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Engineer of the Shoshone and Arapaho Tribes in Fort Washakie, Wyoming, technical studies in support of the Little Colorado River general stream adjudication, and water development projects for the Government of Eritrea. For the last eight years, John has been a civil engineer with the Navajo Department of Water Resources in Fort Defiance, Arizona. He is the branch manager of the Water Management Branch, which is responsible for providing technical support to the Navajo Nation's water rights efforts in five ongoing general stream adjudications in Utah, Arizona, and New Mexico. The Branch also provides technical support for the Navajo Nation's drought response, flood plain management, regional water planning, and watershed restoration.

NAVAJO NATION PLANS FOR THEIR WATER FUTURE

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This paper describes a Navajo Nation water development strategy. According to the dictionary, a strategy is the science and art of conducting a campaign on a broad scale, or the technique for achieving an end. Meeting the water development needs on the Navajo Nation requires a campaign. The development strategy is not a Navajo Nation regional water plan,

and it does not follow the New Mexico template for preparing regional water planning. However, regional and chapter water plans that follow the template are a component of the development strategy. The Navajo Nation is working closely with the Interstate Stream Commission to complete these plans (Figures 1 and 2).



Figure 1.



Figure 2.

The Navajo Nation is a complicated piece of real estate. It encompasses approximately 27,000 square miles within three states. For perspective, when New Mexico water planners look at the Navajo Nation they tend to see a landmass somewhere off to the west. But, when Navajo Nation water planners look at the Navajo Nation, New Mexico is a landmass somewhere off to the east. The perspectives are very different.

The Navajo Nation is bounded by the San Juan River on the north, the Little Colorado River on the south, and the mainstem of the Colorado River on the west. It lies largely within the Upper Colorado River, Lower Colorado River, and Rio Grande basins in Arizona, Utah, and New Mexico (Figure 3). The Navajo Nation, however, did not participate in the formulation of the compacts that allocated the use of water among these basins and states. Not only was the Navajo Nation not at the table, back in 1922 Navajos could not even vote. Consequently, the Navajo Nation

raises complicated unresolved problems. For instance, if you are at the Copper Mine Chapter, which is in Arizona, you cannot see the physical divide between the Upper and Lower Basins. And when you drive from NAPI, which is near Farmington, New Mexico, to Church Rock you can cross the continental divide three times. Yet, when the Navajo Nation tries to address these communities' long-term water supplies, the water management issues telescope into very, complicated dilemmas. That situation is partly the nature of the Four Corners Area, but water planners in the Pecos River Basin and other basins share some aspects of these same problems. The point is that from a water resources standpoint, the Navajo Nation encompasses a tremendously complicated piece of real estate.



Figure 3. Navajo Basins Map

Water Development Problem Statement

The water development strategy begins by describing some basic problems confronting the Navajo Nation. Unemployment on the Reservation is between 40-50 percent compared to 4 percent for the region (Figure 4). Per capita income on the Reservation is approximately \$5,000 per year, which is less than one fourth of the per capita income for the region (Figure 5). About half of the Navajo families on the Reservation live below the federal poverty levels compared to 13 percent of families for the United States (Figures 6-8). And, between 30-40 percent of households do not have direct access to public water systems.

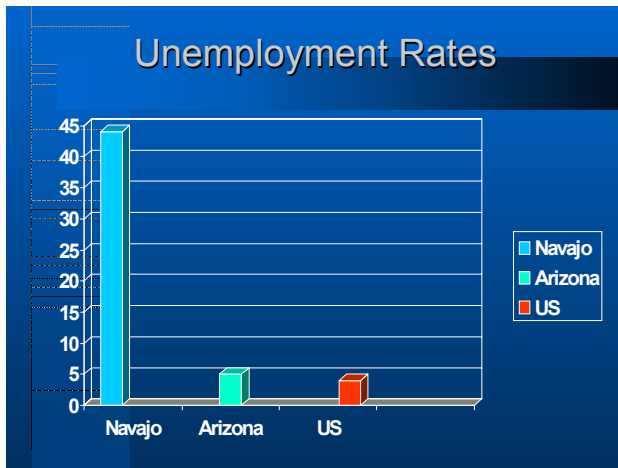


Figure 4. Unemployment Rates

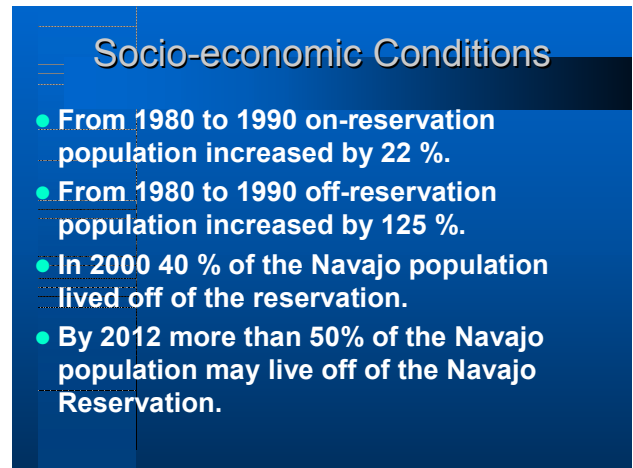


Figure 7. Socio-economic Conditions

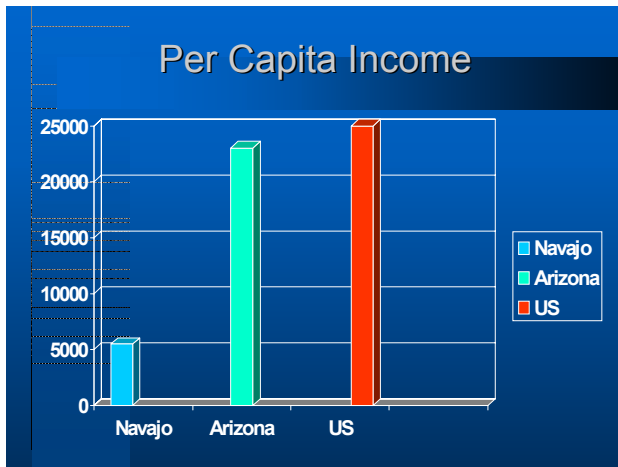


Figure 5. Per Capita Income

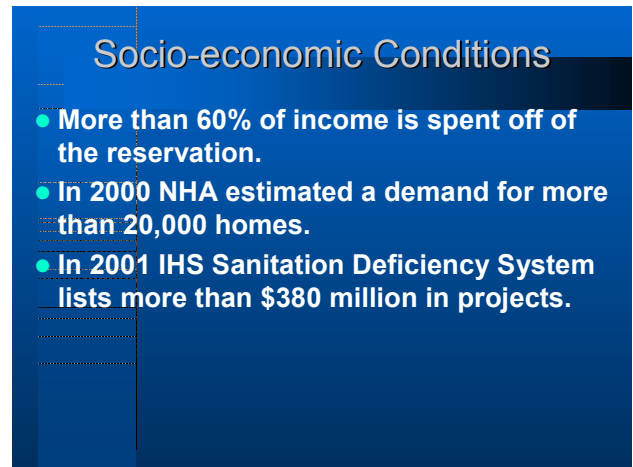


Figure 8. Socio-economic Conditions

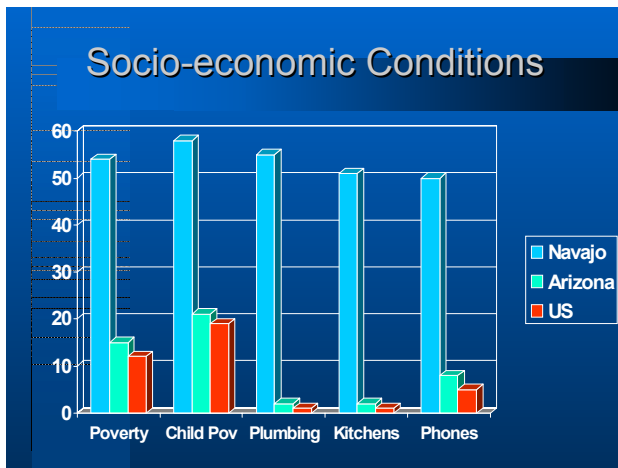


Figure 6. Socio-economic Conditions

The Navajo Housing Authority (NHA) estimated in the year 2000 an immediate demand for 20,000 additional homes on the Navajo Nation. The Indian Health Service (IHS) Sanitation System Deficiency List included \$380 million of projects. At current IHS funding levels, which are between \$15 and 20 million per year, there are decades of deficiencies with which to deal.

There is stress associated with these conditions. One result of this stress is out migration. According to the U.S. census, in the year 2000 the on-reservation population exceeded 180,000, but an additional 100,000, or approximately 40 percent of the Navajo people, live off of the reservation. From 1980 through 1990, the on-reservation population increased by about 22

percent, while the off-reservation population increased by 125 percent. The Navajo Nation Division of Economic Development projected that by 2012 more than half of the Navajo people will be living off the reservation. Out-migration is not unique to the Navajo Nation. Many Native American communities face this same challenge. But the fact remains that after more than 100 years of trusteeship, it is extremely difficult for the majority of the Navajo people to find a livelihood on the Navajo Nation, which is supposed to be a permanent homeland for the Navajo people. And, part of the reason for this failure is water.

The Navajo population is expected to increase by the year 2040 to nearly 500,000. The lack of infrastructure, the lack of economic development, the low per capita water use rates, and the sustained poverty are closely related. Implementing this strategy may not immediately create a sustainable economy for the Navajo Nation. But adequate water is a necessary, if not sufficient, condition for prosperity. And, if the proposed water projects can close these gaps by even a small percentage, the benefits that can be attributed to those projects are monumental.

Even when Navajos do have incomes on the Reservation, the dollars don't circulate on the Reservation. Instead, the dollars flee to the border towns, the Farmingtons, the Gallups, and the Albuquerque. The dollars go where the Costco's and Home Depot's are. For example, the Navajo Nation economy captures less than 8 percent of the \$660 million annual tourism revenue in the Four Corners area. If enhanced tourist infrastructure increases that percentage to 12 percent, the Navajo economy could generate tens of millions of dollars annually.

It is not correct to portray the Navajo Nation as a hapless victim. A lot is going on to improve these conditions. The Navajo Nation is investing its own resources and is working with other agencies to invest further resources (Figure 9). For instance, the Navajo Housing Authority is investing \$90 million a year in housing. The BIA Roads Program is investing \$60 million per year in roads. The Department of Energy Rural Electrification Program has authority to construct \$15 million in power lines. The Navajo Nation Department of Economic Development has 60 economic development projects with a total cost of \$312 million. These are all ambitious programs (Figure 10). But, every single project requires more water.



Figure 9. Navajo Economic Development

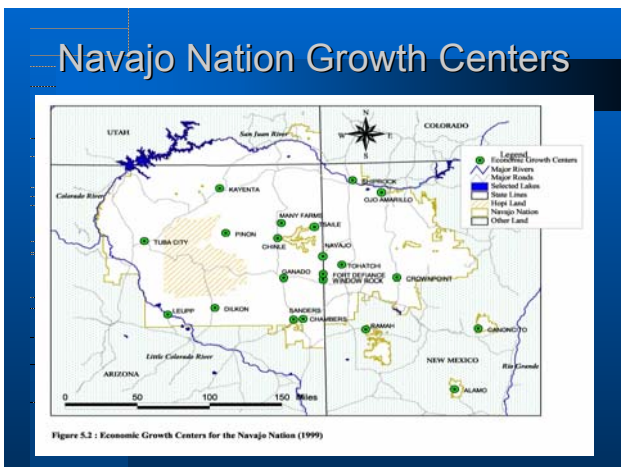


Figure 10. Navajo Nation Growth Centers

Time and time again, new infrastructure gets constructed, and the water infrastructure fails to keep up. For instance, four years ago in Navajo Mountain, Arizona, a high school was constructed with state funding and the public water system still does not have adequate capacity. In Pueblo Pintado, New Mexico, a high school is under construction and the NTUA public water system does not have enough capacity for it. And that is when the water department is forced to approach the States and others due to water supply emergencies.

The Navajo Department of Water Resources has developed a strategy to attempt to address this problem. The major components of this strategy are: 1) regional water projects, 2) improve small public water systems, 3) improve service to water haulers, 4) rehabilitation of small irrigation projects, 5) complete NIIP, 6) watershed restoration, and 7) drought mitigation and response (Figure 11).

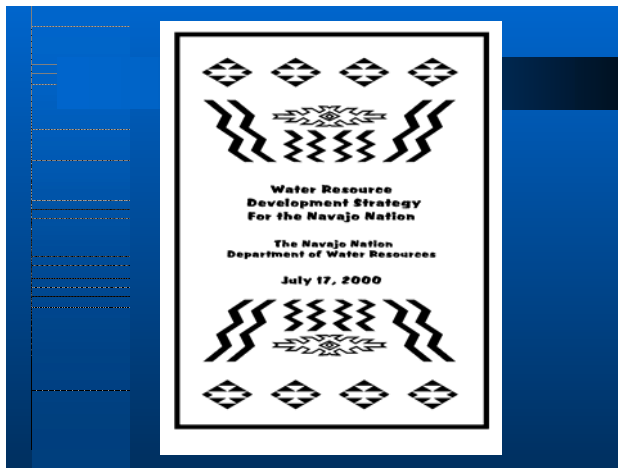


Figure 11. Water Development Strategy

Additional efforts are being made in a number of other areas including, among others, improving the reliability of stock water, improving unsafe dams, and improving flood plain management.

Regional Water Supply Projects

The water development strategy component includes proposals for several large regional water supply projects: 1) the Western Navajo Pipeline, 2) an alternate water source to the Peabody Mine, 3) the Three Canyon Project, 4) the Ganado Regional Project, 5) the Central Navajo Utah Project, 6) the Farmington to Shiprock Pipeline, and 7) the Navajo-Gallup Water Supply Project. These regional water projects make up different pieces of the Navajo Nation's water supply puzzle (Figure 12). Of particular interest to New Mexico are the Farmington to Shiprock Pipeline and the Navajo-Gallup Water Supply Project.

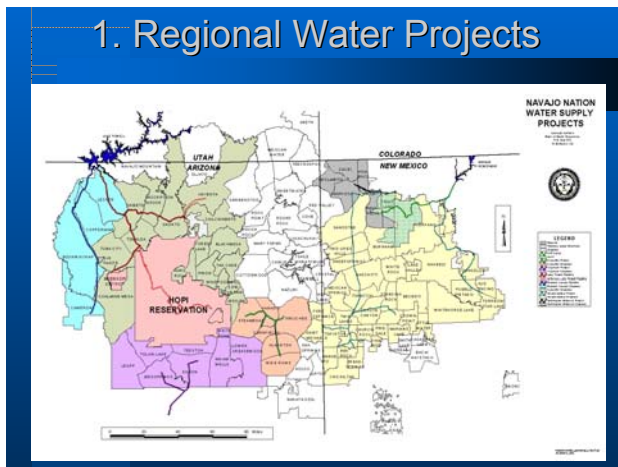


Figure 12. Regional Water Projects

The Farmington to Shiprock Project was authorized as a component of the Animas La Plata Project. It will convey more than 4,600 acre-feet of municipal water to the Shiprock area. Along with conveying water to Shiprock, this project has the potential of enhancing the water supply infrastructure on the western side of the City of Farmington.

The Navajo Gallup Water Supply Project (Figure 13) will convey 37,000 acre-feet of water to 40 Navajo chapters in New Mexico and Arizona, the City of Gallup, and the southern part of the Jicarilla Apache Nation. It will include the largest water treatment in New Mexico, which will be located just outside Kirtland, New Mexico. The Navajo-Gallup Water Supply Project will cross the Farmington to Shiprock Pipeline creating the opportunity for regional conjunctive operation.

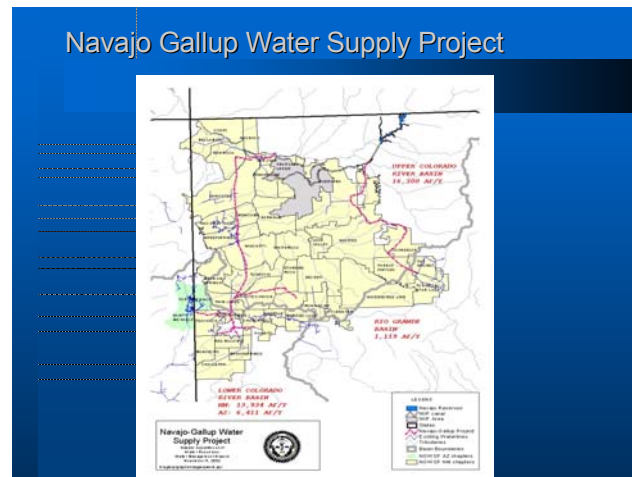


Figure 13. Navajo Gallup Water Supply Project

The Navajo-Gallup Water Supply Project includes two separate laterals. The Cutter Lateral begins at the Cutter Reservoir and conveys water south along Highway 371 toward Pueblo Pintado. The Cutter Lateral will serve the southern part of the Jicarilla Apache Nation, and possibly could include service to communities like Lindrieth. The main Navajo-Gallup Project lateral will divert water from the San Juan River at the existing Public Service Company of New Mexico San Juan Generating Station Diversion and convey water along Highway 491 south toward Window Rock and Gallup. There are trade-offs associated with the point of diversion. For instance, the further upstream the point of diversion is located, the better the water quality. However, the further

upstream the diversion, the impacts on the endangered Colorado Pike Minnow increase. This point of diversion minimizes the impacts to endangered species. And the releases made from Navajo Reservoir for this diversion can contribute to the river flows passing Bloomfield and Farmington.

The Navajo-Gallup Project includes sustainable conjunctive groundwater development. Some Navajo communities will not initially be served by surface water, but their demands will be included in the Project laterals. Even with the Navajo-Gallup Project, the Navajo Nation's municipal groundwater use will double in the Navajo-Gallup Project service area.

The Navajo-Gallup Water Supply Project will serve Window Rock, Arizona, which is the capitol of the Navajo Nation, and one of the larger Navajo communities. Many people question why the Navajo Gallup Project needs to serve communities within Arizona. They suggest that Window Rock can be served with local groundwater instead. The first response is that the Navajo-Gallup Project includes conjunctive groundwater development, and it will develop municipal groundwater to sustainable levels. But, to meet additional demands, Window Rock would need to develop groundwater 40 miles west from the Coconino Aquifer near Ganado. But the Navajo Nation already has projected water demands in the Ganado Area. So, if the Window Rock water demand is shifted to the Ganado Regional System, there is the risk of an inadequate water supply for Ganado Area. Then the Navajo Nation would need to shift Ganado's water demands over to the Three Canyon Project, which will serve the southern part of the Navajo Nation including Leupp and Dilcon. And, if the Three Canyon Project has inadequate water to serve those additional shifted Ganado demands, then the Navajo Nation may have to go all the way to Lake Powell to make up the difference.

The Western Navajo Pipeline begins at Lake Powell and conveys water to Cameron. In some respects, it is a mirror image of the Navajo-Gallup. And, like the Navajo-Gallup Project, it could convey water to non-Navajo communities, in this case the Flagstaff area. The Navajo-Gallup Project, the Ganado Project, the Western Navajo Pipeline, and the Three Canyon Project, all fit together like pieces of a gigantic puzzle.

One cannot say whether the Western Navajo Pipeline is a higher or lower priority than the Navajo-Gallup Water Supply Project. The Navajo Nation

needs both. And, the Navajo Nation must address the water supply needs of all its communities. The water development strategy is intended to do just that. There is a similar vision evolving for the State of New Mexico. One of the objectives of the State Water Plan is to find ways to fit together the pieces of the New Mexico puzzle.

Improve Small Public Water Systems

Another component of the water development strategy is improving the smaller public water systems (Figure 14). The Navajo Nation includes approximately 230 public water systems. Many of these public water systems, like many of the systems throughout the rest of the State of New Mexico, need lots of work.

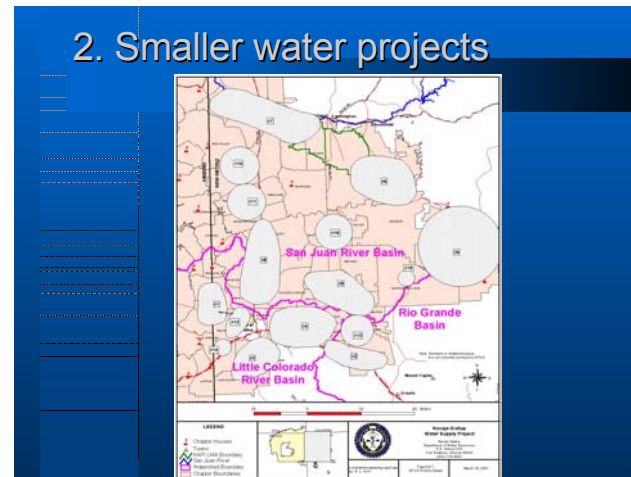


Figure 14. Smaller Public Water Projects

The Navajo Tribal Utility Authority (NTUA) operates more than 90 of the public water systems on the Navajo Reservation. NTUA has ranked its systems based on capacity, infrastructure, and water source. There are several examples of these smaller municipal water development projects. The Page to Le Chee Project, the Albuquerque to Tohajiilee Pipeline, and the Gallup Regional System, which will serve Manuelito, Church Rock, Bird Springs and other communities surrounding Gallup, are examples of these smaller municipal projects. These projects are smaller than the regional projects, and they have shorter planning horizons. But, these projects include greater per capita demand than the Indian Health Service projects because they are intended to include commercial uses. And, many of these projects involve partnerships with local communities. So, instead of adversarial relationships with the border towns, it may

be possible to work collaboratively with these communities.

Improve Services to Water Haulers

Another component of the water development strategy is to improve services to water haulers (Figure 15). On the Navajo Nation, more than 30 percent of the households haul water for their domestic needs. Urban water users in the region pay approximately \$600 per acre-foot for domestic water. On the Navajo Nation, hauling water costs about \$18,000 per acre-foot. One could assume that Navajos must be the richest people in New Mexico if they can afford to pay that much for water. But the reality is that the folks that can least afford it are paying the highest costs. Hauling water in 50-gallon drums over dirt roads is very expensive. And, as water becomes more and more expensive, people use less and less of it. Consequently, per capita water use is very low.



Figure 15. Improve Service to Water Haulers

The big regional projects might serve 60 percent of the chapters. The Indian Health Service assumes that above a certain expense, homes become infeasible to serve from a public water system, and the Navajo Tribal Utility Authority will not accept operation of a system with fewer than three meters per mile. So, many families on the Navajo Nation will be hauling water for a long, long time. The Navajo Environmental Protection Agency is looking more closely at the number and location of households that haul water. They are trying to develop approaches to improve services to water haulers. This effort may result in

additional watering points, or possibly in-household micro-water treatment systems.

Rehabilitate the Small Irrigation Projects

Another component of the water development strategy is rehabilitating the small irrigation projects (Figure 16). During the late 1980s, the Natural Resources Conservation Service conducted an inventory of more than 80 small Navajo irrigation projects and observed that more than half of the project acreage was no longer irrigated. These systems are caught in a cycle of irrigation system deterioration. It is happening on the Navajo Nation, and throughout Indian country. Many irrigation projects suffer from deferred maintenance, which results in a loss of water control. With reduced water control, the water users are less inclined to pay water assessments for operation and maintenance. With fewer resources for operation and maintenance, maintenance is furthered deferred, which leads to further reductions in water control. For a few years, the operators can get away with deferring maintenance. But after a few years the systems deteriorate. The main part of this problem is institutional.

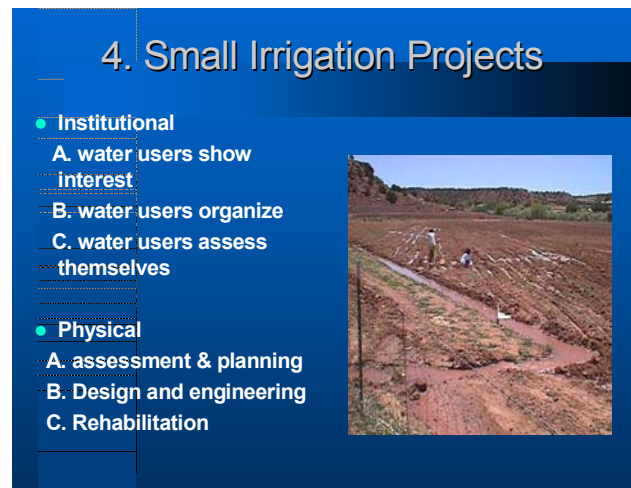


Figure 16. Small Irrigation Projects

The water users were disenfranchised from their own systems. The original systems were operated by their Navajo water users. Then, in the early part of the last century, the systems were subjugated by the federal bureaucracy. And, over time the federal bureaucracy was replaced by Tribal programs. But, the water users were still disenfranchised. It is an institutional problem (Figure 17).

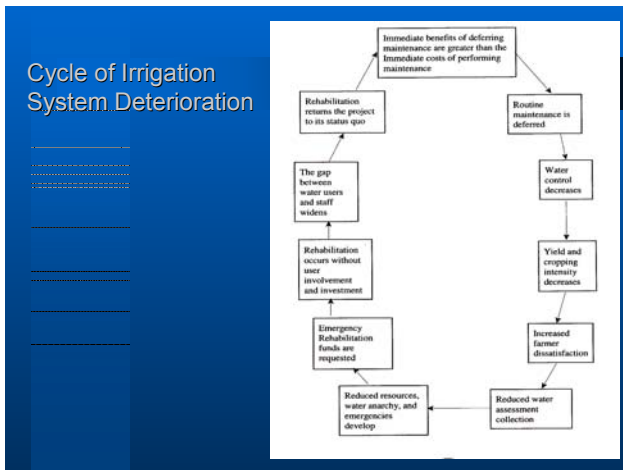


Figure 17. Cycle of Irrigation System Deterioration

One approach to rehabilitation would be a prioritized list of the 80 Navajo irrigation projects. But, that is not how this strategy works. Part of this strategy is not to force federal programs to re-order their current criteria. Instead, it is to coordinate better the resources on irrigation projects where more than one federal agency is working on a specific project. If they are all working together, can they coordinate their activities to do the irrigation project?

Another part of the approach is to create incentives for institutional development and for empowering the water users. Assessment and planning for irrigation projects target those irrigation systems where the water users are interested in organizing and taking some responsibility for irrigation. Design and engineering for irrigation projects specifically target those irrigation systems where the water users have organized. And finally, rehabilitation specifically targets those irrigation systems where the water users are assessing themselves for the operation and maintenance. If the water users are interested in assessing themselves and investing in their own systems, then the water managers should do everything in their power to complete the assessments and planning, the design and engineering, and the actual rehabilitation. There's a long history on the Navajo Nation, and elsewhere, of lining canals and other improvements without changing this cycle of deterioration.

Complete the Navajo Indian Irrigation Project

Another component of the water development strategy is completing the Navajo Indian Irrigation Project (NIIP) (Figure 18). NIIP was authorized in

1962 along with the San Juan Chama Project. The San Juan Chama Project, which diverts water from the San Juan River system to the Rio Grande Basin, was completed in a few years. NIIP, however, is only about 60 percent complete. Even though it faces difficult challenges, completing NIIP is still very important to the Navajo Nation. According to the original authorization, at full build-out NIIP will be more than 110,000 acres, making it the largest irrigation project in New Mexico.



Figure 18. Complete NIIP

The current operation and maintenance of the NIIP canal system is \$4 - \$6 million a year. When it is completed, its operation and maintenance may be \$8 - \$12 million a year. This expense is a huge burden. However, the Navajo Nation has made tremendous strides toward improving the management of NIIP. The farm can work. During the last few years many recommendations to improve its management have been implemented. With vertical integration, NIIP can create the jobs and livelihoods that were part of the project's original purpose.

Watershed Restoration

Another component of the water development strategy is watershed restoration (Figure 19). The Navajo Department of Water Resources has worked with various agencies on comprehensive watershed restoration approaches with mixed success. Many of the proposed treatments are controversial. And as the number of land users increase, the potential conflicts increase in a compounded fashion. Consequently, many of the comprehensive watershed efforts have collapsed under their own weight.



Figure 19. Water Restoration

It is always difficult finding land users who are interested in cooperating with watershed restoration, and who will follow through on the commitments needed to make restoration treatments work. On the Navajo Nation there are additional problems including among others, permitting and clearance problems, fencing problems, grazing disputes, and Chapter disputes. So instead of pushing watershed wide efforts, the Department is proposing 100 demonstration projects over the next five years. Because it is so difficult on the Navajo Nation to get land users, the Navajo staff will work with one land user at a time. The energy needs to go into identifying land users who are willing, and able, to participate in these programs.

The BLM has provided excellent support in the Rio Puerco Watershed. And the Navajo Nation has also worked on demonstrations in the Zuni Watershed in New Mexico, and in Tsaile, Asaayi, and Canyon De Chelly watersheds through the Arizona Water Protection Fund.

Drought Mitigation and Response

Another component of the water development strategy is drought mitigation and response (Figure 20). The entire region is confronting a prolonged drought. In 2002 the Navajo Nation Emergency Management Commission adopted a drought response plan that follows the outline provided by the Nation Drought Mitigation Center. For instance, the Navajo Nation has ranked the public water systems based on drought risk. The Navajo Nation drought declaration process is very similar to the process used by the State of New Mexico. The levels of drought emergency are based on the six-month Standard Precipitation Index (Figure 21).

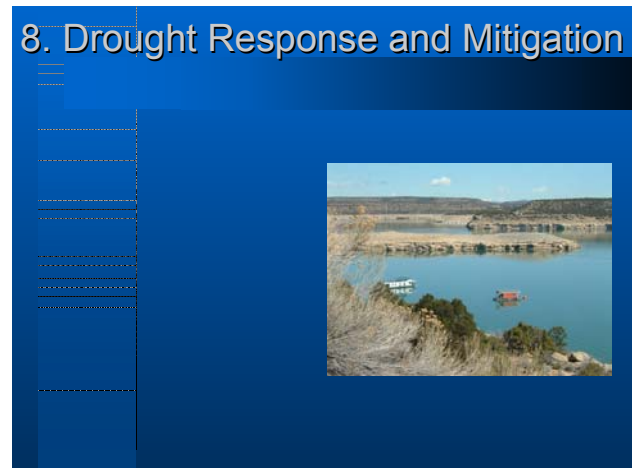


Figure 20. Drought Response and Mitigation

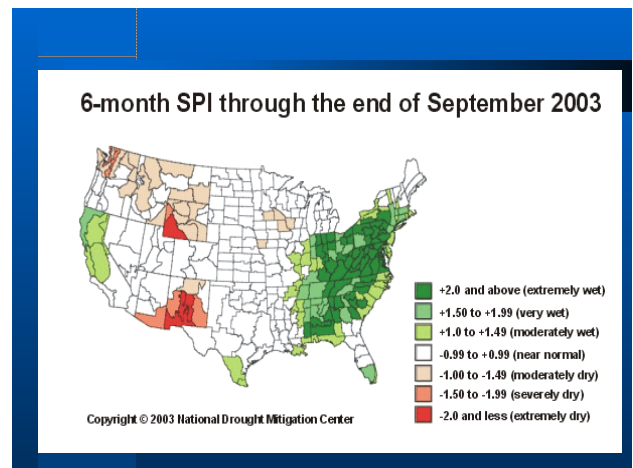


Figure 21. Six-month SPI through September 2003

During the winter of 2004, Navajo Reservoir was nearly as low as it was when the reservoir was first filled (Figure 22). Figure 23 provides the drought forecast for the U.S. In response to this prolonged drought, and for the second year in a row, the Navajo Nation worked with the other water users in the basin to develop a shortage sharing agreement. The effort has been successful. Through this agreement tens of thousands of acre-feet of water have been conserved. And, unlike the Klamath River, in the San Juan Basin there have been no fish kills. And, unlike the Rio Grande Basin, in the San Juan Basin there has not been a protracted legal battle. It has been a very, very, painful process. It is very tough to convince many Navajo Nation leaders that sharing the shortages is the way to go. But every other signatory to this agreement has had that same problem. Somehow sharing shortages during periods of extreme drought has been a very, very tough sell. But it was done in 2003 and I am hoping it will be done in 2004.

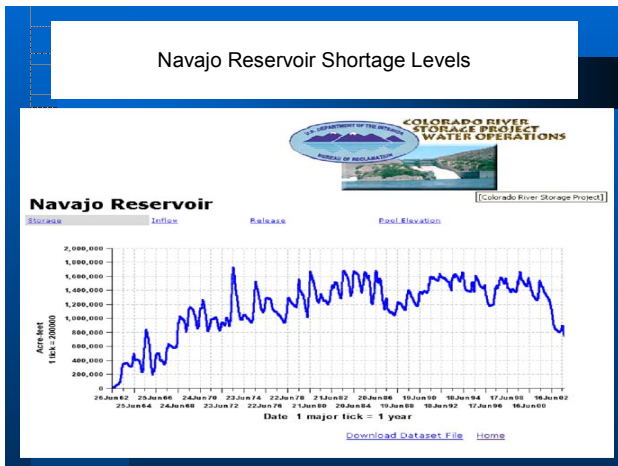


Figure 22. Navajo Reservoir Shortage Levels

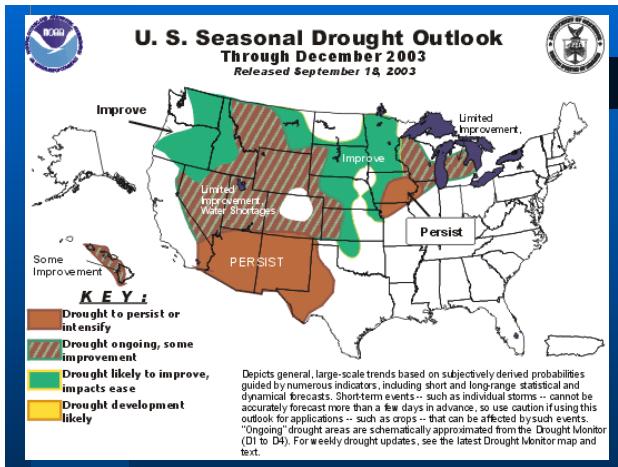


Figure 23. U.S. Seasonal Drought Outlook

Conclusions

The Navajo Nation is committed to improving the standard of living on the reservation. The Navajo Nation has made the development of reliable water supplies one of its highest priorities.

A proposed Navajo Nation settlement was presented to the public on December 5, 2003. This settlement is good for the San Juan River Basin, it is good for the State of New Mexico, and it is good for the Navajo Nation. One of the first impressions many people have is that it is too expensive. But, the cost of the settlement needs to be compared with the alternatives. And, if that settlement results in the implementation of significant portions of this strategy, then those benefits make it a bargain for all sides.