LEVEL ONE WATER-QUALITY INVENTORY FOR MOUNT RUSHMORE NATIONAL MEMORIAL, SOUTH DAKOTA

FINAL PROGRESS REPORT

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INTRODUCTION

Each year, the National Park Service (NPS) targets several parks throughout the United States to participate in baseline water-quality inventories. The NPS selects parks for participation based on a need for current and relative information that will allow for a general assessment of water-quality conditions within the designated park. In November 2000, the U.S. Geological Survey (USGS) entered into an agreement with the NPS to conduct a limited (not to exceed one fiscal year) Level-I Water-Quality Inventory and Monitoring (WAQIM) study of the water resources of Mount Rushmore National Memorial in South Dakota.

Water-quality sampling and streamflow measurement sites were selected with the assistance of NPS employees at Mount Rushmore. Six sites including five surface-water sites and the park's only public-supply well were selected (table 1), and water-quality sampling began in January 2001. Samples also were collected during April, June, and July so that data would represent different hydrologic and climatic conditions. Water samples from selected sites were analyzed for a suite of physical, chemical, and biological constituents. In addition, field measurements of specific conductance, pH, temperature, dissolved oxygen, and streamflow were made during each sampling visit.

Mount Rushmore National Memorial (figure 1) is located about 23 miles southwest of Rapid City, in an area where Precambrian rocks are exposed to form the central core of the Black Hills. The memorial encompasses about 1,200 acres and attracted about 2.7 million visitors in 1999. The climate of the area is subhumid, typically having long cold winters and short mild summers. Most of the precipitation falls as rain during late spring and summer.

Elevations within the memorial range from about 4,400 feet in the valleys to about 5,700 feet at the summit of Mount Rushmore. The memorial lies within the headwaters of Battle Creek, the largest perennial stream in the immediate area. Grizzly Bear Creek, another perennial stream, originates in the Black Elk Wilderness area southwest of Mount Rushmore. Three basins provide most of the drainage for the memorial (Powell and others, 1973). Lafferty Gulch basin encompasses 380 acres and contains both Lafferty Gulch Creek and the west fork of Lafferty Gulch Creek. East Boundary basin encompasses 318 acres and contains an unnamed creek that flows northeast where it joins Grizzly Bear Creek, just above its confluence with Battle Creek. However, this unnamed creek generally was dry during the inventory and therefore was not included in the study. Starling basin encompasses 335 acres and includes Starling Creek that flows south off the memorial to its confluence with Grizzly Bear Creek. Another unnamed creek flows off the eastern side of the memorial below the parking lot and joins Grizzly Bear Creek near the campground. Powell and others (1973) found that flow in most of these smaller creeks largely is a result of contributions (5-20 gallons per minute) from numerous small springs located throughout the memorial. Powell and others (1973) identified at least one spring in each of the three drainage basins.

Mount Rushmore currently obtains its water supply from a single well located in Lafferty Gulch. The well is about 200 feet deep and is completed in fractured mica schist. Recharge to part of the fractured bedrock aquifer supplying water to the well probably is limited to an area of about 120 acres within Lafferty Gulch, located southwest and topographically higher than the well (Powell and others, 1973). Because of its location, the NPS was concerned that the well could be susceptible to contamination when surface water recharges ground water, so the well also was included in the WAQIM study.

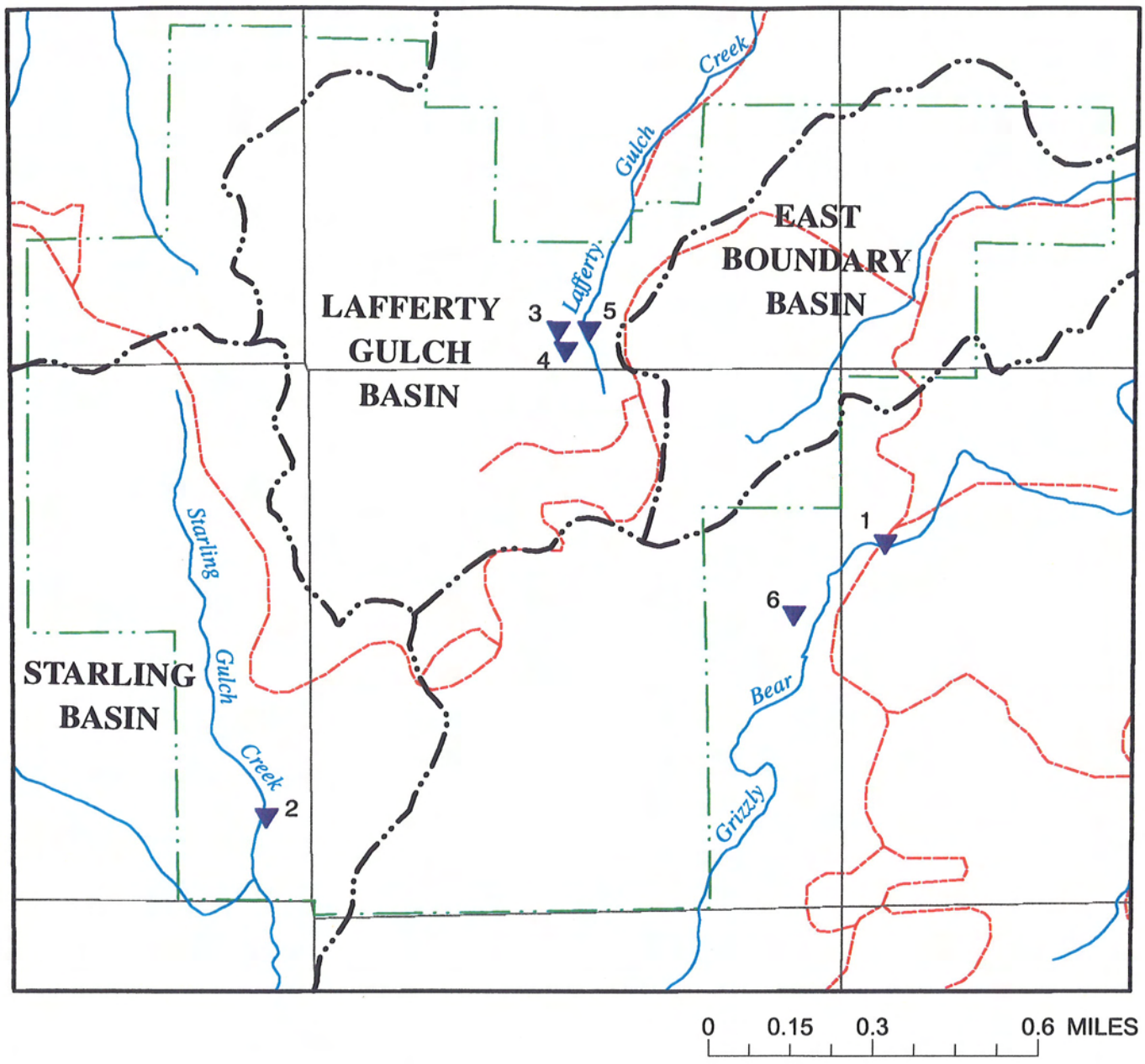

Figure 1. Locations of water-quality sampling sites.

The largest potential influence to the memorial's water resources comes from the millions of people that visit each year. Development and agriculture activities in the surrounding area currently have little impact on the memorial's water resources. The Black Hills National Forest and the Black Elk Wilderness Area comprise much of the area adjacent to the memorial. The memorial also is topographically higher than much of the surrounding area, making it relatively impervious to changing land-use practices nearby.

LOCATION AND DESCRIPTION OF SAMPLING SITES

Six sites located within or near Mount Rushmore National Memorial were sampled between January and July 2001 for the WAQIM study. Water-quality samples and field measurement data were collected at five surface-water sites and from the memorial's only public-supply well. The location and description of sample collection sites are provided in table 1.

Table 1. Location and description of sampling sites used for the Mount Rushmore Water Quality Inventory and Monitoring Study

Site number (fig. 1)	Site name	Latitude (deg/min/sec)	Longitude (deg/min/sec)	Land net location	Location of sample collection site
1	Grizzly Bear Creek	435241	1032614	NW ¼, SW ¼, NW ¼, Sec. 17, T. 2 S., R. 6 E.	Downstream side of the Highway 16A bridge, about 1.2 miles southwest of Keystone
2	Starling Gulch Creek	435214	1032735	SW ¼, NE ¼, SE ¼, SE ¼, Sec. 13, T. 2 S., R. 6 E.	Approximately 30 feet downstream from inflow of spring where hike-in trail meets Starling Gulch Creek
3	Public-supply well	435300	1032656	NW ¼, SE ¼, SE ¼, SW ¼, Sec. 7, T.2 S., R. 6 E.	Located inside well house at Mount Rushmore
4	West Fork Lafferty Gulch Creek	435302	1032657	SE ¼, SE ¼, SW ¼, Sec. 7, T. 2 S., R. 6 E.	Located just downstream from Mount Rushmore public-supply well at metal V-notch weir in creek
5	Lafferty Gulch Creek at Mount Rushmore	435302	1032653	NW ¼, SW ¼, SW ¼, SE ¼, Sec. 7, T. 2 S., R. 6 E.	Approximately 50 feet below the confluence of the West Fork of Lafferty Gulch Creek
6	Unnamed tributary above Grizzly Bear Creek	435234	1032626	SW ¼, SE ¼, SE ¼, NE ¼, Sec. 18, T. 2 S., R. 6 E.	Located about 200 feet upstream of confluence with Grizzly Bear Creek in Grizzly Bear Picnic Area southwest of Keystone

DISCUSSION OF DATA COLLECTION ACTIVITIES

Water-quality samples were collected four times from all but one of the sites located throughout the memorial. The unnamed tributary (site 6) was only sampled three times during the WAQIM study because it was completely frozen in January. Field measurements of water temperature, air temperature, pH, specific conductance, and dissolved oxygen were made at each site prior to the initiation of sample collection activities.

Surface-water samples were collected using standard USGS protocols outlined by Horowitz and others (1994) and by Shelton (1994). Surface- water samples were collected as a grab sample near the centroid of flow because limited width and depth made collection of integrated cross-sectional samples impractical. Aliquots of surface water were carefully collected and composited in precleaned 8-liter churn splitters and covered to reduce the potential for external contamination.

The public-supply well was sampled using methods outlined by Koterba and others (1996). A flow-through chamber was used to obtain field measurements at the well so that contact with the atmosphere was limited. Samples were collected after field measurements stabilized.

Samples for the analysis of common ions, nutrients, and trace metals were shipped overnight on ice to the USGS National Water Quality Laboratory (NWQL) and analyzed using methods described by Fishman and Friedman (1989) and Fishman (1993). Samples for bacteria were collected in pre-sterilized bottles and kept on ice until delivered to a local contract laboratory within hours following collection. Samples for the analysis of benzene, ethyl benzene, toluene, and xylene (BTEX) were collected as grab samples and kept chilled until analyzed using the Enzyme Linked Immunosorbent Assay (ELISA) technique in the USGS South Dakota District laboratory. A single sample collected from the public-supply well in April and was chilled and shipped overnight to the NWQL for analysis for confirmation of total BTEX compounds. Minimum reporting levels for the analyzed properties and constituents are presented in table 4 in the Appendix.

Quality-assurance samples were used to evaluate the precision and accuracy of the analysis of the environmental samples. The quality-assurance samples included an equipment blank, a field blank, and a duplicate field sample. Blank samples were collected and analyzed to identify the presence and magnitude of potential contamination that could bias analytical results. Equipment blanks are aliquots of ultrapure deionized water that are certified trace-element free and processed through the sampling equipment used to collect water-quality samples. Equipment blanks are processed through the sampling equipment in a laboratory or some other controlled environment so that any contamination attributable to the equipment can be isolated and identified. These samples usually are analyzed using a special low-level technique and consequently, reporting levels are typically much lower than techniques used to analyze environmental samples. Field blanks are collected from the sampling equipment at a sample-collection site and represent actual field conditions and are used to identify contamination attributable to the equipment or contamination introduced during sample collection and processing in the field. These samples typically are analyzed using the same analytical methods used for the environmental samples and not the low-level techniques used for equipment blanks.

Duplicate field samples consist of splits from the same sample aliquot that are collected in a manner such that they are assumed to be essentially identical in composition. These samples are used to estimate variability in the sample-collection and analysis process. The duplicate sample was collected in January at the field site established on the West Fork of Lafferty Gulch Creek.

Results of the blank quality-assurance samples indicated that contamination did not significantly influence the analytical results obtained for the environmental samples. Furthermore, results of the duplicate sample also showed good agreement, indicating that there was no significant variability in analytical results attributable to either the sample collection or analysis process.

SUMMARY OF RESULTS

Runoff from parking lots has the potential to be carried to streams draining the memorial. Deicing material applied to roads could be partially responsible for elevated concentrations of sodium and chloride detected in both Starling and Lafferty Gulch Creeks (table 2). Furthermore, dissolved arsenic was detected at concentrations greater than 10 micrograms per liter (µg/L) at three sites including the public-supply well. This is significant because the U.S. Environmental Protection Agency (USEPA) is currently contemplating lowering the drinking water standard for arsenic, and public water suppliers should be concerned about source-water concentrations exceeding 10 µg/L for arsenic.

Concentrations of nitrite plus nitrate (NO_2+NO_3) approached 1 milligram per liter (mg/L) in three of the four samples from the well, which is much less than the drinking water standard of 10 mg/L established by USEPA. Concentrations of NO_2+NO_3 ranged from 3.5 to 6.8 mg/L in samples collected from Lafferty Gulch Creek, which is believed to be within the recharge area for the well. Again these findings are significant because concentrations of NO_2+NO_3 greater than 2 mg/L are generally assumed to result from anthropogenic sources (Mueller and Helsel, 1996).

While nitrite and nitrate were not analyzed separately for this study, nitrite is usually not present in natural waters at concentrations large enough to influence the ionic balance (Hem, 1985). This is because nitrite is often rapidly oxidized to nitrate by nitrifying bacteria. Therefore, it is likely that nitrate is the dominant species of nitrogen that Lafferty Gulch Creek contributes to ground water during recharge periods. During previous investigations, Powell and others (1973) noted nitrate concentrations of about 5.5 mg/L in Lafferty Gulch and suspected the source of nitrate to be the memorial's water treatment plant located upgradient from the sampling site. Grizzly Bear Creek, Starling Gulch Creek, and the unnamed tributary all had NO_2+NO_3 concentrations of about 0.01 mg/L.

Table 2. Summary of water-quality data for Mount Rushmore Water-Quality Inventory and Monitoring Study

[ft^3/s, cubic feet per second; gpm, gallons per minute; NTU, nephelometric turbidity units; µS/cm, microsiemens per centimeter at 25° Celsius; mg/L, milligrams per liter (parts per million); µg/L, micrograms per liter (parts per billion); ND, no data; cfu, colony forming units; mL, milliliters; <, less than; >, greater than; deg C, degrees Celsius; DISS, dissolved; WWT, waste water treatment]

Site number (fig. 1)	Station name	Date	Discharge (ft^3/s) (00061)	Turbidity (NTU) (00076)	Color (00080)	Specific conductance (µS/cm) (00095)	Oxygen dissolved (mg/L) (00300)	pH field (00400)	Nitrogen ammonia (mg/L) (00608)	NO_2+NO_3 as N (mg/L) (00631)
	Lab Blank	1/12/01	ND	0.3	1.0	2.3	ND	6.2	0.002	0.005
	Field Blank	1/23/01	ND	ND	1.0	3.0	ND	6.2	0.002	0.5
1	Grizzly Bear Creek	1/24/01	0.60	0.5	2.5	105	10.6	6.9	0.002	0.025
		4/10/01	3.4	4.0	20	71	15.5	7.4	0.004	0.006
		6/05/01	22.7	14	70	55	15.7	6.5	0.005	0.008
		7/18/01	6.5	8.5	35	69	8.5	6.9	0.008	0.010
2	Starling Gulch Creek	1/24/01	0.02	ND	1.0	303	9.8	6.8	0.002	0.007
		4/12/01	0.02	3.1	12.5	205	14.8	6.9	0.007	0.005
		6/05/01	0.47	7.8	40	173	11.2	7.2	0.072	0.016
		7/18/01	0.20	2.7	7.5	254	12.6	6.6	0.007	0.009
3	Public-supply well	1/23/01	53 gpm	1.8	1.0	114	3.0	6.2	0.002	0.005
		4/11/01	53 gpm	2.2	2.5	111	6.7	6.2	0.003	0.966
		6/12/01	51 gpm	3.8	< 1.0	111	3.7	6.2	0.002	0.844
		7/19/01	52 gpm	2.7	< 1.0	113	8.6	6.2	0.004	0.770
4	West Fork Lafferty Gulch Creek	1/23/01	0.08	2.1	2.5	98	9.7	7.0	0.002	0.921
		4/11/01	0.05	3.3	2.5	97	16.9	6.9	0.003	0.497
		6/05/01	0.02	12.3	30	96	11.3	6.5	0.005	0.324
		7/17/01	0.30	5.5	5.0	97	8.4	7.1	0.005	0.347
4	West Fork Lafferty Gulch Creek **(Duplicate QA/QC)**	1/23/01	0.08	2.4	5.0	98	9.7	7.0	0.002	0.542
5	Lafferty Gulch Creek at Mount Rushmore	1/23/01	0.60	ND	1.0	248	11.2	7.9	0.002	4.3
		4/12/01	0.06	2	5.0	155	15.2	7.6	0.024	3.7
		6/05/01	0.03	14.2	30	322	8.6	7.1	0.007	6.8
		7/17/01	0.06	4.9	5.0	304	8.7	7.8	0.004	3.5
6	Unnamed tributary above Grizzly Bear Creek	4/10/01	0.04	3.1	2.5	354	16.2	7.5	0.004	0.007
		6/05/01	0.20	9.7	50	260	11.2	6.9	0.004	0.009
		7/17/01	0.05	1.8	7.5	351	8.3	7.5	0.005	0.008

Table 2. Summary of water-quality data for Mount Rushmore Water-Quality Inventory and Monitoring Study (Cont.)

Station name	Date	Phos-phorus dissolved (mg/L) (00666)	Phos-phorus ortho (mg/L) (00671)	Phos-phorus total (mg/L) (00665)	Calcium (mg/L) (00915)	Magne-sium (mg/L) (00925)	Sodium (mg/L) (00930)	Potassium (mg/L) (00935)	Chloride (mg/L) (00940)
Lab Blank	1/12/01	ND	0.007	ND	0.002	0.001	0.025	ND	ND
Field Blank	1/23/01	0.004	0.007	0.004	0.021	0.008	0.06	0.09	0.08
Grizzly Bear Creek	1/24/01	0.013	0.009	0.015	10.8	3.1	5.0	1.6	2.2
	4/10/01	0.014	0.009	0.030	5.8	1.7	3.3	1.5	1.9
	6/05/01	0.021	0.014	0.075	5.2	1.5	2.9	1.3	2.2
	7/18/01	0.026	0.023	0.055	6.7	18	3.6	1.7	2.4
Starling Gulch Creek	1/24/01	0.016	0.012	0.016	24.1	6.9	15.5	2.8	39.1
	4/12/01	0.014	0.010	0.023	17.3	5.1	12.4	2.3	28.9
	6/05/01	0.032	0.021	0.047	15.6	4.1	10.7	2.3	23.7
	7/18/01	0.020	0.018	0.029	22	5.9	15	3.1	37
Public-supply well	1/23/01	0.119	0.107	0.112	10.5	2.5	7.8	2.0	4.6
	4/11/01	0.108	0.101	0.108	9.9	2.4	7.3	2.1	3.5
	6/12/01	0.111	0.102	0.111	10.6	2.6	7.8	2.0	3.3
	7/19/01	0.103	0.099	0.111	10.5	2.6	7.9	2.0	3.3
West Fork Lafferty Gulch Creek	1/23/01	0.093	0.085	0.093	10.3	2.0	5.9	1.8	2.7
	4/11/01	0.081	0.073	0.094	10.3	2.0	5.7	1.8	4.3
	6/05/01	0.093	0.078	0.134	9.7	2.2	5.6	1.7	2.6
	7/17/01	0.074	0.077	0.095	9.3	2.0	5.9	1.6	2.6
West Fork Lafferty Gulch Creek **(Duplicate QA/QC)**	1/23/01	0.092	0.087	0.100	10.3	1.9	5.9	1.7	2.7
Lafferty Gulch Creek at Mount Rushmore	1/23/01	0.277	0.270	0.284	20.9	4.7	21.2	3.0	17.1
	4/12/01	0.312	0.277	0.279	22.7	5.1	25.3	2.9	18.9
	6/05/01	1.65	1.60	1.65	27.7	5.5	54.7	6.1	26.2
	7/17/01	0.54	0.551	0.569	21	4.8	31	3.7	22.4
Lafferty Gulch Below WWT Plant+	1/23/01	7.932	7.206	0.009	ND	ND	ND	ND	ND
Unnamed tributary above Grizzly Bear Creek	4/10/01	0.020	0.019	0.047	37.7	7.5	12.7	3.4	34
	6/05/01	0.029	0.024	0.050	32.1	6.4	11.1	3.5	20.2
	7/17/01	0.032	0.030	0.037	42	8.0	13.5	4.7	26

Table 2. Summary of water-quality data for Mount Rushmore Water-Quality Inventory and Monitoring Study (Cont.)

Station name	Date	Sulfate (mg/L) (00945)	Fluoride (mg/L) (00950)	Silica (mg/L) (00955)	Arsenic (µg/L) (01000)	Iron (µg/L) (01046)	Manganese (µg/L) (01056)	Selenium (µg/L) (01145)
Lab Blank	1/12/01	ND	ND	0.0255	0.18	3.0	0.1	0.3
Field Blank	1/23/01	0.11	0.160	0.09	0.18	10	3.2	0.3
Grizzly Bear Creek	1/24/01	15.0	0.094	17.0	0.8	10	3.2	0.4
	4/10/01	10.1	0.084	13.1	0.7	35	3.2	0.4
	6/05/01	5.7	0.200	14.1	1.0	166	6.9	0.2
	7/18/01	6.7	0.100	18	1.4	26	5.0	0.3
Starling Gulch Creek	1/24/01	38.2	0.100	13.9	2.5	10	3.2	0.5
	4/12/01	24.4	0.094	13.9	2.6	21	3.2	0.5
	6/05/01	13.1	0.105	13.3	3.7	63	< 3.0	0.3
	7/18/01	18.0	0.100	16.0	4.7	17	6.0	0.4
Public-supply well	1/23/01	6.3	0.108	26.1	13.9	10	3.2	0.6
	4/11/01	6.6	0.111	25.2	13.3	10	< 3.0	0.3
	6/12/01	6.9	0.089	26.4	14.0	6.4	< 3.0	0.5
	7/19/01	6.9	0.116	25.9	13.2	10	< 3.0	0.4
West Fork Lafferty Gulch Creek	1/23/01	5.4	0.083	22.7	11.9	8.0	3.2	0.7
	4/11/01	6.2	0.107	21.7	12.2	6.5	< 3.0	0.8
	6/05/01	6.2	0.091	22.5	12.2	37	< 3.0	0.4
	7/17/01	6.2	0.100	22.2	12.8	11	< 3.0	0.4
West Fork Lafferty Gulch Creek **(Duplicate QA/QC)**	1/23/01	5.5	0.016	22.7	12.1	10.0	3.2	0.9
Lafferty Gulch Creek at Mount Rushmore	1/23/01	12.9	0.131	24.4	19.2	5.5	3.2	0.8
	4/12/01	14.6	0.116	23.4	4.5	10	3.2	0.5
	6/05/01	19.0	0.156	18.5	16.3	23.5	3.0	0.5
	7/17/01	15.2	0.200	23.4	22.1	6.0	<3.0	0.5
Unnamed Tributary above Grizzly Bear Creek	4/10/01	10.2	0.132	12.4	1.5	5.1	3.2	0.4
	6/05/01	7.1	0.133	13.2	2.8	57	3.0	0.3
	7/17/01	8.7	0.200	18.0	3.2	6.4	10.4	0.2

Table 2. Summary of water-quality data for Mount Rushmore Water-Quality Inventory and Monitoring Study (Cont.)

Station name	Date	Dissolved solids (mg/L) (70301)	Acid neutralizing capacity as $CaCO_3$ (mg/L) (90410)	Fecal coliform (cfu/100 mL) (31625)	Temperature water deg. Celsius (00010)	Temperature air deg. Celsius (00020)	Total BTEX mg/L (ELISA)
Lab Blank	1/12/01	ND	1.9	ND	ND	ND	ND
Field Blank	1/23/01	10	1.8	ND	ND	ND	ND
Grizzly Bear Creek	1/24/01	75	33.9	< 2	0.4	-8.0	<0.1
	4/10/01	48	16.7	< 2	2.5	8.0	<0.1
	6/05/01	42	15.6	7	7.6	12	<0.1
	7/18/01	73	23	23	16	24	ND
Starling Gulch Creek	1/24/01	160	32.6	< 2	0.7	0.0	<0.1
	4/12/01	119	23.6	< 2	2.1	10	>0.1, <0.5
	6/05/01	101	30.5	2	11	18	<0.1
	7/18/01	189	42	20	16	29	ND
Public-supply well	1/23/01	85	41.1	< 2	9.8	4.0	>3.0
	4/11/01	86	41.1	< 2	9.7	2.0	<0.1[1]
	6/12/01	89	41.9	< 2	10	18	<0.1
	7/19/01	88	42.6	< 2	10	19	ND
West Fork Lafferty Gulch Creek	1/23/01	78	37.7	< 2	4.5	4.0	>3.0
	4/12/01	176	76.7	< 2	3.6	4.5	<0.1
	6/05/01	74	36.6	88	9.0	13	<0.1
	7/17/01	74	36.5	10	12	31	ND
West Fork Lafferty Gulch Creek **(Duplicate QA/QC)**	1/23/01	76	37.6	< 2	4.5	4.0	>3.0
Lafferty Gulch Creek at Mount Rushmore	1/23/01	166	70.6	< 2	2.7	5.0	>3.0
	4/11/01	77	37.1	< 2	5.9	2.0	<0.1
	6/05/01	274	135.3	23	10	18	<0.1
	7/17/01	188	88	15	14	31	ND
Unnamed Tributary above Grizzly Bear Creek	4/10/01	178	100.2	< 2	2.0	8.0	<0.1
	6/05/01	150	93.4	3	9.0	ND	<0.1
	7/17/01	202	135	23	17	29	ND

[1]An aliquot from the public-supply well sample was sent to the U.S. Geological Survey National Water Quality Laboratory on Apr. 11, 2001, and found to contain <0.1 mg/L total BTEX. The analysis also estimated MTBE to be present at 0.17 mg/L, which is much less than the U.S. Environmental Protection Agency advisory level of 20-40 mg/L.

Methyl *tert*-butyl ether (MTBE), a gasoline additive, also was detected at about 0.2 µg/L in water collected from the well in April and sent to the USGS NWQL for analysis (table 3). However, the value is near the minimum reporting level for the analytical method used by the laboratory, and is much less than the advisory level of 20-40 µg/L established for MTBE by the USEPA. Together, the nutrient and MTBE data provide some evidence that the aquifer is vulnerable to surface contamination, although additional work would be required to determine the extent of the vulnerability. Table 4 in the appendix provides a comprehensive listing of all the parameters analyzed during the Level-I WAQIM. It also provides some useful definitions as well as minimum reporting levels for the various parameters.

Table 3. Results of laboratory analysis for selected fuel ethers in water collected from Mount Rushmore public-supply well on April 11, 2001

Constituent	Parameter code	Reported concentration (micrograms per liter)
Toluene, total	34010	0.03
Benzene, total	34030	0.03
Ethylbenzene, total	34371	0.03
Ethyl *tert*-butyl ether	50004	0.05
tert-Pentyl methyl ether	50005	0.11
o-xylene, total	77135	0.04
Methyl *tert*-butyl ether	78032	0.17
Diisopropyl ether	81577	0.10
m- and p-xylene	85795	0.02

In conclusion, the results of the Level-I WAQIM study showed that the quality of the Memorial's water resources is generally good with respect to most of the constituents analyzed. Concentrations of arsenic in water from the public-supply well could be problematic if the USEPA lowers the current drinking water standard from 50 µg/L to 10 µg/L as proposed. Elevated concentrations of NO_2+NO_3 detected in samples from Lafferty Gulch Creek have the potential to enter the aquifer and degrade ground-water quality. Additional monitoring in Lafferty Gulch Creek could help locate the source of NO_2+NO_3 and could provide valuable information pertaining to aquifer vulnerability.

PRINCIPAL INVESTIGATOR

The principal investigator for the Mount Rushmore National Memorial Level-I WAQIM study was Allen Heakin, Hydrologist, USGS South Dakota District office. All samples, excluding those submitted for bacteriological analysis and total BTEX using the ELISA technique, were analyzed at the USGS NWQL in Denver, Colorado. Bacteriological samples were analyzed at Energy Laboratories, Inc. in Rapid City, S. Dak., following guidelines established by the USEPA. Experienced personnel from the USGS South Dakota District analyzed samples for total BTEX compounds using the ELISA technique.

REFERENCES

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APPENDIX

Table 4. Water-quality parameter codes, definitions, and reporting levels used for analysis of environmental data presented in this report

[mg/L, milligrams per liter; mL, milliliters; µg/L, micrograms per liter; CFU, colony forming units]

Parameter code	Definition	Minimum reporting levels
00010	Temperature, water, degrees Celsius	0.5
00020	Temperature, air, degrees Celsius	0.5
00061	Discharge, instantaneous stream (cubic feet per second)	0.01
00076	Turbidity (nephelometric turbidity units)	0.1
00080	Color (platinum-cobalt units)	1.0
00094	Specific conductance (microsiemens per centimeter at 25° Celsius)	2.6
00300	Oxygen, dissolved, mg/L	0.1
00400	pH (standard units)	0.1
00608	Nitrogen, ammonia, dissolved, mg/L as N	0.002
00631	Nitrite plus nitrate, dissolved, mg/L as N	0.005
00665	Phosphorus, total, mg/L as P	0.008
00666	Phosphorus, dissolved, mg/L as P	0.006
00671	Phosphorus, orthophosphate, dissolved, mg/L as P	0.001
00915	Calcium, dissolved, mg/L as Ca	0.02
00925	Magnesium, dissolved, mg/L as Mg	0.014
00930	Sodium, dissolved, mg/L as Na	0.09
00935	Potassium, dissolved, mg/L as K	0.24
00940	Chloride, dissolved, mg/L as Cl	0.29
00945	Sulfate, dissolved, mg/L as SO4	0.31
00950	Fluoride, dissolved, mg/L as F	0.10
00955	Silica, dissolved, mg/L as SiO2	0.09
01000	Arsenic, dissolved, µg/L as As	0.9
01046	Iron, dissolved, µg/L as Fe	10
01056	Manganese, dissolved, µg/L as Mn	2.2
01145	Selenium, dissolved, µg/L as Se	0.7
31625	Bacteria, fecal coliform, CFU per 100 mL	2.0
34010	Toluene, total, µg/L	0.05
34030	Benzene, total, µg/L	0.035
34371	Ethylbenzene, total, µg/L	0.030
50004	Ethyl *tert*-butyl ether, µg/L	0.054
50005	*tert*-Pentyl methyl ether, µg/L	0.11
70301	Solids, sum of constituents, dissolved, mg/L	10
77135	o-xylene, total, µg/L	0.038
78032	Methyl *tert*-butyl ether, µg/L	0.17
81577	Diisopropyl ether, µg/L	0.10
85795	m- and p-xylene, µg/L	0.06
90410	Acid neutralizing capacity (ANC) mg/L	1.0

PRINCIPAL INVESTIGATOR

The principal investigator for the Mount Rushmore National Memorial Level-I WAQIM study was Allen Heakin, Hydrologist USGS District office. The USGS District office is located at 1608 Mountain View Road, Rapid City South Dakota, 57702. Questions concerning the WAQIM study should be directed to Allen by e-mail at ajheakin@usgs.gov or by phone at (605)-355-4560 ext. 216.

STATION LOCATION INFORMATION

Location and description of sampling sites used for the Mount Rushmore Water Quality Inventory and Monitoring Study

Site number (fig. 1)	Site name	Latitude (deg/min/sec)	Longitude (deg/min/sec)	Land net location	Location of sample collection site
1	Grizzly Bear Creek	435241	1032614	NW ¼, SW ¼, NW ¼, Sec. 17, T. 2 S., R. 6 E.	Downstream side of the Highway 16A bridge, about 1.2 miles southwest of Keystone
2	Starling Gulch Creek	435214	1032735	SW ¼, NE ¼, SE ¼, SE ¼, Sec. 13, T. 2 S., R. 6 E.	Approximately 30 feet down-stream from inflow of spring where hike-in trail meets Starling Gulch Creek
3	Public-supply well	435300	1032656	NW ¼, SE ¼, SE ¼, SW ¼, Sec. 7, T.2 S., R. 6 E.	Located inside well house at Mount Rushmore
4	West Fork Lafferty Gulch Creek	435302	1032657	SE ¼, SE ¼, SW ¼, Sec. 7, T. 2 S., R. 6 E.	Located just downstream from Mount Rushmore public-supply well at metal V-notch weir in creek
5	Lafferty Gulch Creek at Mount Rushmore	435302	1032653	NW ¼, SW ¼, SW ¼, SE ¼, Sec. 7, T. 2 S., R. 6 E.	Approximately 50 feet below the confluence of the West Fork of Lafferty Gulch Creek
6	Unnamed tributary above Grizzly Bear Creek	435234	1032626	SW ¼, SE ¼, SE ¼, NE ¼, Sec. 18, T. 2 S., R. 6 E.	Located about 200 feet upstream of confluence with Grizzly Bear Creek in Grizzly Bear Picnic Area southwest of Keystone