

**Lakeside Adventure Park
Water Demand Assumptions and Analysis
City of Sturgis, SD**

1. **Operational Period:** Summer days – splashpad/wibit typically operating 79 days. Fennell/CRS Design report and data reviewed and included where appropriate.

2. **Recreation Lake Water Volume**
 - a. 3 - acre lake: Approx. 300' x 400' average of 4' depth with a 12' maximum
 - b. Fill volume estimated at 3.2 – 3.5 MG in spring (every other year)
 - c. Fill rate at 150 gpm over 15 days @ 24 hours per day to fill lake.

3. **Annual Pan Evaporation: 4 MG**
 - a. Pan evaporation in the Sturgis area is typically 4.5' annually.
 - b. During dry years, a 3 - acre lake could require up to 1.9 million gallons of water during the peak 8 weeks of higher temperatures. Throughout the year this could require 4 million gallons of water without filling (per Lakeside Report).

4. **Annual Splashpad Water Demand: 4 MG**
 - a. Operate 79 days per year for recreation and to cover evaporation
 - b. Maximum demand – 159 gpm
 - c. Typical daily demand – 108 gpm for 5 to 10 hours per day
 - d. Typical Hours of use – 500+ hours annually over 79 summer days
 - e. Annual minimum water use – 3.22 million gallons (per Lakeside Report)
 - f. To meet 4 MG of evaporation allows 621 hours of splashpad use

5. **Cleaning, Irrigation and Contingency:**
 - a. Assume wash down water and cleaning water
 - b. Assume water for domestic uses at the facility
 - c. Assume contingency water for additional water/unknown uses
 - d. Assume lawn irrigation around the facility – 2 acres+
 - e. Assume 20% in addition to annual filling, irrigation and maintaining level.

6. **Annual Water Demand Summary:**

Lakeside Water Estimates - Annually		Comments
Lake Filling Volume	3.5 MG	Spring filling
Evaporation (Splashpad)	4 MG	Summer - 108 gpm for 500-600 hours
Subtotal Annual Water Demand	7.5 MG	
20% Contingency	1.5 MG	Cleaning/Domestic/Irrigation/Unknown
Annual Total Water Estimate	9 MG	

**Lakeside Adventure Park
Source Water Alternatives and Analysis
City of Sturgis, SD**

A. Source Water Needs for Lakeside Adventure Park

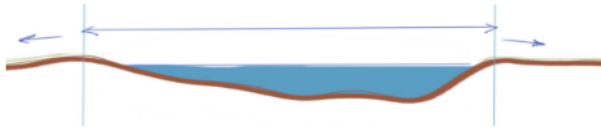
The City of Sturgis is pursuing the evaluation of a new lake recreation facility south of Exit 32. The City has requested a review of water needs and analysis to provide recommended alternatives to provide water for the facility. Foth has reviewed the report prepared for the Lakeside Adventure Park and the following water needs were identified or assumed for the facility:

1. “Clean” recreation lake water - spring water filling of 150 gpm for 15 days
2. Summer daily pressurized water at 108 gpm for splashpad for 600+ hours
3. Lawn irrigation – size estimated at 2+ acres
4. Domestic water for drinking, concessions and restroom facilities
5. Water for cleaning and wash down

Summary:

There is a need for clean pressurized water pumped at a rate of 100 to 150 gpm on a typical day over 6-12 hours per day over a 95 - day period. The primary water demand is during the spring/summer months of May, June, July and August. The annual total need is 9 MG or approximately 2.5% of the City’s annual production. The value of the water at a retail rate is estimated at \$24,000 per year.





B. Source Water Alternatives for Consideration

The following alternatives were considered to provide water for the new lake recreation area. The data provided was developed or referenced from various engineering reports provided by the City of Sturgis. This document is conceptual in nature and detailed preliminary and final designs are needed to advance the top alternatives selected for additional investigation.

1. No Upgrades: Existing City of Sturgis Water System
2. Upgrade City Well No. 4 w/Filtration System
3. New City Drinking Water Well No. 8 at Site
4. New Recreation Well for the Site
5. City Dams and Pipeline

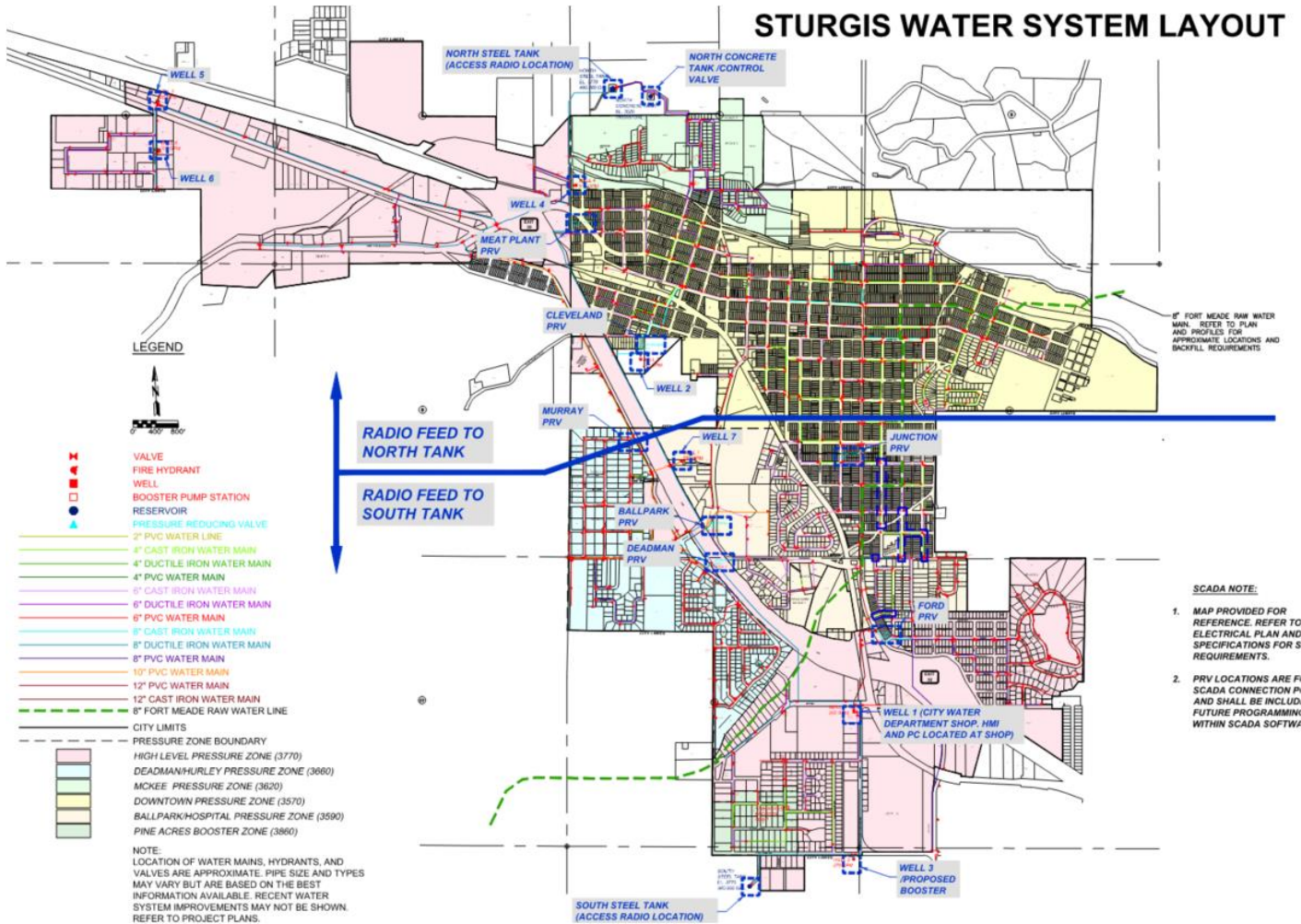
A short-term evaluation of the estimated water supply and demand is listed below. The short-term projections show a potential decline in water supply if no new improvements are completed for City drinking water supply. During this same time period an increase of supply demand is projected due to annexation and City population growth. Storage was not reviewed for the lake recreation needs as the major impact is only on water supply.

C. City Water Supply and Demand Situation:

- a. The Madison aquifer is the most reliable aquifer for high quality and high production drinking water at this time. The current Madison aquifer static water levels are at good levels in 2022. The Minnelusa water is lower quality and lower production water at a shallower depth. The Minnelusa wells can also experience higher sand/sediment levels.
- b. Existing City peak day water demand: 2.75 MGD
- c. Short term forecasted City peak water demand: 3.3 MGD in 5 to 10 years and 3.85 MGD in 10 to 20 years.
 - i. Includes supply needed for annexation of north (253 Acres), west (84 acres) and south (297) annexation areas. Build-out time is unknown and is dependent upon development rates and economic impacts.
- d. Lakeside Adventure Park project requires approximately 100,000 gallons per day of new water demand during the peak City summer demand period. This

results in a future peak day demand of 3.85 MGD upon completion of the annexation areas identified.

- e. Well No. 1 is a Madison well and was drilled in 2013. This well is a strong well at 400 to 450 gpm with good water quality. The City of Sturgis water system layout is shown on the following figure.



- f. Well No. 2 near I-90/Cleveland St. is 72 years old and is reaching the end of its useful life. The production of 245 gpm is not highly reliable for long term projections of water supply. An assumption has been made that Well No. 2 is at risk, at least by 2030, as it will be 80 years old. This well and casing should be monitored and could be in need of replacement.
- g. Well No. 4 is a summer seasonal Minnelusa well near McDonalds at 380 gpm that has high sand content. Well 4 is not operated normally unless emergency conditions exist. Filtration improvements would be needed to operate this

well on a routine basis and the water rights are only available 4 months of the year. This well has limitations and could require major improvements or water rights could be transferred to another site if this well site is abandoned. A new Madison Well 4 could also be considered to replace the existing Minnelusa well.

- h. Wells 3 is located in the southwest part of Sturgis and is 55 years old. Well 3 was refurbished in 2012 and pumps at 380 gpm and is a combination Madison/Minnelusa well. This well is currently operating satisfactorily.
- i. Wells 5 and 6 are Minnelusa wells in the Industrial Park and have limitations while operating simultaneously due to pipeline capacity and cone of influence aquifer impacts. These wells produce sand and Well 6 has issues with pink water. These wells are 20 and 35 years old but are limited due to their close proximity to each other.
- j. Well 7 is a high quality and high producing Madison well drilled in 2003 that produces over 600 gpm. The well is located near I-90 west of Ballpark Road.

D. Well Summary:

Wells 1 and Well 7 are high quality and high producing. Wells 2 and 4 are a concern for the City due to age and sediment conditions. Well 3 is aging and Wells 5 and 6 are limited due to proximity and pipeline capacity.

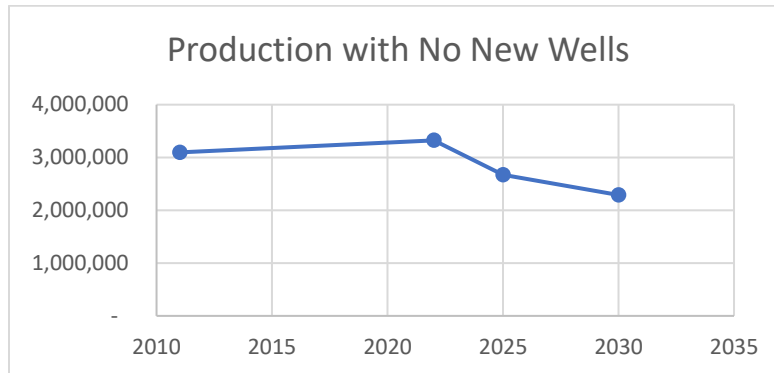
The City of Sturgis should strongly consider adding one or two reliable Madison aquifer drinking water wells to provide additional supply and to provide more redundancy and capacity for the system. If new wells are not constructed and growth occurs as anticipated the water system may encounter issues providing adequate water supply to the Community. Water demand is expected to increase from new growth and for the new lake recreation facility.

City Water Supply Table – Existing Wells

City of Sturgis Supply			Available Supply by Year (gpm)				
Well	Age (2022)	Year Drilled	2011	2022	2025	2030	Age (2030)
1 Madison	9	2013	400	430	430	430	17
2 Madison/Minnelusa	72	1950	245	230	200	0	80
3 Madison/Minnelusa	55	1967	370	380	370	350	63
4 Minnelusa	40	1982	310	380	0	0	48
5 Minnelusa	35	1987	300	340	330	320	43
6 Minnelusa	20	2002	300	378	330	320	28
7 Madison	19	2003	625	600	625	600	27
TOTAL SUPPLY (gpm):			2550	2738	2285	2020	
	Production Hours	16	2,448,000	2,628,480	2,193,600	1,939,200	
	Production Hours	20	3,060,000	3,285,600	2,742,000	2,424,000	
	Production Hours	22	3,366,000	3,614,160	3,016,200	2,666,400	
	Production Hours	24	3,672,000	3,942,720	3,290,400	2,908,800	
	Less Well 1, 2 nd 4	24	3,096,000	3,323,520	2,671,200	2,289,600	

Assumptions: Well 4 and 2 are phased out by 2030. Well 1 removed for firm capacity.

This chart shows the water supply production if no new wells are added and Wells 2 and 4 are phased out and remaining wells are producing water for 20 hours per day.



E. New Well Summary:

Madison wells in the Sturgis vicinity are typically in the 400 to 500 gpm range, which would require the addition of two wells to meet the necessary demand as growth continues. The addition of the identified annexation areas and the lake recreation area shows a projection of 3.95 MGD for peak day demand. Two new wells are needed to meet this demand assuming Wells 2 and 4 are phased out over the next ten years. A summary of water supply with two new wells is shown below.

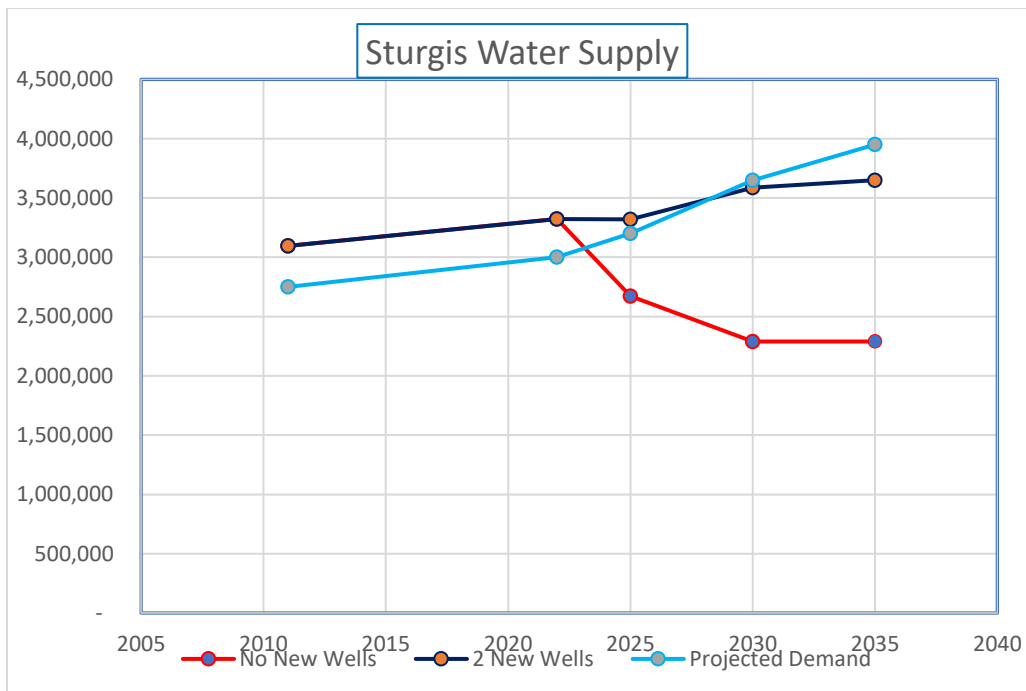
City Water Supply Table – With 2 New Madison Wells

SCENARIO WITH NEW WELLS NO. 8 & 9

Sturgis Water Supply				Available Supply by Year (gpm)				
Well		Age (2022)	Year Drilled	2011	2022	2025	2030	Age (2030)
1	Madison	9	2013	400	430	430	430	17
2	Madison/Minnelusa	72	1950	245	230	200	0	80
3	Madison/Minnelusa	55	1967	370	380	370	350	63
4	Minnelusa	40	1982	310	380	0	0	48
5	Minnelusa	35	1987	300	340	330	320	43
6	Minnelusa	20	2002	300	378	330	320	28
7	Madison	19	2003	625	600	625	600	27
New 8	Madison	-1	2023	0	0	450	450	7
New 9	Madison	-8	2030	0	0	0	450	0
TOTAL SUPPLY (gpm):				2550	2738	2735	2920	
		Production Hours	16	2,448,000	2,628,480	2,625,600	2,803,200	
		Production Hours	20	3,060,000	3,285,600	3,282,000	3,504,000	
		Production Hours	22	3,366,000	3,614,160	3,610,200	3,854,400	
		Production Hours	24	3,672,000	3,942,720	3,938,400	4,204,800	
		Less Well 1, 2 nd 4	24	3,096,000	3,323,520	3,319,200	3,585,600	

Assumptions: Well 4 and 2 are phased out by 2030. Well 1 removed for firm capacity. Wells 8 & 9 added.

The following chart identifies the projected water supply with no new wells and the assumption that Wells 2 and 4 will be phased out. The projected demand is increasing to provide water service to new growth areas and possibly the lake recreation area. One or two wells are needed to maintain capacity and keep up with growth. The water supply and demand situation should be reviewed on an annual basis. The final production of new wells and actual growth demand will dictate the timing and new for additional supply. The chart below shows a potential small supply deficit that should be monitored. The approach has a safety factor as the pumping durations are estimated at 20 hours per day.



The following alternatives were reviewed for use as a source water for the Lakeside Adventure Park:

Alternatives Review

1. No Upgrades: Existing City of Sturgis Water System

- a. The analysis of the existing water supply system identifies a potential declining water supply as wells age and water conditions cause treatment issues. It is not recommended to add water demand from the Lakeside Adventure Park without additional improvements or new wells to the existing supply system.

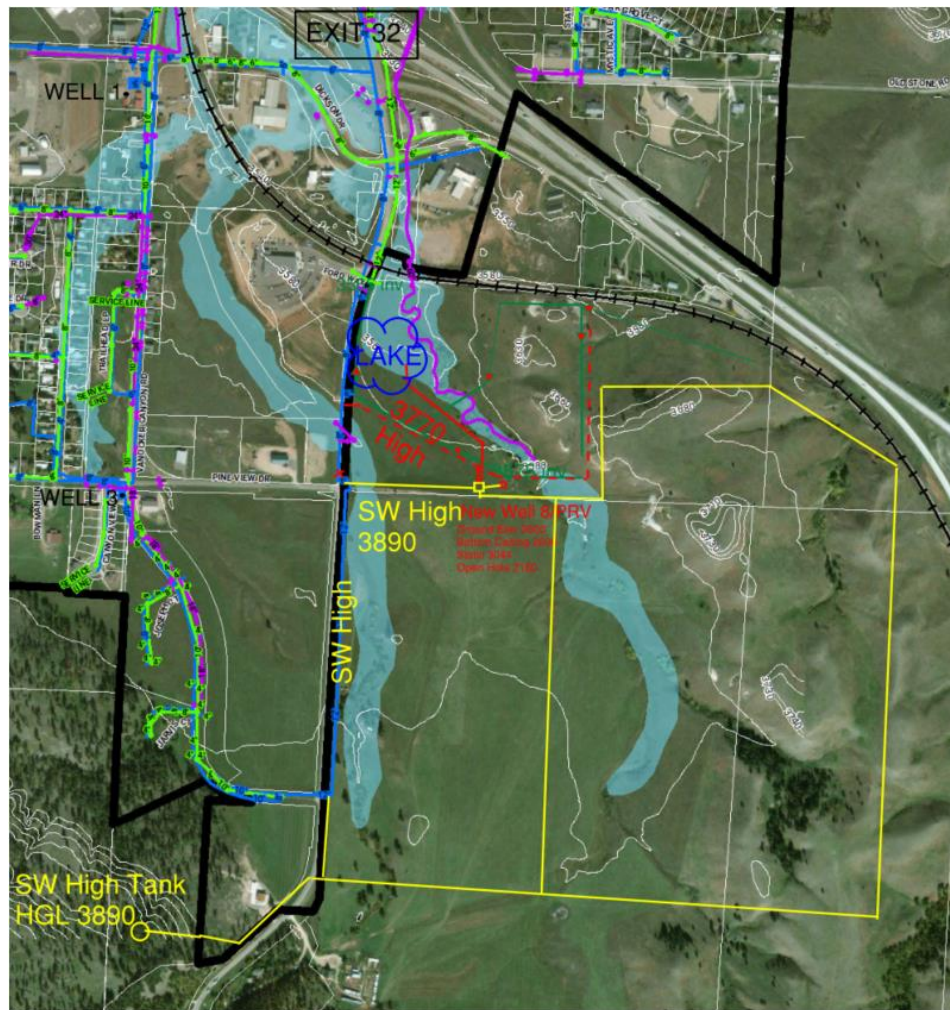
2. Upgrade City Well No. 4 w/Filtration System

- a. Well No. 4 is currently utilized only in emergency situations and is not a reliable quality source of water supply for the City.

- b. Potential improvements could be made to Well No. 4 to provide a quality water source. The well is currently 40 years - old and the condition of the well casing and pump are not fully known. The proposed improvements could include a new membrane filtration system within a new building addition adjacent to the well house. Detailed investigation is needed if this option is selected for further review.
- c. The water rights for Well 4 restrict use to 4 months per year which reduces the available redundancy within the system. Water rights could be applied for at this location with the state of South Dakota.
- d. The rough order of magnitude cost to complete filtration work is estimated to range from \$500,000 to \$750,000. This option could be considered but is not strongly recommended.

3. New City Drinking Water Well No. 8 at Lakeside Site

- a. The 2009 Study of Municipal Water System for the City of Sturgis was prepared by CETEC Engineering Services and recommended a new Well 8 in the same vicinity as the proposed Lakeside Adventure Park property east of Pine View Drive and Vanocker Canyon Rd.
- b. A well in this location would provide a good location for a new Madison well and would allow the City to utilize the well for the lake and distribute water to two different City pressure zones, 3770 High Zone and 3890 SW High Zone as shown in the figure below.



- c. Well 8 would provide a source of water to the 3890 SW High Zone south of Pine View Dr. and would assist with development of the future storage tank and pressure zone in this area of southwest Sturgis. This SW Storage tank is also a high priority to provide additional storage for the City and would provide storage for the Lakeside Adventure Park.
- d. The Madison well spacing is desired at 0.5 miles to 1 mile and this location provides spacing of 0.5 miles east of Well 3 and 0.65 miles southeast of Well 1.
- e. Well No. 8 Parameters:
 - The Madison aquifer depths are very similar to the Well No. 1 site and Madison wells are normally expected a production in the 400 to 500 gpm range for this area. The estimated well depths/profile are as follows:
 - Ground Elevation – 3600'
 - Bottom Casing – 2600'

Static Water – 3050'

Bottom of Open Hole – 2180'

- f. A new Well 8 at this location would also allow the installation of a Pressure Reducing Valve (PRV) between the 3890 and 3770 pressure zones.
- g. A well house would be designed to include a PRV, control valves and SCADA monitoring for the City well, pressure zones and for the lakeside recreation area.
- h. The well would produce untreated raw water for the recreation lake while allowing disinfection prior to distribution to the City water system.
- i. This alternative would provide efficient water system operations and would be incorporated into the overall City water system and would provide a solid third reliable Madison well for the City of Sturgis.
- j. The rough order of magnitude cost is estimated at \$1.0 to \$1.4 Million for well, well house and piping to Vanocker Canyon Rd. A detailed analysis and identification of work scope and developer layouts will require additional investigation.
- k. This alternative is strongly recommended for further consideration as it provides a solution for adding a water source at the Lakeside Adventure Park and also improves the entire City supply and water system. There are multiple benefits to consider with this option.

4. New Recreation Well for the Site

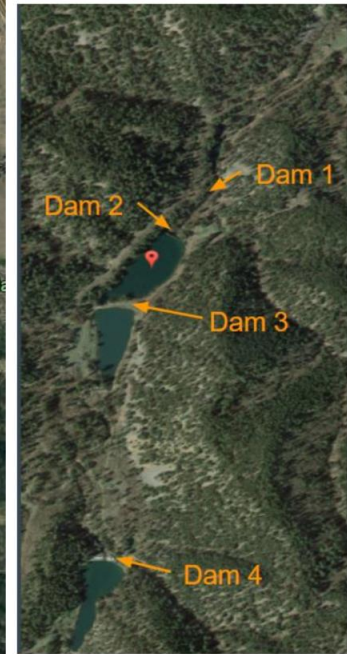
- a. A new stand-alone water well could be drilled at the Lakeside Adventure Park Site south of Exit 32. A seasonal well utilized only for the lake, site irrigation and recreation could be drilled into the Minnelusa aquifer and developed at the 150 to 200 gpm range to provide adequate capacity for the site.
- b. Detailed investigation and design would be needed to identify well size and depth for the site.
- c. A storage evaluation of operating conditions is necessary to verify if a small operational storage tank would be needed to support the lakeside project.
- d. A small building may be necessary to provide freeze protection of pressure tanks and protection of electrical components for the well system.
- e. A variable frequency drive may be necessary to provide a calibrated flow rate for the splashpad and other needs. Operational sequencing for the splashpad would require additional investigation.
- f. An independent SCADA control system could be incorporated to monitor the system remotely.
- g. If this option is selected the cost to construct the well will not benefit the City supply and distribution system. The facility would be constructed as a recreational facility and not as a municipal grade water supply.

- h. The rough order of magnitude cost is estimated in the range of \$300,000 to \$750,000. The details selected for well and well house construction will impact costs. A detailed cost estimate has not been completed. This alternative is feasible and could be considered if the City desires.

5. City Dams and Pipeline

- a. The City of Sturgis owns four (4) dams 2.3 miles south of the proposed Lakeside Adventure Park east of Vanocker Canyon Road with a pipe outlet and overflow to Alkali Creek.
- b. The Sturgis Dam Final Report was completed by the South Dakota School of Mines and Technology in December 2017. Excerpts from the report have been included in the following documentation.
- c. Currently the 8" cast iron pipe is several decades old and is broken and is not able to convey water without repairs. Distribution improvements would also be necessary to extend a pipeline to the lake site.
- d. The dams are aging and are in need of major repairs if they are intended for use by the City as a water source for the Lakeside Adventure Park.
- e. The water quality within the dams is not suitable for swimming and is high in E. coli and is above the EPA and SDDANR requirements for recreational swimming due to fecal coliform.
- f. Filtration and disinfection are needed to bring the water into compliance with recreational swimming requirements.

The project lake location and dam vicinity map are shown below:



- g. There are several design and operational issues with utilizing the dam water for the Lakeside Adventure Park, including:
- i. Poor water and high E. Coli levels
 - ii. Poor condition of the dam structures and risk for failure or repairs. Reliability would be a concern.
 - iii. Age and condition of the pipe outlet and valve for the discharge piping. Valves are non-operational and the piping is in disrepair.
 - iv. The long distance of 2.3 miles of pipe repairs or replacement through rugged terrain also reduces the feasibility of this water source. Lead and copper leaching is also a concern with the existing pipeline.
 - v. The costs to repair the piping and dams is in the order of magnitude of \$1 to \$2 Million.
 - vi. Water filtration and disinfection would be in addition to the dam and piping costs. Controls and automation may also be considered to control flow to the lake.
 - vii. A detailed analysis and investigation are needed to refine this estimate.

Report information on Dam Water Quality:

South Dakota Department of Environment and Natural Resources has surface water standards for many different use categories. The team determined that 74:51:01:50 Criteria for Immersion Recreation Waters and 74:51:01:46 Criteria for Coldwater Marginal Fish Life Propagation Waters were the criteria that needed to be addressed in this situation. These criteria can be seen below in Figures 16 and 17 respectively (SDDENR, 2017). Based on these criteria, Total Coliforms in all four reservoirs are above the E.Coli requirements for swimming and could pose a problem. Solids could also be a concern as the Dissolved Solids are high. Suspended solids were not tested for directly but could also be a concern for fishing. Other concerns include sulfates and alkalinity which have a general trend of increasing as you move upstream. These results were not what were expected and do not show the issues and increase of sulfates and alkalinity that the team expected to see in Reservoir 2 after the visual inspection on first field trip.

Sample Name	TDS (mg/L)	Alkalinity (mg/L)	Chloride (mg/L)	N, Nitrate (mg/L)	Phosphorus - T (mg/L)	Sulfate (mg/L)	T. Coliform (MPN/100mL)	Field pH	Field Temp. (°C)
Reservoir 1	144	119	< 0.500	0.079	0.02	14.4	548	8.5	15.2
Reservoir 2	146	123	< 0.500	< 0.050	0.028	13.4	6240	9.1	15.2
Reservoir 3	154	136	< 0.500	< 0.050	0.011	15.5	488	8.6	13.7
Reservoir 4	211	169	< 0.500	< 0.050	0.011	19.9	1990	7.7	13.5

Report Recommendations and Costs for Dams

Information from the design report:

Design Recommendations

The dams are in such poor condition that performing maintenance on them is not a long-term solution. Largely this is due to the difficulty of performing maintenance or replacing the dams. This led to a low safety and longevity score. The only dam that may be worth the cost of maintenance is Dam 3. If the concrete spillway is replaced and the vegetation is removed from the earthen portion of the dam, Dam 3 would exist at a low risk for the foreseeable future.

The rough order of magnitude cost for dam repairs is listed below. A detailed cost estimate has not been completed.

Final Cost Estimates		
Removal of Dam 4	Replacement of Dam 3 Spillway	Repair of Dam 2
\$83,310	\$64,922	\$339,956

Conclusion

Extensive issues were found in the team's visual structural and geotechnical analyses of the Sturgis dams. This includes seepage, erosion, cracking, and spalling. It was determined that, for safety reasons, corrective action should be taken if the area is to be open to the public. The design alternatives developed were replacing the dams, performing maintenance, leaving the dams as check dams (with empty reservoirs), and tearing down some or all of the dams. Based on our comparison table, the best option is to tear down the dams. However, the cheapest and simplest option is to leave the dams as check dams. Based on the team's meeting with the City Engineer for Sturgis, the team's design focus was on redesigning the spillway of Dam 3 as well as repairing Dam 2. The hydraulic modeling completed in HEC-HMS further emphasized the safety concerns with the dams. The model showed the discharge at each dam during 100- and 50-year storms, under various inputs. It was determined that these storms could cause to dangerously high overtopping that may lead to dam failure.

- h. Based on the SDSM&T report and issues identified in the report it is not recommended to pursue the City dams as a water source for the Lakeside Recreation Park.

Summary of Recommendations

1. No Upgrades: Existing City of Sturgis Water System: **NOT RECOMMENDED**
2. Upgrade City Well No. 4 w/Filtration System: **LOW RECOMMENDATION**
3. New City Drinking Water Well No. 8 at Site: **STRONG RECOMMENDATION**
4. New Recreation Well for the Site: **MEDIUM RECOMMENDATION**
5. City Dams and Pipeline: **NOT RECOMMENDED**

This report includes conceptual information based on resources and analysis available. Foth recommends the City review this document and provide additional input on the alternatives reviewed. This document can be updated based on City input and additional refinements provided.

REFERENCES

1. Lakeside Adventure Park Final Design Report prepared by Fennel Design Inc., CRS Design and Tallgrass Landscape Architecture, December 21, 2021 and Splashpad Flow Thru Water Consumption Cost Estimator data, February 2022.
2. Study of Municipal Water System for City of Sturgis, SD prepared by CETEC Engineering Services, Inc., August 12, 2009.
3. Sturgis Dam Final Report prepared by SDSM&T (Gildemeister, Hemmer, Meckling, Van Dyke, Weinkauf), December 13, 2017.
4. City of Sturgis Geographic Information Systems, 2021 and Richards property data.
5. Sturgis Water System Improvements Phase 2 Engineering Drawings prepared by CETEC Engineering Services, Inc., February 12, 2012.
6. Water System Evaluation for City of Sturgis, SD Technical Memorandum prepared by AE2S, November 18, 2020.
7. EPA 823-F-18-001: 2017 Five-Year Review of the 2012 Recreational Water Quality Criteria
8. EPA 820-F-12-061: 2012 Recreational Water Quality Criteria