Big Sioux **R**iver **A**ction for **V**itality and **O**ptimization **(BRAVO)**

Team 6:
Bennett Gentile, Emily Ortiz, Andrew Stewart

Table of Contents

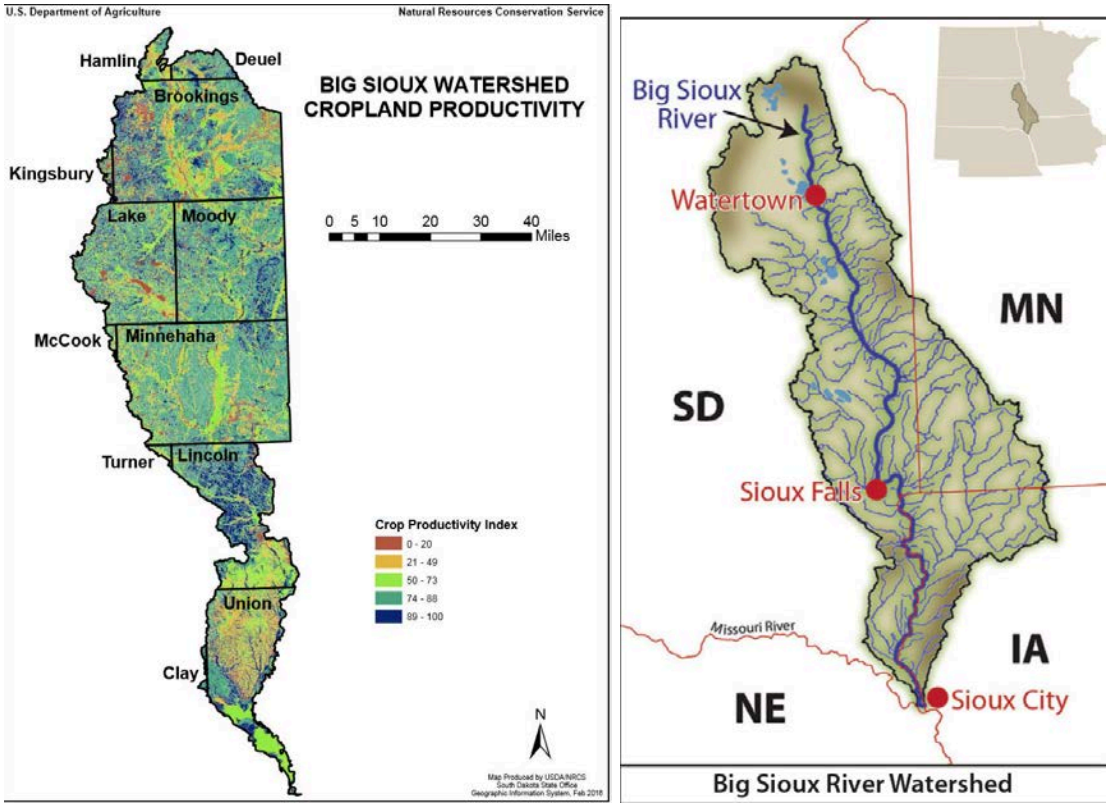
Mission Statement

The BRAVO watershed plan will restore the Big Sioux River by improving the water quality and ensuring environmental and recreational use for future generations. To do this, we aim to get 100% of Big Sioux River segments to meet the beneficial use standard of limited contact recreation and restore 20,000 acres of grassland by 2035. Actionable solutions are needed to restore the Big Sioux River and surrounding ecosystems so that communities are provided with clean water and abundant wildlife.

Background and History

The Big Sioux River Watershed spans approximately 420 miles, flowing south from Summit, South Dakota, and draining into the Missouri River near Sioux City, Iowa. It drains around 8,282 square miles across eastern South Dakota, southwestern Minnesota, and northwestern Iowa. The Big Sioux River watershed was a vital resource of wild game and rich soil for Indigenous peoples, particularly the Santee and Yankton Sioux tribes. After white settlement and violent displacement of Indigenous tribes, the Big Sioux River became a hub for large-scale farming techniques that led to over-tillage and loss of native prairie grass. In the 1970s, the Environmental Protection Agency raised concerns about the river's water quality. In the 1980s, the Upper Big Sioux River Watershed Project to the Lower Big Sioux River Watershed Implementation Project were implemented to stabilize stream banks, manage animal waste, install buffer strips, and restore grasslands. Unfortunately, watershed assessments today still have identified impairment across many river segments and lakes identified as the most populated/ heavy traffic areas. Decades of agricultural runoff, urban development, and untreated wastewater have caused elevated levels of E. coli, total suspended solids, and nutrient pollution. Large cities

such as Brookings, South Dakota, and Sioux Falls, South Dakota, are now increasingly dependent on the watershed for environmental, recreational, and community well-being. It supplies drinking water to about 40% of South Dakota's population and offers vital habitat for wildlife such as game fish, beavers, white-tailed deer, and a variety of bird species. Agriculture is the dominant land use in the watershed, with over 70% of the land used for row crops such as corn and soybeans. Livestock farming is also supported by the watershed through water access and irrigation. Many areas remain impaired and are not meeting beneficial use standards even for limited contact recreation, such as boating and fishing. The BRAVO mission is essential to continuing the policies in place while implementing new incentives to allow residents to enjoy the benefits of the watershed for many generations to come.



(Left: Cropland Productivity in the South Dakota area of the Big Sioux River watershed, Right: Big Sioux River Running through South Dakota, Minnesota, and Iowa)

Policies and Mandates

South Dakota has been proactive in their efforts to remediate areas of the Big Sioux and mitigate further degradation. To support water quality and ecological health in the Big Sioux River watershed, several riparian buffer programs have been developed over the past two decades, offering landowners incentives to adopt conservation practices. The Riparian Area Management (RAM) Program, launched in 2008, was the first of these initiatives, designed as a complement to the federal Conservation Reserve Program. It targets pastureland located within the 100-year floodplain along priority water bodies, requiring a minimum 30-foot vegetative buffer. While grazing is prohibited under RAM, landowners may hay once per year between June 15 and August 31. Control of noxious weeds is mandatory, and some landowners choose to plant shelter belts with cost-sharing support. Participants can enroll for 10 or 15 years and receive a one-time up-front payment of $60–$80 per acre per year. Building on this foundation, the Seasonal Riparian Area Management (SRAM) Program was introduced in 2013 to allow greater flexibility, particularly for pastureland. SRAM permits seasonal grazing and haying, making it more appealing to landowners while still offering significant conservation benefits. Together, RAM and SRAM have enrolled over 4,000 acres, protecting more than 100 miles of streambank. In 2021, South Dakota House Bill 1256 was passed in order to allocate funding to remediation efforts. As part of this legislation, the Riparian Buffer Initiative was launched in 2021 by the South Dakota Department of Agriculture and Natural Resources (DANR), offering increased payments and stricter guidelines. Eligible lands must lie within the Big Sioux River watershed, with buffer widths between 50 and 120 feet and a minimum grass height of four inches. Cutting hay is restricted during peak summer recreation months, and grazing is deferred until fall. The program requires at least a 10-year commitment and offers revised incentive payments of up to

$575 per acre for cropland and $157 per acre for pastureland. A total of $3 million has been allocated to this initiative, with all funds to be used by June 30, 2025. A new five-year phase, backed by $11 million in public and private funds, including over $5.8 million from the city of Sioux Falls, aims to continue this progress. The 2025 legislative agenda for the Big Sioux River emphasizes stronger regulation, transparency, and support for sustainable land use. A top priority is the stricter enforcement of Total Maximum Daily Load (TMDL) regulations to ensure that pollutant levels within the watershed remain within safe limits. Alongside regulatory enforcement, the agenda advocates for increased funding to incentivize farmers and landowners to adopt conservation practices that protect water quality and reduce runoff. Additionally, the agenda calls for greater transparency in pollution monitoring, including the implementation of policies that require real-time water quality data to be made publicly accessible. These initiatives aim to create a more accountable, informed, and collaborative approach to watershed management.

Problems

Problem	Description	Causes
E. coli impairment	75% of the Big Sioux River segments are impaired for E. coli. This means the water has been contaminated with fecal matter to the point where it is unsafe to take part in recreational activity. As a result, communities lose access to the river, along with the economic opportunities that come with it.	Various causes for high E. coli presence include high precipitation levels, agricultural runoff, wastewater treatment plants, failing septic systems, domestic and wild animal waste, and stormwater runoff.
Total Suspended Solids (TSS)	75% of Big Sioux River segments are impaired for TSS. Only 25% meet the beneficial use standard of warm water semipermanent fish life propagation (158 mg/l). TSS levels are elevated in years with higher total rainfall, and in periods of drought, TSS levels decrease.	Total suspended solids are objects in the water– this can be materials such as silt, decaying plant and animal matter, industrial wastes, and sewage. High TSS levels then cause a decrease in water clarity, as well as interfere with water chemistry and the photosynthesis process.
Wildlife Habitat Reduction	As of 2015, grassland acreage in the Big Sioux River watershed reduced down to 17%. This decrease in coverage has resulted in decreased numbers of carp and other wildlife in the watershed.	Increased agriculture in the watershed has resulted in grassland being replaced with more farmland. As of 2015, 72% of the Big Sioux River watershed is farmland. Pollution in the water also negatively impacts the wildlife and habitat in the watershed.

Problem 1: E. coli Levels

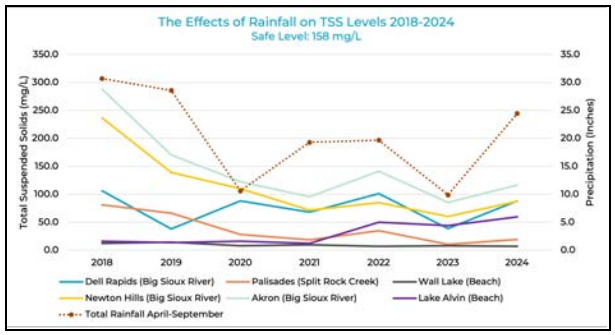
E. coli contamination is one of the biggest issues facing the Big Sioux River today. Alarmingly, only 25% of river segments meet the daily maximum E. coli levels considered safe for limited contact recreation, which is 1,178 colony-forming units(CFU)/ 100 mL of water. Limited contact recreation includes activities like boating, kayaking, fishing, and canoeing. Every segment designated for immersion recreation, such as swimming, currently exceeds the safe threshold of 235 CFU/100 mL. This means that basic recreational access to the river is unsafe for many communities that depend on it for outdoor activity and environmental connection. Sources of E. coli, such as leaky sewage pipes and discharges from wastewater treatment plants, contribute heavily to the contamination in the Big Sioux as urban areas by the river are rapidly growing. Agricultural runoff from feedlots and improperly managed manure also spreads fecal matter into waterways. Wildlife waste and pet feces are additional factors in this issue. After heavy rainfall events, these contaminants enter the river at higher rates, leading to spikes in E. coli levels and unsafe water.

Problem 1: Goals and Recommendations

The BRAVO Watershed Plan is setting a goal to get 100% of Big Sioux River segments to safe E. coli levels for limited contact recreation by 2035. Collaborative and actionable solutions are needed to reach this goal, given the previous progress made. Since agriculture dominates much of the land in the watershed, agricultural lands near waterways will be protected with expanded riparian buffers. Incentives and funding for farmers, pooled across state lines, will help implement better manure management practices and reduce grazing near riverbanks during high rainfall seasons. Due to the increasing municipal use of the watershed, upgrading filtration systems at wastewater treatment plants and identifying aging infrastructure is another actionable

goal of BRAVO. Cracks, leaks, and outdated equipment allow pollutants to enter the river even during normal operations. Investing in modern upgrades will help our goal of protecting public health, keeping recreational areas safe, and making sure cities can grow sustainably without putting more stress on the river. Small actions from the community also make a big difference. Further outreach in the BRAVO plan includes encouraging residents to clean up after pets, check on and maintain their septic systems, and minimize mowing near waterways to allow natural vegetation to act as a filter. These community actions can reduce a significant amount of runoff pollution and help bring the river closer to meeting its recreation and environmental goals. Monitoring and managing the overpopulation of geese, ducks, and other wildlife around parks and riverbanks is another important part of reaching the goal of getting 100% of river segments safe for limited contact recreation. Wildlife is an important part of the river ecosystem, however, high concentrations of birds near urban areas can sometimes contribute to increased bacteria levels in the water. Current hunting seasons near the river help manage these populations, but additional community education could improve awareness of when spikes in E. coli levels are linked to higher bird populations.

Problem 2: Temporary Suspended Solids (TSS)



The Effects of Rainfall on TSS (2018-2024)
– Friends of the Big Sioux

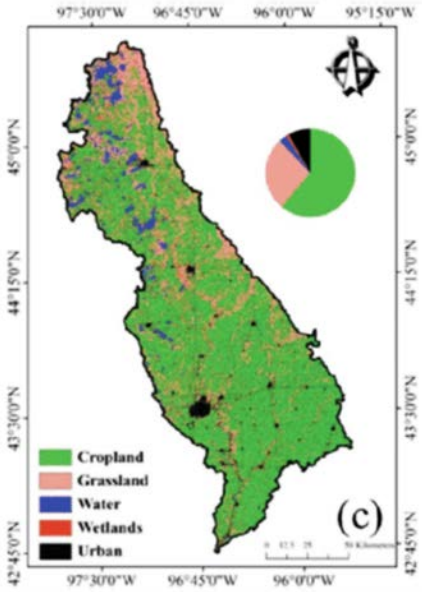
One of the major threats to the health of the Big Sioux River is elevated levels of Total Suspended Solids (TSS), which correlate directly with precipitation levels. During years of higher rainfall, TSS levels rise significantly, while they tend to decrease during drought conditions. TSS consists of particles larger than two microns (such as silt, clay, sand, algae, decaying organic matter, industrial waste, and sewage) that remain suspended in the water. While not all of these materials are harmful, high concentrations reduce water clarity, disrupt aquatic ecosystems, and interfere with essential processes like photosynthesis and oxygen exchange. Excessive TSS can also raise water temperatures and lower dissolved oxygen levels, placing stress on aquatic life. Currently, 75% of river segments in the Big Sioux are impaired for TSS, with only 25% meeting the beneficial use standard of 158 mg/L necessary to support warmwater semipermanent fish life propagation. These conditions pose a significant barrier to restoring the ecological integrity and recreational value of the river.

Problem 2: Goals and Recommendations

The Total Suspended Solids (TSS) goal for the Big Sioux River is to ensure that 100% of river segments meet the fish habitat standard for TSS, with concentrations not exceeding 158 mg/L and a 30-day average of 90 mg/L by the year 2035. Achieving this target will require a multifaceted strategy focused on reducing sediment runoff and improving water quality. One key

method is the implementation of riparian buffer strips, which intercept surface runoff before it enters the river, effectively filtering out sediment, nutrients, and pathogens. These buffers not only reduce TSS but also enhance habitat for fish and wildlife. Another proven practice is the use of cover crops, which protect soil from erosion year-round, improve water infiltration, and reduce sediment loss during critical periods like fall and winter. Additionally, retention basins and sediment traps can be installed to capture runoff during storm events, allowing suspended solids to settle out before water reaches the river. These interventions, when implemented across agricultural and urban landscapes, are essential to restoring and maintaining a healthy, fish-supporting river system.

Problem 3: Wildlife Habitat Reduction



Habitat reduction is another major problem that the Big Sioux River watershed faces. Originally, the land in the watershed was primarily grassland, but the grassland acreage has been reduced down to 17% as of 2015. The main reason for this is the increased agriculture in the area, which takes up 72% of the watershed's land. Decreased habitats result in less biodiversity and decreased wildlife populations, which weakens the ecosystem and makes it vulnerable to diseases and pests. Furthermore, people and wildlife in the area will have less access to natural resources such as food, water, and shelter.

Problem 3: Goals and Recommendations

The BRAVO watershed plan's goal for wildlife habitat reduction is to restore 20,000 acres of grassland, wetland, and forest in the Big Sioux River watershed by 2035. One way this can be accomplished is through contribution to restoration and conservation programs, such as Friends of the Big Sioux River. It will also be important to monitor wildlife populations, and to ensure that species populations are stable. Riparian buffer strips can be used to improve habitat quality for fish, ducks, and other species that rely on the river. Restoring wetlands is another natural way to lessen the impact of runoff and sedimentation, which currently damages the water quality.

Conclusion

The *BRAVO* Watershed plan aims to restore the Big Sioux River by solving the problems of E. coli impairment, TSS impairment, and wildlife habitat reduction. By 2035, we plan to restore 20, 000 acres of grassland, get 100% of river segments to acceptable E. coli levels, and ensure that TSS levels meet the beneficial use standard for fish life propagation. This can be accomplished through a variety of actionable and collaborative solutions, such as riparian buffers, upgraded filtration systems, cover crops, and conservation programs. These will ensure that the Big Sioux River has clean water and abundant wildlife.

References

Big Sioux River Watershed Strategic Plan. (2016). Big Sioux River Watershed Strategic Plan. South Dakota Department of Environment and Natural Resources. https://danr.sd.gov/Conservation/WatershedProtection/ReportsPublications/LowerBigSiouxStrategicPlan2016.pdf

Friends of the Big Sioux River. (2024). 2024 Water Quality Report. https://fbsr.org

Friends of the Big Sioux River. (n.d.). *Watershed*. https://www.friendsofthebigsiouxriver.org/watershed

Haiar, J. (2025, April 17). Millions spent to keep manure out of Big Sioux River paying off, speaker says. South Dakota Searchlight. https://southdakotasearchlight.com/2025/04/17/big-sioux-seeing-payoff-for-investment-in-keeping-manure-out-of-big-sioux-river/

South Dakota Legislature. (2021). House Bill 1256, 96th Legislative Session. https://sdlegislature.gov/Session/Bill/22363

U.S. Nuclear Regulatory Commission. (n.d.). *South Dakota wildlife*. https://www.nrc.gov/docs/ML1224/ML12241A402.pdf