



Voltaire and Saliman Restudy – CWSD Board Meeting Presentation

Mark Gookin, PE, CFM

May 2019

Presentation Outline

- > Current FEMA mapping
- > Changes that will affect FEMA mapping
- > Mapping process
- > Project status
- > Preliminary mapping
- > Discussion

Current FEMA Mapping

Legend

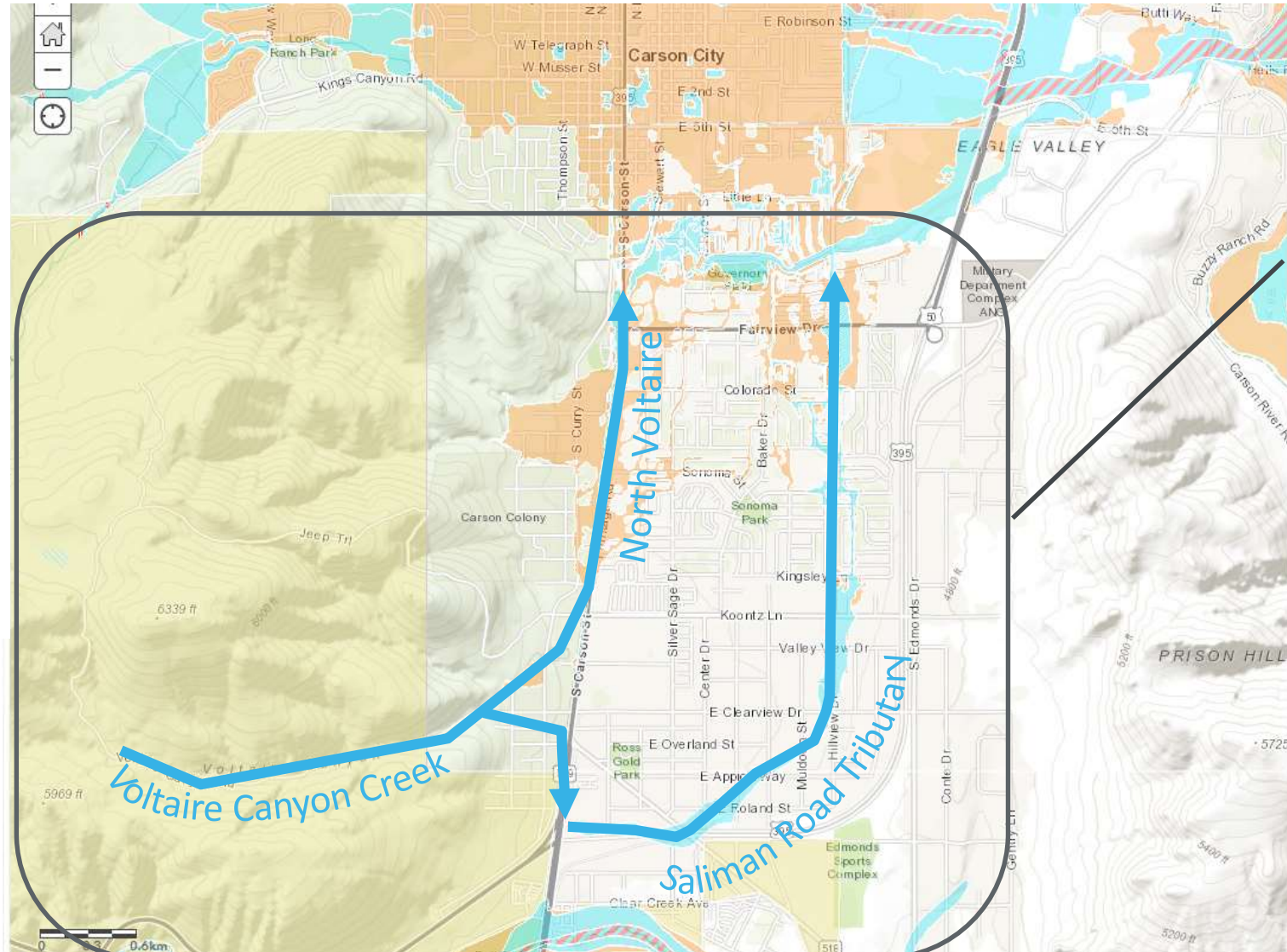
FEMA National Flood Hazard Layer

Flood Hazard Boundaries

- Limit Lines
- SFHA / Flood Zone Boundary
- Other Boundaries

Flood Hazard Zones

- 1% Annual Chance Flood Hazard
- Regulatory Floodway
- Special Floodway
- Area of Undetermined Flood Hazard
- 0.2% Annual Chance Flood Hazard
- Future Conditions 1% Annual Chance Flood Hazard
- Area with Reduced Risk Due to Levee

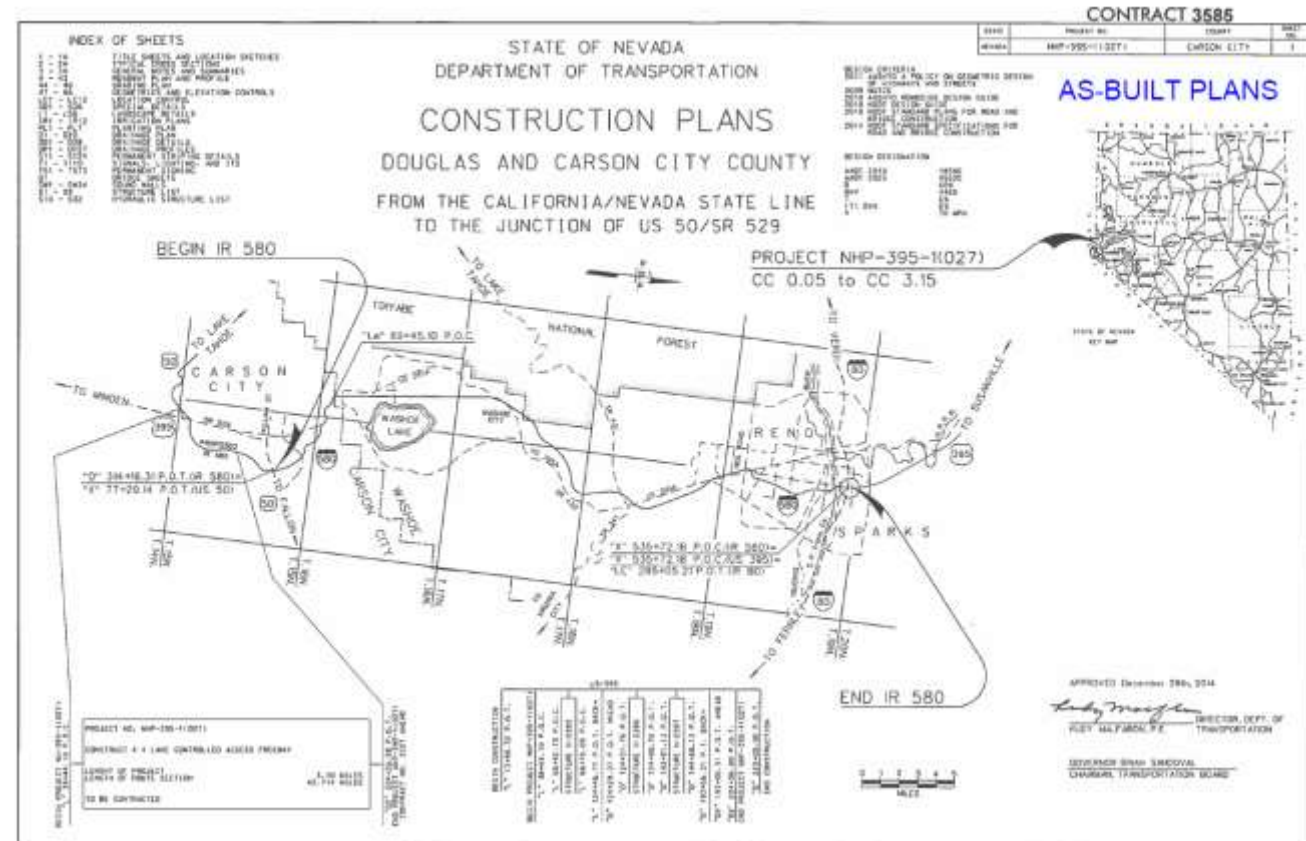


Study Area

Updates from Previous Study – Changes Affecting Mapping

> Freeway extension construction changes:

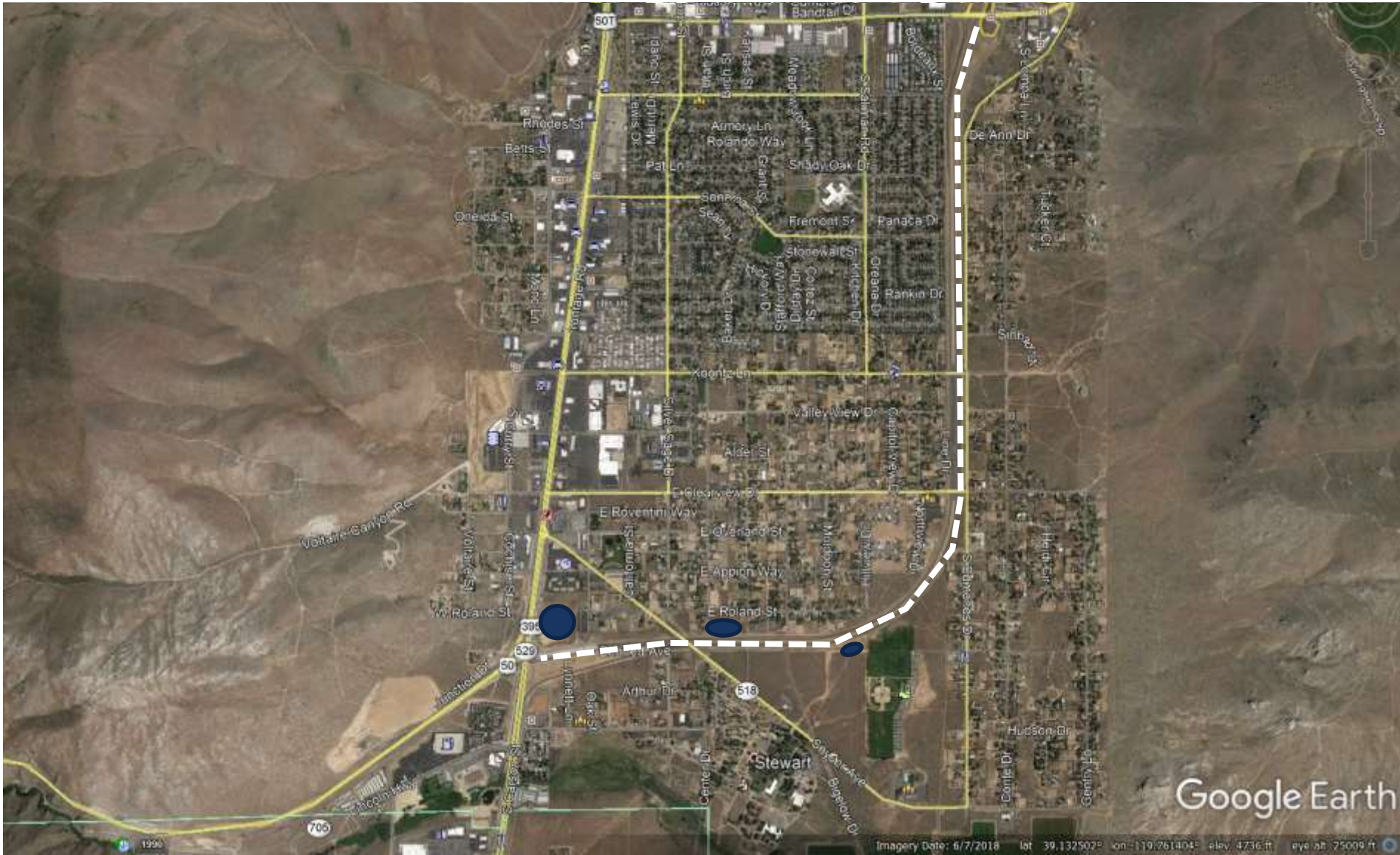
- Landuse (impervious area)
- Routing (storm drain system)
- Storage (basins)
- Topography (new LiDAR data)



Previous Study Areal



Current Study Aerial - Updates from Previous Study



Mapping Process

Update FEMA effective models to include changes:

- Hydrologic Model (SWMM)
 - Provides updated runoff flows
- Hydraulic Model (FLO-2D)
 - Provides updated inundation extents

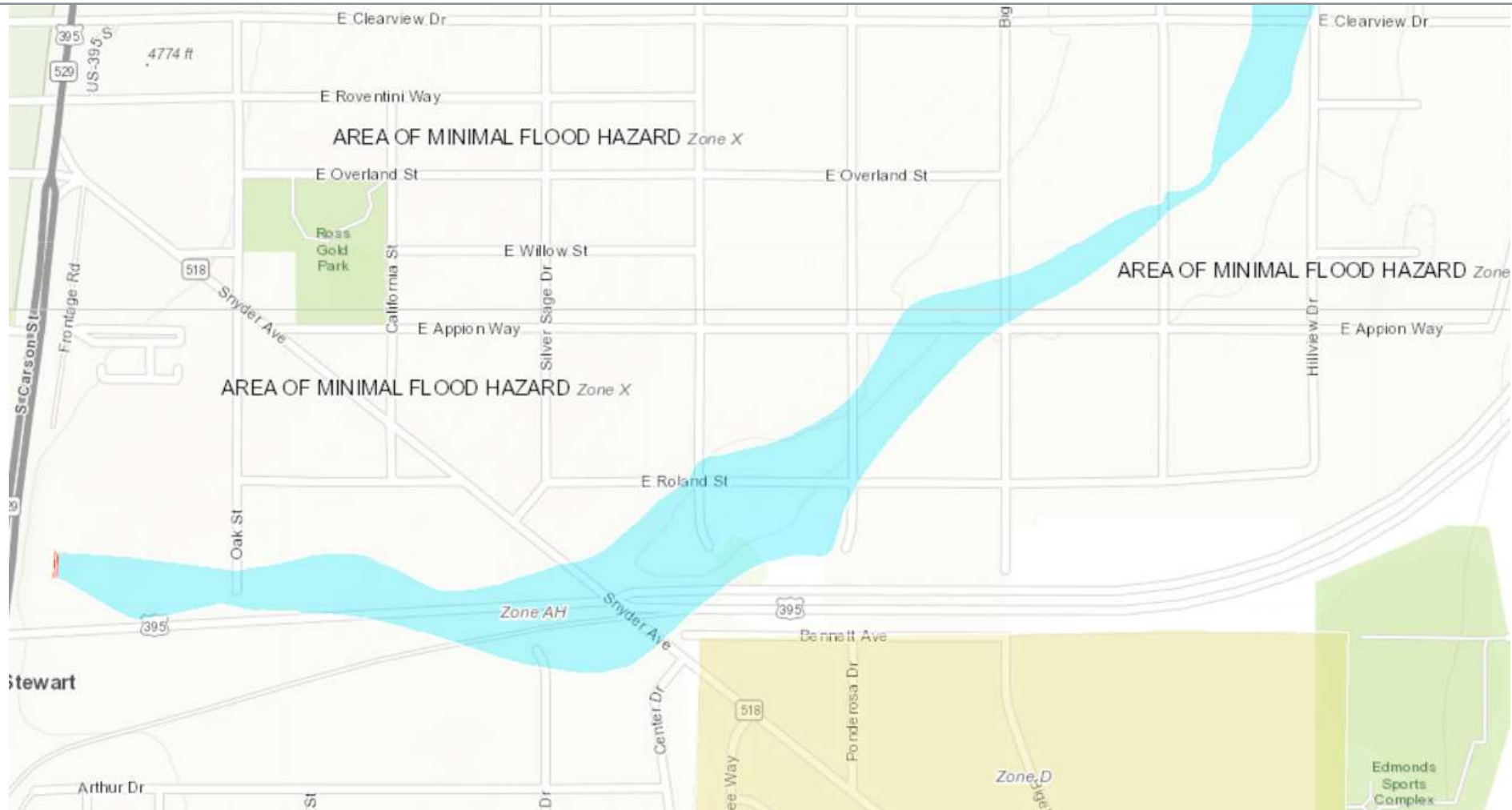
Project Status

Hydrologic and hydraulic models currently under FEMA review

Next Steps:

1. Respond to FEMA comments, update models as necessary
2. Review floodplain mapping extents with Carson City
3. Finalize floodplain mapping, develop FIRM

Preliminary Mapping Example – Current Mapping



 Increase

Presentation Summary

- > Current FEMA mapping
- > Changes that will affect FEMA mapping
- > Mapping process
- > Project status
- > Preliminary mapping
- > Discussion

Thank you

For more information

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Agenda

10:30 a.m. – 10:45 a.m.	Meeting Overview Project Status
10:45 a.m. – 11:00 am	Background Data Previous Models Updated Input Information
11:00 a.m. – 11:15 am	Hydrologic Model Update Methodology and Approach SWMM model development Hydrology Results Comparison SWMM Hydraulic Routing Components
11:15 a.m. – 11:30 am	Hydraulic Model Update FLO-2D model development Hydraulic Results
11:30 a.m. – 12:00 pm	Discussion Schedule update

Project Status

- > Task 1: Develop Topographic Data
 - Submitted 11/18
- > Task 2: Basemap Development
 - Submitted 10/18
- > **Task 3: Develop Hydrologic Data**
- > **Task 4: Develop Hydraulic Data**
- > Task 5: Perform Floodplain Mapping
- > Task 6: Develop FIRM Database

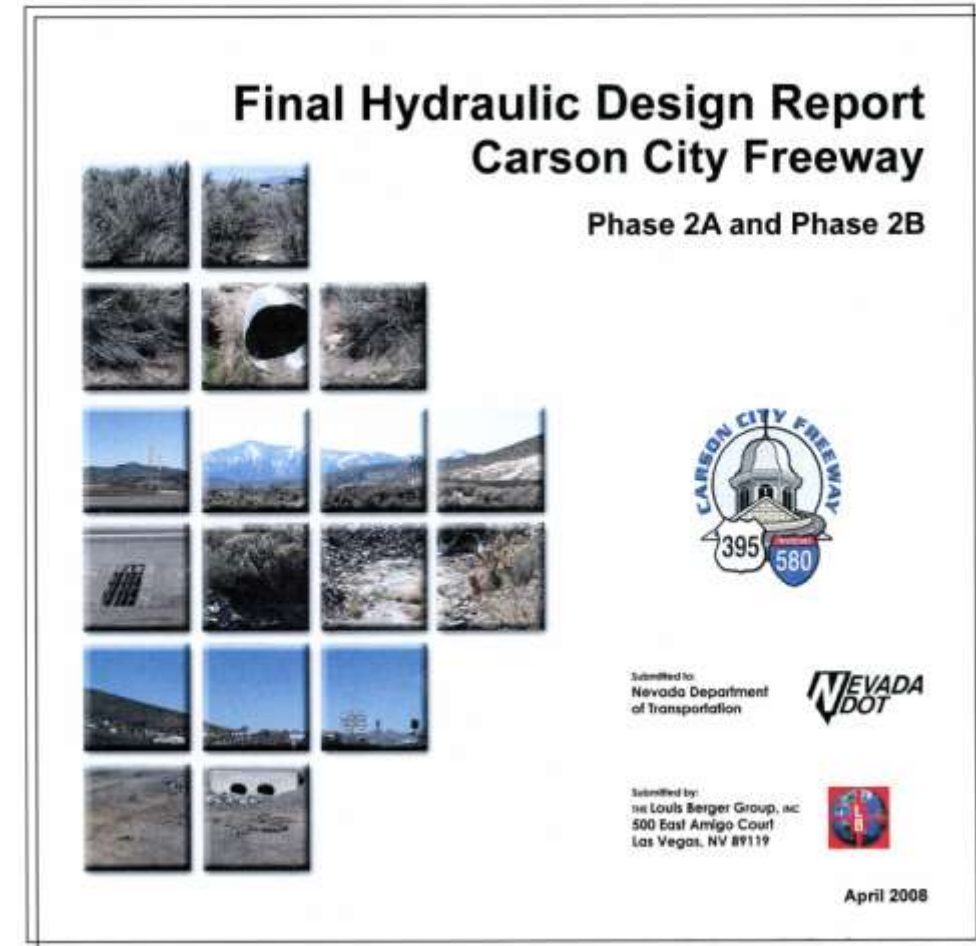
Background Data

Background Data: Sources

- > 2008 NDOT Final Hydraulic Design Report Carson City Freeway Phase 2A and Phase 2B
- > 2014 Southwest Carson City Flood Study (SWFS) Report
- > 2017 Carson City Storm Drain Geodatabase
- > 1999-2018 Record Drawings
- > 2018-05 USGS LiDAR

Background Data: 2008 NDOT

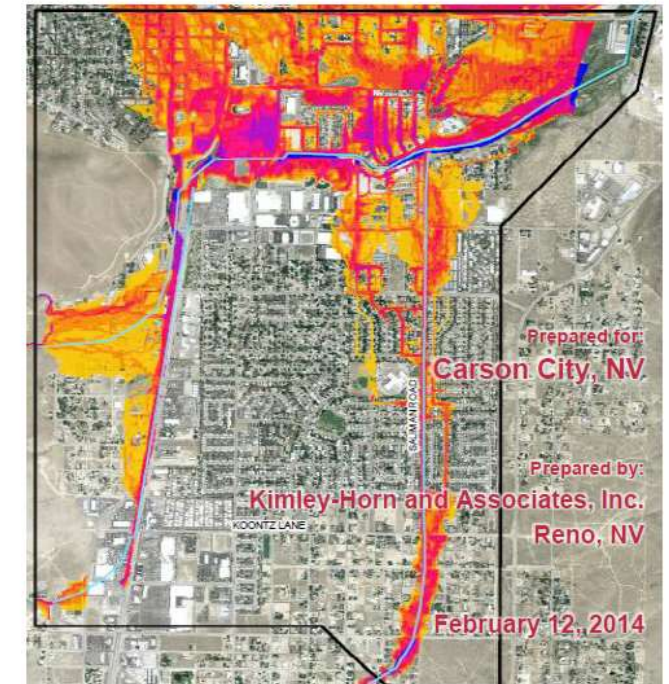
- > 2008 NDOT Final Hydraulic Design Report Carson City Freeway Phase 2A and Phase 2B
- > NDOT Models
 - Hydrology
 - HEC-1 Model
 - Includes study area for 2008 freeway design (current WS delineation)
 - Includes 100-year, 24-hour event rainfall and runoff
 - Hydraulics
 - Basin Stage-Storage-Discharge Curves



Background Data: 2014 SWFS

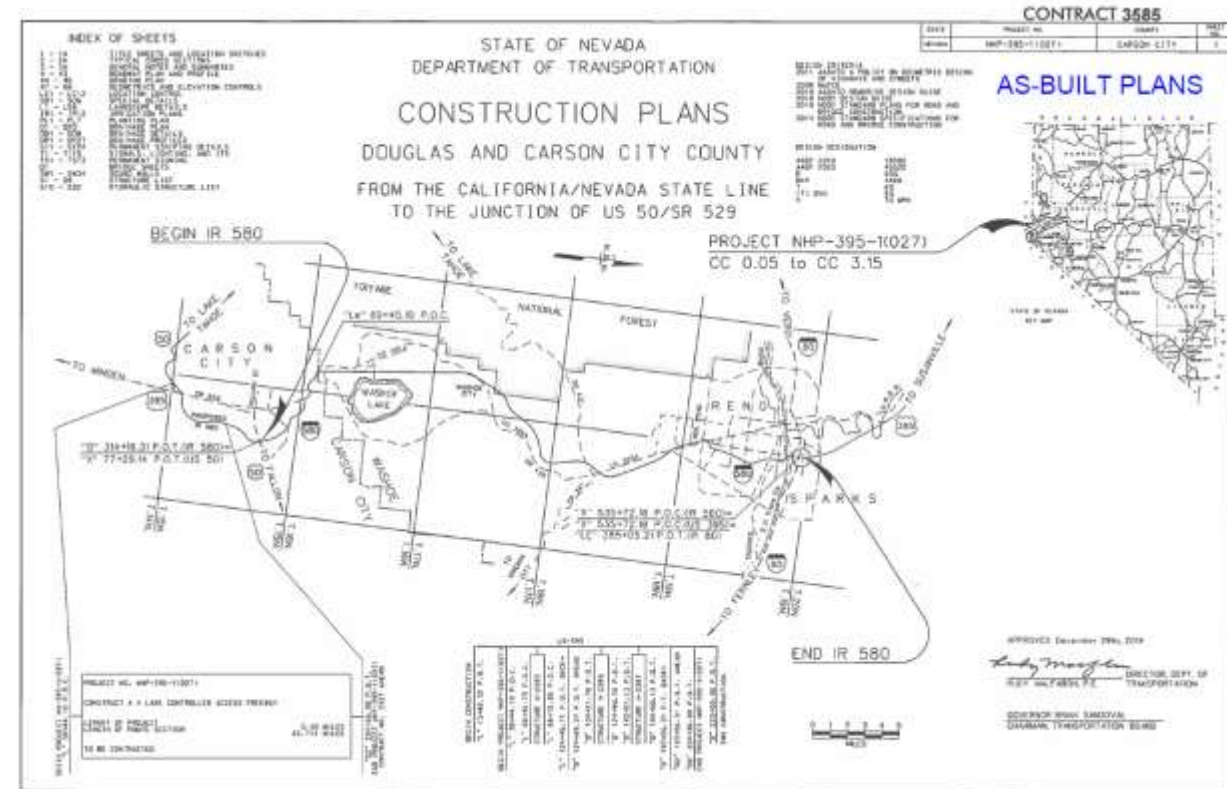
- > 2014 Southwest Carson City Flood Study (SWFS) Report
- > SWFS Models (2016 FEMA effective models)
 - Hydrology
 - SWMM model
 - Includes study area, prior to freeway construction (outdated WS delineation)
 - Includes 100- and 500-year, 24-hour event rainfall and runoff
 - Hydraulics
 - FLO-2D model
 - Includes building footprints within study area
 - Includes pre-construction hydrologic inputs
 - Includes landuse within study area (outdated)
 - Includes channel cross-sections within study area (outdated topography)

Southwest Carson City Flood Study



Background Data: Record Drawings

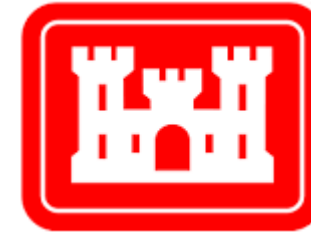
- > 1999 Cochise Retail Center
- > 2002 Clearview Drive Improvement Plans
- > 2006 South Curry Street Civil Improvement
- > 2016 Carson City Freeway Phase 2A and 2B
- > 2018-09 Carson Hills Apartments



Hydrologic Model

Hydrologic Model Selection

- > NDOT HEC1 model
 - Close representation of current conditions
 - Only includes results for 100-year event
 - Methodology inconsistent with current effective FEMA model
- > SWFS SWMM model (current effective model)
 - Pre-construction conditions
 - Subbasin delineations
 - Percent impervious
 - Storage



Methodology

Table 1. Differences in Methodology between SWMM and HEC-1 Hydrologic Models

Model	SWMM (SWFS and VSR) ¹	HEC-1 (NDOT) ²
Runoff Method	SWMM Runoff Non-linear Reservoir Method	SCS Unit Hydrograph
>Main Difference	Unique runoff hydrograph for each subbasin	Predefined SCS runoff hydrograph
Infiltration Method	Green & Ampt	SCS Curve Number ³
>Main Difference	Assumes an infiltration rate	Assumes an infiltration volume
Routing Method	Dynamic Wave	Muskingum-Cunge
>Main Difference	“Hydraulic routing” accounts for pressurized flow in closed conduits	“hydrologic routing” with simplified momentum equation assumes open channel flow

1. Model used for Southwest Carson City Flood Study (Kimley Horn, 2016) and Voltaire and Saliman Restudy (Cardno, 2019)

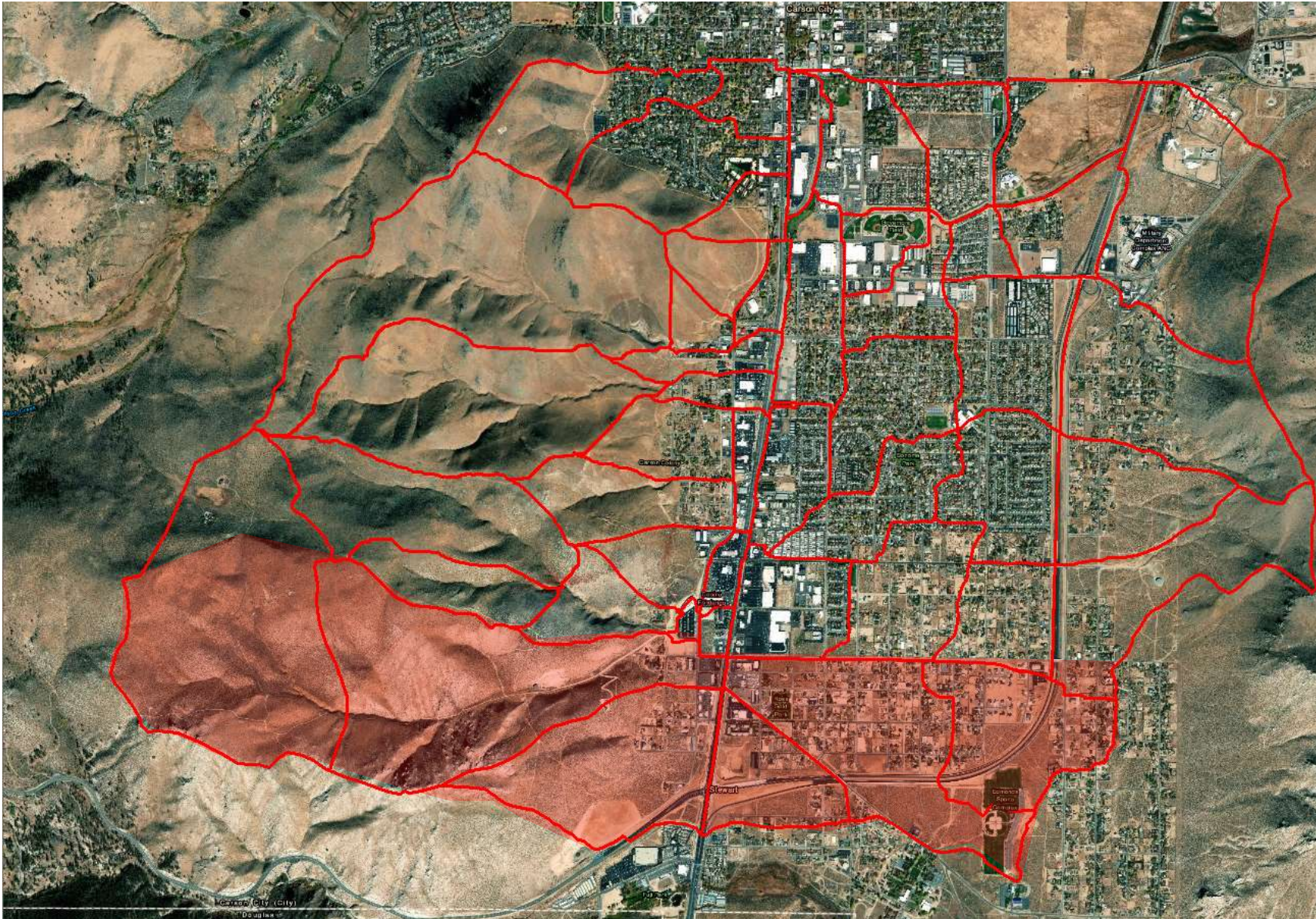
2. Model used for Design of Carson City Freeway Phase 2A and 2B (NDOT, 2008)

3. Considered a “de facto standard in hydrologic engineering practice” (source: INITIAL ABSTRACTION REVISITED, [Victor M. Ponce](http://ponce.sdsu.edu/initial_abstraction_revisited.html) and Luis Magallon, 2015, http://ponce.sdsu.edu/initial_abstraction_revisited.html)

Approach

- > Updated SWFS 2016 effective SWMM model to include freeway
 - Updated watershed delineations (from NDOT HEC-1 model)
 - Updated landuse parameters to include freeway
 - Recalculated area-weighted subbasin parameters (using 2018 LiDAR when applicable)
 - Included storm drain systems from record drawings
 - Updated basin storage/area curves (using 2018 LiDAR)

Southwest Carson City Flood Study (SWFS) Subbasins



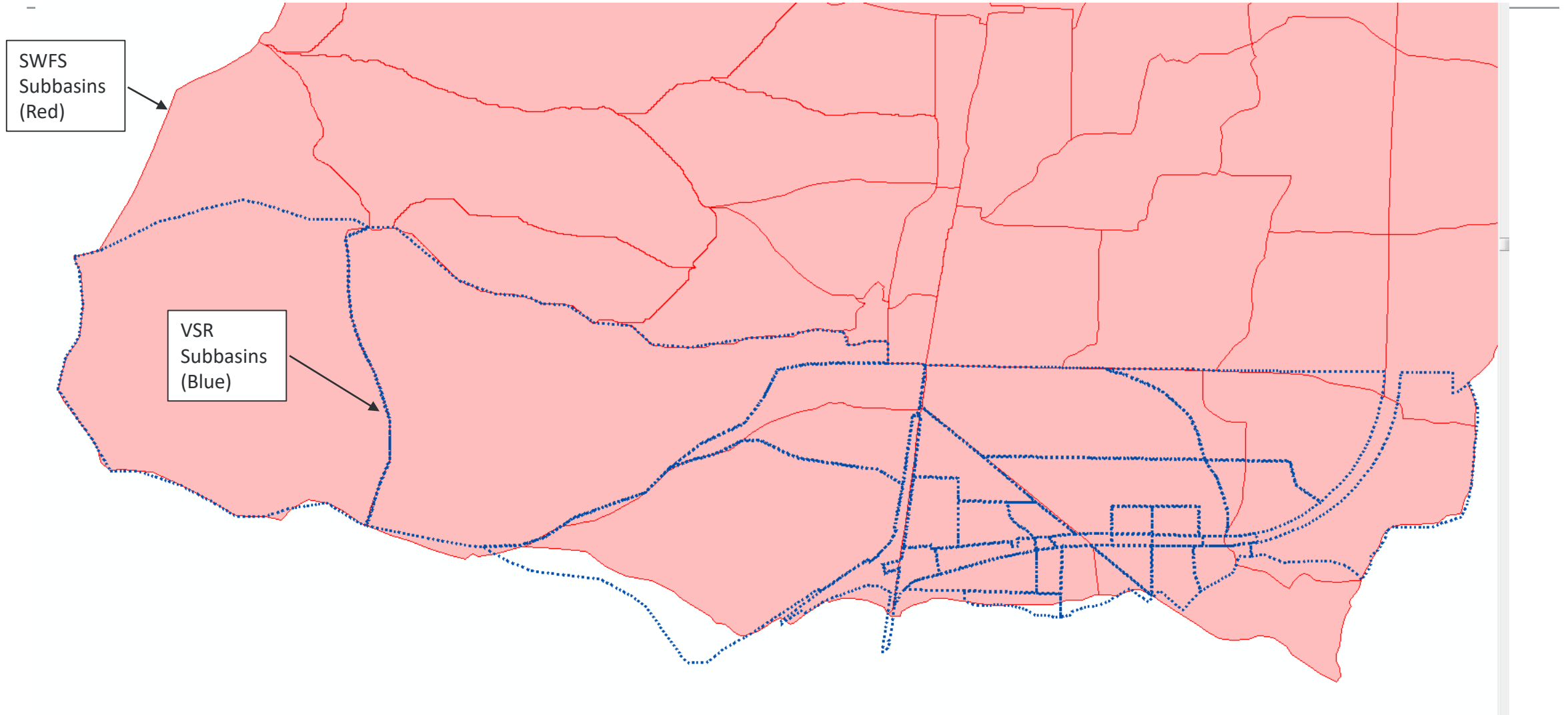
NDOT Subbasins



SWFS and Voltaire and Saliman Restudy (VSR) Subbasins

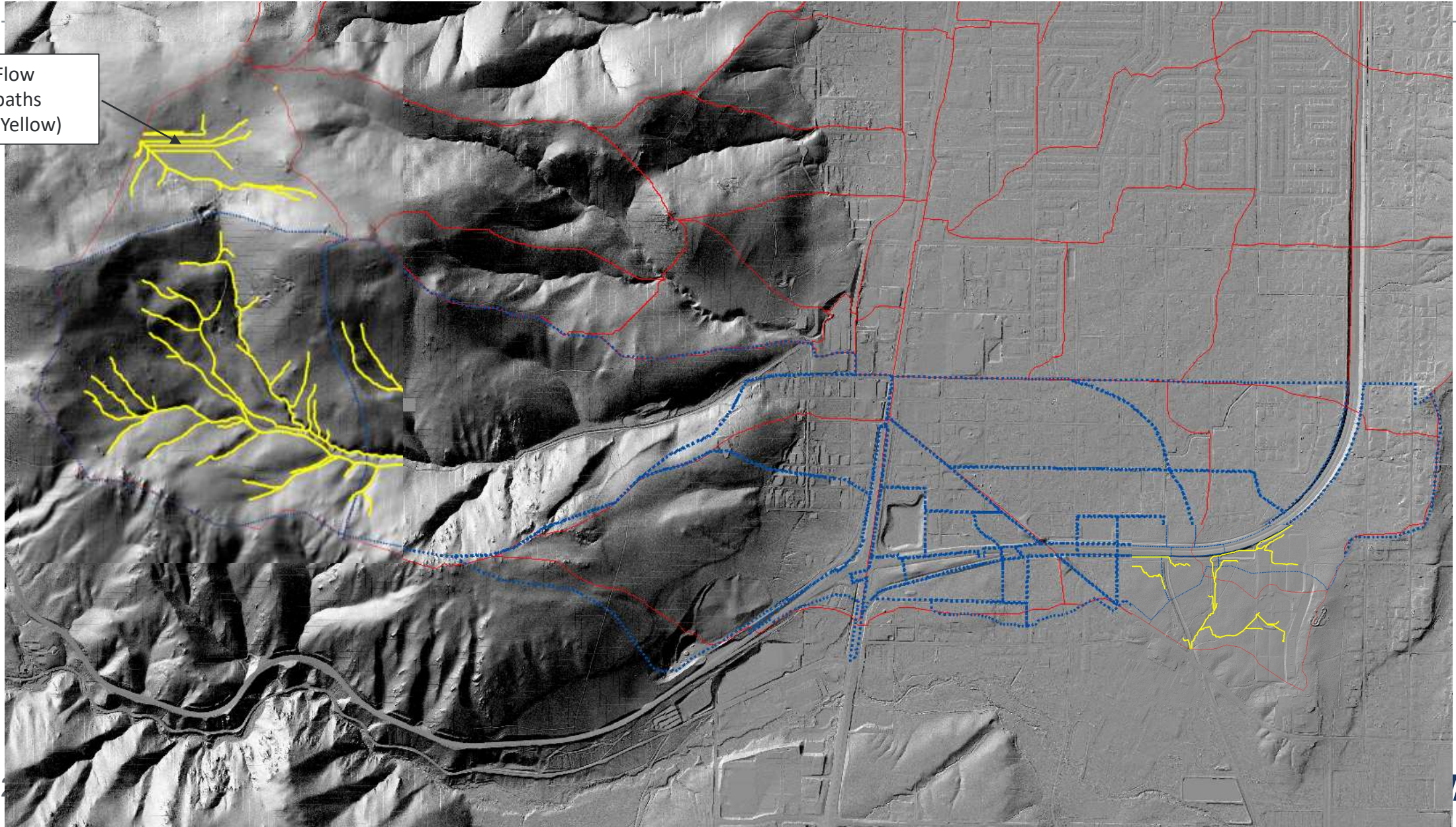


SWFS and VSR Subbasins

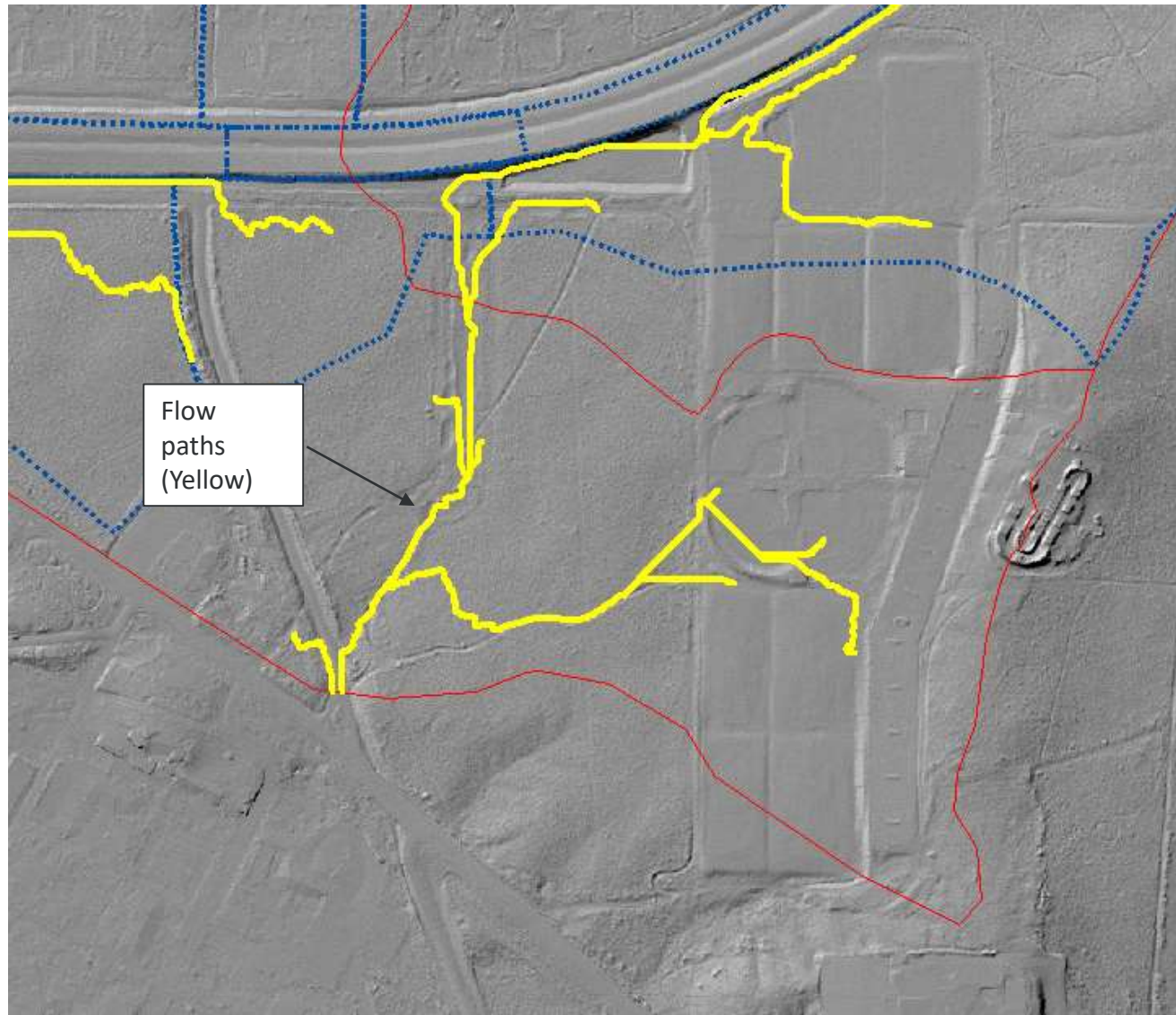


SWFS and VSR Subbasins

Flow
paths
(Yellow)



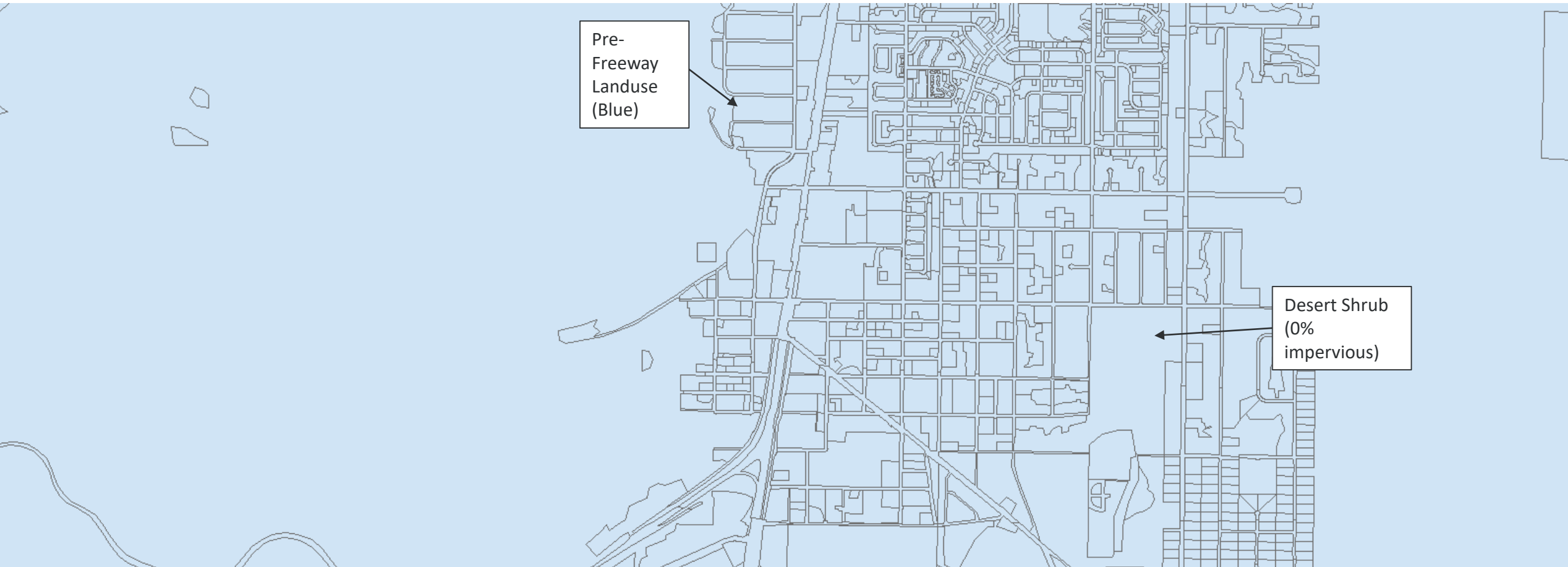
SWFS and VSR Subbasins



SWFS Landuse Layer (Pre-Freeway Construction)

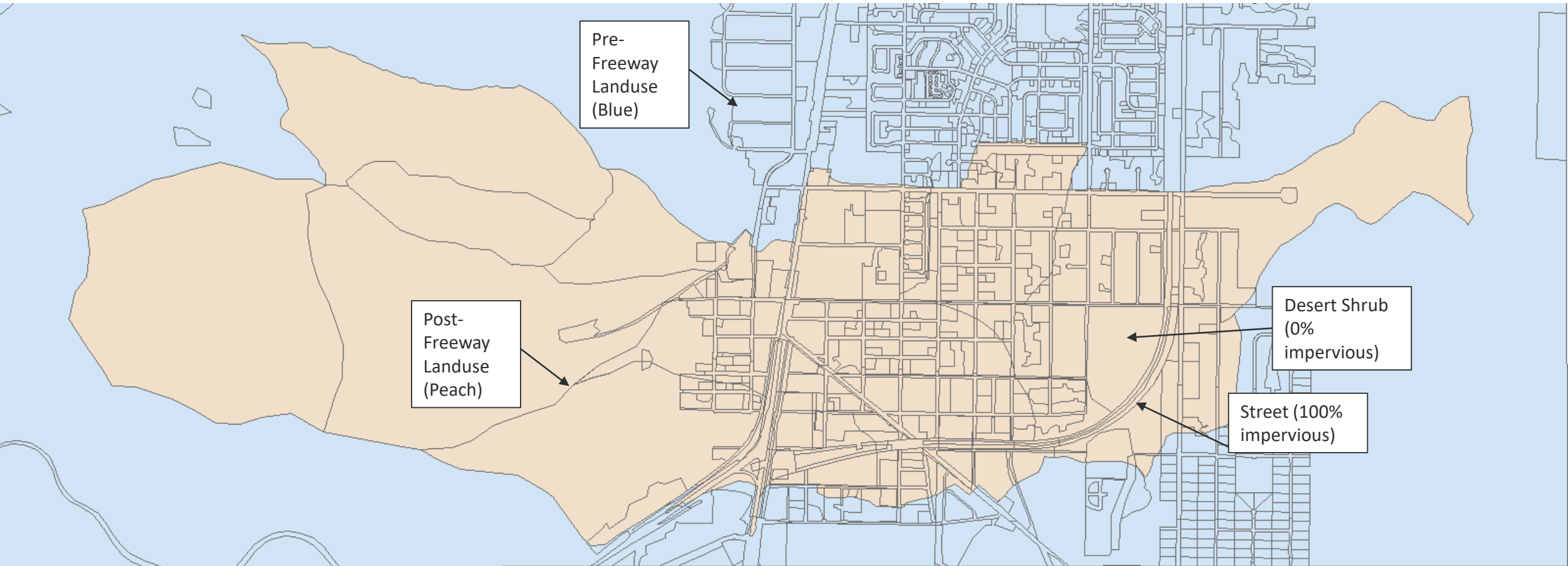


SWFS Landuse Layer (Pre-Freeway Construction)



VSR Landuse Layer (Post-Freeway Construction)

- Increase of ~20 Acres impervious area
- ~1% of contributing area



Hydrologic Model Results: NDOT vs. VSR

Table 2. Hydrologic Model Results Comparison: NDOT HEC-1 Model and VSR SWMM Model

	Contributing Area (Ac)	Total Runoff (Ac-Ft)	% Runoff	% Infiltration
NDOT Model	1,715	156	30	70
VSR Model	1,686	101	20	80

- Total contributing area is 29 acres less than NDOT model
 - Contributing area is 48 acres greater than NDOT model w/o Voltaire subbasin
- Total runoff is 35% less than NDOT model
- Runoff ratio is lower than NDOT model

Hydrologic Model Results: SWFS vs. VSR

Table 3. Hydrologic Model Results Comparison: SWFS SWMM Model and VSR SWMM Model

	Contributing Area (Ac)	Total Runoff (Ac-Ft)	% Runoff	% Infiltration
SWFS Model	1,842	100	18	82
VSR Model	1,686	101	20	80

- Total contributing area is 156 acres less than SWFS model
- Runoff ratio is slightly higher than SWFS model
 - Due to increase in impervious area
- Total runoff is approximately the same
 - Increase in impervious area offset by decrease in contributing area.

Hydrologic Model Results: All Models

Table 4. Hydrologic Model Results Comparison: NDOT HEC-1 Model, SWFS SWMM Model, and VSR SWMM Model

	Contributing Area (Ac)	Total Runoff (Ac-Ft)	% Runoff	% Infiltration
NDOT Model	1,715	156	30	70
SWFS Model	1,842	100	18	82
VSR Model	1,686	101	20	80

VSR – SWMM Hydraulic Routing Components



- > Storm Drain Pipes
- > Storage (Voltaire, Ponderosa, and Detention Basin #3)

VSR – Input Flows into FLO-2D Model

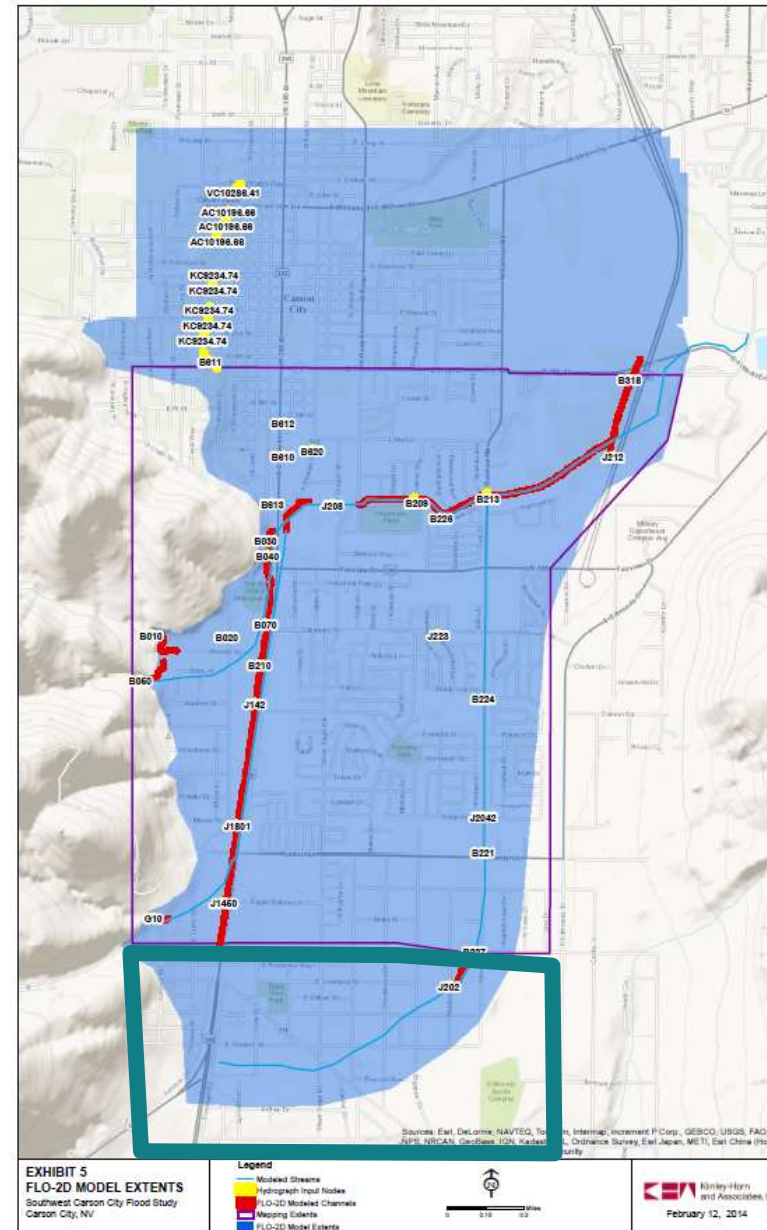


- > Storm Drain Pipe Flooding
- > Storage (Ponderosa Basin) Flooding
- > Directly Contributing Subbasins

Hydraulic Model

SWFS FLO-2D Model Input

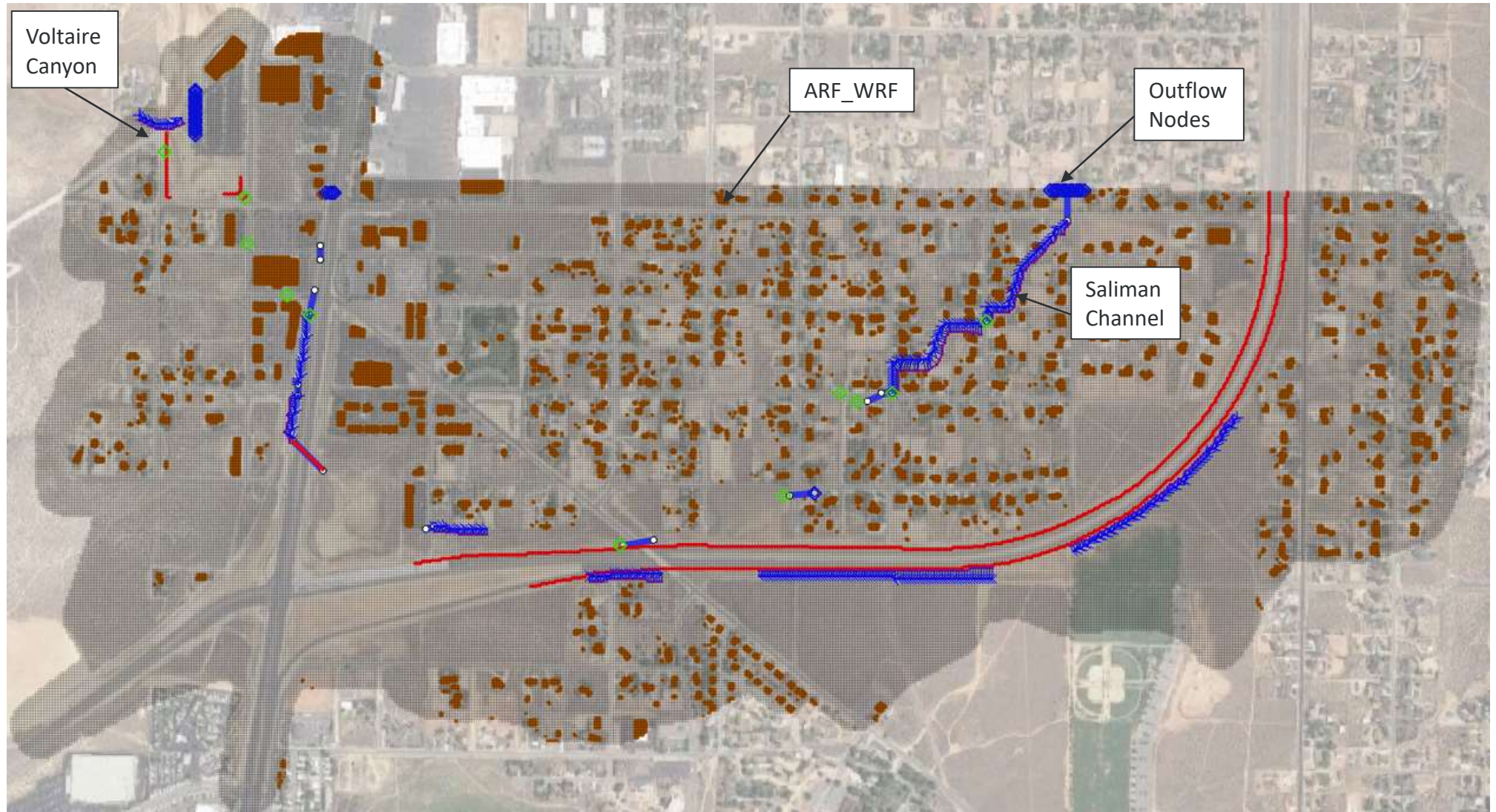
- > VSR model extents in teal
- > Ties in at SWFS model southern boundary



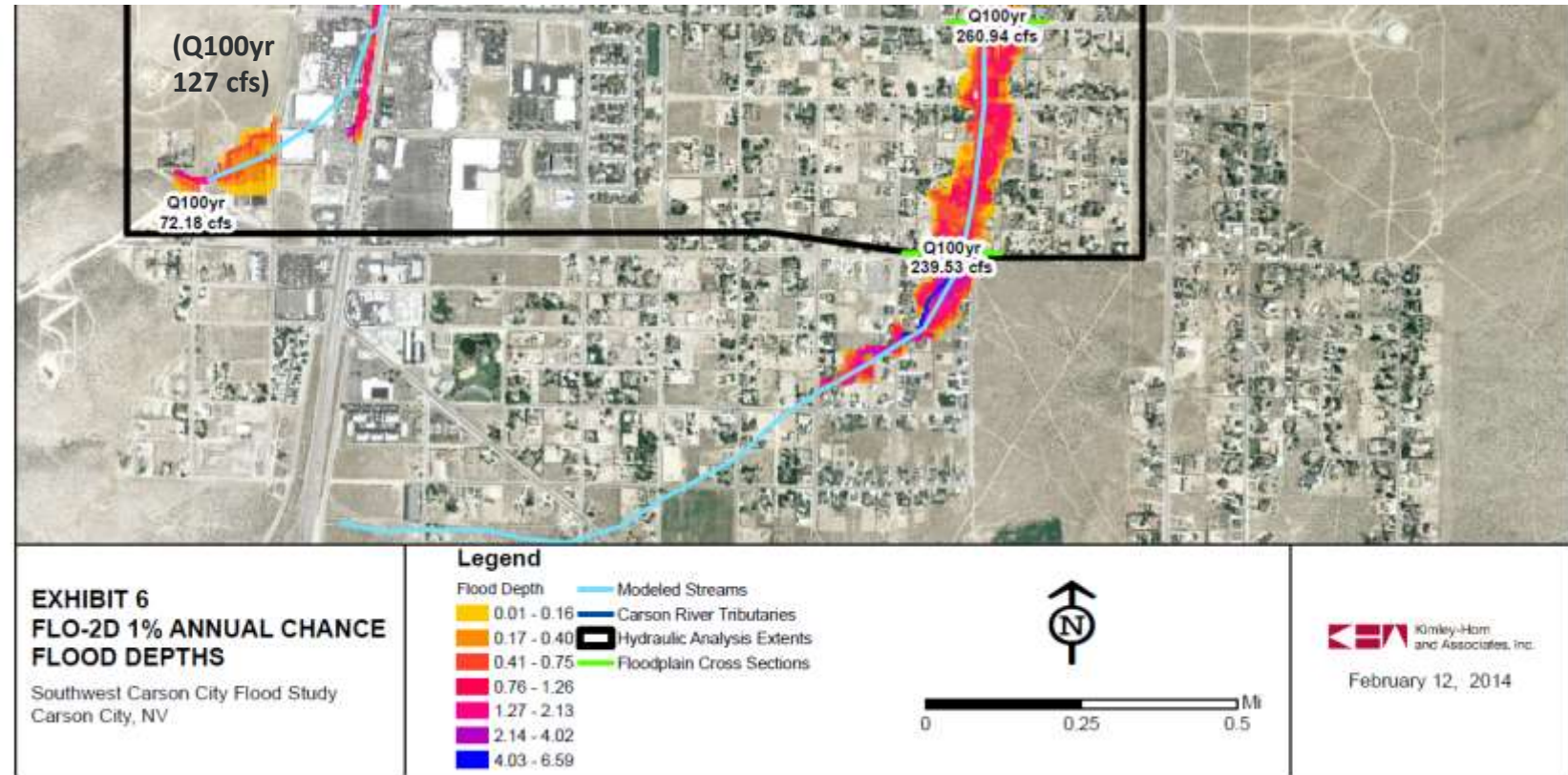
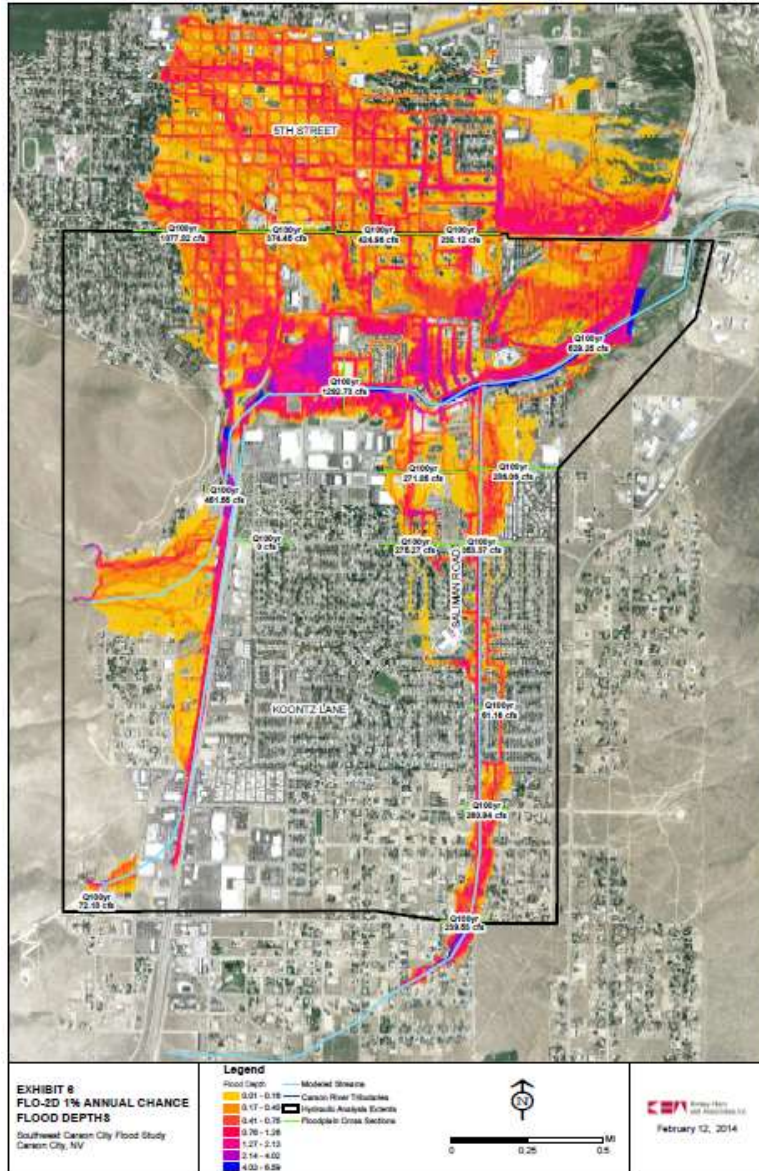
Approach

- > Updated SWFS FLO-2D model
 - Updated hydrology inputs
 - Updated landuse to include freeway
 - Updated channel dimensions and two-dimensional grid elevations from LiDAR data

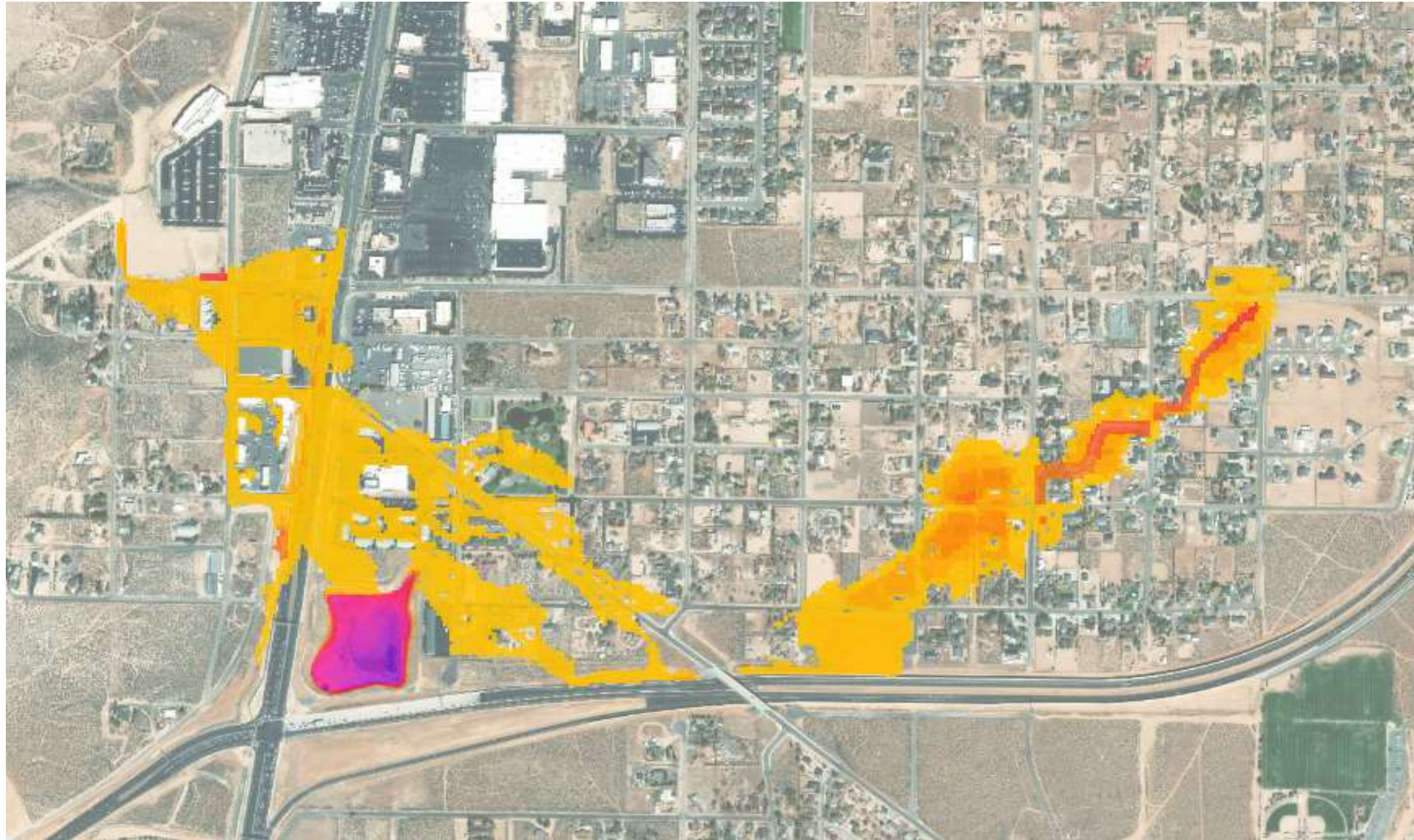
VSR FLO-2D Model Input



SWFS 100-year Flood Depths



VSR 100-year Flood Depths



Legend

Proposed 100-Year Flood Depths (Ft.)

0 - 1
1.01 - 2
2.01 - 3
3.01 - 4
4.01 - 5
5.01 - 6
6.01 - 7
7.01 - 8
8.01 - 9
9.01 - 10
10.01 - 11
11.01 - 12
12.01 - 13
13.01 - 14

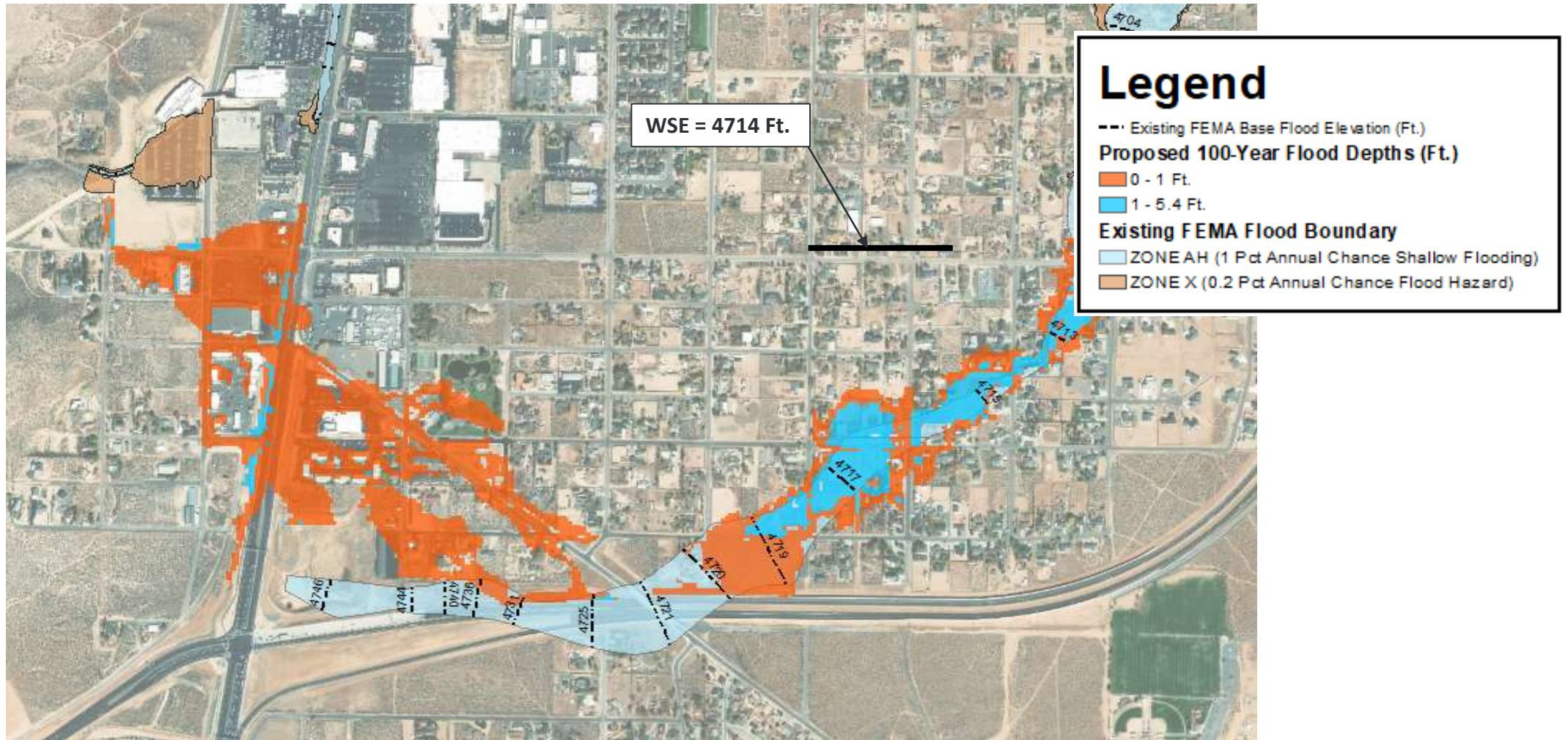
Existing FEMA Mapping



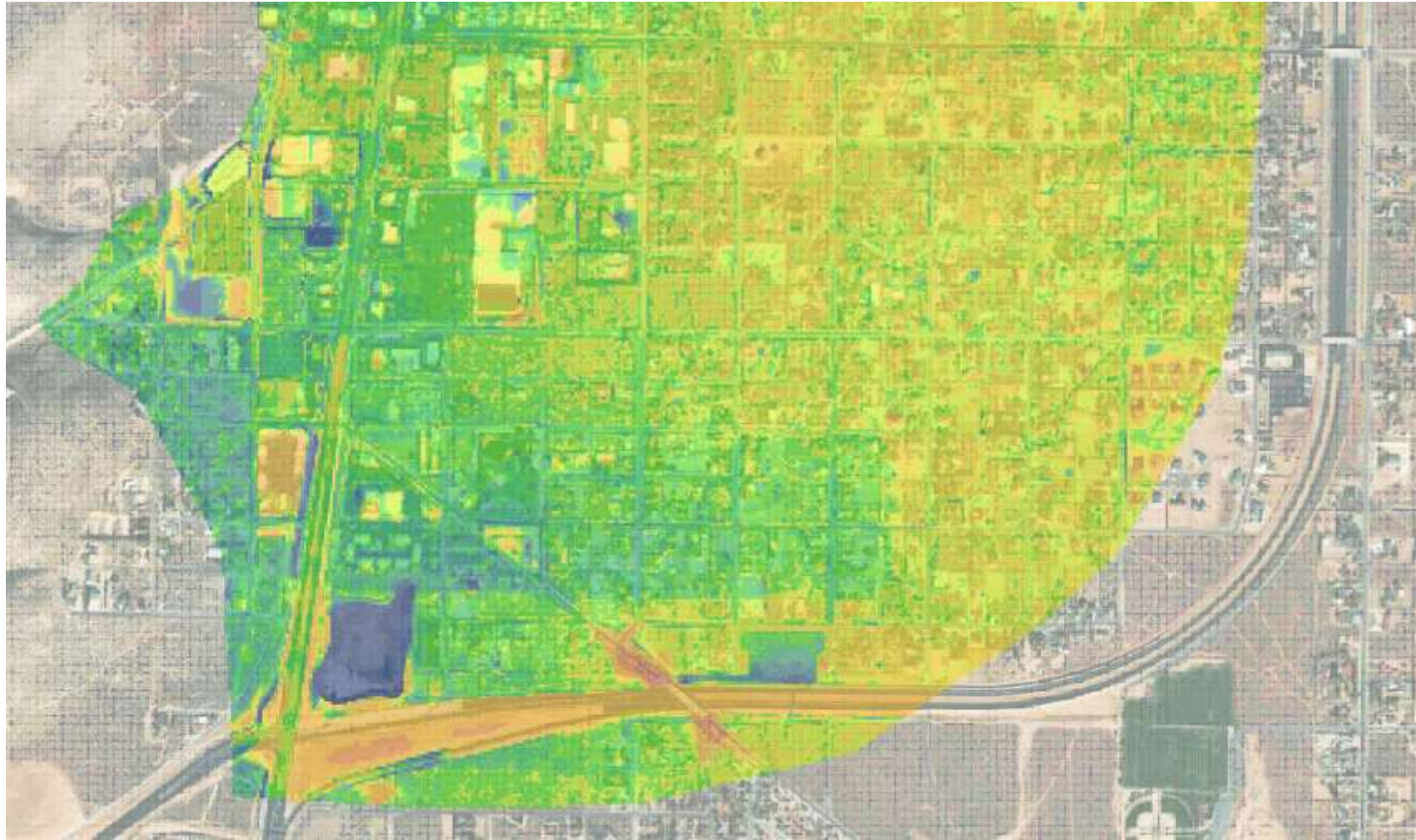
Legend

- Existing FEMA Base Flood Elevation (Ft.)
- Existing FEMA Flood Boundary**
- ZONEAH (1 Pct Annual Chance Shallow Flooding)
- ZONE X (0.2 Pct Annual Chance Flood Hazard)

Preliminary Floodplain Mapping

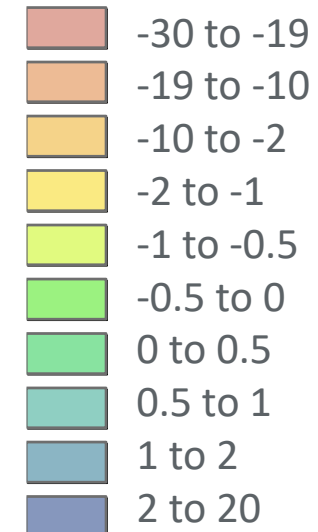


Digital Elevation Model Comparison: 2006 DEM Vs. 2018 DEM

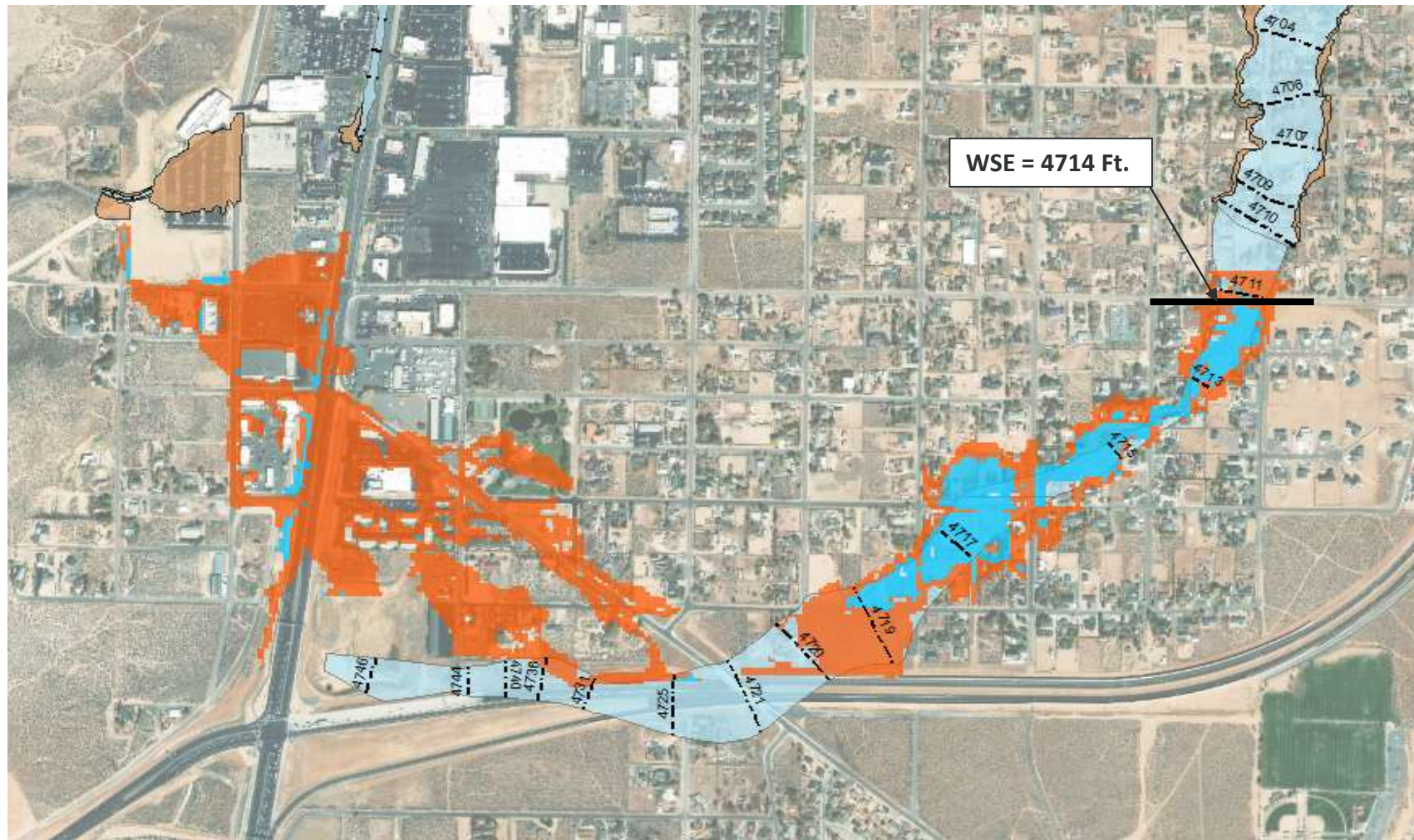


Legend

2006 DEM minus 2018 DEM



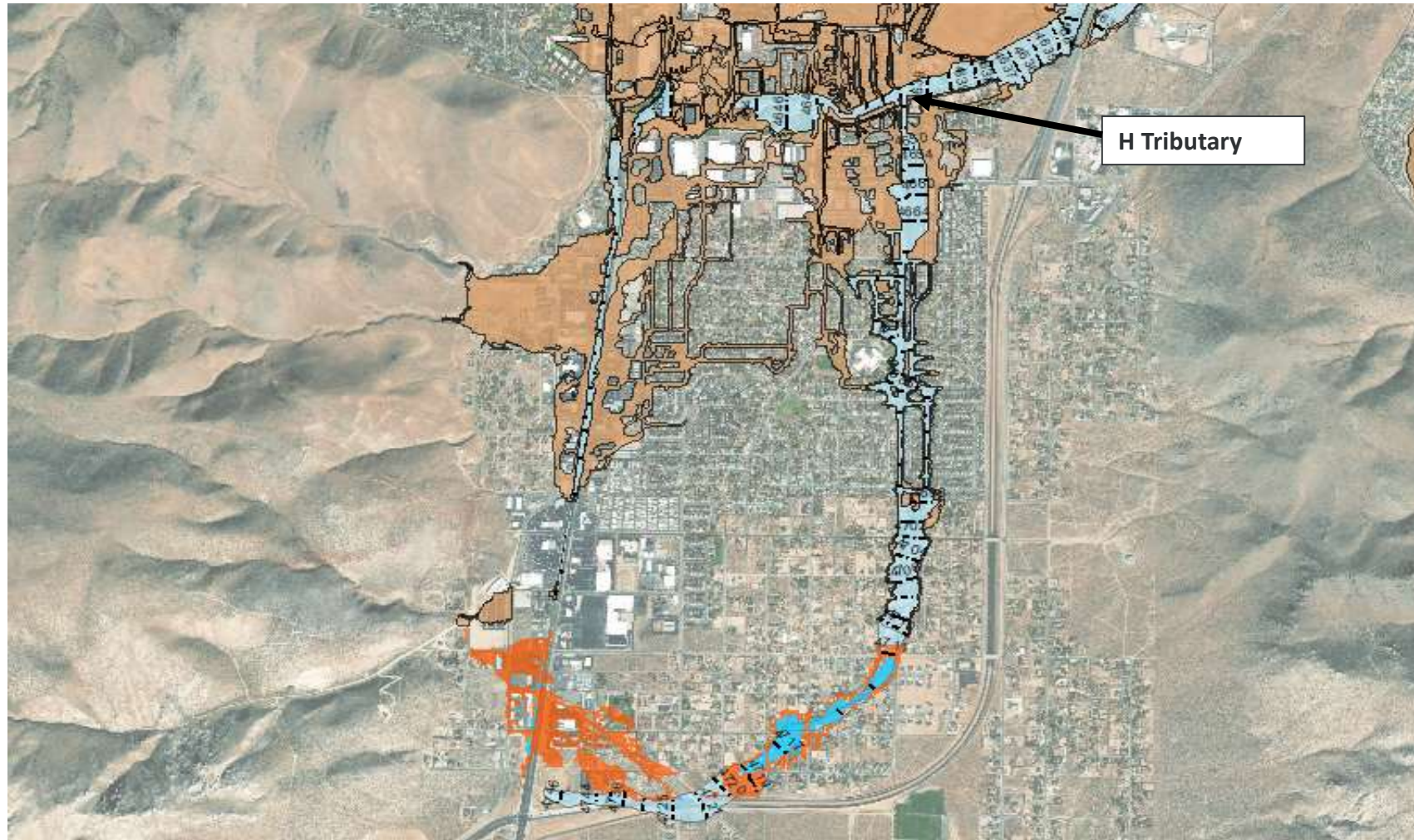
Preliminary Floodplain Mapping



Legend

- Existing FEMA Base Flood Elevation (Ft.)
- Proposed 100-Year Flood Depths (Ft.)**
 - 0 - 1 Ft.
 - 1 - 5.4 Ft.
- Existing FEMA Flood Boundary**
 - ZONE AH (1 Pct Annual Chance Shallow Flooding)
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Preliminary Floodplain Mapping



Legend

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Next Steps

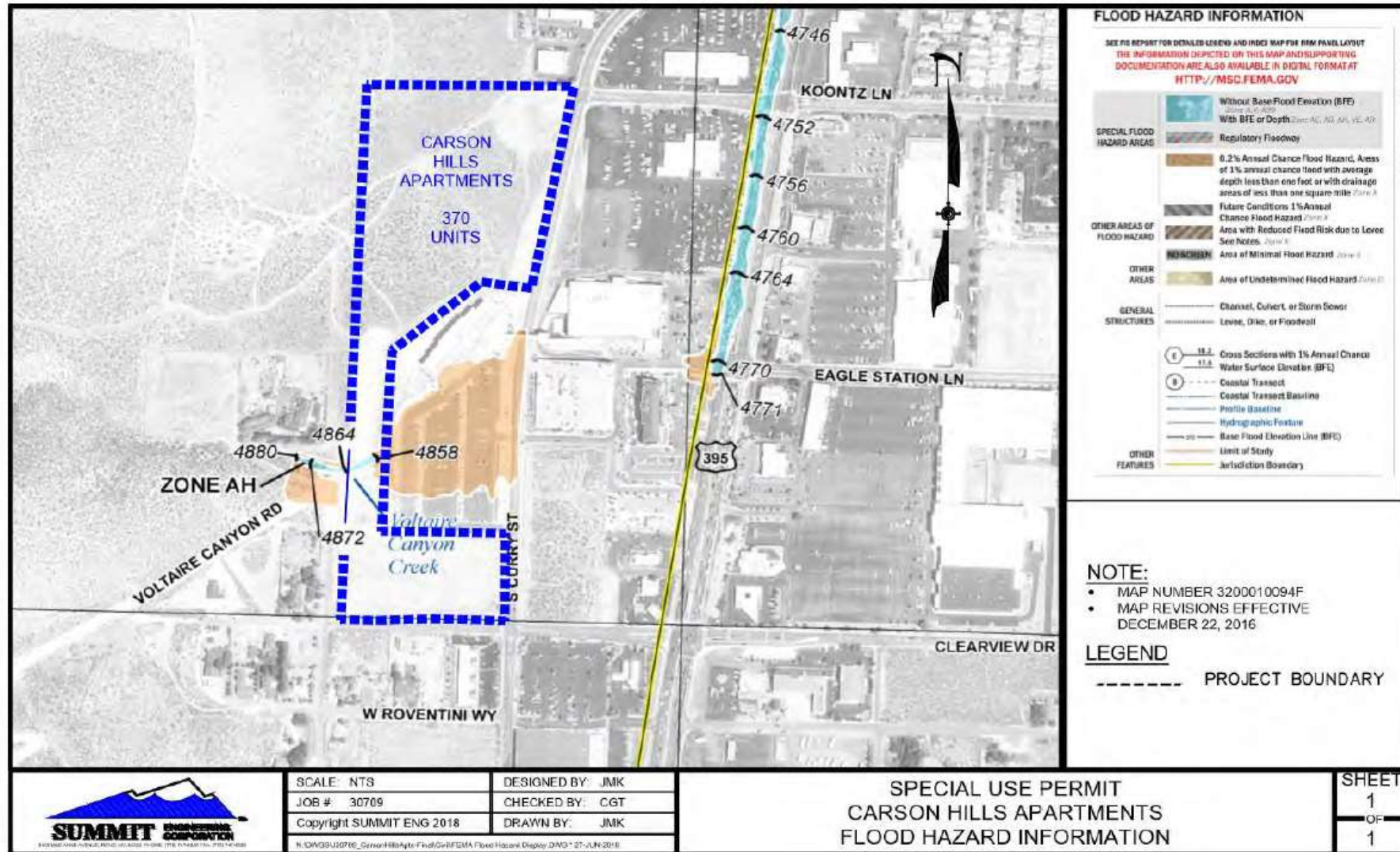
- > **Task 3: Develop Hydrologic Data**
 - 3/1

- > **Task 4: Develop Hydraulic Data**
 - 3/1

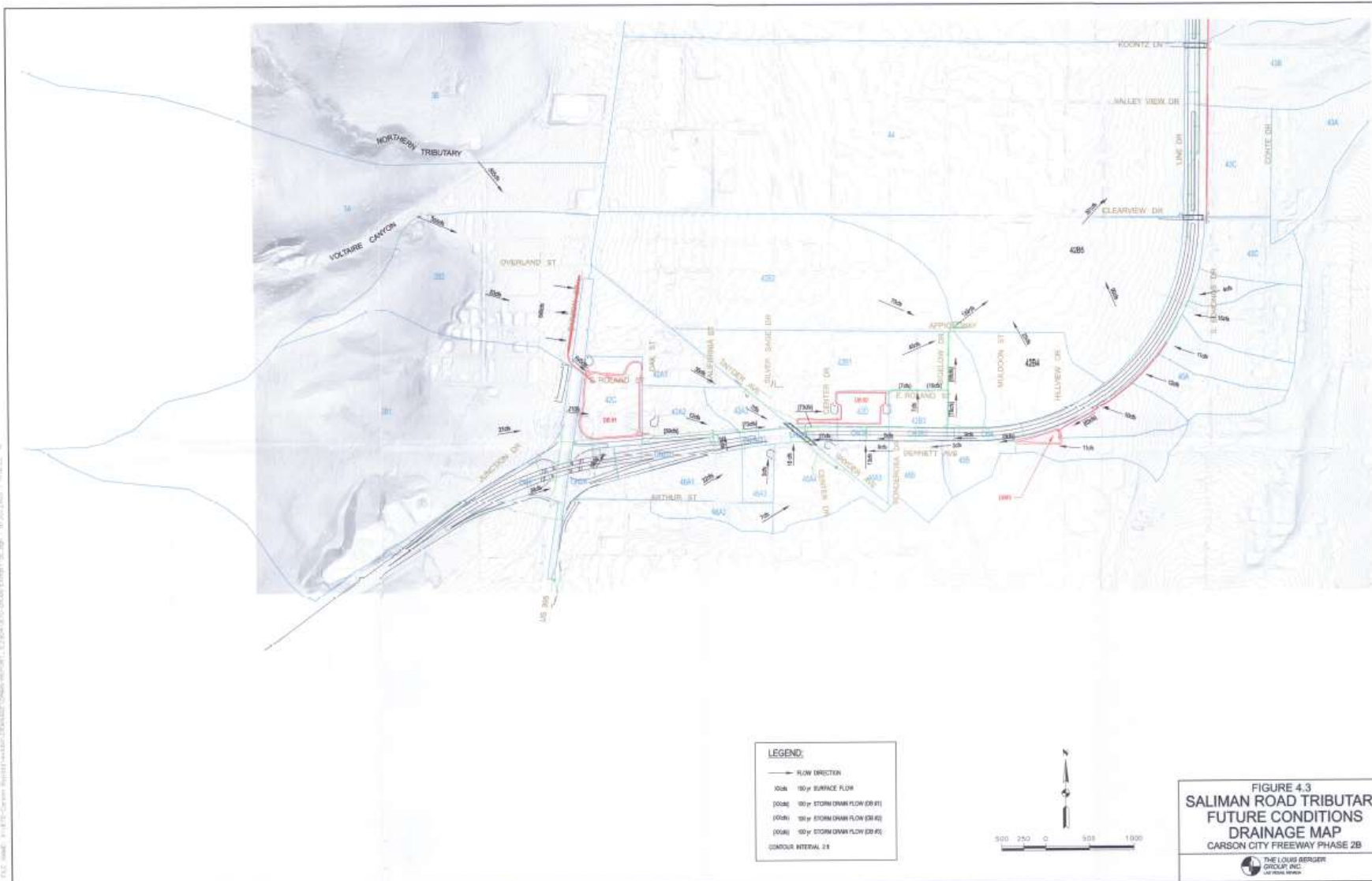
- > Task 5: Perform Floodplain Mapping
 - 4/12

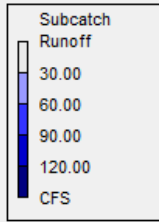
- > Task 6: Develop FIRM Database
 - 5/31

Carson Hills Apartments topography not included in LiDAR

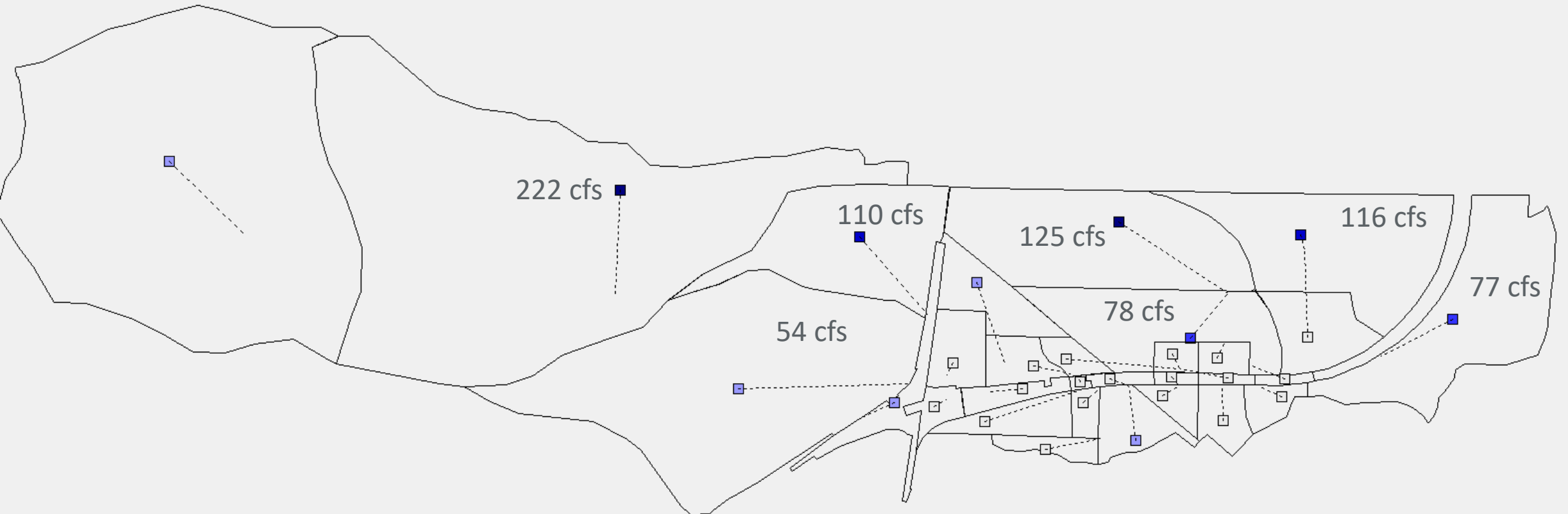


NDOT Future Conditions Drainage Map





01/01/2000 12:10:00

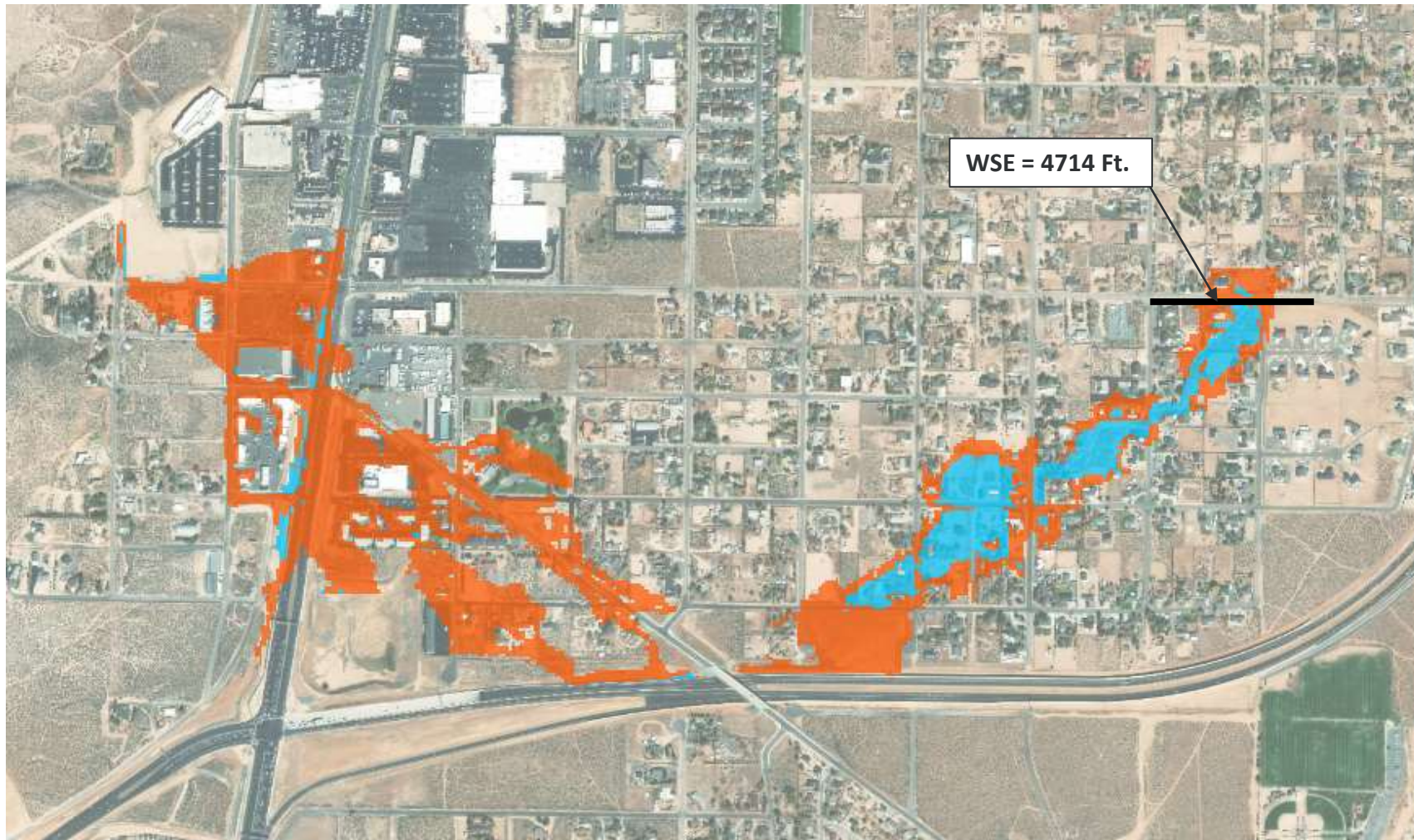


SWFS – SWMM Hydraulic Routing Components



- > Street Flow
- > Channel Flow
- > Storage (Voltaire Basin)

Preliminary Floodplain Mapping



Legend

Proposed 100-Year Flood Depths (Ft.)

0 - 1 Ft.

1 - 5.4 Ft.

Current FEMA Mapping

Legend

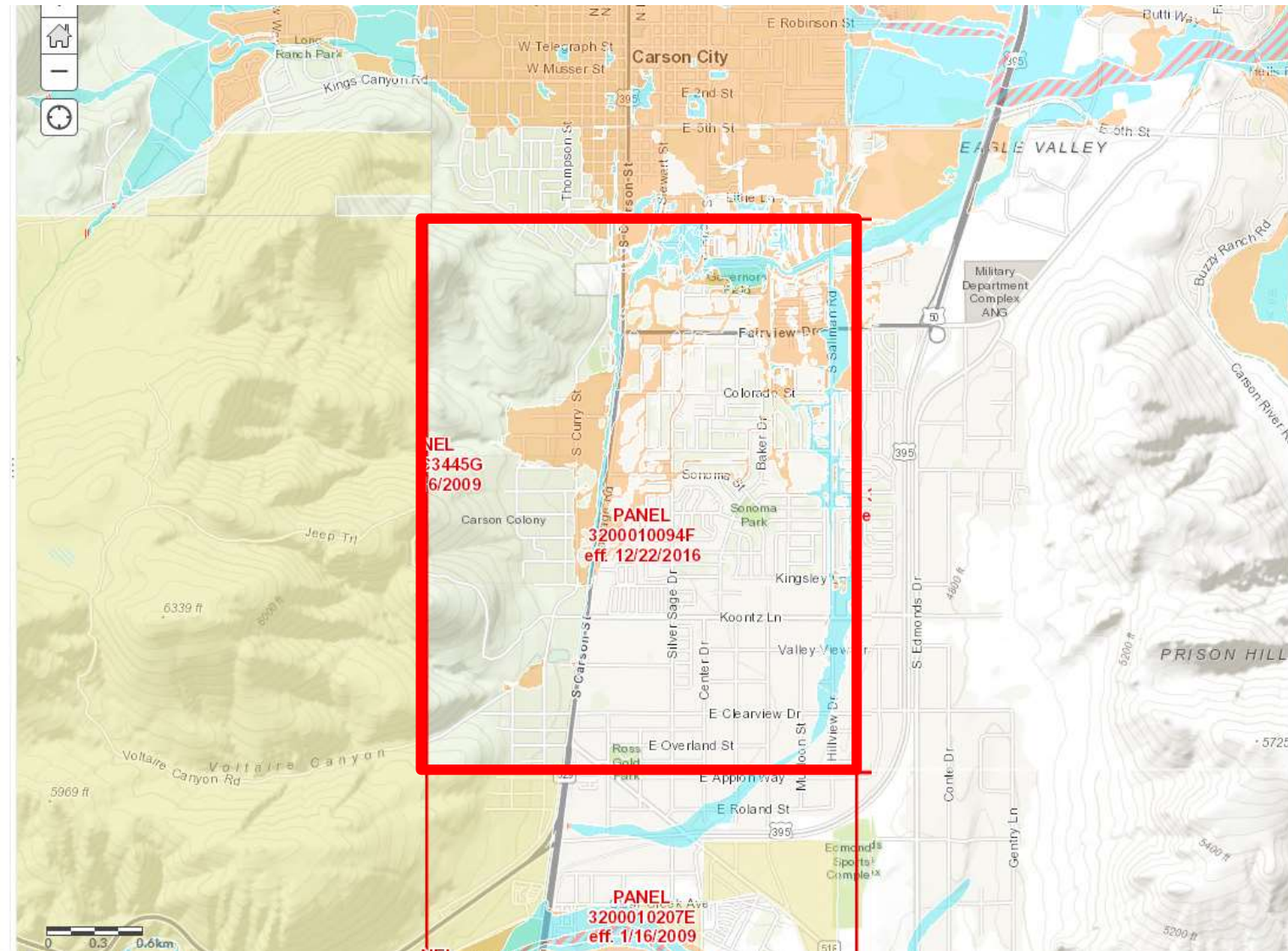
National Flood Hazard Layer (NFHL) - FEMA

Flood Hazard Boundaries

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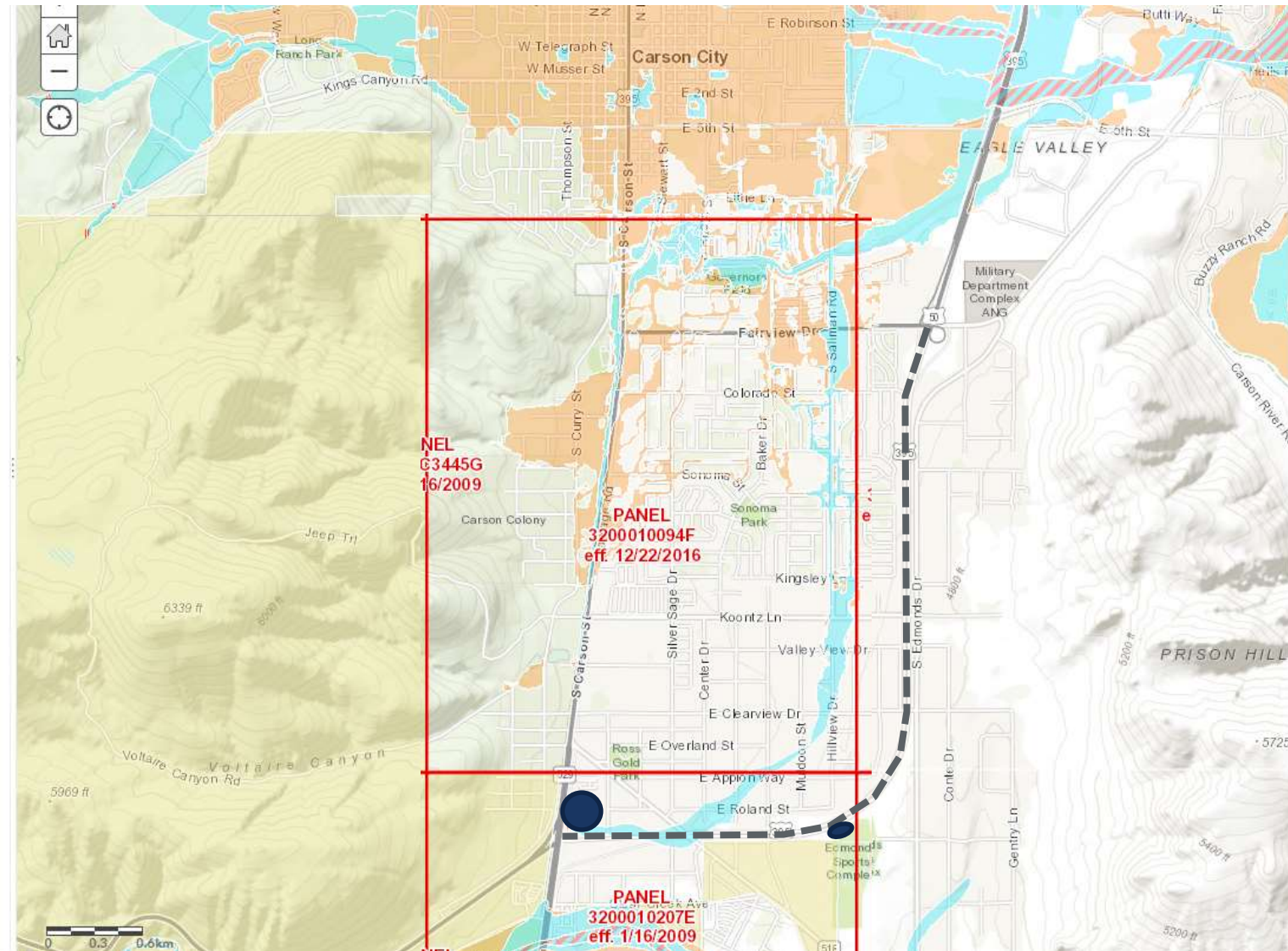
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