Oak Creek Watershed Improvement Plan Appendix C: Best Management Practices (BMP) Project Descriptions

Contents

Introduction

The following are project descriptions for proposed BMP implementation projects in the Oak Creek Watershed intended to reduce *E. coli* concentrations and related water quality problems, such as erosion and sedimentation. Each is a stand-alone project description that can be used for developing funding proposals and implementing projects. Each has an education and outreach component, but there are also stand- alone education and outreach projects that are supportive of the on-the-ground projects. These projects were developed based on the findings of the 2011 water quality investigation as well the findings of past studies and information provided by watershed residents both formally (through a social survey) and informally (anecdotal information). The projects have been reviewed and approved by the Oak Creek Watershed Improvement Commission. They are shown here in order of priority based on multiple lines of evidence that point to the greatest sources *E. coli* contamination of Oak Creek.

Project Prioritization

Project prioritization is described in the "Potential Future Projects" section in Chapter 2 of the Oak Creek Watershed Improvement Plan. There are two tiers of project prioritization. Tier 1are top priority projects and Tier 2 are lower priority projects. Within each tier projects priority is also ranked by project type and by project. The table below shows the tier 1 project priorities, with "1" being the top priority.

OCWIP Top Priority BMP Project

Priority	Project number	Project title
1	EO-2	Oak Creek Canyon Public Outreach Program
2	EO-5	"Even One" *E. Coli* Outreach Project
3	EO-6	Oak Creek Community Outreach Program (OCCOP)
4	SS-1	Oak Creek Commercial Septic System Improvement Incentive Project
5	SW-1	SW-1 Sedona Area Stormwater Improvement Project
6	RC-1	Oak Creek Canyon Public Toilet Access Project
7	RC-3	Keeping Oak Creek Beautiful – Trash Receptacle Access Project

The table below shows the Tier 2 project priorities:

OCWIP Second Tier BMP Project Priorities

Priority	Project number	Project title
8	EO-1	Sedona Dog Waste Reduction Outreach Project
9	EO-3	Lower Oak Creek Watershed Outreach Project
10	EO-4	Recreational Vehicle Proper Waste Disposal Outreach Project
11	SS-2	Oak Creek Residential Septic System Improvement Project
12	RC-2	Oak Creek Canyon Sediment Source Reduction Project
13	RC-4	Oak Creek Watershed Dog Waste Station Installation Project
14	AG-1	Animal Waste BMPs for Oak Creek Watershed
15	AG-2	Oak Creek Irrigation Diversion Erosion Reduction Project
16	AG-3	Lower Oak Creek Erosion Reduction Project

Top Priority Projects

EO-2 Oak Creek Canyon Public Outreach Program

Need

High recreation use of Oak Creek Canyon in the summer contributes to *E. coli* contamination of Oak Creek through several pathways: 1. dog feces, 2. used baby diapers, 3. human feces, 4. food waste that attrack wildlife that defecates near the stream, 5. soil disturbance and erosion that contribute sediment to *E. coli* sediment reservoirs, and 6. disturbance of sediment reservoirs by swimmers and waders causing *E. coli* and related fecal contaminants to enter the water column. Bilingual signage and oral communication are needed to reach both English- and Spanish-speaking recreators.

Description

Conduct a pre-summer and early summer media campaign with a public health awarement focus that includes public service announcements, kiosks, and volunteer contact with recreators at campground and day use areas to get the message out. The message should include health effects of fecal contamination, symptoms of infection due to fecal contamination, pictures of dirty diapers in the woods and blown up pictures of the germs that cause illness. Emphasize that July has the highest risk of contracting illness due to fecal contamination, because of high recreational use and the fact that flushing rains usually start later than July. Involve local businesses in an incentives/reward programs such as free frozen yogurt certificates or Red Rock day passes that volunteers hand out to visitors who pick up dog waste and/or properly dispose of used diapers. The success of this project relies on a presence of volunteers (preferably wearing official looking polo shirts with OCWC insignias) in the high recreational use areas interfacing with the public to convey information, solicit feedback, encourage the public through praise and incentives and generally promote a culture of caring for Oak Creek.

Estimated load reduction

Human feces

A University of North Dakota study for the U.S. Department of Agriculture regarding human waste distributions reveals the average stool produced is 95.5 grams per day, and 2066 ml of urine per day (Parker and Gallagher 1988). The average number of bowel movements per day was 2.54 (Parker and Gallagher 1988), but the number times a person urinates is variable based on the volume of fluid they consume, with a range of 4-10 times per day based on an Internet search. An urination rate of 7 per day will be used in this analysis.

The only access to and through the Oak Creek Canyon is Highway 89-A which carries about 7million visitors a year to Oak Creek and Sedona. Approximately one million of these visitors stop and utilize the publicly owned recreational sites, while 300,000 visit Slide Rock State Park (in Poff and Tecle 2002).

Assuming 60% of the potential visitors use the toilets once for urination and 30% of the potential visitors use the toilets for bowel movements, instead of relieving themselves into the environment, the load reductions for urine and fecal material are:

Urine (l) = 1 million visitors/year * 0.6 * 2066 ml/day * day/7 urinations * 1 liter/1000 ml = 177,086 liters

Fecal Material (kg) = 1 million visitors/year * 0.3 * 95.5 g/day * day/2.54 movements * 1 kg/1000 g = 11,280 kg

The Fecal Material estimate is more important in regard to *E. coli*. *E. coli*, as member of the intestinal flora, is part of the digestive process and is excreted in feces. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Consequently, if 10% (11,280 kg) of fecal material that is now captured by the toilet facilities would have reached the river environment it would result in the potential *E. coli* load of 5.6×10^{12} CFU per year, representing a 100% load reduction compared to not having the toilet facilities.

In order estimate the actual load reduction a survey of rest room users should be conducted.

References:

Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Parker, D. and S. Gallagher, 1988. Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space, accessed July 9, 2012. Located at http://www.nss.org/settlement/moon/library/LB2-611-WasteProcessing.pdf

Poff, B. and A. Tecle, 2002. Bacteriological Water Quality Trend Analysis in Oak Creek Canyon, Arizona. In: Ground Water/Surface Water Interactions, 2002 AWRA Summer Specialty Conference Proceedings, July 1-3, 2002, Keystone, CO. pp. 431-436.

Diapers

Peterson (1974) reported that feces-soiled diapers contained an average of 60 grams of feces. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Assuming that the Trash Receptacle Access Project and the Outreach Program changes the behavior of 100 people per year (i.e. 100 diapers). The average annual load reduction would be 3×10^{10} CFU per year.

References:

Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Peterson, M.L., 1974. Soiled disposable diapers: a potential source of viruses.. American Journal of Public Health: September 1974, Vol. 64, No. 9, pp. 912-914. doi: 10.2105/AJPH.64.9.912

Dog feces

E. coli bacteria are bacteria that are common to the intestinal tracts of humans and animals. Walker and Garfield (2008) found that a gram of fresh dog feces contained an average of 50 million CFU/gram with a range of 2 million to 200 million CFU/gram of *E. coli* bacteria. The average dog excretes 0.75 pounds (340 grams) of waste per day (Clear Choices Clean Water, 2012). That equates to an average 17 billion CFU of *E. coli* bacteria per day per dog. If the Sedona Dog Waste Reduction Outreach/Oak Creek Watershed Dog Waste Station Installation Projects prevents 100 dog/days from contaminating Oak Creek this would result in a load reduction 34 kg of dog feces and 17×10^{12} CFU of *E. coli* bacteria.

The goal of the Outreach Project is to improve community awareness on the role of dog waste in water quality impairment of Oak Creek. The Outreach Project should increase the use of the dog waste stations and the rate of dog waste removal. If the Outreach Project increases use of the dog waste stations from 100 to 300 dog/days the result would be a load reduction of 102 kg of dog feces and 5.1×10^{13} CFU of *E. coli* bacteria.

The actual load reduction will depend on the number of people that utilize the dog waste stations, before and after the Outreach Project. A monitoring program should be implemented to assess the use of the dog waste stations.

References:

Clear Choices Clean Water Organization, access on June 27, 2012 http://clearchoicescleanwater.org/wp-content/uploads/2011/08/pet-waste-FAQs_final.pdf

Walker, M. and L. Garfield, 2008. Dog wastes and water quality: Evaluating the connection at Lake Tahoe. University of Nevada Cooperative Extension, Fact Sheet-08-18.

Sediment

The project seeks to reduce the amount of erosion and sediment entering Oak Creek as a result of soil disturbance from people hiking into Oak Creek Canyon and Slide Rock State Park on unmaintained social trails.

Without knowing the locations of the BMPs that will be implemented, some assumptions must be made in order to formulate a reasonable estimation of load reduction. The Automated Geospatial Watershed Assessment tool (AGWA) with the SWAT model (ARS, 2012) was first run using land cover data downloaded from the SWReGAP server. Land cover was then modified starting at the bridge just below the public swimming area at Slide Rock S.P. upstream just over 0.5 miles to the Halfway Day Use Area in order to represent disturbed soils due to hiking off-trail. Assuming that twenty percent of the entire area could be considered disturbed by people going off the trails and making their own pathways to the stream, the Land Cover Modification Tool within AGWA allows for a partial change of landcover within an area, and the second model reflects that percentage.

The difference between the SWAT model run with normal landcover, and a model run with landcover that reflects 20% of disturbed soil within an area of approximately 50 acres is the reduction of sediment load as a result of trail engineering and maintenance.

Load Reduction: 7.02 tons of sediment per year

References:

Agricultural Research Service (ARS) Website, Access on June, 2012. Automated Geospatial Watershed Assessment Tool located at http://www.tucson.ars.ag.gov/agwa/.

Multiple effects

Because the project is a multi-faceted approach to overall watershed improvement, using different methods and making some assumptions of effectiveness of the BMP when modeling each facet separately is necessary in order to formulate a reasonable estimation of load reduction. The project seeks to reduce the amount of *E. coli* and sediment delivered to Oak Creek during summer stormflow events by first surveying and determining where there are concentrations of human and animal waste, and where erosion problems exist.

If the watershed survey reveals that jeep use is a significant cause of soil disturbance and sediment discharge, then BMP's will be implemented along trails and public outreach will promote practices that will reduce erosion. Each subwatershed with hiking or jeep trails was modeled assuming that the total area of the disturbance by humans was either 10%, 20% or 30% of the total area of subwatersheds with jeep and/or hiking trails, and that BMP's were utilized in the model in those proportions. The Automated Geospatial Watershed Assessment tool (ARS, 2012) with the SWAT model was used to estimate the sediment runoff of the areas of with landcover data that represents normal vegetation, then with landcover data that had been modified to reflect the disturbed areas near jeep and hiking trails within the six subwatersheds. If 10% of the areas were disturbed, recovered normal vegetation would be responsible for the reduction of 19.5 tons of sediment per year.

The STEP L Model (U.S. EPA, 2012) was used to estimate the effectiveness of installing water bars and bioretention ponds to slow runoff and reduce erosion, and the revegetation of areas denuded by erosion in areas near jeep and hiking trails. If humans and jeeps disturbed 10% of the area of subwatersheds with trails, the load reduction as a result of the installation of water bars, bioretention ponds, and native vegetation is 153.9 tons of sediment per year.

Dog waste stations will be installed at all trailheads. Walker and Garfield (2008) found that a gram of dog feces contained an average of 50 million CFU/gram of *E. coli* bacteria. The average dog excretes 340 grams per day (Clear Choices Clean Water, 2012). That equates to 17 billion CFU of *E.coli* bacteria per dog per day. If the project successfully prevents 100 dog/days per year from contaminating Oak Creek, the result would be a reduction of 34 kg of dog feces and 17 x 10^{12} CFU of *E. coli* bacteria.

Public outreach efforts aimed at eliminating human waste contributions to the watershed will be implemented. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Parker and Gallagher (1988) found that the mean human waste in over 25,000 subjects was 95 grams per day of solid fecal matter. That equates to 475 million CFU of *E. coli* per person per day. If the project successfully prevents 100 people per day from

contaminating Oak Creek, the result would be a reduction of 9.5 kg of human feces and 4.75 x 10^{10} CFU of *E. coli* bacteria.

Average annual load reduction:

AGWA SWAT (Soil Disturbance and Normal Vegetation)
19.5 tons of sediment per year

STEP L (Water Bars, Bioretention Ponds, Revegetation)
153.9 tons of sediment per year

Combined Sediment Load Reduction: 173.4 tons of sediment per year

Dog Waste
34 kg (75 lbs) of feces and 17 x 10^{12} CFU per year of *E. coli* bacteria

Human Waste
9.5 kg (21 lbs) of feces and 4.75 x 10^{10} CFU per year of *E. coli.* bacteria

References:

Agricultural Research Service (ARS) Website, Access on June, 2012. Automated Geospatial Watershed Assessment Tool located at http://www.tucson.ars.ag.gov/agwa/.

Clear Choices Clean Water Organization Website, access June 27, 2012. Located at http://clearchoicescleanwater.org/wp-content/uploads/2011/08/pet-waste-FAQs_final.pdf

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Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Parker, D. and S. Gallagher, 1988. Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space, accessed July 9, 2012. Located at http://www.nss.org/settlement/moon/library/LB2-611-WasteProcessing.pdf

U.S. EPA Website, Access June, 2012. Welcome to STEPL and Region 5 Model, http://it.tetratech-ffx.com/stepl/

Animal Waste

E. coli bacteria are bacteria that are common to the intestinal tracts of humans and animals. A 1000-pound horse will defecate from 4-13 times each day and produce 35 to 50 pounds of wet manure (feces

plus urine) daily, or approximately 9.1 tons per year. E. coli concentrations in fresh and dry manure from horses are 6.17×10^4 CFU per gram and 6.31×10^5 CFU per gram, respectively (NERA, 2012).

A mature cow weighting 1000 lbs produces an average of 8.7 lbs/day of manure (NRCS, 2012) or approximately 1.5 tons per year. Wang et al. (2004) showed that *E. coli* populations extracted from fresh cow manure ranging from 6.55×10^6 to 7.6×10^6 cfu per gram of manure (average of 7.1×10^6 cfu per gram).

If the fresh waste from one animal was dumped into the stream the potential average annual *E. coli* load would be:

Horse (CFU/year) = 9.1 tons/yr * 6.17×10^4 CFU per gram * 907,184.74 grams/ton = 5.1×10^{11} CFU per year

Cow (CFU/year) = 1.5 tons/yr * 7.1×10^6 CFU per gram * 907,184.74 gram/ton = 9.7×10^{12} CFU per year

The actual load reduction is based on the number of people currently dumping waste into the streams and the resulting number of people that stop dumped after the implementation of the Outreach Programs. A monitoring program would be implemented to assess the current rate of dumping and to evaluate the behavior changes after the implementation of Outreach Programs.

References:

Natural Resource Conservation Service (NRCS), access on June 25, 2012. Wyoming Comprehensive Nutrient Management Plan Workbook located at http://www.wy.nrcs.usda.gov/technical/wycnmp/

NERA Website, Access July 2012. NE1041: Environmental Impacts of Equine Operation located at http://lgu.umd.edu/lgu_v2/homepages/attachs.cfm?trackID=11196.

Wang, L., K.R. Mankin, and G.L. Marchin, 2004. Survival of Fecal Bacteria in Dairy Cow Manure. Transactions of the ASAE 47(4): 1239-1246.

Project schedule and milestones

<table>
<tr>
<td rowspan="2">Implementation schedule:
January 2012 through September 2014

Measurable milestones:
~ Outreach planning & coordination complete
~ Spring & early summer media campaign complete
~ ADOT approval for highway signs
~ Signs posted along Hwy 89 for public toilets
~ Educational materials posted at #? kiosks
~ Volunteers log recreators observed:
▪ using dog waste stations & trash receptacles</td>
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▪ telling others to pick up waste ▪ using designated trails to reduce erosion ~ Volunteers distribute #? "thank you" gift certificates	

Education and Outreach Strategy

Findings of education needs survey:

At least 12% of residents do not think dog feces impact water quality.
At least 6% of residents do not think used baby diapers impact water quality.
At least 13% of residents do not think human feces impact water quality.
At least 23% of residents do not think soil erosion due to unmaintained trails impacts water quality.
At least 14% of residents do not think leaving food waste near the creek can attract wildlife that contribute to fecal contamination of the creek.
At least 14% of residents do not think that disturbing *E. coli* sediment reservoirs can cause water contamination.

Goals and target audiences:

~ Target audience is summer recreators in Oak Creek Canyon, both English language speakers and English language learners.
~ Inform them of risks to human health from unsanitary practices such as:
  - not picking up dog feces
  - improperly discarding used baby diapers
  - defecating near Oak Creek
  - causing erosion by accessing creek on unmaintained trails
  - leaving food waste near the creek
~ Inform recreators of risk of swimming/wading when water is turbid
~ Offer incentives to recreators for demonstrating and promoting healthy habits
~ Make information available in Spanish and English both orally and in writing

Priority education and outreach projects schedule:

~ Stage campaign to coordinate with completion of public toilets and dog waste station installations.
~ Early summer 2012 - media campaign: Let public know about health risks, expected behavior, availability of toilets, waste receptacles and dog waste stations, future availability of amenities.
~ Early summer 2013 - media campaign: Same as previous year with notice of new amenities.
~ 2013 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: The number of summer time *E. coli* exceedances at Slide Rock State Park decreases.

On-the-ground project effectiveness monitoring plan

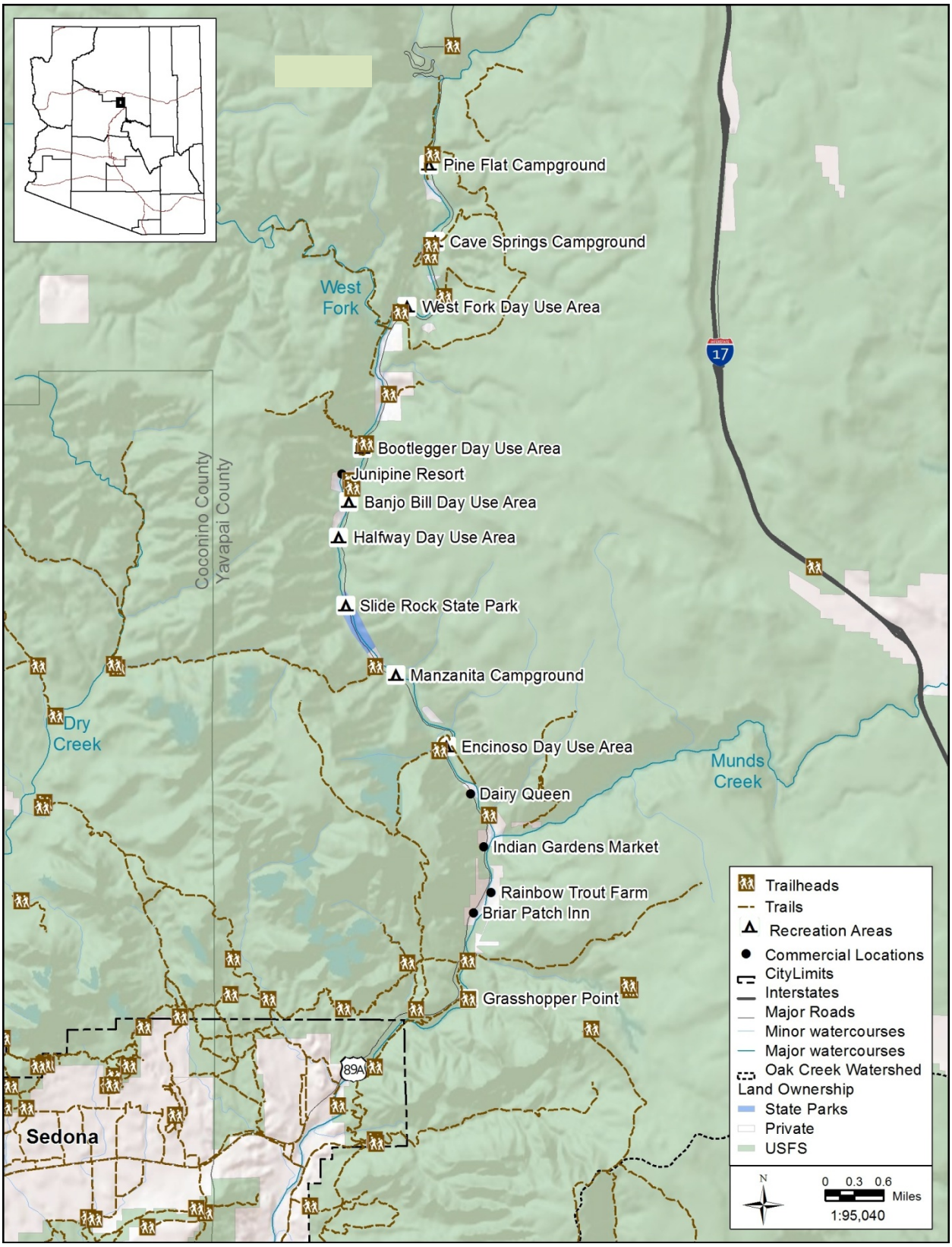
- *Monitoring and reference condition sites*:

Volunteers will observe recreator behavior at Slide Rock State Park and on Coconino National Forest at day use areas, campgrounds, and popular creek access points to determine whether desired behaviors are being exhibited.

- *Parameters & critical conditions:*
  - *E. coli* exceedences at Slide Rock State Park (>235 cfu/100 ml)
  - Observed behaviors
    - picking up dog feces
    - properly discarding used baby diapers
    - using public toilets
    - using maintained trails to avoid erosion
    - removing food waste near the creek
- *Schedule, frequency and duration*:
  Biweekly observations on the weekends throughout the summer, 2012-2014
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  Annual report in the fall of each year

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Recreators exhibit behaviors conducive to reducing *E. coli* contamination. The incidences of dog feces, used baby diapers, human feces, food waste, and soil erosion near the creek decrease.
- *Generation and implementation of second generation improvement projects:*
  Recreators provide feedback on the best locations for installing additional public toilets, trash receptacles, and dog waste stations.
- *Measurable reductions of pollutant loading:*
  Reduced *E. coli* exceedances at Slide Rock State Park
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Annual report in the fall of each year


Pine Flat Campground
Cave Springs Campground
West Fork
West Fork Day Use Area
17
Bootlegger Day Use Area
Junipine Resort
Banjo Bill Day Use Area
Halfway Day Use Area
Coconino County
Yavapai County
Slide Rock State Park
Manzanita Campground
Dry Creek
Encinoso Day Use Area
Munds Creek
Dairy Queen
Indian Gardens Market
Rainbow Trout Farm
Briar Patch Inn
Grasshopper Point
89A
Sedona
Trailheads
Trails
Recreation Areas
Commercial Locations
CityLimits
Interstates
Major Roads
Minor watercourses
Major watercourses
Oak Creek Watershed
Land Ownership
State Parks
Private
USFS
N
0 0.3 0.6
Miles
1:95,040

EO-5 "Even One" *E. Coli* Outreach Project

Need

Recreators often do not grasp the consequences of their actions. Even one fece (dog, diaper or dump) can cause contamination of Oak Creek. This is known from past bacterial DNA studies in Oak Creek Canyon where it was discovered that a single animal (including human animals) can cause fecal contamination of the creek.

Description

Conduct a public outreach program to get the "Even one" message across that even one deposit of human or pet feces can cause contamination that threatens human health. Use fliers, presentations to schools, civic groups and campers, public service announcements and press releases to spread the message about personal responsibility for reducing *E. coli* contamination. Encourage residents and recreators in the watershed to speak up when they see someone polluting with used diapers, human feces, dog feces or food waste that attracts wild animals whose feces also contaminate Oak Creek. Be sure to emphasize that feces do not have to be right next to the creek to have an impact; feces on can be carried miles by stormwater and still cause contamination.

Estimated load reduction

A University of North Dakota study for the U.S. Department of Agriculture regarding human waste distributions reveals the average stool produced is 95.5 grams per day, and 2066 ml of urine per day (Parker and Gallagher 1988). The average number of bowel movements per day was 2.54 (Parker and Gallagher 1988), but the number times a person urinates is variable based on the volume of fluid they consume, with a range of 4-10 times per day based on an Internet search. An urination rate of 7 per day will be used in this analysis.

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Parker, D. and S. Gallagher, 1988. Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space, accessed July 9, 2012. Located at http://www.nss.org/settlement/moon/library/LB2-611-WasteProcessing.pdf

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Project schedule and milestones

<table>
<tr>
<td rowspan="2">Implementation schedule:
March 2012 through September 2014

Measurable milestones:
~ Design of literature, presentations, PSA scripts, and press releases
~ Spring/early summer media campaign completed
~ #? presentations to civic groups
~ Late summer “Thank you” message in media
~ Survey to gage any change in attitudes
~ Annual reports on activities and response from public</td>
<td>Resources and other support commitments:
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<tr>
<td>Pending commitments:
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Estimated commitment date:
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Education and Outreach Strategy

Findings of education needs survey:

The opinions of watershed residents regarding whether feces from various sources pose a threat to the water quality of Oak Creek are as follows:

source	Not sure	Not a problem	Slight problem
Dog feces	10%	12%	28%
Human feces	13%	13%	26%
Wildlife feces	14%	28%	22%

Goals and target audiences:

~ Residents, visitors and school children who recreate in Oak Creek watershed.

~ Make it common knowledge that a single feces (human, pet or wildlife) can cause fecal contamination of Oak Creek that can cause human illness.
~ Affect people's behavior so that do not defecate outdoors, do not litter with used diapers or food waste, do pick up their dog's feces and do encourage others to do the same.

Priority education and outreach projects schedule:
~ Early 2012 - The Oak Creek Community Outreach program collaborative group designs elements of outreach project
~ Summers 2012-2014 – Volunteers give "campfire talks" at Coconino National Forest campgrounds; mix natural history with "Even one" message.
~ Summers 2012-2014 – PSAs with the "Even one" message.
~ School year 2012-2014 – Volunteers/ staff/consultants give presentations to area schools
    - "Deputize" students to bust people who pollute.
    - Provide examples of children who have gotten very ill because of fecal contamination of streams, rivers or lakes.
    - Tie into science learning about microbes and the spread of disease.
    - Provide English and Spanish literature (comic book/coloring book) to take home so parent might see the message.
    - Have a poster contest.
    - Encourage adoption of a reach of Oak Creek
~ Year round - Presentations to civic groups, eg. Chamber of Commerce, Rotary Club, etc.; Encourage adoption of a reach of Oak Creek
~ 2013-2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria:

- Reduced human and pet feces along trails and creek.
- Reduced *E. coli* concentrations in Oak Creek.
- Reduced percentage of human- and dog-sourced bacterial DNA.
- Survey results indicate a change in attitude about the importance of picking up dog waste, properly disposing of used diapers, not defecating outside (especially near water), and not littering in the riparian area with food waste that attracts wild animals whose feces can contaminate water.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Fecal counts will be conducted once per month May through September along popular trails and at popular swim areas (sites to be determined by collaborative group). *E. coli* and bacterial DNA will be sampled at least 3 times per summer the day after storm events that can wash material into the stream.
- *Parameters & critical conditions:*
    - number of presentations given to civic groups
    - number of campfire talks
    - number of school presentations
    - number of PSA airings
    - feces counts (>20 feces per ¼ mile)

- *E. coli* (>90% of baseline average for reach; >235 cfu/100 ml exceedence)
- Bacterial DNA (greater than the historic average percentage of human or dog source.)
- percentage of people reporting desired attitude as determined by survey
- percentage of people exhibiting desired behavior as determined by volunteer observers

- *Schedule, frequency and duration*:
  - Monthly fecal counts, May-September, 2012 -2014
  - Early summer and late summer observations and surveys administered by volunteers in the watershed on busy weekends, 2012 and 2014

- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  - Annual accomplishments reports
  - Final report

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Residents exhibit an understanding and related behaviors regarding the importance of not depositing human or pet feces in the watershed or attracting wildlife with food litter to riparian areas where they may leave feces that contaminate Oak Creek.
- *Generation and implementation of second generation improvement projects:*
  Civic groups or schools may choose to adopt a reach of Oak Creek to patrol for pollution and carry the "Even one" message to recreators.
- *Measurable reductions of pollutant loading:*
  Fecal counts by volunteer monitors show decreased pollutant loading at recreation sites throughout the watershed. *E. coli* concentrations and the percentage of human- and dog-sourced bacterial DNA are reduced.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  - Annual accomplishment reports and final report posted on OCWC website.
  - Feature stories in local media on project implementation and effectiveness.

EO-6 Oak Creek Community Outreach Program (OCCOP)

The Oak Creek Community Outreach Program (OCCOP) is a comprehensive program designed to promote better stewardship of Oak Creek by the watershed community, and reduce or eliminate trash and fecal contamination. The objective is to raise the awareness level, particularly of those living, working or recreating in the proximity of Oak Creek, regarding the consequences to littering and pollution, as well as changing the outdoor behavior of all visitors to Oak Creek. Framers of the program will coordinate all education and outreach projects described in the watershed improvement plan, with the OCCOP serving as an umbrella for these activities.

SS-1 Oak Creek Commercial Septic System Improvement Incentive Project

Need

Some septic systems in Oak Creek Canyon appear to contribute 20 to 200 cfu/100 ml (average = 72) to Oak Creek by way of spring discharge, whereas average *E. coli* concentrations in the creek are about 10 cfu/100ml based on 2011 monitoring. Also, in the Page Springs area discharge from a spring that is in the vicinity of a large commerical septic system has been found to exceed the *E. coli* standard for full body contact. These springs also tested postive for human DNA, indicating possible septic leakage. These more or less steady supplies of *E. coli* during the summer months may innoculate sediment reservoirs that are later disturbed by recreation or storm events to cause exceedences of *E. coli* in the water column. Evaluation and upgrade of septic systems is needed, particularly for commercial septic systems with seasonally large loads.

Description

Technical assistance will be offered to property owners for septic system evaluation and remediation design, and a subsidy will be offered for system upgrades.

Estimated load reduction

Approximately 10 springs in the Oak Creek Canyon area contain elevated concentrations of *E. coli.* Some failing septic systems in the watershed produce effluent that is intercepted by the springs and carried to the creek. These septic-influenced springs may provide a steady supply of *E. coli* to Oak Creek that may suffuse sediment reservoirs that can be later disturbed by recreational activity or a storm event causing exceedances of *E. coli* in the water column.

The project seeks to reduce the amount of effluent from failing septic systems by offering property owners technical assistance for septic system evaluation and remediation design. Upgrades to the failing septic systems will reduce contaminants from entering the springs, and improve water quality.

The STEPL model (U.S. EPA, 2012) is a spreadsheet tool that uses data inputs provided by the EPA to estimate nutrient and sediment loads. Best management practices can be incorporated into the model to determine the load reductions that would occur if the BMPs are implemented.

The numbers reflected in the load reduction results represent the remediation of all failing septic systems within the five subwatersheds adjacent to Oak Creek Canyon.

Using nitrogen and phosphorus as indicates for *E. coli* the average annual load reduction is:
Sediment – 77.9 tons per year (14.2%)
Nitrogen (N) – 3,506.5 lbs per year (10.3%)
Phosphorus (P) – 601.6 lbs per year (7.8%)

References:

U.S. EPA Website, Access June, 2012. Welcome to STEPL and Region 5 Model, http://it.tetratech-ffx.com/stepl/

Project schedule and milestones

Implementation schedule: January 2012 through December 2014 *Measurable milestones:* ~ Baseline springs monitoring complete ~ Septic upgrades identified & prioritized ~ Upgrade funding secured ~ Upgrades implemented ~ Implementation report ~ Follow-up monitoring complete ~ Follow-up report complete	*Resources and other support commitments:* ADEQ 319(h) grants ???? *Commitment date(s):* None at this time *Pending commitments:* Unknown at this time *Estimated commitment date:* None at this time

Education and Outreach Strategy

Findings of education needs survey:

Watershed residents' opinions about whether improperly functioning septic systems threaten water quality are as follows:

	Not sure	Not a problem	Slight problem	Moderate problem	Large problem
Improperly built or maintain residential septic systems	13%	10%	14%	29%	25%
Improperly built or maintain commercial septic systems	13%	11%	16%	25%	25%

Watershed residents rank septic systems as one of the top three biggest contributors to creek contamination that can cause human illness as follows:

#1 – 23.4%

#2 – 13.2%

#3 – 9.1%

There seems to be a pretty high awareness in the general population about the potential impacts of septic system on water quality. Outreach should be focused on owners of septic systems in locations of concern, such as where there is shallow groundwater.

Goals and target audiences:

~ Reach commercial septic system owners in Oak Creek Canyon.
~ Inform them of risks to human health from poorly functioning septic systems.
~ Offer incentives (technical assistance, evaluation, subsidy) for upgrading septic systems.
~ Work cooperatively with land owners to assure completion of upgrades.

Priority education and outreach projects schedule:

~ Early 2013 - outreach
~ Late 2013 - cooperative agreements
~ 2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: *E. coli* concentrations below 5 cfu/100 ml in spring discharge near septic systems.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Five springs in Oak Creek Canyon with a history of elevated *E. coli* and suspected commercial septic system influence will be monitored along with one reference spring in each vicinity (one spring could serve as reference for multiple affected springs in close proximity). Springs to monitor are those that have shown elevated *E. coli* (greater than 2 cfu/100 ml) and tested positive for human DNA, including:
    - S41 upstream of Slide Rock State Park and
    - S70, S71 and S109 at lower Indian Gardens
    - S107 in the Page Springs area

  Other springs may be added to the monitoring list if areas of concern are identified through examination of septic system records, field reconnaissance, and/or sample testing.
- *Parameters & critical conditions:*
  - *E. coli:* >5 cfu/100 ml if sample is collected directly at a spring discharge point. This is a conservative threshold; the presence of any *E. coli* in spring water could be considered elevated *E. coli*, since the bacteria do not naturally occur in groundwater. The critical condition for samples collected away from the spring discharge point is >10 cfu/ml. In this situation it is important to confirm potential septic influence through DNA testing.
  - DNA: presence of human DNA
- *Schedule, frequency and duration*:
  Early and late summer samples for 1 year pretreatment and 2 years post-treatment.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  Project implementation report, 2-year follow-up monitoring report

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Residents exhibit an understanding and willingness to have properly functioning septic systems.
- *Generation and implementation of second generation improvement projects:*
  Residents seek additional assistance with septic system improvements.
- *Measurable reductions of pollutant loading:*
  Reduced *E. coli* concentrations
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Project implementation report, 2-year follow-up monitoring report. Feature stories in local media on project implementation and effectiveness.

SW-1 Sedona Area Stormwater Improvement Project

Need

Summer stormflow events in the Sedona area deliver large doses of *E. coli* to Oak Creek. Stormwater samples from Carroll Canyon Wash, Soldier Wash, a storm drain at Tlaquepaque, Arroyo Roble and Jordan Wash have yielded *E. coli* concentrations exceeding the water quality standard of 235 cfu/100 ml for full body contact on multiple occasions, with concentrations often greater than 2,419.2 cfu/100 ml and 2 samples greater than 6,000 cfu/100 ml in summer 2011. Although DNA testing was inconclusive (6 of 6 samples where negative for dog DNA; this is probably erronenous, since previous studies in Oak Creek Canyon regulary found dog DNA), it is still suspected that much of stormwater *E. coli* comes from dog feces, because there are obvious concentrations of dog feces deposited along trails within and adjacent to the city where residents and visitors walk their dogs. The City of Sedona and neighboring Coconino National Forest have a some dog waste "mitt" and collection stations and provide education/outreach, but these efforts need to be expanded to change dog owners attitudes and behaviors in order to reduce the loading of *E. coli* and other fecal pathogens in the watershed due to dog feces.

Human DNA was found in a water sample from Carroll Canyon Wash collected from a pool of standing water near the Chavez Crossing Road bridge on the morning of September 6, 2012 following a storm event the night before. The *E. coli* count for this sample was > 2,419.2. This results warrants further monitoring and investigation in the Carroll Canyon Wash watershed to determine if there are human fecal sources affecting water quality. Sources might include leaking sewer pipes, sewer overflows and human waste long trails. Whereas Carroll Canyon historically was a location to dump extra sewage in case of an overflow (Amina Sena personal communication), the City of Sedona has significantly reduced the number of overflows within the City over the last five years (Charles Mosely personal communication). Also the city has a sewer pipe inspection program; the City has inspected its gravity sewer pipe system once during the last five years and is preparing to begin the second round of inspections (Charles Mosely personal communication). Watershed stakeholders should stay engaged with City of Sedona and offer support for the sewer inspection program, as well as a potential study that would look at sewer system overflows, sewer lateral work (repair/replacement) on private property, and septic tank failure and repair records versus storm events and *E. coli* concentrations to look for correlations.

Finally, a tremendous amount of sediment is discharge to Oak Creek from Sedona Washes, especially Carroll Canyon. This sediment contributes to *E. coli* sediment reservoirs in Oak Creek which when disturbed cause increased *E. coli* concentrations in the water column. Erosion problems need to be identified and ammeliorated. Continued monitoring of turbidity and *E. coli* in stormwater from Sedona area washes is needed to more accurately identify source areas of sediment and bacteria, so that best management practices can be implemented accordingly. The City of Sedona has implemented a pro-active best management practices program under the MS-4 program relative to sediment. Stakeholders should work with the City to help ensure that BMPs are effective. The monitoring programshould endeavor to differentiate sediment that is part of natural background and sediment that is generated within and adjacent to the city due to human activity.

Description

To address the problems of dog feces, human waste, and sediment in Sedona stormwater loading Oak Creek with *E. coli* and promoting *E. coli* sediment reservoirs, the following actions will be taken:

1. Conduct surveys of smaller watersheds (eg. Dry Creek, Carroll Canyon, Soldier's Wash, Arroyo Roble, Jordan Pump) in Sedona to determine where there are concentrations of animal and human waste and where erosion problems exist,
2. To determine where best to focus efforts, sample stormwater at the boundary where washes pass from Yavapai County or national forest land into City of Sedona to determine the relative contributions of fecal contamination from outside and within the City's jurisdiction,
3. Interface with jeep tour companies to determine how they handle situations when customers need to defecate while on a tour. Is this a source of fecal material in the watershed? Encourage the use of ammo boxes or other small portable toilets to reduce loading in the watershed. Appeal to tourists protecting the fragile desert soils.
4. If the watershed survey reveals that jeep use appears to be a significant cause of erosion and sediment discharge, work with tour companies and use outreach to promote practices that reduce erosion,
5. Work collaboratively with City of Sedona to support inspection of sewer lines through pressure testing or other means to determine whether any leaks exist that could introduce untreated sewage to washes,
6. Establish dog waste stations and at all trailheads. Work collaboratively with City of Sedona, Arizona State Parks and Coconino National forest to establish a funding and staff to maintain waste stations,
7. Install erosion control measures such as waterbars on hiking and jeep trails to slow the flow of water and revegetation with native plants in areas that have been denuded,
8. If appropriate, install detention and settling basins to slow runoff for reducing erosion and to intercept fecal matter before it is carried by washes to Oak Creek.
9. Encourage the establishment of a city or regional stormwater utility or similar payment structure to fund upgrades and maintenance of the stormwater system to protect water quality and aquatic habitat of Oak Creek,
10. Monitor *E. coli* and turbidity in Sedona washes during stormflow before, during and after implementing best management practices.

Estimated load reduction

Because the project is a multi-faceted approach to overall watershed improvement, using different methods and making some assumptions of effectiveness of the BMP when modeling each facet separately is necessary in order to formulate a reasonable estimation of load reduction. The project seeks to reduce the amount of *E. coli* and sediment delivered to Oak Creek during summer stormflow events by first surveying and determining where there are concentrations of human and animal waste, and where erosion problems exist.

If the watershed survey reveals that jeep use is a significant cause of soil disturbance and sediment discharge, then BMP's will be implemented along trails and public outreach will promote practices that will reduce erosion. Each subwatershed with hiking or jeep trails was

modeled assuming that the total area of the disturbance by humans was either 10%, 20% or 30% of the total area of subwatersheds with jeep and/or hiking trails, and that BMP's were utilized in the model in those proportions. The Automated Geospatial Watershed Assessment tool (ARS, 2012) with the SWAT model was used to estimate the sediment runoff of the areas of with landcover data that represents normal vegetation, then with landcover data that had been modified to reflect the disturbed areas near jeep and hiking trails within the six subwatersheds. If 10% of the areas were disturbed, recovered normal vegetation would be responsible for the reduction of 19.5 tons of sediment per year.

The STEP L Model (U.S. EPA, 2012) was used to estimate the effectiveness of installing water bars and bioretention ponds to slow runoff and reduce erosion, and the revegetation of areas denuded by erosion in areas near jeep and hiking trails. If humans and jeeps disturbed 10% of the area of subwatersheds with trails, the load reduction as a result of the installation of water bars, bioretention ponds, and native vegetation is 153.9 tons of sediment per year.

Dog waste stations will be installed at all trailheads. Walker and Garfield (2008) found that a gram of dog feces contained an average of 50 million CFU/gram of *E. coli* bacteria. The average dog excretes 340 grams per day (Clear Choices Clean Water, 2012). That equates to 17 billion CFU of *E.coli* bacteria per dog per day. If the project successfully prevents 100 dog/days per year from contaminating Oak Creek, the result would be a reduction of 34 kg of dog feces and 17 x 10^{12} CFU of *E. coli* bacteria.

Public outreach efforts aimed at eliminating human waste contributions to the watershed will be implemented. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Parker and Gallagher (1988) found that the mean human waste in over 25,000 subjects was 95 grams per day of solid fecal matter. That equates to 475 million CFU of *E. coli* per person per day. If the project successfully prevents 100 people per day from contaminating Oak Creek, the result would be a reduction of 9.5 kg of human feces and 4.75 x 10^{10} CFU of *E. coli* bacteria.

Average annual load reduction:

AGWA SWAT (Soil Disturbance and Normal Vegetation)
19.5 tons of sediment per year

STEP L (Water Bars, Bioretention Ponds, Revegetation)
153.9 tons of sediment per year

Combined Sediment Load Reduction: 173.4 tons of sediment per year

Dog Waste
34 kg (75 lbs) of feces and 17 x 10^{12} CFU per year of *E. coli* bacteria

Human Waste
9.5 kg (21 lbs) of feces and 4.75 x 10^{10} CFU per year of *E. coli.* bacteria

References:

Agricultural Research Service (ARS) Website, Access on June, 2012. Automated Geospatial Watershed Assessment Tool located at http://www.tucson.ars.ag.gov/agwa/.

Clear Choices Clean Water Organization Website, access June 27, 2012. Located at http://clearchoicescleanwater.org/wp-content/uploads/2011/08/pet-waste-FAQs_final.pdf

Walker, M. and L. Garfield, 2008. Dog Wastes and Water Quality; Evaluating the Connection at Lake Tahoe. University of Nevada Cooperative Extension, Fact Sheet-08-18.

Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Parker, D. and S. Gallagher, 1988. Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space, accessed July 9, 2012. Located at http://www.nss.org/settlement/moon/library/LB2-611-WasteProcessing.pdf

U.S. EPA Website, Access June, 2012. Welcome to STEPL and Region 5 Model, http://it.tetratech-ffx.com/stepl/

Costs

????

Project schedule and milestones

<table>
<tr>
<td rowspan="2">Implementation schedule:
January 2012 through December 2014

Measurable milestones:
~ Tributary watershed surveys complete
~ Stormwater sampling complete
~ Cooperative agreement for funding and maintenance of dog waste stations complete
~ Dog waste station installed at all trailheads
~ Outreach and education for dog waste stations complete
~ Sewer system inspection complete
~ Erosion control measures installed
~ Retention basins installed
~ Follow-up monitoring complete
~ Project progress and completion reports</td>
<td>Resources and other support commitments:
ADEQ 319(h) grants
????
Commitment date(s):
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<tr>
<td>Pending commitments:
City of Sedona??
<Unknown at this time>
Estimated commitment date:
<None at this time ></td>
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Education and Outreach Strategy

(See also OCWIP Project #EO1 - Sedona Dog Waste Reduction Outreach Project)

Findings of education needs survey:

Watershed residents' opinions about potential sources of contamination in stormwater that could affect human health in Oak Creek are as follows:

	Not sure	Not a problem	Slight problem	Moderate problem	Large problem
Dog feces that are not picked up and disposed properly	10%	12%	28%	22%	19%
Human feces deposited outdoors	13%	13%	26%	18%	23%
Erosion and sediment due to the following:					
Building & road construction	17%	17%	28%	17%	6%
Road maintenance	17%	20%	34%	19%	6%
Low water creek crossings	17%	26%	28%	14%	3%
Unmaintained " social" trails	18%	23%	31%	13%	4%
Jeep/ORV trails	15%	16%	22%	21%	13%

Goals and target audiences:

~ Reach people who hike and walk dogs on trails in tributary watersheds in the Sedona area.
~ Reach home owners who might be prone to tossing dog feces into drainage ways.
~ Reach jeep tour company owners and drivers as well as others who use jeep trails for recreation.
~ Inform the public of risks to human health from dog and human feces left in the watershed.
~ Have volunteers offer incentives (eg. OCWC water bottles, gift certificates for frozen yogurt, etc.) for picking up dog feces and/or encouraging others to do so.
~ If increased taxes may be needed to cover the cost of stormwater and/or sewage improvements, work with City of Sedona to develop appropriate outreach campaign.

Priority education and outreach projects schedule:

~ 2012 - initial outreach;
~ 2013-2014 adapt and modify outreach and continue activities
~ 2013, 2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: *E. coli* concentrations below <235 cfu/100 ml and turbidity <50 NTU in Sedona washes during storm events.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  E. coli and turbidity should be monitored in Sedona washes during summer storm events before and after implementing best management practices. Process dilutions of *E. coli* samples to quantify concentrations >2,419.2 cfu/100 ml.
- *Parameters & critical conditions:*
  - *E.coli* (>235 cfu/100 ml)
  - Turbidity (>50 NTU)
  - DNA (presence of human DNA; dog DNA >10%)
- *Schedule, frequency and duration*:
  Two to four storm events during monsoon season 2012-2014. Try to capture "first flush" when rainfall is of great enough magnitude and intensity to move fecal material from uplands into washes.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; City of Sedona; Coconino National Forest
- *Reporting plan:*
  Produce an annual report of summer water quality results and interpretation by November.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Residents, visitors, and tour drivers exhibit an understanding and willingness to reduce fecal contamination and erosion in Oak Creek tributary watersheds in the Sedona area.
- *Generation and implementation of second generation improvement projects:*
  City of Sedona considers establishing a stormwater utility to support ongoing outreach and improvement/maintenance of stormwater infrastructure to reduce pollutant loading in Oak Creek.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations, turbidity and human and canine sources of fecal contamination in stormwater runoff in Sedona
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; City of Sedona; Coconino National Forest
- *Reporting plan, how findings will be used:*
  Quarterly and final reports to funding agencies. Progress reports on OCWC website. Feature stories in local media on project implementation and effectiveness.


Soldier Wash
Mormon Canyon
Sedona
Dry Creek
89A
Carroll Canyon Wash
Chavez Crossing Campground
179
Crescent Moon Day Use Area
Red Rock Crossing
Red Rock Loop Rd
Red Rock State Park
Oak Creek
Verde Valley School Rd
Exceeding E.coli
Trailheads
Trails
Arterial Road
Residential Road
CityLimits
Recreation Areas
Major Roads
Minor watercourses
Major watercourses
Oak Creek Watershed
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0 0.25 0.5
Miles
1:63,360

RC-1 Oak Creek Canyon Public Toilet Access Project

Need

There is a shortage of public restrooms in Oak Creek Canyon, especially access that does not require a Red Rock Pass. Many people will park along the highway and hike into the creek rather than pay the fee. Because toilet and trash amenities on national forest land are associated with fee areas, but many recreators avoid the fee areas, they have limited options for sanitary toilet facilities. The public rest room at Indian Gardens is one available toilet. The others are primarily in a limited number of commerical sites, many of which are not available to general public. This shortage of public toilets sometimes results in people defecating near the stream where feces can wash into the channel during storm events, thereby contributing to fecal contamination of Oak Creek water that threatens human health. The shortage of public toilets is a long-standing problem that requires priority attention.

Description

Work with Coconino N.F., business owners, and ADOT to establish restrooms at intervals that will help ensure the public can conveniently access them rather than defecating near the stream. Post signs along the highway indicating public restrooms. Establish collaborative agreements and funding to maintain restrooms. This is a high priority, which was identified in the past and has not had enough action.

Estimated load reduction

A University of North Dakota study for the U.S. Department of Agriculture regarding human waste distributions reveals the average stool produced is 95.5 grams per day, and 2066 ml of urine per day (Parker and Gallagher 1988). The average number of bowel movements per day was 2.54 (Parker and Gallagher 1988), but the number times a person urinates is variable based on the volume of fluid they consume, with a range of 4-10 times per day based on an Internet search. An urination rate of 7 per day will be used in this analysis.

The only access to and through the Oak Creek Canyon is Highway 89-A which carries about 7million visitors a year to Oak Creek and Sedona. Approximately one million of these visitors stop and utilize the publicly owned recreational sites, while 300,000 visit Slide Rock State Park (in Poff and Tecle 2002). Assuming 60% of the potential visitors use the toilets once for urination and 30% of the potential visitors use the toilets for bowel movements, instead of relieving themselves into the environment, the load reductions for urine and fecal material are:

Urine (l) = 1 million visitors/year * 0.6 * 2066 ml/day * day/7 urinations * 1 liter/1000 ml = 177,086 liters

Fecal Material (kg) = 1 million visitors/year * 0.3 * 95.5 g/day * day/2.54 movements * 1 kg/1000 g = 11,280 kg

The Fecal Material estimate is more important in regard to *E. coli*. *E. coli*, as member of the intestinal flora, is part of the digestive process and is excreted in feces. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Consequently, if 10% (11,280 kg) of fecal material that is now captured by the toilet facilities would have

reached the river environment it would result in the potential *E. coli* load of 5.6 x 10^{12} CFU per year, representing a 100% load reduction compared to not having the toilet facilities.

In order estimate the actual load reduction a survey of rest room users should be conducted.

References:

Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Parker, D. and S. Gallagher, 1988. Distribution of Human Waste Samples in Relation to Sizing Waste Processing in Space, accessed July 9, 2012. Located at http://www.nss.org/settlement/moon/library/LB2-611-WasteProcessing.pdf

Poff, B. and A. Tecle, 2002. Bacteriological Water Quality Trend Analysis in Oak Creek Canyon, Arizona. In: Ground Water/Surface Water Interactions, 2002 AWRA Summer Specialty Conference Proceedings, July 1-3, 2002, Keystone, CO. pp. 431-436.

Costs

Item	**units**	**price/unit**	**cost**
full service restrooms with water well and septic system	#	$$	$$$
vault toilets	#	$$	$$$
portable toilets			
Purchased	#	$$	$$$
rented - # toilet x # months (2012-2014)	#	$$	$$$
highway pullouts and parking	#	$$	$$$
easement or purchase of land for toilets on private property	#	$$	$$$
Annual maintenance costs for first 3 years	#	$$	$$$
Signage along Hwy 89A	#	$$	$$$
Legal fees for permit processing, establishment of maintenance agreements, construction contracting, establishment of easements or property purchase contracts, etc. (some if this may count as inkind contribution from participating agencies?)	#	$$	$$$

Project schedule and milestones

Implementation schedule: January 2012 through December 2014	*Resources and other support commitments:* ADEQ 319(h) grants

Measurable milestones: ~ Meet with collaborators (USFS, SRSP, local business owners, ADOT) to discuss roles and responsibilities, cost-sharing, necessary permits and clearances, etc. ~ Make a complete inventory of available toilets, distance between toilets, ownership and accessibility; identify gaps that must be filled. ~ Select sites for additional toilets and types of toilets to be installed. ~ Complete all permits, clearances, construction contracting and maintenance agreements. ~ Construct flush toilets (including water wells and septic systems where needed) and necessary pull outs and parking ~ Place portable or vault toilets with adequate pull outs and parking ~ Signage installed along Hwy 89A. ~ Outreach activities complete ~ Monitoring complete ~ Reporting complete	???? *Commitment date(s):* <None at this time > *Pending commitments:* <Unknown at this time> *Estimated commitment date:* <None at this time >

Education and Outreach Strategy

Findings of education needs survey:

At least 13 % of watershed residents do not think human feces are a source of water contamination in Oak Creek.

Watershed residents think the lack of toilet facilities threatens Oak Creek water quality as follows:

	Not sure	Not a problem	Slight problem	Moderate problem	Large problem
Lack of public toilet facilities near creek and trailheads	8%	5%	18%	29%	32%

Goals and target audiences:

~ Swimmers, waders, hikers and fishermen in Oak Creek Canyon who need public access toilets
~ Stress how important it is for human and environmental health that they not defecate near the creek
~ Inform them of collaborators' efforts to increase public toilet access
~ Let them know where toilets are now and where they will be in the near future
~ Encourage them to tell others where to access toilets

~ Explain the health risks of discarded used diapers and encourage them to dispose of used diapers in trash receptacles at public toilets.
~ Have volunteers offer incentive items to people observed using public toilets
~ Have workers or volunteers (in uniform – polo shirt or T shirt) conducting fecal counts on the weekend to show a presence along the creek and interface with the curious public to offer information about reducing pollution, including directing them to available public toilets.

Priority education and outreach projects schedule:
~ Summer 2012 - radio PSA (including on the Slide Rock S.P. park information frequency) about available public toilets, the importance of using them, and upcoming additional toilets. Try to come up with something fun and catchy (eg. if not too distasteful or outdated, use a spin-off of the Cheech and Chong "What's that?" skit) or come up with a good catch phrase. Encourage public participation in siting of new toilets. Advertise public meeting.
~ Public meeting(s) July/August 2012 soliciting comment on siting of public toilets.
~ Feature stories in local media lauding the collaborative effort to increase toilet access in Oak Creek Canyon and soliciting input from the public.
~ 2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Increased use of public toilets. Reduced human feces observed along Oak Creek in Oak Creek Canyon. Human-sourced DNA in fecal bacteria of Oak Creek reduced from an average of 16% in 1998-1999 samples.

On-the-ground project effectiveness monitoring plan

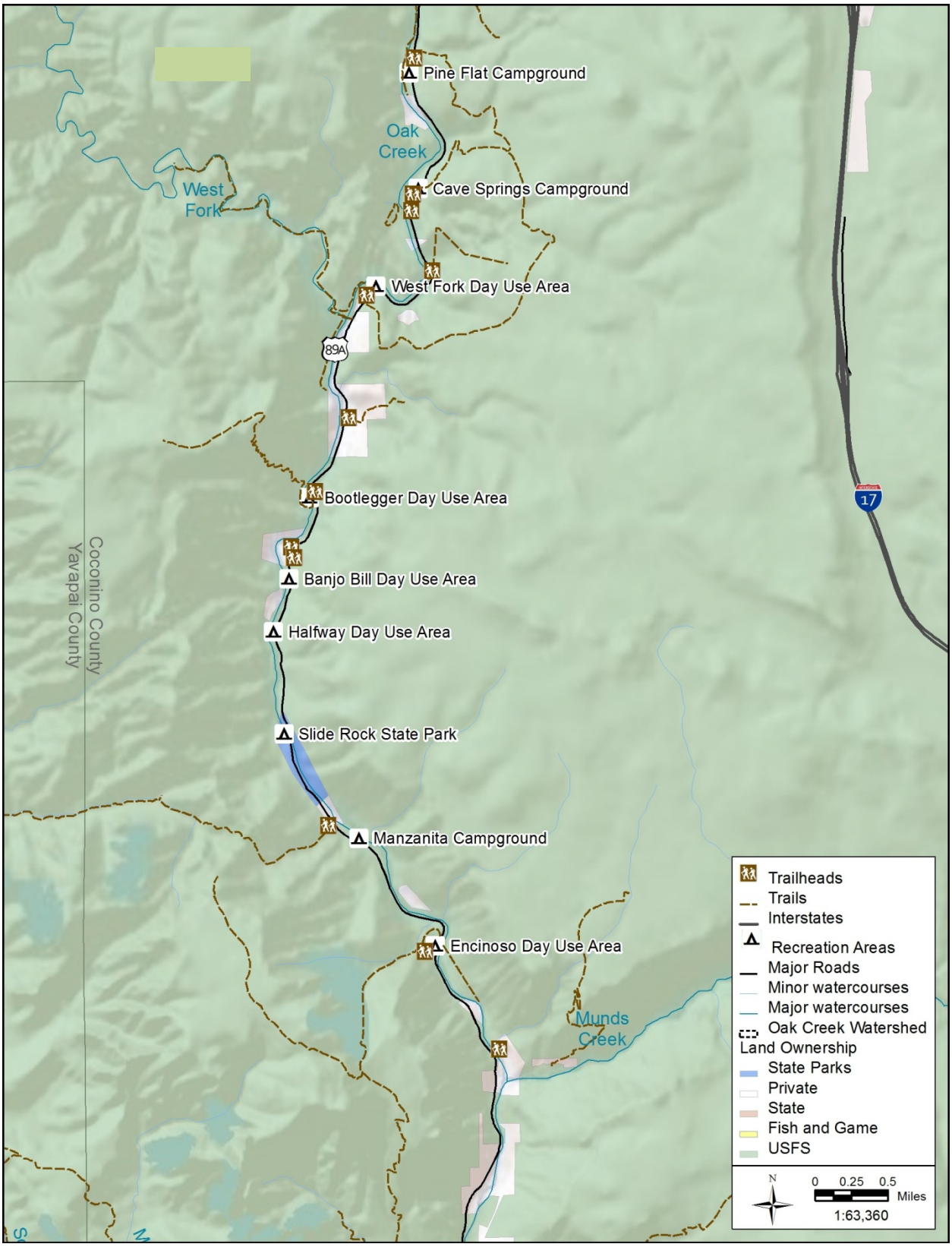
- *Monitoring and reference condition sites*:
  Volunteers will monitor the number of people utilizing public toilets. Approximately ## sites along the creek in Oak Creek Canyon will be monitored for *E. coli* and human-sourced bacterial DNA in proximity to new toilet installations and new signage for toilet access.
- *Parameters & critical conditions:*
  - Fecal counts along popular stretches of Oak Creek (>X human feces per ¼ mile); feces will be picked up and bagged so they are not double counted [Research degradation time for feces; if practical, space fecal count intervals so that previous feces would have decomposed, if volunteers are not wanting to pick up feces.]
  - *E.coli* (>10 cfu/100 ml for elevated values, >235 cfu/100 ml for exceedence)
  - DNA (average >15% human-sourced DNA in fecal bacteria)
- *Schedule, frequency and duration*:
  Public toilet use counts and fecal counts will be conducted twice per month May through September. *E. coli* and DNA sampling during high-use weekends in the early-, mid- and late summer and the day of or the day following a storm event that increases streamflow. Baseline monitoring will be accomplished in 2012 and effectiveness monitoring will be conducted in 2013-2014.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Coconino National Forest; Coconino County Rural Environmental Corp [contract for services to conduct fecal counts and *E. coli* sampling? Require at least one Spanish speaking crew member to interface with the

public. Try to have crews along creek on the weekend for a presence to make visitors aware of the ramifications of their actions.]

- *Reporting plan:*
  Annual report on summer monitoring results and interpretation by November of each year. Final analysis report in Fall 2014.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Recreators exhibit an understanding and willingness to use public toilets rather than defecating near the creek in order to reduce *E. coli* and other fecal contaminants that threaten human health.
- *Generation and implementation of second generation improvement projects:*
  The public may identify additional sites where portable or vault toilets may be appropriate, initiating future projects.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations and human-sourced bacterial DNA
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Slide Rock State Park; Coconino National Forest
- *Reporting plan, how findings will be used:*
  Annual accomplishments and monitoring report in the fall each year will be posted to OCWC website. Feature stories in local media will describe project implementation and effectiveness.


Pine Flat Campground
Oak Creek
West Fork
Cave Springs Campground
West Fork Day Use Area
89A
Bootlegger Day Use Area
17
Coconino County
Yavapai County
Banjo Bill Day Use Area
Halfway Day Use Area
Slide Rock State Park
Manzanita Campground
Encinoso Day Use Area
Munds Creek
Trailheads
Trails
Interstates
Recreation Areas
Major Roads
Minor watercourses
Major watercourses
Oak Creek Watershed
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0 0.25 0.5
Miles
1:63,360

RC-3 Keeping Oak Creek Beautiful – Trash Receptacle Access Project

Need

Trash receptacles are lacking in many places along Oak Creek that are popular recreation sites, leading visitors to litter. Used diapers that are dumped contribute to *E. coli* pollution as does food waste that attracts wildlife whose feces add to *E. coli* concentrations.

Description

Work with Coconino N.F., business owners, and the state parks to place trash receptacles at convenient locations. Work out collaborative agreements and funding to maintain trash receptacles. Investigate the cost/value of bear-proof receptacles and install as appropriate.

Estimated load reduction

Diapers

Peterson (1974) reported that feces-soiled diapers contained an average of 60 grams of feces. Brandys (2007) found that human stool contained an average of 5 million CFU/gram of *E. coli* bacteria. Assuming that the Trash Receptacle Access Project and the Outreach Program changes the behavior of 100 people per year (i.e. 100 diapers). The average annual load reduction would be 3×10^{10} CFU per year.

References:

Brandys, B. 2007. Quantifying Bacteria Levels in Water Categories 1-3. Occupational and Environmental Health Consulting Services, accessed July 11, 2012. Located at: http://www.bio-reveal.com/AdminWeb/userfiles/image/file/IICRC%20S520%20-%20IICRC%20S500/Quantifying-Levels-02-07.pdf

Peterson, M.L., 1974. Soiled disposable diapers: a potential source of viruses.. American Journal of Public Health: September 1974, Vol. 64, No. 9, pp. 912-914. doi: 10.2105/AJPH.64.9.912

Costs ????

Project schedule and milestones

<table>
<tr>
<td rowspan="2">Implementation schedule:
January 2012 through December 2014

Measurable milestones:
~ Survey of popular recreation sites without trash receptacles
~ Coordination meetings with collaborators (USFS, services vendor for USFS, state parks, businesses, City of Sedona, OCWC, etc.) to discuss funding, permits, clearances, and maintenance
~ MOA regarding trash receptacle placement and maintenance</td>
<td>Resources and other support commitments:
ADEQ 319(h) grants
????
Commitment date(s):
<None at this time></td>
</tr>
<tr>
<td>Pending commitments:
<Unknown at this time>
Estimated commitment date:
<None at this time ></td>
</tr>
</table>

~ Purchase and installation of trash receptacles ~ Litter surveys before and after receptacle placement ~ Quarterly and final reports	

Education and Outreach Strategy

Findings of education needs survey:

Watershed residents reported the following opinions about litter and baby diapers as the biggest contributors to creek contamination that can cause human illness:

	#1 contributor	#2 contributor	#3 contributor
litter	23.4%	8.7%	15.1%
Baby diapers	11.7%	14.3%	9.4%

At least 14% of watershed residents did not think that leaving food waste at campgrounds or picnic sites attracts wild animals whose feces can contaminate Oak Creek.

Goals and target audiences:

~ Swimmers, waders, hikers and fishermen in Oak Creek Canyon.
~ Use signs next to trash receptacles and PSAs to inform recreators of the risks to human health from *E. coli* and how increased *E. coli* in water can be caused by littering food waste and used diapers
~ Have volunteers offer incentive items to people observed using waste receptacles rather than littering.

Priority education and outreach projects schedule:

~ Early summer 2012 - trash receptacles and signs in place
~ Summer 2012-2014 - radio PSA about risks of elevated *E. coli* and what people can do to reduce the risk, including reducing using trash receptacles rather than littering food waste and used diapers. Include PSA on Spanish language radio stations.
~ 2013 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Reduced incidence of food waste and used diapers in recreation areas. Reduced *E. coli* concentrations in Oak Creek.

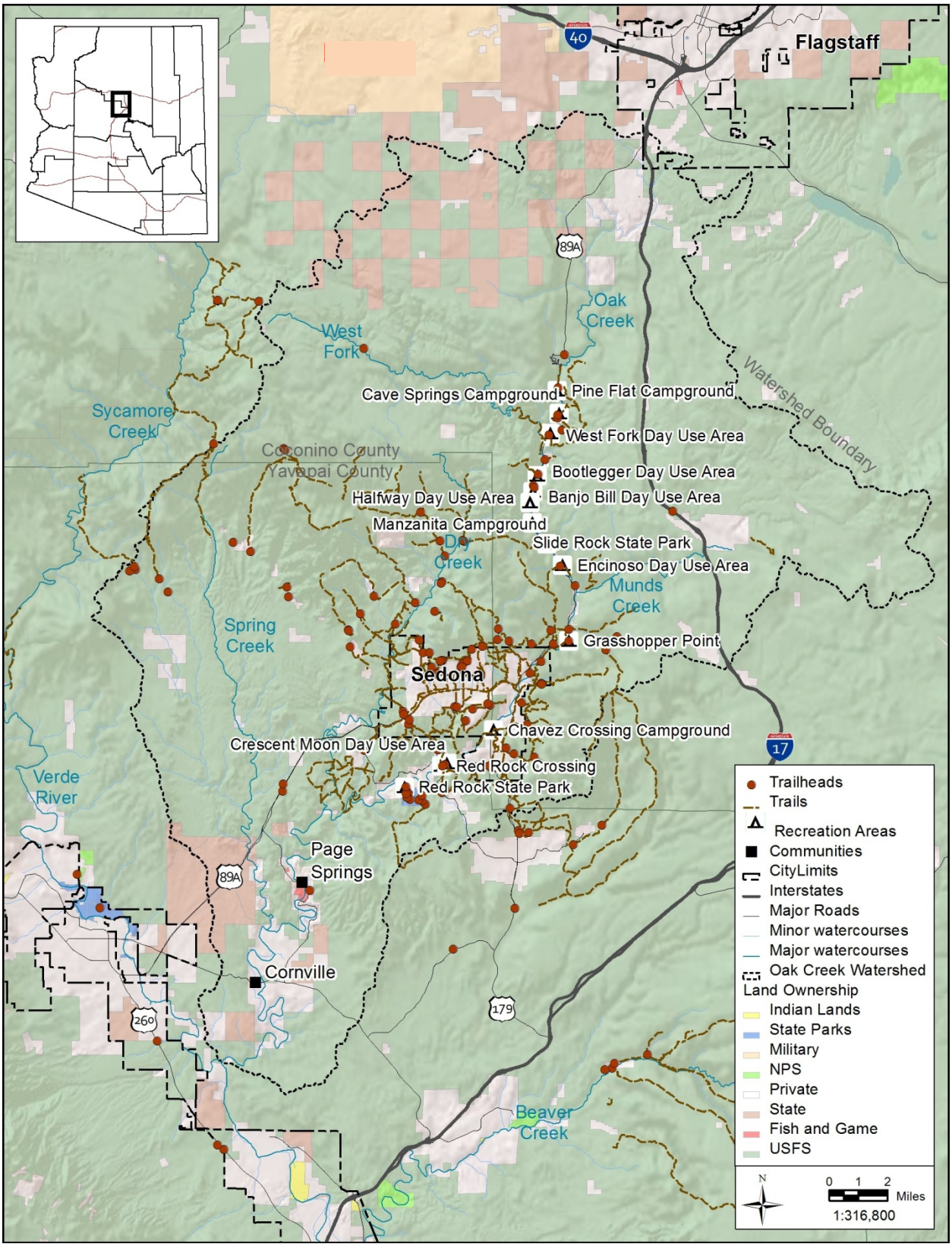
On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Pre- and post-implementation litter counts in the vicinity of waste receptacle placement sites. *E. coli* monitoring in Oak Creek downstream of popular recreation sites, such as Midgely Bridge where trash receptacles have been added.
- *Parameters & critical conditions:*
  - Litter counts (average values $\geq$ to values prior to installation of receptacles)
  - *E. coli* (>235 cfu/100 ml during storm events; > 90% of average baseline concentration prior to installation of trash receptacles)

- *Schedule, frequency and duration*:
  Twice monthly litter counts during summer 2012-2013. *E. coli* monitoring in early, mid- and late summer during high use weekends and during or the day after at least 3 storm events.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Coconino Rural Environmental Corp? [See if CREC be recruited to conduct litter counts and other monitoring activities. If OCWC subcontracts to have CREC provide services, make a requirement that the crew has at least one Spanish speaking member for interfacing with the public.]
- *Reporting plan:*
  Annual accomplishments and monitoring report in the fall of each year. Final report.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Recreators exhibit an understanding and willingness to use trash receptacles rather than litter to reduce *E.coli* contamination of Oak Creek.
- *Generation and implementation of second generation improvement projects:*
  Recreators provide feedback on additional locations for waste receptacles to reduce litter that contributes to *E. coli* pollution.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations. Reduced litter counts, including used diapers and food waste.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Coconino National Forest; Coconino Rural Environmental Corp
- *Reporting plan, how findings will be used:*
  Annual accomplishments and monitoring report in the fall of each year posted to OCWC website. Feature stories in local media on project implementation and effectiveness.


Flagstaff
40
89A
Oak Creek
West Fork
Watershed Boundary
Cave Springs Campground
Pine Flat Campground
West Fork Day Use Area
Sycamore Creek
Coconino County
Yavapai County
Bootlegger Day Use Area
Halfway Day Use Area
Banjo Bill Day Use Area
Manzanita Campground
Slide Rock State Park
Dry Creek
Encinoso Day Use Area
Munds Creek
Spring Creek
Grasshopper Point
Sedona
Chavez Crossing Campground
Crescent Moon Day Use Area
Red Rock Crossing
Red Rock State Park
17
Verde River
Page Springs
89A
Cornville
260
179
Beaver Creek
Trailheads
Trails
Recreation Areas
Communities
CityLimits
Interstates
Major Roads
Minor watercourses
Major watercourses
Oak Creek Watershed
Land Ownership
Indian Lands
State Parks
Military
NPS
Private
State
Fish and Game
USFS
N
0 1 2
Miles
1:316,800