



Research article

The politics of baselining in the Grants uranium mining district of northwestern New Mexico

Thomas A. De Pree^{a,b}^a 1305 Lobo Pl, Albuquerque, NM, 87106, USA^b 110 8th St, Troy, NY 12180, USA

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ABSTRACT

During the second half of the twentieth century, northwestern New Mexico served as the primary production site for one of the world's largest nuclear arsenals. From 1948 to 1970 the "Grants uranium district" provided almost half of the total uranium ore accumulated by the United States federal government for the production of nuclear weapons, in addition to becoming a national source for commercial nuclear energy from the late 1960s to the early 1990s. By the twenty-first century, after a prolonged period of economic decline that began in the late 1970s, all uranium mining and milling in New Mexico had ceased, leaving a legacy of environmental health impacts. What was once referred to as "The Uranium Capital of the World" now encompasses over a thousand abandoned uranium mines and seven massive uranium mill tailings piles, which are associated with airborne and soil contamination as well as groundwater plumes of uranium and other contaminants of concern, in a landscape that has been fractured by underground mine workings and punctured by thousands of exploratory boreholes. This article presents an ethnographic study of the diverse forms of expertise involved in monitoring and managing the mine waste and mill tailings. Drawing from over two years of ethnographic research, I describe the relationship between different stakeholders from local communities, government agencies, and transnational mining corporations as they deliberate about the possibility of cleaning up the former mining district. My thesis is that the possibility of cleaning up the Grants district hinges on the "politics of baselining"—a term I introduce to describe the relationship between stakeholders and their competing environmental models and hydro-geological theories; each accounts for a different geological past prior to mining that can be deemed "natural," as the background against which to measure the anthropogenic impacts from mining.

1. Introduction

During the second half of the twentieth century, northwestern New Mexico served as the primary production site for one of the world's largest nuclear arsenals. From 1948 to 1970 the "Grants uranium district" provided roughly half of the total uranium ore accumulated by the United States federal government for the production of nuclear weapons, in addition to becoming a national source for commercial nuclear energy from the late 1960s to the early 1990s. More than 340 million pounds of uranium oxide (U_3O_8) have been produced from the sandstone uranium deposits of the Jurassic Morrison Formation in northwestern New Mexico, accounting for more than 30 percent of total production in the United States (McLemore and Chenoweth, 2017:1). The geologist William Chenoweth once described the status of uranium mining in New Mexico, "the acquisition of raw materials," as one of the most underreported aspects of U.S. Cold War history (1988:2). Despite

media that have depicted the exceptionality of the state of nuclear development in New Mexico, the legacy of uranium mining and milling in the region has been backgrounded in national discourse. Consider the most prolific yet unheralded radioactive spill in U.S. history, the Church Rock mill spill of July 16, 1979. Although affected workers and local residents commemorate and memorialize the event annually, it does not register at broader scales of collective memory. Unlike the other stages of the nuclear development (e.g., the production of nuclear weapons), which have been made exceptional in the popular imaginary, uranium mining was made banal (see Hecht, 2009; Masco, 2006).

By the twenty-first century, after a prolonged period of economic decline that began in the late 1970s, all uranium mining and milling in the state had ceased, leaving a legacy of environmental and public health impacts (Dixon, 2015; Khoury, 2013; Shuey and Ronca-Battista, 2007). What was once referred to as "the Uranium Capital of the World" now encompasses about a thousand abandoned uranium mines

E-mail addresses: tad2135@tc.columbia.edu, thomas@depree.com, thomasdepree6@gmail.com.

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and seven massive uranium tailings piles; each of which is associated with expansive groundwater plumes of uranium, radium, selenium, molybdenum, vanadium, and other contaminants (Robinson, 1998). “Tailings” are by-products of the milling process that often remain onsite as a matter of industrial procedure. Situated in context with heavy metals and other toxic constituents (e.g., lead, zinc, copper, arsenic, cadmium, mercury, selenium, cyanide, polychlorinated biphenyl, and asbestos), tailings pose a range of environmental and human health risks (Ceto and Mahmud, 2000:30). A qualitatively thick description of uranium tailings would have to account for their chemical toxicity as amalgams of heavy metals as well as their “radon daughters,” alpha and beta particles and gamma rays. Uranium tailings may retain about eighty percent of their initial radioactivity (Brugge and Goble, 2002).

In New Mexico, tailings have been amassed into unlined piles near the former uranium mills that once crushed the sandstone and limestone host-rocks for subsequent leaching by sulfuric acid and carbonate, respectively. It is difficult to describe the material quality of these tailings piles from outside to inner core. They cannot even be characterized monolithically as solid, liquid, or gas. It would be near impossible just to find the bottom of the tailings piles and the beginning of the alluvial aquifer. Each tailings pile is associated with expansive groundwater plumes of uranium and other contaminants that have impacted multiple levels of the underground aquifer system. The mills themselves have been buried in the same piles they produced. For example, at the Bluewater disposal site, the infrastructure of the mill was decommissioned and dumped in the large tailings pile along with other contaminated equipment onsite, and from other sites. “Bluewater” is named for the water that is known to collect there; hence its previous life as a thriving agricultural community and part of “The Carrot Capital of the World.” Grants has been the self-proclaimed capital of the world twice for the production of two very different commodities.

Initially, the mills were situated at the nexus of large sources of groundwater in order to process the ore, the uranium mines from which the ore was extracted, and the railroads where the Atomic Energy Commission (AEC) had established uranium-vanadium ore-buying stations. The mill tailings piles were fashioned by the AEC former policy to “dilute and disperse” so-called “low-level” radioactive waste (Hagen, 1992:117). The tailings piles in the Grants mining district are situated precariously in basins, valleys, alongside rivers, in the course of former arroyos, and on fractures and fault lines above groundwater aquifers—in places where water flows, both above ground and underground. The fact that these tailings rest *unlined* means there are scarce precautionary barriers between radioactive materials and the nearby soil, water, and air. The AEC designation of “low-level” radioactive waste allowed for an alternative form of mine waste management.

After congress dismantled the AEC in 1974, a key environmental law was passed: The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, which authorized the Environmental Protection Agency (EPA) to set environmental health standards and groundwater protection limits, the Nuclear Regulatory Commission (NRC) to license sites, and the Department of Energy (DOE) to provide perpetual care for designated legacy sites (Department of Energy, 2014). This triadic federal cleanup regime can be supplemented by state environment departments and influenced by the industry experts of transnational mining corporations, as well as the independent experts hired by local communities, grassroots groups, and regional NGOs. The purpose of this article is to account for the emergence of such an environmental cleanup regime and how diverse forms of expertise become entangled through the politics and technology of cleaning up a former mining district. The analytic concept of the “regime” is used to underscore the systematic and planned way in which the cleanup is calculated, ordered, and executed. I am also thinking of the historian of science Gabrielle Hecht’s concept of “technopolitical regimes,” which refers to the strategic practices of people and institutions that govern, and the contested nature of their designs and use of technology to achieve particular political outcomes (2009:16).

Characterized in terms of ecological “sacrifice zones,” the geography of uranium mining and milling in New Mexico, and the current policy and practice of environmental cleanup have been called out as forms of “environmental injustice” and “environmental racism” (Johnston, 2007; Lorenzo, 2017; Voyles, 2015). The Grants uranium district overlaps significant portions of Indigenous lands, including parts of the Navajo Nation (*Dinétah*) and Laguna Pueblo (*Kawaika*), adjacent to Acoma Pueblo (*Haaku*) and Zuni Pueblo (*Shiwinna*), in a region that is considered vitally significant to all 19 Pueblos of New Mexico, as well as recognized tribes of Arizona, Colorado, and Utah. The former mining district also overlaps Anglo settler communities and Hispanic land allotments. In the Grants region, Indigenous lands and labor would bear the brunt of the extraction and primary production process, in addition to bearing an uneven proportion of the legacy of environmental health hazards and inadequate public health services.

There is a growing body of scholarship responding to the legacy of uranium mining and milling primarily in Navajo Country, as well as Laguna Pueblo and Acoma Pueblo (Brugge et al., 2006; Johnston, 2007; Lorenzo, 2017; S. Ortiz, 1980; Pasternak, 2010; Reno, 1981; Voyles, 2015). There has been an established paradigm of environmental health research in the region for over four decades, as well as a growth and diversification in the environmental health literature within recent years (see Lewis et al., 2015). The College of Pharmacy at University of New Mexico was awarded a grant from the National Institute of Environmental Health Sciences (NIEHS) to establish the UNM METALS Superfund Research Program. The National Science Foundation’s (NSF) Established Program to Stimulate Competitive Research (EPSCoR) at the University of New Mexico, New Mexico Tech, and New Mexico Highlands University has developed a component on uranium that addresses the biogeochemistry and mobility of uranium in the environment in New Mexico.

My question about the possibility of cleaning up ecological “sacrifice zones” builds on this growing body of regional environmental health scholarship, in addition to anthropological literature on mining, nuclear development, and the promise and failure of technology. According to Joseph Masco, “Official estimates of the cost of cleaning up the Cold War nuclear complex ranged from \$100 to \$380 billion at the end of the Cold War, the DOE was forced to admit that some sites were beyond environmental remediation given current technology, and were, thus, de facto national sacrifice zones” (2006:220). Barbara Rose Johnston and Shirley Fiske raise questions about the failure of current technology and describe how the promise of remediation is undergirded by “assumptions that science and technology will evolve to effectively address the complex nature of the contamination” (2014:4). Stuart Kirsch refers to the “fallacy of ecological modernization theory,” which questions the assumption “that new technologies can be developed to mitigate ongoing environmental impacts of mining” (2014:195). Kirsch cites Richard York and Eugene Rosa’s critique of the sociologist Arthur Mol’s (1995) claim that “the only possible way out of the ecological crisis is by going further into the process of modernization,” which introduces several challenges drawn from counter findings in their study of how “the most highly modernized nations (as indicated by per capita GDP, urbanization, and economic structure) have the highest environmental impacts” (2003:276). Proponents of ecological modernization theory “have generally failed to refute the claims from demodernization and political economic perspectives that capitalism and modernization are incompatible with ecological sustainability” (York and Rosa, 2003:278).

In this article, I will take Kirsch’s notion of the *fallacy of ecological modernization theory* to task through an ethnographic examination of the constraints and possibilities of cleaning up ecological “sacrifice zones.” By raising questions about the possibility of cleaning up “sacrifice zones,” we can test the promise of modernization, which has long been under scrutiny among anthropologists (see Ferguson, 1999; Scott, 1998). I am suggesting that such skepticism in the anthropological literature on modernization can be leveraged in ways that improve the application of environmental sciences and engineering in former mining

districts. In the following section, I will describe my methods of ethnographic study of the diverse forms of expertise involved in monitoring and managing the Grants mining district. Though the focus is on the experts who monitor and manage the mine waste and mill tailings, I consider many different perspectives on the policy, planning, design, and engineering of uranium mill tailings piles. This distributed course of research contributes to the many cases in which environmental sciences and engineering have been positively improved through the inclusion of diverse stakeholder perspectives and forms of knowledge (Hoover et al., 2015; Scammell, 2010).

The goal of this article is to refine our understanding of the relationship between different “stakeholders” involved in cleaning up the mining district, as they deliberate about the possibility of “reclaiming” abandoned uranium mines, “remediating” Superfund sites, and “restoring” the natural and cultural resources of northwestern New Mexico. Stakeholders in local communities, government employees, and transnational mining corporations all have different, often conflicting perspectives regarding appropriate technical applications and outcomes of environmental cleanup, not to mention different terms, concepts, and metaphors, which carry different meanings and values. This course of research contributes to critical understandings in environmental anthropology of the triad stakeholder model of analysis that emerged in international development discourse in the 1980s as a tool for managing public deliberations between three categories of actors: “the corporation,” “the state,” and “the community” (Ballard and Banks, 2003; Fortun, 2001; Jacka, 2015; Kirsch, 2014).

My thesis is that the possibility of cleaning up the Grants uranium district hinges on the “politics of baselining”—a concept I introduce to account for the relationship between stakeholders and their competing environmental models and hydrogeological theories. Each model accounts for a different past prior to mining that can be deemed “natural,” as the background against which to measure the anthropogenic impact of uranium mining and milling. By contesting baseline levels of environmental data, stakeholders deliberate about appropriate technologies and techniques of environmental monitoring, modelling, and engineering using incommensurable terms of “restoration,” “remediation,” and “reclamation.” Each of these terms refers to a different geological past prior to mining, and different possible futures after mining.

2. Materials and methods

How can an ethnographic analysis of the ways diversely positioned stakeholders analyze the emergent environmental cleanup regime contribute to the application of environmental sciences and engineering? In the last few decades of the twentieth century, the social production of scientific knowledge and expertise garnered significant ethnographic attention from anthropologists (see Fischer, 1999). The emergent ethnographies of science offer a cumulative approach that leverages diversity and difference to better come to terms with a rapidly changing world (Fortun, 2009). By situating the disciplined and narrow focus of technical and scientific practice within its broader social and historical context, the limits of knowledge, limitations in research design, and limited impact of research findings are revealed. There are four features that support the rationale for ethnography in this study: (1) it offers comparative or “juxtapositional” insight between case studies; (2) it provides the tools necessary for a fine-grain analysis of the particular details that underlie broader social phenomena; (3) it accounts for implicit meanings, unstated values, attitudes, and beliefs, which reveal how people *really* think and act; finally, (4) it is “emic” in the sense that it accounts for the specific language and logic, key terms, concepts, and metaphors used by particular communities of practice.

2.1. Ethnographic engagement

My initial ethnographic fieldwork began during the summer of 2014 through collaborative research with the Multicultural Alliance for a Safe

Environment (MASE)—a regional environmental advocacy organization that coordinates the efforts of five local grassroots groups from various parts of the Grants mining district: Eastern Navajo Diné Against Uranium Mining (ENDAUM), Laguna-Acoma Coalition for a Safe Environment (LACSE), Red Water Pond Road Community (RWPRC), Bluewater Valley Downstream Alliance (BVDA), and Post-71 Uranium Workers Committee (Post-71). These are groups that have emerged in response to the legacy of uranium mining. Their mission is to “restore and protect the natural and cultural environment through respectfully promoting intercultural engagement among communities and institutions.” They also work in close collaboration with the Southwest Research and Information Center (SRIC) and New Mexico Environmental Law Center (NMELC), and in relation to various other local, regional, national, and international organizations.

2.2. Public meetings

After my initial work with MASE and colleagues in 2014, I returned to New Mexico in August 2017 to carry out long-term multi-locale ethnographic fieldwork under the auspices of Rensselaer Polytechnic Institute’s Humanities, Arts, and Social Sciences Fellowship. The research portion of which lasted until December 2018. My ethnographic focus was placed on public meetings where the whole gamut of stakeholders would come together to discuss the limitations and possibilities of cleaning up the Grants mining district. At these joint-agency multi-stakeholder meetings, I documented my observations with hand-written notes and photographs when permitted. In these situations, I would introduce myself as a doctoral student of science and technology studies (STS) from Rensselaer Polytechnic Institute and disclose the purpose of my dissertation research in common language (e.g., “I am studying different perspectives on the possibility of cleaning up the Grants mining district and the diverse forms of expertise involved in such an undertaking”). Most of the meetings took place at the Cibola County Building in Grants. Finally, in addition to meetings and hearings, I participated in public tours of the Grants district, visiting and even going on top of uranium mill tailings piles.

2.3. Interviews

Through this course of research, I developed a network of over a hundred interlocutors. I collected unstructured and semi-structured interviews with key stakeholders through the process of interlocutor referral (“snowball sampling”). I began by interviewing my closest colleagues at MASE, followed by interviewing the colleagues they recommended. I also requested interviews with various stakeholders at the aforementioned meetings. Unstructured interviews were used to identify questions that could not be known in advance and to identify appropriate courses of questioning given a particular interlocutor’s experience and expertise. Interviews were documented by audio-recording and hand-written notes when verified informed consent was received. In addition to interviews, I had conversations on a daily basis with people in Grants, Gallup, Milan, Socorro, Santa Fe, and Albuquerque. With permission, I accounted for these conversations in hand-written fieldnotes.

2.4. Archives

I supplemented my ethnographic fieldwork with archival research in the Geologic Information Center at New Mexico Institute of Mining and Technology, the Center for Southwest Research and Special Collections at University of New Mexico, Southwest Research and Information Center (SRIC), the collection of the Cibola County Historical Society, and the library at the Grants branch of New Mexico State University (NMSU). The archival research was accompanied by the collection and analysis of corporate, government, and NGO reports, news coverage, and relevant scientific publications.

3. Results and discussion

In this section, I will apply my thesis about the politics of baselining to three ethnographic case studies at three different remediation sites in the Grants uranium district: the Bluewater site, the Homestake site, and the Crossroads of the San Mateo Creek Basin. My analysis of the Bluewater site shows how the Department of Energy Office of Legacy Management monitors-in-perpetuity after sites have been “successfully remediated.” The description of the Homestake site identifies the kinds of environmental engineering that are employed in corporate reclamation projects prior to meeting the site-specific standards of successful remediation. Finally, the case study of the Crossroads of the San Mateo Creek Basin offers an analysis of two public meetings hosted by the Environmental Protection Agency where attention shifts from the complex problems associated with uranium mill tailings piles to uranium mine discharge and drainage.

3.1. The Bluewater site

On April 20th, 2018, the Department of Energy (DOE) Legacy Management (LM) organized a tour of the Bluewater “disposal cell” at a site they are tasked with monitoring and managing (Fig. 1). The tour was given at the request of the Bluewater Valley Downstream Alliance (BVDA)—“a grassroots group made up largely of residents and property owners directly affected by groundwater pollution and radiation releases from the Homestake/Barrick Gold Mining Company uranium mill and tailings pile near Milan, NM and by the historic discharges of mining and milling waste from dozens of mines and two other uranium mills in the Ambrosia Lake Mining District northwest of Grants, NM” (MASE, 2019a, b). The DOE was accompanied by their colleagues from the Nuclear Regulatory Commission (NRC) who are responsible for licensing and permitting the Bluewater site under the auspices of UMTRCA.

The Bluewater “disposal site” is authorized as a Title II UMTRCA site because it was licensed by the NRC when UMTRCA was enacted. Under Title II jurisdiction, “long-term custody of the site” becomes the responsibility of either the federal government or the “host-state.” The DOE assumed responsibility when the state of New Mexico declined to be the “long-term custodian” of the site. Under Title II, the licensee was deemed responsible for “remedial action.” The original operator, Anaconda Copper Company, became a subsidiary of the oil company ARCO in 1977, so ARCO inherited the environmental liability. The mill was decommissioned in 1989 and “reclamation” began in 1991. The NRC designated the site “successfully reclaimed” in 1996 and the Legacy Management inherited the site from ARCO in 1997 (Department of Energy, 2018).



Fig. 1. The Bluewater Large Tailings Pile. Photograph by the author.

There are two uranium mill tailings piles on the site: the smaller 1.3 million-ton tailings pile is left over from the original carbonate-leach mill that processed no more than 300 tons of uranium ore a day from the limestone deposits between 1953 and 1958; and, the large tailings pile (see Fig. 1) is the by-product of an acid-leach mill that was constructed in 1957 to process the sandstone uranium ore from Anaconda's Jackpile-Paguate Mine in Laguna Pueblo, which was once the world's largest open pit mine. The mill reached peak production in 1978 at 6000 tons of ore a day. By 1982, milling operations ceased in the wake of the declining national market for uranium oxide (U_3O_8). According to Paul Robinson, Research Director at SRIC, “New Mexico has the gold, silver, and bronze medals for mill tailings size [in the nation], and these commingled piles are 20 million ton plus” (September 13, 2018). The Bluewater large tailings pile is the “gold medal.” It contains an estimated 23 million tons of tailings and other contaminated materials. It is 354 acres around the base and about 250 acres on the surface. The DOE calculates the total activity of 11,200 Ci of radium-226 that is contained by 4–12 inches of “riprap” erosion protection layer and 1.7–2.6 feet of low-permeability radon barrier beneath that. For the riprap, they used crushed basalt quarried at the Homestake site. Though they are capped on top, underneath, the uranium mill tailings piles are unlined. The DOE coordinates a groundwater monitoring network that consists of 19 wells within the site boundary. The main contaminants of concern are molybdenum, selenium, and uranium, though they have also monitored for other contaminants; for example, polychlorinated biphenyl (PCB) monitoring was conducted from 1997 to 2017 (Department of Energy, 2017).

The DOE scientists began the tour by acknowledging the mountain in the background, Mount Taylor (see Fig. 2). All of our guides from DOE and NRC had expertise in the geosciences. The geoscientist Dick Johnson of DOE LM explained that the Bluewater disposal cell is located in a “paleochannel confluence zone” in the watershed of Mount Taylor. “There used to be a canyon here,” he said. “We call them ancestrals. This is the Ancestral Rio San José.” The alluvial aquifer is composed of silts, sands, clays, and gravels deposited by an ancient river and buried under more than a hundred feet of basalt lava flow called “Bluewater basalt” from El Tintero of the Zuni-Bandera volcanic field. “In geologic time there would have been a valley here, an old ancestral riverbed.” He called it a “dirty laundry basket with the old stuff on the bottom and the new stuff on the top.” The tailings “disposal cell” was situated on top of the Bluewater basalt in the middle of a watershed that feeds the Rio San José where two faults intersect—the San Andres fault and the East-West fault—which connect the groundwater aquifers below.



Fig. 2. Visualizing the uranium plume from the Bluewater disposal cell. Mount Taylor in the Background. Photograph taken by the author with permission of DOE LM.

The Bluewater site illustrates how precariously situated these tailings piles are in relation to groundwater resources. Resting on top of two intersecting fault lines, the initial remediation strategy was to drain the wet tailings through the fractured aquifer underneath. One of the scientists called the situation “a perfect storm” and told us that this was the worst place to put a tailings pile. “Geologically speaking, I’d never put it here.” Nonetheless, it’s the site that Legacy Management inherited. 5.7 billion gallons of contaminated water have seeped through the cell. There is a plume of uranium leaving the site at 0.44 mg per liter (see Fig. 2). Although 0.03 mg per liter is the Environmental Protection Agency’s (EPA) “maximum contaminant level” for uranium, in 1997, 0.5 mg per liter was accepted as the “alternative contamination limit” (ACL) by NRC and New Mexico Environment Department (NMED). According to Legacy Management, they are meeting their obligation to protect public health because they are meeting the site-specific standard.

The DOE scientists assured the residents from Milan and Grants who live downgradient that they do not foresee a risk to municipal groundwater sources because the heavy metal contaminant plume had reached a state of “dynamic stability.” When I talked to an independent scientist about this, he scoffed, “These must be some well-behaved heavy metals.” The DOE has not yet defined the leading edge of the groundwater plume. Because the plume is leaving the site under their contaminant-level of concern of 0.5 mg per liter, Legacy Management did not recognize the leading edge as their responsibility. They did not even recognize it as a problem. Because the Bluewater site is performing according to DOE expectations, no remedial action is required.

Such strategies of waste management have been fashioned by two succeeding principles, beginning with the AEC policy of “dilute and disperse” from the 1940s to the 1970s, and followed by the era of “alternative contamination limits,” or ACLs from the 1980s onward, which permit levels of pollution beyond the EPA’s established MCLs. ACLs and cognates of “alternate concentration limits” and “alternative abatement standards” can be obtained if it is deemed (technologically) infeasible to achieve MCLs. In the following section, I will juxtapose the Bluewater site with the Homestake mill site, and add another level of stakeholder analysis by describing the critical terms and concepts of the Bluewater Valley Downstream Alliance (BVDA) and other residents who live between the Bluewater site and the corporate “reclamation project” of Homestake Mining Company, a subsidiary of Barrick Gold Corporation. Unlike the Bluewater site, the Homestake site has not been “successfully remediated.” It offers unique insight into an active corporate reclamation project that has not yet achieved standards of “remediation.”

3.2. The Homestake site

On a Tuesday morning, July 29, 2014, a group of us gathered in the parking lot of the Navajo Lodge in Albuquerque, New Mexico. MASE arranged a “human rights tour” of the Grants mining district that was followed by a “tribunal hearing” at a community center in Gallup. MASE Coordinator, Susan Gordon, piloted the eleven-passenger rental van. I was sitting co-pilot. We were accommodating six representatives of a national NGO based in New York City and Atlanta called the Human Rights Network (HRN). They were compiling cases for a “Shadow Report” for the United Nations (UN) Committee on the Elimination of All Forms of Racial Discrimination (CERD), which would be presented later that summer in Geneva. Our itinerary was to visit three sites associated with uranium mining and milling: first, the Jackpile-Paguate mine site in Laguna Pueblo; then, the Homestake mill site in Milan; and finally, the Church Rock mill site in the “checkerboard area” of the Navajo Nation. All three sites have been listed on the EPA’s Superfund National Priorities List (NPL).

For the purpose of this article, I will describe our visit to the Homestake site in order to foreground the peculiar stakeholder relations between transnational mining corporations and local communities, and

the technopolitics of environmental cleanup at this particular location. Gabriel Hecht’s concept of “technopolitics” refers to “the strategic practice of designing or using technology to constitute, embody, or enact political goals” (2009:15). I use the term to describe the corporate engineering of uranium tailings piles, and how local community stakeholders who have been impacted the most critique the reclamation project.

In Milan, we met our colleague from BVDA. She joined us in the van as we continued north on state highway 605 toward the Homestake mill tailings site. The mill was constructed by an early version of United Nuclear-Homestake Partners in 1958 and operated through 1990. At optimal production, it produced 3500 tons of ore a day. Because the uranium ore processed contained under 0.2% content of uranium oxide, 99.8% of what went through the mill has remained onsite in the form of two uranium mill tailings piles. The “Large Tailings Pile” (LTP) has 23 million tons of tailings; it is one mile in length and 100 feet high (Fig. 3). The “Small Tailings Pile” contains roughly 1.5 million tons of tailings (SRIC, 2010a, b). Because uranium mills require a significant amount of water to process the uranium ore, the Homestake mill was situated in the lower San Mateo Creek Basin, between the San Mateo watershed area of Mount Taylor and the Rio San José, on top of a geologic fault line that connects the alluvial aquifer with the deeper bedrock aquifers.

There is a long record of groundwater contamination at the site from the seepage of the tailings. The EPA recognizes the impacts of the two tailings piles on the San Mateo alluvial aquifer, as well as the Upper, Middle, and Lower Chinle aquifers (Environmental Protection Agency, 2010; Environmental Protection Agency, 2018b). The Chinle aquifers are the most significant drinking water aquifers in the residential subdivisions downgradient from the tailings piles. According to Southwest Research Information Center (SRIC), the U.S. Public Health Services first reported groundwater contamination at the site in 1962. SRIC refers to an investigation conducted by the EPA in 1975 as the critical point of intervention. During the investigation, the EPA identified selenium as the most significant contaminant at the Homestake site. According to SRIC, “The EPA investigators also found that uranium concentrations in groundwater had reached 25 to 50 times the concentration found in samples of unaffected groundwater” (spring 2010:4). This prompted the EPA to draft the first Groundwater Protection Plans for the area, in collaboration with an early version of the NMED.

In addition to leakage, the Homestake tailings pile was subject to “flushing and diluting.” During an interview with Candace Head-Dylla of BVDA, I asked: “Can you tell me a little bit more about the tailings pile itself? How was it engineered? You already mentioned that they are unlined, and they haven’t capped them with clay material for example. They are pouring water on top of them so that they drain or at least we think that practice has stopped.” She responded:



Fig. 3. Homestake Large Tailings Pile. Photograph by the author.

It did. They did that until recently. We finally, and again this is through MASE. This is through working with the EPA. The EPA brought in USGS [U.S. Geological Survey] and they took a look at the remediation process ... We sent a request to the [NRC] ... that request precipitated the USGS coming in and doing an analysis of the remediation at the Homestake site. What the USGS found was that why would you be adding water [to] the water you are already trying to clean? You are increasing the volume of water. This isn't done any place else. The tailings need to be dried, not have increased water put on them. And so that is when they stopped the flushing ... They were flushing. They were getting all of this uranium down at the bottom and then they were collecting it and treating it. When in fact, when you've got stuff in there in the bottom, that process is not as easy to predict where deposits are going to remain. And so, that is one reason, and this was really smart, that the NRC is making them look at *rebound*. Now that they have stopped the flushing, they are getting the heavy rebound, like high numbers of contaminants that are now seeping from various spots (Head-Dylla, June 6th, 2018).

"Flushing" refers to the process by which Homestake pumped clean water from the San Andres-Glorieta aquifer into the large tailings pile, forcing a contaminated tailings slurry through the fractured aquifer below. The process of flushing increased the amount of contaminated water, fracturing the structure of the groundwater system, raising the water-level, diluting groundwater samples, and depositing "secondary uranium salts" in the vadose zone of soils above the aquifers through groundwater "mounding" (Myers, 2015). These areas are then susceptible to a "rebound" of contamination. Candace explained how the actions of MASE prompted EPA, NRC, and U.S. Geological Survey (USGS) to investigate and cease the practice of flushing and diluting.

Current "best practices" at designated Title I sites of UMTRCA follow protocol of dry tailings, placed below-grade, lined on the bottom and covered on top. Whereas southwestern Colorado and southeastern Utah have become subjects of state-of-the-art reclamation techniques and technologies, remediation in New Mexico has become an exemplar of a different kind. One explanation leveraged to justify Title II UMTRCA sites and the mediocre, run-of-the-mill cleanup regime in New Mexico is the designation of "commingled tailings." When the U.S. government stopped purchasing uranium for the manufacture of nuclear weapons in 1970, the commodity of uranium oxide became a commercial source for nuclear energy, and the by-products commingled: the tailings contained the by-products of both pre-1970 "weapons era" and post-1970 "commercial era." As a result, the federal government was deemed partly responsible for funding the cleanup. The Potentially Responsible Party (PRP), Homestake in this case, assumed responsibility for the other portion, and was placed in charge of designing and implementing the cleanup plan.

Where the federal government is deemed responsible for environmental hazards, taxpayer dollars are at stake. Candace from BVDA remarked, "The tailings at Homestake are 'commingled' and, so far, taxpayers have forked out \$90 million on cleanup at the site. This is the taxpayer portion of what has been spent so far with another \$55 million currently budgeted. The ramifications of these facts are huge—particularly when you realize how little has been accomplished to date" (June 6th, 2018). With about six hundred wells onsite, a colleague once told me that Homestake is "the largest remediation well-complex in the NRC system." According to SRIC's calculations, "By 1997, 20 years of clean-up effort had resulted in the extraction of groundwater totaling more than 2.6 billion gallons (more than 8100 acre-feet), and drainage of more than 270 acre-feet of liquid from the tailings by 'toe drains.'" Despite those efforts, groundwater contamination remained under the tailings and in downstream areas including the subdivision where BVDA residents live" (2010:5). The SRIC report also accounts for how "Homestake Mining Company sought to ease its cleanup burden by proposing alternative concentration limits. This would weaken groundwater cleanup requirements by raising the concentration of

contaminant that would be allowed in groundwater after clean-up" (2010:5).

The perspectives of local residents and grassroots groups that have emerged in response to the legacy of uranium mining and milling add a critical dimension to the stakeholder analysis. This approach was inspired by Stuart Kirsch's study of "corporate science," which accounts for the strategies by which corporations use science to defer criticism (2014:12). Kirsch encourages us to study "corporations by examining how they produce and manipulate science in order to influence their critics and avoid regulation" (12). Highlighting the strategy of "flushing and diluting" offers insight into the *corporate engineering* of uranium mill tailings piles as an entanglement of technology and politics. BVDA recognized how MASE and colleagues were able to stop the practice of flushing and diluting through their work with EPA, USGS, and NRC, which indicates how local social movements can enhance the efficacy of the cleanup regime, changing industrial practices in complex and dynamic ways, fundamentally altering the technological systems used to manage uranium tailings piles, and improving regional environmental health.

The Homestake site also shows how ACLs made the corporate reclamation project possible. ACLs are at the heart of the difference between what government employees refer to as "remediation," meaning restored to a (alternative) limit, and what local communities call "restoration," which means back to the way it was prior to mining; whereas "reclamation" from the corporation's purview means salvaging mining-impacted landscapes for an alternative economic purpose. ACLs can be established according to what the EPA, NRC, and other permitting authorities define as the "baseline" or "background" levels of contamination at particular sites. The following section illustrates what I term the "politics of baselining," in which different stakeholders calculate what the "naturally" occurring levels of uranium in the groundwater would have been prior to the anthropogenic impacts of mining. This concept builds on an emerging body of literature on "baselining," including studies of "baselining pollution" during an environmental risk exercise in Chile (Ureta, 2017), and "contentious baselining" regarding natural gas extraction from the Marcellus Shale in Pennsylvania (Kinchy, 2019).

3.3. The Crossroads of the San Mateo Creek Basin

On Thursday, October 18th, 2018, the U.S. EPA Region 6 facilitated two meetings at the Cibola County Building in Grants: one for MASE and colleagues in the morning and afternoon, and one for local residents in the evening. The purpose of the meetings was the public release of the EPA's *Phase II Ground Water Investigation Report for the San Mateo Creek Basin Legacy Uranium Mines Site, Cibola and McKinley Counties, New Mexico* (Environmental Protection Agency, 2018a). Building on a decade of research, the study provides the groundwork for their proposal for the San Mateo Creek Basin Superfund site through the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). At the meetings, the EPA Site Coordinator Kevin Shade and Project Supervisor Mark Purcell summarized the report. They described their basin-wide model as an analytical tool that can be used to better understand and address widespread contamination from uranium mines.

The study intentionally ignores the environmental impacts from the large tailings piles (described in detail in the previous sections) in order to focus on contamination from about 85 uranium mines, roughly one-third of which were "wet mines." According to the EPA, the mining industry pumped over a hundred billion gallons of mine water in order to extract and process the uranium ore deposited below the water table, then released the water into Arroyo del Puerto and San Mateo Creek, which come to a confluence before draining into the Rio San José. "The Crossroads" is at the center of their basin-wide model, where state highways 605 and 509 come to a junction and contour a "Y"-shaped basin. This is where the discharged mine water infiltrated underground aquifers through seepage, fault lines, boreholes from historic

exploratory drilling, and underground mine workings, which connect different levels of the groundwater system. They identified a “massive slug of mine water,” a uranium-selenium groundwater plume, that is making its way downgradient to the Homestake mill tailings site.

During the meetings, MASE and colleagues realized that the EPA had not completed a Record of Decision (ROD) at the Homestake Superfund site, which is situated within the proposed San Mateo Creek Basin Superfund site; they had not established “baseline” or “background” levels for the groundwater (Environmental Protection Agency, 2018c). This moment was identified by BVDA as a “political opening,” a chance to contest the baseline levels of contamination and limit their exposure to environmental health hazards. Despite over a decade of Superfund research that lays out multiple lines of geochemical evidence of the impacts of mining on groundwater, the EPA’s decision about what background level of contamination would be accepted for the site was reduced to an October 2016 “split-sample event.” It was referred to as a “snapshot” and “split-sample” event because at that moment the USGS was contracted by EPA Region 6 and the consultant Arcadis was contracted by Homestake (Barrick Gold Corporation) to cross-examine a single point of analysis, a one-time groundwater sample.

In September 2018, Homestake and Arcadis published a white paper based on their results entitled, *Evaluation of Water Quality in Regard to Site Background Standards at the Grants Reclamation Project* (Ulrich et al., 2018). They held a conference call with interested stakeholders to announce the release of their conceptual site model, which describes “local naturally occurring mineral sources of uranium to groundwater upgradient of the Grants Reclamation Project” (2018:1). It concludes that the heterogeneous alluvial material containing uranium that cuts through their site naturally eroded upgradient. Homestake accounts for the initial investigation in 2016, in which “the EPA began to investigate the Site Background Standards for the Grants Reclamation Project due to the anomalously high concentration (0.2 mg per liter) of dissolved uranium detected in site background well DD. Well DD is a key location used in the calculation of the Site Background Standards, and the natural occurrence of uranium here has been questioned by stakeholder groups and regulatory agencies” (2018:1; emphasis added).

Questions raised by stakeholder groups and regulatory agencies were precipitated by a study funded by MASE on behalf of the core group BVDA entitled, *Conceptual Flow and Transport Model Uranium Plume near the Homestake Millsite Milan, NM* (Myers, 2015). The study introduced a “conceptual flow model” (CFM) for the lower San Mateo Creek Basin and suggests that groundwater “mounding” under the Homestake site has “reversed the gradient and caused [uranium] advection to the northeast” (Myers, 2015). Dr. Myers’ hypothesis spotlights how the hydraulic impact from the Homestake tailings pile has reversed the flow of groundwater to the northeast of the pile. The report also identifies the roughly one-square-mile “data gap” northeast of the Homestake tailings piles. Hypothetically, the “data gap” conceals the intersection of the groundwater plume from the Homestake pile, the Bluewater plume, and the plume from the mine water discharge upgradient. The “very frustrating data gap” was also acknowledged by EPA as an area that conceals a “faulted graben” where the land drops down between the two faults. The EPA did not take a position on whether the hydraulic fracture in the bedrock upgradient of the Homestake site was “natural” or anthropogenic. It could be the result of natural environmental processes; it could also be the result of Homestake’s “hydraulic flow regime” and the significant amount of pumping that occurs onsite.

EPA employed USGS to address this outstanding “data gap.” USGS took a reductive approach, taking a single sample from well DD—a “key location” selected by Homestake for determining Site Background Standards. The split-sampling event led to a publication by USGS that the EPA would use to establish background. In May 2018, BVDA hired Dr. Myers and the aqueous geochemist Ann Maest to draft a memorandum that identifies limitations in the USGS “groundwater fate and transport conceptual model.” During a meeting at Senator Martin Heinrich’s office in downtown Albuquerque, Dr. Myers and Dr. Maest

were invited by BVDA to call in from Reno, Nevada and Boulder, Colorado respectively, and vet the USGS publication and what it would purport as baseline. Identifying the spatial and temporal limitations of the USGS publication, and the fact that they sampled a well that was impacted by the Homestake uranium tailings plume, Myers and Maest called for a deeper consideration that includes data-points across space and time. They referred to historic USGS environmental information from the 1960s onward and groundwater samples throughout the basin, and suggested they be utilized to establish baseline. They encouraged USGS to include a “limitations section” in the publication.

The description above indicates several key aspects of the politics of baselining. First, it accounts for the manifestation of what Stuart Kirsch calls “corporate science” (2014). According to Kirsch, “One of the rhetorical strategies employed by mining companies to defend themselves from criticism is to invoke comparisons that “naturalize” their environmental impacts” (2014:140). He discusses how mining corporations “make inappropriate comparisons between natural and industrial systems” and employ the “use of the rhetoric of nature to downplay the responsibility of mining companies for their environmental impacts” (139–140). In the case depicted above, Homestake attempted to naturalize the industrial impacts of uranium tailings on groundwater by developing a geological theory that accounts for how uranium could have eroded naturally upgradient from the site. Conversely, we can understand the work of Dr. Myers and Dr. Maest as an emergent form of “civic science,” which refers to “how science can be fashioned to serve the public good” (Fortun and Fortun, 2005:44). Kim Fortun and Mike Fortun elaborate on their term and describe how the “civicness” refers to their interlocutors’ “ability to create an applied science that undergirded regulations protecting public health through the scientific definition of environmental and biological risk” (2005:45).

4. Conclusion

Each case depicted above illustrates different aspects of the concept of the “politics of baselining.” In the discussion of the Homestake site, the politics of baselining reveals how corporations attempt to limit their environmental liabilities by naturalizing industrial impacts and producing forms of “corporate science” (Kirsch, 2014), which establish baseline data that permit a higher level of contamination in the environment, thereby limiting the extent to which they are obligated to cleanup. State and federal permitting regimes give the permits that allow for alternative contamination limits (ACLs) and allow companies to pollute up to seemingly arbitrary levels, as demonstrated in the case study of the Bluewater site. The case studies also demonstrate that government employees are not hopeless “intermediaries”; they are “mediators” that change what passes through (Hull, 2012; Latour, 2005). The EPA meetings regarding the San Mateo Creek Basin Superfund proposal are examples of “political openings” that create spaces for local communities to work together to limit their exposure to environmental health risks. Finally, the meeting at Senator Heinrich’s office in which Dr. Myers and Dr. Maest vetted the USGS publication that would infer baseline at the Homestake site shows how grassroots groups, local communities, and regional NGOs employ independent scientists who criticize strategies of corporate science and produce forms of “civic science” (Fortun and Fortun, 2005). Civic science establishes lower baseline levels of contamination that register under the maximum contaminant levels (MCLs). By tracing lines of geochemical evidence, each stakeholder’s model imagines a different geological past prior to mining that can be deemed “natural,” as the background against which to measure the anthropogenic impact of “man-made” piles of uranium tailings and abandoned mines.

Declaration of competing interest

None.

CRediT authorship contribution statement

Thomas A. De Pree: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing.

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