



**DEPARTMENT OF ENVIRONMENT
and NATURAL RESOURCES**

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**RECOMMENDATION OF CHIEF ENGINEER FOR WATER PERMIT
APPLICATION NO. 2730-2, United Order of South Dakota**

Pursuant to SDCL 46-2A-2, the following is the recommendation of the Chief Engineer, Water Rights Program, Department of Environment and Natural Resources concerning Water Permit Application No. 2730-2, United Order of South Dakota, c/o Seth Jeffs, 11571 Farmer Rd, Pringle SD 57773.

The Chief Engineer is recommending Approval of Application No. 2730-2 with a 20 year term pursuant to SDCL 46-1-14 and 46-2A-20 because 1) evidence is not available to justify issuing this permit without a 20 year term limitation, 2) the proposed diversion can be developed without unlawful impairment of existing rights, 3) the proposed use is a beneficial use, and 4) it is in the public interest with the following qualifications:

1. In accordance with SDCL 46-1-14 and 46-2A-20, Permit No. 2730-2 is issued for a twenty year term. Pursuant to SDCL 46-2A-21, the twenty year term may be deleted at any time during the twenty year period or following its expiration. If the twenty year term is not deleted at the end of the term, the permit may either be cancelled or amended with a new term limitation of up to twenty years. Permit No. 2730-2 may also be cancelled for non-construction, forfeiture, abandonment or three permit violations pursuant to SDCL 46-1-12, 46-5-37.1 and ARSD 74:02:01:37.
2. The new well approved under this Permit will be located near domestic wells and other wells which may obtain water from the same aquifer. The well owner under this Permit shall control his withdrawals so there is not a reduction of needed water supplies in adequate domestic wells or in adequate wells having prior water rights.
3. The new well authorized by Permit No. 2730-2 shall be constructed by a licensed well driller and construction shall comply with Water Management Board Well Construction Rules, Chapter 74:02:04 with the well casing pressure grouted (bottom to top) pursuant to Section 74:02:04:28.
4. The Water Permit Holder shall report to the Chief Engineer annually the amount of water withdrawn from the Madison aquifer that is authorized by Water Permit Nos. 2610-2 and 2730-2.

See report on application for additional information.

Jeanne Goodman, Chief Engineer

December 5, 2014

WATER PERMIT APPLICATION NO. 2730-2
UNITED ORDER OF SOUTH DAKOTA
NOVEMBER 12, 2014

Water Permit Application No. 2730-2 proposes to appropriate water from the Madison aquifer at a maximum diversion rate of 0.46 cubic feet of water per second (cfs). Water is to be diverted from two existing wells which were authorized by Water Permit No. 2610-2, and a proposed well. Water Permit No. 2610-2 authorizes diversions of up to 0.21 cfs from two wells located in the NW¼ SE¼ of Section 10, T6S-R3E, Custer County. This application proposes to authorize the construction of a third well, also located in the NW¼ SE¼ of Section 10, T6S-R3E, and authorize a total maximum diversion from the three wells of 0.67 cfs. The water will be used in the United Order of South Dakota’s water system.

AQUIFER: Madison aquifer (MDSN)

Aquifer Characteristics:

The Madison aquifer is a regionally extensive aquifer contained within the Madison Limestone, locally known as the Pahasapa Limestone, and the Englewood Limestone. The aquifer underlies portions of North Dakota, South Dakota, Montana, Wyoming, Saskatchewan, Manitoba and Alberta. The Madison aquifer underlies most of western South Dakota and parts of Eastern South Dakota (Figure 1). The Madison aquifer contains an estimated 644,827,200 acre-feet of recoverable water in storage in Western South Dakota (Allen and others, 1985) and 51,512,300 acre-feet of recoverable water in storage in Eastern South Dakota (Hedges and others, 1982).

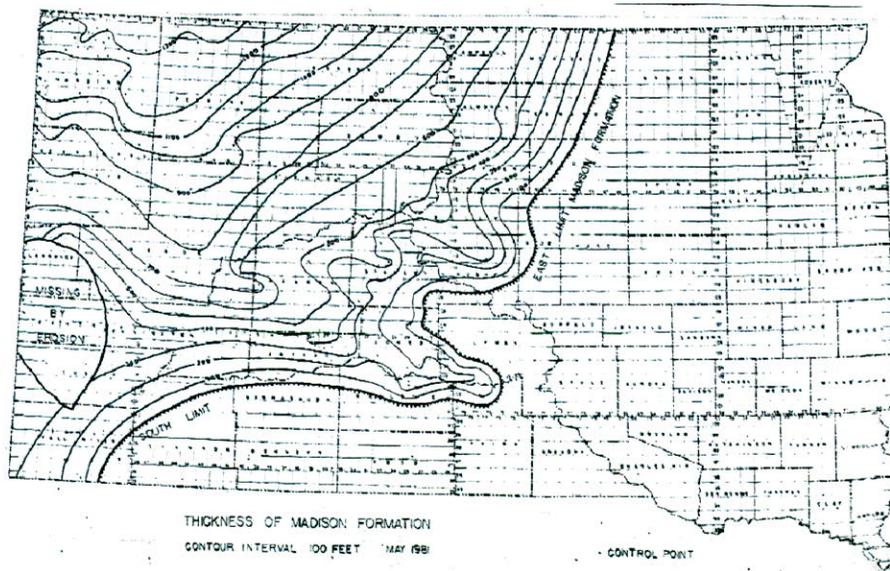


Figure 1. Areal Extent of the Madison Formation in South Dakota: modified from (Gries, 1981).

The Madison aquifer is considered a “mature karst aquifer” (Long and others, 2012) and is composed of a fine to medium crystalline, cavernous limestone and dolomite. The Madison is expected to be approximately 300 feet thick in this area (Carter and Redden, 1999a); and (Carter and Redden, 1999b). The upper portion of the Madison Limestone is karstic, therefore it contains randomly distributed zones of secondary porosity and permeability formed by weathering of

exposed surfaces, groundwater solution and fracturing. The lower part of the Madison Limestone and the Englewood Limestone generally have lower permeability than the upper part of the Madison aquifer in the Black Hill (Greene, 1993). The average porosity of the Madison is estimated to be 11%, and the effective porosity from which recoverable water can be obtained by wells is assumed to be 5% (Rahn, 1979).

The well site proposed by this application is located approximately five miles southwest of the Madison Limestone outcrop (Strobel and others, 1999). In this area, the Madison Limestone dips to the southwest at approximately 240 feet per mile (approximately three degrees) (Carter and Redden, 1999a). The DENR-Water Rights Program has record of three existing wells constructed for the United Order of South Dakota. The top of the Madison was reported to be 785 feet below grade in one well log, 715 feet below grade in a second well log and is inferred to be 719 feet below grade in the third log (Water Rights, 2014c). The static water level of the wells was reported to be 650' (06/05/2005), approximately 800' (10/20/2010) and approximately 800' (10/15/2007) respectively.

SDCL 46-2A-9

Pursuant to SDCL 46-2A-9, a permit to appropriate water may be issued only if there is reasonable probability that there is unappropriated water available for the applicant's proposed use, that the proposed diversion can be developed without unlawful impairment of existing rights and that the proposed use is a beneficial use and in the public interest.

Water Availability:

The availability of unappropriated water can be evaluated by considering SDCL 46-6-3.1 which requires that "No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source." The statute provides that "An application may be approved, however, for withdrawals of groundwater from any groundwater formation older than or stratigraphically lower than the greenhorn formation in excess of the average estimated annual recharge for use by water distribution systems." Water Permit Application No. 2730-2 proposes to appropriate water from the Madison aquifer, a water source that is older than the Greenhorn Formation, and the water is to be used by a water distribution system. Therefore, the Board need not consider the recharge versus withdrawal issue.

Existing Rights:

This applicant has been utilizing wells completed into the Madison aquifer that were authorized by Water Permit No. 2610-2 since 2007 with no significant impact. The additional diversion rate proposed by this application is relatively low and will not likely have a noticeable effect to the Madison aquifer. There are 64 completion reports on file with the DENR-Water Rights Program within approximately five miles of the wells that are to be used to supply this appropriation (Water Rights, 2014c). The majority of these domestic wells appear to be completed into the Minnelusa aquifer and at least two are completed into the Deadwood aquifer. Wells completed into aquifers that are either stratigraphically above or below the Madison aquifer (i.e. Minnelusa and Deadwood respectively) are not expected to be affected by this proposed appropriation since the lower Minnelusa formation can be considered a confining bed that isolates the Madison hydraulically from shallower aquifers, and the bottom portion of the Madison isolates the Madison from lower

aquifers. Only three of the domestic wells on file appear to be completed into the Madison aquifer. Based on the legal location provided on the completion reports, the Madison aquifer wells are all located over three and three quarter miles from the site(s) of Application No. 2730-2.

The diversion point locations for existing water rights and future use permits appropriating water from the Madison aquifer in this area are shown in Figure 2 and identified in Tables 1 and 2.

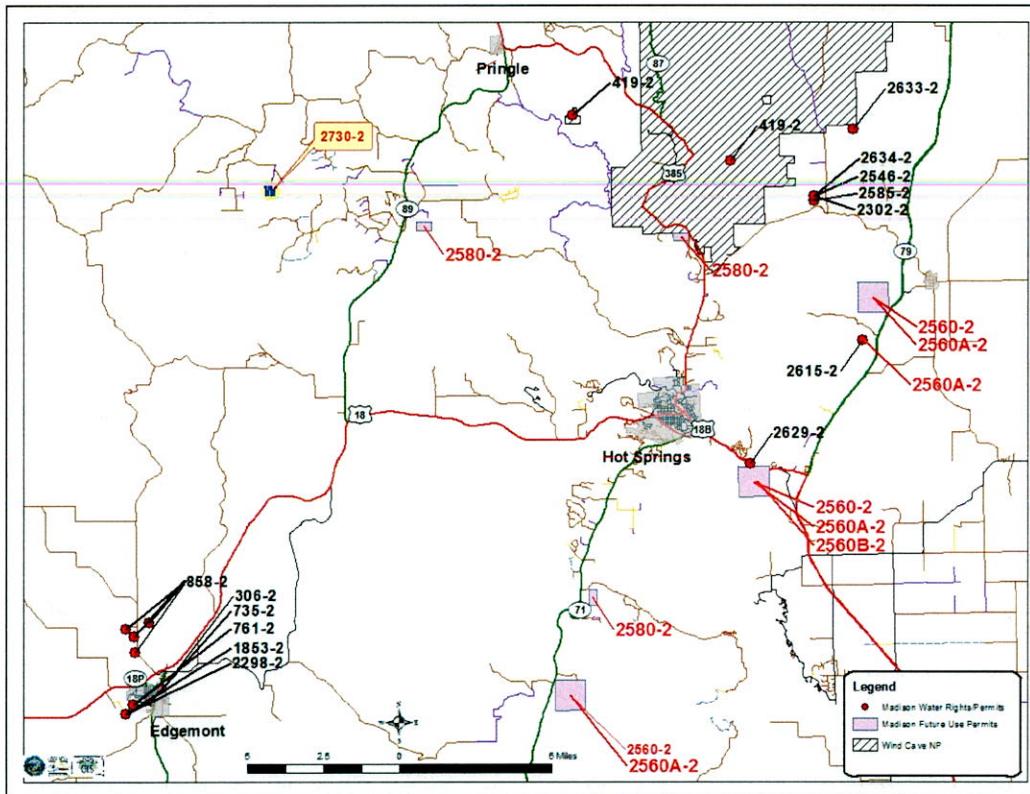


Figure 2. Location of the diversion point(s) proposed by Water Permit Application No. 2730-3, diversion points for existing Madison aquifer water rights/permits, and areas of Madison aquifer future use permits in the vicinity (Water Rights, 2014b).

Table 1. Water Rights/Permits appropriating water from the Madison aquifer in the vicinity of the diversion points proposed by Application No. 2730-2(Water Rights, 2014b).

PERMIT NO	NAME	PRIORITY DATE	STATUS	USE	CFS	ACRES	AC-FT /YR
306-2	CITY OF EDGEMONT	12/14/1945	LC	MUN	0.31		
419-2	WIND CAVE NATIONAL PARK	12/29/1955	LC	COM/IRR	0.15		
735-2	TENNESEE VALLEY AUTHORITY	12/26/1961	LC	IND	0.66		
761-2	CITY OF EDGEMONT	04/09/1962	LC	MUN	0.41		
858-2	WYOMING DAKOTA RAILROAD PROPERTIES INC	02/05/1965	LC	IRR	9.36	655.75	
1853-2	CITY OF EDGEMONT	08/23/1983	IL	MUN			
2298-2	CITY OF EDGEMONT	08/28/1993	LC	REC/MUN	1		
2302-2	EBEN W STREETER	02/07/1994	LC	RWS	0.033		
2546-2	EBEN STREETER	01/03/2005	PE	RWS	0.21		
2615-2	FALL RIVER WATER USERS DISTRICT	05/16/2005	PE	RWS	0.67		
2629-2	FALL RIVER WATER USERS DISTRICT	05/16/2005	PE	RWS	1		
2585-2	SOUTHERN BLACK HILLS WATER SYS	05/08/2006	DF	RWS	2.67		1600
2610-2	UNITED ORDER OF SOUTH DAKOTA	02/09/2007	PE	SHD	0.21		
2633-2	SOUTHERN BLACK HILLS WATER SYSTEM	06/20/2008	PE	RWS	0.67		
2634-2	STREETER FAMILY LIMITED PARTNERSHIP	07/17/2008	PE	RWS	0		

LC= Water License, IL= Incorporated, PE= Water Permit, DF= Deferred, MUN= municipal, COM= Commercial, IRR= Irrigation, IND= Industrial, REC= Recreational, RWS= Rural Water System, SHD= Suburban Housing Development

Table 2. Future Use Permits reserving water from the Madison aquifer in the vicinity of the diversion points proposed by Application No. 2730-2(Water Rights, 2014b).

FUTURE USE PERMIT NO.	NAME	ORIGINAL RESERVATION (AC-FT/YR)	REMAINING RESERVATION (AC-FT/YR)
2560-2	FALL RIVER WATER USERS DISTRICT	750	0
2580-2	SOUTHERN BLACK HILLS WATER SYSTEM	1474	1474
2560A-2	FALL RIVER WATER USERS DISTRICT	*	0
2560B-2	FALL RIVER WATER USERS DISTRICT	*	0

* FUTURE USE PERMIT NOS. 2560A-2 AND 2560B-2 AMEND FUTURE USE PERMIT NO. 2560-2 TO EXPAND THE FUTURE USE AREA AND DO NOT RESERVE ADDITIONAL WATER

Since the Madison is under artesian conditions in this area, drawdown from pumping a well may extend over a fairly large area. The transmissivity of the aquifer is very heterogeneous with values that range over several orders of magnitude (Putnam and Long, 2007). In addition, the aquifer characteristics of the Madison can vary considerably within a short distance (Greene, 1993).

Carter and others (2001) developed hydrologic budgets for the Madison and Minnelusa aquifers combined, using nine subareas to cover the Black Hills. The subareas were identified on the basis

of hypothetical flow paths and were selected with the intent of minimizing flow across the boundaries. The well(s) that is/are to be used to supply this appropriation is/are located in Carter and others' (2001) subarea 8. Carter and others (2001) estimated the transmissivity of the Madison aquifer on the border of the subarea near the well site at 1,463 feet squared per day (ft^2/d). Applying this estimated transmissivity and assuming a storage coefficient of $S= 2 \times 10^{-4}$, the drawdown 1,000 feet from a well pumping 0.46 cfs would be less than 19 feet after one year of continuous pumping based on the Theis Equation (see Figure 3) ("Theis Equation Calculator").

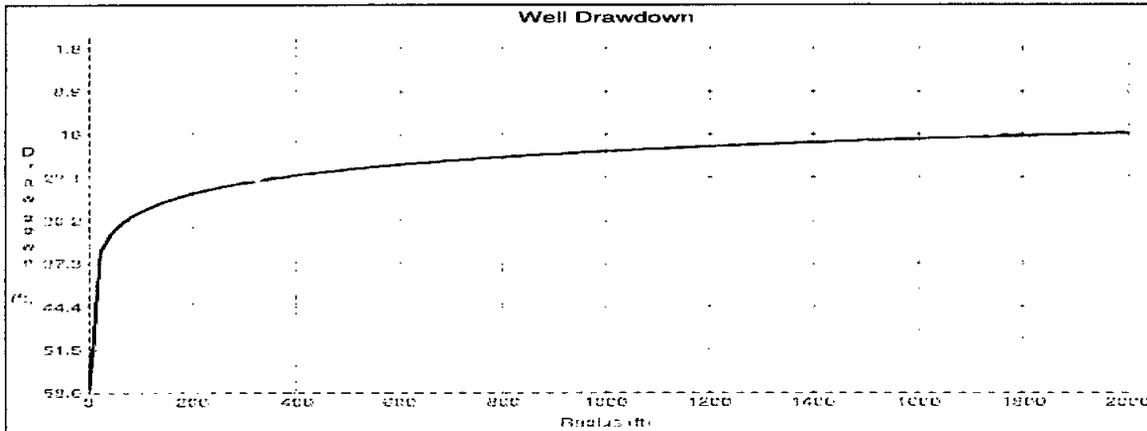


Figure 3. Drawdown predicted from a well pumping 0.46 cfs from the Madison aquifer, continuously for one year, assuming $T= 1,463 \text{ ft}^2/\text{d}$, $S= 2 \times 10^{-4}$. (modified from ("Theis Equation Calculator"))

Assuming the combined diversion rates of Water Permit No. 2610-2 and Water Permit No. 2730-2 (if approved) are pumped from a single well, a transmissivity of 1,463 ft^2/d and a storage coefficient of $S= 2 \times 10^{-4}$, the drawdown 1,000 feet from a well pumping 0.67 cfs would be less than 28 feet after one year of continuous pumping based on the Theis Equation (see Figure 4) ("Theis Equation Calculator").

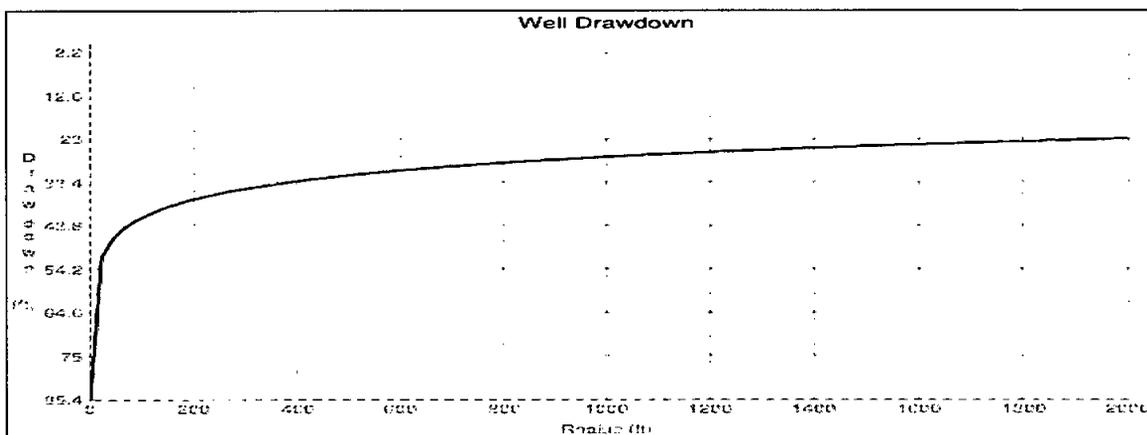


Figure 4. Drawdown predicted from a well pumping 0.67 cfs from the Madison aquifer, continuously for one year, assuming $T= 1,463 \text{ ft}^2/\text{d}$, $S= 2 \times 10^{-4}$. (modified from ("Theis Equation Calculator"))

The Theis equation requires a number of simplifying assumptions, some of which may not apply in this case; however, the solution is still useful to show that drawdown should not be significant.

Wells supplying existing Water Rights/Permits and domestic uses are protected from adverse impacts per Water Management Board rules 74:02:04 and 74:02:05, which were promulgated pursuant to SDCL 46-6-6.1. These rules provide for the regulation of large capacity wells to the degree necessary to maintain an adequate depth of water for a prior appropriator in wells that have the ability to produce water **independent of artesian pressure**. Simply put, the pump placement in a prior appropriator's well is not necessarily protected.

If the water levels in the Madison aquifer were to decline, owners of existing wells bear the responsibility of lowering the pump inlet in the well to the top of the aquifer, if necessary. Increased lift would decrease the pump discharge; or require a larger pump or a different type of a pump to maintain the same output.

An increase in operating expenses that may result from interference between wells is not necessarily an adverse impact. The Water Management Board considered this situation in the matter of Water Permit Application 2313-2, Coca-Cola Bottling Company of the Black Hills (Water Rights, 1995). The Board adopted findings of fact and conclusions of law that basically state that if the increased cost or decreased production is considered an adverse impact, it could be in conflict with SDCL 46-1-4, which requires South Dakota's water resources to be put to beneficial use to the fullest extent of which they are capable.

It should be noted however, that well interference (drawdown) measured at Water Rights' observation wells located near high capacity municipal wells in Spearfish, Sturgis and Rapid City has never been significant (i.e. drawdown of only a few feet or tens of feet) (Water Rights, 2014a).

Given the distance between the well(s) that is/are to supply this appropriation and existing Madison wells well interference is not expected to be adverse.

The well sites proposed by this application are located approximately five miles west of the "Argyle" well site proposed by Future Use Permit No. 2580-2. Approval of this application should not hinder development of the future use permit due to the distance involved.

Beneficial Use:

Pursuant to SDCL 46-1-6 (3) beneficial use is defined as:

“any use of water within or outside the state, that is reasonable and useful and beneficial to the appropriator, and at the same time is consistent with the interests of the public of this state in the best utilization of water supplies;

The applicant has the burden of proof in establishing that an application is a beneficial use of water.

Public Interest Issues:

In the past, there have been two “public interest” issues raised that could potentially be obstacles to developing the Madison aquifer in the Southern Black Hills: the possibility of affecting artesian spring discharge; and the possibility of affecting the water resources at Wind Cave National Park.

Artesian Springs:

The water at a number of springs in the southern Black Hills area contains geochemical and isotopic characteristics of the Madison aquifer (Whalen, 1994). These springs are classified as Type 2 springs by Rahn and Gries (1973), meaning “The springs do not dry up and serve as points of permanent discharge from the carbonate aquifer” (Rahn and Gries, 1973). Major springs in the area identified by Naus and others (2001) are shown in Figure 5.

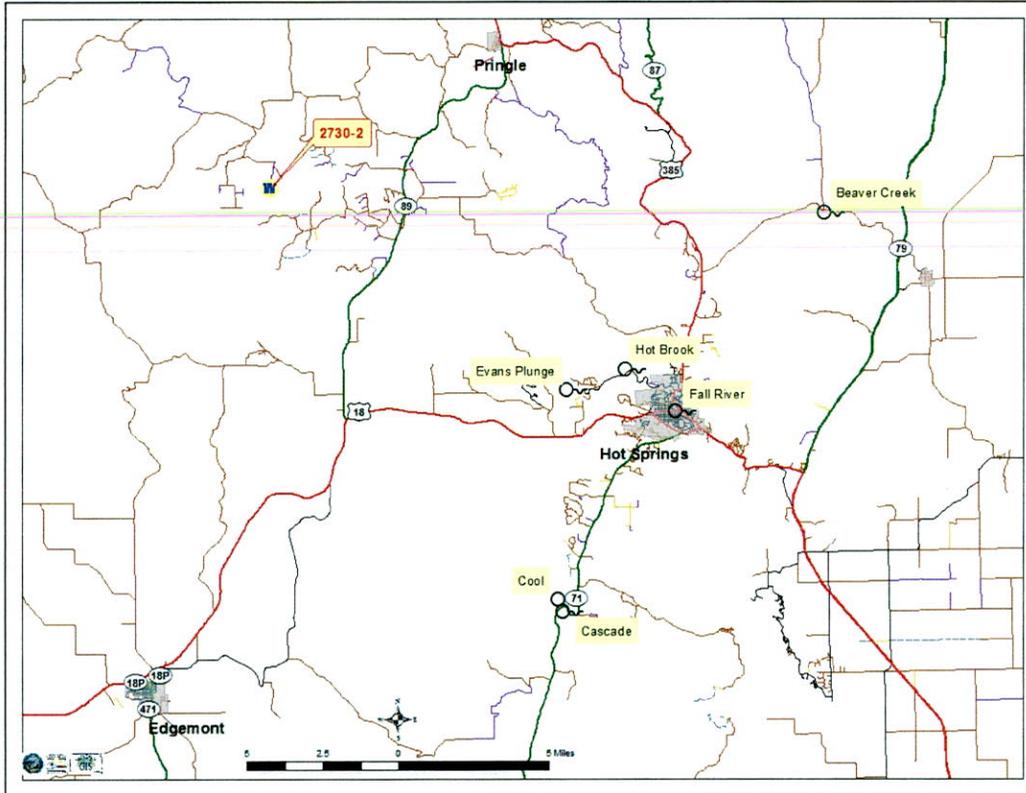


Figure 5. Location of the diversion point(s) proposed by Water Permit Application No. 2730-2, and the location of major springs in the vicinity.

The discharge of one of these springs, Beaver Creek Spring, is measured by National Park Service personnel. The spring is located approximately two and one-quarter miles east of SD DENR-Water Rights’ Observation Well CU-91A. A comparison of the discharge of Beaver Creek Springs and the potentiometric surface of the Madison aquifer suggests a relationship may exist between the two (see Figure 6). At this time it is not possible to determine if a cause and effect relationship exists between the Madison aquifer potentiometric surface and the spring flow or if the two have similar responses to the same hydrologic conditions. If a cause and effect relationship exists between the Madison aquifer potentiometric surface and the spring discharge, a decline of the potentiometric surface in the vicinity of the springs could decrease spring discharge.

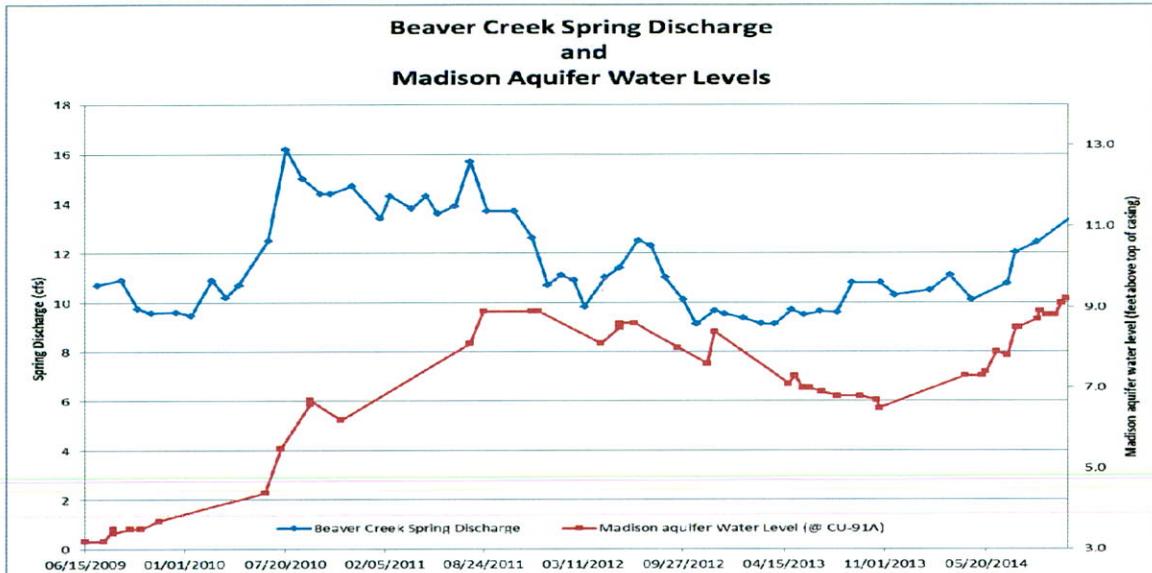


Figure 6. Beaver Creek Spring Discharge compared to Madison aquifer potentiometric surface measured at observation well CU-91A (“Aquarius Web Data Portal.”; Water Rights 2014a)

When considering Future Use Permit No. 2560-2 for Fall River Water User District, the Water Management Board accepted that SD Water Law does not protect artesian head pressure as a means of diversion and determined that well interference resulting in decreased discharge from these “artesian” springs could probably not be considered an adverse impact. The Board did however recognize the “public interest” issues of decreased base flows in area streams that could result from decreased spring discharge as the result of well interference. Approval of Future Use Permit No. 2560-2 included the following qualification:

“At such time as definite plans are made to construct works and put the water reserved by this permit to beneficial use, specific application for all or any part of the reserved water must be submitted and approved prior to construction of facilities pursuant to SDCL 46-5-38.1 with particular attention given to the flows of Beaver Spring, Cascade Springs and Hot Springs.” (Water Rights, 2014b)

Subsequently, when considering the deferral of Water Permit Application No. 2585-2, Southern Black Hills Water System, the Water Management Board adopted a conclusion of law (No. 11) which states in part “The only protection South Dakota law provides when considering an application for an underground water permit for flow from an artesian spring is under the public interest criteria.”

The well site(s) proposed by this application is/are located over eleven miles from the nearest major spring (Evens Plunge). A fairly large change in the hydraulic gradient in the vicinity of the springs would be necessary to significantly affect the groundwater flow rates and consequently the spring’s discharge. Given the distance involved and the relatively low diversion rate proposed by this application, (0.67 cfs maximum), it is unlikely that drawdown from this well would have a measurable impact on spring discharge.

Wind Cave National Park:

The National Park Service (NPS) has intervened in matters of water permit applications from the Madison aquifer in the past. In 2007, the NPS filed a petition to intervene in the matter of Water Permit Application No. 2610-2. The NPS was concerned that “the Application No. 2610-2, over time and in combination with senior water right applications ... will adversely impact Wind Cave National Park (Wind Cave NP) senior water rights and water-dependent resources.” The water-related resources cited by the NPS include: lakes and pools in the lower reaches of Wind Cave, three perennial streams (Cold Springs, Beaver, and Highland Creeks), many intermittent and ephemeral stream courses, and over 95 seeps and springs. The NPS later withdrew their opposition to granting the water permit but restated its concerns about the potential impacts of appropriations from the Madison aquifer.

Lakes and Pools:

The lakes and pools in Wind Cave National Park are in hydraulic connection with the Madison aquifer and the water table of the Madison aquifer is accessible at the deepest part of the cave (Long and others, 2012) . The stages of the lakes fluctuate in response to climatic conditions similar to fluctuations in the Madison potentiometric surface measured in DENR-Water Rights’ Observation Well CU-91A, (see Figure 7).

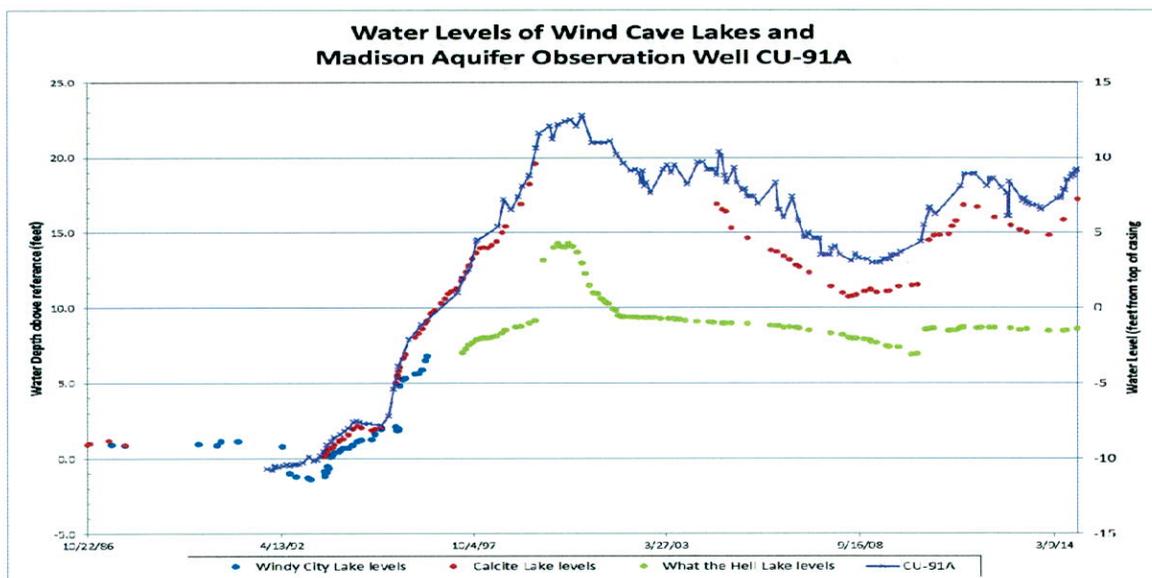


Figure 7. Water Levels of Wind Cave National Park Lakes compared to Madison aquifer potentiometric surface measured at observation well CU-91A (Hughes; Water Rights 2014a)

The lakes and pools in Wind Cave are located approximately thirteen miles east of the well site(s) proposed by this application (see Figure 8).

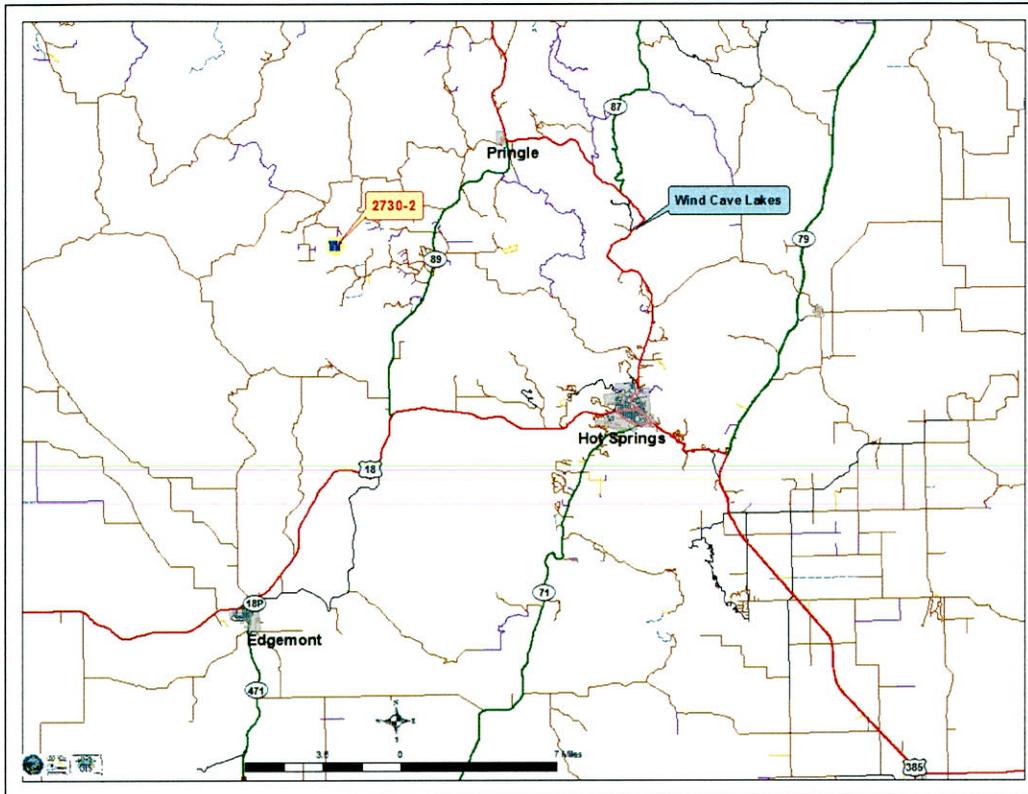


Figure 8. Location of the diversion point(s) proposed by Water Permit Application No. 2730-3, and the location of lakes and pools in Wind Cave National Park.

The impacts of pumping the well proposed by this application is expected to be negligible on the Wind Cave Lakes, especially when compared with the natural fluctuations because of the distances involved (>5 miles) and the relatively small diversion rate proposed (0.67 cfs maximum).

Streams (Perennial and Ephemeral):

The NPS identified three perennial streams (Cold Spring, Beaver and Highland Creeks) as “water resources of high value at Wind Cave NP”. The entire length of Cold Spring Creek is located on formations that are geologically lower than the Madison and therefore are not expected to be influenced by Madison aquifer withdrawals. Beaver and Highland Creeks are typically dry in their reaches downstream from the loss zone (Madison, Minnelusa and Minnekahata aquifer outcrops) because the upstream flow is usually insufficient to meet or exceed the streams’ loss thresholds. Since loss thresholds are assumed to be generally constant (Hortness and Driscoll, 1998), any fluctuations of the groundwater levels caused by pumping will not affect the frequency that the reaches of Beaver Creek and Highland Creek downstream of the loss zones are dry.

Seeps and springs:

The majority of the seeps and springs identified by the NPS are obviously not related to the Madison aquifer. They either surface in geologic formations hydrologically isolated from the Madison at elevations hundreds of feet higher than the water level of the Madison, or in geologic formations older than (below) the Madison. The few seeps or springs identified by the NPS that are actually situated on the Madison outcrop are likely expressions of localized perched conditions that would not be impacted by any changes in water level of the regional system.

TERM LIMITATION:

SDCL 46-2A-20 requires that "... no water permit for construction of works to withdraw water from the Madison formation in Butte, Fall River, Custer, Lawrence, Meade and Pennington counties may be issued for a term of more than twenty years, unless the water management board determines, based upon the evidence presented at the hearing that:

- (1) Sufficient information is available to determine whether any significant adverse hydrologic effects on the supply of water in the Madison formation would result if the proposed withdrawal were approved; and
- (2) The information, whether provided by the applicant or by other means, show that there is a reasonable probability that issuance of the proposed permit would not have a significant adverse effect on nearby Madison formation wells and springs."

Evidence is not available to justify issuing this permit without a term limitation of 20 years.

Conclusions:

1. The Madison aquifer is a viable aquifer in this area.
2. This diversion will not adversely impair existing water rights.
3. Information is not available to approve this application without a 20 year term limit



Ken Buhler
SD DENR-Water Rights Program

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