WATERSHED MANAGEMENT PLANS FOR EIGHT SUB-BASINS OF THE HUALAPAI RESERVATION

Submitted to:

United States Environmental Protection Agency

75 Hawthorne St.

San Francisco, CA 94105

Prepared by:

Hualapai Department of Natural Resources

P.O. Box 300

Peach Springs, AZ 86434

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1.0 INTRODUCTION

There are eight sub-basins on the nearly one-million acre Hualapai Reservation in northwestern Arizona for which Watershed Management Plans have yet to be developed (Figure 1). Watershed Management Plans (Plans) provide for descriptions of existing features and land use practices that may affect water quality of watersheds. Point and non-point sources of pollution are also identified and evaluated in the Plans. Plans also identify management measures that can be implemented to improve watershed water quality. Plans have previously been developed for Spencer Creek Canyon watershed and Mohawk Canyon (a prominent side canyon of the Coconino Plateau watershed) with funding from U.S. EPA and the U.S. Bureau of Reclamation. This document will provide Plans for the remainder of the Colorado Plateau watershed, the Upper Gila watershed, Peach Springs Canyon, Truxton Wash, Granite Gorge, Western Hualapai Plateau (including Quartermaster Canyon) and the Big Sandy watershed (Figure 1).

The northern border of the Hualapai Reservation is 108 miles of the Colorado River in Grand Canyon. Because most of the watersheds (except Truxton Wash and Upper Gila) on the Hualapai Reservation drain into the Colorado River and add to the impairment (mainly sediment and fecal coliform) of that water body, the identification of non-point source pollution sources and associated mitigation actions can directly affect future water quality of the Colorado River. Therefore, most of the management measures identified here are directed at improving water quality of the Colorado River.

In the Hualapai Tribe's Unified Watershed Assessment (Hualapai Department of Natural Resources 1999) four of the tribe's watersheds (including the Colorado River) were identified as Class I watersheds that are in need of restoration and have a high priority (within the next two years) for remediation. These watersheds are the Peach Springs Watershed, Coconino Plateau Watershed, Truxton Wash Watershed and the Colorado River. The dominant non-point source of water pollution from these watersheds is sediment and fecal coliform (from feral animals and livestock). Three of t he watersheds were classified as Class II watersheds with a medium priority for remediation (within the next five years). These watersheds were the Western Hualapai Watershed, the Upper Gila Watershed and the Spencer Creek Watershed (with a previously developed watershed management plan as discussed above and not addressed here). The dominant non-point source pollutants emanating from these watersheds are also sediment and fecal coliform. One watershed was identified as being a Class III watershed; the Granite Gorge Watershed also with a five year horizon for remediation. The dominant non-point sources of pollution emanating from this watershed are sediment, fecal coliform and organic hydrocarbons. The Big Sandy Watershed was not evaluated in the 1999 assessment.

2.0 WATERSHED EVALUATIONS

2.1 Coconino Plateau

2.1.1 Physical Setting

The Coconino Plateau Sub-basin varies greatly in elevation from 1245 feet at the Colorado River to over 7,000 feet in the ponderosa pine forest. This watershed is approximately 620 square miles in size. Much of the basin is vegetated with pine forests and pinyon-juniper vegetation as well. The northern portion of the plateau is canyon-lands of Grand Canyon dominated by desert-scrub vegetation. Three main canyons drain this sub-basin into the Colorado River (National Canyon, Mohawk Canyon and Prospect Valley; Figure 2). Prospect Valley is the largest drainage with a length of nearly 20 miles. The Toroweap Monocline geologically controls Prospect Valley with the drainage bottom composed of a thick sequence of Quaternary era alluvium (HDNR 1999). Mohawk Canyon is defined by the Mohawk-Stairway fault and is approximately 9 miles long. It is a deeply eroded canyon that contains little alluvium. National Canyon is the furthest east of the canyons, parallels the Mohawk fault and exhibits deep erosion.

2.1.2 Unique Features

As mentioned above, Prospect Valley, Mohawk Canyon and National Canyon are spectacular canyon features of this watershed (Figure 3) and provide a source for much of the sediment that is eroded into the Colorado River from this sub-basin. In addition, the extensive ponderosa pine forests provide for a successful silviculture program supplying timber products at a profit to the tribe. Silvicultural activities can also add to the impairment of waters draining from this watershed.

2.1.3 Water Sources

Table 1. Water sources in the Coconino Plateau Watershed (Figure 4).

Site Name	Type	Elevation	Non-point Source	Water(s) Affected
Wild Horse Spring	Intermittent Spring	4678	Feral animals, sediment erosion	Colorado River
Cave Spring	Intermittent Spring	5600	Feral animals, sediment erosion	Colorado River
Peyate Spring	Intermittent Spring	6046	Feral animals, sediment erosion	Colorado River
Three Springs	Perennial Springs	1625	Human impacts	Colorado River
Pumpkin Spring	Perennial Spring	1450	Human impacts	Colorado River
Warm Springs	Perennial	1810	Human impacts	Colorado River
Ridenour Spring	Perennial	1575	Livestock, wildlife	Colorado River
Cement Tank	Intermittent	4680	Livestock, wildlife	Colorado River
Red Spring	Intermittent	3570	Feral animals, sediment	Colorado River
Moss Spring	Intermittent	3800	Feral animals, sediment	Colorado River

2.1.4 Water Quality

Several of the springs in the Coconino Plateau Watershed have been fenced to prevent access by feral animals. This has greatly improved the water quality of those springs. To date, Wild Horse Spring, Red Spring, Moss Spring, Peyate Spring and Ridenour Spring have been fenced. Many of these springs were also fitted with water pipes and drinkers outside of the fence to provide water for wildlife. Some of the springs that are currently impaired include Wild Horse Spring, Three Springs, Pumpkin Spring and Warm Springs. Wild Horse Spring is impaired because the fence has been knocked down by feral animals and the animals have damaged the vegetation and polluted the water such that there is low levels of dissolved oxygen. The three springs along the Colorado River in Grand Canyon (Three Springs, Pumpkin Spring and Warm

Springs are affected by human visitation (stirring up silt, deposition of waste, damage to vegetation). Below, we provide the specific water quality monitoring data from the water sources in the Coconino Plateau Watershed.

SITE NAME: Wild Horse Spring **SITE NO.** S41

G.P.S. LOCATION: LAT N 3607.734 **LON** W 11259.867

SITE DESCRIPTION: Site is located on the western slope of Mohawk Canyon in the upper supai formation. Water issues at an approximate rate of 1/5 gallon a minute, from a 2 inch round hole in the side of a rock mound. In 2004 the site was enhanced with the following modifications. The extent of the wetland was encompassed in a barbed wire fence. A cement trough was constructed around water discharge in order to capture water. The trough is plumbed to a wildlife drinker located outside the fence enclosure.

DATE & SITE CHANGES:

October 3, 1997: On this date a diagram of the site was incorporated into the field notebook, depicting a riparian area at the base of the flow and documented that this spring source has been known to flow all year round.

August 9, 2005: Upon arrival at the site we noted that the southwest corner of the fence was down. Further investigation revealed that the eastern side of the fence was also down. The pipe work from the cement tank to the drinker was damaged, probably the result of wildlife trampling. Bees have made an extensive hive in the soil surrounding the rock wall where water emerges. Elk and deer feces were observed around the area.

Table 2. Wild Horse Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity(ppt)	Temp.(°C)	D.O.	Turbidity (NTU)
10/3/97	7.5	409	766	0.4	22.0	1.2mg/L 10%	
08/9/05	8.25	261	544	0.3	19.1	6.01mg/L 103.1%	.66

SITE NAME: Cave Spring **SITE NO.** M2

G.P.S. LOCATION: LAT N 3602.965 **LON** W 11302.047

SITE DESCRIPTION: Site is located at the base of a Coconino sandstone cliff. There are several small seeps located along an area about 15 feet long. Small dams have been constructed around the seeps in order to catch water. These dams are about 4 feet wide, 1-foot long, and 4 inches high. Tracks and feces in the area indicate that wild horses and wildlife are frequently using this site as a source of water.

DATE & SITE CHANGES:

August 9, 2005: Upon arrival at the site a strong odor of horse excrement was noticed. Soil surrounding the water source has been trampled and has a muddy consistency. The periphery of both the water and the wetted areas has a blackish coloration. This spring site was discovered in a survey of the Mohawk Canyon Watershed management plan and did not have a name. Through collaboration with a tribal elder (Everett Manakaja Sr.) and elder tribal members in the Department of Natural Resources, Joel Querta and Dudley Manakaja the spring was named in the Hualapai language, Oyalalcava – "Spring in the mouth of the cave" (Cave Spring).

Table 3. Cave Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity(ppt)	Temp.(°C)	D.O.	Turbidity(NTU)
08/9/05	8.25	261	544	0.3	19.2	6.01mg/L 103.1%	.66

SITE NAME: Peyate Spring **SITE NO.** M1

G.P.S. LOCATION: LAT N 360215. 807 **LON** W 1130220.042

SITE DESCRIPTION: Site is located at the southernmost end of Mohawk Canyon, on the western slope at an elevation of 6046. The water source is found at the back of approximately 7 feet wide by 8 feet tall cave that is approximately 6 feet in depth. Water drips off the back wall at several different places and is pooled by a cement catchment. A metal pipe fence constructed to keep out wild horses and feral animals surrounds the mouth of the cave. The predominant wetland vegetation at this site consists of grass.

DATE & SITE CHANGES:

August 23, 2005: Site has minimal disturbance with the presence of some elk and coyote feces were noticed inside the fence enclosure.

Table 4. Peyate Spring water quality sampling history and results.

Date	**PH**	**TDS(mg/L)**	**Conductivit y(uS)**	**Salinity (ppt)**	**Temp .(°C)**	**D.O.**	**Turbidity(NTU)**
08/9/05	8.25	261	544	0.3	19.2	6.01mg /L 103.1%	.66

SITE NAME: Pocamote Spring **SITE NO.** S40

G.P.S LOCATION: LAT N 354925. 160 **LON W** 1130941. 072

SITE DESCRIPTION: The spring is located on the eastern side of Prospect Valley in a side canyon. Water issues out from 5 major seeps along a portion of the canyon where the geology changes from white sandstone to a red amorphous sandstone. The highest yielding seep has a 15-foot by 4-foot trough built at the bottom of the flow for containment, there are two other lower yielding seeps from the canyon wall that have small water containments built around them. Historically there was water that flowed in a creek bed in close proximity to these seeps that also had low containment dam built across the creek bed.

DATE & SITE CHANGES:

June 10, 2005: On this site visit there is an abundance of elk feces scattered about the area and in the water catchments. Along the trails accessing this site signs of cattle were observed (tracks and feces). The largest water trough has green algal growth and silt deposits in the bottom. Oak and Pinion trees are located in the vicinity and small grass grows in the wetted areas on the ground.

Table 8. Pocamote Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivit y(uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity(NTU)
6/10/05	7.88	200	418	0.2	16.1	8.38mg/ L 107.3%	0.52

SITE NAME: Three Springs **SITE NO.** S23

G.P.S LOCATION: LAT N 355294 **LON W** 1131912

SITE DESCRIPTION: Located at river mile 215.6 on river left of the Colorado River in the Grand Canyon. The site is accessible by boat or helicopter. This spring is visited by river running trips and has a well-established trail leading to the spring. This site is 1600 feet in elevation and is 1/8 mile up Three Springs Canyon from the Colorado River. The lower spring is in an open part of the canyon immediately above a short chasm where the creek passes through tapeats sandstone. It is covered with dense vegetation and permanently flows. There is minor disturbance from river runners where a trail crosses the creek at the tip of a low waterfall; otherwise, hikers do not enter the densely vegetated area. The second spring is about 1/3 of a mile up the canyon.

DATE & SITE CHANGES:

March 4, 2002: On this site monitoring visit the Grand Canyon National Park Service accompanied the Water Resources Technician. A representative of the NPS explained that the trail was improved because of hikers causing disturbances to the wetland vegetation as well as slope damage. Lining the trail with rocks made these improvements. This will keep people from taking short cuts down slope. Alkalinity; 255 mg/l (test conducted by Grand Canyon National Park hydrologist).

March 1, 2003: Weather conditions bright and sunny with high storm clouds. Heavy rain storms throughout the night and early morning hours. Extensive wetland vegetation was present with large pools of water.

September 22, 2005: Water was tested approximately 20 feet from the rivers edge. There was sparse vegetation approaching the site, which allowed for easy access.

Table 9. Three Springs water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp.(°C)	D.O.	Turbidity (NTU)
10/9/97	8.17	322	605	0.3	23	51% 4.1 mg/L	
4/28/98	8.25	295	617	0.3	20	71% 5.8 mg/L	
12/4/98	8.29	312		0.3	18	63% 5.7 mg/L	
8/2/99	8.02	321	667	0.3	22		
3/4/02		302	636	0.3	12		1.1
9/22/05	8.13	258	537	0.3	27.7	6.36mg/L 84.5%	11.8

SITE NAME: Pumpkin Spring **SITE NO.** S24

G.P.S LOCATION: LAT N 35502 **LON W** 1131959

SITE DESCRIPTION: Located at river mile 213 on the river left of the Colorado River in the Grand Canyon. This site is accessible by boat or helicopter. This spring is located on the Colorado River and is at the rivers edge. Due to its proximity to the river the spring is under water during high flows. This spring is a primary source of water for wildlife and visited by people on river trips. Alkalinity; 1,815 mg/l (test conducted by Grand Canyon National Park hydrologist).

DATE & SITE CHANGES:

August 2, 1999: There has not been any major physical change to the spring and the surrounding area and there is a noticeable sulfur odor present around the spring source.

March 27, 2001: On this site visit there was a strong sulfur odor and there was a film of green algae floating on the surface of the spring pool. The temperature on this site visit was very warm.

March 1, 2002: On this site visit the spring was accessed by boat and we arrived in the late afternoon. There was no odor of sulfur present and the water was barely flowing over the rock containment formation. In the pool of water, there was visible bubbling indicating spring flow into the pool of water.

March 1, 2003 Cold windy day with heavy rains upon arrival to the site. The color of the water was light green and there were several clumps of brownish gray residue floating on the surface of the pool.

September 22, 2005: The water has a greenish color to it, with yellow green grime along the periphery of the water. The turbidity meter had to be re-adjusted in order to read and record higher values.

Table 10. Pumpkin Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp.(°C)	D.O.	Turbidity(NTU)
4/28/98	6.45	7840	1272	8.1	29		
8/2/99	6.42	5955	1094	6.2	34		
3/27/01	6.38	7930	1407	8.2		66% 6.0	

							mg/L	
3/3/02		6630	1199		6.7	20	61%	22.8
3/1/03	6.94	5910	1057		6.0	21		1. 2. 3. 86.6
9/22/05	6.36	1470	2980		1.5	32.7	7.4mg/L 93.0 %	17.2

SITE NAME: Warm Spring **SITE NO.** S29

G.P.S LOCATION: LAT N 361148 **LON W** 1130459

SITE DESCRIPTION: Located at river mile 179.3 on river left of the Colorado River. Discharge begins on the east side of the mouth of Prospect Canyon, and descends north toward the Colorado River, in the Grand Canyon. This spring location is accessed by boat or helicopter. This spring runs year round, has deep pools in the area, and is surrounded with very dense vegetation.

DATE & SITE CHANGES:

March 3.2002: On this site monitoring visit the Water Resource Technician was accompanied by a representative of the Grand Canyon National Park Service. Arrived at the site at approximately 11:00 a.m. field parameter samples were retrieved from a cool shady area. Vegetation in the area consisted of saw grass and a mesquite tree. Flat shaped orange and black water beetles were present in the water. Alkalinity-662 mg/l (test conducted by Grand Canyon National Park hydrologist).

August 8, 2002: On this site-monitoring visit we arrived at 09:00 a.m. The weather conditions are sunny and humid.

February 27, 2003: The area surrounding the site has become overgrown with saw grass. This vegetation was bent over and laid on in order to expose and access spring flow.

September 22, 2005: The site is overgrown with sawgrass and no major changes to site. The field water parameters were sampled approximately 5 feet from the river.

Table 11. Warm Springs water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp.(°C)	D.O.	Turbidity (NTU)
10/15/97	6.82				24		
11/17/98	6.53	703	1303	0.7	25	54% 4.7 mg/L	
8/2/99	8.51	596	1233	0.6	26	51% 3..0 mg/L	
3/3/02	6.15	629	1287	0.6	24.0		1. 2. 3. 0.9
8/8/02	6.5	500	1043	0.5	24.7	6.6mg/L	1. 2. 3. 4.9
2/27/03	6.84	583	1213	0.6	22		1. 2. 3. 1.0
9/22/05	6.77	427	887	0.4	25.3	6.84mg/L 87.0%	0.48

SITE NAME: Ridenour Spring **SITE NO.** S10

G.P.S LOCATION: LAT N 360435 **LON W** 1131047

SITE DESCRIPTION:
Seep issues from base of Hermit shale, on Esplanade at top of upper member of Supai formation, elevation 5120 feet. The spring seeps out of the ground on the sidewalls of a drainage ditch and collects in several small pools in the lower flats of the drainage ditch. The spring is located to the west of an old copper mine, on the plateau adjacent to Prospect Ridge. The road to the point is approximately 40 miles from Peach Springs, and another 3 miles down the canyon wall. This spring site has been enhanced to

provide a source of water for wildlife and cattle. The site can be accessed by vehicle or helicopter.

DATE & SITE CHANGES:

October 2, 1997: There was a tiny seep.

November 19, 1998: The spring was running and had a thin layer of ice covering it.

August 2, 1999: There was no water present. Only a muddy spot remained at the spring area. There was not enough water present to take measurements.

March 27, 2001: On this monitoring date this site was accessed by vehicle and there was no water present, only wet ground around the spring site. The continued lack of water is a direct result of the continued drought.

August 8, 2002: On this monitoring date, the conditions remain the same, with no water present due to the drought.

August 26, 2005: Enhancement efforts were made to this site before this visit. A metal pipe fence has been constructed around the spring enclosing an area roughly 60 by 80 feet. The area below the spring seep has been dug out and a 4-foot by 3-foot pool now exists. A small dam has been constructed around the pool. A smaller spring approximately 15 feet away from the bigger one has been piped to a drinker trough located outside the fence enclosure.

Table 12. Ridenour Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp .(°C)	D.O.	Turbidity (NTU)
10/2/97	8.13	310	576	0.3	17	3.4mg/L 32%	
11/19/98	7.45	408	842	0.4	2	6.0mg/L 52%	
8/26/05	7.91	404	837	0.4	17.1	5.04mg/L 63.5%	1.92

SITE NAME: Cement Tank Spring **SITE NO.** S31

G.P.S LOCATION: LAT N 360732.750 **LON W** 113042.188

SITE DESCRIPTION: This spring is located in Prospect Canyon. There is rock and a cement containment wall to keep flooding from washing out the spring source. The wall is about 30 to 40 yards above the cement trough. In 1997 this spring was running and in 1998 the spring was running at a very low trickle. In 1999, the spring was running as it had in 1997. At all three visits to the cement tank, it was full of sediment. Mainly wildlife and birds use it. At one time this location was used by people and may still be used by some individual that know of its location.

DATE & SITE CHANGES:

August 8, 2002: On this site monitoring visit there was not any water present, due to continued drought conditions in the region.

September 2, 2005: The cement water capture is full of sediment. However there was water coming out of the bottom of this trough. The water ran for about 10 feet before it came to a small rock overhang. Field parameters were acquired from a small pool at this point.

Table 13. Cement Tank Spring water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp.(°C)	D.O.	Turbidity (NTU)
10/2/97	11.7	1090	1950	1.1	22	0.8mg/L 9%	
11/16/98	7.50	849	1751	0.9	9	5.8mg/L 54%	
8/2/99	12.56	768	1575	0.8	20		
8/8/99							
8/8/02							
9/2/05	8.29	348	722	0.3	23.2	6.51mg/L 89.1%	7.46

2.1.4.1 Water Quality Goals

The main goal for water quality in the Coconino Plateau Watershed is the reduction of sediment and fecal contaminants in the water that is produced within the watershed and the water that drains the watershed during storm runoffs. In addition, we hope to improve the dissolved oxygen levels in the water sources to support a greater diversity of aquatic biota.

2.1.5 Pollutant Sources

The main source of pollutants on the Coconino Plateau Watershed is sediment runoff due to the erosive condition of the soils, silvicultural and road construction activities and from trampling by livestock and feral animals. In addition, wildfires cause an increase in soil erosion and an increase in sediment loads during storm runoffs. In addition, feral animals cause fecal and nitrogen contamination of water sources across the watershed. Human activities also act to increase sediment and nitrate levels at water sources along the Colorado River.

2.1.6 Land Use Practices

Cattle grazing, silviculture and recreation are the main land use activities occuring on the Coconino Plateau Watershed. There are 1,665 Animal Unit Months (AUM's) allocated on the Coconino Plateau Watershed, but around one-half of those are actually in operation at any one time. During times of drought, livestock tend to congregate around available water supplies thus causing impaction of the soils and loss of vegetation. This causes an increase in soil erosion resulting in increased sediment levels during storm runoffs.

There are twenty-five timber harvest compartments across the Coconino Plateau Watershed. The use of heavy equipment causes disturbance of the soil surface causing increased sediment levels in storm runoff. In addition, there is often a need to develop new roads to access timber resources. These new roads also result in greater sediment erosion during storms.

Recreational activities across the Coconino Plateau Watershed include big-game hunting, river rafting and hiking. Hunters increase sediment runoff due to the disturbance of the soils surface from their trucks and trailers. River rafters affect spring water quality along the Colorado River as discussed above. Hikers may increase the levels of nitrates in storm water runoff to a slight degree.

2.1.7 Proposed Mitigation Actions

- Install sediment traps at appropriate locations to reduce sediment runoff to the Colorado River

- Limit access to springs along the Colorado River
- Increase water storage and supplies across the plateau to spread concentrations of livestock
- Mitigate activities that disturb the soil surface (e.g. road construction, logging)
- Remove feral livestock from side canyons of the Colorado River
- Fence remaining springs that are being affected by feral animals

2.1.8 Recommendations

This watershed was classified as Class I Watershed in need of immediate remediation to improve water quality. We recommend immediate implementation of the above identified management measures to begin to reduce the impairment of the waters draining from the Coconino Plateau Watershed.

2.2 Upper Gila

2.2.1 Physical Setting

This 120 square mile sub-basin adjoins the Coconino Plateau to the north and drains into the upper Verde Watershed of the Gila River basin (Figure 1). The upper part of the basin is forested and is geologically composed of consolidated sedimentary rocks exposed at the land surface. The lower part of the basin is an alluvial valley formed by down faulting along the Aubrey Cliffs. The drainage flows southeast across the Reservation boundary onto private land in the Aubrey Valley. All streams in this sub-basin are ephemeral. Several shallow wells are located in the alluvial valley near Frazier Wells. These wells produce water for cattle and wildlife. The shallow unconfined water table puts these wells at risk to contamination from surface sources.

2.2.2 Unique Features

The Hualapai Tribe's Endangered Fish Rearing Facility (Facility) is one of the unique feature of the Upper Gila watershed. The Facility is comprised of one, two and one-half acre re-circulation pond and twelve, one-half acre rearing ponds. The Facility uses water from a well drilled on-site. The well produces 40 gallons per minute. Effluent from the Facility is used to water the Native Tree Nursery as discussed below. The Facility is currently rearing the endangered razorback sucker. This species has been reared for the past five years. The tribe is currently working with the U.S. Fish and Wildlife Service and the Arizona Game and Fish Department to obtain endangered humpback chub for future rearing.

The Hualapai Tribe's Native Tree Nursery (Nursery) is also located in the Upper Gila Watershed. The Nursery covers twenty acres of land with 7-10 rows available for growing trees. Native Goodding's willows are currently being grown there to provide material for riparian restoration projects. A portion of the Nursery is also used for the

production of vegetables. Squash, watermelon, pumpkins and onions are grown at the Nursery.

2.2.3 Water Sources

As mentioned above, there are several wells located on the Upper Gila Watershed. Wells are located at Blue Mountain and two at Frazier Wells (Figure 2). Upper and Lower Pine Springs are the only natural springs located in this watershed. There are no perennial streams in this sub-basin.

Site Name	Type	Elevation	Non-point Source	Water(s) Affected
Pine Springs (lower)	Well	6410	Livestock, silviculture	Frazier Wells aquifer
Pine Springs (upper)	Intermittent Spring	6600	Livestock, silviculture	Frazier Wells aquifer
Fish Facility (Frazier Wells)	Well	5953	Livestock, silviculture	Frazier Wells aquifer

2.2.4 Water Quality

Water quality of the well water is generally good and potable. Testing has been done at Frazier Wells, Upper Pine Springs and Lower Pine Springs. In general, water quality is good at all water sources including the wells in this watershed. Below, we provide the water quality testing results for each source.

SITE NAME: Fish Facility Well **SITE NO.** G13

G.P.S LOCATION: LAT N 3545.918 **LON W** 11304.947

SITE DESCRIPTION: Well is located at the north east corner of the Hualapai Department of Natural Resources' Endangered Fish Rearing Facility. The depth to water in this well is approximately 74 feet and the submersible pump is set to a depth of 126 feet and pumps at a rate of 75 gallons per minute. The water from this well is used to fill endangered fish rearing stock ponds with water. The effluent from these ponds overflows into a 2-½ acre pond. The effluent water is used at the 20-acre native tree nursery, to irrigate approximately 150 native willows that were propagated from clippings from willows along the Colorado River and other wetlands on the reservation.

DATE & SITE CHANGES:

July 8, 2005: Water sample was collected from faucet just off primary water line.

Table 14. Fish Facility well water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity(NTU)
7/8/05	7.02	184	383	0.2	22.7	5.91mg/L 72.4%	1.62

SITE NAME: Pine Springs (Lower) **SITE NO.** S37

G.P.S LOCATION: LAT N 3550.165 **LON W** 11305.622

SITE DESCRIPTION: This site is a groundwater well that was developed by tapping into ground water flow below the actual spring. The depth to water is approximately 30 feet and the pump is powered with solar panels generating electricity. Approximately 10 gallons a minute is pumped to a large earthen reservoir providing a source of water for cattle and wildlife.

DATE & SITE CHANGES:

June 6, 2002: On this site monitoring visit there was not any water present due to the drought conditions of the region. Since there was not any water present, there is no field parameter sampling to report.

June 17, 2005: before visit a ponderosa pine tree was removed in order to allow maximum sunlight on solar panels. Well and solar panels are working properly. Water was taken from the surge tank near the well for testing.

SITE NAME: Pine Springs (Upper) **SITE NO.** 44

G.P.S LOCATION: LAT N 3550.585 **LON W** 11306.984

SITE DESCRIPTION: Site is located approximately 1 mile northwest of lower pine springs well. Spring waters issues from the back of a small cave. The Cave is approximately 20 feet wide, 5 feet tall and approximately 15 feet deep. There are several places where water drips onto cave floor and a small narrow water flow extends for approximately 40 to 50 yards down stream.

DATE & SITE CHANGES:

May 18, 2005: Moss growing around the water pool has a bluish gray coloration. There is grass growing along the extent of the water flow. Ponderosa pine and oak tress line the perimeter around the site.

Table 16. Upper Pine Springs water quality sampling history and results.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity(NTU)
5/18/05	7.03	291	605	0.3	18.7	3.36mg/L 49.0%	1.45

2.2.4.1 Water Quality Goals

The goal for water quality in the Upper Gila Basin is to reduce non-point source pollution in the form of sediment and fecal coliform through reductions in sage brush communities (which promote soil erosion) and by enforcement of the tribe's Water Resources Ordinance with regard to septic system installation and operation guidelines. In addition, through appropriate livestock management, it may be possible to reduce inputs from livestock waste.

2.2.5 Pollutant Sources

The main sources of non-point source pollution in the Upper Gila Basin are sediment caused by logging and cattle grazing. In addition, livestock and feral animals are a source of nitrate pollution into runoff waters. Finally, septic systems may contribute to groundwater contamination.

2.2.6 Land Use Practices

Several timber harvest compartments are located within the Upper Gila Basin watershed (Figure 3). While logging has not been recently conducted, timber sales have occurred in the past in these compartments and are likely to occur in the future. Harvest activities contribute to sediment runoff in the watershed.

Cattle grazing also occurs within the Upper Gila Basin watershed. Approximately, 810 Animal Unit Months (AUM's) are alloted within this sub-basin. Currently, there are 623 animals grazing. Waste from these animals contributes to nitrate and coliform pollution to runoff waters.

2.2.7 Proposed Mitigation Actions

- Manage cattle resources according to grazing association management plans
- Manage logging operations to minimize surface disturbance
- Regulate the installation and maintenance of domestic septic systems
- Rip-rap or otherwise protect drainage banks where there is a danger of substantial erosion.
- Install sediment traps to reduce erosion into the Gila drainage.

2.2.8 Recommendations

This watershed was classified as a Category II watershed with a ranking of "Medium Priority". The above identified mitigation actions should be implemented within the next two years or sooner.

2.3 Peach Springs Canyon

The Peach Springs Canyon Sub-basin is centrally located on the Hualapai Reservation and begins near Peach Springs and runs to the Colorado River (Figure 1). The only road to the river in lower Grand Canyon runs down Peach Springs Canyon and is known as Diamond Creek Road. There are four perennial water sources in Peach Springs Canyon; Diamond Spring and Creek, Peach Springs, McGee Spring and Mesquite Spring.

Site Name	Type	Elevation(	Non-point Source	Water(s) Possibly

		ft)		Impacting
Diamond Spring/Creek	Perennial	1775-1300	Wildlife, vehicle traffic	Colorado River Blue Mountain Spring
McGee	Perennial	4000	Wildlife Cattle, feral animals	Colorado River
Pocamate Spring	Perennial Spring	2110	Livestock, wildlife	Colorado River
Mesquite Spring	Perennial Spring	2417	Livestock, wildlife, vehicle traffic	Colorado River

2.3.1 Physical Setting

The Peach Springs Sub-basin lies west of the Upper Gila Watershed and includes the town of Peach Springs (Figure 1). The sub-basin encompasses approximately 300 square miles of mostly desert scrub habitats dominated by canyon formations. The canyon begins just north of Peach Springs and runs into Grand Canyon to the Colorado River. The perennial springs flow from the Muav limestone formation. Diamond Creek runs for approximately five miles to the Colorado River (Figure 2) with an average discharge of 3 cubic feet per second. During monsoon storms, however, the Diamond Creek drainage and the Peach Springs Canyon drainage can experience severe flooding. In fact, Diamond Creek Road is routinely washed out by these storms.

2.3.2 Unique Features

Peach Springs, McGee Springs, Mesquite Spring, Diamond Springs and Diamond Creek are the most spectacular aquatic features of the Peach Springs sub-basin. The canyon formations are also breathtaking and thousands of tourists each year come to travel down Diamond Creek Road to see the spectacular geological formations (including Diamond Peak) and the Colorado River itself. Even Mesquite Spring is visited by many tourists who come to hear the stories of what the unique spring wetland resources meant to Hualapai Tribal members for hundreds of years.

2.3.3 Water Sources

As mentioned above, Diamond Spring, Peach Springs, McGee Spring and Mesquite Spring are perennial water sources in the Peach Springs Canyon watershed. Photographs of these sources can be found in Figures 4-6.

2.3.4 Water Quality

SITE NAME: Diamond Creek (Source) **SITE NO.** S9

G.P.S. LOCATION: LAT N 355602 **LON** W 1131032

SITE DESCRIPTION: Site is located at the head of Diamond Creek canyon in a small side canyon. Spring can be accessed by hiking or helicopter. Riparian vegetation is abundant throughout this side canyon and mostly consists of cottonwood trees. Water emerges from approximately 30 feet above the creek bed and is surrounded by dense hanging gardens. Water is dispersed from three major discharges that combine into one flow at the base of the creek bed. The combined flow measurement of the major discharges is approximately 100 gallons per minute. The site is very isolated and remote and appears that wildlife only access the site on occasion.

DATE & SITE CHANGES:

April 22, 2005: On this visit nitrate, nitrite and reactive phosphorous content of the water was assessed and macroinvertebrate samples were collected. There were no tracks, feces or disturbed vegetation to indicate frequent use of the site by wildlife. The creek bed gravels are very hard and are possibly the result travertine deposits.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity (ppt)	Temp.(°C)	D.O.	Turbidity(NTU)
4/22/05	7.97	206	422	0.2	22.7	7.25 mg/L 95%	0.55

SITE NAME: McGee Spring **SITE NO.** S42

G.P.S LOCATION: LAT N 353540.373 **LON W** 1132611.491

SITE DESCRIPTION: Site is located approximately 7 miles south on diamond creek road. On the right side of road, there is a small side canyon where water emerges from a small cave. A small earthen dam about 6 inches high contains water. Willow trees and other wetland vegetation are abundant in the area.

DATE & SITE CHANGES:

July 7, 2005: Cattle and wildlife frequently use the spring flow as a source of water, evident by the presence of several trails that lead to the spring. The pool of water has dense green algal growth. In the future there may be plans to enclose the spring and wetland areas and the development of a cattle and wildlife water trough outside of the enclosure.

Date	PH	TDS (mg /L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity(NTU)
7/7/05	7.35	241	503	0.2	16.3	4.35mg/L 51.2%	0.25

SITE NAME: Peach Spring **SITE NO.** S20

G.P.S LOCATION: LAT N 353530 **LON W** 11326

SITE DESCRIPTION: Site is located along the floor of Peach Spring Wash about 5 miles north of the community of Peach Springs. The main spring area is fenced off from livestock, and water feeds into an old concrete trough. Cattails grow in the trough and desert wetland species grow below trough in outflow. A saline seep is recognized on the wall of the canyon upstream from the trough. A continuous flow of water discharges from the old concrete trough. Cutting down non-native Tamarisk trees and planting native Goodings Willows and Peach trees have enhanced the spring site. Water flows down Peach Springs Canyon and collects in a dam approximately ¼ of a mile north of the spring. The dam has substantial wetland vegetation around the water and is utilized for swimming and picnics in the summer.

DATE & SITE CHANGES:

September 29, 1997: Arrived on site at approximately 2:00 p.m. and departed at 3:00 p.m.

August 5, 1999: On this site visit the spring flow was extremely slow and the depth of water was too shallow to collect any water samples.

March 7, 2000: Arrived at approximately 4:00 p.m. the weather is clear and cool with a slight breeze. At the spring site there was brown moss build up and dead tree limbs at the edge of water pool. Recent grading of the dirt road has created dirt build up on the shoulder of the road. This has caused the spring source to pool up and seep

through the dirt berm. Three water samples were taken and preserved with nitric acid.

August 18, 2003: Recent flash floods have cleared away most of the small vegetation along the
perimeter of the spring flow. Clear waters are present.

June 16, 2004: This site has undergone some drastic changes as the result of a project to renovate this water system. One of the changes made directly affected the water channel as it no longer fed by the pipe work it used to come from. The new water flow comes from a man made channel about 15 feet from the old source.

Table Z. Historic water quality data from Peach Springs.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity (NTU)
9/29/97	7.62	299	55	0.3	23		
8/5/99	7.48	216	442	0.2	22		
3/7/00	7.53	61	129.4	0.1	15		
8/18/03	7.38	289	598	0.3	22.0	117.5% 8.50 mg/L	2.1

SITE NAME: Mesquite Spring

SITE NAME: Mesquite Spring **SITE NO.**
G.P.S. LOCATION: LAT N

SITE DESCRIPTION: Site is located about 11 miles north of the community of Peach Springs. The spring discharge is captured in a concrete box. The soil saturation below this structure has a surface area of approximately 20 feet by 10 feet. The dominant vegetation around this spring site is mesquite bosque and covers an area of about 100 feet by 200 feet.

DATE & SITE CHANGES:
October 8, 2003: Burros and coyotes seem to be frequently visiting the site as evident for tracks and fecaln matter. Also, there are a lot of quail feathers around the

area indicating a fresh kill. There is approximately 8 inches of water in the catchment. However, about 3 inches of the surface is plant debris. There was a slight stagnant odor.

June 16, 2004: Arrived at site a many birds flew away. Eight birds were actually seen and counted. A rattle snake was seen at the site near the water. The water had an odor of sewage to it. Green algal growth with pinkish periphery was observed.

Table R. Historic water quality data for Mesquite Spring.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity (NTU)
10/8/03	7.48	476	585	0.5	16.1	.25mg/L 3.1 %	32.3
6/16/04	7.93	459	950	0.5	23.8	3.41mg/L 45.8%	5.76

2.3.4.1 Water Quality Goals

The main goal for water quality in the Peach Springs Canyon Watershed is the reduction of sediment and fecal contaminants in the water that is produced within the watershed and the water that drains the watershed during storm runoffs. In addition, we hope to conserve the integrity of the wetland resources that maintain the good water quality at water sources in this sub-basin.

2.3.5 Pollutant Sources

The majority of non-point source pollution in the Peach Springs Canyon Watershed is sediment carried by runoff waters during monsoon storms. This sediment is deposited into the Colorado River adding to its impairment. In addition, feral animals and livestock have polluted McGee Spring and Peach Springs with fecal waste adding to the nitrate levels. Ultimately much of this nitrogenous waste is washed into the Colorado River as well.

Vehicles traveling down Diamond Creek Road also cause sediment erosion into Diamond Creek as they cross and drive down the creek to access the Colorado River. It is unknown how much sediment is released into the creek and Colorado River from this pollutant source.

2.3.6 Land Use Practices

Land use practices that occur in the Peach Springs Canyon sub-basin include cattle grazing, transportation and recreation. The Peach Springs Livestock Association grazes an average of 487 Animal Unit Months (AUM'S) in this watershed throughout the year. Diamond Creek Road is the main thoroughfare for river running take outs from Grand Canyon river rafting activities. In addition, Hualapai River Running accesses the Colorado River for their river rafting expeditions from April through October.

A total of 24,657 river rafters are permitted to raft the Colorado River in Grand Canyon in each year under the new Colorado River Management Plan (CRMP) of Grand Canyon National Park. Approximately 60 percent of these passengers exit at Diamond Creek. Under the CRMP, Hualapai River Runners are permitted to transport up to 90 passengers per day (April to October) down the river as accessed by Diamond Creek Road.

2.3.7 Proposed Mitigation Actions

- Fence McGee Springs to prevent access by livestock and feral animals
- Improve fencing at Mesquite Spring
- Channel Diamond Creek so that vehicle traffic does not pollute the waters
- Remove feral animals
- Fence the Peach Springs wetlands
- Remove tamarisk to reduce evapotranspiration
- Manage livestock to reduce impacts to water quality

2.3.8 Recommendations

In the 1999 Unified Watershed Assessment (HDNR 1999) Peach Springs Canyon was identified as a Category I watershed with a High Priority for remediation. Fencing of McGee Springs is the first activity that should be engaged. An assessment of the feasibility of protecting the Peach Springs wetlands is also a number one priority. Channelization of Diamond Creek near the confluence with the Colorado River should also be immediately evaluated and designed. Removal of feral animals should be considered within one to two years. Management of cattle and removal of tamarisk should be ongoing activities.

2.4 Truxton Valley

Site Name	Type	Elevation	Non-point Source	Water(s) Possibly Impacting
HDNR Well	Perennial	4791	Anthropogenic	Truxton Wash Aquifer
Surprise	Perennial	5200	Wildlife	Truxton Wash

Spring				

2.4.1 Physical Setting

The seventy-five square mile Truxton Valley sub-basin adjoins the Peach Springs Canyon sub-basin and includes the community of Peach Springs (Figure 1). The terrain is flat terraces interspersed with rolling hills. The dominant vegetation type is juniper/grasslands. A limestone mine is located up gradient from Peach Springs, and the reservation water supply is located down gradient in Truxton where several wells are located. A small, 1.5 square mile satellite of the reservation is located approximately 10 miles west of Peach Springs in Valentine, AZ. A short section of the Truxton Wash flows perennially (except in extreme drought) near Valentine. Groundwater occurs from the Tertiary lacustrian, gravel and volcanic deposits which supply the municipal wells for Peach Springs.

2.4.2 Unique Features

The town of Peach Springs, Truxton Wash and the Burlington-Northern Santa Fe Railroad are the dominant features of the Truxton Wash sub-basin. The wash carries stormwater runoff nearly fifty miles to Red Lake in the Hualapai Valley. Red Lake is normally dry except for during unusual periods of above-normal precipitation. Peach Springs is the center of the Hualapai populus, and the tribal administration is located there. Approximately 2,000 individuals reside in Peach Springs. The Burlington-Northern Santa Fe Railroad bisects the center of Peach Springs. Over 100 trains per day travel along the railway through Peach Springs.

2.4.3 Water Sources

The Truxton Well, Mud Tank Well and Surprise Spring are the main water supplies within the Truxton Wash sub-basin. Water quality of the wells are good and monitored bi-weekly by the Hualapai Department of Public Works. The Surprise Spring water quality is also good and provides water for wildlife.

2.4.4 Water Quality

SITE NAME: Hualapai DNR Well **SITE NO.** G1

G.P.S LOCATION: LAT N 353137.392 LON W 1132521.958

SITE DESCRIPTION: Well is located in the Hualapai Department of Natural Resources compound. A 10,000-gallon surge tank is located at the site. The water from the well serves as a primary component of water distribution for the southeastern side of the reservation from Peach Springs with distribution lines and laterals extending a distance of 14 miles to a large water storage tank at Blue Mountain. The water tank gravity feeds to

lateral pipelines that fill water troughs in the area.

DATE & SITE CHANGES:

July 13, 2005: Well is functioning properly and surge tank is full. Water sample was collected from the access panel on the surge tank.

Date	PH	TDS (mg/L)	Conductivity(uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity(NTU)
7/16/05	7.08	330	686	0.3	23.9	4.64mg/L 64.7%	0.17

SITE NAME: Truxton Wash **SITE NO.**

G.P.S. LOCATION: LAT N 352307 **LON** W 1133925

SITE DESCRIPTION: This site located on Hualapai Indian lands about 20 miles west of the main reservation near the town of Valentine. The water flow fluctuates seasonally but is perennial. The United States Geological Survey has chosen the site to monitor discharge and has set up a gaging station at this location.

DATE & SITE CHANGES:

June 30, 2004: On this visit the sky is partly cloudy with winds coming out of the west. Vegetation consists of Cottonwood Trees, shrubs and Grasses. Numerous Jack rabbit and cottontail rabbits inhabit the area. No field parameters or macroinvertebrate sampling was done at the site due to there being no water. This maybe caused by drought or the pumping of water for municipal uses, but we cannot be certain.

Date	PH	TDS(mg/L)	Conductivity(uS)	Salinity(ppt)	Temp. (°C)	D.O. mg/l	Turbidity(NTU)
5/25/06	7.65	292	606	0.3	17.8	5.95	0.30
8/24/06	7.91	293	261	0.1	26.8	5.85	5.89

SITE NAME: Surprise Spring **SITE NO.**

G.P.S. LOCATION: LAT N 353108 **LON** W 1132404

SITE DESCRIPTION: This site is located about 2 miles south east of Peach Springs on the western slope of a small ravine. The emergence of water comes from a small seep at the back of a 40 foot long cave. The bottom of the cave is filled with water and the

depth decreases as water approaches the entrance. The walls of this cave have been reinforced by support beams to prevent subsidence and potential loss of this water source. The water here has been utilized to provide livestock with drinking water. This was accomplished by tapping water from the cave to a 3000 gallon storage tank at the bottom of this ravine using pvc pipe. This tank in turn feeds a concrete water trough. Presently, this system is no longer in use as the amount of water needed to run this system is not available, most likely due to drought.

DATE & SITE CHANGES:
October 7, 2003: At this time there is not enough water flow to see any movement in the stream. However, Water trickling at the back of the cave was heard. A brownish brush like vegetation was noticed at the bottom of the pool. The depth of water at the entrance is approximately 1 foot and about 4 feet wide.

May 18, 2004: Site has not changed significantly since last visit. Although the water seems to have a light green suspension to it. Green algal growth in the bottom of the pool was noted. Also there is very little vegetation growing on the side of the stream flow consisting of grasses and weeds.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O.	Turbidity (NTU)
10/7/03	7.97	712	844	0.3	17.4	3.26mg/ L 42.4%	6.86
5/18/04	8.25	328	678	0.3	14.1	4.79mg/ L 58.17%	9.16

SITE NAME: Horse Trough **SITE NO.**

GPS LOCATION: LAT N 35330 **LONG W** 1133705

SITE DESCRIPTION
This spring site is located approximately 11 west of Peach Springs at the foot of the Music Mountains. The spring has been enhanced by digging out the spring source from the hillside and shoring up the hillside around the spring source with timber braces; similar in structure to hillside mine entrances. Tapped into the water source is a piping system that siphons water from the spring source and gravity flows down hill to a water storage tank and trough; approximately 50 yards away. The hillside spring source is fenced to prevent livestock and wildlife from contaminating the source.

DATE AND SITE CHANGES:

October 1, 1997 There was not enough water present to take any field parameters.

August 3, 1999 The spring was very shallow and had just enough water present to conduct measurements

May 5, 2002 Due to a continued drought, on this site visit there was no water present and no field parameter sampling was conducted.

July 22, 2004 No water present on this monitoring visit. No field parameters taken.

Table Q. Historic water quality data for Horse Trough spring.

Date	PH	TDS(mg/L)	Conductivity (uS)	Salinity(ppt)	Temp. (°C)	D.O. mg/l	Turbidity(NTU)
10/1/97	8.34	391	728	0.4	19.0		
4/22/98	9.86	428	890	0.4	12.0	4.1	
8/3/99	8.05	295	626	0.3	21.0	2.1	

2.4.4.1 Water Quality Goals

The water quality goal for the Truxton Valley sub-basin is to reduce nitrates in the Truxton aquifer through livestock management practices and through a septic system monitoring program. We also propose to implement an emergency response plan for spills resulting from activities of the Burlington-Northern Santa Fe Railroad. Finally, we propose to maintain the fence at Surprise and Horse Trough Springs to prevent access by livestock and feral animals thereby maintaining good water quality.

2.4.5 Pollutant Sources

Pollutant sources in the Truxton Valley watershed include stormwater runoff, livestock waste, hazardous material spills from the railroad, septic systems, open dumping and other municipal activities.

2.4.6 Land Use Practices

Cattle grazing, municipal activities, railroad trains, automobile traffic and surface mining of limestone are the main land use practices affecting the Truxton Valley watershed. Other mining activities also occur down gradient from the Hualapai Reservation.

2.4.7 Proposed Mitigation Actions

- Maintain fences at Surprise and Horse Trough Springs
- Implement storm-water runoff management plan
- Implement Source Water Protection Plan for the Truxton and Valentine aquifers
- Work with Burlington-Northern/Santa Fe Railroad regarding pollutant discharge containment and prevention
- Maintain monitoring program of all water sources

2.4.8 Recommendations

Because of the populus of Peach Springs, the Truxton Valley watershed was identified as having the most non-point source pollution on the Hualapai Reservation. It is therefore recommended that this sub-basin be given the highest priority for implementation of mitigation actions to reduce the effects of non-point source pollution on water quality.

2.5 Granite Gorge

2.5.1 Physical Setting

2.5.2 Unique Features

2.5.3 Water Sources

2.5.4 Water Quality

2.5.4.1 Water Quality Goals

2.5.5 Pollutant Sources

2.5.6 Land Use Practices

2.5.7 Proposed Mitigation Actions

2.5.8 Recommendations

2.6 Western Hualapai Plateau

2.6.1 Physical Setting

8.0 WATER QUALITY MONITORING PROGRAM

The watershed covers approximately 30 square miles and drains to the Colorado River in Grand Canyon (Figure 2). Within the canyon, there are six springs that issue varying amounts of water depending on environmental conditions (Figure 3). One spring, the Mohawk Spring creates a perennial stream that flows to the Colorado River. Several spring enhancement projects have been implemented in Mohawk Canyon to protect the wetland vegetation surrounding the springs while continuing to deliver water to the local wildlife. Land use practices and conditions that affect water quality in Mohawk Canyon include timber harvest, feral livestock and burros, road development, fire suppression, mining, hunting, cattle grazing on the rim, camping/hiking and forest fires.

1.1 Background

Mohawk Canyon is located in the remote northeastern portion of the Hualapai Reservation on the Mohawk/Stairway fault (Hualapai Tribe 1996). This canyon consists of precambrian rock at the bottom of the canyon with flat-lying sedimentary sandstones, siltstones and limestones of Paleozoic age above. The canyon is approximately 13 miles in length and one mile wide at its widest point. Mohawk Canyon descends from an elevation of over 6,000 feet at the edge of the Coconino Plateau to an elevation of approximately 1,300 feet at the Colorado River in Grand Canyon. The habitat consists of steep canyon walls with Mohave desert vegetation dominated by creosote bush (*Larrea tridentata*), brittlebush (*Encelia farinosa*) and various cacti (*Opuntia spp*). The dominant wildlife species include desert bighorn sheep (*Ovis canadensis*), mule deer (*Odocoileus hemionus*), mountain lion (*Felis concolor*) and various birds, small mammals and reptiles.

In the past, a small copper mine was operated at the eastern rim of the canyon. Remnants of the mine are still present. A breccia-pipe test hole was also installed near the mine, but never developed. The ponderosa pine (*Pinus ponderosa*) forest just south of Mohawk Canyon has 25 timber harvest compartments that are scheduled for harvest every 25 years. Due to difficulty in soliciting bids on the timber harvests, however, there has not been a compartment harvested since 2000. Cattle are grazed in the area surrounding Mohawk Canyon and feral burros and horses inhabit the canyon.

1.2 Goals and Objectives

The overall goal of creating a watershed management plan for Mohawk Canyon is to maintain and/or improve water quality in the canyon. This includes the water at the spring issuances, water in the perennial stream and runoff water entering the canyon from outside. Other objectives that support the overall goal are listed below.

- Identify sources of water and other resources of significance in Mohawk Canyon
- Identify and evaluate land use practices that could have an effect on water quality in Mohawk Canyon
- Summarize water quality data for the water sources in the canyon
- Report on water quality enhancement projects that have been implemented in the past
- Identify mitigation measures that could lessen the impact of land use practices on water quality
- Develop a monitoring program for assessing changes in the ecosystem parameters within and outside Mohawk Canyon
- Develop a Geographic Information Systems data base for use in monitoring long term changes in Mohawk Canyon

1.3 Consultation and Coordination

As part of the development of the Mohawk Canyon Watershed Management Plan, we contacted Northern Arizona University, the United States Geological Survey and the Arizona Department of Environmental Quality to gather information about water quality data, natural factors affecting water quality in Mohawk Canyon and information on the type and effectiveness of mitigation measures. This information was incorporated into the plan throughout the document.

2.0 MOHAWK CANYON RESOURCES

2.1 Springs

The springs in Mohawk Canyon are crucial resources for the vegetation and wildlife that occur there. In general, the vast majority of life is dependent upon the water that springs and other surface waters provide in the arid southwest. The amount of water issuing from the springs is dependent upon environmental conditions including precipitation and utilization. Due to the extended drought that the Hualapai Reservation has been experiencing since 1999, many springs of the Hualapai Reservation have gone dry. Fortunately, all of the springs in Mohawk Canyon continue to have water at this time.

In general, the quality of the water issuing from the springs in Mohawk Canyon is good. Problems with water quality have arisen in the past, however, due to contamination of the water by livestock waste and dead livestock. This contamination reduces the levels of dissolved oxygen. Fortunately, we have been able to fence most of the spring areas to keep feral animals and burros from the spring sources. Following is a description of the various springs, their location and typical conditions.

2.1.1 Mohawk Spring

Mohawk Spring is located toward the northern end of Mohawk Canyon approximately 1 mile from the confluence with the Colorado River (Figure 3). As mentioned above, the spring creates a perennial stream that flows down to the Colorado. Water quality was sampled in February, 2003 during inclement weather. Unfortunately, due to the threat of flash flood, there was not time to sample turbidity or dissolved oxygen. We believe that the water is not very turbid normally, but becomes turbid during periods of high discharge. In general, the levels of dissolved oxygen of the water flowing from the springs in Mohawk Canyon are within acceptable limits, and we expect that the level of dissolved oxygen in the water issuing from Mohawk Spring to be acceptable as well. The water quality data are provided below in section 4.0.

2.1.2 Red Spring

Red Spring is located in upper Mohawk Canyon in a side canyon approximately one-quarter of a mile from the canyon floor at an elevation of 5,200 feet. The spring occurs at the division of the Coconino Sandstone-Hermit Shale geological formations. Water issues from seven openings in the rock wall and flows across a red wall bench (Figure 4). The spring was improved over 50 years ago with mud plaster rock walls installed to capture the flowing water. A pipe was installed to divert water from one of the seeps into the water catchment.

In normal years, there is a good flow of water from the spring issuances that supports a diverse and dense vegetation community (Hualapai Tribe 1999, 2003). Unfortunately, due to the extended drought that the Hualapai Reservation has been experiencing, there is little flow at the time of preparation of this document. As discussed below, there has been substantial improvements to the spring in recent years to protect the spring sites from trampling by feral animals and from contamination by animal waste.

2.1.3 Moss Spring

Moss Spring is located in upper Mohawk Canyon at the base of a Coconino Sandstone cliff at an elevation of 5,600 feet (Figure 5). The outlet is along a horizontal crack ten meters long and about one foot high about 400 feet above the canyon floor. There is a pool of standing water about three meters wide and 30 meters long. Horse and burro trails lead to the spring which is heavily impacted and unvegetated (Hualapai Tribe 2003). There is light impact on the vegetation below the spring with water bent grass showing the most signs of grazing. As discussed below, the spring has been enhanced through the installation of a water catchment and trough.

Water quality of the Moss Spring has been improved through the spring enhancement projects described below. Prior to enhancement, dissolved oxygen levels of the water were low (Hualapai Tribe 2003) probably due to contamination by livestock and burro waste.

2.1.4 Wildhorse Spring

Wildhorse Spring is located approximately five miles from the Colorado River in lower Mohawk Canyon (Figure 3). The spring was recently fenced with 800 feet of chain-link fence. A catchment was constructed at the spring issuance and a pipe installed that carries the water outside of the fence to a trough. The trough is heavily used by wildlife and feral animals.

2.1.5 Peyate Spring

Peyate Spring is located just south of Moss Spring on the same side of Mohawk Canyon (Figure 3). This is a small spring emanating from the red-rock ledge. There is limited amounts of vegetation supported by the spring due to the rocky nature of the issuance. The spring is, however, another important source of water for wildlife. In the future, we may need to fence the spring and install a drinker to prevent contamination of the spring by feral animals.

2.1.6 Un-named Springs

There are two other springs in Mohawk Canyon that are not named. For the purposes of this management plan, we will refer to these springs as M1 and M2 (Figure 3). These springs are located in the Rizno-Rock outcrop complex and Torriorthents complex. These springs are intermittent depending on rainfall, but are an important source of water for desert bighorn sheep and other animals when they are running. The rock outcrop supports limited vegetation but is important for nest sites, resting cover, hunting perches, escape routes, and dens.

Because the winter of 2004-5 was a wet year, we made a special visit to these springs in the summer of 2005 to GPS the locations, characterize water quality and characterize any wetland vegetation associated with the springs. The water quality data for these springs is given below in Section 4.0. We also assessed the potential for development (e.g. catchment construction) so that they might hold water year round.

2.2 Mines

An abandoned copper mine is located on the rim of Mohawk Canyon that was operated in the distant past. Some equipment and mine entrances still exist in the area. There is a possibility that rainfall washing through the mine area could be extracting minerals from the mine tailings. A closer examination of the materials by a soils scientist would help alleviate any fears of contamination of the water running into Mohawk Canyon from the mine tailings. In addition, an experimental test hole was

drilled near the mine in an attempt to locate uranium deposits in Breccia pipes in the area. It is believed that the hole was abandoned many years ago.

2.3 Caves

There are numerous caves and crevices in Mohawk Canyon. The caves were utilized by humans in the historic past. The caves also provide roosting habitat for numerous bat species. It is unknown the number of bats inhabiting the caves or the duration of their inhabitation.

2.4 Wildlife

As mentioned previously, many of the wildlife species that occur in Mohawk Canyon depend on the springs for water and habitat. In addition to the desert bighorn sheep, mule deer and mountain lion listed previously, the endangered California Condor, Chukar, Ringtail cat, Common Raven, Kangaroo rat, Golden Eagle, Peregrine Falcon, Canyon Wren, Violet-green Swallow, Chuckwalla, Gambel's Quail, Mourning Doves, gray fox (*Urocyon cinereoargenteus*), coyotes (*Canis latrans*) and various raptors can be found in the canyon. These species are greatly dependent on good water quality for their existence. Any factor that negatively affects the water quality of Mohawk Canyon will therefore have an impact on the populations of these species.

2.5 Vegetation

The baseline habitat in Mohawk Canyon is consistent with Mohave Desert vegetation as described above. Otherwise, the majority of the vegetation is associated with the springs and the perennial stream. The dominant vegetation at the springs is golden columbine (*Aquilegia chrysantha*), maidenhair fern (*Adiantum capillus-veneris*), monkey flower (*Mimulus guttatus*), Theylpodium (*Theylpodium integrifolium*), blue-eyed grass (*Sisyrchinchium demissum*), water bent (*Agrostis semiverticulata*), white virgin's bower (*Clematis ligusticifolia*) and stinky locoweed (*Astragalus praelongus*). Most of these species are facultative wetland plants with a few being obligate wetland species.

In addition, there is a substantial stand of netleaf hackberry (*Celtis reticulata*) that runs along the bottom of the drainage suggesting that a subterranean pool or flow of water exists beneath the ground's surface. This vegetation is important in providing shade and other habitat features in this desert environment.

2.6 Nautiloid Beds

Austin (2004) describes nautiloid beds found in Mohawk Canyon in the center of the drainage approximately six miles south of the confluence with the Colorado River. Sometime in the Mississippian epoch (310 to 340 million years ago), "a large-volume flow slide, probably from a shoreface in southwest Colorado, retained high density and laminar flow conditions as it inflated with a moderate amount of water forming a shallow-marine, hyperconcentrated gravity current with sediment volume concentration

about 35%. The current hydroplaned westward toward southern Nevada at 6 m/s through the carbonate platform in northern Arizona" (Austin 2004). This laminar sheet of sediment covered billions of orthocone nautiloids (molluscs) of the genus *Gnathodus.* The nautiloids were large, cylindrical animals approximately eight inches in length. The nautiloid fossils are exposed in the sediment layer in Mohawk Canyon.

The main threat to the nautiloid beds comes from erosion due to excessive water runoff and from recreationists hiking up the canyon from the river. Potential mitigation actions include reforestation following wildfires, installation of sediment traps and closure of Mohawk Canyon to hikers from the river.

2.7 Cultural Resources

The cultural resources found within Mohawk Canyon have been identified in two separate studies that we are aware of. In the 1960's, Mr. Robert Euler performed surveys of cultural sites in Mohawk Canyon as part of a land claim of the Hualapai Tribe. In 1999, the Federal Aviation Administration (FAA) contracted with the tribe to perform an ethnographic study of Mohawk Canyon and other areas of the reservation. Results of these studies are confidential. We will, however, consult with the Hualapai Department of Cultural Resources prior to any on-the-ground actions as to potential impacts to cultural resources.

3.0 LAND USE IMPACTS

While Mohawk Canyon is in a fairly remote location, there still are a variety of human and natural activities that affect water quality of Mohawk Canyon. Cattle are grazed on the rim of the canyon providing non-point source pollution in the way of fecal coliform contamination. Similarly, there are many feral animals that inhabit the interior of the canyon. Up-gradient from the canyon is a ponderosa pine forest that is periodically harvested for timber. The timber harvest activities as well as the increased runoff from deforestation have the potential to affect water quality of Mohawk Canyon. In addition, fire suppression is the management prescription for the pine forest (Christensen 2003). Various chemicals can be used to suppress forest fires that have the potential to affect water quality of Mohawk Canyon. Recreationists from hikers to hunters have the potential to impact water quality as well due to the deposition of human waste. Finally, there is a nearby road that accesses Prospect Valley from which sediment runoff is created during winter and monsoon rain storms. Each of these activities is discussed further below.

3.1 Cattle Grazing

Cattle Districts four and five graze cattle on the rim of Mohawk Canyon. The total number of animal unit months (AUM's) currently utilizing the area is 221.1. This area, however, is authorized for 855.0 AUM's . The grazing plans for the two districts is

such that the animals are brought to the Mohawk Canyon area at the beginning of June and they remain there until the beginning of September. To keep the animals from entering into Mohawk Canyon (to prevent having to round up the animals from the canyon and to prevent damage to the springs) a fence was constructed at the mouth of the canyon. Unfortunately, the fence is currently in a state of disrepair. Repair of the fence is one of the mitigation actions identified in this plan.

As is the case with all livestock activities, cattle cause non-point source pollution through the deposition of waste in the environment. Through repair of the fence, however, it should be possible to minimize the pollution from cattle into the waters of Mohawk Canyon.

3.2 Feral Animals

Feral horses, burros and escaped cattle occur in Mohawk Canyon; often in appreciable numbers. These animals can have a severe impact on the water quality and vegetation of the springs in the canyon. Fortunately, we have been able to find funding from a variety of sources to fence most of the springs in the canyon. This has resulted in vast improvements to water quality and increases in wetland area around the springs. In the past, we have also used helicopters and net-guns to capture and transport the animals out of the canyon and to local markets. If funding is available, we will continue to remove feral animals in the future.

3.3 Timber Harvest

Twenty-five timber harvest compartments have been delineated in the ponderosa pine forest on the eastern portion of the Hualapai Reservation just south of Mohawk Canyon (Figure 6). The schedule is to harvest one compartment per year on a 25 year rotation. The specific activities involved during timber harvests that could impact water quality are the improper installation of access roads, the use of heavy machinery during the skidding process and driving on roads during periods when the roads are saturated with rain water. Improper road installation occurs when roads are placed on too steep of a slope and at an improper aspect. This results in increased gullying and increased sediment erosion. Careless use of heavy machinery can also disrupt the soil's surface, create gullying and increase soil compaction in certain situations. Finally, driving on saturated roads greatly increases gullying and soil compaction thereby enhancing water runoff.

The practices utilized by the Hualapai Tribe's Forestry Program, however, are such that they minimize soil erosion and sediment runoff into Mohawk Canyon. We feel that overall, timber harvest activities have little impact on the water quality of Mohawk Canyon.

3.4 Road Access to Prospect Valley

The Lone Pine Road runs approximately seven miles along the beginning portion of Mohawk Canyon and then turns left toward Prospect Valley (Figure 7). The road is dirt and is occasionally maintained by the Hualapai roads department. Due to the lack of vegetative cover and the slope, water falling on the road tends to run along the edge of the road into the canyon. This runoff gets charged with sediment from the road's surface and the road right-of-way. The sediment ultimately gets deposited in Mohawk Canyon and is available as future sediment runoff. With the implementation of sediment traps as described below, we can hopefully reduce the amount of sediment being transported into the canyon.

3.5 Road Access to Mohawk Canyon

The Thorton Tank road, one mile north past the Thorton Tower Road, runs approximately 14 miles towards Mohawk Canyon. At approximately 14 miles, it turns right and enters into Mohawk Canyon for approximately 5 miles (Figure 7). The road has been washed out because Laguna Valley drains into Mohawk Canyon.

3.6 Fire Suppression

On rare occasions, slurry bombers are called to fight forest fires on the eastern portion of the Hualapai Reservation near Mohawk Canyon. The last time chemicals were used on a fire on the Hualapai Reservation was in 2004 at Horse Flats. The chemical used as a fire retardant is soap and water dyed red**.**

3.7 Camping/Hiking/Hunting

Visitors on river trips in Grand Canyon often hike up from the river for sightseeing activities. These are usually day trips and we do not believe that a substantial amount of human waste is deposited by these individuals. Others, however, who are backpacking or camping in Mohawk Canyon probably do deposit human waste. Similarly, hunters who have a camp in Mohawk Canyon may deposit waste there. Below, we identify mitigation measures that will hopefully reduce water pollution from human waste in Mohawk Canyon.

4.0 WATER QUALITY AND WETLAND/WATER QUALITY IMPROVEMENT ACTIVITIES

4.1 Water Quality Summary

Water quality was initially only monitored at Moss and Red Springs in Mohawk Canyon. In the summer of 2005, a visit was made to the two un-named springs (M1 and M2) where water quality was measured. The water quality parameters that have been monitored include pH, total dissolved solids (TDS), conductivity, salinity, temperature, dissolved oxygen and turbidity. These parameters have been monitored

annually since 1997 at Red and Moss Springs with the exception of 2000 and 2001. Following are the results of those water quality monitoring efforts.

Table 1. Water quality monitoring data for Moss Spring.

Date	**PH**	**TDS (mg/L)**	**Conductivity (uS)**	**Salinity (ppt)**	**Temp. (°C)**	**D.O.**	**Turbidity (NTU)**
10/10/97	8.16	220	416	0.2	16		
4/27/98	7.93	209	433	0.2	13	25% 2.5mg/L	
8/2/99	8.16	22	234	0.1	12		
8/2/02	8.7	216	455	0.2	19.7	42.0%	
9/23/03	8.0	211	437	0.2	17.0	94.3% 7.20mg/L	1.5

Table 2. Water quality monitoring data for Red Spring.

Date	**PH**	**TDS**	**Conductivit**	**Salinity**	**Temp**	**D.O.**	**Turbidity**

		(mg/L)	y (uS)	(ppt)	. (°C)		(NTU)
10/3/97	7.5	409	766	0.4	22		
4/27/98	7.81	411	037	0.4	14	10% 1.2mg/ L	
8/2/99	8.43	347	715	0.3	21	13% 1.2mg/ L	
8/8/02	7.9	740	354	0.4	25.5	200% 11.0mg /L	
9/23/03	7.35	331	687	0.3	24	29.6% 2.5mg/ L	3.0

In general, these data show that water quality has improved at Moss Spring since it was fenced in 1997 as the level of dissolved oxygen has increased from 2.5 mg/l in 1998 to 7.2 mg/l in 2003. Similarly, Total Dissolved Solids (TDS) decreased from 740 mg/l in 2002 to an acceptable level of 331 mg/l in 2003 at Red Spring following fencing. Conductivity, pH, salinity and turbidity were all within acceptable levels. As the level of precipitation has increased going into 2005, water quality of the springs besides Red and Moss should be investigated to begin to develop a data base for future comparisons.

Table 3. M1 Spring water quality data.

Date	PH	TDS (mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O. mg/l	Turbidity (NTU)
8/23/05	8.87	185	386	0.2	19.4	5.81	2.37

Table 4. M2 Spring water quality data.

Date	PH	TDS (mg/L)	Conductivity (uS)	Salinity (ppt)	Temp. (°C)	D.O. mg/l	Turbidity (NTU)
8/9/05	8.25	261	544	0.3	19.2	6.0	0.66

4.2 Exclusion Fence at Head of Mohawk Canyon

The exclusion fence at the head of Mohawk is an old existing fence stretching for approximately 1/4 mile. The purpose of this fence is to keep cattle and feral animals from going into the canyon. Our plan is to repair the fence in places where it is down.

4.3 Red Spring Project

Red Spring was fenced in 1999 to keep feral horses from degrading the water quality and wetland vegetation. A pipe and drinker was installed to allow wildlife access to water (Figure 8). Water quality, quantity, and macroinvertebrate sampling will continue to be monitored. During a future visit to this spring, we will clean the silt out of a watering trough intended to capture water.

4.4 Moss Spring Project

Moss Spring was fenced in 1999. A catchment, pipe and drinker were also installed. Water quality, quantity, and macroinvertebrate sampling will continue to be monitored. Future repairs at this spring will include renovating the catchment and reconnecting the piping system to a trough outside the fenced area.

4.5 Wildhorse Spring Project

Wildhorse Spring was fenced in 2004 and a catchment was constructed to facilitate movement of the water into a drinker outside the fence (Figure 9). The catchment also facilitates wetland vegetation productivity. We will continue to monitor water quality at this spring. In the future we plan on raising the piping inside of the catchment and installing wire webbing to keep moss from accumulating within the pipe. We will also reattach the trough to the piping system and stabilize to allow for watering outside of the fenced area.

4.6 M1 Catchment Dam

A cement/rock catchment dam was constructed in the early 1990's to capture the flow from the M1 spring so that wildlife would have a more readily available source of water (Figure 10).

4.7 Apron Catchment Project

The U.S. Bureau of Reclamation, Lower Colorado Region in Boulder City, Nevada funded the construction of four remote water catchments on the Hualapai Reservation. One of these catchments was constructed in the Mohawk Canyon watershed. This catchment is located at the border of Mohawk Canyon and National Canyon (hereafter referred to as the Lesicka catchment; Figure 11). The Lesicka catchment consists of a concrete/rock dam that is 20 feet wide by two feet tall that funnels water runoff to a four inch pipe that is connected to a six foot deep drinker (Figure 12) and then to two, 2,500-gallon storage containers. As water is removed from

the drinker, water from the storage tanks equalize the water level among the three containers.

4.8 Sage Removal Project

The U.S. Environmental Protection Agency funded a sage brush removal project to decrease non-point source sediment pollution for runoff into Mohawk Canyon. Approximately 1,800 acres of sage brush (*Artemesia sp.*) was cleared using an aerially-applied herbicide (Spike). The existing sage brush was then allowed to naturally decompose and the areas were invaded by native grasses that stabilize the soil. Native grasses are better at stabilizing the soil than sage brush so that sediment runoff into Mohawk Canyon will be reduced at the project's end.

5.0 FUTURE MITIGATION ACTIONS

5.1 Fix Entrance Fence

The fence at the beginning (southern end) of Mohawk Canyon was erected in 1994 by the Hualapai Natural Resources Department and has become in disrepair over the past several years. We propose to repair the fence by installing new fence posts, new wire and new stays where needed. After the fence is repaired, it will be important to remove all feral horses and burros from the interior of Mohawk Canyon to help preserve the spring resources. Regular fence maintenance in the future will ensure that the integrity of the fence remains intact.

5.2 Repair Troughs and Pipelines

At some of the springs where we have installed fencing, catchments, pipelines and drinking troughs (e.g. Moss Spring**,** Red Spring), the equipment has come to be in a state of disrepair primarily due to damage by feral animals. We propose to replace and repair damaged tanks, pipes and catchments at Red, Wildhorse, and Moss Spring.

5.3 Control Feral Animals and Cattle Grazing

Install exclusion fences around springs and into the canyon where needed. We then propose to remove the feral animals using a helicopter and net-gun. This method of removal has been very successful in the past. Unfortunately, due to the state of disrepair of the fences, the animals have made their way back into the canyon. The fences also keep cattle from the canyon. It will also be important, however, to maintain the fences that keep cattle and feral animals from the rim of the canyon to reduce non-point source pollution from entering the canyon.

5.4 Implement Fire Management Plan

The Hualapai Tribe's Fire Management Plan (Christensen 2003) was adopted by the U.S. Bureau of Indian Affairs (BIA) in 2003 and is currently being implemented by the Hualapai Tribe and BIA. The Fire Management Plan calls for prescribed burning and mechanical fuels reductions to reduce fuel loads and thereby decrease the likelihood of catastrophic wildfires. Wildfires increase the amount of sediment entering the canyon with subsequent rains. Prescribed burning and mechanical fuels reductions will dramatically reduce the chances of wildfire. We are currently seeking funding from the Federal Emergency Management Agency for these activities.

5.5 Remove Feral Animals

The last time feral animals were removed from Mohawk Canyon was in 1999, where a total of 53 feral horses were taken out by helicopter. It took 6 days to complete the capture activities. Currently, there are approximately 20 head of horses in Mohawk Canyon that we plan to remove once funding is secured.

5.6 Improve M2 Spring

M2 spring in the lower canyon could be improved by constructing water containment structures to reduce evaporation and provide for a more reliable supply of water. Desert bighorn sheep and mule deer would benefit from this improvement.

5.7 Control Access to Prevent Exotic Introductions

Visitation by recreationists can introduce non-native, undesirable plant species to the springs in Mohawk Canyon. Species such as tamarisk and camelthorn (*Alhagi camelthornii*) have been introduced to other side canyons of Grand Canyon by hikers unknowingly carrying seeds on their clothing and shoes to these areas. We propose to limit the areas in Mohawk Canyon that can be accessed from the Colorado River. More specifically, we propose to limit access to the first one-quarter mile from the Colorado River in Mohawk Canyon. This can be accomplished by proposing this action to the Hualapai Tribal Council who can pass this limitation by resolution.

5.8 Install Silt Traps Up-gradient

With funding from the U.S. Environmental Protection Agency and the U.S. Bureau of Reclamation, we have installed silt traps in Milkweed and Peach Springs canyons to reduce the amount of sediment pollution into the wetlands and streams found there. We propose to seek funding to install silt traps up-gradient of Mohawk Canyon to similarly protect water quality there.

5.9 INSTALL AIR QUALITY MONITORING STATION

The Hualapai Air Program has been in operation since 1995. The initial work included performing an air emission inventory of the Hualapai Reservation and surrounding area. The actual air quality monitoring program began in 1995 with a Particulate Matter 2.5 micron and Particulate 10 micron and meteorological tower. The meteorological tower measures wind speed, wind direction, humidity, solar radiation, precipitation, and atmospheric pressure.

The Hualapai Air Program has established two air quality monitoring stations; one at the Earthship in Peach Springs and one at Grand Canyon West at the airport terminal. A third air quality monitoring station has been approved for the Big Sandy portion of the reservation for fiscal year 2006. A natural gas-fired power plant is being proposed south of the Big Sandy Reservation and the Big Sandy Air Quality Monitoring Station is to establish an air pollution baseline before and during the operation of the power plant. An air monitoring station at Mohawk Canyon would provide data on emissions from the Navajo Generating Plant in Page, Arizona and the Mohave Generation Plant in Laughlin, Nevada. A knowledge of air quality in Grand Canyon is important to the recreational and economic development potential of the tribe. We are currently seeking funds to implement an air monitoring station for Mohawk Canyon.

5.9.1 PARAMETERS TO BE MONITORED

There are six air criteria pollutants that are tracked by Environmental Protection Agency. They are carbon monoxide, mercury, sulfur oxide, nitrogen oxide, lead, and particulate matter. Due to the costs of the monitoring equipment and laboratory analysis, the Hualapai Air Program selected to monitor particulate matter 2.5 microns and particulate matter 10 microns. Again, this program is contingent upon funding.

5.9.2 Monitoring Schedule

Establishment of a air quality monitoring station at Mohawk Canyon would provide for continuous monitoring of the air quality parameters identified above. The filters would be collected every other week and sent to a laboratory in California where the analyses are performed. The results provide data on what contaminants were in the air the previous monitoring period.

6.0 MONITORING PROGRAM

6.1 Water Quality/Wetlands

We propose to continue to monitor water quality and wetland parameters in the spring and fall of each year dependent on the availability of funding. Continuing to build

on a data base will allow the tribe to identify changes in wetland health and water quality parameters over time thereby allowing us to identify land use activities that may be affecting these resources. The water quality parameters to be monitored will continue to be those reported above. The biological parameters to monitored will include benthic macroinvertebrates and vegetation.

6.2 AIR QUALITY

6.2.1 EXISTING AIR QUALITY DATA BASE

There is a wealth of air quality data collected by Hualapai tribal member air technicians since 1995. Desert Research Institute, our air consultant and laboratory analyst, continues to store all pertinent air quality data in it's raw format and in quarterly written reports for the Hualapai Air Program and Environmental Protection Agency, Region 9.

The Hualapai Air Program is actively involved in EPA's National Environmental Information Exchange Network (NEIEN) program. As a result, the Hualapai Air Program is storing previous air quality data in our local mainframe in the Hualapai Department of Natural Resources. As the NEIEN program is moved forward, the Hualapai Air Program will be able to transmit data directly to the HDNR mainframe.

6.3 Biodiversity

6.3.1 Existing Bio-monitoring Data Base

Biological data that exists for Mohawk Canyon includes annual surveys for desert bighorn sheep and macroinvertebrate data for Red and Moss Springs beginning in 2004. Table 3 gives the results of our sheep surveys in Mohawk Canyon for 1994 through 2002. Tables 4 and 5 give the results of our macroinvertebrate sampling at Moss and Red Springs respectively.

Table 5. Desert bighorn sheep survey results for 1994-2002.

	Class Animal									
Year	**I**	**II**	**III**	**IV**	**Ewes**	**Lmbs**	**Male Yrlg**	**Fem Yrlg**	**Unc**	**Total**
1994	0	0	2	1	13	5	2	0	0	23
1995	0	0	4	0	9	5	2	0	0	20
1996	6	5	3	6	24	11	0	0	0	55
1998	4	9	8	2	37	11	0	0	0	71

1999	2	1	2	0	14	10	0	0	0	29
2000	2	3	4	0	4	1	0	0	0	14
2001	1	2	2	0	9	3	0	1	1	19
2002	3	2	4	2	20	2	0	0	4	37

These data suggest that the extended drought that has affected the entire Hualapai Reservation over the past five years has affected the desert bighorn sheep population in Mohawk Canyon as the population has declined by more than one-half in the past two years. Hopefully, the spring enhancement projects and water catchments that we have constructed over the last several years will help to improve conditions for sheep in the coming years.

Table 6. Moss Springs Macroinvertebrate Sampling Results

June, 2004		**August, 2004**	
TAXA	NUMBER	TAXA	NUMBER
Tanypodinae	32	Chironomidae	25
Tanytarsini	1	Tanypodinae	26
Argia	1	Tanytarsini	5
		Saldidae	1
		Microvelia	2
		Argia	8
		Progomphus	1
		Libellula	5
		Oligochaeta	1

Totals = 3	**34**	**9**	**74**

The macroinvertebrate abundance and diversity increased dramatically between the June and August sampling periods at Moss Spring (Table 4). We are not certain why this pattern occurred, but we are seeing a similar pattern across most of the 18 wetlands we began monitoring in 2004. We are currently consulting with invertebrate ecologists to determine the significance of these changes and to understand how the invertebrate community structure reflects water quality at Moss and Red Spring. As is evident in Table 5, Red Spring did not have any water at the June sampling period so no macroinvertebrates were found. It is interesting, however, how quickly the invertebrate community responded once water resumed flowing at Red Spring (Table 5).

Table 7. Red Spring Macroinvertebrate Sampling Results			
June, 2004		**August, 2004**	
TAXA	NUMBER	TAXA	NUMBER
No Water		Melyridae	3
		Sphaeridiinae	2
		Chironomini	1
		Chironomus	1
		Tanytarsini	7
		Culiseta	49
		Callibaetis	1
		Cicadellidae	1
Totals =		**8**	**65**

6.4 Cultural Resources

The archaeological features identified in the Euler and FAA studies mentioned above will be monitored based on specific project needs. Here, whenever we propose to implement a spring restoration project or other activity that has the potential to impact the surface of the ground, we will consult with the Hualapai Cultural Resources Program to ascertain as to whether any archaeological or cultural features are likely to be affected. If there are features that may be affected, we will have the Cultural Resources Program monitor the features during implementation of the activity. Of course, all activities must have National Environmental Policy Act (NEPA) and approval of the tribe's Interdisciplinary Team and Tribal Council prior to implementation.

7.0 GEOGRAPHIC INFORMATION SYSTEM (GIS)

The Hualapai Tribe's GIS Program has prepared GPS polygons for the perimeters of Moss, Red, Wild Horse and Peyate Springs in Mohawk Canyon. We can use these polygons to compare wetland size over time as affected by our restoration and enhancement projects (e.g. fencing), drought and land use practices to measure the success of our projects, to understand natural variation in wetland size and to identify impacts of land use practices on these important wetland resources. In addition, the GIS layers have the physical location of each spring and the associated water quality data base. We will soon begin to add the macroinvertebrate data base into the GIS system.

8.0 LITERATURE CITED

Austin, S.A. 2003. Nautiloid mass kill and burial event, Redwall Limestone (Lower Mississippian), Grand Canyon region, Arizona and Nevada. Final Report to Grand Canyon National Park Id#GRCA-00097. 69pp.

Christensen, K.M. 2003. Fire Management Plan for the Hualapai Reservation. Adopted by the U.S. Bureau of Indian Affairs, Phoenix, AZ. 48 pp.

7.1 Water Quality Layer

7.2 Wetland Enhancement Project Layer

7.3 Mitigation Project Layer

September 2, 2004

Mohawk Canyon Watershed Management Plan Team Member
Department of Natural Resources
P.O. Box 300
Peach Springs, AZ 86434

Dear Colleague,

This letter is to request your input into remaining sections of the Mohawk Canyon Watershed Management Plan. I personally, do not possess the information required to complete the remaining sections of the Plan and am asking for your assistance with providing information and/or for writing some of the remaining sections with which you may be familiar with. There is money in the budget (see Don Bay) to compensate you for your time working on this project. It would be helpful if you could first identify which sections you could work on so that there is not duplicative efforts.

I appreciate your assistance and look forward to hearing from you. Thanks.

Sincerely,

Kerry Christensen, Senior Scientist
Hualapai Department of Natural Resources

Figure 5. A representative photograph of the vegetation at Moss Spring.

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September 9, 2005

Mr. Bill Green
U.S. Bureau of Reclamation
Lower Colorado Region
P.O. Box 61470
Boulder City, NV 89006-1470

Dear Mr. Green,

Please consider the enclosed draft final report for the Hualapai Tribe's Mohawk Canyon Watershed Management Plan. Completion of this management plan greatly focuses the tribe's efforts to improve water quality of Mohawk Canyon for the benefit of wildlife and the general public. We greatly appreciate your and your agency's efforts to improve environmental conditions and water quality on the Hualapai Reservation, and we look forward to continued coordination and cooperation on future endeavors to benefit the environment.

Please contact our office if we can provide additional information.

Sincerely,

Donald E. Bay, Director
Hualapai Department of Natural Resources