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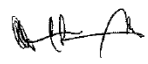
NATIONAL PARK SERVICE

Water Resources Division
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February 17, 2017

Memorandum

To: Kate Cannon, Superintendent, Arches National Park (ARCH)

Through: Alan Ellsworth, Chief, Aquatic Systems Branch (ASB) 

From: Michael Martin, Hydrologist (WRD)

Subject: Technical assistance evaluation of three culvert crossings in the vicinity of Salt Wash along Delicate Arch road.

Executive Summary

In response to Technical Assistance Request #1205, WRD staff conducted a hydraulic and geomorphic assessment of three culvert crossings in the vicinity of Salt Wash along Delicate Arch Road on July 18 and 19, 2016. The overall purpose of the assessment is developing channel design criteria to support an exotic vegetation management project (PMIS #) designed to remove a large area of exotic *Tamarix*, and also to provide flow conveyance for three drainages, Salt Valley Wash, Salt Wash, and Winter Camp Wash. Careful reconnaissance of the three drainages indicated that Salt wash and Winter Camp Wash had completely filled in (aggraded) with sediment and some type of conveyance channel would need to be re-established for the area to pass water and sediment. Available LIDAR data of the area should provide enough topographic control to incorporate gradient analyses into channel design.

Project Overview

Background

Delicate Arch road crosses the three drainages over a distance of about one km (3300 feet) with Salt Valley Wash to the west, Salt Wash in the center, and Winter Camp Wash to the east (Figure 1). All three washes may be subject to floodflows and sediment transport. Both Salt Valley Wash and Winter Camp Wash are ephemeral drainages, flowing only in response to rainfall, while Salt Wash, the largest of the three drainages, is perennial. When the road was last upgraded in the 1990's, all three crossings were fitted with culverts and all of the crossings responded differently with respect to sediment transport and flow hydraulics. Currently, channel and floodplain aggradation has rendered all of the culverts completely buried or non-functional.

The confluence of these three drainages forms an elongated, aggradational valley that resembles a coalescing alluvial fan. Areal imagery indicates that as recently as the 1970's, Salt Wash maintained a single-thread channel with a meandering planform through the area of the road crossings and on through the downstream valley. Currently, Salt Wash and its immediate tributaries form a braided system with shifting channels downstream from the crossing area. This braided reach is sub-irrigated by the perennial flow of Salt Wash, which has allowed an extensive riparian forest, much of which is *Tamarix*, to become established. The channel appears to regain a single-thread, meandering form about 600 m (2000ft) downstream from the crossing area (Figure 1).

Problem Statement

The combination of the sediment accumulation at and below the crossings coupled with the encroachment of *Tamarix* and other riparian species, has resulted in complete loss of a favorable downstream gradient, which leads to further sediment aggradation and deteriorating conditions. Under the current scenario, the crossing area will continue to be problematic and result in traffic disruptions, road closures, and potentially visitor hazard. It is likely both the alignment and elevation of the road crossings that create the sediment and water conveyance problems. A long-term solution of road re-design is recognized by the park and funding is currently being sought through PMIS #231001.

In the interim, a channel treatment and maintenance plan is being enacted to reduce the frequency and duration of road closures, at least for the immediate future (PMIS #230637). The three drainages, Salt Valley Wash, Salt Wash and Winter Camp Wash all interact with the road crossing in different ways and therefore, there is no single, simple solution. However, removal of select portions of the accumulated sediment and established exotic vegetation coupled with construction of an efficient "pilot" channel through the aggradation zone should improve water and sediment conveyance. Because of the conditions and the causes associated with the problem, any treatments will be temporary and will likely include some ongoing maintenance. Properly designed and constructed channel(s) may provide some relief from continual maintenance and improve visitor safety.



Figure 1. Google Earth Image showing the Delicate Arch road where it crosses Salt Valley Wash, Salt Wash, and Winter Camp Wash.

Individual Crossing Descriptions

Salt Valley Wash

At the time of the site visit, the western-most ephemeral drainage, Salt Valley Wash (Figure 2), was functioning the best of the three crossings and appeared to be capable of passing incoming water and sediment, at least under the prevailing conditions. However, the crossing does not perform as designed and is suffering structurally as a result. The culverts that were installed in the 1990's have completely filled in with alluvium and the asphalt surface, which serves as a low-water-crossing during times of discharge, has experienced undercutting and erosion on the downstream side (Figure 3). Even though Salt Valley Wash is passing sediment and water, runoff events will continue to erode away the road surface and likely compromise the crossing at some time.



Figure 2. Salt Valley Wash looking downstream from the road crossing. Note the floodplain is relatively free of aggraded sediment. NPS -2016.



Figure 3. Salt Valley Wash, looking west across the channel from the road crossing. Note the failed asphalt where discharge periodically pours off the road surface. NPS-2016.

Salt Wash

Salt Wash, the middle crossing, is the largest drainage of the three and the only one with perennial flow (Figure 1). This catchment drains over 240 sq. km (150 sq. miles) and has formed a prominent valley both up and downstream of the crossing. Aerial imagery from the middle of last Century indicates that the historical Salt Wash channel was a well-developed meandering stream with a relatively constant channel width of between 10 and 20 m. (33-66 ft). Under the current aggraded conditions, Salt Wash and the other two drainages essentially form an elongated alluvial fan through a braided channel system. The perennial flow has supported sub-irrigation and an extensive woody and herbaceous riparian community, much of it composed of *Tamarix*. The combination of the aggradation and vegetation establishment has led to extremely poor flow conveyance conditions and there was practically no downstream flow at the time of the site visit even though there was substantial backwater at the crossing (Figures 4 and 5). Reconnaissance of the area immediately downstream of the crossing found only one small channel conveying flow (Figure 6).



Figure 4. Salt Valley Wash looking upstream from the road crossing. Note that the culvert intake is completely submerged. This channel width may be somewhat representative of historic channel geometry. NPS – 2016.



Figure 5. Salt Valley Wash looking downstream from the road crossing. Note that the culvert outlet is completely submerged due to downstream aggradation and vegetation establishment. NPS – 2016.



Figure 6. Salt Valley Wash about 200 m (650 ft) downstream of the road crossing. Note the small channel (about 0.3-0.5 m wide) that has formed through the alluvium, the only area obviously conveying flow downstream of the crossing. NPS – 2016.

Winter Camp Wash

Winter Camp Wash is the eastern most of the three drainages (Figure 1). The primary issue with this crossing is extreme sediment aggradation that has resulted in a sediment management issues and frequent road closures. The culvert passage has completely filled and currently functions as a low water crossing. This crossing however, does not pass sediment and the downstream channel and floodplain have aggraded substantially, currently providing little to no hydraulic passage. Reconnaissance level evaluation suggests that there is sufficient downstream gradient to provide both flow and sediment conveyance. However, the adverse grade in the accumulation area has to be completely reworked or removed.



Figure 7. Winter Camp Wash looking down-valley just west of the road crossing. The accumulated sediment is from previous clearing operations and blocks part of a former channel. Note the well-established tamarisk on the mounds of sediment, which are spoil material. The culverts are below grade and completely buried. NPS – 2016.

Recommendations Regarding Treatment of the Area

As mentioned, this consultation was provided to inform a vegetation management project specifically on developing channel design criteria. Currently, the park is planning to treat the area by removing much of the exotic riparian vegetation that has become established downstream of the crossings. As part of this project, the plan includes excavation of conveyance channels downstream of the crossings and exposure of the three buried culverts. Preliminary design cross sections vary from about 30 feet wide at Winter Camp Wash to 90 feet wide at Salt Wash with depths mostly between 0.3 m to 1 m ((1 – 3 ft).

No design specifications were reported for Salt Valley Wash. Recently acquired LIDAR data of the area should allow a detailed gradient analysis and facilitate the design of efficient channels as well as develop cut and fill volumes.

Gradient is one of the primary physical constraints on both sediment and water conveyance; therefore, a detailed gradient analysis using available LIDAR data should be considered carefully in channel design. The LIDAR data should provide a reasonable downstream starting elevation for the design channel and allow an accurate calculation of overall valley slope. Additionally, channel parameters may be evaluated and selected to ensure adequate conveyance of water and sediment. With knowledge of a potentially achievable gradient, proposed channel configurations may be evaluated for hydraulic efficiency using standard software packages such as HEC-RAS or WINXSPRO. WRD will be available to support further analyses and design at the request of the park. It is important to note that if the design channel does not adequately convey water and sediment, the area could re-aggrade in as little as one storm event. As mentioned, aggradation will likely continue regardless of channel design as long as the crossing is in its current position.

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