CONFRONTING THE WATER ETHICS OF A DOMINANT SOCIETY: ENGINEERING SOCIAL JUSTICE FOR THE NAVAJO NATION

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By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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AN INTRODUCTION TO THE U.S. WATER CRISIS

Technical progress made through industrialization and urban expansion within the United States has come at a very high environmental cost. The spread of cities has drastically changed the hydrologic landscape thereby increasing stormwater runoff. This increase in water quantity has led to the degradation of many streams through erosion and increased pollutant loads. Additionally, hazardous industrial practices in the 20th century, such as uranium mining, have had lasting impacts on the quality of water in many areas. The impact of industry on water quality is a threat to both the environment and communities who rely on these polluted sources for drinking water.

From 2012 to 2013, the City of Charlottesville along with the Rivanna Water and Sewer Authority (RWSA) and the Nature Conservancy completed one of the largest urban stream restoration projects in the United States on Meadow Creek (City of Charlottesville, 2013). While many stream restoration projects are beneficial for an initial period of time, a large majority of these projects have proven ineffective long term. Currently, there are three main methods for stream restoration: restoration of channel morphology, restoration of ecological function, and restoration beyond the channel (Palmer, Hondula, & Koch, 2014, p. 249-253). Most projects, including the one completed on Meadow Creek, have restored the design of the channel itself, such as reshaping it with boulders or wood to hold more water. This method does not address the source of the excess stormwater reaching the stream, often leading to its ultimate failure. In order to ensure the long-term restoration of a stream, best management practices (BMPs) must be implemented at the source of urban runoff. A BMP is a practice or combination of practices that is effective in managing the volume and quality of stormwater runoff. These practices could include anything from minimizing fertilizer use or building bioretention systems. Another

concern with the United States' water is groundwater contamination. The Navajo Nation is experiencing a water crisis due to the uranium pollution of groundwater from improper management of abandoned mines. Within the Navajo Nation today, there are at least 1,000 abandoned mines, exposing many communities to hazardous pollutants such as uranium and arsenic (Panikkar & Brugge, 2007,pg. 122). Past plans to try to address this water crisis have proven ineffective, and research of the area is scarce. While the extent of health threats from these mining practices on communities is still largely unknown, numerous studies have linked uranium mining to kidney diseases (Panikkar & Brugge, 2007, p. 138). This radioactive contamination can also lead to pancreatic, bladder, and reproductive organ cancers and can even be deadly (Tsosie, 2015, p. 220). This contamination is especially an issue for the Navajo people, as close familial ties to the land and cultural significance of the earth keep them from leaving these dangerous conditions. Additionally, typical water use practices such as the construction of dams have been destructive to the ecological functions of rivers that these people rely on, making it a very controversial topic today (Groenfeldt, 2019, p. 15).

All individuals have the right to clean and safe water, so these two water-related concerns need to be addressed. This technical research and loosely coupled STS research look to provide greater understanding of the social, economic, and hydrologic factors that affect water quality management within the United States, and provide a framework for how to go about addressing them. While the former will be focused on developing an equitable green infrastructure plan to address urban stormwater runoff in the Meadow Creek Watershed, the latter will focus on engineering an ethical and collaborative solution to the Navajo water crisis.

THE SCARS OF INDUSTRY: A LOOK INTO THE NAVAJO NATION WATER CRISIS

The water sources within Navajo communities have been vulnerable to arsenic and uranium contamination due to the geologic characteristics of the region, lack of proper infrastructure and regulation, low socioeconomic status of the Navajos, and the region's previous involvement in the uranium mining industry (Credo et al., 2019, p. 7). The soil composition in the American Southwest contains sandstone and limestone bedrock with iron-oxide and iron-sulfide minerals along with an abundance of uranium. Because of this abundance in minerals, from 1944 to 1986 the Navajo Nation was the largest producer of domestic uranium ore in the United States for use in nuclear weaponry (Credo et al., 2019, p. 1). The water table underlying this region is high. For example, groundwater underlying the Puerco River in the Colorado River basin in Arizona is very shallow. Uranium mines had to constantly be dewatered as the groundwater became exposed. This practice combined the uranium and other minerals from the mine with the exposed water and released this mixture directly into the surface water. Today, the exposed surfaces of the mine come in contact with rainwater, causing them to infiltrate into groundwater sources. Despite the passage of the Comprehensive Environmental Response, Compensation, and Liability Act in 1980, which addresses sites highly contaminated by hazardous materials, uranium mines in these areas have remained largely untouched. This lack of oversight could in part be because the Navajo are a sovereign nation and are therefore legally outside of the U.S. government's jurisdiction. It is estimated by Navajo authorities that around 15,000 homes within the Navajo Nation lack running water and/or electricity (Volkert, 2020). To make matters worse, 30% of Navajo people get their drinking water from unregulated sources, as they are often the closest (Credo et al., 2019, p. 7).

In recent history, tribal water rights have been circumvented by the United States government through a variety of tactics. An example of this can be seen in the early justification of uranium mining. The United States government claimed that uranium mining was crucial to maintaining national security during wartime. As a result, certain information about the mines was kept classified, and the federal government maintained sovereignty over this land use (Tsosie, 2015, p. 213). The analysis of this topic requires a greater understanding of the severity of contaminated groundwater sources, lack of water infrastructure in the Southwest, the disregard of cultural significance of water and land in previous designs, and the extent of tribal water rights. In response, the main research question posed by this project is: how can we combine the traditional ecological knowledge of the Indigenous Peoples with more modern water treatment technology? This scholarly article provides an analysis of water quality and quantity measures for the Navajo Water crisis through an environmental and social justice perspective and makes an informed recommendation for better water resource procedures.

WATER ETHICS

Ethics are an intrinsic dimension of water policy, program, and practice. Water management practices within the United States have resulted in clashes of cultural values between the U.S. and indigenous nations. Choices in physical infrastructure such as dams and mines have been so destructive to the ecological functions of rivers and the indigenous communities who depend on them (Groenfeldt, 2019, p. 165). Even with the advocacy efforts of International Rivers and other non-governmental organizations over the last three decades, this development still occurs at the expense of these communities. Similarly, state governments within the United States have found ways to circumvent the UN's recognition of Indigenous peoples' rights in 2007. For example, New Mexico has a "use it or lose it" policy through which

water can only be diverted for purposes that are economically beneficial. This policy does not include flow that benefits the ecological functions of the river (Groenfeldt, 2019, p.167). The water rights for cultural and ceremonial uses of the Navajo Nation are also not included in these laws. Because of these legal challenges, indigenous communities have often been excluded from discussions about water management practices. Additionally, indigenous cultural and spiritual understandings about water are often misunderstood or simply ignored by dominant societies (Groenfeldt, 2019, pp. 171-172).

Indigenous water ethics play a crucial role in working towards more collaborative and mutually beneficial water resource projects that will address issues like the Navajo Nation water crisis. Groenfeldt, founder and director of the Water-Culture Institute in Sante Fe, advises that U.S. stakeholders translate Indigenous knowledge into ethical principles, and then integrate those principles into our socio-ecological system of modern life (p. 166). Indigenous peoples value water for its spiritual and life-generating properties. In this way, they view water as having a form of consciousness and in a meaningful way being alive (Groenfeldt, 2019, p. 168). Western ontologies of water are limited to its physical and chemical characteristics and its value as a resource. Even though the Navajo Nation is considered a sovereign nation, because the United States is the dominant society of the land and waterways within the country, indigenous water ontologies are not given the same weight as scientific rationalism. To address this issue, the social value of water bodies should be weighted equally with the economic value in water resource discussions. Indigenous culture and spirituality is linked to the health of surrounding water bodies. In other words, the development of solutions to the Navajo Nation water crisis needs to undergo the process of "unlearning" its Euro-American assumptions about the nature of water and place further emphasis on traditional ecological knowledge that indigenous peoples

can provide (Groenfeldt, 2019, p. 174). This traditional knowledge includes spiritual and social beliefs and is based upon long and close association to the environment. This close association allows for indigenous peoples to better understand what different sites can sustain. The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment Report on Biodiversity and Ecosystem Services published in 2019 revealed that, although Indigenous Peoples and Local Communities (IPLC) manage only around 28% of the global land area, ILPC's lands constitute 40% of the area that is formally protected and about 37% of ecologically intact landscapes (Ch.3, p. 16). These statistics indicate that dominant societies of the world can learn from indigenous conservation practices and efforts. Groenfeldt makes an excellent point that further representation of Indigenous scientists and scholars within the water sciences may help with the application of this knowledge in engineering applications (p. 175).

INTERSECTION OF DUTY ETHICS AND RIGHTS ETHICS: THE ENGINEER'S ROLE

All human beings have a right to life, an idea first introduced by John Locke's theory of rights ethics. In the engineering code of ethics, engineers must hold paramount the health, safety, and welfare of individuals. Therefore, in any engineering applications in the Navajo water crisis, engineers must prioritize providing clean and safe water to the Navajo people, as water is fundamental to life. When considering Immanual Kant's theory of duty ethics, engineers have a moral responsibility to learn more about Indigenous ethics in relation to how they view water and water ecosystems. Engineers also have a duty to consider the morality or lack thereof of their own water values such as the "use it or lose it" policy. The U.S. industry is the source of the uranium contamination within the groundwater of this region. As previously stated, crucial

information about the uranium mines was withheld from the Navajo people under the guise of national security, and since the mines operated on tribal lands, no state laws were applied that might protect workers (Tsosie, 2015, p. 213). However, as the Navajo were employed by federal mines, the actions of the U.S. government went directly against the provisions outlined in the Federal Mine Safety and Health Act of 1977 which states that "the first priority of all in the mining industry must be the health and safety of its most precious resource - miners," (Division of Mine Health and Safety, 1978). As the dominant society within the continental United States, U.S. engineers must take real initiative in the inclusion of the Navajo Nation in water-related projects. To do this, engineers must improve upon the practical skills discussed by Martin and Schinzinger (2009) including moral awareness, moral communication, and tolerance of diversity (2009, p. 11).

REVIEW OF CURRENT WATER RESOURCE PROCEEDINGS

Chief et al. (2016) emphasize in their research that the integration of Western and indigenous sciences in a way that is beneficial to both of their knowledge systems is crucial to water resource management (p. 1). Current procedures for water resource management and distribution planning, however, are set up in such a way that discourages this integration. These procedures can be represented using Carlson's linear handoff model displayed in Figure 1 below.

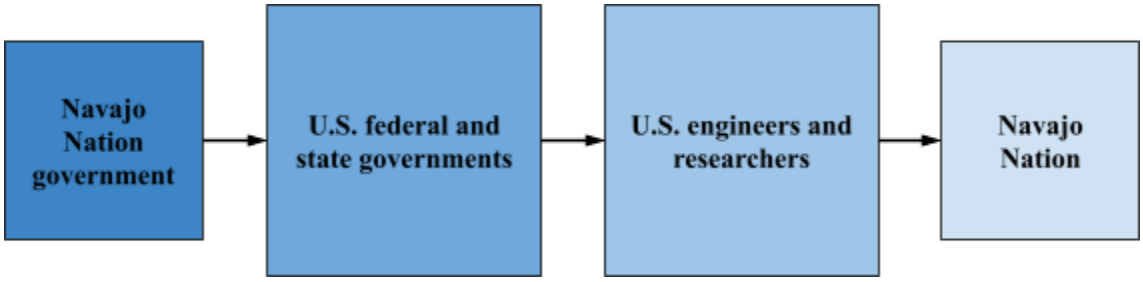

Figure 1: Handoff Model of Current Water Resource Projects for the Navajo Nation: This figure displays how current water resource strategies have been developed and diffused through the Navajo Nation. (Adapted by Caroline Marquis (2020) from Carlson 2009)

Consider the Northeastern Arizona Indian Water Rights Settlement Agreement. According to Shebala (2012), in November of 2010, the Navajo Nation Council approved this rights agreement that included the settlement of Lower Colorado Basin water rights and federal funding of $800 million of Navajo water projects including the Western Navajo pipeline (para. 5). This agreement died when Arizona senator Kyl told the tribe that he could not sponsor it because of the proposal's high cost. Kyl's bill included three water projects in exchange for the tribe waiving their water rights to the Little Colorado River. Community organizations opposed this bill stating, "This bill reduces tribal sovereignty and relinquishes water rights from the Navajo" (Shebala, 2012, Public meeting today section, para. 6). This case is one of many examples of how the needs expressed by the Navajo Nation government and its people have been consistently minimized by economic and industrial concerns.

NAVAJO WATER PROJECT

More than 150 years ago, the Navajo signed the Treaty of Bosque Redondo with the federal government, giving up large portions of their land and autonomy in exchange for resources for things like infrastructure and healthcare (DigDeep, 2020). Despite this treaty, the Navajo Nation still faces issues related to poor resource allocation and funding from the federal government. DigDeep began the Navajo Water Project in 2014 to address the concerns of water scarcity within this region. According to DigDeep (2020), this community-managed utility alternative has brought running water to 250 families within the Navajo Nation. Projects are by a counsel of clients and local leaders to enact long-lasting change (About section). While DigDeep has seen a lot of local success, as a nonprofit organization it is limited due to its reliance on donations and volunteers. With over 15,000 Navajo homes in need of water, federal funding and

resources brought on by U.S. policy changes are required to bring about widespread, sustainable solutions to this complex water crisis.

APPLICATIONS OF ACTOR-NETWORK THEORY IN DESIGNING A SOLUTION

Actor-Network Theory developed in 1986 by Bruno Latour, Michael Callon, and John Law has many applications in the development of a successful water resource management plan for the Navajo Nation Water Crisis. As shown in Figure 2, there are six primary actors: uranium mining, the U.S. government, U.S. engineers and researchers, Navajo Nation government agencies, Navajo engineers and researchers, and Navajo communities.

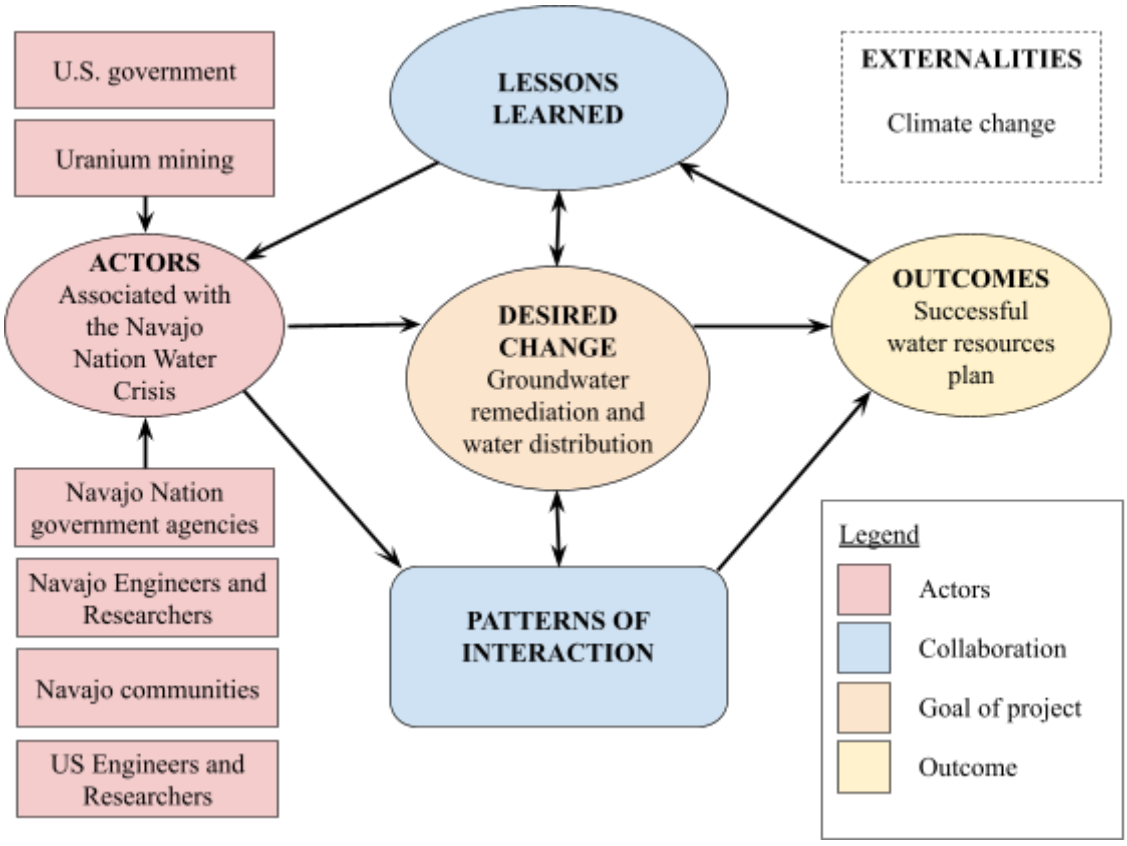

Figure 2: Application of Actor-Network Theory in Navajo Nation Water Crisis: This figure displays that in order to accomplish a successful water resources plan, all actors involved with the design challenge must interact and learn from one another. (Adapted by Caroline Marquis (2020) from Sellamuttu, de Silva, Khoa, & Samarakoon 2008)

The booming industry of uranium mining in the latter half of the 20th century exposed dangerous pollutants within the soil to the elements, resulting in infiltration and contamination of groundwater sources. Additionally, unregulated water sources throughout Arizona and Utah are outside of the boundaries for management by both the Arizona Department of Water Resources and the Navajo Nation Department of Water Resources (Credo et al., 2019, p. 3). Both US and Navajo governmental agencies must interact to address issues such as these. Engineers and researchers continue to study this region and can provide important data and technical perspectives on addressing this water resource problem. The inclusion of both U.S. and Navajo engineering principles is crucial to planning an effective solution to this water crisis. Lastly, input from Navajo communities should not be overlooked, as they have personal experience and local knowledge related to this issue. Climate change is an externality, or a factor that is influencing this water crisis outside of the original scope of the issue. Analysis of summertime droughts from 1901 to 2010 using the Palmer Drought Severity Index (PDSI) reveals that 2001 to 2010 produced the second largest area affected by drought (Nania et al., 2014, p. 43). This occurrence of drought could result from increased temperature. As these droughts persist, they can result in decreases in streamflow, deficits in soil moisture, and lowering of groundwater tables, thus accentuating this water scarcity further.

METHODOLOGY FOR THE DESIGN OF BETTER WATER RESOURCE SOLUTIONS

The linear handoff model that is currently used will continue to fail in designing a solution to this water crisis. The model does not allow for productive communication and collaboration of all stakeholders affected by this issue. Actor-Network theory should be applied to create a circular handoff model, shown in Figure 3 below, that provides more avenues for all stakeholders to contribute to an effective sociotechnical solution. Navajo communities must be

included in the initial discussion of potential water treatment and distribution options, as they are directly affected by these projects. Additionally, their knowledge of problems specific to individual communities will aid in designing more effective case by case solutions. It is the responsibility of U.S. engineers and researchers and Navajo engineers and researchers to understand the needs as well as beliefs of the Navajo people. If engineers fail to communicate with and learn from the Navajo, designed solutions will continue to fail the Navajo people.

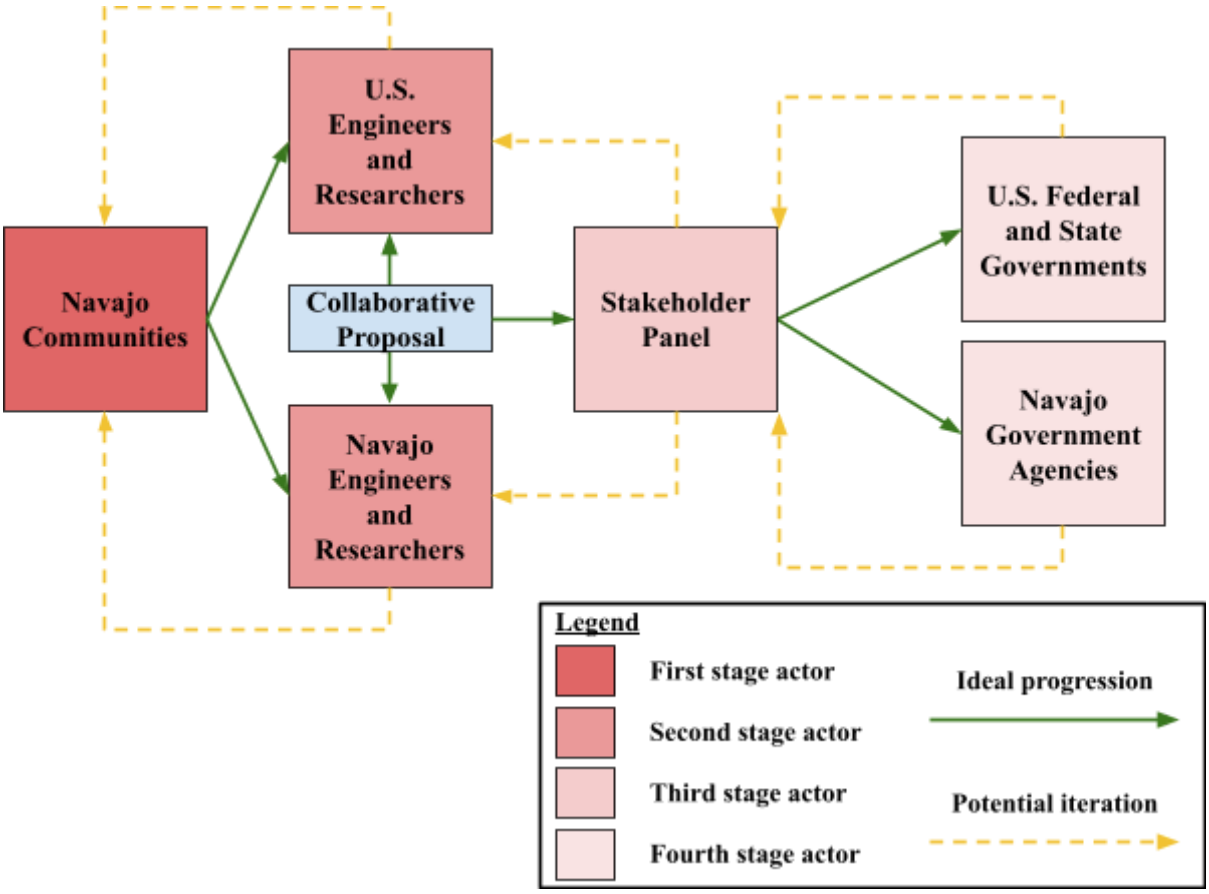

Figure 3: Methodology for Better Practices: This figure displays how an effective water resource solution would be developed and diffused through society. (Adapted by Caroline Marquis (2020) from Carlson 2009)

A recommended avenue for assessing the needs, values, and desires of the Navajo people would be through an engineering survey. The results of this survey will help in directing the engineer's design to incorporate both social and technical considerations. Developing trust is an

important aspect of community-based participatory research, and is cited as a necessary element for the success of group processes (de Lemos et. al, 2007, p.3). Cultural education for U.S. engineers and researchers prior to in-field study will help to minimize the risk of disrespecting Navajo culture. This education in addition to collaboration with Navajo experts will help to foster an environment of trust. The next stage in this new model is the development of an engineering proposal that includes both Navajo and U.S. sociotechnical expertise. This proposal would then be sent to a stakeholder panel composed of elected Navajo community leaders, engineers and researchers, and state representatives from Arizona and New Mexico. Adding this stakeholder panel to this process will help to eliminate any miscommunication between engineers and both the U.S. and Navajo governments. The engineering code of ethics and United Nations Declaration of Indigenous Rights must be referenced when this panel meets to ensure ethical proceedings. History has shown that the U.S. federal and state governments have struggled to actively listen to Navajo government proposals. Many treaties have been broken and Navajo rights sacrificed for the sake of economic progress. This panel will help to ensure that a variety of perspectives are considered before any government action is taken. Ultimately, the U.S. and Navajo government must work together to enact policy changes and designate funds to address this water crisis.

MOVING TOWARDS BETTER WATER RESOURCES PRACTICES

While projects like the Navajo Water Project have been successful in helping people within these vulnerable communities get clean water, long-term sustainable change will only be brought on by changes to the way the U.S. government regulates water and interacts with the Navajo government. Engineering solutions of the past have often not fully addressed these problems. For example, United States uranium mining and other industrial practices have led to

many environmental and socioeconomic problems around water quality and quantity. To provide a framework for this interaction, this solution applied Actor-Network Theory to create a circular handoff model of technological innovation. This analysis has highlighted that the best engineering practices include past, present, and future considerations by incorporating indigenous values into current practices. An ethical engineer is a sociotechnical expert and therefore must always start with the human factor. In the case of the Navajo Water Crisis, engineering sustainable practices means placing traditional human values at the forefront of design thereby confronting the water practices of the dominant society.

An additional avenue for engineers to explore is how to incorporate other indigenous values and goals into their design. For example, in recent years many tribes have expressed interest in green energy. Solar-powered home water treatment systems could remove uranium from water hauled by the Navajo. Rain barrels could also supply a source of water thus minimizing the amount of water that needs to be hauled. A topic that should be explored further in the future in relation to indigenous water rights is the question of whether sacred water bodies should be given human rights. The Māori tribe in New Zealand has successfully fought for the Whanganui River to have the legal rights of a human. This act ensures that the river cannot be mistreated by any human practices.

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