights of Indigenous outside Canada and the United States.

Recommendations to the United Nations System and International processes:

1) That the Permanent Forum 11th session in its half-day session on food sovereignty consider the direct links between food sovereignty, environmental violence and reproductive health and the specific impacts to Indigenous women, children and unborn generations.

2) That the World Conference on Indigenous Peoples address reproductive and environmental health, and receive the report of the 3rd symposium to be held in 2014 in the autonomous region of Nicaragua.

3) That effective, transparent international mechanisms be established to ensure accountability, redress and restitution with the full participation of affected Indigenous Peoples and for UN Human rights bodies to dedicate particular attention to the matter of environmental violence.

4) That the World Conference on Sustainable Development (Rio + 20, 2012) reaffirm the "precautionary approach as an alternative to the models of "risk assessment" and "management" of toxic chemicals and

pesticides, and recognize and support sustainable agricultural methods and practices used traditionally by Indigenous Peoples.

5) That UN Conventions and national laws which permit the export, transport and import of banned pesticides, wastes and other toxics without the free, prior and informed consent of the Indigenous Peoples and communities who may be impacted be immediately reviewed and revised

6) That the United Nations, its agencies and members ensure that Human Rights principles and standards are mainstreamed in all international standard-setting processes addressing environment and development, including the United Nations Declaration on the Rights of Indigenous Peoples.

7) That the UN Permanent Forum on Indigenous Issues, the UN Special Rapporteur on the Rights of Indigenous Peoples and other UN bodies and mechanisms focus attention and collect information from Indigenous Peoples, in particular Indigenous women, on the links between environmental contamination and reproductive health and recommend effective solutions and remedies at the international level.

8) We endorse the "Indigenous Mothers Against Mercury" open letter's recommendations calling for strong language in the new legally-binding International Treaty on Mercury, to "*halt emissions of mercury into the environment from all sources, including the burning of coal," and "to ensure the full, formal and effective participation of Indigenous Peoples, including Indigenous women."* We also recommend that the Permanent Forum at its 11th session call upon States and the UN Environmental Program to incorporate the recognition of Indigenous Peoples and in the operative text of the Treaty.

Cross Cutting

1) We recommend that States, UN agencies and Indigenous Peoples affirm and utilize the Precautionary Principle, recognizing Indigenous Peoples' traditional knowledge about the effects of chronic pollution as well as the social stressors caused by development and industry that impact and divide communities. These include increased mental health concerns, violence against Indigenous women, children, and families, sexually transmitted infections including HIV, incarceration, child removal and suicide.

2) We reiterate our support for a moratorium on new fossil fuel exploration, processing and extraction, as the first step towards the full phase-out of fossil fuels with a just transition to sustainable energy and the protection of our Peoples and ecosystems from the devastating impacts of climate change.

3) We call upon Indigenous, National and International processes to respect the traditional knowledge of Indigenous women regarding sustainable development, environmental protection, cultural practices, food production and health and to include their full and effective participation as leaders and experts in all levels of decision-making on these matters.

Conclusion

We commit to continue our work and fulfill our responsibilities to our children and the generations still to come. We commit to reclaim our wellness as Indigenous women and Peoples. We reaffirm that our children have a right to be born healthy and to live in a clean environment, and that in order to heal our Peoples and Mother Earth, we have to continue to heal ourselves, tell our stories and be who we are.

"We are like a strong river that rises and falls, is always connected and will never stop flowing."

Affirmed by consensus of the participants in the Symposium on April 29th, 2012:

1. Alice Skenandore – Midwife, Wise Women Gathering Place, LCO Ojibwe, Wisconsin, USA
2. Alyssa Macy – International Indian Treaty Council, Warm Spring Tribe, Oregon , USA
3. Andrea Carmen - International Indian Treaty Council, Yaqui Nation, Mexico, USA
4. Aurelia Espinoza Buitimea – Traditional healer, curandera and midwife, Jittoa Bat Natika Weria, Yaqui Nation, Sonora Mexico
5. Blanch Okboak – Teller Traditional Council, Inupiat, Alaska
6. Brandy Standifer – Village of Tyonek Tribal Member, Tyonek, Alaska
7. Camille Gemmill – Youth Representative, Gwich'in Nation, Alaska
8. Charlotte Jane Kava - Inupiat, St. Lawrence Island, Native Village of Savoonga, Alaska
9. Danika Littlechild – International Indian Treaty Council, Ermineskin Cree Nation, Canada
10. Donna Miranda-Begay – Chairwoman, Tubatulabal Tribe, California, USA
11. Edda Moreno – Centro para la Autonomía y Desarrollo de los Pueblos Miskitu, Nicaragua
12. Elvia Beltran Villeda - Red Indigena de Turismo de México, Pueblo Hnahnu, Mexico
13. Emily (Funny) Murray – Elim Students Against Uranium, Inupiaq, Elim, Alaska
14. Erin Konsmo - Native Youth Sexual Health Network, Metis Nation, Canada
15. Enei Begay – Black Mesa Water Coalition, Dine, Arizona, USA
16. Faith Gemmill - California Indian Environmental Alliance, International Indian Treaty Council, REDOIL, Arctic Village, Gwich'in, Alaska and Pit River, Wintu California, USA
17. Faustina Buitimea Gotogopicio – Tradtional healer, curandera, Yaqui Nation, Sonora Mexico
18. Harriett Penayah – Elder, Native Village of Savoonga, St. Lawrence Island, Yupik, Alaska
19. Hinewirangi Kohu –Te Rau Aroha, Maori Women's Centers, Aotearoa (New Zealand)
20. Jackie Warledo - International Indian Treaty Council, Seminole Nation of Oklahoma, USA
21. Janet Mitchell – Inupiaq, Kivalina City Council, Alaska
22. Janet Daniels – Elder, Chickaloon Native Village, Chickaloon, Alaska
23. Jeannette Corbiere Lavel – Native Women's Association of Canada, Anishnabe Nation, Canada
24. Jessica Danforth - Native Youth Sexual Health Network, Mohawk Nation, USA and Canada
25. Judy Hughes – National Aboriginal Health Organization, Metis Nation, Canada
26. Julia Dorris – Traditional Council of Kalskag, Yupik, Alaska
27. Kandi Mossett – Indigenous Environmental Network, Fort Berthold Indian Reservation, USA
28. Kari L. Shaginoff - International Indian Treaty Council, Ya Ne Dah Ah Tribal School, Chickaloon, Alaska
29. Karla Brollier – Alaska Community Action on Toxics, Ahtna-Cantwell, Alaska
30. Kathy Sanchez – Tewa Women United, San Ildefonso Pueblo, New Mexico, USA
31. Lisa Wade – Chickaloon Village Health Director, Chickaloon, Alaska
32. Manuela Victoria Barrientos Carbajal – Chirapaq, Community of Hualia, Peru
33. Maria Berenice Sandez Lozada – Di sunga a Nana Shimjai, Nahua-Otomi, Mexico
34. Marian Naranjo - Honor Our Pueblo Existence, Santa Clara Pueblo, New Mexico, USA
35. Martha Itta - Inupiaq, Tribal Administrator, Native Village of Nuiqsut, Alaska
36. Maudilia López Cardona - Frente de Defensa Miguelense, Mam Maya, Guatemala
37. Melina Laboucan-Massimo – Lubicon Cree First Nation, Canada
38. Monique Sonoquie - California Indian Basket Weavers Alliance, Chumash, California, USA
39. Norma Chickalusion – Village of Tyonek Tribal Member, Tyonek, Alaska

40. Patricia Wade – Editor Chickaloon News, Chickaloon, Alaska
41. Pauline Kohler – Aleknagik Traditional Council, Yupik, Alaska
42. Penny Westing – Chickaloon Village Traditional Council Secretary, Chickaloon, Alaska
43. Princess Lucaj – Gwich'in Steering Committee, Gwich'in, Alaska
44. Rita Blumenstein – Traditional Healer, Yupik, Chefornak, Alaska
45. Rosemary Ahtuangaruk – Inupaiq, Native Villate of Nuiqsut, Alaska
46. Samantha Englishoe – Alaska Community Action on Toxics, Tlingit, Gwichin
47. Sewa Carmen – Chickaloon Village Youth Representative, Chickaloon, Alaska
48. Shawna Larson – Chickaloon Village Traditional Council Member, Chickaloon, Alaska
49. Sondra Stuart – Chickaloon Village Tribal Citizen, Chickaloon, Alaska
50. Susie Booshu – Native Village of Gambell, Yupik, Alaska
51. Viola Waghiyi – Native Village of Savoonga, St. Lawrence Island, Yupik, Alaska
52. Xiomara Ownes – Traditional Healer, Tlingit, Athabascan, Alaska

Appendix F

Sovereignty: Long Live Mother Earth – Women's Declaration 2012: Year of Indigenous Women, by *Las Mujeres Hablan*: The Women Speak.

Sovereignty: Long Live Mother Earth

Women's Declaration 2012: Year of Indigenous Women

Preamble

Indigenous women have sacred parallel earth energy with Mother Earth.

In our diverse yet increasingly interdependent homelands, it is imperative that we, the people of Earth, declare our responsibility to one another as in all relationships, to the greater community of life and to future generations. We are one human family with one earth community with a common destiny. Yet as female and male energy is found within the other, so are we to love each other and do no harm to each other in the home of our mother, Mother Earth. All lands are sacred and in sacred time and space.

Humanity is part of a vast evolving multi-verse. Earth is our home and our mother is alive with a unique community of life givers. The life givers are Women. The protection of Women, their vitality and their well-being is the sacred fluid and energy of love.

The Earth community stands at a defining moment in time. Injustices, poverty, ignorance, corruption, crime and violence against women have deepened and our earth mother is crying and suffering. Corrupt fundamental racism has made changes into our present attitudes and values. Militaristic ways of making a living as have become harmful and destructive. Extreme materialism has dug deep into the holy body of our Mother Earth. These unhealthy ways need to be returned to the light of truth and colorful sounds of lovingness returned to our Earth Mother. The choice is ours: to care for our Mother Earth and one another or participate in the destruction of ourselves and all life givers.

We, therefore, declare the following:

1. Whereas, women are the nurturers of the human seed within their wombs are bearers of the blessing of creation through the process of giving birth,

2. Whereas, in worldwide ancient creation stories, in ancient cultures and throughout human life narratives ,women have played a profound role to return and revere earth as our source of all life,

3. Whereas, women's bodies are intimately connected to Mother Earth as reflected in our moon cycles that are the basis for procreation and birthing of children,

4. Whereas, mothers and grandmothers continue to be the primary caregivers of children through breastfeeding, feeding, and nurturing, from infancy to all the stages of our human lives,

5. Whereas, women have also nurtured other women herstorically and traditionally serving as midwives and helping one another raise their children along with their extended families,

6. Whereas, women are believed to have been the first seed savers and contributed to the

cultivation of crops in a way that transformed human existence and, today, in our families, communities mothers and grandmothers have continued to be the primary caretakers of seeds,

7. Whereas, women have a special relationship with food in their role as farmers, nurturers, seed savers, and cooks and, therefore, they are the holders of culturally significant recipes and methods for storing and preparing food,

8. Whereas, many of the increasing numbers of small scale, independent farmers are women farmers from various backgrounds who are dedicated to growing clean, healthy, and fair food and to restoring harmony to the earth,

9. Whereas, women provide an important support system for all the activities of operating our family farms and ranches, including serving as part of the labor essential to the process, providing meals for other laborers, and teaching children the values of land-based culture and way of life,

10. Whereas, women are often the teachers of life skills to their children and are therefore important to ensuring that traditional knowledge is passed from generation to generation.

11. Whereas, women play important roles in our communities as spiritual leaders who offer blessings at important times in our lives and who offer guidance on important life decisions,

12. Whereas, women in traditional communities hold essential traditional knowledge including teachings about medicinal plants, where they can be harvested, and how they should be used,

13. Whereas, in recorded time, women's role as homemakers was broad and including helping one another to build,thatch ,plaster, and maintain their earthen homes,

14. Whereas, for millennia, women have harvested foods such as *piñon*, *quelites*, *tsimaja*, asparagus, *verdolagas*, *chocoyole*, and many varieties of berries, which we regard as special gifts and blessings,

15. Whereas, herstorically and traditionally, women's roles in families and communities were highly valued and the equally important role of men included providing the needed support system in order to raise healthy families,

16. Whereas, women today are often not respected as they were traditionally and are often subjected to violence in their own homes by those closest to them,

17. Whereas, women today and herstorically have, out of the love of their children and men in their families, have been at the forefront of resisting all forms of domesticated violent ways of living, including economic ways of the war culture,

18. Whereas, because of the nature of women's bodies related to procreation and our intimate relationship with the earth through farming, herb gathering, and earthwork, we are particularly sensitive to exposure to toxic pollutants from various sources,

19. Whereas, the parts of our bodies meant to nurture and nourish our children are also most susceptible to disease and cancer considering that elevated levels of breast cancer, ovarian cancer, and other deadly diseases result from exposure to toxins,

20. Whereas, mothers and grandmothers who feed and nurture their children are concerned about the existence of synthetic hormones and pesticide residues in foods resulting in unprecedented effects on boys and girls such as premature puberty, cancer, and other long-term effects that are unknown,

21. Whereas, our families are also threatened by the unknown health and ecological effects of genetically engineered seeds, plants, and animals, and we are gravely concerned about the patenting of human life which could have unintended consequences for our families and future generations,

22. Whereas, sacred homelands are manipulated settings for various polluting industries, mining operations, power plants, and nuclear facilities that, although serve as a tainted source of financial income for some of our families, also are responsible for pollution that harms all of our families and are part of a pattern of economic development that displaces traditional peoples from the land,

23. Whereas, women are often low-wage workers in these same polluting industries exposed to certain toxins and women are often low-wage agricultural workers who are exposed to pesticides and herbicides in industrial agriculture,

24. Whereas, women have played a key role along with men in social movements to achieve social, economic, and environmental justice by voicing concerns about the threats of toxins to our families and by calling for livelihoods for ourselves and our families that are clean, healthy, and dignified,

25. Be it resolved that we are gathered to declare our reverence for our women ancestors of ancient times that nurtured generation upon generation so that we could be given the blessings of life for all,

26. Be it further resolved that we will collectively and intentionally work to carry on the seed saving, farming, and land-based traditions of our ancestors and to pass these teachings on to the younger generations,

27. Be it further resolved that we will resist the genetic engineering and patenting of life so that we may maintain the integrity of our seeds, our right to grow our own food, and the sacredness of life itself,

28. Be it further resolved that we will raise our children to be conscious human beings mindful of the sacred gift of life we have been granted by the creator, to be reverent of our Mother Earth, and to be respectful in their relations,

29. Be it further resolved that we will work in solidarity with each other in our struggles to defend the air, land, and water from contamination, exploitation, and militarization,

30. Be it further resolved that we honor, respect, and recognize the dignity of women and

their families throughout the world and here at home who are subjected to exposure to toxins through their work, their food, or their proximity to pollution and that we resolve to speak and act in solidarity with them in efforts to defend the health of their families and communities,

31. Be it further resolved that we will continue to play an important role in reshaping our communities to achieve a vision of safe, healthy, and joyful lives for our families and communities with good, healthy and locally grown food, good livelihoods that honor the dignity of every human person, and a meaningful and spiritual relationship with Mother Earth.

36. Be it further resolved that we will honor and respect the women in our lives including our mothers, sisters, aunties, grandmothers, and great-grandmothers by thanking them for giving us live and for nurturing us throughout our lives,

37. Be it further resolved that we will teach our children, both boys and girls, the importance of living close to the land, having good relations with one another, and acting with dignity and respect in our actions to protect Mother Earth.

38. May it be further resolved that we the undersigned, have read this document and are in support of **Sovereignty: Long Live Mother Earth**

Women's Declaration for 2012: Year of Indigenous Women. We find it to be true and will assist wherever possible to learn and teach the children the importance of living close to the land, having respectful relations with one another and act with dignity and respect to protect Mother Earth, so she in turn can continue to care for us.

Appendix G

References to Indigenous Women in the ALTA Outcome Document, Compiled and submitted to the World Conference of Indigenous Women, October 28 – 30, 2013, Lima Peru, by Andrea Carmen (North America Region) and Mililani Trask (Pacific Region).

References to Indigenous Women in the ALTA Outcome Document

"We reaffirm the peremptory norms of international law, including on equality and non-discrimination, and assert that the realization of the rights of Indigenous Peoples, including those affirmed in the Declaration, must be upheld by States, individually and collectively, free from all forms of discrimination including discrimination based on race, ethnicity, religion, **gender**, sexual orientation, age and disability. We also reaffirm that the Declaration must be regarded as the normative framework and basis for the Outcome Document and its full realization. ***(Preamble, Paragraph 7)***

"We condemn violence against Indigenous **women,** youth and children as one of the worst human rights violations affecting Indigenous Peoples and families. Violence against Indigenous **women**, youth and children is dehumanizing and also affects their spiritual development and violates their fundamental rights." ***(Preamble, Paragraph 9)***

"*Recommend* that States uphold and respect the right of self determination and the free, prior and informed consent of Indigenous Peoples who do not want mining and other forms of resource extraction, "development" and technologies deemed as degrading to their human, cultural, **reproductive** and ecosystem health. Where mining and other forms of resource extraction are already occurring, States shall develop mechanisms with the full and effective participation of Indigenous Peoples to develop a comprehensive strategy for ecologically sustainable and equitable development to end and prevent uncontrolled and unsustainable industrial contamination and degradation with plans for clean-up, remediation and restoration. Such as strategy shall incorporate strengthening the capacity of Indigenous youth in relation to sustainable development practices based on Indigenous knowledge and the relationship with the land as well as the protection and promotion of the important role of traditional knowledge holders including Indigenous Elders and **women**;" ***(Theme 1: Indigenous Peoples' lands, territories, resources, oceans and waters, Paragraph 6)***

" *Recommend* that all UN agencies, funds and programmes engaging in activities impacting on Indigenous Peoples from advisory councils or forums composed of representatives of Indigenous Peoples including **women,** youth and persons with disabilities to engage in dialogue and provide advice on policy making and country and regional level operations;" ***(Theme 2: UN system action for the implementation of the rights of Indigenous Peoples, Paragraph 6)***

"*Recommend* that States using the principles of Indigenous consent, ownership, control, and access, collect, analyze and disaggregate data on Indigenous Peoples, including Elders, **women,** youth, children and persons with disabilities, to help draft and implement public policy and legislation that better

addressed the situation of Indigenous Elderly, **women**, youth, children and persons with disabilities;" ***(Theme 3: Implementation of the Rights of Indigenous Peoples, Paragraph 3)***

"*Recommend* that States uphold and implement the rights of Indigenous **women** as sacred life givers and nurturers as well as strengthen – with the full and effective participation of Indigenous **women** – the protection of Indigenous **women** and girls though the formulation and implementation of national, regional and international plans of action developed in conjunction with Indigenous Peoples effective laws, policies and strategies;" ***(Theme 3: Implementation of the Rights of Indigenous Peoples, Paragraph 5)***

"*Recommend* States with the full, equal and effective participation of Indigenous **women**, youth and girls take immediate action to review, monitor and provide comprehensive reports on violence against indigenous **women**, youth and girls, in particular sexual violence, domestic violence, trafficking and violence related to extractive industries as well as provide redress for victims;" ***(Theme 3: Implementation of the Rights of Indigenous Peoples, Paragraph 6)***

"*Recommend* States cease current, and refrain from any further, militarization and initiate processes to demilitarize the lands, territories, waters and oceans of Indigenous Peoples. This can be achieved inter alia through the repeal and/or discontinuance of "anti terrorist", national security, immigration, border control and other special laws, regulations, operations and executive orders that violate the rights of Indigenous Peoples. Special measures should be taken to ensure the protection of Indigenous Elders, **women**, youth, children and persons with disabilities, particularly in the context of armed conflicts;" ***(Theme 3: Implementation of the Rights of Indigenous Peoples, Paragraph 7)***

"*Recommend* States support programmes of Indigenous Peoples to strengthen the capacity of Indigenous youth, including the transmission of traditional knowledge, innovations and practices as well as languages and on the important role of Indigenous Peoples including Elders and **women** as traditional knowledge holders. Further, that States and UN agencies, programs and funds respect and promote Indigenous Peoples' right to free, prior and informed consent in relation to their traditional knowledge and traditional cultural expressions;" ***(Theme 4: Indigenous Peoples' priorities for Development with free, prior and informed consent, Paragraph 3)***

Referencias a las Mujeres Indígenas en el Documento Final de ALTA

"Reafirmamos las normas imperativas del derecho internacional, incluidas aquellas en materia de igualdad y no discriminación, y afirmamos que la realización de los derechos de los Pueblos Indígenas, incluidos los enunciados en la Declaración, deben ser defendidos por los Estados en forma individual y

colectiva, libre de todas las formas de discriminación, incluida la discriminación por motivos de raza, origen étnico, religión, **género,** orientación sexual, edad y discapacidad. Reafirmamos también que la Declaración debe ser considerada como el marco normativo y la base para el Documento Final y su plena realización." ***(Preámbulo, párrafo 7)***

"Condenamos la violencia contra **las mujeres**, jóvenes y niños Indígenas como una de las peores violaciones de derechos humanos que afectan a los Pueblos y familias Indígenas. La violencia contra **las mujeres**, jóvenes y niños Indígenas es deshumanizante y también afecta a su desarrollo espiritual y viola sus derechos fundamentales. ***(Preámbulo, párrafo 9)***

"Recomendamos que los Estados defiendan y respeten el derecho de libre determinación y de consentimiento libre, previo e informado de los Pueblos Indígenas que no quieran la minería y otras formas de extracción de recursos, "desarrollo" y tecnologías consideradas como degradantes para la salud humana, cultural, **reproductiva** y del ecosistema. Cuando la minería y otras formas de extracción de recursos ya estén ocurriendo, los Estados deberán establecer mecanismos con la participación plena y efectiva de los Pueblos Indígenas para desarrollar una estrategia comprehensiva para el desarrollo ecológicamente sostenible y equitativo para poner fin y prevenir la contaminación industrial incontrolada e insostenible y la degradación, con planes de limpieza, rehabilitación y restauración. Esa estrategia deberá incluir el fortalecimiento de la capacidad de los jóvenes Indígenas en relación con las prácticas de desarrollo sostenible basadas en el conocimiento Indígena y la relación con la tierra, así como la protección y la promoción de la importancia del papel de los titulares de conocimientos tradicionales, incluidos los ancianos y **mujeres Indígenas**;" ***(Tema 1: Tierras, territorios, recursos, océanos y aguas de los Pueblos Indígenas, párrafo 6)***

"Recomendamos que todas las agencias, programas y fondos de las Naciones Unidas que participen en actividades que impactan a los Pueblos Indígenas establezcan consejos consultivos o foros integrados por representantes de los Pueblos Indígenas, incluidas **las mujeres,** jóvenes y personas con discapacidad para participar en el diálogo y proporcionar asesoramiento sobre políticas y operaciones de los países y a nivel regional;" ***(Tema 2: Acción del sistema de la ONU para la implementación de los derechos de los Pueblos Indígenas, párrafo 6)***

"Recomendamos que los Estados, utilizando los principios Indígenas de consentimiento, propiedad, control y acceso, recopilen, analicen y desglosen los datos sobre los Pueblos Indígenas, incluidos los ancianos, **mujeres**, jóvenes, niños y personas con discapacidad, para ayudar a redactar y poner en práctica la política pública y la legislación que se ocupe de mejorar la situación de los ancianos, **las mujeres**, jóvenes, niños y personas con discapacidad Indígenas;" ***(Tema 3: Implementación de los Derechos de los Pueblos Indígenas párrafo 3)***

*"Recomendamos que los Estados respeten e implementen los derechos de **las mujeres Indígenas** como dadoras sagradas de vida y criadoras, así como fortalezcan—con la participación plena y efectiva de **las mujeres Indígenas**— la protección de las mujeres y niñas Indígenas a través de la formulación e implementación de planes de acción nacionales, regionales e internacionales desarrollados conjuntamente con las leyes, políticas y estrategias eficaces de los Pueblos Indígenas;"* ***(Tema 3: Implementación de los Derechos de los Pueblos Indígenas párrafo 5)***

"Recomendamos que los Estados, con la participación plena, equitativa y efectiva de las mujeres, jóvenes y niñas Indígenas, tomen medidas inmediatas para examinar, supervisar y presentar informes completos sobre la violencia contra **las mujeres**, las jóvenes y las niñas Indígenas, en particular la violencia sexual, la violencia doméstica, la trata y la violencia relacionada a las industrias extractivas, así como proporcionen reparación a las víctimas;" ***(Tema 3: Implementación de los Derechos de los Pueblos Indígenas párrafo 6)***

"Recomendamos que los Estados cesen y se abstengan de continuar la militarización actual e inicien procesos de desmilitarización de las tierras, territorios, aguas y océanos de los Pueblos Indígenas. Esto se puede lograr mediante, entre otras cosas, la derogación y/o interrupción de la seguridad nacional "antiterrorista", las leyes sobre inmigración, control fronterizo y otras leyes, reglamentos, operaciones y órdenes ejecutivas especiales que violan los derechos de los Pueblos Indígenas. Se deben tomar medidas especiales para garantizar la protección de los ancianos**, las mujeres**, jóvenes, niños y personas con discapacidad, en particular en el contexto de los conflictos armados;" ***(Tema 3: Implementación de los Derechos de los Pueblos Indígenas párrafo 7)***

Recomendamos que los Estados apoyen programas de los Pueblos Indígenas para fortalecer la capacidad de los jóvenes Indígenas, incluidos aquellos sobre la transmisión de los conocimientos tradicionales, innovaciones y prácticas, así como sobre los idiomas y el papel importante de los Pueblos Indígenas, incluidos los ancianos y **las mujeres**, como titulares de conocimientos tradicionales. Además, recomendamos que los Estados y las agencias, programas y fondos de Naciones Unidas respeten y promuevan el derecho de consentimiento libre, previo e informado de los Pueblos Indígenas en relación con sus conocimientos tradicionales y sus expresiones culturales tradicionales; ***(Tema 4: Prioridades de los Pueblos Indígenas en materia de Desarrollo con consentimiento libre, previo e informado, párrafo 3)***

Compiled and submitted to the World Conference of Indigenous Women, October 28 – 30, 2013, Lima Peru, by Andrea Carmen (North America Region) and Mililani Trask (Pacific Region)

Elaborado y presentado a la Conferencia Mundial de las Mujeres Indígenas, 28 de octubre - 30, 2013, Lima, Perú, por Andrea Carmen (Región de América del Norte) y Mililani Trask (Región de Pacífico).