

## WATER QUALITY CONCERNS

The pollutants of concern contributing to the impairments in the Upper Granite Creek Watershed are nutrients—nitrogen and phosphorus—and *E. coli* bacteria.

### **Potential Sources of Pollution**

#### Aging Sewer Infrastructure



*Above:* A sheet of metal acts as a temporary cover on a sewer manhole in Miller Creek that overflowed during a storm.

Thirty-three percent (14.94 sq. mi) of the project area is connected to Prescott’s municipal sewer. Prescott has over 300 miles of wastewater collection infrastructure (City of Prescott<sup>a</sup>, 2010) that relies primarily on gravity for transporting liquid waste to the primary wastewater treatment plant, located above Watson Lake at the base of the watersheds. There are 185 municipal lines and five miles of private service lines within the WIP project area. Many of the sewer lines, sewer mains, and manholes are located in the creek beds or adjacent to the creeks. This becomes an acute water quality problem if a pipe leaks or breaks or if sewage overflows at a manhole. With some of this infrastructure as old as 90 years (City of Prescott<sup>a</sup>, 2010) and even recent infrastructure in need of

upgrades, sewer overflows are not entirely uncommon. During a heavy winter storm in January 2010, stormwater inundated aging sewer lines, resulting in sewer overflows from five manholes along Granite Creek and Miller Creek. The cumulative effect of the inflow and infiltration forced the sewage plant to discharge three million gallons of partially treated effluent into nearby Granite Creek just above Watson Lake (Dodder, 2010).

In response to this unintended discharge, the City of Prescott has made further efforts to prevent sewer overflows. They have closely surveyed all manholes in waterways throughout the city, replaced manhole covers that were ripped off in the storm, locked all covers that currently have the locking ability, and identified all manhole lids that will be upgraded to incorporate the locking ability. A manhole insert program is also being implemented to reduce the amount of inflow water that enters manholes from the streets. The City approved water and sewer rate increases to fund upgrades to the wastewater treatment facility and maintenance to the system.

Private service lines connecting individual residences to the city’s mainline also represent potential sources of nutrients and bacteria in the case of a leak or blockage. It is difficult to know how frequent these types of occurrences are or how they are handled and, therefore, quantify the impact to water quality.

The discharge of untreated sewage directly to bodies of water poses serious environmental and human health risks. Human waste contains organic material; bacteria in the water decompose the organic material which produces additional nutrients for plant growth. The decomposition

process requires oxygen, leading to a decrease in the amount of oxygen available to aquatic life. In addition to increased nutrient and decreased oxygen levels, untreated sewage contains bacteria (such as Salmonella), viruses (such as Hepatitis A) and parasites (such as Giardia and Cryptosporidium) that are capable of causing disease in humans.

In this document, the term ‘sewer’ refers to the municipal sanitary sewer system. Prescott is considered a Municipal Separate Storm Sewer System (MS4), meaning that the sanitary sewer and stormwater sewer systems are not connected (See *General Permit BMPs Applied in Watershed*).

### Failing or Ill-Maintained Septic Systems

The exact number of on-site wastewater treatment systems, or septic systems, in the Upper Granite Creek Watershed is not known. However, residences in the unincorporated area of Yavapai County typically use these systems to dispose of household wastewater. Nearly 10% of the watershed is unincorporated land that is not national forest, tribal, or other state or federal lands. Additionally, a small percentage of residences within the City of Prescott that have not been connected to the municipal sewer infrastructure rely on septic systems for wastewater disposal. There are approximately 5,000 customers of the city’s water service that are not connected to the sewer system; this includes both city and county residents.

Septic systems are typical wastewater disposal systems in rural areas. When operating properly, septic systems remove many pollutants and provide some measure of protection for human health and for the environment. However, even properly functioning septic systems pose a potential impact to nearby surface waters and groundwater. All continuously operated septic systems are expected to discharge to groundwater eventually. Nitrate, a highly soluble chemical, is the primary constituent that septic systems contribute to groundwater. Microbial action in soil or water decomposes wastes containing organic nitrogen into ammonia, which is then oxidized to nitrite and nitrate. Because nitrite is easily oxidized to nitrate, nitrate is the compound predominantly found in groundwater and surface waters. It is a reasonable estimate that a septic system discharges a total load of 19 lbs. /year of nitrate and 0.4 lbs. /year of orthophosphate (Tri-State Water Quality Council, 2005).

While the impact to local surface waters by septic systems is unknown, it is a rough estimate that there are 166 residential parcels outside of the municipal sewer infrastructure (parcels likely to have one or more septic systems) that are within the 100-year floodplain. Due to their proximity to the creeks and higher groundwater levels, the potential water quality impact from these systems—properly functioning or not—is increased.

### Water Reuse (Treated Effluent and Gray Water)

Water reuse is an important conservation measure in arid regions where groundwater and drinking water supplies are limited. However, there are potential environmental and public health risks to its use, if not properly managed. Over-application or application of treated effluent or gray water prior to a rain event may result in runoff to the nearest surface water or groundwater contamination.

Municipal wastewater effluent is often used for watering parks, golf courses, and irrigating other types of outdoor landscaping. Golf courses within the project area encompass 55 acres. Parks encompass 179 acres, although not all of these acres are in grass turf. Local golf courses purchase reclaimed water, or treated effluent, from the City of Prescott to irrigate their grounds. Although the effluent has been treated, there may be salts, nutrients, metals, synthetic organic chemicals and certain long-lived pathogens that remain in the water after treatment.

Gray water is residential wastewater collected from clothes washers, bathtubs, showers, and laundry or bathroom sinks (ADEQ<sup>b</sup>) and piped to a storage tank for later outdoor watering use, generally non-edible landscape plants. As its name connotes, gray water is of lesser quality than potable water, but of higher quality than black water (from toilets). If properly collected and stored, it can be safely re-used, thereby reducing fresh water consumption. Reuse of gray water can also reduce the load on septic tanks and leach fields. While there are many benefits to gray water use, it may contain food particles, detergent or soap residue, and possibly some human pathogens. In Arizona, gray water use at the private, residential level requires a Type 1 Reclaimed Water General Permit for Gray Water for less than 400 gallons per day.

### Horses, Cattle, and Other Livestock

Five acres within the project area are zoned for horses or boarding stables. There are no grazing leases on national forest land within the project area, nor are there any Confined Animal Feeding Operations (CAFOs). The only known grazing within the project area is on Yavapai-Prescott Indian Tribe (YPIT) property as well as on private and State Trust Lands off of Prescott Lakes Parkway east of Highway 89. YPIT encompasses roughly two miles along Granite Creek and a quarter-mile segment of the North Fork of Granite Creek. YPIT land spans Highway 89 just north of the interchange with Highway 69. The tribe grazes a small herd of cattle (maximum 30 head) for a few weeks out of the year in pastures along Granite Creek. Other cattle that may exist within the project area are most likely individual, backyard animals.



*Above: A horse corral along Banning Creek.*

Numerous residents of the Upper Granite Creek Watershed keep animals on their property. Large livestock animals include a few hundred horses and probably no more than a few dozen cattle. In addition, backyard livestock animals may include chickens, ducks, geese, turkeys, sheep, goats and pigs.

Livestock can have detrimental impacts to stream ecosystems if not managed properly. Livestock that are allowed access to a stream can destroy riparian vegetation, compact the soil, and cause bank erosion. Livestock waste can have serious water quality impacts, as well. Manure can contain bacteria, parasites, and nutrients. Pathogens may be present that can cause gastrointestinal illness, posing a public health risk. Excess nutrients from manure input can foster rapid algae growth that is unsightly and will eventually lead to lower dissolved oxygen levels

when the algae die and decompose. Proper management of animal waste can be done through implementing Best Management Practices (BMPs), which are land management practices meant to reduce or prevent runoff of pollutants to waterways.

### Wildlife

The upper Granite Creek Watershed provides suitable habitat for a range of wildlife species. The non-urbanized areas of the watershed are comprised of ponderosa pine and mixed conifer forests, pinyon-juniper woodlands, and interior chaparral. The area is home to known populations of



*Above:* Javelina are a common sight in yards in and around Prescott.

mountain lion, bobcat, mule deer, tassel-eared squirrel and other mammal species. The pine forests of the upper watershed provide habitat for wild turkeys and a host of other avian species. Federally protected species known or suspected to occur in the watershed include bald eagles (known winter roosts at Goldwater Reservoir), American peregrine falcons (known to nest at Thumb Butte), and Mexican spotted owls (the watershed includes designated critical habitat).

Due to the proximity of residential areas to the national forest, wildlife sightings in town are common. Skunks, raccoons, and javelina are common wildlife species in and around town and are drawn to scavenging in gardens, compost piles, and garbage. Wildlife scat could be a significant contributor of nutrients and bacteria in local creeks, especially if their presence is encouraged by human activities.

### Pets

Research shows that a significant source of bacterial contamination in urban watersheds can be attributed to non-human waste—in some cases up to 95% of bacteria being from non-human origins (Alderserio, 1996; Trial, 1993). In urban watersheds, a likely culprit is pet waste in stormwater runoff. Every time it rains, pet waste in yards, parks, or on sidewalks washes down storm drains and into streams, rivers and lakes.

If not disposed of properly, pet waste flows directly into nearby streams and creeks without being treated at wastewater treatment facilities. When pet waste is washed into lakes or streams the waste decays, using up oxygen and sometimes releasing ammonia. Low oxygen levels and ammonia combined with warm temperatures can kill fish. Pet waste also contains nutrients that encourage weed and algae growth. Overly fertile water becomes cloudy and green – unattractive for swimming, boating and fishing. Perhaps most importantly, pet waste carries diseases which make water unsafe for swimming or drinking.



*Above:* Our beloved pets can be water quality nuisances, if their waste is not properly disposed of.

Pet waste may not be the largest or most toxic pollutant in urban waterways, but it is one of the many little sources of pollution that add up to a big problem. Domestic dogs and cats are the most commonly kept animals in the Upper Granite Creek Watershed. Dogs are commonly walked at parks and trails within the watershed, including the Greenways Trail System and West Granite Creek Park in downtown Prescott, as well as at numerous recreation areas within the city and Prescott National Forest. There are several dog boarding and veterinary facilities located near creeks, with one facility actually spanning a creek. The waste collection practices of these facilities are not known. The Willow Creek Dog Park, the only dog park in the area, is outside of the WIP project area.

## Fire

Fire plays an important role in the Upper Granite Creek watershed. The predominant vegetation types in the upper portions of the watershed are ponderosa pine forest and interior chaparral, both of which are fire adapted ecosystems. In 2002, the Indian Fire burned more than thirteen hundred acres just south of the city of Prescott, in the southern portion of the watershed. This human caused wildfire burned with high severity and created a lasting impact on the vegetation and watershed condition. As a result, burned areas were treated by the Prescott National Forest to prevent catastrophic flooding and possible loss of life and property in post burn precipitation



*Above:* The haze from a fire in School House Gulch hangs in the air.

events. Treatments included aerial seeding, broadcast mulching (hydro-mulch), contour tree felling, straw bale check dams, and roadwork. In the time since the fire, vegetation in the burned area has responded, and the area currently supports chaparral species, oak trees and a healthy grass component. Numerous other wildfires have occurred in the upper watershed over the past decade, though all have been smaller in scale than the Indian Fire.

Prescribed fire also plays an integral role in the upper watershed. Approximately 40% of the project area is managed by the Prescott National Forest. Given the proximity of this forested land to the adjacent and imbedded private property, a major goal of the Prescott National Forest is fuels reduction and treatment. Prescribed fire (planned ignitions) occurs throughout much of the USFS lands within the project area. Areas of treatment are burned on a recurring basis with an objective of reducing hazardous fuel loading in areas near private property, and restoring fire to its natural role in the ecosystem. The Prescott National Forest takes every precaution to protect creeks and riparian areas from directly receiving ignition while still reducing fuel buildup; however fires, both wild and prescribed, are likely to have a water quality impact in the watershed.

Fires can have both positive and negative effects on the physical, chemical, and biological components of aquatic systems (Forest Encyclopedia Network, 2010). The effects of a fire on water quality depend on the size of the fire, intensity, and severity of the burn. Fires have the potential to increase stream nutrients, particularly nitrate and phosphorus. Nitrate, a highly mobile ion, is at risk of leaching from the burned area. Phosphorus, which readily binds to

sediments, is more likely to be transported to a nearby water body through soil erosion; the rate at which soil erosion occurs post-burn depends on how much ground cover was burned and the surrounding topography. Fires may also increase stream temperature, which in turn will reduce the dissolved oxygen level.

### Impervious Cover and Stormwater

Impervious cover in the project area is 5,310 acres or 18.6% (**Fig. 5**). Impervious surfaces, or hardscapes such as asphalt, concrete, and rooftops, do not allow water to infiltrate the ground. When it rains, or when snow melts, the runoff moves quickly over these surfaces, picking up contaminants and depositing them into receiving water ways. Alteration of the natural landscape with impervious surfaces also increases the volume and velocity of runoff and peak flow, increasing problems with flooding and erosion in streams and washes (Clarke and Stoner, 2001). Science generally agrees that stream degradation will consistently occur at even low levels of imperviousness within a watershed (10-20%), with severe degradation expected beyond 25% impervious cover (USEPA; CWP, 2003). Additionally, research shows that annual phosphorus, nitrogen, chemical oxygen demand (COD), & metal loads increase in direct proportion with increasing impervious area (USEPA).

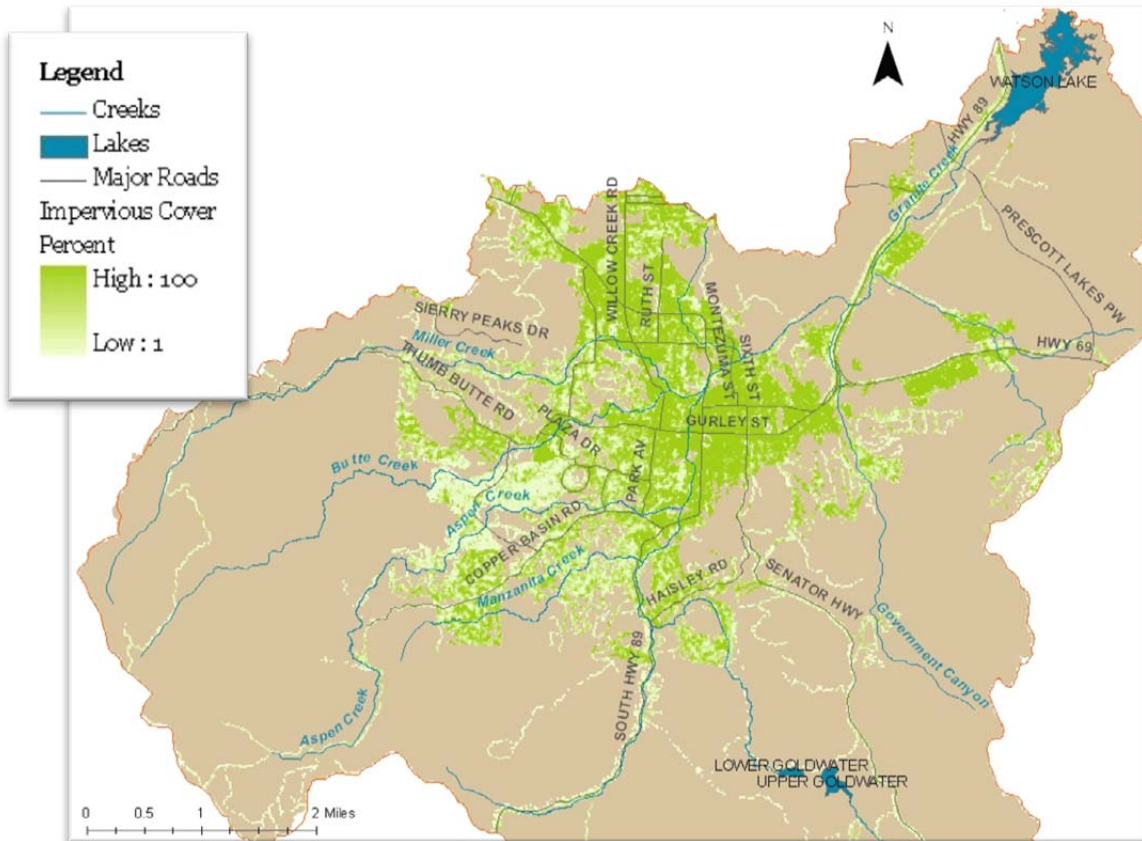
While impervious cover and stormwater are not direct pollutants, they play a well-recognized role in the degradation of water quality (CWP, 2009; Reese, 2009). Different schools of thought, such as Volume-Based Hydrology (VBH), have developed around the concept of runoff volume as something to mitigate and manage in order to improve or protect water quality. As in other urban watersheds, the Granite Creek Watershed faces challenges to managing stormwater and the nutrients and bacteria transported in stormwater.



*Above:* Stormwater from a road drains directly into Butte Creek.

Both the City of Prescott and Yavapai County are MS4 entities, meaning that their stormwater system is separate from a municipal sewer system. Stormwater is not treated before it is directly discharged into the nearest waterway through ditches, scuppers, drainpipes, concrete slides and other features (City of Prescott<sup>b</sup>). With a portion of the Upper Granite Creek Watershed being urbanized, existing riparian vegetation and topography often have been altered, graded, or paved, removing natural detention, filtration/infiltration functions. Prescott has 400 miles of streets and storm sewers.

Stormwater inundation of the City of Prescott’s aging sewer infrastructure is a problem known to result in sewer overflows into the creeks.



**Figure 5: Impervious Cover in the Upper Granite Creek Watershed**

Impervious cover within the Upper Granite Creek Watershed is estimated at 18.6%. This figure demonstrates that impervious cover is primarily clustered in the urban, developed areas of the watershed. Impervious surfaces are hardscapes such as asphalt, concrete, and rooftops that impede natural infiltration. Even low levels of imperviousness can have detrimental impacts to stream health.

### Recreation

There is a significant amount of recreation within the watershed, from the Greenways Trail System downtown to the Prescott National Forest’s system of motorized and non-motorized trails. There are recreation sites, dispersed camping areas, and numerous summer camps in the upper watershed.

Lack of adequate restroom facilities and poor sanitation practices by recreationists (swimmers, boaters, campers, hikers, etc.) can introduce human waste and, therefore, *E. coli* bacteria and other pathogens, into waterways. The risk to water quality increases with heavier use and proximity to a waterway. ADEQ studies along Oak Creek, a popular recreation area in central Arizona, determined that recreation was a human source of *E. coli* more so than a source of nutrients. Oak Creek is currently impaired for *E. coli* bacteria; the 1999 TMDL analysis determined that there were no nitrogen or phosphorus impairments within the Oak Creek watershed (ADEQ, 2010). For the purposes of this project, recreation is considered a source of *E. coli*, not nutrients.

## Environmental and health risks

### Algal Blooms

Every summer, hot weather and low water levels in Watson Lake result in the prolific growth of algae and aquatic plants. These blooms are unsightly and hinder recreational opportunities on the lake. Additionally, certain types of algae pose a health risk to humans and wildlife (see “fish kill” below).



*Above:* Filamentous green algae below the surface of Watson Lake.

The condition of the lake has drawn the scrutiny of the public and elected officials and was the focus of a series of articles printed in The Daily Courier in the summer of 2010:

- Algae creates nuisance on Watson and Willow Lakes, 7/5/2010
- Solution for lakes starts upstream (Editorial), 7/11/2010
- Lake algae on Tuesday agenda for Prescott City Council; solutions range from weed harvesting to added fee, 7/11/2010
- Prescott Council looks at solutions for water quality issues in Willow, Watson Lakes, 7/13/2010

### Fish Kill

A fish kill occurred in Watson Lake in July 6, 2000. The kill consisted entirely of Golden shiner (*Notemigonus crysoleucus*) (AZGFD, 2009). There was an algal bloom, identified as Aphanizomenon, occurring during the kill, high pH between 9.5 - 9.8, and chlorophyll-a levels were 10 to 15 times higher than typical for the summer (AZGFD, 2009; ADEQ<sup>a</sup>, 2004; Civiltech Engineering, 2009). Aphanizomenon is a type of algae from a genus that causes nuisance algal blooms and can produce a toxin that can kill fish. This type of algae is normally associated with lakes that have a high pH and elevated nutrient levels (AZGFD, 2009).

Fish kills can also occur as a result of low dissolved oxygen. Excess nutrients can fuel the growth of algae and aquatic plants; when the vegetation decays oxygen is consumed, resulting low dissolved oxygen levels.

### Recreation

Watson and Willow Lakes are touted gems of the Prescott area that attract recreationists and tourists from across the state and beyond. As mentioned above, the growth of algae and aquatic plants can hinder recreational opportunities on the lakes for boating, fishing, wildlife viewing, and sight-seeing. Bacteria in surface runoff may make waters unsafe for fishing, boating, and other forms of water-based recreation.

Public Health

Fecal coliform bacteria may occur in ambient water as a result domestic sewage contamination or nonpoint sources of human and animal waste. Bacteria and pathogens are nearly always present in high concentrations in surface runoff (Clarke and Stoner, 2001).

The presence of *E.coli* bacteria in aquatic environments indicates that the water has been contaminated with the fecal material of man or other animals. If *E.coli* is present, the source water may have been contaminated by pathogens or disease producing bacteria or viruses which can also exist in fecal material. The presence of fecal contamination is an indicator that a potential health risk exists for individuals exposed to this water. Some waterborne pathogenic diseases include typhoid fever, viral and bacterial gastroenteritis and hepatitis