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From the Shore: Gavins Point Project History and Sedimentation Impacts

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Evolution of the Pick Sloan Plan

The 1944 Pick-Sloan Plan for development of the water resources of the Missouri River Basin represented a compromise between the separate engineering proposals developed by Colonel Lewis A. Pick of the U.S. Army Corps of Engineers (USACE) and William G. Sloan of the Bureau of Reclamation (Reclamation). The Pick Plan was primarily concerned with the development of flood control measures to protect the lower Missouri Basin. It was hastened by devastating floods on the Missouri River in 1943 that severely impacted the urban centers of Omaha, Kansas City, and St. Louis. The Sloan Plan was focused on the construction of irrigation facilities primarily in the upper Missouri Basin. It was driven by demands for reclamation projects in response to the drought conditions and economic depression of the previous decade. Although these seemingly contradictory programs were proposed by two powerful agencies traditionally at odds with one another, a remarkable conciliation of the two plans was rather quickly achieved at a two-day conference in Omaha, Nebraska in October 1944.[1]

The Omaha conference conciliation was essentially an agreement between Federal engineers that allocated jurisdiction over the proposed projects, giving the USACE primacy over the Missouri's main stem dams. However, this approach failed to address the critical policy issues of environmental impacts, water allocations to the Basin states, and Indian tribal sovereignty and water rights.[2] Together, the two agencies approved $150 million worth of projects that one or the other had previously considered of little or no value. No attempt was made to consolidate or justify costs, exact dimensions were never specified, and duplications were not addressed. The problem of determining whether there was sufficient water to support both irrigation in the Upper Basin and navigation in the Lower was ignored, even though Sloan himself publicly doubted that there would be adequate capacity for both purposes. Although the development of hydropower was a key element among the multiple purposes of the projects proposed, details concerning the development and distribution of hydropower were likewise not addressed.[3]

Also left unresolved was the problematic issue of how the Pick-Sloan Plan would be administered. The Missouri River States Committee (MRSC), formed in 1943 at the urging of South Dakota Governor Merrill Q. Sharpe to serve as a quasi-official link between the governors of the Basin states and the Federal Government, favored joint administration by the USACE and Reclamation. However, Presidents Franklin Roosevelt and Harry Truman and other prominent politicians and interest groups preferred to see the plan administered by a Missouri Valley Authority (MVA) patterned after the highly successful Tennessee Valley Authority (TVA).[4] Begun in 1933, the TVA sought to modernize the Tennessee Valley region through several programs, including the enhancement of water resources.[5]

The Pick-Sloan Plan was subsequently incorporated into the proposed Flood Control Act for 1944. The Plan grew support as a measure to help stabilize the economy of the Missouri Basin by drawing people back to the region following the Great Depression.[6] However, it also generated tension between the Upper and Lower Basin states regarding which region might gain priority for its interests. One of the results of this friction was that Senator Joseph O'Mahoney of

Wyoming co-sponsored an amendment with Senator Eugene Donald Millikin of Colorado that set priorities for irrigation by providing preference to upstream consumptive uses of water over downstream uses.[7] The legislative bill moved quickly through Congress and on December 22, 1944, just eight weeks after the Omaha Conference, President Roosevelt signed it into law.[8] The Pick-Sloan Plan was thus approved without any environmental assessments or public comment periods initiated by the Federal agencies. It was also put into place without consultation with, or adequate protections for, the several Indian Tribes within the Missouri Basin that would be adversely and disproportionally impacted by its projects.[9]

The remaining elements of the complete Pick-Sloan package were authorized in 1945 when Congress passed the River and Harbors Act of that year. That legislation retained the O'Mahoney-Millikin amendment and authorized the proposed nine-foot navigation channel between Sioux City and St. Louis.[10] President Truman and other politicians and interest groups still supported legislative proposals to place Plan administration under the MVA. However, the Basin's governors, again led by Governor Sharpe, opposed these bills, as did ultimately most of their constituents.[11]

Officially labeled the Missouri River Basin Development Program, the Pick-Sloan Plan was gradually expanded to include the construction of 150 multiple-purpose reservoir projects. In addition to flood control, these dams were designed to provide the benefits of hydroelectric power, navigation, recreation, and improved water supplies.[12] The backbone of the Pick-Sloan Plan was provided by five massive dams constructed by the USACE on the main stem of the Missouri River: Garrison in North Dakota, and Oahe, Big Bend, Fort Randall, and Gavins Point in South Dakota. Garrison and Oahe now rank among the top five dams in the United States that hold the most water.[13] The Plan also incorporated the Fort Peck Dam in Montana, which was constructed by the USACE in the 1930s, and remains the third largest dam in the world.[14]

The hundreds of thousands of acres of private and public lands needed for construction of these projects were taken by the U.S. Government by right of eminent domain. All or part of existing communities and family farms and ranches within the taking areas of these projects were made the subject of condemnation proceedings in U.S. District Courts. In the case of the USACE takings, property owners were presented with blind appraisals allegedly based on existing market values, initially with no allowance for relocation costs. There was no negotiation with Army appraisers; those who objected to the valuations could only appeal to the Courts through legal counsel at their own expense.[15]

Because the USACE sited its main stem dams to prevent major impacts to population centers such as Williston, Bismarck, Mobridge, Pierre, and Yankton, and because many of the Indian reservations in the Dakotas and Nebraska were situated along Missouri River shorelines, development of the Pick-Sloan projects had an oversized impact on Native American lands and resources. Construction of the five main stem dams resulted in the inundation of over 554 square miles of Native American land and displacement of more than 900 tribal families.[16] The Fort Peck project had previously caused the involuntary resettlement of 350 Sioux and Assiniboine families on the Fort Peck Reservation in Montana.[17]

Sensitive to the criticism that the Pick-Sloan Plan lacked an integrated and dynamic view of the entire Missouri River Basin, the Truman Administration placed the program under the rather loose-knit coordination of the Missouri Basin Inter-Agency Committee (MBIAC) in 1945.

This voluntary body was created to coordinate Federal and State activities and to provide administrative guidelines. However, the MBIAC was not given any statutory authority, appropriations, or enforcement powers. As a result, it quickly fell under the domination of the USACE: its first two chairman were Army engineers, including Pick himself who served for more than three years. Because it held no public hearings and had absolutely no power to change policy, the Committee was criticized as being a mere "debating society." [18]

The MBIAC's approach to Missouri Basin problems was piecemeal and its preoccupation with engineering methods prevented adequate consideration of such important human factors as the condemnation of farms and ranches and the relocation of families. In its critical initial stages, the Pick-Sloan administrative structure also paid inadequate heed to environmental problems such as sedimentation, bank erosion, and threats to fish and wildlife species and habitats, as well as plant species and vegetation zones. It likewise failed to sufficiently address issues of soil conservation and the deceleration of water runoff. A more centralized administrative structure, such as that proposed for the MVA, which would have been headquartered within the Basin, would likely have received an annual block appropriation for all its activities and functions. In comparison, the numerous independent agencies involved with the Pick-Sloan Plan, all directed primarily out of headquarters in Washington, D.C., had to deal with several separate committees in Congress for funding of their specific components of the overall program. As a result of this situation, the USACE often received generous amounts for dam construction during years when other involved agencies, such as the Bureau of Indian Affairs and the U.S. Fish and Wildlife Service, were not able to receive appropriations for their project-related needs.[19]

For most of its history, the largest critical problem with the administrative structure of the Pick-Sloan Plan has been its failure to be inclusive of all interested parties. It did not provide adequate opportunity for the input and involvement of State, local, and Tribal governments, environmental and other special interest groups, or private citizens. Neither did it recognize any of these parties to be actual shareholders in the development of present and future policies and programs related to the water resources of the Missouri Basin.

The MBIAC was replaced by the Missouri River Basin Commission (MRBC) in 1972, which also lacked any regulatory or binding authority and was without any mandate to address growing environmental issues. After the MRBC was decommissioned in 1981, the Basin states created the Missouri Basin States Association (MBSA). This organization, in many ways more effective and innovative than its predecessors, changed its name to the Missouri River Basin Association (MRBA) and expanded its membership to include tribal representatives and water management officials from the States. The Missouri River Natural Resources Committee (MRNRC) was established in 1987 to address ecological issues, and the Mni-Sosi Tribal Water Rights Coalition was formed in 1990 to represent tribal interests.[20]

None of these organizations succeeded in providing effective administrative or shareholder input for policy decisions guiding management of what is now known as the Pick-Sloan Missouri Basin Program.

Development of the Gavins Point Project

Although Congress approved the overall Pick-Sloan Plan in 1944, with an estimated cost of approximately $2 billion, each component of every project was dependent on the subsequent approval of annual appropriations from Congress. Supporters of the Gavins Point Dam were disappointed that by 1950 the project had not received any funding. Largely through the efforts of South Dakota Senator Chan Gurney, Congress finally provided an appropriation of $5 million for initial development in 1951.[21] Development of the project was largely driven by an increased need for hydropower, [22] although local politicians, business interests, outdoor enthusiasts, and farmers quickly saw and welcomed its potential for both future recreation and tourism and enhancement of the agricultural economy.[23]

The USACE began development of the Gavins Point project in March 1952. The dam site straddled the boundary between Yankton County, South Dakota, and Cedar County Nebraska, four miles upstream and west of the town of Yankton. A comparatively low-head structure, the dam was built with concrete and rolled earth. One of its key purposes was to re-regulate stream releases below the Fort Randall Dam to provide a more uniform flow downstream.[24] No techniques to manage sediment were considered in the project's design phase.[25] Nor had the Pick Plan contained any specific references for the control of sediment, although critics had strongly stressed that sediment management should be considered as one of the Plan's multiple purposes.[26]

The project was constructed as a joint venture of three private firms: the Western Contracting Corporation out of Sioux City; the Massman Construction Co., based in Kansas City; and the J.A. Jones Co. from Charlotte, North Carolina.[27] Total project construction costs totaled approximately $50 million.[28]

The Gavins Point project was the farthest downstream and smallest of the USACE's six Missouri River main stem dams. The reservoir behind the dam, just twenty-five miles in length was named Lewis and Clark Lake after the explorers Meriwether Lewis and William Clark who had encamped at several sites in the area during their famous expedition of 1804. The project took its name from a nearby distinctive promontory on the north shore of the Missouri that had been named in honor of Michael J. Gavin, a prominent Yankton-area farmer and businessman.[29] Although Gavins Point was near the original site proposed for the dam, the final location selected by the USACE was at Calumet Bluff, where Lewis and Clark first met with the Sioux.[30] This alternative site was chosen because it offered a shorter span between the dam and shoreline, which meant that it would require less fill material.[31]

In comparison to the other main stem projects, the USACE condemned far less Native American lands for development of the Gavins Point Dam. However, the project inundated 593 acres of the Santee Sioux Reservation in Knox County, Nebraska. This represented about 8.5 percent of the Reservation's land base.[32]

System and Project Expectations and Benefits

Flood Control

Residents of the Lewis and Clark Lake region fully expected to receive some level of all benefits promised by the Pick-Sloan Plan. In regard to flood control, the USACE has succeeded in safeguarding long stretches of the Missouri and its tributaries from the catastrophe of frequent

high floods, particularly in the region below Sioux City. The Pick-Sloan system has nearly eliminated the river's annual floods in those areas affected by the dams' flow regulation. [33] The Gavins Point project has contributed to these achievements, as one of its purposes was to reduce flood damage through its storage capacity and provide greater safety to the surrounding area in any flood event "of spillway design magnitude."[34] The USACE has estimated that the main stem dams and levees have prevented $60 billion in flood damages since inception, indexed to price values of 2016.[35]

The state of Nebraska is one of the principal beneficiaries of these protections, as are Iowa and Missouri. However, the USACE's harnessing of the river is far from secure. Many areas of the Basin are still vulnerable to flooding, as demonstrated, for example, by the damaging floods of 1967, 1973, 1975, 1984, 1986, 1987, 1993, 1996, 1997, 2011, and 2019, as well as by the inundations described below in areas immediately upstream from the Gavins Point project.[36] The USACE claims that the benefits provided outweigh the losses.[37] Yet, flood damages in the Basin still average about $95 million each year.[38] Moreover, flood losses are certain to increase if more protective measures are not implemented.

Hydropower

Those anticipating development of the main stem dams expected that their power output would "amount to many times the quantity previously generated" in the region,[39] and that the Gavins Point project would contribute to this expansion by generating at least 100,000 kilowatts of power.[40] The Pick-Sloan projects have vastly increased the availability of electricity in the Basin states, and the three generators at the Gavins Point power plant eventually developed an output capacity of 132,297 kilowatts.[41] The primary purpose the dam serves in the system's overall energy regime is to maintain the release rate for the upstream reservoirs at Fort Randall, Big Bend, and Oahe. As a result, the rate of power generated at Gavins Point only rarely changes.[42]

The USACE maintains that hydropower provides the greatest national benefit of all the purposes that justify the Pick-Sloan projects. In 2006, it estimated that the cumulative value of all the hydropower was nearly $6 billion, if amortized to current dollar values.[43] However, South Dakota residents long have been troubled by the inequity of the power distribution. Most of the electricity generated by the power plants within their state is transmitted to other states, as well as to Canadian provinces. South Dakota receives only about 19 percent of the total economic benefit of the Pick-Sloan power projects, even though the giant power plants at the Oahe, Big Bend, and Fort Randall dams generate about 69 percent of the system's normal hydropower capacity. Moreover, Nebraska is the greatest beneficiary, receiving about 27 percent of the system's total power allocation benefits.[44]

Hydropower provides a relatively dependable, cost effective, and efficient source of energy. The Pick-Sloan power plants reduce the need for additional alternative generating sources such as coal, oil, gas, and nuclear power. These facilities provide a large capacity of electrical energy when compared to thermal electric-generation systems, and thus also reduce the need to burn fossil fuels, which in turn results in acid rain, air pollution, and the greenhouse effect.[45] However, during the period since 1975, the hydropower-generating capacity of the Pick-Sloan system has been substantially reduced because of several factors, including the increase of sediment deposition in the reservoirs. Moreover, the value of the hydropower produced has not

been maximized because the USACE has controlled water releases to meet other system purposes and requirements, such as flood control and navigation, as well as certain environmental and legal mandates. As described below specifically regarding the Gavins Point project, streamflow depletions caused by sedimentation and bank erosion have reduced the system's hydropower-generating capacity and are expected to do so even more substantially in the future.[46]

Recreation

According to local newspaper coverage, the potential of the Gavins Point project for recreational development was the benefit most anticipated and welcomed by residents of the region. For example, a 1953 article noted that folks were not "overlooking the flood control and power production features" of the project, "but what really generates enthusiasm is the prospect of a . . .long reservoir set down in picturesque surroundings and accessible to more people than any other of the man-made Missouri River lakes. . .. Furthermore, it is ideally adapted to recreation because of its stable pool."[47] The article also noted a significant number of people had already applied for lease sites for cabins and cottages, and that the South Dakota and Nebraska state governments were drafting master plans for recreational development.[48]

Of all the benefits promised by the Pick-Sloan projects, water-based recreation is the program purpose that has most exceeded all original expectations. The recreational opportunities include boating, boating-related activities such as water skiing, swimming, sport fishing, hunting, camping, picnicking, hiking, biking, wildlife and nature viewing, and other outdoor activities. Each year, hundreds of thousands of recreationists flock to the thousands of acres of lands developed to support this range of activities along the approximately 6,000 miles of the main stem reservoir shorelines. This recreational development has been very beneficial to the economy of local communities, creating thousands of jobs and generating millions of dollars in income.[49]

Unlike flood control, hydropower, and navigation, recreation is one of the Pick-Sloan system attributes whose benefits accrue mostly to the states in which the main stem dams were developed. Of the ten Basin states, 75 percent of the benefits go to the three states of North and South Dakota and Nebraska. South Dakota receives the greatest percentage of benefits (36 percent, but Nebraska also is a significant beneficiary (with 16 percent). For decades the Lewis and Clark Lake has attracted more people than any of the other main stem reservoirs, often exceeding two million visitors each year. This has fostered tourism as an important contributor to the regional economy.[50]

In 1978, Congress established a 59-mile section of the Missouri between the Gavins Point Dam downstream to the Ponca State Park in Nebraska as a National Recreational River jointly implemented by the USACE and the National Park Service. This action was taken to enhance recreational opportunities and provide greater protection of cultural and natural resources. A 39-mile section between the Fort Randall Dam downstream to the village of Niobrara, Nebraska was added in 1991, as was the last 20 miles of the Niobrara River and 6 miles of the Verdigre Creek in Nebraska.[51] Unfortunately, the two Missouri River stretches have been affected substantially by altered streamflow and changes in the transport and deposition of sediment.[52]

Water Supply

Another of the benefits promised by the Pick-Sloan Plan was the development of adequate supplies of good quality water for municipal, industrial, domestic, and agricultural uses. In common with recreation, water supply is a program purpose that has expanded far beyond original expectations. Today, the system provides a sufficient supply of water to all who choose to utilize its reservoirs as a source. Unlike many other systems, the USACE does not charge users either for the water supplied or for the cost of storing it in the reservoirs. Users need only to finance the cost of developing and maintaining water-intake systems. By 2006, over 1,600 water intakes had been established within the system, and municipal intakes provided the main source of water for over three million people, mostly in the Lower Basin (below Sioux City).[53] The system also has made water available to several rural communities in South Dakota and Nebraska.[54]

The USACE's release of water from the reservoirs to serve other Pick-Sloan program purposes has at times adversely affected water intakes. Low pool levels during drought periods and high sediment concentrations have periodically combined to shut down or drastically impair some intake systems.[55] Although the Pick-Sloan Plan also promised to deliver water of good quality, the condition of the reservoir waters has been deteriorating for many years. The growth of algae has increased steadily, and the dissolved oxygen levels at the bottom of the lakes means that they can no longer support certain fish species. In some instances, water in arms of the reservoirs has been found to no longer be potable.[56]

Irrigation

Irrigation has become the abandoned orphan of the Pick-Sloan Plan. Although Reclamation promised to irrigate 5.3 million acres of farmland within the Basin, by 1989 it had only developed irrigation for about 465,000 acres. The large main stem projects promised for the Dakotas never materialized. For example, South Dakota was promised 950,000 acres of new irrigated lands, but Congress deauthorized its main delivery system, the Oahe Diversion Project in 1982.[57] Only about 24,000 acres were irrigated within the state by 1990. In comparison, Nebraska only lost 15,000 acres to Pick-Sloan development but benefitted from 220,000 acres of irrigated land.[58]

Irrigation development was handicapped by a long and heated debate over the feasibility, suitability, cost-effectiveness, and practicality of reclamation in the Basin. Once Reclamation began to examine Sloan's plans more carefully, it discovered that much of the prairie land it hoped to claim was simply not irrigable.[59] Residents of the Dakotas long justified the Oahe diversion project, as well as the Garrison diversion project in North Dakota, on the basis of their being a potential offset to the sacrifices they were compelled to make for the construction of the main stem dams in their states that primarily benefited citizens of the Lower Basin. However, the ethic on which reclamation was originally based – to settle the land and produce abundant crops –no longer has sufficient relevance in the Northern Plains to justify major Federal irrigation projects. As a result, the O'Mahoney-Millikin amendment to the Pick-Sloan Plan, which established priority for irrigation in the Upper Basin, has proven to be largely worthless.[60] On the positive side, however, nearly 900 of the water intakes within the system are used by irrigators (mostly private).[61]

Navigation

The value of navigation on the Missouri River below the Gavins Point Dam has become the Pick-Sloan benefit most often questioned today. The stabilized channel begins at Nebraska's Ponca State Park and extends to the mouth of the Big Sioux River near Sioux City, Iowa. From there, the navigation channel extends 734 miles to the Missouri's confluence with the Mississippi River 15 miles above St. Louis. Navigation is primarily supported by water storage in the large reservoirs behind the Fort Peck, Garrison, and Oahe dams.[62] Lewis and Clark Lake has no water stored for the purpose of navigation.[63]

The 9-foot deep and 300-foot-wide navigation channel has become controversial from both an economic and an environmental perspective. Its benefits are substantially localized to the lower stretch of the river and derive principally to the State of Missouri. While it has cost billions of dollars to build and maintain the channels, their net annual benefit has only been a few million dollars. Commercial traffic has never met the USACE's expectations, while the project continues to negatively alter the natural ecosystem of the lower Missouri valley.[64]

Residents of the Upper Basin did not expect many benefits from the navigation channel. However, they did anticipate clear recreational navigation for small craft on the USACE's main stem reservoirs.[65] To their dismay they have discovered that clear sailing has been problematic in many areas. This is due in part to initial clearing operations that left trees and structures above or barely below the water surfaces.[66] On Lewis and Clark Lake many underwater hazards have been created by sedimentation and bank erosion, especially in the delta areas. Boating also has been impaired at times by receding water levels at ramps and docks. Dredging of channels has often been required to provide boat clearances. [67]

Challenges to the Gavins Point Project

Sedimentation, Bank Erosion, and Littoral Drift

In 1954, it was reported that the portion of the Pick-Sloan dams then in place was rapidly moving sediment out of the Missouri River.[68] The next year, a regional newspaper reported that Lewis and Clark Lake would be "a clear lake with almost no trace of sedimentation."[69] USACE engineers publicly opined that sedimentation in the system would "not be very grave."[70] By 1956, however, just after completion of the Gavins Point project, residents of the area began to alert the USACE and South Dakota Senator Francis Case regarding bank erosion on the Lake shores, as well as along the river below Yankton. Residents also described an alarming rate of sedimentation flowing into the lake, as well as a rapid sediment buildup on the Bazile Creek tributary thought to be the cause of local flooding.[71]

Army officials expressed little concern in 1954 regarding the probability of sediment deposition filling up the reservoirs. However, they also cautioned that they did not have much accumulated knowledge regarding the effect of sedimentation on river flows. Brigadier General W.E. Potter, the Missouri Division Engineer in Omaha, openly wondered if with the dams taking out the sediment of the main flow of the Missouri, "the river won't work harder to tear down the banks and pick up more of it."[72] This cautious optimism stands in stark contrast to statements uttered by USACE officials after sedimentation did in fact become a "very grave" worry for the Gavins Point project. For example, an Army official in 1978 claimed that the USACE knew that sedimentation would be a problem when it built the dams.[73] Even now, the USACE maintains

that sedimentation is a "natural and predictable" result of the project and, in essence, that residents of the region must learn to live with it.[74]

In an initial response to the concerns of local citizens regarding bank erosion, sedimentation, and flooding in the late 1950s, a USACE official stated that sediment in the lake was not interfering with the authorized purposes of the Gavins Point project. Furthermore, he stated that the implementation of mitigating controls to reduce sedimentation in the lake, as well as on the river and its Niobrara River and Bazile Creek tributaries, was neither feasible nor justified economically.[75]

Before development of the main-stem dams and the navigation channel, the Missouri carried 150-200 million tons of sediment each year. The man-made reservoirs, including Lewis and Clark Lake, now capture much of the organic matter that erodes from basin soils and the meandering stream banks. The river now carries only about 50 tons annually.[76] Sediments are transported to the lake via the Missouri's tributaries. Over 50 percent of the inflow originates on the Niobrara River, a fast-moving stream with extreme turbidity or cloudy waters that carries a heavy load of sand and some silt from Nebraska's Sand Hills.[77] Other sediment sources on the Missouri below the Fort Randall Dam include Ponca Creek and Bazile Creek.[78]

The Niobrara sediment deposits close to the mouth of that stream, where it forms a delta, as well as downstream into the lake.[79] Gradually, the Niobrara River delta has expanded northward. This has caused a backwater effect, meaning increased water surface levels, on both the Niobrara and the Missouri, as well as sediment deposition further upstream. What is described as the delta foreset, meaning the inclined part of the delta found at the end of the stream channel, continues to migrate downstream towards Gavins Point Dam.[80]

When the Missouri waters enter the Lake, their velocity decreases, and the carried sediment load drops off to also form a delta of vegetated islands and shallow channels, as well as smaller deltas elsewhere. This delta is migrating about 550 yards each year. Major sediment deposition now effects the upper third of the lake and is continuing to grow.[81] A 2011 USACE report indicated that an average of 2,700 acre-feet of sediment had been deposited every year below the pool elevation of 1,210 feet m.s.l (mean sea level). The deposit rate of an average of 6,054 acre-feet between 2007 and 2011 was six times higher than the average had been between 1965 and 1975.[82]

Bank erosion and littoral drift are other contributing factors to sediment deposition and redistribution. Erosion is caused by wave action, wind, precipitation, and the annual freeze-thaw cycle. Littoral drift is the movement of sediment along shorelines driven by waves and wind. Upstream sediment deposition has occurred most prevalently in the area between the confluence of the Missouri and the Niobrara down to the areas of Springfield, South Dakota and Santee, Nebraska.[83]

General Impacts

The deposit of river sediments into the lake delta has shortened the length of the reservoir, and the migration of the delta has reduced its storage capacity by at least 30 percent.[84] This represents the greatest loss of storage of any of the Pick-Sloan dams.[85] Storage depletion means that sedimentation has significantly decreased the volume of water needed to provide flood control and produce hydropower and irrigation supply. Thus, the project has lost its original capacity to prevent typical flood events, resulting in increased flood damages for the

region.[86] Lower water levels can result in increased power costs for municipalities and irrigators.[87] The problems of sedimentation, bank erosion, and littoral drift will determine the usable life span of the Lake. These deteriorating factors not only increase maintenance costs at the Gavins Point project but also decrease all its benefits, including the long-term future of its popular recreation areas. The problems of decreased water surface areas have already impacted most of the Lake's recreation areas and water access points.[88] Littoral drift creates greater sediment deposition on boat ramps than does sediment inflowing from upstream. Sediment accumulation across harbor entrances, in embayments, and on launching ramps continues to threaten boating facilities. Channels have been dredged in shallow waters to facilitate boat clearance.[89] Because of delta formation, boaters now must navigate what the *Sioux Falls Argus-Leader* described as "a narrow, shallow channel through sifting sand."[90] In addition to its impacts on recreational development, shoreline erosion also threatens private land and infrastructure, as well as archeological, cultural, and historical sites. The deposition of silt also has caused habitat changes adversely affecting fish spawning areas. Encroachment of the delta has elevated the groundwater table creating greater flood risks and negatively impacting vegetation and shoreline developments.[91]

Sediment deposition in the river channel has had similar impacts. It has reduced the channel's capacity and increased its water surface level, resulting in flooding as well as elevated groundwater levels. This has likewise caused loss of agricultural land, damage to infrastructure, destruction of cottonwood trees, changes to vegetation, and adverse impacts on fish habitat.[92]

The USACE has the nearly impossible task of managing water releases from the Gavins Point Dam to balance all system purposes and requirements. Increased velocity upstream can carry more water into the lake. Raising water levels to provide flood control downstream can cause bank erosion and flooding along the reservoir shorelines. Releases can negatively impact recreational facilities and water intake systems. Drawdowns increase water velocity downstream and cause streambank degradation because the water is deficient in sediment. Releases also have negative economic and environmental impacts. Moreover, drawdowns can increase flooding and impede drainage from farmlands.[93]

Increased stream flow in spring can flood the sandbars where shoreline birds such as the threatened piping plover nest and impact the shallow water habitat where some endangered or imperiled fish species, such as the pallid sturgeon, spawn. At Gavins Point, the USACE now must oversee all these water management challenges for a project that is increasingly losing capacity to provide for its original system benefits due to the unchecked growth of sedimentation and bank erosion.[94]

The main stem dams have reduced the sediment flow downstream of the Gavins Point project, which has caused significant channel incision (the downcutting of the stream that decreases elevation of the bed) and bed degradation (the process by which the stream bed is eroded to a new lower level at a faster rate than would occur normally). The greatest degradation, 9 feet or more, has occurred just downstream from the Dam. The clear, so-called "hungry water" (hungry for sediment) discharged from the project also creates bank destabilization. Channel incision has undercut the stream banks and caused the abandonment of some water intake structures. Channel incision also has extended into the Missouri's tributaries, causing damages to infrastructure, and disconnecting the river from its flood plain. This disconnection has effectively

blocked rejuvenation of the floodplain forest and wetlands habitat. Changes in the river's pre-regulation regime of sediment transport and deposition have also reduced turbidity and changed landforms. The near-shore and riparian shallow water and sandbar habitats also have been impacted in a way that has posed a serious threat to important native fish and bird species.[95]

Specific Samples of the Negative Impacts of the Gavins Point Project

Niobrara, Nebraska

In 1975, 589 residents of the village of Niobrara were forced to relocate due to rising water tables. Most moved to a new town of 100 new homes constructed on a hill just north of the old townsite, a redevelopment aided in part by a $11.4 million Congressional appropriation to the USACE. The total cost of the relocation and restoration was estimated by the USACE to be $20,238,000. The village initially lost upwards of 20 percent of its former residents who moved to Springfield, South Dakota and elsewhere.[96] Sediment clogged at the mouth of the Niobrara River where it meets the Missouri behind the Gavins Point Dam caused river waters to rise and elevated the groundwater table to levels just a few feet below the surface. The USACE first informed townsfolk of these threats in 1961.[97] The increasingly rising waters flooded basements and agricultural lands, making farming impossible. The overrun also flooded Niobrara State Park, a popular recreation area that contributed significantly to the local economy. Standing water killed trees and turned both the town and the Park into a mosquito-infested swamp. [98]

Springfield, South Dakota

Residents of the town of Springfield were hopeful that the Gavins Point project would transform their community into a prime recreation area. After the blue waters of Lewis and Clark Lake reached their boat ramps, those expectations were largely met until the late 1960s. However, folks then started increasingly noticing heavy sedimentation as tons of silt carried around a bend in the Missouri reduced the stream flow and created small islands, sandbars, shifting channels, and standing bullrushes in shallow water. Sediment deposition in the narrowed channel caused the flooding of nearby farmlands. The situation worsened by 1975 when increased water releases from the reservoir to prevent flooding in North Dakota silted in the town's water intake structure. The town brought in emergency pumps to clean out the intake structure at considerable expense, but by 1978 the stream flow became too wide and shallow to allow continued pumping.[99] In 1981, Congress appropriated funds to the USACE for the relocation of Springfield's water intake facility.[100]

Springfield continued to be plagued by sedimentation issues arising from the Niobrara River. In 2011, for example, sediment filled the Lewis and Clark Lake inlet housing the community's boat basin and marina, making the bay too shallow for boat use. Recovery necessitated the dredging of a channel from the boat ramp to an outlet of the lake, funded in part by a grant from the State Game, Fish, and Parks Department.[101]

Bazile Creek, Nebraska

Bazile Creek is a spring-fed stream flowing more or less northward in northeastern Nebraska though the Santee Indian Reservation and emptying into the Missouri River about five miles east of the village of Niobrara. The water supply of the Reservation is almost entirely dependent on a well field in the Creek on the western end of the reserve. Sediment deposition around the confluence of the Niobrara River with the Missouri has regularly caused flooding

along a seven-mile stretch of the Creek. These inundations have impacted both Indian and non-Indian farms and ranchers, and some property owners have lost up to 40 percent of their land base.[102] Water quality deteriorated as nitrate-nitrogen and coliform bacteria levels grew to exceed the drinking-water standards of the Environmental Protection Agency (EPA), while frequent floods impacted water supply. A record flood flow in 1999 completely inundated the Bazile Creek well field and contaminated the Reservation's entire water sources. Many months of cleanup were required to restore the water system, during which emergency water supplies were delivered by truck.[103]

Nebraska Highway 12

Nebraska Highway 12 is a road extending east from Valentine to near South Sioux City. It runs through the village of Niobrara and portions of the Missouri National Recreation River area, and just south of the Chief Standing Bear Memorial Bridge. The road continues across Bazile Creek and the Santee Indian Reservation before eventually proceeding southeasterly. The delta formed by sediment deposition near the confluence of the Missouri and Niobrara rivers has caused frequent flooding of the roadway over the years. Water releases from the Fort Randall Dam and sediment deposits immediately downstream from that facility have also been contributing factors. Overtopping of the highway has occurred every year in some portions, such as in the Bazile Creek area.[104]

During the tremendous Missouri River floods of 2011, inundation of Highway 12 cut off access to the Chief Standing Bear Memorial Bridge that crosses over to Springfield, South Dakota. This created a difficult situation for residents of the region who needed to cross the bridge for work, business, or family connections.[105] The historic flood of 2019 collapsed the Spencer Dam on the Niobrara River and sent a 11-foot wave downstream that swept away the Mormon Canal Bridge, which carried Highway 12 over the river just west of the village of Niobrara, as well as dozens of buildings. The flooding also again caused temporary closure of the Chief Standing Bear Memorial Bridge.[106]

In 2015, what is now the Nebraska Department of Transportation (NDOT) applied to the USACE for authorization to rehabilitate the road. The NDOT later withdrew this initial application to propose an alternative plan. Its new project would raise the roadway three feet above the expected 100-year flood level on approximately 12.2 miles of the highway. The USACE has yet to complete a final Environmental Impact Statement for this proposed plan. [107]

Mitigation Initiatives

Habitat Restoration and the Missouri River Recovery Program

The Missouri River system is no longer a healthy waterway. Over one million acres of aquatic and terrestrial habitat has been lost through the construction of the Pick-Sloan dams, authorized in the 1944 Flood Control Act, and the Bank Stabilization and Navigation Project (BSNP). The loss of quality habitat is so acute that American Rivers, an advocacy group that annually promotes the preservation and restoration of rivers, has multiple times listed the Missouri as one of the Nation's "most endangered rivers."[108] A rise of chlorophyl-a levels and in concentrations of E. coli bacteria has resulted in a decline in water quality in Lewis and Clark Lake. The State of Nebraska included the reservoir in its 2020 list of impaired waters because of the threat these contaminants pose to aquatic life.[109]

Under the 1973 Endangered Species Act, the U.S. Fish and Wildlife Service (USFWS), issued biological opinions (BiOps) in 2000, 2003, and 2018. The BiOps direct the USACE's habitat recovery plans and related activities along the Missouri.[110] The 2000 BiOp maintained the continued existence of one fish species, the pallid sturgeon, was endangered, and two bird species, the piping plover and the interior least tern, threatened by the existing riverine conditions and the USACE's ongoing operation of the river system.[111] Scientists also have classified 51other native fish species as rare or declining due to habitat loss.[112] In 2018, the USFWS delisted the interior least tern as a threatened species.[113] The 2018 BiOp outlines proposed actions for the continued protection of endangered and threatened species to be developed in consultation with the USACE and other Federal agencies.[114]

In 2004, the USACE and the USFWS established the Missouri River Recovery Program (MRRP). The purpose of this initiative was to develop and implement comprehensive ecosystem recovery actions for the river in partnership with system shareholders, including States, Tribes, other regulatory agencies, and non-governmental organizations.[115] Under the umbrella of the MRRP, the USACE established the Missouri River Ecosystem Restoration Plan (MRERP), again in partnership with the USFWS. Early management actions included Emergent Sandbar Habitat (ESH) and Shallow Water Habitat (SWH) projects in an attempt to restore some pre-dam features of the river to recover the listed species.[116]

As part of the 2007 Water Resources Development Act (WRDA), Congress authorized establishment of the Missouri River Recovery Implementation Committee (MRRIC, a.k.a. "Mr. Ric") to provide guidance on recovery actions. This 70-member forum, which includes Federal, State, Tribal, and stakeholder interests from throughout the basin, was the nation's first such organization formed to provide shareholder input. Its focus has been on the restoration of ecological habitat rather than broader management of the river system.[117] The MRERP is currently suspended, due to a 2010 legislative action that curtailed funding, and critics of MRRIC charge that its potential policy recommendations are paralyzed by its stringent consensus requirements, and its failure to not allow dissenting opinions.[118]

The USACE developed numerous ESH and SWH projects along the river in compliance with the USFWS' Biological Opinions. The ESH projects were built primarily to benefit bird species; the SWH projects were designed mostly for the endangered pallid sturgeon. These projects involved the dredging, movement, and placement of sediment to develop sandbars, chutes, and side channels. These endeavors also entail making structural adjustments in engineered projects (notching a levee, for example).[119]

To encourage the birds to nest at the highest elevations on the sandbars below Gavins Point Dam, the USACE releases small flows from the dam during the pre-nesting season. The Corps has constructed emergent sandbar habitat between the dam and Ponca State Park. To benefit the pallid sturgeon and other fish species, the USACE has likewise implemented actions to enhance habitat conditions, including developing Interception Rearing Complexes (IRCs) for more shallow water habitat downstream from the Park.[120]

Compliance with the Biological Opinions under the MRRP also includes four other components in addition to the ESH and SWH projects. These are fish and wildlife mitigation, flow modification, a cottonwood management program, and a Science and Adaptive Management Plan (SAMP). Mitigation includes the purchase of private floodplain lands from

willing sellers, for habitat recovery projects. One of the intents of the Gavins Point Dam's "spring rise" flow modification was to redistribute sediment and contribute to the creation and maintenance of SWH and ESH projects. The plan for cottonwood forest management, which also has been paused due to lack of funding, includes identification of sites for cottonwood regeneration where sediment has been newly deposited.[121] The USACE's latest SAMP, a giant document of more than 500 pages, was issued in August 2018. It provides research and monitoring to evaluate the biological response of all the MRRP programs and efforts.[122]

Thus far, the USACE's ESH and SWH projects have been developed, implemented, and monitored. They are part of a more systematic and long-term adaptive management program. Given the very real uncertainties of these projects, however, it is entirely possible that they will not succeed in meeting the requirements of USFWS's Biological Opinions or avoid jeopardizing the continued existence of two listed species.[123]

The Increased Project Costs of Sedimentation Management

In 2016, a team of three academic engineers analyzed the Gavins Point Dam as a case study in sediment management. They estimated that certain known expenditures for sedimentation impacts totaled $257,945,000. These costs included relocating the Niobrara village, acquiring and relocating damaged real estate, maintaining and redesigning Highway 12, and constructing and maintaining the ESH program. However, this estimate was not comprehensive in regard to estimating the cost of all impacts. For example, it did not include the cost of dredging the channel for boat clearances or constructing and maintaining the SWH. This estimated figure represented more than five times the original $50,000,000 it cost to build the Dam. However, that original $50 million cost was the equivalent of $367.7 million in 2015 dollars.[124] Regardless, the increased costs of certain elements of sedimentation management then approached, and will eventually exceed, the cost of building the Gavins Point Dam.

Summary

The Water Resources Development Act (WRDA) of 2016 authorized the USACE to develop sediment management plans for reservoirs in the upper Missouri River. However, the legislation provided no funding for the development of such plans.[125] Such action has been similarly echoed with the deauthorization of the Title IX Missouri River Task Force in South Dakota by Section 359 of the WRDA of 2020.[126] The purpose of the Task Force, created by the WRDA of 2000, was to reduce siltation in the Missouri River in South Dakota with implementation of a long-term strategy. However, the USACE placed the group in pending status in 2015 due to lack of Congressional funding, and Congress ultimately deauthorized the Task Force in 2020.[127]

Achieving sustainability of the Gavins Point project demands a comprehensive sediment management plan sufficiently funded to adequately address all present and potential adverse conditions. Without such a plan, a filled-up Lewis and Clark Lake and "hungry water" river channel not only will continue to encumber all project benefits, but also be an economic burden on generations to come. Avoiding the potential obsolescence of the project will require more than the present, traditional, piecemeal, and often short-sighted policies and funding approaches to sediment management. This situation is further exacerbated by the USACE's long stretches

between Master Plan updates. It will require a holistic life-cycle management plan involving the USACE and all shareholders, which incorporates increased engineering, scientific, and economic analyses; implements action of best practices based on those analyses; and pursues all potential sources for increased funding.[128]

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