Second Tier Priority Projects

EO-1 Sedona Dog Waste Reduction Outreach Project

Need

Stormflow events in Sedona deliver large doses of *E. coli* to Oak Creek, often > 2,419 cfu/100 ml, the maximum level measurable by Colilert ® without sample dilution, and as high as 8,202 cfu/100 ml as measured using sample dilution. Although dog DNA analysis of summer 2011 water samples was inconclusive (6 of 6 samples collected in the Sedona areas tested negative for dog DNA, which seems to be an errror, since dog DNA was found everywhere in Oak Creek Canyon in past studies), there is still reason to believe dog feces are a major source of fecal bacteria since significant concentrations are often seen along popular trails in the Sedona area. Dog owners need to know the seriousness of leaving dog waste along trails and in yards where it can wash into tributaries of Oak Creek during storms. They need to be encouraged to pick up and properly dispose of dog feces. While the City of Sedona does encourage pick-up of animal feces, through signage, information on their website, and the stocking of feces bag stations at some trailheads, and the the City tries to control of sediment from the Sedona Dog Park, additional actions can be taken to build on these efforts and more comprehensively address the dog waste problem.

Description

Implement an outreach program that includes radio and newspaper stories, public service announcements, and presentations to civic groups. Use brief motivational messages that get across 4 points: 1. the danger of *E.coli* and health effects on children, 2. causes of *E. coli* contamination, 3. pet-owner behaviors that reduce *E. coli* contamination, 4. "Deputizing the World", i.e. encouraging residents to speak up when they see others leaving dog waste unattended. Time outreach to correspond with establishment of dog waste stations. Before and after trailhead surveys will be conducted to determine effectiveness of outreach campaign.

Estimated load reduction

Dog waste

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 x 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 x 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.

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

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/

Project schedule and milestones

Implementation schedule: March 2012 through September 2014 *Measurable milestones:* ~ Design of literature, presentations, PSA scripts, and press releases ~ Pre-campaign trailhead survey ~ Spring media campaign completed ~ #? presentations to civic groups ~ Late summer follow-up trailhead survey ~ Late summer "Thank you" message in media ~ Report on year one and year two activities and results	*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:

20% of watershed residents walk their dog near Oak Creek.

Dog feces were rated as 1st, 2nd and 3rd biggest contributors to creek contamination by 7.2%, 10.6%, and 10.6% or watershed residents respectively.

44.5 % of watershed residents own a dog.

Of those who own dogs 45.6% walk their dog in the watershed.

Most dog-owning residents (64%) said they always pick up their dog waste, while 19.2% said "most of the time", 5.6 % said "sometimes", 3.2% said "rarely", and 8.0% said "never".

83.5% of watershed residents with dogs say they would use dog waste stations if more were made available at parks and trails.

Watershed residents' opinion of whether dog feces threaten Oak Creek water quality is as follows:

	Not sure	Not a problem	Slight problem
Dog feces that are not picked up and disposed properly	10%	12%	28%

Goals and target audiences:
~ Outreach to residents of Sedona who walk their dogs on trails in and around the city.
~ Outreach to Sedona Humane Society.
~ Increase understanding of importance of picking up dog waste.
~ Affect behaviors so that more pet owners pick up and properly dispose of dog waste.

Priority education and outreach projects schedule:
~ Early 2012 - surveys and outreach
~ Late summer 2012 - follow-up surveys
~ Early 2013 - Year 2 surveys and outreach

~ Late summer 2013 - Year 2 follow-up surveys
~ 2013 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Survey results indicate a change in attitude about the importance of picking up dog waste. At least 20% more people report picking up waste and telling others to do so.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Fecal counts will be conducted once per month May through September on 4 popular trails in the Sedona area: Huckaby Trail, Baldwin Trail, West Fork Trail (all FS System trails) and Chavez Crossing trail (social trail). These trails all parallel significant reaches of Oak Creek and West Fork and have some tradition of dog use.
- *Parameters & critical conditions:*
  - number of presentations given to civic groups
  - feces counts (>20 feces per ¼ mile)
  - percentage of people reporting desired attitude
  - percentage of people exhibiting desired behavior
- *Schedule, frequency and duration*:
  - Monthly fecal counts, May-September, 2012 and 2013
  - Late spring and late fall hiker surveys, 2012 and 2013
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  - Year 1 accomplishments report.
  - Project implementation report

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Residents exhibit an understanding of the importance of proper dog feces disposal and willingness to pick-up dog waste and encourage others to do so.
- *Generation and implementation of second generation improvement projects:*
  Residents seek expansion of dog waste stations to trailheads that do not have them.
- *Measurable reductions of pollutant loading:*
  Fecal counts by volunteer monitors show decreases in pollutant loading along Sedona trails.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  - Year 1 accomplishments report.
  - Project implementation report.
  - 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
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

Photos

Dog feces in drainage on national forest land upstream of Elf Neighborhood. This drainage is a tributary of Carroll Canyon Wash.

Multiple dog feces in the channel and on the bank. Little Elf drainage

EO-3 Lower Oak Creek Watershed Outreach Project

(aka The "Don't Put Crap in the Creek" Project")

Need

Dumping of animal waste into ditches or the creek may be increasing instream *E. coli* concentrations. Construction of irrigation diversion dams may cause sediment deposition that contributes to *E. coli* sediment reservoirs. *E. coli* concentrations were higher (56.4 cfu/100 ml average) at Page Springs and Cornville during July 2012 prior to the monsoon than upstream reaches of Oak Creek (eg. 31.4 cfu/100 ml at Chavez Crossing Campground in Sedona and 10.3 cfu/100 ml in Oak Creek Canyon on average). Turbidity was also noticeably greater. Increased sediment and sediment-water contact in these reaches seems to be the cause of higher *E. coli* concentrations. Although the July 2011 values did not exceed the Full Body Contact standard, there is a concern about *E. coli* loading in this reach that could contribute to exceedences during storm events that disturb sediments.

Description

Work collaboratively with Cooperative Extenstion Service to educate land owners about the impacts of animal waste dumping and provide technical assistance for implementing best management practices for animal waste management. Provide technical assistance to identify best practices for reducing erosion and sedimentation associated with annual earth moving for irrigation diversions. Outreach may involve best management practices workshops.

Estimated load reduction

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 December 2014

Measurable milestones:
~ Enter into MOU with Cooperative Extension Service
~ Plan and implement a workshop or series of workshops to
o listen to landowners' concerns and needs
o teach BMPs for animal waste management and irrigation diversions and
~ Follow-up with assistance for implementing BMPs</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>

Education and Outreach Strategy

Findings of education needs survey:

The educational needs survey showed that at least 15% of residents do not think livestock waste poses a threat Oak Creek water quality.

At least 17% of residents do not think irrigation diversions cause erosion and sedimentation that poses a threat Oak Creek water quality.

Goals and target audiences:

~ Reach private property owners who irrigate along Oak Creek and/or raise livestock along Oak Creek.
~ Inform them of risks to human health from dumping of animal waste into ditches or the Creek.
~ Educate them about *E. coli* sediment reservoirs and the importance of reducing sedimentation, such as through better practices when constructing irrigation diversion.
~ Offer incentives (technical assistance, evaluation, subsidy) for implementing best management practices.
~ Work cooperatively with land owners to assure implementation of BMPs.

Priority education and outreach projects schedule:

~ Fall 2012 - MOU or informal agreement with Cooperative Extension Service
~ Spring 2013 - BMP workshops; identify land owner needs and challenges; seek ways of helping to meet needs
~ 2013-2014 - Follow-up assistance to landowners for implementing BMPs
~ 2014 - Success stories coverage

Monitoring and Evaluating Effectiveness

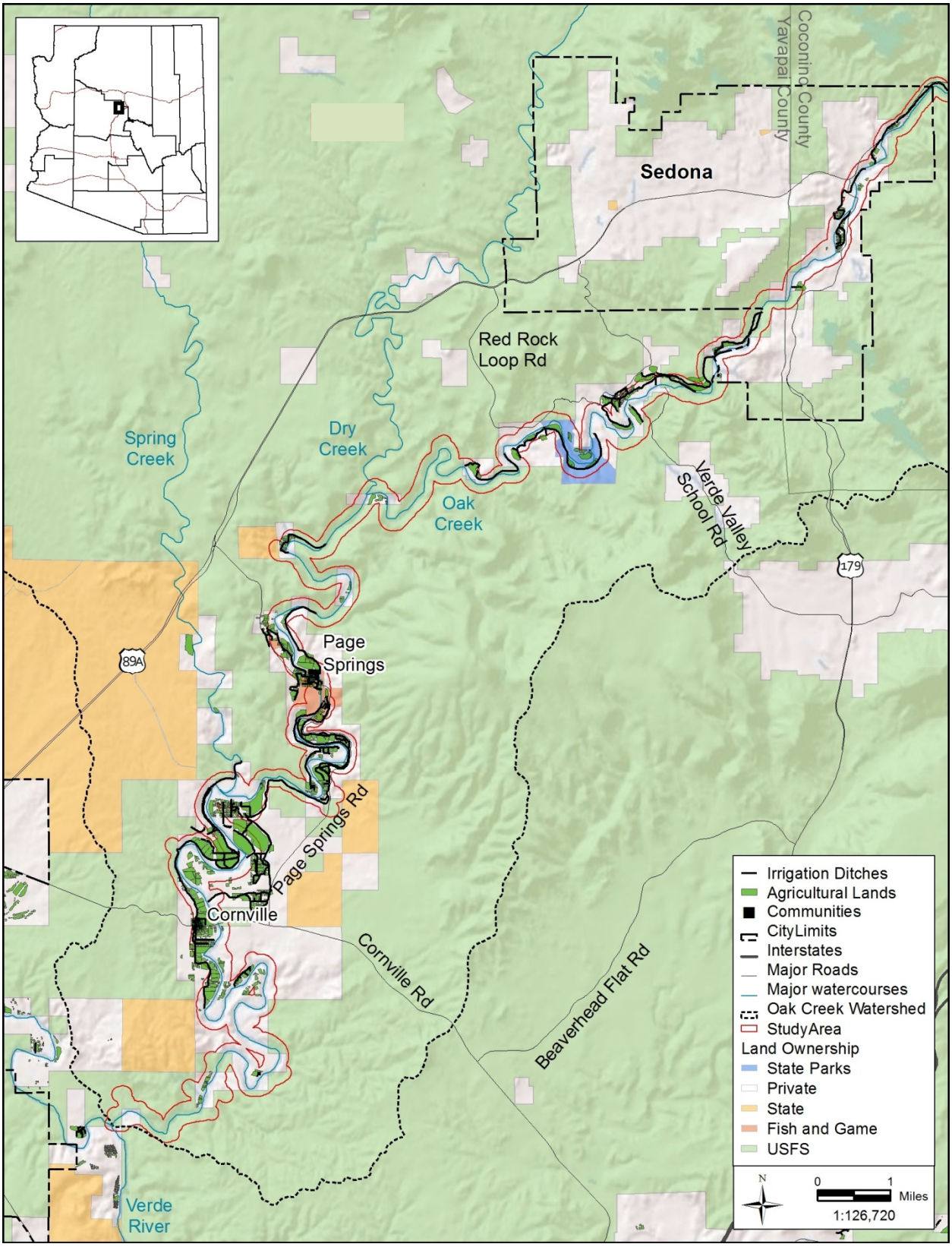
Long-term effectiveness criteria: Landowners at Page Springs and Cornville adopt the regular use of BMPs to reduce sedimentation and pollution by animal waste in Oak Creek.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  At least 3 sites each in Page Springs and Cornville will be selected to monitor sediment accumulation, turbidity and *E. coli* concentrations.
- *Parameters & critical conditions:*
  - turbidity (50 NTU)
  - sediment observed through aerial photography and/or field survey
  - *E. coli* (>60 cfu/100 ml)
- *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:*
  At least 10 property owners attend workshop(s) hosted by Cooperative Extension Service and OCWC and learn animal waste management or irrigation diversion practices that reduce sedimentation and fecal pollution of Oak Creek.
- *Generation and implementation of second generation improvement projects:*
  Land owners may provide insight into projects needed to reduce erosion, sedimentation and animal waste inputs into lower Oak Creek.
- *Measurable reductions of pollutant loading:*
  Reduced *E. coli* concentrations
  Lower turbidity measurements during pre-monsoon
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Workshop outcomes report
  BMP implementation report
  Feature stories in local media on project implementation and effectiveness.


Sedona
Coconino County
Yavapai County
Red Rock
Loop Rd
Spring
Creek
Dry
Creek
Oak
Creek
Verde Valley
School Rd
179
89A
Page
Springs
Page Springs Rd
Cornville
Cornville Rd
Beaverhead Flat Rd
Verde
River
Irrigation Ditches
Agricultural Lands
Communities
CityLimits
Interstates
Major Roads
Major watercourses
Oak Creek Watershed
StudyArea
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0
1
Miles
1:126,720

EO-4 Recreational Vehicle Proper Waste Disposal Outreach Project

(aka The "Don't Put Crap in the Creek" Project)

Need

RV owners may be dumping "black water" into ditches or the creek as evidenced by sewage odor at the Page Springs bridge adjacent to an RV park and past observance of dumping into Oak Creek at Pine Flat and at Cave Springs Crossing. Such dumping, although hopefully not common practice, poses an enormous health risk to downstream swimmers and waders when it occurs.

Description

Work with RV park owners and Coconino National Forest to inform campers of the health effects of dumping waste and assure that they know where to properly dispose of waste.

Estimated load reduction

A typical recreational vehicle holding tank is 40 gallons, although most people will discharge the tank before it is full due to odors. 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). Assuming the average family size of 2.6 people and one week of use the amount of waste created would be:

Urine (l) = 2.6 people * 2066 ml/day * 7 days * 1 liter/1000 ml = 37.6 liters

Fecal Material (kg) = 2.6 people * 95.5 g/day * 7 days * 1 kg/1000 g = 1.7 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.

Assuming that the Outreach Project changes the behavior of 100 recreational vehicle users per year the average annual E coli load reduction would be 8.7×10^{11} CFU per year.

In order estimate the actual load reduction a survey of recreational vehicle users should be conducted.

Project schedule and milestones

<table>
<tr>
<td rowspan="2">Implementation schedule:
January 2013 through December 2014

Measurable milestones:
~ Engage RV park owners and CNF in discussions regarding the best approach to educating campers.
~ Design a simple, brief, punchy flier(s) that educates campers about health risks of RV waste dumping and a map of waste station</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>

locations in the watershed. ~ Implement RV owner outreach through fliers and campground visits by volunteers.	

Education and Outreach Strategy

Findings of education needs survey:

The education needs survey targeted residents not campers, so we do not have data on educational needs. However, we will solicit information from RV park owners, the Forest Service and Forest Service's vendor to determine what prevailing attitudes and beliefs are among RV camper owners.

Goals and target audiences:

~ Recreational Vehicle (RV) owners camping in the Oak Creek Watershed
~ Educate RV owners about health risks of "black water" dumping into Oak Creek or its irrigation ditches
~ Provide locations of legitimate waste dump sites, including costs and contact information.
~ Amend attitudes and practices of some RV owners who do not think dumping is a problem.

Priority education and outreach projects schedule:

~ Early 2013 - Meet with CNF and RV park owners
~ Early 2013 - Develop flier
~ Summer 2013 and 2014 - Distribute flier through RV park managers and CNF staff and/or vendor
~ Mid-summer 2013 and 2014 – Volunteers check to see if fliers are being distributed and talk with RV owners in campgrounds to see if they have gotten the message and to survey attitudes, including soliciting input on where disposal stations are needed.

Monitoring and Evaluating Effectiveness

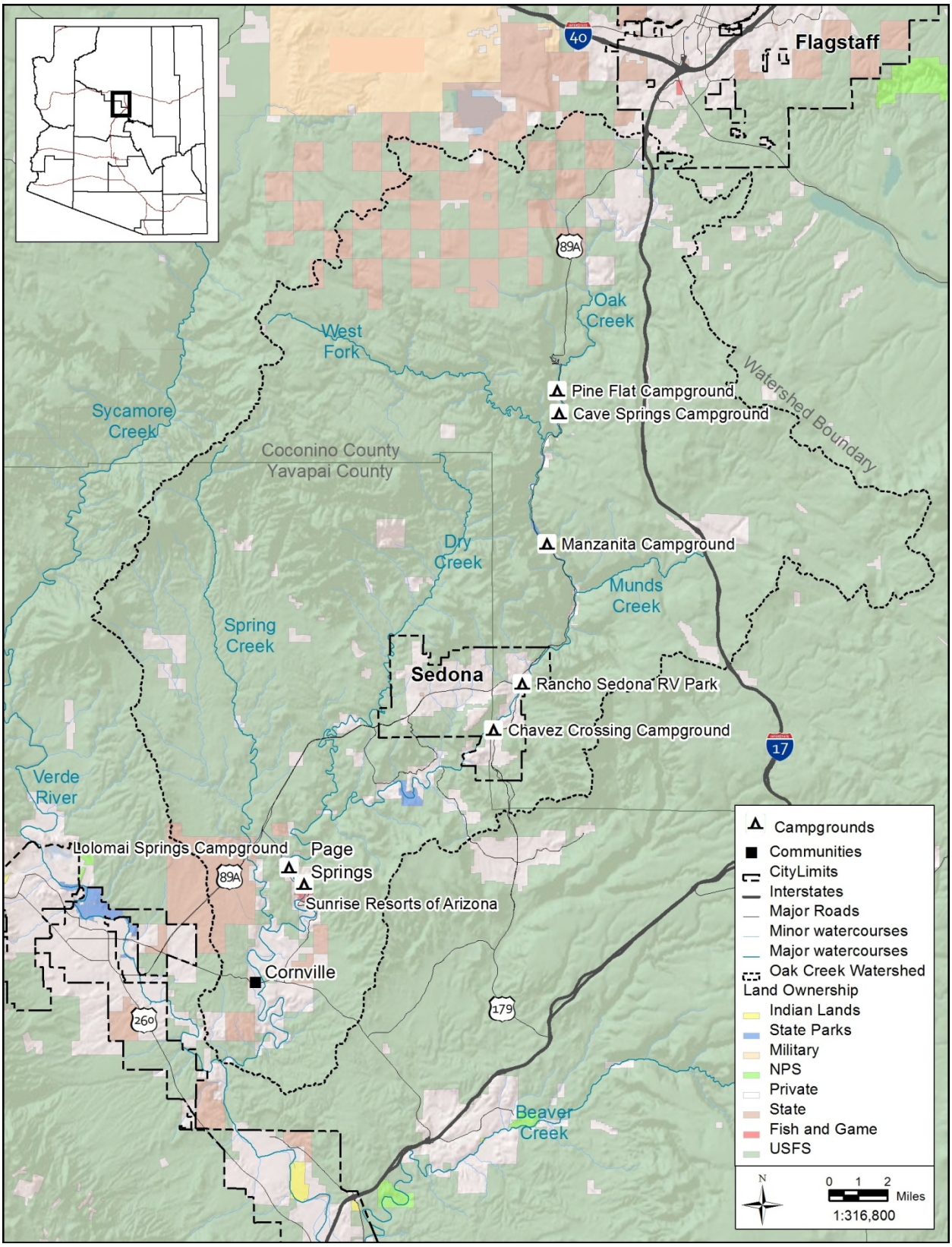
Long-term effectiveness criteria: Decreased observations of illegal dumping of RV black water

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  The number of RVs using CNF campgrounds will be surveyed by volunteers. Use of dumping stations will be observed.
- *Parameters & critical conditions:*
  - Number of RVs in campground
  - Number of RV waste dumpings per weekend
  - Statements by RV owners regarding attitudes and practices related to waste
  - Statements by RV owners regarding places where RV waste stations are needed
- *Schedule, frequency and duration*:
  Volunteers conduct biweekly surveys of RV campground use, waste dumping, and RV owner attitudes and provide information during summer 2013 and 2014.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  Annual reports in the fall of 2013 and 2014

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  RV owners recognize health risks of dumping RV black water into Oak Creek or its ditches and modify behavior as evidenced by fewer incidences of dumping and expressions of RV owners' attitudes.
- *Generation and implementation of second generation improvement projects:*
  RV owners express outstanding needs for waste disposal stations so future projects can help support an adequate density of disposal stations.
- *Measurable reductions of pollutant loading:*
  Reduced incidences of black water dumping
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Annual reports in the fall of 2013 and 2014. Success story feature articles.


Flagstaff
40
89A
Oak Creek
West Fork
Watershed Boundary
Pine Flat Campground
Cave Springs Campground
Sycamore Creek
Coconino County
Yavapai County
Dry Creek
Manzanita Campground
Munds Creek
Spring Creek
Sedona
Rancho Sedona RV Park
Chavez Crossing Campground
17
Verde River
Lolomai Springs Campground
Page Springs
Sunrise Resorts of Arizona
Cornville
260
179
Beaver Creek
Campgrounds
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

SS-2 Oak Creek Residential Septic System Improvement Project

Oak Creek Residential Septic System Improvement Project

Need

Some septic systems in the watershed appear to have effluent that is intercepted by springs that carry *E. coli* and/or other pathogens to the creek. During summer 2011 monitoring in Oak Creek Canyon, 20 to 200 cfu/100 ml (average = 72 cfu/100 ml) *E. coli* was found in spring water that emerges from underneath some properties with septic systems. By contrast, only an average *E. coli* concentrations of 9.5 cfu/100ml based was found in creek water. Although E. coli concentrations in spring discharge are below the water quality standard for *E. coli*, they are elevated compared to other spring water and compared to Oak Creek. Therefore, these possibly septic-influenced springs may provide more or less steady supplies of *E. coli* during the summer months that might 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 residential septic systems appears warranted, particularly for community systems with large loads or systems installed during the period of approximately the 1970s to 1980s when deep trenches were a preferred installation and may not have left adequate separation between the leachfield and spring beds.

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. OCWC will continue monitoring *E. coli* and nutrients in spring discharge, as well as other markers such as DNA and possible tracer dyes, to identify properties where septic system upgrades appear to be in order.

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/

Costs ????

Project schedule and milestones

<table>
<tr>
<td rowspan="2">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</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>

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 private septic system owners in Oak Creek Canyon and the Page Springs area where spring underlie septic leachfields.
~ 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 2012 - outreach
~ Late 2012 - cooperative agreements
~ 2013 - 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*:
  Approximately 3 springs in Oak Creek Canyon with a history of elevated *E. coli* and suspected residential 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).
- *Parameters & critical conditions:*
  - *E. coli* (>5 cfu/100 ml)
  - 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 in spring discharge where *E. coli* was previously elevated
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Report on outreach effort. Feature stories in local media on project implementation and effectiveness.

RC-2 Oak Creek Canyon Sediment Source Reduction Project

Need

Past studies have noted that sediment reservoirs of *E. coli* buildup at Slide Rock throughout the summer. These reservoirs are composed of fine sediment. Some fine sediment may be yielded from the upper watershed due to hundreds of miles of minimally maintained forest roads, timber harvest by heavy equipment, ATV use, fire scars, soil sculpting actions, and/or grazing. Other sediment is likely generated locally due to soil disturbance from people hiking into the Oak Creek on unmaintained social trails. While Coconino National Forest has done some work to stabilize slopes where social trails have caused erosion, a comprehensive evaluation of erosion problems and implementation of solutions may be needed, in both the riparian areas and the larger watershed.

Description

Evaluate erosion problems upstream of Slide Rock S.P. and within the park, as well as at other high use areas in Oak Creek Canyon where recreators hike down steep slopes from the highway to the creek. Couple this localized evaluation with a more comprehensive study of sediment production and transport in Oak Creek watershed to determine the relative sediment contributions from streamside erosion and erosion in the uplands. Implement best management practices to reduce erosion. Establish well engineered and maintained trails where feasible. Work within national forest trail system guidelines to enable volunteers to perform trail maintenance work. Post signs regarding importance of avoiding erosion to reduce *E. coli* sediment reservoirs that contribute to water quality problems that can close Slide Rock State Park and cause human illness. Have volunteers interface with recreators to discuss the importance of reducing erosion as well as other practices for reducing pollution. Work with Coconino National Forest to develop a plan for addressing sediment source areas in the uplands.

Estimated load reduction

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/.

Costs

????

Project schedule and milestones

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

Measurable milestones:
~ Comprehensive study of sediment production and transport in Oak Creek watershed complete, including recommendations to Coconino N.F.
~ Streamside soil stability survey complete
~ Trail improvement and erosion control measures planned
~ All USFS permits and clearances acquired
~ Trail improvement and erosion control measures installed
~ Outreach activities complete
~ Reporting complete</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>

Education and Outreach Strategy

Findings of education needs survey:

Watershed residents' opinions of whether erosion and sediment related to recreational activities threaten water quality are as follows:

Activity	Not sure	Not a problem	Slight problem	Moderate Problem	Large 3Problem
Low water creek crossings	17	26	28	14	3
Unmaintained "social" trails	18	23	31	13	4
Jeeps/ORV trails	15	16	22	21	13
Other sources	17	3	2	2	2

Goals and target audiences:

~ Swimmers, waders, hikers and fishermen in Oak Creek Canyon.
~ Inform them of risks to human health from *E. coli* sediment reservoirs in the stream that are partly due to erosion along way trails.
~ Have volunteers offer incentive items to people observed using proper trails rather than cutting across steep slopes and causing erosion.

Priority education and outreach projects schedule:

~ Early summer 2012 - outreach
~ July 2012 - radio PSA about risks of elevated *E. coli* and what people can do to reduce the risk, including reducing erosion, and protect themselves (eg. not swimming in turbid water).
~ 2013 - success stories coverage

Monitoring and Evaluating Effectiveness

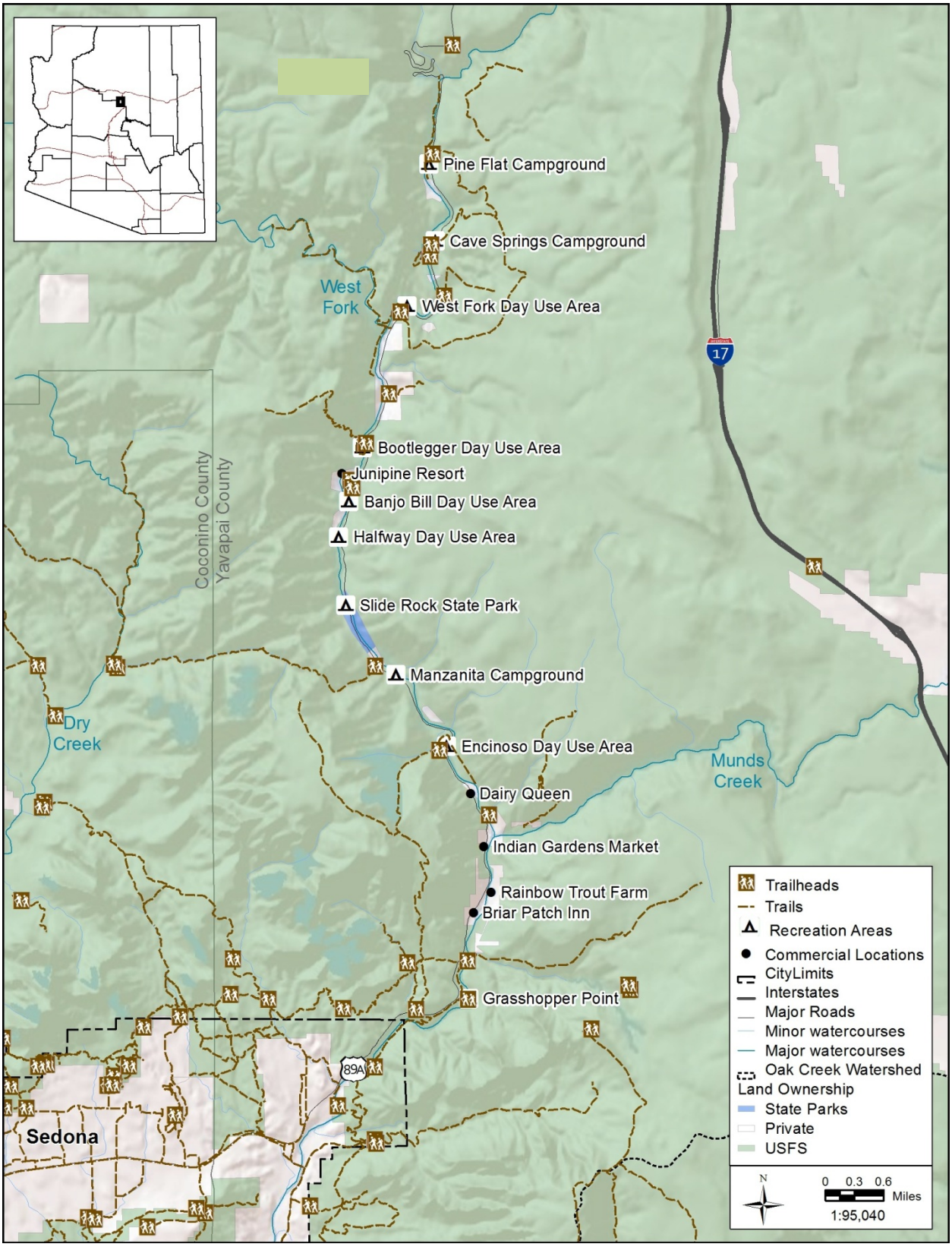
Long-term effectiveness criteria: Reduced *E. coli* exceedances at Slide Rock State Park. Turbidity during peak visitation at S.R.S.P. reduced.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Approximately #? sites along the creek in Oak Creek Canyon will be monitored for *E. coli* and turbidity where soil erosion due to unmaintained way trails (ie. "social trails") is apparent.
- *Parameters & critical conditions:*
  - *E. coli* (>10 cfu/100 ml for elevated values, >235 cfu/100 ml for exceedence)
  - turbidity (>10 NTU for elevated values, >50 NTU for values associated with *E. coli* exceedences)
- *Schedule, frequency and duration*:
  Sampling will occur during high-use weekends in the early-, mid- and late summer. 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; Slide Rock S.P. and Coconino National Forest
- *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 reduce erosion when accessing the creek on way trails in order to reduce *E. coli* sediment reservoirs that can contribute to water contamination and human illness.
- *Generation and implementation of second generation improvement projects:*
  Volunteer organizations, such as Friends of the Forest, provide access trail maintenance and outreach to continue reduced sediment loads.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations and turbidity
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Slide Rock S.P. and Coconino National Forest
- *Reporting plan, how findings will be used:*
  Implementation accomplishments and monitoring results will be included in an annual report that will be posted to the OCWC website. Feature stories in local media will describe project implementation and effectiveness. Utilize any local hotel/restaurant/campground/chamber of commerce publications to run a small advertisement or mini-feature on protecting Oak Creek.


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

RC-4 Oak Creek Watershed Dog Waste Station Installation Project

Need

As evidenced by historic and recent investigations that have included DNA source testing of fecal bacteria, dog feces contribute to *E. coli* contamination in Oak Creek. This is especially true in the Sedona area where residents regularly walk their dogs on trails and often do not pick up their dog's feces. Picking up dog feces would be greatly encourage if pet owners had bags readily available for waste and an appropriate trash receptacle at the trailhead instead of having to put bagged feces in their vehicle to carry it home and dispose.

Description

In conjunction with the Sedona Dog Waste Reduction Outreach Project which will encourage social pressure to pick up dog waste, this project will establish dog waste stations at as many trailheads as possible within 3 miles of Oak Creek. OCWC will work collaboratively to secure funding for establishment and maintenance of dog waste stations. Prior to the selection of sites and installation of waste stations, meetings will be convened with collaborators to discuss roles and responsibilities, cost-sharing, necessary permits and clearances, etc. One topic of discussion will be the issue of whether USFS policy allows establishing dog waste stations where there are not official national forest system trails, such as at the Chavez Ranch area that is heavily used for exercising dogs.

Estimated load reduction

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.

Costs

Item	Units	price/unit	cost
Permits and clearances for waste station installation	#	$$	$$$
Dog waste stations	#	$$	$$$
Legal fees for permit processing, establishment of maintenance agreements, installation contracting (inkind?)	#	$$	$$$

Project schedule and milestones

Implementation schedule:
January 2012 through December 2014

Measurable milestones:
~ Meeting with collaborators (USFS, State Parks) to discuss roles and responsibilities, cost-sharing, necessary permits and clearances, etc.
~ Completed inventory of trails with dog waste stations and those without; identify gaps that must be filled and prioritize the sequence of installations
~ Completed permits, clearances, construction contracting and maintenance agreements
~ Installation of dog waste stations and sign explaining the importance of using them to reduce fecal contamination of Oak Creek and human health risks
~ Effectiveness monitoring complete
~ Reporting 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:

20% of watershed residents walk their dog near Oak Creek.

Dog feces were rated as 1st, 2nd and 3rd biggest contributors to creek contamination by 7.2%, 10.6%, and 10.6% or watershed residents respectively.

44.5 % of watershed residents own a dog.

Of those who own dogs 45.6% walk their dog in the watershed.

Most dog-owning residents (64%) said they always pick up their dog waste, while 19.2% said "most of the time", 5.6 % said "sometimes", 3.2% said "rarely", and 8.0% said "never".

83.5% of watershed residents with dogs say they would use dog waste stations if more were made available at parks and trails.

Watershed residents' opinion of whether dog feces threaten Oak Creek water quality is as follows:

	Not sure	Not a problem	Slight problem
Dog feces that are not picked up and disposed properly	10%	12%	28%

Goals and target audiences:

~ Pet owners who walk dogs on trails within 3 miles of Oak Creek.
~ Work collaboratively with the Sedona Human Society.
~ Increase understanding of importance of picking up dog waste.
~ Affect behaviors so that more pet owners pick up and properly dispose of dog waste.
~ See "Sedona Dog Waste Reduction Outreach Project" for complete details of outreach activities

Priority education and outreach projects schedule:

~ Early 2012 - outreach; trailhead surveys of pet owner attitudes and behaviors
~ Late summer 2012 - follow-up surveys
~ 2013-2014 - continued outreach and follow-up surveys
~ 2013-2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Reduced dog feces counts along trails in Oak Creek watershed. Reduced *E. coli* concentration in Oak Creek, especially *E. coli* with dog-sourced bacterial DNA.

On-the-ground project effectiveness monitoring plan

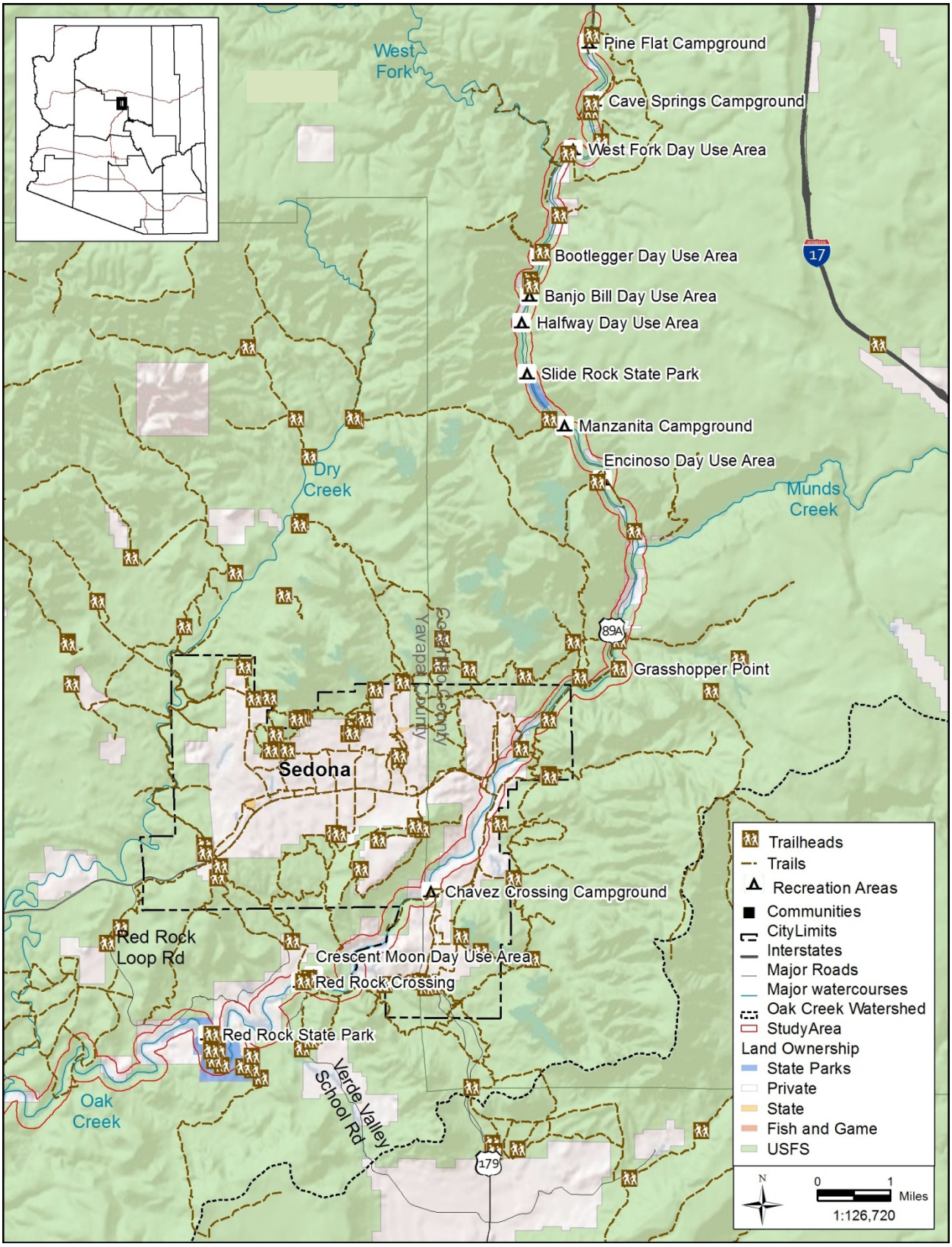
- *Monitoring and reference condition sites*:
  Conduct regular dog feces counts in the summer along trails with a large volume of dog walking, especially Huckaby Trail, Baldwin Trail, West Fork Trail (all FS System trails) and Chavez Crossing trail (social trail). Monitor *E. coli* concentrations and bacterial DNA in Oak Creek during storm events or the day after storm events downstream of the mouths of tributary watersheds with a large volume of dogs walking on trails, including Jordan Pump, Soldier Wash, and Carroll Canyon.
- *Parameters & critical conditions:*
  - Fecal counts along popular trails (>20 dog feces per ¼ mile); feces may be picked up and bagged so they are not double counted.
  - Volume of dog feces collected at waste stations (number of bags dispersed and weight of collection at the waste station)

- *E.coli* (> 90% of average past background or stormflow concentrations; >235 cfu/100 ml for exceedence)
- DNA (seasonal average equal to or greater than baseline or past percentages of dog-sourced DNA in fecal bacteria)

- *Schedule, frequency and duration*:
  Dog fecal counts twice per month in summer. *E. coli* and DNA sampling at least 3 times per summer during or the day after stormflow events.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Coconino National Forest; Coconino County Rural Environmental Corp. [Try to contract CREC 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 trails on the weekend for a presence to make dog walkers 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:*
  Pet owners exhibit an understanding and willingness to use dog waste stations rather than leaving dog waste on the ground where it can wash into Oak Creek and cause fecal contamination that threaten human health.
- *Generation and implementation of second generation improvement projects:*
  Pet owners may identify additional sites where dog waste stations may be appropriate, initiating future projects.
- *Measurable reductions of pollutant loading:*
  Reduced *E. coli* concentrations and dog-sourced bacterial DNA in Oak Creek water. Reduced dog feces along trails.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants; Slide Rock State Park; Coconino National Forest; Coconino Rural Environmental Corp
- *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.


West Fork
Pine Flat Campground
Cave Springs Campground
West Fork Day Use Area
Bootlegger Day Use Area
Banjo Bill Day Use Area
Halfway Day Use Area
Slide Rock State Park
Manzanita Campground
Encinoso Day Use Area
Dry Creek
Munds Creek
Yavapai County
Coconino County
89A
Grasshopper Point
Sedona
Chavez Crossing Campground
Red Rock Loop Rd
Crescent Moon Day Use Area
Red Rock Crossing
Red Rock State Park
Oak Creek
Verde Valley School Rd
179
17
Trailheads
Trails
Recreation Areas
Communities
CityLimits
Interstates
Major Roads
Major watercourses
Oak Creek Watershed
StudyArea
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0
1
Miles
1:126,720

AG-1 Animal Waste BMPs for Oak Creek Watershed

Need

Some livestock owners have reportedly dumped animal waste into irrigation ditches that drain into Oak or into Oak Creek directly. Elevated *E. coli* concentrations in Oak Creek in areas where livestock are kept appears to corroborate waste dumping and its impacts. For example, from Page Springs to the Verde Confluence the average baseline *E. coli* concentration in summer 2011 was 56.4 cfu/100 ml, compared to 31.4 cfu/100 ml at Chavez Crossing Campground in the City of Sedona and 10.3 cfu/100 ml in Oak Creek Canyon. Concentrated doses of fecal matter can cause spikes in *E. coli* and other related pathogens as well as innoculate *E. coli* sediment reservoirs that later contaminate water when disturbed by storm flows or recreation activities. The resulting pathogen loads may threaten the health of people wading and swimming in Oak Creek. The excess nutrients and organic matter can also have a deleterious impact on aquatic life. Perhaps some livestock owners do not know the serious environmental impacts of dumping animal waste into water bodies. Outreach, education and technical support are needed to help landowners initiate best management practices for animal waste.

Description

OCWC will collaborate with Cooperative Extension Service, the Verde Natural Resources Conservation District, local ditch assocations and any livestock organizations in the watershed. The location of all livestock owners will be determined through aerial and driveby surveys and any available databases related to livestock producers and horse, goat, sheep, llama etc. owners. A focused outreach effort will be made to educate livestock owners on the water quality impacts of dumping animal waste into water. Assistance will be provided to implement best management practice alternatives to dumping, such as those listed on the Cooperative Extension Service website: http://ag.arizona.edu/animalwaste. Demonstration workshops will be held in the watershed to teach BMP background and techniques to livestock owners. Workshop presenters should appeal to landowners environmental ethics but also emphasize if there is an economic advantage to proper waste management, such use of waste for improving soil fertility or selling composted waste to farmers and gardeners. Material and technical assistance will be provided to operators as they initiate BMPs. USFS hydrologist Amina Sena recommends pursuing a grant to fund a pick up for livestock waste at no cost for one year to quantify exactly how much people may potentially be dumping in the creek

Estimated load reduction

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 x 10^4 CFU per gram * 907,184.74 grams/ton = 5.1 x 10^{11} CFU per year
Cow (CFU/year) = 1.5 tons/yr * 7.1 x 10^6 CFU per gram * 907,184.74 gram/ton = 9.7 x 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.

Costs

????

Project schedule and milestones

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

Measurable milestones:
~ Collaboration agreement with Cooperative Extension Service and the Verde Natural Resources Conservation District
~ Map of irrigation 22 irrigation ditches and contact information for each
~ Survey of livestock properties including location, livestock type and estimated number of animals
~ #? BMP workshops
~ #? livestock owners provided material and technical assistance for initiating BMPs
~ Quarterly and final reports</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>

Education and Outreach Strategy

Findings of education needs survey:

The following reflects watershed residents' views on the whether livestock waste threatens water quality:

Ag. Runoff	Not sure	Not a problem	Slight problem
Livestock manure	20%	15%	22%

Goals and target audiences:

~ Owners of warm-blooded livestock in Oak Creek watershed
~ Advertise workshops in local specialty publications (eg. 4H newsletter), bulletin boards at feed stores, NRCD list serve or newsletter, etc.
~ Inform livestock owners of risks to human health from dumping livestock excrement into water, because of pathogens and dosing of *E. coli* sediment reservoirs that later cause water contamination when reservoirs are disturbed by stormflows or recreation activity.
~ Provide educational workshops and hands-on demonstrations while assisting livestock owners with the initiation of BMPs.

Priority education and outreach projects schedule:

~ Spring 2012 - Establish collaboration with other natural resources professionals who can provide expert instruction
~ Fall through Spring 2012-2014 – BMP workshops and demonstrations
~ 2014 - success stories coverage

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Reduced *E.coli* concentrations in reaches of Oak Creek where livestock are common.

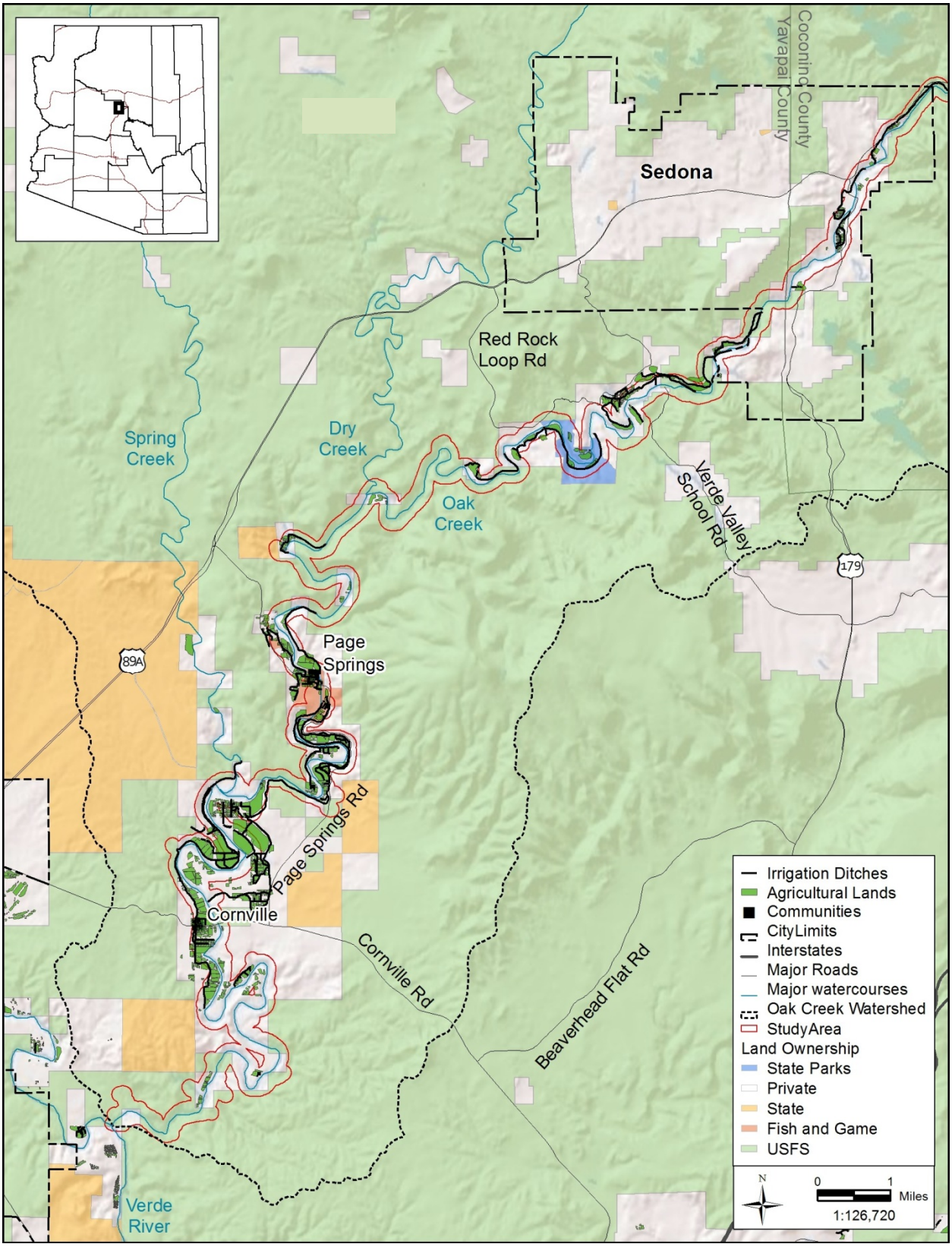
On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Continue monitoring *E. coli* and DNA at OCWIP monitoring sites during summer months in reaches where livestock are common, from below Red Rock State Park (M29) to Cornville Estates (M41).
- *Parameters & critical conditions:*
  - *E. coli* (greater than average baseline concentration for each site in 2011)
  - DNA, if practical and affordable (% horse-, sheep-, etc.-sourced bacterial DNA greater than percentages found in Oak Creek Canyon by Southam in 1999) University of Arizona could test bovine DNA and forward water samples or extracted DNA to other lab(s) for testing of other livestock species.
- *Schedule, frequency and duration*:
  At least 3 samples each during baseline and stormflow conditions throughout the summer months, 2012-2014. Sampling may be combined with sampling efforts for other projects.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants, University of Arizona and other contracted genetics laboratories

- *Reporting plan:*
  Annual report on sampling, data analysis and interpretation. Assessment of BMP effects on water quality in project final report.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Livestock owners exhibit an understanding and willingness to use animal waste management BMPs to reduce fecal contamination of Oak Creek.
- *Generation and implementation of second generation improvement projects:*
  Local ditch associations seek grant funding for projects to improve animal waste management to maintain quality of irrigation tail water.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations. Reduced percentage of bacterial DNA attributed to livestock species.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants, University of Arizona and other contracted genetics laboratories
- *Reporting plan, how findings will be used:*
  Annual reports on workshop and demonstration attendance. Feature stories in specialty publications for livestock owners regarding progress of project and results of monitoring. Success stories in local media.


Sedona
Coconino County
Yavapai County
Red Rock
Loop Rd
Spring
Creek
Dry
Creek
Oak
Creek
Verde Valley
School Rd
179
89A
Page
Springs
Page Springs Rd
Cornville
Cornville Rd
Beaverhead Flat Rd
Verde
River
Irrigation Ditches
Agricultural Lands
Communities
CityLimits
Interstates
Major Roads
Major watercourses
Oak Creek Watershed
StudyArea
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0
1
Miles
1:126,720

AG-2 Oak Creek Irrigation Diversion Erosion Reduction Project

Need

Annual earth moving activities to build or restore irrigation diversion structures may be introducing large quantities of sediment to creek, which can contribute to *E. coli* sediment reservoirs, which in turn cause water contamination when sediments are disturbed by stormflows or recreation activities. This is evidenced by anecdotal accounts, aerial photo interpretation and *E. coli* concentrations that have been found higher in reaches with irrigation diversions that appear to be contributing sediment to the stream channel. Also, irrigation tailwater that enters ditches may deliver sediment to the creek from fields with unstable soils. Besides sediment inputs potentially increasing *E. coli* in to Oak Creek water, sediment is also disruptive to benthic organisms that are essential to the stream's food web. Most of the sediment problems associated with irrigation appear to be in the lower reaches of Oak Creek where stream bed and bank material is finer grained and usually must by reworked on an annual basis for maintenance of diversion structures. In Oak Creek Canyon there are several diversion structions, but the coarseness of the material and the infrequency with which it is disturbed may mean there is less erosion and sedimentation.

Description

Map all irrigation diversions and ditches. Have volunteers float/wade the creek with a GPS unit, camera, and notebook to inventory irrigation infrastructure (diversion dams, gates, ditch starts, ditch outfalls, etc.). Work collaboratively with Yavapai County GIS, ADWR, NRCD and Cooperative Extension on mapping ditches. Engage local ditch associations. Interface with Army Corp of Engineers to ascertain whether there are current 404 permits for diversions or whether some diversions predate the 404 rules and are thereby exempt due to a grandfather clause. For any diversions that do require a 404 permit, evaluate structures to see if excavations may be out of compliance. Identify problem areas and provide incentives to implement Best Management Practices, such as using larger diameter material for diversion dams, as recommended by NRCD, Cooperative Extension Service or others, to reduce erosion and sedimentation associated with irrigation diversions. Develop a plan for at least 3 diversion structures to reduce erosion/sedimentation and provide assistance in applying for grants to fix problems.

Estimated load reduction

The StepL modeling tool was used to estimate the load reductions by reducing sediment caused by irrigation structures. It was assumed that the BMPs would have a load reduction efficiency of 50%. The estimated average annual load reduction is:
Sediment – 10.2 tons per year
Nitrogen (N) – 267.6 lbs per year
Phosphorus (P) – 30.2 lbs per year

References:

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:
~ Collaboration agreement with Cooperative Extension Service and the Verde Natural Resources Conservation District
~ Map of irrigation 22 irrigation ditches and contact information for each
~ Survey of irrigation infrastructure condition and erosion/sedimentation trouble spots
~ #? 404 permits identified as out of compliance (if relevant)
~ #? diversion renovation plans/grant proposal frameworks
~ Quarterly and final reports</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 (Sept 2011)></td>
</tr>
</table>

Education and Outreach Strategy

Findings of education needs survey:

The following reflects watershed residents' views on the whether irrigation diversions can cause erosion and sedimentation that may threaten water quality:

Activity	Not sure	Not a problem	Slight problem
Construction and maintenance of irrigation diversions	21%	17%	28%

Goals and target audiences:

~ Irrigation association members along Oak Creek
~ Contact association administrators (ie. ditch bosses or similar) and invite them to a round table discussion about irrigation infrastructure on Oak Creek and how it might be affecting water quality. Dangle the carrot of assistance with writing grant proposals to obtain funds for system upgrades. Establishing a friendly working relationship with ditch administrators is critical.
~ After irrigation systems have been surveyed and problem spots are identified, go on a "show me" tour of the good, the bad and the ugly with interested members of irrigation associations. Advertise and/or invite though contact information provided by ditch administrators.
~ Solicit volunteers among ditch associations to participate in demonstration projects and collaboratively write grant proposals with volunteers for further system upgrades.
~ Host demonstrations of BMPs to reduce erosion and sedimentation associated with irrigation diversions.

Priority education and outreach projects schedule:

~ Fall 2012 to Spring 2013 – Round table discussions
~ Spring 2013 – Show me tour(s)
~ Fall 2014 to Spring 2014 - Demonstration projects (might be combined with animal waste BMP demonstration projects in a 2-day conference, maybe rent the Dancing Apache?)

Monitoring and Evaluating Effectiveness

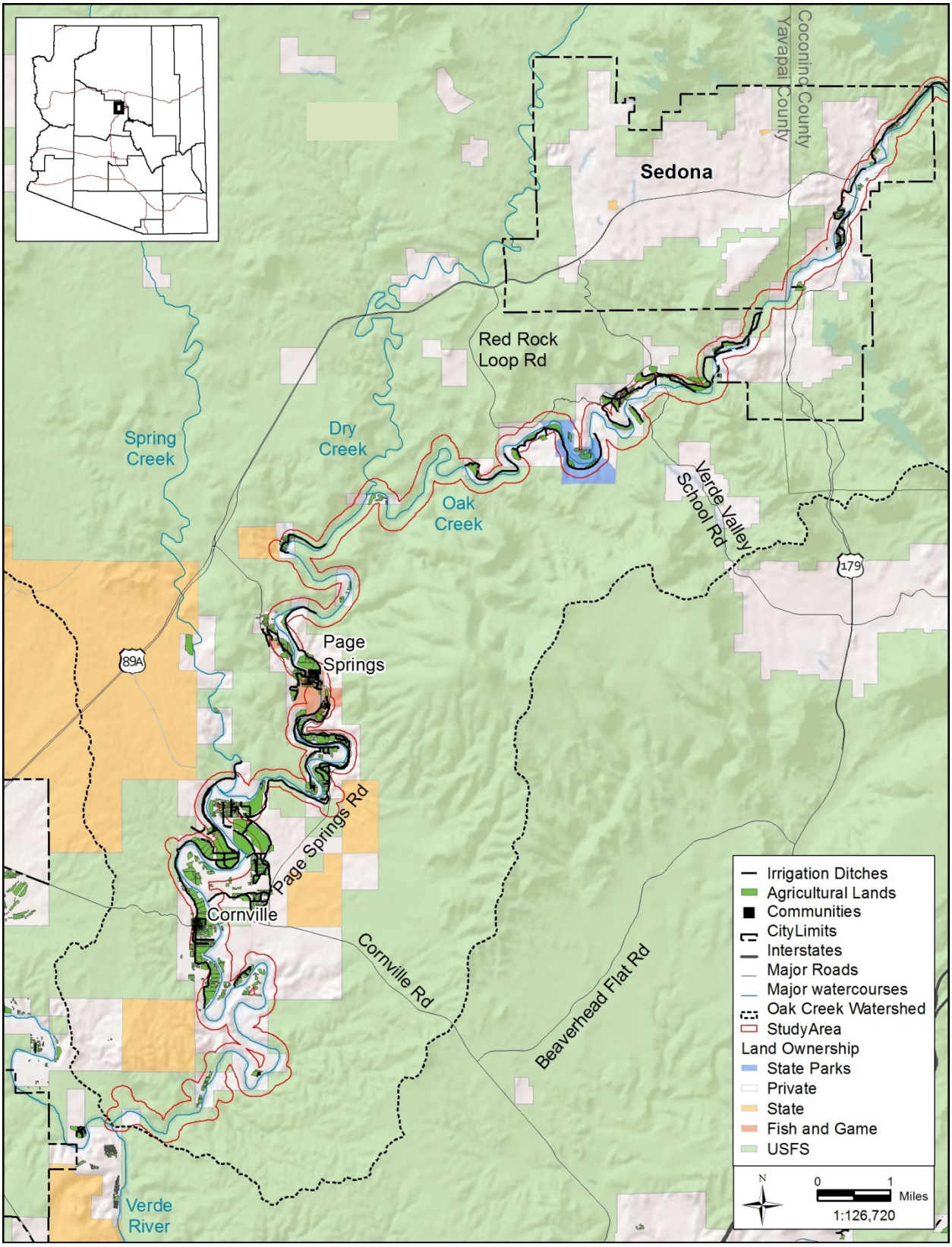
Long-term effectiveness criteria: Reduced *E. coli* concentrations and sediment in reaches of Oak Creek where irrigation diversions correspond with erodible materials.

On-the-ground project effectiveness monitoring plan

- *Monitoring and reference condition sites*:
  Continue monitoring *E. coli* and turbidity at OCWIP monitoring sites during summer months in reaches where irrigation diversions correspond with erodible materials, from below Red Rock State Park (M29) to Cornville Estates (M41).
- *Parameters & critical conditions:*
  - *E. coli* (greater than average baseline concentration for each site in 2011)
  - Turbidity (>50 NTU)
- *Schedule, frequency and duration*:
  At least 3 samples each during baseline and stormflow conditions throughout the summer months, 2012-2014. Sampling may be combined with sampling efforts for other projects.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  Annual report on sampling, data analysis and interpretation. Assessment of the adoption irrigation diversion BMPs and potential effects on water quality in project final report.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Irrigators exhibit an understanding and willingness to use BMPs to reduce erosion and sedimentation associated with irrigation diversions in Oak Creek.
- *Generation and implementation of second generation improvement projects:*
  Local ditch associations seek grant funding for projects to upgrade irrigation diversions so that annual maintenance is less disruptive and generates less sediment.
- *Measurable reductions of pollutant loading:*
  Reduced *E.coli* concentrations. Reduced turbidity.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan, how findings will be used:*
  Annual reports on show me tour and demonstration attendance. Feature stories in specialty publications for livestock owners regarding progress of project and results of monitoring. Success stories in local media.


Sedona
Coconino County
Yavapai County
Red Rock
Loop Rd
Spring
Creek
Dry
Creek
Oak
Creek
Verde Valley
School Rd
179
89A
Page
Springs
Page Springs Rd
Cornville
Cornville Rd
Beaverhead Flat Rd
Verde
River
Irrigation Ditches
Agricultural Lands
Communities
CityLimits
Interstates
Major Roads
Major watercourses
Oak Creek Watershed
StudyArea
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0
1
Miles
1:126,720

Photos

Examples of how excavation of fine-grained material can be very disruptive to the channel. These photos are from the Verde River upstream of Deadhorse Ranch State park.

AG-3 Lower Oak Creek Erosion Reduction Project

Need

Turbidity is persistent in the lower reaches of Oak Creek – Page Springs through Cornville to Verde River confluence – even during dry weather when upper reaches of Oak Creek are clear, indicating multiple sources of sediment in the lower reaches. These same reaches have baseline *E. coli* concentrations higher that upper reaches (56.4 cfu/100ml average compared to 31.4 cfu/100 ml in Sedona area and 10.3 cfu/100 ml in Oak Creek Canyon). Reportedly there is a least one low-water crossing (a.k.a. ford) across Oak Creek downstream of Cornville that may be contributing sediment to the creek. Sediment is a problem because it causes turbidity which has been strongly correlated with *E. coli* in Oak Creek, probably because *E.coli* on sediment particles transfers to the water when the particles are suspended in the water column. Low water crossings need to be mapped and evaluated and alternatives explored to reduce erosion and sedimentation. Also, erosion has been observed after summer monsoon rain along roadways in the Cornville area, eg. along Sexton Ranch Road, which is likely delivering sediment to Oak Creek. Sediment production from roadways, properties under development, and recently developed needs to be evaluated to determine whether Yavapai County should revise policies, road mainteance procedures, regulations or building codes to limit erosion and sedimentation.

Description

Map all low-water crossings on Oak Creek. Have volunteers float/wade the creek with a GPS units, camera, and notebook to inventory low water crossings and notes locations with apparent elevated turbidity. (Field work can be combined with inventory of irrigation infrastructure.) Assess road network conditions for adequate drainage to avoid erosive flows along road beds or ditches. Inspect recently developed properties that are without established vegetation to see whether stormwater BMPs are needed to slow runoff and reduce erosion. Work collaboratively with property owners and/or Yavapai County to explore implementing improvements to reduce sediment inputs. Improvements may include cement fords or bridges (depending on resources available) terracing, additional culverts, improved road prisms and so forth. Offer to help write grant proposals to secure funding to upgrade low-water crossings and road drainage.

Estimated load reduction

The project will map low-water crossing on Oak Creek which in itself will not produce a load reduction in sediment. The project will provide information for the formulation of future BMPs to reduce sedimentation.

Costs

????

Project schedule and milestones

Implementation schedule: January 2012 through December 2014 *Measurable milestones:* ~ Meet with Roads Division of Yavapai County Public Works to discuss road	*Resources and other support commitments:* ADEQ 319(h) grants ???? *Commitment date(s):* <None at this time >

maintenance and improvements that could reduce erosion and sedimentation ~ Low-water crossings inventoried ~ Roadway inspections complete ~ Meet with property owners regarding low-water crossings and any properties with overt erosion problems ~ Report with recommendations and grant proposal frameworks ~ Quarterly and final reports	*Pending commitments:* <Unknown at this time> Approach SRP; they may be interested in erosion control projects to reduce sedimentation of water storage reservoirs *Estimated commitment date:* <None at this time >

Education and Outreach Strategy

Findings of education needs survey:

The following reflects watershed residents' view on the impacts of road construction and road maintenance on erosion and sedimentation which can affect water quality:

Activity	Not sure	Not a problem	Slight problem
Road construction	17%	17%	30%
Road maintenance	17%	20%	34%

Goals and target audiences:

~ Property owners in the lower reaches of Oak Creek watershed
~ Contact property owners and/or Yavapai County regarding low-water crossings, roadways or building sites that appear to be contributing to erosion and sedimentation and discuss options for improving the road network and overall soil stability. Keep in mind that Yavapai County has a very strong property rights ethic and may not welcome any strangers who appear on their door step regardless of your intentions. Send a post card in advance of visit to inform property owner about the project, give them a link to the OCWC website, and provide a contact phone number.
~ Take interested property owners on a "show me" trip to see erosion problems. Pitch idea of helping with grant proposals and/or lobbying the county for upgrades to reduce erosion. Also sell the idea of better access to their properties during storm events.

Priority education and outreach projects schedule:

~ Winter/spring 2013 – post cards and site visits
~ Summer 2013 – Show me tour(s)
~ Fall 2013 to Spring 2014 – Writing grant proposal and holding forums with Yavapai County and residents to seek funding and develop a plan for improving roadways to reduce erosion.

Monitoring and Evaluating Effectiveness

Long-term effectiveness criteria: Reduced turbidity and *E. coli* concentrations in the lower reaches of Oak Creek

On-the-ground project effectiveness monitoring plan

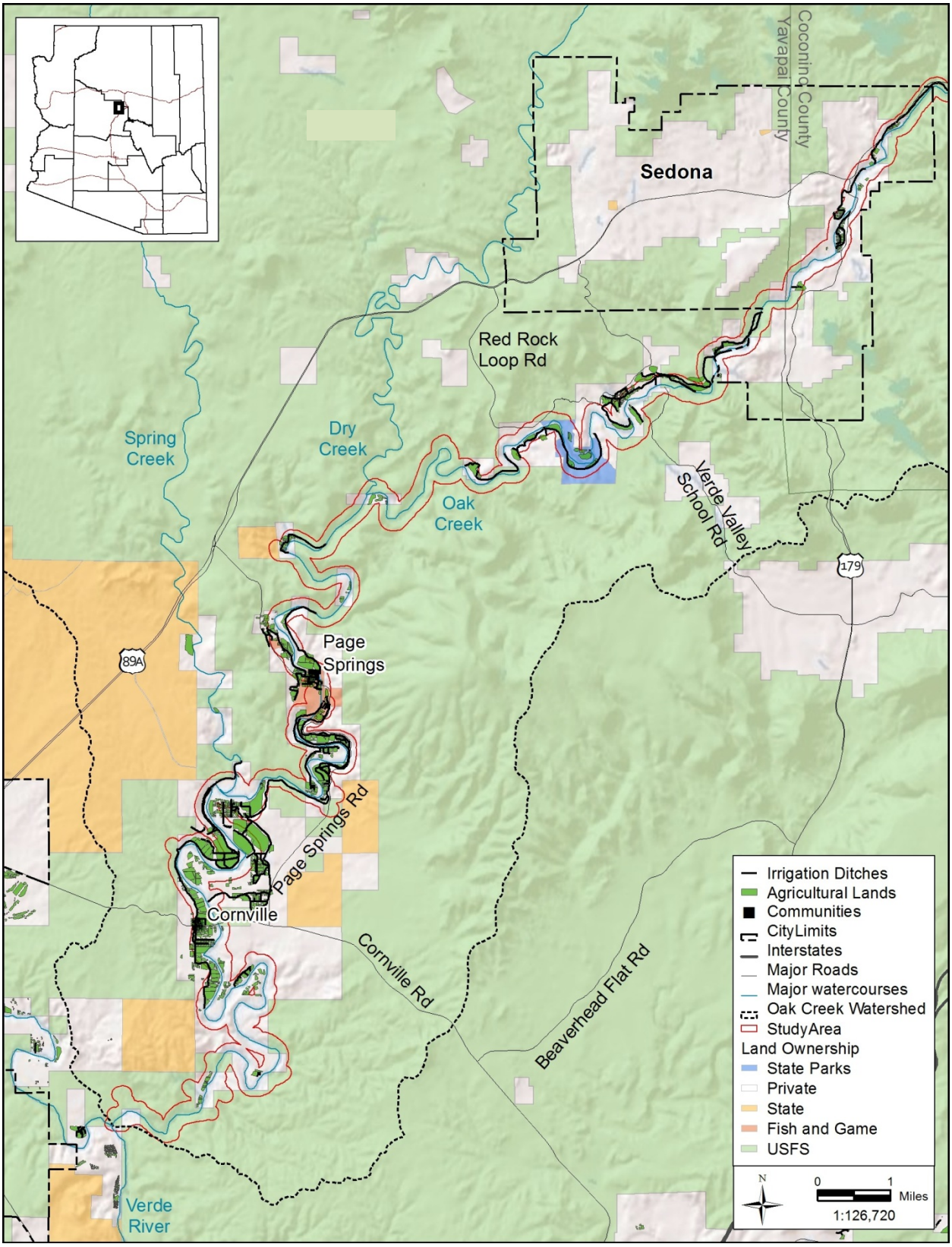
- *Monitoring and reference condition sites*:

Continue monitoring *E. coli* and turbidity at OCWIP monitoring sites during summer months in reaches where turbidity is usually elevated compared to upstream reaches, from Page Springs down to the Verde River confluence.

- *Parameters & critical conditions:*
  - *E.coli* (greater than average baseline concentration for each site in 2011)
  - turbidty (>50 NTU)
- *Schedule, frequency and duration*:
  At least 3 samples each during baseline and stormflow conditions throughout the summer months, 2012-2014. Sampling may be combined with sampling efforts for other projects.
- *Volunteers and/or staff for monitoring and data analysis:*
  OCWC volunteers, staff and consultants
- *Reporting plan:*
  Annual report on sampling, data analysis and interpretation. Assessment of possible correlations between road conditions and turbidity in project final report.

Education effectiveness monitoring

- *Long-term behavior change criteria:*
  Property owners appreciate the importance of reducing sedimentation through proper roadway design, construction and maintenance to help reduce water quality impacts and take action to improve road conditions.
- *Generation and implementation of second generation improvement projects:*
  Property owners seek grant funding and/or Yavapai County support for projects to upgrade roadways and low-water crossing to reduce sedimentation.
- *Measurable reductions of pollutant loading:*
  Reduced turbidity. 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:*
  Annual reports on show me tours. Feature stories in local media.


Sedona
Coconino County
Yavapai County
Red Rock
Loop Rd
Spring
Creek
Dry
Creek
Oak
Creek
Verde Valley
School Rd
179
89A
Page
Springs
Page Springs Rd
Cornville
Cornville Rd
Beaverhead Flat Rd
Verde
River
Irrigation Ditches
Agricultural Lands
Communities
CityLimits
Interstates
Major Roads
Major watercourses
Oak Creek Watershed
StudyArea
Land Ownership
State Parks
Private
State
Fish and Game
USFS
N
0
1
Miles
1:126,720