UTTON TRANSBOUNDARY RESOURCES CENTER

EARTHEN DAM REMOVAL IN NEW MEXICO

A study investigating the barriers to and the feasibility of removing dams across the state

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SUMMARY

Dams in New Mexico serve many functions—providing water storage for agricultural, municipal, and industrial use, controlling floodwaters, and protecting water necessary for interstate compact compliance. Because water supply reservoirs and their corresponding dams play a major role in providing New Mexico with water for drinking and irrigation, it is necessary to consider the long-term role of dams in the state. A significant number of dams in New Mexico are no longer structurally sound or no longer serve their original intended function. Modifying or removing an aging dam and restoring the waterway is often cheaper than continuing to maintain a dam that no longer serves its intended purpose.[1] Should funding be available, many of these older dams could be modified or removed to improve community access to the river, revitalize riparian ecosystems, restore natural river flow, reduce evaporation out of reservoirs, and potentially increase surface water available across New Mexico.[2]

Dams ripe for modification or removal were identified using information from the National Inventory of Dams and ecological criteria determined by the New Mexico Game and Fish Department. This analysis is intended to stimulate conversation around the future of dams in New Mexico and serve as a foundation for future investigations.

Image is not of a specific dam, but it exemplifies the terrain and geography of northern New Mexico, east of the Sangre de Cristos, where so many privately owned dams listed in this report are located. *Photo by Rin Tara*

1 *See* David L. Deen, *Defunct Dams Still Damage Rivers,* Connecticut River Conservancy (Oct. 14, 2016), https://www.ctriver.org/defunct-dams-still-damage-rivers/.

2 *See* EPA, Frequently Asked Questions on Removal of Obsolete Dams 2 (2016).

BACKGROUND

PURPOSES OF DAMS

The Bureau of Reclamation defines a dam as a structure "built across a watercourse to impound or divert water."[3] Dam construction across New Mexico and the West began in earnest around 1900, to store enough water to irrigate the growing agriculture industry and control the annual flooding on rivers like the Rio Grande.[4] Most dams in New Mexico were built during the 20th Century, although irrigation systems, like acequias,[5] have been employed in New Mexico for centuries.[6] Dams grew in popularity as the United States entered the era of modern industrialization, and the majority of large-scale dam projects were approved and constructed between 1930 and 1965.[7] Based on the available data from the National Inventory of Dams, most dams in New Mexico are used for water storage or flood prevention.

Water storage dams generally create reservoirs, which hold water for irrigation and human and stock consumption. Flood prevention dams seek to divert or hold water in such a way that prevents flooding from impacting human lives or structures.[8] Many dams serve both purposes. A complex system of laws, compacts, and doctrines governs the usage of water in these reservoirs.

Queen Isabella first acknowledged existing water rights in New Mexico during Spain's occupation. Spain consistently recognized the Pueblos' right to use under the Doctrine of Repartimiento de Agua.[9] This system allowed all parties to share of water during shortages, with no seniority of water rights.[10] These same rights were then recognized by Mexico and eventually by the United States government, until 1907, when the Doctrine of Prior Appropriation was codified New Mexico.[11]

The Doctrine of Prior Appropriation,

This is Hopewell Lake outside Tres Piedras. Not on the list, but geographically and functionally similar to many dams on the list.
Photo by Rin Tara

also referred to as "first in time, first in right", establishes a priority system that allocates water based on the seniority of water claims. In years of shortage, those with the earliest priority dates can make a priority call and use the limited water before those with more junior claims.

This doctrine, in its early application, ignored the obvious seniority of indigenous peoples who had lived throughout the West for thousands of years.[12] In 1908, the Supreme Court acknowledged the seniority of tribes' water rights, but many of these rights have never been quantified.[13] The Doctrine of Prior Appropriation was adopted in New Mexico in 1907 to encourage the Bureau of Reclamation to invest in large-scale water storage projects, such as the Carlsbad Irrigation District and Elephant Butte Reservoir.[14]

While the official adoption of Prior Appropriation allowed the Bureau of Reclamation to work in New Mexico, it did not change the existing water allocation norms in the state.[15] In other words, the system of Prior Appropriation exists in New Mexico, but is often not enforced. Although permits for water usage are issued through the Office of the State Engineer with priority dates, New Mexico engages in shortage sharing far more often than strict priority enforcement.[16] The state's complex water allocation history informs present-day water management.

DAM REMOVAL NATIONWIDE

Dams are removed for a variety of reasons. Most of the successful dam removal in the United States occurs east of the Mississippi, where water has been a historically abundant resource. For example, a 21-foot-high dam on the South Branch of the Gale River in New Hampshire was removed pursuant to the requirements in the Special Use Permit from the Forest Service which allowed the dam to be constructed by a local company for a water supply system in 1955.[17] The permit in question expired and the water supply system was no longer in use so the permit could not be renewed. New Hampshire's government identified river connectivity as a priority, which motivated the state to remove the dam completely,[18] in collaboration with Federal agencies and non-profits.[19]

In the West, dam removal projects tend to be focused on decrepit and dangerous dams. These projects are generally completed with private or non-profit funds and project management. In Santa Fe, New Mexico, the 25-foot-high Two Mile Dam in Santa Fe Canyon was decommissioned due to safety concerns, and the land on which the dam was located was sold to the Nature Conservancy.[20] The Nature Conservancy went on to restore the natural wetland of the Santa Fe River,[21] which had not been a wetland since the dam's construction in 1893.[22]

In Lake City, Colorado, the Hidden Treasure Dam, a historic but defunct dam built in the 1890s,[23] was removed by the private owners to reduce the flood risks on Henson Creek after winter runoff.[24]

In Hotchkiss, Colorado, the Conservation Alliance sponsored and managed the removal of the Chipeta Dam, an obsolete 4-foot-high diversion dam built in the 1950s,[25] on the North Fork of the Gunnison River.[26]

Lastly, Jefferson County in Colorado removed the Hall Dam, which was located adjacent to a recreation area. The dam removal was accompanied by the restoration of the neighboring recreation area following a historical 2013 flood.[27] These projects demonstrate that where funding, political will, and relevant science are all available, dam removal is possible in cases where the dam in question is no longer in use.

SUCCESSFUL DAM REMOVAL ON TRIBAL LANDS

Tribes all over the United States have been successful in removing dams on waterways within or adjacent to their tribal lands. The St. Regis Mohawk Tribe in upstate New York orchestrated the removal of the Hogansburg Dam on the St. Regis River.[28] The Hogansburg Dam was originally constructed over a century ago and had been refurbished for hydroelectric power in the middle of the 20th Century.[29]

When the dam was up for relicensing in the 2000s, the dam owner did not want to make the necessary updates to continue operating the dam.[30] The St. Regis Mohawk Tribe used the opportunity to become a co-licensee in the dam.[31] The Tribe then coordinated with the Fish and Wildlife Service, the New York State Department of Environmental Conservation, and a non-profit organization Trout Unlimited, to remove the dam and restore salmon habitat.[32]

The Penobscot Indian Nation was instrumental in removing a series of dams from the Penobscot River and restoring river flow.[33] This project began with a settlement related to the Lower Penobscot River hydroelectric projects filed with the Federal Energy Regulatory Commission in 2004, which addressed fish passage, energy generation, and Tribal issues.[34] The settlement created a Trust, which oversaw and funded the removal of three dams, beginning in 2012.[35]

Most famously, perhaps, is the incredible impact of the Elwha River Restoration Act in restoring the Elwha River.[36] There, the Lower Elwha Klallam Tribe was able to include the transfer of some land from Olympic National Park back into trust for the Tribe.[37] This was possible because of the Treaty of Point No Point, which reserved certain tracts of land in trust for many of the tribes in the Olympic National Park area.[38] This, coupled with the Boldt Decision, from *U.S. v. Washington*, which explicitly stated that Tribes in Washington were entitled to 50 percent of the salmon in the state, paved the way for dam removal on the Elwha River.[39] In participating in the dam removal process, Tribes have the opportunity to further improve tribal resources.

DAM MODIFICATION TO MEET ECOLOGICAL NEEDS

In some cases, where funding is unavailable for large-scale dam removal, it may be possible to modify existing dams to prioritize the human and ecological needs of a given area. This is exemplified in the 2016 Biological Opinion for the Rio Grande silvery minnow (silvery minnow). The silvery minnow, which is Federally listed as an endangered species, lives in the middle reach of the Rio Grande in New Mexico and relies on river connectivity for pelagic spawning.[40] In the Middle Rio Grande, four dams impact river connectivity in this area, including Cochiti Dam, Angostura Diversion Dam, Isleta Diversion Dam, and San Acacia Dam.[41] These dams cause population segmentation,[42] in addition to impacting the silvery minnows' pelagic spawning.[43]

The 2016 Biological Opinion included a reasonable and prudent measure that likely would alter long-term population outcomes—the creation of fish passages in existing dams, like San Acacia.[44] Fish passages are structures that allow silvery minnows and other fish to bypass dams, which are normally a serious obstacle to fish movement and pelagic spawning.[45] Silvery minnows have demonstrated their ability to use fish passages both in a lab setting and in a natural setting.

This is Hopewell Lake outside Tres Piedras. Not on the list, but geographically and functionally similar to many dams on the list.
Photo by Rin Tara

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CURRENT SITUATION

INFRASTRUCTURE

Many New Mexico dams are structurally outdated and in need of repair.[46] More than fifty percent of dams in the United States were constructed half a century ago.[47] Most dams were constructed to last about fifty years, plus or minus ten years.[48] Nearly 85% of dams, nationwide, have reached the fifty-year mark and thus the end of their originally anticipated lifespan.[49] In New Mexico, where the National Inventory of Dams has recorded 407 dams, the average dam is 57 years old.[50] This means that the average dam in New Mexico has already outlived its intended lifespan.

Almost half of New Mexico's high hazard dams are in poor or unsatisfactory condition.[51] Federal dam safety regulations state that poor condition applies to a dam in which deficiencies within the dam could realistically occur and unsatisfactory condition applies where a safety deficiency requires immediate emergency remediation.[52] High hazard dams are categorized as such because their catastrophic failure has the high likelihood of causing loss of life.[53]

Owners of high hazard dams in New Mexico are required to maintain Emergency Action Plans (EAPs), which detail what the entity responsible for the dam will do in the event of a catastrophic dam failure. An EAP is a document submitted to the Office of the State Engineer that details conditions that could cause a dam emergency, proactive steps that can be taken to prevent emergency, and actions that can prevent loss of life or property in the event of a dam emergency.[54] Many of the high hazard dams within New Mexico lack the required EAP.

As development in New Mexico

continues, areas that used to be low hazard become more populated and the hazard level for the failure of the dam increases, sometimes referred to as hazard creep.[55] This exemplified in areas like the Rio Chama floodplain, where residential and commercial structures have been constructed in the floodway of the Chama without regard to the risk of significant human and structural costs in the event of a flood event.[56]

The repair needs for the infrastructure of many of the dams in New Mexico far outweigh the funding available to repair the dams.[57] Consequently, low hazard dams, those for which failure of the dam would not lead to significant loss of life, fall to the bottom of the list when it comes to dam repair and replacement.

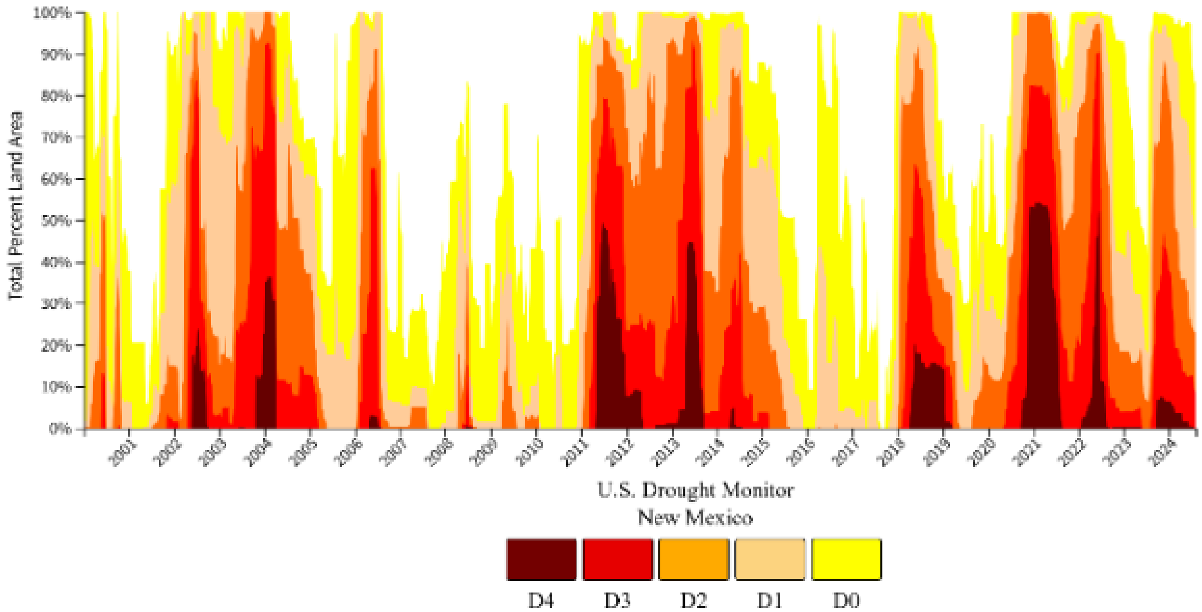
Although some funding is available through the National Dam Safety Program Act,[58] most of this funding is limited to high hazard dams and states must apply for the funding directly.[59] Funding is not available to the significant number of the dams in need of maintenance that are owned by local governments or private parties, or those dams that are classified as "low hazard". Furthermore, tribes appear to be ineligible to apply for these funds independently of states.

Documentation of dams on tribal lands varies across tribes. The Bureau of Indian Affairs (BIA) maintains one database of dams on tribal lands. Independently, another expert estimates that there are upwards of 800 dams on tribal lands in New Mexico.[60] The current data for dams in New Mexico likely does not accurately represent dam structures across all tribal, pueblo, and nation lands, particularly because of the disconnected nature in which dams on tribal lands have been managed and the necessity of maintaining tribal sovereignty.

CLIMATE CHANGE

Water stored in reservoirs behind dams is vulnerable as annual temperatures rise and increase evaporation. New Mexico, and the American southwest are experiencing increased aridity resulting from climate change.[61] Climate change contributed to the severe, widespread drought that began in 2000 and is ongoing across the western United States.[62] Between 2000 and 2020, average temperatures in New Mexico rose between 1.4 and 2 degrees Fahrenheit.[63] Both drought and warmer temperatures reduce water levels in reservoirs.

While water loss, to some degree, is inevitable, evaporation can be minimized by changing how water is stored, either by storing water at higher elevations,[64] or by storing water underground in aquifers rather



Southwestern US Lands Under Drought Conditions, 2000-2024 (https://www.drought.gov/states/new-mexico#drought-overviewt).

than in reservoirs aboveground.[65] Dam removal and modification are important tools for climate adaption.

Current data indicates that droughts will likely become more prevalent due to global warming.[66] Global warming results in an increase in the annual ambient temperatures, also typical of a drought, which in turn increase evaporative losses in waterbodies.[67] A decrease in precipitation leads to reduced water levels in rivers, and when combined with increased water temperatures and evaporation, reduces river flow.[68]

These dramatically lower water levels, in turn, put stress on both individual organisms and entire riparian ecosystems.[69] Organisms under water experience higher rates of mortality.[70] Those that do survive are likely to seek more favorable conditions elsewhere.[71] As droughts become more common and widespread, riverine populations will suffer.

When coupled with global warming, impediments to waterway connectivity, such as dams, can further alter riverine ecology. Dams artificially alter the normal hydrological cycle of a river by impeding river flow and reducing maximum river flows downstream from the dam.[72] During a drought, this pattern is exacerbated due to lower water levels in reservoirs and waterways. Consequently, river ecosystems risk long-term population loss during periods of drought. The current drought conditions in New Mexico have exemplified this regime.

There is a need to develop a deeper understanding of the environmental impacts of various water storage patterns, volumes, and releases in reservoirs across New Mexico. This information could improve decision-making on dam operation, modification, and removal.

Image is not of a specific dam, but it exemplifies the terrain and geography of northern New Mexico, east of the Sangre de Cristos, where so many privately owned dams listed in this report are located. *Photo by Rin Tara*

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66 *See* EPA, *Climate Change Indicators: Drought*, https://www.epa.gov/climate-indicators/climate-change-indicators-drought (last visited Jul. 26, 2021).

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68 *Id.*

69 *Id.*

70 *Id.*

71 *Id.*

72 *See* Michael Collier, Robert H. Webb, John C. Schmidt, Dams and Rivers: A Primer on the Downstream Effects of Dams 7 (1996).

METHODOLOGY

This search for dams was limited to those owned by a local government or private parties. This was done to identify dams that do not usually receive funding for maintenance or removal. Earthen dams were selected for their prevalence in New Mexico and their straightforward construction.

The initial search focused on high hazard dams, those for which failure would cause a loss of life. However, removal of these dams can be costly and would require human relocation in some cases. Additionally, the federal government provides many funding opportunities for the repair and removal of high hazard dams.

In contrast, low hazard dams (those for which failure would cause no loss of life and little property damage) receive almost no funding attention despite being as old or older than many high risk dams.

Dam removal is a relatively novel concept and the removal of low hazard dams, which pose fewer barriers to completion, could provide helpful insights for the removal of high hazard dams in the future.

Global Positioning System (GPS) Coordinates for dams that met the criteria described above were copied from the National Inventory of Dams and cross-checked against the US National Dam Database.[73] These coordinates were then imported into CalTopo to create a GeoJSON file.[74] Each GeoJSON file was converted to a CSV file and imported into the QGIS mapping tool program.[75] These data were then overlayed with the environmental factors discussed below.

In analyzing which dams would be

ripe for removal or modification, many environmental factors were considered, including the maps created by the New Mexico Department of Game and Fish (hereafter NMDGF) as part of the New Mexico Environmental Review Tool "to inform and guide the Departmental wildlife and wildlife habitat conservation priorities and to inform the public in project and development planning."[76] These maps are helpful for identifying areas in which dam removal and riparian restoration would help protect biodiversity and aid the NMDGF in their mission to conserve and protect wildlife.[77] The New Mexico Environmental Review Tool created by NMDGF, provides Geographic Information System (GIS) map data for Fish and Wildlife Critical Habitat, Important Plant Areas, Species of Concern, and Wildlife Corridors.[78]

Important Plant Areas are locations within New Mexico that support a wide variety of sensitive plant species or are the last areas where endangered plant species are found.[79] The United States Fish and Wildlife Service Critical Habitat designations are areas of habitat considered necessary for the survival of species listed under the Endangered Species Act.[80]

Wildlife Corridors are modelled after a GIS analysis of mountain lion (Puma concolor) corridors across New Mexico and are designed to show the connections between core habitats for a variety of species.[81]

Lastly, Species of Concern Areas denote a species for which the United States Department of Agriculture (USDA) has concerns about its longevity.[82]

A future study could include data from the New Mexico Ripiarian Habitat Map tool (NMRipMap 2.0), which includes a variety of data maintained by Natural Heritage New Mexico.[83]

Each of the GIS maps described above was imported into QGIS. These datasets were then visually compared with dam locations. The datasets were included in the full criteria for evaluation. The criteria were as follows: FWS Critical Habitat, Important Plant Area, Species of Concern, Wildlife Corridor, year built/updated, and maximum storage. To identify the dams that should be considered for updates or removal, each criterion about a dam, including the presence of each ecological factor, and the area around the dam were weighted equally.

Given the 50-year lifespan of the average dam, any dam built before 1975 has exceeded their lifespan. Dams built before 1950 have exceeded their lifespan by more than 20 years. To prioritize dams that are more likely to fail based on age, dams built or updated before 1950 were given a point, dams built or updated between 1950 and 1969 were given half a point, and dams built or updated between 1970 and 2021 were not given any points.

Successful dam removal projects, as noted in the background section, tend to be completed on smaller dams. Given this precedent, it will likely be easier to begin with the removal of smaller dams, both from a financial and a scientific perspective. The removal of smaller dams will allow scientists and engineers to study the consequences of small-scale dam removal in New Mexico and optimize the process for larger dams. Consequently, reservoirs with a maximum storage of less than 100 acre-feet were given one point, those with less than 1,000 acre-feet of maximum storage were given half a point, and those with more than 1,000 acre-feet of maximum storage were not given any points.

The dams were then sorted based on the points they were allocated, those with the most points were identified as being the best candidates for removal. It is important to note that the selected criteria do not reflect the individual needs of the communities.

San Gregorio Dam. *Photo by Rin Tara*

73 National Inventory of Dams, *supra* note 53; US National Dams, *Homepage*, https://nationaldams.com/index (last visited Jul. 26, 2021).

74 Caltopo, *Homepage*, https://caltopo.com/ (last visited Jul. 26, 2021).

75 QGIS, *Homepage*, https://www.qgis.org/en/site/ (last visited Jul. 26, 2021).

76 New Mexico Department of Game and Fish, *Environmental Review Tool* (last visited Jul. 26, 2021), https://nmert.org/content/map?savedmap=2922.

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78 New Mexico Department of Game and Fish, *supra* note 80.

79 New Mexico Energy, Minerals, and Natural Resources Department, New Mexico Rare Plant Conservation Strategy 26 (2017).

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81 *Id.*

82 USDA, *Species of Conservation Concern Frequently Asked Questions* (Jun. 2016), https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fseprd507865.pdf.

83 Natural Heritage New Mexico, https://nhnm.unm.edu/ (last visited Dec. 9, 2024).

FINDINGS

The low hazard dam with the most points is the French Lake Dam. This dam is located in an important plant area, which is also designated as an area for species of concern. Additionally, is it also located within a wildlife corridor and was built before 1950. The other low hazard dams of note are Koehler Dam and El Paso Natural Gas Dam No. 5.

Although the remediation, modification, or removal of high hazard dams poses more hurdles than low hazard dams, these dams were still included in the body of research to develop a clearer picture of the potential for dam removal in New Mexico.

The high hazard dam with the most points is the Morphy Lake Dam. It was built in 1940 and has a maximum storage of 507 acre-feet. Morphy Lake Dam is located in an important plant area and in an area that is home to species of concern. This dam is also adjacent to an area designated as critical habitat by the Fish and Wildlife Service.

Other high hazard dams owned by local governments with similarly high points are the Alto Lake Dam, Los Alamos Canyon Dam, and McClure Dam. The Lake Maloya Dam also meets the above criteria, but it provides drinking water for a large swath of northern New Mexico and is therefore not a good candidate currently.

Among the privately-owned high hazard dams, Webster Dam, located outside Pecos, NM, on Philmont Boy Scout Ranch and the Jaritas Reservoir B Dam received the most points. Both dams are located in important plant areas, areas that are home to species of concern, and were constructed before 1920.

Overall, given the ecological criteria and current research, the dams most eligible to be considered for removal or modification pursuant to this analysis are El Paso Natural Gas Dam No. 5, French Lake Dam, and Koehler Dam. As noted earlier, this analysis is merely meant to guide conversations within the communities where each dam is located. It bears noting that these lists and analyses do not include an accurate representation of failing or high-hazard dams on tribal lands. While it was not possible to include undocumented dams for this limited analysis, there are likely a notable number of dams on tribal lands that would be eligible for removal or modification.

San Gregorio Dam. *Photo by Rin Tara*

NEXT STEPS

In the case of the dams identified in the previous section, the next step is to speak with dam owners and the communities around the dams identified to understand each dam's uses and functions, or lack thereof. In some communities, removal of dams and the restoration of natural river flow might serve local economies and ecosystems without significantly disrupting water supply for drinking and irrigation.[84] Other communities may need traditional dam and reservoir structures. The primary hurdle in both these cases is securing funding. As explained in the background section of the paper, federal funding is often not available for low hazard dam removal, and consequently many of these projects rely on private or non-profit funding.

In the case of unrecorded dams or other earthen impediments to waterway connectivity, the first step in the process is to create an inventory. Evidence indicates that the initial identification could be done via remote analysis. It may be possible to train artificial intelligence (AI, hereinafter) to scan high-quality satellite imagery to identify and catalogue dam-like structures in New Mexico. As an example, high quality Google Earth imagery, which is publicly searchable, could be used to train an AI to identify structures that may be dams. Publicly available cloud-computer AI programs, like Machine Learning program available in Earth Engine, may be able to perform the computations necessary.

To train an AI like the one mentioned above, it may be necessary to aggregate GPS (global positioning system) coordinates of known dams, manually, in order to effectively teach the AI which structures should be identified. One study used Google Earth Engine and Sentinel Imagery to identify tailings piles and detention dams in Brazil, with decent success.[85] The majority of the work was done in training the AI, which required 1,300 example site imagery, examples, and were compiled manually. Similarly, another study used Sentinel high-resolution imagery to detect beaver dams.[86]

Other options for imagery include Lidar (light detection and ranging) imaging which is very high-resolution but also very data intensive, or imaging available on OpenTopography.[87] OpenTopography presents its own set of challenges, since there are some gaps in data around Santa Fe, New Mexico, and nearby tribal lands, but this data can be pulled for free through a higher education institution.

Following identification of potential dam structures, individual communities must be given deference for next steps. Each analysis should consider the individual hazard of each dam, the potential for cascading failures between the dam in question and other dams in the same hydrological area, and the potential for hazard creep. In some cases, dams can be rebuilt or repaired to meet current standards and to provide the service that was dam was initially built to provide. In these cases, the dams might also be modified to meet any ecological needs, such as fish passage. In other cases, it will be necessary remove dams entirely either for safety reasons or to meet community needs.

ALTERNATIVE DAM STRUCTURES

In the case of diversions and other incomplete barriers to river connectivity, there is a growing body of research on natural weirs and meanders. Much of this work is discussed in Bill Zeedyk's book, *Let the Water do the Work*.[88] Often, work to restore river connectivity and improve ecosystem outcomes is not at odds with the creation of effective diversions or weirs. The work on removing full barriers, like traditional earthen dams, requires more consideration.

It is necessary to consider that many dams in the American Southwest provide water supply for drinking and irrigation.[89] Many communities rely completely on these reservoirs, particularly in dry years. One solution that has been employed in Arizona with relatively high levels of success is storing water supplies by recharging aquifers.[90] The current regulations in New Mexico make it difficult for aquifer recharging projects to receive the necessary traction.[91]

Existing New Mexico state legislation poses challenges for aquifer recharging programs including the limiting of aquifer recharging to governmental entities and requiring that the project be designed and built before a permit for actual recharging can be obtained.

If New Mexico legislation incentivized underground water storage, it would lessen the need for reservoirs, which contributes significantly to evaporative water loss.[92] The use of aquifers to store long-term drinking and irrigation water in New Mexico could expand the number of dams that are candidates for removal, while also making better use of the limited water resources available in the state.

Ongoing aridification reminds states like New Mexico of the need for creative water management and storage. Funding given directly to the communities working to assess their dam-related needs, remove failed dams, and modify existing dams can be the difference between an impacted waterway and a free-flowing river. Considering waterway connectivity alongside other factors like water storage and development will benefit river health and connectivity in New Mexico.

Image is not of a specific dam, but it exemplifies the terrain and geography of northern New Mexico, east of the Sangre de Cristos, where so many privately owned dams listed in this report are located. *Photo by Rin Tara*

84 Billington et al, *supra* note 7, at 2.

85 *See generally* Remis Balaniuk et al., *Mining and Tailings Dam Detection in Satellite Imagery Using Deep Learning*, 23 Sensors 6936 (2020).

86 Emily Fairfax, *Identifying Beaver Dams with Remote Sensing*, Emily Fairfax Science, https://emilyfairfaxscience.com/research/findingbeavers/ (last visited Dec. 11, 2023).

87 *See* OpenTopogreaphy, *Homepage*, https://opentopography.org/ (last visited Dec. 11, 2023).

88 *See generally* Bill Zeedyk & Van Clothier, Let the Water Do the Work (2014).

89 *See generally* Resources for the Future, Margaret Walls & Leonard Shabman, Federal Funding for Dam Removal in the United States (2020).

90 City of Tucson, *Recharged Water*, https://www.tucsonaz.gov/water/recharged-water (last visited Jul. 26, 2021).

91 *See* Stephen T. Finch, Jr., Aquifer Storage and Recovery: The New Mexico Story 22 (Oct. 17, 2019).

92 Chris Mooney, *Reservoirs are a Major Source of Global Greenhouse Gases, Scientists Say* (Sept. 28, 2016), https://www.washingtonpost.com/news/energy-environment/wp/2016/09/28/scientists-just-found-yet-another-way-that-humans-are-creating-greenhouse-gases/?utm_term=.6c4595f4220b; WildEarth Guardians, *supra* note 66, at 16.

APPENDICES

FINDINGS DATA

For further explanations of the following data, please see section "Findings" on page 20.

LOW HAZARD DAMS OWNED BY LOCAL GOVERNMENTS

Dam Name	FWS Critical Habitat	Important plant area	Species of Concern	Wildlife Corridor	Year built	Storage (max)	Ranking
EL PASO NATURAL GAS DAM NO. 5	Y-adjacent	Y-highest	Y-highest	N	1962, 1999	42 acre feet	4
SAN GREGORIO DAM	N	Y-lowest	Y-highest	N	1947, 1958	500 acre feet	3
BIBO	N	N	Y-second lowest	N	1969	64 acre feet	2.5
SIX MILE POWER DAM	N	N	Y-highest	N	1905	350 acre feet	2.5
SEBOYETA IRRIGATION DAM	N	N	Y-second lowest	N	1969	61 acre feet	2.5
CUBERO IRRIGATION	N	N	Y-second lowest	N	1971	68 acre feet	2
ANTELOPE VALLEY DAM NO. 2	N	N	Y-second lowest	N	1958, 1984	4,478 acre feet	1
ANTELOPE VALLEY DAM NO. 3	N	N	Y-second lowest	N	1920, 1931, 2000	1,280 acre feet	1

LOW HAZARD DAMS OWNED PRIVATELY

Dam Name	FWS Critical Habitat	Important plant area	Species of Concern	Wildlife Corridor	Year built	Storage (max)	Ranking
FRENCH LAKE DAM	N	very high	high	Y	1947	463 acre feet	4.5
KOEHLER DAM	N	N	moderate	adjacent	1911	90 acre feet	4
LEWIS RESERVOIR DAM	N	very high	moderate	N	1933	156 acre feet	3.5
ABBOTT LAKE UPPER DAM	N	high	moderate	N	1919	156 acre feet	3.5
ABBOTT LAKE LOWER DAM	N	high	moderate	N	1912	111 acre feet	3.5
BOLACK NO 1 DAM	Y	very high	high	N	1962, 2004	182 acre feet	3.5
WALL LAKE DAM	N	moderate	high	N	1949	188 acre feet	3.5
EKLUND STORAGE WORKS DAM	N	N	high	N	1915	32 acre feet	3
FORT HERON PRESERVE PHASE I DAM	N	very high	high	N	1950, 2001	66 acre feet	3
FORT HERON PRESERVE PHASE II DAM	N	very high	high	N	1950, 2002	18 acre feet	3

LOW HAZARD DAMS OWNED PRIVATELY

Dam Name	FWS Critical Habitat	Important plant area	Species of Concern	Wildlife Corridor	Year built	Storage (max)	Ranking
CHINO MINES DAM NO. 8	N	very high	moderate	N	1974, 2013	44 acre feet	3
CROWLEY IRRIGATION SYSTEM	N	very high	high	N	1950	180 acre feet	3
DWIGHT BAKER DAM	N	very high	high	N	1957	115 acre feet	3
URRACA DAM	N	very high	N	Y	1952	136 acre feet	3
CORRALITAS DAM	N	N	moderate	N	1942	90 acre feet	3
CHINO MINES RESERVOIR NO. 7 DAM	N	Very high	high	N	1959	499 acre feet	3
HORSE LAKE DAM	N	N	high	N	1935	552 acre feet	2.5
Aragon Dam	N	N	moderate	N	1942	281 acre feet	2.5
SNYDER LAKE DAM	N	N	moderate	N	1940	340 acre feet	2.5
ROMERO LAKE DAM	Y	N	high	N	n/a	363 acre feet	2.5
BERLIER RESERVOIR DAM	N	N	moderate	N	1953, 2004	97 acre feet	2
LA CUEVA DAM NO. 1	N	N	high	N	1935	6,510 acre feet	2
JARITAS DAM NO. 2	N	high	N	N	1902	1,760 acre feet	2
SINK HOLE GAP RESERVOIR	N	N	N	N	1943	91 acre feet	2
MAXWELL DAM NO. 2	N	N	moderate	N	1955	2,883 acre feet	1.5
VAN BRUGGEN RESERVOIR DAM	N	N	N	N	1904	106 acre feet	1.5
RED LAKE LA CUEVA DAM NO. 2	N	N	high	N	1950	6,510 acre feet	1.5

LOW HAZARD DAMS OWNED PRIVATELY

Dam Name	FWS Critical Habitat	Important plant area	Species of Concern	Wildlife Corridor	Year built	Storage (max)	Ranking
JAMES CANYON DAM	N	N	high	N	2002	980 acre feet	1.5
LAKE ISABEL DAM	N	N	N	N	1919, 1949	6,500 acre feet	1
HOWARD ROBERTSON DAM	N	N	N	N	1974	63 acre feet	1
POLING IRRIGATION SYSTEM DAM	N	N	low	N	1955	227 acre feet	1
WEATHERLY RESERVOIR DAM	N	N	N	N	1914	1,083 acre feet	1
MAXWELL DAM NO. 13	N	N	N	N	1955	4,951 acre feet	0.5
SMITHSON RESERVOIR NO. 1	N	N	low	N	1970	200 acre feet	0.5
SMITHSON RESERVOIR NO. 3	N	N	low	N	1970	255 acre feet	0.5
SMITHSON RESERVOIR NO. 4	N	N	low	N	1970	230 acre feet	0.5
HITTSON CREEK DAM	N	N	N	N	1974	600 acre feet	0.5

HIGH HAZARD DAMS OWNED BY LOCAL GOVERNMENTS

Dam Name	FWS Critical Habitat	In riparian corridor	Important plant area	Species of Concern	Wildlife Corridor	Year built	Affected River	EAP?	Storage (max)	Ranking
Morphy Lake Dam	Y-adjacent	Y	Y-outstanding	Y-highest	N	1940	Rio Morphy (?)	Yes	507 acre-feet	4.5
Lake Maloya Dam	Y	Y	N	Y-highest	Y	1914	Chicorica Creek River	No	5,030 acre-feet	4
Alto Lake Dam	Y-adjacent	Y	Y-outstanding	Y-highest	N	1965	Eagle Creek	Yes	449 acre feet	4
Los Alamos Canyon Dam	Y	Y	Y-moderate	Y-highest	N	1943, up. 2013	Rio Grande River	Yes	74 acre-feet	4
Nichols Dam	Y-adjacent	Y	Y-outstanding (adjacent)	Y-least concern	Y	1943, up. 1983, 1988, 2014	Santa Fe River	Yes	1,234 acre feet	4
McClure Dam	Y-adjacent	Y	Y-outstanding (adjacent)	Y-second least concern	Y	1926, up. 1936, 1947, 1988, 1995, 2015	Santa Fe River	Yes	4,278 acre feet	4
Cerro Dam	N	Y	Y-outstanding (adjacent)	Y-highest	N	1956	Latir Creek	Not Req'd	72 acre feet	3.5
Cimmaroncito Dam	N	Y	Y-very high	Y-highest	Y	1948, up. 1984	Cimmaroncito Creek	Yes	189 acre feet	3.5
San Mateo Lake Dam	Y-adjacent	Y	N	Y-highest	N	1935, up. 1954, 1984	San Mateo Creek	Yes	90 acre feet	3
Cabresto Dam	N	Y	Y-outstanding (adjacent)	Y-highest	N	2012	Lake Fork Creek	Yes	1,442 acre feet	2

HIGH HAZARD DAMS OWNED PRIVATELY

Dam Name	FWS Critical Habitat	Important plant area	Species of Concern	Wildlife Corridor	Year built	Storage (max)	Ranking
Webster Dam	N	Y- very high	Y	Y	1909	1,050 acre feet	4
Jaritas Reservoir B. Dam	N	Y-very high	Y	N	1917	57 acre feet	4
Ute Creek Dam	N	Y- very high	Y	Y	1913, mod. 1983	200 acre feet	3.5
Throttle Dam No 2	N	N	Y	Y	1914	5,000 acre feet	3
Bill Evans Dam	Y-adjacent	N	Y-highest	N	1969	2,375 acre feet	2.5
Costilla Dam	N	Y-outstanding	Y	N	1920, mod. 1993	30,000 acre feet	2
Springer Lake Dam	N	N	Y	N	1920, mod. 1985	8,200 acre feet	1
Miami Lake Dam No. 2	N	N	Y	N	1913, mod. 2009	4,140 acre feet	1