Name of Project: Characterization of Impacts of Decentralized Wastewater Treatment Systems Overlying Fractured or Solution-Enhanced Aquifers and Watersheds

General Project Budget:

The total cost of the 2 ½ year project is **$552,700.**

Partners:

USGS (Coop Program)	$ 225,000
DENR (DWSRF Grant)	200,000
Rapid City	25,000

* Joint Funding Agreement with West Dakota lead entity

SDGS (Drilling and support)	76,700
West Dakota Water (admin support)	10,000
West Dakota (contract drilling if needed)	16,000

Background/Problem:

The Black Hills of South Dakota provides a unique demonstration site for evaluating the nationwide magnitude of malfunctioning on-site and decentralized wastewater treatment systems (septic systems) and characterizing associated effects on surface- and ground-water quality. The hydrogeology of the area is diverse and complex, and many of the watersheds and aquifers are characterized by fractured or solution-enhanced bedrock. This secondary porosity may be less effective at attenuating potential contaminants than sand and gravel units, which have been studied more extensively. In addition, many of these areas have thin soil cover, and compromised storage tanks or drain fields may be situated directly on bedrock with fractured or solution-enhanced porosity.

Population growth in the Black Hills area is rapid, and about 45 percent of the recent population growth has occurred in unincorporated areas (Carter and others, 2002) where septic systems commonly are used for waste-water treatment. Many of the developing areas are located in recharge areas for important aquifers that have large secondary porosity and provide most of the municipal and private water supplies in the area. Development of widespread, regional problems could take decades because of large storage volumes in these aquifers, thus, examination of potential problems in small study areas is especially critical.

Numerous septic systems also exist in high-value Black Hills watersheds that are characterized by fractured Precambrian igneous and metamorphic rocks that also may have limited potential for removal of some contaminants. Many of these areas also have thin soil cover that is highly variable in extent. Although septic effects in these areas have not been extensively studied in the Black Hills, human DNA has been found in streams (Dr. Scott Kenner, South Dakota School of Mines and Technology, oral communication). As in other hydrogeologic settings, septic systems commonly are the most cost-efficient method of waste-water treatment; however, little is known about treatment efficiency.

A need exists to strengthen a nationwide knowledge base for procedures that may be effective in assessing the influence of septic systems in similar settings. Issues regarding treatment efficiency of septic systems in fragile settings are highly visible in the Black Hills area.

Objectives:

Primary objectives include the following: (1) Identify suitable small study areas (clusters) overlying fractured or solution enhanced rocks where high densities of septic systems may affect water quality; (2) Sample and analyze ground water and surface water for preliminary indicators of septic influence, including nutrients, chloride, bromide, boron, and fecal coliform; (3) Sample a selected subset of sites for additional analysis of nitrogen isotopes, selected waste-water compounds, and microbiological indicators (4) Characterize the effects of septic systems based on the presence of these indicators, and evaluate the relative utility of various indicators in characterizing the effects of septic systems on water quality in each of the study clusters.

Approach:

Two hydrogeologic settings have been selected as focus areas, including: (1) fractured igneous and metamorphic rocks (4 to 6 clusters); and (2) carbonate bedrock dominated by fracturing or solution-enhanced porosity (3 to 5 clusters). A third setting in an alluvial ground-water setting (1 or 2 clusters) with known influence from septic systems (Bad Moccasin, 1986) will be selected to provide a data set for comparison.

The first phase (year 1) of the project will consist of selection of appropriate study clusters in the various hydrogeologic settings, identification of appropriate sampling sites, installation of sampling wells where needed, and collection of reconnaissance samples for relatively inexpensive indicators of potential septic influence. This approach is designed to prescreen sample sites with preliminary indicators, so that samples for more robust wastewater compounds and microbiological indicators can be collected during phase 2 (year 2) at sites with the highest probability of representing surface water and ground water with septic influence.

About 130 samples are budgeted for collection during phase 1 and parameters analyzed will include low-level nutrients chloride, bromide, boron, and fecal coliform. Concentrations of nutrients can be useful for characterizing septic influence. Chloride and bromide are useful indicators of anthropogenic contamination because they are: 1) highly soluble, 2) minimally affected by adsorption once dissolved in water, and 3) not altered by oxidation-reduction reactions (Hem, 1985). Chloride-bromide ratios also can be useful in indicating the presence of sewage. Boron indicates possible contamination because it is found in human sewage as a residue of detergents. Although there may be natural variability in these constituents in different hydrologic settings, the differences in chloride-bromide ratios and boron within clusters could be a useful tool in indicating stream sites and wells that have a high probability of septic influence.

A subset of about 20 samples are budgeted for collection during phase 2, which will include sites where phase 1 results indicate the highest potential for septic influence. These phase 2 sites will be resampled for the phase 1 constituents plus some combination of isotopes of nitrogen and oxygen in nitrate, wastewater compounds, and several microbiological indicators of pathogens. Phase 2 sampling will be conducted during timeframes when phase 1 sampling results indicate the highest probability of detection. If feasible, fluorescent dye may be injected in septic tanks in selected clusters as a tracer, if a suitable study setting can be identified.

The wastewater compound analysis includes multiple indicators of human wastewater, such as caffeine and cholesterol, hormones, pesticides, and volatile organic compounds. The analysis was developed by the USGS to detect chemicals commonly expected in wastewater (Zaugg and others, 2002).

Expected Accomplishments of Product:

Statistical analyses will be performed to examine correlations between different indicators of septic influence on surface and ground-water. Where possible, differences between fractured rock, carbonate rock, and alluvial settings will be documented. Expected results will be critical to addressing high-visibility issues regarding high-value aquifers and watersheds in the Black Hills area. Excellent potential also exists for transfer value for other similar terrains throughout the United States.

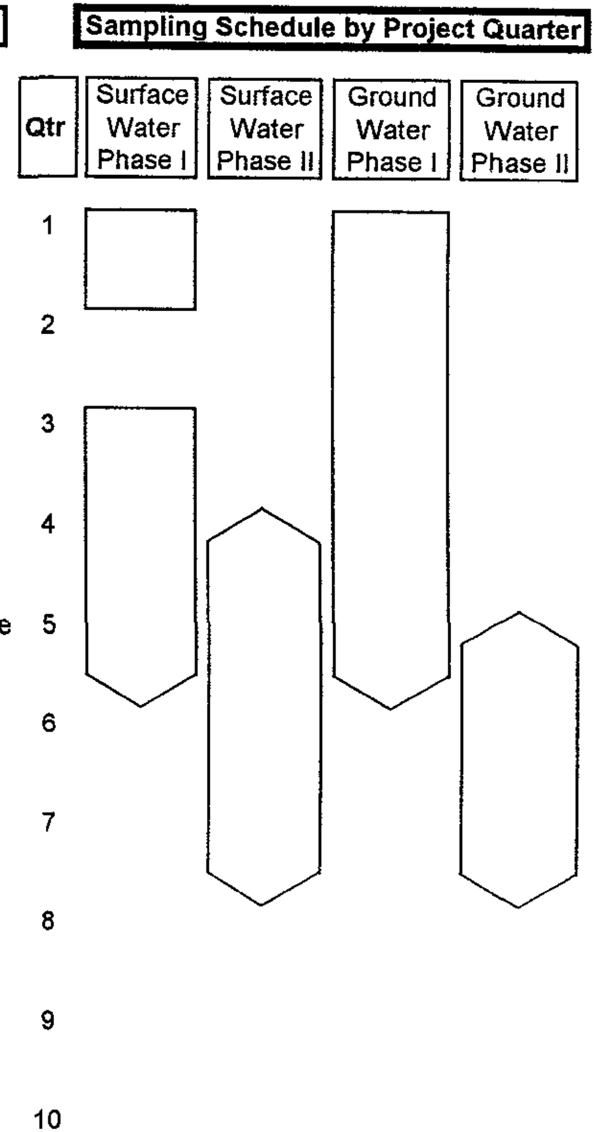
Interim Milestones:

See attached Chart.

West Dakota / DENR (DWSRF) Project "Characterization of Impacts of Decentrialized Wastewater Treatment Systems"

Project Milestones

Qtr	Months	Tasks
	2006	
1	Apr - June	Project planning, site reconnaissance location of well sites, observation well drilling (carbonate and alluvial) by SDGS, and initiate surface & ground water sampling - Phase I
2	July - Sept	Compile and evaluate observation well information and locate existing private well sites (precambrian), continue ground water sampling, examination of laboratory data
3	Oct - Dec	Conduct reconnaissance level sampling (surface water and ground water - Phase I), evaluate need for contract drilling, continue examination of laboratory data
	2007	
4	Jan - Mar	Continue sampling to include initial Phase II surface water samples, examine results, determine need for contract drilling, develop drilling plan if needed to include bid specifications and drilling locations
5	Apr - June	Contract drilling (if needed), continue Phase I and Phase II sampling per schedule to include Phase II ground water sampling
6	July - Sept	Continue Phase II sampling, determine preliminary findings, initiate report writing
7	Oct - Dec	Complete Phase II sampling, compile and analyze data, continue report writing
	2008	
8	Jan - Mar	Continue to compile and analyze data, continue report writing
9	Apr - June	Draft final report for peer review
10	July - Sept	USGS Peer Review Process and Publication of Final Report according to USGS standands



West Dakota / DENR (DWSRF) Project "Characterization of Impacts of Decentrialized Wastewater Treatment Systems"

Budget Breakout by Quarters

USGS Coop Program	FY 2006		FY 2007				FY 2008				Total
	2006 Apr-Jun 1	2006 Jul-Sep 2	2006 Oct-Dec 3	2007 Jan-Mar 4	2007 Apr-Jun 5	2007 Jul-Sep 6	2007 Oct-Dec 7	2008 Jan-Mar 8	2008 Apr-Jun 9	2008 Jul-Sep 10	
Project Management	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	3,800	0	34,200
Project planning and site recon	7,600	0	0	0	0	0	0	0	0	0	7,600
Select private wells and drill observation wells (carbonate)	7,600	0	0	0	0	0	0	0	0	0	7,600
Compile and evaluate drilling information	0	3,800	0	0	0	0	0	0	0	0	3,800
Select private wells (Precambrian) and evaluate need for contract drilling	0	7,600	3,800	3,800	3,800	0	0	0	0	0	19,000
Phase I SW sampling	14,000	0	10,350	3,450	10,350	0	0	0	0	0	38,150
Phase I GW sampling	7,000	7,000	17,250	4,140	11,040	5,520	0	0	0	0	51,950
Select Phase II sample sites	0	0	0	3,800	3,800	3,800	0	0	0	0	11,400
Phase II SW sampling	0	0	0	17,210	34,720	17,360	17,360	0	0	0	86,650
Phase II GW sampling	0	0	0	17,210	34,720	17,360	17,360	0	0	0	86,650
Examination of laboratory data	0	3,800	3,800	3,800	3,800	3,800	0	0	0	0	19,000
Compile and analyze data	0	0	0	0	0	7,600	7,600	3,800			19,000
Report writing	0	0	0	0	0	3,800	7,600	11,400	22,800	0	45,600
Draft of final report	0	0	0	0	0	0	0	0	3,800	0	3,800
Revise draft report	0	0	0	0	0	0	0	0	3,800	0	3,800
Final report completed	0	0	0	0	0	0	0	0	3,800	0	3,800
Printing									8,000		8,000
Subtotal	**$40,000**	**$26,000**	**$39,000**	**$57,210**	**$106,030**	**$63,040**	**$53,720**	**$19,000**	**$46,000**	**$0**	**$450,000**
Total for Fiscal Year	**$66,000**		**$265,280**				**$118,720**				
USGS / Cooperators*	**$33,000**	**$33,000**	**$132,640**		**$132,640**		**$59,360**		**$59,360**		**$450,000**

*** Cooperators: USGS 50% / DENR DWSRF 44.44% and Rapid City 5.56%**

	1	2	3	4	5	6	7	8	9	10	Total
Project Administration (WDD)	$1,500	$1,000	$1,000	$1,500	$1,000	$1,000	$1,000	$1,000	$1,000		$10,000
Project Administration (SDGS)	4,640	1,160	580	580	1,160	1,160	1,160	580	580		12,760
SDGS drilling obser. Wells	63,940										63,940
Contract drilling (if needed)					8,000	8,000					16,000
Total	$70,080	$2,160	$1,580	$2,080	$10,160	$10,160	$2,160	$1,580	$1,580	$0	102,700
Program Total	**$110,080**	**$28,160**	**$40,580**	**$59,290**	**$116,190**	**$73,200**	**$55,880**	**$20,580**	**$47,580**	**$0**	**$552,700**

Total Project:	**$552,700**	**Percent**
USGS	225,000	40.7
DENR (DWSRF)	200,000	36.2
Rapid City	25,000	4 5
SDGS	76,700	13.9
West Dakota Water	26,000	4.7