



Water Use in Forest Service Recreation Areas: Guidelines for Water System Designers

Kathleen Snodgrass, Project Leader

During the summer of 2005, data about water use and recreation visitation were gathered at Forest Service campgrounds (figure 1) and day-use recreation areas throughout the country to answer the questions:

- Has the amount of water each person uses when visiting national forest recreation areas changed in the last 30 years?
- Are our recreation water systems sized to provide the amount of water forest visitors need?

Recreation use and plumbing fixtures have changed a lot in the last 30 years. More people now camp in recreational vehicles (RVs) and trailers than in tents. Most RVs and



Figure 1—Water is supplied at several faucets, but not in restrooms, at Sunshine Campground in the Norwood District of the Grand Mesa-Uncompahgre-Gunnison National Forests in the Rocky Mountain Region.

Highlights...

- Recreation use patterns have changed a lot in the last 30 years, but Forest Service design guidelines for sizing water systems have remained the same.
- Forest Service water systems need to be designed and constructed to provide visitors the amount of water they need. Water systems that are larger than necessary cost more and don't benefit visitors.
- An informal survey showed that water use appears to be lower than it used to be in more developed campgrounds, but appears to be higher than it used to be in less developed campgrounds.

trailers are almost twice as big as during the 1970s, and almost all RVs and trailers now contain bathrooms. Standard plumbing fixtures use only half as much water as they did during the 1970s.

Despite these changes, the Forest Service is still using guidance for sizing water systems from the 1970s—the



Forest Service Handbook 7409.11, Section 44.11 - Exhibit 01, Average Daily Design Flow (excerpted in table 1). The table lists average daily design flows used when designing water supply systems for Forest Service recreation areas.

It's important that the design flow table match actual water-use rates so Forest Service water systems can be designed and constructed to provide the amount of water that is needed without spending extra money for water systems that are larger than necessary. Data were collected to find out whether standard water-use rates for recreation areas have changed as a result of recreation and plumbing fixture changes and whether the table should be updated.

Collecting Data

Managers at a wide range of Forest Service recreation areas with drinking water systems were asked whether they would volunteer to collect data for the study. Recreation areas that supply water with hand pumps were not included in the study because there's no convenient way to meter water use.

Initially, managers at 67 recreation areas volunteered to collect information during the 2005 use season. Due to a variety of difficulties, such as winter storms, contractor delays, and miscommunication, information was collected monthly or more frequently at only 41 recreation areas.

Table 1—Forest Service Handbook 7409.11, Section 44.11 - Exhibit 01 (recreation information only).

<u>Average Daily Design Flow</u>		
<u>Consumer Use</u>	<u>Consumption in gallons per day</u>	<u>Unit</u>
<u>Camping Facility</u>		
Without flush toilets	5	PAOT*
With flush toilets	20-30	PAOT*
With flush toilets and showers	25-50	PAOT*
Trailer with —		
Water connection	25	PAOT*
Water and sewer connection	50	PAOT*
<u>Day use</u>		
Without flush toilets	1	Person
With flush toilets	5	Person
With toilets and showers	20	Person
<u>Travel Trailer Dump Station</u>	20-30	Trailer
<u>Miscellaneous</u>		
Organization camp	35-75	Person

*PAOT—Persons At One Time.

The average daily demand should be computed as a summation of the products of individual system users and their respective per capita daily consumption.

Yearly average data from 2004 was supplied for eight additional recreation areas.

The initial request for volunteers said that recreation areas would not be included in the study unless water meters had already been installed. Because some provinces were underrepresented or not represented at all, the project paid for water meters to be installed at four locations.

The author suspected there might be some differences in water use in different parts of the country based on cultural patterns and weather. The “Built Environment Image Guide for the National Forests and Grasslands” (BEIG) includes a system of eight provinces (figure 2) that provides a handy method of sorting recreation areas into groups with similar ecological and cultural characteristics. Volunteer data collectors were sought in each of the eight BEIG provinces, including the tropical El Yunque National Forest in Puerto Rico (part of the Southeast Coastal Province).

Table 2 shows the number of forests and recreation areas where data were collected in each province. Unfortunately, we were unable to collect data in the Northeast Province.

Since the average daily design flow table showed different rates for recreation areas with different uses and development levels, each area was placed into one or more

Table 2—Data collection sites.

BEIG Province	Number of Forests	Number of Areas
Northeast	0	0
Southeast Mountain	1	3
Southeast Coastal	2	7
Tropical	1	2
Lakes	2	6
Great Plains/Prairie	2	2
Rocky Mountain	10	19
North Pacific	3	8
Southwest	2	2

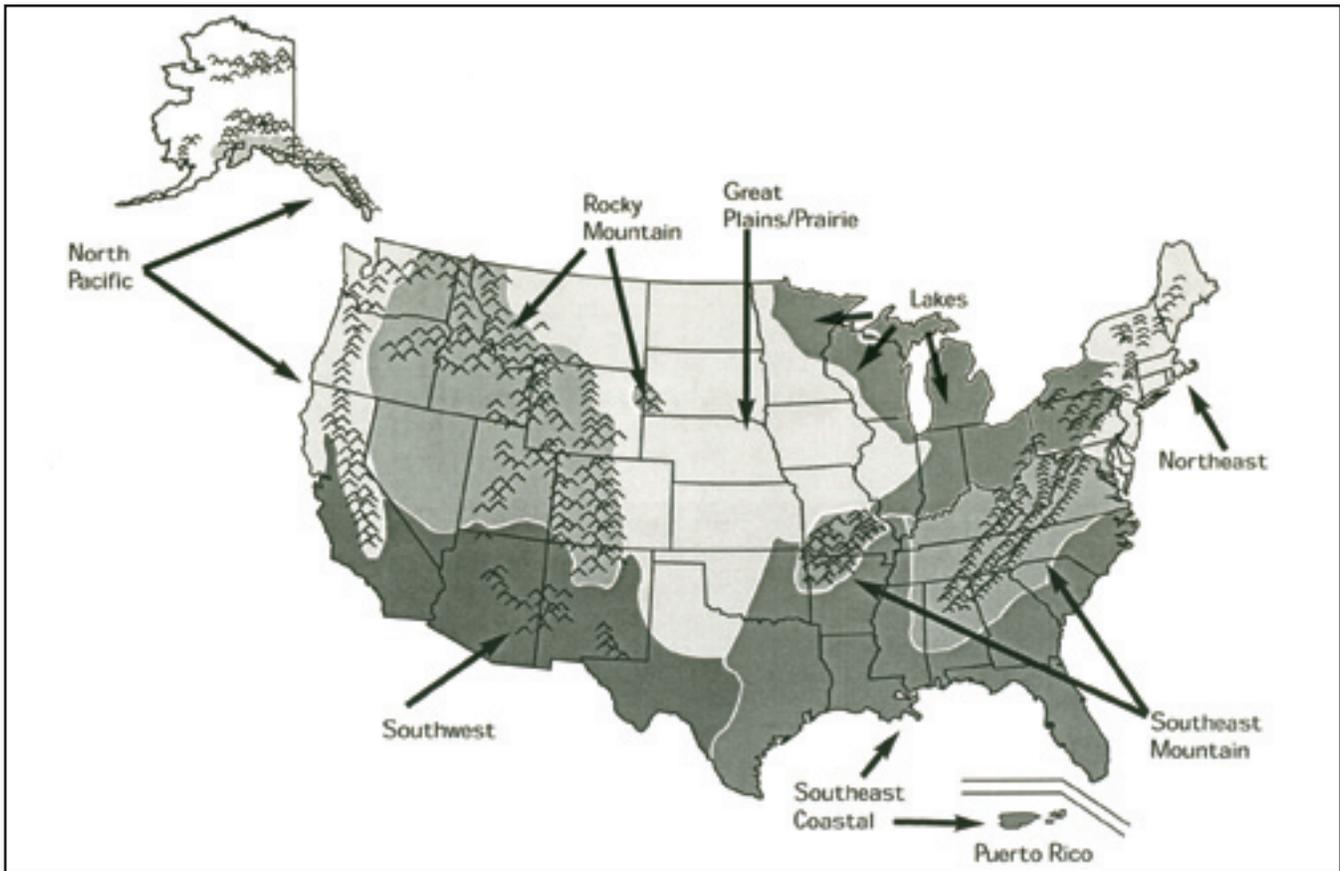


Figure 2—This map shows the general boundaries of the eight Built Environment Image Guide provinces.

categories as shown in table 3. The size of campgrounds and day-use areas varied from 8 to 382 individual camping or day-use sites, but most campgrounds and day-use areas had between 20 and 80 individual sites. No data were collected in categories C-4 and V-2.

Table 3—Recreation site use categories.

Designation	Description
C-1	Camping: pit, composting, or vault toilets
C-2	Camping: flush toilets
C-3	Camping: flush toilets and showers
C-4	Camping: water connections at individual sites (no sewer)
C-5	Camping: water and sewer connections at individual sites
D-1	Day use: pit, composting, or vault toilets
D-2	Day use: flush toilets
D-3	Day use: flush toilets and showers
RV-1	Wastewater dump station
V-1	Visitor center: flush toilets
V-2	Visitor center: pit or vault toilets
O-1	Organization camp: flush toilets, showers, kitchens

The author expected that water use would vary during the year. If that occurred, water system designers would need to know when the most water was used per person, the maximum water use per person, and the seasonal average water use to size systems appropriately. Water meters were read at least monthly to capture seasonal variations in water use.

For this study, it was critical that water use and visitor counts covered the exact same time periods. For instance, if visitors were only counted Thursday, Friday, Saturday, and Sunday each week, the water meter had to be read at the beginning of the day on Thursday and at the end of the day on Sunday so the meter reading would reflect only the amount of water used by the visitors who were counted. Visitors were counted every day at most of the recreation areas, so water meter readings could be obtained weekly or monthly and still accurately show the amount of water used by the visitors who were counted.

Water use was tracked monthly at most recreation areas, but 15 recreation areas tracked water use daily and another 7 recreation areas tracked water use weekly, as shown in table 4. That information may be helpful to those designing water systems where peak water use is critical. Because the file is large and is likely to be useful to only a few people, it is not

Table 4—Recreation areas tracking water use and visitors daily and weekly.

Daily			Weekly		
Category	Name	Province	Category	Name	Province
D-2	Palma De Sierra	Southeast Coastal (Tropical)	C-2	Oreville	Rocky Mountain
D-2	Palo Colorado	Southeast Coastal (Tropical)	C-1	Horsethief	Rocky Mountain
C3/D3/RV1	Chippewa	Lakes	C-1	Grizzly Bear	Rocky Mountain
C3/D3/RV1	Wanaki	Lakes	C-1	Pactola	Rocky Mountain
C3/D3/RV1	Norway Beach	Lakes	C-1	Whitetail	Rocky Mountain
C3/D3/RV1	Cass Lake	Lakes	C-1	Baumgartner	Rocky Mountain
C-2/RV-1	Quartz Creek	North Pacific	C-1	Lee Creek	Rocky Mountain
C1/D1/RV1	Russian River	North Pacific			
C-1	Taneum	North Pacific			
C-1	Mineral Springs	North Pacific			
C-1	Crystal Springs	North Pacific			
C-2	Salmon La Sac	North Pacific			
C-2/D-2	Lake Kachess	North Pacific			
C-1	Woodbine	Great Plains/Prairie			
C-2	Field Tract	Southwest			

included in this tech tip or posted on the Web. It is available from the author.

A very simple water- and visitor-use tracking sheet was provided to the volunteers, but they were free to use whatever method of recording data was most convenient. Most information was recorded on the tracking sheet, but some recreation areas had existing tracking methods and continued to use them during the study. The volunteers were instructed to record the dates, water meter readings, and visitor counts. They were also asked to note anything that would cause more water to be used than usual, such as flushing the system or a break in a water line.

Some locations used actual nose counts of visitors, but many locations just counted the number of occupied individual campsites or day-use sites and multiplied by a predetermined average number of occupants per site to get an estimate of the number of people at the location at one time (PAOT). Because these PAOT ratios have been developed based on actual visitor numbers over time, they are reasonably accurate.

Results

As data began to flow in from the volunteers, a spreadsheet was created showing recreation area categories, number of individual campsites or day-use sites at each area, host information, and the water- and visitor-use data reported for each area. The spreadsheet is available from the author or the Forest Service's internal Web site at <http://fsweb.wo.fs.fed.us/eng/programs/water/documents/excel/wateruse.xls>. The spreadsheet includes worksheets showing background data for all recreation areas studied, monthly data for those recreation areas that tracked water and visitor use, monthly data organized by province, and monthly data organized by use category. The spreadsheet contains more detailed information than is presented in this tech tip.

Three campgrounds had unusually high water use. One campground included a horse washing station. At another campground, a timer flushed the toilets and urinals automatically. The host at the third campground routinely ran a lot of water to flush the system. Data from those three campgrounds are not included in the summary tables presented in this tech tip, but are included in the complete spreadsheet.



Figure 3 shows the yearly average water use in gallons per visitor day for all the recreation areas included in this study. It may be helpful to refer to this figure while considering the use patterns explained below.

Use Patterns by Month

As expected, the amount of water used per visitor day did vary over the season, but the variation differed depending on the province. Table 5 shows general trends in the various provinces. The timing of the peak use during the season

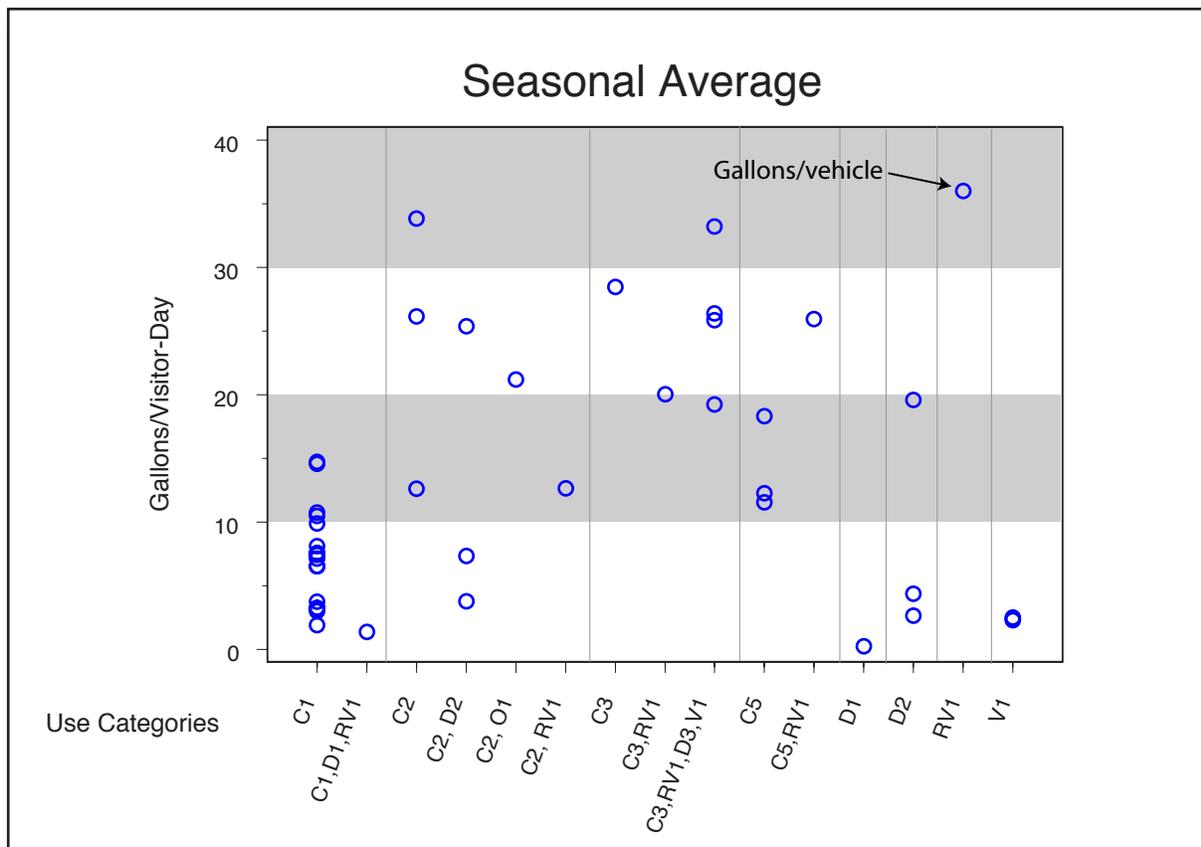


Figure 3—The average use of water per visitor day at different types of Forest Service recreation areas.

Table 5—Peak months for water use and visitation.

Province	Peak month for water use/visitor	Second highest month	Peak month for number of visitors	Ratio of peak to average use
Southeast Mountain	No data—only yearly averages reported			
Southeast Coastal	October	August	June/July	1.7
Tropical	May	June	July	1.3
Lakes	July	August	July	1.2
Great Plains/Prairie	August	July	July	2.0
Rocky Mountain-North	June/Sept	August	July/August	1.7
Rocky Mountain-South	June	August	July/August	2.0
North Pacific-WA	No pattern	No pattern	August	1.3
North Pacific-AK	No pattern	No pattern	July	1.7
Southwest	July	August	June	1.3

is probably not very important except in locations where there is a big difference between peak use and average use, especially if less water is available during the time of peak use.

Water Use at Recreation Areas With Hosts

Each volunteer recreation area submitted information regarding the presence or absence of a host and the utility connections that were provided at the host's site, if any. The presence or absence of a host or differences in host site utility connections didn't seem to make any significant difference in the average water use in gallons per visitor day for campgrounds. The presence of a host may increase water use per PAOT at day-use sites. There was only one day-use site that reported an onsite host, so the data are not conclusive.

Use Patterns by Development Category

The person who proposed the project suspected that campers now draw less water at Forest Service campgrounds than when the average daily design flow table was assembled. That's because more campers have self-contained trailers and recreational vehicles, and fewer persons are camping in tents. Interestingly, water use does seem to be lower than it used to be in more developed campgrounds, but it seems to be higher than it used to be in less developed campgrounds.

As an example, water use at 15 of the 19 campgrounds with pit or vault toilets (C-1) was higher during the peak use month than the 5 gallons per PAOT shown in the average daily design flow table. Half of the campgrounds had more than 10 gallons of water used per PAOT in their peak month. Seasonal average use varied from 1.4 gallons per PAOT to 14.7 gallons per PAOT. The design flow shown on the average daily design flow table should probably be at least doubled to 10 gallons per PAOT for campgrounds without flush toilets.

In contrast, the four campgrounds with individual water and sewer connections (C-5, figure 4) had much lower water use than the 50 gallons per PAOT shown in the average daily design flow table. Seasonal water use averages ranged from 11.5 to 25.9 gallons per PAOT. The highest monthly peak water use was 30.1 gallons per PAOT. The design flow can probably be reduced from 50 to 30 gallons per PAOT for campgrounds with individual water and sewer connections.



Figure 4— Campers who use large trailers often prefer campsites with individual water and sewer connections.

The eight campgrounds with flush toilets but no showers or water and sewer hookups at individual campsites (C-2) had average seasonal water use ranging from 3.8 to 33.8 gallons per PAOT. The average daily design flow table suggests design flows of 20 to 30 gallons per PAOT. The only campground that recorded peak month use over 30 gallons per PAOT has an old, possibly leaky, water system. Two campgrounds experienced yearly average use under 10 gallons per PAOT. The yearly average and peak monthly use at the other five campgrounds was within the range shown on the average daily design flow table. The use rate shown in the average daily design flow table seems to be about right for this category.

The water systems of all but one of the six campgrounds with flush toilets and showers but no water and sewer hookups at individual campsites (C-3) also included day-use areas, wastewater dump stations, and/or small visitor centers. All campgrounds showed seasonal average water use of between 19.2 and 33.2 gallons per PAOT. Use during

the peak month ranged from 23.3 to 39.3 gallons per PAOT, less than the 25 to 50 gallons per PAOT shown on the average daily design flow table. That range could probably be reduced to 20 to 40 gallons per PAOT.

Seasonal average water use at the only day-use area without flush toilets (D-1) that had its own water system was 0.2 gallons per PAOT. Hikers may bring their own water to this very high-use trailhead. No conclusions on use rates for this type of recreation area should be drawn from the limited data in this survey. The average daily design flow table recommends allowing 1 gallon per PAOT at this type of recreation area.

Water use varied significantly at the three day-use areas with flush toilets (D-2) that had their own water systems. The water use at day-use areas in the tropical rain forest in Puerto Rico ranged from 2 to 5.6 gallons per PAOT and averaged 3 gallons per PAOT. This use rate is very close to the 5 gallons per PAOT shown on the average daily design flow table. The other day-use area with flush toilets—at an arid location in New Mexico—experienced a seasonal average of 19.6 gallons per PAOT. It is likely that people did use water at a higher rate at the day-use area in New Mexico. However, the water system was also used for irrigation, and there was no way to tell how much water was used for plants and how much was used by visitors. The rate shown on the average daily design flow table is probably reasonable for this category.

Although nine recreation areas included in this study had wastewater dump stations (RV-1), only one of them had a separate meter for the dump station. The vehicles visiting that facility used an average of 36 gallons each. That's a little higher than the 20 to 30 gallons shown on the average daily design flow table, but is probably more representative of the larger tanks on newer recreational vehicles and trailers. The table should probably be changed to show 30 to 40 gallons per vehicle.

One recreation area in the study included an organization camp (O-1) that was on the same water system as an adjacent campground. The average water use rate for that combined C-2/O-1 recreation area was 21.2 gallons per PAOT, similar to other C-2 campgrounds. No conclusions on use rates for organization camps should be drawn from the

limited data in this survey. It would be more reasonable to assume that organization camps will use water at about the same rate per person as administrative site bunkhouses.

Although data on visitor centers (V-1) were not requested for this study, six recreation areas provided information. Four were small visitor centers that were on the same water system as adjacent campgrounds. The two stand-alone visitor centers are moderately sized, and both are at the same forest. One receives about 55,000 visitors a year (figure 5) and the other



Figure 5—The Burgess Junction Visitor Center in the Tongue District of the Bighorn National Forest (Rocky Mountain Region) is visited by about 55,000 people each year. The restrooms are very busy.

receives about 300,000 visitors a year. Many of the visitors at the more heavily used center arrive on tour buses that stop on the route from Mount Rushmore National Memorial to Yellowstone National Park. Few buses stop at the other visitor center. Each center is normally staffed with two or three employees.

Visitors commonly exit their vehicles, use the restrooms and water fountains, then explore the visitor centers and short interpretive trails. Water use averaged 2.3 gallons per visitor at the more heavily used visitor center and 2.5 gallons per visitor at the other visitor center. Visitor centers are not listed on the average daily design flow table. Considering the increasing number of visitor centers constructed and managed by the Forest Service or concessionaires and the number of visitors that use them, they probably should be included in the table.

Conclusions

Recreational water use patterns appear to have changed significantly since the 1970s. The water use values shown in Forest Service Handbook 7409.11, Section 44.11 - Exhibit

01 (Average Daily Design Flow) should probably be changed as suggested in table 6 and in the section on “Use Patterns by Development Category” to make them more useful as guidance for designing Forest Service water systems.

Table 6—Current and suggested average daily design flows. This table only contains recommendations for types of recreation areas where reasonable conclusions can be reached from the results of this study.

<u>Recreation Area Use Type</u>	<u>Current design flow (gallons of water per day)</u>	<u>Recommended design flow (gallons of water per day)</u>
<u>Camping Facility</u>		
Without flush toilets	5	10
With flush toilets	20-30	20-30
With flush toilets and showers	25-50	20-40
Individual site water and sewer connections	50	30
<u>Day use</u>		
With flush toilets	5	5
<u>Wastewater Dump Station</u>	20-30	40 (gallons per vehicle)
<u>Visitor Center</u>	—	2-3

About the Author

Kathleen Snodgrass came to MTDC as a project leader in 2001. She graduated from Washington State University in 1974 with a bachelor’s degree in architectural studies and spent about 10 years in highway design and construction with the Idaho Division of Highways. She began her career with the Forest Service in 1984. Kathie worked in facilities, landscape architecture, land line, and general engineering on the Nez Perce National Forest for about 10 years and was the forest’s facilities architect for about 7 years before coming to MTDC.

Library Card

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This tech tip explains the changes that should be made to Forest Service guidance for sizing drinking water systems in recreation areas. Recreation use has changed a lot in the last 30 years. Now, more people camp in recreational vehicles and trailers than in tents. Although standard plumbing fixtures use only half as much water as they did in the 1970s, most recreational vehicles and trailers are almost twice as big as they were then, and almost all of them include bathrooms. Data on water use by visitors were collected at about 50 Forest Service recreation areas across the country. Water use now appears to be lower than it used to be in more developed campgrounds, but it's higher than it used to be in less developed campgrounds.

Keywords: design flows, drinking water, dump stations, facilities, organization camps, picnic areas, potable water, recreation, recreation areas, recreational vehicles, showers, toilets, visitor centers, water systems

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For additional information about water use in recreation areas, contact Kathleen Snodgrass at MTDC:

Phone: 406-326-3922
Fax: 406-329-3719
E-mail: ksnodgrass@fs.fed.us

Forest Service and Bureau of Land Management employees can search a more complete collection of MTDC's documents, videos, and CDs on their internal computer networks at:

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