Chapter 3 – Watershed Improvement Strategy

Best Management Practices Projects

As the result of the field investigation, social survey and review of past studies, OCWC is proposing 15 projects to reduce sources of *E. coli* and related fecal contamination in Oak Creek. These projects are outlined in detail in Appendix B. The project descriptions are intended to serve as a foundation for future funding proposals and project work plans. Table 14 provides the titles of the 15 projects. They are arranged by topic in order of priority, ie. Education and Outreach is the highest priority. The topics include Education and Outreach, Septic Systems, Stormwater, Recreation, and Agriculture. Priority ranking is based on knowledge from investigation results, past studies, observation, and anecdotal evidence. These priority rankings are subject to change following further review by the OCWC and OCWIC.

Table 14. Oak Creek WIP proposed BMP projects in order of priority

Project ID	Project Name
Top Priority Projects	
EO-2	Oak Creek Canyon Public Outreach Program
EO-5	"Even One" *E. Coli* Outreach Project
EO-6	Oak Creek Community Outreach Program (OCCOP)
SS-1	Oak Creek Commercial Septic System Improvement Incentive Project
SW-1	Sedona Area Stormwater Improvement Project
RC-1	Oak Creek Canyon Public Toilet Access Project
RC-3	Keeping Oak Creek Beautiful – Trash Receptacle Access Project
Second Tier Projects	
EO-1	Sedona Dog Waste Reduction Outreach Project
EO-3	Lower Oak Creek Watershed Outreach Project
EO-4	Recreational Vehicle Proper Waste Disposal Outreach Project
SS-2	Oak Creek Residential Septic System Improvement Project
RC-2	Oak Creek Canyon Sediment Source Reduction Project
RC-4	Oak Creek Watershed Dog Waste Station Installation Project
AG-1	Animal Waste BMPs for Oak Creek Watershed
AG-2	Oak Creek Irrigation Diversion Erosion Reduction Project
AG-3	Lower Oak Creek Erosion Reduction Project

Load Reduction

Through the implementation of Best Management Practices, over the course of several years, *E. coli* loading in Oak Creek may be expected to decrease considerably and the incidence of WQS exceedances should also decrease. However, evidence shows that it unlikely that exceedances can be completely eliminated, because storm events deliver large loads of *E. coli* to Oak Creek,

much of which comes from wildlife sources. This loading, along with turbulent resuspension of *E. coli* from sediment reservoirs, causes *E. coli* counts in Oak Creek that far exceed the water quality standard but attenuate to background levels over 2 to 3 days following the storm event.

The University of Arizona estimated load reductions for each of the BMP projects using modeling techniques, pollutant loading values from the literature, and Oak Creek monitoring data. Table 15 is a summary of the estimated pollutant load reductions. The BMP project descriptions include explanations of UA's methods and findings.

Table 15. Pollution load reduction estimations for each Oak Creek BMP project

Project #	**Project Title**	**Estimated Load Reduction**	**source**
EO-1	Sedona Dog Waste Reduction Outreach Project	5.1×10^{13} CFU *E. coli* bacteria/year	dog feces
EO-2	Oak Creek Canyon Public Outreach Program	5.6×10^{12} CFU *E. coli* bacteria/year	human feces
		3×10^{10} CFU *E. coli* bacteria/year	diapers
		5.1×10^{13} CFU *E. coli* bacteria/year	dog feces
		7.02 tons of sediment/year	erosion
EO-3	Lower Oak Creek Watershed Outreach Project – Animal Waste Dumping	5.1×10^{11} CFU *E. coli* bacteria/year	horse feces
		9.7×10^{12} CFU *E. coli* bacteria/year	cow feces
EO-4	Recreational Vehicle Proper Waste Disposal Outreach Project	8.7×10^{11} CFU *E. coli* bacteria/year	human feces
EO-5	"Even One" *E. Coli* Outreach Project	5.6×10^{12} CFU *E. coli* bacteria/year	human feces
SS-1	Oak Creek Commercial Septic System Improvement Incentive Project	77.9 tons sediment/year	septics
		3,506.5 lbs nitrogen/year	septics
		601.6 lbs phosphorus/year	septics
SS-2	Oak Creek Residential Septic System Improvement Project	77.9 tons sediment/year	septics
		3,506.5 lbs nitrogen/year	septics
		601.6 lbs phosphorus/year	septics
SW-1	Sedona Area Stormwater Improvement Project	17×10^{12} CFU *E. coli* bacteria/year	dog feces
		4.75×10^{10} CFU *E. coli* bacteria/year	human feces
RC-1	Oak Creek Canyon Public Toilet Access Project	5.6×10^{12} CFU *E. coli* bacteria/year	human feces

RC-2	Oak Creek Canyon Sediment Source Reduction Project	7.02 tons per year	erosion
RC-3	Keeping Oak Creek Beautiful – Trash Receptacle Access Project	3 x 10^{10} CFU *E. coli* bacteria/year	diapers
RC-4	Oak Creek Watershed Dog Waste Station Installation Project	5.1 x 10^{13} CFU *E. coli* bacteria/year	dog feces
AG-1	Animal Waste BMPs for Oak Creek Watershed	5.1 x 10^{11} CFU *E. coli* bacteria/year 9.7 x 10^{12} CFU *E. coli* bacteria/year	horse feces cow feces
AG-2	Oak Creek Irrigation Diversion Erosion Reduction Project	10.2 tons sediment/year 267.6 lbs nitrogen/year 30.2 lbs phosphorus/year	erosion
AG-3	Lower Oak Creek Erosion Reduction Project	none; This project would provide information for development of future BMPs	

Reducing loads to meet standards is one of the objectives of the WIP. Reducing loads to meet standards necessarily entails eliminating human-related sources as much as possible to try to meet the TMDL reduction recommendation. Because eliminating all human sources would be extremely challenging, priorities should be set to reduce those sources that most affect *E. coli* exceedances during the summer months when there is high level of human contact with Oak Creek water. It is the finding of the OCWC that the greatest effort should be spent where the greatest opportunity exists to reduce human contact with pathogens, in other words where the greatest concentration of recreational water use occurs, with the acknowledgement that recreation in Oak Creek occurs throughout its entire length.

All of the proposed projects provide needed *E. coli* load reduction, but the largest reductions would most likely come from identifying sediment and *E. coli* sources in tributary wash watersheds in and around Sedona. Also the Oak Creek Canyon Public Toilet Campaign and the Commercial Septic System Improvement Demonstration Program would be important. Some reduction would occur immediately upon implementation, but total reduction is not likely to occur until there is comprehensive control of nonpoint source fecal pollution in the Oak Creek Watershed.

Cost-effectiveness comparison

Although an in-depth cost analysis was not completed for this report, generally the education and outreach projects are probably the most cost effective, since change in human behavior is necessary to reduce fecal contamination in Oak Creek. Also, outreach does not require permitting or pose technical challenges for the most part. Projects that physically support behavior changes, such as installation and maintenance of public toilets, trash receptacles and dog waste stations, are all expected to be cost effective in addressing pollution. Mitigation measures for septic systems may be very expensive, but should not be ruled out, since where

needed these projects could have a significant effect on human health. Projects for some of the agricultural impacts in the lower watershed were ranked lower because the causation is not as directly attributable, fewer recreators may be impacted, and the cost in time and effort to address these concerns is considerable for an uncertain outcome.

Other resources and barriers considered

Several funding opportunities and potential collaborations exist to support proposed projects, including:

- Arizona Community Foundation
- Arizona Department of Environmental Quality
- Arizona Department of Water Resources/Arizona Water Protection Fund
- Arizona Public Service
- Bureau of Land Management
- Bureau of Reclamation
- Coconino County
- Coconino National Forest
- Clean Water Act Section 319(h) grants
- City of Sedona
- EQIP
- Kling Family Foundation
- Nina Mason Pulliam Charitable Trust
- National Science Foundation research grant related to *E. coli* in sediments
- Red Rock State Park
- Salt River Project
- Sedona Community Foundation
- Sedona New Frontiers
- Slide Rock State Park
- Udall Foundation
- United States Environmental Protection Agency
- Yavapai County
- The Walton Family Foundation
- Watershed Management Group
- WIFA

Land owners' desire and commitment to maintain improvements are important for project success. Considerations include the following:

- Agricultural land owners need to be engaged.
- Firm commitments are needed for maintaining dog waste collection stations.
- Septic system owners need to be approached in a non-threatening way, encourage collaboration and provide assistance.
- City of Sedona continued commitment to stormwater monitoring and public outreach.
- Elf Neighborhood desires to resolve flooding problems that may impact water quality

The Oak Creek Watershed is fortunate to have technical support available from several sources. Technical support may involve loaning monitoring equipment, providing technical advice, reviewing documents and outreach materials, providing student workers for assessment tasks, sharing historic data, providing technical expertise, collaborating on funding proposals, assisting with permitting processes, contributing to any needed environmental assessments prior to project implementation, entering into cost share agreements, and linking project activities to larger regional water management objectives. Sources of technical support may include:

- ADEQ
- City of Sedona
- Arizona State Parks
- Northern Arizona University
- University of Arizona
- OCWC volunteer experts
- The Nature Conservancy
- Sierra Club
- Verde Watershed Association
- Yavapai County Water Advisory Committee
- Coconino National Forest
- Bureau of Reclamation
- ADWR

Training and educational support available from:

- Northern Arizona University
- University of Arizona, Cooperative Extension Service
- NEMO
- OCWC volunteer experts

Several organizations may provide community involvement in implementation and maintenance, including:

- Home Owners Associations
- Friends of the Forest
- OCWC
- Master Watershed Stewards
- Spring Stewards

Some potential barriers to implementation include the following

- Absentee landowners
- It could be difficult to reach recreation users with information during the brief window they are in the watershed.

Other Recommendations

Water Quality Monitoring

Oak Creek Watershed Council should continue to monitor water quality in Oak Creek and perhaps enter into a collaborative relationship with Friends of the Forest who does regular *E. coli* monitoring. Beyond water quality monitoring, systematic testing of Oak Creek sediment should be conducted to see were *E. coli* sediment reservoir hot spots exists and to try to trace upgradient sources of *E. coli*. Coordinated sampling at various points along Sedona washes would be very beneficial to locate source areas of *E. coli* that is washed into Oak Creek during storm events. Turbidity testing may be another very useful way to locate erosion problems and sediment sources that contribute to *E. coli* sediment reservoirs.

Scientific investigations

Since Crabill published his results in 1999, we have known that a primary mode of *E. coli* contamination in Oak Creek is disturbance of *E. coli* sediment reservoirs by recreation or storm events. Southam (2000) repeated this finding and urged further investigation of Oak Creek sediment. Yet, only limited sediment testing (by ADEQ in 2004 and 2005) has been conducted in the past 12 years, and the methods and results differed from Southam's, so a both methods should be employed simultaneously to test the efficacy of each for monitoring *E. coli* sediment reservoirs. Also, testing of sediment up- and downstream of suspected *E. coli* sources should be done to determine the extent to which sources may "charge" reservoirs with bacteria. While many of the efforts to reduce *E. coli* have been well intentioned, none have proven effective. BMPs are not likely to be fully effective until sediment reservoir hot spots are identified and the *E. coli* stored in these reservoirs is traced back to its source. If Oak Creek contains more fine sediment than would naturally occur without human activity in the watershed, then identification of priority sediment reduction projects is in order. A geomorphic study of the bedload and bank deposits may be able to determine if sediment load in Oak Creek has changed over the past approximately 140 years since settlement by non-Indians. Forest restoration work in the upper watershed over the next 10 to 20 years is likely to generate additional sediment. Working with the Coconino National Forest, sediment and dissolved organic carbon discharge from the upper watershed should be monitored both because of potential to generate *E. coli* sediment reservoir and because of potential impacts on aquatic life.

The very obvious loading of *E. coli* into Oak Creek from washes in the Sedona area begs for a study of the washes in and around Sedona. Perhaps, as a City of Sedona's engineer asserts, a concentration of wildlife around the perimeter of Sedona is the primary source of *E. coli*. Or perhaps pet waste and human waste are also significant sources. Human DNA appeared in only 1 of 4 stormwater DNA samples (Carroll Canyon), but it was a strong positive (3 of 3). Dog DNA was negative in all 4 stormwater samples and 2 stormflow creek samples, which seem to be erroneous results due to a fairly high detection limit or perhaps degraded sample, since Southam's results regularly showed dog DNA is Oak Creek. A stratified stormwater sampling

scheme should be devised with 1. high density *E. coli* and DNA sampling, 2. follow-up DNA testing where *E. coli* levels are high, and 3. systematic isolation of areas that appear as sources of *E. coli*, especially from human and dogs. This would require a high level of coordination and sufficient volunteer or paid personnel to accomplish, because storm events that produce stormwater flow are infrequent and unpredictable. Alternatively, automated samplers with cooling systems to preserve samples and cellular text messaging to alert investigators that a sample is available for pickup could be used, but such systems are expensive. In either case, ground surveys of fecal matter should be conducted throughout the tributary wash watersheds to determine where there are concentrations of human, pet or wildlife feces that may contribute to *E. coli* loading. Plots may be established along transects and feces found within a plot would be tossed outside the plot so that on subsequent outings only new feces are counted, to obtain an estimate of the human, pet or wildlife defecation rates in the area.

NPDES and MS4 Compliance Monitoring

Although tracking water discharge permits in the watershed would not necessarily rise to the level of a project, some sort of communication is needed between watershed advocates and the NPDES and MS4 Permit Units of ADEQ to see if resources can be pooled to facilitate regular compliance monitoring of wastewater treatment systems and stormwater systems in the watershed. These systems are self-monitoring and there is little independent monitoring of downstream water quality. Ongoing monitoring of *E. coli* concentrations in Oak Creek might be useful to identify wastewater discharges of concern. Discharge Monitoring Reports for the Sedona Ventures WWTP that discharges to Dry Creek and Pinewood Sanitary District that discharge to Munds Creek were viewed at ADEQ. No exceedances were found in Sedona Ventures records and in fact discharge effects flow down Dry Creek that reaches Oak Creek. Pinewood Sanitary District (Pinewood) reported one exceedance during January of 2011. During the period 2005-2011, Pinewood listed several emergency discharges, which are allowed under their permit (with monitoring) to avoid pond levels becoming too high on their dam. The most reasonable monitoring would be to keep tabs on when Munds Creek flows in the spring or during monsoon season and sample flow to see if any *E. coli* may be coming down from Munds Park.

Conclusion

The same actions recommended in 1999 by ADEQ's first TMDL report and by Southam in 2000 (see Chapter 1) are needed yet today to reduce *E. coli* and related fecal contamination in Oak Creek. Some have been implemented on a limited basis, but a more comprehensive effort is needed to educate the public and provide the means for healthy behaviors (eg. dog waste collection stations and adequate toilet access). The fact that our findings echo those of previous studies that were completed more than 10 years ago underscores the importance of translating science to the public through effective public outreach efforts. Science is not meant to sit on a shelf moldering in a forgotten professional journal or agency report. Scientific findings must be transformed into public knowledge that has the power to affect human behavior to improve the environment. That is why 5 out of 15 of the proposed projects are education and outreach projects, and the remaining 10 projects each have a key education and outreach element, all of which would fall under the umbrella of the Oak Creek Community Outreach Program (OCCOP). Although actions of the Oak Creek Watershed Council (previously Oak Creek Canyon Task Force), ADEQ, Coconino National Forest, Slide Rock State Park and others have tried to reduce *E. coli*, records of *E. coli* exceedances at SRSP show no trend in either frequency or severity. This lack of response may be because some key science-based recommendations of the past have not been acted upon. Our hope is that this WIP and the projects created from it will remedy this situation.