

HAZARD MITIGATION GRANT PROGRAM
**1830 Bennett Court Repetitive Loss
Property Acquisition and Demolition**
Douglas County Project Subapplication



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HAZARD MITIGATION GRANT PROGRAM PROJECT SUBAPPLICATION

NOTE: Please click within the greyed section to begin typing in each section of the application.

DISASTER NUMBER:

TBD

JURISDICTION NAME:

Douglas County

PROJECT TITLE:

1830 Bennett Court Repetitive Loss
Property Acquisition and Demolition



HAZARD MITIGATION GRANT PROGRAM (HMGP)

INTRODUCTION

INTRODUCTION

As a result of the declaration of a major federal disaster or aggregate Fire Management Assistance declarations, the State of Nevada is eligible for HMGP funding. The State has established priorities to accept project subapplications from subapplicants statewide, state agencies, tribal governments, local governments, and Private Non-Profits.

Hazard mitigation activities are aimed at reducing or eliminating future damages. Activities include cost effective hazard mitigation projects and hazard mitigation plans approvable by the Federal Emergency Management Agency (FEMA).

Nevada's Enhanced State Hazard Mitigation Plan (ESHMP) accreditation resulted in additional dollars available for local agencies' hazard mitigation plan and project funding for Hazard Mitigation Grant Program (HMGP). To maintain ESHMP status, further information is requested by FEMA. This information is requested as a means of assessing the pro-activity of your community or agency.

PUBLIC ASSISTANCE

If your project is aimed at repairing a damaged facility resulting from a federally declared disaster, contact the Public Assistance (PA) Program at disaster-recovery@dem.nv.gov. HMGP does not fund repairs for damages that result after a disaster.

TIME EXTENSIONS

Time extensions may be requested and will be approved or denied on a case-by-case basis. To request additional time to submit a subapplication, send an email to the mitigation@dem.nv.gov mailbox. The subject line must include: "Subapplication Time Extension Request (include Disaster Number and Project Control Number)". The body of the message must include justification and specific details supporting why more time is needed and how much additional time is requested. **Time extensions must be requested 120 days prior to end of period of performance.**

QUESTIONS

Submit all HMGP subapplication questions to the following mailbox: mitigation@dem.nv.gov.

HAZARD MITIGATION GRANT PROGRAM REGULATIONS

REGULATIONS

Federal funding is provided under the authority of the [Robert T. Stafford Emergency Assistance and Disaster Relief Act \(Stafford Act\)](#) through FEMA and the Nevada Division of Emergency Management (NV DEM). NV DEM is responsible for identifying program priorities, reviewing subapplications and forwarding recommendations for funding to FEMA. FEMA has final approval for activity eligibility and funding.

The federal regulations governing HMGP are found in Title 44 of the Code of Federal Regulations (44CFR), Part 201 (Planning) and Part 206 (Projects) and in Title 2 of the Code of Federal Regulations (2CFR), Part 200 (Uniform Administrative Requirements).

Regulations have been developed to implement the National Environmental Policy Act (NEPA). These regulations, as set forth in Title 40, Code of the Federal Regulations (CFR) Parts 1500-1508, require an investigation of the potential environmental impacts of a proposed federal action, and an evaluation of alternatives as part of the environmental assessment process. The FEMA regulations that establish the agency-specific process for implementing NEPA are set forth in 44 CFR Part 10. FEMA will lead the NEPA clearance process.

FEMA GUIDANCE

FEMA requires that all projects adhere to the [Hazard Mitigation Assistance Program and Policy Guide 2023](#).

HAZARD MITIGATION GRANT PROGRAM ELIGIBILITY CHECKLIST

Before completing the subapplication, review the following HMGP eligibility checklist to ensure project meets the requirements for HMGP funding.

- Construction/Ground-Breaking:** No construction or ground-breaking activities are allowed prior to FEMA approval. HMGP does not fund projects that are in progress or projects that have already been completed.
- Scope of Work:** The project scope of work (SOW) must be consistent with the SOW provided in the approved Notice of Interest (NOI).
- Benefit Cost Analysis:** FEMA Benefit Cost Analysis (BCA) Toolkit Version 6.0 must be used to conduct the BCA. FEMA will only consider subapplications that use a FEMA-approved BCA methodology. Documentation to support all BCA calculations must be included in subapplication. Projects with a benefit cost ratio (BCR) of less than 1.0 will not be considered. BCA will be verified by FEMA and NV DEM upon subapplication submittal. 5% Initiative Projects do not need a BCA. Planning grants do not need a BCA. Projects under \$1 Million may create a BCA narrative answering the five noted questions from FEMA.
- Subapplicant Eligibility:** Subapplicant must be an eligible State Agency, Local Government (City, County, Special Districts), Federally Recognized Tribe or Private Nonprofit (PNP) Organization. PNP is defined as private nonprofit educational, utility, emergency, medical, or custodial care facility, facilities providing essential governmental services to the general public and such facilities on Indian reservations (see 44 CFR Sections 206.221(e) and 206.434(a)(2)).
- LHMP/MJHMP:** Subapplicant must have a FEMA approved and adopted Local or Multi-Jurisdictional Hazard Mitigation Plan (LHMP or MJHMP) to be eligible for HMGP funding. If a jurisdiction has its own governing body, jurisdiction must be covered under its own plan. LHMP's/MJHMP's expire five years after FEMA approval. Failure to update plan before expiration date may cause project deobligation.
- Cost Share:** Local funding match of 25% of the total project cost is required by the subapplicant. HMGP matching funds must be from a non-federal source. The State does not contribute to local funding match.
- Period of Performance:** Projects must be completed (including close-out) within the 36-month Period of Performance (POP). POP begins upon FEMA approval/funding of the subapplication.

HAZARD MITIGATION GRANT PROGRAM ELIGIBILITY CHECKLIST (continued)

- Complete Subapplication:** Failure to include all required documentation will delay the processing of your subapplication and may result in denial of project. The SOW, cost estimate, cost estimate narrative, management costs cost estimate, work schedule and BCA must accurately mirror each other to be considered for funding. The budget narrative must include a detailed description of every cost estimate line-item, including the methodology used to estimate each cost.

- Regulations:** Subapplications that are inconsistent with state and federal HMGP regulations, or do not meet eligibility criteria will not be considered.

- Duplication of Programs:** HMGP funding cannot be used as a substitute or replacement to fund activities or programs that are available under other federal authorities, known as Duplication of Programs (DOP).

- Time Extensions:** Unless a time extension has been approved before the deadline, subapplications must be postmarked by the applicable deadline to be considered for funding.



SUBAPPLICANT MUST BE ABLE TO CHECK EVERY BOX TO QUALIFY FOR HMGP FUNDING.

SUBAPPLICATION FORMAT INSTRUCTIONS

NV OEM requires the following format to be used for all HMGP subapplications.

COMPLETE SUBAPPLICATION PACKAGE CONSISTS OF THE FOLLOWING:

Electronic Version of the completed application

- Table of Contents
- All electronic attachments must be clearly titled

Send electronic version to NV OEM either by email, DropBox or Microsoft Word 365 Zip function.

- Attachments must be in one of the following formats: Microsoft Word Version 2007 (or newer), Microsoft Excel or Adobe PDF
- Benefit Cost Analysis (BCA) 6.0 must be included (both PDF and Excel format)
- All electronic attachments must be clearly titled

ORGANIZATION OF THE FOLDERS MUST BE LABELED IN THE FOLLOWING FORMAT:

0. Table of Contents
1. Subapplication
2. Scope of Work
3. Designs
4. Studies
5. Maps
6. Photos
7. Schedule (Additional documentation work schedule components, Gantt chart, etc.)
8. Budget ([HMGP Cost Estimate Spreadsheet](#) and cost estimate narrative)
9. Match ([Local Match Commitment Letter Template](#))
10. BCA Report ([BCA Version 6.0](#) report and BCA supporting documentation)/BCA Narrative for projects under \$1 Million
11. Maintenance ([Project Maintenance Letter Template](#))
12. Environmental ([FEMA's Site Information, Environmental Review and Checklist](#) and all other environmental documentation)
13. Supporting Docs (Any extra supporting documentation)

EMAIL COMPLETED SUBAPPLICATIONS TO:

mitigation@dem.nv.gov

PROJECT SUBAPPLICATION FORM

SUBAPPLICANT INFORMATION

1. **SUBAPPLICANT:**
NAME OF STATE AGENCY, TRIBAL GOVERNMENT, LOCAL GOVERNMENT, PRIVATE NON-PROFIT OR SPECIAL DISTRICT APPLYING FOR FUNDING

2. **TYPE:** STATE/LOCAL GOVERNMENT **TRIBAL GOVERNMENT** PRIVATE NON-PROFIT SPECIAL DISTRICT

3. **FIPS #:** IF YOU DO NOT KNOW YOUR FEDERAL IDENTIFICATION PROCESSING SYSTEM NUMBER (FIPS #), REQUEST BY EMAILING mitigation@dem.nv.gov

4. **UEI #:** IF YOU DO NOT KNOW YOUR DATA UNIVERSAL NUMBERING SYSTEM (DUNS) #, CALL DUN & BRADSTREET (D&B) @ 1-866-705-5711 FOR INFORMATION

5. **COUNTY:** THE NAME OF THE COUNTY WHERE THE PROPOSED PROJECT IS LOCATED

6. **POLITICAL DISTRICT NUMBERS:** CONGRESSIONAL: STATE ASSEMBLY: STATE LEGISLATIVE: PROVIDE ONLY THE NUMBERS OF THE POLITICAL DISTRICTS FOR THE SUBAPPLICANT

7. **PRIMARY CONTACT:** POINT OF CONTACT FOR YOUR PROJECT. NEVADA DEM WILL CONTACT THIS PERSON FOR QUESTIONS AND/OR REQUESTS FOR INFORMATION

NAME: Mr. Ms. **FIRST:** **LAST:**

TITLE:

ORGANIZATION:

ADDRESS:

CITY: **STATE:** **ZIP CODE:**

TELEPHONE: **FAX:**

EMAIL:

8. **ALTERNATIVE CONTACT:** BACK-UP POINT OF CONTACT FOR YOUR PROJECT. NEVADA DEM WILL CONTACT THIS PERSON IF PRIMARY CONTACT IS UNAVAILABLE

NAME: Mr. Ms. **FIRST:** **LAST:**

TITLE:

ORGANIZATION:

ADDRESS:

CITY: **STATE:** **ZIP CODE:**

TELEPHONE: **FAX:**

EMAIL:

LOCAL HAZARD MITIGATION PLAN INFORMATION

9. LOCAL HAZARD MITIGATION PLAN (LHMP) REQUIREMENT:

- i** A FEMA approved and locally adopted LHMP is required to receive federal funding for all project subapplication activities. Subapplicants for HMGP funding must have a FEMA-approved Mitigation Plan in place at the time of sub-award. Subapplication will be reviewed to ensure that the proposed activity is in conformance with subapplicant’s plan. For State agencies, please use the currently approved Enhanced State Hazard Mitigation Plan.

A. NAME/TITLE OF YOUR LHMP: Douglas County Hazard Mitigation Plan

<p>B. LOCAL SINGLE JURISDICTIONAL MULTHAZARD MITIGATION PLAN:</p> <p>DATE SUBMITTED TO NV DEM: 11/11/24</p> <p>DATE APPROVED BY FEMA: 4/24/25</p> <p>DATE ADOPTED BY LOCAL AGENCY: 12/19/24</p>	OR	<p>LOCAL MULTI JURISDICTIONAL MULTHAZARD MITIGATION PLAN:</p> <p>DATE SUBMITTED TO NV DEM: </p> <p>DATE APPROVED BY FEMA: </p> <p>DATE ADOPTED BY LOCAL AGENCY: </p> <p>LEAD AGENCY: </p>
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C. IF YOUR PROJECT IS REFERENCED IN YOUR LHMP, INDICATE WHERE THE PROPOSED PROJECT CAN BE FOUND; USE N/A FOR NOT APPLICABLE BOXES:

CHAPTER	PART	SECTION	PAGE
III. Mitigation Strategy	Goal #1	Action 1.8.5	III-24



DO NOT INCLUDE A COPY OF YOUR PLAN WITH SUBAPPLICATION.

D. PROVIDE A SHORT NARRATIVE DETAILING HOW YOUR PROJECT ALIGNS WITH THE RISK AND HAZARD ASSESSMENTS, STRATEGIES, GOALS AND/OR OBJECTIVES OF YOUR PLAN:

Flooding is the number one hazard in Douglas County. Based on historical events, flooding is a high probability in Douglas County. Goal 1 in the County’s Hazard Mitigation plan is to “Protect Lives, Property, and the Natural Environment.” Objective #1.8 is to “Reduce the possibility of damage and losses due to flood,” and Action #1.8.5 is to “Implement the Ruhestroth Area Drainage Plan,” which is one of the effects of this project.

COMMUNITY INFORMATION

10. COMMUNITY PARTICIPATION:

A. CHECK BOX(ES) IF YOUR COMMUNITY PARTICIPATES IN ANY OF THE FACTORS BELOW:

Select a column appropriate to your type of project. Acronyms include: Community Wildfire Protection Plan (CWPP), Community Rating System (CRS) Plan and Unreinforced Masonry (URM) Participation.

FIRE

CWPP, FIRE WIRE, FIRE SAFE

CURRENT CEQA ACTIVITY

DEFENSIBLE SPACE

FLOOD

CRS PLAN

CURRENT CEQA ACTIVITY

HYDROLOGY STUDY

EARTHQUAKE

SHAKEOUT DRILL PARTICIPATION

URM PARTICIPATION

B. PROVIDE A NARRATIVE DESCRIPTION OF ALL OF FACTORS SELECTED FROM LIST ABOVE:

Douglas County participates in FEMA's CRS program and is currently rated 6. The County encourages all property owners within the Special Flood Hazard Areas to obtain flood insurance.

C. IS YOUR JURISDICTION REQUIRED TO PROVIDE PUBLIC NOTICE OF THIS PROJECT?

Yes No If yes, provide details:

PROJECT INFORMATION

11. PROJECT TITLE: 1830 Bennett Court Repetitive Loss Property Acquisition and Demolition

MUST USE THE SAME PROJECT TITLE ORIGINALLY USED IN THE APPROVED NOTICE OF INTEREST (NOI). IF YOU NEED TO CHANGE YOUR PROJECT TITLE, CONTACT NV DEM at mitigation@dem.nv.gov

12. PROJECT LOCATION:

A. IDENTIFY THE COUNTY/COUNTIES WHERE THE ACTIVITY WILL OCCUR:

Douglas County

B. LATITUDE/LONGITUDE COORDINATES:

FEMA requires that all projects be geo-coded using latitude and longitude (lat/long) using NAD-83 or WGS-84 datum. The lat/long coordinates must be expressed in degrees including five or more decimal places (e.g., latitude 36.999221, longitude -109.044883).

LATITUDE	LONGITUDE
38.895769285457746	-119.68924762290547



IF THERE ARE MORE THAN ONE SET OF LAT/LONG COORDINATES, PROVIDE ON SEPARATE DOCUMENT AND ADD TO MAP SECTION OF BINDER.

C. STRUCTURE COORDINATES:

- For projects that protect buildings or other facilities, provide coordinates for each structure at either the front door of the structure or the intersection of the public road and driveway that is used to access the property.
- For large activity areas, such as detention basins or vegetation management projects, the location must be described by three or more coordinates that identify the boundaries of the project.
- The polygon created by connecting the coordinates must encompass the entire project area.

Map is attached; see map "5.3_Bennett Acquisition Project Map"

The coordinates shown include that of the boundary of the parcel, as well as the boundary of ground disturbance.

D. STAGING AREA:

Describe the project staging area. This is the area where the project equipment, materials and/or debris will be staged. Include a vicinity map with the proposed staging area(s) in the map section of the binder.

Map is attached; see map "5.2_Bennett Acquisition Staging Area Map"



AERIAL MAP(S) OF STAGING AREA(S) MUST BE INCLUDED IN SUBAPPLICATION.

E. SITE PHOTOS:

- A minimum of three ground photos per project site are required. Include in photo section of the binder.

F. MAPPING REQUIREMENTS:

Provide the following mapping elements in the map section of the binder:

- If project area has been mapped using GIS software, include the completed Shapefiles in electronic versions of full application.
- Include a vicinity map of the general area showing major roads. Aerial photographs may be used as vicinity maps.
- Prominently mark the project location on the vicinity map.
- Provide a detailed project map that clearly identifies the project boundaries.
- Project map must show all lat/long coordinates provided in the project description.
- Vicinity map and the project map must both have a north arrow and scale.

 SEND ONLY ELECTRONIC VERSIONS OF MAPS.

G. PUBLIC ASSISTANCE (PA) PROGRAM FUNDING:

List any Public Assistance Disaster Survey Reports (DSR) or Project Worksheets (PWs) that were completed at the project location from previous disasters. List all current engagement with PA for this current disaster and include date(s) if known:

N/A

H. DEED RESTRICTIONS THAT LIMIT FEDERAL FUNDING:

Is there a deed restriction or permanent conservation easement on the property at the project site that would prohibit federal disaster funding (e.g., a previously FEMA funded acquisition of a structure on this property)? If yes, describe in detail.

No

13. PROJECT DESCRIPTION:

A. APPLICATION TYPE:

- Project 5% Activity

5% activities are defined as mitigation actions that are consistent with your local hazard mitigation plan and meet all HMGP requirements but may be difficult to conduct a standard BCA to prove cost-effectiveness. Examples: early earthquake warning system, back-up generators for critical facilities, public awareness campaign, mitigation specific community outreach activities.

B. PROJECT TYPE:

Select at least one project type; select as many as needed to accurately describe project.

<input type="checkbox"/> EARTHQUAKE	<input type="checkbox"/> FIRE	<input checked="" type="checkbox"/> FLOOD	<input type="checkbox"/> OTHER
<input type="checkbox"/> CODE ENFORCEMENT	<input type="checkbox"/> DEFENSIBLE SPACE	<input checked="" type="checkbox"/> ACQUISITION	<input type="checkbox"/> CRITICAL FACILITY GENERATOR(S)
<input type="checkbox"/> NON-STRUCTURAL	<input type="checkbox"/> FIRE RESISTANT BUILDING MATERIALS	<input type="checkbox"/> DRY FLOOD PROOFING	<input type="checkbox"/> DROUGHT <input type="checkbox"/> TSUNAMI
<input type="checkbox"/> STRUCTURAL	<input type="checkbox"/> FIRE VEGETATION MANAGEMENT	<input type="checkbox"/> FLOOD CONTROL	<input type="checkbox"/> WIND

<input type="checkbox"/> NON-STRUCTURAL & STRUCTURAL	<input type="checkbox"/> SOIL STABILIZATION	<input type="checkbox"/> ELEVATION	<input type="checkbox"/> OTHER: <input type="text"/>
<input type="checkbox"/> Resilience and Climate Change Adaptation : Projects that mitigate risk through restoration of the natural environment			

C. DESCRIBE PROBLEM/HAZARDS/RISKS:

Describe the problem this project is attempting to solve and the expected outcome. Describe the hazards and risks to life, safety and any improvements to property in the project area for at least the last 25 years. Describe in detail how the project reduces hazard effects and risks.

The property at 1830 Bennett Court has experienced repeated losses due to flooding, and its location makes it susceptible to future flooding. Acquiring this property and removing the structure will remove a potential hazard from the flood plain in a SFHA, mitigating future flooding of this structure while also improving flood control for the area.

D. DESCRIBE RECENT EVENTS THAT INFLUENCED THE SELECTION OF THIS PROJECT:

Describe recent events (e.g. changes in the watershed, discovery of a new hazard, zoning requirements, inter-agency agreements, etc.) that influenced the selection of this project.

Flooding in this area worsened after the Sept. 25, 2025, Connor Fire impacted the Ruhenstroth drainage area, destroying vegetation that had previously helped reduce flooding. The fire additionally caused sediment in the area to become hydrophobic, leading to additional runoff. Heavy rainfall post-fire led the property to flood again.

E. SCOPE OF WORK (SOW):

STATE EXACT SOW DOCUMENT TITLE:

1. Describe the entire SOW of the project in clear, concise, ample detail.
2. Must provide a thorough description of **all tasks and activities** to be undertaken.
3. Must be written in sequential order from start to finish of the project.
4. Describe any land acquisition activities, and/or right-of-way or access easements that need to be obtained.
5. If structural, discuss how the structure/building/facility will be constructed or retrofitted.
6. Include building or structure dimensions, material types, depth and width of excavations, volume of materials excavated, type of equipment to be used, staging and parking areas, and any phasing of the project.
7. If any tunneling is proposed, describe the method and any temporary trenches or pits.
8. Describe any demolition activities that need to occur prior to construction or retrofitting.



INSERT THIS DOCUMENT IN THE SOW ORDER OF YOUR ELECTRONIC DOCUMENTS.

F. HAS YOUR JURISDICTION PREVIOUSLY RECEIVED HMGP FUNDING?

Yes No Unknown | If yes, provide disaster number(s):

G. HAS YOUR JURISDICTION RECEIVED ANY OTHER FUNDING?

Describe all other funding received for this project and all other recent projects. Identify the funding source (i.e., Federal, State, Private, etc.).

Douglas County has not received other funding for this project, but the County is a recipient of many other federal and state funds and is well-equipped to manage federal grants of this size. Below is a list of federal grants received by the County:
 NDOT FHWA – 20.205 P656-15-063 \$2,231,675. Completed on time and within Budget
 NDOT FHWA – 20.205 \$603,720. Completed on time and within Budget.
 NDOT FHWA – 20.205 P242-21-019 \$350,000. Completed on time and within Budget.

NDOT USDHS – 97.047 9704715-2506 \$1,572,404. Completed on time and within Budget.
 NDOT USDOT –20.205 PR056-15-063 \$764,995. Completed on time and within Budget.
 NDOT FTA – 5311 20.509 PR504-19-802 \$473,375 Completed on time and within Budget.
 NDOT FTA – 5339 20.509 PR578-21-802 \$400,000 In progress.
 DOJ OVW – 16.589 2017WRAX004 \$1,496,308. Closes Mar 2024.
 DOJ OVW – 16.589 15JOVW-23-GG-02809-RURA \$750,000 New award.
 FAA – 20.106 AIP-3 32-0013-033-2019 \$2,611,723. Completed on time and under Budget.
 FAA –20.106 3-32-0013-037-2021 \$382,837 Completed on time and within Budget.
 FAA – 20.106 3-2-0013-036-2020 \$3,265,536 Completed on time and within Budget.
 US Treasury – 21.019 CARES – \$8,920,482
 US Treasury – 21.019 CSLFRF – \$9,499,223

H. RELATED PROJECTS:

Describe any other projects or project components (whether or not funded by FEMA), which may be related to the proposed project, or are in (or near) the proposed project area. FEMA must look at all projects to determine a cumulative effect. FEMA reviews all interrelated projects under NEPA regulations.

Douglas County is working to address flooding in the Smelter Creek area in a comprehensive way, as outlined in the Ruhenstroth Area Drainage Master Plan. This includes various stormwater efforts such as upgrading, replacing and installing culverts, and a proposed sediment basin upstream of the residential Ruhenstroth area. However, these efforts are unlikely to improve the flooding faced by the property at 1830 Bennett Court due to its location in relation to the drainage canal.

I. HAZARD ANALYSIS TYPE:

Select the hazard(s) below that this project will protect against. Select as many as needed.

- | | | | |
|--|---|---|--|
| <input type="checkbox"/> BIOLOGICAL | <input type="checkbox"/> EARTHQUAKE | <input type="checkbox"/> LAND SUBSISTENCE | <input type="checkbox"/> TERRORIST |
| <input type="checkbox"/> CHEMICAL | <input type="checkbox"/> FIRE | <input type="checkbox"/> MUD/LANDSLIDE | <input type="checkbox"/> TORNADO |
| <input type="checkbox"/> CIVIL UNREST | <input type="checkbox"/> FISHING LOSSES | <input type="checkbox"/> NUCLEAR | <input type="checkbox"/> TOXIC SUBSTANCES |
| <input type="checkbox"/> COASTAL STORM | <input checked="" type="checkbox"/> FLOOD | <input type="checkbox"/> SEVERE ICE STORM | <input type="checkbox"/> TSUNAMI |
| <input type="checkbox"/> CROP LOSSES | <input type="checkbox"/> FREEZING | <input type="checkbox"/> SEVERE STORM(S) | <input type="checkbox"/> WINDSTORM |
| <input type="checkbox"/> DAM/LEVEE BREAK | <input type="checkbox"/> HUMAN CAUSE | <input type="checkbox"/> SNOW | <input type="checkbox"/> OTHER (describe below): |
| <input type="checkbox"/> DROUGHT | <input type="checkbox"/> HURRICANE | <input type="checkbox"/> SPECIAL EVENTS | <input type="text"/> |

J. DESIGN PLANS:

- If your project requires design plans, plans should be prepared to supplement the SOW. FEMA prefers 60% design completion at time of application submission. If the project involves ground disturbance, (e.g. enlarging ditches or culverts, diversion ditches, detention basins, storm water improvements, etc.) include the following:
- Scale:** Plans should be drawn to scale (e.g. 1" to 100' or 1" to 200') depicting the entire land parcel, showing buildings, improvements, underground utilities, other physical features, dimensions and cross sections.
 - Identification:** Indicate agency name, landowner, civil engineer, soil engineer, geologist, map preparer, and date of map preparation. Also, indicate the name of the project.
 - Legend/Orientation:** Include a legend explaining all lines and symbols. Identify property acreage and indicate direction with a north arrow (pointing to top or right-hand side of the plan).
 - Dimensions:** Show property lines and dimensions. Also, show boundary lines of project and their dimensions if only a portion of the property is being utilized for the project.
 - Structures:** Identify all existing and proposed buildings and structures including storm drains, driveways, sidewalks and paved areas.

6. **Utilities:** Indicate names and location of utilities on property (water, sewage, gas, electric, telephone, cable).
 7. **Roads/Easements:** Indicate location, names, and centerline of streets and recorded roads. Identify any utility, drainage or right-of-way easements on the property.
 8. **Drainage:** Show the location, width and direction of flow of all drainage courses on site.
 9. **Grading/Topographic Information:** Show existing surface contours on-site and bordering the property
 10. **Parking:** Show all construction parking and staging areas and provide dimensions.
 11. **Cross Sections:** Provide cross sections of proposed buildings, structures or other improvements, and any trenches, temporary pits or catchment basins.
- If applicable, provide studies and engineering documentation, including any Hydrology and Hydraulics (H&H) data.
- If applicable, provide drawings or blueprints that show the footprint and elevations.



PLEASE SEND ELECTRONIC VERSIONS OF DESIGN PLANS, DRAWINGS OR BLUEPRINTS.

K. PROJECT ALTERNATIVES:

Identify three project alternatives. NOTE: Proposed action is not based solely on cost but must address feasibility.

1. ALTERNATIVE #1 – NO ACTION:

Describe the No Action alternative below. The No Action alternative evaluates the consequences of taking no action and leaving conditions as they currently exist.

If no action is taken, the property at this location faces the risk of continued flooding and loss.

2. ALTERNATIVE #2 – PROPOSED ACTION:

Describe the Proposed Action alternative below. The Proposed Action alternative is the proposed project to solve the problem. Explain why the proposed action is the preferred alternative. Identify how the preferred alternative will solve the problem, why the preferred alternative is the best solution for the community, why and how the alternative is environmentally preferred and why the project is the economically preferred alternative.

Douglas County seeks to acquire the property to resolve the flooding issues faced by the homeowners and also contribute to improved flood control in the project area and surrounding properties. The project will consist of the acquisition of the property; demolition of the structure currently on the property; capping of all utilities; and restoration of the property to its natural or neutralized topographical state. In addition, there appears to be an area north of the site that has been re-graded and modified, with berming placed on the adjacent property owned by Bureau of Land Management. The County will work with BLM and gain permission to restore this area as well, specifically to regrade the berms and restore the original profile and natural drainage patterns.

3. ALTERNATIVE #3 – SECOND ACTION ALTERNATIVE:

Describe the Second Action alternative below. The Second Action alternative described must also solve the described problem. State why this alternative wasn't chosen. It must be a viable project that could be substituted in the event the proposed action is not chosen.

Elevating the home is another flood preventative measure that could be considered, but it would likely be cost prohibitive for the homeowner.

WORK SCHEDULE INFORMATION

14. PROJECT WORK SCHEDULE:

The intent of the work schedule is to provide a realistic appraisal of the time and components required to complete the project.

- Describe each of the major work elements and milestones in the description section below.
- Project subapplication examples are: construction, architectural, design, engineering, inspection, testing, permits, project management, mobilization and de-mobilization.
- State the total timeframe anticipated for each of the work elements.
- State the total timeframe anticipated to complete the project.
- Work schedule must mirror SOW, budget and BCA. OPTIONAL: Provide the work schedule in GANTT chart form as supplemental documentation in the work schedule section of the binder Include this information as an example.

WORK SCHEDULE EXAMPLE		
#	DESCRIPTION	TIMEFRAME
1.	Kick-off, 90% design meetings	3 months
2.	Final contract drawing development	5 months
3.	Open bids and award contract	4 months
4.	Construction – Mobilization	5 months
5.	Construction – Demolition	4 months
6.	Construction – Concrete and conduit work	2 months
7.	Construction – Trenching	2 weeks
8.	Construction – Utility relocation	4 months
9.	Construction – Electrical Installation	1 month
10.	Construction – Site Restoration	1 week
11.	Construction – Complete punch list	2 months
12.	Construction – Demobilization	1 week
13.	Project Close-out and record drawings	2 months
14.	Grant Close out	3 months
TOTAL MONTHS:		36 months



TOTAL PROJECT DURATION (INCLUDING CLOSE-OUT) MUST NOT EXCEED A 36 MONTH PERIOD OF PERFORMANCE (POP).

#	DESCRIPTION	TIMEFRAME
1.	Grant Awarded	1 day
2.	Funding Accepted	120 days
3.	Acquisition	120 days
4.	Demolition Bid Solicitation and Award	60 days
5.	Demolition Permit	1 week
6.	Utility Disconnection	1 week
7.	Structural Demolition and Debris Removal	30 days
8.	Well Abandonment	30 days
9.	Septic System Decommissioning	30 days
10.	Land Grading and BLM Property Remediation	30 days
11.	Complete Public List	15 days
12.	Project Close-out	30 days
13.	STANDARD VALUE (DO NOT CHANGE) Grant Close-out	3 months
TOTAL MONTHS:		19 mo

If more lines are needed than provided, indicate the title of document in box 1 and attach a separate work schedule in the schedule section of binder.

COST ESTIMATE INFORMATION

15. HMGP COST ESTIMATE SPREADSHEET:

A. COST ESTIMATE INSTRUCTIONS:

Using the [HMGP Cost Estimate Spreadsheet](#), provide a detailed cost estimate breakdown.

Spreadsheet, provide a detailed cost estimate breakdown.

- Cost estimate describes the anticipated costs associated with the SOW for the proposed mitigation activity. Cost estimates must include detailed estimates of cost item categories.
- Only include costs that are directly related to performing the mitigation activity. If additional work, such as remodeling, additions, or improvements are being done concurrently with the mitigation work, do not include these costs in the submitted budget.
- Documentation that supports the budget must be attached to the subapplication in the budget section of the binder.
- Total costs must be consistent with the requested federal share plus the matching funds and must be consistent with the project cost in the Benefit Cost Analysis (BCA), SOW, and work schedule.

#	ITEM NAME	Unit Qty	UNIT	UNIT COST	COST EST TOTAL
1.	Pre-Award Costs: Develop BCA	4	HR	\$150	\$600
2.	Temp. Inlet Filter Rolls	4	EA	\$250	\$1000
3.	Temp. Fiber Roll	1850	LF	\$3	\$5550
4.	Hydraulic Mulch	1000	SQYD	\$2	\$2000
5.	Plane Asphalt Concrete Pavement	650	SQYD	\$22	\$14300
6.	Street Sweeping for 30 days	30	EA	\$350	\$10500
7.	Roadway Excavation	70	CY	\$40	\$2800
8.	Aggregate Base, Class 2	210	CY	\$75	\$15750
9.	Remove Concrete Pavement	650	SQYD	\$340	\$10540
10.	Asphalt Concrete, Type B	180	TON	\$150	\$27000
11.	Asphalt Concrete, Leveling	10	TON	\$300	\$3000
12.	Asphalt Concrete Dike, Type A	235	LF	\$15	\$3525
13.	Asphalt Concrete Dike, Type F	125	LF	\$8	\$120
14.	Place Asphalt Concrete	15	SQFT	\$8	\$120
15.	18" Corrugated Steel Pipe Riser	5	LF	\$125	\$625
16.	24" Reinforced Concrete Pipe	275	LF	\$170	\$46750
17.	84" Reinforced Concrete Pipe Install	572	LF	\$400	\$228800
18.	Precast Triple Concrete Box Culvert	44	LF	\$1500	\$66000
19.	Curb Inlet - Type B-1 (L=9')	1	EA	\$6000	\$6000
20.	Curb Inlet - Type B-1 (L=13')	1	EA	\$6300	\$6300
21.	Curb Inlet - Type B-1 (L=15')	1	EA	\$6800	\$6800
22.	Storm Drain Cleanout - Type A-8	3	EA	\$7500	\$22500
23.	8" PVC Sewer	89	LF	\$100	\$8900
24.	Cellular Block (Precast)	4100	SQFT	\$20	\$82000
25.	Project Identification Sign	2	EA	\$1000	\$2000
Total Project Cost Estimate:					\$573480



NOTE: If requesting sub-recipient management costs, these must be requested in a separate cost estimate spreadsheet.

B. INELIGIBLE COSTS:

The following are ineligible line items:

- Lump Sums
- "Other" Costs
- Cents (must use whole dollar amounts, round unit prices up to whole dollars)
- Contingency Costs
- Indirect Charges
- Miscellaneous Costs
- Overhead Costs

C. PRE-AWARD COSTS:

Eligible pre-award costs are costs incurred after the disaster date of declaration, but prior to grant award. Pre-award costs directly related to developing the application may be funded.

- Developing a BCA
- Submission of subapplication
- Workshops or meetings related to development
- Preparing design specifications
- Gathering environmental and historic data



Subapplicants who are not awarded funds will not receive reimbursement for pre-award costs.

D. COST ESTIMATE NARRATIVE:

FEMA requires a cost estimate narrative that explains all projected expenditures in detail. The cost estimate narrative is intended to mirror the cost estimate spreadsheet and should include a full detailed narrative to support the cost estimates listed in the HMGP Project Cost Estimate Spreadsheet.

If your cost estimate includes City, County, or State employees' time (your agency), include personnel titles and salary/hourly wages plus benefits for a total hourly cost. Detailed timesheets must be retained.

Title the document "Cost Estimate Narrative" and include in the budget section of the binder.

16. FEDERAL/NON-FEDERAL SHARE INFORMATION:

A. FUNDING RESTRICTIONS:

HMGP funding is restricted to a maximum of \$5 million federal share for each project subapplication. FEMA will contribute up to 75 percent of the total project cost. A minimum of 25 percent of the total eligible costs must be provided from a non-federal source. State does not contribute to local cost share.

For example: for a \$6,250,000 total project cost, the federal requested share (75 percent) would be \$5,000,000. The non-federal match share (25 percent) provided would be \$1,250,000.

A jurisdiction may contribute an amount greater than the 25 percent non-federal share.

For example: for a \$10,000,000 total project cost, the federal requested share cannot exceed \$5,000,000. Therefore, the non-federal match provided must be \$5,000,000, which exceeds 25 percent of the total cost share. The sum of the non-federal and federal shares must equal the total project cost. In some instances, a grant may be 90% reimbursable with 10% match.

B. TOTAL PROJECT COST ESTIMATE:

\$799,798

Enter total cost formulated on [HMGP Cost Estimate Spreadsheet](#) ENTER \$ IN BOX ABOVE



VERIFY ALL AMOUNTS ENTERED ARE ACCURATE.

INCORRECT AMOUNTS WILL DELAY PROCESSING OF YOUR SUBAPPLICATION.

FEDERAL SHARE (75% MAXIMUM)	REQUESTED AMOUNT:	\$599,848.50
		ENTER \$ IN BOX ABOVE
	PERCENTAGE AMOUNT:	75%
		ENTER % IN BOX ABOVE
NON-FEDERAL SHARE (25% MINIMUM)	REQUESTED AMOUNT:	\$199,949.50
		ENTER \$ IN BOX ABOVE
	PERCENTAGE AMOUNT:	25%
		ENTER % IN BOX ABOVE

C. NON-FEDERAL MATCH SOURCE: MATCH COMMITMENT LETTER:

- Use the [Local Match Commitment Letter Template](#) to complete this section and add completed letter to the match section of the binder.

- A signed Match Commitment Letter must be provided on agency letterhead.
- The non-federal source of matching funds must be identified by name and type.
- If “other” is selected for funding type, provide a description.
- Provide the date of availability for all matching funds.
- Provide the date of the Funding Match Commitment Letter.
- The funds must be available at the time of submission unless prior approval has been received from NV DEM.
- If there is more than one non-federal funding source, provide the same information for each source on an attached document.
- Match funds must be in support of cost items listed in the cost estimate spreadsheet.
- Requirements for donated contributions can be found in 2 CFR 200.306.

BENEFIT/COST EFFECTIVENESS INFORMATION

17. BENEFIT/COST EFFECTIVENESS INFORMATION

A. BCA INSTRUCTIONS:

FEMA will only consider subapplications from subapplicants that use a FEMA-approved methodology to conduct the Benefit Cost Analysis (BCA). BCA must be legible, complete and well-documented.

- Project BCAs must demonstrate cost-effectiveness through a Benefit Cost Ratio (BCR) of 1.0 or greater.
- Projects with a BCR of less than 1.0 will not be considered for funding.
- Total project cost must be used in the BCA.
- Maintenance of a completed HMGP project is not an eligible reimbursement activity but must be included in the BCA.

BCA Version 6.0 is the only software that is allowed for conducting a BCA. Some project types may qualify for pre-calculated benefits. Additional information on the BCA Toolkit is available at: <https://www.fema.gov/benefit-cost-analysis>.

 The FEMA BCA Technical Assistance Helpline is available to provide assistance with FEMA’s BCA software by calling 1-855-540-6744 or via email at BCHelpLine@FEMA.dhs.gov. The FEMA helpline is only to be utilized for technical assistance questions. The FEMA helpline will not verify the accuracy of your BCA.

B. BCA INFORMATION:

Once the BCA is completed, enter information requested below.

- 1. NET PRESENT VALUE OF PROJECT BENEFITS:**
- 2. TOTAL PROJECT COST ESTIMATE:**
- 3. BENEFIT COST RATIO:**

C. ANALYSIS TYPE:

- FLOOD WILDFIRE EXEMPT (5% PROJECTS) EARTHQUAKE

- HURRICANE WIND
 DROUGHT
 PRE-CALCULATED
 LANDSLIDE
 DAMAGE FREQUENCY ASSESSMENT (DFA)

D. ANALYSIS DATE (date BCA was conducted):

E. PROVIDE BCA ELECTRONIC COPIES IN FORMAT DESCRIBED BELOW:

- Provide An electronic copy of the report in the BCA section of the binder and all backup documentation for information used in the BCA.

MAINTENANCE ASSURANCE INFORMATION

18. PROJECT MAINTENANCE INFORMATION:

A. MAINTENANCE ASSURANCE LETTER:

- Using the [Project Maintenance Letter Template](#), identify all maintenance activities required to preserve the long-term mitigation effectiveness of the project.
- Examples of maintenance include inspection of the project, cleaning and grubbing, trash removal, replacement of worn out parts, etc.
 - Attach a maintenance schedule, estimated annual costs, and a signed maintenance commitment letter for the useful life of the project.

NATIONAL FLOOD INSURANCE PROGRAM (NFIP)

19. NFIP INFORMATION:

 CONTACT YOUR COUNTY OR LOCAL FLOODPLAIN ADMINISTRATOR FOR NFIP INFORMATION.

A. NFIP PARTICIPATION:

1. Is the jurisdiction where the project is located participating in the NFIP? YES NO
- a. If yes, are they in good standing? YES NO
- b. If no, explain:

B. PROJECT LOCATION:

1. Is this project located in a floodplain or floodway designated on a FEMA Flood Insurance Rate Map (FIRM)? YES NO
- a. Mark the project location on the FIRM and attach to subapplication in the maps section of the binder.
2. Provide the following information for the location of the project:
- a. FIRM panel number:
- b. FIRM zone designations:
- c. NFIP community ID number:

C. LAST COMMUNITY ASSISTANCE VISIT (CAV) DATE: 3/1/2024

ENVIRONMENTAL INFORMATION

20. ENVIRONMENTAL INFORMATION:

A. FEMA ENVIRONMENTAL CHECKLIST:

- Complete the [FEMA Site Information, Environmental Review, and Checklist](#) and attach to the environmental section of the binder. Provide a detailed response to each question. Attach supporting documentation in compliance with [FEMA's frontloading requirements](#).

OTHER

21. OTHER

A. CID Number: 320008

NOTE: If any work is to occur on federal land, you MUST reach out to the federal agency and include a copy of that correspondence with your application.

***FEMA allows 5% of total project cost (federal and non-federal total) for subrecipient management costs reimbursed at 100% (no match required).**

PRINT THIS PAGE – ORIGINAL SIGNATURE IS REQUIRED

PROJECT CONDITIONS

Indicate by checking each box below that you will adhere to these listed project conditions.

- If during implementation of the project, ground-disturbing activities occur and artifacts or human remains are uncovered, all work will cease and FEMA, NV DEM, and the State Historic Preservation Officer (SHPO) will be notified.
- If deviations from the approved scope of work result in design changes, the need for additional ground disturbance, additional removal of vegetation, or will result in any other unanticipated changes to the physical environment, FEMA will be contacted and a re-evaluation under NEPA and other applicable environmental laws will be conducted.
- If wetlands or waters of the U.S. are encountered during implementation of the project, not previously identified during project review, all work will cease and FEMA will be notified.
- Due to the Federally mandated Environmental and Historic Preservation (EHP) review; no construction will occur for this project prior to FEMA and NV DEM approval.

AUTHORIZATION

The undersigned does hereby submit this subapplication for financial assistance in accordance with the Federal Emergency Management Agency's (FEMA) Hazard Mitigation Grant Program (HMGP) and the State Hazard Mitigation Administrative Plan and certifies that the subapplicant (e.g., organization, city, or county) will fulfill all requirements of the program as contained in the program guidelines and that all information contained herein is true and correct to the best of our knowledge.

Subapplicant Authorized Agent

NAME: Tom Dallaire, P.E.

TITLE: Community Development Director

ORGANIZATION: Douglas County

SIGNATURE:

DATE: 2/27/2025

C. LAST COMMUNITY ASSISTANCE VISIT (CAV) DATE: 3/1/2024

ENVIRONMENTAL INFORMATION

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TITLE: Community Development Director

ORGANIZATION: Douglas County

SIGNATURE: 

DATE: 2/27/2025

HAZARD MITIGATION GRANT PROGRAM
**1830 Bennett Court Repetitive Loss Property
Acquisition and Demolition**
Douglas County Project Subapplication

SCOPE OF WORK

The following is a Scope of Work (SOW) for the 1830 Bennett Court Repetitive Loss Property Acquisition and Demolition.

DESCRIPTION

Douglas County seeks to acquire a property that has faced repetitive losses due to flooding on Bennett Court in the Ruhenstroth community in the town of Gardnerville, Douglas County. This project will resolve the flooding issues at this property and also contribute to improved flood control in the project area and surrounding properties. The project will consist of the acquisition of the property; demolition of the structure currently on the property; capping of all utilities; and restoration of the property to its natural or neutralized topographical state. In addition, there appears to be an area north of the site that has been re-graded and modified, with berming placed on the adjacent property owned by Bureau of Land Management. The County will work with BLM and gain permission to restore this area as well, specifically to regrade the berms and restore the original profile and natural drainage patterns.

TASKS AND ACTIVITIES

In order to successfully complete the Project, the following tasks are contemplated as listed below. The Project schedule meets the maximum 36-month Period of Performance.

1. Grant Awarded (1 day). Self-explanatory.
2. Funding Accepted (120 days). Once the grant is awarded Douglas County requires that an item is prepared and presented to the Board of County Commissioners (BOCC) to formally accept the award. This process requires preparation of a staff report, presentation to the County's Internal Review Committee (IRC), scheduling of the item at a regularly scheduled board meeting and then finally presentation to the BOCC for approval.

3. Acquisition (120 days). Acquire the property located at 1830 Bennett Court. Before any work can be done on the site the County will need to acquire the land at the market rate before the September 2025 flooding event. The property includes an 1,874 SF home that was constructed in 1995.
4. RFP for Demolition and Land Grading/Remediation (60 days): The County will procure a qualified contractor through a competitive process, conforming to all Federal procurement regulations in 2 CFR Part 200 and C 4220.1F and 49 CFR part 26.
5. Douglas County-issued Demolition Permit (1 week). A demolition permit by Douglas County will be acquired.
6. Utility Disconnection (1 week). Before any structural demolition begins, the site must be rendered safe and disconnected from municipal or private grids.
 - a. Electrical: Coordinate directly with NV Energy to perform a formal service disconnection and meter removal. No demolition shall commence until a "Safe-to-Demo" clearance is provided.
 - b. Gas/Propane: Conduct a final site sweep to confirm the absence of any buried or obscured propane tanks. (Current assessment indicates no propane infrastructure is present).
 - c. It would be the desire of the county to remove all underground piping related to these facilities and would ask that these conduits be removed from the site.
7. Structural Demolition and Debris Removal (30 days). The primary objective is the complete removal of all man-made structures and accumulated refuse.
 - a. Primary Structure: Complete demolition of the residential home, including roof, walls, floors, foundations and footings, other out buildings and fencing. The material will be removed from the site and disposed of as needed. The home was estimated to be constructed in 1994/1995, and we do not anticipate that lead paint or asbestos materials were used in the home. There may be a requirement to make a report of the materials of the home so the contractor removing the home knows what environmental controls will be needed for the demolition operations.
 - b. Hardscape & Perimeter: Removal of the concrete driveway, wooden decks, and concrete patios and all concrete footings and piers. All perimeter fencing and posts must be extracted and disposed of.
 - c. General Cleanup: Systematic removal of all "junk," scattered debris, and non-natural materials from the entirety of the property.
8. Well Abandonment (30 days). All work must comply with the Nevada Division of Water Resources (NDWR) regulations.

- a. Procedure: The existing well must be properly capped and filled using approved materials (typically neat cement or bentonite grout) to prevent groundwater contamination.
 - b. Compliance: A formal Well Driller's Report (Plugging Record) must be filed with the State of Nevada to officially decommission the well.
9. Septic System Decommissioning (30 days). The onsite sewage disposal system must be rendered inert and structurally sound.
 - a. Pumping: A licensed septage hauler must pump all effluent from the tank.
 - b. Demolition: The top of the septic tank (lid/riser) must be crushed or removed to prevent future collapses or "voids."
 - c. In-filling: The remaining tank cavity must be filled with sand or engineered fill and compacted.
10. Land Grading and BLM Property Remediation (30 days). The site will be returned to a natural or neutralized topographical state.
 - a. BLM Land Restoration: Specifically, re-grade the berms located on adjacent Bureau of Land Management (BLM) land to restore the original profile and natural drainage patterns. There appears to be an area north of the site that has been re graded and modified and berming was placed on the neighboring property that is owned by Bureau of Land Management. The County will need to work with Bureau of Land Management and gain permission to restore the area back to the original natural state.
 - b. Site-Wide Regrading: Perform a comprehensive regrade of the property. This includes smoothing out prior grading modifications, filling excavations from the demo, and ensuring the site is stabilized against erosion and protected during future storm events from erosion during a flooding event.
11. Complete Punch List (15 days). A punch list will be developed and the contractor will complete the necessary corrections prior to finalizing the permit.
12. Project Close-out (30 days). Release of bonds and final payment will be made to the contractor to close out the project.
13. Grant Close-out (90 days). Grant paperwork will be finalized and submitted to the funding agency along with the record drawings, test results, inspection reports and other documents as may be required or requested by the funding agencies.

LAND ACQUISITION

Douglas County will acquire 1830 Bennett Court, a 1.13 acre property with APN: 1220-24-101-002.

CONSTRUCTION

There is no construction associated with this project at this time.

DEMOLITION

The house at 1830 Bennett Court will be demolished. Please see above for the scope of work for this section of the project.



REVISIONS	



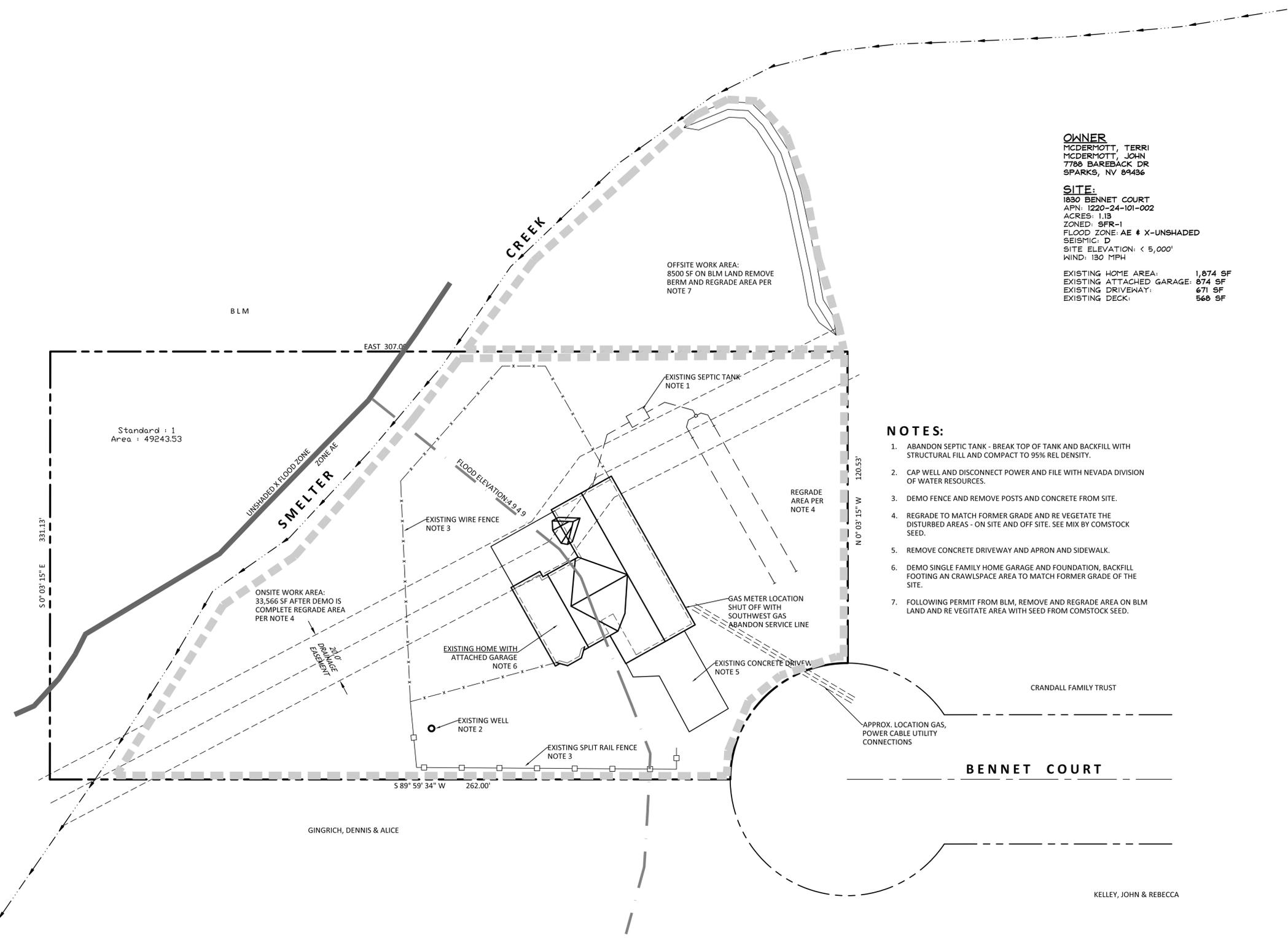
DEMO PLAN FOR:
DOUGLAS COUNTY
1830 BENNET COURT
GARDNERVILLE NV 89460
 APN: 1220-24-101-002
 NEVADA
 DOUGLAS COUNTY

DEMOLITION
PLAN

RELEASE DATE:
FEBRUARY 2026
 SHEET NUMBER:
D1



SETTELMAYER RANCHES INC



OWNER
 MCDERMOTT, TERRI
 MCDERMOTT, JOHN
 7788 BAREBACK DR
 SPARKS, NV 89436

SITE:
 1830 BENNET COURT
 APN: 1220-24-101-002
 ACRES: 1.13
 ZONED: SFR-1
 FLOOD ZONE: AE # X-UNSHADED
 SEISMIC: D
 SITE ELEVATION: < 5,000'
 WIND: 130 MPH

 EXISTING HOME AREA: 1,874 SF
 EXISTING ATTACHED GARAGE: 874 SF
 EXISTING DRIVEWAY: 671 SF
 EXISTING DECK: 568 SF

- NOTES:**
1. ABANDON SEPTIC TANK - BREAK TOP OF TANK AND BACKFILL WITH STRUCTURAL FILL AND COMPACT TO 95% REL DENSITY.
 2. CAP WELL AND DISCONNECT POWER AND FILE WITH NEVADA DIVISION OF WATER RESOURCES.
 3. DEMO FENCE AND REMOVE POSTS AND CONCRETE FROM SITE.
 4. REGRADE TO MATCH FORMER GRADE AND RE VEGETATE THE DISTURBED AREAS - ON SITE AND OFF SITE. SEE MIX BY COMSTOCK SEED.
 5. REMOVE CONCRETE DRIVEWAY AND APRON AND SIDEWALK.
 6. DEMO SINGLE FAMILY HOME GARAGE AND FOUNDATION, BACKFILL FOOTING AN CRAWLSPACE AREA TO MATCH FORMER GRADE OF THE SITE.
 7. FOLLOWING PERMIT FROM BLM, REMOVE AND REGRADE AREA ON BLM LAND AND RE VEGITATE AREA WITH SEED FROM COMSTOCK SEED.



REVISIONS	



DEMO PLAN FOR:
DOUGLAS COUNTY
1830 BENNET COURT
GARDNERVILLE NV 89460
 APN: 1220-24-101-002
 NEVADA
 DOUGLAS COUNTY

OWNER
 MCDERMOTT, TERRI
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DEMOLITION
PLAN

RELEASE DATE:
FEBRUARY 2026
 SHEET NUMBER:
D1

Ruhenstroth Area Drainage Master Plan Phase 1

Technical Support Data Notebook



October
2020

prepared for
Douglas County | Carson Water Subconservancy District



Date Signed: October 21, 2020

MICHAEL J. KELLOGG
Professional Geologist (AZ, CA, UT, TX, OR)
Date Signed: October 21, 2020



8400 S Kyrene Rd, STE 201
Tempe, AZ 85284
www.jefuller.com

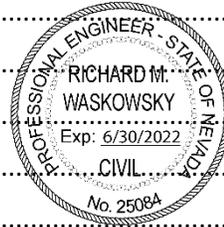
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Date Signed: October 21, 2020
 MICHAEL J. KELLOGG
 Professional Geologist (AZ, CA, UT, TX, OR)
 Date Signed: October 21, 2020

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Date Signed: October 21, 2020

MICHAEL J. KELLOGG

Professional Geologist (AZ, CA, UT, TX, OR)

Date Signed: October 21, 2020

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Appendices

Appendix A – QSI LiDAR Report

Appendix B – Supporting Data (Digital)

1 INTRODUCTION

1.1 PROJECT PURPOSE

Phase I of the Ruhenstroth Area Drainage Master Plan (RADMP) was developed to meet three primary objectives:

1. Evaluate and identify flooding and sedimentation hazards within the project area by completion of a technical study that includes data collection, review of previous studies, information gathering from public agencies and residents, hydrologic and hydraulic modeling, geomorphic assessments, and field surveys.
2. Develop concepts for all-weather access crossings of Smelter Creek for existing conditions.
3. Provide stakeholder coordination and public outreach of the project through a series of public meetings to inform of the existing hazards and to present the mitigation alternatives.

Each major task of the project is presented herein with a description of the technical approach, analysis results, interpretation of results, and applicability to the overall project purpose. The results of this study can be used as a planning tool and as input to the design of potential future drainage infrastructure and flood mitigation measures that are appropriate for the physical environment for both existing and future development.

Phase II of the Ruhenstroth ADMP is a future study that will be used to develop a series of alternatives to either partially or wholly mitigate the hazards identified in Phase I of the ADMP.

1.2 PROJECT LOCATION

The Ruhenstroth ADMP watershed area is 18 square miles and is located on the western slopes of the Pine Nut Mountains, approximately 16 miles south of Carson City (Figure 1-1). The study area is located entirely within Douglas County about 6 miles southeast of the Minden-Gardnerville area. The primary focus area of the RADMP is the lower watershed area downstream of the mountains, also shown on Figure 1-1.

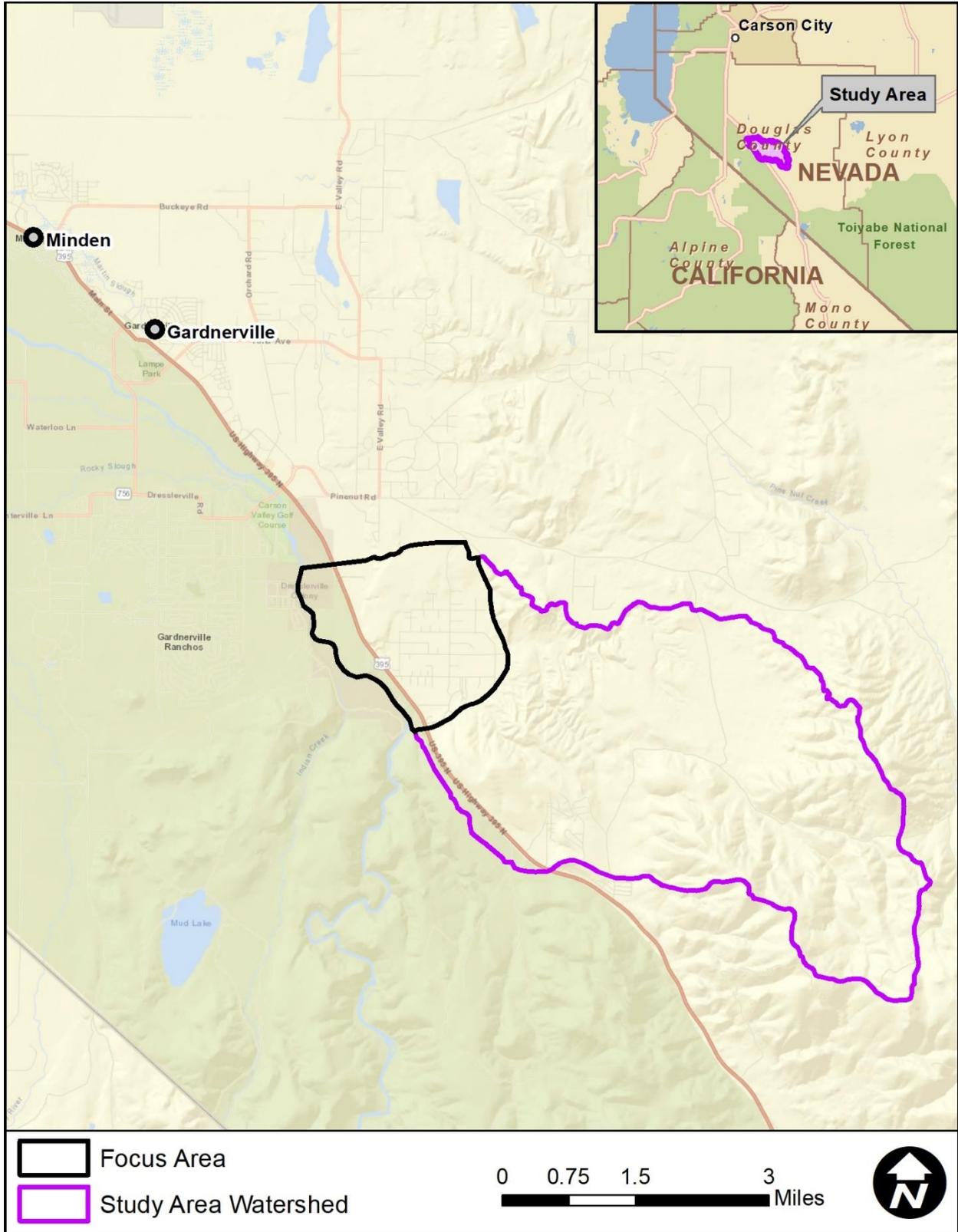


Figure 1-1. Study area vicinity map

1.3 PREVIOUS STUDIES

An early phase of the study included research and collection of previous reports and studies relevant to the ADMP area. These included drainage reports for local subdivisions, flood insurance studies (FIS), and geologic reports. A summary of the different types of reports are summarized in the following sections.

1.3.1 Subdivision Drainage Reports

Several drainage reports and drainage studies were collected from the county agencies and included information that was used directly in the development of the existing conditions hydraulic model (Section 2). The documents provided information on the location and design for drainage facilities within the individual subdivisions. All the collected drainage reports are included in the digital data appendix (Appendix B). Table 1-1 lists the collected documents.

Table 1-1. Collected subdivision drainage reports

Title	Author	Date	Subdivision
Drainage Reports and Drainage Studies			
Dry Creek Estates Planned Unit Development Drainage Report	Lumos & Associates	May 1999	Dry Creek Estates
Technical Drainage Study for Pinto & Palomino Parcel Maps	Western Engineering & Surveying Services	March 2, 2001	N/A
Settelmeyer Ranches Conceptual Drainage Study	RO Anderson Engineering	June 19, 2004	Settelmeyer Ranches
Conceptual Drainage Study Tentative Parcel Map, Cayuse Drive	Western Engineering & Surveying Services	August 16, 2004	N/A
AU LLC Map Technical Drainage Study	RO Anderson Engineering	October 31, 2004	N/A
Shoemaker Parcel Map Conceptual Drainage Study	RO Anderson Engineering	September 9, 2005	N/A
Scott Parcel Map Technical Drainage Study 629 Appaloosa Lane	RO Anderson Engineering	December 7, 2005	N/A
Technical Drainage Study for 733 Mustang Lane	Building & Site Engineering, Inc.	December 10, 2005	N/A
Scott Parcel Map Addendum to Technical Drainage Study 629 Appaloosa Lane	RO Anderson Engineering	March 1, 2006	N/A
Technical Drainage Report for Saddlerock Development	EXD Engineering	November 7, 2006	Saddlerock

Title	Author	Date	Subdivision
Drainage Report for Mullen Site Improvement Permit, 1894 Palomino Lane	EXD Engineering	December 14, 2006	N/A
Conceptual Drainage Study for 616 Appaloosa Lane	Keith R. Schaffer, PE	July 2, 2007	N/A
Technical Drainage Report for Saddlerock Development	EXD Engineering	July 23, 2007	Saddlerock
Conceptual Drainage Study for Pasek Property 670 Mustang Lane	Resource Concepts, Inc.	April 20, 2010	N/A
Technical Drainage Study for 1901-1905 Arabian Lane	RO Anderson	December 16, 2015	N/A

1.3.2 Flood Insurance Studies

Federal Emergency Management Agency (FEMA) Flood Insurance Studies (FIS) for Douglas County were collected and reviewed for historical flooding records and regulatory discharge estimates for watercourses in the study area. Table 1-2 lists the collected studies and derived information. Although the goal of this study is not to “match” the FIS discharge estimates, they do provide a base-level comparison for the hydraulic model results (see Section 2.3). The consistency of discharges between years in Table 1-2 suggests that there has been no revision to the hydrology for FEMA regulatory studies since at least 1999.

Table 1-2. Flood Insurance Studies

Study Date	County	Ruhenstroth ADMP Watercourses	100-year Discharge (cfs)
November 1999	Douglas	Smelter Creek	1,050
January 2010	Douglas	Smelter Creek	1,050
June 2016	Douglas (current effective)	Smelter Creek	1,050

1.3.2.1 Effective FEMA Floodplain Mapping

As of the date of this study, Smelter Creek is the only watercourse in the study area with FEMA regulatory floodplains (Figure 1-2). Table 1-3 lists the descriptions for each flood zone within the study area. Like the FIS discharges, FEMA floodplain mapping provides a base-level comparison of flood risk for the hydraulic modeling results from this study. The 1% chance floodplain is the only zone with a flood insurance requirement for homes with federally backed mortgages.

Table 1-3. FEMA flood zones within the study area

Flood Zone	Definition	Flooding Type	Recurrence Interval
AO	Average depths have been determined; flood depths range from 1 to 3 feet.	Shallow sheet flow	1% chance
A	No base flood elevation is provided	Riverine	1% chance
AE	Base flood elevation (BFE) is provided	Riverine	1% chance
AE with Floodway	BFE and Floodway is provided	Riverine	1% chance
Shaded X	0.2 Percent annual chance flood hazard	Riverine, Other	0.2% chance
Unshaded X	Area of minimal flood hazard	-	-

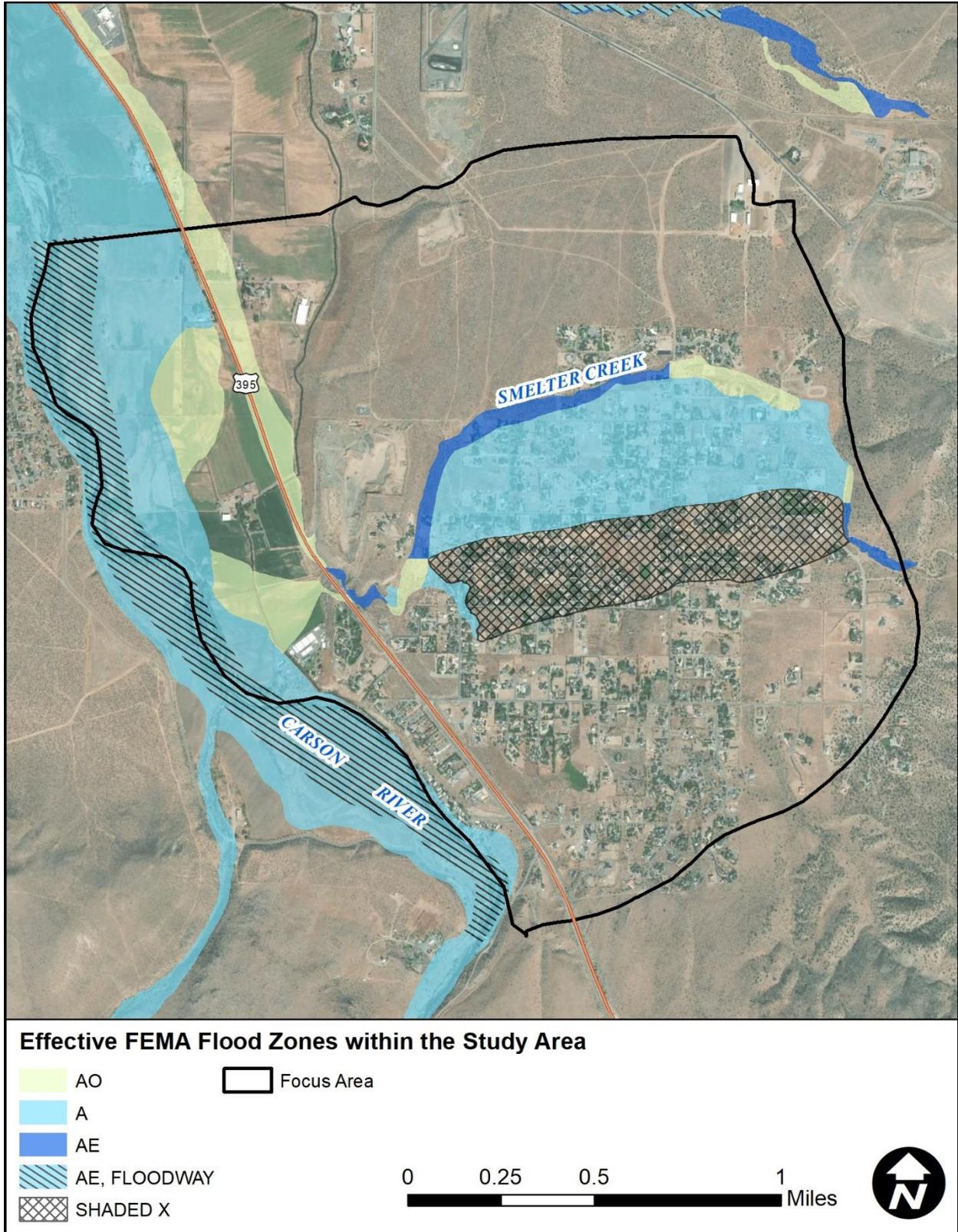


Figure 1-2. Effective FEMA Floodplains

1.3.3 U.S. Army Corps of Engineers Alluvial Fan Mapping

In December 2017, the U.S. Army Corps of Engineers (USACE), Sacramento District, published a study titled *Alluvial Fan Mapping for the Carson River Watershed Methodology* (Floyd, 2017) which included the RADMP study area. The purpose of the mapping study was to classify the relative risk of alluvial fan landforms within the Carson River Watershed. Alluvial fan landforms were identified and assigned a risk ranking based on the following categories:

- Appearance of active or inactive
- Existence of disturbances
- Presence of infrastructure

Within each category, a series of risk factors were examined. For example, the Active/Inactive category included four risk factors:

- Soil Development
- Alluvium
- Unconfined Flow
- Incised Channels

The risk factors were assigned a relative score and summed to derive an overall hazard ranking by watershed. Figure 1-3 from the report depicts the distribution of relative risk rankings by watershed. Figure 1-4 shows the identified alluvial fan landforms near the RADMP study area and their assigned risk.

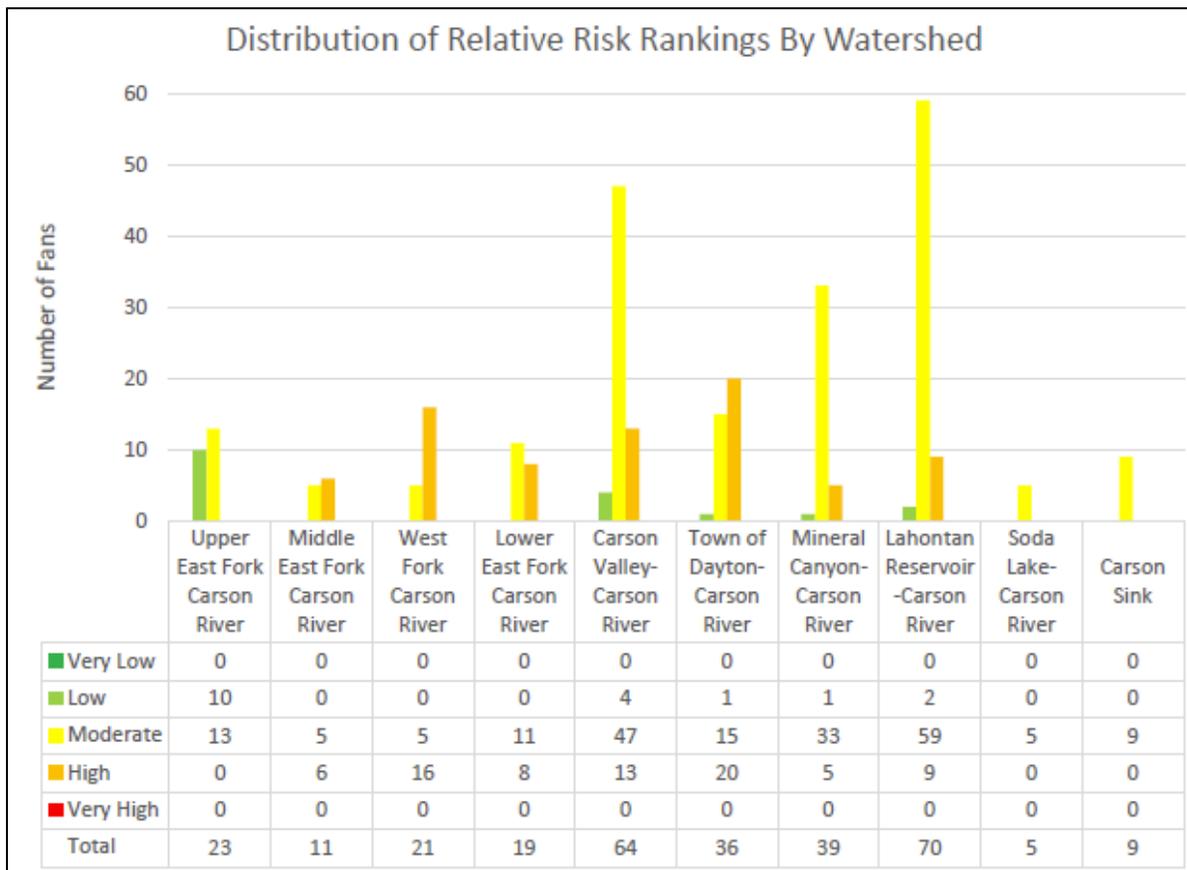


Figure 1-3. Distribution of relative risk rankings by watershed, from Floyd (2017)

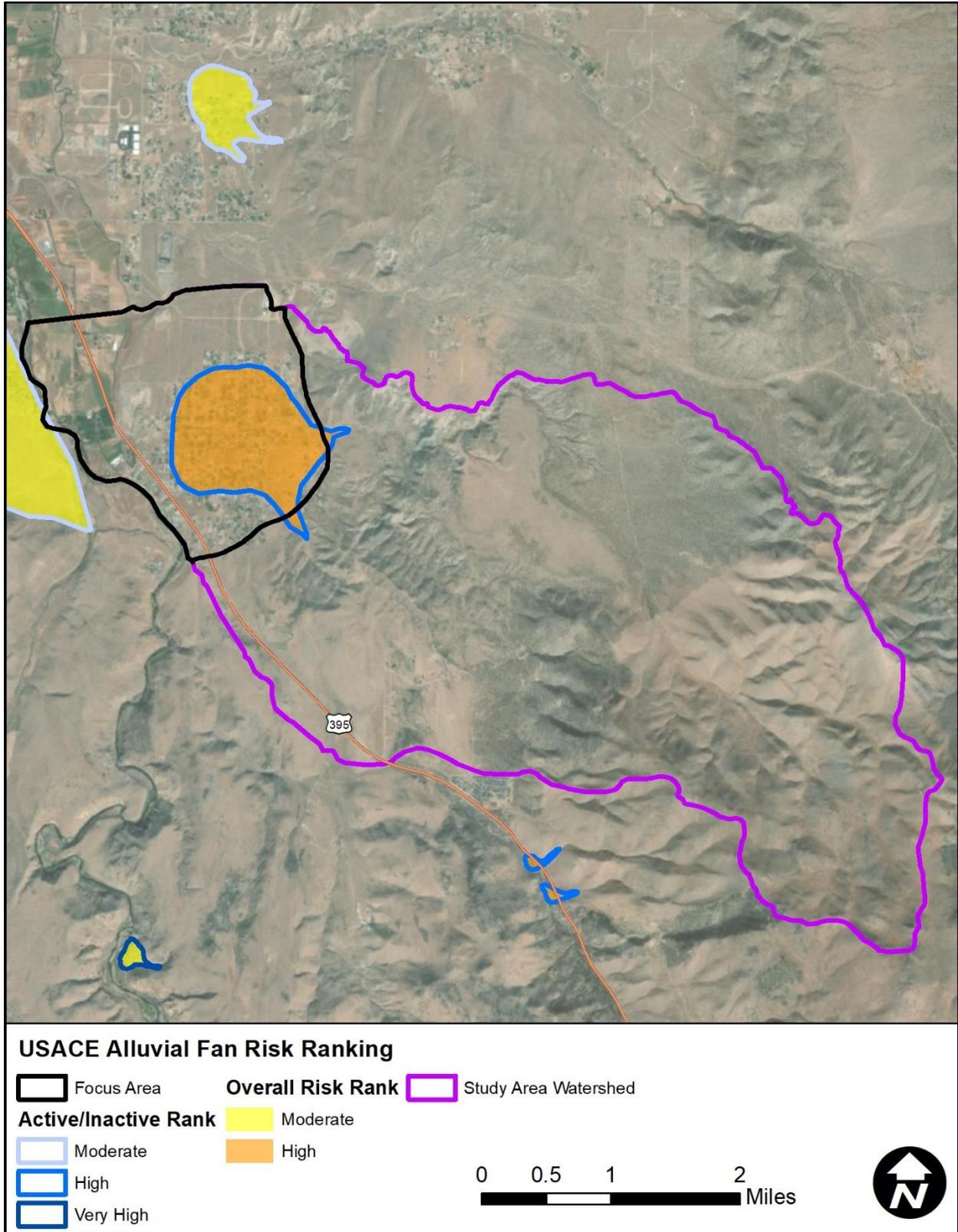


Figure 1-4. USACE alluvial fan risk ranking

1.3.4 Smelter Creek Regional Flood Control Project

In 2015 CWSD and Douglas County initiated a study on the feasibility of a regional flood control project for Smelter Creek (RO Anderson Engineering, 2015). The study included hydrologic modeling of the Smelter Creek watershed, conceptual design of a flood control reservoir, and an estimate of probable costs. The following is from the conclusions section of the study report:

The Smelter Creek watershed has experienced several large hydrologic events in recent years, including the most recent events in 2014 and 2015 that caused unquantified damage to private property, roads, and drainage structures in the Ruhenstroth subdivision in Douglas County, Nevada. In order to alleviate flood risks to these downstream areas, construction of an on-stream (Smelter Creek) regional flood control reservoir, just east of the Ruhenstroth subdivision on BLM managed land was first proposed in early 2011. Subsequently, CWSD retained ROA to prepare a feasibility-level study to identify alternative solutions to alleviate future flooding resulting from severe hydrologic events that occur in Smelter Creek Watershed. The following is the summary of our findings and conclusions:

The effective FIS lists only 1-percent annual chance peak flow for Smelter Creek watershed. This peak flow rate estimate was probably based on the hydrologic study that was performed in late 1980s using HEC-1, and may not accurately represent current land use characteristics or available hydrologic data generated since that former analysis was prepared. It is therefore, appropriate and prudent to evaluate the hydrology of this watershed and estimate 1-percent annual chance peak flows based on updated precipitation data developed by NOAA.

- *The hydrologic study performed by ROA personnel and presented in this report used current NOAA precipitation data to build balanced design storm hyetographs for each sub-basin that takes area-reduction factors, altitude, etc. into consideration thereby producing reliable peak runoff estimates. In addition, the revised hydrologic study also includes estimated peak flows resulting from 0.2-percent-annual chance and ½ PMP events.*
- *This hydrologic study estimated peak runoff resulting from 1-percent annual chance flood to be approximately 730 cfs, which is 350 cfs lower than the effective peak flow (1,080 cfs). The proposed discharge entering the flood control reservoir during the occurrence of 0.2-percent-annual-chance event is approximately 2,183 cfs.*
- *General PMP rainfall depths were computed using HMR-49 guidelines, and the resulting rainfall data was used to construct a hyetograph that was applied uniformly over the entire watershed. The resulting hydrograph at the most downstream end of the watershed was taken and the ordinates of this flood hydrograph were divided in half to obtain ½-PMF. The resulting ½-PMF was routed through the proposed flood control reservoir.*
- *While preparing this feasibility analysis, Nevada Division of Water Resources, Bureau of Dam Safety was contacted to confirm the design inflow event that the proposed structure will be required to be designed to safely mitigate. From those discussions, the proposed structure will likely be characterized as a High Hazard Dam. The Design Inflow criteria will therefore be the ½-PMP event. That is, the*

proposed dam and its appurtenances must be sized to pass the ½-PMF through the proposed spillway with approximately three feet of freeboard before overtopping.

- *After reviewing the estimated peak flood flows from 1-, 0.2-percent, and ½-PMF events, four alternate flood control basin locations were considered, and a feasibility analysis was performed, which culminated in the selection of two potential locations for this regional flood control basin — Alternative 3 and Alternative 4.*
- *The embankment of the proposed Alternative 3 flood control structure is 36 feet high with a normal storage capacity of 202.5 acre-feet, and a storage capacity of 392.6 acre-feet at dam crest. The proposed flood control basin incorporates a 60-inch low level primary outlet, and an emergency spillway with 20-ft bottom width.*
- *The embankment of the proposed Alternative 4 flood control structure is 32 feet high with a normal storage capacity of 176.8 acre-feet, and a storage capacity of 391.5 acre-feet at dam crest. The proposed flood control basin incorporates a 60-inch low level primary outlet, and an emergency spillway with 20-ft bottom width.*
- *The primary and emergency outlet works were designed such that during the 1-percent annual chance flood, the outflow discharge is limited to 380 cfs through the 60-inch primary outlet; and, during 0.2-percent annual-chance flood and ½-PMF events, the emergency spillway safely conveys incoming flood flows with sufficient freeboard and some attenuation.*
- *The Engineer’s Preliminary Estimate of Probable Costs for Alternative 3 is \$3,170,000, and for Alternative 4 is \$2,550,000, which amount includes allowances for construction contingencies, land acquisition, engineering design, permitting and construction phase services.*
- *A hydraulic model of downstream reach of Smelter Creek below the proposed flood control facility was developed using HEC-RAS. A set of three steady flow rates that represent discharges from the proposed reservoir during the occurrence of 1-, 0.2-percent, and ½-PMF events were used to perform steady state flow simulations. The results of these simulations were processed in ArcGIS environment and preliminary floodplain boundary maps were produced.*
- *The resulting floodplain boundary maps were compared with FEMA effective FIRMs, and number of structures / parcels that may be removed from the SFHA was estimated. It is estimated that only 3 structures will remain in the revised SFHA compared to 120 structures that are currently in the effective SFHA for this area of Douglas County.*
- *Building an instream flood control basin on Smelter Creek with an estimated cost of \$3.17 million dollars for Alternative 3 or \$2.55 million dollars for Alternative 4 results in direct and substantial benefit to the residents of Ruhenstroth subdivision, particularly those within the regulatory floodplain of Smelter Creek. The project provides additional indirect benefits to the residents of Douglas County by reducing potential damage to public infrastructure such as roads and drainage structures in this area.*
- *The Smelter Creek Regional Flood Control project is eligible for FEMA’s Hazard Mitigation Grant Program that currently provides 75% grants for qualified projects.*

- *If successful in obtaining a Hazard Mitigation Grant for this project, the required local match to complete Alternative 3 improvements is estimated to be \$792,250. Assuming this amount could be funded through a Flood Control District (NRS 543.170-543.830, or a local Assessment District at an effective interest rate of 5% and a term of 25 years, the annual payments would be about \$225/benefitted parcel. Without grant funding, using the same financing terms, the estimated annual payment is about \$900 per benefitted parcel. These per parcel amounts, \$225/year and \$900/year, are understood to be less than what many of the homeowners impacted by this floodplain currently pay for flood insurance in this area.*
- *For Alternative 4, the required local match to complete the planned improvements is estimated to be \$637,500. Assuming this amount could be funded through a Flood Control District (NRS 543.170-543.830, or a local Assessment District at an effective interest rate of 5% and a term of 25 years, the annual payments would be about \$180/benefitted parcel. Without grant funding, using the same financing terms, the estimated annual payment is about \$720 per benefitted parcel. These per parcel amounts, \$180/year and \$720/year, are understood to be less than what many of the homeowners impacted by this floodplain currently pay for flood insurance in this area.*
- *Preliminary BCA shows a BCA of 2.27 for Alternative 3, and a slightly better BCA of 2.82 for Alternative 4.*
- *The proposed locations of the regional flood control basins were compared to the locations of USGS- documented earthquake faults (Quaternary Faults). There are no identified active faults within the limits of the proposed dam and reservoir.*
- *From these investigations, we conclude that the project is eminently feasible and worthy of pursuing further.*

Following the completion of the 2015 Smelter Creek study, Douglas County applied for construction funding for the project through a FEMA Hazard Mitigation Grant Program (HMGP) application in December 2016. The initial grant request was unsuccessful. Douglas County revised the grant application Benefit-Cost Analysis (BCA) and resubmitted to FEMA in December 2017. The second grant application was also unsuccessful. Douglas County conducted a more robust BCA analysis and concluded that the benefit-cost ratio was not favorable to receive HMGP funding. As of the date of this ADMP report the Smelter Creek Flood Control Project has not been constructed.

1.4 HISTORICAL FLOWPATH ASSESSMENT

Understanding the historical evolution of a geomorphic system is critical to understanding present-day processes and predicting future trends. Natural systems can take hundreds of thousands of years to develop, and their morphology is a direct reflection of this long-development period. Anthropogenic changes to a natural system often result in abrupt changes that can be managed for a brief period, but quite often the disturbed system will trend back to its natural condition, despite efforts to change and maintain it.

A historical flowpath assessment was conducted for the ADMP study area to assess the natural flowpaths of the study watercourses with the goal that understanding the natural flowpaths will aid in understanding the current flooding patterns and potential future flooding trends.

1.4.1 Aerial Photography

Historical aerial photography from 1954 (earliest year available) were collected and semi-rectified using ArcGIS software tools. The natural flowpaths for the project watercourses were identified and delineated from the photography. Figure 1-5 shows the historical aerial photography and Figure 1-6 the modern aerial photography (2018) for the ADMP focus area. The 1954 photographs pre-date much of the development within the focus area and shows the landforms in a (mostly) natural condition. The locations of the dominant flowpaths for the major drainage channels were interpreted and delineated from the 1954 photographs to compare with the 2019 locations. The 2019 channel locations were derived from the ADMP LiDAR mapping which was flown in October 2019 (see 2.2.3).

1.4.2 Summary

The most significant changes in flowpath alignment since 1954 have occurred due to manmade channel realignments as development progressed in the watershed (Figure 1-7).

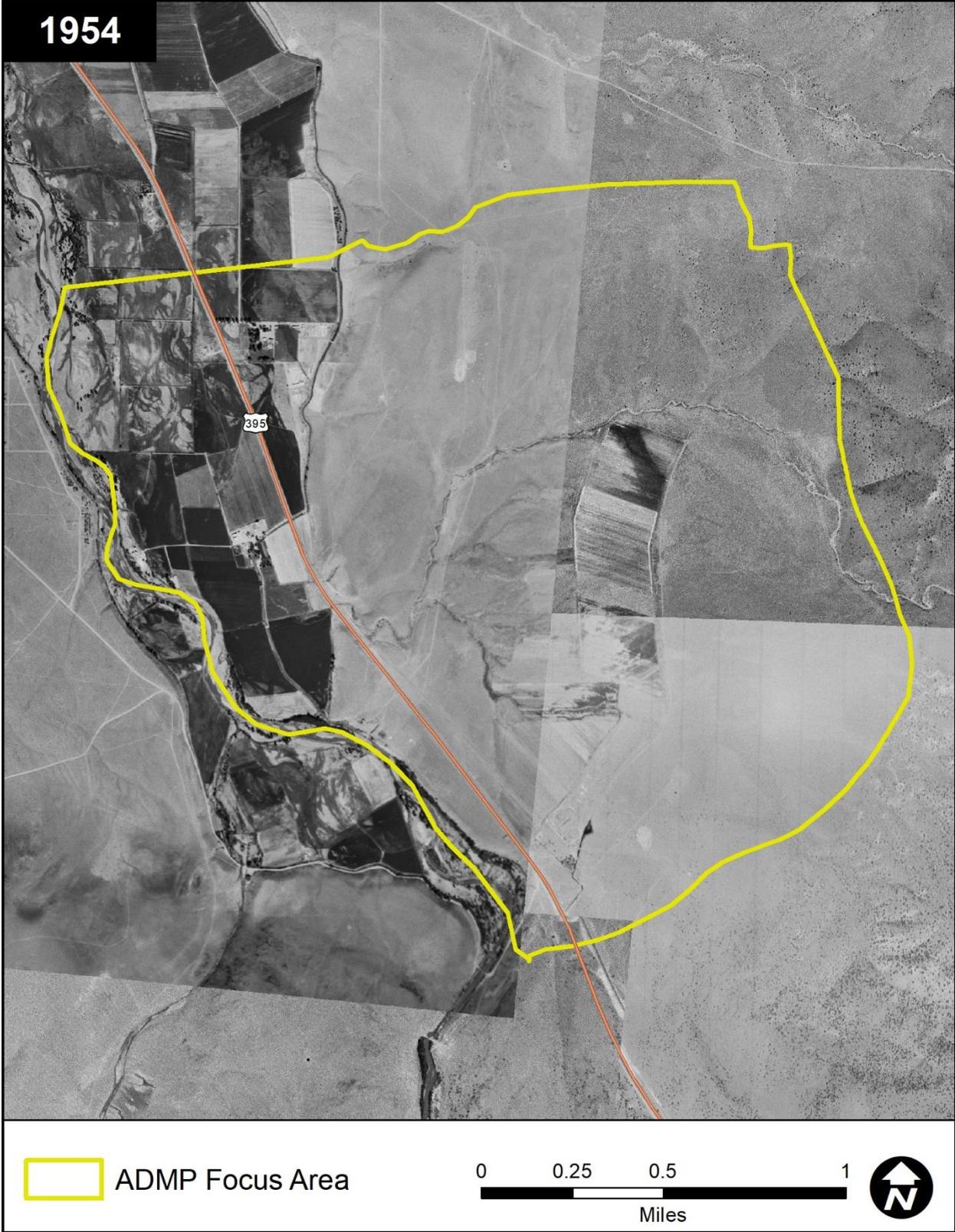


Figure 1-5. 1948 aerial photography

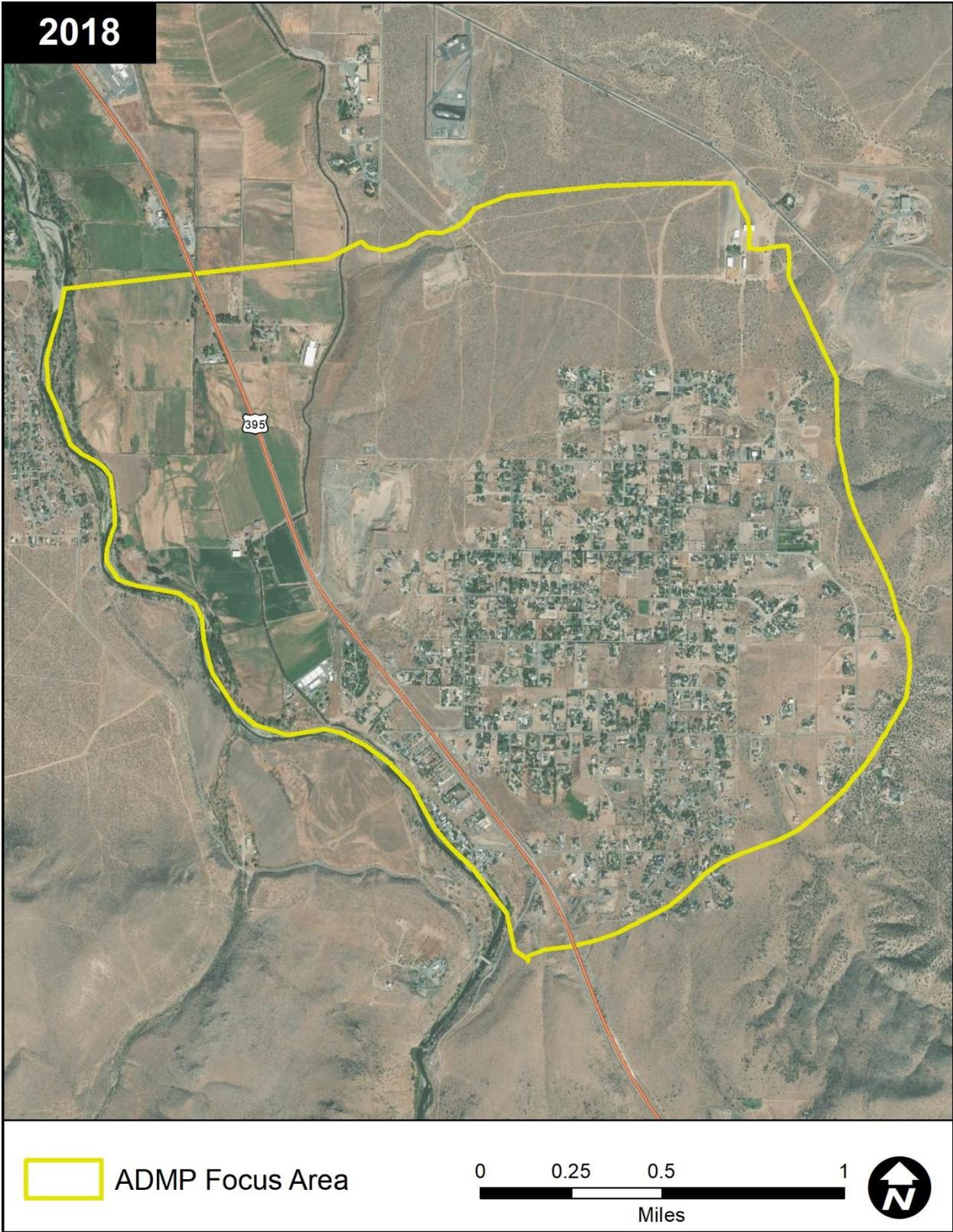


Figure 1-6. 2017 aerial photography



Figure 1-7. Historical flowpath comparison

2 HYDROLOGIC AND HYDRAULIC MODELING

2.1 METHOD DESCRIPTION

Modeling for the Ruhenstroth ADMP study area was completed using the FLO-2D Pro software package¹, Build No. 19.07.21 with an executable dated June 10, 2020. This version has extensive improvements in model runtime and accuracy. In addition, this version has been tested by the Flood Control District of Maricopa County and is approved for use in their studies.

FLO-2D is a combined rainfall-runoff model (i.e., both hydrologic and hydraulic). Therefore, both on-site and off-site modeling was completed using the FLO-2D software.

2.2 MODEL DEVELOPMENT

2.2.1 Spatial Reference System

All data that was generated for the RADMP used the horizontal control of the Nevada Coordinate System, West Zone, NAD83; while the vertical datum was the North American Vertical Datum of 1988 (NAVD 88). The units of measurement were US survey feet.

2.2.2 Model Domain and Grid Size

The Ruhenstroth watershed contains many small drainage structures that need to be adequately captured in the model to provide the most accurate results. Some of these features include small (12- to 18-inch) driveway culverts and minor roadside drainage ditches. Therefore, a high-resolution, 10-foot grid size was selected to provide the necessary detail to model these features.

With the Build No. 19.07.21 FLO-2D executable, model runtime is significantly reduced. Therefore, the entire watershed was able to be modeled in one domain with a 10-foot grid size. The grid size and the number of cells in the model are shown in Table 2-1, while the spatial location of modeling domain boundary in relation to the focus area is shown in Figure 2-1.

Table 2-1. FLO-2D model domain areas and number of grid elements

Grid Size	Domain Area (sq. miles)	Number of Grid Elements
10-ft	18.2	5,072,033

¹ <https://www.flo-2d.com/>

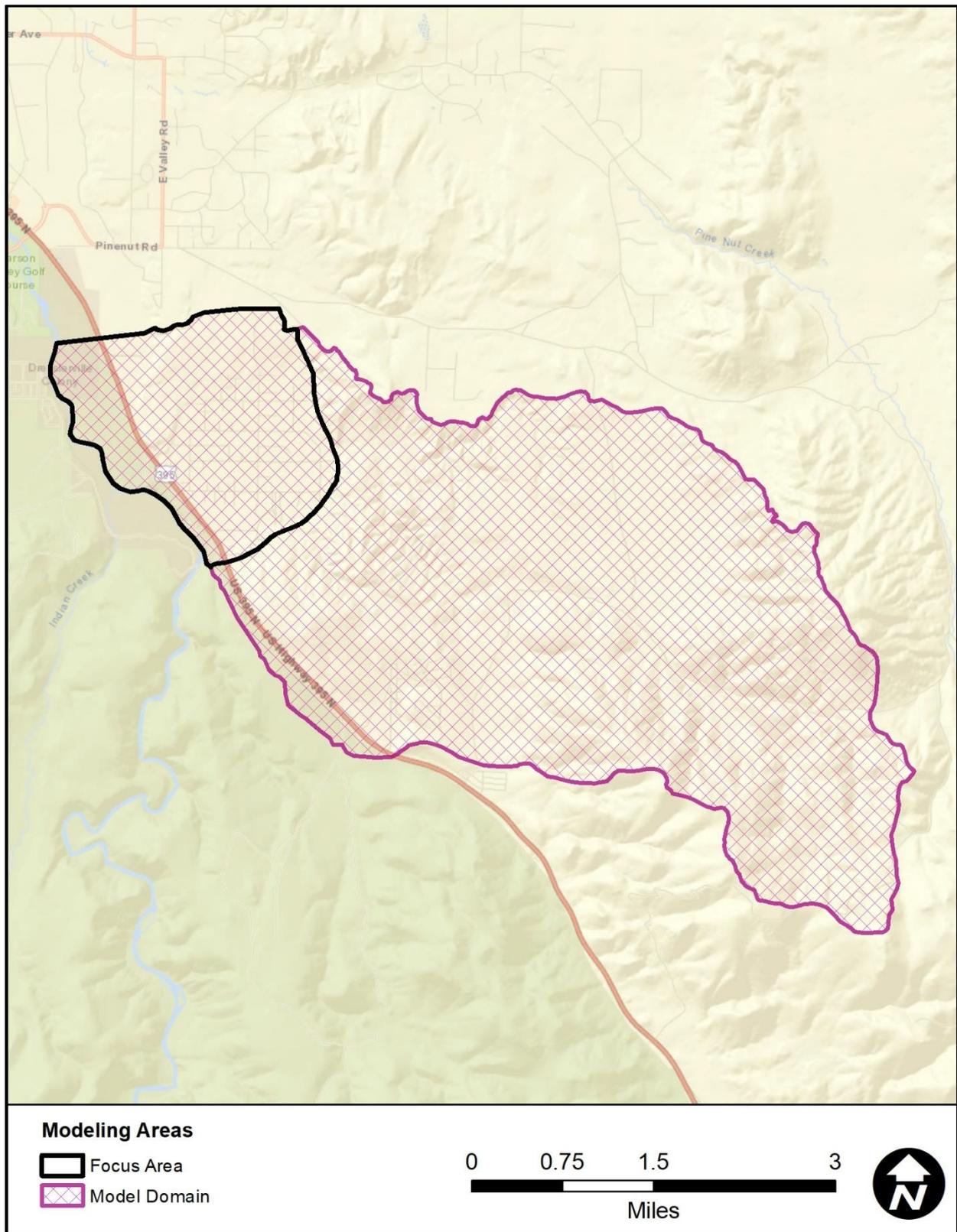


Figure 2-1. Modeling domain used in the Ruhensroth ADMP

2.2.3 Grid Element Elevations

As a part of this project, LiDAR data was collected by aircraft at an average density of 8 pulses per square meter on October 24, 2019. The detailed specifications for the LiDAR acquisition are shown in Table 2-2, while the LiDAR product survey report is included in Appendix A.

Through software processing, the mapping contractor, Quantum Spatial, Inc. (QSI) developed a bare earth ESRI grid raster with a 3-foot pixel resolution. This 3-foot bare earth raster was then resampled to a 10-foot raster that reflects the average grid elevations that are used in the actual FLO-2D model.

Table 2-2. LiDAR settings and specifications, reproduced from QSI (2019)

LiDAR Survey Settings & Specifications	
Acquisition Dates	October 24, 2019
Aircraft Used	Cessna Caravan 208B
Sensor	Riegl
Laser	VQ-1560i
Maximum Returns	Unlimited
Resolution/Density	Average 8 pulses/m ²
Nominal Pulse Spacing	0.35 m
Survey Altitude (AGL)	1825 m
Survey speed	145 knots
Field of View	58.5°
Mirror Scan Rate	117 lines/sec per channel
Target Pulse Rate	700 kHz per channel
Pulse Length	3 ns
Laser Pulse Footprint Diameter	32.85 cm
Central Wavelength	1064 nm
Pulse Mode	Multiple Times Around (MTA)
Beam Divergence	0.18 mrad
Swath Width	2,045 m
Swath Overlap	55%
Intensity	16-bit
Accuracy	RMSE _z (Non-Vegetated) ≤ 9 cm NVA (95% Confidence Level) ≤ 20 cm

2.2.4 Precipitation Development

The Douglas County *Design Criteria and Improvements Standards* (2017) specify that storm drains and other drainage facilities be designed to convey the 25-year, 24-hour recurrence interval design storm. This manual also specifies that the 100-year, 24-hour recurrence interval design storm be used under certain situations. Additionally, the 100-year, 6-hour storm event was chosen because this higher intensity duration usually results in higher peak flow estimates for smaller (i.e., < 20 square miles) drainage areas, such as those that exist within the study area.

Therefore, to meet the design standards and the objectives of the Ruhenstroth ADMP, three design storms were simulated. These were:

- 25-year, 24-hour
- 100-year, 24-hour
- 100-year, 6-hour

2.2.4.1 Precipitation Depths

NOAA Atlas 14 (NOAA14) precipitation depth estimates were downloaded from the National Weather Service (NWS) website (2018) as raster images, then used to apply the spatially varied rainfall estimate for each grid element in the model. This means that the point statistics are used at each grid cell in the FLO-2D model, which is different than the typical centroid-based precipitation estimates that are used in lumped parameter (e.g., HEC-HMS or HEC-1) modeling. Point rainfall statistics were selected because:

- 1) using point rainfall has been the general procedure for other ADMP studies in the southwest
- 2) using point statistics results in reasonable but conservative flow estimates.

The maximum rainfall point values for each submodel are shown in Table 2-3.

Table 2-3. Maximum NOAA14 point rainfall estimates (in inches) by recurrence interval

Storm Event		
25Y24H	100Y6H	100Y24H
4.594	2.619	5.901

2.2.4.2 Hyetographs

For this study, two different hyetographs were selected – one for the 24-hour storms and one for the 6-hour storm. The NDOT (2015) hyetograph for the HUC-12 region was used for the 24-hour storms since it represents the latest research on hyetograph development in Nevada and has performed well on other ADMPs, such as the Dayton Valley ADMP (JEF, 2019b).

Since the drainage areas are all less than 20 square miles in the Ruhenstroth study area, a very intense hyetograph was chosen for the 6-hour storm to simulate a short duration, high intensity summer event. This approach was taken for the Johnson Lane Area Drainage Maser Plan (JEF, 2018) and produced reasonable results. Thus, the 6-hour pattern 1 distribution from the Flood Control District of Maricopa County (FCDMC, 2018) was used to simulate the 100-year 6-hour storm event. The two different hyetographs are shown in dimensionless form in Figure 2-2.

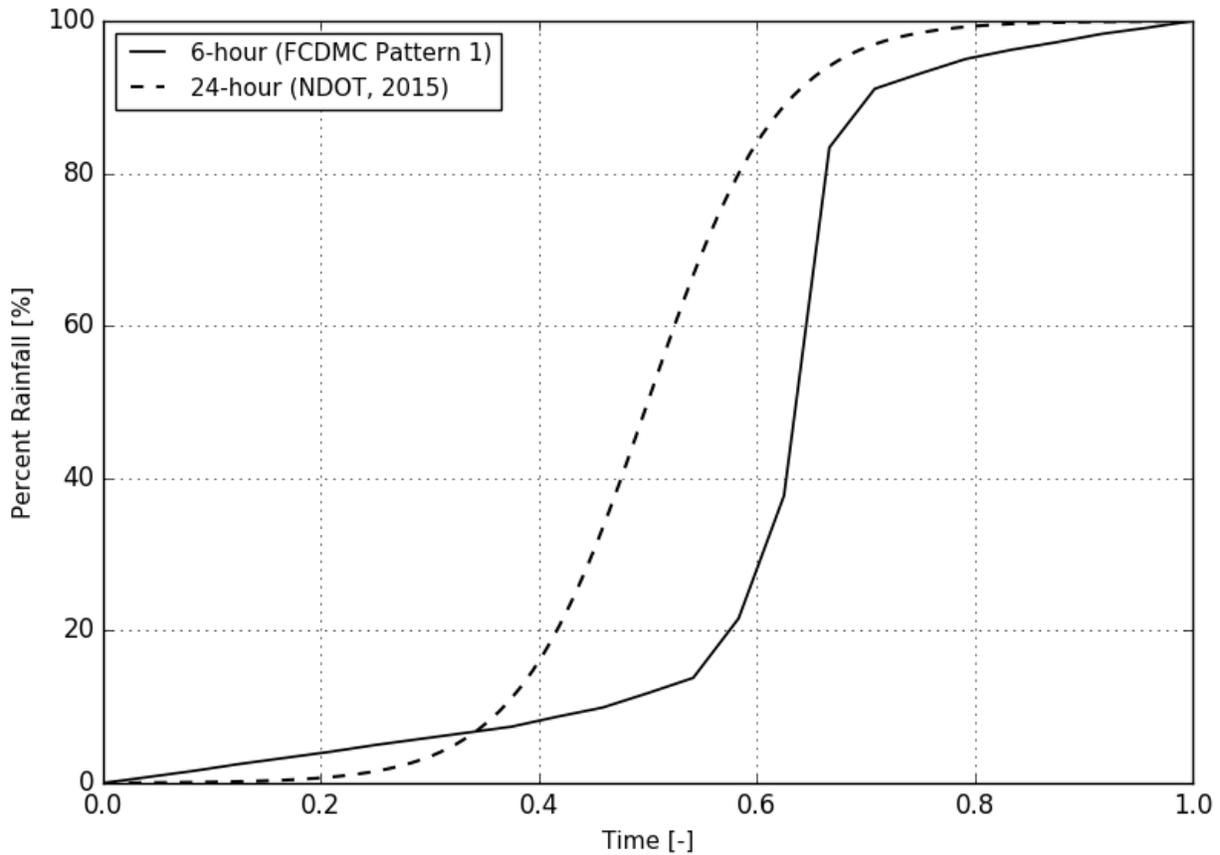


Figure 2-2. Comparison of 6- and 24-hour hyetographs used in the RADMP

2.2.5 Grid Element Roughness (Manning’s n Values)

The FLO-2D model uses two Manning’s n values to estimate roughness on each element. These are the shallow n value and the base n value. These two parameters allow FLO-2D to calculate a depth-varying roughness, which better approximates physical flood routing in a natural system. For depths below 0.5 feet, the shallow n or half the shallow n value is used. Between 0.5 feet and 3 feet, a function based on the base n value is used; and, at depths greater than 3 feet, the base n value is used. Please see the FLO-2D Data Input Manual (FLO-2D Software, Inc., 2019) for the details about how depth-varying roughness is applied in the software.

Each grid element is assigned an average shallow n and base n value based on the underlying surface conditions. For this study, a detailed surface feature classification was developed by refining land use data provided by Douglas County and adding more detail in areas where the initial delineations were too generalized. For example, major areas of pavement (parking lots and roads) and wash corridors were delineated in the modeling area since these features can act as major conveyances. Buildings and other structures were also added based on the latest available aerial photography (see Section 2.2.8).

The base and shallow n values for each classification were chosen based on experience on other studies, engineering judgment, and research papers, such as Yochum *et al.* (2014), Jarret (1985), and JEF (2020a). Table 2-4 lists the surface classification and its corresponding Manning’s n values that were used in this analysis. The spatial distribution of the surface classification is shown in Figure 2-3.

Table 2-4. Surface classification and corresponding Manning's n value

Surface Classification	Base n	Shallow n
Upper Watershed Rangeland	0.080	0.40
Focus Areas Rangeland	0.055	0.18
Maintained Turf	0.045	0.12
Rural Residential	0.035	0.15
Unimproved Road	0.026	0.10
Agriculture	0.060	0.30
Building	0.024	0.10
Pavement	0.020	0.10
Wash	0.060	0.18
Water	0.040	0.10

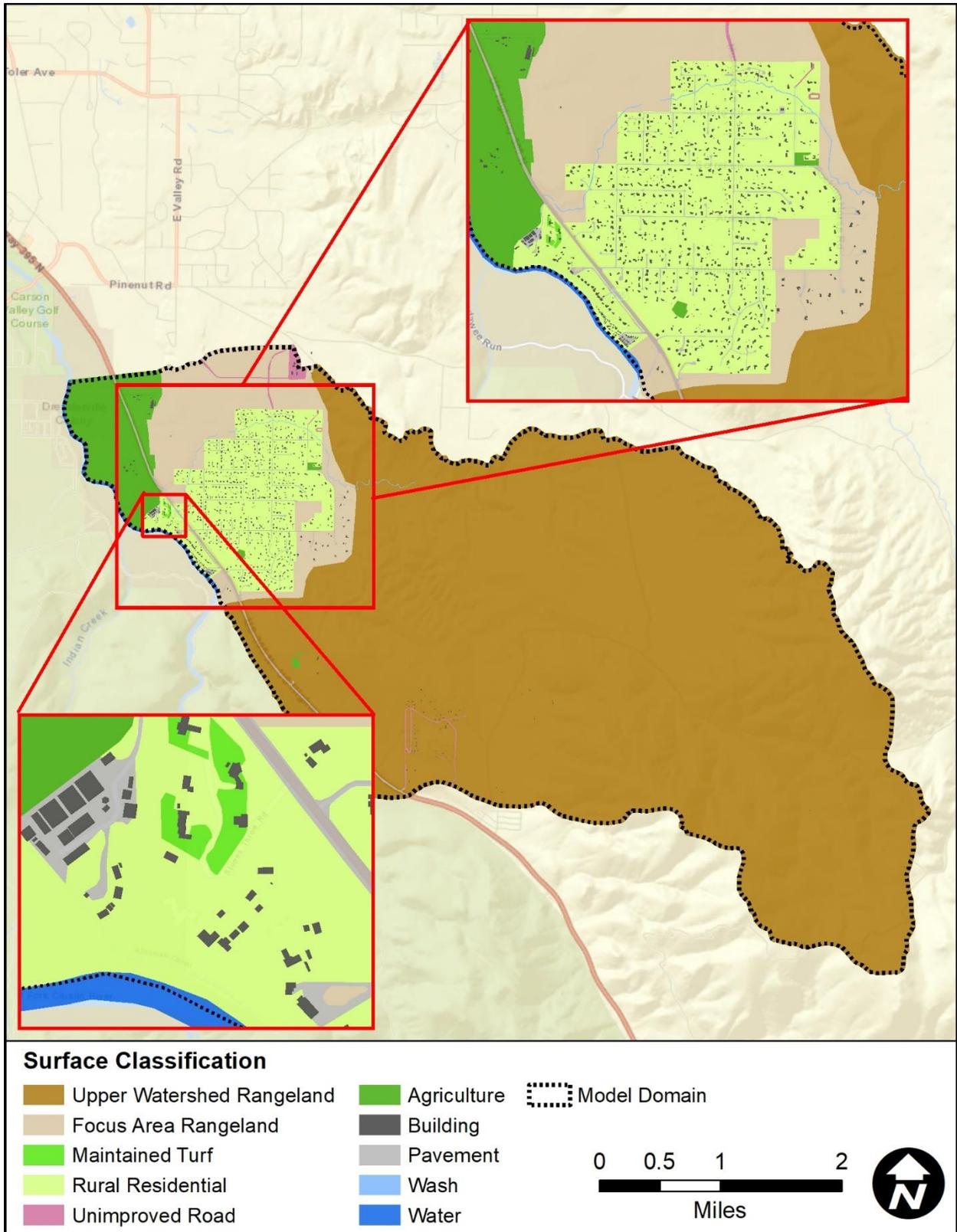


Figure 2-3. Surface classification used to assign grid element roughness in the FLO-2D model

2.2.6 Infiltration Development

Since 1) the previous flood insurance study used the Green and Ampt (GA) infiltration methodology and 2) this methodology is a more physically based infiltration model, the GA methodology was used for this study. In general, the GA infiltration parameters are a function of the subsurface soil type or the features on the ground surface (e.g., a layer of asphalt that covers the soil). As such, the NRCS (2019) soils data was used to develop the soils-based infiltration values. For the ground features, a detailed surface classification shapefile was developed for this study (see Section 2.2.5). This shapefile helped define the surface-based infiltration parameters that were used in the modeling. Additionally, the Smelter Creek Feasibility Engineering Study (RO Anderson Engineering, 2015) was also reviewed to maintain consistency with that study.

2.2.6.1 Soils-based

The infiltration parameters more dependent on the subsurface soils are:

- The hydraulic conductivity at natural saturation (XKSAT) in inches per hour,
- The soil moisture deficit (DTHETA),
- The wetting front suction in inches (PSIF),
- Rock outcrop as a percentage, and
- Limiting infiltration depth in feet, which is the depth at which infiltration stops.

The XKSAT parameter was developed from the NRCS saturated hydraulic conductivity (KSAT). The KSAT values were calculated with the NRCS Soils Data Viewer² for the dominant soils condition at a depth range from 0 to 20 inches. The spatial variability of the KSAT values within the study watershed is shown in Figure 2-4.

These KSAT values were converted to inches per hour and adjusted by equation (1), which is from the *Drainage Design Manual for Mohave County* (Mohave County, 2018). Equation (1) is:

$$XKSAT = CF * KSAT \quad (1)$$

where *CF* is a correction factor and *KSAT* is the saturated hydraulic conductivity. Based on the discussion in the Mohave County manual, the *CF* can range 0.1 to 0.9; but both the Arizona Department of Transportation (ADOT) and Mohave County recommend 0.5 as the *CF*. Therefore, a value of 0.5 was used as the *CF* in this study. Finally, calculated XKSAT values that exceeded 2 inches per hour were capped at 2 inches, per the Mohave County methodology. The final XKSAT values that were used in the FLO-2D modeling are shown in Figure 2-5

² https://www.nrcs.usda.gov/wps/portal/nrcs/detailfull/soils/survey/geo/?cid=nrcs142p2_053620

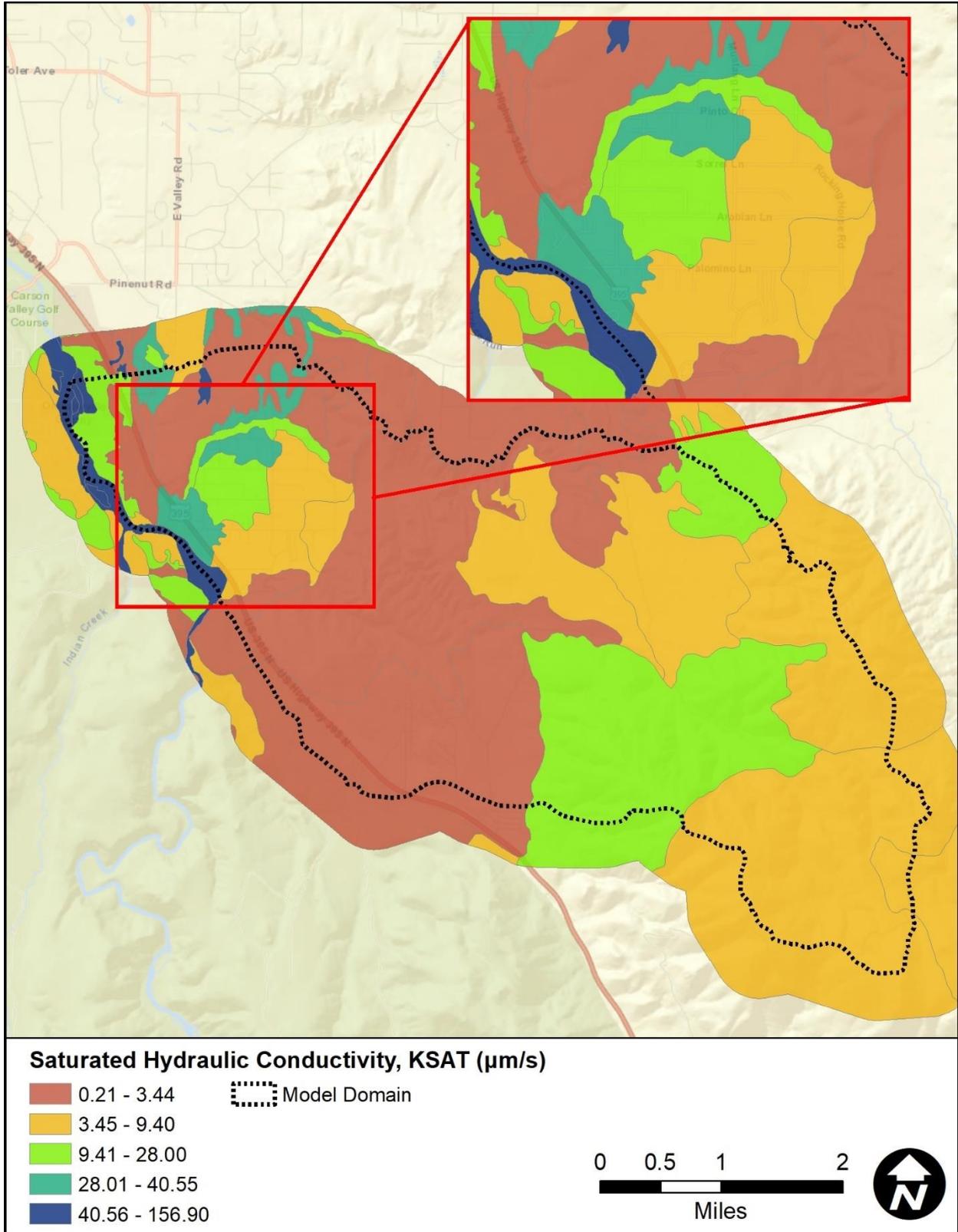


Figure 2-4. Spatial variability of the saturated hydraulic conductivity

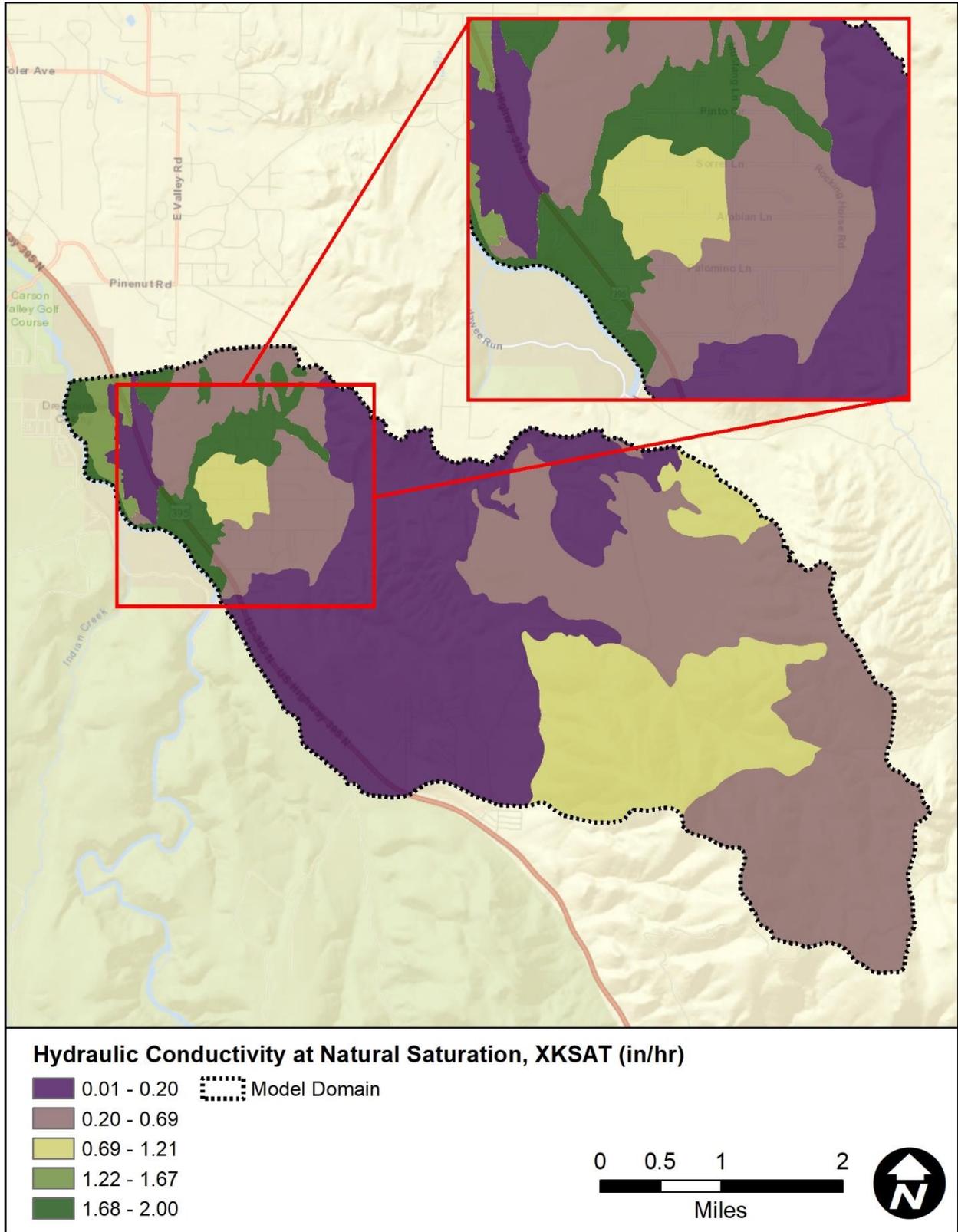


Figure 2-5. XKSAT values used in the FLO-2D modeling

Once the XKSAT values were determined, the values of DTHETA and PSIF were selected from Figure 2-6 and Figure 2-7, respectively. These charts are taken from Mohave County (2018), and they relate the DTHETA and PSIF values to a given XKSAT value. The DTHETA initial moisture condition was chosen based on the surface classification and is discussed in Section 2.2.6.2. The DTHETA and PSIF values that were used in the modeling are shown in Figure 2-8 and Figure 2-9, respectively.

Rock outcrop was set to zero, but percent impervious was used in the surface-based infiltration values (see Section 2.2.6.2). Limiting infiltration depth was set to 20 inches (or 1.67 feet) based on the minimum depth to restrictive layer of 19.69 inches that was extracted from the NRCS soils data. The spatial variability of the depth to a restrictive layer is shown in Figure 2-10, but again the minimum depth of 1.67 feet was used for the entire modeling domain.

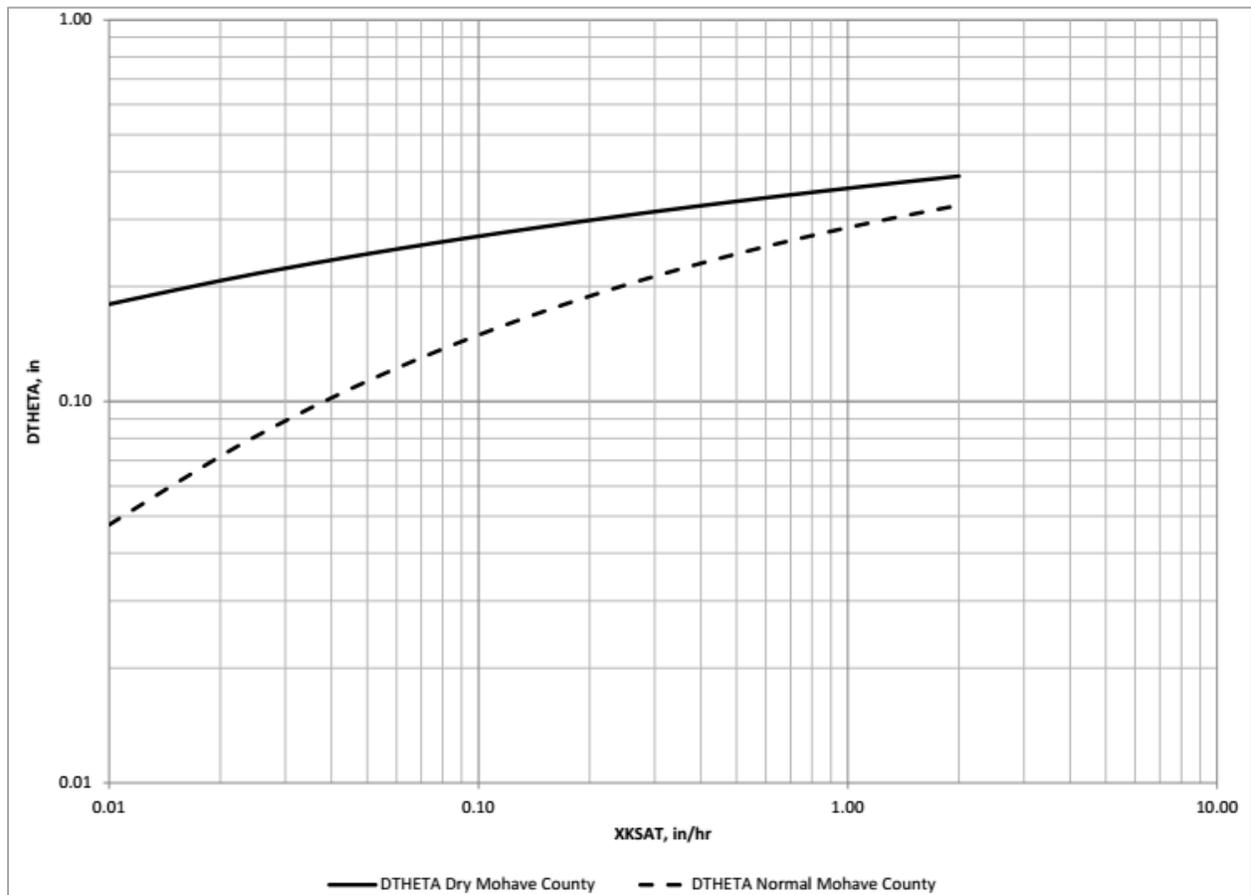


Figure 2-6. Values of DTHETA as a function of XKSAT, reproduced from Mohave County (2018).

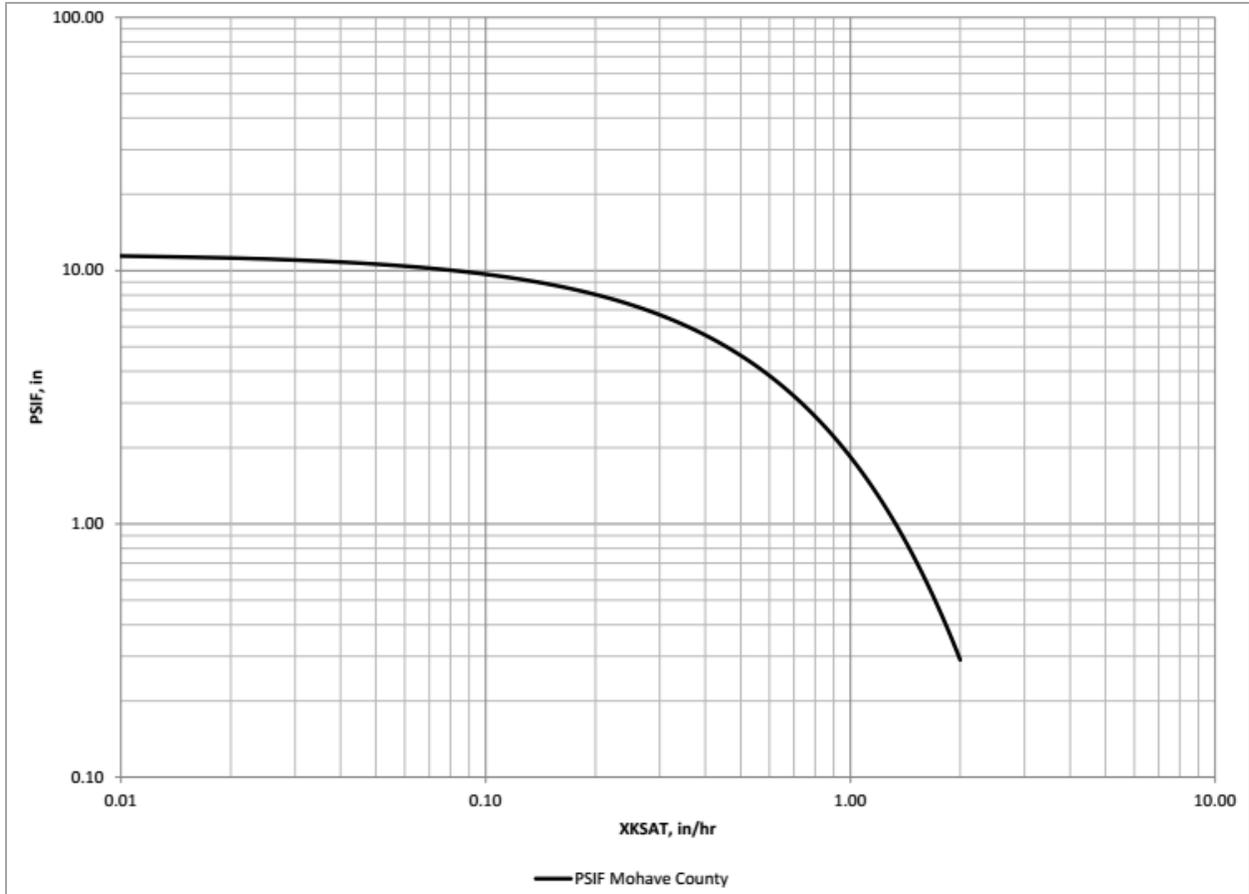


Figure 2-7. Values of PSIF as a function of XKSAT, reproduced from Mohave County (2018).

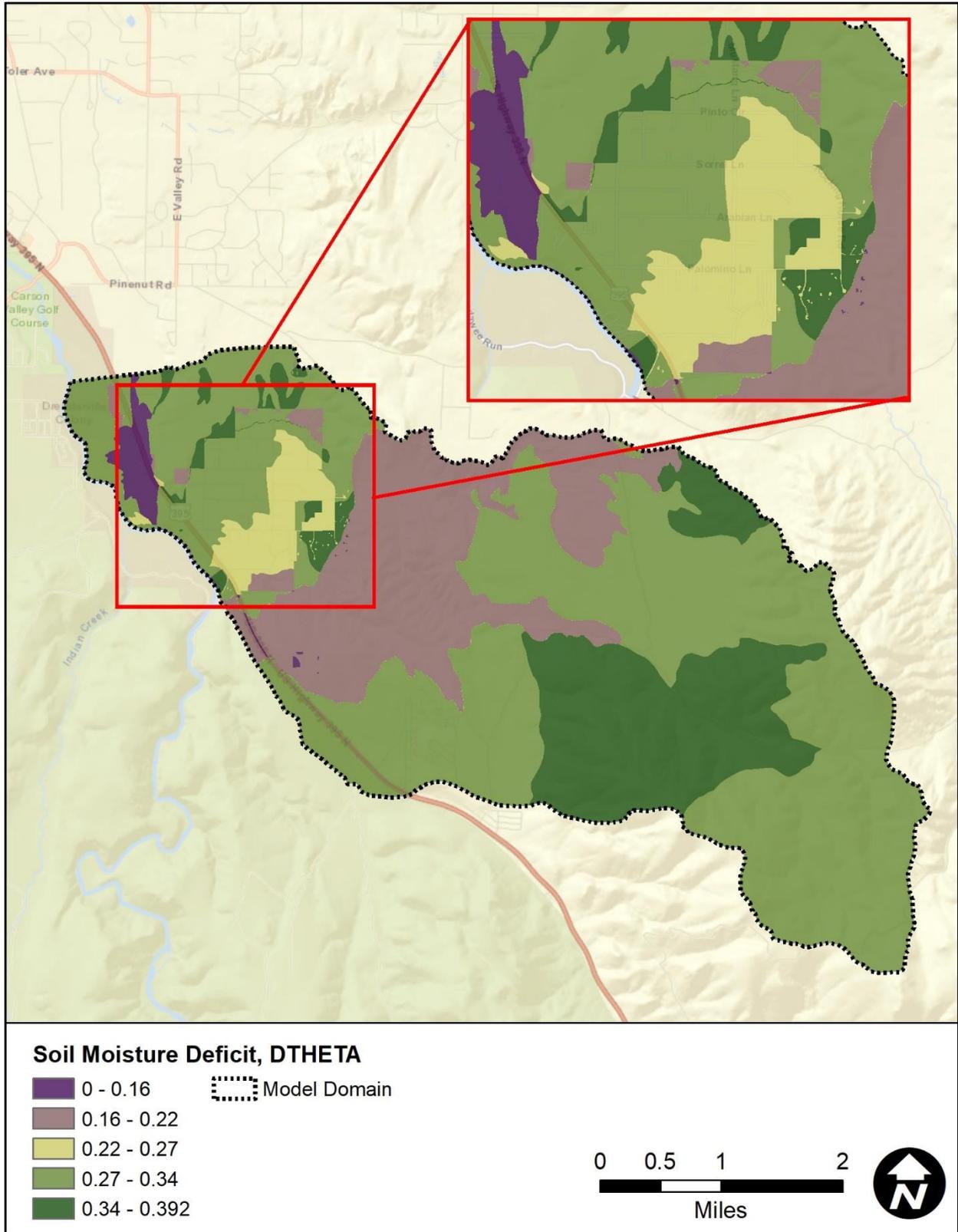


Figure 2-8. DTHETA values used in the FLO-2D modeling

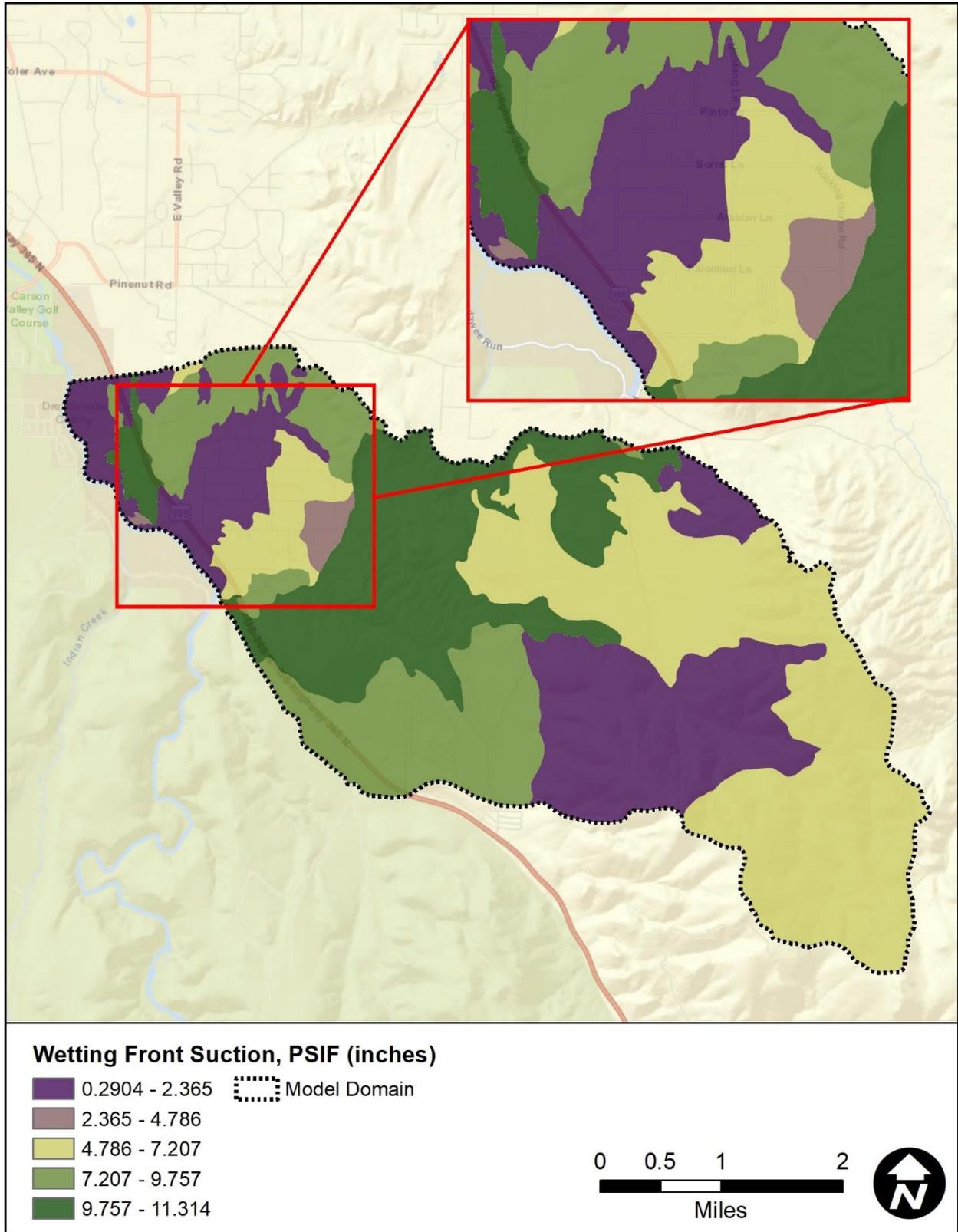


Figure 2-9. PSIF values used in the FLO-2D modeling

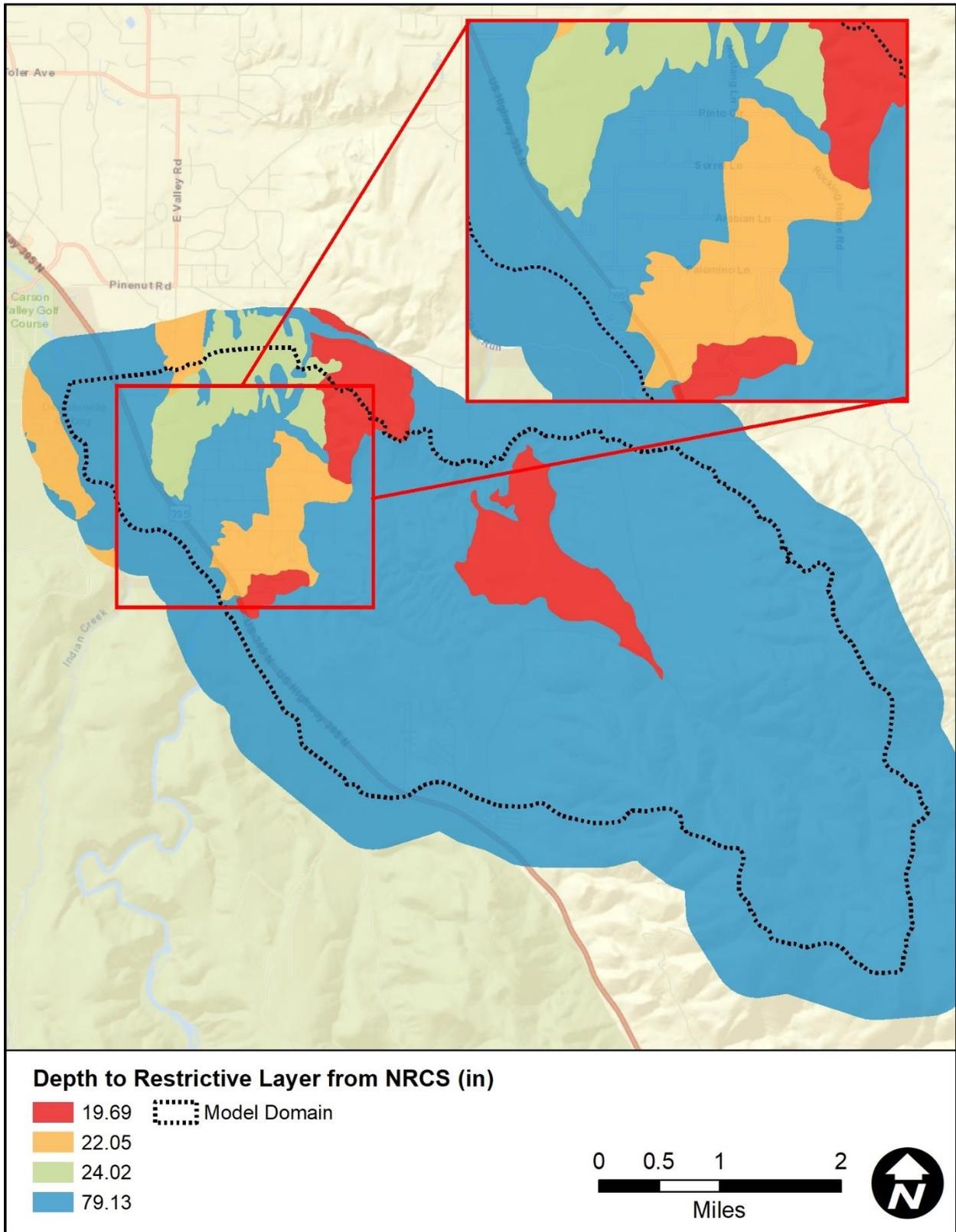


Figure 2-10. Spatial variability of the depth to a restrictive layer, from NRCS (2019)

2.2.6.2 Surface-based

The infiltration parameters which are dependent on the conditions and type of the ground surface are:

- Percent impervious, and
- Initial abstraction (IA) in inches.

Table 2-5 shows the surface classification and the corresponding percent impervious and the IA, while the spatial distribution of these land use categories is shown in Figure 2-3. These were selected based on experience in other studies, such as the Alpine View Estates ADMP (JEF 2019a) and the Dayton Valley ADMP (JEF, 2019b), field observations from both JEF and Douglas County staff, and aerial photograph interpretation of the study area. The unimproved roads were given a percent impervious value of 50% to account for added compaction through repeated vehicle use.

Table 2-5. Surface classification with corresponding percent impervious and initial abstraction

Surface Classification	Percent Impervious (%)	Initial Abstraction ¹ (in)	DTHETA Condition
Upper Watershed Rangeland	0	0.45	dry
Focus Areas Rangeland	0	0.35	dry
Maintained Turf	0	0.10	normal
Rural Residential	15	0.15	normal
Unimproved Road	50	0.10	dry
Agriculture	0	0.50	normal
Building	95	0.05	normal
Pavement	95	0.05	normal
Wash	0	0.10	dry
Water	100	0.00	saturated
1. Note that the initial abstraction used in the modeling has been reduced by 0.048 inches to recognize that the TOL (surface detention) value used by FLO-2D acts as a part of initial abstraction			

2.2.7 Hydraulic Structures

Both culverts and minor storm drains can be simulated with the hydraulic structure routine within the FLO-2D software. Please see the FLO-2D Data Input Manual (FLO-2D Software, Inc., 2019) and the FLO-2D Reference Manual (FLO-2D Software, Inc., 2018) for more details on the application of this routine and its associated modeling options.

All culverts (there are no storm drains within the study area) that were modeled as a part of this ADMP are shown in Figure 2-11. Douglas County provided the consultant team with GIS and as-built data for some structures within the study area and NDOT provided sizes and locations for culverts along US 395. Additionally, JEF staff conducted a field verification visit to the study area in January 2020 to locate additional structures and to verify the information developed from the collected data (e.g. locations, sizes, overall condition, etc.).

2.2.7.1 Culverts

In 2016, the Flood Control District of Maricopa County (FCDMC) produced a comprehensive FLO-2D verification report in which recommendations on modeling hydraulic structures were provided. Per those recommendations, the generalized culvert equation option in FLO-2D was used in the Ruhenstroth ADMP models for single barrel box and circular culverts as a first option. If a single culvert crossing used multiple barrels (or pipes), a rating table was developed assuming inlet control for the culvert. The modeling options that were used to model culverts are summarized in the list below.

- 1) Generalized culvert equations used for single barrel boxes and circular culverts with no tailwater influence (i.e., INOUTCONT parameter set to 0 because the generalized equations account for tailwater conditions).
- 2) If a culvert had multiple barrels (or pipes), a rating table was developed based on inlet control or the width in the generalized culvert equations was adjusted to match the equivalent area of the multiple barrels. Rating tables were used for this study.
- 3) If a culvert had significant sediment blockage, a rating table was developed based on inlet control with a reduced discharge based on the percent area clogged.
- 4) If a culvert had an irregular shape (i.e., ellipse or arch), a rating table was developed based on a simplified EPA-SWMM model (and the flow reduced if there was significant sediment blockage).
- 5) If tailwater conditions could affect flow, a rating table was used and the INOUTCONT parameter in FLO-2D was set to 1.
- 6) If there was potential for reverse flow in a culvert, a rating table was used and the INOUTCONT parameter in FLO-2D was set to 2.

2.2.7.1.1 Clogging Factors

If a culvert was observed to have significant sediment blockage during a field investigation, an appropriate reduction in flow was applied to the rating table or the open area (e.g., if a culvert was blocked by 50%, the flow or open area was reduced by 50%).

In general, smaller culverts (<36 inches) used a 50% clogging factor. Larger culverts (≥ 36 inches and box culverts) did not have a clogging factor except where sediment deposition was observed at the culvert or in the watersheds that exhibited high sediment transport rates. The culverts that used a clogging factor were denoted by adding a “clg” to the name of the structure in the FLO-2D HYSTRUC.DAT input file.

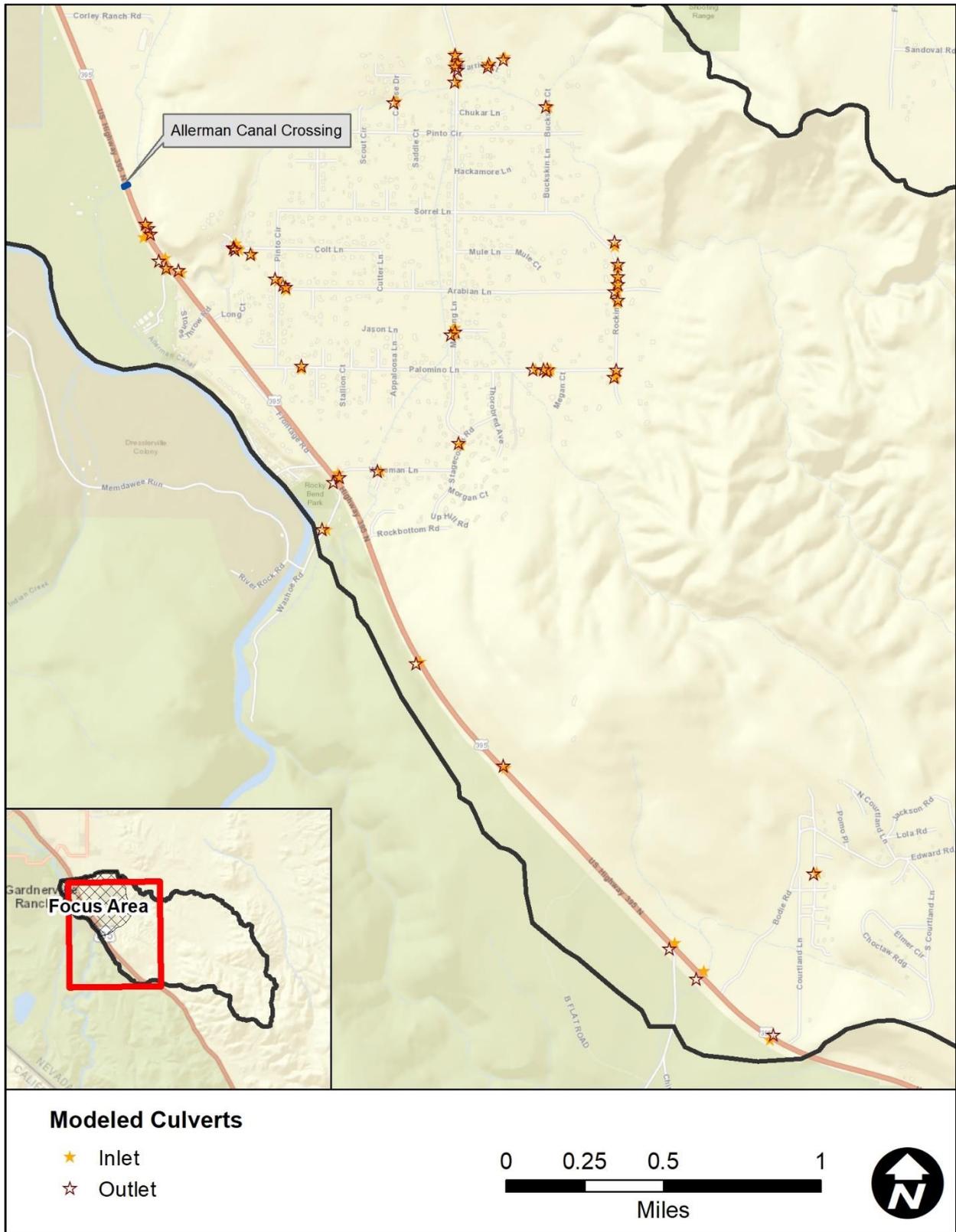


Figure 2-11. Locations of all modeled hydraulic culverts

2.2.7.1.2 Driveway Culverts

Within the focus area, almost every house has a small driveway culvert that allows small roadside ditch flows to pass underneath the driveway (see the example in Figure 2-12). These culverts usually range in size from 12- to 18-inches with the largest driveway culverts observed at 24-inches. Since these culverts are at nearly every house, there are hundreds of such structures within the study area – a number that is impracticable for field verification of every location. Therefore, a generalized rating table was developed for driveway culverts where a detailed measurement was not available. A comparison of the rating tables developed assuming inlet control and a 50% clogging factor for circular culvert sizes 12- to 24-inches and the generalized table is shown in Figure 2-13. The generalized rating table gives a good approximation of flow capacity for a typical driveway culvert at depths below 2 feet (i.e., depths that are commonly seen in roadside ditches). The generalized rating table also uses a 50% clogging factor.

2.2.7.1.3 Allerman Canal Crossing

Since the water surface slope in a canal is extremely flat, the Allerman Canal crossing of US 395 was modeled with lowered cell elevations that approximated the water surface upstream and downstream. This was done to prevent erroneous oscillations that can occur in a FLO-2D hydraulic structure when the headwater/tailwater conditions are nearly equal (e.g., at an equalizer pipe between two basins). The location of the crossing is shown in Figure 2-11.



Figure 2-12. Typical driveway culverts

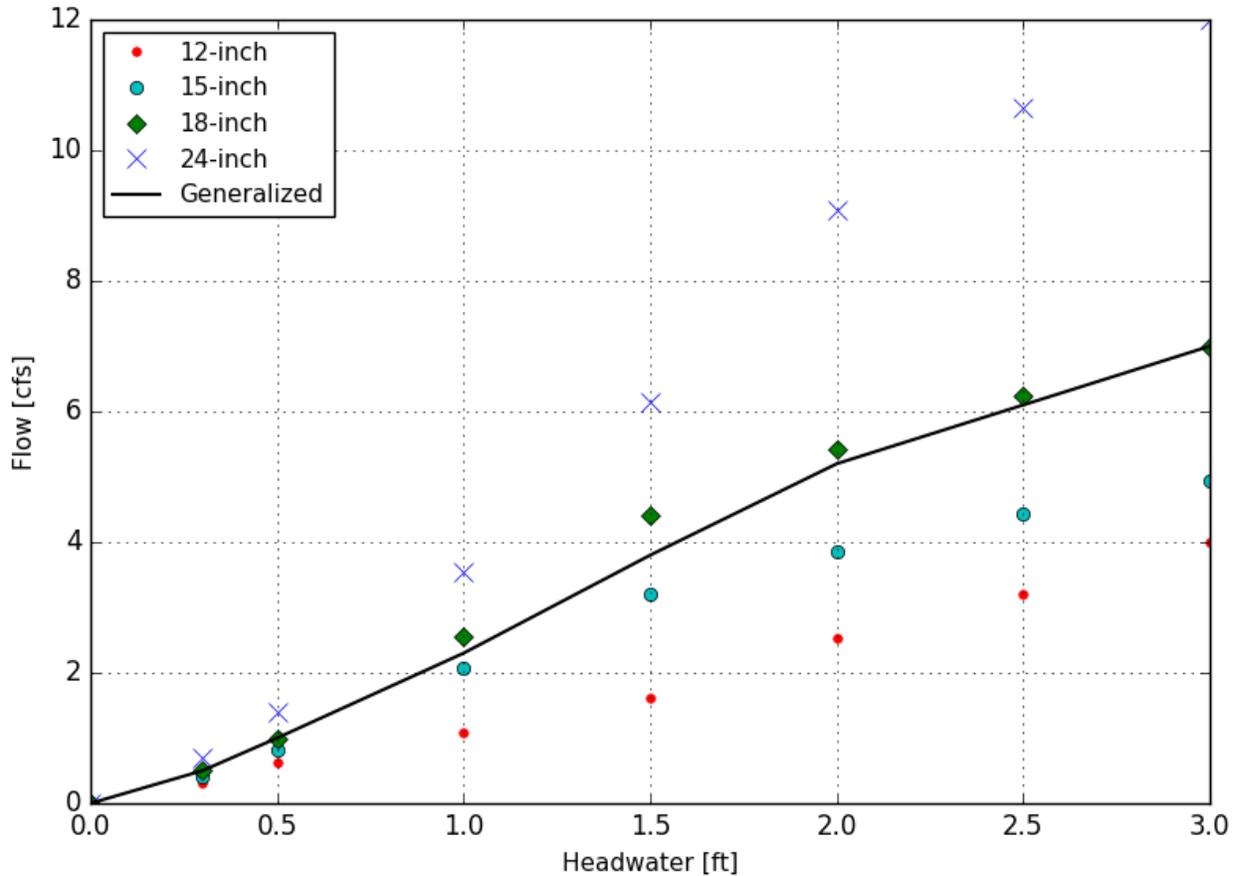


Figure 2-13. Rating table comparison

2.2.8 Buildings (as Flow Obstructions)

Douglas County provided a shapefile of building footprints as a part of initial data collection for this study. This shapefile was updated by the consultant team using the latest available aerial photography (dated late 2018) to reflect the most current conditions.

This updated shapefile was used to create a global area-weighted 10-foot pixel blocked obstruction raster (representing each FLO-2D grid element). The raster was then used to extract the percentage of area obstructed by buildings and assigned to area reduction factors (ARF) for each grid in the model. Cells that were 100% blocked used the FLO-2D totally blocked element routine. The buildings that were modeled with the ARF functionality are shown in Figure 2-3.

2.2.9 Model Control Parameters

CONT.DAT and TOLER.DAT contain numerical stability and simulation controls for the FLO-2D model. The CONT.DAT file controls simulation time, output report time interval, some numerical controls and model switches, such as infiltration and rain. The total simulation time was set to 15 hours for the 6-hour storm, while the total simulation time was set to 30 hours for the 24-hour simulations. These times were sufficient to ensure the floodwave has traveled through the entire study area.

2.2.9.1.1 CONT.DAT

In the CONT.DAT file, the global Manning's n value adjustment factor (AMANN) and the limiting Froude number (FROUDL) were the numerical controls that were used in the Ruhenstroth ADMP. For this study, these controls were set to:

- AMANN = 0 (depth integrated roughness is used with the SHALLOWN parameter)
- FROUDL = 0.95
- SHALLOWN = 0.40 (spatially varied shallow Manning's n was also used, see Section 2.2.5)

For the limiting Froude number, a value of 0.95 was used in this study to be consistent with FEMA modeling procedures since the FLO-2D model may be used as the basis for future floodplain delineation and/or redelineation.

The global SHALLOWN parameter was set to 0.40 for the modeling area to account for the increased roughness due to large boulders, rocks, and vegetation at shallow depths. However, the spatially varied shallow n was applied per the detailed surface feature classification, so that a lower shallow n could be used where appropriate (e.g., on paved streets).

2.2.9.1.2 TOLER.DAT

The TOLER.DAT file contains the numerical tolerance settings specified for the model. These settings include: the flow exchange tolerance (TOL), percent allowed change in flow depth (DEPTOL), dynamic wave stability criteria (WAVEMAX), and Courant-Friedrich-Lewy numerical stability parameter for floodplain grid element flow exchange (COURANTFP). For the RADMP models, the settings applied were:

- TOL = 0.004 feet (the depth at which FLO-2D begins to route flow)
- DEPTOL = 0 (not used, model uses Courant number as stability criteria)
- WAVEMAX = 0 (not used, model uses Courant number as stability criteria)
- COURANTFP = 0.6 (main stability criterion used by FLO-2D)

These values have been used in similar studies, which yielded reasonable results. For this project, these values have produced good model stability and reasonable results.

2.3 MODEL RESULTS

2.3.1 Floodplain Cross-Sections

Floodplain cross-sections were developed and included in the FPXSEC.DAT file to query flow hydrographs, peak discharges, and flow volumes from the FLO-2D model at key locations, such as:

- Major flow concentration locations,
- Areas near potential mitigation sites, and
- Areas of interest to Douglas County

Major floodplain cross-section locations are shown on Figure 2-14. Hydrograph plots at the floodplain cross-sections for each storm event are included in Appendix B. The peak flow and volume for each floodplain cross-section are shown in Table 2-6.

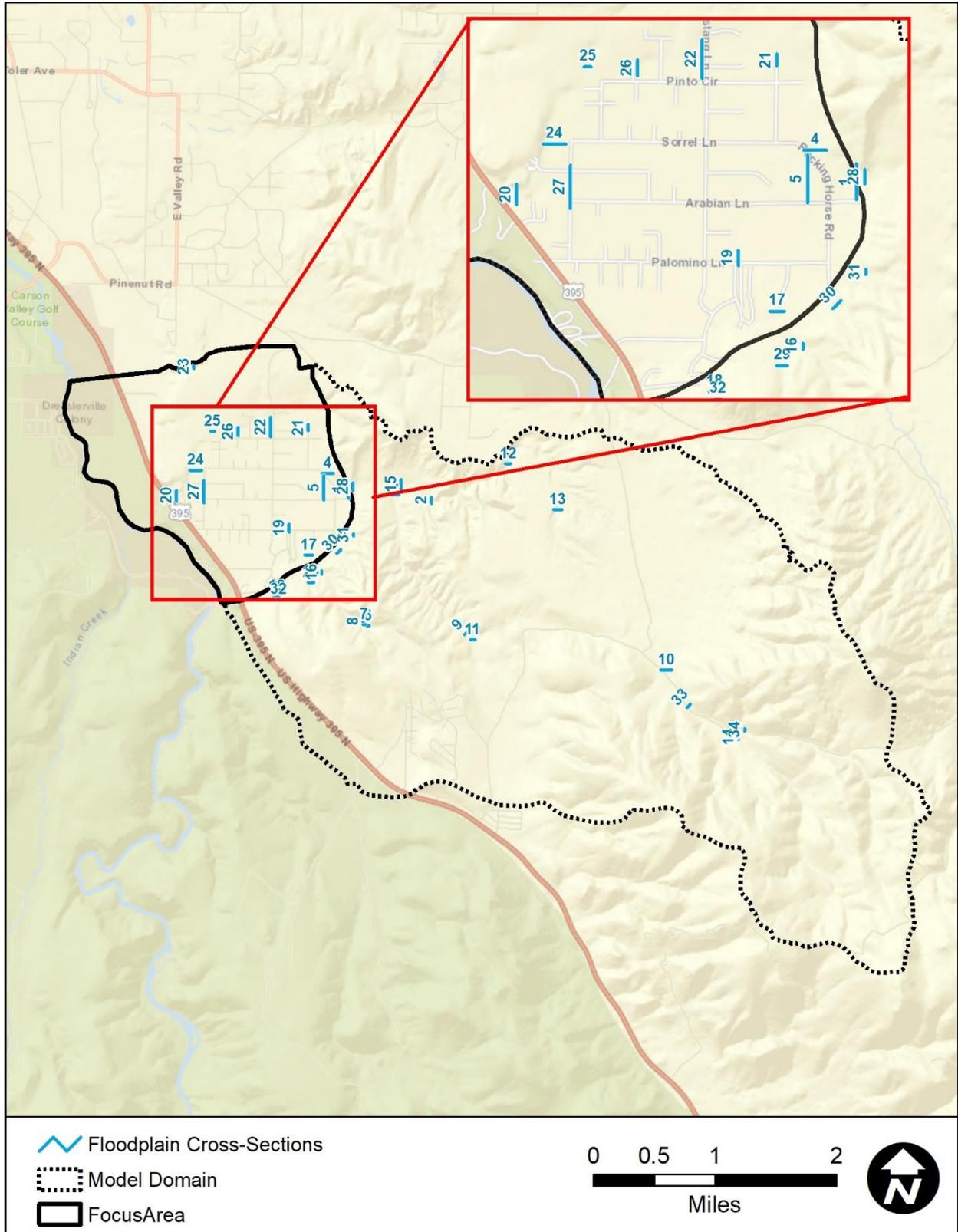


Figure 2-14. Floodplain cross-section locations

Table 2-6. Peak flow and volume results from the FLO-2D floodplain cross-sections

ID	100Y24H		100Y6H		25Y24H	
	Peak Flow	Volume	Peak Flow	Volume	Peak Flow	Volume
	cfs	ac-ft	cfs	ac-ft	cfs	ac-ft
1	1233	476	1393	232	636	241
2	793	255	1009	136	266	108
3	391	161	736	72	256	93
4	1232	475	1373	231	632	240
5	1	0	9	0	0	0
6	87	32	221	14	61	21
7	43	16	113	7	30	10
8	133	48	331	21	93	32
9	204	71	416	34	83	31
10	576	119	1323	78	97	15
11	119	31	114	14	15	6
12	726	212	1028	115	189	79
13	575	131	1005	81	87	24
14	310	64	658	38	66	11
15	840	288	981	150	327	130
16	212	78	464	34	151	52
17	236	86	528	37	168	58
18	51	19	91	8	37	13
19	266	93	527	38	172	59
20	1400	554	964	232	669	267
21	480	228	482	107	329	118
22	1221	472	997	221	599	233
23	0	0	3	0	0	0
24	1206	459	840	206	555	220
25	0	0	9	1	0	0
26	1219	468	932	216	587	229
27	244	91	345	27	128	44
28	1231	475	1389	232	634	241
29	25	9	111	4	19	6
30	32	12	138	5	23	8
31	15	6	66	2	11	4
32	49	18	88	8	36	12
33	580	119	1301	76	101	16
34	240	49	527	30	43	6

2.3.2 Depth and Discharge Results

Flow depth and discharge results from the existing conditions FLO-2D modeling are shown on Figure 2-15 through Figure 2-20. These figures are for general illustrative purposes and not practical for

obtaining detailed information at site-specific locations. For more detailed information, please see the digital data in Appendix B, which includes the grid-based results for maximum flow depth, maximum peak discharge, maximum velocity, and other FLO-2D output.

2.3.3 Animations

Google Earth animations of the Lower model have been included with the digital model results (see Appendix B). These animations are helpful for visualizing the dynamic nature of the flooding as it moves through the study area.

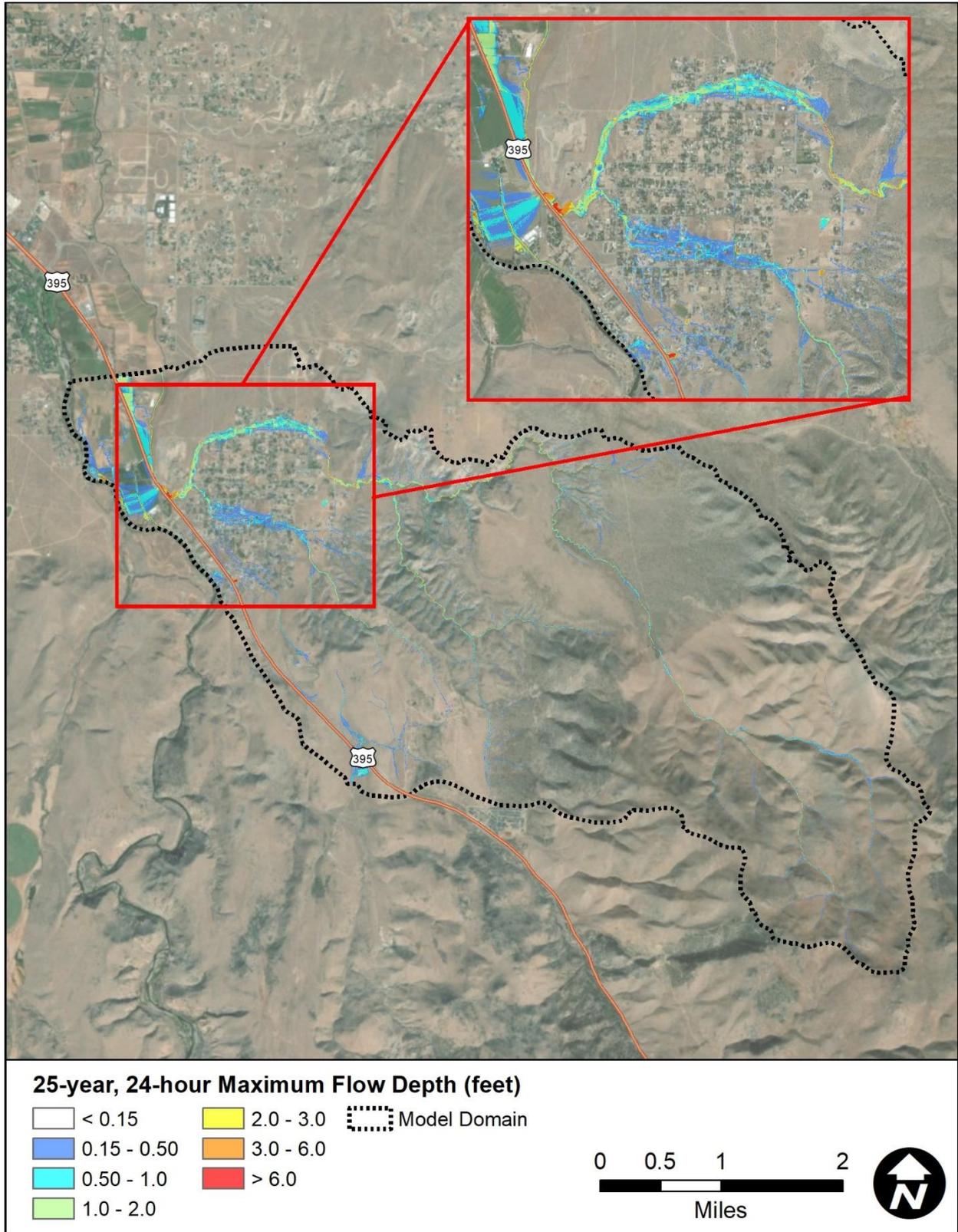


Figure 2-15. Existing conditions 25-year, 24-hour flow depth results

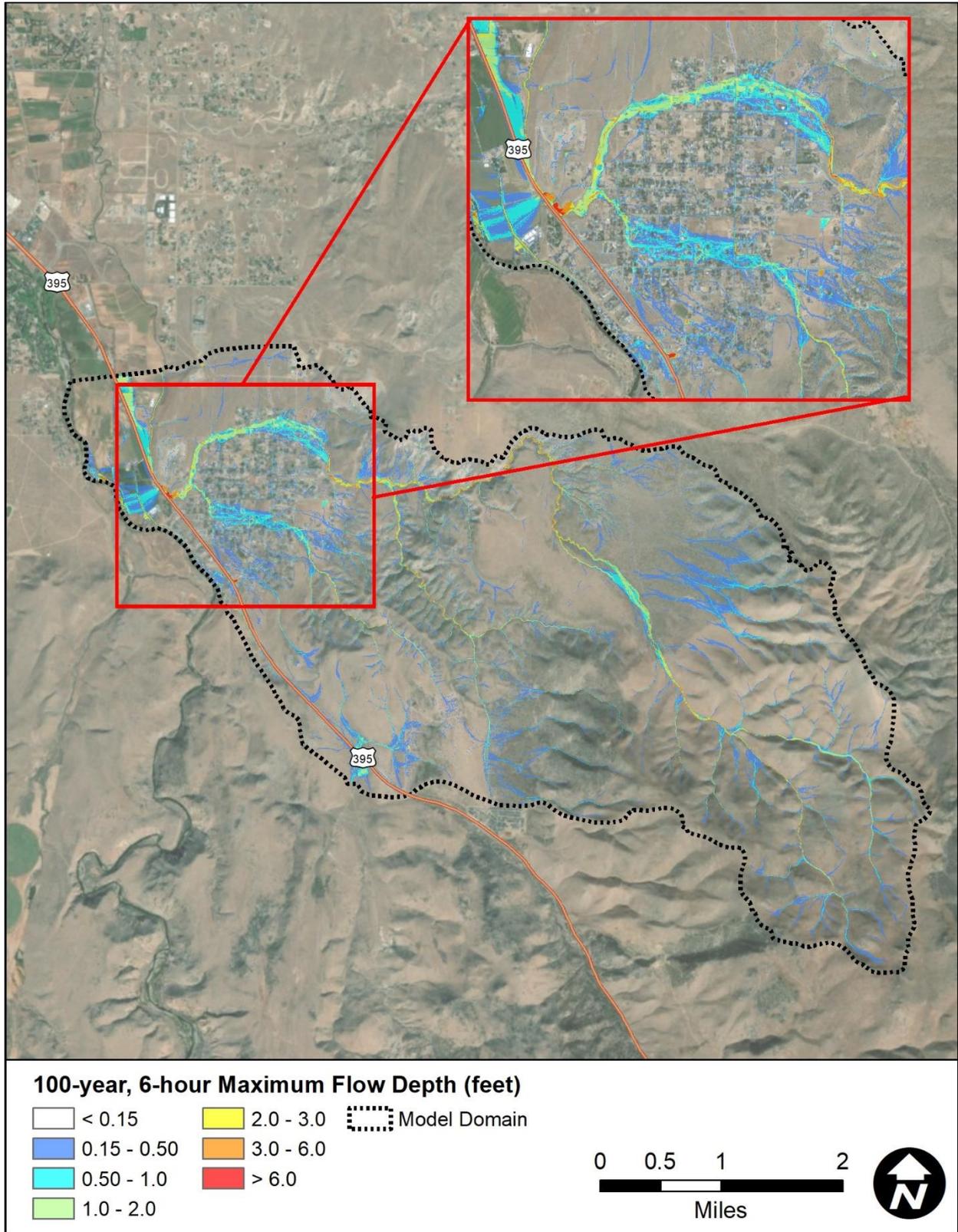


Figure 2-16. Existing conditions 100-year, 6-hour flow depth results

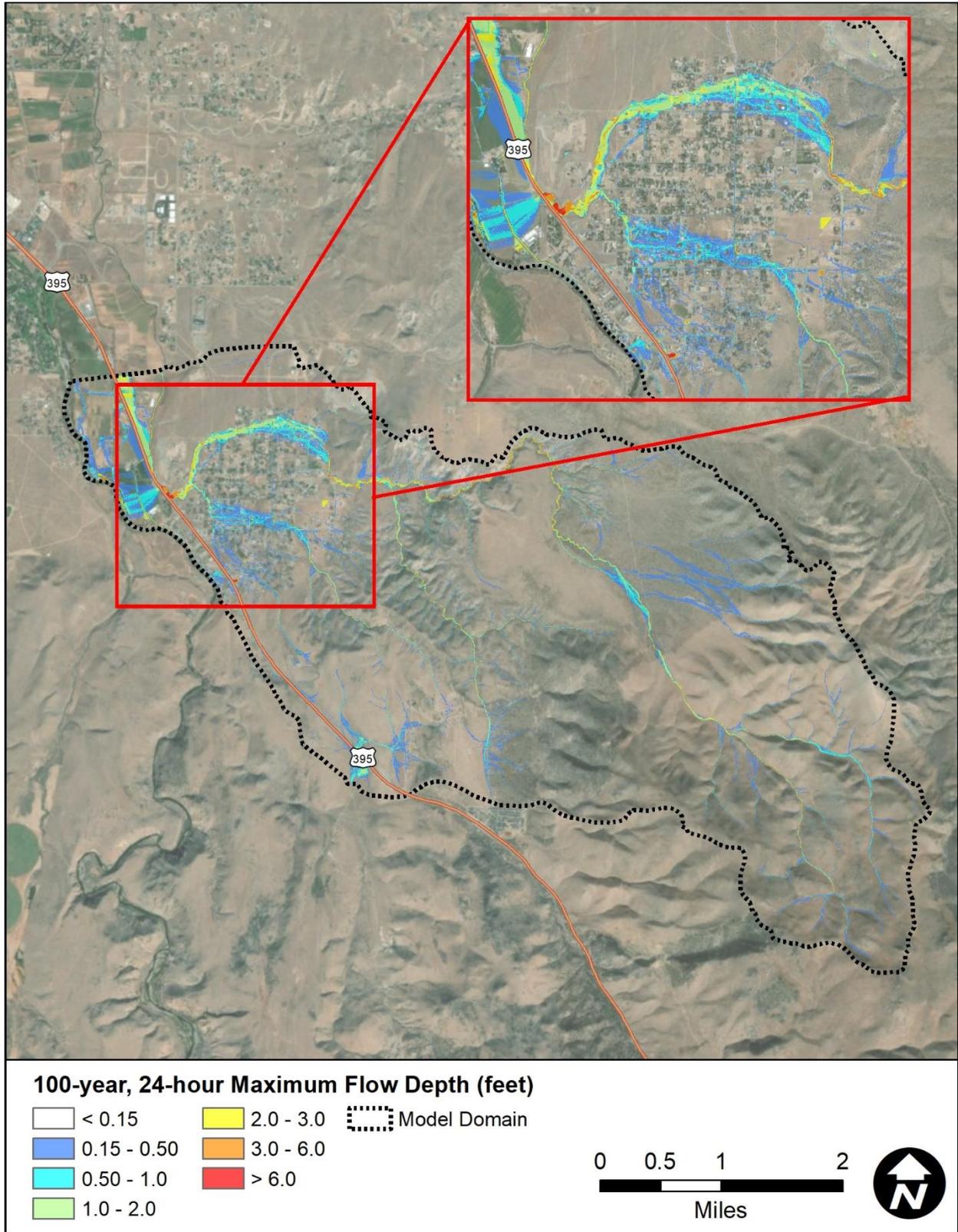


Figure 2-17. Existing conditions 100-year, 24-hour flow depth results

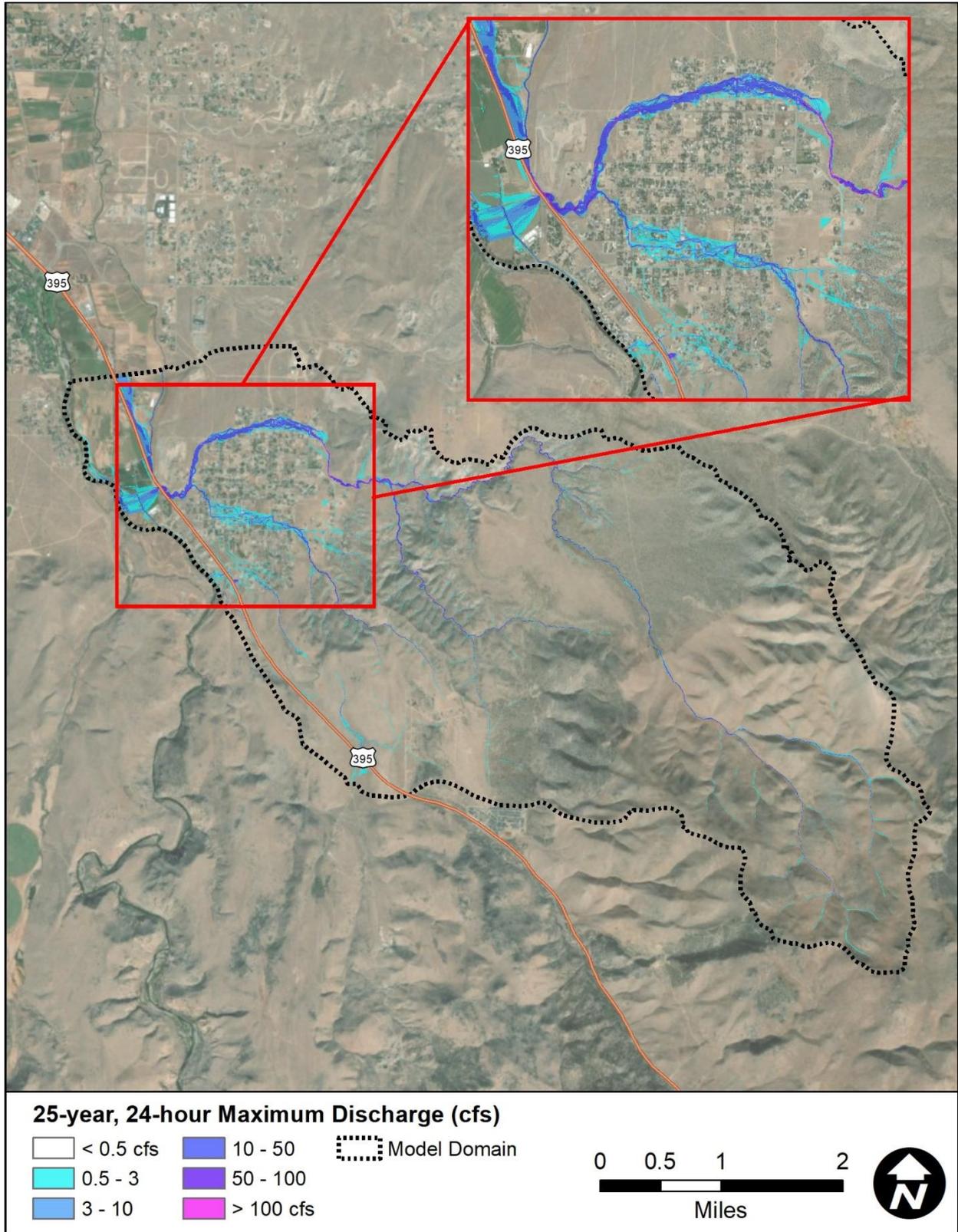


Figure 2-18. Existing conditions 25-year, 24-hour discharge results

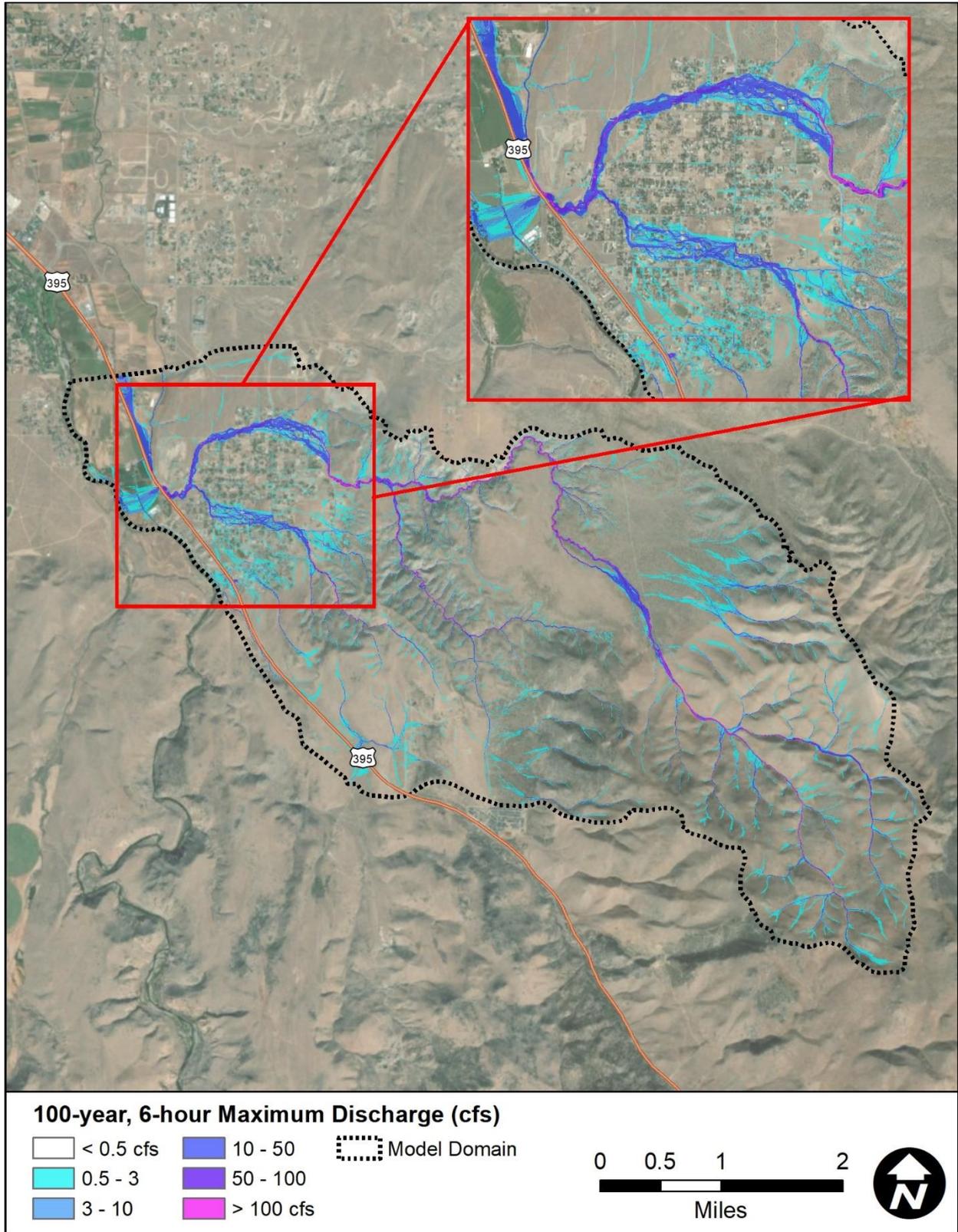


Figure 2-19. Existing conditions 100-year, 6-hour discharge results

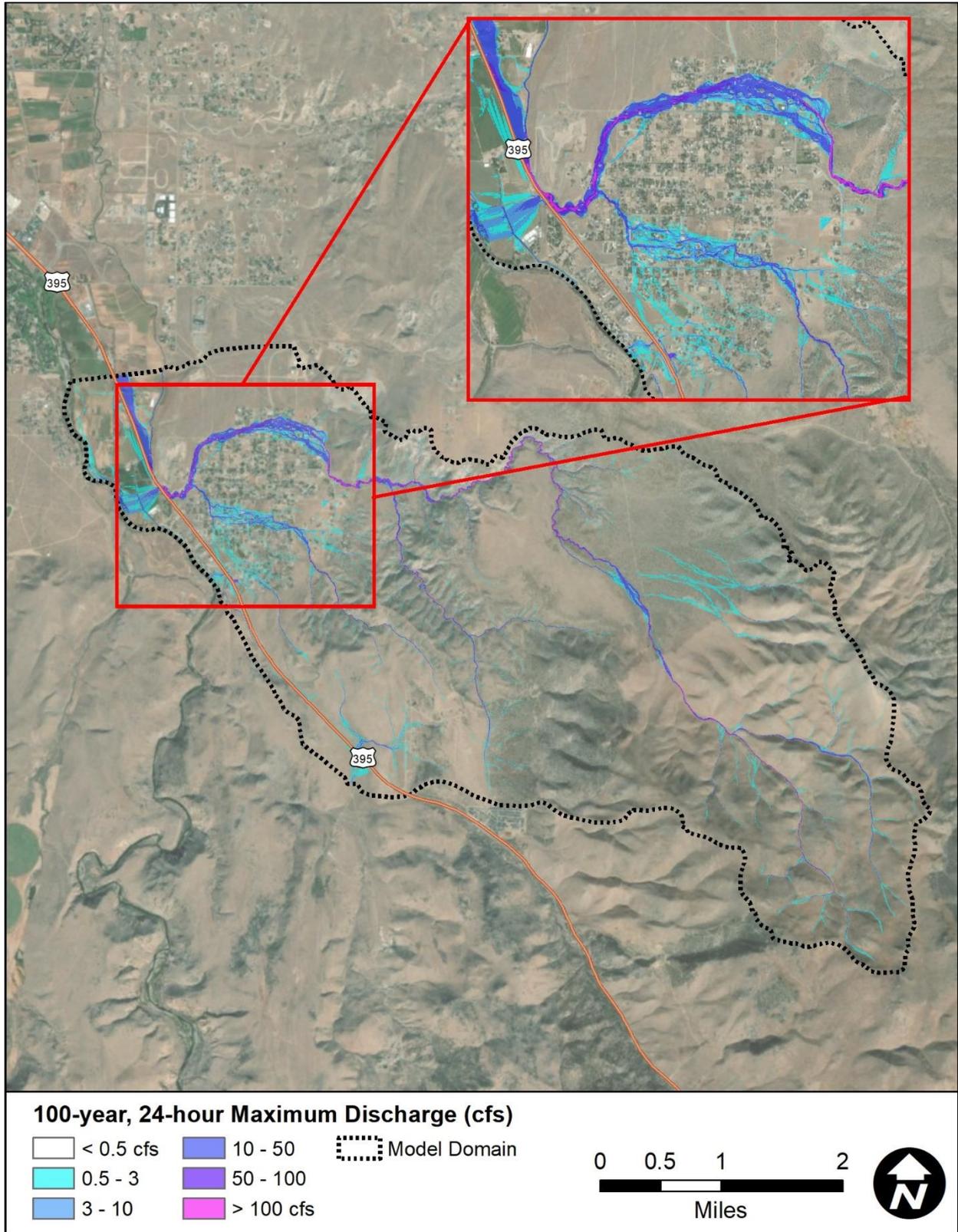


Figure 2-20. Existing conditions 100-year, 24-hour discharge results

2.4 VERIFICATION OF RESULTS

2.4.1 Comparison with USGS Regression Equations

As a verification of model results, the 100-year 6- and 24-hour results at seven drainage basins were compared with the 100-year USGS regression equation, shown as Equation (1), for the Eastern Sierras Region 5 (USGS, 1997).

$$Q_{100} = 7000AREA^{0.782}(ELEV/1000)^{-2.18}(LAT - 28)^{4.6} \quad (2)$$

Where:

- Q_{100} is the 100-year peak discharge (cfs)
- $AREA$ is the drainage area (square miles)
- $ELEV$ is mean basin elevation (ft)
- LAT is the latitude of site (decimal degrees)

The results from this comparison are shown in Table 2-7 and Figure 2-21, while the basin locations used for this comparison are shown in Figure 2-22.

Table 2-7 shows both the 100-year 6-hour (labeled as 100Y6H) and the 100-year 24-hour (labeled as 100Y24H) peak flow results from the FLO-2D modeling compared with the 100-year flow from the regression equation. The unit discharges for each basin and the median values are also calculated and shown in the table.

The comparison indicates that the FLO-2D results for the entire study area are generally reasonable. In Figure 2-21, all results fall below the USGS envelope curve and within the cloud of values, and both the 100-year 6-hour and 100-year 24-hour results follow the low- to middle-elevation study area line (which includes USGS Regression Regions 2-16, not just Region 5). However, both storm values are above the 100-year discharge relation for Region 5, but it should be noted that the USGS used mean values for variables other than drainage area when plotting this line. Therefore, this plot may not appear to fit the data.

In general, the results appear reasonable. The 100-year 24-hour median unit discharge compare extremely well with the median generated from Equation (1). However, the 100-year 6-hour median unit discharge is much larger than the regression median, but the 6-hour results are dominated by basins that are much smaller than 1 square mile where localized intense storm events can generate very high peak flows.

Table 2-7. Comparison with 100-year USGS regression equation

Basin ID	Basin Area	Regression Peak Flow	Regression Unit Discharge	100Y6H Peak Flow	100Y6H Unit Discharge	100Y24H Peak Flow	100Y24H Unit Discharge
	mi ²	cfs	cfs/mi ²	cfs	cfs/mi ²	cfs	cfs/mi ²
1	11.828	1,473	125	1,389	117	1,231	104
2	3.451	449	130	1,301	377	580	168
3	2.930	552	189	736	251	391	134
4	0.605	179	296	464	768	212	350
5	0.128	54	419	88	691	49	385
6	0.084	40	480	138	1,645	32	379
7	0.065	33	503	111	1,713	25	390
8	0.040	23	579	66	1,643	15	377
		Median:	358	-	729	-	363

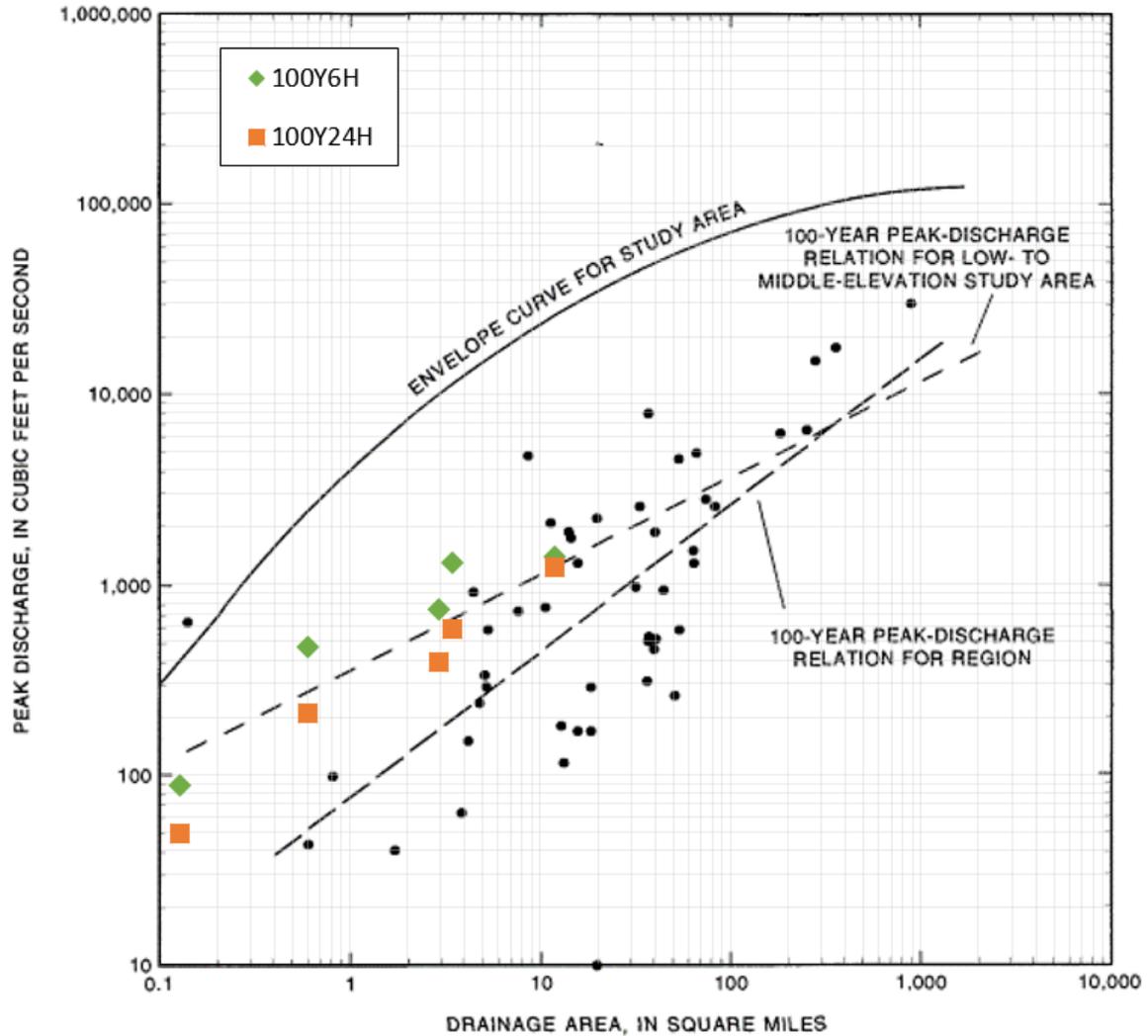


Figure 2-21. Comparison of FLO-2D results with the relations between 100-year peak discharge and drainage area and plot of maximum peak discharge of record and drainage area for gaged sites in the Eastern Sierras Region 5, adapted from USGS (1997)

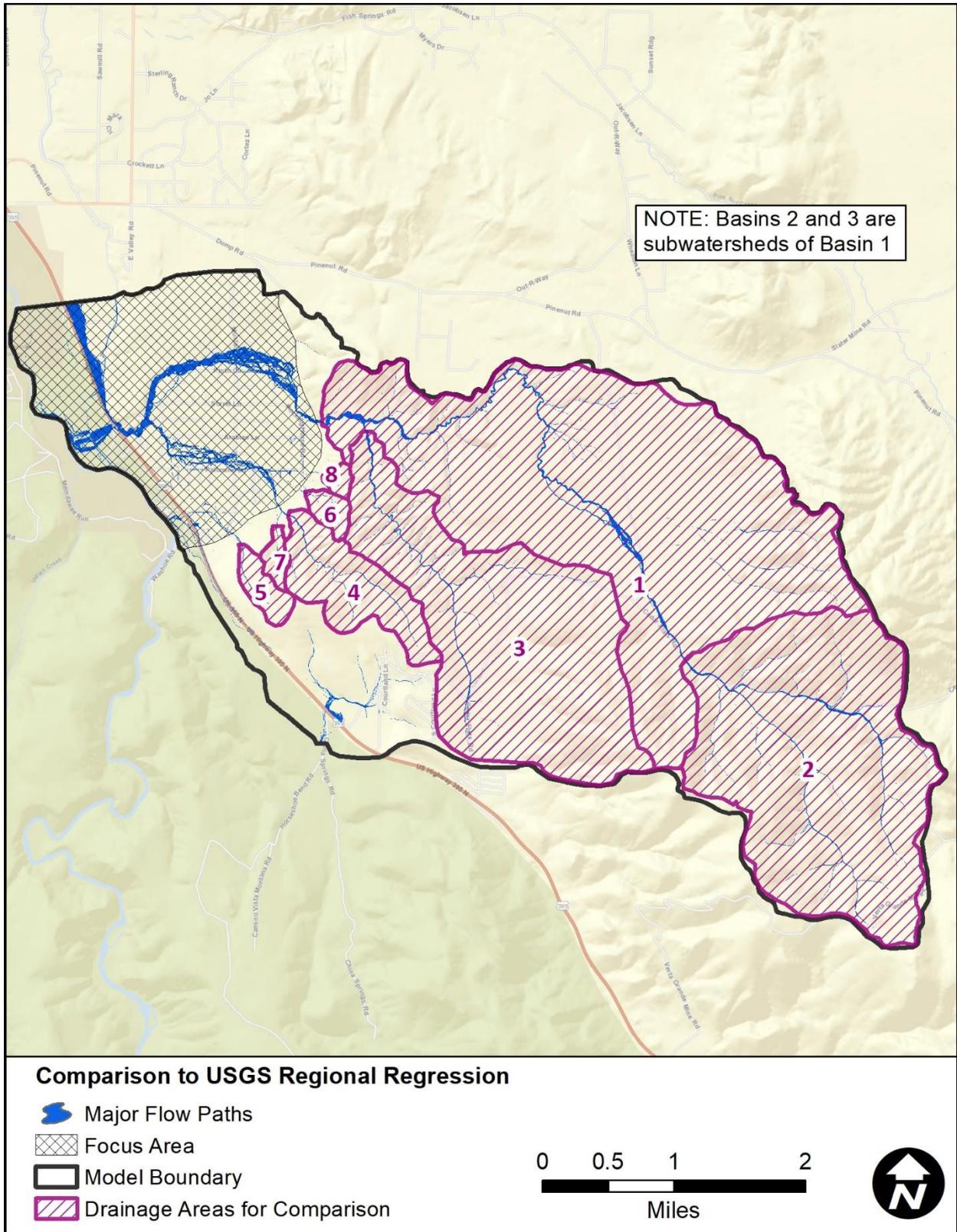


Figure 2-22. Drainage basins used for comparison of FLO-2D results to the USGS 100-year regression equations

2.4.2 Additional USGS Data

As part of another hydrology update project, NDOT recently obtained peak flow estimates for both inactive and active crest stage sites. Since these were crest gages, they contained only peak flow estimates rather than entire hydrographs.

The maximum peak of record for each gage was parsed from the USGS data peak flow data, while the drainage area was collected from each gage’s site description on the USGS website. However, not all gages listed the drainage area in the site description. Of the 216 total sites, forty-five did not list the drainage area, and these sites were excluded from the comparison to the ADMP peak results. A summary of the drainage area statistics for all 216 sites is shown in Figure 2-23, and the spatial location of the sites is shown in Figure 2-24.

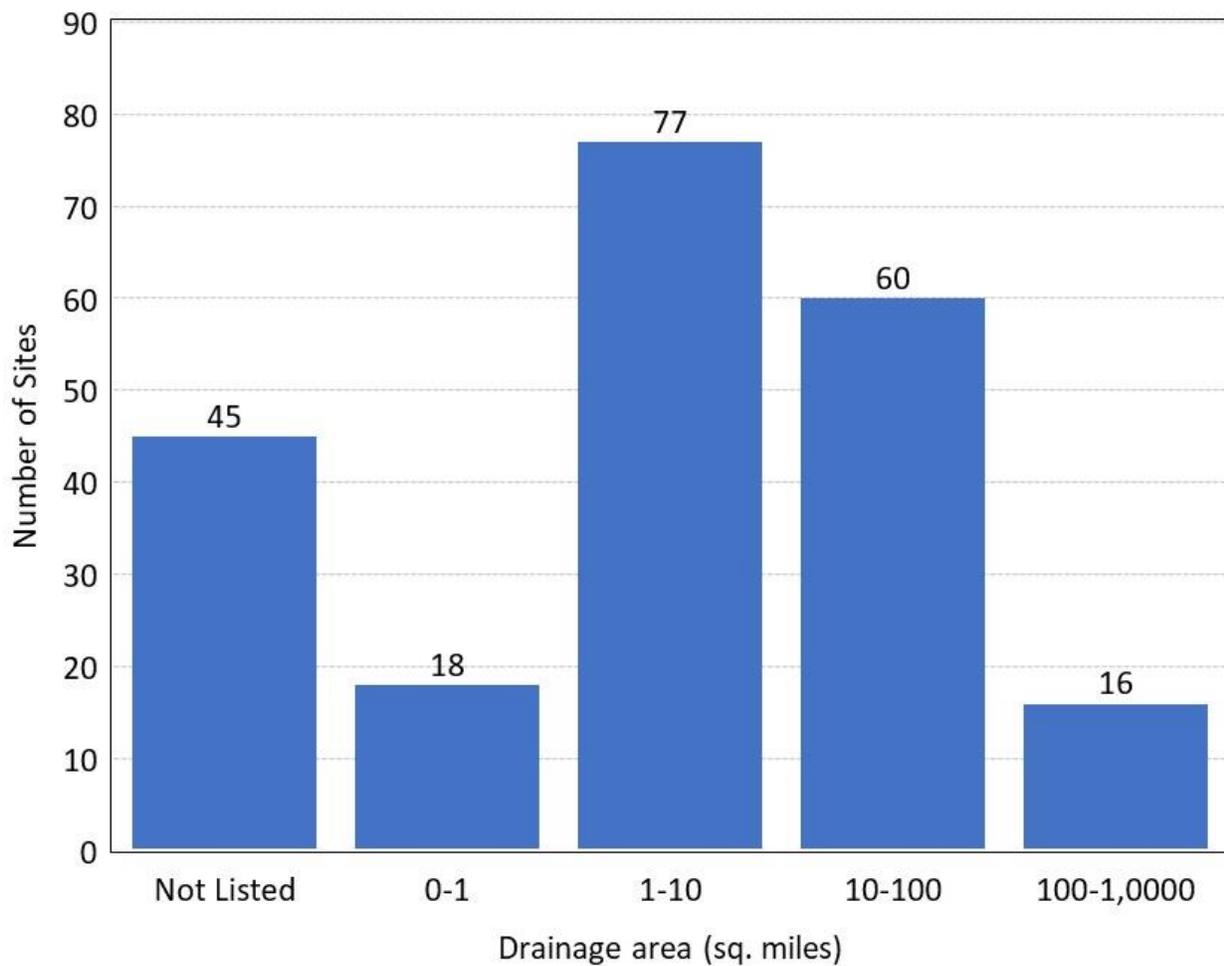


Figure 2-23. Drainage area statistics for USGS crest stage sites

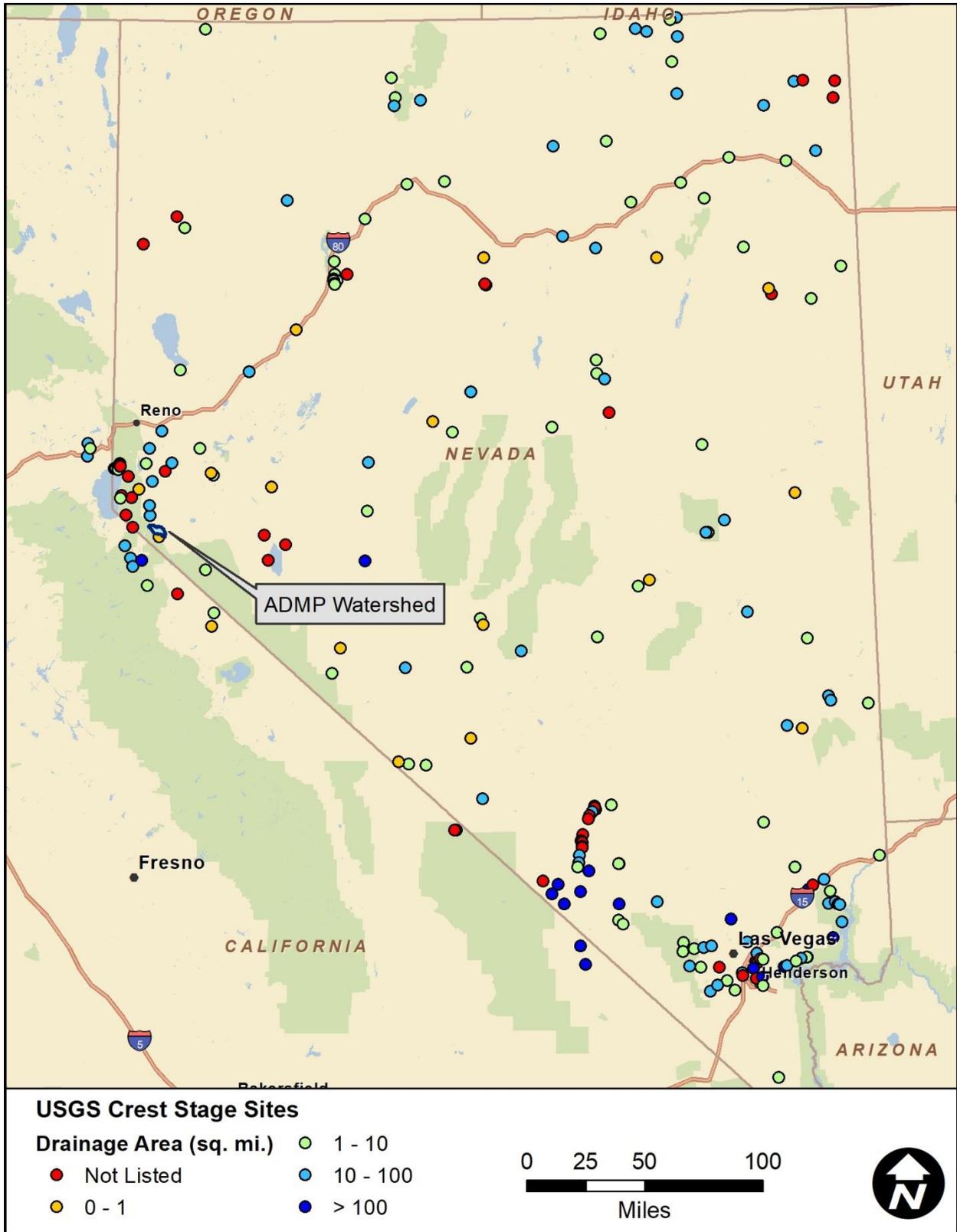


Figure 2-24. Location and drainage areas of USGS crest stage sites

As an additional verification of the peak flow estimates for the ADMP, the crest stage flow peak estimates were compared with the 100-year, 24-hour and 100-year, 6-hour FLO-2D results and peak flow estimates from the 1997 100-year regression equation (Equation 1). This comparison is shown as Figure 2-25. As before, both the FLO-2D and the 100-year regression estimates fall within the cloud of data, which provides another indicator that the RADMP results are reasonable.

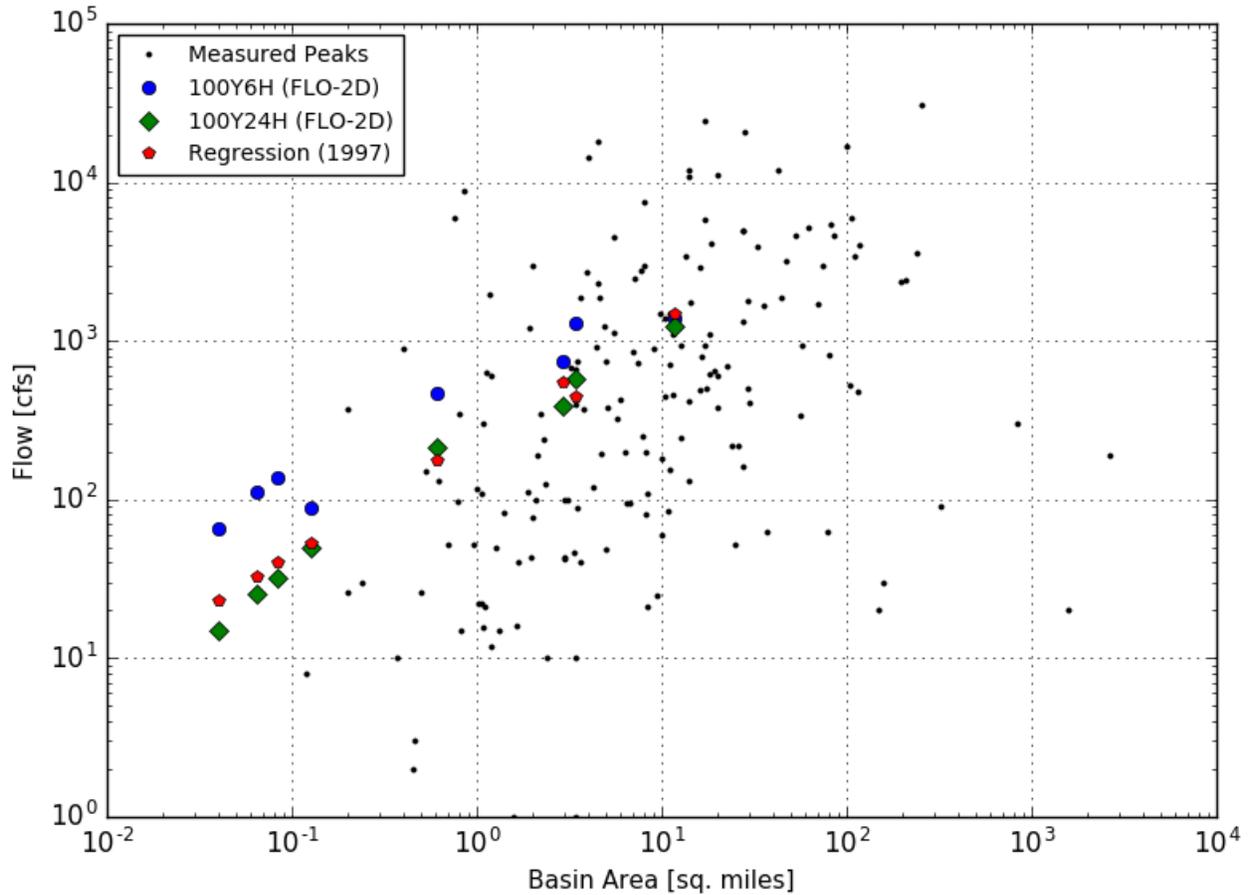


Figure 2-25. Comparison of FLO-2D results, 1997 100-year regression equation, and peak flow estimates from crest stage sites

2.4.3 Historical Flooding Documentation

As a part of the public outreach effort, the consultant team collected photographs, videos, and anecdotal information of historical flooding from residents within the ADMP study area as well as Douglas County staff. This information was used to help verify and adjust the FLO-2D model if needed. In general, the model results corresponded well with the historical information. Four locations where documentation was submitted are listed below and are illustrated in Figure 2-26 through Figure 2-29 to show the correlation between model results and actual flooding accounts.

- Buckskin Court crossing
- Horseman Court crossing
- Near Lacey Court and Mustang Lane
- Near Bennett Court and Pinto Circle

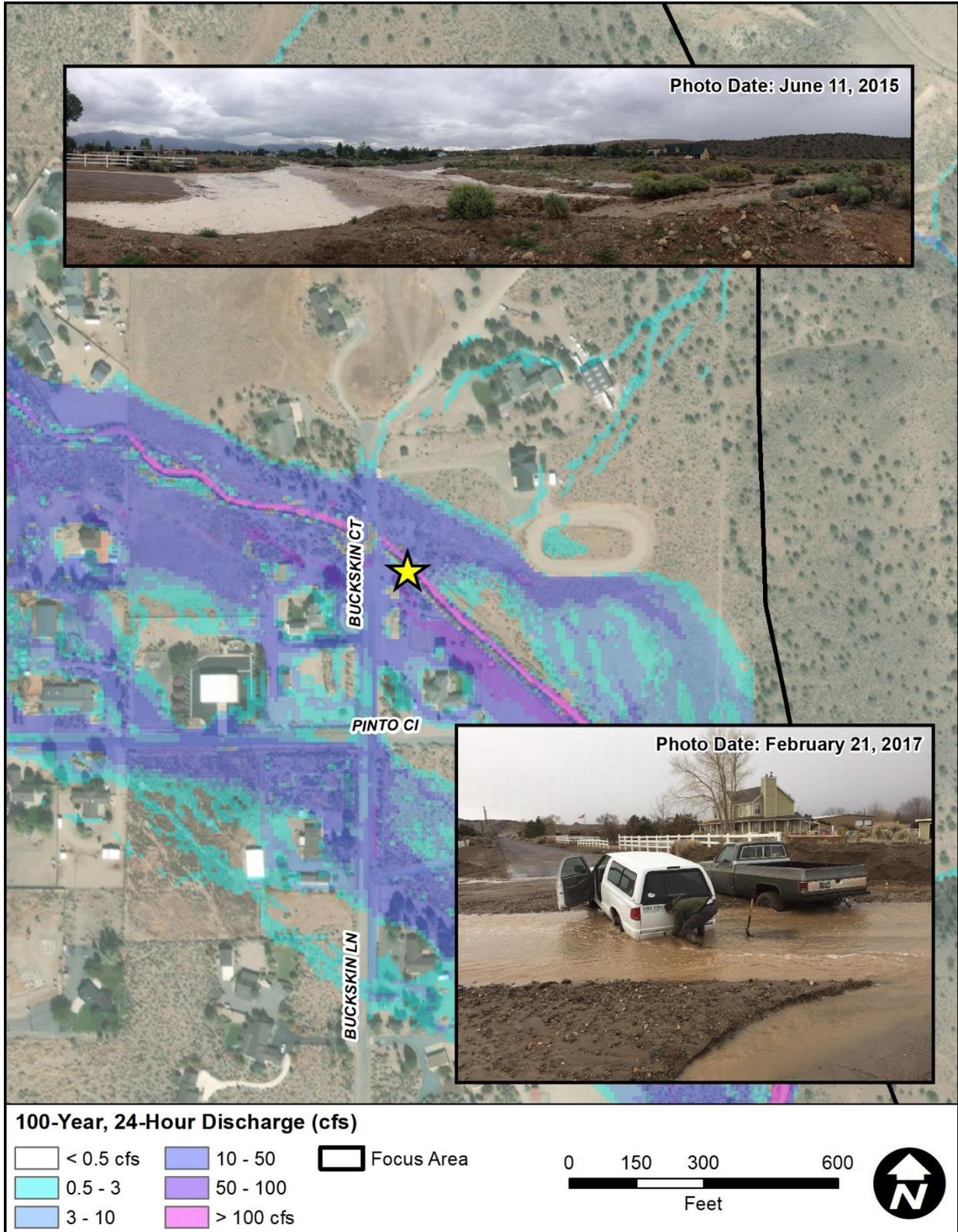


Figure 2-26. Verification for the Buckskin Court crossing area



Figure 2-27. Verification for the Horseman Court crossing area

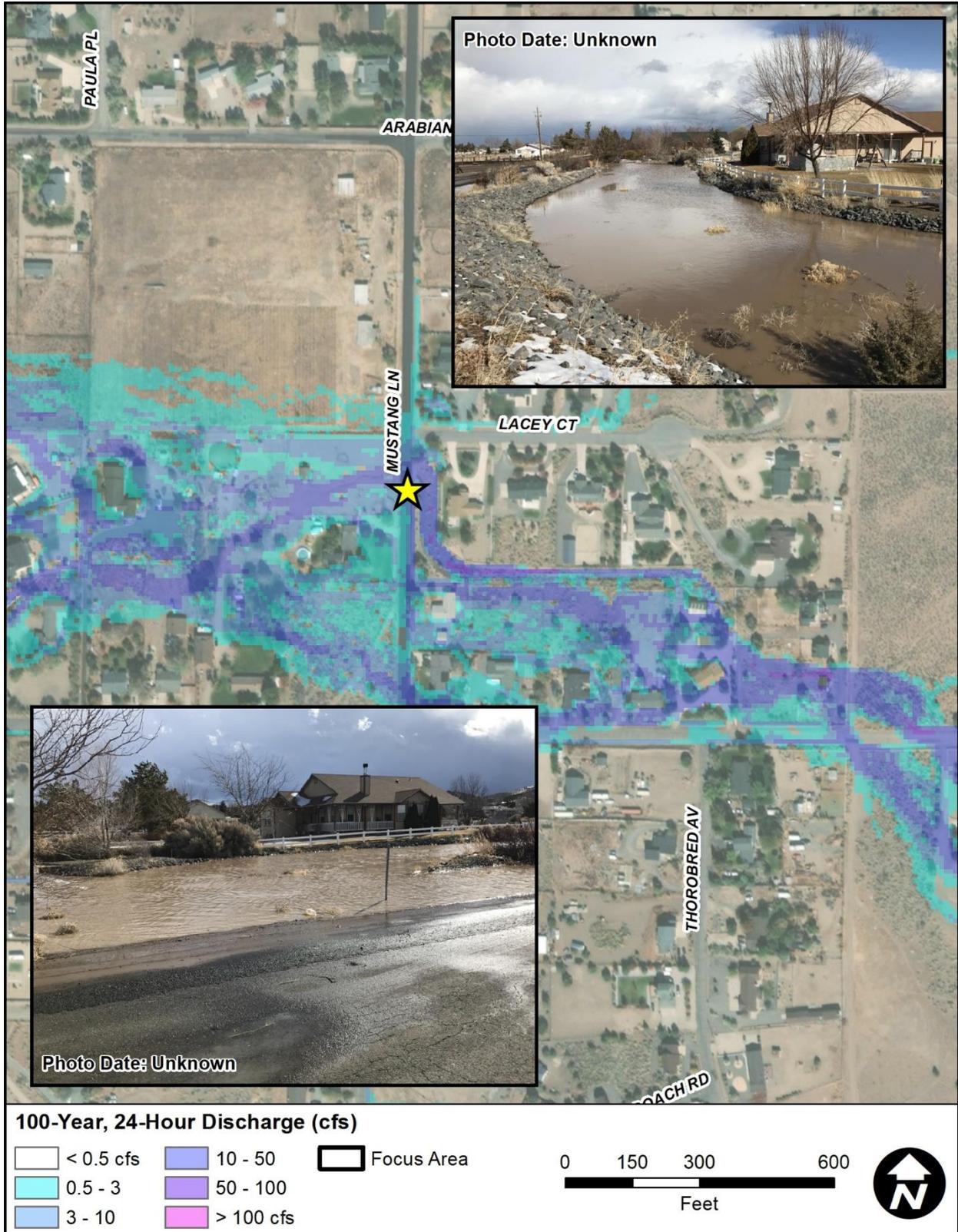


Figure 2-28. Verification for the Lacey Court/Mustang Lane area

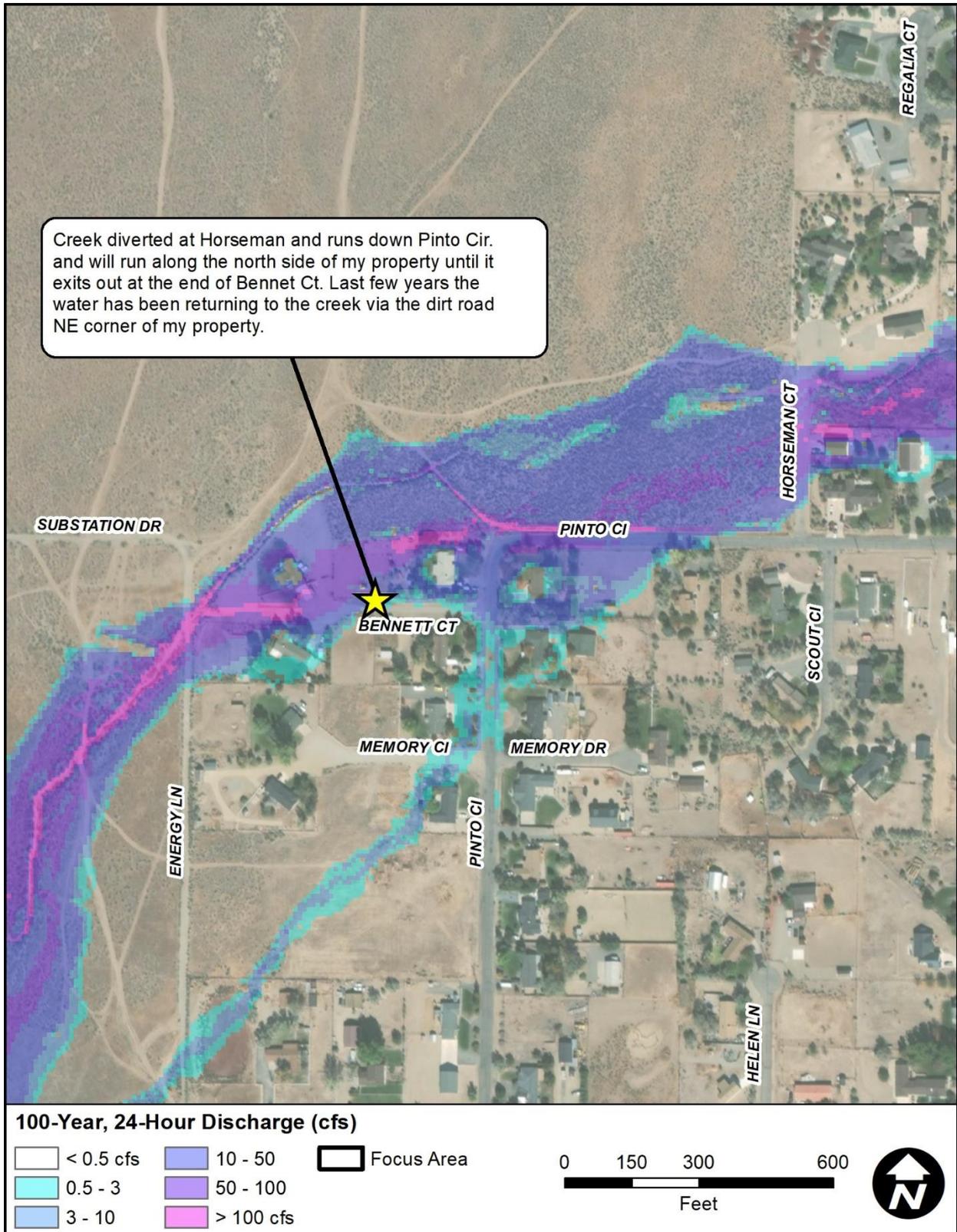


Figure 2-29. Verification for the Bennett Court/Pinto Circle area (resident-provided comment)

2.5 SUMMARY

The existing conditions FLO-2D models were created using the best available information for land cover, surface classification, topography, and hydrology. Every effort was made to ensure the models represented existing conditions as of the date of the LiDAR survey.

Photographs and anecdotal information collected from both Douglas County and the residents within the community were used to help calibrate and verify the modeling results. Like all models, the RADMP FLO-2D models are a simulation of potential conditions that could occur during a range of storm events. The models cannot exactly replicate actual, observed storm events at all locations within the community due to the vast number of variables that change with each unique storm event.

The modeling results reflect the complex flooding and sedimentation hazards that exist within the Ruhenstroth study area. The results provide valuable, quantitative, detailed information from which future planning and development decisions can be based. The existing conditions models also serve as a foundation from which potential mitigation alternatives can be assessed (Section 5).

Although the ADMP FLO-2D modeling effort was not intended to replicate an actual historical flood event, the comparison of the modeling results with USGS regression equations, anecdotal flood information, and independent hydraulic calculations indicate the project FLO-2D models suitably depict storm runoff conditions – indicating that the underlying input parameters are reasonable. Given the distributary nature of the flooding within the community, and the high sediment transport rates, flooding characteristics (e.g., depth, discharge, location) are likely to change from one flood event to the next. Even small anthropogenic changes to the landscape (e.g. dirt piles, berms, construction of outbuildings, landscaping debris piles, etc.) will result in sediment accumulation, channel scour, and changes in flowpath directions that may not be represented in the project FLO-2D modeling. In other words, the results of the modeling represent potential flooding conditions as of the date of the project topographic mapping. Updated mapping and FLO-2D modeling are recommended if major changes to the landscape occur in the future.

3 SEDIMENTATION ANALYSES

3.1 SEDIMENT SAMPLING AND TRANSPORT ANALYSIS

3.1.1 Sediment Sampling

Since the ADMP study area has known sedimentation issues (see example of sediment deposition at a culvert in Figure 3-1), a sediment transport analysis was conducted to help evaluate the source and identify mitigation solutions. Seven sediment samples were collected in September 2020 by JEF staff to help classify the type of sediment being transported to (and through) the ADMP focus area. The sampling locations are shown along with the sample IDs in Figure 3-2. All sediment samples were analyzed by mechanical sieve, and the gradation curves from each of these samples are shown in Figure 3-3, while major characteristics of the sediment are tabulated in Table 3-1.



Figure 3-1. Example of sediment deposition at culvert

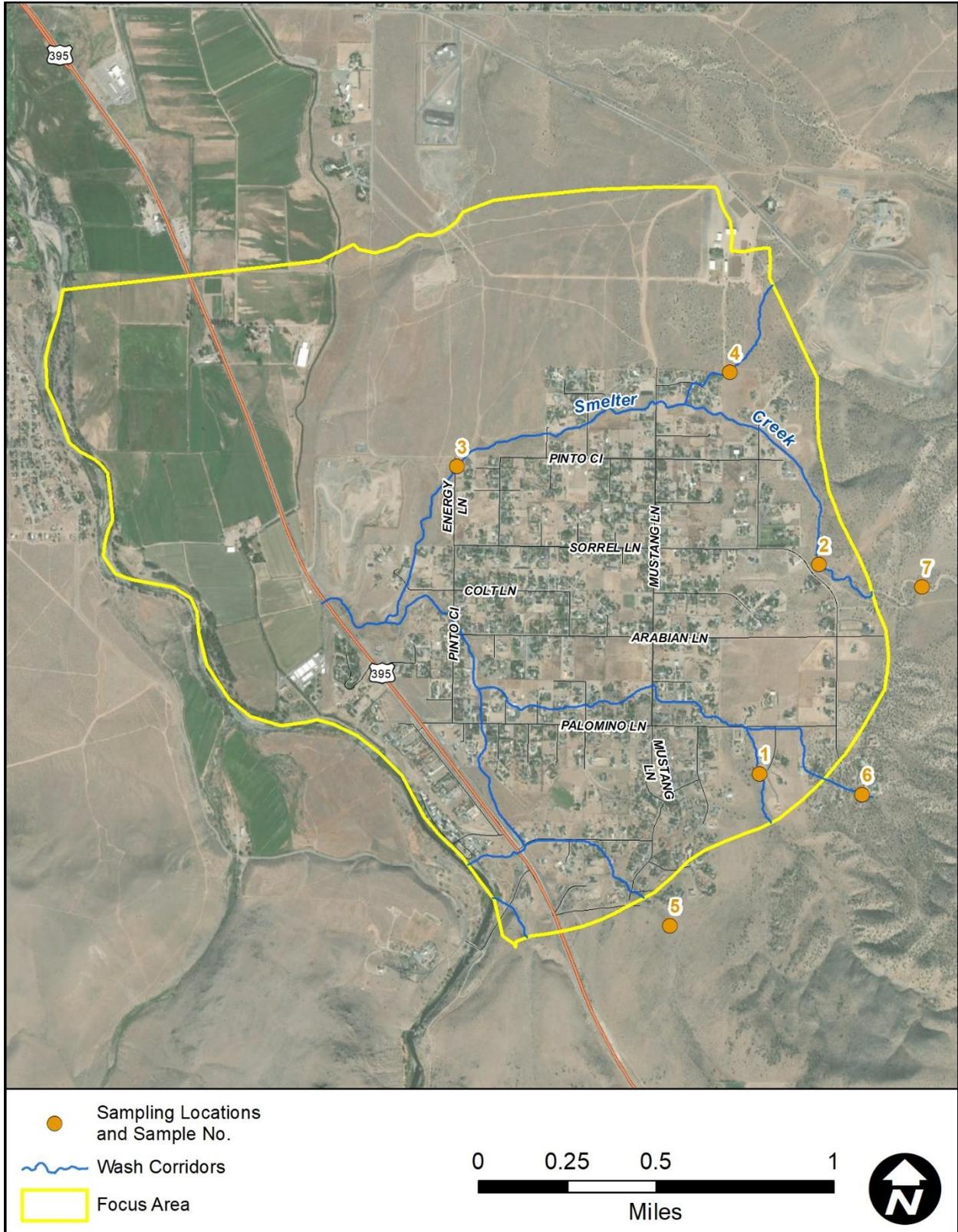


Figure 3-2. Sediment sample locations and sample ID

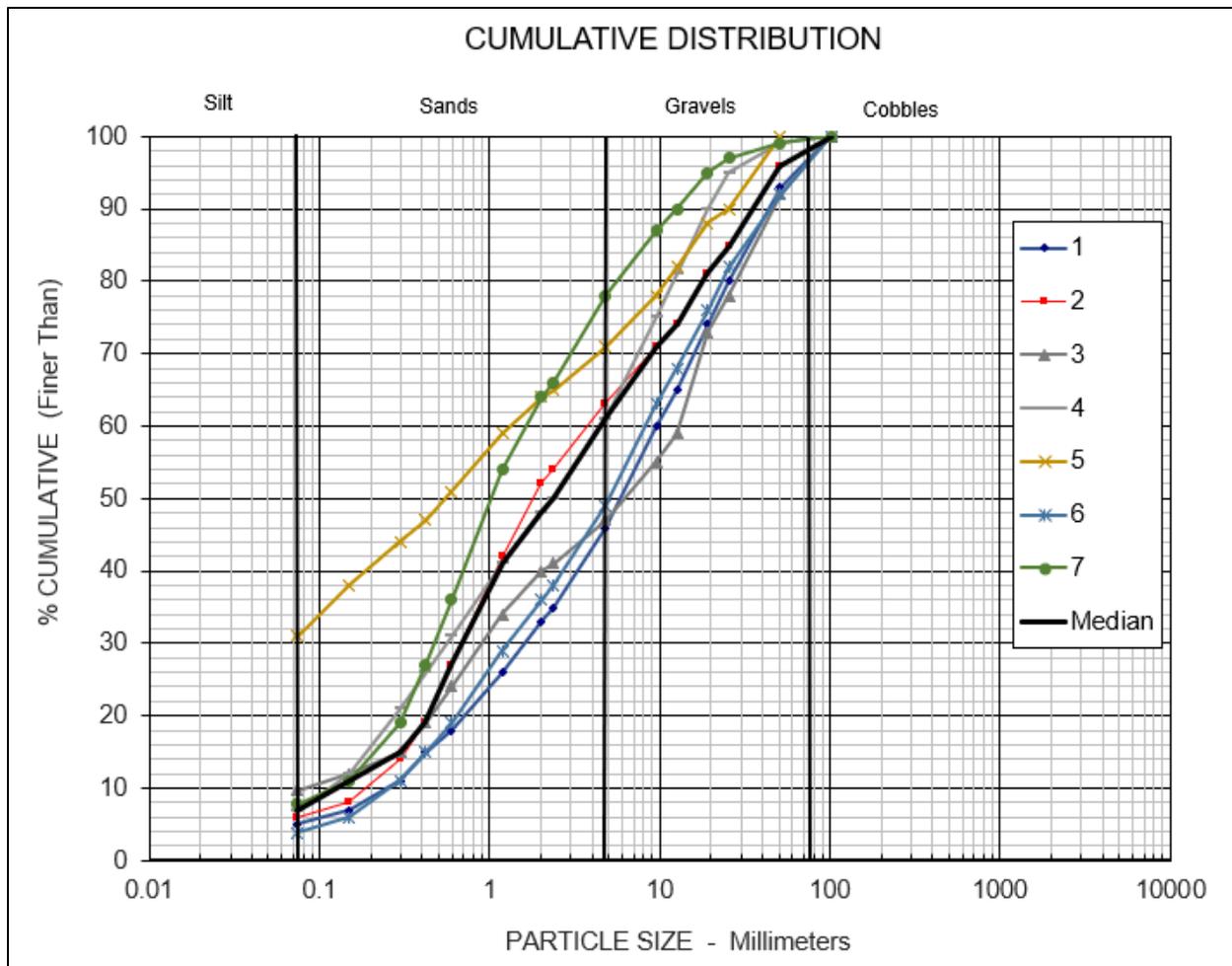


Figure 3-3. Gradation curves for the collected sediment samples

Table 3-1. Major characteristics of the sediment within the lower watershed

ID	Type	D16 (mm)	D50 (mm)	D84 (mm)	G
1	Sieve Analysis	0.48	6.12	33.22	14.58
2	Sieve Analysis	0.35	1.84	23.80	14.61
3	Sieve Analysis	0.33	6.54	36.29	20.39
4	Sieve Analysis	0.22	2.38	14.80	13.83
5	Sieve Analysis	-	0.55	14.80	-
6	Sieve Analysis	0.46	5.10	30.48	13.57
7	Sieve Analysis	0.24	1.06	7.93	9.49
Median	-	0.34	2.38	23.80	14.21
Average	-	0.35	3.37	23.04	14.41

3.1.2 Sediment Transport Analyses

The FLO-2D hydraulic modeling was used to assess the trends of both flooding and sedimentation throughout the study area. Hydraulic data from FLO-2D inherently includes both discharge and flow depth at each grid element. This hydraulic data was used to estimate sedimentation using the Yang sediment transport equation (1973, 1984) on a cell-by-cell scale. The median values from Table 3-1 were used in the sediment calculations.

For each modeled storm event, the total accumulated (i.e., throughout the entire storm event) sediment transport capacities were calculated at each cell. These accumulated capacities can identify areas where deposition or scour may be expected. The detailed results will be discussed in Section 3.2.

3.1.2.1 Yang Equation

Sediment transport was calculated using the Yang sediment transport methodology. This approach followed the calculation outline found in the HEC-RAS Hydraulic Reference Manual (USACE, 2016). The grain size distribution was discretized into three equal mass components where sediment transport capacity was computed separately for each component and the results were combined while weighting the capacity of each component by its relative mass contribution. The governing equation for estimating sediment concentration for each grain size using the Yang approach is as follows:

$$\log C_t = 5.435 - 0.286 \log \frac{\omega d_m}{\nu} - 0.457 \log \frac{u_*}{\omega} + \left(1.799 - 0.409 \log \frac{\omega d_m}{\nu} - 0.314 \log \frac{u_*}{\omega} \right) \log \left(\frac{VS}{\omega} - \frac{V_{cr}S}{\omega} \right) \quad (3)$$

$$\log C_t = 6.681 - 0.633 \log \frac{\omega d_m}{\nu} - 4.816 \log \frac{u_*}{\omega} + \left(2.874 - 0.305 \log \frac{\omega d_m}{\nu} - 0.282 \log \frac{u_*}{\omega} \right) \log \left(\frac{VS}{\omega} - \frac{V_{cr}S}{\omega} \right) \quad (4)$$

Where:

- C_t is the total sediment concentration (ppm)
- ω is the particle fall velocity (ft/s)
- d_m is the median particle diameter (ft)
- ν is the kinematic viscosity (ft²/s)
- u_* is the shear velocity (ft/s)
- V is the average channel velocity (ft/s)
- S is the energy gradient (ft/ft)

Equation 3 is used for sand with a median diameter < 2mm, while Equation 4 is for gravel with a median diameter is ≥ 2mm. Within a model spanning 2-dimensions in plan-view, such as FLO-2D, the Yang methodology differentiates itself through application of vectorized parameters – average channel velocity and slope, notably. Using time-varying output from FLO-2D, the direction of maximum velocity at each time step was determined and the terms utilized in the Yang equation were applied in that direction. This method allows the sediment transport capacity analysis to adapt to changes in peak flow direction which is especially valuable in areas of flowpath uncertainty such as coalescing alluvial fans and areas subject to flooding sources that can change over time (e.g., distributary flooding patterns).

3.2 RESULTS

3.2.1.1 *Sediment Rasters*

Since the total accumulated transport is calculated at each cell, an overall map of the study area with sediment transport capacities can be produced similar to the FLO-2D results presented in Section 2.3. Since the 100-year, 24-hour storm produces the largest amount of volume and sediment, it is used as a representative example. The relative total accumulated sediment transport within the focus area calculated with the Yang equation is shown in Figure 3-4. Note - The colors in both these figures represent relative transport capacity to each other, so green is relatively low compared to red, but green is higher than areas without color.

In general, the results are as expected. Higher sediment transport rates appear in the channels, while rates decrease as the flow leaves the mountain channels and spreads out over the landscape. Unsurprisingly, Smelter Creek produces the most sediment because it has the largest drainage area with the longest drain time.

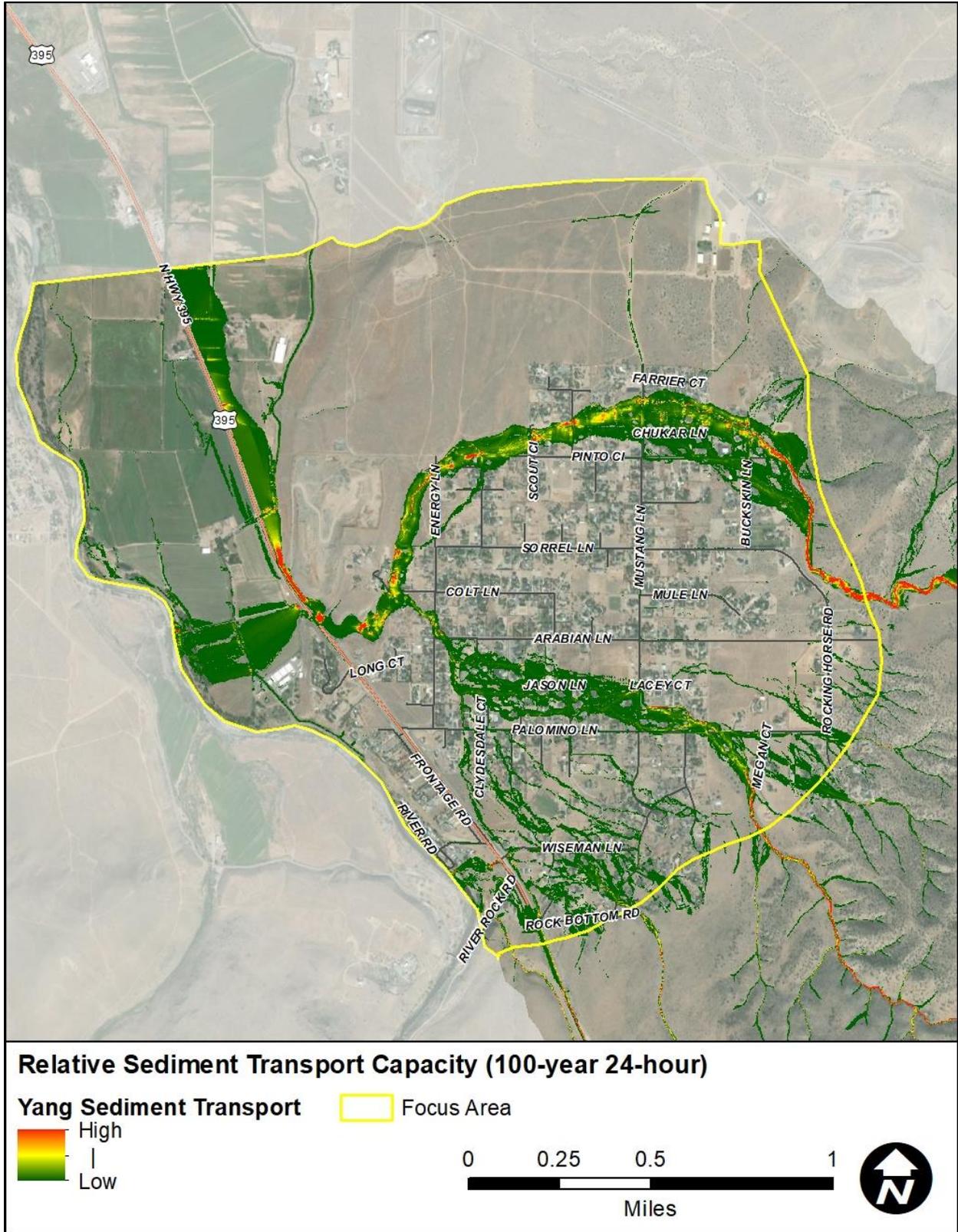


Figure 3-4. Total accumulated sediment transport capacity by the Yang methodology for the 100-year, 24-hour event

3.2.2 Sediment Profiles

Two sediment transport profiles were developed for the major contributing flow paths within the ADMP focus area because alternatives will most likely be developed to control these sediment inflow points. The sediment delivery along the profiles are shown for the three modeled storm events, i.e., 100-year 24-hour (100Y24H), 100-year 6-hour (100Y6H), and the 25-year 24-hour (25Y24H). The 100Y24H Yang sediment raster is shown in the background to reference the areas of transport.

To develop these profiles, the total accumulated sediment transport through each station (or cross-section) over the entire storm event was calculated for the Yang equation. The transport profiles are plotted and shown in Figure 3-5. These plotted profiles used a moving average to smooth the noise in the data so that general trends can be identified.

In this study, these profiles were used in two ways. First, the profiles can be used to identify areas where sediment transport is not in equilibrium or out of balance. This is important because when sediment transport is out of balance, erosion (degradation) or deposition (aggradation) is occurring within the wash. When sediment transport is increasing (i.e., the slope change is positive), the wash is gathering sediment through degradation. Conversely, when the sediment transport profile is decreasing, and the slope change is negative, the wash is losing sediment through aggradation.

Areas where there can be significant erosion or deposition are highlighted on the profile. Basically, as flow exits the mountains on the righthand (or upstream) area of the profiles, the transport capacity is the highest. This means that sediment is generally deposited within the focus area as flow moves through the Ruhenstroth area. This phenomenon can be clearly seen in the Unnamed Wash profile.

In the Smelter Creek profile, other areas of erosion and deposition are highlighted. As Smelter Creek exits the mountains, the sediment transport capacity clearly decreases. However, there are additional areas where there is significant erosion and deposition. For any potential mitigation alternatives, it is necessary to either capture or smooth this profile so that the sediment is passed through the system without erosion or deposition, but sediment basins may be required to mitigate any potential increase in sediment delivered to downstream property owners.

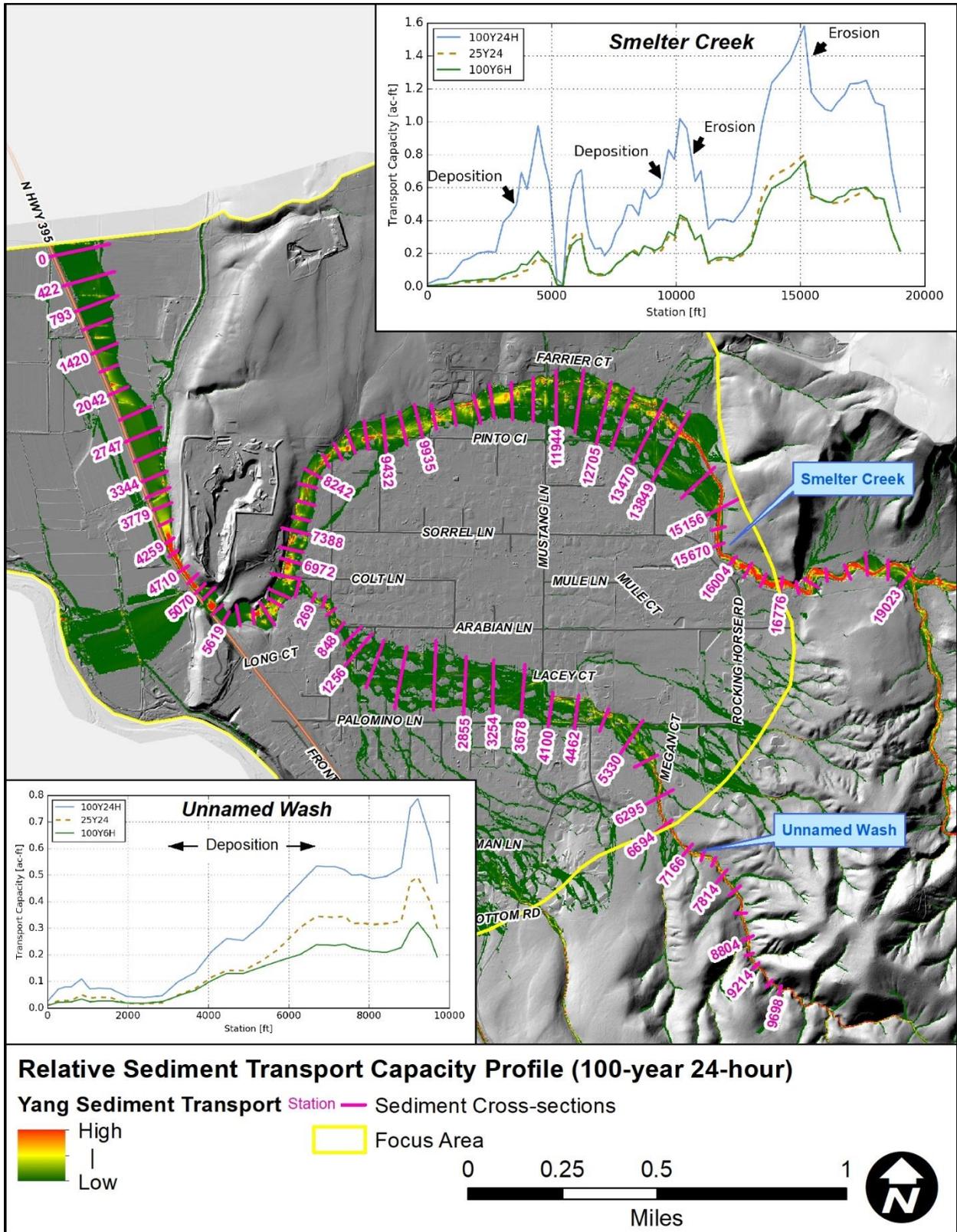


Figure 3-5. Cumulative sediment transport profile for the primary overland flow path throughout the 100-year 24-hour event

4 FLOOD HAZARD CLASSIFICATION

4.1 PURPOSE

During a severe storm event, flood waters flow throughout the Ruhenstroth ADMP study watershed. Not all flood hazards pose a risk to people or to their properties. Flood risk depends on the presence of both a flood hazard and a person, their property, or vehicle. As an example, flow in a constructed flood control channel does not present a risk until someone enters the channel. Identifying areas where flood waters may cause risks that potentially harm people, vehicles, or property is an important objective of the ADMP. Identification of potential flood risks in the study area helps the consultant team prioritize which flood problems should be addressed and in what order and provides valuable information to Douglas County personnel on where to focus response efforts during a flood event.

For the purposes of this study, flood hazards were defined based on the physical characteristics of the flood water – that is, the location, depth, and velocity associated with those flood waters. The hydrology and hydraulic modeling results were used to define flood hazards for three storms:

- The 25-year, 24-hour event
- The 100-year, 24-hour event
- The 100-year, 6-hour event

The flood risk assessment involved selecting criteria and quantifying flood risks throughout the study watershed using the FLO-2D model results. Three types of potential flood risks were assessed – flooding risks to pedestrians, passenger vehicles, and buildings.

The building flood inundation assessment is a planning-level analyses to estimate the number of habitable structures potentially inundated by flow depths greater than six inches. This Phase I analysis was done considering existing conditions. A proposed conditions assessment will be conducted during the Phase II (separate study) portion of the ADMP.

The following sections describe the flood classification criteria, methodology, and description of provided electronic files for each potential flood risk assessment.

4.2 FLOODING HAZARDS TO PEDESTRIANS

Pedestrian flood hazards were classified using the depth-velocity relationship outlined in the United States Bureau of Reclamation (USBR) Technical Memorandum 11 (TM 11) (1988). The depth-velocity relationships presented in TM 11 are a good basis for flood hazard classification since the criteria are widely accepted. TM 11 presents two possible classifications for pedestrians: flood danger levels for adults and for children. This study considers the flood danger classification for children throughout the entire watershed to simplify the methodology and to be conservative. The depth-velocity flood danger level relationship from TM 11 is shown as Figure 4-1.

The following three categories exist for pedestrian flood hazards:

- *Low*: These are areas with depths and velocities corresponding to the Low Danger Zone as shown in Figure 4-1. Low pedestrian hazards are not displayed on the map exhibits because, per

TM11, low hazard zones do not present a threat to children of almost any size (excluding infants) and cover all areas not classified with a higher flood hazard.

- *Moderate*: Areas with depths and velocities corresponding to the Judgment Zone in Figure 4-1 have been labeled as having a moderate potential flood hazard to pedestrians.
- *High*: Areas with depths and velocities corresponding to the High Danger Zone in Figure 4-1 have been labeled as having a high potential flood hazard to pedestrians.

The flood hazards to pedestrians have been digitized in GIS in the form of a raster. The rasters generated for the risk analysis coincide with the FLO-2D grid elements with a 10-foot by 10-foot pixel size. The raster contains values of 1, 2, and 3 which correlates to a low, moderate, and high hazard classification, respectively. Since the 100-year, 6-hour storm produces the largest peak runoff for most areas (see Table 2-6, the flooding hazard from this storm event is shown as Figure 4-2.

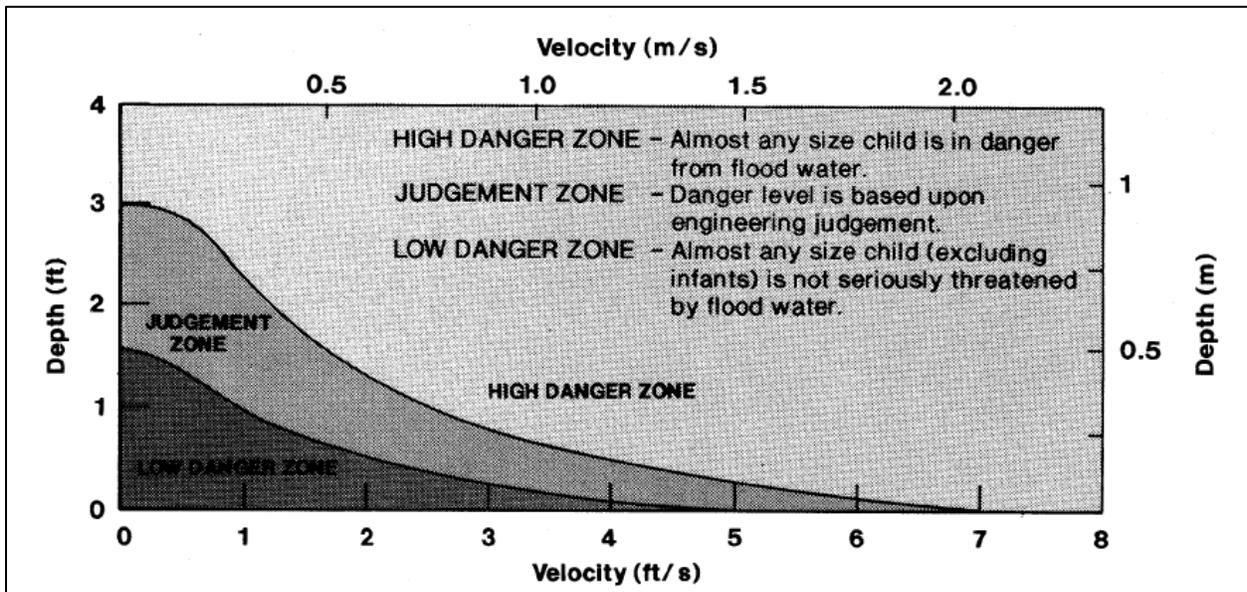


Figure 4-1. Depth-Velocity flood danger level relationship for children, from USBR (1988)

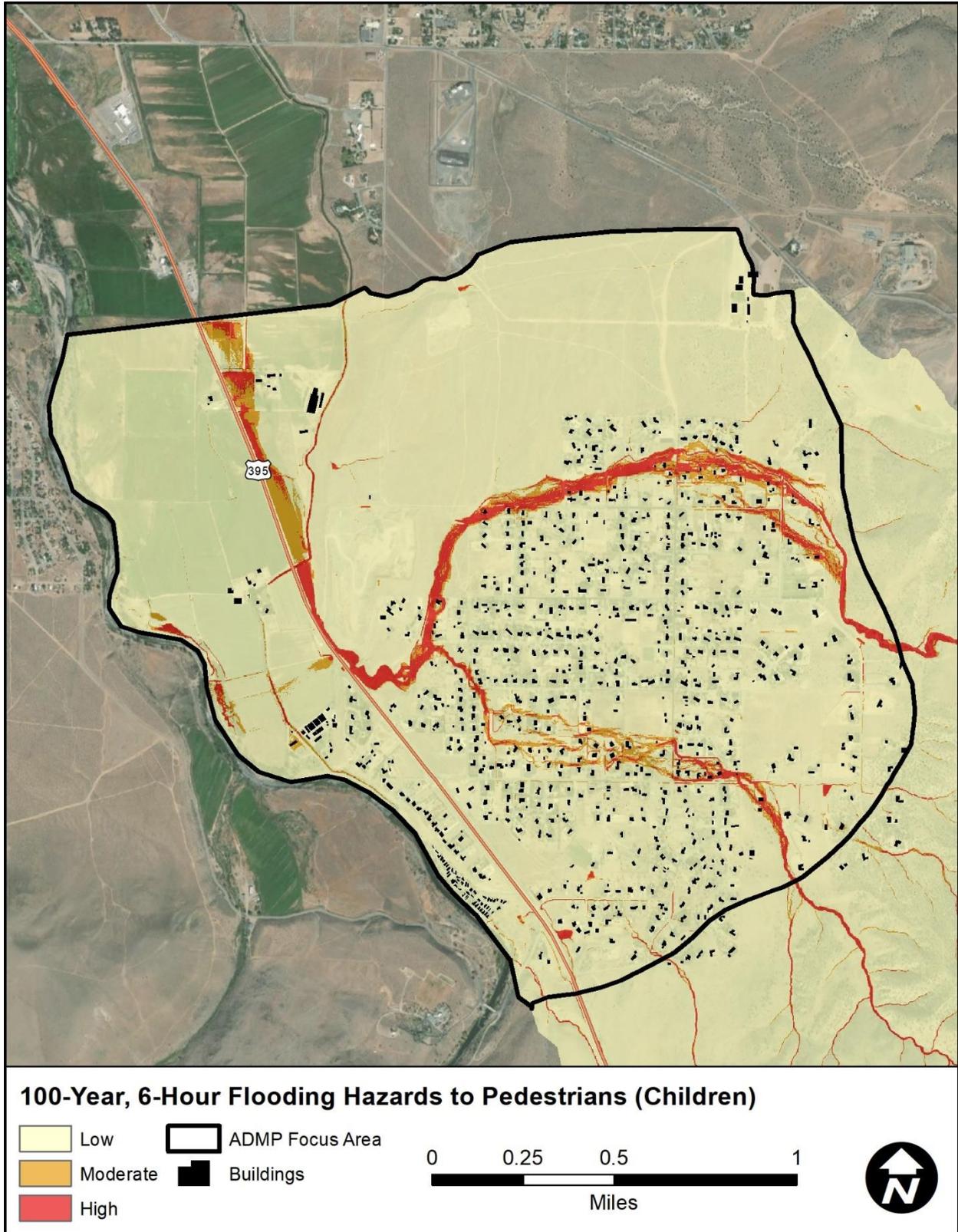


Figure 4-2. USBR criteria flooding hazards to pedestrians based on the 100-year, 6-hour results

4.3 FLOODING HAZARDS TO PASSENGER VEHICLES

Potential hazards to passenger vehicles were classified using a combination of minimum depth criteria and the depth-velocity relationship in TM 11 as shown in Figure 4-3. The following four categories exist for passenger vehicle flood hazards:

- **Low:** This hazard category is based solely on minimum depth criteria and is for roadway crossings with depths less than half a foot. Low passenger vehicle hazards are not displayed on the map exhibits because low hazard zones indicate areas where vehicles “are not seriously in danger” and, as such, almost any size passenger vehicle can safely pass. Also, this hazard classification covers all areas not classified with a higher flood hazard. This classification is not explicitly shown in the Figure 4-3.
- **Moderate:** This hazard category is based on a combination of minimum depth criteria and the depth-velocity relationship in TM 11. Specifically, these are roadway crossings with depths and velocities falling into the Low Danger Zone (as shown in Figure 4-3 that also have greater than a half a foot of depth. The threshold depth of half a foot was chosen because half a foot of water will reach the bottom of most passenger cars and can cause loss of control and possible stalling.
- **High:** Roadway crossings with depths and velocities corresponding to the Judgment Zone in have been labeled as having a high potential flood hazard for passenger vehicles.
- **Very High:** Roadway crossings with depths and velocities corresponding to the High Danger Zone in Figure 4-3 have been labeled as having a very high potential flood hazard for passenger vehicles.

The flood hazards to passenger vehicles have also been digitized in GIS in the form of a raster. The raster contains values of 1, 2, 3, and 4. These values correlate to low, moderate, high, and very high classification, respectively. The TM 11 flooding hazards to vehicles for the 100-year, 6-hour storm is shown in Figure 4-4.

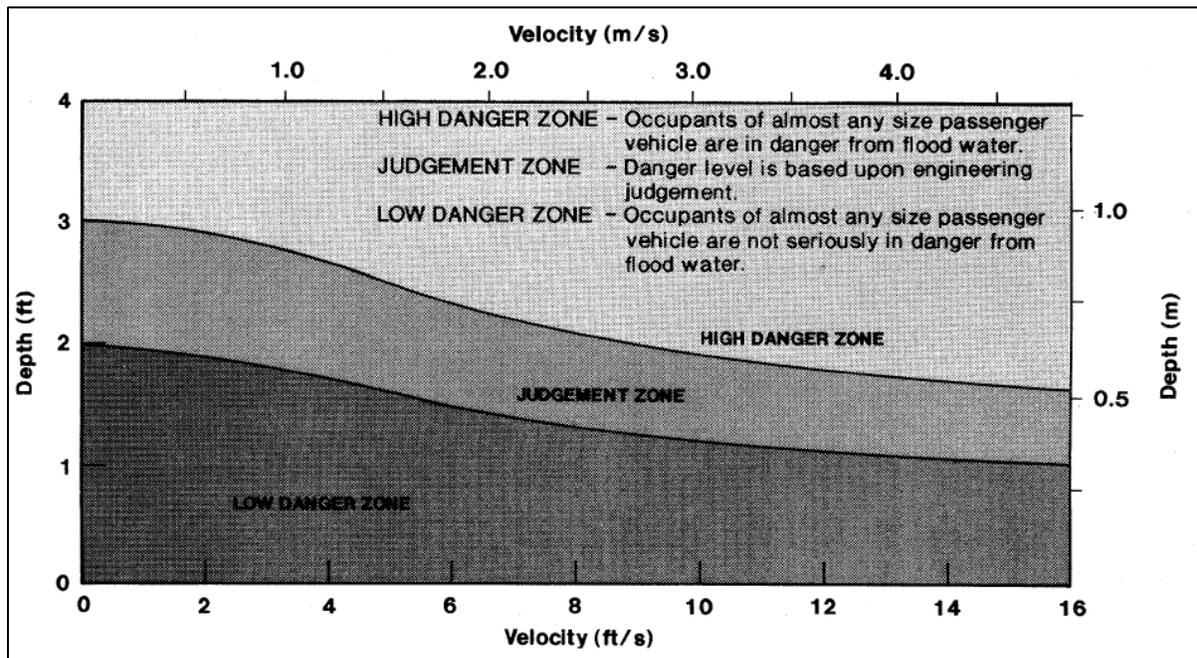


Figure 4-3. Depth-Velocity flood danger level relationship for passenger vehicles, from USBR (1988)

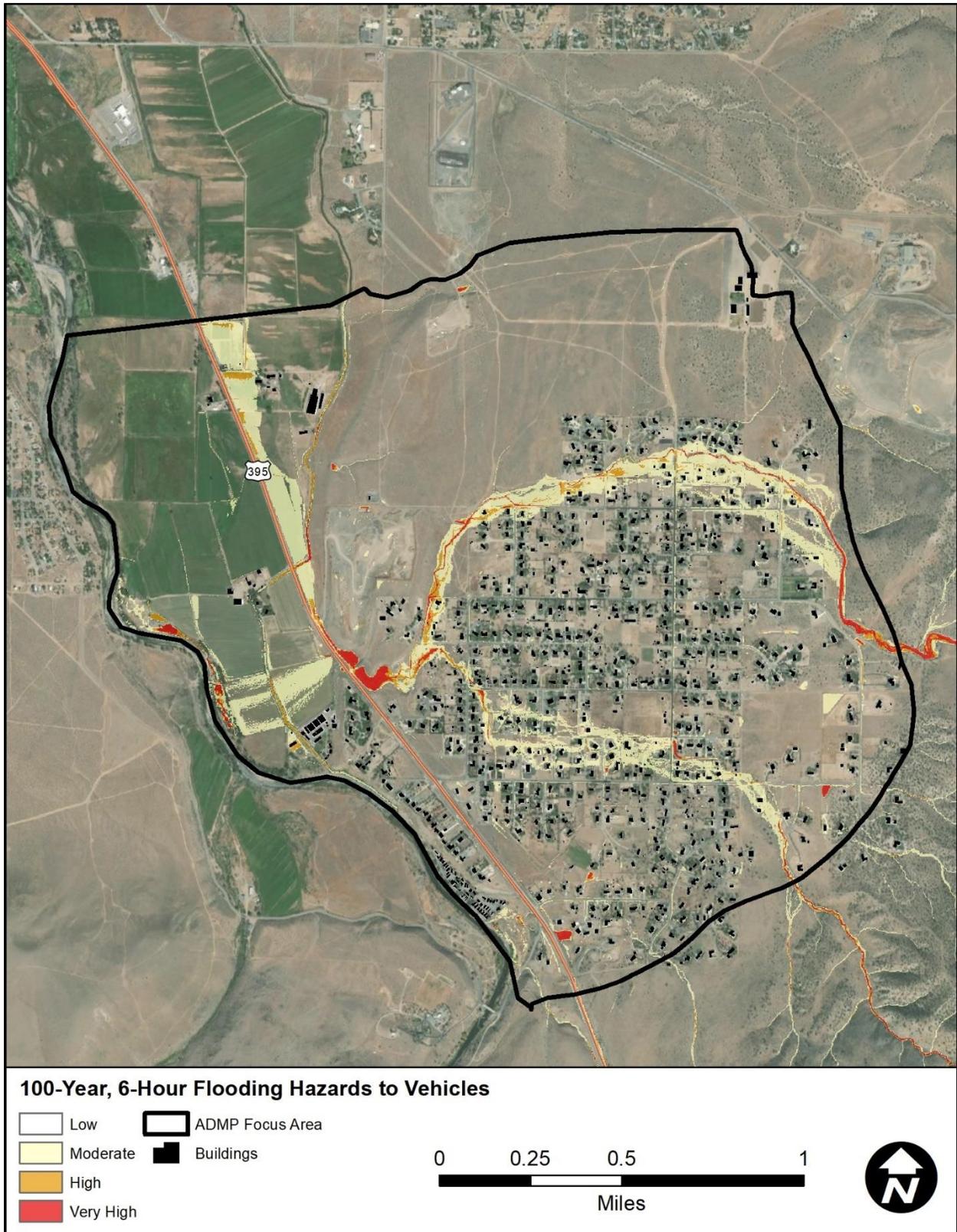


Figure 4-4. USBR criteria flooding hazards to vehicles based on the 100-year, 6-hour results

To isolate the actual risk to vehicles, the County’s street centerlines GIS layer was intersected with the hazards zones to produce a “Potential Risk to Passenger Vehicles” map. This isolates the road crossings that pose a risk to vehicles during a storm event. All three storm events produce conditions of “High” or “Very High” risk using the USBR criteria. The flood risk road crossing locations are shown in Figure 4-5 through Figure 4-7, respectively.

The road crossing locations are listed below by storm event (numbering corresponds to Figure 4-5 through Figure 4-7). By identifying these specific locations in the ADMP, Douglas County has the information needed to respond during flood events by dispatching road crews to close the high flood risk crossings. It also provides a list of locations to potentially be considered for future road improvements in the County’s capital improvement planning.

25-Year, 24-Hour

1. Smelter Creek at Energy Lane (Very High)
2. Smelter Creek at Horseman Court (High)
3. Smelter Creek at Cayuse Drive (High)
4. Smelter Creek at Mustang lane (High)
5. Smelter Creek at Buckskin Lane (High)
6. Smelter Creek at Unnamed Access Road (High)

100-Year, 6-Hour

1. Smelter Creek at Energy Lane (Very High)
2. Smelter Creek at Horseman Court (High)
3. Smelter Creek at Cayuse Drive (High)
4. Smelter Creek at Mustang Lane (High)
5. Smelter Creek at Buckskin Lane (High)
6. Palomino Lane between Rocking Horse Court and Megan Court (High)
7. Smelter Creek at Unnamed Access Road (High)

100-Year, 24-Hour

1. Smelter Creek at Energy Lane (Very High)
2. Smelter Creek at Horseman Court (High)
3. Smelter Creek at Cayuse Drive (High)
4. Smelter Creek at Mustang lane (Very High)
5. Smelter Creek at Buckskin Lane (High)
6. Colt Lane and Sullivan Drive (High)
7. Smelter Creek at Unnamed Access Road (Very High)

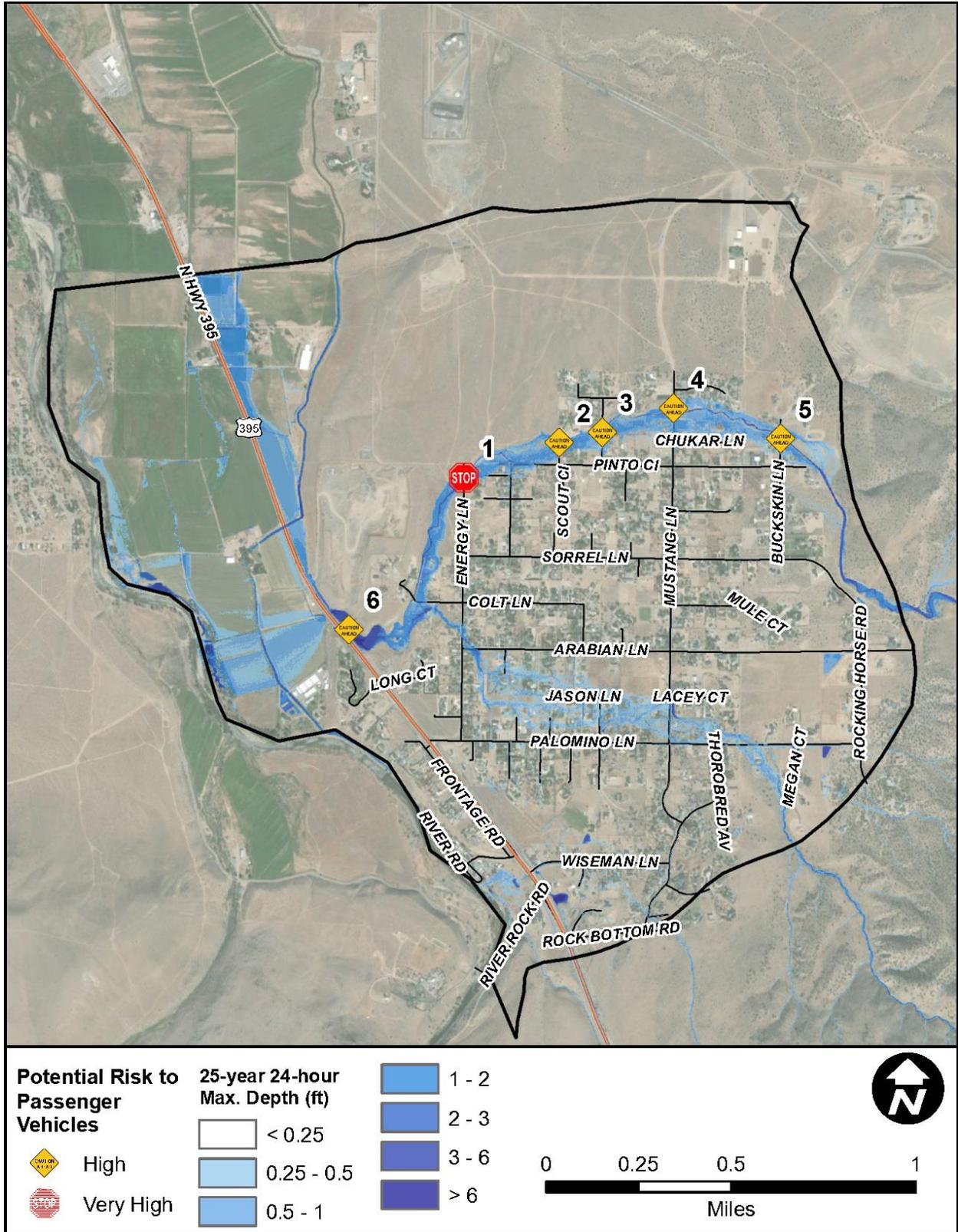


Figure 4-5. Hazardous road crossings during a 25-year, 24-hour storm (USBR criteria)

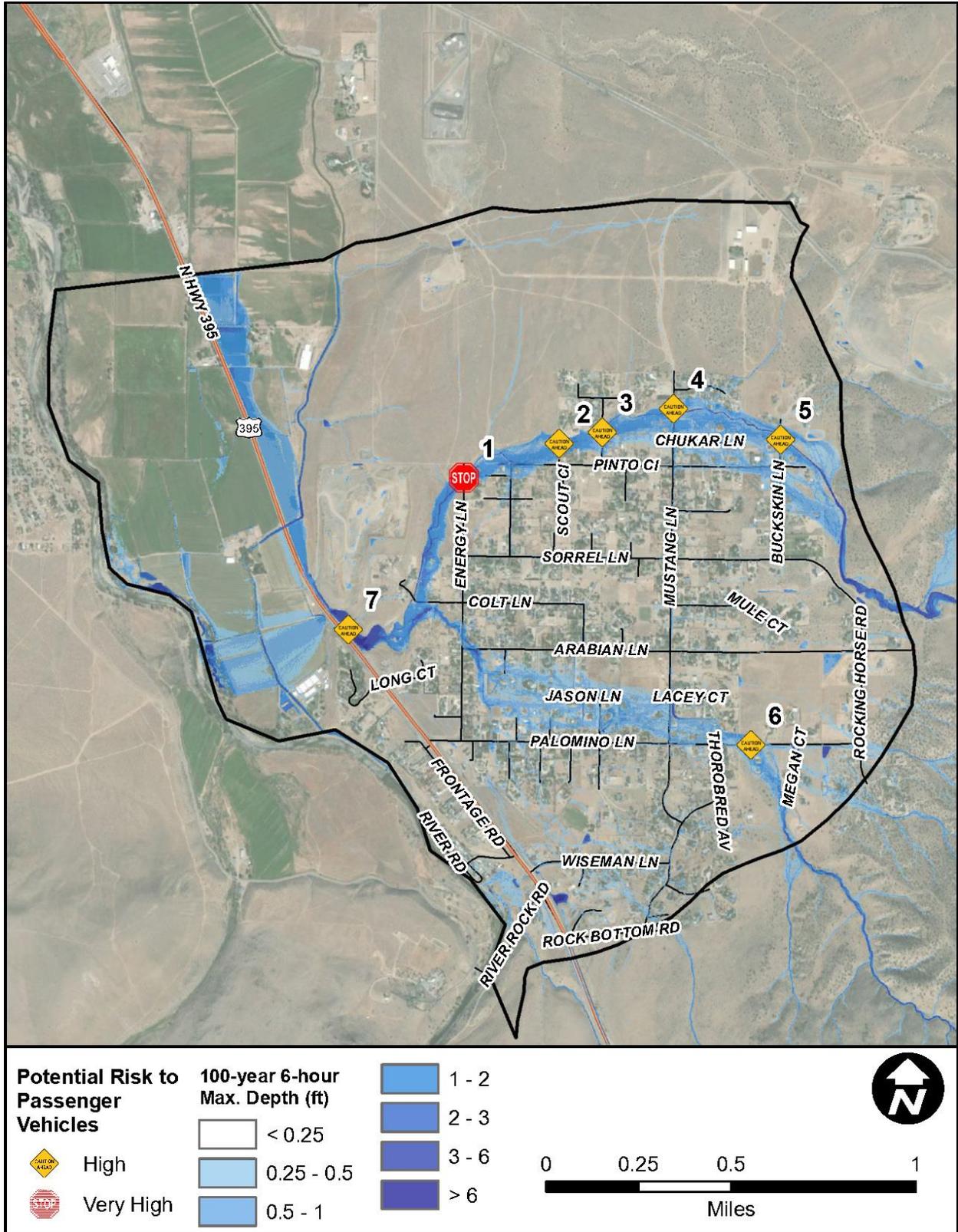


Figure 4-6. Hazardous road crossings during a 100-year, 6-hour storm (USBR criteria)

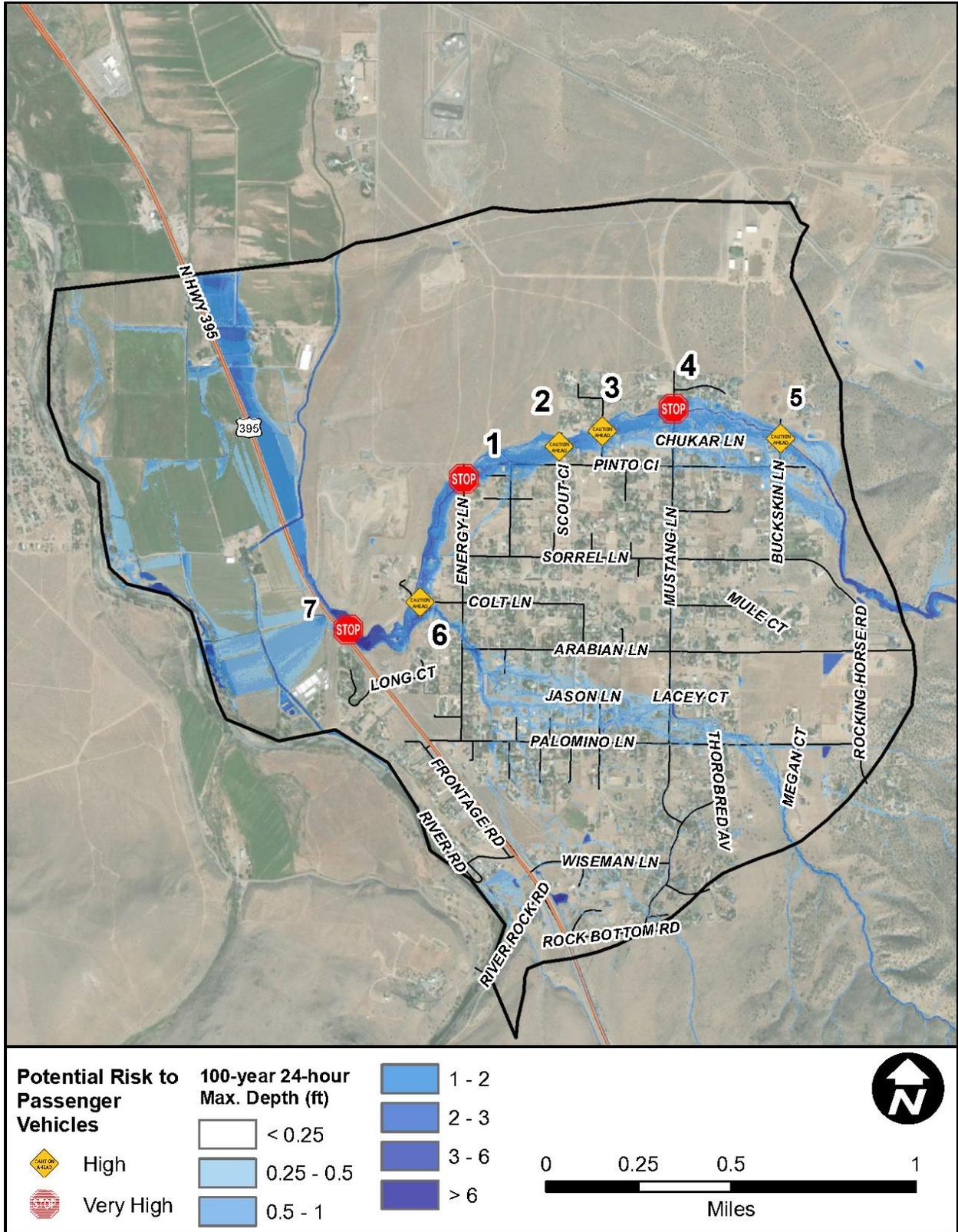


Figure 4-7. Hazardous road crossings during a 100-year, 24-hour storm (USBR criteria)

4.4 FLOODING HAZARDS TO STRUCTURES

Potential hazards to buildings were classified using the depth-velocity relationship from TM 11. The depth-velocity relationship from TM 11 is shown as Figure 4-8. The following three categories exist for potential flood hazards to structures:

- *Low*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the low danger zone in Figure 4-8 have been designated as having a low potential flood hazard.
- *Moderate*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the judgment danger zone in Figure 4-8 have been designated as having a moderate potential flood hazard.
- *High*: Buildings that have contact with at least one FLO-2D grid element that has a depth-velocity relationship corresponding to the high danger zone in Figure 4-8 have been designated as having a high potential flood hazard.

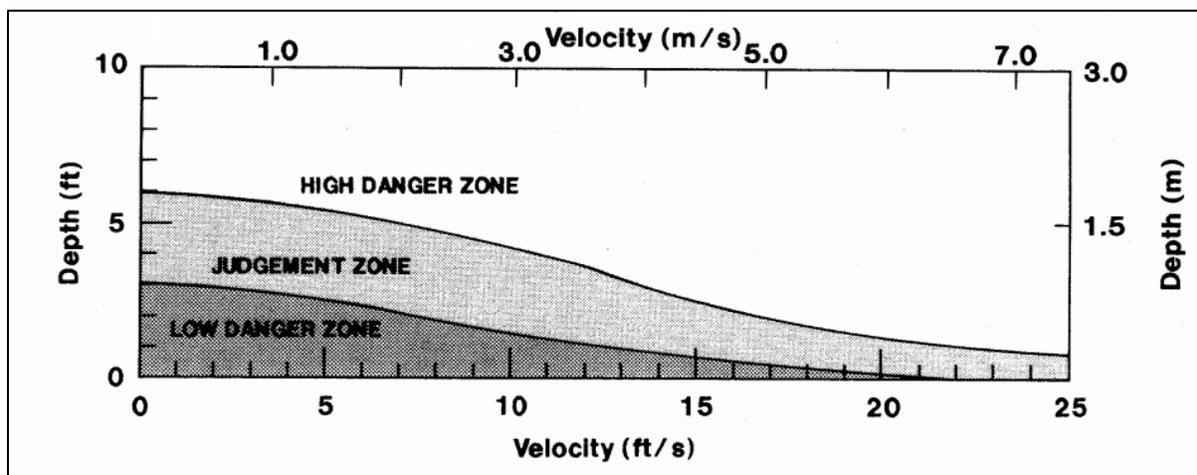


Figure 4-8. Depth-Velocity flood danger level relationship for structures built on foundations, from USBR (1988)

To create the building flood hazard classification, the building polygon shapefile is intersected with the flood hazard layer using GIS software tools. When multiple grid cells from the flood hazard layer intersect one building polygon, the maximum hazard classification is assigned to the building. Buildings with less than 600 square feet (e.g., unattached garages or sheds) were not considered because they were assumed to be uninhabited due to their size. The result is a building polygon shapefile with a hazard attribute classifying low, moderate, or high flood hazards.

The tabulated building hazard results are shown in Table 4-1. Due to the relatively shallow flooding in the project area and how the TM criteria were developed (i.e. to assess conditions downstream of a dam during a dam failure), there is only one building with a moderate hazard classification during the 100-year 6-hour event. All other buildings are classified as having a low hazard classification during the studied events. As a representative example, the 100-year 6-hour flooding hazards to buildings raster is shown in Figure 4-8.

Table 4-1. Building flooding hazard classification results (USBR criteria)

Existing Conditions				
Recurrence Interval	Building Count	Building Count	Building Count	Total Building Count
	Low	Moderate	High	
25Y24H	953	0	0	953
100Y24H	953	0	0	953
100Y6H	952	1	0	953

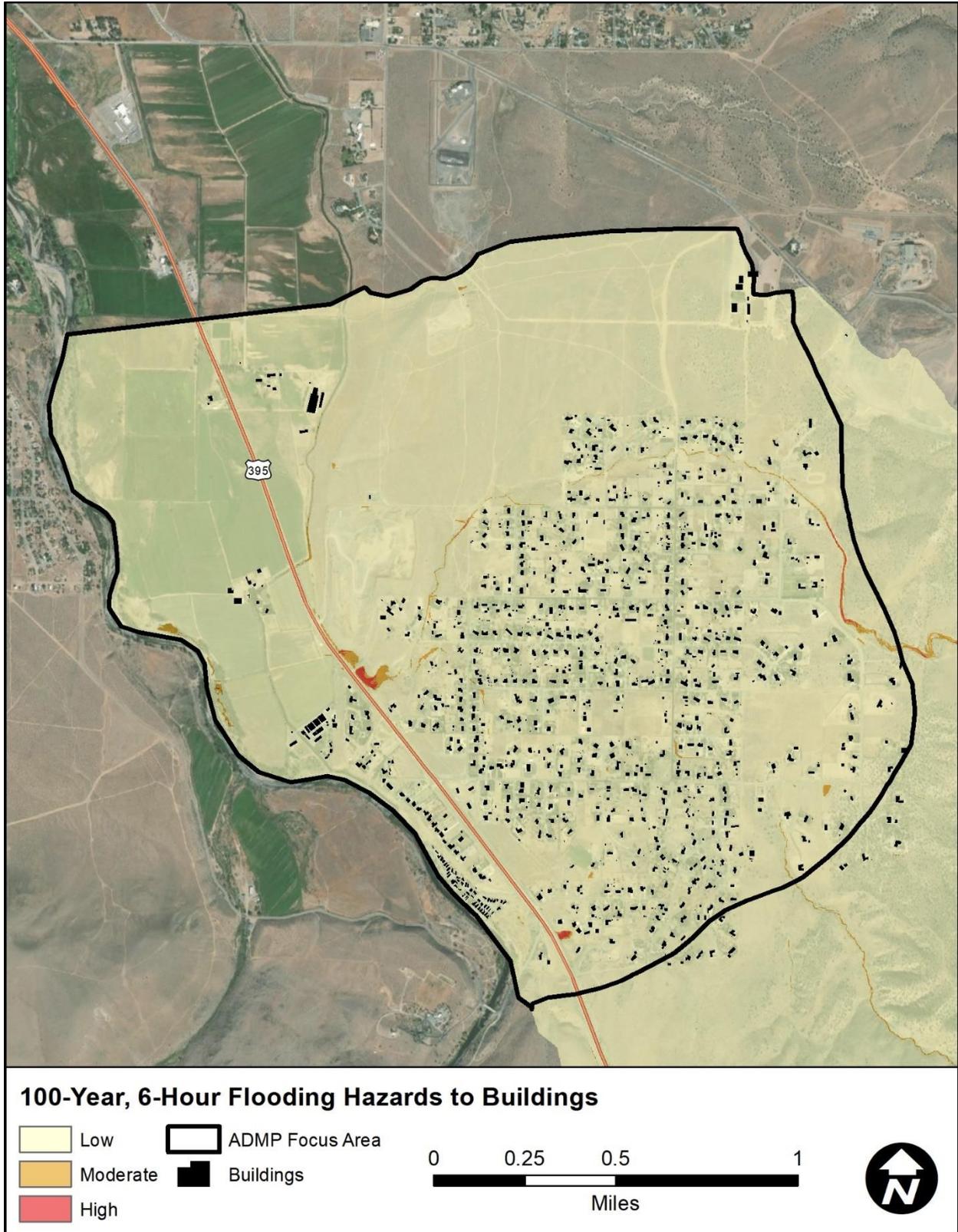


Figure 4-9. USBR criteria flooding hazards to buildings based on the 100-year, 6-hour results

4.5 BUILDING INUNDATION ASSESSMENT

4.5.1 Methodology

The USBR TM 11 procedures are commonly used within the engineering community for assessing flood risk. However, TM 11 was developed “for estimating the downstream area susceptible to flooding due to a dam failure” (USBR, 1988). As such, lower flood depths may produce a “Low” risk classification for buildings when using TM 11 but may be of a sufficient depth to justify a higher risk classification. To both verify the TM 11 results and to provide a lower threshold risk assessment, a separate building impact analysis was run using the building footprint data and the maximum depth results from the FLO-2D modeling for the base conditions. The maximum depth layers only consider the maximum depth that occurred during the model simulation.

From the building footprint data, there are 1,319 structures within the study area; however, not all these structures are habitable structures (e.g. - water tanks or sheds). For this analysis, the same 600 square foot filter that was used in the Flooding Hazard to Structures (Section 4.4) analysis was applied. After applying this filter there are 953 structures in the study area.

4.5.2 Existing Conditions

Each building was classified based on the maximum depth that fell within the structure outline. The structures were tabulated into four groups:

- 1) 0.25 ft < Depth (inclusive of groups 2 through 4 below)
- 2) 0.25 ft < Depth ≤ 0.5 ft – Low
- 3) 0.5 ft ≤ Depth ≤ 1.0 ft – Moderate
- 4) 1.0 ft < Depth – High

The results for existing conditions are tabulated in Table 4-2, while the results for the 100-year 6-hour storm are shown in Figure 4-10.

Table 4-2. Buildings that are impacted by various depths (base conditions)

Existing Conditions				
Recurrence Interval	Building Count Flow Depth	Building Count Flow Depth	Building Count Flow Depth	Total Building Count
	0.25' < h ≤ 0.5'	0.5' < h ≤ 1'	1' < h	0.25' < h
25Y24H	135	68	17	220
100Y24H	162	106	32	300
100Y6H	281	149	43	473

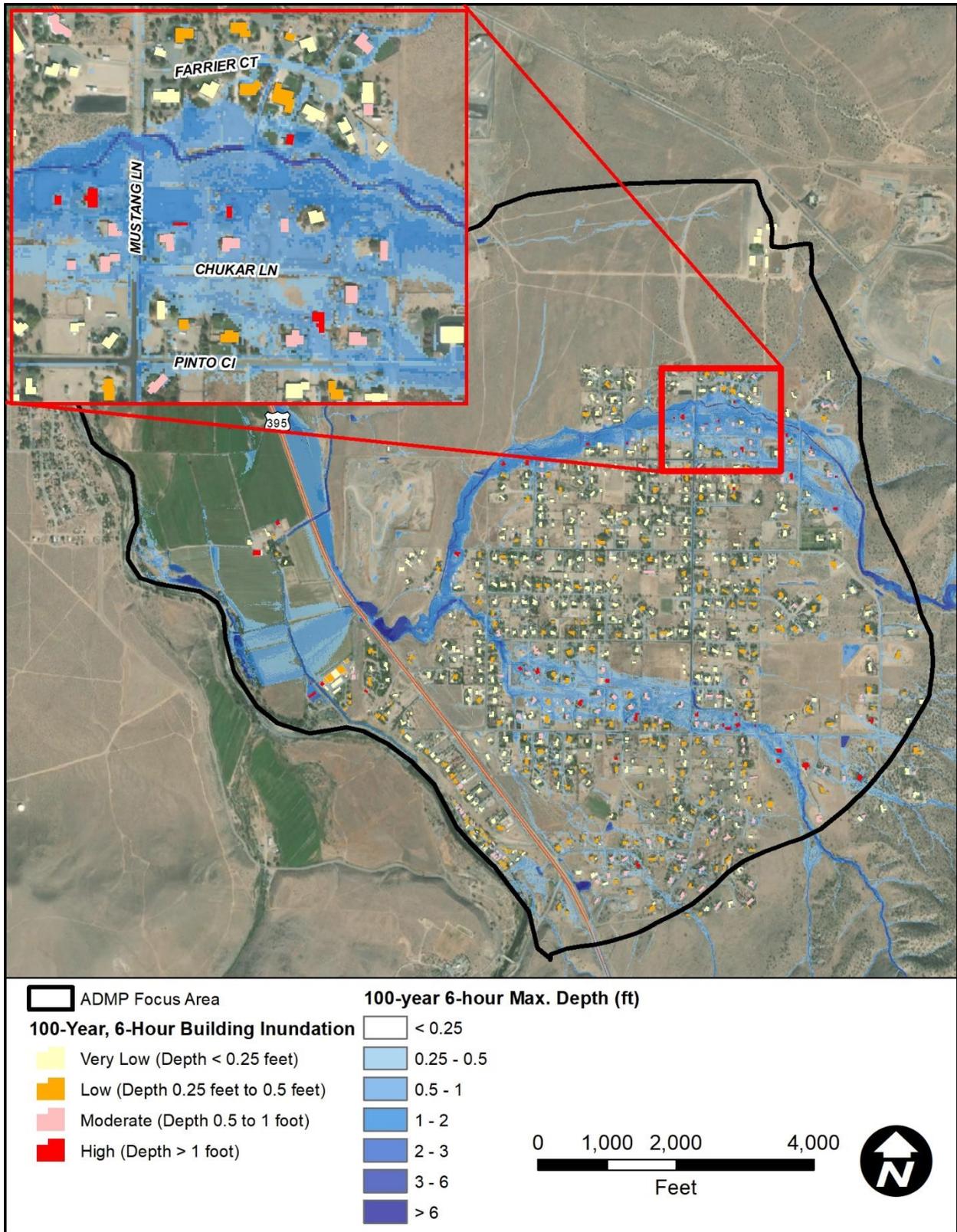


Figure 4-10. Building inundation assessment (100-Year, 6-Hour) result example

4.6 SUMMARY

In this section the methodologies and results from four separate hazard assessments were presented. These included:

- Flood hazards to children
- Flood hazards to vehicles
- Flood hazards to buildings
- Building inundation assessment

These analyses help identify areas that have a higher risk of flooding and which property and infrastructure are most susceptible to damage. Having this information helps focus the mitigation alternative to areas where they are most needed. Additionally, the building inundation assessment will provide a baseline from which potential future mitigation projects can be assessed for flood risk and cost effectiveness.

5 ALL-WEATHER ACCESS

5.1 INTRODUCTION

As a part of Phase 1, alternatives that provide all-weather access for both the 25-year and 100-year flood events for four road crossings of Smelter Creek were developed. The crossings are:

- Buckskin Lane
- Mustang Lane
- Cayuse Drive
- Horseman Lane

A map that shows the locations of these crossings with the FLO-2D 100-year 6-hour results is shown as Figure 5-1. In Douglas County, all-weather access is defined as a 12-foot wide dry lane that shall be maintained centered on the roadway. Since the roadway crossings are perpendicular to flow, all-weather access for this Task is defined as all flow contained in the culvert with no roadway overtopping.

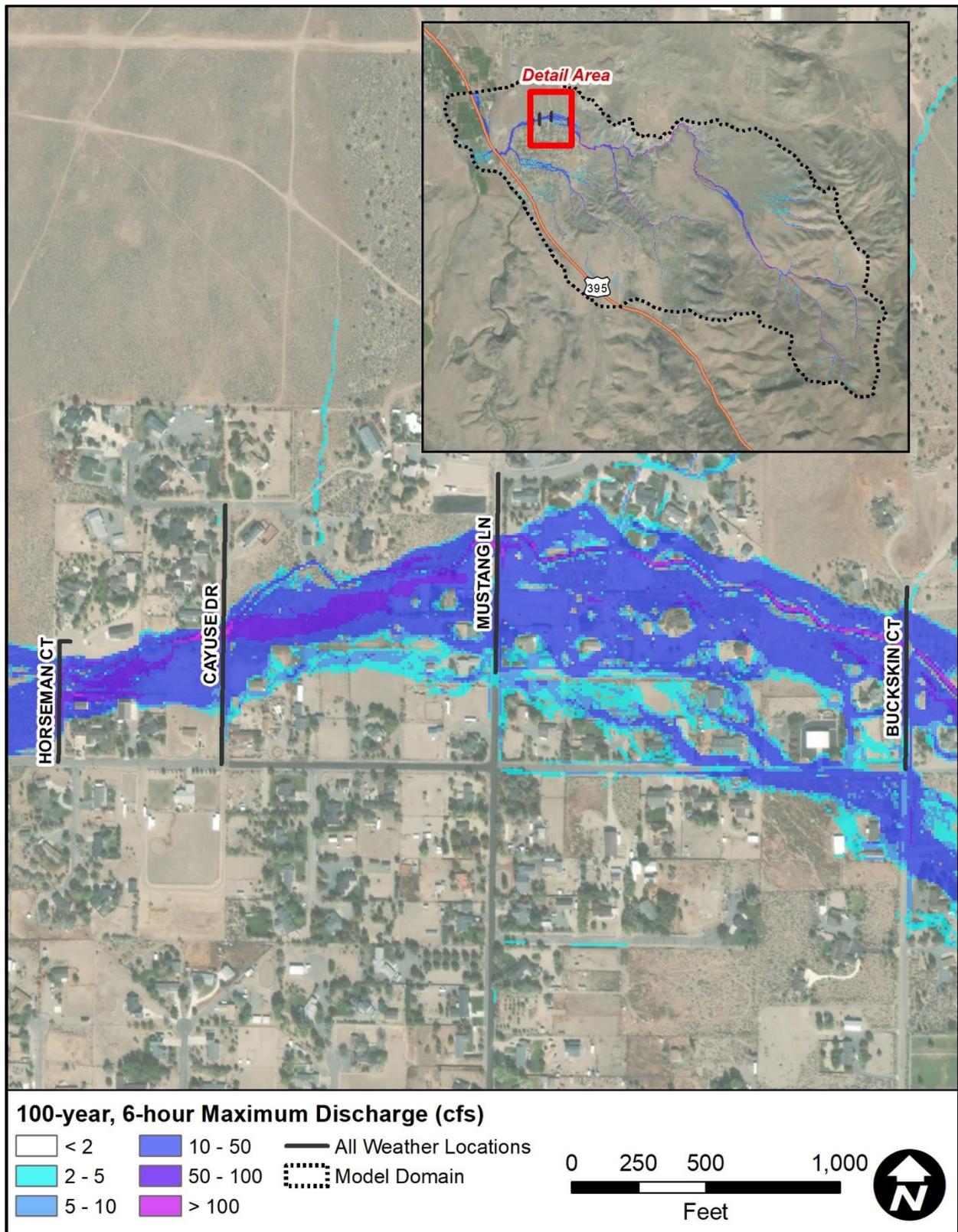


Figure 5-1. Location of all-weather access roadway crossings, shown with 100-year 6-hour maximum discharges

5.2 METHODOLOGY AND RESULTS

Although the historical alignment of Smelter Creek is mostly preserved, reaches of the present channel do not have capacity to convey the 100-year, 6-hour or the 25-year, 24-hour peak flows without overtopping and flooding adjacent properties. If only the four road crossings were improved without corresponding improvements to the adjacent Smelter Creek channel, these breakouts would be exacerbated and adverse impacts would occur (i.e., flow in the channel would pond behind the new culverts and roadway embankments and be diverted outside the channel corridor). Therefore, it is recommended that the existing channel be improved within the Ruhenstroth community to prevent breakouts and to contain flow at the new crossings. The concept elements are described below.

5.2.1 Smelter Creek Conveyance Improvements

5.2.1.1 Design Parameters

Using normal depth calculations, two concept channels (25-year and 100-year) were developed to prevent flow breakouts along the channel and at the proposed culvert locations. The design characteristics are:

- 25-Year Design
 - Flow (cfs): 640
 - Slope (ft/ft): 0.01
 - Manning's n value: 0.06 (same as FLO-2D modeling)
- 100-year Design
 - Flow (cfs): 1380
 - Slope (ft/ft): 0.01
 - Manning's n value: 0.06 (same as FLO-2D modeling)

5.2.1.2 Typical Sections

Based on the design parameters, two typical sections were developed. The 25-year typical section is shown as Figure 5-2, and the 100-year section is shown as Figure 5-3. In the 25-year section, the bottom width is 35 feet, side slopes are 3:1 (H:V), and 1-foot of freeboard is provided. Similarly, the bottom width is 45 feet, side slopes are 3:1 (H:V), and 1-foot of freeboard is provided in the 100-year section. These dimensions were chosen based on 1) the geometry of the existing upstream channel where it has capacity, 2) the estimated headwater elevation at the new culverts, and 3) the width of the new culverts was approximately the same as the bottom width of the channel.

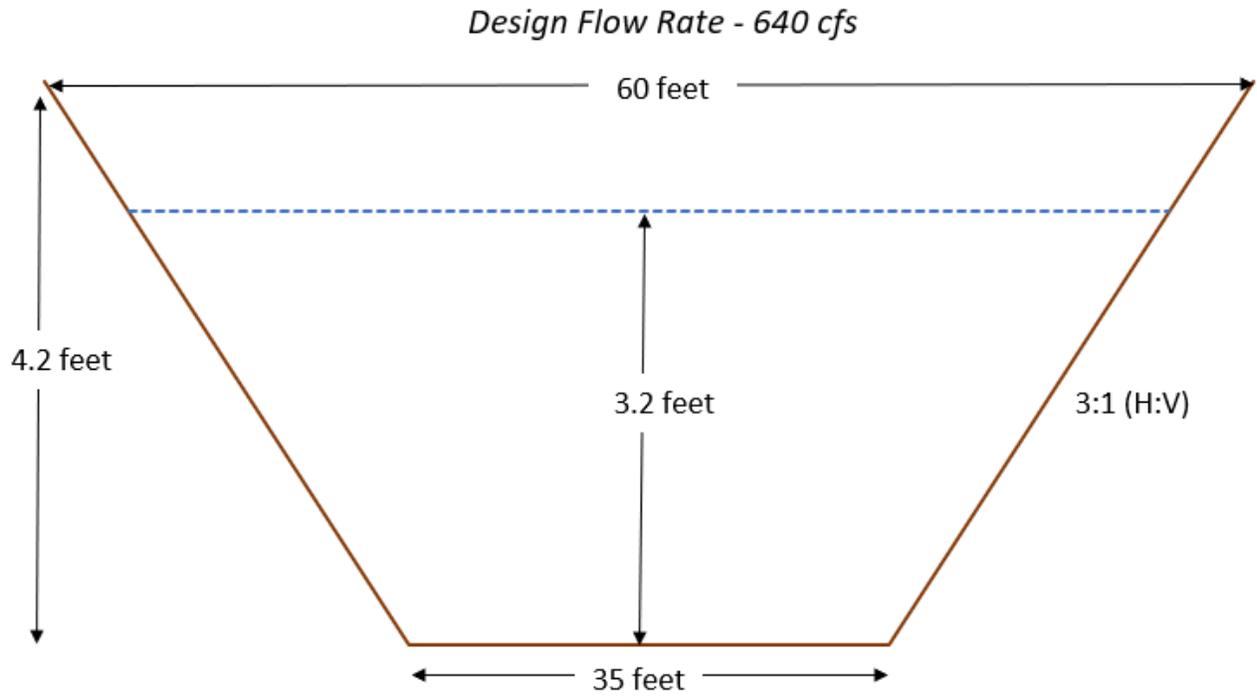


Figure 5-2. 25-year typical section

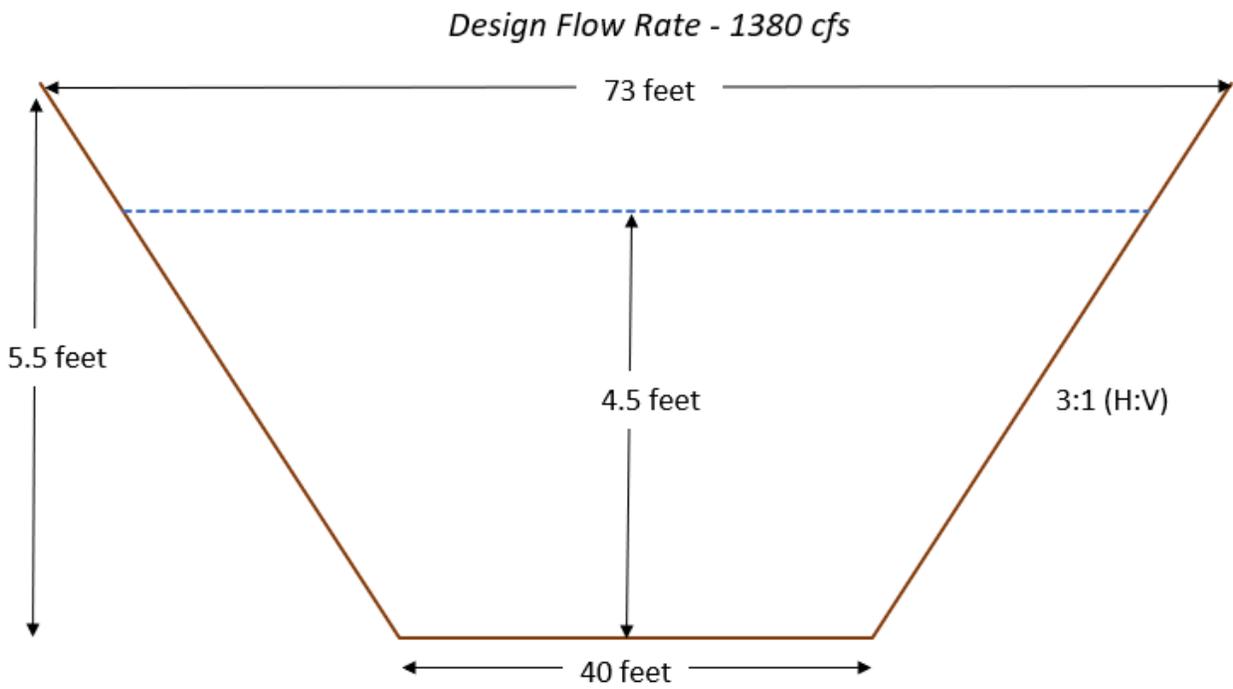


Figure 5-3. 100-year typical section

5.2.2 New Culverts

Using HY-8 and standard NDOT box culvert sizes, multiple culvert configurations were analyzed to estimate which configuration better aligned with the new channel. That is, headwater depths were reduced to be contained within the estimated freeboard of the new channels, and the width of the installed culverts approximately matched the upstream channel. The suggested culvert configurations are shown below:

- 25-Year Design
 - 4 barrel 8-ft by 5-ft reinforced concrete box culvert (RCBC)
- 100-year Design
 - 5 barrel 8-ft by 5-ft RCBC

The 25-year suggested improvements and existing conditions 25Y24H storm discharges are shown Figure 5-4, while the 100-year improvements and existing conditions 100Y24H storm discharges are shown in Figure 5-5.

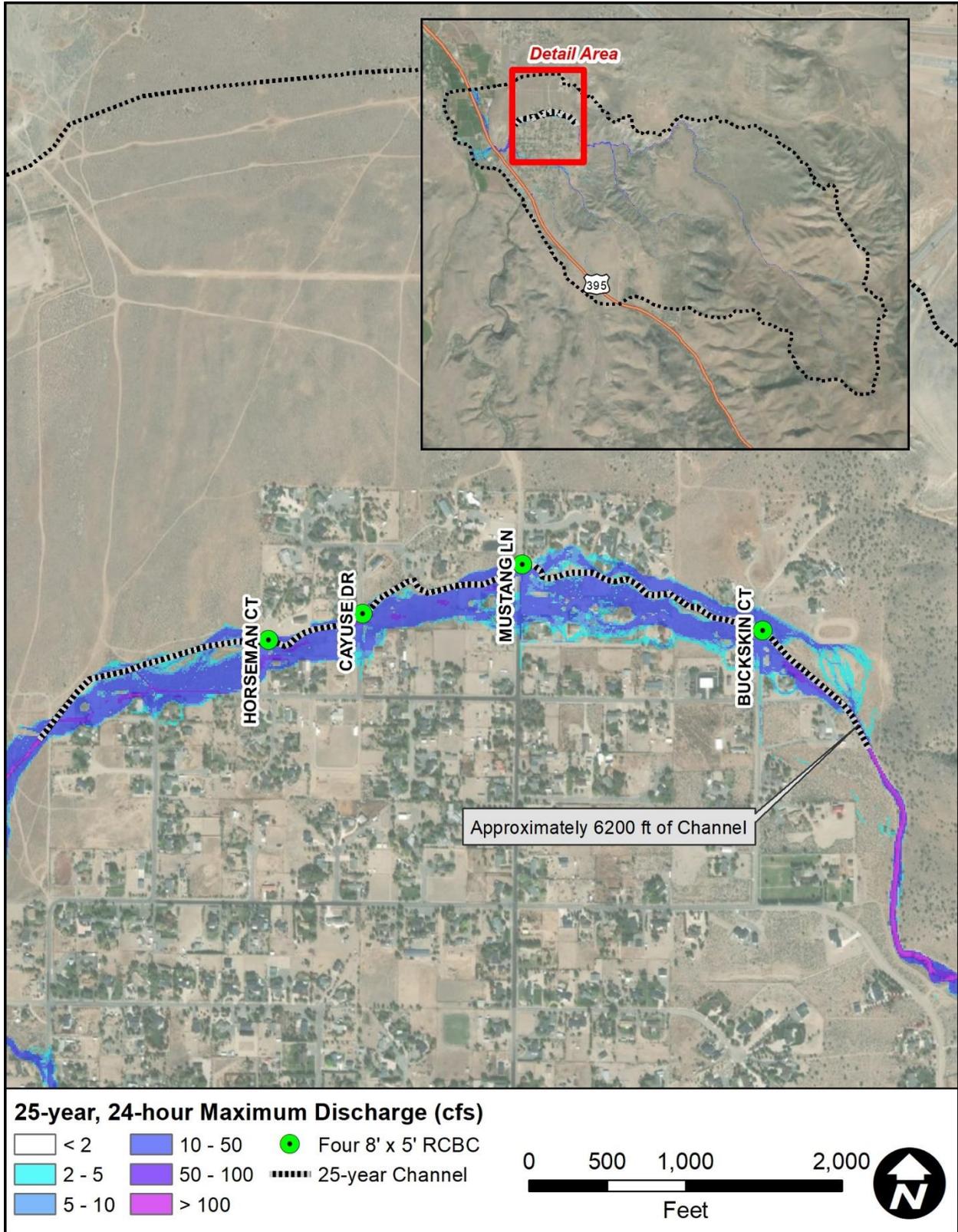


Figure 5-4. 25-year concept improvements

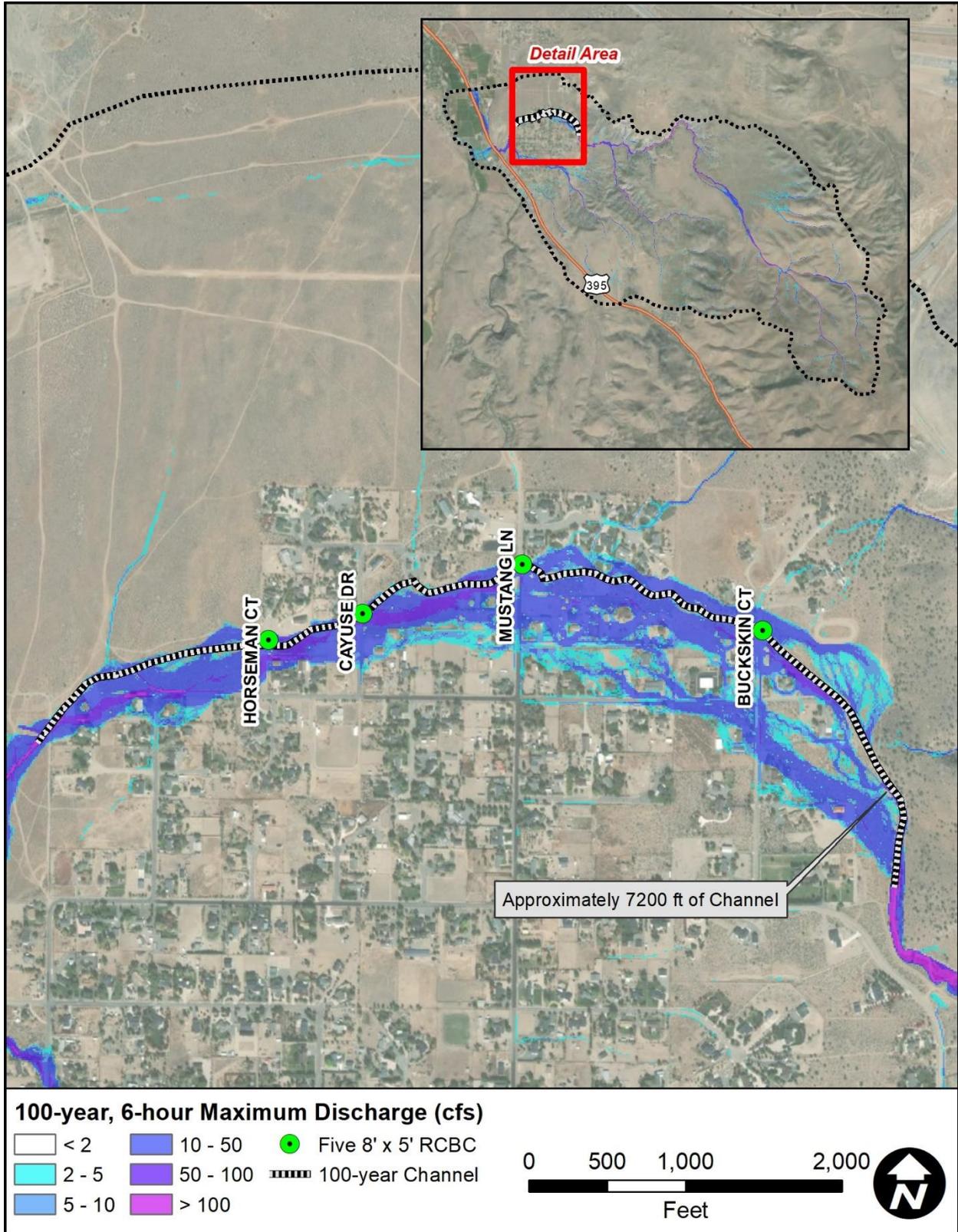


Figure 5-5. 100-year concept improvements

5.2.2.1 Culvert Cost Estimates

Since detailed surface modeling of the proposed channel was not performed during Phase 1 and Douglas County has already graded parts of the Smelter Creek channel, the County requested that cost estimates for channel grading and installation be postponed until more accurate quantities of cut/fill would be developed. Therefore, approximate cost estimates for only the new culverts are listed in Table 5-1 and Table 5-2. These costs were developed based on NDOT Bid Tabulation data. Note - These estimates do not consider detailed costs for right-of-way (ROW) acquisition, drainage easements, permit fees, FEMA CLOMR/LOMR development. As such, a 30% contingency was added to the total cost to account for unforeseen items.

Table 5-1. 25-year concept cost estimates

Item	25-Year Storm Cost Estimate
New Culverts (4 total)	\$680,000
Contingency (30%)	\$204,000
Total	\$884,000

Table 5-2. 100-year concept cost estimates

Item	100-Year Storm Cost Estimate
New Culverts (4 total)	\$840,000
Contingency (30%)	\$252,000
Total	\$1,092,000

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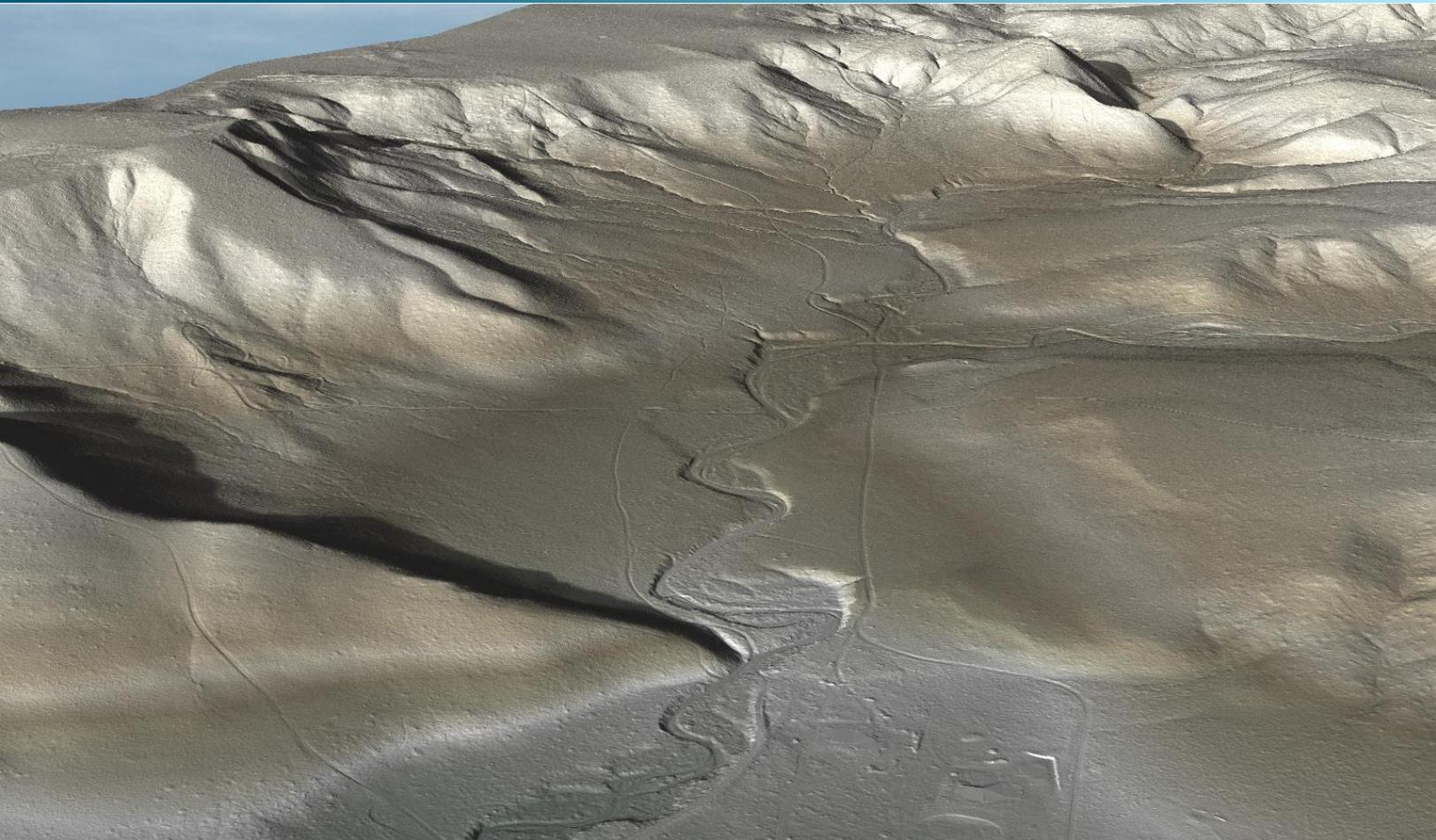
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APPENDIX A

QSI LiDAR Report

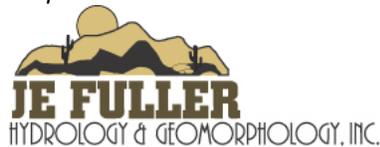
December 13, 2019



Ruhenstroth, Nevada LiDAR

Technical Data Report

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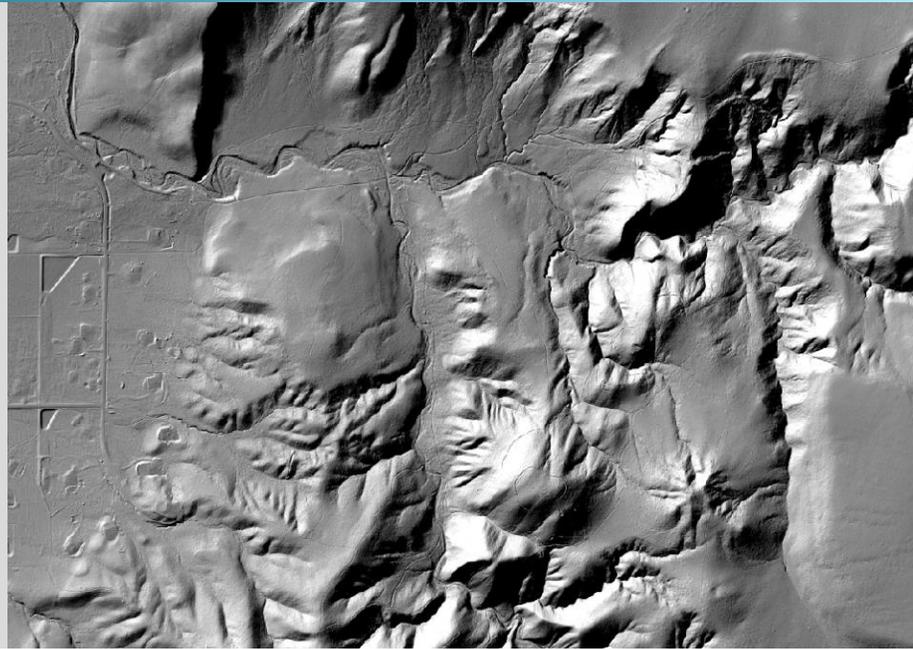
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Cover Photo: A view looking east over the Ruhenstroth project area. The image was created from the LiDAR bare earth model colored by elevation.

INTRODUCTION

A top down view of a hillshade digital elevation model showing the terrain east of Ruhestroth



In October 2019, Quantum Spatial (QSI) was contracted by JE Fuller (JEF) to collect Light Detection and Ranging (LiDAR) data in the fall of 2019 for the Ruhestroth site in Nevada. Data were collected to aid JEF in assessing the topographic and geophysical properties of the study area to support the creation of the Ruhestroth Area Drainage Master Plan.

This report accompanies the delivered LiDAR data and documents contract specifications, data acquisition procedures, processing methods, and analysis of the final dataset including LiDAR accuracy and density. Acquisition dates and acreage are shown in Table 1, a complete list of contracted deliverables provided to JEF is shown in Table 2, and the project extent is shown in Figure 1.

Table 1: Acquisition dates, acreage, and data types collected on the Ruhestroth site

Project Site	Contracted Acres	Buffered Acres	Acquisition Dates	Data Type
Ruhestroth, Nevada	12,420	13,250	10/24/2019	LiDAR

Deliverable Products

Table 2: Products delivered to JEF for the Ruhenstroth site

Ruhenstroth, Nevada LiDAR Products	
Projection: Nevada State Plane West	
Horizontal Datum: NAD83 (2011)	
Vertical Datum: NAVD88 (GEOID12B)	
Units: US Survey Feet	
Points	LAS v 1.4 <ul style="list-style-type: none">All Classified Returns
Rasters	3.0 Foot ESRI Grids <ul style="list-style-type: none">Bare Earth Digital Elevation Model (DEM)
Vectors	Shapefiles (*.shp) <ul style="list-style-type: none">Project BoundaryTile Index

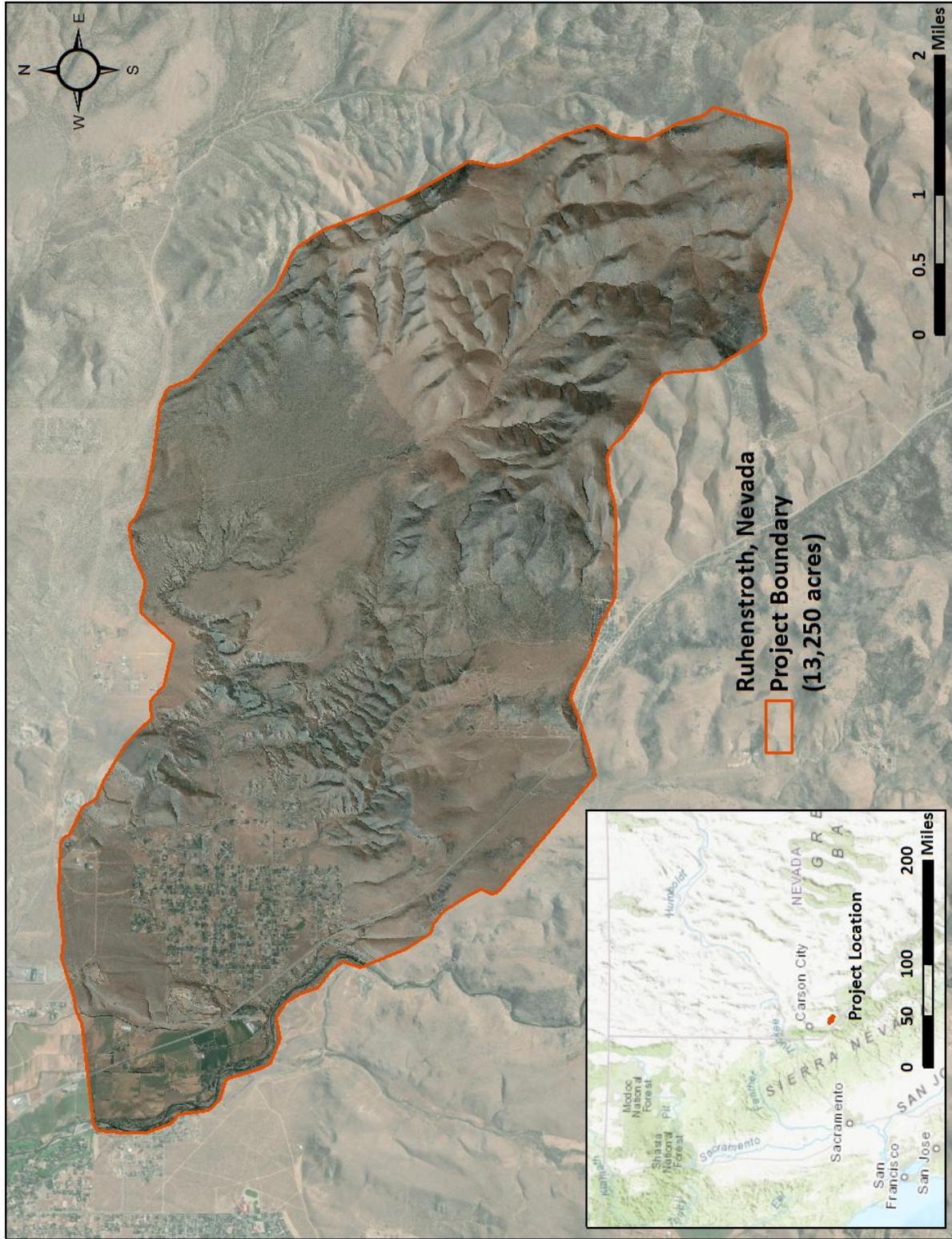


Figure 1: Location map of the Ruhenstroth site in Nevada

QSI's Cessna Caravan



Planning

In preparation for data collection, QSI reviewed the project area and developed a specialized flight plan to ensure complete coverage of the Ruhestroth LiDAR study area at the target point density of ≥ 8.0 points/m² (0.74 points/ft²). Acquisition parameters including orientation relative to terrain, flight altitude, pulse rate, scan angle, and ground speed were adapted to optimize flight paths and flight times while meeting all contract specifications.

Factors such as satellite constellation availability and weather windows must be considered during the planning stage. Any weather hazards or conditions affecting the flight were continuously monitored due to their potential impact on the daily success of airborne and ground operations. In addition, logistical considerations including private property access and potential air space restrictions were reviewed.

Airborne LiDAR Survey

The LiDAR survey was accomplished using a Riegl VQ-1560i system mounted in a Cessna Caravan. Table 3 summarizes the settings used to yield an average pulse density of ≥ 8 pulses/m² over the Ruhenstroth, Nevada project area. The Riegl VQ-1560i laser system can record unlimited range measurements (returns) per pulse. It is not uncommon for some types of surfaces (e.g., dense vegetation or water) to return fewer pulses to the LiDAR sensor than the laser originally emitted. The discrepancy between first return and overall delivered density will vary depending on terrain, land cover, and the prevalence of water bodies. All discernible laser returns were processed for the output dataset.

Table 3: LiDAR specifications and survey settings

LiDAR Survey Settings & Specifications	
Acquisition Dates	October 24, 2019
Aircraft Used	Cessna Caravan 208B
Sensor	Riegl
Laser	VQ-1560i
Maximum Returns	Unlimited
Resolution/Density	Average 8 pulses/m ²
Nominal Pulse Spacing	0.35 m
Survey Altitude (AGL)	1825 m
Survey speed	145 knots
Field of View	58.5°
Mirror Scan Rate	117 lines/sec per channel
Target Pulse Rate	700 kHz per channel
Pulse Length	3 ns
Laser Pulse Footprint Diameter	32.85 cm
Central Wavelength	1064 nm
Pulse Mode	Multiple Times Around (MTA)
Beam Divergence	0.18 mrad
Swath Width	2,045 m
Swath Overlap	55%
Intensity	16-bit
Accuracy	RMSE _z (Non-Vegetated) \leq 9 cm
	NVA (95% Confidence Level) \leq 20 cm



Riegl VQ-1560i

All areas were surveyed with an opposing flight line side-lap of $\geq 55\%$ ($\geq 100\%$ overlap) in order to reduce laser shadowing and increase surface laser painting. To accurately solve for laser point position (geographic coordinates x, y and z), the positional coordinates of the airborne sensor and the attitude of the aircraft were recorded continuously throughout the LiDAR data collection mission. Position of the aircraft was measured twice per second (2 Hz) by an onboard differential GPS unit, and aircraft attitude was measured 200 times per second (200 Hz) as pitch, roll and yaw (heading) from an onboard inertial measurement unit (IMU). To allow for post-processing correction and calibration, aircraft and sensor position and attitude data are indexed by GPS time.

Ground Survey

Ground control surveys were conducted to support the airborne acquisition. Ground control data were used to geospatially correct the aircraft positional coordinate data and to perform quality assurance checks on final LiDAR data.

Base Stations

Base stations were utilized for collection of ground survey points using real time kinematic (RTK) and post processed kinematic (PPK) survey techniques.

QSI utilized two existing permanent active CORS on the SMARTNET network for the Ruhenstroth LiDAR project (Table 4, Figure 2). QSI's professional land surveyor, Steven J. Hyde (NVPLS#22474) certified the ground survey work.

Table 4: Base Station positions for the Ruhenstroth acquisition. Coordinates are on the NAD83 (2011) datum, epoch 2010.00

Base Station ID	Latitude	Longitude	Ellipsoid (meters)
P143	38° 45' 36.58612"	-119° 45' 53.35789"	1734.147
NVCC	39° 10' 50.94039"	-119° 45' 55.01479"	1419.696

QSI utilized static Global Navigation Satellite System (GNSS) data collected at 1 Hz recording frequency for each base station. During post-processing, the static GNSS data were triangulated with nearby Continuously Operating Reference Stations (CORS) using the Online Positioning User Service (OPUS¹) for precise positioning. Multiple independent sessions over the same monument were processed to confirm antenna height measurements and to refine position accuracy.

¹ OPUS is a free service provided by the National Geodetic Survey to process corrected monument positions. <http://www.ngs.noaa.gov/OPUS>.

Ground Survey Points (GSPs)

Ground survey points were collected using real time kinematic (RTK) and post-processed kinematic (PPK) survey techniques. For RTK surveys, a roving receiver receives corrections from a nearby base station or Real-Time Network (RTN) via radio or cellular network, enabling rapid collection of points with relative errors less than 1.5 cm horizontal and 2.0 cm vertical. PPK surveys compute these corrections during post-processing to achieve comparable accuracy. RTK and PPK surveys record data while stationary for at least five seconds, calculating the position using at least three one-second epochs. All GSP measurements were made during periods with a Position Dilution of Precision (PDOP) of ≤ 3.0 with at least six satellites in view of the stationary and roving receivers. See Table 5 for Trimble unit specifications.

GSPs were collected in areas where good satellite visibility was achieved on paved roads and other hard surfaces such as gravel or packed dirt roads. GSP measurements were not taken on highly reflective surfaces such as center line stripes or lane markings on roads due to the increased noise seen in the laser returns over these surfaces. GSPs were collected within as many flightlines as possible; however, the distribution of GSPs depended on ground access constraints and monument locations and may not be equitably distributed throughout the study area (Figure 2).

Table 5: QSI ground survey equipment identification

Receiver Model	Antenna	OPUS Antenna ID	Use
Trimble R8	Integrated Antenna	TRM_R8_GNSS	Rover

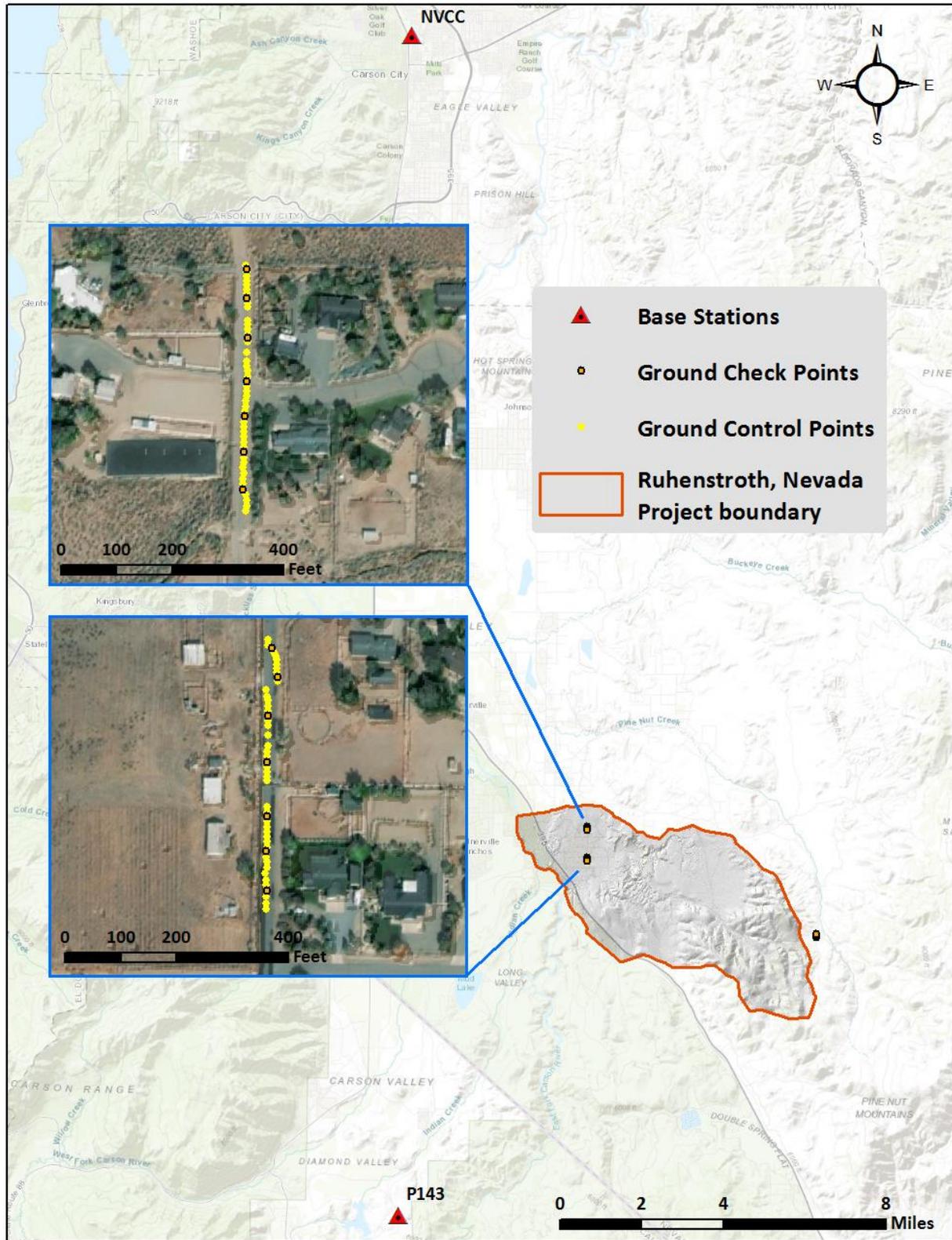
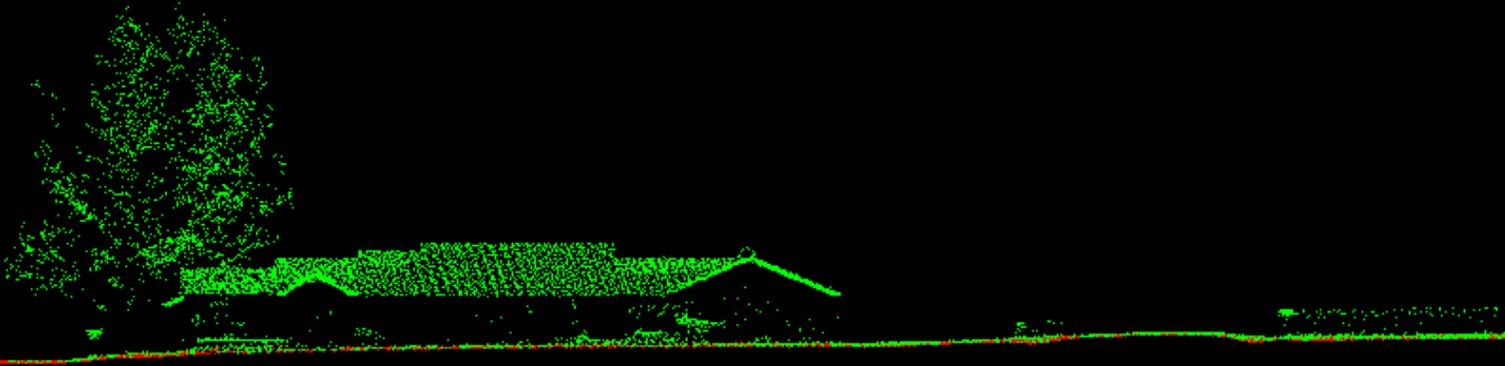


Figure 2: Ground survey location map

This LiDAR cross section shows a view of a house and trees in the Ruhestroth project boundary, colored by point classification.

Default 
Ground 



LiDAR Data

Upon completion of data acquisition, QSI processing staff initiated a suite of automated and manual techniques to process the data into the requested deliverables. Processing tasks included GPS control computations, smoothed best estimate trajectory (SBET) calculations, kinematic corrections, calculation of laser point position, sensor and data calibration for optimal relative and absolute accuracy, and LiDAR point classification (Table 6). Processing methodologies were tailored for the landscape. Brief descriptions of these tasks are shown in Table 7.

Table 6: ASPRS LAS classification standards applied to the Ruhestroth dataset

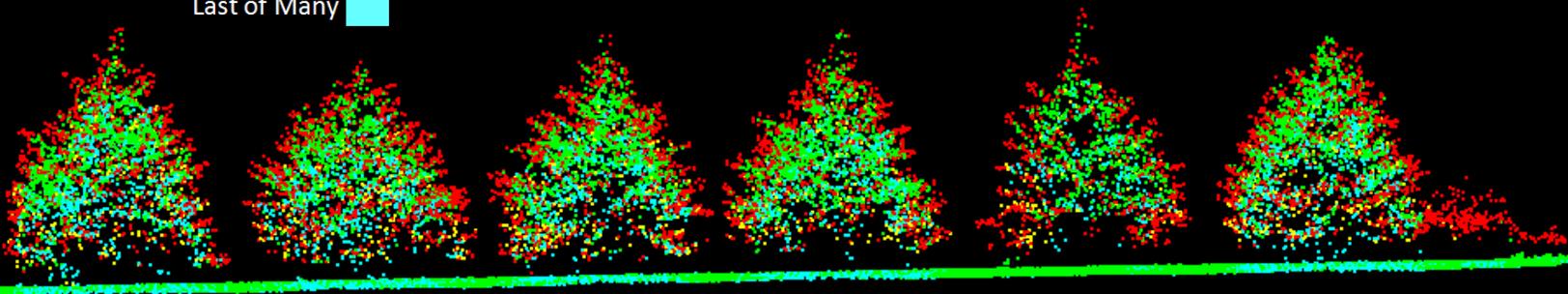
Classification Number	Classification Name	Classification Description
1	Default/Unclassified	Laser returns that are not included in the ground class, composed of vegetation and anthropogenic features
2	Ground	Laser returns that are determined to be ground using automated and manual cleaning algorithms
7	Noise	Laser returns that are often associated with birds, scattering from reflective surfaces, or artificial points below the ground surface
129	Edge Clip	Laser returns at the outer edges of flightlines that are geometrically unreliable

Table 7: LiDAR processing workflow

LiDAR Processing Step	Software Used
Resolve kinematic corrections for aircraft position data using kinematic aircraft GPS and static ground GPS data. Develop a smoothed best estimate of trajectory (SBET) file that blends post-processed aircraft position with sensor head position and attitude recorded throughout the survey.	POSPac MMS v.8.3
Calculate laser point position by associating SBET position to each laser point return time, scan angle, intensity, etc. Create raw laser point cloud data for the entire survey in *.las (ASPRS v. 1.4) format. Convert data to orthometric elevations by applying a geoid correction.	RiProcess v.1.8.5
Import raw laser points into manageable blocks to perform manual relative accuracy calibration and filter erroneous points. Classify ground points for individual flight lines.	TerraScan v.19
Using ground classified points per each flight line, test the relative accuracy. Perform automated line-to-line calibrations for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift. Calculate calibrations on ground classified points from paired flight lines and apply results to all points in a flight line. Use every flight line for relative accuracy calibration.	TerraMatch v.19
Classify resulting data to ground and other client designated ASPRS classifications (Table 6). Assess statistical absolute accuracy via direct comparisons of ground classified points to ground control survey data.	TerraScan v.19 TerraModeler v.19
Generate bare earth models as triangulated surfaces. Export all surface models as ESRI GRIDs at a 3.0 foot pixel resolution.	LAS Product Creator 3.0 (QSI proprietary)



This LiDAR cross section shows a view of vegetation and bare ground in the Ruhenstroth project area, colored by point laser echo.



LiDAR Density

The acquisition parameters were designed to acquire an average first-return density of 8 points/m² (0.74 points/ft²). First return density describes the density of pulses emitted from the laser that return at least one echo to the system. Multiple returns from a single pulse were not considered in first return density analysis. Some types of surfaces (e.g., breaks in terrain, water and steep slopes) may have returned fewer pulses than originally emitted by the laser. First returns typically reflect off the highest feature on the landscape within the footprint of the pulse. In forested or urban areas the highest feature could be a tree, building or power line, while in areas of unobstructed ground, the first return will be the only echo and represents the bare earth surface.

The density of ground-classified LiDAR returns was also analyzed for this project. Terrain character, land cover, and ground surface reflectivity all influenced the density of ground surface returns. In vegetated areas, fewer pulses may penetrate the canopy, resulting in lower ground density.

The average first-return density of LiDAR data for the Ruhenstroth project was 1.99 points/ft² (21.38 points/m²) while the average ground classified density was 0.57 points/ft² (6.14 points/m²) (Table 8). The statistical and spatial distributions of first return densities and classified ground return densities per 100 m x 100 m cell are portrayed in Figure 3 to Figure 5.

Table 8: Average LiDAR point densities

Classification	Point Density
First-Return	1.99 points/ft ²
	21.38 points/m ²
Ground Classified	0.57 points/ft ²
	6.14 points/m ²

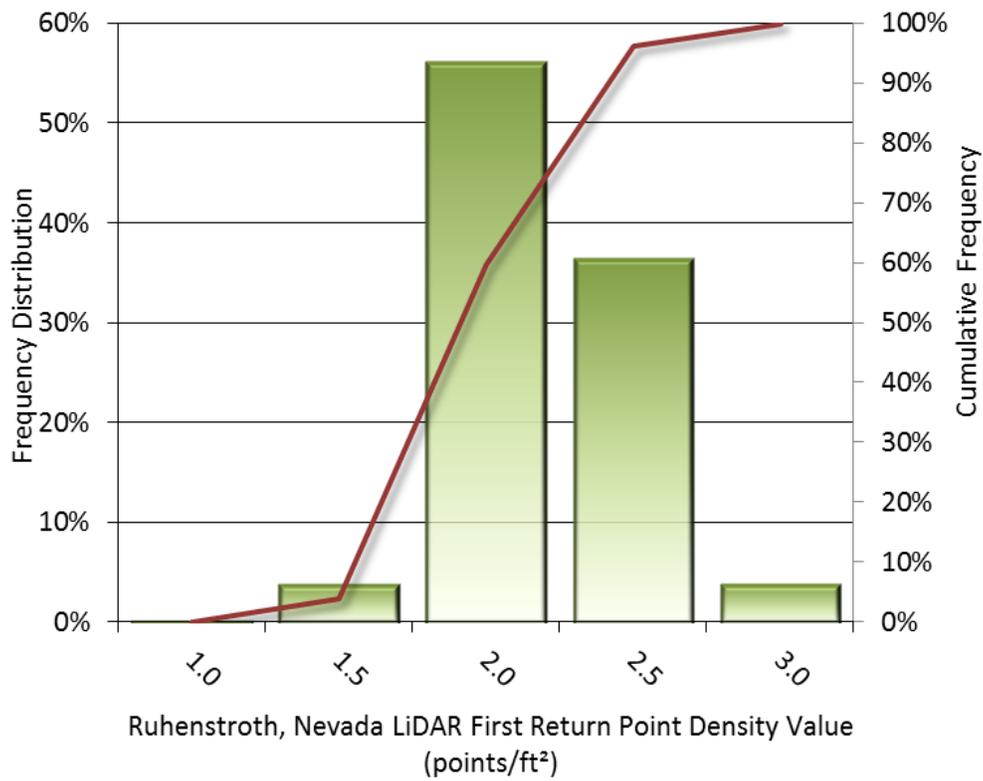


Figure 3: Frequency distribution of first return point density values per 100 x 100 m cell

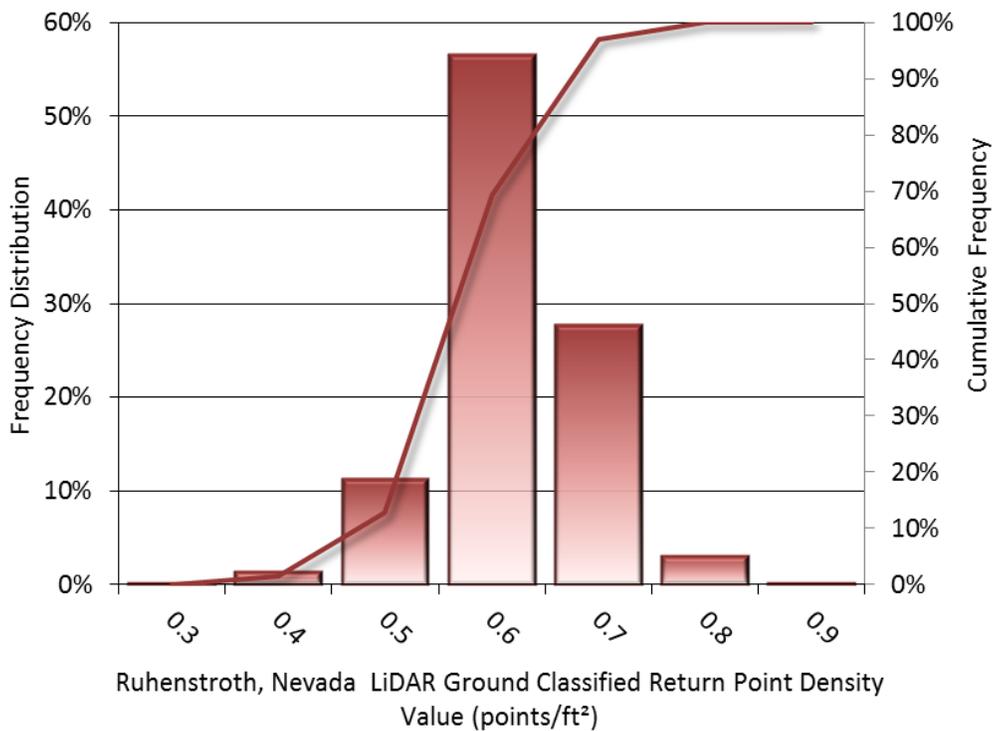


Figure 4: Frequency distribution of ground-classified return point density values per 100 x 100 m cell

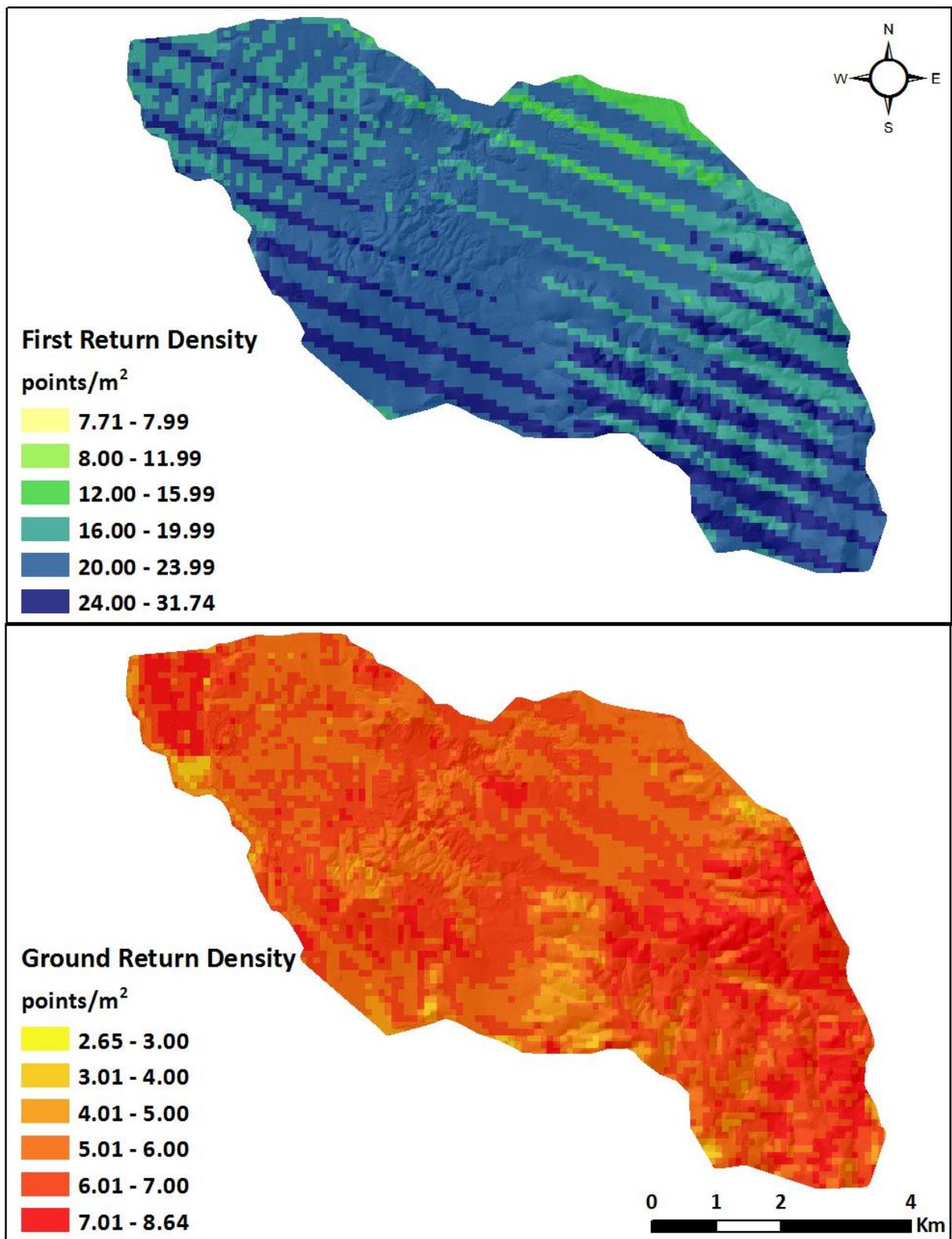


Figure 5: First return and ground-classified point density map for the Ruhestroth site (100 m x 100 m cells)

LiDAR Accuracy Assessments

The accuracy of the LiDAR data collection can be described in terms of absolute accuracy (the consistency of the data with external data sources) and relative accuracy (the consistency of the dataset with itself). See Appendix A for further information on sources of error and operational measures used to improve relative accuracy.

LiDAR Non-Vegetated Vertical Accuracy

Absolute accuracy was assessed using Non-Vegetated Vertical Accuracy (NVA) reporting designed to meet guidelines presented in the FGDC National Standard for Spatial Data Accuracy². NVA compares known ground check point data that were withheld from the calibration and post-processing of the LiDAR point cloud to the triangulated surface generated by the unclassified LiDAR point cloud as well as the derived gridded bare earth DEM. NVA is a measure of the accuracy of LiDAR point data in open areas where the LiDAR system has a high probability of measuring the ground surface and is evaluated at the 95% confidence interval ($1.96 * RMSE$), as shown in Table 9.

The mean and standard deviation (sigma σ) of divergence of the ground surface model from quality assurance point coordinates are also considered during accuracy assessment. These statistics assume the error for x, y and z is normally distributed, and therefore the skew and kurtosis of distributions are also considered when evaluating error statistics. For the Ruhenstroth survey, 21 ground check points were withheld from the calibration and post processing of the LiDAR point cloud, with resulting non-vegetated vertical accuracy of 0.227 feet (0.069 meters) as compared to unclassified LAS, and 0.233 feet (0.071 meters) as compared to the bare earth DEM, with 95% confidence (Figure 6, Figure 7).

QSI also assessed absolute accuracy using 124 ground control points. Although these points were used in the calibration and post-processing of the LiDAR point cloud, they still provide a good indication of the overall accuracy of the LiDAR dataset, and therefore have been provided in Table 9 and Figure 8.

Table 9: Absolute accuracy results

Absolute Vertical Accuracy			
	NVA, as compared to unclassified LAS	NVA, as compared to bare earth DEM	Ground Control Points
Sample	21 points	21 points	124 points
95% Confidence (1.96*RMSE)	0.227 ft 0.069 m	0.233 ft 0.071 m	0.197 ft 0.060 m
Average	0.055 ft 0.017 m	0.022 ft 0.007 m	0.001 ft 0.000 m

² Federal Geographic Data Committee, ASPRS POSITIONAL ACCURACY STANDARDS FOR DIGITAL GEOSPATIAL DATA EDITION 1, Version 1.0, NOVEMBER 2014. <http://www.asprs.org/PAD-Division/ASPRS-POSITIONAL-ACCURACY-STANDARDS-FOR-DIGITAL-GEOSPATIAL-DATA.html>.

Absolute Vertical Accuracy			
	NVA, as compared to unclassified LAS	NVA, as compared to bare earth DEM	Ground Control Points
Median	0.092 ft 0.028 m	-0.001 ft 0.000 m	0.041 ft 0.013 m
RMSE	0.116 ft 0.035 m	0.119 ft 0.036 m	0.101 ft 0.031 m
Standard Deviation (1 σ)	0.104 ft 0.032 m	0.120 ft 0.037 m	0.101 ft 0.031 m

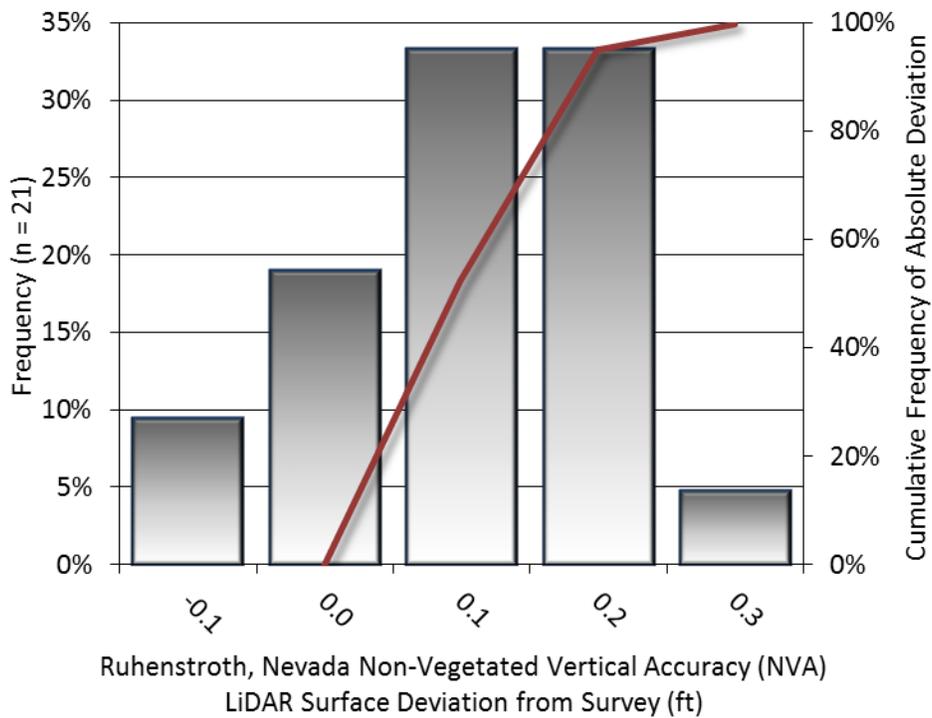


Figure 6: Frequency histogram for LiDAR unclassified LAS deviation from ground check point values (NVA)

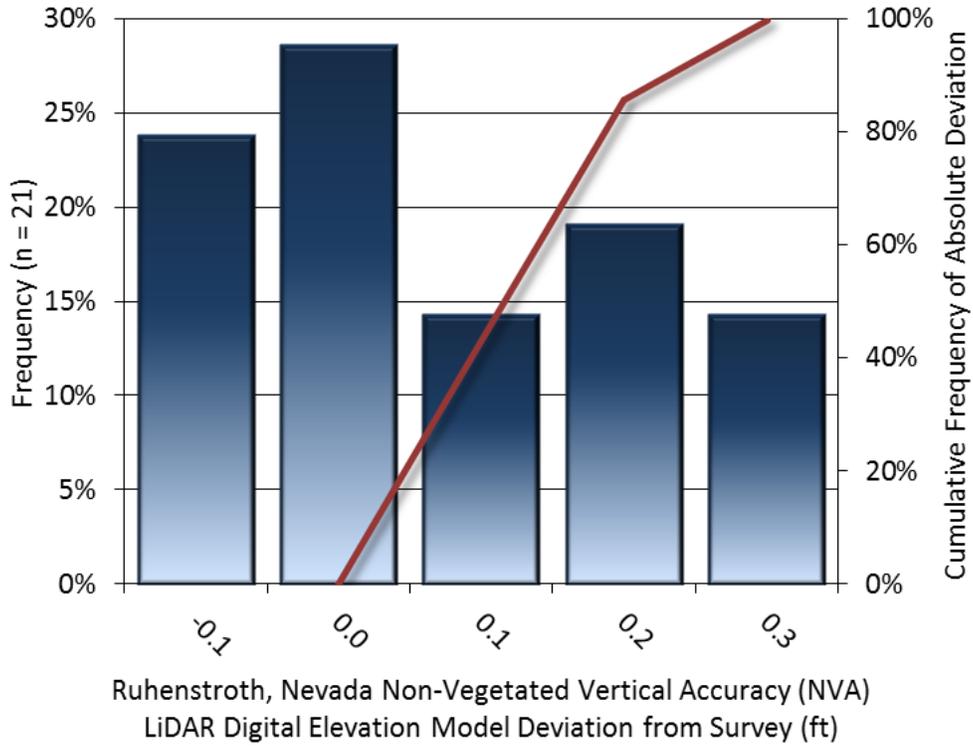


Figure 7: Frequency histogram for LiDAR bare earth DEM surface deviation from ground check point values (NVA)

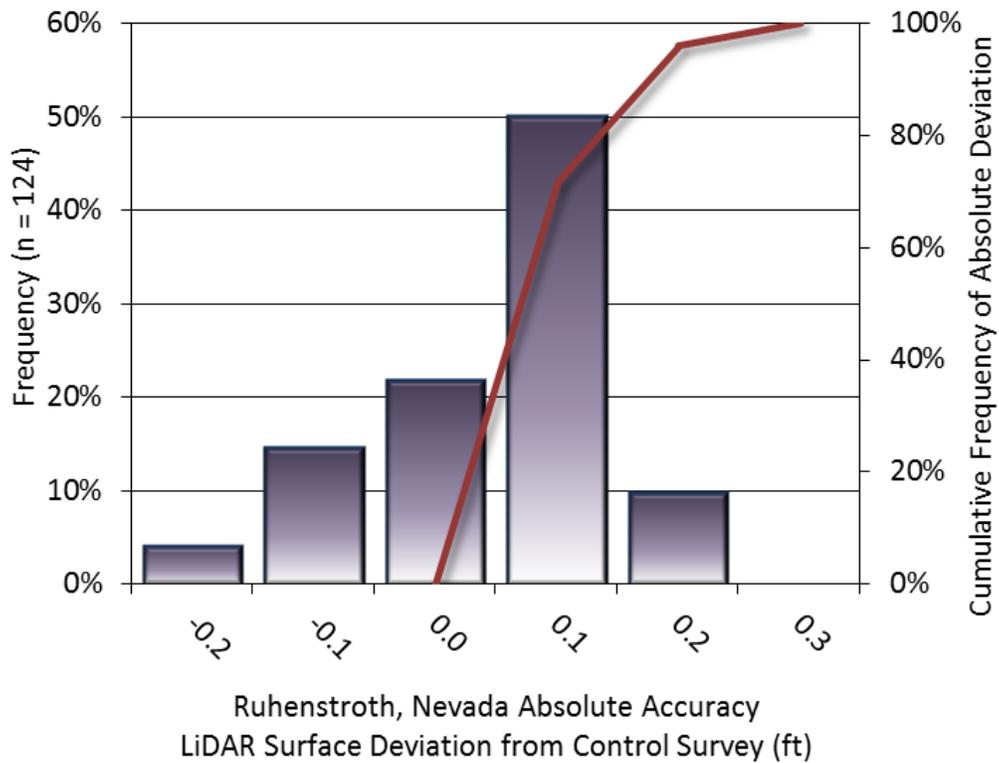


Figure 8: Frequency histogram for LiDAR surface deviation from ground control point values

LiDAR Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the LiDAR system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the Ruhenstroth LiDAR project was 0.082 feet (0.025 meters) (Table 10, Figure 9).

Table 10: Relative accuracy results

Relative Accuracy	
Sample	12 flight line surfaces
Average	0.082 ft 0.025 m
Median	0.077 ft 0.023 m
RMSE	0.083 ft 0.025 m
Standard Deviation (1 σ)	0.012 ft 0.004 m
1.96 σ	0.023 ft 0.007 m

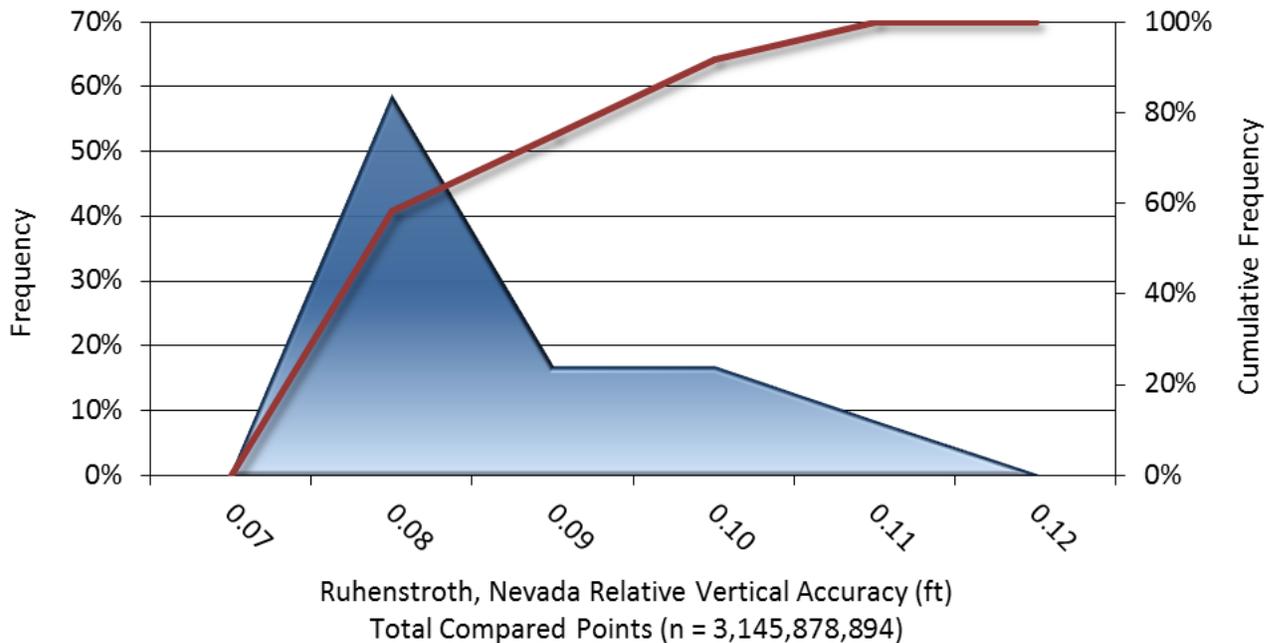


Figure 9: Frequency plot for relative vertical accuracy between flight lines

LiDAR Horizontal Accuracy

LiDAR horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS-derived attitude error. The obtained RMSE_r value is multiplied by a conversion factor of 1.7308 to yield the horizontal component (ACC_r) of the National Standards for Spatial Data Accuracy (NSSDA) reporting standard where a theoretical point will fall within the obtained radius 95 percent of the time. Using a flying altitude of 1,825 meters, an IMU error of 0.015 decimal degrees, and a GNSS positional error of 0.002 meters, the horizontal accuracy (ACC_r) for the LiDAR collection is 0.65 feet (0.20 meters) at the 95% confidence level (Table 13). Data from the Ruhenstroth dataset have been tested to meet horizontal requirements at the 95% confidence level, using NSSDA reporting methods.

Table 11: Horizontal Accuracy

Horizontal Accuracy	
RMSE _r	0.95 ft
	0.29 m
ACC _r	1.65 ft
	0.50 m

CERTIFICATIONS

Quantum Spatial, Inc. provided LiDAR services for the Ruhenstroth project as described in this report.

I, Jackie Monge, have reviewed the attached report for completeness and hereby state that it is a complete and accurate report of this project.


Jackie Monge (Dec 18, 2019)

Dec 18, 2019

Jackie Monge
Project Manager
Quantum Spatial, Inc.

I, Steven J. Hyde, PLS, being duly registered as a Professional Land Surveyor in and by the state of Nevada, hereby certify that the methodologies, static GNSS occupations used during airborne flights, and ground survey point collection were performed using commonly accepted Standard Practices. Field work conducted for this report was conducted on October 25, 2019.

Accuracy statistics shown in the Accuracy Section of this Report have been reviewed by me and found to meet the "National Standard for Spatial Data Accuracy".




Steven J Hyde, PLS
Quantum Spatial, Inc.
Corvallis, OR 97330

1-sigma (σ) Absolute Deviation: Value for which the data are within one standard deviation (approximately 68th percentile) of a normally distributed data set.

1.96 * RMSE Absolute Deviation: Value for which the data are within two standard deviations (approximately 95th percentile) of a normally distributed data set, based on the FGDC standards for Non-vegetated Vertical Accuracy (NVA) reporting.

Accuracy: The statistical comparison between known (surveyed) points and laser points. Typically measured as the standard deviation (σ) and root mean square error (RMSE).

Absolute Accuracy: The vertical accuracy of LiDAR data is described as the mean and standard deviation (σ) of divergence of LiDAR point coordinates from ground survey point coordinates. To provide a sense of the model predictive power of the dataset, the root mean square error (RMSE) for vertical accuracy is also provided. These statistics assume the error distributions for x, y and z are normally distributed, and thus we also consider the skew and kurtosis of distributions when evaluating error statistics.

Relative Accuracy: Relative accuracy refers to the internal consistency of the data set; i.e., the ability to place a laser point in the same location over multiple flight lines, GPS conditions and aircraft attitudes. Affected by system attitude offsets, scale and GPS/IMU drift, internal consistency is measured as the divergence between points from different flight lines within an overlapping area. Divergence is most apparent when flight lines are opposing. When the LiDAR system is well calibrated, the line-to-line divergence is low (<10 cm).

Root Mean Square Error (RMSE): A statistic used to approximate the difference between real-world points and the LiDAR points. It is calculated by squaring all the values, then taking the average of the squares and taking the square root of the average.

Data Density: A common measure of LiDAR resolution, measured as points per square meter.

Digital Elevation Model (DEM): File or database made from surveyed points, containing elevation points over a contiguous area. Digital terrain models (DTM) and digital surface models (DSM) are types of DEMs. DTMs consist solely of the bare earth surface (ground points), while DSMs include information about all surfaces, including vegetation and man-made structures.

Intensity Values: The peak power ratio of the laser return to the emitted laser, calculated as a function of surface reflectivity.

Nadir: A single point or locus of points on the surface of the earth directly below a sensor as it progresses along its flight line.

Overlap: The area shared between flight lines, typically measured in percent. 100% overlap is essential to ensure complete coverage and reduce laser shadows.

Pulse Rate (PR): The rate at which laser pulses are emitted from the sensor; typically measured in thousands of pulses per second (kHz).

Pulse Returns: For every laser pulse emitted, the number of wave forms (i.e., echoes) reflected back to the sensor. Portions of the wave form that return first are the highest element in multi-tiered surfaces such as vegetation. Portions of the wave form that return last are the lowest element in multi-tiered surfaces.

Real-Time Kinematic (RTK) Survey: A type of surveying conducted with a GPS base station deployed over a known monument with a radio connection to a GPS rover. Both the base station and rover receive differential GPS data and the baseline correction is solved between the two. This type of ground survey is accurate to 1.5 cm or less.

Post-Processed Kinematic (PPK) Survey: GPS surveying is conducted with a GPS rover collecting concurrently with a GPS base station set up over a known monument. Differential corrections and precisions for the GNSS baselines are computed and applied after the fact during processing. This type of ground survey is accurate to 1.5 cm or less.

Scan Angle: The angle from nadir to the edge of the scan, measured in degrees. Laser point accuracy typically decreases as scan angles increase.

Native LiDAR Density: The number of pulses emitted by the LiDAR system, commonly expressed as pulses per square meter.

APPENDIX A - ACCURACY CONTROLS

Relative Accuracy Calibration Methodology:

Manual System Calibration: Calibration procedures for each mission require solving geometric relationships that relate measured swath-to-swath deviations to misalignments of system attitude parameters. Corrected scale, pitch, roll and heading offsets were calculated and applied to resolve misalignments. The raw divergence between lines was computed after the manual calibration was completed and reported for each survey area.

Automated Attitude Calibration: All data were tested and calibrated using TerraMatch automated sampling routines. Ground points were classified for each individual flight line and used for line-to-line testing. System misalignment offsets (pitch, roll and heading) and scale were solved for each individual mission and applied to respective mission datasets. The data from each mission were then blended when imported together to form the entire area of interest.

Automated Z Calibration: Ground points per line were used to calculate the vertical divergence between lines caused by vertical GPS drift. Automated Z calibration was the final step employed for relative accuracy calibration.

LiDAR accuracy error sources and solutions:

Type of Error	Source	Post Processing Solution
GPS (Static/Kinematic)	Long Base Lines	None
	Poor Satellite Constellation	None
	Poor Antenna Visibility	Reduce Visibility Mask
Relative Accuracy	Poor System Calibration	Recalibrate IMU and sensor offsets/settings
	Inaccurate System	None
Laser Noise	Poor Laser Timing	None
	Poor Laser Reception	None
	Poor Laser Power	None
	Irregular Laser Shape	None

Operational measures taken to improve relative accuracy:

Low Flight Altitude: Terrain following was employed to maintain a constant above ground level (AGL). Laser horizontal errors are a function of flight altitude above ground (about 1/3000th AGL flight altitude).

Focus Laser Power at narrow beam footprint: A laser return must be received by the system above a power threshold to accurately record a measurement. The strength of the laser return (i.e., intensity) is a function of laser emission power, laser footprint, flight altitude and the reflectivity of the target. While surface reflectivity cannot be controlled, laser power can be increased and low flight altitudes can be maintained.

Reduced Scan Angle: Edge-of-scan data can become inaccurate. The scan angle was reduced to a maximum of $\pm 29.25^\circ$ from nadir, creating a narrow swath width and greatly reducing laser shadows from trees and buildings.

Quality GPS: Flights took place during optimal GPS conditions (e.g., 6 or more satellites and PDOP [Position Dilution of Precision] less than 3.0). Before each flight, the PDOP was determined for the survey day. During all flight times, a dual frequency DGPS base station recording at 1 second epochs was utilized and a maximum baseline length between the aircraft and the control points was less than 13 nm at all times.

Ground Survey: Ground survey point accuracy (<1.5 cm RMSE) occurs during optimal PDOP ranges and targets a minimal baseline distance of 4 miles between GPS rover and base. Robust statistics are, in part, a function of sample size (n) and distribution. Ground survey points are distributed to the extent possible throughout multiple flight lines and across the survey area.

50% Side-Lap (100% Overlap): Overlapping areas are optimized for relative accuracy testing. Laser shadowing is minimized to help increase target acquisition from multiple scan angles. Ideally, with a 50% side-lap, the nadir portion of one flight line coincides with the swath edge portion of overlapping flight lines. A minimum of 50% side-lap with terrain-followed acquisition prevents data gaps.

Opposing Flight Lines: All overlapping flight lines have opposing directions. Pitch, roll and heading errors are amplified by a factor of two relative to the adjacent flight line(s), making misalignments easier to detect and resolve.

APPENDIX B

**Digital Data Submittal
(separate submittal)**

Ruhenstroth Area Drainage Master Plan Phase 2

Technical Support Data Notebook



September
2021

prepared for
Douglas County | Carson Water Subconservancy District



Date Signed: September 27, 2021

MICHAEL J. KELLOGG
Professional Geologist (AZ, CA, UT, TX, OR)
Date Signed: September 27, 2021



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Date Signed: September 27, 2021

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Appendices

Appendix A – Ruhenstroth ADMP Phase 1 TSDN (separate digital submittal)

Appendix B – Concept Design Sheets, Construction Cost Estimates, and Life-Cycle Cost Estimates (separate digital submittal)

Appendix C – Supporting Data (separate digital submittal)



Date Signed: September 27, 2021

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1 INTRODUCTION

1.1 PROJECT PURPOSE

The Ruhenstroth Area Drainage Master Plan (ADMP) Phase 2 study (Phase 2) is the continuation and conclusion of the Ruhenstroth ADMP Phase 1 study (Phase 1). The Phase 1 study was developed to meet three primary objectives:

1. Evaluate and identify flooding and sedimentation hazards within the project area by completion of a technical study that includes data collection, review of previous studies, information gathering from public agencies and residents, hydrologic and hydraulic modeling, geomorphic assessments, and field surveys.
2. Develop concepts for all-weather access crossings of Smelter Creek for existing conditions.
3. Provide stakeholder coordination and public outreach of the project through a series of meetings to inform of the existing flooding risk within the community.

The Phase 1 study was completed in October 2020 and included the following key elements:

- Historical Flowpath Assessment
- Existing Conditions Hydrologic and Hydraulic Modeling
 - Verification of Results
- Sedimentation Analyses
- Flood Hazard Classification
- Smelter Creek All-Weather Access Assessment

An open house public meeting introducing the Phase 1 study to the Ruhenstroth community was held on January 14, 2020, from 5:30pm to 7:00pm at the Douglas County Fairgrounds (920 Dump Road, Gardnerville, NV 89410). Approximately 30 individuals were in attendance for the open house.

The Phase 2 study was developed to meet the following primary objectives:

- Identify flood hazard mitigation alternatives:
 - For or both the 25-year, and 100-year storms to minimize the impact of flooding to the community.
- Develop concept-level designs for the preferred alternatives
- Community outreach to present the suite of alternatives

1.2 PROJECT LOCATION

The Ruhenstroth ADMP watershed area is 18 square miles and is located on the western slopes of the Pine Nut Mountains, approximately 16 miles south of Carson City (Figure 1-1). The study area is located entirely within Douglas County about 6 miles southeast of the Minden-Gardnerville area. The primary focus area of the RADMP is the lower watershed area downstream of the mountains.

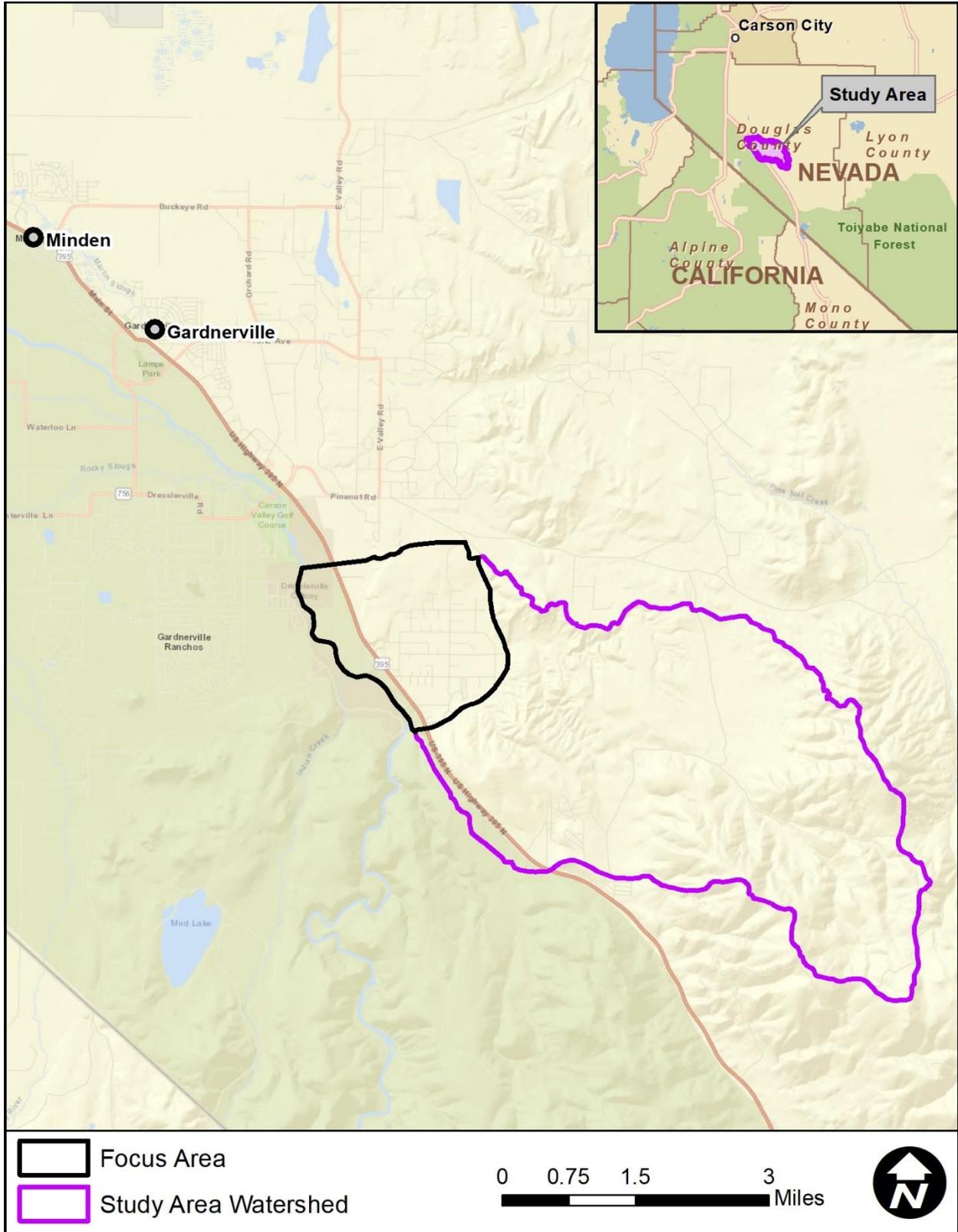


Figure 1-1. Study area vicinity map

1.3 PHASE 1 HYDROLOGIC/HYDRAULIC MODELING SUMMARY

The Phase 1 hydrologic and hydraulic modeling tasks form the foundation of the Phase 2 assessment. The existing conditions FLO-2D models were created using the best available information for land cover, surface classification, topography, and hydrology that were available at the time of the study (early to middle 2020). Every effort was made to ensure the models represented existing conditions as of the date of the project LiDAR survey.

Photographs and anecdotal information collected from both Douglas County staff and the residents within the Ruhestroth community were used to help calibrate and verify the modeling results. Like all models, the ADMP FLO-2D models are a simulation of potential conditions that could occur during a range of storm events. The models cannot exactly replicate actual, observed storm events at all locations within the community due to the vast number of variables that change with each unique storm event.

The modeling results reflect the complex flooding and sedimentation hazards that exist within the Ruhestroth study area. The results provide valuable, quantitative, detailed information from which future planning and development decisions can be based.

Although the ADMP FLO-2D modeling effort was not intended to replicate an actual historical flood event, the comparison of the modeling results with USGS regression equations, anecdotal flood information, and independent hydraulic calculations indicate the project FLO-2D models suitably depict storm runoff conditions – indicating that the underlying input parameters are reasonable. Given the distributary nature of the flooding within the community, and the high sediment transport rates, flooding characteristics (e.g., depth, discharge, location) are likely to change from one flood event to the next. Even small anthropogenic changes to the landscape (e.g., dirt piles, berms, construction of outbuildings, landscaping debris piles, etc.) will result in sediment accumulation, channel scour, and changes in flowpath directions that may not be represented in the project FLO-2D modeling. In other words, the results of the modeling represent potential flooding conditions as of the date of the project topographic mapping. For reference, the Phase 1 Technical Support Data Notebook is included in its entirety in Appendix A.

2 REGIONAL FLOOD MITIGATION ALTERNATIVES

2.1 INTRODUCTION

The development of the regional alternatives comprised the following elements:

- 1) Initial alternative brainstorming, formulation, and evaluation.
- 2) Development of conceptual drainage improvements along Smelter Creek from upstream of the Ruhenstroth community to the U.S. Highway 395 crossing.
- 3) Development of conceptual drainage improvement to the Unnamed Tributary to Smelter Creek that enters the Ruhenstroth community just south of Megan Court.
- 4) Preliminary 15% design plans, construction cost estimates, and lifecycle cost estimates for the selected mitigation alternatives to Smelter Creek and the Unnamed Tributary to Smelter Creek.

JE Fuller (JEF) served as the lead on the flood hazard identification and alternative formulations with assistance from Lumos and Associates (Lumos), who were the lead in the development of the 15% design plans and cost estimates for the selected mitigation alternatives. Figure 2-1 summarizes the process for developing the regional alternatives.

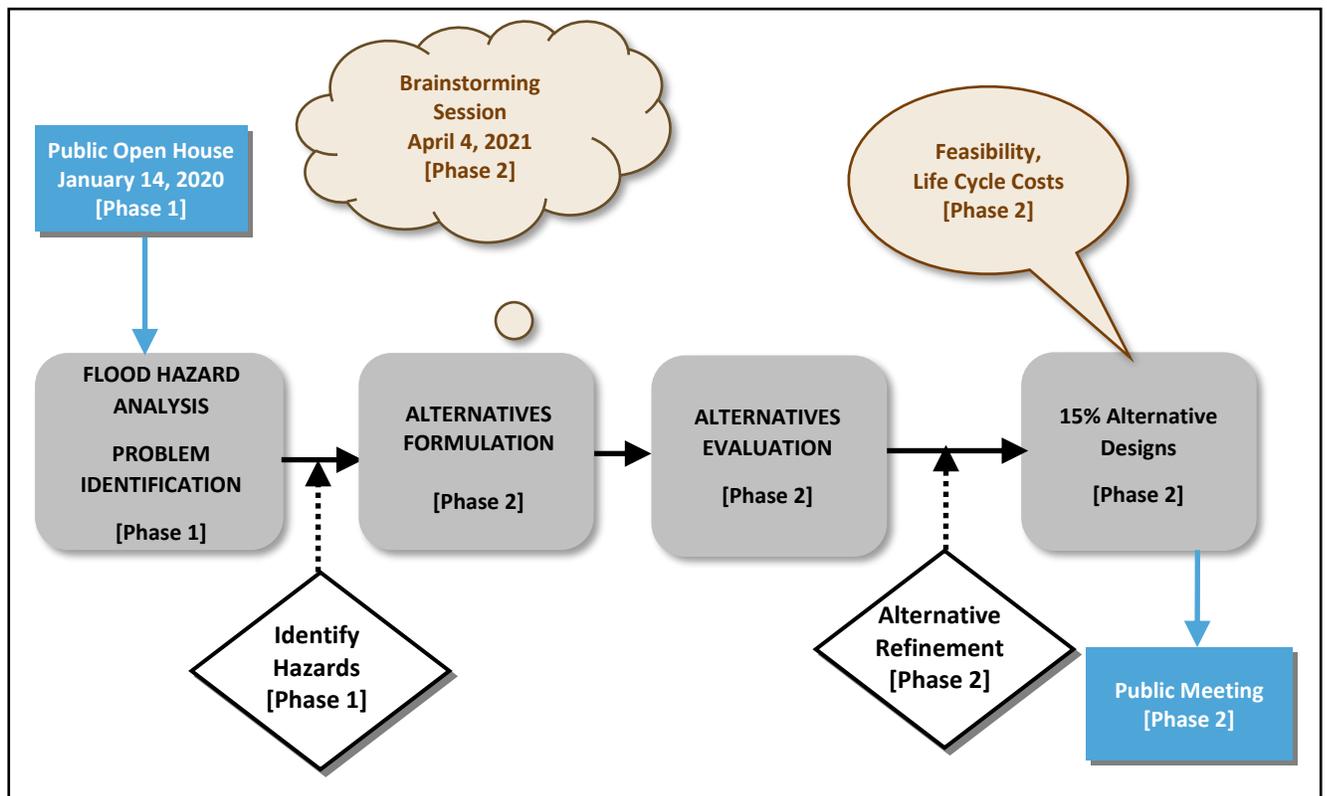


Figure 2-1. Development process for the regional flood mitigation alternatives for the ADMP

2.2 MITIGATION ALTERNATIVES

On April 4, 2021, the JEF technical team conducted a brainstorming session to develop initial mitigation concepts and verify their feasibility. The meeting resulted in the conceptualization of several regional mitigation systems. On June 30, 2021, the technical team met with Douglas County to present and discuss the mitigation system options. The system options were comprised of the following structure elements:

- Smelter Creek sediment basin
- Smelter Creek channel improvements
- Smelter Creek culvert improvements
- Unnamed tributary channel improvements
- Unnamed tributary storm drain system option
- Unnamed tributary detention basin option

Through the Alternatives Formulation and Alternatives Evaluation process, the technical team developed three mitigation alternative systems that were presented to Douglas County. Each system was comprised of the elements listed above which could result in significant mitigation of offsite flooding to the Ruhenstroth community. Multiple iterations of the alternatives were presented and discussed with Douglas County over the course of the project. Initially, both 100-year and 25-year recurrence interval storm event regional alternatives were to be developed; however, upon multiple discussions with the technical team, Douglas County determined that only the 25-year recurrence storm event would advance to concept design. Each alternative system is described in the following sections and summarized in Table 2-1.

2.2.1 Smelter Creek Alternative

Under existing conditions, the Smelter Creek channel does not have capacity for the 25-year storm runoff at multiple locations within the Ruhenstroth community resulting in flows overtopping the channel and flooding adjacent properties. In addition, all the road crossing culverts along Smelter Creek lack capacity for the 25-year discharge resulting in roadway overtopping (Figure 2-2).

Sediment accumulation within both the Smelter Creek channel and culverts has historically been problematic. Douglas County stormwater management crews are frequently called upon to remove sediment to maintain flow conveyance. To mitigate some of the sedimentation issues, a sediment basin is being proposed on Bureau of Land Management (BLM) property upstream of Ruhenstroth.

To mitigate the lack of conveyance for the 25-year discharge, Smelter Creek channel improvement are being proposed beginning from the proposed sediment basin and extending to the U.S. Highway 395 crossing. In addition to the channel improvements, upgraded culverts are being proposed at all Smelter Creek crossings to allow conveyance of the 25-year discharge without overtopping the roads. Design specifics for the channel and culvert improvements can be found in Appendix B.

The proposed Smelter Creek alternative system is shown in Figure 2-3.

2.2.2 Unnamed Tributary Alternative 1

As shown in Figure 2-2, the Unnamed tributary to Smelter Creek originates in the hills south of Ruhenstroth and flows into the community. Upstream of Palomino Lane the channel does not have capacity for the 25-year, 24-hour storm and flows begin to breakout flooding adjacent properties. The

lack of a concise conveyance corridor downstream of Palomino Lane results in widespread, shallow flooding through a large swath of the community. Given the lack of a conveyance corridor and/or available right-of-way, the technical team determined that the only viable mitigation options were to either create a conveyance corridor via a storm drain system or detain as much flow volume as possible upstream of Palomino. The Unnamed Tributary Alternative 1 includes a storm drain system that captures the flow upstream of Palomino Lane and conveys it downstream to an eventual outfall in Smelter Creek. To prevent the breakout flow upstream of Palomino Lane, channel modifications are proposed that will convey the flow from the upper watershed to Palomino Lane. Immediately upstream (south) of Palomino Lane a small sediment inlet basin is proposed that will remove some sediment from the system and transition the flow from the channel into the storm drain. The technical team attempted several design iterations using standard circular storm drain sizes; however, given the uneven terrain between the sediment inlet basin and U.S. 395, it was determined that the only viable design option would be a 5-foot (wide) by 3-foot (high) concrete box storm drain that would extend beneath Palomino Lane, then north along the U.S. 395 right-of-way to Smelter Creek. Design specifics for the channel and storm drain improvements can be found in Appendix B.

The proposed Unnamed Tributary alternative 1 system is shown in Figure 2-4.

2.2.3 Unnamed Tributary Alternative 2

A second alternative for the Unnamed tributary was developed and includes a detention basin located within privately-owned Parcel 1221-19-002-030 (north of Palomino Lane). Like the Unnamed Tributary Alternative 1, channel modifications are proposed that will convey the flow from the upper watershed to Palomino Lane. A 60-inch diameter concrete pipe is proposed beneath Palomino Lane and extending to the detention basin. The basin is approximately 4.5 acres in footprint with a storage capacity of approximately 28 ac-ft with one-foot of freeboard. A 24-inch outlet pipe is proposed to extend from the proposed basin directly west to the existing detention basin located near Mustang Lane and Lacey Court. The pipe would extend beneath the following parcels:

- 1220-24-701-054
- 1220-24-701-049

The total flow volume computed for the 25-year, 24-hour storm for the Unnamed tributary is approximately 58 ac-ft, which is 30 ac-ft greater than the proposed basin capacity. The basin design includes a spillway on the southwest corner to allow overflow to return to the existing conditions flowpath.

The proposed Unnamed Tributary alternative 2 system is shown in Figure 2-5.

Table 2-1. Alternative comparison summary

Alternative System	Structure Elements	Opportunities	Constraints
Smelter Creek	<ul style="list-style-type: none"> • New Sediment Basin • Improvements to culverts at the following crossings: <ul style="list-style-type: none"> ○ Buckskin Ln ○ Mustang Ln ○ Cayuse Dr ○ Horsemen Ct • New culvert between Pinto Ct and Sullivan Ln 	<ul style="list-style-type: none"> • Regional mitigation solution • Minimal private land right-of-way acquisition needed • Removes a significant number of properties from the 25-year flood risk 	<ul style="list-style-type: none"> • Coordination with BLM • Coordination with NDOT
Unnamed Tributary Alt 1	<ul style="list-style-type: none"> • Channel improvement upstream of Palomino Ln • Sediment inlet basin at Palomino Ln • New storm drain along Palomino Ln right-of-way from just west of Megan Ct to U.S. 395 • New culvert along U.S. 395 to Smelter Creek confluence 	<ul style="list-style-type: none"> • Regional mitigation solution • Minimal private land right-of-way needed • Removes a significant number of properties from the 25-year flood risk 	<ul style="list-style-type: none"> • Coordination with BLM • Coordination with NDOT
Unnamed Tributary Alt 2	<ul style="list-style-type: none"> • Channel improvements upstream of Palomino Ln • New detention basin at Parcel 1221-19-002-030 	<ul style="list-style-type: none"> • Regional mitigation solution • Removes a significant number of properties from the 25-year flood risk 	<ul style="list-style-type: none"> • Coordination with BLM • Acquisition of Parcel 1221-19-002-030 • Right-of-way acquisition for Parcels 1220-24-701-054 and 1220-24-701-049 for the basin outlet pipe

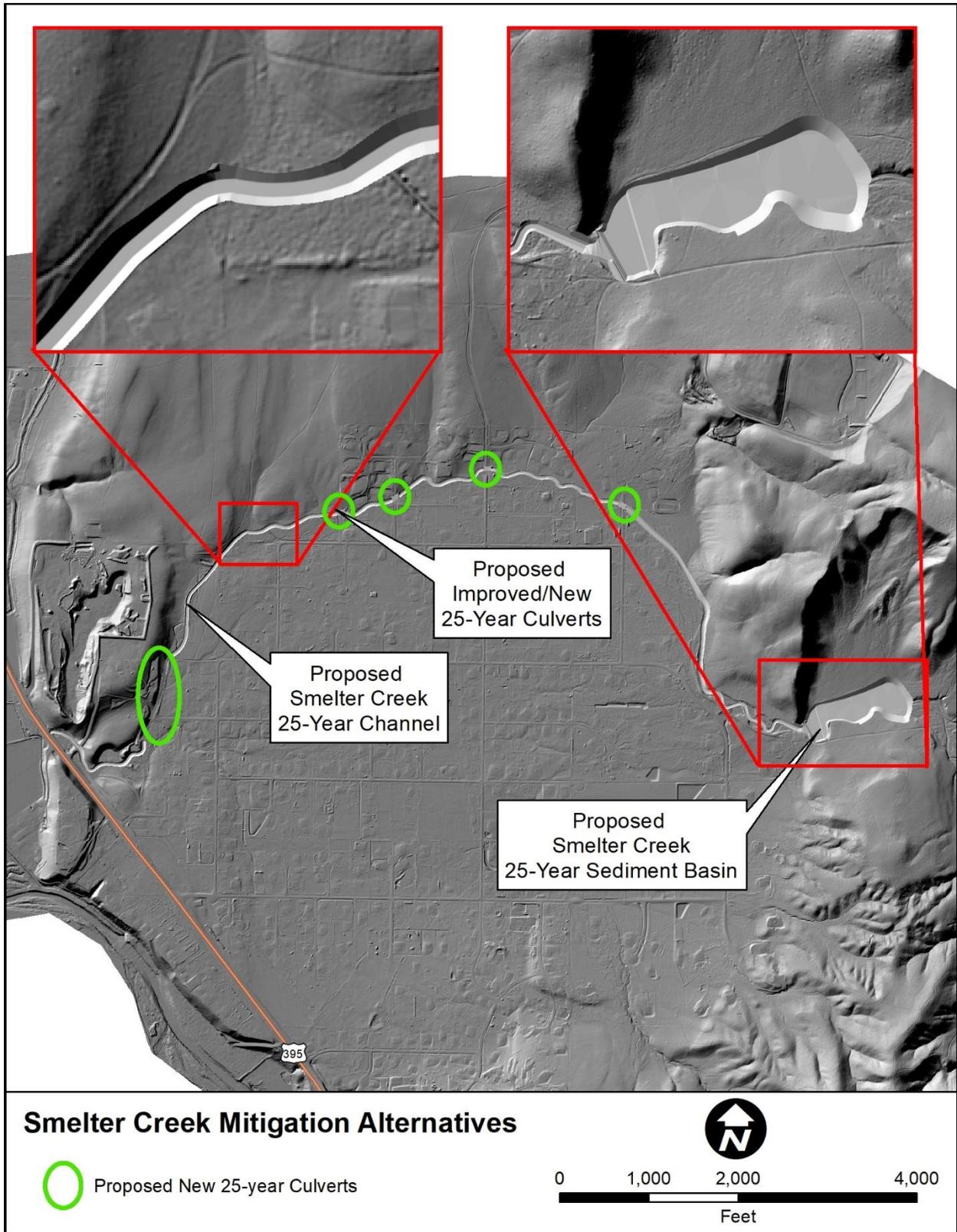


Figure 2-3. Smelter Creek proposed alternative system

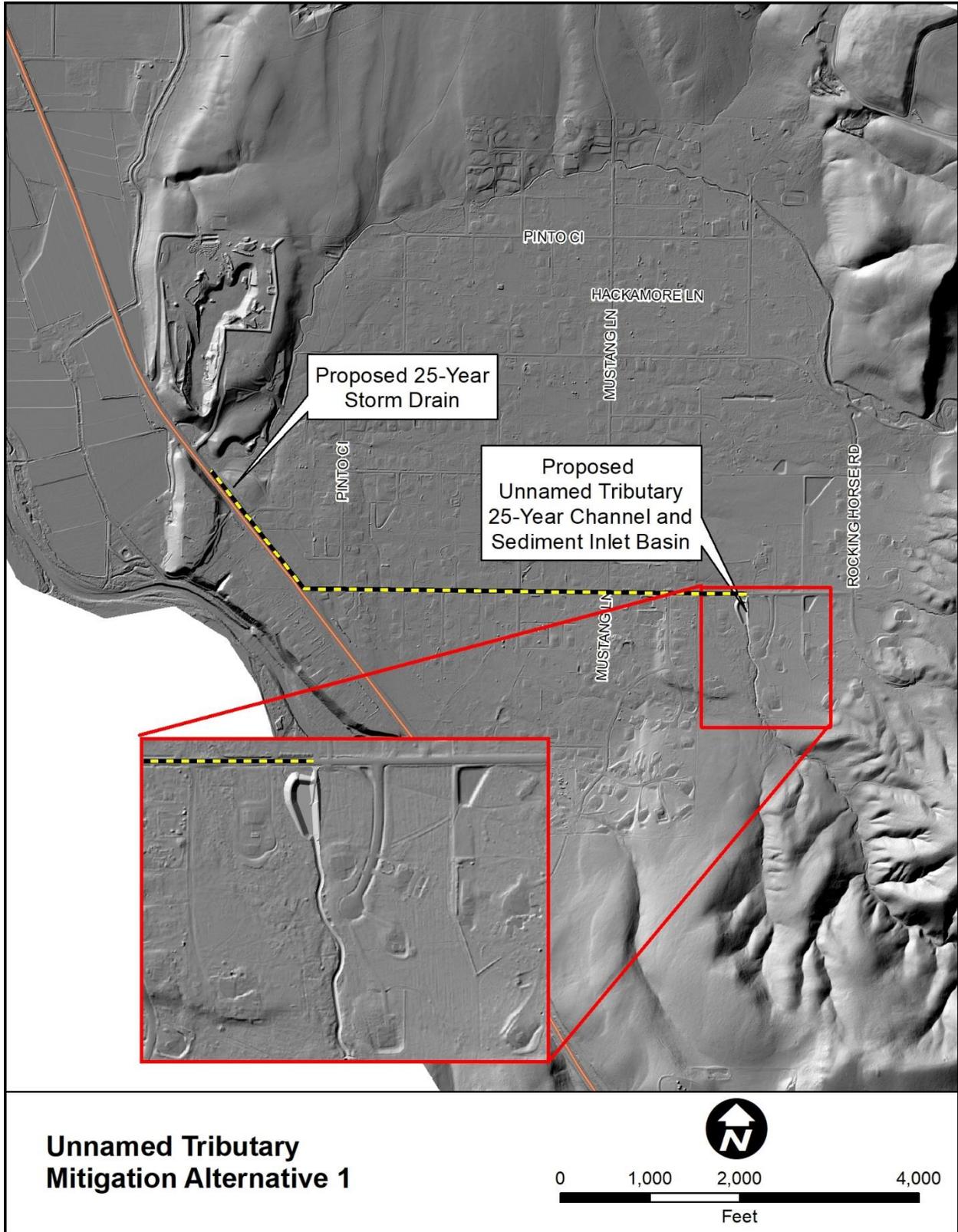


Figure 2-4. Unnamed Tributary alternative 1 system

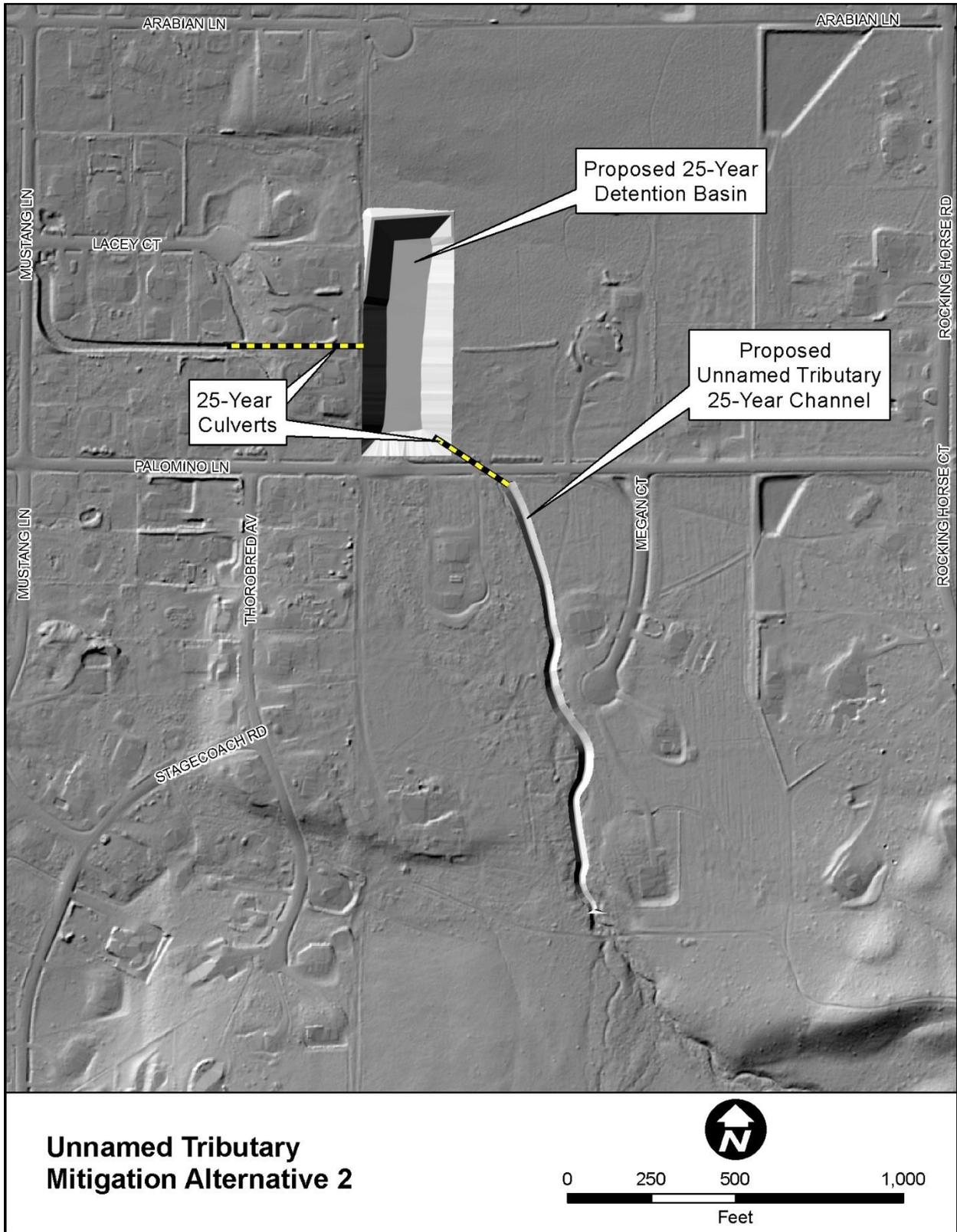


Figure 2-5. Unnamed Tributary alternative 2 system

2.4 BENEFITS SUMMARY

2.4.1 Buildings Benefit

A flood risk benefits analysis was performed for each of the three alternative systems. The Phase 1 study included a building inundation assessment to evaluate the number of buildings within the study area that are impacted by flood depths greater than 0.25 feet (3 inches) (Figure 2-7 and Figure 2-8). Each building was classified based on the maximum depth that fell within the structure outline. The structures were tabulated into four groups:

- 1) $0.25 \text{ ft} < \text{Depth}$ (inclusive of groups 2 through 4 below) – Very Low
- 2) $0.25 \text{ ft} < \text{Depth} \leq 0.5 \text{ ft}$ – Low
- 3) $0.5 \text{ ft} \leq \text{Depth} \leq 1.0 \text{ ft}$ – Moderate
- 4) $1.0 \text{ ft} < \text{Depth}$ – High

The same assessment was conducted considering each of the three proposed alternative systems for the 25-year, 24-hour; 100-year, 6-hour; and 100-year, 24-hour storms. The results are shown in Figure 2-9 through Figure 2-12.

The proposed conditions building flood risk analysis is summarized in Table 2-2. The last column in the tables show the estimated benefit when compared to existing conditions.

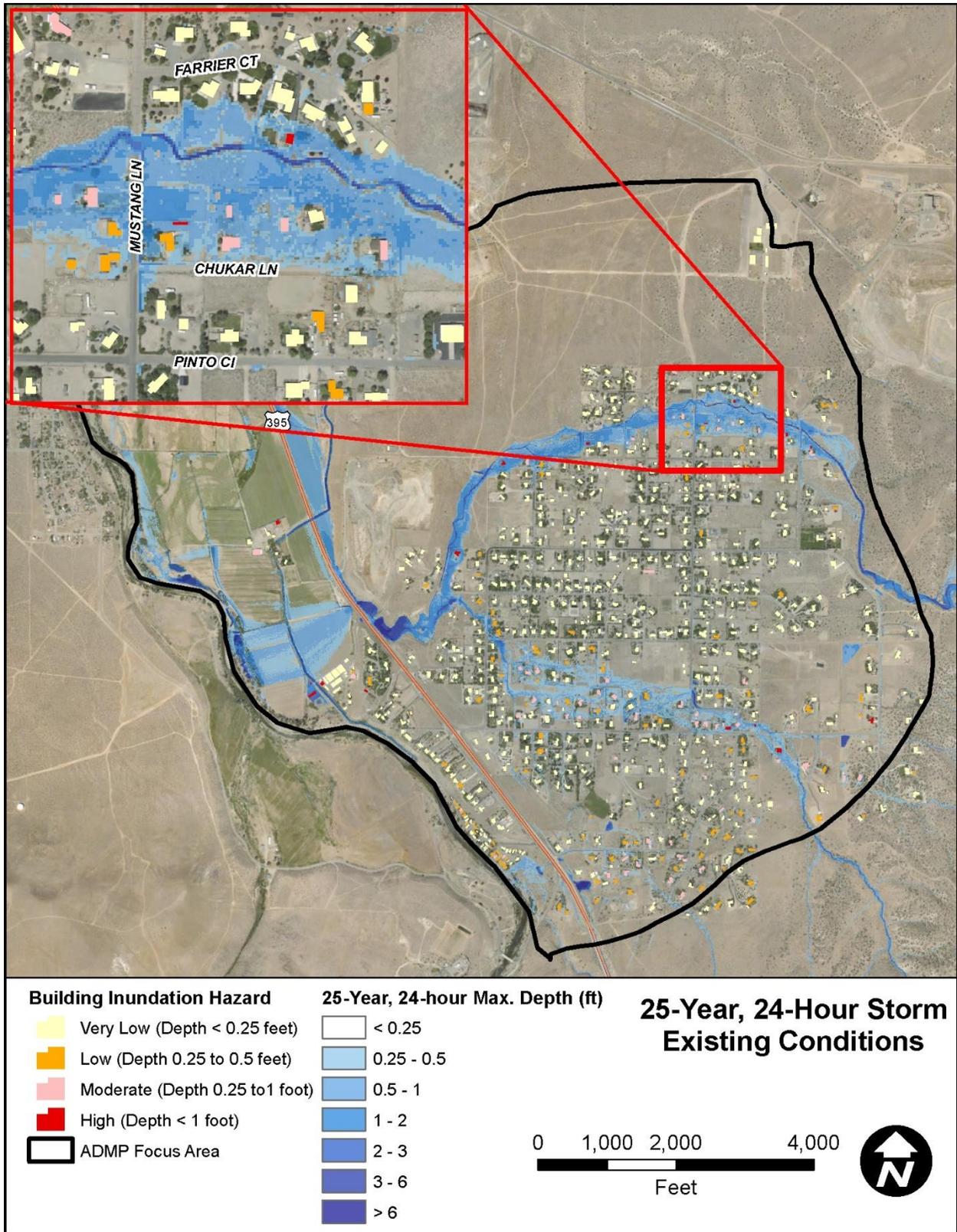


Figure 2-7. Existing conditions building inundation assessment for 25-year, 24-hour storm

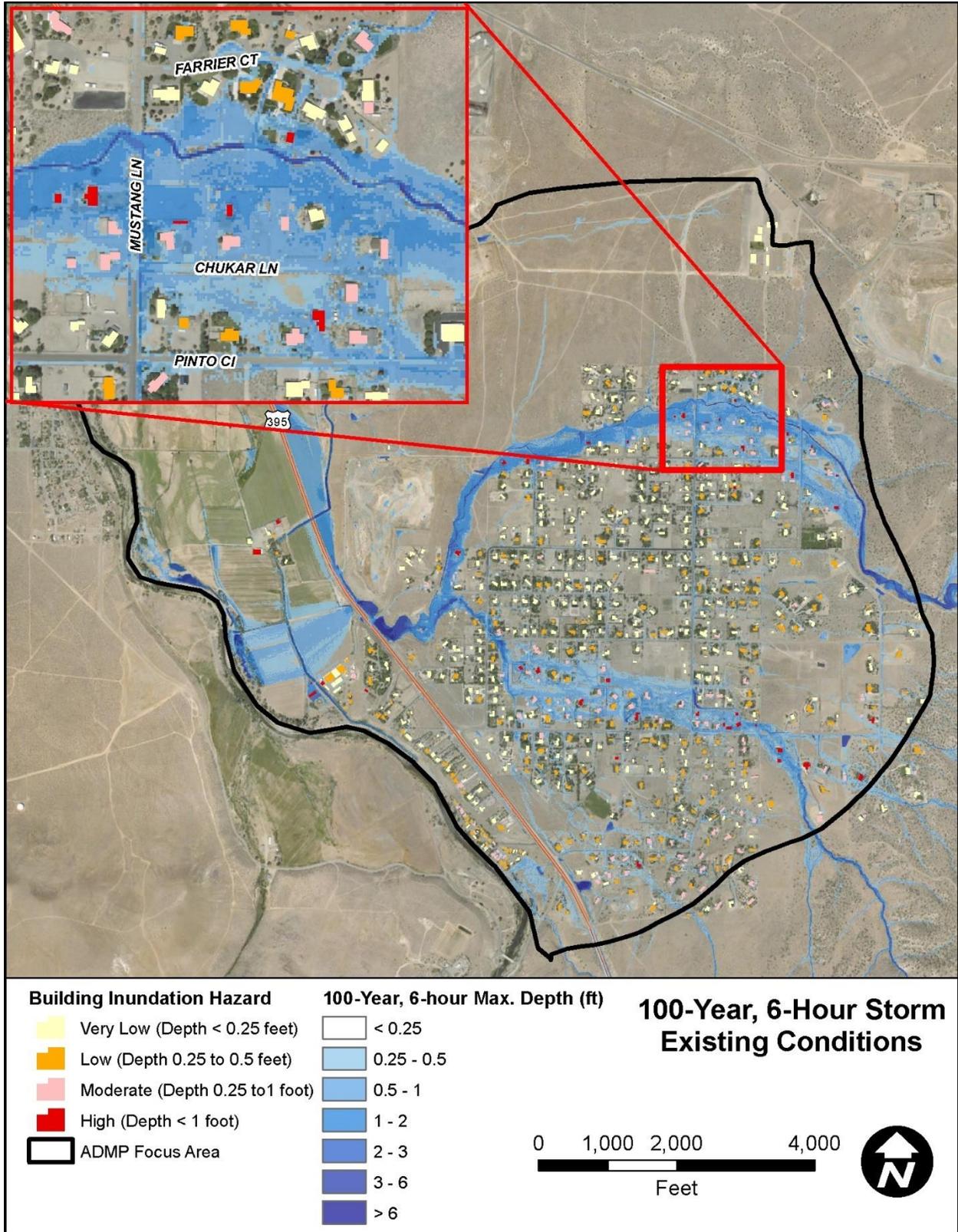


Figure 2-8. Existing conditions building inundation assessment for 100-year, 6-hour storm

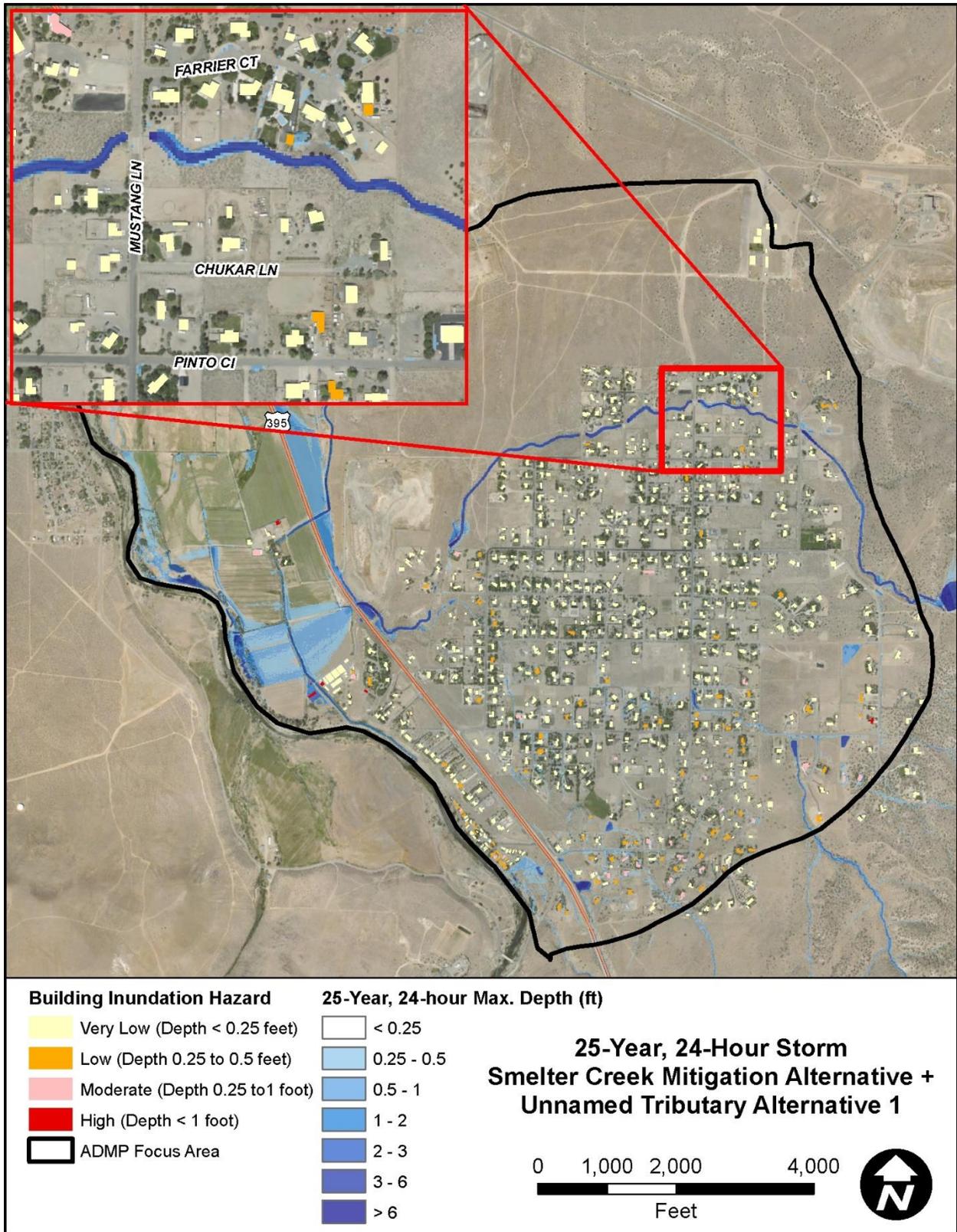


Figure 2-9. Smelter Creek + Unnamed Tributary Alternative 1 building inundation assessment for 25-year, 24-hour storm

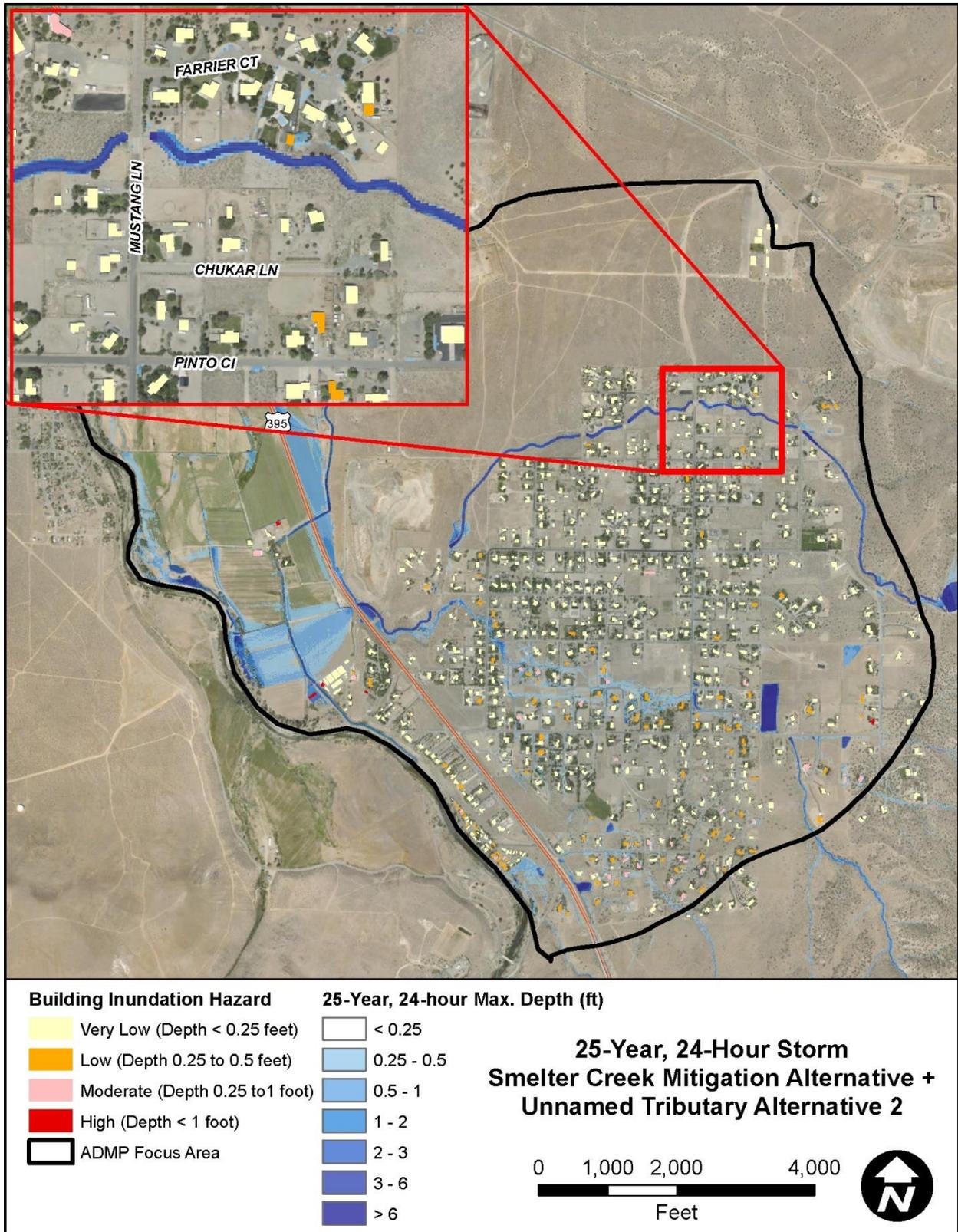


Figure 2-10. Smelter Creek + Unnamed Tributary Alternative 2 building inundation assessment for 25-year, 24-hour storm

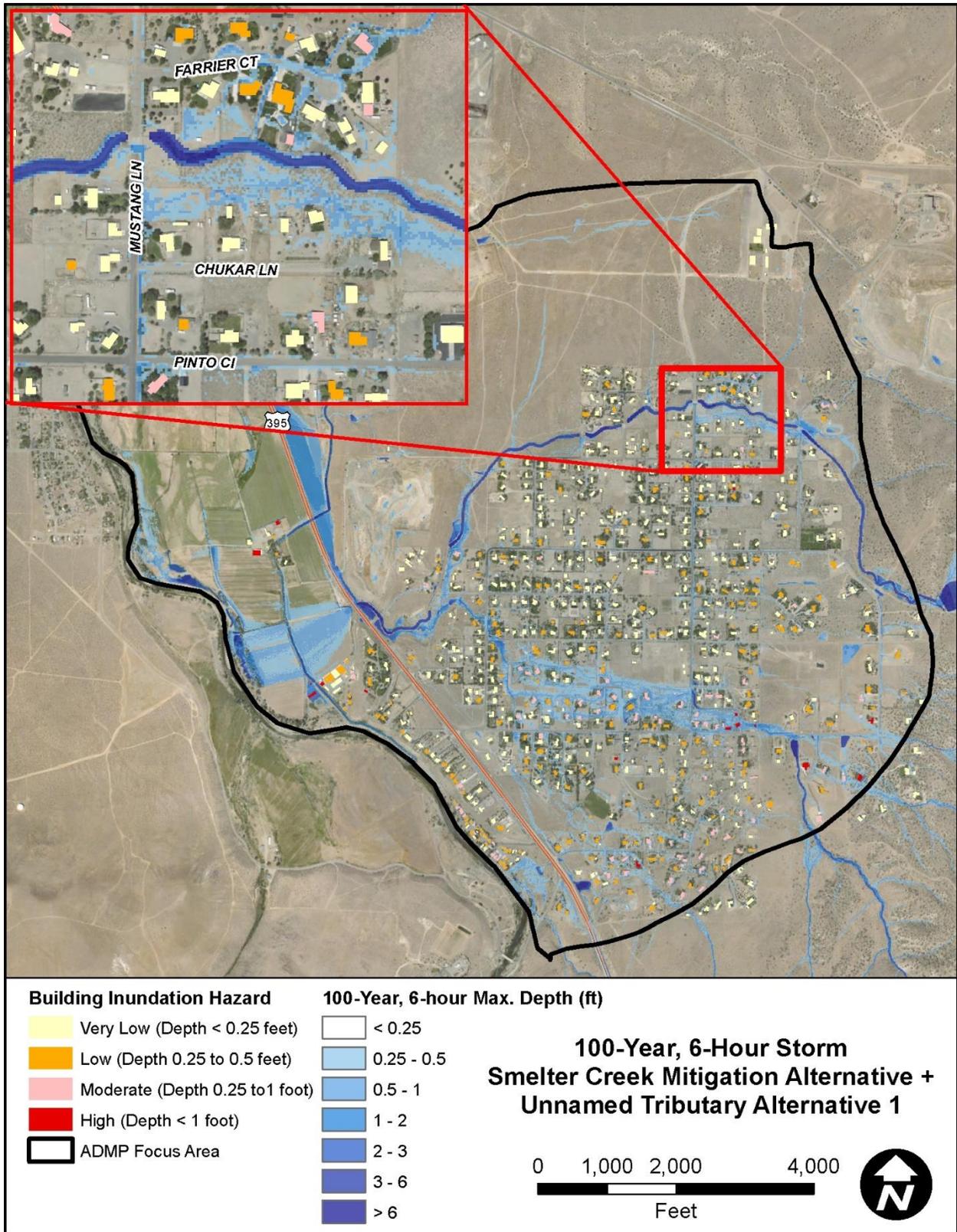


Figure 2-11. Smelter Creek + Unnamed Tributary Alternative 1 building inundation assessment for 100-year, 6-hour storm

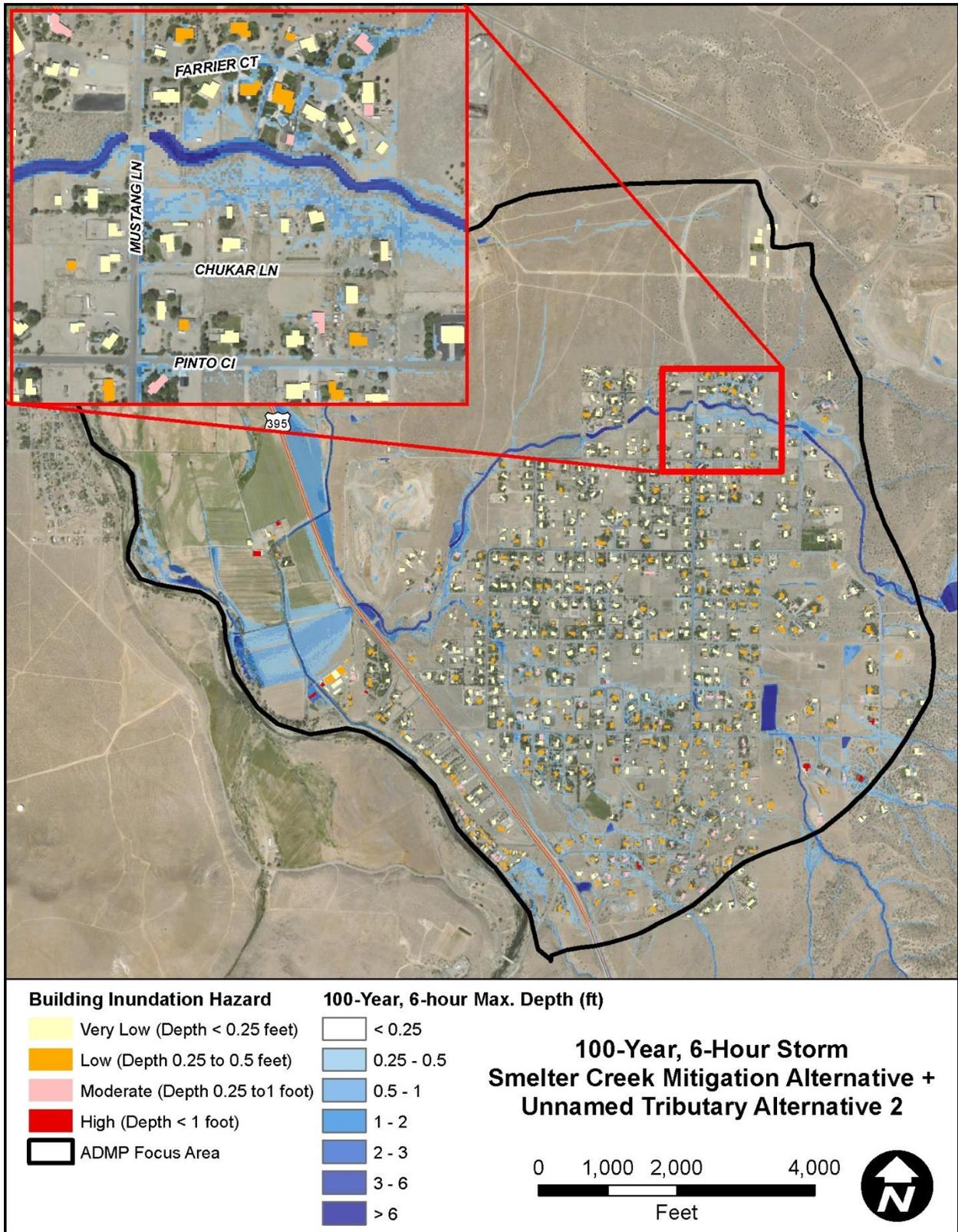


Figure 2-12. Smelter Creek + Unnamed Tributary Alternative 2 building inundation assessment for 100-year, 6-hour storm

Table 2-2. Building Inundation Benefit Summary

Condition	Building Count Flow Depth (feet)	Building Count Flow Depth (feet)	Building Count Flow Depth (feet)	Total Building Count	Benefit (Buildings Removed)
	0.25 < h ≤ 0.5 (Low)	0.5 ≤ h ≤ 1 (Moderate)	1 < h (High)		
25-Year, 24-Hour Storm					
Existing	135	68	17	220	-
Smelter Creek + Unnamed Trib Alternative 1	107	32	6	145	75
Smelter Creek + Unnamed Trib Alternative 2	118	36	6	160	60
100-Year, 6-Hour Storm					
Existing	281	149	43	473	-
Smelter Creek + Unnamed Trib Alternative 1	264	113	16	393	80
Smelter Creek + Unnamed Trib Alternative 2	270	84	12	366	107
100-Year, 24-Hour Storm					
Existing	162	106	32	300	-
Smelter Creek + Unnamed Trib Alternative 1	145	57	10	212	88
Smelter Creek + Unnamed Trib Alternative 2	137	74	11	222	78

2.4.2 Flood Inundation Area Benefit

The proposed mitigation alternatives are effective in reducing the overall flood risk to the Ruhenstroth community. Another metric to measure benefit is the overall area that is removed from the flood risk by implementing the alternatives. Table 2-3 lists the total area (acres) that are impacted by flood depth greater than 0.25 feet within the ADMP focus area under existing conditions compared with the flood depth area considering the mitigation alternatives

Table 2-3. Flood Risk Area Benefit Summary

Condition	Total Flood Risk Area (acres)	Benefit (acres removed)
	h ≥ 0.25 feet	
25-Year, 24-Hour Storm		
Existing	218	-
Smelter Creek + Unnamed Trib Alternative 1	135	83
Smelter Creek + Unnamed Trib Alternative 2	147	71
100-Year, 6-Hour Storm		
Existing	318	-
Smelter Creek + Unnamed Trib Alternative 1	243	75
Smelter Creek + Unnamed Trib Alternative 2	219	99
100-Year, 24-Hour Storm		
Existing	301	-
Smelter Creek + Unnamed Trib Alternative 1	215	86
Smelter Creek + Unnamed Trib Alternative 2	237	64

2.4.3 Depth Reduction Benefit

Figure 2-13 and Figure 2-14 illustrates the change in 25-year, 24-hour storm flow depths resulting from the proposed alternatives. The warmer colors represent a reduction in flow depth (benefit) and the cooler colors represent an increase flow depth. Note – the areas of highest increase in flow depth are the proposed alternative basin structures and the Smelter Creek channel improvements.

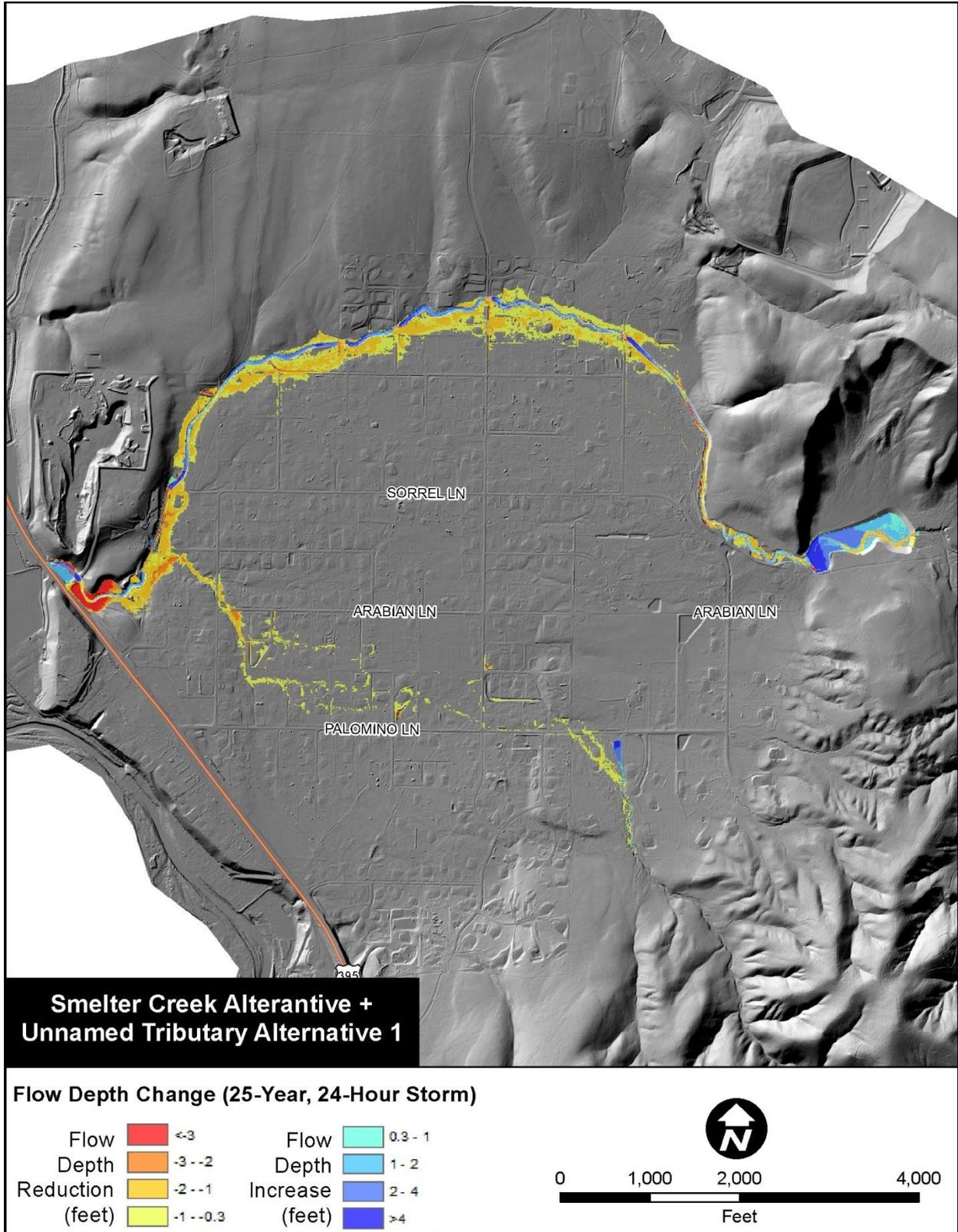


Figure 2-13. With alternatives condition change in flow depth (25-year, 24-hour storm)

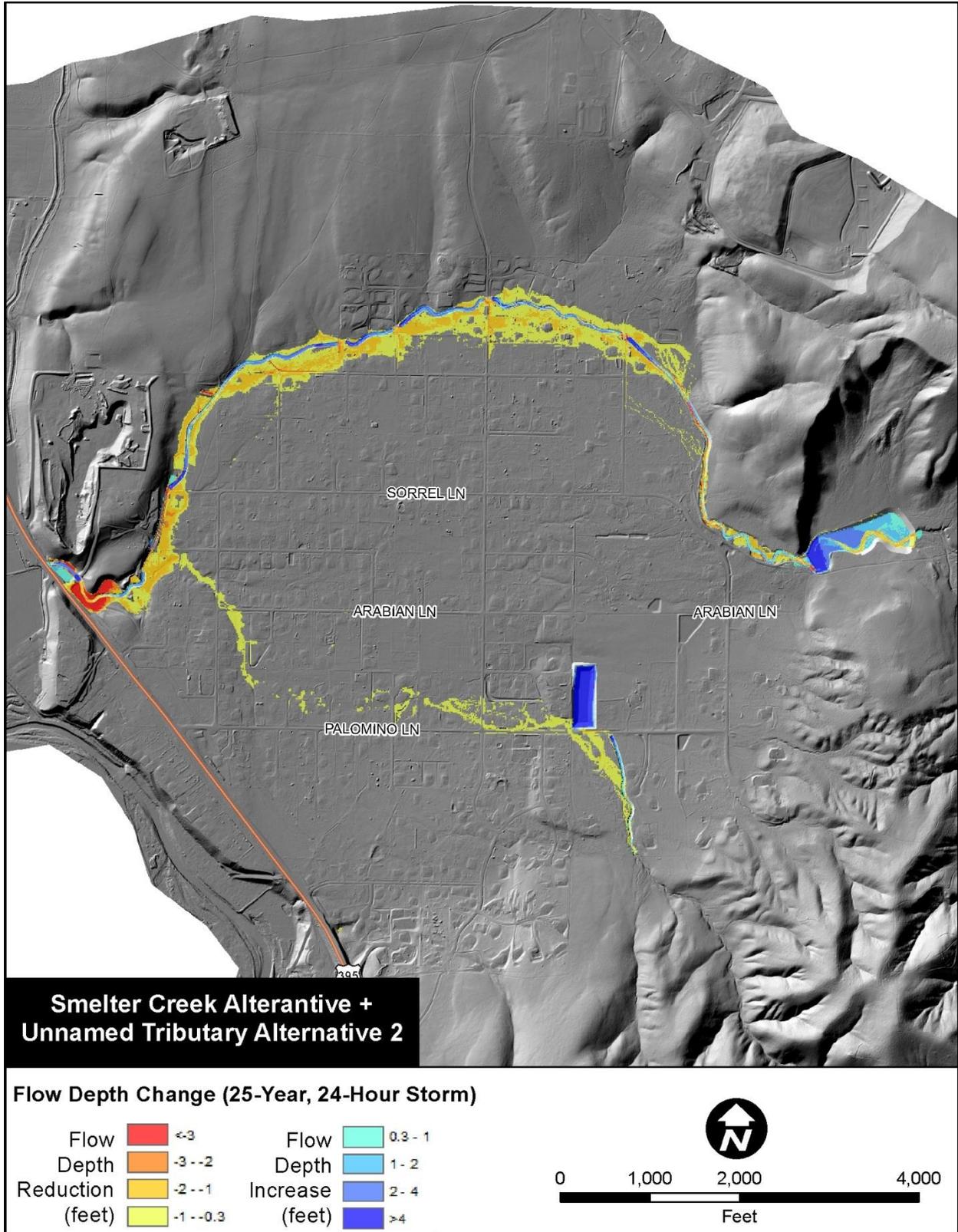


Figure 2-14. With alternatives condition change in flow depth (25-year, 24-hour storm)

2.5 ADMP MITIGATION PRIORITIZATION

The regional alternative structures presented in this report can be designed and constructed in phases as funding sources are identified and/or become available. Construction should occur beginning furthest downstream so as not to cause adverse flooding conditions due to point-source releases of stormwater.

Figure 2-15 shows a potential construction phasing strategy that could be implemented for Smelter Creek by Douglas County, while Table 2-4 lists a possible phasing schedule with associated costs. Note that the phasing cost for the Smelter Creek channel was computed by dividing the total channel cost by the number of phases. The actual costs of each phase of channel construction may vary from those in Table 2-4 due to variability in channel geometry and erosion protection and that if phased into multiple construction contracts, certain bid items such as mobilization will be increased.

It is not recommended that either of the two Unnamed Tributary Alternatives be constructed in phases. The costs for the two Unnamed Tributary Alternatives are summarized in Table 2-5. Both Alternatives provide similar benefits (see Table 2-2 and Table 2-3), but the storm drain option (Alternative 1) appears to function better for longer duration storms with larger flow volumes while the basin option (Alternative 2) functions better for shorter duration storms. While both Alternatives provide substantial benefits to the community, the County and residents should determine which option is preferred given Right-of-Way needs, project cost, and other constraints.

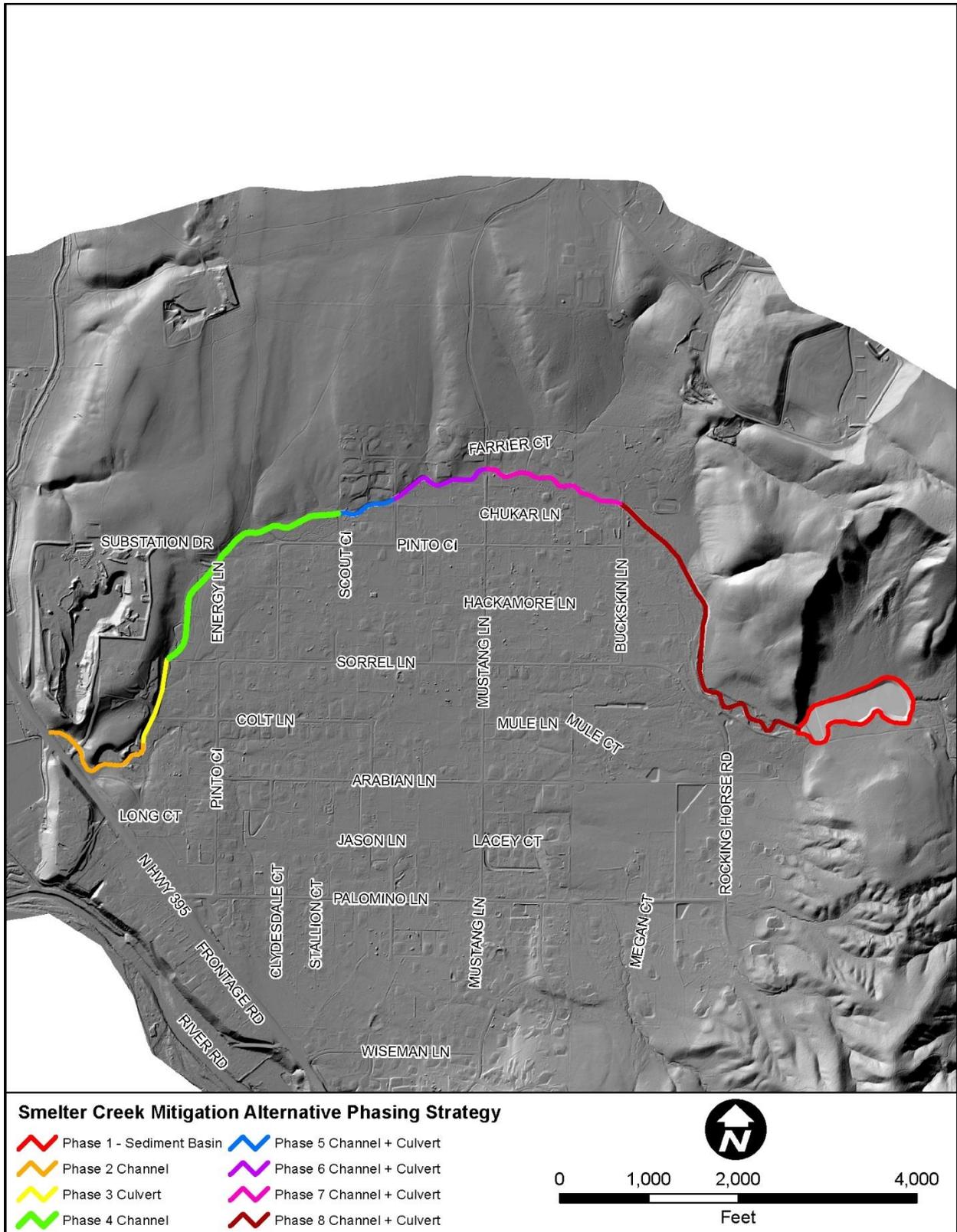


Figure 2-15. Potential mitigation construction phasing strategy

Table 2-4. Smelter Creek potential mitigation construction phasing and cost estimates

Phase	Structure Elements ¹	25-Year Structure Cost Estimates ^{2,3}
Smelter Creek Phase 1	Sediment Basin	\$4,576,000
Smelter Creek Phase 2	Channel (~1,450 LF)	\$1,030,000
Smelter Creek Phase 3	Box Culvert (~1,030 LF)	\$ 3,090,000
Smelter Creek Phase 4	Channel (~2,800 LF)	\$1,995,000
Smelter Creek Phase 5	Channel (~580 LF) Box Culvert (Horseman Ct)	\$412,000 \$240,000
Smelter Creek Phase 6	Channel (~1,115 LF) Box Culvert (Cayuse Dr)	\$792,000 \$240,000
Smelter Creek Phase 7	Channel (~1,600 LF) Box Culvert (Mustang Ln)	\$1,133,000 \$240,000
Smelter Creek Phase 8	Channel (~3,780 LF) Box Culvert (Buckskin Ct)	\$2,682,000 \$240,000
<ol style="list-style-type: none"> 1. LF = linear feet (approximate) 2. Construction costs have been rounded for simplification. See Appendix B for a detailed breakdown of cost estimates. 3. Does not include right-of-way acquisition or property acquisition costs. 		

Table 2-5. Unnamed Tributary Alternatives cost summary

Phase	Structure Elements ¹	25-Year Structure Cost Estimates ^{2,3}
Unnamed Tributary Alternative 1	Channel Sediment Inlet Basin Storm Drain	\$11,432,000
Unnamed Tributary Alternative 2	Channel Culvert (Palomino Ln) Detention Basin Outlet Culvert	\$2,500,000
<ol style="list-style-type: none"> 1. LF = linear feet (approximate) 2. Construction costs have been rounded for simplification. See Appendix B for a detailed breakdown of cost estimates. 3. Does not include right-of-way acquisition or property acquisition costs. 		

2.6 FUTURE DESIGN CONSIDERATIONS

The following considerations should be incorporated into the mitigation structures final design:

- The mitigation alternatives confine and convey stormwater through the Ruhenstroth area more efficiently than in historical conditions. While the ADMP modeled the mitigation alternatives and noticeable adverse depth impacts were not identified, a detailed assessment of possible adverse impacts should be considered during final design.
- The overall sediment delivery of the watercourses should be analyzed in detail to ensure that the point source sediment delivery from the upper watersheds do not cause any adverse sedimentation effects downstream.
- The sediment calculations used in this study were regional in nature and are generally applicable to channels with sandy bedload sediment. A more site-specific sediment analysis is recommended for each structure during the final design process.
- If any mitigation system is implemented, the overflow spillways need to be carefully evaluated and designed to ensure that adverse impacts do not occur during larger events.

2.7 ADMP LIMITATIONS

While the results are based on detailed topography, hydrology, and hydraulic modeling, they represent the existing conditions as of the date of the LiDAR mapping. Because of the unique landform and sediment characteristics of the watershed, the topography and distribution of flow can be very dynamic (i.e., small culverts or drainage channels can quickly fill with sediment causing water to change course from what it was previously).

Furthermore, this study did not analyze rain on snow events, flooding recurrence intervals greater than 100-year in any detail, or post-wildfire flooding events. These types of events are considered outside the scope of the typical area drainage master plan process. These atypical events could create hydraulic conditions that exceed standard 25-year or 100-year design storms.

3 REFERENCES

Douglas County, 2017, Design Criteria and Improvement Standards.

JE Fuller, Inc. (JEF), 2020, Ruhestroth Area Drainage Master Plan – Phase 1 Technical Study Data Notebook, Douglas County, Nevada.

Nevada Department of Transportation (NDOT), 2015, Streamlining Hydrologic Prediction Processes Using New and More Accurate Techniques and Methods, NDOT Research Report, Report No. 530-13-803.

APPENDIX A

Ruhenstroth ADMP Phase 1 TSDN

(separate digital submittal)

APPENDIX B

**Concept Design Sheets, Construction Cost Estimates,
and Life-Cycle Cost Estimates
(separate digital submittal)**

APPENDIX C

**Digital Data Submittal
(separate digital submittal)**



1830 BENNETT COURT PROPERTY ACQUISITION AND DEMOLITION





 Project Parcel to be Acquired
 Area to be Cleared and Restored
 Staging Area

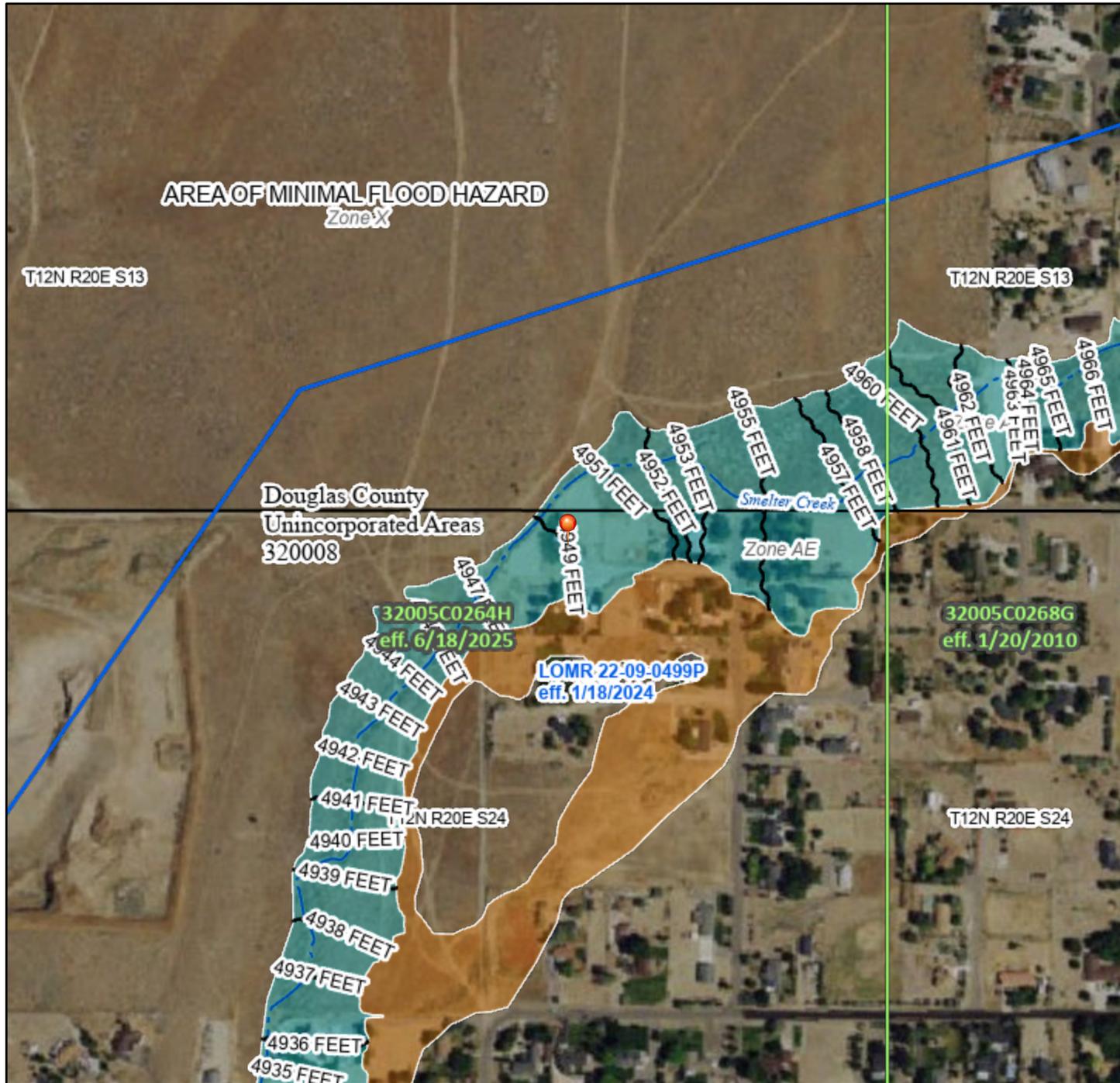
**1830 BENNETT COURT
PROPERTY ACQUISITION AND DEMOLITION**



National Flood Hazard Layer FIRMMette



119°41'44"W 38°53'59"N



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
GENERAL STRUCTURES		Area of Undetermined Flood Hazard Zone D
		Channel, Culvert, or Storm Sewer
		Levee, Dike, or Floodwall

OTHER FEATURES		20.2 Cross Sections with 1% Annual Chance
		17.5 Water Surface Elevation
		8 Coastal Transect
		Base Flood Elevation Line (BFE)
		Limit of Study
		Jurisdiction Boundary
		Coastal Transect Baseline
		Profile Baseline
		Hydrographic Feature
		No Digital Data Available
		Unmapped

MAP PANELS

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 **2/27/2026 at 7:04 AM** 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.



200-00 42

20-YD

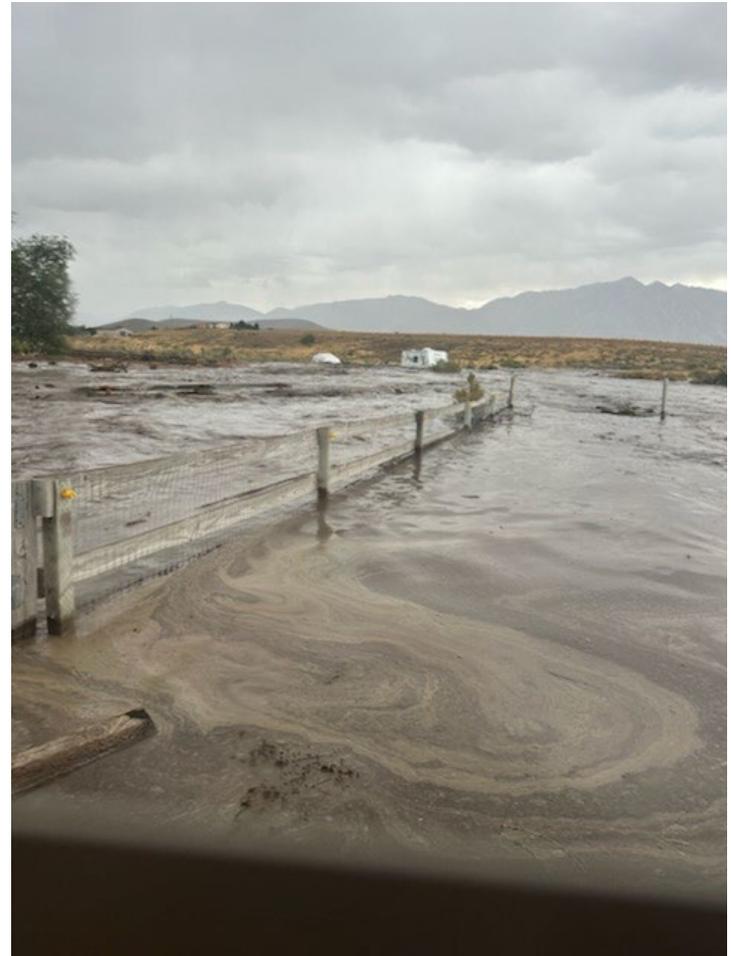


200-00 42

20-YD



Flooding and Impacts at 1830 Bennett Court









Water line visible on house after recent flooding

14. PROJECT WORK SCHEDULE

#	DESCRIPTION	TIMEFRAME
1.	Grant Awarded	1 day
2.	Funding Accepted	120 days
3.	Acquisition	120 days
4.	Demolition Bid Solicitation and Award	60 days
5.	Demolition Permit	1 week
6.	Utility Disconnection	1 week
7.	Structural Demolition and Debris Removal	30 days
8.	Well Abandonment	30 days
9.	Septic System Decommissioning	30 days
10.	Land Grading and BLM Property Remediation	30 days
11.	Complete Public List	15 days
12.	Project Close-out	30 days
13.	STANDARD VALUE (DO NOT CHANGE) Grant Close-out	3 months
TOTAL MONTHS:		19 months

HMGP Cost Estimate Spreadsheet

DATE	JURISDICTION NAME	DISASTER & PROJECT OR PLANNING #	PROJECT OR PLANNING TITLE
2/11/2026	Douglas County		1830 Bennett Court Repetitive Loss Property Acquisition and Demolition

#	Item Name	Unit Quantity	Unit of Measure	Unit Cost	Cost Estimate Total
1	Acquisition of 1830 Bennett Court, Gardnerville, NV 89460	1	AC	\$ 740,000.00	\$ 740,000.00
2	Demolition Permit through Douglas County	1	EA	\$ 450.00	\$ 450.00
3	Disconnect power meter and remove service NV Energy	1	EA	\$ 1,500.00	\$ 1,500.00
4	Disconnect power meter and remove service NV Energy	1	EA	\$ 1,500.00	\$ 1,500.00
5	Structural Demolition and Debris Removal	1874	SF	\$ 22.00	\$ 41,228.00
6	Well Abandonment	1	EA	\$ 2,500.00	\$ 2,500.00
7	Septic System Decommissioning	1	EA	\$ 5,000.00	\$ 5,000.00
8	Overall Site Grading and BLM property Remediation	0.95	AC	\$ 8,000.00	\$ 7,600.00
9					\$ -
10					\$ -
11					\$ -
12					\$ -
13					\$ -
14					\$ -
15					\$ -
16					\$ -
17					\$ -
18					\$ -
19					\$ -
20					\$ -
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28					\$ -
29					\$ -
30					\$ -
31					\$ -
32					\$ -
33					\$ -
34					\$ -
35					\$ -
36					\$ -
37					\$ -
38					\$ -
39					\$ -
40					\$ -
Total Project Cost Estimate:					\$ 799,778.00

AC	ACRE
CF	CUBIC FOOT
CY	CUBIC YARD
DAY	DAY
EA	EACH
HR	HOUR
LF	LINEAR FOOT
LS	LUMP SUM
MBF	MILLION BOARD FEET
MI	MILE
SEAT	NUMBER OF SEATS
SF	SQUARE FOOT
SQ	UNKNOWN
SY	SQUARE YARD
SY/IN	SQUARE YARD PER INCH
TON	TON
FT	FOOT
IN	INCH

HAZARD MITIGATION GRANT PROGRAM
**1830 Bennett Court Repetitive Loss
Property Acquisition and Demolition**
Douglas County Project Subapplication

COST ESTIMATE NARRATIVE

The included cost estimate on this project was developed by Douglas County Community Development Director Tom Dallaire, P.E., using estimates drawn from recent comparable projects.

The acquisition of the property at 1830 Bennett Court is estimated to cost \$740,000. This is based on the market rate for properties in this area before the September 2025 flooding event. The property includes an 1,874 SF home that was constructed in 1995.

A demolition permit from Douglas County and disconnecting utilities will cost \$450 and \$3,000 respectively.

The demolition of the structure (1,874 SF home) was estimated at a cost of \$22/SF, totaling \$41,228.

The well abandonment is estimated at \$2,500, and the septic system decommissioning at \$5,000.

Finally, the overall site grading and remediation of the BLM property is estimated at \$7,600.

The resulting total project cost is estimated at \$799,778.

The requested Federal share is 75% or \$599,848.50.

The non-federal match provided by Douglas County will be \$199,949.50.

JENIFER DAVIDSON
County Manager

WENDY LANG
Assistant County Manager

KATHY LEWIS, CPA
Chief Operating Officer



1594 Esmeralda Avenue
Minden, Nevada 89423

www.douglascountynv.gov
775-782-9821

OFFICE OF THE COUNTY MANAGER

25 February 2026

Nevada Office of Emergency Management
2478 Fairview Drive
Carson, NV 89701

RE: Letter of Match Commitment

Dear Ms. Lafferty,

Douglas County is pleased to submit an application to the Federal Emergency Management Agency (FEMA) for funding assistance provided by the FY25 Hazard Mitigation Grant opportunity, for activities identified by communities whose economies are injured by natural disasters. Douglas County is committed to ongoing mitigation efforts to protect lives and property by addressing recurring flooding issues that disrupt public and emergency services, transportation networks, and commercial activity. Post-fire flooding has caused significant damage to homes, overtopped roads, and threatened U.S. 395, a vital corridor for emergency access and local commerce.

This project fortifies critical infrastructure essential to protecting the existing residential area and enhances its resilience against future disasters. By enhancing resilience to natural disasters, this investment focuses on disaster mitigation to reduce catastrophic damage, ensuring emergency services and essential daily services remain functional, safeguarding jobs, and preventing economic disruption within the community.

As a further demonstration of our commitment, Douglas County commits matching funding of \$199,944.00 to this project and guarantees the availability of staff and resources necessary to complete the project on time.

As a rural area, we believe that Douglas County's project represents an important opportunity that aligns with FEMA's program goal of emphasizing forward-looking, resilience-based investments. This project represents a strategic use of federal funds to reduce future recovery costs, support sustainable economic growth, and strengthen the region's long-term adaptive capacity. We support this Project without reservation.

Sincerely,

A handwritten signature in cursive script, appearing to read 'Jenifer Davidson', is written over a light blue circular stamp.

Jenifer Davidson County Manager
Douglas County, Nevada
cmoffice@douglasnv.us

Mailing Address: P.O. Box 218, Minden, NV 89423

HAZARD MITIGATION GRANT PROGRAM
**1830 Bennett Court Repetitive Loss
Property Acquisition and Demolition**
Douglas County Project Subapplication

COST-EFFECTIVENESS NARRATIVE

The following is a Cost-Effectiveness Narrative for the 1830 Bennett Court Repetitive Loss Property Acquisition and Demolition (“Project”).

Douglas County seeks to acquire a property that has faced repetitive losses due to flooding on Bennett Court in the Ruhenstroth community in the town of Gardnerville, Douglas County.

The current homeowner has owned the property since 2003, says the property flooded in both 2023 and 2025. In 2023, flooding affected the crawlspace.

In 2025, flooding in this area worsened after the Sept. 25, 2025, Connor Fire, which destroyed vegetation that had previously helped reduce flooding. The fire additionally caused sediment in the area to become hydrophobic, leading to additional runoff.

Heavy rainfall post-fire led the property to flood again in 2025, this time leading to two inches of water and mud in the entire home. Please see “6.4_Photos of Flooding and Impacts at 1830 Bennett Court” for photos of the flooding and impacts.

Due to the ongoing aftereffects of the fire and the gradual alignment of the drainage canal in this area, it seems likely that the home will face flooding again in the future. The homeowner does have flood insurance and has already filed claims for the 2023 and 2025 events.

In order to forestall future losses and damage, Douglas County is proposing to acquire the property and demolish any structures on the property, which consists primarily of the 1,875 SF home. Any hardscape (such as the concrete driveway) will also be removed, and the septic system decommissioned, the well capped and existing utilities disconnected and removed. The entire property will be returned restored to its natural or neutralized topographical state; specifically by regrading the property, filling excavations from the demolition, and ensuring the site is stabilized against erosion. In addition, there appears to be an area north of the site that has been re-graded and modified, with berming placed on the adjacent property owned by Bureau of Land Management. The County will work with BLM and gain permission to

restore this area as well, specifically to regrade the berms and restore the original profile and natural drainage patterns.

Cost estimates used for the acquisition, demolition and regrading were drawn from comparable transactions and projects completed recently in Douglas County.

HOW OFTEN DOES THE HAZARD BEING MITIGATED OCCUR?

The home has flooded twice since 2023 (in 2023 and 2025).

HOW MANY PEOPLE BENEFIT FROM THE PROJECT

In addition to the homeowner, other residents in the area will benefit from the improved flood control that will result from removing the structure in the SFHA.

WHAT WILL BE DAMAGED IF THE PROJECT IS NOT IMPLEMENTED?

The home will likely continue to suffer losses from flooding.

WHAT PUBLIC SERVICES/BUSINESSES WOULD LOSE FUNCTION?

N/A

REFERENCES

- Documentation of flood claims can be provided upon request.



COMMUNITY DEVELOPMENT
1594 Esmeralda Avenue, Minden, Nevada 89423

Tom Dallaire, P.E.
DIRECTOR

775-782-6201
FAX: 775-782-6297
website: www.douglascountynv.gov

Building Division
Engineering Division
Planning Division
Code Enforcement Division
Vacation Home Rental Division
Stormwater Division

PROJECT MAINTENANCE LETTER

February 27, 2026

Douglas County Community Development
PO Box 218
Minden, NV 89423

RE: Bennett Ct. – SFD Repetitive Loss Structure Acquisition and Demolition Project Subapplication

Dear State Hazard Mitigation Officer:

This is to confirm that Douglas County Community Development is committed to perform the necessary maintenance for the entire useful life of this project (30 YEARS) once completed. The Douglas County Community Development is allocating an annual budget of \$10,000 which will allow maintenance to occur as needed to ensure the Bennett Ct. – SFD Repetitive Loss Structure Acquisition and Demolition project remains in good repair and operational.

ENTITY RESPONSIBLE FOR THE MAINTENANCE:

Douglas County

Example: City of Townsville

PAST MAINTENANCE TASKS INVOLVED:

Maintenance cost before mitigation were \$300,000 if there was a flood event. Maintenance cost on a year with no flooding would be \$0.

Explain the maintenance cost before mitigation and explain what the maintenance activities included in the past.

FUTURE MAINTENANCE TASKS INVOLVED:

Maintenance consists of keeping the Smelter Creek channel clear of debris and sediment.

Explain the maintenance cost after mitigation and explain what the maintenance activities will include in the future.

FUTURE MAINTENANCE SCHEDULE:

Annually

Example: Annually

FUTURE COST OF MAINTENANCE:

\$10,000

Example: \$10,000.00

MAILING ADDRESS: P.O. Box 218, Minden, Nevada 89423

SOURCE OF FUTURE MAINTENANCE FUNDS:

Douglas County Stormwater Enterprise Utility Fund

Example: Flood Control Funds

Please contact Courtney Walker with questions.

Sincerely,

A handwritten signature in black ink that reads "Courtney Walker". The signature is fluid and cursive, with the first name being more prominent.

Courtney Walker

Stormwater Program Manager

775.782.6215

cwalker@douglasnv.us

Hazard Mitigation Assistance Grants

Environmental and Historic Preservation Information Checklist

Overview

The following checklist details the minimum needed for the Federal Emergency Management Agency (FEMA) to carry out Environmental and Historic Preservation (EHP) review of a Hazard Mitigation Assistance (HMA) grant project. During the EHP review process, FEMA evaluates the potential impacts of a project on the human and natural environment to comply with federal laws, regulations, and Executive Orders (EO), and may include formal consultation with Federal, State, Tribal, regulatory, and permitting agencies.

As part of the project application development, the subapplicant should provide documentation that accurately describes the project so that FEMA can conduct its federal EHP compliance review. The level of detail should include information on the environmental and cultural resources that may be impacted by the proposed project, its purpose and location, existing environmental conditions in the project area, potential project impacts, best management practices (BMPs), different alternatives considered for the project, and mitigation strategies to address environmental impacts of the project.

The gathering of this information may include readily available information or data from relevant sources, but may also necessitate completing relevant EHP-specific technical studies or surveys, coordination with relevant regulatory and permitting agencies, and pertinent documentation completed by local, state, or federal agencies. Completion of some technical EHP studies may require hiring of a consultant.

Designs for projects should be developed to the point where location is clearly identified as well as methodology for project construction, implementation, and operation. For some projects, that may be conceptual or preliminary engineering, for others it may require at least 60 percent design to allow for those details to be clearly defined. Examples of proposed projects that require at least 60 percent design development are those that entail new construction, ground disturbance, structure retrofits (excluding single-family residential elevation or seismic), infrastructure development or improvements, and slope or embankment stabilization.

Advance Assistance and Phased Projects

Advance Assistance and Phased projects are two funding approaches that allow for studies to develop the details necessary for a full and eligible grant application. These funding options should include the completion of environmental studies and documentation required to conduct the required state and federal EHP reviews. *Any ground disturbing studies (including borings for Geotechnical studies, shovel test pits for archaeological surveys, and wells for subsurface water testing) must be identified in these project applications and their location and methodology described using the same checklist criteria as a standard project review.*

Standard Project EHP Review

The following checklist provides instructions to identify the key details needed to conduct an EHP review for a project and is intended to reduce the need for an exhaustive Request for Information (RFI) from FEMA as part of the review process. It is organized by section to first list information needed for all projects, with additional sections for specific project types and resource impacts that require additional analysis and information. Not all line items are relevant for every project, so the “not applicable” boxes should be selected and sections skipped where appropriate.

The sections of the EHP Checklist are organized in the following manner:

Section 1 – Scope of Work Information required for All Projects. This section is scope and location information that allows for the capture of the critical project details for all projects – the “where” and the “how”.

Section 2 – EHP Considerations required for All Projects. This section requests specific information related to details needed to determine existing compliance actions already completed and project elements that prompt EHP compliance with specific laws or Executive Orders.

Section 3 – EHP Considerations for Projects Impacting Buildings/Structures. This section identifies additional information relevant to a project directly impacting a building/structure (including activities such as seismic or wind retrofit, fire hardening, floodproofing, elevation, and acquisition).

Section 4– EHP Considerations for Hazardous Fuels Reduction Projects. This section requests additional information that is relevant to vegetative fuels reduction/wildfire mitigation projects.

Section 5 – EHP Considerations for Flood Risk Reduction Projects. This section requests additional information for projects that impact hydraulic conditions and/or flood hazard areas.

Section 1 - Scope of Work Information – ALL PROJECTS

For ALL PROPOSED PROJECTS, the following information is the minimum required for FEMA EHP compliance review.

Basic Project Description: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of the proposed work to be completed, inclusive of related work that would not be financially covered under this grant but completed concurrently. Include design drawings, photographs and other documents that provide a clear picture of the proposed funding action.	2_Bennett Acquisition Scope of Work.pdf 6. PHOTOS (Folder)		<input type="checkbox"/>
Provide project alternatives that could be utilized if the proposed project is determined to be not feasible. Include a “no action” alternative. These should be reasonable and realistic options.	1_ Bennett Acquisition Subapplication.pdf		<input type="checkbox"/>
Provide the geographic coordinates (latitude/longitude) and the physical site address of the project area.	38.89577, -119.68925 1830 Bennett Court, Gardnerville, NV 89460		<input type="checkbox"/>
Provide a geographic information system (GIS), computer-aided design (CAD), Google Earth files (.kmz), map, or image that clearly shows the boundaries of the project area. The information provided should include the boundaries of project activities (temporary and permanent), including staging areas, access routes, any areas of vegetation removal, and the affected structure(s).	5. MAPS (Folder)		<input type="checkbox"/>
If the project would disturb the ground for any reason: Provide a description of the activities (both temporary and permanent) that would require ground disturbance and the method of disturbance (e.g. grading, trenching, excavating). Provide a map or image that clearly shows the activities (both temporary and permanent) that would require ground disturbance, inclusive of the depth and extent.	2_ Bennett Acquisition Scope of Work.pdf 5.4_ Bennett Acquisition Project Map.pdf	<input type="checkbox"/>	<input type="checkbox"/>
Provide an estimate of the area of ground disturbance in acres or square feet.	42,066 SF	<input type="checkbox"/>	<input type="checkbox"/>
Provide a description of the existing ground surface conditions that would be disturbed at each site (e.g., pavement, landscape shrubs and trees, previously undisturbed soils with vegetation).	Native sand and vegetation	<input type="checkbox"/>	<input type="checkbox"/>

Basic Project Description: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of all vehicles and equipment that would be used to implement the project.	Excavator, dumpster bins, backhoe with bucket, skid steer, water truck		<input type="checkbox"/>
Provide a schedule that includes construction, operation, and maintenance activities, including the months or seasons when work would occur and typical number of workdays/work hours.	2_Bennett Acquisition Scope of Work.pdf 7_Bennett Acquisition Schedule.pdf		<input type="checkbox"/>
Provide a description of any known hazardous or contaminated materials that may be present in the project area or that are needed to implement the project.		<input checked="" type="checkbox"/>	
If your project would use any hazardous materials: Description of the BMPs that would be used to minimize exposure of people and the environment to those materials and how they would be discarded.		<input checked="" type="checkbox"/>	
Provide an explanation of any controversy that exists or could exist related to the project.	It is hoped that the project will not cause controversy.		
Provide a description of any existing or planned public engagement activities for the project.	Neighbors will be notified of project.		<input type="checkbox"/>
If burning is proposed: Identify any state or local permits required and provide copies of permits.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Provide a list of all Best Management Practices (BMPs) to be implemented, as part of the project, to reduce potential impacts.	13.2_Bennett Acquisition Overview of BMP Plan.doc		<input type="checkbox"/>
Describe any environmental or historic preservation mitigation measures that would be incorporated into the proposed project.		<input checked="" type="checkbox"/>	
If any portion of this proposed project will occur on private land, notification and/or coordination must occur prior to review by EHP. Provide details about what portions of the project area this entails, and documentation of the coordination inclusive of a response from the landowner(s). EHP may require a right-		<input checked="" type="checkbox"/>	

Basic Project Description: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
of-entry to conduct environmental studies in support of compliance activities and having this in place before EHP review can expedite these activities.			

Section 2 – EHP Considerations – ALL PROJECTS

For ALL PROPOSED PROJECTS, the following information is the minimum required for FEMA EHP compliance review.

EHP Considerations: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
State and/or Federal Agency Coordination			
Provide a description of any agency coordination and permits obtained from federal, state or local agencies to implement the project. Provide copies of any coordination materials, permit applications, or approvals.	13.2_Bennett Acquisition Overview of BMP Plan.doc		<input type="checkbox"/>
Provide copies of USFWS Species List from the Information for Planning and Consultation for Project Area: https://ecos.fws.gov/ipac/			<input type="checkbox"/>
Provide copies of previous biological reports/studies/surveys for the project area.	See folder 4. Studies	<input type="checkbox"/>	<input type="checkbox"/>
Provide copies of archaeological, built-environment, and/or other cultural resources studies. Provide appropriate point-of-contact (POC) and contact information in the “Location of Provided Information”. POC will be contacted during EHP Project review to retrieve information. (Do not attach or submit with application package to secure confidential cultural resources information)		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Does the project require a Section 404 Clean Water Act permit from the US Army Corps of Engineers? If Yes, provide the permit, permit application, or identified permit type (for future application; i.e. Nationwide Permit, Individual Permit).		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Does the project require a Section 401 Clean Water Act certification? If one has been obtained, provide the documentation detailing any mitigation measures required (ex. riparian vegetation restoration a 3:1 ratio)		<input checked="" type="checkbox"/>	
If any portion of this proposed project will occur on public lands managed by a Federal Agency (US Forest Service, Bureau of Land Management, National Park Service, US Fish & Wildlife, Bureau of Reclamation), notification and/or coordination must occur prior to review by EHP. Provide details about what portions of the project area this entails, project point of contact at the Federal Agency, and documentation of the coordination inclusive of a response from the Agency.	2_Bennett Acquisition Scope of Work.pdf 3_Bennett Acquisition Demolition Plan	<input type="checkbox"/>	

EHP Considerations: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Impacts to Surface Waters (e.g., ponds, lakes, rivers, streams, wetlands, or other waterbodies).	NOT APPLICABLE ☒		
Provide a description of any surface waters in or near the project area.			<input type="checkbox"/>
Provide a description of any measures that would be used to avoid waterbodies or to avoid impacting water (e.g., setbacks, cofferdams, silt fence).			<input type="checkbox"/>
Provide any permits or applications that were developed related to project impacts on surface waters.			<input type="checkbox"/>
Project Impacts on Floodplain			
Provide a FIRM map showing the project location in proximity to mapped floodplains.	5.4_Bennett Acquisition FIRMETTE Map.pdf		<input type="checkbox"/>
If the project and any elements (temporary or permanent) are within, adjacent to, or have any potential to impact a floodplain provide a narrative that details the impact.	This project will benefit the floodplain due to the removal of a residential structure.	<input type="checkbox"/>	<input type="checkbox"/>
If the project has any potential to impact a floodplain, or involves new activities related to channeling water flows (culverts, stormwater drainages) that may alter flow, provide a narrative that details the impact (including upstream and/or downstream impacts). An hydrologic and hydraulic (H&H) study for the project may be necessary for this.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Vegetation Removal (see Section 4 for hazardous vegetative fuels projects)	NOT APPLICABLE ☒		
Provide a description of the type and amount of vegetation (e.g., two oak trees, one-quarter acre of turf grass) that will be removed to complete the project activities.	No vegetation will be removed.		<input type="checkbox"/>
Provide a description of how vegetation would be removed (e.g., rootball removal, flush cut, dug up, chemical weed killer).			<input type="checkbox"/>
Provide photographs of the vegetation to be removed in the project area.			<input type="checkbox"/>
Would you restore vegetation after the project is complete or is restoration and mitigation required as a condition of a permit (e.g Section 401 Clean Water Act permit)? Provide a description of where and how	Douglas County will coordinate with Comstock	<input type="checkbox"/>	<input type="checkbox"/>

EHP Considerations: ALL PROJECTS	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
vegetation will be planted (e.g., by hand, with machinery, broadcast seeding), as well as the types and species of vegetation to be planted.	Seed to revegetate using native species.		
Would any special techniques be used to ensure survival of the plants/seeds (e.g., mulch, irrigation, protective fencing)? Provide a description of techniques used.	Broadcasting under hydra mulch	<input type="checkbox"/>	<input type="checkbox"/>

Section 3 – EHP Considerations – STRUCTURES

For projects that impact existing STRUCTURES, in addition to the information required for all projects, the following information is the minimum required to determine EHP compliance requirements.

Additional Information: ALL STRUCTURES	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of the structure(s) that would be physically modified as part of the implementation of the project, including the year that they were originally constructed. "Structures" can include any element of the built environment that would be altered; e.g. bridges, culverts, lampposts, utility lines, or buildings.	An 1874 SF house constructed in 1995 will be demolished as part of this project.		<input type="checkbox"/>
Provide a description of the proposed structural modifications (e.g., roof, eave, overhang, soffit, exterior wall, vent, gutter, downspout, window, or door modifications) for each structure.	N/A		
Provide a description of any prior improvements or additions that have been made to the structure(s) (e.g., new windows, change in roofing material from original construction), changes to the original location (relocation), or other modifications to the original structure(s).	N/A		<input type="checkbox"/>
Provide photographs of each impacted structure. External photos should be taken of each side and the corners, resulting in a minimum of 8 photographs per structure. For interior or modifications, provide photographs of the elements that would be altered or impacted.	6.1_Bennett Acquisition Photo 1.jpg 6.2_Bennett Acquisition Photo 2.jpg 6.3_Bennett Acquisition Photo 3.jpg		
If the structure(s) are designated historic properties or in a designated historic district, provide information on the known historic property/district, as applicable.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
For Retrofit Projects (Ignition-Resistant Construction, Seismic Retrofit, Wind Retrofit), provide at least 60% engineering drawings.		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Structure Elevation	NOT APPLICABLE <input checked="" type="checkbox"/>		
Provide a description of the number of structures to be elevated, including the size and type of structure(s), and foundation type.			<input type="checkbox"/>

Additional Information: ALL STRUCTURES	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of the elevation method and the steps required to implement the project. What mechanism would be used to elevate the structure(s) (e.g., continuous foundation walls; elevation on open foundations, such as piles, piers, posts, or columns; or elevating on fill)?			<input type="checkbox"/>
Provide a description the existing conditions of the ground surface that would be disturbed at each site (e.g., pavement, landscape shrubs and trees, or previously undisturbed soils with vegetation) and the extent of proposed disturbance at each site due to the construction activities.			<input type="checkbox"/>
Acquisition/Demolition	NOT APPLICABLE <input type="checkbox"/>		
Provide a description of the type of foundation of each structure to be acquired and how it will be removed/demolished.	Concrete foundation that will be removed by excavator and recycled		<input type="checkbox"/>
Provide a description of how the property would be restored to an open space.	2_ Bennett Acquisition Scope of Work.pdf		<input type="checkbox"/>
Description of the activities that would require ground disturbance (e.g., foundation excavation, utility line removal, staging area clearing) and show locations on a map or plan view; include the length, width, and depth of the ground disturbance.	2_ Bennett Acquisition Scope of Work.pdf 3_ Bennett Acquisition Demolition Plan 5.1_ Bennett Acquisition Project Map		<input type="checkbox"/>
Infrastructure Retrofit	NOT APPLICABLE <input checked="" type="checkbox"/>		
Is the project considered part of the critical infrastructure of your community? If yes, describe.		<input type="checkbox"/>	<input type="checkbox"/>
Provide a description of how the project would change the capacity of the infrastructure in the area where the project is being implemented.			<input type="checkbox"/>

Section 4 – EHP Considerations – HAZARDOUS FUELS REDUCTION

For projects that include HAZARDOUS FUELS REDUCTION, in addition to the information required for all projects, the following information is the minimum required to initiate EHP compliance review.

Hazardous Fuels Reduction	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of the type of vegetation (e.g., species, sizes, invasive/native) to be removed and where would it be removed from (e.g. within 100 feet of structures).	Not applicable		<input type="checkbox"/>
Provide a description of methods proposed to remove vegetation (e.g., herbicides, hand tools, mechanical equipment).	Not applicable		<input type="checkbox"/>
Provide a description of any limits on vegetation removal (e.g., only trees less than 12 inches at diameter breast height, limbs up to 10 feet above the ground).	Not applicable		<input type="checkbox"/>
Provide a description of any hazardous trees to be removed, including the felling and removal method (dragging, skidding, etc.).		<input checked="" type="checkbox"/>	<input type="checkbox"/>
Provide a description of method and location of vegetation be disposal (e.g., burned on-site, chipped and mulched on-site and at other applicant properties, removed off-site to landfill or compost facility, left in place as snags).	Not applicable		<input type="checkbox"/>
Provide photos illustrating current vegetation conditions in the project area.	Not applicable		<input type="checkbox"/>
Provide a description of the topography within the project area (e.g., steep slopes/mountainous, rolling hills, relatively flat). Are there any restrictions related to slope where the project activities would occur (e.g., skid-steer masticators would only be used on gentle slopes)?	Not applicable		<input type="checkbox"/>
Herbicide Use – Hazardous Fuels Reduction	NOT APPLICABLE <input checked="" type="checkbox"/>		
Identify the types of herbicides proposed and describe whether the herbicides would be used in riparian areas near streams, wetlands, or other waterbodies. Provide an estimate of the distance from the waterbody.			<input type="checkbox"/>
Provide a description of any BMPs that would be used to minimize the impact of herbicides on the environment and people in the project area.			

Hazardous Fuels Reduction	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Riparian Areas – Hazardous Fuels Reduction	NOT APPLICABLE ☒		
Provide an estimate of the distance from waterbodies within the project area (streams, wetlands, or other waterbodies) and any BMPs related to work near these areas.			<input type="checkbox"/>
Describe methods and BMPs for work in these riparian areas.			<input type="checkbox"/>

Section 5 – EHP Considerations – FLOOD RISK REDUCTION

For projects that include FLOOD RISK REDUCTION, in addition to the information required for all projects, the following information is the minimum required to initiate EHP compliance review.

FLOOD RISK REDUCTION	Location of Provided Information (pdf. title, link, document reference, etc.)	Not Applicable	Not Provided (Project may not proceed to EHP review)
Provide a description of the proposed project’s scope of work and clearly explain how the project elements relate or connect to existing flood control or drainage components.	2_ Bennett Acquisition Scope of Work.pdf		<input type="checkbox"/>
Provide a description of how the project will reduce flood risks and the area that would benefit from flood risk reduction.	2_ Bennett Acquisition Scope of Work.pdf		<input type="checkbox"/>
Provide an estimate of the size of the area that would benefit from the flood risk reduction.	2_ Bennett Acquisition Scope of Work.pdf		<input type="checkbox"/>
Provide a narrative and supporting documentation on the upstream and/or downstream impacts of implementing the proposed project. For a project involving activities related to channeling and altering water flow (culverts, stormwater drainages) an H&H study is required.	See 4. Studies		<input type="checkbox"/>

HAZARD MITIGATION GRANT PROGRAM
1830 Bennett Court Repetitive Loss Property Acquisition and Demolition
Douglas County Project Subapplication

BMP PLAN

Project Construction, Operation, and Maintenance

The following section generally describes the activities that are anticipated to occur before and during project construction and throughout operation and maintenance of the Project. Existing and newly constructed roads would provide access for project construction, operation, and maintenance.

Preconstruction Activities (Site Preparation, Surveying, and Staking)

Roadway/traffic flagging would occur on an as-needed basis when heavy machinery is accessing the Project Area. If necessary, biologically and culturally sensitive areas would be avoided through pre-construction flagging and/or monitoring during construction.

Construction Personnel, Equipment, and Vehicles

Although the specific personnel conducting construction activities is unknown at this time, a contractor would be selected through the bidding process by Douglas County Public Works Department. The following list is the typical equipment that would be used for construction and maintenance:

- Excavators (John Deere 85G)
- Bull dozers
- Scrapers
- Articulated dump trucks
- Loaders (Caterpillar 938F)
- Compaction equipment

Construction Activities including Site Grading and Excavation

Following preconstruction activities, construction activities would include vegetation trimming/clearing, demolition, cleanup, maintenance, and site reclamation. Excavators, bull dozers, scrapers, articulated dump trucks, and loaders would be used to remove sediment from each of the basins and channels. The material would be hauled off-site. The material to be removed consists of fine silts, sands, and gravels. Slope stabilization would be made to all cuts and fill areas. Stabilization may include mediation such as reseeding for the natural visualization of the subject areas.

Construction Best Management Practices

To minimize fugitive dust, BMPs would be implemented:

- Limiting disturbed areas to those only required for construction of the projects and preservation of natural vegetation through establishment of firm construction limits.

- Water would be utilized during construction to control dust during construction.
- Water would be sprayed so it would not concentrate and run-off the site.

To minimize potential soil erosion, BMPs would be implemented:

- Sediment wattles or other erosion control devices would be utilized on the face of all exposed slopes.
- Seeding would be installed with a seed mixture approved by the BLM on exposed slopes once construction of the slopes is completed.
- Rock protection would be installed to dissipate the velocity of run-off where necessary.

To minimize traffic noise and measures to limit visual intrusions, BMPs would be implemented:

- Noise from construction would be limited to the daylight hours of 6am to 6pm. Most of the basins and channels would be at or below existing grade. This would provide a natural screen for construction noise and lights.
- No off-site materials would be brought in and only native soils/gravels/rock would be visible after the project is complete.

Erosion Control and Stormwater Drainage

Any erosion during construction would be controlled by implementing a Stormwater Pollution Prevention Plan (SWPPP), as required by the Nevada Department of Environmental Protection (NDEP), Bureau of Water Pollution control for projects disturbing more than one acre.

Maintenance Interval

Maintenance would be conducted annually and after large storm events.

Maintenance Personnel and Equipment

The personnel conducting the maintenance activities would be employees of the Douglas County Stormwater Maintenance Division. Currently there is one Stormwater Maintenance Supervisor and four Stormwater Maintenance Operators. All five employees hold Class A Commercial Driver's Licenses with a tanker endorsement and are proficient on an excavator, loader, and a ten-wheeler dump truck. A John Deere 85G excavator and a Caterpillar 938F loader would be used.

Other Federal, State, and Local Agency Permit Requirements

Douglas County would obtain permission from the Bureau of Land Management for activities on BLM property.