QUEEN CREEK
2017 AQUATIC SPECIES AND HABITAT SURVEYS FOR ARIZONA GAME AND FISH DEPARTMENT

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RECOMMENDED CITATION

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EXECUTIVE SUMMARY

In October 2017, the Arizona Game and Fish Department conducted fish and aquatic herpetological surveys along Queen Creek on Tonto National Forest and Boyce Thompson State Park lands downstream of the Superior Waste Water Treatment Plant and documented >240 juvenile and adult lowland leopard frogs (*Rana yavapaiensis*), as well as multiple age classes of green sunfish (*Lepomis cyanellus*). Red-spotted toad (*Bufo punctatus*) metamorphs were abundant throughout the survey reach (300+) and one black-necked gartersnake (*Thamnophis cyrtopsis*), a species usually found near water, was detected in a deep pool. Aquatic habitat within Queen Creek is primarily shallow runs and riffles, with a few deep pools (>1 meter). A predominantly native riparian tree overstory creates a significant amount of shade and canopy cover, beneficial to numerous wildlife and aquatic habitat quality.

On five separate days leading up to and during surveys, the Department documented fluctuating surface flows in volume, velocity and downstream extent between days. Despite the fluctuations which created periods of intermittent and continuous surface flows throughout the survey reach, aquatic wildlife and numerous other avian and terrestrial species appeared to utilize this habitat. Aquatic species appeared to be thriving and reproducing. During the October 2017 surveys, the Department conducted wet/dry mapping to document flow regimes at the time of the surveys. Flow regimes varied between two survey dates. Overall, there was a 26% difference between total meters of wet segments measured along Queen Creek on Oct. 23rd versus Oct. 31st; which equates to a 63% change between survey dates. Further investigations to identify contributing sources for fluctuating flows along Queen Creek revealed two main sources; discharges from Imerys Perlite Mine USA, Inc. and the Superior Waste Water Treatment Plant. The largest volumes of flow originated from the Imerys Perlite Mine discharges, and appear to be the primary reason intermittent surface flows exist.

To supplement biological surveys, water quality and fish/frog tissue samples were collected to evaluate Queen Creek against state water quality standards and determine if bioaccumulation of heavy metals in aquatic wildlife may be a current issue. The Arizona Department of Environmental Quality (ADEQ) has designated uses of Aquatic and Wildlife effluent dependent water (A&Wedw) and Partial Body Contact (PBC) for the surveyed reach of Queen Creek due to the Town of Superior Wastewater Treatment Plant (WWTP) discharge. Queen Creek is on Arizona's 303(d) list of impaired waters and currently ADEQ is developing Total Maximum Daily Load calculations for dissolved copper. Laboratory results of Department water quality and fish tissue samples indicate Queen Creek generally has good water quality that should support a diverse population of fish and other aquatic organisms. The analysis of tissue samples collected on October 31, 2017 and July 10, 2018 indicate that chromium, copper, mercury and zinc are probably a non-issue for both the Green sunfish and Leopard frog.

The surveys addressed a data gap in current knowledge about the occurrence or abundance of fish and/or aquatic herp species within Queen Creek. A couple historical native fish stocking records suggest native fish may have been present in the past, but there is no current evidence they have persisted over time. Additional survey would be requisite to future wildlife management actions.

QUEEN CREEK 2017 AQUATIC SPECIES AND HABITAT MONITORING FOR ARIZONA GAME AND FISH DEPARTMENT

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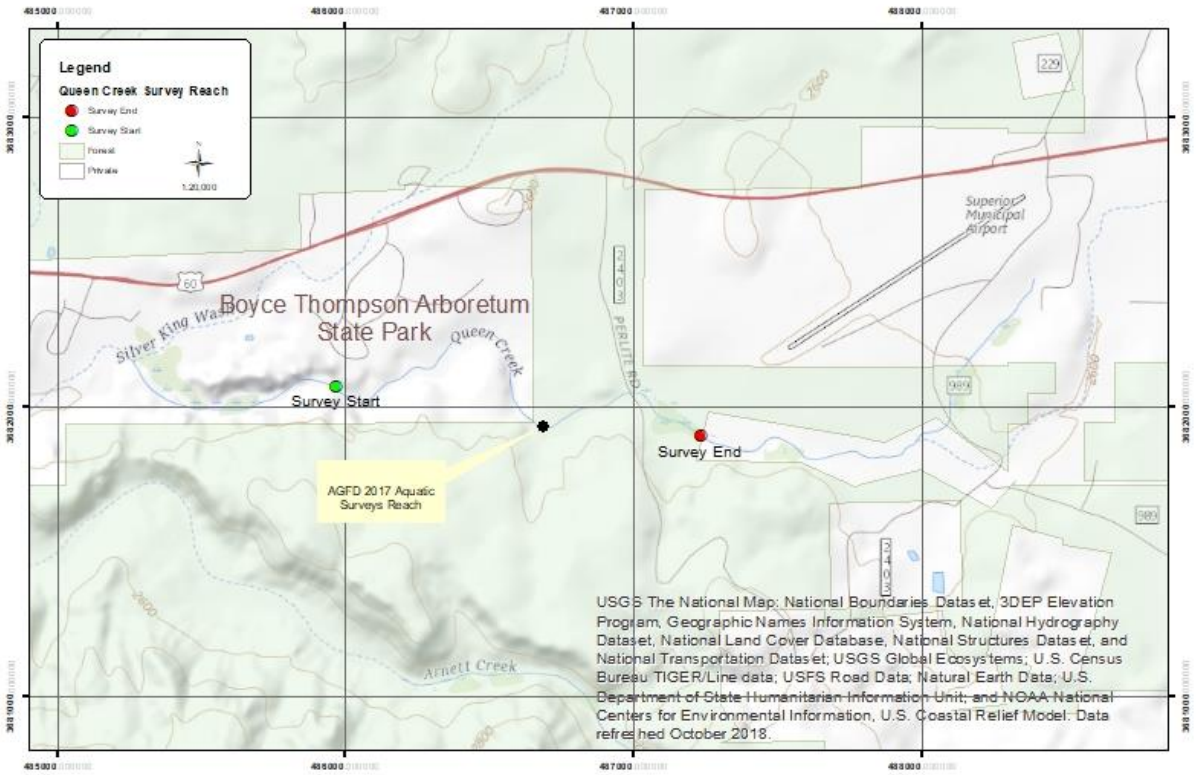
INTRODUCTION

In the fall of 2017 the Arizona Game and Fish Department (Department) conducted fish and aquatic herpetological surveys to document the presence or absence of native aquatic species (fish, amphibians and reptiles), sample water quality and investigate the flow regime of an approximate 1 mile reach of Queen Creek between the Town of Superior and the Boyce Thompson Arboretum (Figure 1) in Gila County, Arizona. Surveys were conducted on Tonto National Forest (TNF) and Boyce Thompson Arboretum State Park lands downstream of the Superior Waste Water Treatment Plant (WWTP) and FR989.

Figure 1. Queen Creek survey reach and location near the Town of Superior in Gila County, Arizona



The survey reach of Queen Creek is characterized by a narrow gallery of mature native riparian vegetation with a high amount of invasive species in the understory (Photos 1-4). The tree overstory was dominated by mature Fremont cottonwood (*Populus fremontii*), Arizona ash (*Fraxinus velutina*), Gooding's willow (*Salix gooddingii*). Also present, in lower numbers, were non-native tree species Mexican palo verde (*Parkinsonia aculeate*), tamarisk (tamarisk sp.), and tree of heaven (*Ailanthus altissima*). Velvet mesquite (*Prosopsis velutina*) was common in the

uplands, and there were nonnative date palms (*Phoenix dactylifera*) in a few areas. Shrubs included burroweed (*Baccharis sarthroides*), common cocklebur (*Xanthium strumarium*), lantana (lantana sp.); and the forbs Western ragweed (*Ambrosia psilostachya*), wild celery (*Apium graveolens*), silverleaf nightshade (*Solanum elaeagnifolium*), and sacred datura (*Datura wrightii*), with the frequent vine canyon grape (*Vitis arizonica*). Stream side vegetation is dominated by bermuda grass (*Cynodon dactylon*), common cocklebur, speedwell (Veronica sp.), cattail (Typha sp.), carex (Carex sp.), tall flatsedge (*Cyperus eragrostis*) and Johnson grass (*Sorghum halepense*).

Photos 1-4. Representative photos of streamside vegetation.

Numerous wildlife sign were noted throughout surveys including deer, javelina, raccoon, skunk and other small rodents. Common game species throughout the Queen Creek area include mule deer, white-tailed deer, mountain lion, javelina, mourning dove, white-winged dove, Gambel's quail, desert cottontail and black-tailed jackrabbit. Desert bighorn sheep range throughout the Mineral Mountains and within the immediate vicinity of Arnett Creek and Queen Creek downstream of Superior. Portions of Queen Creek lie within the Boyce Thompson Arboretum and Arnett-Queen Creeks IBA (Recognized May 2007, National Audubon Association). The diversity of habitats within the IBA including the two intermittent creeks provide migratory, winter and breeding habitat for at least 275 species, including 62 of Special Conservation Status in Arizona (http://aziba.org).

Historically, a few special status and aquatic species have been documented in Queen Creek and nearby Arnett Creek and Telegraph Canyon including lowland leopard frog (*Rana Yavapaiensis*), Common black hawk (*Buteogallus anthracinus*), Sonora mud turtle (*Kinostern sonoriense*), longfin dace (*Agosia chrysogaster*), Gila topminnow (*Poeciliopsis occidentalis*), Roundtail chub (*Gila robusta*) and desert pupfish (*Cyprinodon macularius*).

Lowland leopard frogs historically occurred at Pump Station Spring in the upper Queen Creek watershed, but current status is unknown. The last documented observation was a juvenile on September 2, 1992 (AGFD Heritage Data Management System (HDMS). In the vicinity of the surveys reported herein, leopard frogs were documented prior to the survey in June of 2017. In recent years, this species has been documented in nearby Arnett Creek, Telegraph Canyon and tinajas associated with the Mineral Mountains south of Picketpost Mountain. In 2017 leopard frog was documented approximately 3 miles from the survey reach within Happy Camp Canyon, a tributary to Queen Creek originating north and west of Superior, Arizona. Historically, this species also occurred downstream at Benson Spring, but has not been documented since 1992; and it was documented in Arnett Creek near the confluence of Queen Creek in 1981 (HDMS). Sonora mud turtle was documented at Benson Spring as recently as June 2017 (HDMS, 4-2-18).

Historic native fish survey data and species occurrence records within the Queen Creek drainage in Pinal County are nearly nonexistent. This does not mean fish did not exist, but indicates that Queen Creek has not been a focus for native fish surveys or stocking efforts in recent years; or flow regimes have been variable or diminished and have not supported fish reproduction and survival over time. With that said, Robinson (2008b) reports a reference from Bagley et.al. (1991) that desert pupfish were stocked into Queen Creek pre-1978 at an unknown location. According to Voeltz and Bettaso (2003) the source stock was from nearby BTA pond and the species did not persist in Queen Creek. During the same time period there is a reference to Gila topminnow (wild source) stocked into Queen Creek pre-1977 (Weedman 1998); however according to Voeltz and Bettaso (2003) there were no stocking records for Queen Creek, but topminnow were collected from Queen Creek 1976 Apr 28 and believed to have been escapees from the BTA pond. Lastly, Minckley and Brooks (1985) reported a Queen Creek stocking record for Gila chub in the 1930's and there is a 1938 record of a historically occupied locality for Gila chub (*Gila intermedia*) in Queen Creek (USFWS 2015); but according to a 1996 status review for this species no chub have been collected in Queen Creek since 1938 (Weedman et. al. 1996).

Arnett Creek is a tributary to Queen Creek downstream of the 2017 Queen Creek survey reach reported herein. Arnett Creek native fish repatriation began in the mid-90's in coordination with the Tonto National Forest (TNF; Bizios and Tate 1995). The 1995 re-establishment project included construction of a fish barrier, completed in 1996/97, to block upstream movement of fish from Queen Creek into the perennial portion of Arnett Creek where native fish have since been re-stocked. Over the years the Department in coordination with the TNF renovated Arnett Creek to remove nonnative green sunfish and mosquitofish; and conducted stockings of multiple native fish species (1999 - 2017) including longfin dace, Gila topminnow, desert sucker (*Catostomus clarkii*) and Sonora sucker (*Catostomus insignis*) into Arnett Creek to reestablish native fish populations (Robinson, 2008b; various field/survey reports on file with AGFD Aquatics Branch). Most recently, longfin dace stocked into Arnett Creek and Telegraph Canyon July 2007; and Gila topminnow stocked into Arnett Creek May 2017 have persisted to date (Pers. comm. A. Robinson).

Restocking of Gila topminnow into Telegraph Canyon is planned for the future, pending non-native oleander (*Nerium oleander*) removal throughout the canyon. Flows downstream of these perennial stocking locations are ephemeral and Arnett is usually dry to the confluence with Queen Creek. The Department has no record or supporting evidence that suggests native fish transplanted into Arnett Creek have ever successfully colonized into Queen Creek from these re-establishment locations.

Currently, the nearest occurrence of native fish to the Queen Creek survey reach is within Ayer Lake at Boyce Thompson Arboretum. Ayer Lake is supplied by well water sourced most likely from Queen Creek. The lake is a closed system and there is no hydrologic connectivity to Queen Creek. Ayer Lake has been a refuge site for Gila topminnow and desert pupfish since the 1970's, and most recently stocked after a third renovation of the lake in the early 1980's (A. Robinson, 2008a). These populations have been a source for many populations established elsewhere since the 1980's (C. Carveth, AGFD Region IV; memo April 19, 2007). Currently these native fish species coexist with nonnative fathead minnows (*Pimephales promelas*), mosquitofish (*Gambusia affinis*) and red swamp crayfish (*Procambarus clarkia*). Nonnative fathead minnows have been present since 1985 and mosquitofish were documented in November 2010. During the most recent AGFD survey of Ayer Lake in 2015, no Gila topminnow were detected, only mosquitofish. Sonora mud turtle and lowland leopard frog also inhabit the lake (AGFD; CAMP and Native Fish Program, Aquatics Wildlife Branch).

On three separate days, September 22 and October 18 and 20, 2017 during reconnaissance visits to Queen Creek in preparation for conducting biological surveys, the Department observed fluctuating surface flows in volume and extent along the creek. Fluctuations in flows created periods of intermittent surface water and periods of continuous surface flows throughout the survey reach. Increased stream flow volume and velocity expanded stream widths and depths. Despite these fluctuations aquatic wildlife and numerous other avian and terrestrial species appeared to utilize the stream and riparian habitat. Aquatic species appeared to be thriving and reproducing. As a result of these observations, the Department decided to investigate stream flow point sources and flow regimes concurrent with fish and herpetological survey work and discussion follows in the results section of this report.

METHODS

For all investigations we recorded data using Universal Transverse Mercator (UTM) coordinate system, Zone 12, and map datum North American Datum 1983 (NAD 83). All survey work was conducted between survey start and end points illustrated in Figures 1 and 2.

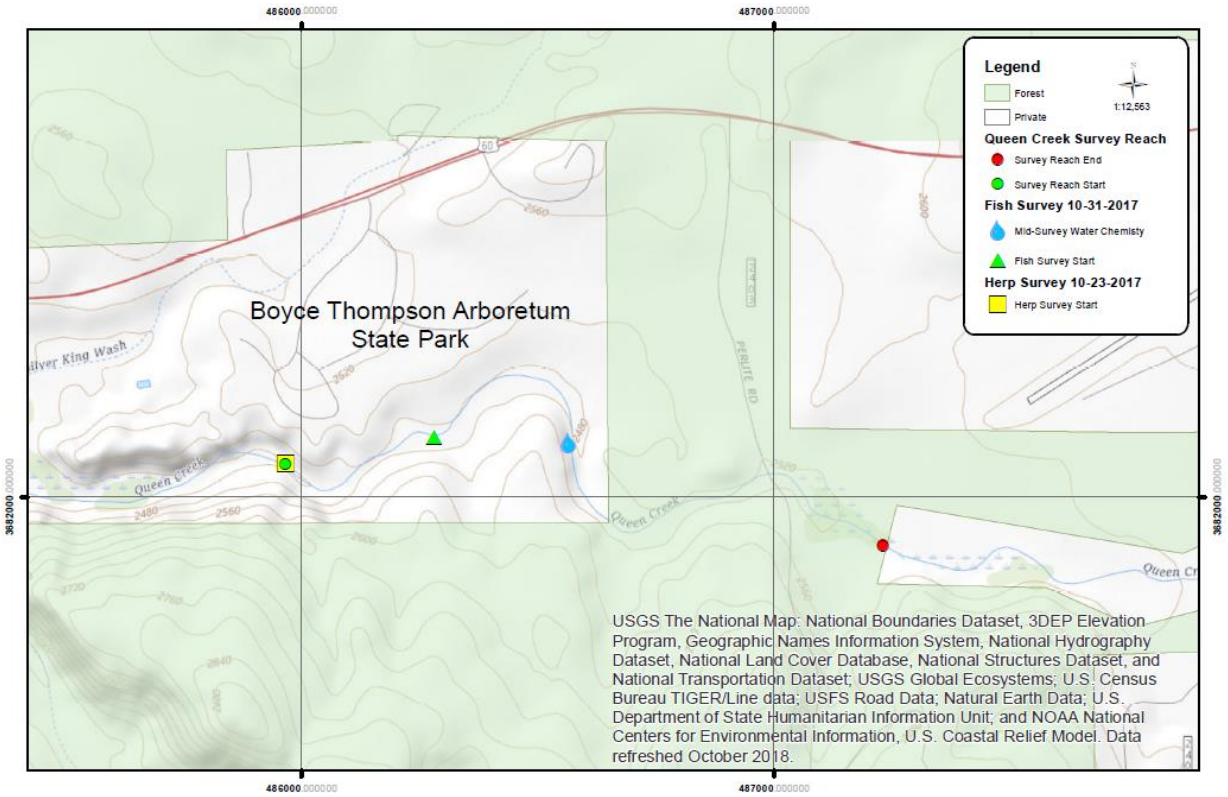
During fish and aquatic herpetological (hereafter "herp") surveys the Department conducted wet/dry mapping to characterize Queen Creek stream flows during the survey periods. During the fish survey we collected fish and frogs for tissue analysis and water quality analysis. The methods and results for these investigations are presented below.

AQUATIC HERPETOLOGICAL SPECIES SURVEY

A visual encounter survey was conducted to determine presence/absence of aquatic herp species along a 1 mile reach of Queen Creek starting downstream at 12S 485965 3682070, at 10:50. The

survey ended upstream at 12S 487231E 3681897N, at 13:50 (Figure 2). Four surveyors walked both sides of the stream along the wetted greenline and narrow floodplain to efficiently detect aquatic herp species. Focal species included lowland leopard frogs and any gartersnake species, however all observed species were documented. Species were not collected for weight or morphological measures, although all lowland leopard frogs and gartersnakes were counted. A few voucher photographs were taken to document presence.

Figure 2. Aquatic herp and fish survey locations along Queen Creek on October 23 and 31, 2017; Gila County, Arizona.



FISH SURVEY

On October 31st, 2017 Department personnel conducted an electrofishing survey of Queen Creek, downstream of Superior AZ. The survey began at the first wetted section of the creek within Boyce Thompson Arboretum State Park (12S 486281E, 3682127N) at 11:16, and proceeded upstream approximately 1 mile to survey end (12S 487231E, 3681897N) at 13:53 (Figure 2). The survey method for native fish populations follows standard electrofishing protocols for small streams outlined in Bonar (et al. 2009).

WATER QUALITY INVESTIGATIONS

STUDY AREA

The portion of Queen Creek under evaluation is approximately 3 kilometers long and has designated uses of Aquatic and Wildlife effluent dependent water (A&Wedw) and Partial Body Contact (PBC). The Arizona Department of Environmental Quality (ADEQ) defines effluent–dependent water (edw) as surface water that consists of a point source discharge of wastewater,

without a point source discharge the stream segment would be ephemeral. ADEQ has determined that the A&Wedw designation for Queen Creek is due to the Town of Superior Wastewater Treatment Plant (WWTP) discharge. However, the WWTP operates at 23% capacity which is 120 gallons/minute (gal/min) or 0.27 cubic feet per second (ft^3/sec). From January 2016 through September 2017 (21 months) the WWTP discharged an average of 93 gal/min (0.21 ft^3/sec) with a maximum average discharge of 136 gal/min (0.30 ft^3/sec) during January 2016. Therefore, surface flow is minimal, in Queen Creek, a distance less than 650 meters in an unnamed wash. There is an additional discharge from Imerys Perlite Mine that enters Queen Creek from the south immediately downstream the effluent discharged from the WWTP. The volume discharged from Imerys is comparable to the flow from the WWTP at 170 to 180 acre-feet per year. However, the Imerys discharge occurs for 12 hours a day, five days a week; which equates to 305 gal/min or almost 0.7 ft^3/sec for 12 hours 5 days a week. This almost daily discharge from Imerys results in saturated soil conditions, which provides reliable moisture throughout an approximate two mile reach of riparian habitat along Queen Creek. Further discussion on flow regime follows.

METHODS

Sample Collections:

On October 31, 2017 two sets of discrete water samples were collected from Queen Creek for laboratory analysis ten meters upstream of Perlite Road (FR2403) within the fish survey reach at 12S 486974E 3682048N (Figure 3). Water chemistry field parameters were measured with a Juniper Systems Amphibian2 multiparameter data sonde. Water samples collected for trace metals were all preserved with nitric acid; dissolved metals were first filtered through a 0.45 micron filter and then acidified. Water samples for nutrient analysis were preserved with sulfuric acid.

Concurrent with water quality sampling and fish surveys, two sets of tissue samples were collected from Queen Creek to evaluate and document current baseline conditions of trace metals in aquatic wildlife. Both samples consisted of green sunfish (*Lepomis cyanellus*) and lowland leopard frog (*Rana yavapaiensis*). Green sunfish (three adults and multiple juveniles) and five lowland leopard frogs were collected during fish surveys on October 31, 2017 from multiple sites along the fish survey reach. A second set of samples were collected on July 10, 2018 within the same survey reach (Figure 3) and included two green sunfish and four lowland leopard frogs. Due to this relatively restricted perennial reach samples were composited by species and do not represent individual collection locations. Individual fish and frogs were weighed, measured and muscle tissue excised and milled for analysis. Samples were kept in a frozen condition until analyzed.

All samples (water and tissue) were kept on ice for transport to either the Arizona Game or Fish Department's Water Quality Laboratory or Legend Technical Service Laboratory located in Phoenix Az.

Chemical Analysis:

Water samples were analyzed for a broad spectrum of parameters. Legend Technical Services analyzed for arsenic, cadmium, lead, and selenium using ICP Mass Spec. (U.S. EPA. 1994 Method 200.8); Zinc by ICP-Atomic Emission (U.S.EPA 1994 Method 200.7); Mercury by Hydride Generation (U.S.EPA 1994 Method 245.1). Water analysis conducted by the Arizona Game and

Fish Laboratory used methods from the U.S. EPA Environmental Monitoring and Support Laboratory (U.S. EPA 1993) or Standard Methods (SM 2012).

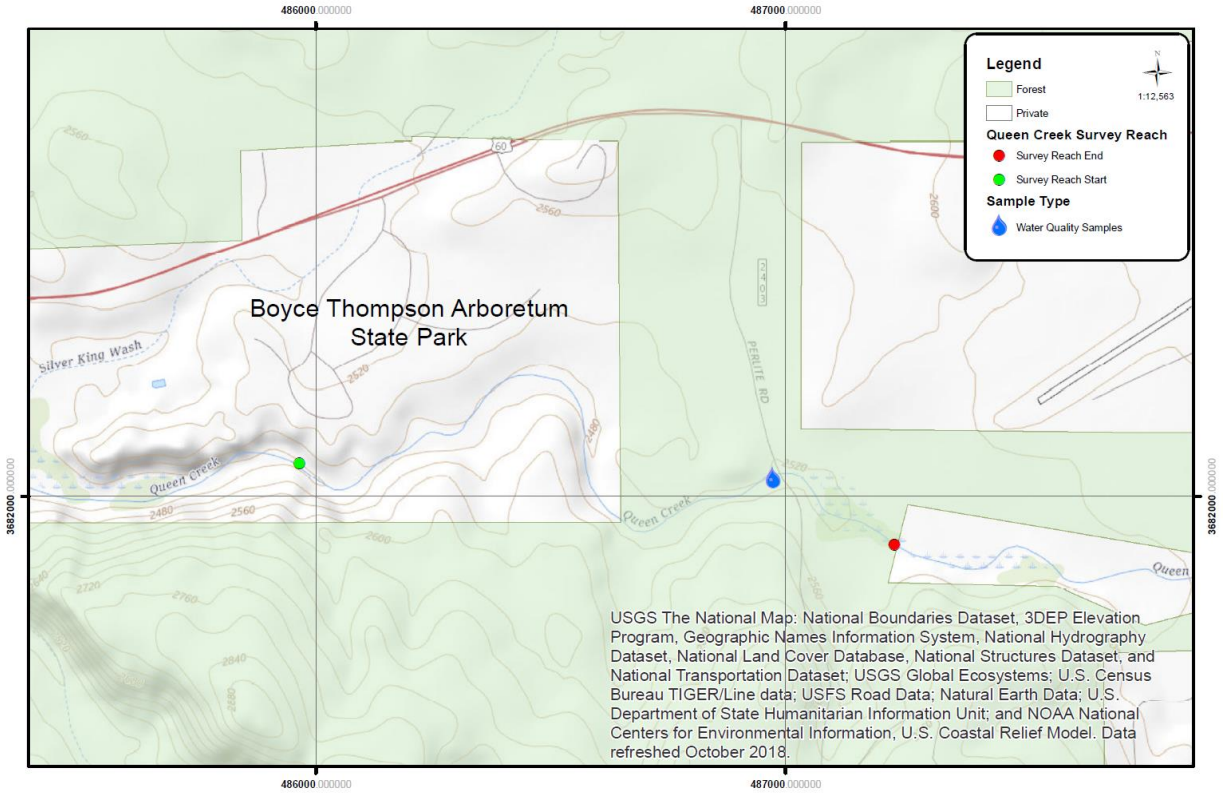
Water sample results were compared to existing water quality standards associated with effluent dependent reach of Queen Creek. These standards are promulgated by the Arizona Department of Health Services.

Tissue Analysis:

Tissues from Queen Creek were analyzed for arsenic, copper, lead, selenium, zinc and mercury at Legends Technical Services in Phoenix, Arizona. Results were compared with fish samples from six Arizona locations collected in 1984 for the U.S. Fish and Wildlife Service's National Contaminant Biomonitoring Program (NCBP). Mercury results were compared with green sunfish collected from 12 Arizona stream between 2000 and 2004 for the Environmental Protection Agency's Environmental Monitoring and Assessment Program (EMAP). The average concentrations for both data sets were calculated along with the 85^{th} percentiles. Trace metal concentrations could be considered elevated when they exceed the 85^{th} percentile of the Arizona average. The 85^{th} percentile is not based on toxic or nontoxic conditions but only provides a frame of reference.

All tissue analysis was conducted by Legend Technical Services using ICP-Atomic Emission (U.S. EPA 2007) and Hydride Generation (U.S. EPA 1998). All samples are reported as mg/kg wet weight.

Figure 3. Locations for water quality sampling and collection of fish and frog specimens for tissue analysis from Queen Creek on October 31, 2017 and July 10, 2018, Gila County, Arizona.



QUEEN CREEK FLOW REGIME INVESTIGATIONS

Concurrent with the October 23 and 31st fish and aquatic herpetological surveys, the Department conducted wet/dry mapping along the survey reaches and took representative photographs of variable stream flows and aquatic habitat features. We followed a wet/dry mapping protocol developed by a volunteer river monitoring program, Arizona Nonpoint Education for Municipal Officials (NEMO) Program, and used across Arizona for tracking/recording changes in flows for perennial reaches of rivers between years. Since the NEMO Program was launched The Nature Conservancy developed wet/dry mapping instructions and data forms to share with volunteer efforts across the state (http://azconservation.org/projects/water/wet_dry_mapping; Turner and Richter 2010) and we used these methods for data collection and processing. Mapping the river each year at the same time can provide valuable data on long-term trends and changes to base flows. Ideally, mapping is conducted at the hottest driest time of the year (mid-June before monsoon season is standard) to characterize base flows. In our case we mapped during aquatic species surveys to investigate and document fluctuating stream flow conditions at the time of survey, in light of the variable flow regimes we witnessed during the month preceding the surveys.

The beginning and end points of all surface water reaches ≥9.1m in length were recorded using Global Positioning System (GPS; Garmin rino 520HCX) technology. Dry gaps <9.1m were disregarded; and isolated pools off the main channel were recorded independently as pools. The water beginning and end coordinates were imported to a Geographic Information System (GIS) and snapped to the closest points on a linear representation of the stream (modified National

Hydrography Dataset, 1:24:000-scale, US Geological Survey, http://nhd.usgs.gov) to produce final maps that illustrate wet/dry reaches and calculate percentages of stream meters that were wet or dry.

In conjunction with aquatic species surveys and wet/dry mapping, surveyors took representative photographs of stream flows and habitat features to document general survey conditions.

RESULTS AND DISCUSSION

AQUATIC HERPETOLOGICAL SPECIES SURVEY

During surveys lowland leopard frogs were numerous along intermittent reaches of Queen Creek and surveyors documented 241 lowland leopard frogs representing two age classes (adult and juvenile; Photos 5 & 6; Figure 2). Red-spotted toad metamorphs were abundant (300+) throughout the survey reach (Photo 7). One black-necked gartersnake, a species usually found in riparian habitat, was detected in a deep pool at the furthest downstream point of surface water (12S 486281E 3682126N; Photo 8) during this survey. Surveyors were unable to get a photo of the snake as it was swimming on the opposite side of the pool, but photo vouchers were taken for the leopard frogs and toads (Photos 9 & 10). Incidentally, we documented the exoskeleton of one small crayfish during this survey. Crayfish were present in Queen Creek, but were not abundant.

Photo 5 and 6. Adult lowland leopard frogs were numerous along Queen Creek, October 23, 2017.


Photo 7 and 8. Red spotted toad metamorph observed along Queen Creek (left); and pool at NAD 83 12S 486281 3682126 where black-necked gartersnake was observed (right) October 23, 2017.

Photos 9 and 10. Adult lowland leopard frog captured along Queen Creek, October 23, 2017.

FISH SURVEY

Surveyors collected approximately 250 young-of-the-year (YOY) and 21 adult green sunfish. We visually observed approximately 200-300 other individuals (Photos 11 & 12). Three adult and three juvenile northern crayfish (*Orconectes virilis*) were captured and approximately one to two dozen other individuals were visually observed. A diverse assemblage of aquatic macroinvertebrate species were observed in Queen Creek including giant water bugs (*Belostomatidae*), water boatman (*Corixidae*) and water striders (*Gerridae*) to name a few (Photo 13 & 14).

There were several dozen leopard frogs present throughout the survey reach. No native species of fish were captured or observed during the survey; however, there appears to be suitable habitat for Roundtail chub, Gila topminnow, speckled and longfin dace, desert and Sonora suckers; assuming flows were constant as they were on the day of the survey. Under "normal" flows, when discharges are not occurring, habitat may still be suitable for chub, Gila topminnow, longfin dace, desert suckers and Sonora suckers (Photos 15-17). There were intermittent pools throughout with

three or four pools 1m or greater in depth. Further evaluation of stream habitat and flows would be necessary to adequately determine suitability for native fish.

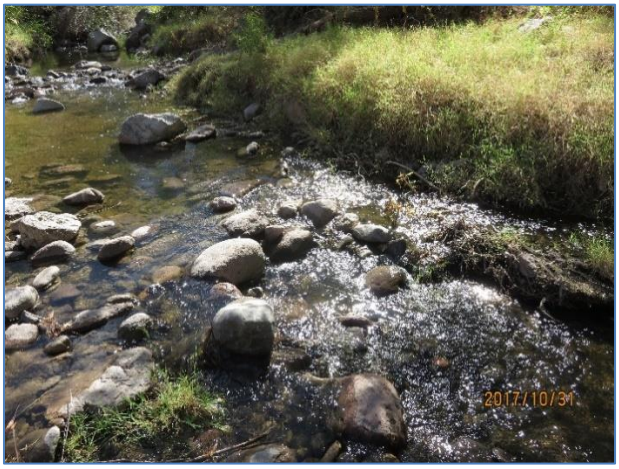
There was a good flow of water during the survey which was absent during a wet-dry survey conducted on October 23, 2017. No stream flow measures were taken during the survey. The water chemistry was measured at survey start (11:16) and approximately ½ mile upstream mid-survey at 12:21 (Table 2; Figure 2). Without the water release from the mine, the pools and flowing water would normally be more intermittent.

Table 1. Water chemistry measures taken during the fish survey along Queen Creek October 31, 2017.

Sample Location	Time	UTM Easting	UTM Northing	Temperature Celcius	pH	Conductivity mS	Salinity Parts/1000
Survey Start	11:16am	486281	3682127	19.1	7.5	1.60	0.79/1000
Mid-Survey	12:21pm	486564	3682115	17.0	7.5	0.94	0.47/1000

Photos 11 and 12. Adult and juvenile green sunfish captured during electrofishing surveys in Queen Creek, October 31, 2017.

Photos 13 and 14. Giant water bugs (left; Belostomatidae) and juvenile crayfish (right) captured during electrofishing surveys in Queen Creek, October 31, 2017.



Photos 15-17. Stream habitat included deep pools, riffles and runs along Queen Creek, October 31, 2017.

WATER QUALITY INVESTIGATIONS

Water Quality

On October 31, 2017 two sets of water samples were collected from Queen Creek ten meters upstream of Perlite Road within the fish survey reach at 12S 486974E 3682048N (Figure 3). During the initial sampling event at 09:51 there was only a trickle of water flowing in Queen Creek. After the first set of samples was collected the flow in Queen Creek began to increase considerably. The data sonde was left in place to monitor changes in the water quality as the flow increased (field parameters Table 3). When the readings stabilized at 10:45 a second set of water samples were collected at 10:46. The flow increased an estimated 7 to 10 times and remained elevated for the entire time the survey was being conducted (until 12 noon). The flow increase was attributed to the daily dewatering operations at the Imerys Perlite mine. A comparison of the water quality field parameters (Table 3) collected during this event indicated that the first set of samples collected at 09:51 was primarily bank storage flow from the previous days pumping or inflow from sub surface water. The second set of samples collected at 10:46 was representative of Imerys Perlite mine daily dewatering operations.

Table 2. Field parameters collected with data sonde from Queen Creek October 31, 2017.

Field Parameters	9:51 AM	10:46A
Temperature (°C)	18.41	16.96
Conductivity (µs/cm)	1102	450
pH (std. units)	7.41	8.02
Dissolved Oxygen (mg/l)	3.89	8.13
% saturation	42.1	86.3
Turbidity (ntu)	0.98	5.52
Oxidation Reduction Potential (mv)	229.2	203.3
Total Dissolved Solids (mg/l)	706.3	474.2
Chlorophyll (µg/l)	1.2	6.69

Analysis of Queen Creek water samples indicated generally good water quality that should support a diverse population of fish and other aquatic organisms (Appendix B). However, it should be noted that at the time of sampling the only flow in this portion of Queen Creek was from the Perlite mine and the Town of Superior WWTP. There was no flow from the upstream ephemeral portion of Queen Creek that is currently on Arizona's 303(d) List of Impaired Waters for copper. Contribution from the headwaters of Queen Creek during precipitation events could have a negative impact to the aquatic wildlife in the perennial reach. The average hardness (343 mg/l) of the two flow regimes in Queen Creek was used to calculate the water quality standards for Cd, Cu, Pb, Ag and Zn (Appendix B).

Tissue Analysis

The Level of Detection (LOD) for arsenic, lead, and selenium on the tissue samples collected October 31, 2017 were not in a range that comparisons could be made to other tissue data from Arizona. Therefore, another set of tissue samples were collected on July 10, 2018. Baseline trace metal tissue data for fish in Arizona is somewhat limited and information on metal concentrations in frog tissue is for the most part unavailable. Results of the tissue samples collected from Queen Creek are indicative a low accumulation of the trace metals analyzed (Table 3).

Table 3. Metals analysis for tissue collected from Queen Creek. Concentrations are in mg/kg wet weight.

Green Sunfish (*Lepomis Cyanellus*)		Tot. Length (mm)		Weight (g)							
Date Collected	*n*	Avg.	Range	Avg.	Range	As	Cu	Pb	Hg	Se	Zn
October 31, 2017	3	146	105-188	61	21-111	<13	<0.66	<6.6	0.18	<13	6.7
July 10, 2018	2	139	135-142	51	43-59	<0.4	0.71	<0.1	<0.07	0.51	6.9
Leopard frog (*Rana yavapaiensis*)		SVL (mm)		Weight (g)							
Date Collected	*n*	Avg.	Range	Avg.	Range	As	Cu	Pb	Hg	Se	Zn
October 31, 2017	3	61	56-70	23	15-34	<13	0.99	<6.6	<0.07	<13	6.1
July 10, 2018	4	60	59-62	21	18-23	<0.4	1.1	<0.1	<0.06	<0.4	6.4

Arsenic

The 85th percentile for arsenic in Arizona fish tissue is 0.26 mg/kg. The value for both the Green sunfish and the frog tissues were below the Level of Detection (LOD) of 0.48 mg/l. For statistical computations in the NCBP report (Schmitt and Brumbaugh 1990) a value of one-half of the LOD

was assigned if the analytical result was less than the LOD. Therefore the < 0.48 mg/kg can be assigned a value of 0.24 mg/kg arsenic which is below the 85th percentile.

Copper
The 85th percentile for copper in Arizona is 1.01 mg/kg. The average for copper in the green sunfish from Queen Creek is only 0.52mg/kg.

Lead
The 85th percentile for lead in Arizona is 0.28 mg/kg. Green sunfish as well as the frog tissue from Queen Creek was less than the LOD (0.14 mg/kg lead).

Selenium
On a national basis the 85th percentile for the geometric mean for selenium in fish tissue is 0.73 mg/kg (Schmitt and Brumbaugh 1990). Due to the seleniferous soils in Arizona the 85th percentile based on the average for the Arizona is 2.08 mg/kg. The green sunfish was below both of these values at 0.51 mg/kg selenium and the frog tissue was below the LOD.

Zinc
The 85th percentile for zinc in fish tissue for Arizona is 66.7 mg/kg. The green sunfish from Queen Creek averaged 6.8 mg/kg while the frog tissue was comparable at 6.3 mg/kg.

Mercury
Using the EMAP data for green sunfish (n=38) collected from 12 Arizona streams the 85th percentile for mercury in green sunfish 0.16 mg/kg. There were two values for green sunfish from Queen Creek one was 0.18 mg/kg and the other was less than the LOD of 0.067 mg/kg. Therefore one-half the LOD (0.034 mg/kg was assigned to the less than value for an average of 0.11 mg/kg mercury for green sunfish in Queen Creek.

More samples need to be collected from this portion of Queen Creek to develop a more complete evaluation of trace metals. These samples should be collected from the lower and the upper reaches of the perennial portion and consist of both sediment and fish tissue. The list of trace metals analyzed should be expanded to include aluminum, cadmium and nickel. Also, whole fish analysis should be conducted to determine entire body burden of trace metals.

QUEEN CREEK FLOW REGIME INVESTIGATIONS

Aquatic species habitat within Queen Creek is primarily shallow runs/pools and riffles; but there are a few pools with complex habitat structure (overhanging banks, riparian vegetation, tree roots, large woody debris and emergent plants) and variable substrates. The riparian vegetation creates a significant amount of shade and canopy cover, beneficial to numerous wildlife species and aquatic habitat quality. Streambanks are well covered with live vegetation, litter and/or rocks (see Photos 18-22). Surveyors observed intermittent flows within Queen Creek during all visits described below.

Photos 18-22. Stream habitat included cobble and sand substrates, overhanging banks, large woody debris along Queen Creek, October 31, 2017.

Concurrent with fish and aquatic herp survey work, the Department investigated stream flow point sources and detected two main sources contributing to flows within the survey reach downstream from the Superior WWTP.

During aquatic species surveys October 23 and 31st, and on three separate days prior to surveys (9/22/17, 10/18/17, and 10/20/17), the Department observed fluctuating stream flows between days in Queen Creek along the survey reach and at the old Perlite Road (FR 2403) crossing location (Figure 1).

On September 22nd stream flows were low and intermittent throughout the survey reach and at the old Perlite Road (FR2403) crossing (Photo 23). On October 18th surveyors noted elevated flows at the old Perlite Road crossing previously visited (Photo 24). On October 20th surveyors visited Queen Creek at the old Perlite Road (FR 2403) crossing again to see if flows were low or elevated and observed that flows were at low levels similar to the September 22nd visit (Photo 25). During the October 31st fish survey a continuous surface flow of greater volume and velocity than previously witnessed on all other days was observed. Flows appeared to be increasing in depth

beginning at "WW1" (Figure 5), and continuous from that point upstream to the survey end. Photo 26 shows the elevated flows at the old Perlite Road (FR2403) crossing.

Photo 23 (left; 9/22/17) and Photo 24 (right; 10/18/17) shows fluctuating flows between days along Queen Creek at the Perlite Road crossing (FR2403) in Figure 5 and 6 (NAD83 12S 486973.63E 3682047.7N).

Photo 25 (left; 10/20/17) shows flows are reduced to conditions similar to 9/22/17 along Queen Creek at the Perlite Road crossing (FR2403) in Figure 5 and 6 (NAD83 12S 486973.63E 3682047.7N); and elevated on 10/31/17 at the same location (Photo 26; right).

As a result of these observations surveyors decided to investigate potential sources for flows and variations in flows upstream. On October 20th surveyors visited an unnamed tributary to Queen Creek (Figure 4); and where effluent water is discharged downstream from the Superior WWTP on TNF lands, to determine: a) if elevated surface flows may originate from discharges by the Superior WWTP and b) if reaches within this drainage should be included in upcoming aquatic species surveys. Surveyors observed low flows and no physical evidence (debris, vegetation or changes in channel morphology) that would indicate fluctuating flows with greater volume or velocity within this channel downstream to the confluence with Queen Creek. Based on this visit, it appears that discharges from the Superior WWTP are low in volume and result in maintenance of a narrow (<1 meter in width) and shallow wetted channel (Photos 27 and 28). The Department

determined that observed elevated stream flows in Queen Creek could not have originated from this source. During the site visit we detected one lowland leopard frog (12S 488118.29E 3682086.80N).

Photo 27 and 28. Unnamed tributary to Queen Creek downstream of the Superior WWTP, October 20, 2017.

Subsequent research with Arizona Department of Environmental Quality (ADEQ) on WWTP discharge indicates that total annual discharges to Queen Creek from the Superior WWTP in 2016 were approximately 136 acre-feet (ADEQ; AZPDES Permit AZ0021199). As of September 2017, the total volume of water discharged to Queen Creek was 75 acre-feet for 2017. Flow releases averaged 94 gal/min or 0.21 ft^3/sec from 2016-2017. The discharge data from the Superior WWTP confirms the physical evidence and channel morphology that the Superior WWTP contributes a small amount to the base flow in Queen Creek. See Appendix A for additional information on annual discharges from the Superior WWTP.

During the October 23rd aquatic herp survey, there were no flows in Queen Creek at the old Perlite Road (FR2403) crossing. However, surveyors came across the leading edge of an elevated flow event near the survey reach end W15 (Photo 29; 12S 487207.08E/3681913.48N; Figure 5). Upstream from this point flows were elevated and continuous (Photo 30); and downstream they were similar to previous low flow conditions.

Further investigation confirmed that flows originated upstream from the Imerys Perlite Mine USA, Inc., a perlite mining facility that has been operating about two miles south of Highway 60 southwest of Superior since 1950. The Imerys Perlite mine covers an area of approximately 6 acres. There are two main mining pits, or quarries, on the property. Discharges from the deeper of the two perlite mine pits were flowing along an unnamed drainage into Queen Creek (Figure 4). It appears that discharges from Imerys Perlite Mine provide a significant contribution to perennial surface water and stream flows along this reach of Queen Creek. During the perlite mining process, Imerys operates a sump pit pump to dewater the deeper of the two perlite mine pits. Imerys operates the sump pump for dust control and access to the mineral, with excess water from the

quarry discharged to an unnamed tributary which flows north into Queen Creek not far downstream from the Superior WWTP discharge point.

Photo 29 (left; (NAD83 12S 487207.08E/3681913.48N) leading edge of elevated flows; and Photo 30 (right) continuous flows upstream from leading edge.

Department personnel observed mine discharges on October 18, 23 and 31st, 2017, downstream in Queen Creek and visually confirmed flows were being released from Imerys Perlite mine property into the unnamed tributary to Queen Creek at the boundary of the Tonto National Forest on October 23rd. On each of these days we confirmed at the Queen Creek/FR989 crossing that there were no surface flows originating from Queen Creek upstream of the Superior WWTP or Imerys Perlite Mine.

Figure 4. October 20, 2017 site visit to unnamed tributary to Queen Creek downstream from Superior WWTP; Gila County, Arizona.

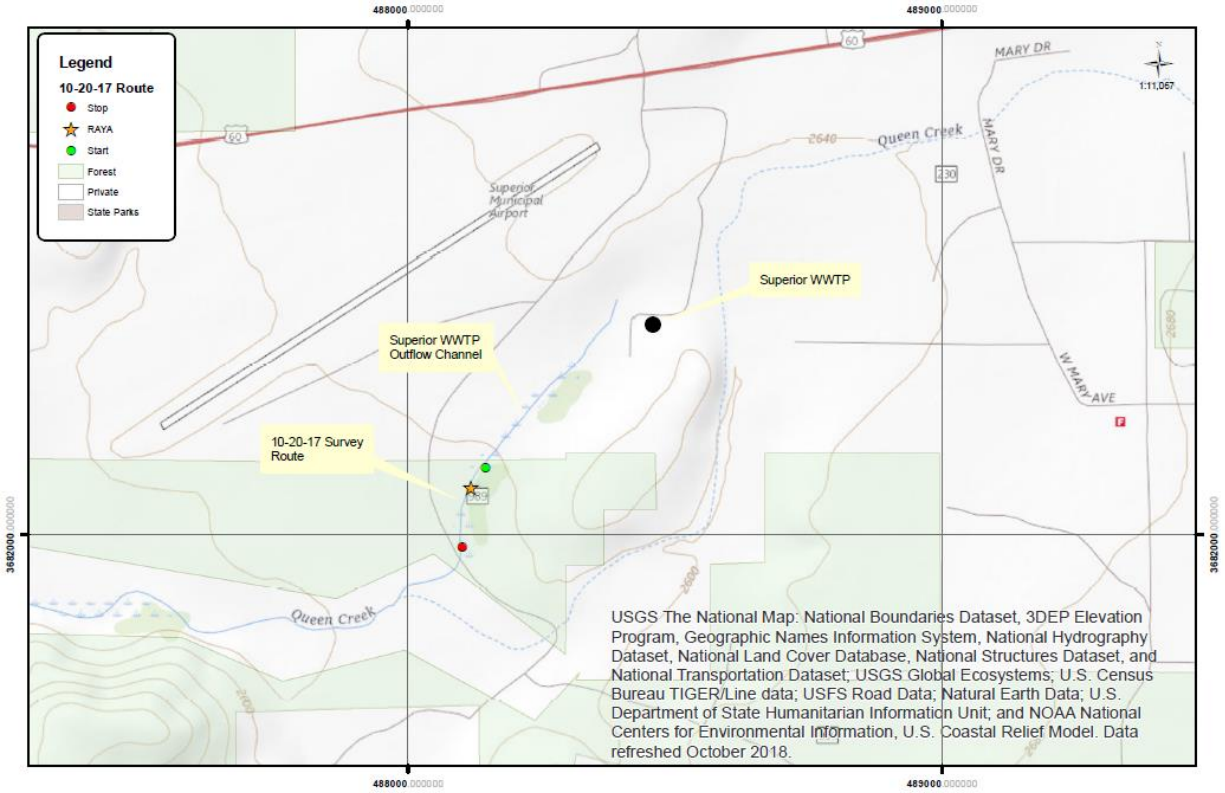


Figure 5. Imerys Perlite USA, Inc. mine facility and unnamed tributary where discharges were observed by the Department on October 23, 2017; Gila County, Arizona.

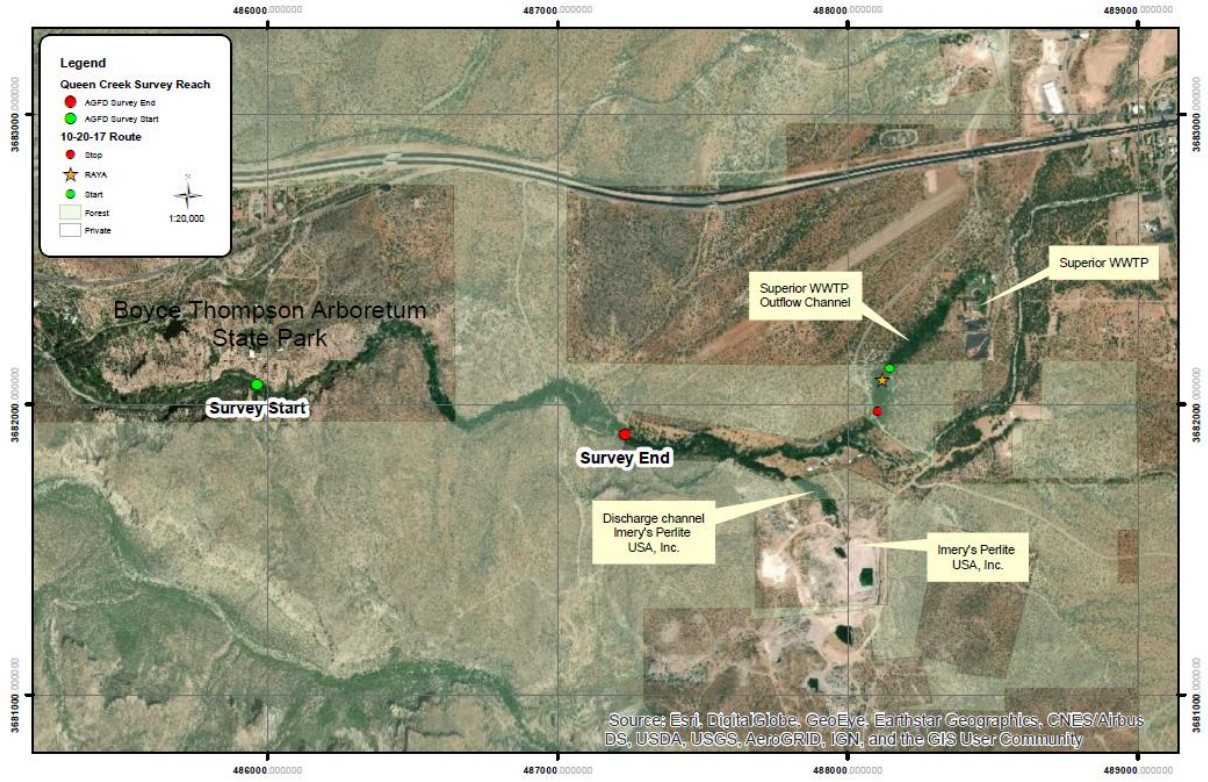
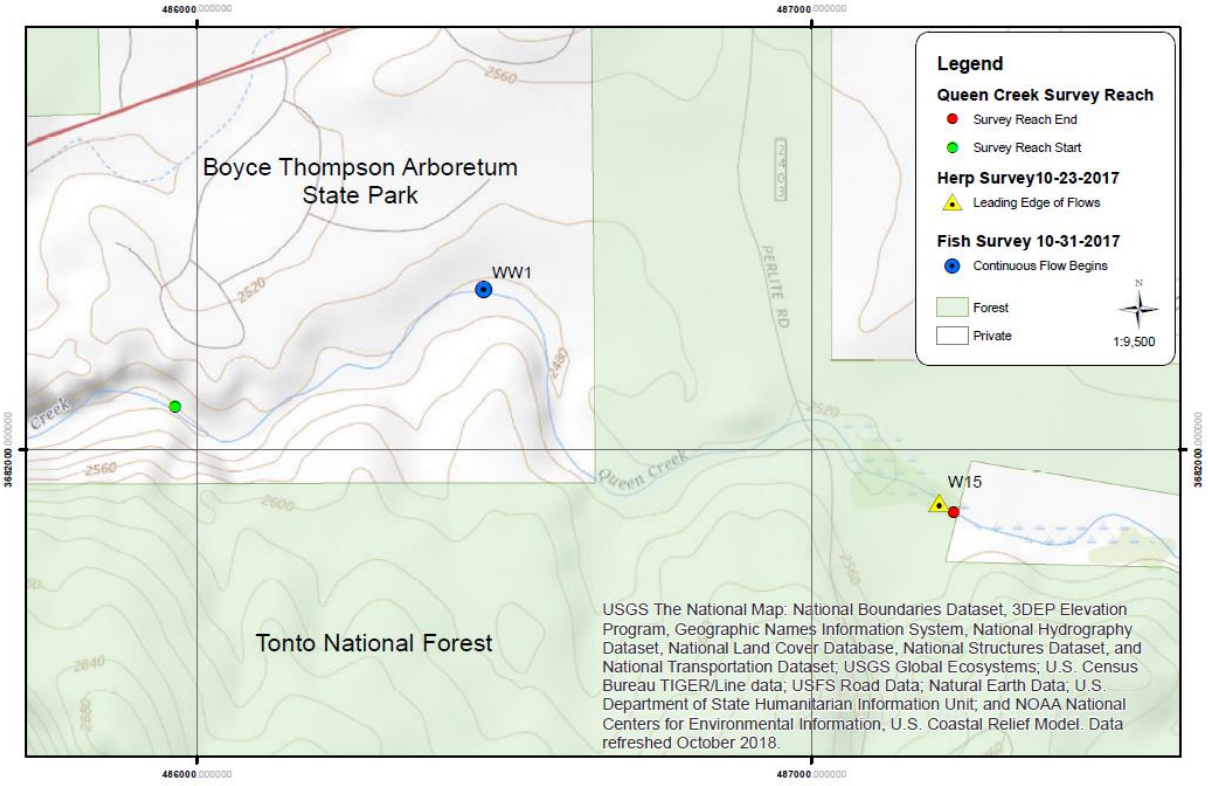


Figure 6. Locations where Queen Creek flows changed abruptly during October 23 and 31st surveys.



Wet/Dry Mapping Results

During the October 23 and 31st aquatic species surveys, the Department conducted wet/dry mapping to document the flow regimes at the time of the surveys. The total length of the survey reach for both surveys was approximately 1740 meters. Flow regimes varied between the two survey dates. Approximately 41% of the survey reach was wet on October 23 (Figure 7). There was a greater proportion of wet segments (67%) along the survey reach October 31st (Figure 8); and flows were continuous along the upstream half of the survey reach, unlike October 23rd.

Overall, there was a 26% difference between total meters of wet segments measured along Queen Creek on Oct. 23rd versus Oct. 31st; which equates to a 63% change between survey dates. Results are summarized in Table 5, as well as Figures 7 and 8 below.

Table 4. Wet and dry stream segment measures taken during the fish survey along Queen Creek October 31, 2017.

Collected	Status	Total meters in Survey Reach	% Total Survey Length	Total Survey Length (meters)
10/23/2017	Wet	713.082271	40.99	1739.78
10/23/2017	Dry	1026.554659	59.01	1739.78
10/31/2017	Wet	1164.88021	66.96	1739.78
10/31/2017	Dry	574.8967367	33.04	1739.78

Figure 7. Surveyed wet and dry reaches along Queen Creek on October 23, 2017, Gila County, Arizona.

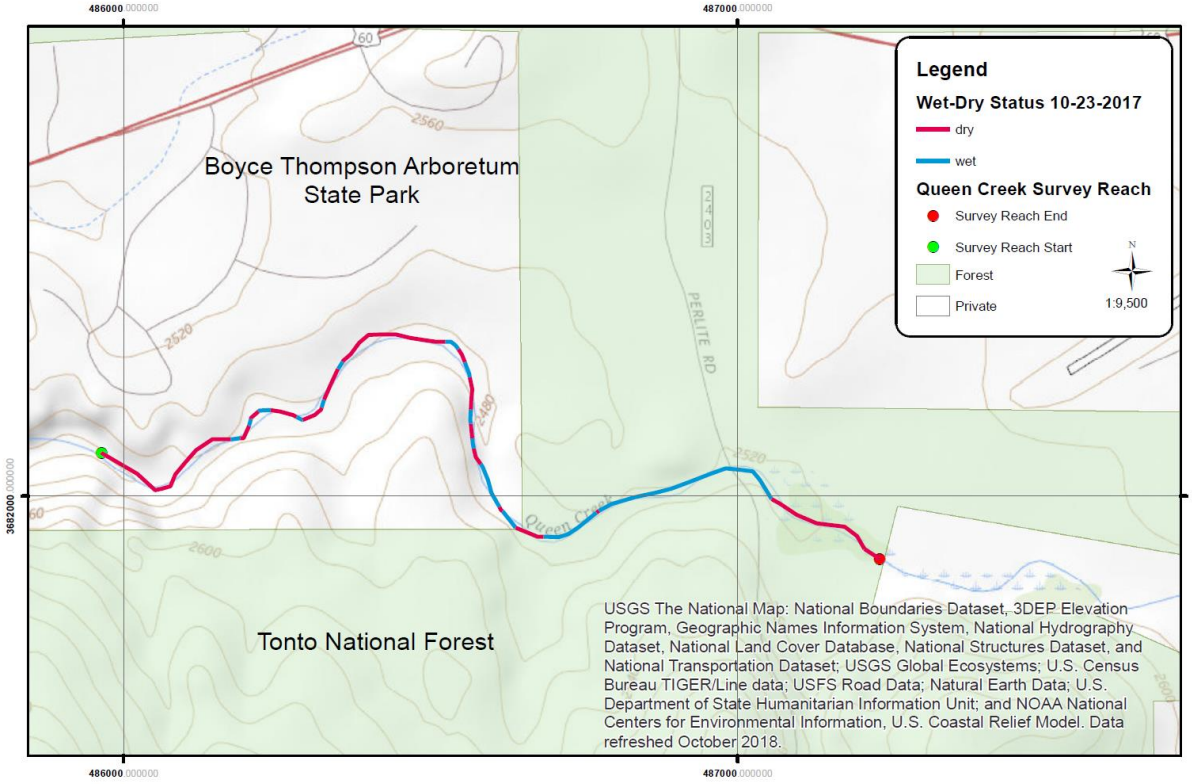
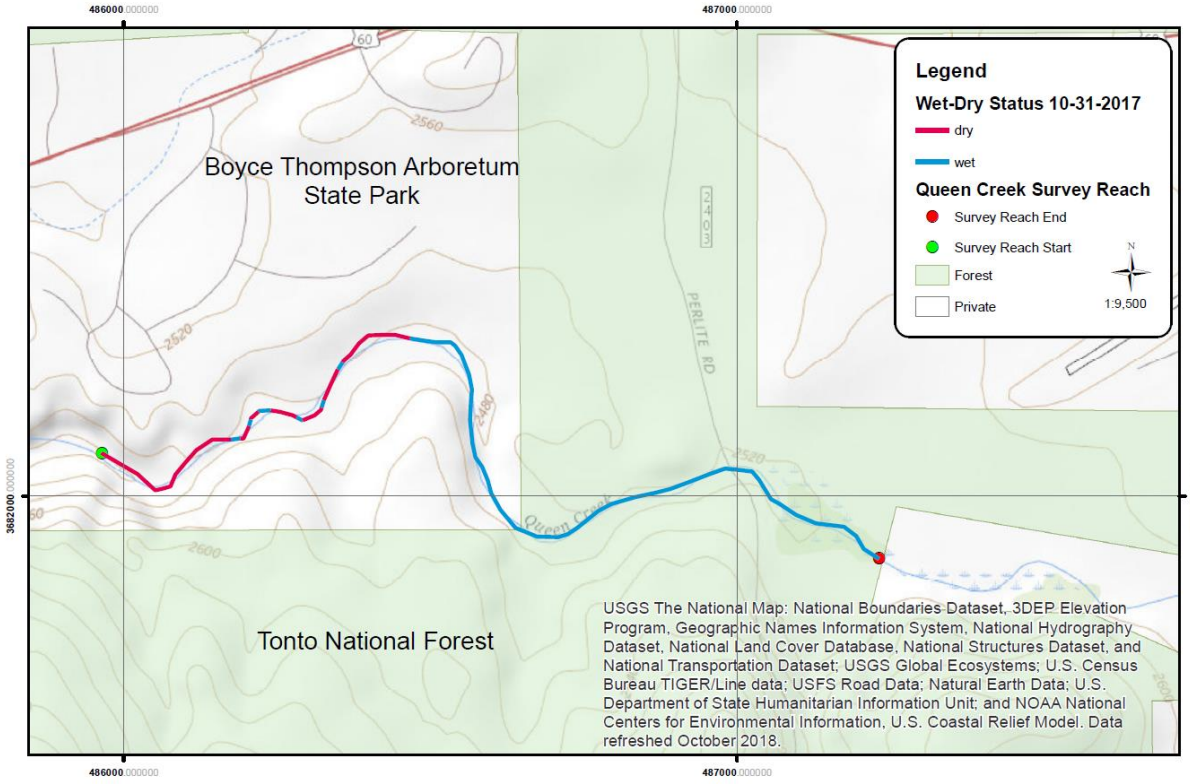


Figure 8. Surveyed wet and dry reaches along Queen Creek on October 31, 2017, Gila County, Arizona.



DISCUSSION

FUTURE MONITORING AND MANAGEMENT RECOMMENDATIONS

Surveyors recommend further investigation into the quantity and timing of water releases from the Superior Waste Treatment Plant and the Imerys Perlite Mine, Inc. sites. These water releases appear to be supporting aquatic and riparian species within the area currently, and a better understanding of the potential permanence and flow regimes of these sources could help inform future management opportunities to restore native fish populations as well as other native aquatic herp species.

Wet/Dry mapping of Queen Creek at the same time each year can provide valuable data on long-term trends and changes to base flows. Ideally, mapping is conducted at the hottest driest time of the year (mid-June before monsoon season is standard) to characterize base flows. In this case surveyors mapped during aquatic species surveys to report stream flow conditions at the time of survey, in light of the variable flow regimes witnessed during the month preceding the surveys. In the future, wet/dry mapping would be valuable to inform long-term habitat and aquatic species management plans and could be timed during June, consistent with other statewide NEMO projects. We recommend implementing a future wet/dry monitoring program for Queen Creek.

Last, surveyors recommend future fish and wildlife surveys to understand population trends, and to detect additional species this reconnaissance level survey may have missed. This survey addressed a data gap in current knowledge about the occurrence or abundance of fish and/or aquatic herp species within Queen Creek. The Department has no record of previous survey as far back as review of Department databases and program files allowed. Additional survey would be requisite to future wildlife management actions.

The surveys presented in this report provide a current baseline for existing habitat conditions along an approximate 1 mile reach of Queen Creek herein characterized as intermittent. Surveyors would recommend additional aquatic habitat assessment prior to future wildlife management actions.

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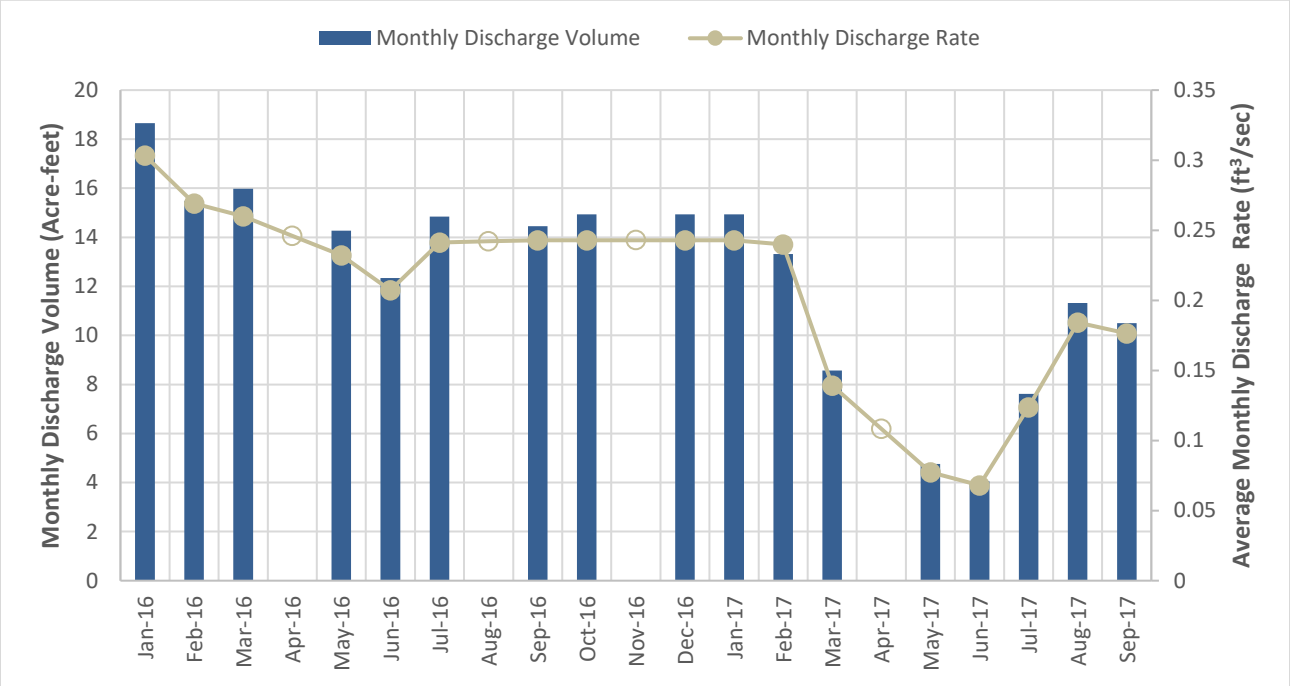
APPENDIX A - Superior WWTP Monthly Discharge Volume and Average Monthly Discharge Rate, Jan 2016 - September, 2017



APPENDIX B – Results of Queen Creek water quality sampling at NAD 83 12S 486974E 3682048N on October 31, 2017; Pinal County, Arizona.

Queen Creek (NAD83 12S 486974E 3682048N)	**Sample Collection**		**A&Wedw**	
Date	**Time**		**Standards**	
October 31, 2017	**9:51**	**10:46**	**Chronic**	**Acute**
Arsenic µg/l (D)	11	7.2	150	340
Barium µg/l (D)	<1000	<1000	NNS	NNS
Cadmium µg/l (D)	<0.1	<0.1	*1.32	*26.05
Chromium µg/l (D)	<5	<5	NNS	NNS
Copper µg/l (D)	<5	9.4	*25.7	*74.3
Iron µg/l (D)	<100	<100	1000	NNS
Lead µg/l (D)	<1	<1	*3.29	*84.41
Manganese µg/l (D)	359	67	NNS	NNS
Mercury µg/l (D)	<0.2	<0.2	0.01	2.4
Selenium µg/l (D)	<2	<2	2	NNS
Silver µg/l (D)	<20	<20	NNS	*26.8
Zinc µg/l (D)	<20	<20	*333	*333
Cyanide µg/l (T)	<10	<10	41	9.7
Calcium mg/l (D)	132	74		
Magnesium mg/l (D)	27	15		
Sodium mg/l (D)	73	51		
Potassium mg/l (D)	8	10		
Hardness mg/l (D)	439	248		
Sulfate mg/l (T)	159	95	NNS	NNS
Chloride mg/l	77.4	46.1		
Fluoride mg/l	0.366	0.317		
(NO_3+NO_2) - N mg/l	0.218	1.19		
TKN mg/l	<0.3	0.373		
Total N mg/l	<0.518	1.563		
Tot. Phosphorus mg/l	0.437	0.433		
Total Suspended Solids mg/l	<3.0	7.9		
Total Dissolved Solids mg/l	743	504		

*Average hardness of 343 was used to determine water quality standards