GEI Consultants

Geotechnical
Water Resources
Environmental and
Ecological Services

The Influence of Pet Recreation Areas on Soil and Water Quality at Chatfield State Park

Submitted to:
Chatfield State Park
Aurora, Colorado

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1.0 Introduction

At the request of Chatfield State Park, GEI Consultants, Inc. completed a study to evaluate the potential influence of companion pets and their fecal wastes on microbial soil and water quality near the designated use area. Chatfield State Park maintains the Dog Training Area downgradient of the reservoir that is adjacent to two recreational ponds. This area receives varying levels of pet recreational use depending upon the season. The potential effects of pet wastes on water quality is a common topic of many federal and state water quality brochures (SWWQ 2005, Washington State DOE, Wilmington NC), but few studies have specifically examined this relationship.

The most commonly cited water quality concern as related to pet waste is microbial contamination, typically related to fecal coliforms. Fecal coliform bacteria are a sub-group of the total coliform group found in the feces of warm-blooded animals such as people, livestock, wildlife, and pets. Excessive levels of fecal coliforms often indicate there is a greater risk of human pathogenic bacteria such as *Cryptosporidium* or *Campylobacter* that may result in gastroenteric illnesses. Other water quality concerns include increased nutrients and depleted oxygen levels related to microbial decomposition when heavy precipitation events wash fecal waste into nearby waters. Recreational use studies have shown that nearly 50 percent of all dog owners exercise their pets in public use areas; however, up to 40 percent of dog owners do not clean up their pets' waste. The total amount of waste can become substantial depending on the number of dog owners and their frequency of use of the area.

2.0 Methods

To evaluate the potential influence of companion pets on the microbial soil and water quality in the Chatfield State Park pet recreation area, GEI conducted this study in late May to early June 2008. Study site transects were established on May 22, 2008, with samples being collected on June 3, 2008. The colder temperatures observed during the winter and early spring are not conducive to microbial activity and pet use is likely to be less. Therefore, estimates made during warmer months will conservatively estimate impacts during colder months. The study consisted of three main components, fecal waste surveys, microbial analysis of water samples, and microbial analysis of soil samples.

2.1 Fecal Waste Surveys

The first part of the study was to document pet usage and their fecal waste in the recreational use area, with special reference to activities near the ponds. Multiple transects originating from waters edge and extending in a perpendicular manner for 100 m from the ponds were randomly established within the study area (Figure 1). Three transects were established upgradient of the pet recreation area, near the spillway pond, and served as a reference area (Transects 1-3). Seven transects were established within the pet recreation area (Transects 4-10), and three transects were established at a pond downgradient of the pet recreation area (Transects 11-13). Because there is no pond in the Chatfield State Park that is downgradient of the pet recreation area, the downgradient transects were established at Lake 1 of the South Platte Park. Visual inspections along a 2 m wide path for each transect, both outward and the return trip to the shore of the pond, documented the occurrence and location of fecal waste. Fecal wastes were collected along each transect and stored in separate Ziploc bags and weighed (dry weight, dw) to determine a total waste load for each transect.

2.2 Water Microbial Analyses

In combination with the transect surveys, microbial water quality samples were collected using sterile sampling techniques (i.e., new examination gloves for each transect site and sterile Whirl-Pak bags) from the ponds within the pet area, and the upgradient and downgradient areas. The samples were collected near the origin of each transect, for a total of 13 samples. Water samples were stored in a cooler and returned to the GEI Laboratory for analysis of fecal coliforms. Fecal coliform analyses were performed using Standard Method 9221E (APHA 2005). The detection limit was 2 coliforms per 100 ml.

Laboratory results were compared to the current numerical standard for fecal coliforms of 200 coliforms per 100 ml of sample for the South Platte stream segment immediately downstream of Chatfield Reservoir.

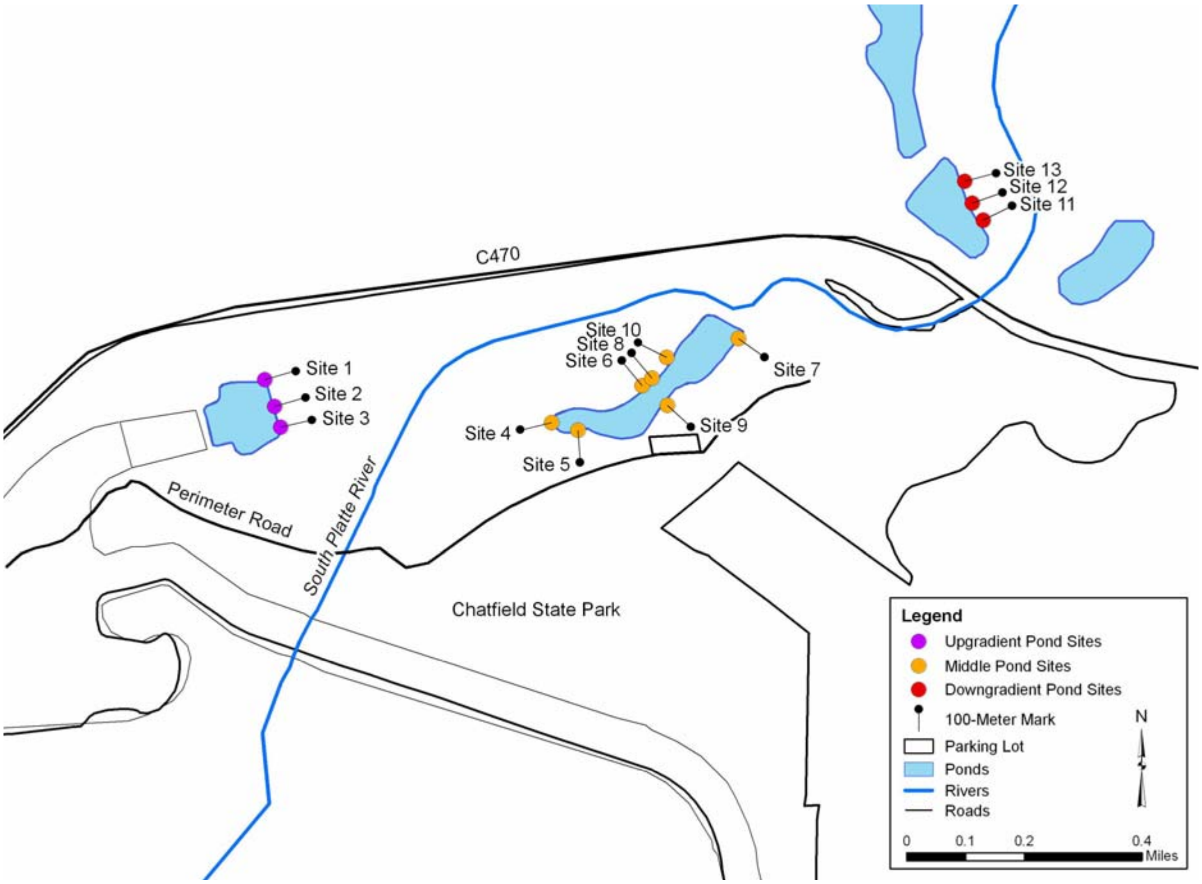

Figure 1: Sample site and transect locations in the Chatfield State Park pet recreation area.

2.3 Soil Microbial Analyses

A combination of soil composite and "sample by chance" soil samples were collected along the established transects using clean sampling techniques (i.e., alcohol sterilization of metal putty knife between transects, and sterile Whirl-pac bags). Five soil samples were collected from randomly determined points along each transect, and combined to create one composite sample for each transect from each of the three upgradient transects (Transects 1-3) and the three downgradient transects (Transects 11-13). At each point along the transect, the above ground vegetation was removed using shears, and a 9 square inch soil sample was outlined using a 3 inch metal putty knife. Approximately 9 cubic inches of soil was removed by sliding the putty knife below the demarcated soil sample. Each composite sample essentially represents the range of soil microbial conditions along their respective transect. Within the pet recreation area, composite soil samples were collected along transects 4, 5, 6, and 10, and "sample by chance" soil samples were collected along the three remaining transects 7, 8, and 9. These "sample by chance" soil samples were collected beneath pet waste locations along the respective transects. Based on the number of observed dog waste per transect, between one and five direct contact soil samples were collected and combined to create one sample. These samples represent a worst case scenario for fecal contamination within the pet recreation area. Soil samples were stored in a separate cooler (i.e., not with water samples) and returned to the GEI Laboratory for analysis of fecal coliforms.

Soil was manually homogenized in the Whirl-Pak bag and 10 grams of soil was added to 100 ml diluent water to make a 10^{-1} dilution before inoculation, resulting in 10 grams of soil per 100 ml sample. Fecal coliform analyses were performed using Standard Method 9221E (APHA 2005). The detection limit for this analysis was 20 coliforms per 100 ml (or 10g) sample.

3.0 Results

3.1 Fecal Waste Surveys

No dog waste was observed in the three transects upgradient of the recreation area. In the transects within the pet recreation area, between two and five fecal wastes were collected at each transect (Figure 2). At the downgradient locations, only one fecal waste was collected along Transect 12. The average number of fecal samples collected per transect (200 m^2 area) was 0 feces for the upgradient area, 3.3 feces for the pet recreation area, and 0.3 feces for the downgradient area.

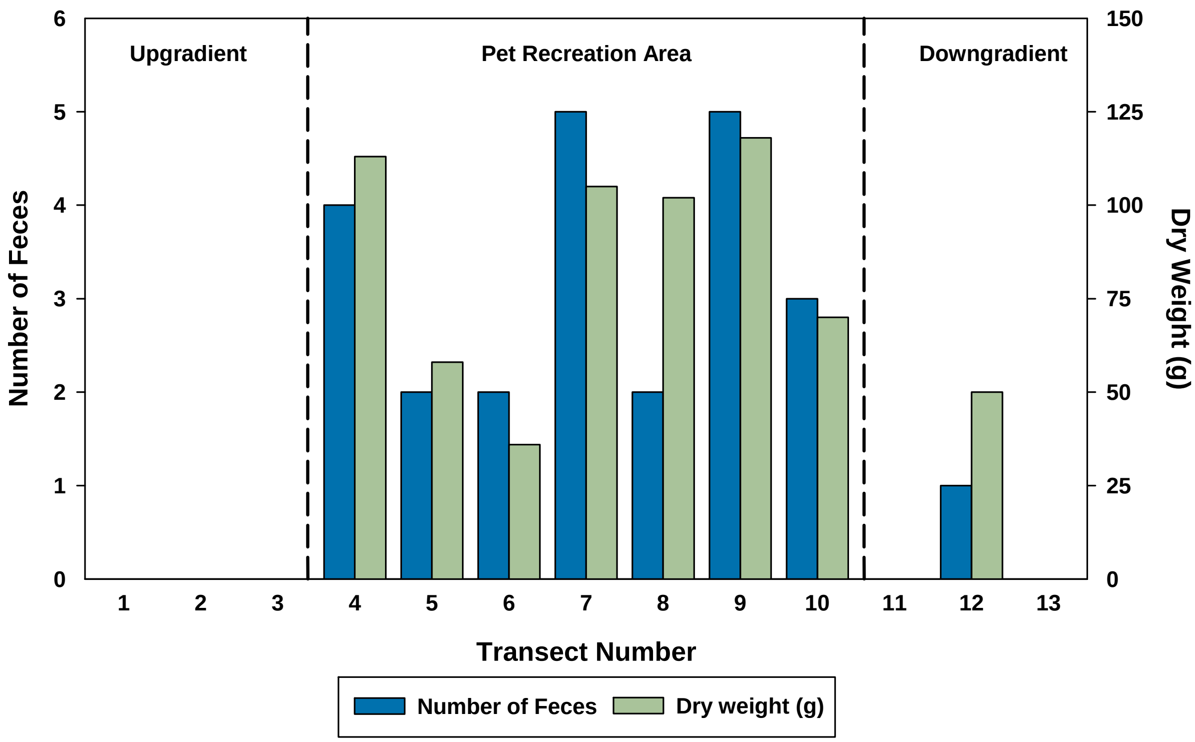

Figure 2: Number of feces and dry weight (g) for samples collected along each transect in the study area at Chatfield State Park.

Total dry weight of the fecal samples ranged from 36 to 118 g, with an average of 86g per 200m^2 within the pet recreation area (Figure 2). In the downgradient section, fecal dry weight was 50g per 200m^2.

3.2 Water Microbial Analyses

All fecal coliform analyses of water samples collected from the upgradient and downgradient transects, and within the pet recreation area resulted in levels well below the numerical standard of 200 coliforms/100 ml (Figure 3). Fecal coliform levels upgradient of the pet area ranged from <2 to 4 coliforms/100 ml. The highest level detected in the study area was 22 coliforms/100 ml in the water sample collected at transect nine, within the pet recreation area. However, fecal coliform levels in other transects within the pet area were not substantially different from the upgradient sites, ranging from 2 to 6 coliforms/100 ml. Fecal coliform levels in the downgradient transects ranged from 2 to 4 coliforms/100 ml.

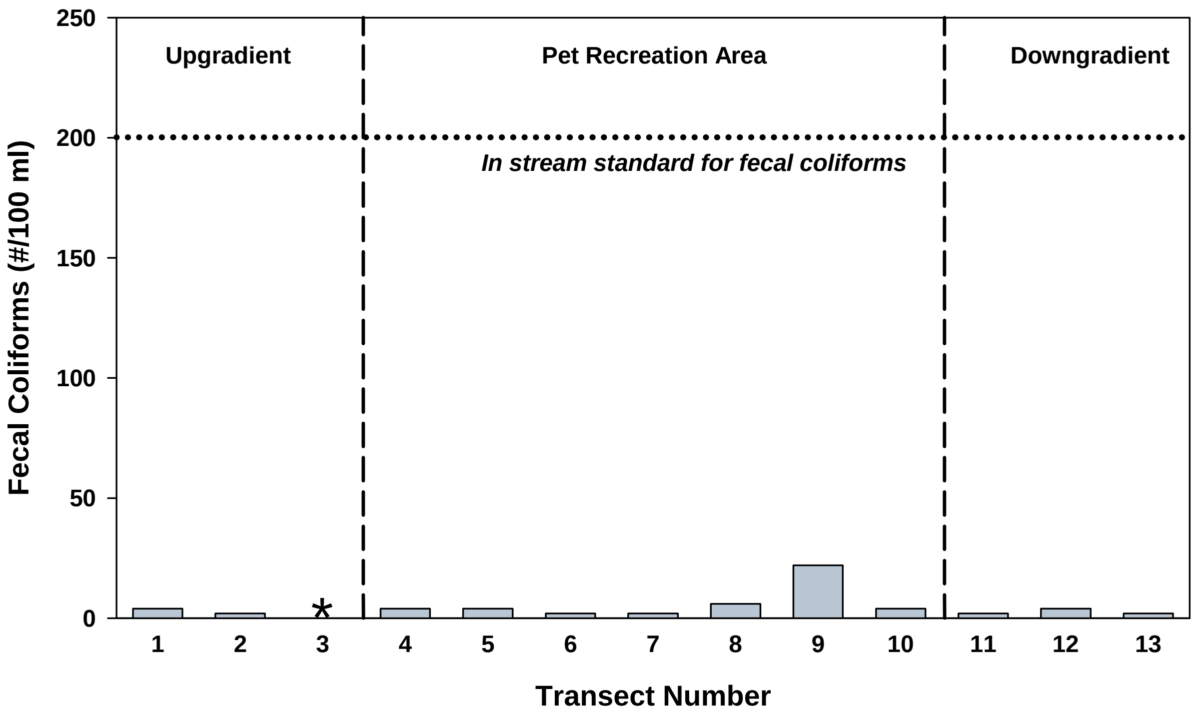

Figure 3: Number of fecal coliforms per 100 ml water sample for each transect, compared to the in-stream numerical standard of 200 coliforms/100 ml. Asterisk denotes results less than the method detection limit of 2 coliforms/100 ml.

As part of the analytical method for fecal coliform bacteria, total coliform bacteria were also determined. Total and fecal coliform data for both water and soil samples are provided in Table 1. The results of the total coliform analyses were used as a quality control measure to validate the fecal coliform results. As expected, total coliform numbers are greater than fecal coliforms in water samples from all transects, ranging from 11 to 300 coliforms per 100 ml. This observation is not surprising given that coliform bacteria are common in natural waters. Their presence does not necessarily indicate contamination (APHA 2005).

Table 1: Number of total and fecal coliforms in water and soil samples for each transect.

Transect	Water		Soil	
	Total Coliforms (#/100 ml)	Fecal Coliforms (#/100 ml)	Total Coliforms (#/100 ml)	Fecal Coliforms (#/100 ml)
1	11	4	110	40
2	23	2	230	20
3	13	<2	<20	<20
4	22	4	<20	<20
5	50	4	230	<20
6	130	2	<20	<20
7	80	2	800	140
8	300	6	230	230
9	80	22	230	40
10	30	4	40	20
11	130	2	230	20
12	27	4	80	<20
13	22	2	40	<20

3.3 Soil Microbial Analyses

Fecal coliform levels in soil samples collected upgradient of the pet area ranged from <20 to 40 coliforms/100 ml (Figure 3). In the pet recreation area, fecal coliform levels ranged from <20 to 230 coliforms/100 ml. In the downgradient transects, fecal coliform levels were either less than or at the method detection limit of 20 coliforms/100 ml. The highest levels detected in the pet recreation area were 140 and 230 coliforms/100 ml from transects seven and eight, respectively. These two transects represent a worst-case scenario for fecal coliform abundance, because soil samples were collected directly beneath pet wastes. The third "sample by chance" transect (9) revealed 40 coliforms/100 ml. Within the pet recreation area, the "sample by chance" soil samples revealed greater numbers of fecal coliforms than the randomly collected soil samples, which is expected; although the number of coliforms was relatively low in the "sample by chance" transects. Three of the four transects where soil was randomly sampled revealed coliform levels less than the method detection limit, while the fourth transect contained coliforms equal to the method detection limit. Fecal coliform levels in the randomly sampled soil transects of the pet recreation area were similar to levels observed in the upgradient transects, as well as the downgradient transects.

As discussed in Section 3.2, total coliform bacteria also were determined in soil samples. Similar to the results of the water analyses, total coliform bacteria were greater than fecal coliform bacteria in all soil samples ranging from <20 to 800 coliforms per 100 ml (Table 1). Again, this does not indicate contamination, it does however confirm that the analytical method used in this study was appropriate for detecting coliform bacteria in soil.

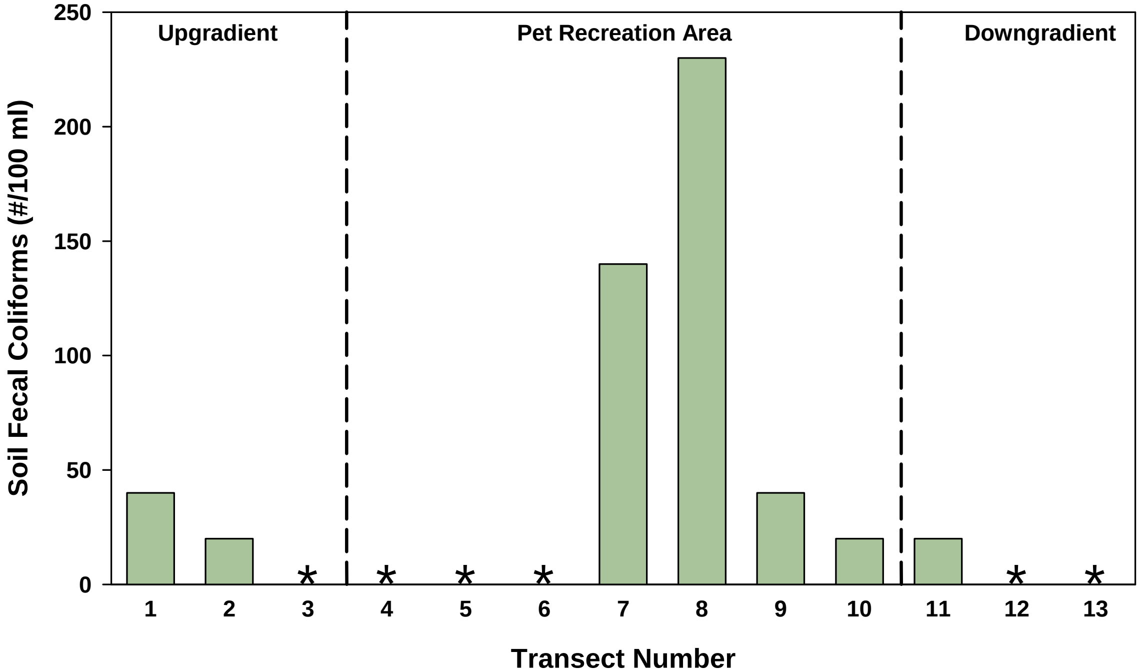

Figure 4: Number of fecal coliforms per soil sample for each transect. Asterisk denotes results less than the method detection limit of 20 coliforms/100 ml.

4.0 Summary

The amount of fecal waste collected varied between the transect sites. No pet waste was observed in the upgradient area, indicating this area was an appropriate reference area with no substantial pet use. The number of pet waste collected in the more active zone of the pet recreation area was greater than in the downgradient area, in both number of feces and dry weight.

The results of the microbial water analyses collected from Chatfield State Park indicate that pets are not greatly affecting the microbial water quality of the ponds in this area. The greatest fecal coliform level detected in any of the samples was 22 coliforms/100 ml, which is substantially less than the numerical standard of 200 coliforms/100 ml for the South Platte stream segment immediately downstream of Chatfield Reservoir. Although the quantity of pet waste varied between the upgradient and downgradient transects, and the pet recreation area, the fecal coliform levels in the water samples did not substantially vary between the three areas. These results indicate that pets did not greatly contribute to the levels of fecal coliforms found in the ponds during the study. During both the pre-site and sample collection visit, dogs were observed playing in the ponds near many transect sites.

Analysis of soil samples randomly collected along the transects, as well as the direct contact "sample by chance" sample underneath fecal samples showed that fecal coliform levels varied between <20 to 230 per 100 ml. The "sample by chance" transects revealed the greatest fecal coliform levels in the pet recreation area. However, the fecal coliform levels in the randomly sampled transects of the pet recreation were similar to levels observed in both the upgradient and downgradient transects. The variability in fecal coliform levels from the "sample by chance" direct contact samples may be a result of the timing and duration of the fecal waste being in the environment. Survival of coliform bacteria in soil is negatively affected by increasing temperature and dessication (Zaleski, et al. 2005). Van Donsel et al. (1967) showed that the number fecal coliform bacteria were reduced by 90 percent in soils within 3.3 days in the summer and within 13.4 days in the fall. Due to the short expected lifespan of fecal coliform bacteria in soil, it is unlikely that they would be easily transported to water bodies in runoff situations.

Based on these data, companion pets do contribute a greater quantity of fecal waste in the pet recreation area rather than in adjacent upgradient or downgradient areas. However, due to the low levels of fecal coliforms found in the soil and water samples, it does not appear that pets substantially affect the microbial soil or water quality at Chatfield State Park. In other pet recreation studies (SWWQ 2005), including the concurrent Cherry Creek study, observations were made that confined entry-ways to the recreation area greatly affected the way pets "marked" their territory. Once pets arrived at the recreation area, and traveled through the confined entry-way, they would often urinate or defecate in the nearby area to mask the scent of previous pets. Management strategies for the pet recreation area may evaluate the effectiveness of confined entry-ways into the park and locate pet waste receptacles near these locations to encourage pet owners to help maintain the natural resource provided by the State Parks.

5.0 References

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