Cover Page

Arizona Water Protection Fund
Application Cover Page
FY 2019

Title of Project: Harrenburg Wash Enhancement Project

Type of Project:
☒ Capital or Other
☐ Water Conservation
☐ Research

Stream Type:
☐ Perennial
☐ Intermittent
☒ Ephemeral

Your level of commitment to maintenance of project benefits and capital improvements:
☐ < 5 years ☐ 5-10 years ☐ 11-15 years ☒ 16-20 years

Applicant Information:
Name/Organization: Coconino County
Address 1: Parks and Recreation
Address 2: 2446 Fort Tuthill Loop
City: Flagstaff
State: AZ
ZIP Code: 86005
Phone: (928) 679-8000
Fax: (928) 774-2572
Tax ID No.: [redacted]

Inside an AMA: Yes ☐ No ☒

If yes, which AMA:
☐ Phoenix
☐ Tucson
☐ Prescott
☐ Pinal
☐ Santa Cruz

Type of Application:
☒ New
☐ Continuation

Contact Person:
Name: Elizabeth Krug
Title: Community Relations Coordinator
Phone: (928) 679-8027
Fax: (928) 774-2572
e-mail: lkrug@coconino.az.gov

Any Previous AWPF Grants:
☐ Yes ☒ No

If yes, please provide Grant #(s):

Arizona Water Protection Fund Grant Amount Requested:

$133,098.00

If the application is funded, will the Grantee intend to request an advance:
☐ **Yes** ☒ **No**

Matching Funds Obtained and Secured:

Applicant/Agency/Organization:	Amount ($):
1. Applicant	8,800.00
2.	
3.	

Total: 8,800.00

Has your legal counsel or contracting authority reviewed and accepted the Grant Award Contract General Provisions?
☐Yes ☒No ☐N/A

Signature of the undersigned certifies understanding and compliance with all terms, conditions and specifications in the attached application. Additionally, signature certifies that all information provided by the applicant is true and accurate. The undersigned acknowledges that intentional presentation of any false or fraudulent information, or knowingly concealing a material fact regarding this application is subject to criminal penalties as provided in A.R.S. Title 13. The Arizona Water Protection Fund Commission may approve Grant Awards with modifications to scope items, methodology, schedule, final products and/or budget.

Cynthia Nemeth-Briehn	Director, (928) 679-8004
Typed Name of Applicant or Applicant's Authorized Representative	**Title and Telephone Number**
Cynthia L. Nemeth-Briehn	9-7-18
Signature	**Date Signed**

Executive Summary

Harrenburg Wash, located near Kachina Village in Coconino County, Arizona, is located about seven miles south of Flagstaff, Arizona, and is owned and managed by Coconino County Parks and Recreation. The Harrenburg Wash Enhancement Project seeks to enhance habitat and recreational opportunities at Harrenburg Wash. Coconino County Parks and Recreation desires to improve the stability, productivity and habitat quality for the wash, just upstream from its confluence with Pumphouse Wash, both of which are in the Upper Verde River Watershed and are the headwaters of Oak Creek Canyon.

The wash area has been impacted by: the building, filling and partial breaching of an earthen dam and a relatively large pond where a downstream channel is consistently being overtopped by water causing the trail prism to wear out and erode due to high water velocity; channel excavations to create open water; flood plain fill; and invasion of non-native weed species.

This enhancement project is four-fold and will focus on: making improvements to the channel; treating invasive weeds; incorporating re-vegetation efforts along the channel, in the uplands and in an old parking area; and other items that will contribute to low maintenance and higher habitat quality.

The wash area and the public will benefit from this enhancement project for over 20 years, as enhancements will positively impact water quality in the area. Water quality will be improved through less sediment flow and decreased surface water runoff, with Harrenburg Wash slowing and absorbing flood waters. Through the addition of native plants and forbs, cottonwoods and willows, the wash area will experience a higher biodiversity of plant and animal species. Additionally, with less invasive weeds and more plant and animal diversity, visitors will experience increased recreational opportunities.

The Harrenburg Wash Enhancement Project has five tasks. Task #1 is to obtain the necessary permits for the project, which may include a Section 404 Permit under the Clean Water Act and a Coconino County Grading Permit. Additional items may include a completed wetlands delineation and Ordinary High Water Survey, archaeological survey, and biological assessment. Task #2 is to complete a design plan of the project. Task #3 is construction and re-vegetation, which consists of improving the channel to address the eroding trail prism and headcuts, widening and reshaping an already-breached dam, spraying invasive weeds, and planting native grasses and forbs, willows and cottonwoods. Task #4 is maintenance and monitoring, which includes additional invasive weed spraying for 3-4 years and manual pulling for 6-7 years. Task #5 is a final report and presentation, which will be done when the grant is completed.

Project costs total $126,760, with administration costs of $6,338 added (of 5% of project costs), for a grant request of $133,098. Coconino County Parks and Recreation is providing $8,800 of matching funds, from Direct Labor and Equipment Costs. Without project funding from the Arizona Water Protection Fund, it is unlikely this project will be completed, resulting in increased water flow from the restricted culverts, continued headcutting in the wash, and greater spread of invasive species.

Project Overview

Background: Harrenburg Wash, located near Kachina Village in Coconino County, Arizona, is located about seven miles south of Flagstaff, Arizona, and is owned and managed by Coconino County Parks and Recreation. The Harrenburg Wash Enhancement Project seeks to enhance habitat and recreational opportunities at Harrenburg Wash. Coconino County Parks and Recreation desires to improve the stability, productivity and habitat quality for the wash, just upstream from its confluence with Pumphouse Wash, both of which are in the Upper Verde River Watershed and are the headwaters of Oak Creek Canyon.

The wash area was once privately owned, and the owners created an earthen dam for a fishing pond. The dam was purposely breached decades ago, but the elevation of the breach is high enough to cause water to back up after runoff events. The breached pond area supports a wetland that Coconino County wishes to preserve and enhance. The wash area has been impacted by: the building, filling and partial breaching of an earthen dam and a relatively large pond where a downstream channel is consistently being overtopped by water causing the trail prism to wear out and erode due to high water velocity; channel excavations to create open water; flood plain fill; and invasion of non-native weed species. A previous brief assessment of the site by the Natural Resource Conservation Service pointed out the need to prevent future headcutting through the breached dam and into the wetland.

Goals: The Harrenburg Wash Enhancement Project is four-fold and will focus on: making improvements to the channel; treating invasive weeds, specifically diffuse knapweed; incorporating re-vegetation efforts along the channel, in the uplands and in an old parking area; and other items that will contribute to low maintenance and higher habitat quality.

Objectives:

1. *Channel Improvements* - There are several impacts to the channel that will be addressed for the area to reach its full potential. The potholed/excavated areas that have initiated headcuts will be refilled with the materials that were removed. The outlet of the wetland through the already-breached dam will be widened and reshaped to approximate a natural stable channel, based on a geomorphic reference from the area. Below the breach area, the undersized culverts will be replaced with a pedestrian bridge.

2. *Weed Treatment* - Approximately seven acres will be treated to control diffuse knapweed. Two methods will be used: spraying knapweed in the spring while it is still small and actively growing, followed by manual pulling and bagging in mid-summer when it is large and easily found but before it has begun to set seed. Manual pulling will occur for six to seven years to help prevent re-infestation from the seed bank and neighboring seed sources. This is anticipated to be a low level of effort compared to initial management efforts. Native vegetation should be well enough established to prevent re-infestation.

3. *Revegetation* – This project will incorporate re-vegetation of disturbed areas in the channel improvement area with appropriate native grass and forb seed or wetland plugs. The value of the habitat can potentially be increased by research value. This area may provide an ideal site for planting genetically important cottonwoods in a refugia situation. Northern Arizona Cottonwood Research Group is actively looking for sites that provide refugia habitat for genetically unique cottonwoods whose habitat is endangered by warming climate and flow alteration. The old parking area will be over-seeded with a native grass and forb mix. While this

site does not have the wet meadow potential of the area above the already-breached dam, it can support a diverse native grass and forb community. Given the habitat and recreational value of the site, an emphasis will be put on including plants valuable to pollinator species in this area. Both early and late season flowering plants will be included in the seed mix. Previous replanting efforts have worked except in areas with high cinder content. These cinders will be removed from the site or reworked into trail cover so that native soil suitable for seeding is exposed. Light mulching with weed-free straw or wood chips will be utilized to improve germination and establishment.

4. *Other Items* – There is an above-ground electrical line that dead ends near the wetland. This wire and two associated wooden poles will be removed from the site. There are several piles (approximately 40 cu yds) of broken asphalt and concrete that have been dumped on the site. These will be removed and disposed of in a lawful manner. The remaining material will be smoothed over and replanted. The current parking lot area creates a concentrated runoff into the channel. This is caused in part by a rubble/rock wall that borders the parking area. The wall traps runoff and directs it down the trail towards the channel. The wall also creates a difficult weed treatment area since weeds and seed fall between the crevices in the rock. Removal of the wall and replacement with single rocks or a fence will improve runoff direction and help maintain the area as weed free. The routing of the trail will be moved to accommodate siting of the crossing in a different area more amenable to a short pedestrian bridge. Monitoring of the success of the project will be focused on increasing the length of period for wetted soil conditions and favorable changes to the meadow vegetation community. These items will be measured with a series of vegetation transects and several piezometers located within the meadow. These will be installed and monitored before the project is implemented to allow some baseline data to be collected.

Statement of Problems: The Harrenburg Wash area has been impacted by: the building, filling and partial breaching of an earthen dam; channel excavations to create open water; flood plain fill; and invasion of non-native weed species. This project seeks to enhance habitat and recreational opportunities at Harrenburg Wash. Coconino County Parks and Recreation desires to improve the stability, productivity and habitat quality for the wash, just upstream from its confluence with Pumphouse Wash.

Statement of Solutions: The Harrenburg Wash Enhancement Project is four-fold and involves improving the channel down from the already-breached dam, weed treatment, revegetation, and other items that will contribute to low maintenance and higher habitat quality.

Statement of Project Years of Benefit to the Resource and General Public: In terms of benefits, the resource and the public benefits from this project for well over 20 years, as Coconino County Parks and Recreation owns the land and is managing it as open space. The area will undergo construction and re-vegetation for the first few years of the grant, and with continued monitoring and maintenance of the area, we anticipate less invasive weeds, more native plant cover, and a revitalized channel that is free of headcutting. Water quality will be improved through less sediment flow and decreased surface water runoff, with the wash slowing and absorbing flood waters. Through the addition of native plants and forbs, cottonwoods and willows, the area will experience a higher biodiversity of plant and animal species. And with less invasive weeds, more plant and animal diversity, the area will provide for more recreational opportunities.

Project Location & Environmental Contaminant Form

Project Location & Environmental Contaminant Information
FY 2019

Project Location Information

1. County: Coconno	2. Section(s): 19, 30	3. Township: T20N	4. Range: R07E

5. Watershed: Upper Verde River Watershed
6. 8 or 10 Digit Hydrologic Unit Code (HUC): 15060202
7. Name of USGS Topographic Map where project area is located: Mountainaire, AZ
8. State Legislative District: 06
   (Information available at: http://azredistricting.org/districtlocator/
9. Land ownership of project area: Coconino County
10. Current land use of project area: Open Space
11. Size of project area (in acres): 7 DIRECT
12. Stream Name: Harrenburg Wash
13. Length of stream through project area: 0.25 miles
14. Miles of stream benefited: 0.25 miles
15. Acres of riparian habitat: 7 acres will be:
    - ☒ Enhanced
    - ☐ Maintained
    - ☐ Restored
    - ☐ Created

16. General description and/or delineation for the area of impact of the project within the watershed.
Harrenburg Wash is one of three areas that make up Pumphouse County Natural Area; is part of the Upper Verde River Watershed and is the headwaters of Oak Creek Canyon. The main natural water source is Griffiths Spring.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:
Harrenburg Wash is located in Kachina Village, 7 miles south of Flagstaff, in Coconino County, AZ. From I-17, exit 337 and go to Kachina Village; turn north on Kathina Trail; turn left/south on Ancient Trail and follow road to parking area north of Jadito Trail and Kachina Village Utility building.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? ☐ **YES** ☒ **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants: _____
2. Are there known environmental contaminants in the project vicinity? ☐ **YES** ☒ **NO** If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants: _____
3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? ☐ **YES** ☒ **NO**

Scope of Work

Task #: 1

➢ **Task Title: Permitting**

➢ Task Description: Obtain Section 404 Permit, including wetland delineation and Ordinary High Water Survey, archaeology survey, and a biological assessment. Additional permits may be required, for example: Stormwater Pollution Prevention Plan – Arizona Department of Environmental Quality 401 Permit; Coconino County Grading Permit and plan, that includes a hydraulic model and drainage report.

➢ Task Purpose/Objective: The purpose of obtaining these permits is to comply with local, state, and federal laws before any work begins on the project.

➢ Responsible personnel: Natural Channel Design personnel

➢ Deliverable Description: Section 404 Permit, Coconino County Grading Permit

➢ Deliverable Due Date: Before construction begins.

➢ Task Cost (rounded to the nearest dollar): $22,736

Task #: 2

➢ **Task Title: Design**

➢ Task Description: Obtain design plan of project prior to construction and re-vegetation.

➢ Task Purpose/Objective: The purpose of obtaining design plan is to ensure project meets specifications for permitting and construction.

➢ Responsible personnel: Natural Channel Design personnel

➢ Deliverable Description: Design Plan, including a re-vegetation plan

➢ Deliverable Due Date: In conjunction with permitting and before construction begins.

➢ Task Cost (rounded to the nearest dollar): $5,182

Task #: 3

➢ **Task Title: Construction and Re-Vegetation**

➢ Task Description: Mobilize/demobilize earthwork for channel improvements in the Harrenburg Wash area. This area includes an already-breached dam, built in the 1960s and subsequently breached; a parking area to remove concrete/asphalt and smooth out; fill, compact and smooth pot holes; remove a culvert and road prism; remove an old electric line; reshape breach channel; and install rock chute and step pool. Re-vegetation of the area will include soil preparation for overseeding with native grasses and forbs. Additionally, the project will supply and place: straw mulch, wetland plugs, cottonwood trees, and willows.

➢ Task Purpose/Objective: By implementing the above construction items, the area has the potential to function as a wet meadow wetland system with a relatively large open water area. While extended dry periods will continue to dry the surface water, improving soil water storage in the upper meadow will likely lengthen the period of open water and high ground water. Extension of the wetted period should improve habitat quality for facultative wetland plants, aquatic invertebrates and amphibious wildlife that will benefit from higher productivity and longer inundation periods. Additionally, higher groundwater for longer periods of time should encourage a more widespread wetland plant community

with greater productivity and resistance to erosion. The purpose of re-vegetation is to encourage native plant species in the wetland area that will contribute to greater habitat diversity.

➢ Responsible personnel: Natural Channel Design, Inc. personnel; Coconino County Parks and Recreation staff Geoffrey Gross and James Richardson

➢ Deliverable Description: Photos of construction work. Photos of area re-vegetation with native plants, forbs, willows, and cottonwoods.

➢ Deliverable Due Date: After design plan has been developed and permits obtained.

➢ Task Cost (rounded to the nearest dollar): $88,892

Task #: 4

➢ **Task Title: Maintenance and Monitoring**

➢ Task Description: Implement weed treatment (herbicide) on diffuse knapweed; install piezometers in Harrenburg Wash for monitoring purposes.

➢ Task Purpose/Objective: By implementing an herbicide weed treatment on diffuse knapweed in the upland area for multiple years, we hope to bring the weed under control and prevent further spreading. By installing piezometers in Harrenburg Wash, we plan to monitor water levels for management purposes.

➢ Responsible personnel: Natural Channel Design, Inc. personnel, Coconino County Parks and Recreation staff Geoffrey Gross and James Richardson

➢ Deliverable Description: Report that includes the number of acres of diffuse knapweed treated per year, number of piezometers installed on-site, and data from piezometers.

➢ Deliverable Due Date: Weed treatment begins after construction begins; monitoring can begin immediately to get baseline data; long-term monitoring will occur as part of Coconino County Parks and Recreation maintenance program.

➢ Task Cost (rounded to the nearest dollar): $7,750

Task #: 5

➢ **Task Title: Final Report and Presentation**

➢ Task Description: Report and provide presentation on project and objectives achieved to Arizona Department of Water Resources.

➢ Task Purpose/Objective: Confirm objectives and deliverables achieved.

➢ Responsible personnel: Coconino County Parks and Recreation staff Geoffrey Gross and James Richardson

➢ Deliverable Description: Report and presentation

➢ Deliverable Due Date: After project completed.

➢ Task Cost (rounded to the nearest dollar): $2,200

Budget

Proposed Budget for Harrenburg Wash Enhancement Project				
Item Description	***Quantity***	***Unit***	***Unit cost***	***Total***
Task #1 Permitting				
Outside Services				
Permitting 404 (includes wetland delineation, arch survey and Biological assessment)	320	hrs	$35	$11,280
Permitting County grading plan with hydraulic model and drainage report	178	hrs	$35	$6,275
Design and construction oversight	147	hrs	$35	$5,182
Task #2 Design				
Outside Services				
Design and construction oversight	147	hrs	$35	$5,182
Task #3 Construction and Re-Vegetation				
Capital Oultay & Equipment Costs				
Earthwork mobilization/demobilization	1	ls	$2,500	$2,500
Fill, compact and smooth pot holes	50	cu yd	$12	$600
Supply and place logs or rock mulch	3	ea	$4,688	$14,064
Remove concrete/asphalt and smooth	50	cu yds	$70	$3,500
Remove culvert and road prism	61	cu yds	$12	$732
Reshape breach channel	1000	cu yds	$12	$12,000
Rock chute/Step pool	4	ea	$2,402	$9,608
Remove electric line	1	ls	$2,000	$2,000
Soil prep	2	acres	$625	$1,250
Overseed with native grasses and forbs	4	acres	$500	$2,000
Supply and place straw mulch	2	acres	$688	$1,376
Supply and place wetland plugs	250	ea	$2	$500
Supply and place cottonwood trees	61	ea	$30	$1,830
Supply and place willows	375	ea	$18	$6,750
Supply and place pedestrian bridge (40')	1	ea	$25,000	$25,000
Outside Services				
Design and construction oversight	147	hrs	$35	$5,182
Task #4 Maintenance and Monitoring				
Capital Outlay & Equipment Costs				
Weed treatment (herbicide)	4	ea	$1,625	$6,500

Piezometer	5	ea	$250	$1,250
Task #5 Final Report and Presentation				
Direct Labor Costs				
Final Report and Presentation	40	hrs	$32	$1,280
Final Report and Presentation	40	hrs	$23	$920
Sub Total				**$126,760**
Administrative Costs 5%				$6,338
Total				**$133,098**

Matching Funds Breakdown

Proposed Budget for Harrenburg Wash Enhancement Project				
Item Description	***Quantity***	***Unit***	***Unit cost***	***Total***
Task #2 Design				
Direct Labor Costs				
Design oversight	20	hrs	$32	$640
Design oversight	20	hrs	$23	$460
Task #3 Construction and Re-Vegetation				
Direct Labor Costs				
Construction oversight (6 weeks)	60	hrs	$32	$1,920
Construction oversight (6 weeks)	60	hrs	$23	$1,380
Task #4 Maintenance and Monitoring				
Direct Labor Costs				
Maintenance oversight	40	hrs	$32	$1,280
Maintenance oversight	40	hrs	$23	$920
Monitoring	40	hrs	$32	$1,280
Monitoring	40	hrs	$23	$920
Total				**$8,800**

Maps and Schematics

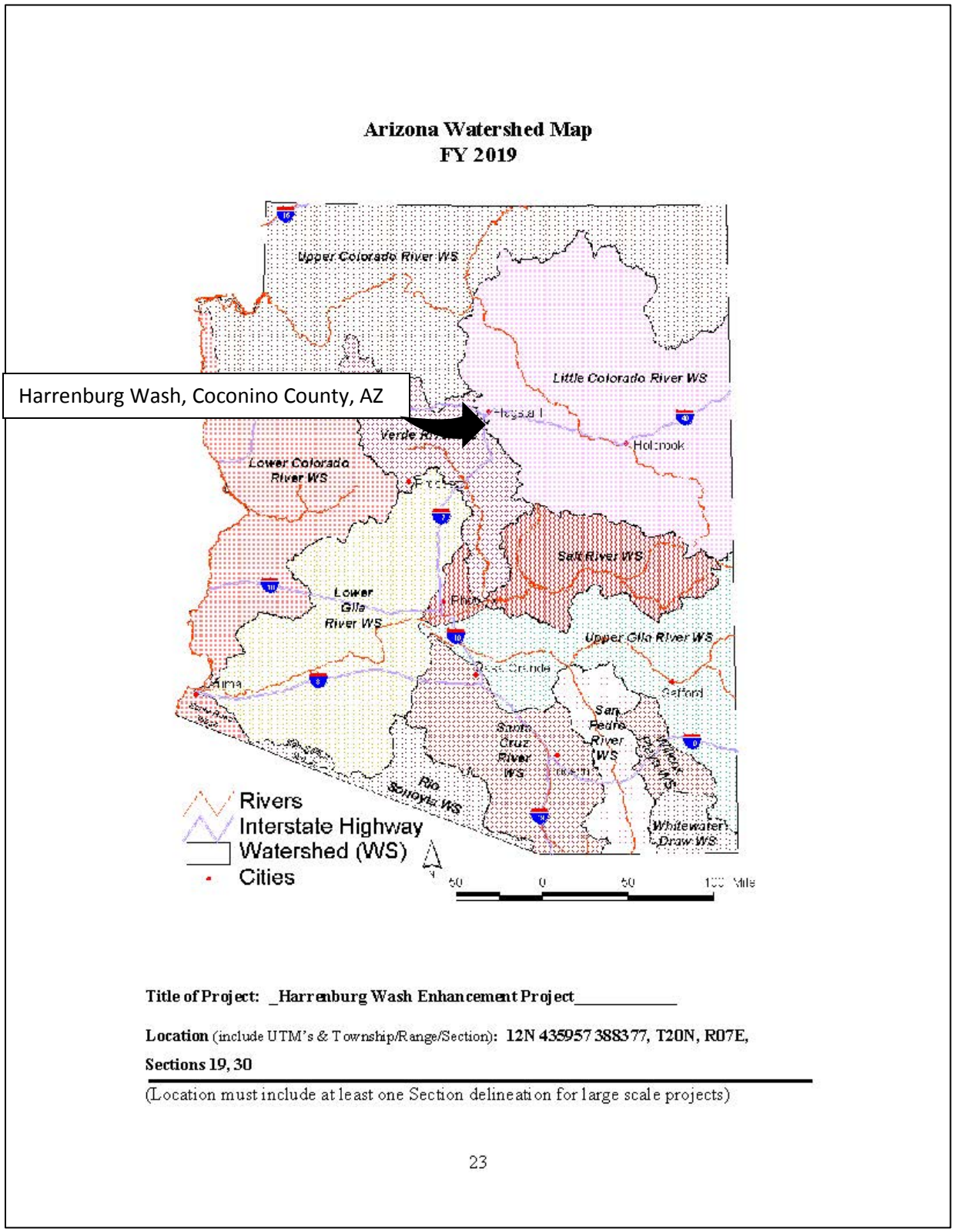


Figure 1. Arizona Watershed Map.

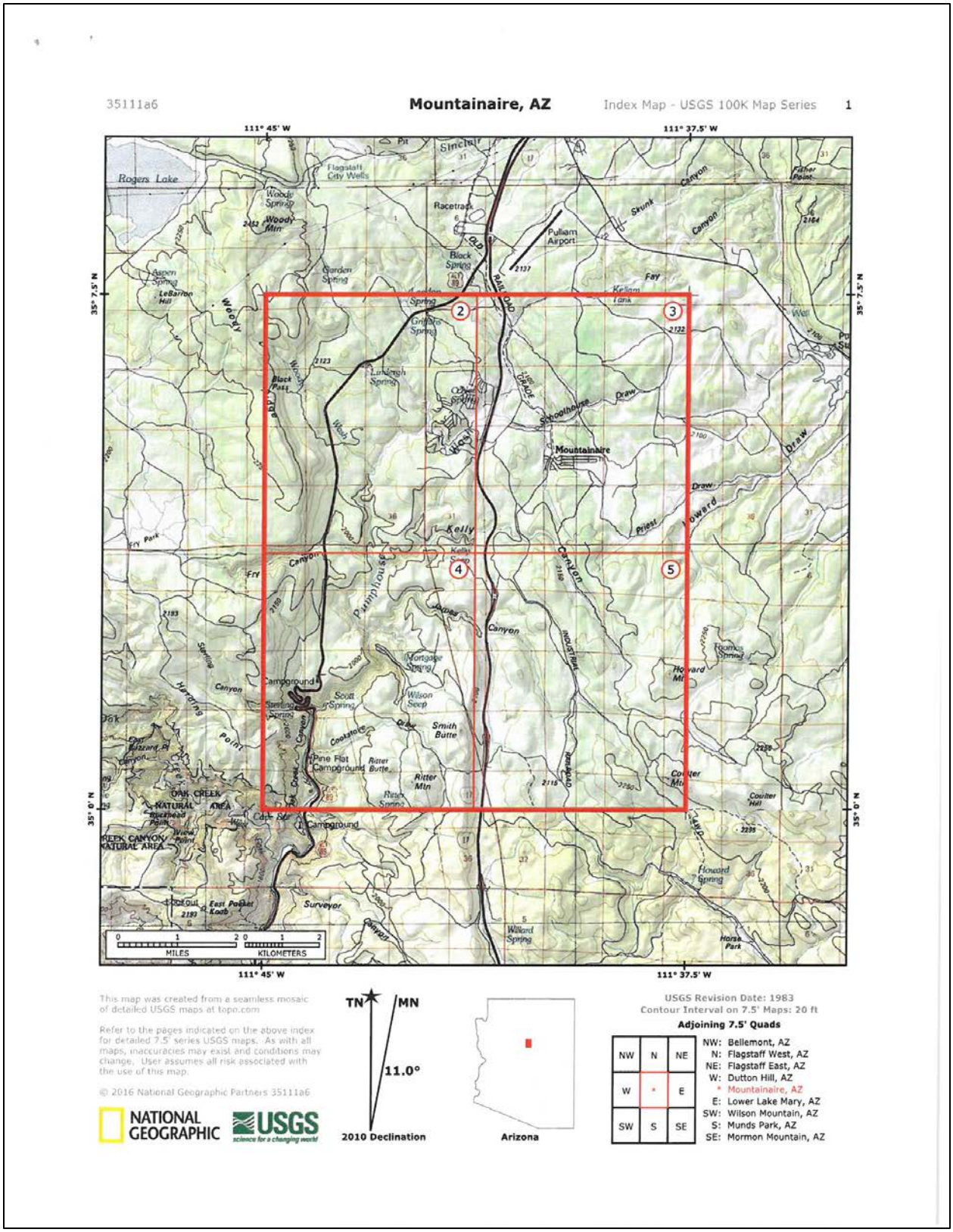
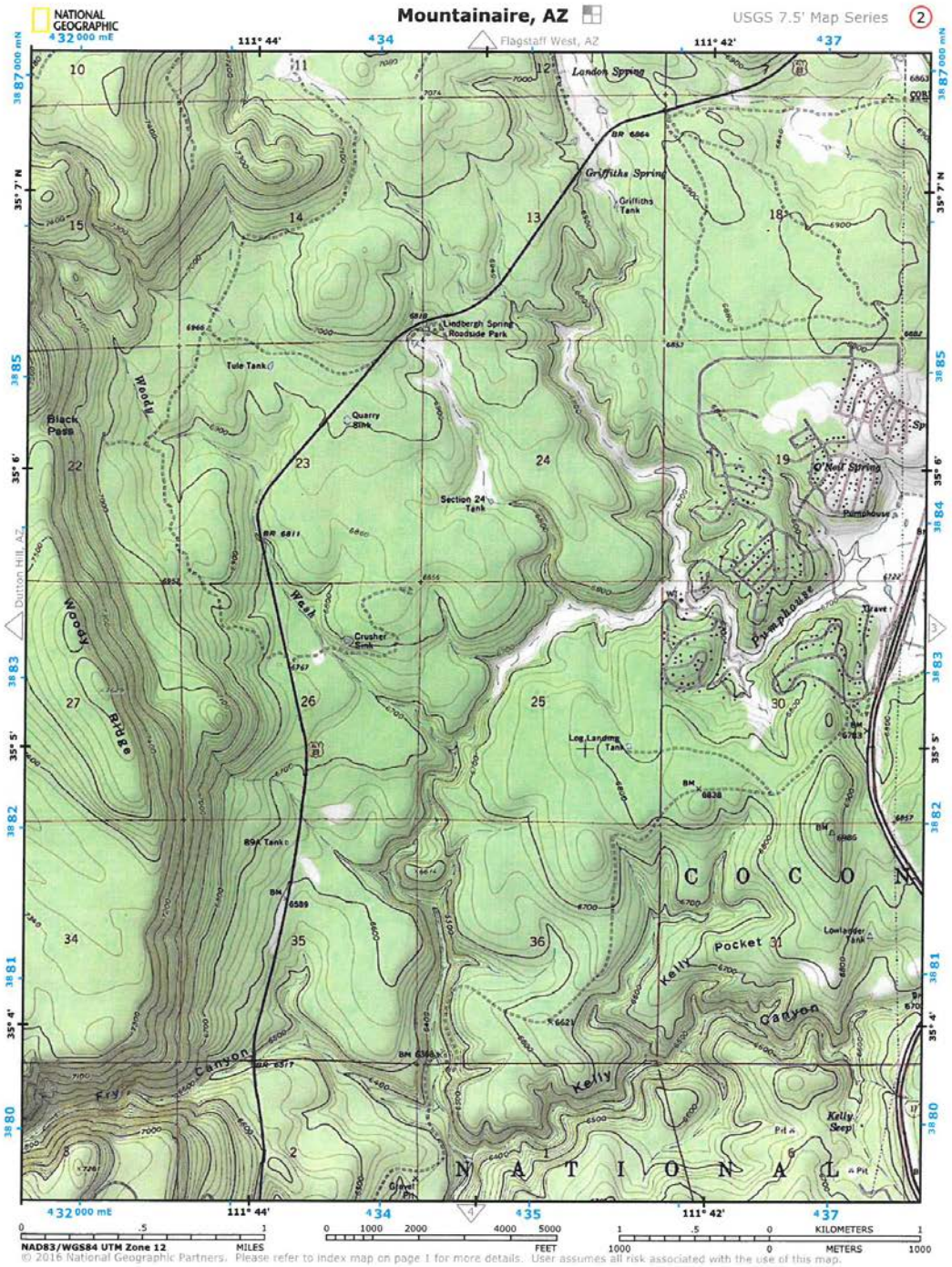


Figure 2. USGS Topo Map.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Mountainaire, AZ
USGS 7.5' Map Series
2
Flagstaff West, AZ
Dutton Hill, AZ
London Spring
Griffiths Spring
Griffiths Tank
Lindbergh Spring
Roadside Park
Tule Tank
Quarry Stnk
Black Peak
Woody Wash
Section 24 Tank
O'Neil Spring
Pumphouse
Crusher Stnk
Log Landing Tank
89A Tank
Lowlander Tank
Kelly Pocket
Kelly Canyon
Fry Canyon
Kelly Seep
C O C O N
N A T I O N A L
NAD83/WGS84 UTM Zone 12
MILES
FEET
KILOMETERS
METERS
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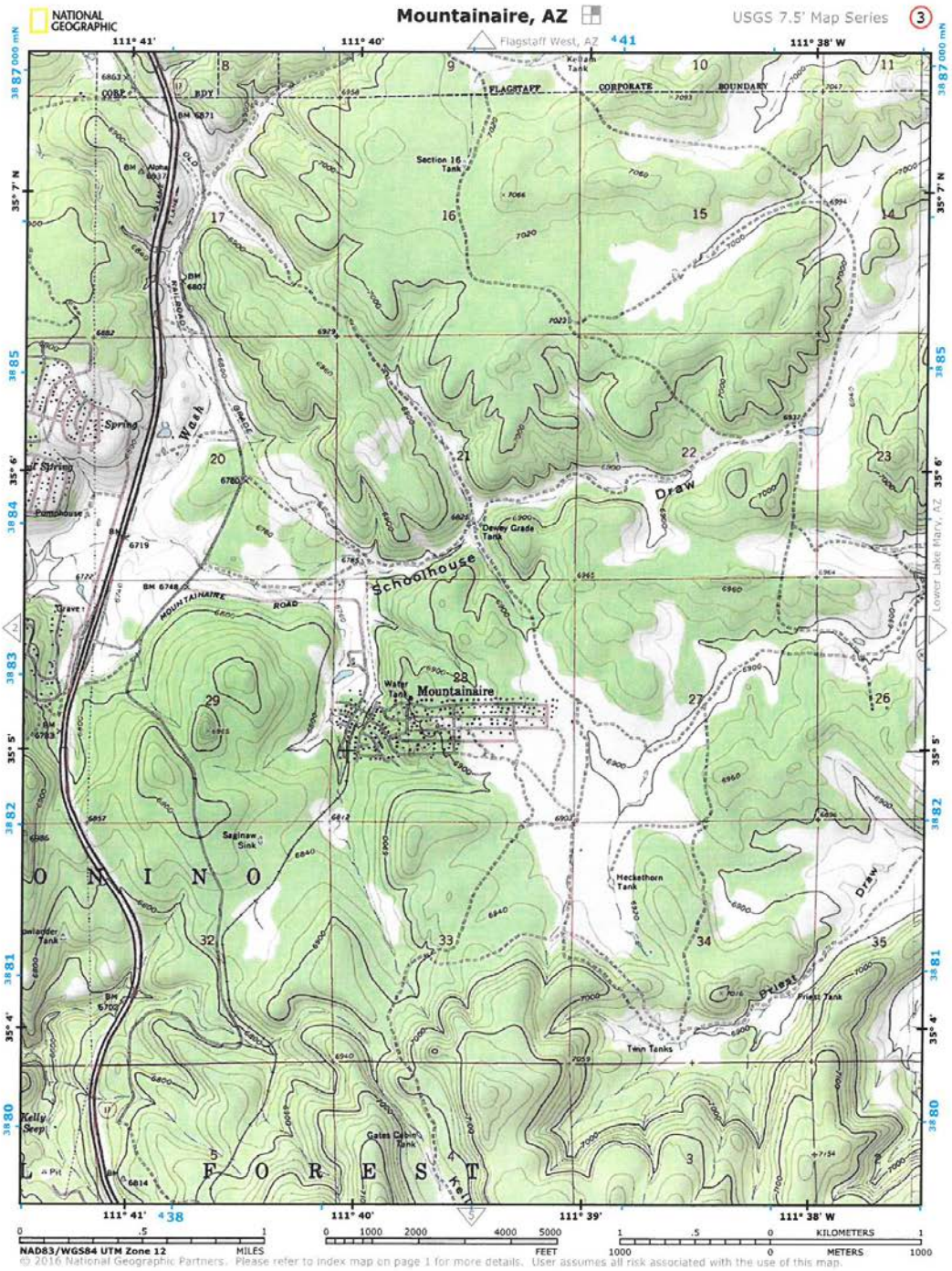
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Mountainaire, AZ
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3
Flagstaff West, AZ
111° 41'
111° 40'
111° 38' W
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35° 7' N
35° 6'
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35° 4'
FLAGSTAFF
CORPORATE
BOUNDARY
Section 16 Tank
Spring
Wash
Draw
Schoolhouse
Dewey Grade Tank
MOUNTAINAIRE
ROAD
Water Tank
Mountainaire
Saginaw Sink
Heckethorn Tank
Priest
Priest Tank
Tenn Tanks
Gates Cabin Tank
Kelly Seep
F O R E S T
Lower Lake Mary, AZ
NAD83/WGS84 UTM Zone 12
MILES
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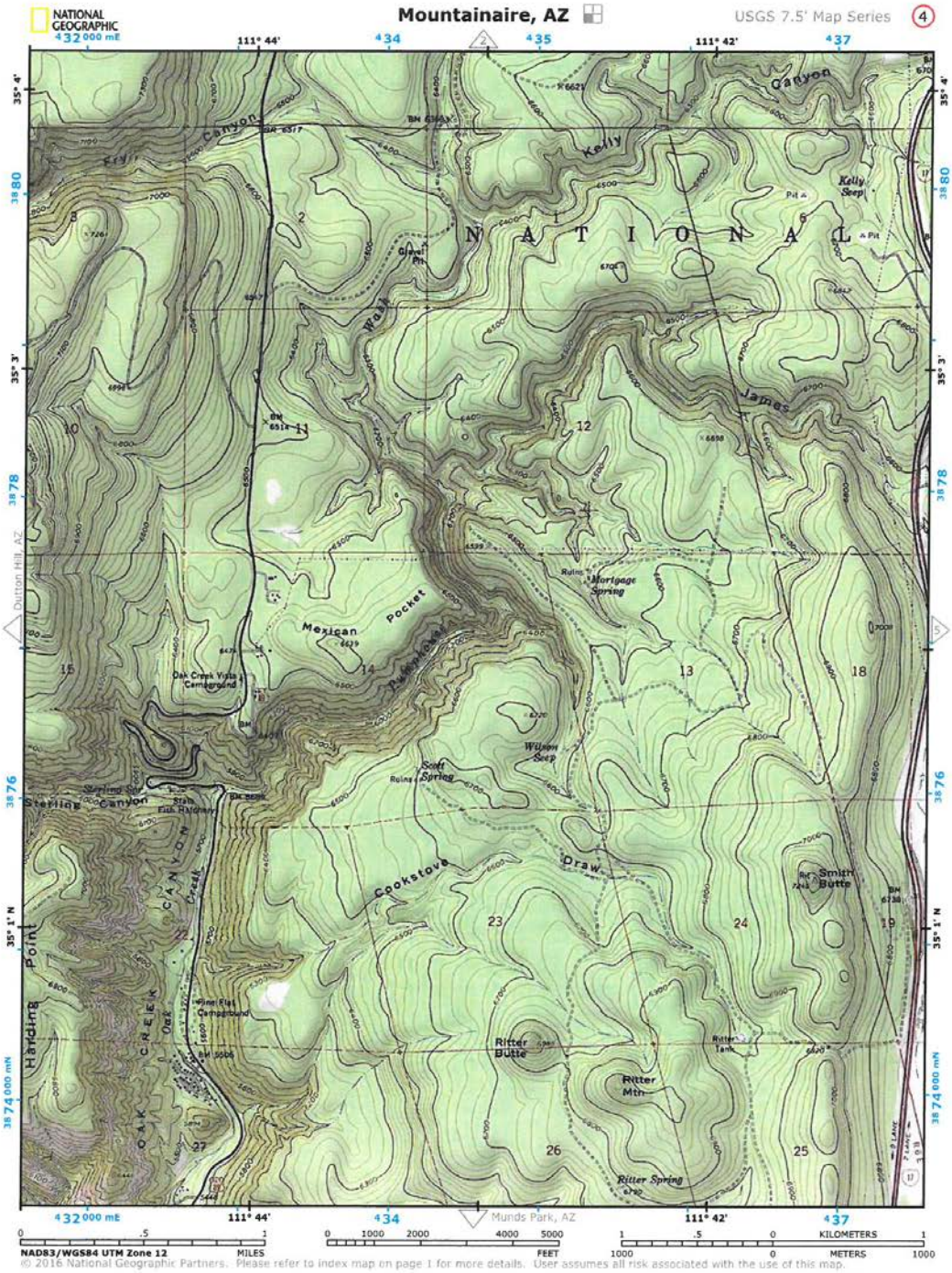
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Mountainaire, AZ
USGS 7.5' Map Series
4
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N A T I O N A L
Harrenburg Wash
Kelly Canyon
James
Mexican Pocket
Pumphouse
Mortgage Spring
Oak Creek Vista Campground
Sterling Canyon
Scott Spring
Willow Seep
Cookstove Draw
Smith Butte
Ritter Butte
Ritter Mtn.
Ritter Spring
Ritter Tank
Hancock Flat Campground
Harding Point
OAK CREEK CANYON
Oak Creek
Dutton Hill, AZ
Munds Park, AZ
NAD83/WGS84 UTM Zone 12
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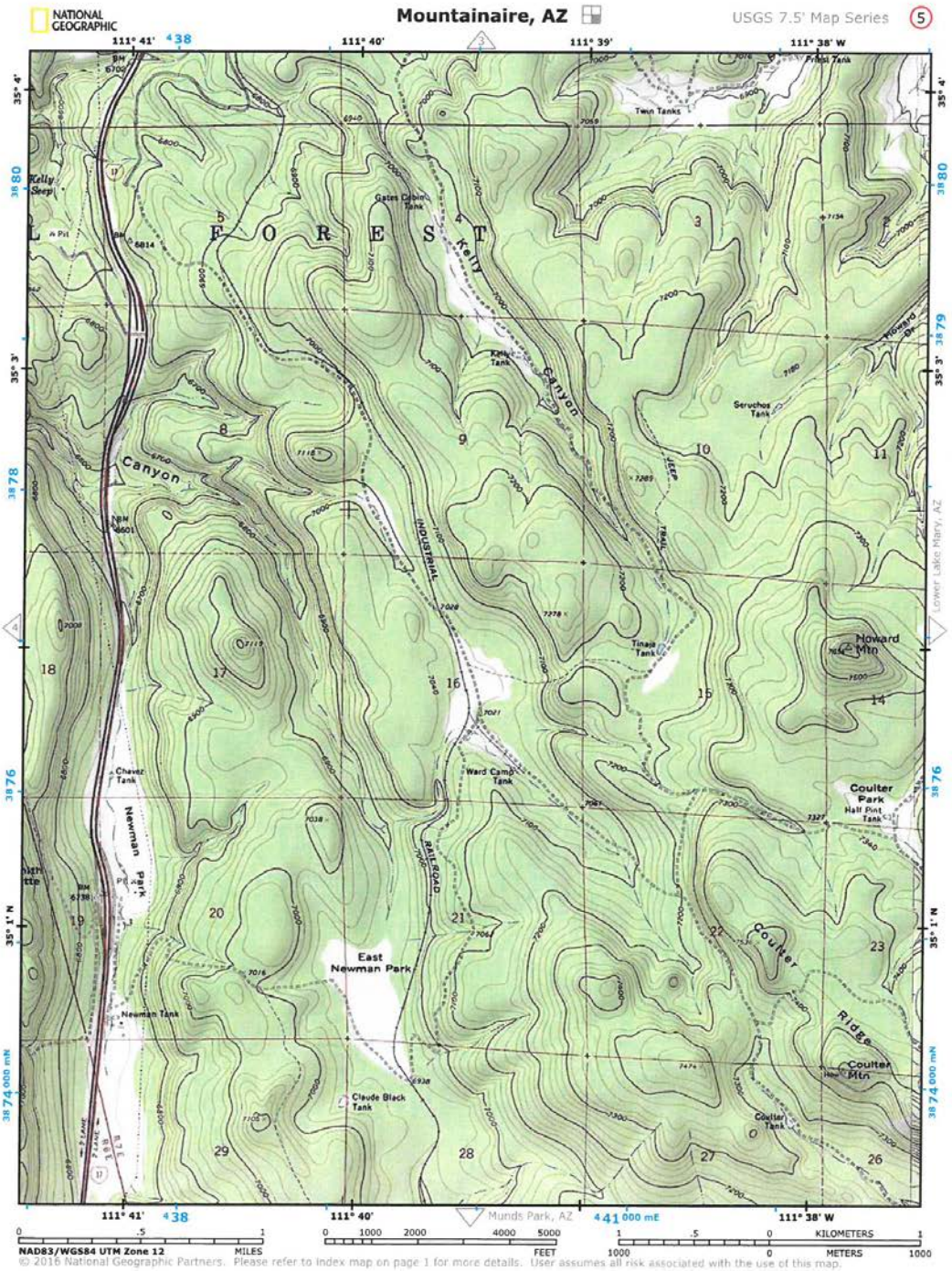
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111° 38' W
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35° 3'
35° 1' N
38 80
38 79
38 78
38 76
38 74 000 mN
438
441 000 mE
FOREST
Kelly Canyon
Canyon
INDUSTRIAL
RAILROAD
Howard Mtn
Coulter Park
Coulter Ridge
Coulter Mtn
East Newman Park
Newman Park
Munds Park, AZ
Lower Lake Mary, AZ
Twin Tanks
Gates Cabin Tank
Kelly Tank
Seruchos Tank
Tinaja Tank
Ward Camp Tank
Chavez Tank
Newman Tank
Claude Black Tank
Coulter Tank
Half Pint Tank
NAD83/WGS84 UTM Zone 12
MILES
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KILOMETERS
METERS
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Figure 3. Location map of the Harrenburg Wash Enhancement Project area.

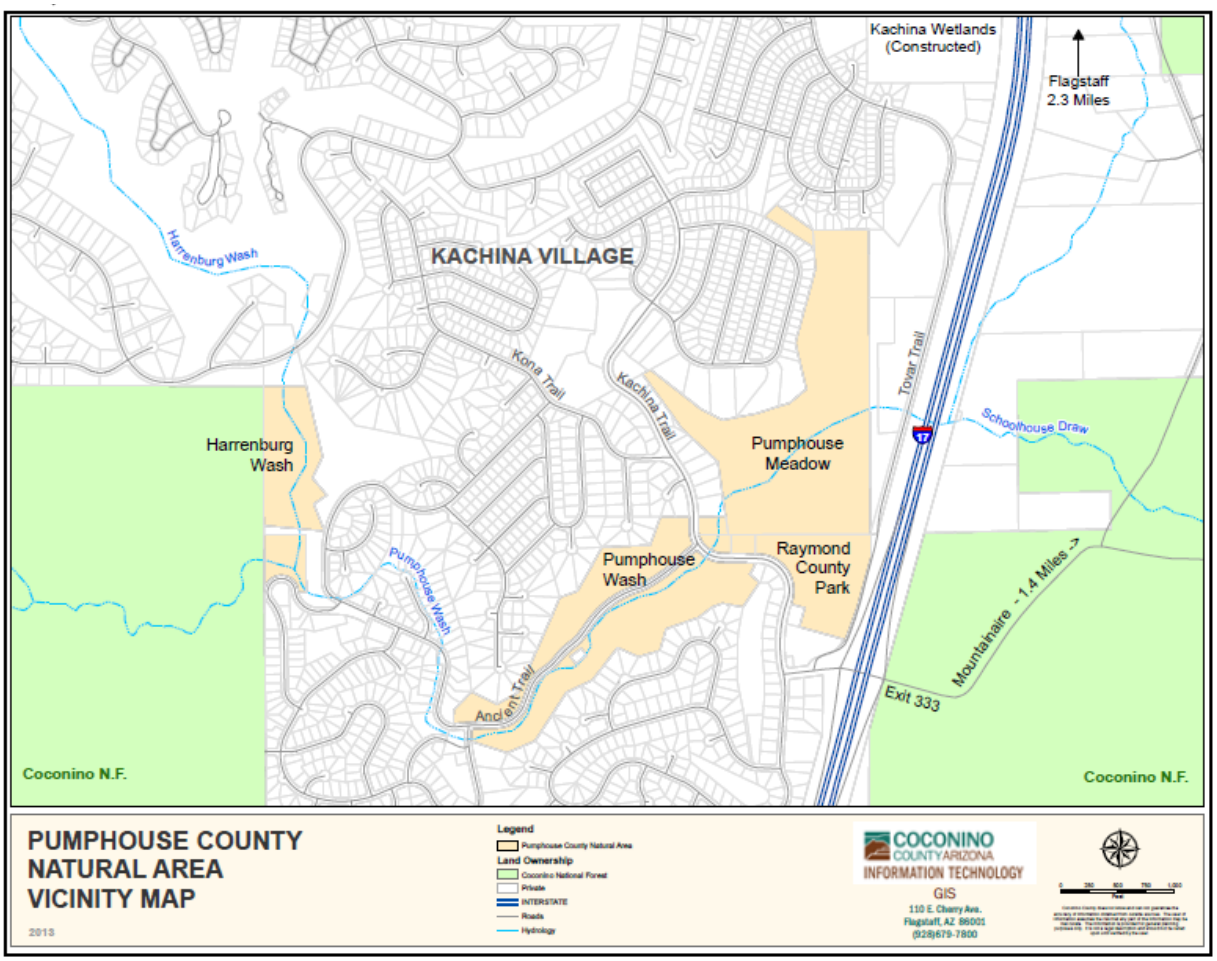


Figure 4. Location map of the Harrenburg Wash Enhancement Project area.

Map is from the Pumphouse County Natural Area Resource Management Plan & Natural Area Operations.

Figure 5. Harrenburg Wash Enhancement Project area map showing proposed weed management, planting areas, and channel work, prepared 9/6/18.

Harrenburg Wash runs north/south from private property boundary to Kachina Village Improvement District (KVID) and Coconino County lands. Project is bounded by private lands to the east and Coconino National Forest land to the west. This map illustrates where proposed project will take place.

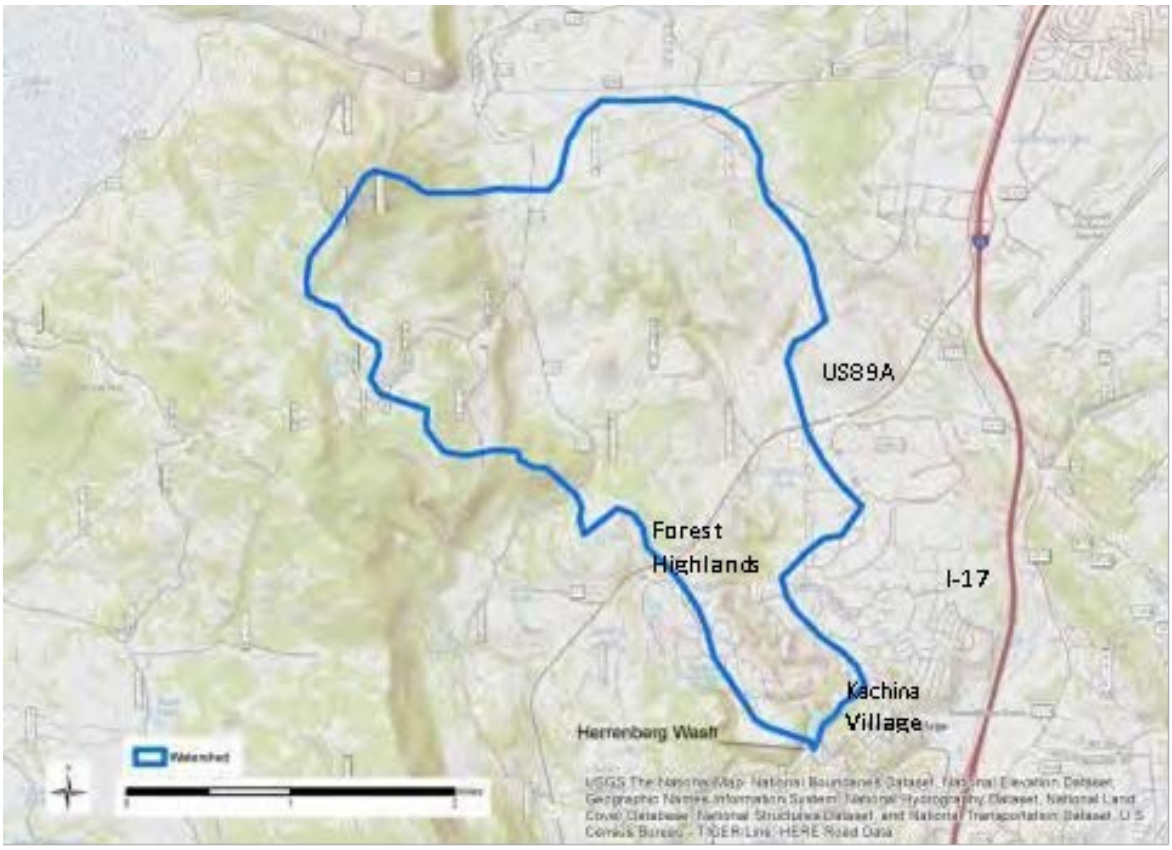


Figure 6. Watershed boundary for Harrenburg Wash Enhancement Project Area.

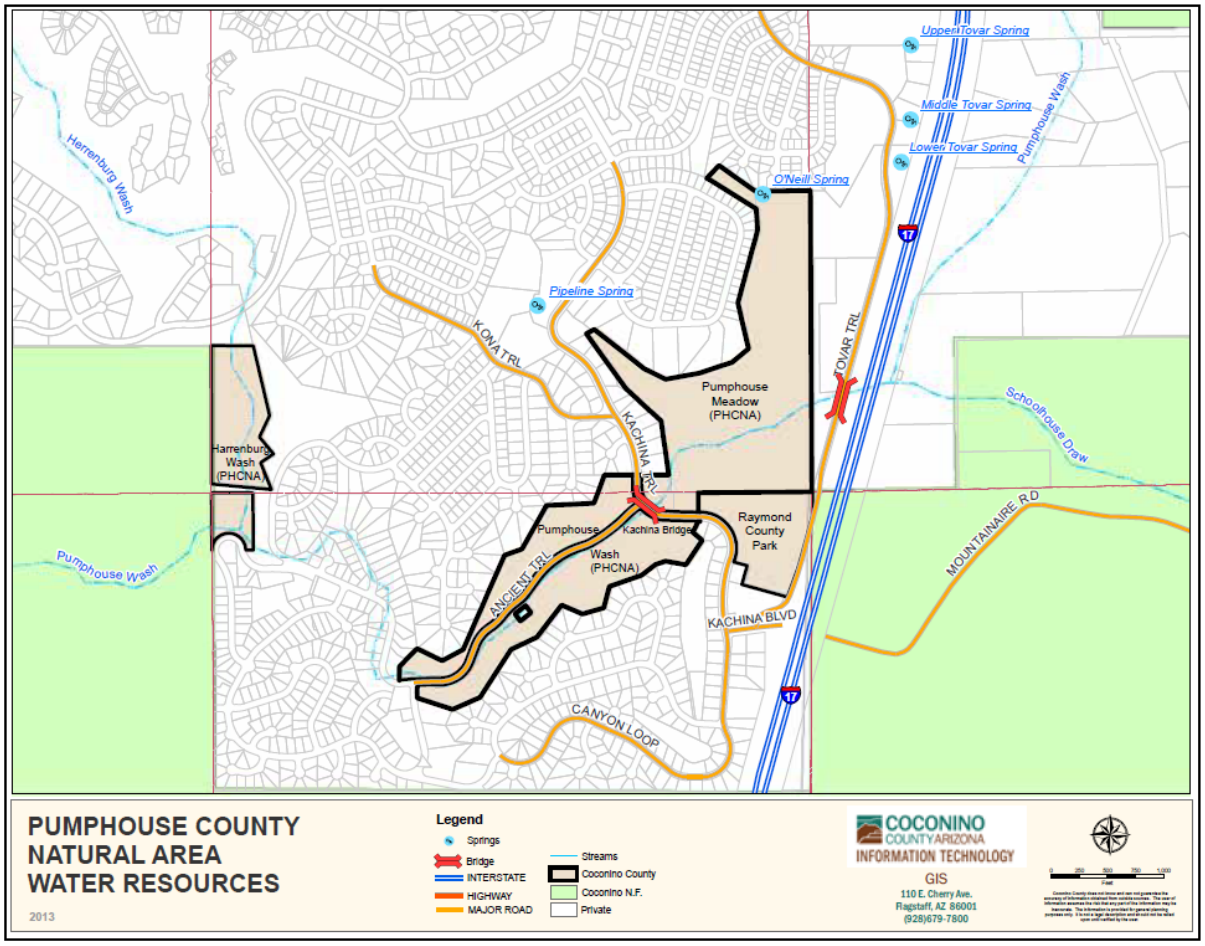


Figure 7. Water resources map for Harrenburg Wash Enhancement Project Area.

Map is from the Pumphouse County Natural Area Resource Management Plan & Natural Area Operations.

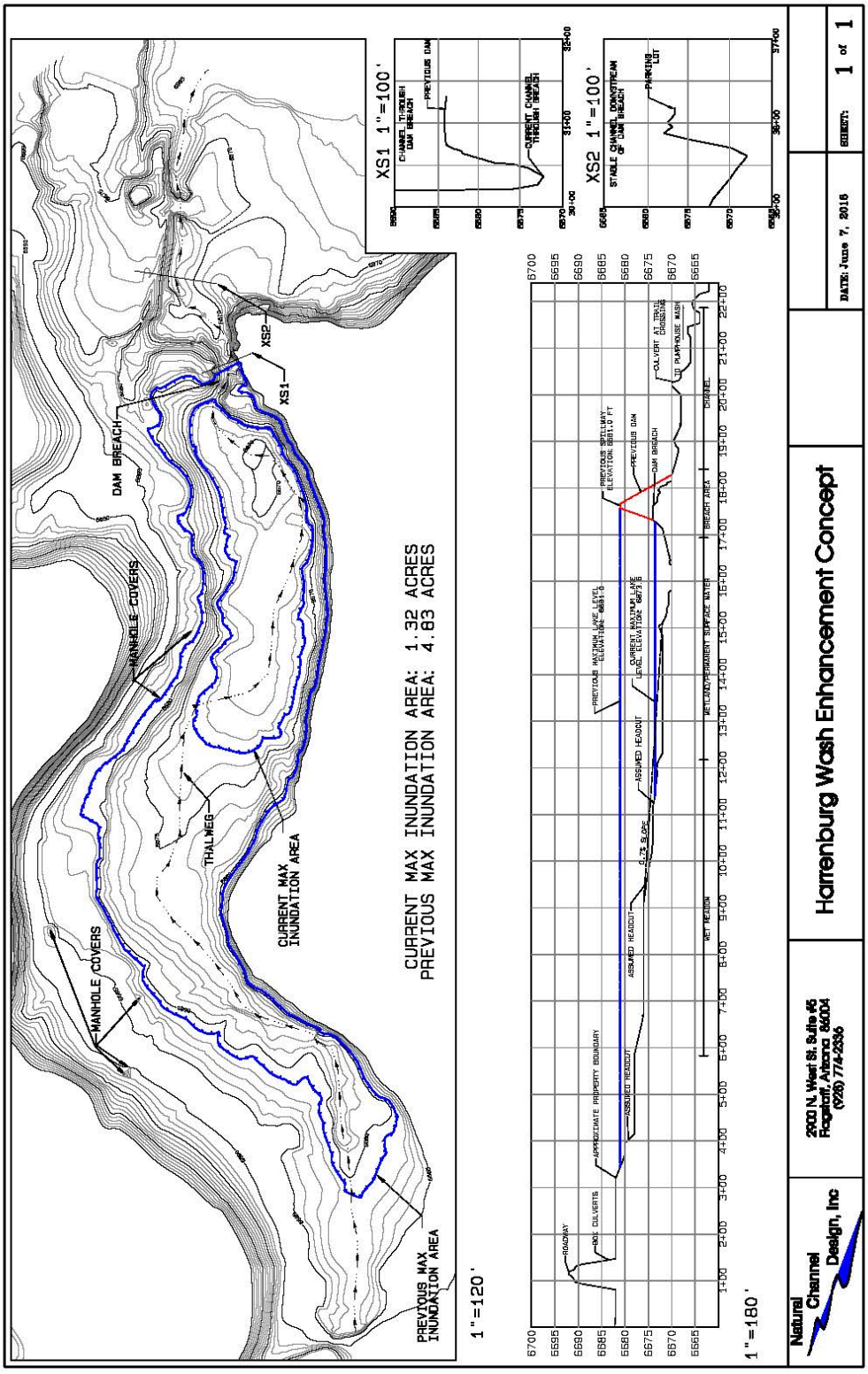


Figure 8. Topography and Channel Features of Harrenburg Wash, as mapped by Natural Channel Design.

USDA
United States Department of Agriculture
Forest Service

U.S. Department of Transportation
Federal Highway Administration

Tech Tips

National Technology & Development Program • **Recreation** • July 2013 • 2300 • 1223–2316P–MTDC

Innovative Design for a Short-Span Timber All-Terrain Vehicle Trail Bridge

Jerry D. Barrow, Civil Engineer and James Scott Groenier, Project Leader

A simple, inexpensive, 12-foot-long sawn timber bridge that was designed for an all-terrain vehicle (ATV) trail is also suitable for horse, bicycle, and pedestrian trails that cross small drainages (figure 1). The photographs and construction details in this tech tip originate from a project completed at the Tombigbee National Forest, Mississippi, by Trails Unlimited, a U.S. Department of Agriculture, Forest Service enterprise team that works on trail construction projects throughout the country.

The design of this short-span bridge has been used in national forests in the Southern Region (R-8) of the Forest Service. Other jurisdictions may have other specifications and their own approval requirements for similar trail bridges. It meets the load design criteria of 90 pounds per square foot and is capable of carrying a 10,000-pound trail dozer or similar equipment. The design is suitable for clear spans of 6 to 24 linear feet, using pressure-treated timbers. The assembly hardware, such as bolts, nails, and screws, is hot-dipped galvanized.

The bridge design itself is straightforward (figure 2). The approximate cost of the materials used to build the bridge is $1,500. A knowledgeable, four-person crew can assemble the bridge in about 8 hours. Although the crew needs to assemble the bridge onsite, the longest individual component is 12-feet long, so the crew can carry the components to the site with small motorized equipment, or by hand, if necessary.

Highlights...

- A new design for a simple, inexpensive short-span timber all-terrain vehicle trail bridge is available.
- The design meets current bridge design-load requirements and uses innovative ideas to increase the longevity and sustainability of the structure.
- This tech tip includes a sample drawing of a 12-foot bridge.

Figure 1—This bridge was constructed on an ATV trail at the Tombigbee National Forest, Mississippi.

For additional information, contact: *USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808–9361. Phone: 406–329–3900; fax: 406–329–3719; email: wo_mtdc_pubs@fs.fed.us*

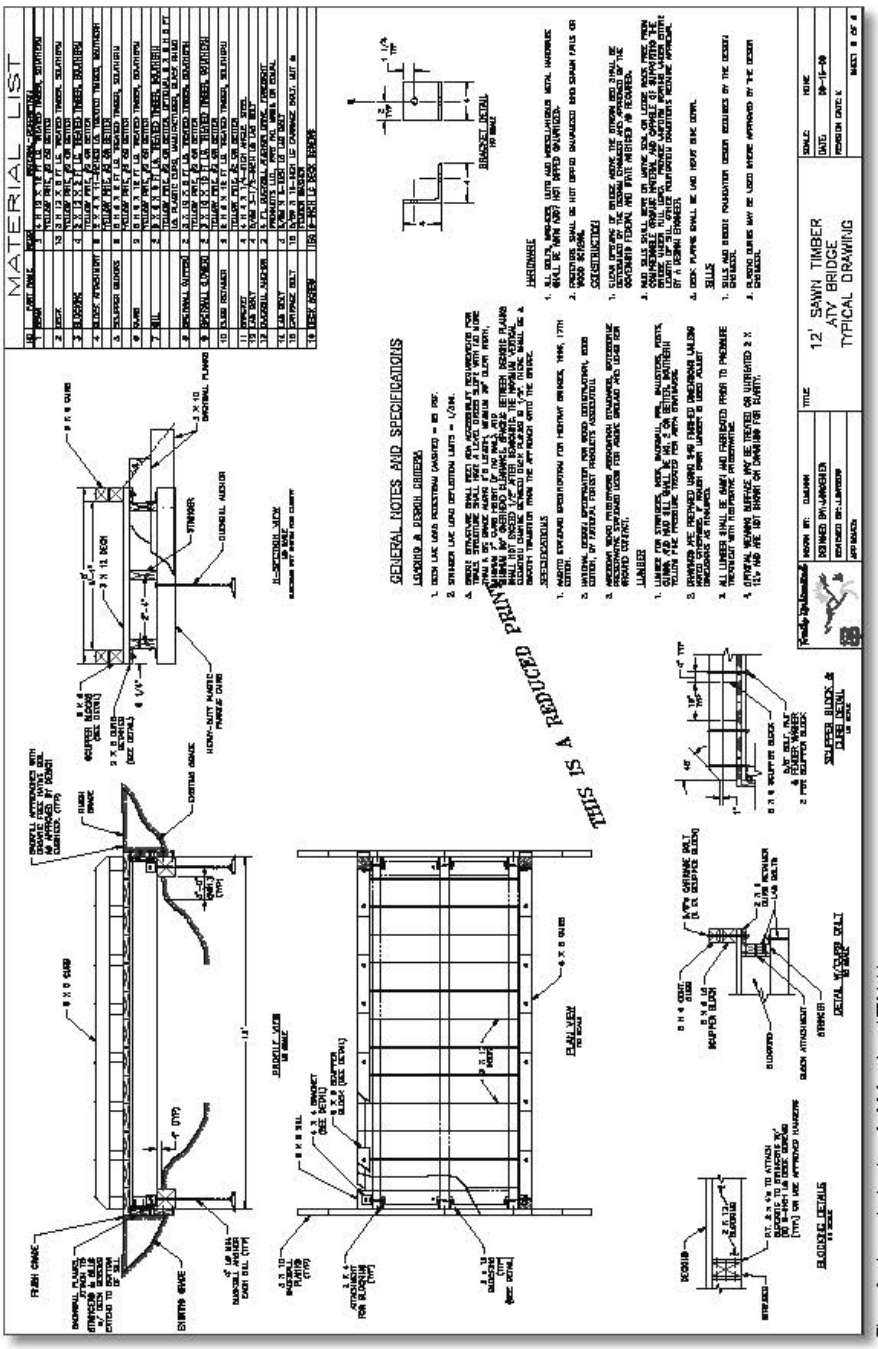


Figure 2—A sample drawing of a 12-foot-long ATV bridge.

Details and Features That Increase Longevity

Several features of this bridge design add to its longevity and are innovative when compared with traditional designs.

The foundation consists of heavy-duty plastic or concrete parking curbs, anchored down with one Duckbill earth anchor per sill.

- Using inexpensive aluminum or polymeric flashing bent over the stringers extends the stringer life by preventing wood-to-wood contact and standing water on the stringer.
- Extending the decking over the top of the backwall reduces the chance of water running down between the backwall and stringer. This extension reduces the chance that the end grain of the stringer will wick moisture into the end of the stringer.
- Extending the decking out over the stringers 6 inches makes installation of the curb easier. Water will run off the end of the decking and not run down the side of the stringers.
- Lengthening the backwalls prevents dirt from wrapping around them and accumulating on the sills against the stringers. This longer backwall helps keep stringers clean and dry and prevents backfill from eroding at the approaches.
- Using 6-inch by 6-inch curbing with 6-inch by 6-inch scupper blocks provides an 11-inch high barrier that helps reduce the chance of ATV tires driving over the curb.
- Allowing for 6-inch scupper openings helps water drain better and reduces the chance of leaves collecting on the deck.
- Using paving blocks at the bridge approaches drains water away from the approaches, stabilizes the trail transition material onto the deck, and helps prevent potholes at the approaches caused by backfill settlement and erosion caused by ATV tires, bicycle tires, horse hooves, and even hikers.
- Using running planks is strongly recommended to protect the transverse decking from wear due to snowmobile tracks and horseshoes. Running planks were not used on this ATV bridge.

Construction Details

The innovative features of this design also add to its longevity.

Foundation

The sills consist of 6-inch by 6-inch by 8-foot heavy-duty recycled plastic parking curbs (figure 3) that resist decay. Each sill is anchored by one Duckbill earth anchor attached to a 4-foot-long, 1/2-inch diameter galvanized steel all-thread rod. The Duckbill anchor, like a toggle bolt, can be driven into the ground with a hydraulic or mechanical jackhammer with the aid of a steel rod gad. Then a ratchet is used to tighten the nut, pulling up the rod, causing the anchor to pivot in the ground, and anchoring it in place. About 3 inches of rod needs to be pulled up to obtain about 3,000 pounds of anchor force. The anchor keeps the sill in place and prevents it from floating off in floods (figure 4).

Sills can also be formed from precast concrete curbs or planks, which stay in place due to their weight and last a long time. Traditional sills are 8-inch by 8-inch by 6-foot long treated southern pine timber, No. 2 grade or better.

Figure 3—Heavy duty plastic parking curbs, anchored by Duckbill anchors, serve as sills. Two backwall planks are buried to the depth of the bottom of each sill. The backwall is extended well to the sides of the bridge to prevent earth-to-wood contact for both the sill and stringers. Decking extends over the top of the backwall to prevent water running down between the backwall and the end of the stringers.

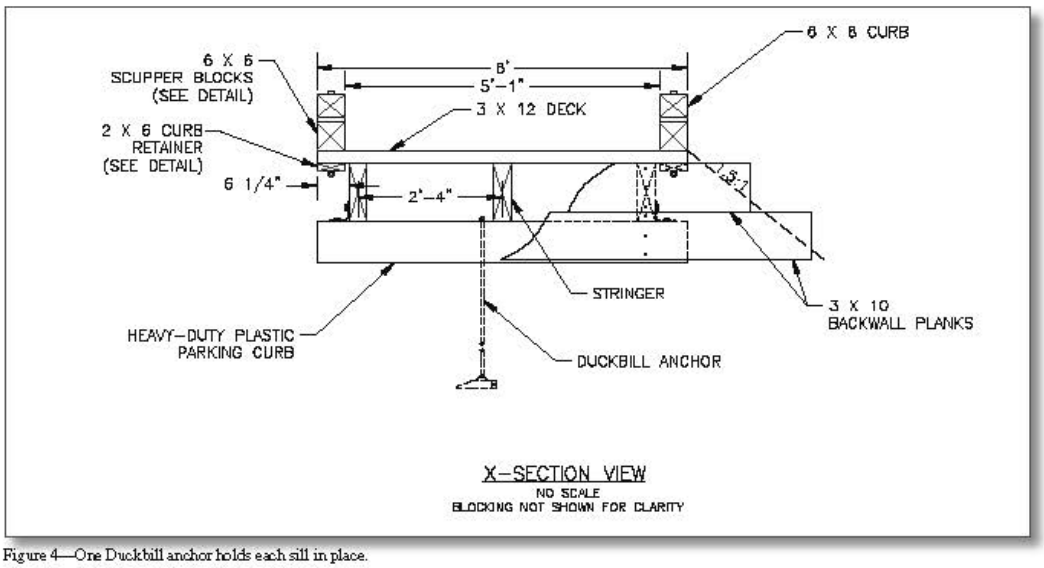


Figure 4—One Duckbill anchor holds each sill in place.

Stringers

The 12-foot-long ATV bridge requires three 4-inch by 12-inch pressure-treated southern pine stringers. Using three stringers provides redundancy for the structure. If one stringer fails, the other two stringers should be able to support most of the load. When a bridge has two stringers and fails, the structure is more likely to fall into the stream. The three stringers are placed on the sill and the two outside stringers are fastened down with 4-inch by 4-inch by ¼-inch steel angle brackets. Blocking between stringers secures and holds down the center stringer and prevents lateral rotation of the stringers. An optional, but inexpensive, way to extend the life of the stringers and protect them from dirt and water is to bend a strip of aluminum or polymeric flashing over the length of the top of each stringer.

Backwall Details

Installing backwalls at the ends of the bridge provides another practical design detail to help keep the stringers and sills clean and free of dirt (see figure 3). The backwall extends to the bottom of the sill to keep dirt from contacting the ends of the stringers. The upper backwall plank extends a minimum of 1 foot beyond the sides of the bridge and the lower backwall plank extends a minimum of 2 feet. The extended backwalls help keep dirt from wrapping around the backwall and accumulating on the sills next to the stringers (figure 5). They also help prevent the approach fill from eroding. Any location where dirt contacts the wood may also accumulate water and start the wood-decay process that will reduce the lifespan of the structure.

Extending the decking over the top of the backwall provides another important detail: reducing the chance of water running down between the backwall and stringer. When water runs down the end of the stringers, the end grain of the stringer may wick moisture into the end of the stringer and start to decay.

Supplemental Information

SHPO Form

STATE HISTORIC PRESERVATION OFFICE
Review Form

In accordance with the State Historic Preservation Act (SHPO), A.R.S. 41-861 *et seq*, effective July 24, 1982, each State agency must consider the potential of activities or projects to impact significant cultural resources. Also, each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. Therefore, it is understood that **recipients of state funds are required to comply with this law** throughout the project period. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance, **including those on private and federal lands.**

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund, Arizona Department of Water Resources
2. Project Title: Harrenburg Wash Enhancement Project
3. Applicant Name and Address: Coconino County, Parks and Recreation, 2446 Fort Tuthill Loop, Flagstaff, AZ 86005
4. Current Land Owner/Manager(s): Coconino County
5. Project Location, including Township, Range, Section: T20N, R07E, Sections 19, 30
6. Total Project Area in Acres (or total miles if trail): 7
7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground?
   ☒ YES ☐ NO
8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: Removing soil from already-breached dam; filling in of potholes that are causing headcuts; planting of trees in wetland area.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: Area was previously scraped off for an existing road, existing sewer lines; old parking area has added fill, about 2 acres.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? ☐ YES ☒ NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? ☐ YES ☐ NO ☒ UNKOWN

If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? ☒ YES ☐ NO

If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? ☐YES ☒ NO

If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

Applicant Signature /Date 9-7-18 Applicant Printed Name Geoffrey Gross

FOR SHPO USE ONLY
SHPO Finding: ☐ Funding this project will not affect historic properties. ☐ Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) ☐ Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments:
For State Historic Preservation Office: Date:

STATE OF ARIZONA
HISTORIC PROPERTY INVENTORY FORM

Please type or print clearly. Fill out each applicable space accurately and with as much information as is known about the property.

PROPERTY IDENTIFICATION
For properties identified through survey: Site No. _____ Survey Area: _____

Historic Names (*enter the name(s), if any that best reflect the property's historic importance*): Harrenburg Wash

Address: 3305 Kachina Trail, Flagstaff, AZ 86005

City or Town: Flagstaff ☐ Vicinity County: Coconino Tax Parcel No.: 11617010, 11619052

Township: T20N Range: R07E Section: 19, 30 Quarters: _____ Acreage: 7

Block: _____ Lot(s): _____ Plat (Addition): _____ Year of plat (addition): _____

UTM Reference – Zone: 12N Easting: 435957 Northing: 388377

USGS 7.5' quadrangle map: Mountainaire, AZ

ARCHITECT: _____ ☒ not determined ☐ known Source: _____

BUILDER: _____ ☒ not determined ☐ known Source: _____

CONSTRUCTION DATE: 1960s ☐ known ☒ estimated Source: _____

STRUCTURAL CONDITION
☐ Good (*well maintained; no serious problems apparent*)
☐ Fair (*some problems apparent*) Describe: _____
☐ Poor (*major problems; imminent threat*) Describe: _____
☒ Ruin/Uninhabitable

USES/FUNCTIONS
Describe how the property has been used over time, beginning with the original use: Earthen dam built in the 1960s for a fishing pond; deliberately breached; land purchased by Coconino County and managed as open space.

Sources: _____

PHOTO INFORMATION
Date of photo: _____
View Direction (looking towards): _____

Attach a recent photograph of property in this space.
Additional photographs may be appended.

SIGNIFICANCE
To be eligible for the National Register, a property must represent an important part of the history or architecture of an area. The significance of a property is evaluated within its historic context, which are those patterns, themes, or trends in history by which a property occurred or gained importance. Describe the historic and architectural contexts of the property that may make it worthy of preservation.

A. HISTORIC EVENTS/TRENDS – *Describe any historic events/trends associated with the property:* _____

B. PERSONS – *List and describe persons with an important association with the building:* _____

C. ARCHITECTURE – Style: _____ ☐ no style

Stories: _____ ☐ Basement Roof Form: _____

Describe other character-defining features of its massing, size and scale: _____

INTEGRITY
To be eligible for the National Register, a property must have integrity (i.e. it must be able to visually convey its importance). The outline below lists some important aspects of integrity. Fill in the blanks with as detailed a description of the property as possible.

Location - ☐ Original Site ☐ Moved: Date: _____ Original Site: _____

DESIGN
Describe alterations from the original design, including dates: _____

MATERIALS
Describe the materials used in the following elements of the property:

Walls (structure): _____

Walls (sheathing): _____

Windows: _____

Roof: _____

Foundation: _____

SETTING
Describe the natural and/or built environment around the property: _____

How has the environment changed since the property was constructed? _____

WORKMANSHIP
Describe the distinctive elements, if any, of craftsmanship or method of construction: _____

NATIONAL REGISTER STATUS (*if listed, check the appropriate box*)
☐ Individually Listed; ☐ Contributor; ☐ Non-contributor to _____ Historic District

Date Listed: _____ ☐ Determined eligible by Keeper of National Register (date: _____)

RECOMMENDATIONS ON NATIONAL REGISTER ELIGIBILITY (opinion of SHPO staff or survey consultant)

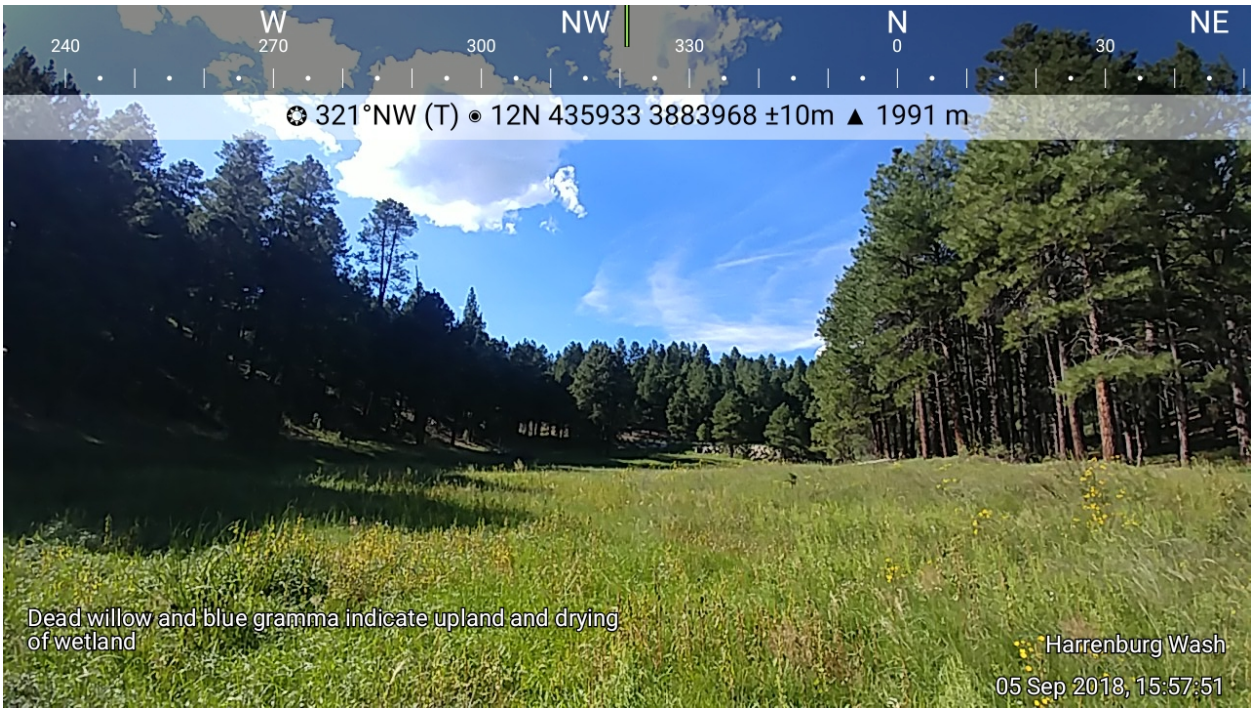
Property ☐ is ☐ is not eligible individually.

Property ☐ is ☐ is not eligible as a contributor to a listed or potential historic district.

☐ More information needed to evaluate.

If not considered eligible, state reason: _____

Picture 1. View of old electrical pole, with project area to the right.
This is the view looking north, with the breached dam in the distance next to the rocky outcropping.



Picture 2. View of upland.
Looking south, a dead willow and blue gramma are indicative of drying of the wetland.

Key Personnel

Geoffrey Gross is the Natural Resources Supervisor for Coconino County Parks and Recreation. His main job duties are habitat restoration and monitoring, forestry and forest ecology, and trail planning construction and maintenance He has a B.S.in Biology and a B.A. in Fine Arts both from Northern Arizona University. He has experience in wetland restoration and has worked with the County's open space program for the last 19 years. Geoffrey has implemented a wide variety of habitat projects, including pond restoration for frog reintroduction, invasive species eradication, and revegetation projects. He will be the project manager for the restoration effort, from planning to completion including maintenance for the coming years.

Allen Haden is an aquatic ecologist and a principal at Natural Channel Design, Inc. Allen has broad experience in stream systems and aquatic habitats of the arid southwest. He has been involved in research and management of human impacts on river ecosystems in the southwest for over 15 years. He has a broad understanding of the field of aquatic ecology and its applications to management of ecosystems which house threatened and endangered species. He has expertise in sampling and statistical techniques for monitoring biological and physical aspects of riparian/aquatic/wetland habitats, as well as an understanding of life history requirements and threats to southwestern native species. Allen has extensive experience with habitat enhancement projects and has designed and provided construction observation services for numerous restoration projects. He has authored and coauthored several refereed manuscripts on effects of nonnative species and links between habitat quality and ecology of aquatic communities. Allen received a B.S. in Forestry and Wildlife from Virginia Polytechnic Institute and State University in Blacksburg, VA, and a M.S. in Biology from Northern Arizona University in Flagstaff. He has completed Levels I - IV river short courses in the inventory, classification, assessment and design of natural channels at Wildland Hydrology.

Michael Kearly, P. E. is the lead civil engineer at Natural Channel Design, Inc. (Az- Civil Engineer 34587). Michael is principal Civil Engineer with NCD since 2013. Michael is licensed in Arizona, New Mexico, Colorado, Nevada and Utah, with over 23 years of experience. During his career, he has worked as a geotechnical engineer, based in Prescott, Arizona and as site development consulting engineer, based in Flagstaff, Arizona. Michael has also served as Assistant County Engineer for Coconino County. During his career, Michael has gained over 18 years of experience in hydrologic and hydraulic modeling of watersheds and planning for stormwater mitigation for developed and undeveloped sites. He is also a certified as a Floodplain Manager by the Association of State Floodplain Managers with experience in FEMA related floodplain modeling and regulatory issues. Michael has completed Levels I-III river short courses, in inventory, classification, and assessment of natural channels from David Rosgen at Wildland Hydrology. Michael is an Arizona native, having lived and worked in the Tucson, Prescott and Flagstaff areas and having designed civil engineering infrastructure projects across the southwest.

James Richardson Is the Open Space Trades Worker for Coconino County Parks and Recreation. He has extensive experience operating heavy equipment, along with years of ranching and open space habitat project experience. James has worked with the open space program at Coconino County for the last three years.

Cathy Scudieri is a civil engineer-in-training with Natural Channel Design. She has a deep interest in both environmental engineering and ecological restoration. Cathy has a B.S. in Civil Engineering from Virginia

Polytechnic Institute and State University and a M.S. in Environmental Engineering from University of Illinois at Urbana-Champaign. She also has a M.S. in Forestry from Northern Arizona University. She has completed Level I and II river short course in the inventory of natural channels from David Rosgen at Wildland Hydrology as well as Wetland Delineation Training from Richard Chinn Environmental Training, Inc. She has authored several refereed manuscripts on understory vegetation response in prescribed burning sites. She has extensive research in the study of herbaceous vegetation in southwestern ponderosa pine forests. Cathy also held a high-level position at the U.S. Environmental Protection Agency as an environmental engineer working in municipal wastewater permitting under the Clean Water Act reviewing permits, training wastewater treatment plant operators, and assessing operational problems. She has broad understanding and skills required for collaboration and interfacing with tribal and municipal governments as well as with local, state, and federal agencies. Cathy provides drafting, engineering, surveying, ecological, native revegetation planning, and permitting expertise to NCD project planning.

Mark Wirtanen is a riparian/wetland biologist and engineering technician for Natural Channel Design, Inc. with over 15 years of professional experience. Mark has served as a field biologist and manager for riparian and geomorphic studies of the rivers of the arid southwest. He has a B.S. in Wildlife Biology from Northern Arizona University and broad knowledge of field methods as well as CAD software and GIS systems. Mark has completed Levels I – III river short courses in natural channel inventory, classification, and assessment from David Rosgen at Wildland Hydrology. He has conducted training workshops utilizing the geomorphic approach to stream restoration design. Mark provides assessment, design and construction observation services.

Project Site Photographs

Picture 1. Generally stable channel conditions between confluence and old dam that is now breached.
View is looking upstream from trail crossing.

Picture 2. Undersized culvert and eroding trail prism.
Flows have overtopped the road prism and eroded the downstream side of fill prism. View is looking upstream.

Picture 3. Breach through dam.
View is looking downstream from the wetland area that exists above the breached dam.

Picture 4. Wetland area.
View is looking upstream from breached dam. This area exhibits relatively permanent inundation except during extremely dry weather.

Picture 5. Typical conditions in upper meadow.
Flow channel is typically a shallow wide swale vegetated with wetland plants. However, potholes cut into the meadow have initiated headcuts.

Picture 6. Excavated pool forming a headcut in meadow.
Note that excavated materials are still piled adjacent to excavation.

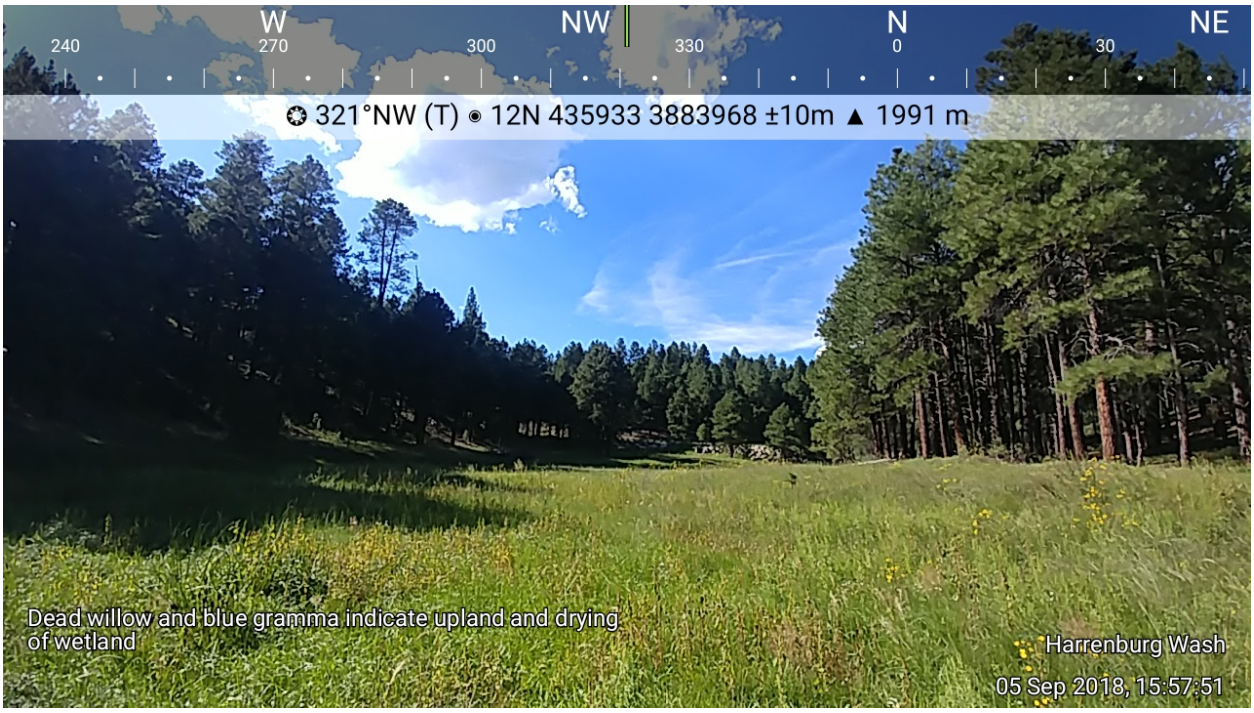
Picture 7. Restored area (previously a parking lot)
Has not regrown with native vegetation.

Picture 8. Knapweed infestation
Infestation is the most dense in bare portions of the old parking area.

Picture 9. Approximate limits of knapweed treatment within the project area.
Majority of the 7 acres is not dense, however, the old and new parking areas have patches of denser infestations.

Picture 10. View of old electrical pole, with project area to the right.
This is the view looking north, with the breached dam in the distance next to the rocky outcropping.

Picture 11. Beaver Dam Analogues (BDAs) in the project area.
Coconino County Parks and Recreation installed three BDAs in the project area last winter.



Picture 12. View of upland.
Looking south, a dead willow and blue gramma are indicative of drying of the wetland.

Existing Plans, Reports, Information Relevant to the Project

Coconino County. (2014). Pumphouse County Natural Area Resource Management Plan & Natural Area Operations. http://coconino.az.gov/DocumentCenter/View/5397/CCPR-Pumphouse-Report?bidId=. Accessed 9/6/18.
Summary:
Located three miles south of the City of Flagstaff, the Pumphouse County Natural Area is situated in Coconino County in the community of Kachina Village, a residential community of approximately 2,500 residents. The Natural Area, which encompasses 125 acres, protects the riparian and wetland areas supported by Pumphouse Wash and its associated springs. Conservation studies consistently recognize the Natural Area, which contributes to the unique waters of Oak Creek and the Verde River system, as a crucial resource in need of long-term protection. In 2000, CCPR began accepting land donations to form the beginning of the Natural Area. Subsequently, in 2002, the voters of Coconino County recognized these benefits by approving the Coconino Parks and Open Space Sales Tax (CPOS), which has since provided capital acquisition funds to purchase the remaining parcels to create the three sites, Pumphouse Meadow, Pumphouse Wash, and Harrenburg Wash that comprise the current 125-acre Natural Area. CCPR continues as the land manager and conservation steward under the CPOS program to administer long-term initiatives that focus on resource conservation management, appropriate outdoor recreation, and the future development of a regional environmental education facility.
The policies set forth in the Kachina Village Area Plan recognizing the public's desire to conserve wetlands and riparian areas associated with the Pumphouse Wash system are realized in this resource management and operations plan. This plan will guide CCPR, its partners, and interested citizens in the management and operation of this unique resource for future generations. As such, CCPR will implement stewardship activities to ensure the conservation of both natural and cultural resources. In addition, this plan provides direction for visitor use, appropriate recreation, and the realization of the area's full potential as a location for enhanced environmental education and outreach.

Natural Channel Design, Inc. (2018). Memo: Harrenburg Wash Enhancement Concepts.
Summary:
Natural Channel Design, Inc. provided a memo to Arizona Game and Fish Department for Harrenburg Wash Enhancement Concepts. Please see full memo in the supplemental material.

Coconino County. (2009). Coconino County Parks and Recreation Department Organizational Master Plan. http://coconino.az.gov/DocumentCenter/View/1685/FINAL-Master-Plan-11-17-09?bidId=. Accessed 9/6/18.
Summary:
The Coconino County Parks and Recreation Department contracted with PROS Consulting LLC (PROS) to develop an Organizational Master Plan that would aid the Department in sustaining a high quality park and recreation system over the next 10 years. This project seeks to provide sound and realistic recommendations, strategies, tactics, and suggested initiatives that address current and evolving park and recreation needs of residents of Coconino County.

Coconino County. (2015). Coconino County Comprehensive Plan.
http://www.coconino.az.gov/1948/Long-Range-Planning. Accessed 9/6/18.
The 2015 Coconino County Comprehensive Plan features a section on Parks, Open Space, Trails, & Recreation. There is a goal that addresses open space and public lands, and it encourages policies and

actions that reduce negative impacts to communities and the environment. Additional goals center around county and neighborhood parks, trails, and recreation partnership and coordination.

Letters of Community Support

We are attaching three letters of support for the Harrenburg Wash Enhancement Project: Arizona Game and Fish Department; John Aber, resident of Kachina Village; and Dr. Christina Vojta, wildlife ecologist and Audubon Steward for Kachina Wetlands Bird Sanctuary.

September 4, 2018

Reuben Teran
Arizona Department of Water Resources
Arizona Water Protection Fund
1110 W. Washington St., Ste. 310
Phoenix, AZ 85007

Re: Letter of Recommendation for Harrenburg Wash Enhancement Project

Dear Mr. Teran,

The Arizona Game and Fish Department works in close association with Coconino County Parks and Recreation, and we are writing in support of their grant application for the Harrenburg Wash Enhancement Project. Harrenburg Wash provides a rare resource for local migratory wildlife; perennial water and wetlands! Harrenburg Wash and its trailhead also provide frequently-used public access to County Open Space and the nearby Coconino National Forest.

The restoration work that is proposed for Harrenburg Wash is needed in order to address several erosion and invasive species problems that could spread downstream if they are not addressed. The proposed channel improvements will arrest the headcutting that is occurring and the weed treatments and revegetation will address the diffuse knapweed infestation that is slowly spreading outward. These improvements will improve wildlife habitat and the public recreation experience at this important location.

Thank you for considering this project.

Sincerely,

Robert Nelson
Habitat Evaluation and Lands Program Manager

azgfd.gov | 928.774.5045
FLAGSTAFF OFFICE: 3500 S. LAKE MARY ROAD, FLAGSTAFF AZ 86005

Reuben Teran
Arizona Department of Water Resources
Arizona Water Protection Fund
1110 West Washington Street, Suite 310
Phoenix, Arizona 85007

September 6, 2018

Dear Mr. Teran,

I am writing in support of the Coconino County Parks and Recreation Department's grant application for the Harrenburg Wash Enhancement Project. As a longtime resident of Kachina Village, I enjoy hiking and wildlife watching daily in and around Harrenburg and Pumphouse Wash. The area is an important part of the headwaters of Oak Creek Canyon and the Verde River watershed, and this grant would help accomplish some important conservation objectives including management of noxious weeds in the area. I strongly encourage you to select the Harrenburg Wash Enhancement Project for grant funding as requested. Thank you very much for your consideration.

Sincerely,

John Aber
[redacted]
Flagstaff, Arizona 86005

Reuben Teran
Arizona Department of Water Resources
Arizona Water Protection Fund
1110 W. Washington St., Ste. 310
Phoenix, AZ 85007

September 6, 2018

Dear Mr. Teran,

I am writing in support of the proposal for the Harrenburg Wash Enhancement Project. I'm pleased that Coconino County's Department of Parks and Recreation is committed to restoring both the structure and vegetation of Harrenburg Wash. In particular, I strongly support the removal of diffuse knapweed and enhancement of the site with native grasses and forbs. Given that Harrenburg Wash constitutes the headwaters of Oak Creek, these measures are greatly needed.

In my role as Audubon Steward for the nearby Kachina Wetlands Bird Sanctuary, I recognize that birds and other wildlife utilize large landscapes, not simply small tracts that are under specific ownerships. All land owners must work together to control invasive species across lands of mixed ownership. Harrenburg Wash is an important component of a larger landscape that plays a significant role for migrating birds as well as resident wildlife. Thus, enhancement of Harrenburg Wash will contribute to the value of the entire area.

Sincerely,

Christina Vojta

Christina Vojta, Ph.D.
Wildlife ecologist
Audubon Steward for Kachina Wetlands Bird Sanctuary

Evidence of Control and Tenure of Land

When recorded, mailto:

Highlands Fire Department
568 Kona Trail
Flagstaff, AZ 86001

QUITCLAIM DEED

DATE: October 25, 2002

EXEMPTION: This Deed is exempt, pursuant to A.R.S. §42-1614(A)(3), from the requirements of A.R.S. §42-1601, et. seq., because a political subdivision of the State of Arizona is the named Grantor.

GRANTOR: Highlands Fire District
568 Kona Trail
Flagstaff, Arizona 86001

GRANTEE: Coconino County, Arizona
110 E. Cherry
Flagstaff, Arizona 86001

WITNESSETH

For and in consideration of FIVE DOLLARS ($5.00) and other valuable consideration, the Grantor hereby quitclaims to Grantee all of its right, title, and interest in and to the following real property:

Beginning at the Northwest corner of Section 30, Township 20 North, Range 7 East, Gila and Salt River Base and Meridian; thence Easterly along the North line of Section 30 a distance of 369.22 feet; Thence Southerly parallel with the West line of Section 30 a distance of 509.07 feet; thence Westerly Parallel with the North line of Section 30 a distance of 66.74 feet to a nontangent curve whose radius is 175.23 feet and whose center bears North 75°43'04"

East; thence Northwesterly along said curve through a central angle of 6°34'37" a distance of 20.11 feet to a point of reverse curvature; thence along a curve having a radius of 150.00 feet through a central angle of 172°48'00" a distance of 452.39 feet to a point where said curve becomes tangent to the West line of Section 30; thence Northerly along the West line of Section 30 a distance of 509.07 feet to the point of beginning.

TO HAVE AND TO HOLD the same, together with all and singular rights and appurtenances thereto in anywise belonging unto the said GRANTEE, its successors and assigns subject to the following restrictions:

1. Said parcel to be used by Coconino County solely for conservation and recreational purposes including constructing and maintaining a parking area, trailhead, and day use recreation facilities.

2. If the said parcel is used for a purpose other than those specified herein, title to the parcel and any improvements or appurtenances thereon shall automatically revert to the Highlands Fire District.

IN WITNESS WHEREOF, the Grantor has executed this instrument the day and year first above written.

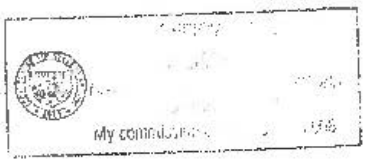
HIGHLANDS FIRE DISTRICT

By: Thomas R. Hanson

Its Chairman

STATE OF ARIZONA)
) ss.
County of Coconino)

The foregoing instrument was acknowledged before me this 25 day of October, 2005, by Thomas R. Hanson, the Chairman of the Highlands Fire District Governing Board.



Notary Public

My Commission Expires:

April 1, 2006

Original of this document to Anna Wharton for recording. Full photo copy in Pumphouse Land Titles file.

When recorded, mailto:

Highlands Fire Department
568 Kona Trail
Flagstaff, AZ 86001

QUITCLAIM DEED

DATE: October 25, 2002

EXEMPTION: This Deed is exempt, pursuant to A.R.S. §42-1614(A)(3), from the requirements of A.R.S. §42-1601, et. seq., because a political subdivision of the State of Arizona is the named Grantor.

GRANTOR: Highlands Fire District
568 Kona Trail
Flagstaff, Arizona 86001

GRANTEE: Coconino County, Arizona
110 E. Cherry
Flagstaff, Arizona 86001

WITNESSETH

For and in consideration of FIVE DOLLARS ($5.00) and other valuable consideration, the Grantor hereby quitclaims to Grantee all of its right, title, and interest in and to the following real property:

Beginning at the Northwest corner of Section 30, Township 20 North, Range 7 East, Gila and Salt River Base and Meridian; thence Easterly along the North line of Section 30 a distance of 369.22 feet; Thence Southerly parallel with the West line of Section 30 a distance of 509.07 feet; thence Westerly Parallel with the North line of Section 30 a distance of 66.74 feet to a nontangent curve whose radius is 175.23 feet and whose center bears North 75°43'04"

Candace Owens – RECORDER
OFFICIAL RECORDS OF COCONINO COUNTY 3278631 08/28/2001 12:54A
FIRST AMERICAN TITLE INS CO D 17 09

3278631
Page: 1 of 8
D

WHEN RECORDED MAIL TO:

Clark of the Board of Supervisors
Coconino County
219 E. Cherry Ave
Flagstaff, Az. 86001

271-1431635

SPECIAL WARRANTY DEED

This deed is being re-recorded to correct the legal description shown on Exhibit "A".

15

Candace Owens – RECORDER
OFFICIAL RECORDS OF COCONINO COUNTY
FIRST AMERICAN TITLE INS CO D
3269129
15.00
3269129
Page: 1 of 6
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When recorded, mail to:

Clerk of the Board of Supervisors
Coconino County
219 E. Cherry Avenue
Flagstaff, AZ 86001

EXEMPT UNDER ARS 11-1134 A3
211-14316 35

SPECIAL WARRANTY DEED

For the consideration of Ten Dollars, and other valuable consideration, the undersigned

KACHINA VILLAGE IMPROVEMENT DISTRICT, a county improvement district established under Title 48, Ch. 6 Arizona Revised Statutes

The Grantor herein, does convey to

COCONINO COUNTY, a political subdivision of the State of Arizona

The Grantee, the following real property situated in Coconino County, Arizona:

See Exhibit 1 attached hereto and by this reference incorporated herein.

This Special Warranty Deed is made and accepted subject to the following conditions, reservations, covenants, and exceptions, to wit:

1. There is hereby reserved to the Kachina Village Improvement District, its successors and assigns, for the use and benefit of the District, a perpetual and non-exclusive easement for an underground gravity flow sewer line, and effluent force main, and a sewer lift station until its removal including maintenance thereof and vehicular access thereto. Said easement is more particularly described in Exhibit 2 attached hereto.
2. The use of the real property conveyed herein is restricted solely for parks and open space purposes in perpetuity.
3. This deed is subject to all matters of record, including the Intergovernmental Agreement between Grantor and Grantee, zoning and other regulations, laws and ordinances pertaining to the Property.

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Page: 2 of 6
D

and all matters that an accurate inspection and/or accurate survey of the Property would reveal.

And the Grantor hereby binds itself and its successors to warrant and defend the title, as against all acts of the Grantor herein and no other, subject to the matters above set forth.

IN WITNESS WHEREOF, the Grantor has caused this instrument to be executed this 7th day of February, 2004.

KACHINA VILLAGE IMPROVEMENT DISTRICT

By _____
Matthew G. Ryan, Chairman, Board of Directors

ACCEPTED BY GRANTEE:

COCONINO COUNTY

By _____
Matthew G. Ryan, Chairman, Board of Supervisors

ATTEST:

_____
Deputy Clerk of the Board

Approved as to Form:

_____
Deputy County Attorney

3278631

3269129

STATE OF ARIZONA)
) ss.
County of Coconino)

On April 7, 2004, before me, the undersigned Notary Public, personally appear Matthew G. Ryan, personally known to me to be the person whose name is subscribed to the within instrument and acknowledged to me that he executed the same in his authorized capacity as chairman of the Board of Directors, Kachina Village Improvement District.

Notary Public

My Commission Expires:

8/7/2007

OFFICIAL SEAL
ANNA C. WHORTON
NOTARY PUBLIC - STATE OF ARIZONA
COCONINO COUNTY
My commission expires Aug. 7, 2007.

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Page: 4 of 8

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Page: 3 of 6

No. 2711431635

EXHIBIT "A"

A PARCEL LOCATED IN THE WEST HALF, SECTION 19, TOWNSHIP 20 NORTH, RANGE 7 EAST, GILA AND SALT RIVER BASE AND MERIDIAN, COCONINO COUNTY, ARIZONA, AND MORE SPECIFICALLY DESCRIBED AS FOLLOWS:

FOR REFERENCE BEGIN AT A 5/8 INCH REBAR ON THE WESTERLY RIGHT-OF-WAY OF JADITO TRAIL AND THE WEST LINE OF SECTION 19; THENCE NORTH 00 DEGREES 30 MINUTES 19 SECONDS WEST (BASIS OF BEARING PER DOCKET 354, PAGE 154 C.C.R.O.) 509.70 FEET TO THE NORTHWEST CORNER OF SECTION 19, A BRASS CAP STAMPED RLS 18215; THENCE ALONG THE WEST LINE OF SECTION 19 NORTH 00 DEGREES 10 MINUTES 22 SECONDS WEST 79.61 FEET TO A 1/2 INCH REBAR CAPPED RLS 29884 ALSO BEING THE TRUE POINT OF BEGINNING; THENCE CONTINUE NORTH 00 DEGREES 10 MINUTES 22 SECONDS WEST ALONG THE WEST LINE OF SECTION 19, 1,230.22 FEET TO A 1/2 INCH REBAR CAPPED RLS 29884; THENCE SOUTH 89 DEGREES 57 MINUTES 31 SECONDS EAST 375.60 FEET TO A 1/2 INCH REBAR CAPPED RLS 29884; THENCE SOUTH 13 DEGREES 16 MINUTES 27 SECONDS EAST 636.96 FEET TO A CAP STAMPED LS 18215; THENCE SOUTH 25 DEGREES 09 MINUTES 14 SECONDS WEST 210.29 FEET TO A CAP STAMPED LS 18215; THENCE SOUTH 39 DEGREES 58 MINUTES 33 SECONDS EAST 195.18 FEET TO A CAP STAMPED LS 18215; THENCE SOUTH 55 DEGREES 41 MINUTES 46 SECONDS WEST 138.83 FEET TO A CAP STAMPED RLS 18215; THENCE SOUTH 21 DEGREES 49 MINUTES 51 SECONDS EAST 253.98 FEET TO A 1/2 INCH REBAR CAPPED RLS 18215; THENCE NORTH 85 DEGREES 17 MINUTES 48 SECONDS WEST 535.73 FEET BACK TO THE TRUE POINT OF BEGINNING.

RESERVING UNTO THE GRANTOR, THEIR HEIRS, SUCCESSORS AND ASSIGNS, A 50 FOOT RADIUS TURN-A-ROUND EASEMENT DESCRIBED AS FOLLOWS: FOR REFERENCE BEGIN AT THE SOUTHEAST CORNER OF SAID PARCEL, A 1/2 INCH REBAR CAPPED RLS 18215; THENCE NORTH 85 DEGREES 17 MINUTES 48 SECONDS WEST 82.64 FEET TO THE RADIUS POINT OF SAID EASEMENT.

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Page 6

Natural Channel Design, Inc.

2900 N West St, Ste 5
Flagstaff, AZ 86004
(o) 928-774-2336
(c) 928 600-6649

MEMO

# of pages: 16

DATE: 6/7/2018

TO: Hannah Griscom AGFD

FROM: Allen Haden, Natural Channel Design, Inc.

RE: Harrenburg Wash Enhancement Concepts

Background

This memo focuses on conceptual plans for enhancement of habitat and recreational opportunities at Harrenburg Wash near Kachina Village/Forest Highlands in Coconino County. Arizona Game and Fish Department, in cooperation with Coconino County Parks and Recreation, desires to improve the stability, productivity and habitat quality for the wash, just upstream from its confluence with Pumphouse Wash.

This area has been impacted by the building, filling and partial breaching of a relatively large pond; channel excavations to create open water; flood plain fill; and invasion of non-native weed species. The breached pond area does support a wetland that both AGFD and Coconino County wish to preserve/enhance. A previous brief assessment of the site by the Natural Resource Conservation Service did point out the need to prevent future headcutting through the dam and into the wetland (Trip Report to Dave McKay, State Conservationist; February 19, 2008; File code 210-7).

Natural Channel Design has been tasked with doing an initial assessment of the site, determining its ecological potential and developing a concept-level plan that can be utilized for planning and budgeting purposes. The concept plan, as included herein, is not meant as a construction document and further analysis and design will be required before implementation can begin.

Project Area

Harrenburg Wash is a tributary to Pumphouse Wash. A major portion of the Harrenburg drainage is within the Forest Highlands development and golf course. The main natural water source is Griffiths Spring with other sources including irrigation runoff from the golf course. The project area is the most downstream portion of the drainage basin and extends upstream from the confluence with Pumphouse Wash to the northern parcel boundary near Griffiths Springs Road. The project land is owned by Coconino County (2

parcels) and Kachina Village Improvement District (1 parcel). See Figure 1 & Figure 2 on the following pages.

Figure 1. Location map of the Harrenburg Wash Project area.

The valley had previously been dammed to form a fishing pond. The earthen embankment extended across the valley floor and backed water to near the north property boundary, creating a 4.8 acre pond with a maximum depth of approximately 11 feet at the embankment. This dam was purposefully breached several decades ago. However, the elevation of the breach is high enough that a small pool is still stored behind the dam during runoff events. This pool has formed a wetland which dries out to the point of no surface water during very dry periods but holds surface water during normal precipitation periods. The current inundation area is approximately 1.3 acres with a maximum depth of 3.5 feet and storage of approximately 2 acre-feet of water. See Appendix A for approximate elevations and extents. Relatively permanent surface flows during normal precipitation periods are present in the channel through the meadow upstream of the dam and wetland. Flows are ephemeral downstream of the dam to the confluence with Pumphouse Wash.

A buried sewer line runs parallel to the wash for most of the length of the valley and a dead end aerial powerline extends into the valley near the pond.

The proximity of the wash to USFS lands on one side and the major residential areas of Kachina Village and Forest Highlands encourages recreational use, while the surface water is a major wildlife attractant.

Figure 2. Project area map showing land ownership boundaries.
Harrenburg Wash runs north/south from private property boundary to Kachina Village Improvement District (KVID) and Coconino County lands. Project is bounded by private lands to the east and Coconino National Forest land to the west.

Hydrology

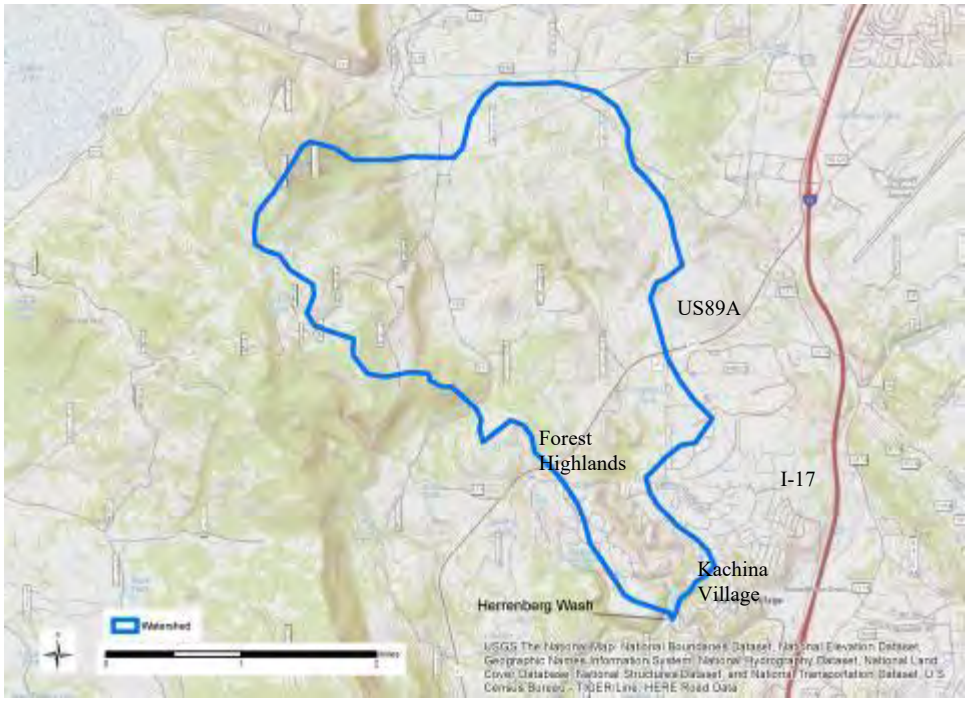


Figure 3. Watershed boundary for Harrenburg Wash Project Area.

The watershed draining to the project area is 6.6 square miles. The majority of the watershed is low density housing and golf course. There are several golf course ponds that can capture portions of the runoff. However, these ponds are kept relatively full with treated wastewater which is utilized for the golf course irrigation.

Base flow through the project area is relatively perennial, except during extended dry periods. No measurement of baseflow has been attempted and there was no baseflow during the assessment period of April 2018 due to drought conditions. Damp soil was evident in the bottom of the channel even after an extended period of low precipitation.

Flood discharge analysis for the site was estimated utilizing several methods to provide a range of estimates. Estimates to bracket the design flows were made using the National Stream Statistics method (NSS), National Flood Frequency method (NFF) and Wildcat 5 model. The results are tabulated below and show a relatively good agreement between the various methods with the NSS estimates showing consistently lower estimates than the other two methods and NFF providing consistently more conservative estimates of flood discharge.

Table 1 - Flood Frequency Estimates for Project Area

Return Interval	NSS (cfs)	NFF (cfs)	Wildcat 5 (cfs)
Q2	60	84	155
Q5	137	374	353
Q10	208	540	579
Q25	322	918	924
Q50	422	1,345	1220
Q100	535	1,632	1547

Channel Morphology and Condition

Channel morphology was examined by visual analysis during the site visit in April 2018. Topography measured on site during the assessment was combined with available 2-foot contour maps to provide a topographical map of the site that includes specific channel/wetland features. See Appendix A. There are several specific reaches of channel with specific channel morphology. These are described below.

Beginning at the confluence, the first reach extends upstream to the base of the old dam. This channel has been incised into the valley floor but has widened to a point that shows an active channel combined with an appropriately sized flood plain. This channel appears to be relatively stable with fair amounts of appropriate native vegetation, including willows and grasses. The only impairment in this reach is a set of undersized culverts that form a road crossing to the old parking area, downstream of Kachina Village. These culverts show indications of having been overtopped and a portion of the crossing prism has eroded away. See Figures below.

Figure 4. Generally stable channel conditions between confluence and old dam.
View is looking upstream from trail crossing.

Figure 5. Undersized culvert and eroding trail prism.
Flows have overtopped the road prism and eroded the downstream side of fill prism. View is looking upstream.

The second reach of channel is the short reach through the breach of the dam. The breach was opened up to the west of the historic channel such that water flowing through the breach has to formed a new channel the eventually connects back to the original. This reach is steeper than the remainder of the channel and is protected from headcutting or extensive lateral erosion by very large rock which once formed the downstream face of the dam. There is a short reach of bank erosion caused by the channel forming itself in a new path and the actual breach through the dam has very steep banks without an adequate flood plain. This condition likely leads to higher velocities and downstream bank erosion during high flows. The overflow spillway is located on the eastern side of the valley in this reach. This channel has not experienced flow in many years, judging by vegetation and channel condition. Again, large rocks and a concrete sill at the top of the spillway help to prevent erosion in the unlikely scenario that this channel sees significant flow. Some flow may be provided by a small side drainage which feeds into the top of the spillway.

Figure 6. Breach through dam.
View is looking downstream from the wetland area that exists above the dam.

The third reach of the project area is just upstream of the dam and is represented by the small ponded area and wetland. The elevation of the outlet through the dam breach ponds water to a maximum depth of 3 feet. There is an obvious depression left over from excavation of the pond that forms the wetland. Vegetation is dominated by native wetland plants even during dry periods. Native willows and several narrowleaf cottonwoods have been planted just above the highwater line in this area.

Figure 7. Wetland area.
View is looking upstream from dam. This area exhibits relatively permanent inundation except during extremely dry weather.

The fourth reach is the remainder of the project area. This reach is typified by a relatively small active channel with a wide, low flood plain. The channel is dominated by wetland vegetation and while the low flood plain has a mix of wetland and drier species. The higher flood plain is dominated by bunch grasses. There have been several impacts to this portion of the channel. Several 'pools' were apparently intentionally dug into the meadow to expose and/or deepen surface water. These pools have initiated head cuts that extend up through the meadow system, through the fine grained soils of the old pond bed. This has resulted in some channel incision throughout the reach with associated lowering of the ground water table. The floodplain in this reach has also been impacted. While the sewer line and maintenance road are located along the margin of the valley, fill used to create the maintenance road has narrowed the flood plain somewhat from its original form. Additionally, there are several truck loads of asphalt and old concrete that have been dumped onto the floodplain.

Figure 8. Typical conditions in upper meadow.
Flow channel is typically a shallow wide swale vegetated with wetland plants. However, potholes cut into the meadow have initiated headcuts.

Figure 9. Excavated pool forming a headcut in meadow.
Note that excavated materials are still piled adjacent to excavation.

Vegetation

The existing vegetation was assessed during May 2018. Because of the short duration of the assessment, there may be important species that were not noted. However, the season was useful for noting many of the common problematic weed species from the region and for recognition of the major species inhabiting the project site. Additionally, a review of plant collections in the area were made utilizing SEINet.com. No collections were listed within the immediate project area. However, there have been multiple collections of aquatic species within the watershed. None of the species found have been identified as listed Threatened or Endangered.

Wetland species typical of permanently and episodically inundated areas on the Coconino Plateau are common in the wetland. Typical of these are Carex spp., Bulrush and Typha sp. Also typical of the area are several arroyo willow shrubs and narrowleaf cottonwood trees. Both the trees and willow shrubs were planted during a previous enhancement effort. They appear to be thriving although there is no noticeable regeneration of these plants. Notably there is little evidence of heavy browsing by elk or deer as would normally be expected on these types of plants. There is a dead arroyo willow at the upper end of the meadow. This single plant appears to have established during the period when the old lake elevation backed water into the area and has since died due to gradual drying in the meadow after the breach.

The restored parking area has a few large patches that lack native vegetation. They are areas with heavy cinders, lots of bare ground and many weedy annuals including knapweed. This area has been reseeded in the past in efforts to reclaim the parking area.

Much of the seeded area is doing well and is supporting appropriate vegetation for this flood terrace. However, approximately 0.5 to 1.0 acres remains bare or contains undesired species. The bare areas are also characterized by thick patches of cinder parking lot materials.

Figure 10. Restored area (previously a parking lot)
Has not regrown with native vegetaion.

Figure 11. Knapweed infestation
Infestation is the most dense in bare portions of the old parking area.

Weeds

Diffuse knapweed (*Centaurea diffusa*) is the most prolific weed in the project site. While it is not dense and dominant through the project it is common and widely dispersed. Densest concentrations are located within bare areas of the old parking area and around current trailhead parking area. Diffuse knapweed is an aggressive species and should be treated while the area still has a strong stand of native plants that can fill in the treated areas.

Recommendations

The area has potential to function as a wet meadow wetland system with a relatively large open water area. While extended dry periods will continue to dry the surface water, improving soil water storage in the upper meadow will likely lengthen the period of open water and high ground water. Extension of the wetted period should improve habitat quality for facultative wetland plants, aquatic invertebrates and amphibious wildlife that will benefit from higher productivity and longer inundation periods. Additionally, higher groundwater for longer periods of time should encourage a more widespread wetland plant community with greater productivity and resistance to erosion.

The wetland behind the pond should be preserved by maintaining the outlet of the pond at its current elevation. The maximum water surface elevation maintained by the outlet appears to support a valuable wetland vegetation community without drowning plants in the deep areas.

Channel Improvements

There are several impacts to the channel that should be addressed in order for the area to reach its full potential. The potholed/excavated areas that have initiated headcuts need to be refilled with the materials that were removed. The intent is to have runoff closer to the surface of the meadow and be allowed to spread out, and infiltrate into the soil rather than running off quickly. This should extend the period of high soil moisture for the meadow and increase productivity. The fill areas will need to be protected with log spreaders or rock mulch in combination with planting of native wetland vegetation to foster the establishment of a healthy stand of native vegetation that will provide long term stabilization of the soils.

The outlet of the wetland through the dam breach should be widened and reshaped to approximate a natural stable channel, based on a geomorphic reference from the area. It appears that the bankfull channel through the breach is relatively well formed but there is no adequate flood plain for this short section of channel, meaning that during higher flow events, the erosive power of the flows through the breach is magnified. Additionally, the channel is routed to an area with relatively soft soils that has created a small area of erosion. This can be eliminated by rerouting of the channel towards the original downstream channel. The area of the breach is steeper than the original channel and there is a moderate danger of headcutting into the existing wetland. While the large rock material at the site appears to reduce the danger of a headcut under current conditions, changes to the channel should also be aimed at protection from future headcutting. A

step-pool channel design can be designed and constructed for this reach. Construction can utilize the large boulder material found on the site.

Below the breach area, the undersized culverts should be replaced with a pedestrian bridge or a pedestrian low water crossing. The intent is to reduce overtopping of the trail prism and the resultant high velocity and erosion that occurs here. A prefabricated bridge would be a preferred alternative. However, the crossing could be accomplished with less expensive measures, including the placement of larger culverts in the existing prism. The full design process should explore the requirements of this crossing (equestrian, bike or pedestrian only traffic) and provide a cost analysis of various options. This is likely to be the most expensive task within the entire project. Costs will vary greatly given the design criteria of the bridge (traffic type and weight and flood discharge) as well as the type of bridge. Appendix B provides an example of a simple site built bridge which would likely be adequate for pedestrian and equestrian traffic up to a roughly 25 year return interval flow. This criteria and design will require considerably more discussion and scrutiny before it can be finalized.

Weed Treatment

Approximately 7 acres should be treated to control diffuse knapweed. The most effective treatment includes spraying knapweed in the spring while it is still small and actively growing, followed by manual pulling and bagging in mid-summer when it is large and easily found but before it has begun to set seed. Current herbicide treatments costs can be estimated at $175/ac. Therefore, herbicide treatment will cost approximately $1,225 per year and the area will need to be treated for 3 to 4 years. Manual pulling should occur for 6 to 7 years to help prevent re-infestation from the seed bank and neighboring seed sources. This is anticipated to be a low level of effort compared to initial management efforts. Native vegetation should be well enough established to prevent re-infestation by then. The approximate treatment area is shown in Figure 12.

Figure 12. Approximate limits of knapweed treatment within the project area.
Majority of the 7 acres is not dense, however, the old and new parking areas have patches of denser infestations.

Revegetation

Revegetation of disturbed areas with appropriate native grass and forb seed or wetland plugs will be necessary. Habitat diversity can be improved through planting of willows and cottonwoods along the fringe of the permanently wetted soils. These types of plants will not survive in the permanently wetted soils associated with the wetland or wet meadow area. Areas with similar hydrologic conditions at this elevation seldom support solid overstory gallery forests of these trees and shrubs. However, smaller clumps of plantings can provide habitat. The value of the habitat can potentially be increased by research value. This area may provide an ideal site for planting genetically important cottonwoods in a refugia situation. Northern Arizona Cottonwood Research Group is actively looking for sites that provide refugia habitat for genetically unique cottonwoods whose habitat is endangered by warming climate and flow alteration. Dr. Tom Whitham or Dr. Kevin Grady at Northern Arizona University could be potential partners for supply and planting of cottonwood trees. These types of plantings would provide high value research and conservation resources as well as habitat.

The old parking area should be overseeded with a native grass and forb mix. While this site does not have the wet meadow potential of the area above the dam, it can support a diverse native grass and forb community. Given the habitat and recreational value of the site, an emphasis should be put on including plants valuable to pollinator species in this area. Both early and late season flowering plants should be included in the seed mix. Previous replanting efforts have worked except in areas with high cinder content. These cinders should be removed from the site or reworked into trail cover so that native soil suitable for seeding is exposed. Light mulching with weed-free straw or wood chips should be utilized to improve germination and establishment.

Other items

Several other items of work will contribute to low maintenance and higher habitat quality.

- There is an above-ground electrical line that dead ends near the wetland. This wire and two associated wooden poles should be removed from the site.
- There are several piles (~ 40 cu yds) of broken asphalt and concrete that have been dumped on the site. These should be removed and disposed of in a lawful manner. The remaining material should be smoothed over and replanted.
- The current parking lot area creates a concentrated runoff into the channel. This is caused in part by a rubble/rock wall that borders the parking area. The wall traps runoff and directs it down the trail towards the channel. The wall also creates a difficult weed treatment area since weeds and seed fall between the crevices in the rock. Removal of the wall and replacement with single rocks or a fence will improve runoff direction and help maintain the area as weed free. The routing of the trail may be moved to accommodate siting of the crossing in a different area more amenable to a short pedestrian bridge.
- Trail crossings in the upper portion of the meadow should be built to accommodate wetter soils for longer periods of time. It may be necessary to utilize stepping stones across the meadow as a hardened trail surface during wet periods.
- Monitoring of the success of the project should be focused on increasing the length of period for wetted soil conditions and favorable changes to the meadow vegetation community. These items can be measured with a series of vegetation transects and several piezometers located within the meadow. These should be installed and monitored before the project is implemented to allow some baseline data to be collected.

Permitting

Work within wetlands and jurisdictional waters of the United States are regulated through Section 404 of the Federal Clean Water Act. The wetland and sections of the meadow meet the criteria for inclusion under this act. A first priority of the project should be to do a wetland delineation and waters of the U.S. ordinary high water survey to understand the limits of jurisdictional waters in the project area. Once those boundaries are known the design process can work around those boundaries as necessary to limit any impacts inside the jurisdictional area. If impacts can be limited below those required to trigger the need for a 404 permit, no permit will be needed. However, it is likely that permitting will be required. All the proposed actions in this assessment could likley be included under a Nationwide Permit #27 for habitat enhancement. Under the Nationwide Permit, this would provide and expedited platform to gain a 404 permit and begin work. Submittal for a 404 permit should be done at least several months prior to planned construction startup. The items required for a 404 permit submittal would be:

- Relatively complete plan with good estimate of cut and fill inside jurisdictional limits
- Completed wetlands delineation and Ordinary High Water Survey for submittal to show preliminary jurisdictional limits of Clean Water Act

- Archaeological survey for submittal to State Historic Preservation Office
- Biological Assessment of the site and project to provide to U.S. Fish and Wildlife Service

Other permits that may be required:

- Coconino County grading permit with a drainage report. This report may be most important to the replacement of the stream crossing. It is anticipated that the County would want to see a relatively detailed hydraulic model of changes caused by the bridge or other infrastructure given the proximity of the water treatment plant downstream.
- Stormwater Pollution Prevention Plan – Arizona Department of Environmental Quality 401 permit.
- Keeping the outlet of the breach at its current elevation will have the effect of ponding approximately 2 acre-feet of surface water. This is the same amount of surface water storage that is currently occurring and considerably less than was originally stored behind the dam. This storage right should be confirmed as an existing water right so that it does not become contested in the future. If the storage right cannot be confirmed, there may be a need to lower the spillway to prevent storage of surface water. A wet meadow habitat would still be a sustainable project goal. All of the site enhancements suggested in this assessment would still apply.

Potential Costs

Conceptual level costs were estimated utilizing comparative costs from NCD projects of similar scope and scale. Final cost estimates will likely change as the design process refines quantities, materials and methods needed to implement the project. Consequently, these costs should be utilized as a planning tool only and should not be considered a bid for services or a final budget. We have added a line item contingency of 25% to the conceptual budget which is meant to cover some market changes, design changes and unforeseen budgetary items that may arise during the full, final design and implementation phases of the project.

A breakdown of conceptual level costs for final design, permitting and implementation is provided in Table 2. The costs provided are not inclusive of volunteer labor or donated materials. We have utilized market value costs for the analysis. While substantial savings may be realized by receiving in-kind donations of materials, labor, equipment, etc., this analysis should allow estimation of the value of those in-kind contributions. Other specific tasks (specifically the bridge) may be accomplished with far less investment than has been estimated. Costs for the bridge or crossing can vary widely depending on design requirements. A rather high cost for the bridge has been included in the estimate and a design suggestion for a very low cost solution to the issue is included in the Appendix. A cost efficient design that meets the needs of all stakeholders can be developed as part of the final design process. It should be noted that individual tasks identified in this concept plan do not necessarily have to happen together as a complete and entire project. Specific tasks could be accomplished individually as time and budget

allow. This would allow less expensive, 'low hanging fruit' to move forward while funding is sought for more complex and expensive tasks.

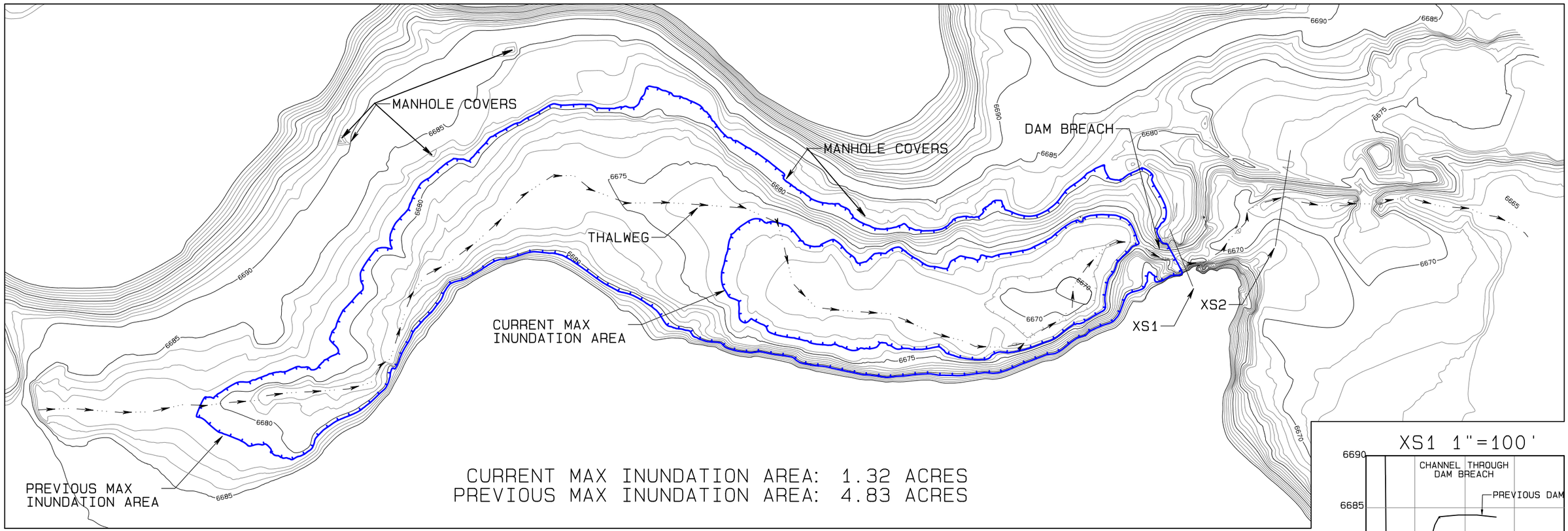
Itemized Conceptual Budget

Table 2

Conceptual Costs for Harrenburg Wash Enhancement				
Item Description	***Quantity***	***Unit***	***Unit cost***	***Total***
Earthwork mobilization/demobilization	1	ls	$ 2,000	$ 2,000
Fill, compact and smooth pot holes	40	cu yd	$ 12	$ 480
Supply and place logs or rock mulch	3	ea	$ 1,000	$ 3,000
Remove concrete/asphalt and smooth	40	cu yds	$ 70	$ 2,800
Remove culvert and road prism	50	cu yds	$ 12	$ 600
Reshape breach channel	800	cu yds	$ 12	$ 9,600
Rock chute/Step pool	4	ea	$ 1,925	$ 7,700
Soil prep	2	acres	$ 500	$ 1,000
Overseed with native grasses and forbs	4	acres	$ 400	$ 1,600
Supply and place straw mulch	2	acres	$ 550	$ 1,100
Supply and place wetland plugs	200	ea	$ 2	$ 300
Supply and place cottonwood trees	50	ea	$ 30	$ 1,500
Supply and place willows	300	ea	$ 18	$ 5,400
Supply and place pedestrian bridge	1	ea	$ 20,000	$ 20,000
Weed treatment (herbicide) - 4 years	4	ea	$ 1,300	$ 5,200
Remove electric line	1	ls	$ -	$ -
Piezometer	4	ea	$ 250	$ 1,000
Design and construction oversight	1	ls	$ 12,456	$ 12,456
Permitting 404 (includes wetland delineation, arch survey and Biological assessment	1	ls	$ 9,000	$ 9,000
Permitting County grading plan with hydraulic model and drainage report	1	ls	$ 5,000	$ 5,000
			Total	**$ 89,736**
			25% contingency	**$ 22,434**
			Project total	**$ 112,170**

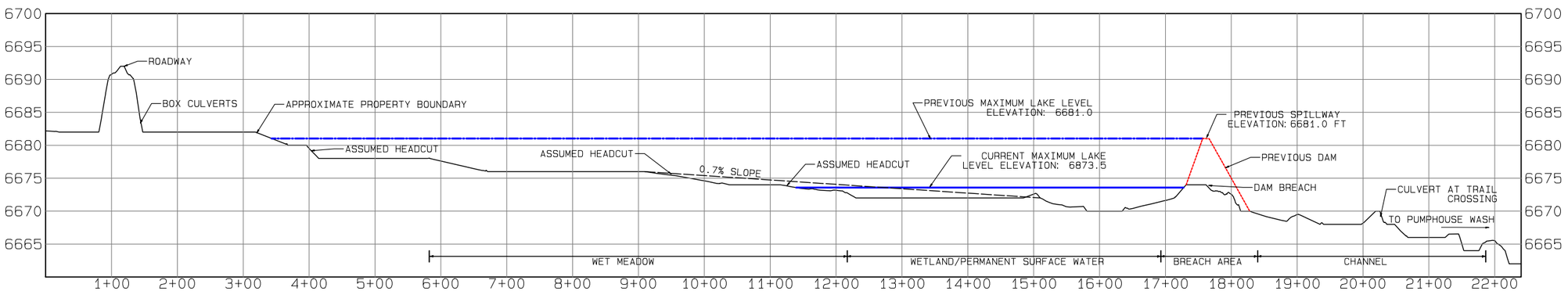
Appendix A

Topography and Channel Features



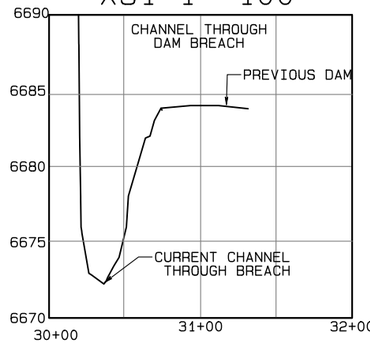
CURRENT MAX INUNDATION AREA: 1.32 ACRES
PREVIOUS MAX INUNDATION AREA: 4.83 ACRES

1"=120'

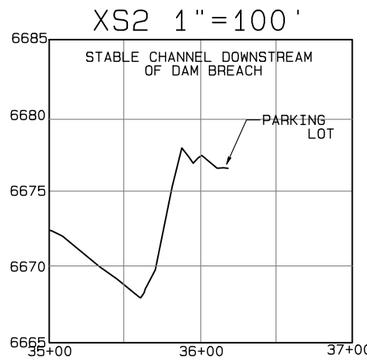


1"=180'

XS1 1"=100'



XS2 1"=100'



Natural Channel Design, Inc

2900 N. West St. Suite #5
Flagstaff, Arizona 86004
(928) 774-2336

Harrenburg Wash Enhancement Concept

DATE: June 7, 2018

SHEET: 1 of 1

Appendix B

Potential Pedestrian/Equestrian Bridge Design (USFS)

United States Department of Agriculture
Forest Service

U.S. Department of Transportation
Federal Highway Administration

Tech Tips

National Technology & Development Program • **Recreation** • July 2013 • 2300 • 1223–2316P–MTDC

Innovative Design for a Short-Span Timber All-Terrain Vehicle Trail Bridge

Jerry D. Barrow, Civil Engineer and James Scott Groenier, Project Leader

A simple, inexpensive, 12-foot-long sawn timber bridge that was designed for an all-terrain vehicle (ATV) trail is also suitable for horse, bicycle, and pedestrian trails that cross small drainages (figure 1). The photographs and construction details in this tech tip originate from a project completed at the Tombigbee National Forest, Mississippi, by Trails Unlimited, a U.S. Department of Agriculture, Forest Service enterprise team that works on trail construction projects throughout the country.

The design of this short-span bridge has been used in national forests in the Southern Region (R-8) of the Forest Service. Other jurisdictions may have other specifications and their own approval requirements for similar trail bridges. It meets the load design criteria of 90 pounds per square foot and is capable of carrying a 10,000-pound trail dozer or similar equipment. The design is suitable for clear spans of 6 to 24 linear feet, using pressure-treated timbers. The assembly hardware, such as bolts, nails, and screws, is hot-dipped galvanized.

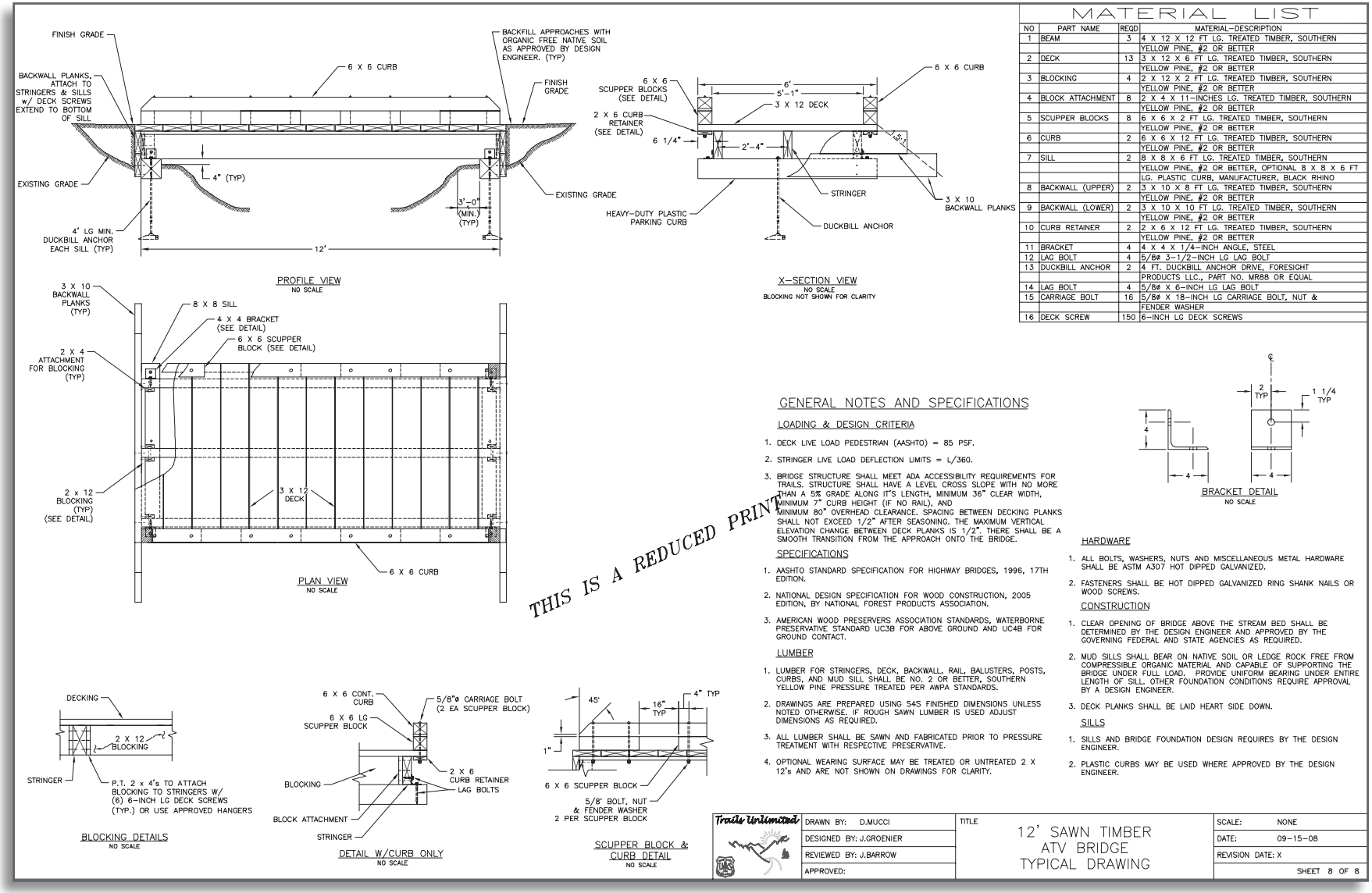
The bridge design itself is straightforward (figure 2). The approximate cost of the materials used to build the bridge is $1,500. A knowledgeable, four-person crew can assemble the bridge in about 8 hours. Although the crew needs to assemble the bridge onsite, the longest individual component is 12-feet long, so the crew can carry the components to the site with small motorized equipment, or by hand, if necessary.

Highlights...

- A new design for a simple, inexpensive short-span timber all-terrain vehicle trail bridge is available.
- The design meets current bridge design-load requirements and uses innovative ideas to increase the longevity and sustainability of the structure.
- This tech tip includes a sample drawing of a 12-foot bridge.

Figure 1—This bridge was constructed on an ATV trail at the Tombigbee National Forest, Mississippi.

For additional information, contact: *USDA Forest Service, MTDC; 5785 Hwy. 10 West; Missoula, MT 59808–9361.*
Phone: 406–329–3900; fax: 406–329–3719; email: wo_mtdc_pubs@fs.fed.us



MATERIAL LIST

NO	PART NAME	REQD	MATERIAL-DESCRIPTION
1	BEAM	3	4 X 12 X 12 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
2	DECK	13	3 X 12 X 6 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
3	BLOCKING	4	2 X 12 X 2 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
4	BLOCK ATTACHMENT	8	2 X 4 X 11-INCHES LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
5	SCUPPER BLOCKS	8	6 X 6 X 2 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
6	CURB	2	6 X 6 X 12 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
7	SILL	2	8 X 8 X 6 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER, OPTIONAL 8 X 8 X 6 FT LG. PLASTIC CURB, MANUFACTURER, BLACK RHINO
8	BACKWALL (UPPER)	2	3 X 10 X 8 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
9	BACKWALL (LOWER)	2	3 X 10 X 10 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
10	CURB RETAINER	2	2 X 6 X 12 FT LG. TREATED TIMBER, SOUTHERN YELLOW PINE, #2 OR BETTER
11	BRACKET	4	4 X 4 X 1/4-INCH ANGLE, STEEL
12	LAG BOLT	4	5/8ø 3-1/2-INCH LG LAG BOLT
13	DUCKBILL ANCHOR	2	4 FT. DUCKBILL ANCHOR DRIVE, FORESIGHT PRODUCTS LLC., PART NO. MR88 OR EQUAL
14	LAG BOLT	4	5/8ø X 6-INCH LG LAG BOLT
15	CARRIAGE BOLT	16	5/8ø X 18-INCH LG CARRIAGE BOLT, NUT & FENDER WASHER
16	DECK SCREW	150	6-INCH LG DECK SCREWS

GENERAL NOTES AND SPECIFICATIONS

LOADING & DESIGN CRITERIA

1. DECK LIVE LOAD PEDESTRIAN (AASHTO) = 85 PSF.
2. STRINGER LIVE LOAD DEFLECTION LIMITS = L/360.
3. BRIDGE STRUCTURE SHALL MEET ADA ACCESSIBILITY REQUIREMENTS FOR TRAILS. STRUCTURE SHALL HAVE A LEVEL CROSS SLOPE WITH NO MORE THAN A 5% GRADE ALONG IT'S LENGTH, MINIMUM 36" CLEAR WIDTH, MINIMUM 7" CURB HEIGHT (IF NO RAIL), AND MINIMUM 80" OVERHEAD CLEARANCE. SPACING BETWEEN DECKING PLANKS SHALL NOT EXCEED 1/2" AFTER SEASONING. THE MAXIMUM VERTICAL ELEVATION CHANGE BETWEEN DECK PLANKS IS 1/2". THERE SHALL BE A SMOOTH TRANSITION FROM THE APPROACH ONTO THE BRIDGE.

SPECIFICATIONS

1. AASHTO STANDARD SPECIFICATION FOR HIGHWAY BRIDGES, 1996, 17TH EDITION.
2. NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION, 2005 EDITION, BY NATIONAL FOREST PRODUCTS ASSOCIATION.
3. AMERICAN WOOD PRESERVERS ASSOCIATION STANDARDS, WATERBORNE PRESERVATIVE STANDARD UC3B FOR ABOVE GROUND AND UC4B FOR GROUND CONTACT.

LUMBER

1. LUMBER FOR STRINGERS, DECK, BACKWALL, RAIL, BALUSTERS, POSTS, CURBS, AND MUD SILL SHALL BE NO. 2 OR BETTER, SOUTHERN YELLOW PINE PRESSURE TREATED PER AWPA STANDARDS.
2. DRAWINGS ARE PREPARED USING S4S FINISHED DIMENSIONS UNLESS NOTED OTHERWISE. IF ROUGH SAWN LUMBER IS USED ADJUST DIMENSIONS AS REQUIRED.
3. ALL LUMBER SHALL BE SAWN AND FABRICATED PRIOR TO PRESSURE TREATMENT WITH RESPECTIVE PRESERVATIVE.
4. OPTIONAL WEARING SURFACE MAY BE TREATED OR UNTREATED 2 X 12's AND ARE NOT SHOWN ON DRAWINGS FOR CLARITY.

BRACKET DETAIL
NO SCALE

HARDWARE

1. ALL BOLTS, WASHERS, NUTS AND MISCELLANEOUS METAL HARDWARE SHALL BE ASTM A307 HOT DIPPED GALVANIZED.
2. FASTENERS SHALL BE HOT DIPPED GALVANIZED RING SHANK NAILS OR WOOD SCREWS.

CONSTRUCTION

1. CLEAR OPENING OF BRIDGE ABOVE THE STREAM BED SHALL BE DETERMINED BY THE DESIGN ENGINEER AND APPROVED BY THE GOVERNING FEDERAL AND STATE AGENCIES AS REQUIRED.
2. MUD SILLS SHALL BEAR ON NATIVE SOIL OR LEDGE ROCK FREE FROM COMPRESSIBLE ORGANIC MATERIAL AND CAPABLE OF SUPPORTING THE BRIDGE UNDER FULL LOAD. PROVIDE UNIFORM BEARING UNDER ENTIRE LENGTH OF SILL. OTHER FOUNDATION CONDITIONS REQUIRE APPROVAL BY A DESIGN ENGINEER.
3. DECK PLANKS SHALL BE LAID HEART SIDE DOWN.

SILLS

1. SILLS AND BRIDGE FOUNDATION DESIGN REQUIRES BY THE DESIGN ENGINEER.
2. PLASTIC CURBS MAY BE USED WHERE APPROVED BY THE DESIGN ENGINEER.

Trails Unlimited	DRAWN BY: D.MUCCI	TITLE: 12' SAWN TIMBER ATV BRIDGE TYPICAL DRAWING	SCALE: NONE
	DESIGNED BY: J.GROENIER		DATE: 09-15-08
	REVIEWED BY: J.BARROW		REVISION DATE: X
	APPROVED:		SHEET 8 OF 8

Figure 2—A sample drawing of a 12-foot-long ATV bridge.

Details and Features That Increase Longevity

Several features of this bridge design add to its longevity and are innovative when compared with traditional designs.

The foundation consists of heavy-duty plastic or concrete parking curbs, anchored down with one Duckbill earth anchor per sill.

- Using inexpensive aluminum or polymeric flashing bent over the stringers extends the stringer life by preventing wood-to-wood contact and standing water on the stringer.
- Extending the decking over the top of the backwall reduces the chance of water running down between the backwall and stringer. This extension reduces the chance that the end grain of the stringer will wick moisture into the end of the stringer.
- Extending the decking out over the stringers 6 inches makes installation of the curb easier. Water will run off the end of the decking and not run down the side of the stringers.
- Lengthening the backwalls prevents dirt from wrapping around them and accumulating on the sills against the stringers. This longer backwall helps keep stringers clean and dry and prevents backfill from eroding at the approaches.
- Using 6-inch by 6-inch curbing with 6-inch by 6-inch scupper blocks provides an 11-inch high barrier that helps reduce the chance of ATV tires driving over the curb.
- Allowing for 6-inch scupper openings helps water drain better and reduces the chance of leaves collecting on the deck.
- Using paving blocks at the bridge approaches drains water away from the approaches, stabilizes the trail transition material onto the deck, and helps prevent potholes at the approaches caused by backfill settlement and erosion caused by ATV tires, bicycle tires, horse hooves, and even hikers.
- Using running planks is strongly recommended to protect the transverse decking from wear due to snowmobile tracks and horseshoes. Running planks were not used on this ATV bridge.

Construction Details

The innovative features of this design also add to its longevity.

Foundation

The sills consist of 6-inch by 6-inch by 8-foot heavy-duty recycled plastic parking curbs (figure 3) that resist decay. Each sill is anchored by one Duckbill earth anchor attached to a 4-foot-long, ½-inch diameter galvanized steel all-thread rod. The Duckbill anchor, like a toggle bolt, can be driven into the ground with a hydraulic or mechanical jackhammer with the aid of a steel rod gad. Then a ratchet is used to tighten the nut, pulling up the rod, causing the anchor to pivot in the ground, and anchoring it in place. About 3 inches of rod needs to be pulled up to obtain about 3,000 pounds of anchor force. The anchor keeps the sill in place and prevents it from floating off in floods (figure 4).

Sills can also be formed from precast concrete curbs or planks, which stay in place due to their weight and last a long time. Traditional sills are 8-inch by 8-inch by 6-foot long treated southern pine timber, No. 2 grade or better.

Figure 3—Heavy duty plastic parking curbs, anchored by Duckbill anchors, serve as sills. Two backwall planks are buried to the depth of the bottom of each sill. The backwall is extended well to the sides of the bridge to prevent earth-to-wood contact for both the sill and stringers. Decking extends over the top of the backwall to prevent water running down between the backwall and the end of the stringers.

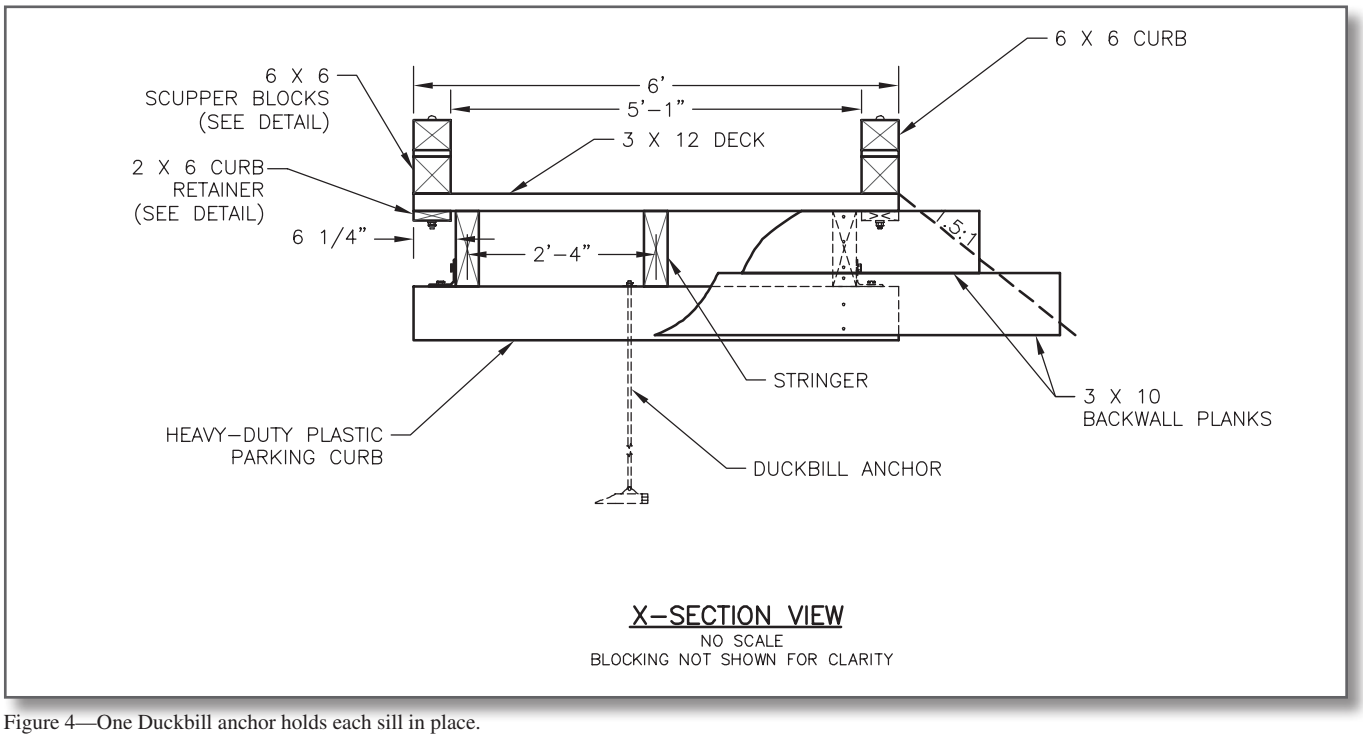


Figure 4—One Duckbill anchor holds each sill in place.

Stringers

The 12-foot-long ATV bridge requires three 4-inch by 12-inch pressure-treated southern pine stringers. Using three stringers provides redundancy for the structure. If one stringer fails, the other two stringers should be able to support most of the load. When a bridge has two stringers and fails, the structure is more likely to fall into the stream. The three stringers are placed on the sill and the two outside stringers are fastened down with 4-inch by 4-inch by ¼-inch steel angle brackets. Blocking between stringers secures and holds down the center stringer and prevents lateral rotation of the stringers. An optional, but inexpensive, way to extend the life of the stringers and protect them from dirt and water is to bend a strip of aluminum or polymeric flashing over the length of the top of each stringer.

Backwall Details

Installing backwalls at the ends of the bridge provides another practical design detail to help keep the stringers and sills clean and free of dirt (see figure 3). The backwall extends to the bottom of the sill to keep dirt from contacting the ends of the stringers. The upper backwall plank extends a minimum of 1 foot beyond the sides of the bridge and the lower backwall plank extends a minimum of 2 feet. The extended backwalls help keep dirt from wrapping around the backwall and accumulating on the sills next to the stringers (figure 5). They also help prevent the approach fill from eroding. Any location where dirt contacts the wood may also accumulate water and start the wood-decay process that will reduce the lifespan of the structure.

Extending the decking over the top of the backwall provides another important detail: reducing the chance of water running down between the backwall and stringer. When water runs down the end of the stringers, the end grain of the stringer may wick moisture into the end of the stringer and start to decay.

Figure 5—When backwalls are not extended beyond the sides of the stringers, backfill wraps around the backwall, which causes dirt to accumulate on the sills, causing the decay process to begin and allowing the bridge approaches to unravel.

Decks

Decking material is 3-inch by 12-inch by 6-foot-long treated southern yellow pine. The 3-inch thick material is enough to withstand the heavy loading and wear of the ATV tires and, for equestrian bridges, reduces the hollow sound of thinner planks, which can spook a horse. The decks, with the wood laid heartwood side down to reduce cupping, are fastened with 6-inch deck screws with large wafer heads. FastenMaster HeadLOK gimlet point deck screws were used on this installation. The large wafer heads increase the pullthrough strength of the screw in the wood.

On heavily used trail bridges or those used by snowmobiles or horses, untreated timber running planks may be fastened to the top of the deck, providing a wear surface that can be replaced easily. They were not used in this installation. Extending the decking out over the stringers by 6 inches makes installation of the curb easier. Water will run off the end of the decking and not run down the side of the stringers.

Curbs

For an ATV trail application, 6-inch by 6-inch treated curbs placed on 2-foot-long sections of 6-inch by 6-inch scupper blocks work well (figure 6). It is difficult for ATV tires to drive over the curb without intentional effort (figure 7). The bridge curb ends should be beveled to protect ATV tires from abrupt impacts. Each 2-foot-long scupper block is fastened to the deck with two 5/8-inch-diameter carriage bolts, secured through the curb and deck to 2-inch by 6-inch curb retainers.

Figure 6—Place curbs on top of scupper blocks, which are held in place with carriage bolts placed through the curb, scupper block, decking, and curb retainer.

Figure 7—The curbs are difficult to drive over with ATV tires without intentional effort. The ends are beveled to protect ATV tires from abrupt impacts.

Approaches

The grid pavement blocks like those shown in figure 8 are outsloped from the bridge end so the backfill at the bridge ends does not settle to create a lip or pothole after repeated traffic impacts.

The last row of grid pavement blocks is angled down to sit approximately 2 feet below the surface. This helps provide a sustainable transition for the approach.

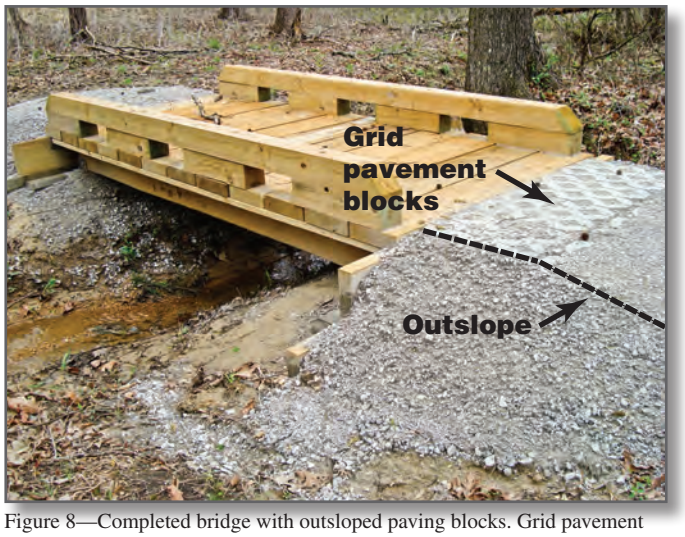


Figure 8—Completed bridge with outsloped paving blocks. Grid pavement blocks sloped downhill from the bridge help prevent the development of potholes adjacent to the bridge backwall. Object markers on each side of both bridge approaches are required for motorized trails on National Forest System lands. The object markers have not yet been installed.

Product Sources

The Forest Service does not endorse products to the exclusion of other products that may be suitable. The following products were used in this installation and should be used as a place to start for comparison with similar products.

- Duckbill anchors <http://foresightproducts.com/duckprod.html>
- FastenMaster HeadLOK gimlet point deck screws <http://www.Fastenmaster.com>
- Percstone pavers (grid pavement blocks) <http://www.hardscapesusa.com>

About the Authors

Jerry D. Barrow joined the Trails Unlimited enterprise team in 2007 as a civil engineer specializing in trail bridge construction. Barrow began his career with the Forest Service in 1985 after 8 years in the private sector and the U.S. Army Corps of Engineers. He earned degrees in forestry and civil engineering from Virginia Tech and the University of Tennessee. He has worked on the Cherokee, Chattahoochee-Oconee, and George Washington National Forests. He served as the project construction engineer for the 1996 Olympic Venue at the Cherokee National Forest.

James Scott Groenier is a professional engineer who began working for the Missoula Technology and Development Center as a project leader in 2003. Groenier started with the Forest Service in 1992 and has worked for the Ashley and Tongass National Forests and for Region 9.

Library Card

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A new design for a simple, inexpensive short-span timber all-terrain vehicle (ATV) trail bridge is available. The design uses innovative ideas to increase the longevity and sustainability of the structure. This tech tip describes the features that increase longevity, provides construction details, and includes a sample drawing of a 12-foot bridge.

Keywords: all-terrain vehicles, ATVs, bridges, motorized recreation, planning, recreation management, sustainability, timber, trails

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