Memorandum

To: Planning Commission
From: Niall Connolly, Principal Planner
Date: June 13th 2025
Re: Erosion Hazard Zone Permit, 517 Watchman Drive

Executive Summary

Carson McKim has applied for an erosion hazard zone permit for 517 Watchman Drive, on behalf of Elizabeth and James Cutler. The Cutlers are planning a remodel of their home, which includes some minor modifications to the footprint of the house. The improvements are all within the moderate risk erosion hazard zone, and partially within the high risk erosion hazard zone. This creates the requirement for an erosion hazard zone permit. The home itself is outside of the Special Flood Hazard Area, and therefore a floodplain development permit is not required.

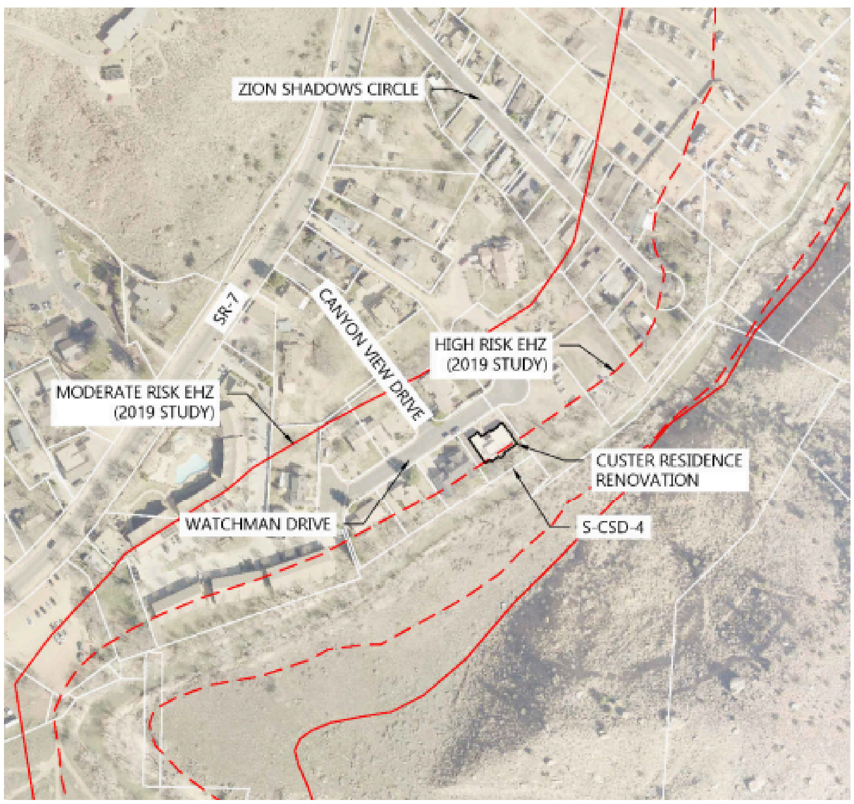


Figure 1. Aerial view of the property, with the erosion hazard zones overlaid.

The study examined the existing bank armoring in this location, as well as the dynamics of the river which affect this property. The study found that the bank has been stable at this location for many years, and it is likely that the existing armoring has contributed to that. The armoring consists of boulders keyed into the bank, along with mature vegetation. The bank armoring includes concrete grout to keep the boulders in position. In some cases, the grout has eroded and a boulder has been lost. However, on the whole, the bank is in good condition. The study does not recommend any interventions at this point. It does recommend that the property owners should monitor the condition of the bank over time, and that maintenance may be needed in the future. This would likely involve renewing the grout between the boulders. Concrete grout is not considered "bioengineering" and generally would be discouraged by the Town in new erosion protection projects. However, because the bank armor has already been built that way, it will be necessary to use concrete grout in future repairs. The property owner will need Town approval for any repairs or improvements that may be necessary in the future.

Applicable Ordinances

The Commission may wish to refer to the following ordinance to help inform the review of this application:

- Chapter 13E: Erosion Hazard Overlay Zone
- Chapter 11B: Village Commercial Zone

Staff Analysis

Standard	***Requirement***	***Proposal***	***Comments***
Floodplain Impacts	An erosion hazard permit application must include an engineering analysis. This must identify potential impacts on adjacent properties and ensure that no increases to base flood elevations in the regulatory floodway occur.	An Erosion Hazard Assessment, prepared by Rosenberg Associates has been submitted. No increase in base flood elevation resulting from this project is anticipated in the floodway. No impacts are anticipated on other properties.	Complies.
Stream Stability Impacts	Engineering analyses must be submitted to document all impacts on adjacent properties due to the proposed land disturbance activities. It is the applicant's responsibility to	No new erosion protection is recommended to be installed. The study recommends monitoring and potential maintenance in the future.	Complies.

	demonstrate that any such impacts are minimal, justified, and consistent with the goals and objectives of the Virgin River Management Plan, and will not cause adverse or detrimental conditions on adjacent, upstream, or downstream properties.		

Erosion Protection Improvements	Bioengineering techniques combining natural vegetation and live materials to provide a stable streambank as envisioned by the Virgin River Management Plan (VRMP) are required for all erosion protection improvements, unless an engineering analysis demonstrates such techniques are not feasible. All erosion protection improvements shall be as minimally impactful to the natural function and appearance of the river system and riparian area as possible. Structural erosion protection improvements such as rock riprap, concrete or gabion structures, etc. may only be used to protect existing or planned structures and infrastructure located within the high risk erosion hazard zone, and only after the Town Engineer has validated an applicant's engineering analysis documenting bioengineering is not a feasible option.	The study recommends that as the grouted vegetation dies over time, the voids should be backfilled with concrete or large rocks. Concrete grout is not considered bioengineering. However, the existing bank armoring has been constructed using grout, and so future repairs may need to continue this. The bank does include mature native vegetation and naturally occurring stones and boulders, which are considered bioengineering techniques. The improvements are partially located in the high hazard erosion zone, and thus structural erosion protection improvements are allowed with the approval of the Town Engineer. Sunrise Engineering has reviewed the applicant’s proposal to use the existing structural erosion protection and has given approval.	Complies.

Materials	Where possible and feasible, stone for rip rap and gabion baskets shall resemble stone naturally found in Springdale in appearance.	No new areas of rip rap are proposed.	Complies/ Not applicable.
Maintenance	The owner of property where erosion protection improvements are located shall inspect all erosion protection improvements at least annually and immediately after major flooding events to assess damage and determine if repairs are necessary. The Town of Springdale has the right to inspect all erosion protection improvements as often as the Town deems necessary. If the Town's inspection reveals necessary repairs to the erosion protection improvements, the property owner shall make the required repairs as soon as feasibly possible after being noticed in writing by the Town. All proposed erosion protection measures shall require a perpetual private easement to be recorded providing unobstructed access for	The property owner has been made aware of their long term maintenance responsibilities.	Complies.

	inspection and maintenance of the erosion protection improvements. The costs to inspect, repair and maintain these improvements shall be the sole responsibility of the applicant or property owner. Required maintenance and repairs shall be completed within a reasonable time at no cost to the Town of Springdale.		
Revegetation	Any proposed disturbance to existing vegetation on the riverbank or within the floodplain must be mitigated by replacing the disturbed vegetation with native riparian plants in accordance with the approved plant list. The replacement vegetation shall be selected to best enhance the natural function of the river system (e.g. flexible species closest to the river, large woody vegetation farther from the river on upper flood terraces). The engineering analysis shall include a section describing the required vegetation mitigation and planting requirements	No disturbance to vegetation in the riparian zone is proposed.	Complies/ Not applicable.

Statement of methodologies and findings	The analysis must include a summary of the methodologies used to support the impact analysis. The engineering analysis and findings shall be summarized in an engineering report including all assumptions, computations and other documentation supporting the analyses and conclusions. The report shall include the engineer's professional opinion that when the land disturbance activities and mitigation measures, if any, are implemented, the proposed land disturbance will not adversely affect reaches or properties upstream, downstream, and across the river from the proposes project. The report must also include the engineer's opinion that the proposed land disturbance minimizes the risk of flood and erosion damage to adjacent properties and the watercourse.	Engineer's analysis and opinion is set out in the report.	Complies.

Planning Commission Action

The Planning Commission should review the proposed Erosion Hazard Zone Permit to determine if it complies with the applicable standards in the Town Ordinance. Staff recommends the Commission specifically consider the following:

- Does the proposed development meet all the requirements of the erosion hazard zone ordinance?

Sample Motion Language
The Commission may refer to the following sample language when making a motion on the application:

The Planning Commission ***approves/denies*** *the proposed Erosion Hazard Zone Permit for 517 Watchman Drive as discussed in the Commission meeting on June 18th 2025. This motion is based on the following findings:*

[LIST FINDINGS]

If making a motion for approval the Commission may wish to consider the following conditions of approval:

1. Any vegetation in the riparian zone that is disturbed during the renovation of the home on the property must be replaced with appropriate revegetation, using plants native to Zion Canyon. Native trees which are removed must be replaced at a ratio of two replacements for every tree removed.
2. Any repairs or improvements relating to the river bank at this location in the future will require Town approval.

EROSION HAZARD ASSESSMENT

Parcel S-CSD-4
Springdale, Utah

Prepared For:

Canyon Contracting
2988 Pear Circle
St. George, UT 84790
(435) 619-2925

Rosenberg Associates
Project No: 14710-25
April 21, 2025

PROFESSIONAL ENGINEER
JARED W. BATES
4/21/25
NO. 7886812
STATE OF UTAH

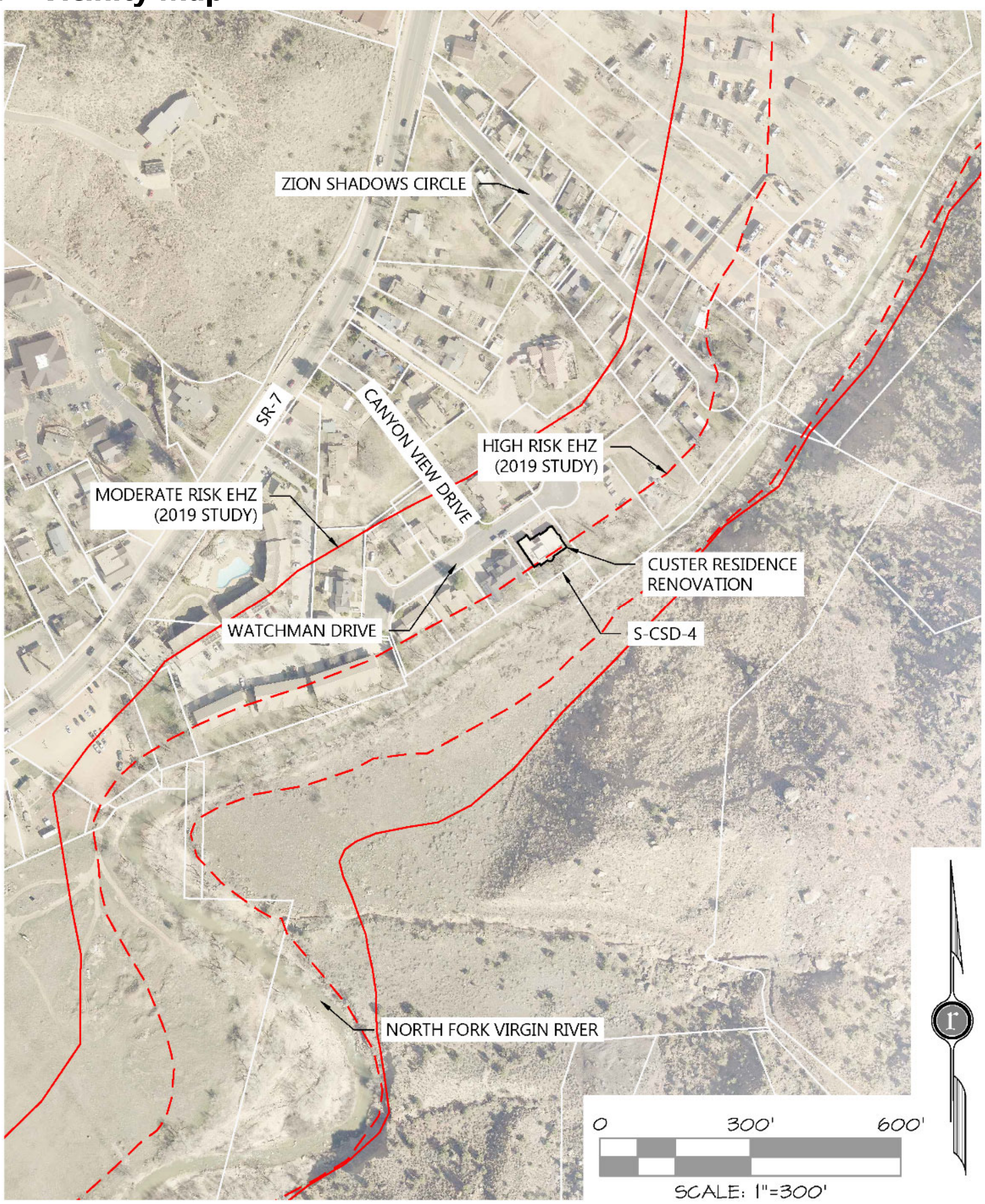
ROSENBERG ASSOCIATES™
CIVIL ENGINEERS LAND SURVEYORS

1.0 INTRODUCTION

1.1 PROJECT OVERVIEW & LOCATION

The renovation of the Custer Residence is proposed along the right (west) overbank of the North Fork of the Virgin River within Parcel S-CSD-4. Parcel S-CSD-4 is a 0.28-acre lot in Springdale, UT, located within Section 28, Township 41 South, Range 10 West, Salt Lake Base and Meridian. The renovation of the residential structure is composed of the addition of a rooftop balcony, bay windows, and other modifications to the building footprint. The project area is bounded by the North Fork of the Virgin River to the south, Watchman Drive to the north, and private land owned by others to the west and east. A copy of the proposed site plan is included in the Appendix. Refer to *Figure 1 – Vicinity Map.*

Figure 1 – Vicinity Map



The Erosion Hazard Zone (EHZ) consists of areas adjacent to the river channel likely to suffer flood related damage by a typical series of flood events over a 60 year period, plus the erosion caused by a single 100 year flood event. The EHZ also includes areas prone to natural channel movement due to geomorphic processes such as meander migration or channel avulsion. It is important to recognize an EHZ is not a "no build" zone, but it serves notice to landowners of the inherent risk that should be addressed through engineering design, insurance, appropriate land uses or avoidance. The Town of Springdale requires an Erosion Hazard Assessment be completed as part of any proposed development or building permits issued on properties impacted by the established Erosion Hazard Zone (EHZ).

The proposed improvements within Parcel S-CSD-4 are partially located within the HREHZ (High Risk Erosion Hazard Zone), and MREHZ (Moderate Risk Erosion Hazard Zone) as defined by the *Draft Erosion Hazard Delineation* (Reference 1). The purpose of this document is to assess the erosion hazard risks associated with the North Fork of the Virgin River adjacent to the proposed renovation, present recommendations to mitigate the risk of lateral erosion damage to proposed structures and ensure proposed improvements associated with the project do not increase the risk of erosion to adjacent properties.

2.0 SITE INVESTIGATION

2.1 SITE CONDITIONS

The study reach of the North Fork of the Virgin River begins adjacent to the cul-de-sac at the end of Zion Shadows Circle and continues downstream for approximately 1,000 feet. The low flow channel of the river consists of a wide, gravelly sand bed with frequent cobbles and the occasional boulder. The stream is primarily composed of alternating riffle and run sequences, with the occasional small pool located downstream of larger boulders. Along the right (west) overbank, the steep active floodplain is moderately vegetated with mature cottonwoods, coyote willows, and mule fat, with a few sections of scatted bunchgrasses in the understory. Naturally occurring larger cobbles and boulders are keyed into the bank upstream and downstream of the project area along both overbanks. The vegetation and presence of naturally occurring cobbles and boulders provide some resistance to erosion and are likely partially responsible for providing stability to the main channels' location. A few of the larger mature cottonwoods just upstream of the project area have been undercut during high flow events, leaving their roots exposed, upon which debris piles have accumulated. Along the left (east) overbank, the moderately sloping active floodplain is moderately vegetated with mature cottonwoods, coyote willows, and rabbitbrush. The low terraces throughout the project area are sparsely vegetated with sagebrush, rabbitbrush, various cacti, and various bunchgrasses.

The west (right) overbank adjacent to the project area was previously armored to varying extents. Large boulders (D50=30") are tiered and keyed into the bank, beginning approximately 5' from the waters' edge and continuing up the overbank to the elevation of the finished floor of the residential structure. Reinforced grout is present between the boulders closer to the water, around the larger cottonwoods, and as an apron adjacent to the downstream property boundary. The thickness of the grout appears to be between 2 and 6 inches. The areas between the boulders are heavily vegetated with an assortment of ash trees, mature cottonwoods, woody shrubs, vines and forbs. Almost no bare earth is present above the lowest keyed in boulders. Damage to a portion of the grouted area is present at the base of the tiered wall, where a large boulder or tree was previously displaced, leaving a hole that is approximately 4′ wide and 3′ tall.

The overbank adjacent to the property downstream of the project area is also armored to varying extents. A curtain of reinforced grout is located along the overbank, with holes where tree stumps have rotted away. The grout begins at the low flow water surface elevation and continues up the streambank to the elevation of the finished floor of the residential structure. Three large "stream barbs" are located at the waters edge that appear to be composed of reinforced concrete. The presence of the bank armoring and vegetation have provided resistance to erosion and are likely partially responsible for preventing larger scale vertical cutbanks from forming previously.

Figure 2 – April 17, 2025. Image of the Custer Residence, looking east from Watchman Drive. The North Fork of the Virgin River is located behind the structure. The proposed improvements are partially located within the HREHZ and MREHZ.

Figure 3 – April 17, 2025. Looking upstream adjacent to the northern edge of Parcel S-CSD-4 along the right (west) overbank. The active floodplain along the right (west) overbank is steeper than the left (east) overbank throughout the study reach. The low flow channel of the river consists of a wide, gravelly sand bed with cobbles and the occasional boulder.

Figure 4 – April 17, 2025. Looking downstream along the right (west) overbank of the North Fork of the Virgin River upstream of Parcel S-CSD-4. A few of the mature cottonwoods along this stretch of the river are undercut, with debris piles accumulating on the low lying branches or trunks.

Figure 5 – April 17, 2025. Looking upstream along the west (right) overbank adjacent to Parcel S-CSD-4. The bank armoring that was previously completed plays a significant role in the stability of this section of streambank. The grout located around some of the larger cottonwoods has limited erosion, preventing undercutting from occurring.

Figure 6 – April 17, 2025. Looking upstream partway up the right (west) overbank of the North Fork of the Virgin River. The covered patio area of the Custer Residence is visible on the left side of the image. The tiered, large boulders that are keyed into the bank are visible in the center of the image. The area between these boulders is heavily vegetated with herbaceous and woody vegetation.

Figure 7 – April 17, 2025.Looking upstream partway up the right (west) overbank of the North Fork of the Virgin River. The apron of grout is visible in the forefront of the image. This grout is present between the lower tiers of keyed in boulders and appears to be between 2 and 6 inches thick. The overbank adjacent to the Custer Residence is heavily vegetated.

Figure 8 – April 17, 2025. Image of the keyed boulders and vegetation along the right (west) overbank of the North Fork of the Virgin River adjacent to the residential structure.

Figure 9 – April 17, 2025. Image of damage to a grouted section of the streambank armoring. It appears that the damage was caused by either a large mature cottonwood falling into the river, or a large boulder being displaced. The damage is approximately 4’ wide and 3’ tall.

Figure 10 – April 17, 2025. Looking downstream along the right (west) overbank of the North Fork of the River at the grouted apron adjacent to the property downstream of Parcel S-CSD-4. Many of the cottonwood trees that had grout placed around them have decayed, leaving holes in the structure. Three “stream barbs” are present adjacent to the waters edge, which will help push high velocity flows away from the bank. The presence of this bank armoring provides limited protection to the proposed improvements by providing stability to the main channels location.

2.3 GEOLOGY AND SOILS INFORMATION

The NRCS has classified soils within most of the project area as NaC – Naplene silt loam, 2 to 6 percent slopes (Reference 2). The NaC soil unit is a relatively loose, silty loam associated with alluvial fans and valleys. These soils generally have a minimum distance to lithic bedrock of 80”. These soil units within the project area have a high potential for erosion and scour damage due to their composition and location.

An investigation of the regional and local geology of the study reach was performed using geologic mapping data obtained from the Utah Geologic Survey (UGS) database. The geology of the stream bed and banks can greatly influence the erosivity of the floodplain, in turn affecting the lateral erosion distances expected during a flood. The spatial extent of the geologic units within the river systems can provide information of where the river has been in the past. The proposed project area is located within the Qa geologic units, which are described as follows in the Geologic Map of the Kanab 30’ x 60’ Quadrangle Kane and Washington Counties, Utah, and Coconino and Mohave Counties, Arizona (Reference 3).

Qa: Alluvium – Mostly sand with lenses of silty clay, sandy silt, and gravel deposited in stream beds, washes, adjacent floodplains, and on low alluvial slopes; includes lower terrace and alluvial fan deposits; 0 to 36 m (0-120 ft) thick.

The fine-grained alluvial material of unit Qa is associated with modern, active channel processes and is highly erosive. The USGS map material description is consistent with the finding in the NRCS soil survey and the site investigation.

2.4 EFFECTIVE FLOODPLAIN INFORMATION

The southeastern edge of the project area is located within Zone AE, defined as areas inside the 1% annual chance floodplain according to FEMA Flood Insurance Rate Map (FIRM), panel 49053C 0895G, dated April 2, 2009 (Reference 4). Most of the project area, including the entirety of the proposed improvements are located within Zone X, defined as areas outside the 1% annual chance floodplain. A FIRMette of panel 0905G and a floodplain exhibit with the project area boundary are included in the Appendix.

2.5 FLOODPLAIN ANALYSIS

To determine the impacts of placing fill within the project area as part of the proposed improvements, a HEC-RAS hydraulic model was prepared based on existing and proposed conditions and compared with the regulatory model of the North Fork of the Virgin River along the study reach. The existing conditions hydraulic model was prepared with geometric data derived from LOMR-14-08-097P, 2017 Washington County LiDAR topography, 2022 field survey data, and 2009 Washington County FIS (Reference 4) regulatory flow information. The proposed conditions hydraulic model was developed by adjusting the elevations along the right (west) overbank based on proposed site improvements. Effective water surface elevations at cross sections not included in the 2015 LOMR or the 2009 Washington County FIS were determined using linear interpolation between regulatory 100-year water surface elevations at established

FEMA cross sections. Table 1 below provides a comparison between effective, existing, and proposed water surface elevations.

Table 1 ***100 Year Water Surface Elevations***				
Station	***Effective 100 Year Water Surface Elevation***	***Existing 100 Year Water Surface Elevation***	***Proposed 100 Year Water Surface Elevation***	***Difference (Proposed – Existing)***
16+115 (FEMA Z)	3885.78′	3885.78′	3885.78′	0.00′
15+743.24	3879.82′	3879.82′	3879.82′	0.00′
15+610 (Project Area)	3879.81′	3879.75′	3879.75′	0.00′
15+514	3877.72′	3877.72′	3877.72′	0.00′
15+232	3876.31′	3876.31′	3876.31′	0.00′

As shown in Table 1 above, the proposed improvements do not change the 100-year water surface elevations, meeting the requirements of Ordinance 2020-04. Based on the hydraulic analysis, the proposed improvements do not impact water surface elevations at properties adjacent to the project area. See the Floodplain Exhibit, the Proposed Erosion Protection Exhibit, and the hydraulic calculations included in the Appendix for additional information.

3.0 RIVER MEANDER & SCOUR ANALYSIS

3.1 HISTORICAL AERIAL PHOTO ANALYSIS

Historic aerial photos from 1960 to 2020 of the study reach were reviewed to establish the location of the North Fork of the Virgin River active channel and determine meander patterns and trends over the extended recent time period, including the impacts of the significant flood events in 2005 and 2010. The results of the analysis illustrated no visible changes to the North Fork of the Virgin River active channel location or any signs of measurable bank erosion adjacent to the site. The consistent location of the North Fork of the Virgin River main channel is likely due to the presence of mature cottonwoods and large boulders along the waters edge, the active floodplain, and active floodplain/low terrace transition zone.

3.2 SCOUR ANALYSIS

Scour depths were calculated based on the Virgin River 100-year flood event. 100-year flood water surface elevations, flow depths, and flow velocities were based on the proposed conditions HEC-RAS model of the study reach.

Total estimated scour depth along the study reach was based on the Clark County Regional Flood Control District Hydrologic Criteria and Drainage Design Manual, which uses a sum of long term degradation, bend scour, and (1/2) anti-dune scour (Reference

5). Table 3 lists the individual components and total scour value calculated along the channel.

Table 3 - Total Scour Depths	
½ Anti-Dune Scour	1.68 ft
Bend Scour	0.34 ft
Long Term Degradation	3.00 ft
Total Scour	***5.04 ft***

3.3 ANALYSIS OF EROSION HAZARD RISK

The proposed improvements are partially located within the HREHZ, and are along a relatively straight, stable reach of the North Fork of the Virgin River. The bank armoring adjacent to the project area consists of large sandstone boulders (D50=30") that are keyed into the bank and arranged into distinct tiers. The boulders appear to begin approximately 5' from the water's edge and continue up the overbank to the finished floor elevation of the existing residential structure. Naturally occurring boulders that are not keyed into the bank are also present next to the water's edge. Reinforced grout is located between boulders closer to the water, around the larger cottonwoods, and as an apron adjacent to the downstream property boundary. The thickness of the grout appears to be between 2 and 6 inches. The grout that rings some of the trees will play a role in limiting the species' growth, potentially impacting the degree to which these trees can provide additional natural bank armoring in the future. Damage to a portion of the grouted area is present at the water's edge, where a large boulder or tree was previously displaced, leaving a hole that is approximately 4' wide and 3' tall. As the grouted vegetation continues to age and eventually decomposes, holes will be left behind. These holes will likely play a role in damaging the integrity of the structure over time. The areas between the boulders are heavily vegetated with an assortment of ash trees, mature cottonwoods, woody shrubs, vines and forbs.

The reinforced grout and stream barbs adjacent to the property downstream of the project area provides additional resistance to erosion.

The bank armoring located adjacent to the project area and the downstream property provides lateral stability to this section of river and will limit channel migration to the west. Although there is evidence of scour by the exposed root structure of several of the larger cottonwoods just upstream of the property, the grout around the mature cottonwoods adjacent to the project area has limited erosion. These grouted cottonwoods provide additional natural armoring, limiting lateral migration of the channel and minimizing the effects of scour. The presence of the bank armoring has likely prevented the formation of vertical cutbanks adjacent to the site.

Based on available information, the existing erosion protection appears to consist of 30" D50 grouted rock rip-rap approximately 3' thick at a 2H:1V slope, installed to the depth of the low flow water surface elevation, that extends to the elevation of the finished floor of the residential structure. The total estimated volume of rock is approximately 4.0 cubic yards per lineal foot.

A calculation of required rip-rap size for the study reach based on tractive stress was used along with the scour depth listed above to assess the efficacy of the existing erosion protection. A rock rip-rap section consisting of 24" D50 (median particle size) rock, 4 feet thick, extending from a height 1 foot above the base food elevation to a depth 5.04 feet below the flowline on a 2H:1V slope would require 6.4 cubic yards of rock per linear foot.

As the proposed improvements will result in minor impacts to the existing developed conditions of the site, the intended use of the area matches the current use, the existing right (west) overbank has remained stable for over 60 years, no disturbance will occur below the top of the bank, and the existing bank armoring provides some protection from lateral migration and scour, no additional erosion protection is recommended at this time.

Based on the Engineer's experience working in this reach of the North Fork of the Virgin River, it is assumed that the project is susceptible to potential damage caused by major flooding and scour. It is the opinion of the Engineer that maintenance of the existing erosion protection and access is required to adequately protect the site.

4.0 RECOMMENDATIONS

4.1 MAINTENANCE

Maintenance of the existing erosion protection is recommended to protect the proposed improvements from potential scour resulting from future flood events. Over time, the grouted vegetation will die and decompose, leaving behind voids. These voids are to be backfilled with concrete or large (min D50=24") rocks when established to maintain the integrity of the structure. Any damage to the large boulders or grout observed after major flood events is to be repaired in a timely manner, with the repairs matching pre-existing conditions.

All applicable provisions of the Uniform Building Code must be adhered to while constructing the proposed improvements and any associated site grading activities. Any public utilities or facilities constructed with the proposed development should be located and constructed to minimize the risk of flood and erosion damage.

4.2 DO NOT DISTURB THE STREAM BANKS & RIPARIAN ZONE

No disturbance should be allowed within the regulatory floodplain, North Fork of the Virgin River wet stream, or the riparian zone without the necessary regulatory permits. Significant biological conditions are anticipated to be part of the regulatory permits issued by the Corps of Engineers or the State Engineers Office as part of any proposed disturbance within the jurisdictional areas. The existing North Fork Virgin River riparian zones should remain undisturbed during the construction process except for the permitted activities. In addition, any disturbed areas within the riparian corridor should be re-vegetated with native Coyote Willow, Gooding Willow or Fremont Cottonwood plantings as appropriate. All proposed grading should adhere to the recommendations of the *Virgin River Management Plan* (Reference 7) as it relates to grading, surface drainage and surface roughness. A Grading Permit and a Floodplain Development Permit is required by the Town of Springdale prior to construction of erosion protection improvements.

4.3 IMPACTS TO STREAM STABILITY AND ADJACENT PROPERTIES

As shown in Table 1 and the Floodplain Exhibit included in the Appendix, 100 year water surface elevations within adjacent properties will not increase above the effective water surface elevations as a result of the proposed improvements. No changes or impacts to the regulatory floodway shall occur with this project. As designed, construction of the proposed improvements should not impact the Waters of the U.S., riparian vegetation, or federally protected endangered species. No impacts to stream stability or sediment transport patterns are anticipated with the project.

4.4 PROVIDE FOR PERPETUAL ACCESS & MAINTENANCE

Perpetual maintenance of the existing erosion protection improvements and legal access to the area between the proposed improvements and the existing erosion protection is required. Routine inspection of the existing erosion protection and access should be completed at least annually and immediately following any major flood event in the river. The 10’ setback from the northeastern property boundary is to be kept clear and maintained for access. Maintenance of the existing erosion protection and access will be the responsibility of the property owner. Any required repair of the existing erosion protection or access shall be completed in a timely manner as per the direction of a professional engineer or his assignee.

4.5 PROPERTY OWNERS SHALL ACKNOWLEDGE RISKS

It should be acknowledged by any current or future property owners that flood events larger than the 100 year flood can and do occur. Areas adjacent to the North Fork of the Virgin River are susceptible to flooding and erosion damage beyond the design events analyzed in this report. Development plans should consider the risk of erosion, sedimentation, and flood damage from large flood events during the design of structural foundation systems, utilities, pavements, and site drainage. Approval of future building permit approvals for the property should be conditioned upon acknowledgement by property owners of the potential risks of flood and erosion damage at this location.

5.0 ENGINEER’S OPINION OF RISK

The findings and recommendations presented in this document are based on a review of existing technical studies concerning the flooding and erosion hazard risks at this location on the North Fork of the Virgin River; a site investigation to determine existing conditions; evaluation of other erosion protection counter measures already in place; engineering analysis and past professional experience working in the area. It is the professional engineering opinion of Rosenberg Associates that if the recommendations presented in this document are implemented and maintained properly, then the risk of lateral bank erosion to the improved Custer Residence will be mitigated as required by the Town of Springdale code. No adverse effects to properties upstream, downstream, or across the river are anticipated with the proposed project.

REFERENCES

1. Draft Erosion Hazard Delineation, Rosenberg Associates, January, 2020.

2. Custom Soil Resource Report for Washington County Area, Utah, Natural Resources Conservation Service, January 18, 2024.

3. Geologic Map of the Kanab 30' x 60' Quadrangle Kane and Washington Counties, Utah, and Coconino and Mohave Counties, Arizona, Utah Geologic Survey, 2008.

4. Washington County Flood Insurance Study, Federal Emergency Management Agency, April 2, 2009.

5. Hydrologic Criteria and Drainage Design Manual, Clark County Regional Flood Control District, 1999.

6. Virgin River Management Plan, Town of Springdale, 2019.

APPENDIX

Custom Soil Resource Report for Washington County Area, Utah – NRCS
FIRMette Washington County FIS, Panel 49053C 0895G
Floodplain Exhibit – North Fork Virgin River, Rosenberg Associates, 2025
Site Plan – Springdale River Park Expansion
Proposed Erosion Protection Plans, Rosenberg Associates, 2025

Hydraulic Model Data
Total Scour Calculations

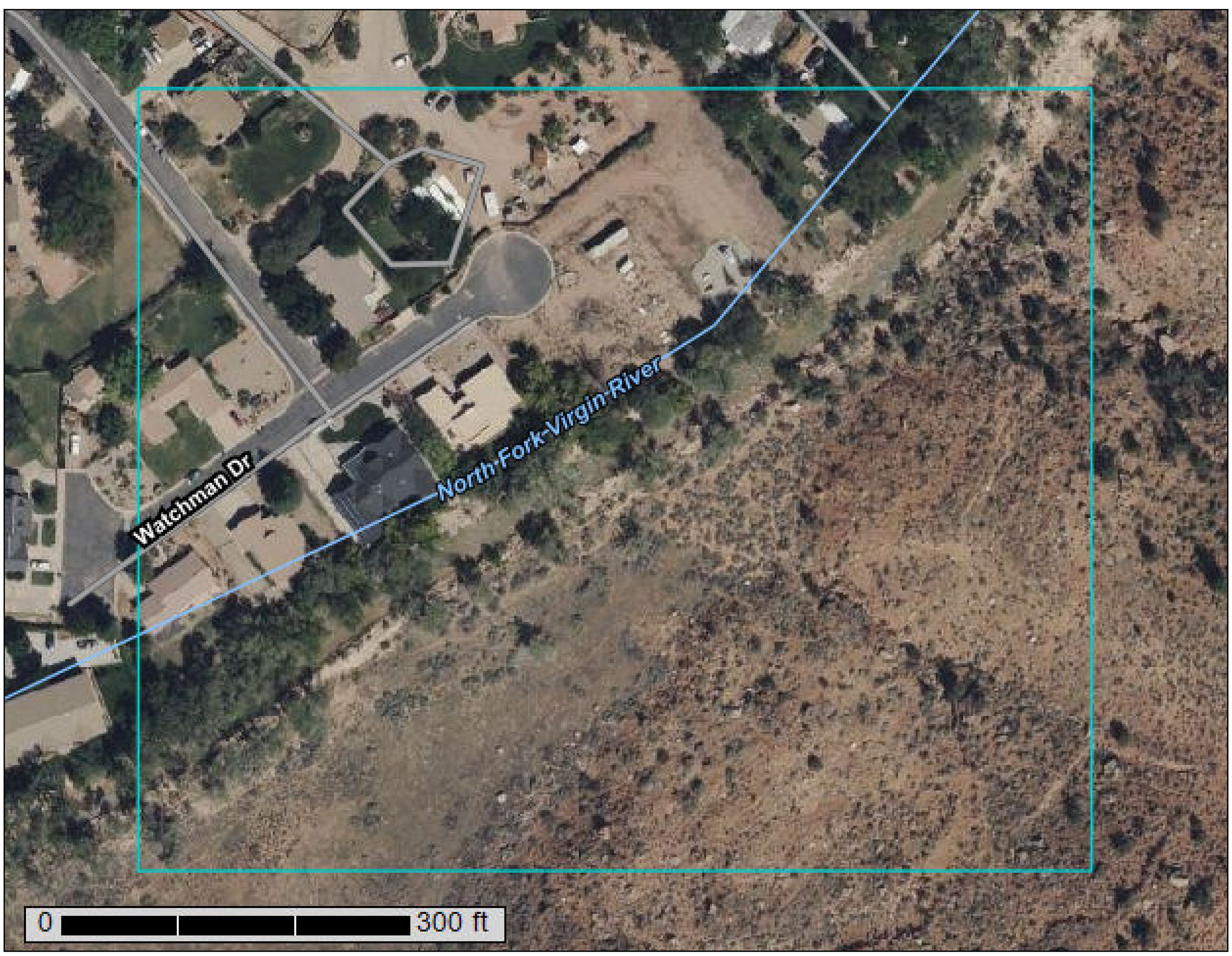
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Washington County Area, Utah, and Zion National Park, Utah



April 21, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

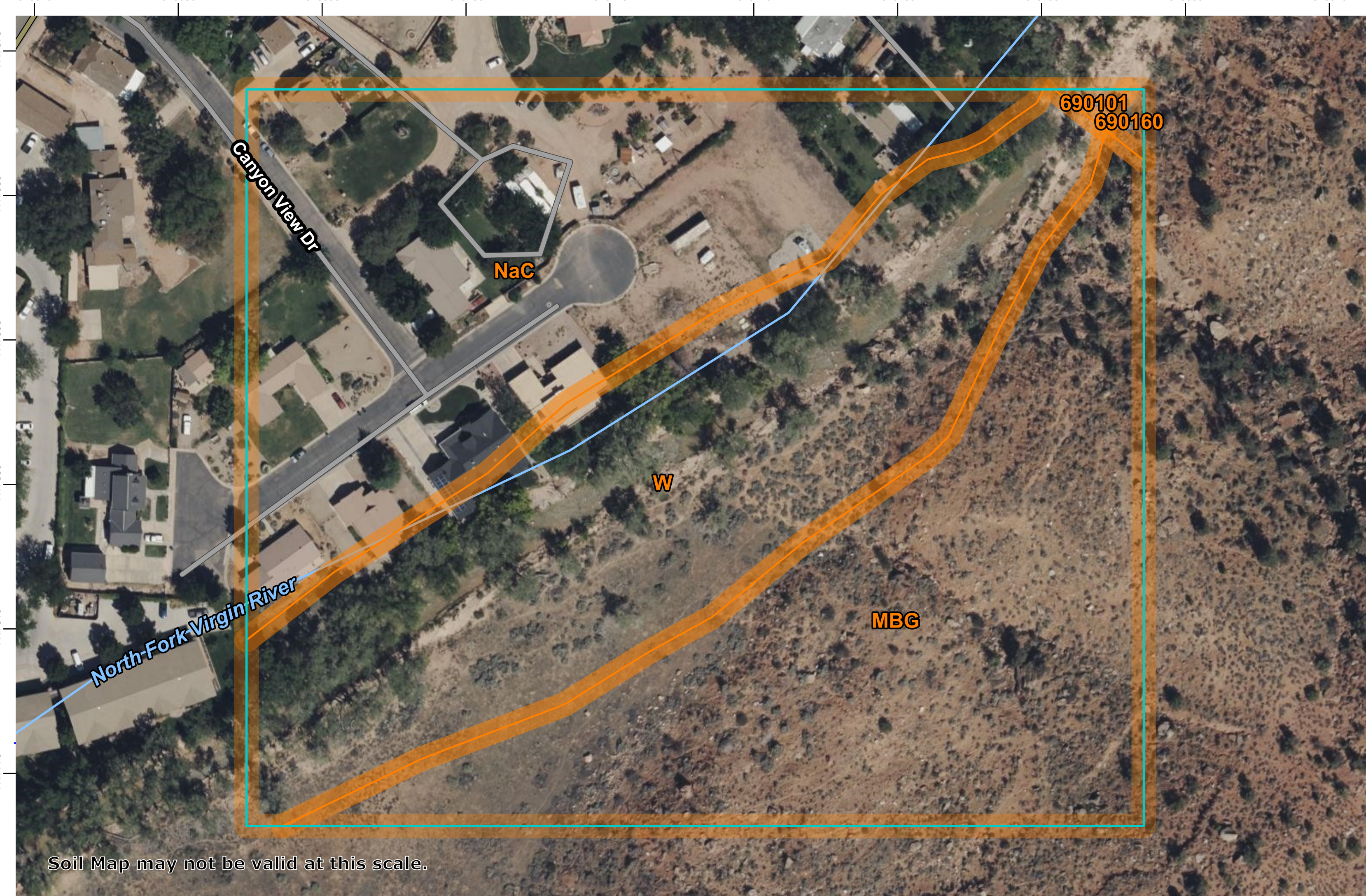
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map



112° 59' 38" W
112° 59' 23" W
37° 11' 29" N
37° 11' 21" N
323010 323050 323090 323130 323170 323210 323250 323290 323330 323370
4117970 4117930 4117890 4117850 4117810 4117770 4117730

Map Scale: 1:1,730 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 25, 50, 100, 150
Feet: 0, 50, 100, 200, 300

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Washington County Area, Utah
Survey Area Data: Version 18, Aug 28, 2024

Soil Survey Area: Zion National Park, Utah
Survey Area Data: Version 4, Aug 28, 2024

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

MAP LEGEND

MAP INFORMATION

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Sep 8, 2022—Sep 29, 2022

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
MBG	Mathis-Rock outcrop complex, 20 to 50 percent slopes	4.3	34.0%
NaC	Naplene silt loam, 2 to 6 percent slopes	4.2	33.0%
W	Water	4.1	32.5%
Subtotals for Soil Survey Area		**12.6**	**99.5%**
Totals for Area of Interest		**12.6**	**100.0%**

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
690101	Radnik-Spenlo-Riverwash-Notom complex, 0 to 10 percent slopes	0.0	0.2%
690160	Mathis Family-Paradox Family-Parida Family complex, 20 to 70 percent slopes	0.0	0.3%
Subtotals for Soil Survey Area		**0.1**	**0.5%**
Totals for Area of Interest		**12.6**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Washington County Area, Utah

MBG—Mathis-Rock outcrop complex, 20 to 50 percent slopes

Map Unit Setting

National map unit symbol: j8fn
Elevation: 4,000 to 5,500 feet
Mean annual precipitation: 12 to 14 inches
Mean annual air temperature: 52 to 59 degrees F
Frost-free period: 165 to 170 days
Farmland classification: Not prime farmland

Map Unit Composition

Mathis and similar soils: 50 percent
Rock outcrop: 20 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mathis

Setting

Landform: Mountain slopes, mesas
Landform position (three-dimensional): Mountainflank
Down-slope shape: Convex, linear
Across-slope shape: Convex
Parent material: Material derived mainly from sandstone

Typical profile

H1 - 0 to 4 inches: very stony loamy fine sand
H2 - 4 to 10 inches: gravelly loamy fine sand
H3 - 10 to 26 inches: very gravelly loamy sand
H4 - 26 to 33 inches: extremely gravelly fine sand
H5 - 33 to 37 inches: unweathered bedrock

Properties and qualities

Slope: 20 to 50 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 1.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: R035XY323UT - Upland Stony Sand (Utah Juniper-Pinyon)
Other vegetative classification: Upland Stony Loam (Pinyon-Utah Juniper) (035XY321UT)

Hydric soil rating: No

Minor Components

Tacan
Percent of map unit: 6 percent

Redbank
Percent of map unit: 6 percent

Rock land, stony
Percent of map unit: 6 percent

Bond
Percent of map unit: 6 percent

Eroded land
Percent of map unit: 6 percent

NaC—Naplene silt loam, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: j8fz
Elevation: 3,600 to 5,300 feet
Mean annual precipitation: 14 to 15 inches
Mean annual air temperature: 44 to 52 degrees F
Frost-free period: 140 to 160 days
Farmland classification: Prime farmland if irrigated

Map Unit Composition
Naplene and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Naplene

Setting
Landform: Alluvial fans, valleys
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium derived from igneous and sedimentary rock

Typical profile
H1 - 0 to 2 inches: silt loam
H2 - 2 to 7 inches: silt loam
H3 - 7 to 15 inches: silt loam
H4 - 15 to 22 inches: silty clay loam
H5 - 22 to 39 inches: silt loam
H6 - 39 to 60 inches: silt loam

Properties and qualities
Slope: 2 to 6 percent

Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 10.8 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R035XY306UT - Upland Loam (Basin Big Sagebrush)
Hydric soil rating: No

Minor Components

Schmutz

Percent of map unit: 5 percent

Redbank

Percent of map unit: 5 percent

Mespun

Percent of map unit: 5 percent

Clovis

Percent of map unit: 5 percent

Chilton

Percent of map unit: 5 percent

W—Water

Map Unit Composition

Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Zion National Park, Utah

690101—Radnik-Spenlo-Riverwash-Notom complex, 0 to 10 percent slopes

Map Unit Setting

National map unit symbol: 2vb0x
Elevation: 3,540 to 4,350 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Radnik and similar soils: 30 percent
Spenlo and similar soils: 30 percent
Riverwash: 20 percent
Notom and similar soils: 15 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Radnik

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A - 0 to 1 inches: fine sandy loam
BC - 1 to 20 inches: fine sandy loam
C - 20 to 67 inches: fine sandy loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Very rare
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: R035XY015UT - Sandy Bottom
Hydric soil rating: No

Description of Spenlo

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

A - 0 to 3 inches: loam
Bt1 - 3 to 24 inches: sandy clay loam
Bt2 - 24 to 33 inches: sandy clay loam
Bk1 - 33 to 41 inches: sandy clay loam
Bk2 - 41 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Very rare
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: R035XY215UT - Semidesert Sandy Loam (4-Wing Saltbush)
Hydric soil rating: No

Description of Riverwash

Setting

Landform: Channels

Interpretive groups

Land capability classification (irrigated): 8
Land capability classification (nonirrigated): 8

Description of Notom

Setting

Landform: Stream terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sedimentary rock

Typical profile

AC - 0 to 4 inches: gravelly fine sandy loam
C1 - 4 to 11 inches: gravelly loamy fine sand
C2 - 11 to 17 inches: very gravelly loamy sand
C3 - 17 to 32 inches: very gravelly fine sand
C4 - 32 to 59 inches: fine sandy loam

Properties and qualities

Slope: 2 to 7 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum content: 3 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: R035XY015UT - Sandy Bottom
Hydric soil rating: No

Minor Components

Windwhistle

Percent of map unit: 5 percent
Landform: Structural benches
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R035XY215UT - Semidesert Sandy Loam (4-Wing Saltbush)
Hydric soil rating: No

690160—Mathis Family-Paradox Family-Parida Family complex, 20 to 70 percent slopes

Map Unit Setting

National map unit symbol: 2vb09
Elevation: 4,100 to 5,200 feet

Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 175 to 220 days
Farmland classification: Not prime farmland

Map Unit Composition

Mathis and similar soils: 40 percent
Paradox family and similar soils: 30 percent
Parida family and similar soils: 20 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Mathis

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Slope alluvium derived from sandstone

Typical profile

A - 0 to 2 inches: gravelly loamy fine sand
CB - 2 to 9 inches: very cobbly loamy fine sand
C - 9 to 34 inches: very cobbly loamy fine sand
R - 34 to 44 inches: bedrock

Properties and qualities

Slope: 20 to 50 percent
Depth to restrictive feature: 31 to 37 inches to lithic bedrock
Drainage class: Somewhat excessively drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 1 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very low (about 1.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R035XY263UT - Semidesert Very Steep Stony Loam (Two-Needle Pinyon, Utah Juniper)
Hydric soil rating: No

Description of Paradox Family

Setting

Landform: Hillslopes
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear

Across-slope shape: Convex
Parent material: Colluvium derived from sandstone over residuum weathered from shale

Typical profile

A - 0 to 4 inches: very cobbly fine sandy loam
BC - 4 to 14 inches: clay loam
Cky - 14 to 20 inches: loam
C - 20 to 52 inches: paragravelly silt loam
Cr - 52 to 61 inches: bedrock

Properties and qualities

Slope: 20 to 70 percent
Surface area covered with cobbles, stones or boulders: 25.0 percent
Depth to restrictive feature: 39 to 59 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 10 percent
Gypsum, maximum content: 2 percent
Maximum salinity: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum: 5.0
Available water supply, 0 to 60 inches: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: R035XY263UT - Semidesert Very Steep Stony Loam (Two-Needle Pinyon, Utah Juniper)
Hydric soil rating: No

Description of Parida Family

Setting

Landform: Ridges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Eolian deposits over slope alluvium derived from sandstone

Typical profile

A - 0 to 2 inches: gravelly fine sandy loam
Bw - 2 to 10 inches: gravelly loam
Bk - 10 to 17 inches: gravelly loam
BCk - 17 to 51 inches: gravelly fine sandy loam
R - 51 to 61 inches: bedrock

Properties and qualities

Slope: 4 to 20 percent
Surface area covered with cobbles, stones or boulders: 3.0 percent
Depth to restrictive feature: 39 to 59 inches to lithic bedrock

Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 35 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: A
Ecological site: R035XY206UT - Semidesert Gravelly Loam (Utah Juniper-Pinyon)
Hydric soil rating: No

Minor Components

Rock outcrop

Percent of map unit: 5 percent

Riverwash

Percent of map unit: 5 percent
Landform: Washes

Soil Information for All Uses

Soil Reports

The Soil Reports section includes various formatted tabular and narrative reports (tables) containing data for each selected soil map unit and each component of each unit. No aggregation of data has occurred as is done in reports in the Soil Properties and Qualities and Suitabilities and Limitations sections.

The reports contain soil interpretive information as well as basic soil properties and qualities. A description of each report (table) is included.

Soil Physical Properties

This folder contains a collection of tabular reports that present soil physical properties. The reports (tables) include all selected map units and components for each map unit. Soil physical properties are measured or inferred from direct observations in the field or laboratory. Examples of soil physical properties include percent clay, organic matter, saturated hydraulic conductivity, available water capacity, and bulk density.

Engineering Properties

This table gives the engineering classifications and the range of engineering properties for the layers of each soil in the survey area.

Hydrologic soil group is a group of soils having similar runoff potential under similar storm and cover conditions. The criteria for determining Hydrologic soil group is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Listing HSGs by soil map unit component and not by soil series is a new concept for the engineers. Past engineering references contained lists of HSGs by soil series. Soil series are continually being defined and redefined, and the list of soil series names changes so frequently as to make the task of maintaining a single national list virtually impossible. Therefore, the criteria is now used to calculate the HSG using the component soil properties and no such national series lists will be maintained. All such references are obsolete and their use should be discontinued. Soil properties that influence runoff potential are those that influence the minimum rate of infiltration for a bare soil after prolonged wetting and when not frozen. These properties are depth to a seasonal high water table, saturated hydraulic conductivity after prolonged wetting, and depth to a layer with a very slow water transmission rate. Changes in soil properties caused by land management or climate changes also cause the hydrologic soil group to change. The influence of ground cover is treated independently. There are four hydrologic soil groups, A, B, C, and D, and three dual groups, A/D, B/D, and C/D. In the dual groups, the first letter is for drained areas and the second letter is for undrained areas.

The four hydrologic soil groups are described in the following paragraphs:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Depth to the upper and lower boundaries of each layer is indicated.

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is 15 percent or more, an appropriate modifier is added, for example, "gravelly."

Classification of the soils is determined according to the Unified soil classification system (ASTM, 2005) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO, 2004).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to particle-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of particle-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Percentage of rock fragments larger than 10 inches in diameter and 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination. Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

References:

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Absence of an entry indicates that the data were not estimated. The asterisk '*' denotes the representative texture; other possible textures follow the dash. The criteria for determining the hydrologic soil group for individual soil components is found in the National Engineering Handbook, Chapter 7 issued May 2007(http://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=17757.wba). Three values are provided to identify the expected Low (L), Representative Value (R), and High (H).

Engineering Properties–Washington County Area, Utah														
Map unit symbol and soil name	**Pct. of map unit**	**Hydrologic group**	**Depth**	**USDA texture**	**Classification**		**Pct Fragments**		**Percentage passing sieve number—**				**Liquid limit**	**Plasticity index**
					Unified	**AASHTO**	**>10 inches**	**3-10 inches**	**4**	**10**	**40**	**200**		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
MBG—Mathis-Rock outcrop complex, 20 to 50 percent slopes														
Mathis	50	A	0-4	Very stony loamy fine sand	GM, GW-GM, SP-SM	A-1-a	5-10- 15	15-20-25	45-55-65	35-48-60	20-30-40	5-10- 15	0-0 -0	NP
			4-10	Gravelly loamy fine sand	SM	A-1-b	0- 0- 0	5-10- 15	75-80-85	65-70-75	35-43-50	15-20-25	0-0 -0	NP
			10-26	Very gravelly loamy sand	SM, GP-GM	A-1-a	0- 0- 0	20-25-30	45-50-55	40-45-50	20-25-30	5-10- 15	0-0 -0	NP
			26-33	Extremely gravelly fine sand	GW-GM	A-1-a	0- 0- 0	20-25-30	35-40-45	25-30-35	20-25-30	5- 8- 10	0-0 -0	NP
			33-37	Unweathered bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Washington County Area, Utah															
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
NaC—Naplene silt loam, 2 to 6 percent slopes														
Naplene	75	C	0-2	Silt loam	CL, CL-ML	A-6, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	65-78-90	25-30-35	5-10-15
			2-7	Silt loam	CL-ML, CL	A-6, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	65-78-90	25-30-35	5-10-15
			7-15	Silt loam	CL-ML, CL	A-6, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	65-78-90	25-30-35	5-10-15
			15-22	Silty clay loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	80-88-95	30-35-40	10-13-15
			22-39	Silt loam	CL-ML, CL	A-6, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	65-78-90	25-30-35	5-10-15
			39-60	Silt loam	CL-ML, CL	A-6, A-4	0- 0- 0	0- 0- 0	100-100-100	95-98-100	85-93-100	65-78-90	25-30-35	5-10-15

Engineering Properties–Zion National Park, Utah														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
690101—Radnik-Spenlo-Riverwash-Notom complex, 0 to 10 percent slopes														
Radnik	30	A	0-1	Fine sandy loam	CL-ML, ML, SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	83-86-94	49-51-61	18-19-25	2-3 -6
			1-20	Fine sandy loam	CL-ML, SC-SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	87-92-99	45-48-58	20-22-25	4-5 -7
			20-67	Fine sandy loam	CL-ML, SC-SM, SM	A-4	0- 0- 0	0- 0- 0	100-100-100	100-100-100	86-91-100	40-42-53	18-20-23	2-4 -6
Spenlo	30	C	0-3	Loam	CL	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	88-96-98	66-73-76	27-31-36	9-11-14
			3-24	Sandy clay loam	CL, SC	A-6, A-7-6	0- 0- 0	0- 0- 0	92-96-100	84-91-100	69-78-89	40-45-53	35-39-44	16-19-22
			24-33	Sandy clay loam	SC	A-6	0- 0- 0	0- 0- 0	100-100-100	100-100-100	83-86-87	44-46-48	32-35-39	14-16-19
			33-41	Sandy clay loam	SC	A-2-6	0- 0- 0	0- 0- 0	88-92-96	76-84-91	63-71-79	30-34-39	29-32-36	12-14-16
			41-65	Gravelly fine sandy loam	SC	A-2-4, A-2-6	0- 0- 0	0- 0- 0	73-79-85	70-77-84	64-72-80	26-31-35	25-27-31	9-10-13
Notom	15	A	0-4	Gravelly fine sandy loam	SM	A-1-b, A-2-4	0- 0- 0	0- 7- 13	78-85-89	57-69-77	48-60-69	21-26-31	0-17 -21	NP-2 -3
			4-11	Gravelly loamy fine sand	SM	A-2-4	0- 0- 0	7-14- 21	81-87-92	62-74-83	58-70-81	20-24-30	0-0 -18	NP-0 -3
			11-17	Very gravelly loamy sand	SW-SM, SM	A-1-a, A-1-b	0- 0- 0	0- 0- 0	69-72-77	38-42-53	29-34-42	10-13-16	0-16 -18	NP-3 -3
			17-32	Very gravelly fine sand	SP-SM	A-1-a, A-1-b, A-2-4	0- 0- 0	0- 2- 6	64-68-76	28-36-52	26-34-51	5- 7- 12	0-0 -17	NP-0 -2

Engineering Properties–Zion National Park, Utah														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			32-59	Fine sandy loam	ML, SM	A-4	0- 0- 0	0- 0- 0	100-100 -100	100-100 -100	83-88- 94	40-42- 53	0-15 -18	NP-2 -3

Engineering Properties–Zion National Park, Utah														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
690160—Mathis Family-Paradox Family-Parida Family complex, 20 to 70 percent slopes														
Mathis	40	A	0-2	Gravelly loamy fine sand	SC-SM, SM	—	0- 0- 0	0- 0- 0	66-69-81	64-68-80	61-66-79	21-24-30	0-19 -23	NP-3 -4
			2-9	Very cobbly loamy fine sand	SC-SM, SM	—	2- 6- 11	12-18-23	59-70-79	56-68-77	53-65-76	18-24-29	0-17 -21	NP-3 -4
			9-34	Very cobbly loamy fine sand	SM	A-2-4	2- 6- 11	12-18-23	59-70-79	56-68-77	52-65-75	15-20-24	0-0 -16	NP-0 -1
			34-44	Bedrock	—	—	—	—	—	—	—	—	—	—
Paradox family	30	C	0-4	Very cobbly fine sandy loam	SC	A-2-4	0- 6- 12	7-14- 19	56-67-77	53-65-75	46-57-68	26-33-39	21-26 -30	6-8 -9
			4-14	Clay loam, loam	CL	A-6	0- 0- 0	0- 0- 0	100-100 -100	100-100 -100	88-91-92	68-70-72	34-38 -41	16-18-20
			14-20	Loam	CL	A-6	0- 0- 0	0- 0- 0	100-100 -100	100-100 -100	91-93-95	75-77-79	31-33 -37	14-15-18
			20-52	Paragravelly silt loam	CL	A-6	0- 0- 0	0- 0- 0	100-100 -100	100-100 -100	94-96-98	84-86-88	27-29 -32	11-12-14
			52-61	Bedrock	—	—	—	—	—	—	—	—	—	—
Parida family	20	A	0-2	Gravelly fine sandy loam	SC-SM, GM	A-1-b, A-2-4	0- 0- 0	1- 3- 7	52-59-71	50-56-69	44-51-65	20-23-30	16-20 -24	1-3 -5
			2-10	Gravelly loam	CL, GC, SC	A-6	0- 0- 0	5- 8- 12	69-76-84	67-75-83	57-65-74	39-45-52	26-30 -33	10-12-14
			10-17	Gravelly loam	CL, SC	A-4	0- 0- 0	4- 7- 11	70-77-85	68-76-84	57-66-74	39-45-52	23-27 -30	7-9 -11
			17-51	Gravelly fine sandy loam	SC-SM, SC	A-2-4, A-4	0- 0- 0	7-14- 20	68-77-85	66-75-84	57-66-76	32-38-44	22-24 -28	6-7 -10
			51-61	Bedrock	—	—	—	—	—	—	—	—	—	—

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American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

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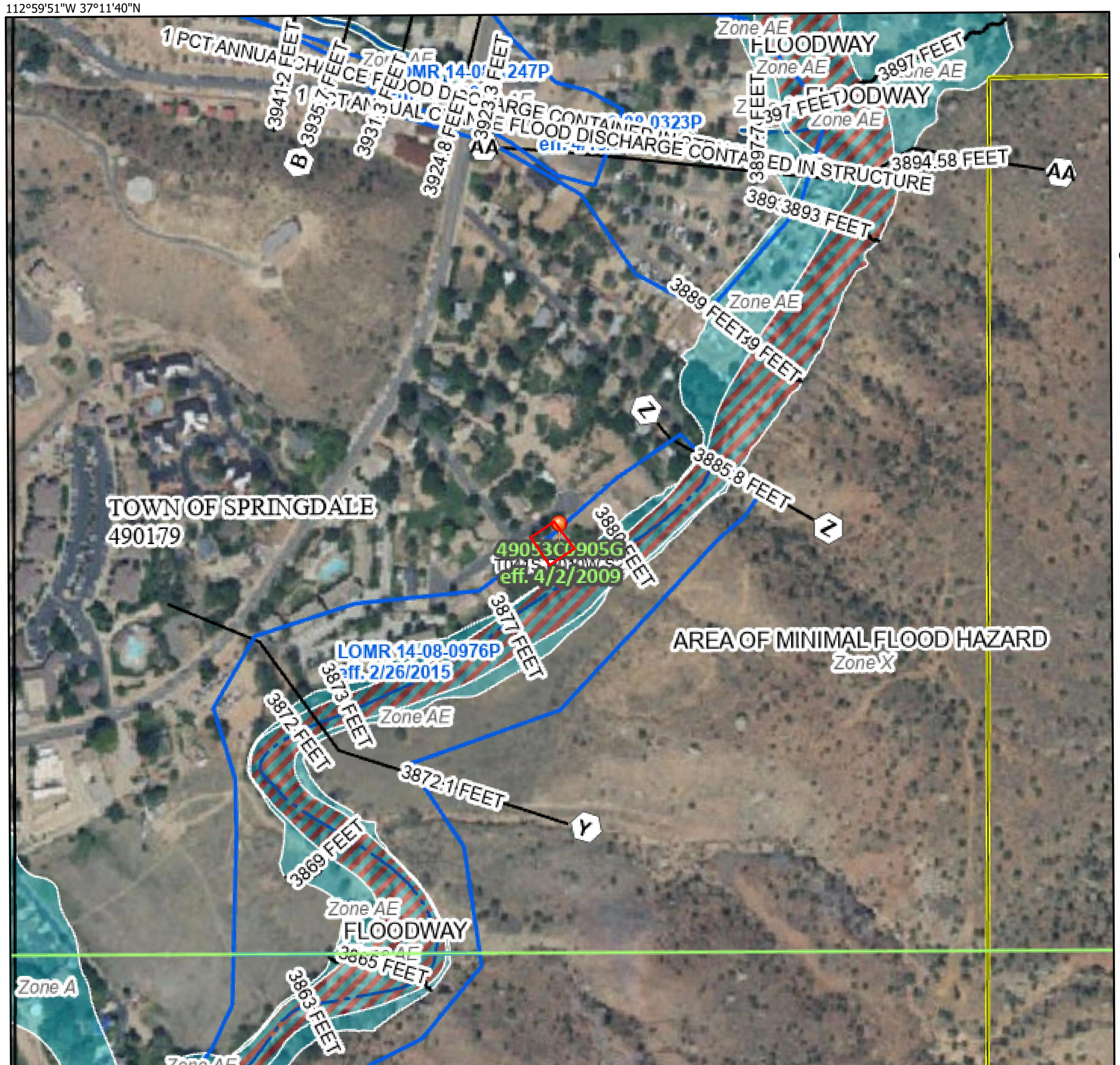
National Flood Hazard Layer FIRMette

FEMA

112°59'51"W 37°11'40"N



112°59'14"W 37°11'12"N

Feet 0 250 500 1,000 1,500 2,000

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 4/21/2025 at 3:21 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

LEGEND

PROJECT AREA

DATE:	4/21/2025
JOB NO.:	14110-25
DESIGNED BY:	WJP
CHECKED BY:	JKB
DWG:	EHZ

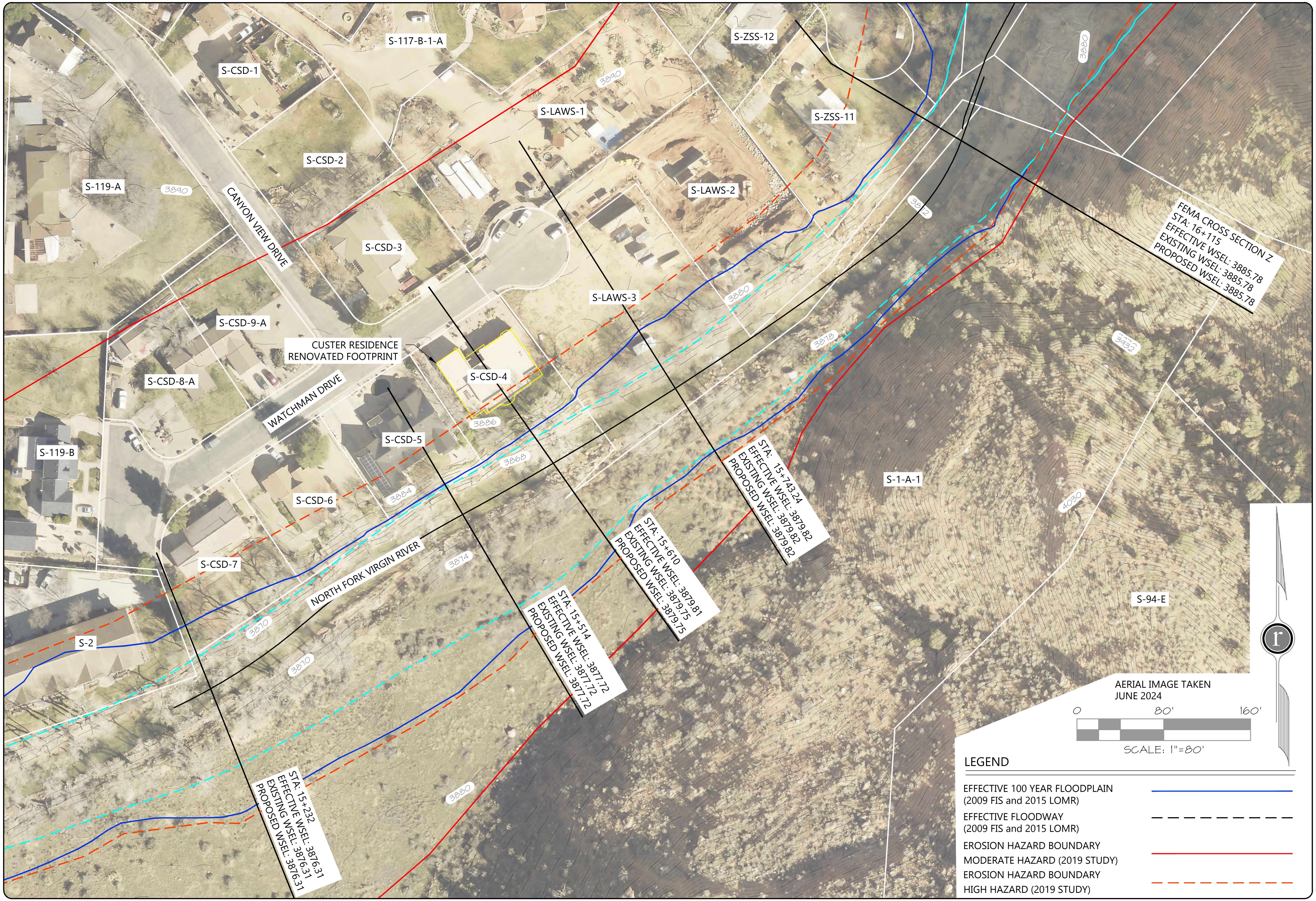
DATE REVISIONS

ROSENBERG ASSOCIATES CIVIL ENGINEERS • LAND SURVEYORS

352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

FEMA FIRMETTE - 0905G
FOR
PARCEL S-CSD-4
SPRINGDALE
UTAH

SHEET
1
1 OF 1 SHEETS



DATE: 4/11/2025
JOB NO.: 1410-25
DESIGNED BY: KJP
CHECKED BY: JKB
DWG: EHZ

REVISIONS

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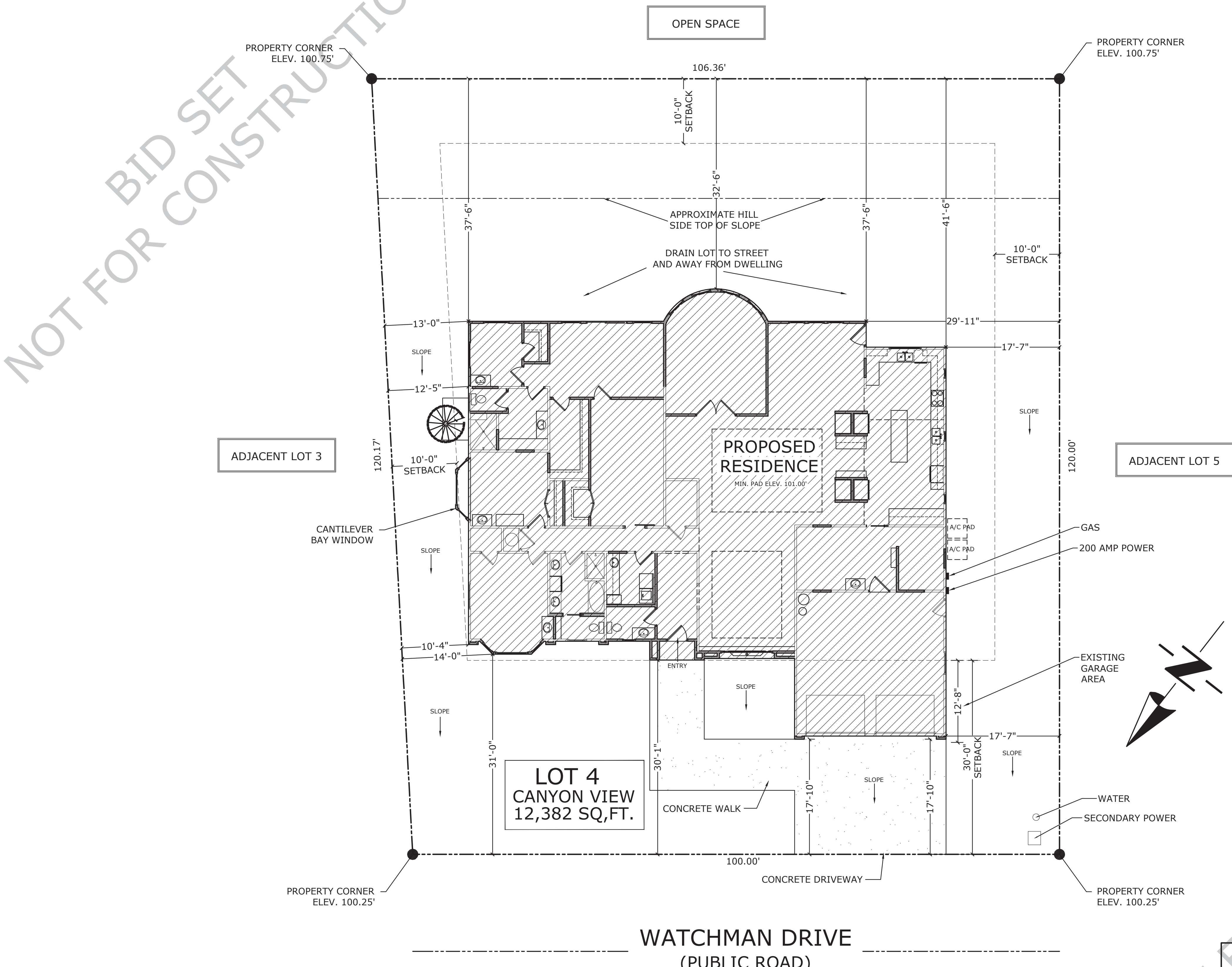
FLOODPLAIN EXHIBIT - NORTH FORK VIRGIN RIVER

FOR

CANYON VIEW LOT 4

SPRINGDALE
UTAH

SHEET
1
1 OF 1 SHEETS



PROPOSED OVERALL SITE PLAN

SCALE: 1/8" = 1'-0"

BUILDING SETBACKS:

FRONT	30'
REAR	10'
SIDES	10'

SITE NOTE:

BEFORE CONSTRUCTION BEGINS BUILDER IS TO:
VERIFY LOT DIMENSIONS AGAINST SITE PLAN DIMENSIONS.
VERIFY BUILDING LOCATION AND ACCESS WITH OWNER.
VERIFY LOCATION OF WATER, SEWER AND UTILITIES ON SITE.
VERIFY PROPERTY CORNER AND BUILDING PAD ELEVATIONS.

BID SET
NOT FOR CONSTRUCTION

NEVIS
HOME DESIGN

NEVIS HOME DESIGN
ST GEORGE, UTAH 84790
801.866.4156

PROPOSED OVERALL
SITE PLAN

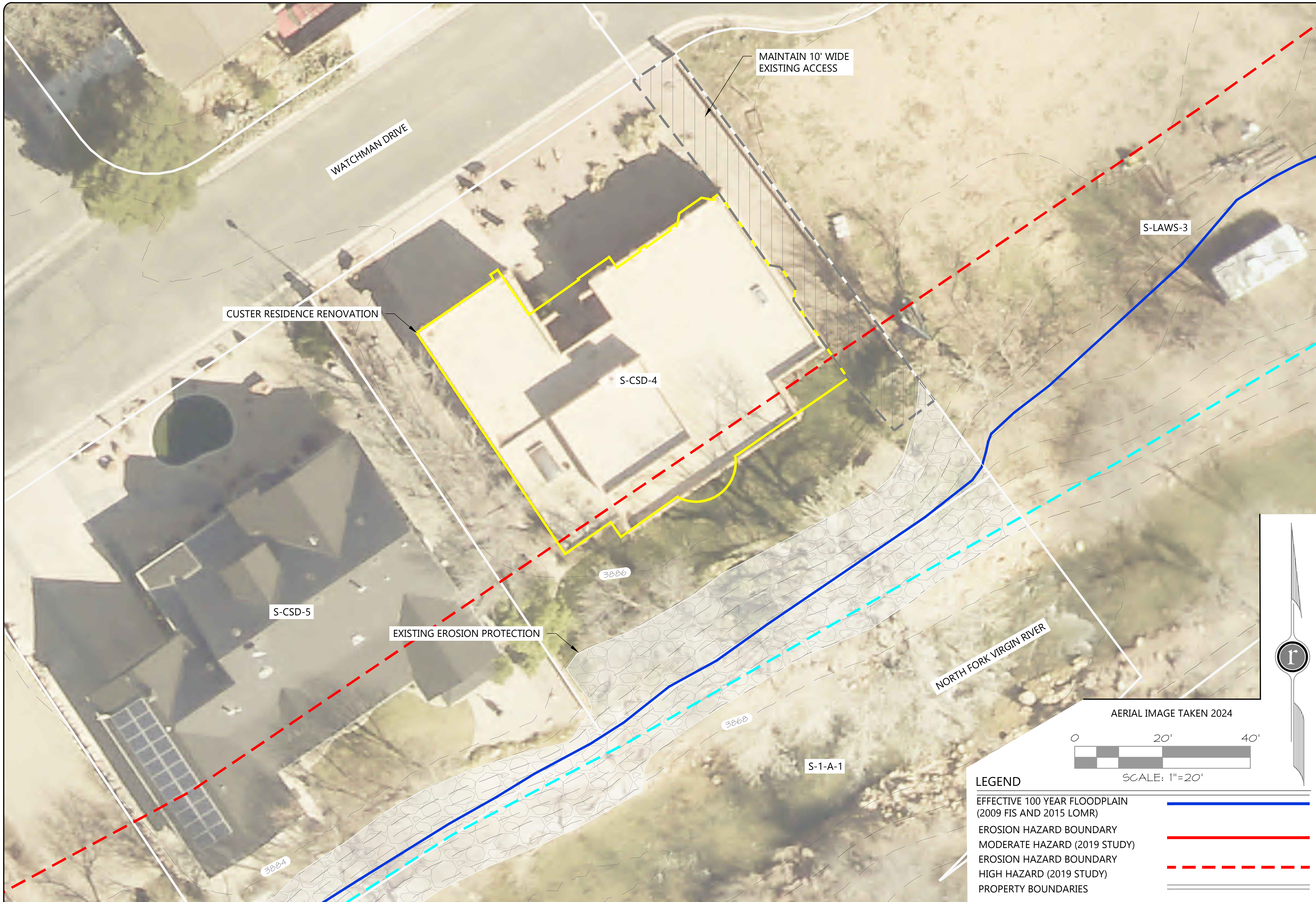
CUTLER RESIDENCE
LOT 4
CANYON VIEW SUBDIVISION
WASHINGTON COUNTY, UTAH

Current Set:	01.14.2025
Bid Set Date:	
Engineering Set:	
Overall Final Set:	

OWNERS:	JIM AND ELIZABETH CUTLER
CONTRACTOR:	CANYON CONTRACTING
PROJECT	# V21-012
DRAWN BY:	BEN GARNER

A1.1

SHEET SCALE: 1/8" = 1'-0"



DATE:	4/21/2025
JOB NO.:	6650-24-005
DESIGNED BY:	WJP
CHECKED BY:	JWB
DWG:	EHZ

REVISIONS DATE

ROSENBERG ASSOCIATES
CIVIL ENGINEERS • LAND SURVEYORS
1989 - 2014 25th ANNIVERSARY

352 East Riverside Drive, Suite A-2
St. George, Utah 84790
Ph (435) 673-8586 Fx (435) 673-8397
www.racivil.com

PLAN VIEW FOR PARCEL S-CSD-4

SPRINGDALE UTAH

SHEET

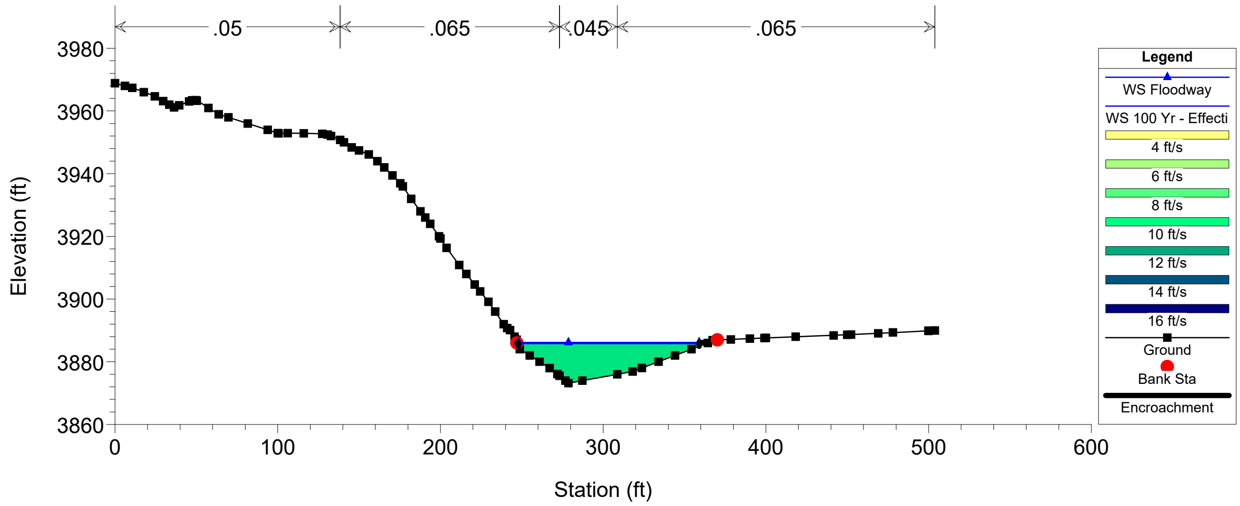
PV

1 OF 1 SHEETS

HEC-RAS Model Results - Effective Conditions - North Fork Virgin River													
FEMA Sta	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Hydr Dpth
			(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(ft)
Z	16+115	100 Yr	8830	3873.2	3885.78	3887.54	0.013625	10.63	830.81	116.05	0.7	12.58	7.16
	15+743.24	100 Yr	8830	3868.76	3879.81	3883.18	0.010395	15.66	733.18	131.33	0.86	11.05	5.58
	15+514	100 Yr	8830	3865.9	3877.72	3880.65	0.008548	14.27	736.85	153.46	0.84	11.82	4.8
	15+232	100 Yr	8830	3863.36	3876.31	3877.8	0.00331	9.94	966.27	177.74	0.61	12.95	5.44

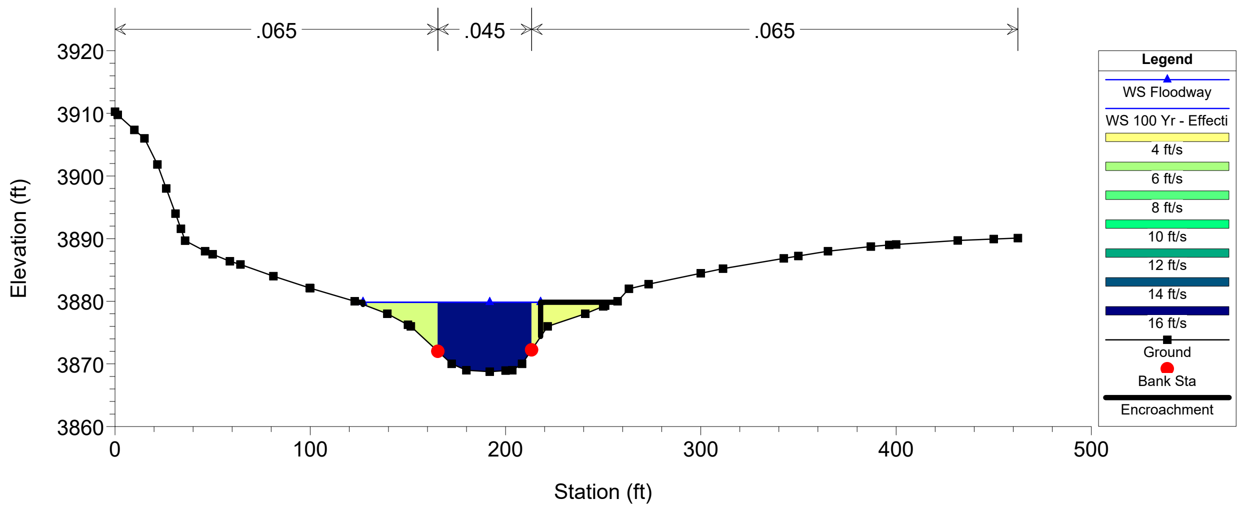
VR-Desert Pearl Ex Cond 2-14-14 Plan: North Fork 4/5/2014

Fema Section Z: 16+115



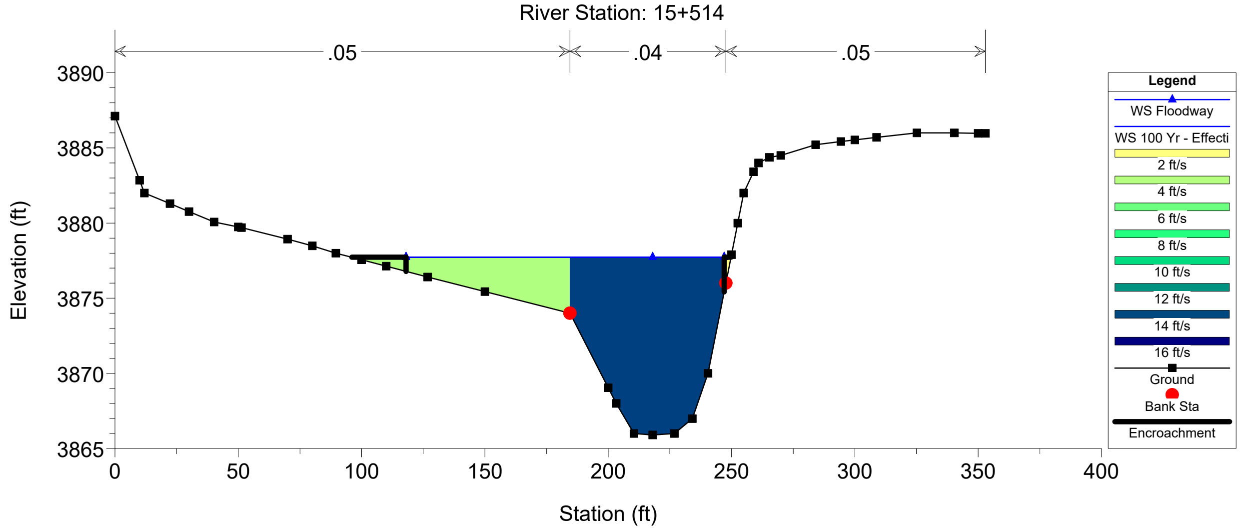
VR-Desert Pearl Ex Cond 2-14-14 Plan: North Fork 4/5/2014

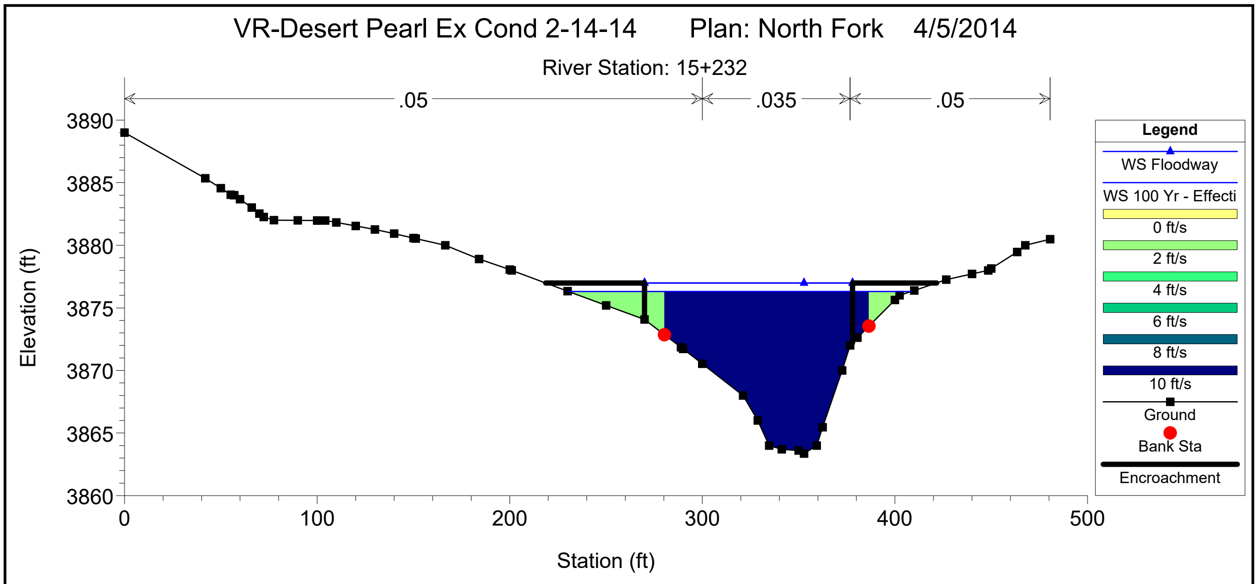
River Station: 15+743.24



VR-Desert Pearl Ex Cond 2-14-14 Plan: North Fork 4/5/2014

River Station: 15+514





VR-Desert Pearl Ex Cond 2-14-14 Plan: North Fork 4/5/2014
River Station: 15+232
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Elevation (ft)
Station (ft)
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Legend
WS Floodway
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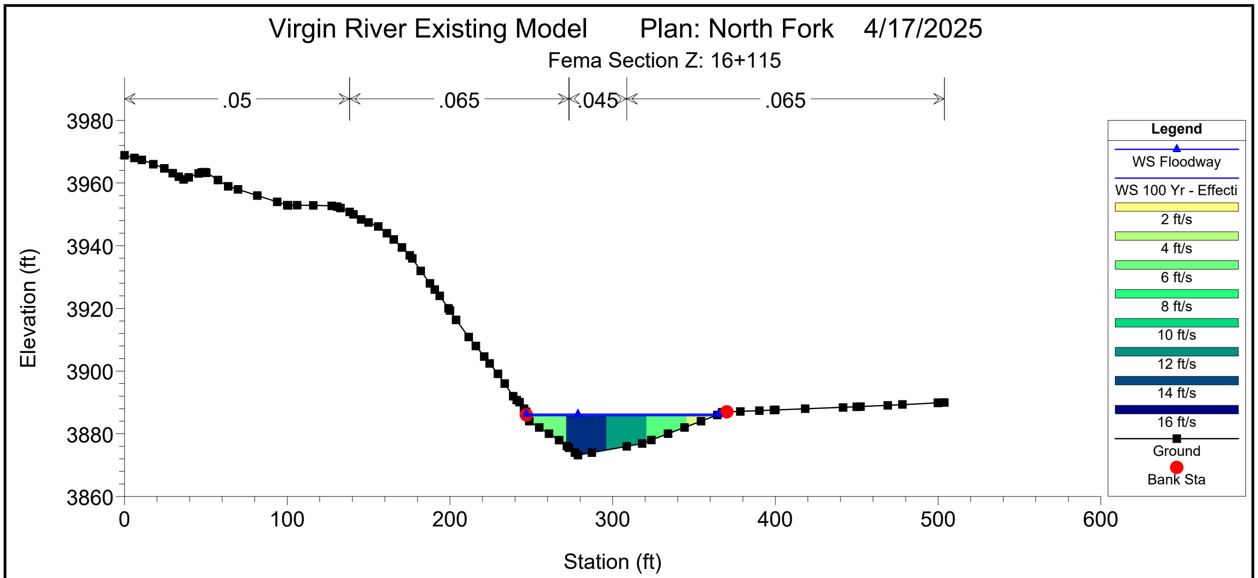
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Encroachment

HEC-RAS Model Results - Existing Conditions - North Fork Virgin River													
FEMA Sta	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Max Chl Dpth	Hydr Dpth
			(cfs)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(ft)	(ft)
Z	16+115	100 Yr	8830	3873.2	3885.78	3887.54	0.013643	10.63	830.41	116.03	0.7	12.58	7.16
	15+743.24	100 Yr	8830	3868.76	3879.82	3883.18	0.010371	15.65	733.95	131.44	0.86	11.06	5.58
	15+610	100 Yr	8830	3864.44	3879.75	3881.3	0.003556	10.29	973.44	155.89	0.56	15.31	6.24
	15+514	100 Yr	8830	3865.9	3877.72	3880.66	0.008538	14.27	737.26	153.52	0.84	11.82	4.8
	15+232	100 Yr	8830	3863.36	3876.31	3877.81	0.003309	9.94	966.4	177.77	0.61	12.95	5.44


Virgin River Existing Model Plan: North Fork 4/17/2025
Fema Section Z: 16+115
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Elevation (ft)
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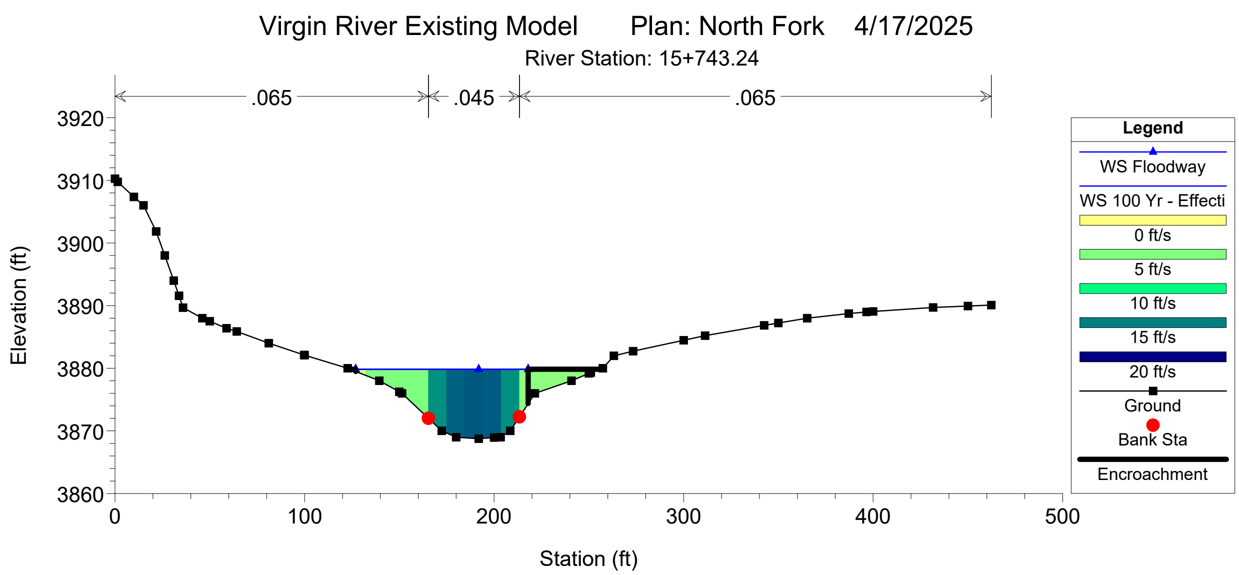
Virgin River Existing Model Plan: North Fork 4/17/2025
River Station: 15+743.24
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Elevation (ft)
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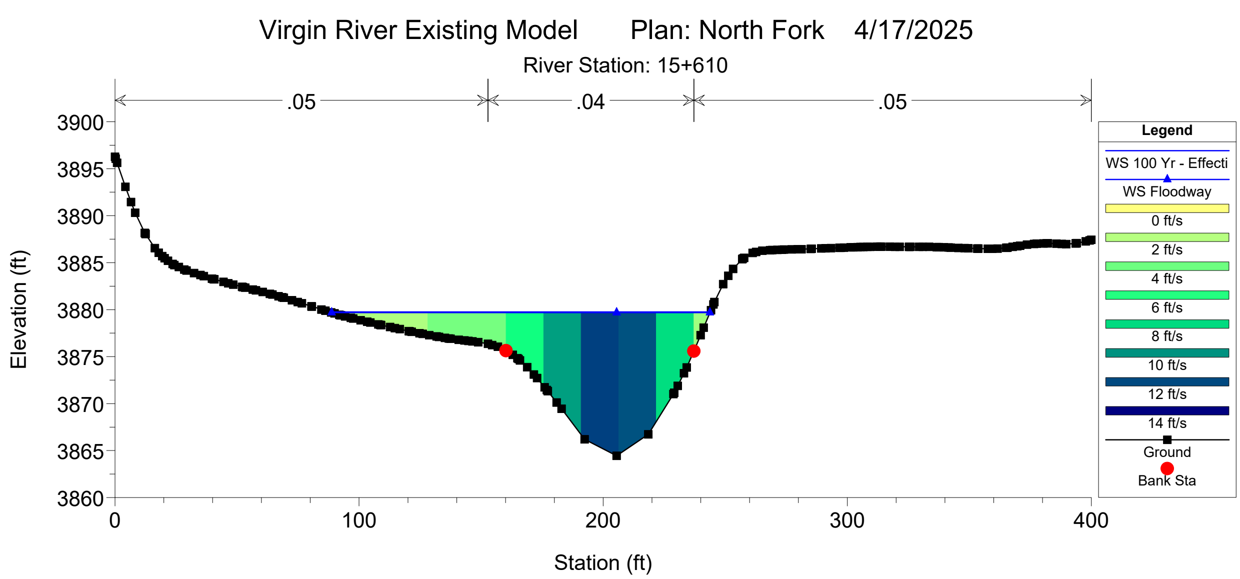
Virgin River Existing Model Plan: North Fork 4/17/2025
River Station: 15+610
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Elevation (ft)
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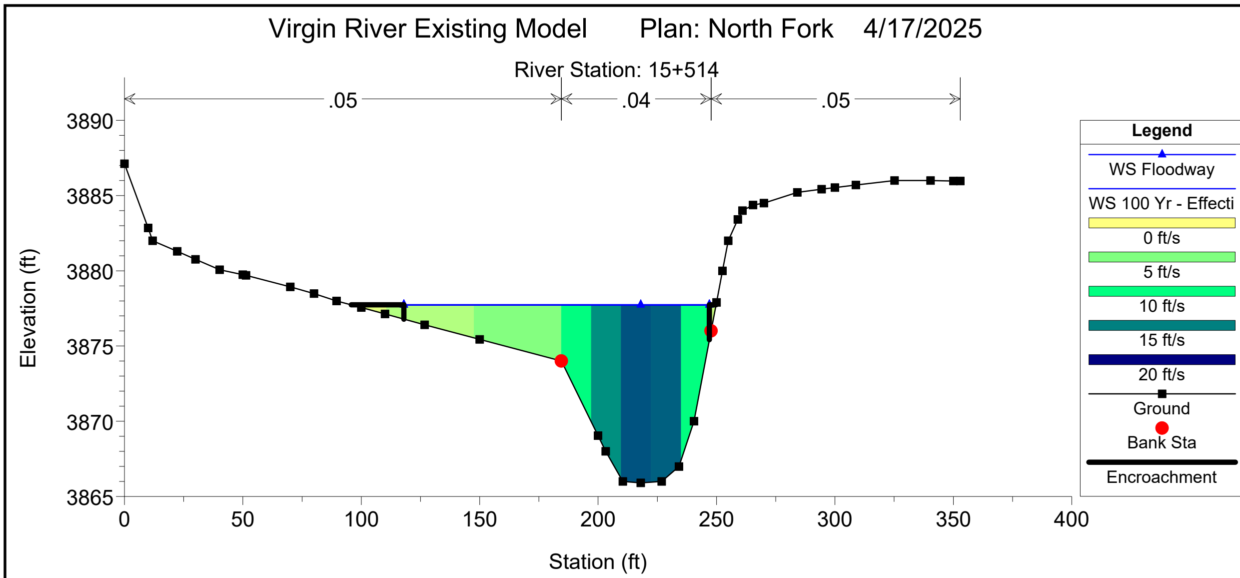
Virgin River Existing Model Plan: North Fork 4/17/2025
River Station: 15+514
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Elevation (ft)
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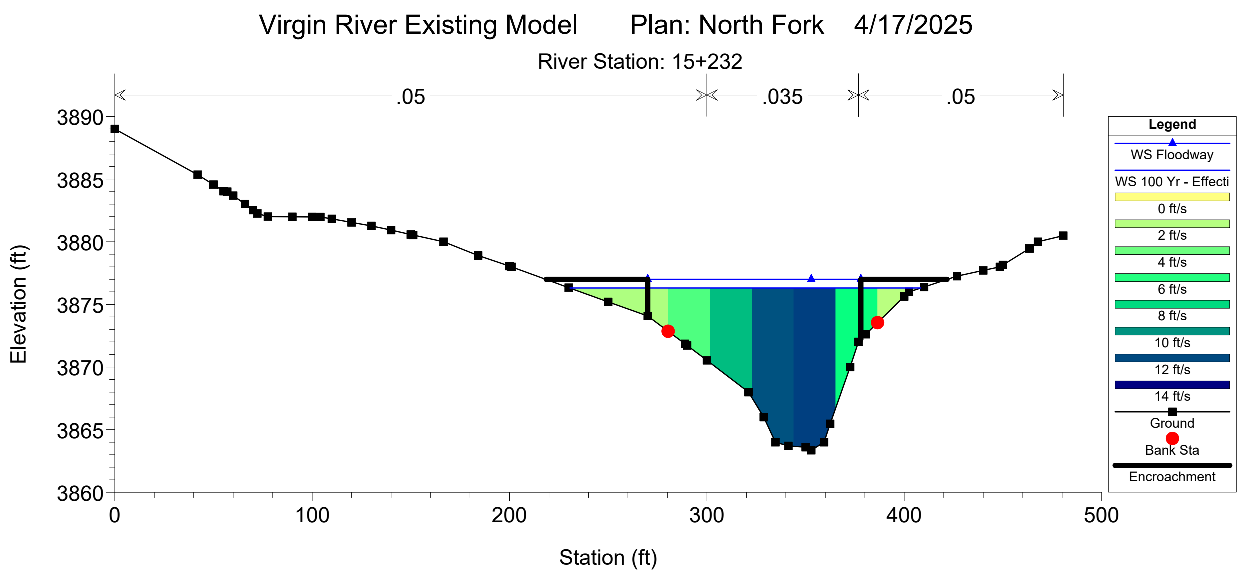
Ground
Bank Sta
Encroachment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River Station: 15+232
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Elevation (ft)
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HEC-RAS Model Results - Proposed Conditions - North Fork Virgin River													
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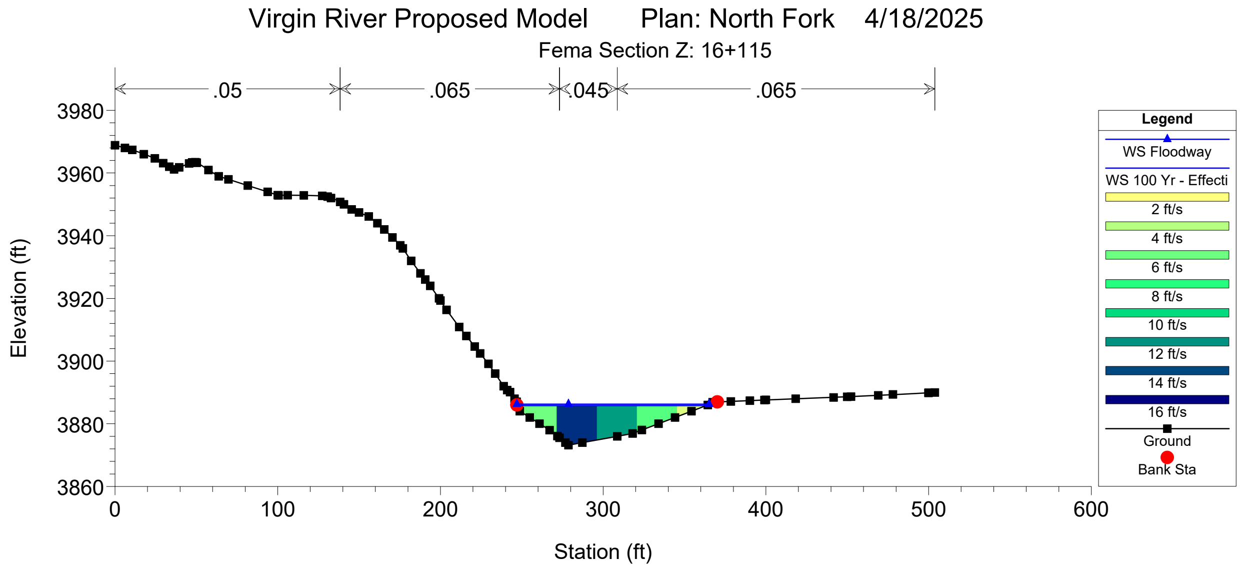
Virgin River Proposed Model Plan: North Fork 4/18/2025
Fema Section Z: 16+115
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Elevation (ft)
Station (ft)
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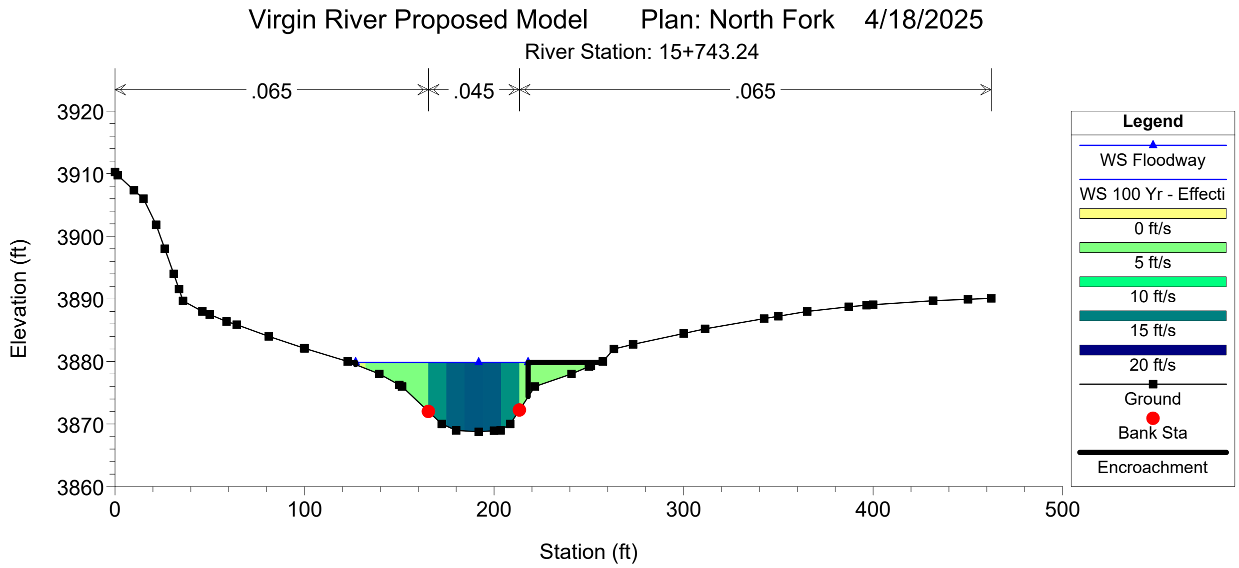
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Elevation (ft)
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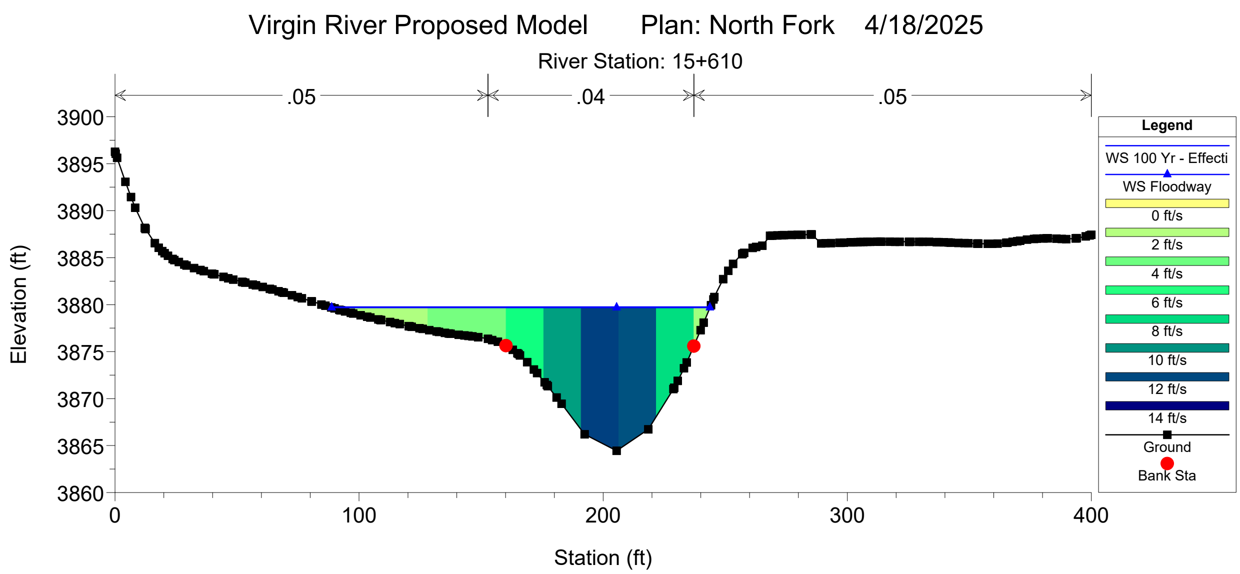
Virgin River Proposed Model Plan: North Fork 4/18/2025
River Station: 15+610
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Elevation (ft)
Station (ft)
Legend
WS 100 Yr - Effecti
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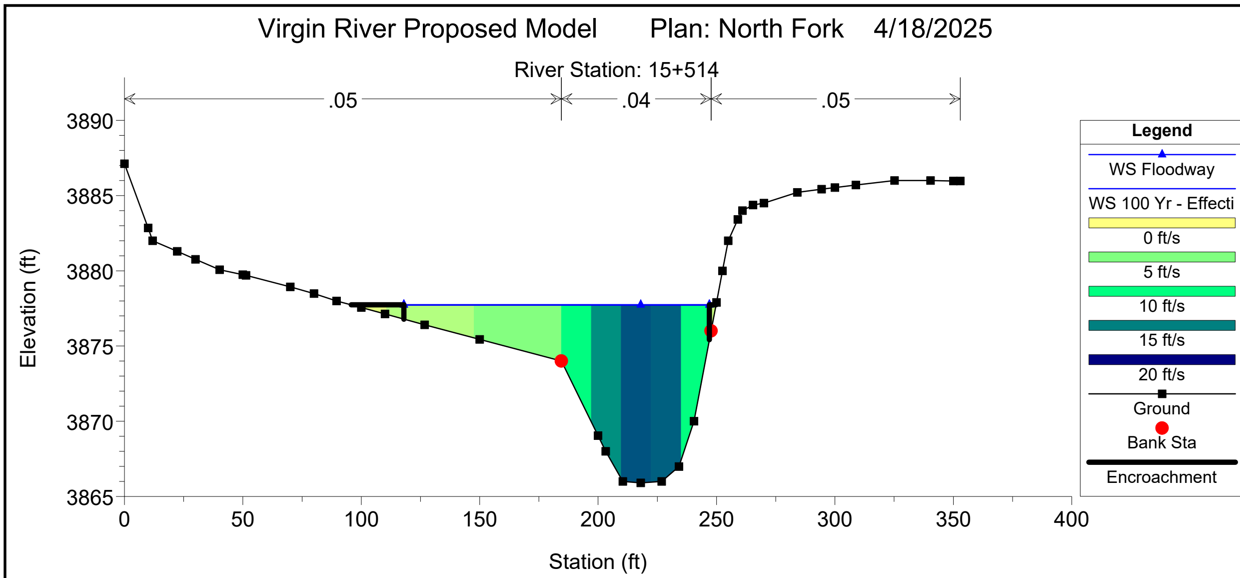

Virgin River Proposed Model Plan: North Fork 4/18/2025
River Station: 15+514
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Elevation (ft)
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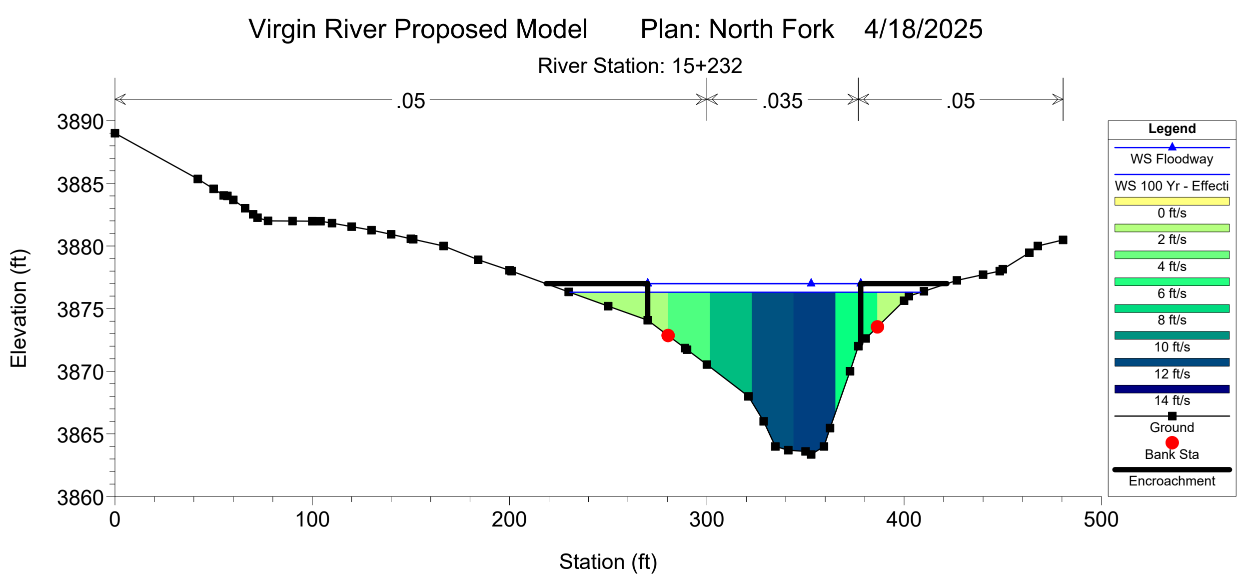
Bank Sta
Encroachment



Virgin River Proposed Model Plan: North Fork 4/18/2025
River Station: 15+232
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Elevation (ft)
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0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Encroachment

Project: Parcel S-CSD-4 BY: WJP DATE: 4/17/2025

Subject: Long Term Degradation CHKD. BY: JWB DATE: 4/17/2025

Assumptions:

Long Term Degradation for this site was determined by estimating the elevation difference in the North Fork Virgin River flowline between 2015 (LOMR 14-08-0976P) and 2022 (Field Survey). This method was chosen as accurate river topography was available. Table 3 shows the difference in flowline elevations at several locations within the study reach. Based on these elevations, the North Fork Virgin River flowline experienced an elevation decrease of 2.68' at Sta.15+743 and an elevation decrease of 2.38' at Sta. 15+514. Review of historical images (1960-present) indicate that the location of the central channel has remained stable throughout the course of the study period. No evidence of head cutting or significant bed degradation is present within the reach. The North Fork of the Virgin River as a whole tends to maintain a relatively stable sediment transport pattern due to the large cobbles and boulders present throughout the bed of the channel. Due to the minor degradation observed within the reach, the stability of the central channel within the study area, and the Engineer's experience working within the reach, a long term degradation value of 3' was assumed as a conservative estimate.

Table 3 - North Fork Virgin River Flowline Elevations

River Station	2015 Flowline Elevation (ft)	2022 Flowline Elevation (ft)	8 Year Change (ft)
15+743	3868.76	3866.1	2.7
15+514	3865.9	3863.5	2.4

Project:	Parcel S-CSD-4	BY:	WJP	DATE:	4/17/2025
Subject:	Bend Scour	CHKD. BY:	JWB	DATE:	4/17/2025

Bend Scour: (Section 704.2.1.4 - Bend Scour
Clark County Hydraulic Criteria and Drainage Design Manual, 8/12/99)

Location:
North Fork Virgin River Sta. 15+743.24

Given:

Average velocity upstream from bend, V =	15.65	ft/s
Maximum depth upstream of bend, Y_{max} =	11.06	ft
Hydraulic depth in channel upstream of bend, Y_h =	5.58	ft
Energy slope upstream of bend, S_e =	0.010371	ft/ft
Angle of bend, α =	18	deg

*Determined by acute angle formed by intersection between projection of flowline and line tangent to outer bank of bend

Equation:

$$Z_{bs} = \left(\frac{0.0685 * Y_{max} * V^{0.8}}{Y_h^{0.4} * S_e^{0.5}} \right) \left(2.1 \left(\frac{\sin^2\left(\frac{\alpha}{2}\right)}{\cos\alpha} \right)^{0.2} - 1 \right)$$

Bend Scour, Z_{bs} = **0.34 ft** ←

Project: Parcel S-CSD-4 BY: WJP DATE: 4/17/2025

Subject: 100 YR Anti Dune Trough Scour CHKD. BY: JWB DATE 2/25/2025

Anti Dune Trough: (Section 704.2.1.3 - Anti Dune Trough Depth
Clark County Hydraulic Criteria and Drainiage Design Manual, 8/12/99)

Location:
North Fork Virgin River Sta. 15+743.24

Given:

100 YR	Average channel velocity, V =	15.65	ft/s
	Hydraulic depth, Y =	5.58	ft

Anti Dune Depth based on Velocity:

Equation:

$$Z_a = 0.0137 * V^2$$

Anti Dune Trough Depth, Z_a = **3.36 ft** ←

Anti Dune Trough Depth (max), Z_a = **2.79**

Project: Parcel S-CSD-4 BY: WJP DATE: 4/17/2025

Subject: Rip-Rap Size CHKD. BY: JWB DATE: 2/25/2025

Riprap Design for Channel Lining Based on Channel Velocity

Rip-Rap: (Section 704.2.1.3 - Clark County Hydraulic Criteria and Drainiage Design Manual, 8/12/99)

Location:
North Fork Virgin River Sta. 15+743.24

Given:

Mean Channel Velocity, V =	15.65	fps
Longitudinal Channel Slope, S =	0.0023	ft/ft
Specific Gravity of Riprap Lining, S_S =	2.50	minimum S_s = 2.50

Smith and Murray Model Equation:

Equation:

$$V = 3(d_{50})^{0.5}(S_s-1)/S^{0.17}$$

Median Rock Size d_{50} = **1.53** ft *Equation 734*
18 in

Riprap Design for Channel Lining Based on Tractive Stress*

Maximum Channel Depth, Y_{max} =	11.06	ft	
Average Energy Slope, S_e =	0.010371	ft/ft	
Channel Stability Factor, F_s =	1.0	1.0 - 1.2	Straight or mildly curving reach
		1.2 - 1.4	Moderate bend curvature with minor impact from floating debris
		1.4 -1.6	Sharp bend with significant impact from floating debris and wave
		1.6 - 2.0	Rapidly varying flow with significant uncertainty in design
Channel Side Slopes =	2.00	H : 1V	2H : 1V max
Trial Average Rock Size, d_{50} =	24.00	in	insert a first trial, then adjust

Tractive Stress Equation $d_{50} = 14.2F_sY_{max}(S_e/K_1)$ *Equation 736*

Solving

Slope Angle with Horizontal, a =	0.4636	rad
Angle of Repose, h =	0.7348	rad
Bank Angle Modification Factor, K_1 =	0.74501	$= (1-(\sin^2 a/\sin^2 h))^{0.5}$ *Lane Equation*
Median Rock Size, d_{50} =	**2.19**	ft
	26	in ←

The hydrodynamic force of water flowing in a channel is known as the tractive force. Flow-induced tractive force should not exceed the permissible or critical shearstress of the riprap. Theabove equation is a relationship to estimate d50 assuming a specific gravity of 2.50