FINAL DRAINAGE MEMO

Forest Road

Prepared for:

City of Sedona

Prepared by:

Kimley-Horn
201 N. Montezuma
Suite 206
Prescott, Arizona 86301

191502008
June 2021

FINAL DRAINAGE MEMO

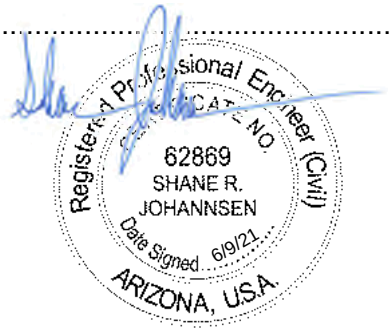
FOREST ROAD

JUNE 2021

Prepared By:

Kimley»Horn

Contents



Figures

Appendices

1.0 INTRODUCTION

PROJECT LOCATION

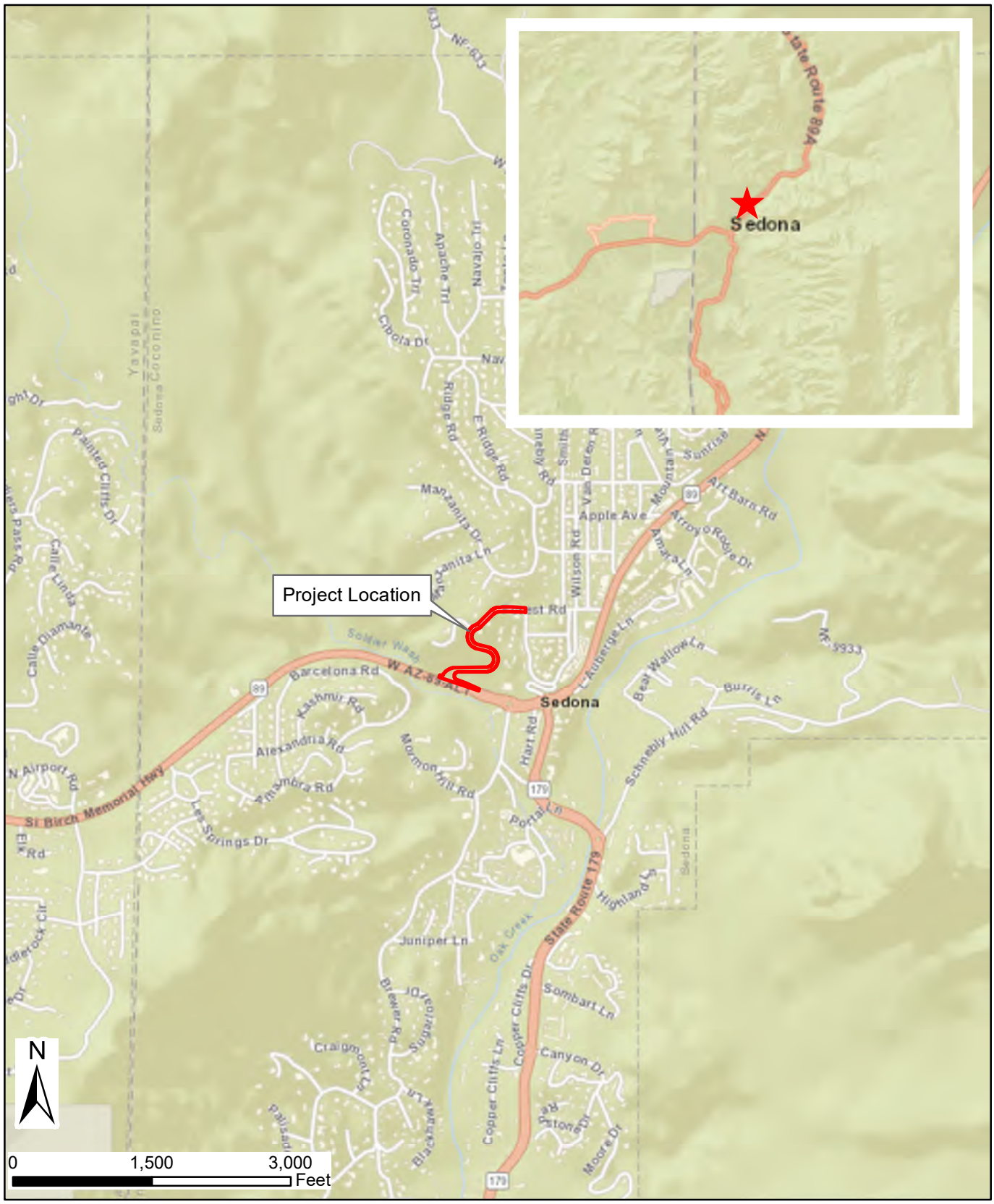
The Forest Road improvements project includes installing new roadway, curb and gutter, multi-use path, culverts between the existing Forest Road and State Route 89A (SR-89A). The new Forest Road will connect to SR-89A west of the existing roundabouts. This project is located within the City of Sedona (City), within Coconino County (County). See **Figure 1** and **Figure 2** for the Location and Vicinity Maps.

BACKGROUND

The purpose of this project is to connect Forest Road to SR-89A west of the existing roundabout to provide an alternate route for emergency vehicles and reduce response times during peak hours which will better serve the City and its residents located in this area.

PURPOSE

The purpose of this memo is to document the existing drainage conditions and proposed drainage improvements associated with the Forest Road Improvements. This memo discusses the methods used to develop the proposed drainage improvements and the impacts to existing drainage infrastructure.



Kimley»Horn Expect More. Experience Better.	**Forest Road Improvements**	**Sedona, AZ**
	Figure 1. Location Map	

Kimley»Horn Expect More. Experience Better.	**Forest Road Improvements**	**Sedona, AZ**
	Figure 2. Vicinity Map	

2.0 FEMA FLOODPLAIN CLASSIFICAITON

LOCAL WATERSHED

The existing topography of the project location generally slopes from north to south. The runoff generated from within the project limits flows to the south toward SR-89A and into Soldier Wash on the south side of SR-89A. Soldier Wash flows from west to east and discharges into Oak Creek.

FLOODPLAIN LOCATIONS

The project is in Flood Insurance Rate Map (FIRM) Panel Number 04005C7657G effective date September 3, 2010. The Forest Road improvements are in Zone “X”. Soldier Wash and Oak Creek located south and east of the project limits are both a Zone AE floodway and floodplain. This project will not make any changes or modifications within the floodway or floodplain. The FEMA FIRMette is included as **Figure 3.**

Zone “X” is defined by FEMA as follows:

> Areas of 0.2% annual chance flood; areas of 1% annual flood chance with average depths of less than 1 foot or with drainage areas 1 square mile; and areas protected by levees from 1% annual chance flood.

Zone “AE” is defined by FEMA as follows:

> Areas subject to inundation by the 1% annual chance flood with Base Flood Elevations (BFE’s) determined.

A floodway area in Zone AE is defined by FEMA as follows:

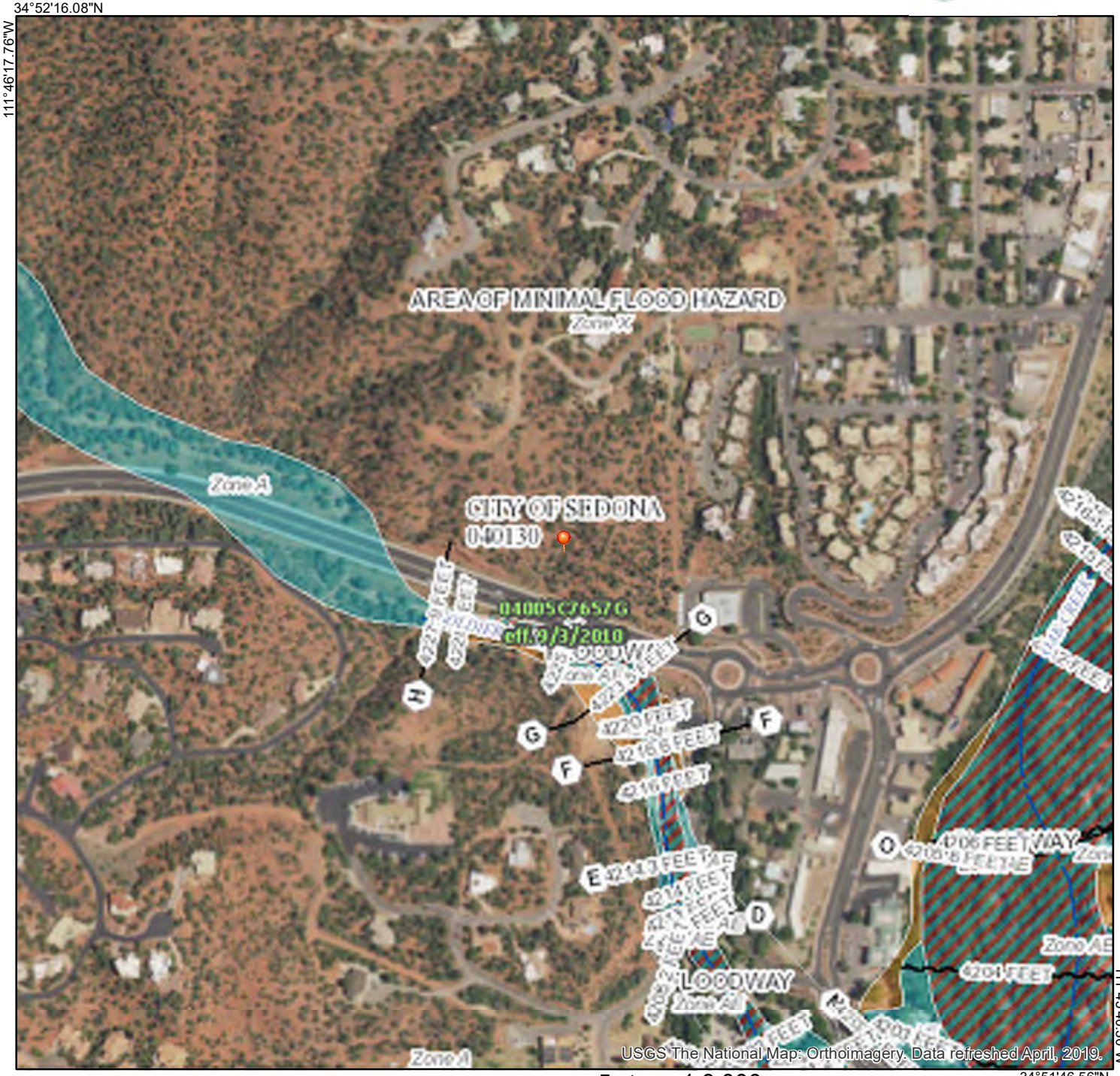
> The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

National Flood Hazard Layer FIRMette

FEMA

34°52'16.08"N

111°46'17.76"W



111°45'40.30"W

34°51'46.56"N

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

1:6,000

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/27/2020 at 5:44:38 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

3.0 EXISTING CONDITIONS

EXISTING DRAINAGE FEATURES

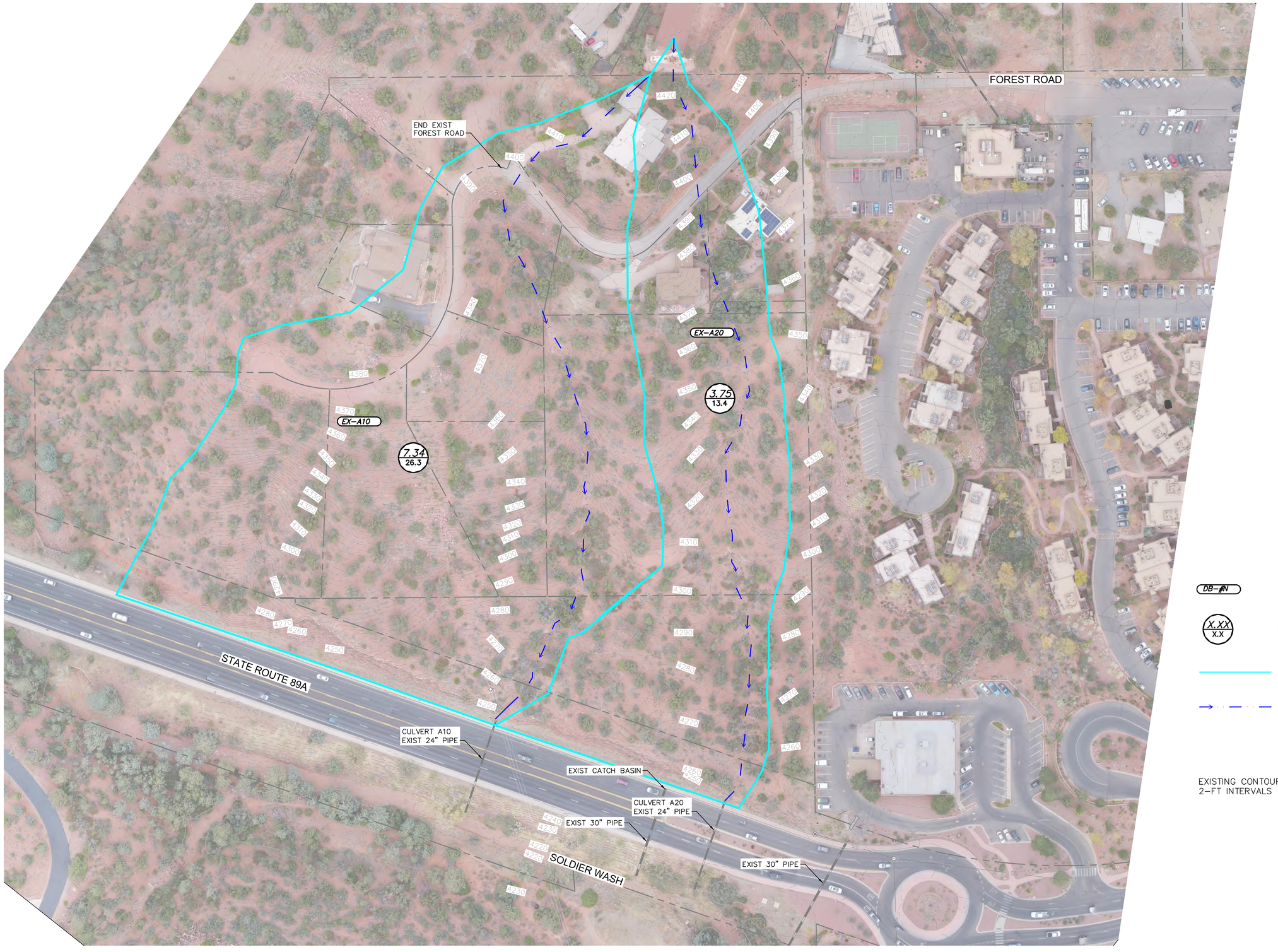
Forest Road in existing conditions is a local road without curb and gutter. It connects to SR-89A to the east and is a dead end approximately 1,500-feet west of the connection. It is the only point of access to SR-89A for several residents. Pavement runoff from Forest Road sheet flows off the roadway and into existing natural ditches that convey runoff south toward SR-89A at slopes of over 20%. The runoff generated by Forest Road and the hillside are captured in three existing culverts on the north side of SR-89A. These culverts convey the runoff under SR-89A and discharge into Soldier Wash on the south side of SR-89A. Refer to **Figure 4** for the existing drainage conditions.

4.0 PROPOSED CONDITIONS

PROPOSED DRAINAGE FEATURES

This project will install a new two-lane roadway with curb and gutter and a multi-use path connecting Forest Road at the top of the existing hillside to SR-89A at the bottom of the existing hillside. Roadside swales will be installed on the high side of the new roadway to convey off-site runoff to new culverts that will be installed under Forest Road. These new culverts will allow existing off-site runoff to be conveyed under Forest Road and toward SR-89A as it does in the existing condition. New catch basins will be installed to capture pavement runoff from Forest Road and discharge into existing ditches. Due to the existing steep slopes, retaining walls will be used where the proposed Forest Road will be constructed in large cut and fill areas.

A new culvert will be installed under Forest Road at the SR-89A connection. This culvert will discharge into a ditch on the north side of SR-89A. This ditch grading will impact an existing 24-inch culvert under SR-89A. This culvert will be extended to the north and the headwall will be reconstructed. The proposed improvements will not impact the existing drainage patterns of the project area. Refer to **Figure 5** for the proposed drainage conditions and impacts to SR-89A. Refer to **Figure 6** for the proposed drainage conditions along Forest Road.



NO.	REVISION	DATE

Kimley»Horn

7740 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=60'
SCALE (V): NONE

DESIGNED BY: SRJ
DRAWN BY: SRJ
CHECKED BY: SRJ

DATE: 06/2021

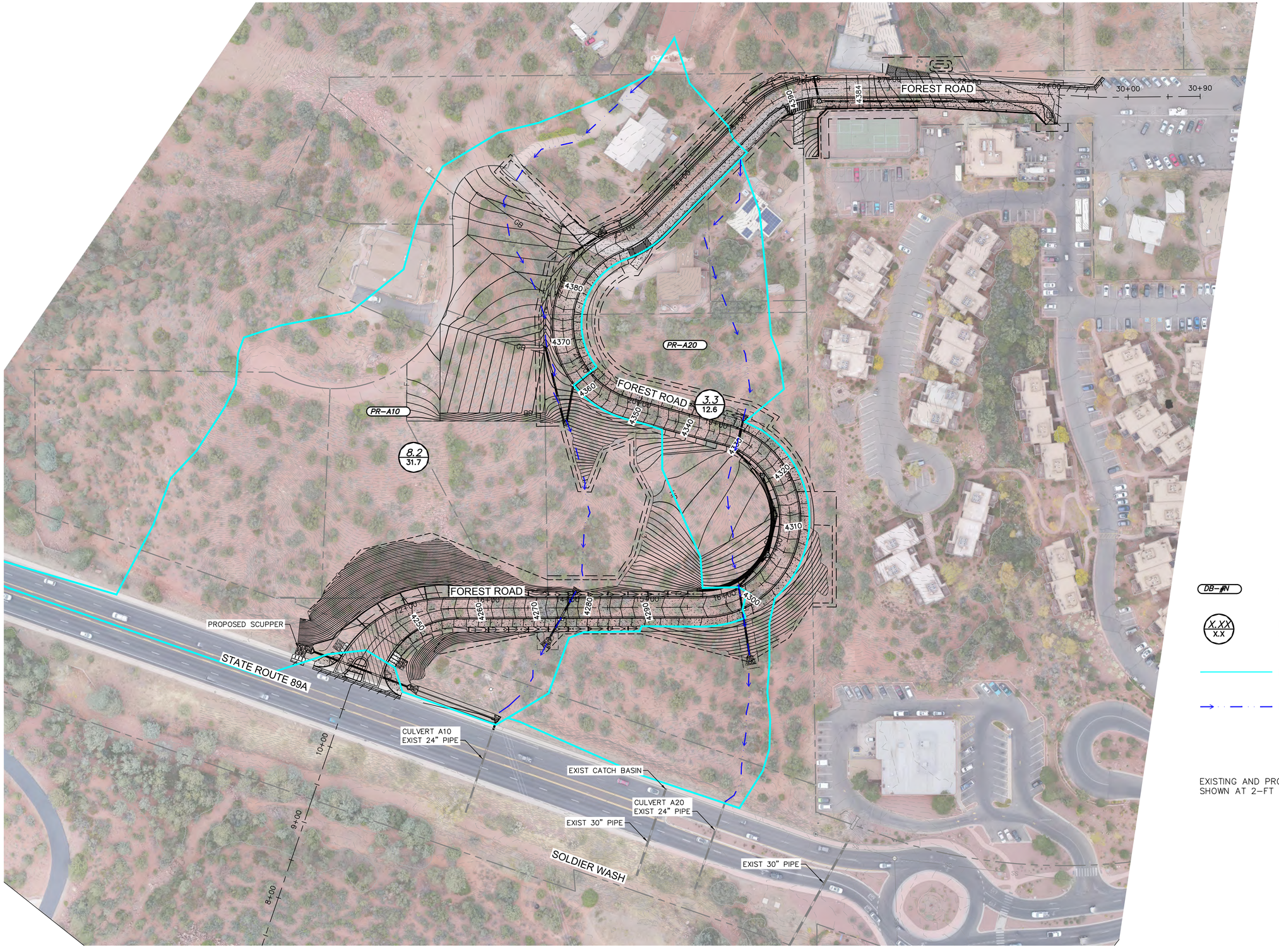
FOREST ROAD IMPROVEMENTS

FIGURE 4

EXISTING DRAINAGE – ADOT CULVERTS

PROJECT NO.
191502008

DRAWING NAME
FIGURE 4



NO.	REVISION	DATE

Kimley»Horn

7740 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944–5500

SCALE (H): 1"=60'
SCALE (V): NONE

DESIGNED BY: SRJ
DRAWN BY: SRJ
CHECKED BY: SRJ

DATE: 06/2021

FOREST ROAD IMPROVEMENTS

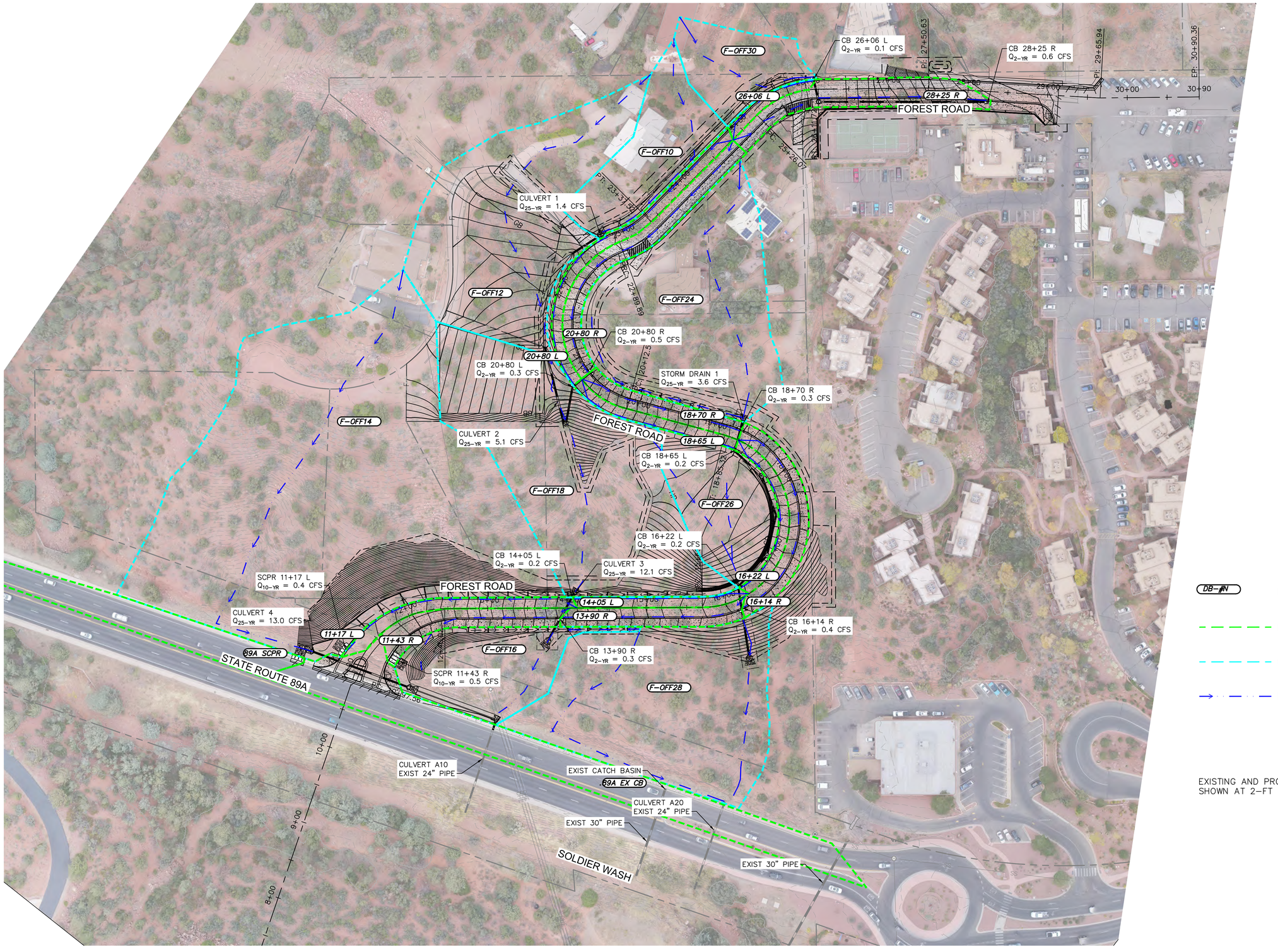
FIGURE 5

PROPOSED DRAINAGE – ADOT CULVERTS

PROJECT NO.
191502008

DRAWING NAME
FIGURE 5

1 OF 1



NO.	REVISION	DATE

Kimley»Horn

7740 North 16th Street, Suite 300
Phoenix, Arizona 85020 (602) 944-5500

SCALE (H): 1"=60'
SCALE (V): NONE

DESIGNED BY: SRJ
DRAWN BY: SRJ
CHECKED BY: SRJ

DATE: 06/2021

FOREST ROAD IMPROVEMENTS

FIGURE 6

PROPOSED DRAINAGE – FOREST ROAD

PROJECT NO.
191502008

DRAWING NAME
FIGURE 6

1 OF 1

5.0 HYDROLOGY AND HYDRAULICS

HYDROLOGY

Rainfall intensities for this project were obtained from the National Oceanic and Atmospheric Administration Atlas 14 (NOAA 14). The Rational Method was used to determine existing and proposed runoff within the project limits. The 2-year storm was used for all on-site pavement runoff and spread calculations within City right of way per the Design Review, Engineering and Administrative Manual (DREAM). Per the DREAM, one 12-foot dry lane is required for the 2-year event and the runoff shall be contained within the right-of-way for the 100-year event. The 10-year storm was used for all on-site pavement runoff and spread calculations within ADOT right of way per the ADOT Roadway Design Guidelines (RDG). Per the RDG, one 12-foot dry lane is required in each direction along SR-89A. The 25-year storm was used for all City of Sedona culverts under the new Forest Road improvements per the DREAM. The 50-year storm was used for culverts under SR-89A per the ADOT Roadway Design Guidelines (RDG). A minimum time of concentration of 10-minutes was used per the Yavapai Drainage Design Manual (YDDM) and the ADOT Highway Drainage Design Manual.

A runoff coefficient of 0.60 was used for the existing natural hillslopes and 0.95 was used for pavement for all storm events. Although the YDDM states to use a 0.85 runoff coefficient for the 2-year event, a conservative value of 0.95 was used to account for the steep slopes throughout the project limits. The improvements associated with this project have minor impacts to the runoff at each location. See **Appendix A** and **Appendix B** for detailed runoff calculations and spread calculations.

See **Table 1** below for a summary of the existing and proposed runoff contributing to the existing ADOT culverts.

Table 1. ADOT Culvert Runoff Comparison

Culvert	Existing C-Value	Existing Drainage Area [ac]	Existing Runoff 50-Year [cfs]	Proposed C-Value	Proposed Drainage Area [ac]	Proposed Runoff 50-Year [cfs]
Culvert A10	0.60	7.34	26.3	0.65	8.18	31.7
Culvert A20	0.60	3.75	13.4	0.64	3.28	12.6

See **Table 2** below for a runoff summary at the Forest Road proposed culverts.

Table 2. Forest Culvert Runoff Summary

Culvert	Drainage Area [ac]	Proposed Runoff 25-Year [cfs]	Proposed Runoff 100-Year [cfs]
Storm Drain 1	2.06	7.0	9.5
Culvert 1	0.45	1.4	1.9
Culvert 2	1.67	5.1	6.9
Culvert 3	3.62	12.1	16.3
Culvert 4	3.96	13.0	17.5

See **Table 3** below for a runoff summary for the Forest Road proposed inlets.

Table 3. Forest Inlet Runoff Summary

Inlet	Drainage Area [ac]	Proposed Runoff 2-Year [cfs]	Proposed Runoff 100-Year [cfs]
11+17 L	0.10	0.2	0.7
11+43 R	0.14	0.3	1.4
14+05 L	0.07	0.2	0.5
13+90 R	0.13	0.3	1.3
16+22 L	0.07	0.2	0.6
16+14 R	0.15	0.4	1.4
18+65 L	0.07	0.2	0.7
18+70 R	0.11	0.3	1.2
20+80 L	0.14	0.3	0.9
20+80 R	0.21	0.5	1.4
26+06 L	0.04	0.1	0.3
28+25 R	0.23	0.6	1.5

See **Table 3** below for a runoff summary for the proposed inlets within ADOT right of way.

Table 4. ADOT Inlet Runoff Summary

Inlet	Drainage Area [ac]	Proposed Runoff 10-Year [cfs]
11+17 L	0.10	0.4
11+43 R	0.14	0.5
89A SCPR	0.37	1.4
89A EX CB	0.75	3.1

HYDRAULICS

Proposed inlets along Forest Road were sized for the to provide a 12-foot travel lane in the 2-year event and to keep runoff within the right-of-way per the DREAM. MAG 532 catch basins and MAG 206 scuppers are used to capture pavement runoff. See **Appendix B** for inlet calculations.

Culvert capacity analysis was completed using HY-8. Proposed culverts under Forest Road were sized to maintain a dry crossing in the 25-year event and to allow a maximum of 12” of overtopping in the 100-year event per the DREAM. For the new culverts under Forest Road the flow at the outlet of the pipe is larger than the inlet due to the proposed catch basins that discharge into the culverts under Forest Road. The flow at the outlet of the pipe was used for the culvert hydraulics so that the maximum flow in the system is accounted for. This is a conservative approach to the culvert analysis because each of the culverts are inlet controlled meaning the capacity is determined by the runoff at the inlet of the pipe and not by the runoff at the outlet. See **Appendix B** for culvert calculations and HY-8 results.

The 50-year event was used to analyze the existing culverts under SR-89A for the existing and proposed condition. Culvert A10 is overtopping the roadway in the existing condition even with the steep slope of the existing culvert. To mitigate this issue, the swale on the north side of SR-89A will be graded deeper and a portion of the existing pipe will be removed and replaced. This will allow more headwater at the upstream end of the culvert and results in no overtopping in the proposed condition. See **Appendix B** for culvert calculations and HY-8 results.

Bentley StormCAD was used to model storm drain system one due to the multiple bends and catch basins. The 25-year event was used to analyze this system because it receives off-site flow similar to the other culverts. See **Appendix B** for storm drain calculations and StormCAD results.

Riprap will be installed at the upstream and downstream ends of proposed culverts and check dams will be installed within new ditches. These approaches will reduce erosion, reduce velocities of the runoff, and help with water quality.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The improvements associated with this project will not impact the existing drainage patterns. Culverts will be installed under Forest Road so that drainage patterns are maintained. Riprap at culverts and check dams will be used to slow the velocity of the runoff in ditches and to help with water quality before reaching SR-89A. The existing culverts at SR-89A will have similar capacity in the proposed condition. A new inlet will be installed along SR-89A to capture runoff before traveling across the new Forest Road connection.

7.0 REFERENCES

City of Sedona, *Design Review, Engineering and Administrative Manual,* May 2019.

Yavapai County, *Drainage Design Manual,* July 2015.

Coconino County, *Drainage Design Criteria,* January 2001.

Arizona Department of Transportation, *Roadway Design Guidelines,* April 2014.

Arizona Department of Transportation, *Highway Drainage Design Manual – Hydraulics,* January 2007.

Arizona Department of Transportation, *Highway Drainage Design Manual – Hydrology,* 2014.

National Oceanic and Atmospheric Administration, NOAA Atlas 14, Precipitation-Frequency Atlas of the United States, 2011

APPENDIX FOR DRAINAGE REPORT CAN BE PROVIDED UPON REQUEST