Civil Engineering
Surveying
Water Resources Management
Water & Wastewater Engineering
Construction Management
Environmental Sciences
Landscape Architecture
Land Planning

CONCEPTUAL DRAINAGE STUDY FOR THE PLATEAU DEVELOPMENT

Carson City, Nevada

Prepared for:

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Job No. TIVCCNV01
October 17, 2018

PROFESSIONAL ENGINEER - STATE OF NEVADA
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10/17/18
CIVIL
No. 14728
Exp:12/31/18

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ABBREVIATIONS

Ac-ft	Acre-feet
CCMC	Carson City Municipal Code 2005
cfs	Cubic feet per second
CMP	Corrugated Metal Pipe
CN	SCS Curve Number
DEM	Digital Elevation Model
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
ft	Foot
ft^2	Square foot
ft^3	Cubic foot
fps	Feet per second
GIS	Geographical Information System
HEC-HMS	USACE Hydrologic Engineering Center Hydrologic Modeling System
HSG	Hydrologic Soil Group
Max.	Maximum
Min.	Minimum
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NV	Nevada
RCBC	Reinforced Concrete Box Culvert
ROW	Right of Way
SCS	Soil Conservation Service (aka Natural Resources Conservation Service)
TMRDM	Truckee Meadows Regional Drainage Design Manual
USACE	United States Army Corp of Engineers
USGS	United States Geologic Survey
vel.	Velocity

1 INTRODUCTION

1.1 Purpose of Study

This report presents the data, hydrologic and hydraulic analyses, and conclusions of a conceptual drainage study performed for the Plateau Project. The information, data, and calculations presented herein are intended to provide conceptual drainage information for the Plateau Tentative Map and remainder rezoned parcels in accordance with the Carson City Municipal Code. This report documents the existing drainage conditions of the project site, presents the proposed drainage system, and includes summaries of analyses evaluating storm flows and proposed mitigations.

Referencing the tentative map plans will aid in the understanding of this report. Future Final Maps will incorporate a technical drainage report supporting the final design of improvements.

This conceptual report documents the existing and proposed conditions of the project for a range of rainfall events. The following are addressed herein:

- Existing information for project site and drainage basin
- Hydrologic analyses for existing site condition and proposed developed condition
- Proposed drainage facilities for drainage management
- Compliance with Carson City Municipal Code 2005 (CCMC) and other applicable ordinances

1.2 Project Location and Description

The Plateau project site is in eastern Carson City, south of U.S. Highway 50 in the area of Drako Way, located in Township 15 North, Range 20 East in portions of Sections 1 and 12. Figure 1-1 shows the location of the project site. The Plateau Development and remainder parcels have the following characteristics:

- 270 Single Family Residential lots on 67.89 acres
- 18.53 acres Multi-Family
    - Estimated 250 EDUs
- 13.81 acres General Commercial

The overall drainage catchment is 262 acres.

The site is not located in a FEMA flood zone. Relevant FEMA flood maps define the area as *outside the 0.2% annual chance flood.* Exhibit 1 shows the FEMA flood zone mapping adjacent to Plateau.

1.3 Drainage Patterns

Drainage to, and through, the site is from a 262-acre catchment that is roughly bounded by Rifle Range Road to the east and Astro Drive to the north. Drainage flows westerly through the proposed SFR site to a location just south of the intersection of Morgan Mill Road and Drako Way. Downgradient drainage then continues ~1,000 feet to the Carson River near the intersection of North Deer Run Road and Brunswick Canyon Road before entering the Carson River. Existing conditions at the site include ~85 acres of previously mass graded site with slopes ranging from 2.5 to 4.5 percent and land cover consisting of some bare earth, and areas of sagebrush and grass understory in fair to good condition. There is a fair amount of land disturbance from off highway vehicle use on the property site. Photos of site were collected and are and are contained in Appendix F. Onsite and offsite undisturbed areas consist of sagebrush with grass understory in good condition with sparse Pinyon Pine-Juniper on the upper catchment areas. Slopes range from 5 to 20 percent in the upper offsite catchment. Offsite and onsite soils are classified as very high runoff potential with hydrologic soil group type D soils.

The subject site includes the Old Carson City Landfill (Facility ID # A-000050). The old landfill has been previously capped and NDEP has required that a stormwater management plan (SWMP) be developed for the old landfill site which will be Common Open Space and mitigated with grading and drainage under the proposed conditions. A draft SWMP is currently on file with NDEP with a final SWMP due after acceptance of a tentative map.

Figure 1-1: Plateau Location Map

[Google Maps: https://www.google.com/maps/search/google+maps/@39.1897644,-119.7016629,4292m/data=!3m1!1e: accessed 10/10/2018]

2 METHODOLOGY AND ASSUMPTIONS

The offsite and onsite drainage areas total 0.4 square miles (262 acres). This conceptual report documents the following:

- Pre-development hydrology
- Post-development hydrology and mitigation
- Hydraulic analysis of flow in proposed roadways and catch basins

This conceptual drainage study for the Plateau Development and remainder parcels adheres to the 2005 CCMC requirements for conceptual studies including sections *14.2 Technical Criteria*, *14.6 Submittal and Review* process, and *14.8 Conceptual Drainage Study*. Per table 14.1 of the CCMC, the SCS TR-55 computation procedure is used as the Contributing Basin Area is over 100 acres. For the on-site storm drain system analysis, the Rational Method and Manning's Equation are used to show compliance with *Table 14.2 Design Storm Street Capacity Limitations* of the CCMC.

2.1 Hydrologic Methods

The hydrologic analysis for on- and offsite peak flows is performed using version 4.2 of the USACE HEC-HMS flood hydrograph software. The HEC-HMS model represents the response of a watershed to a storm event and estimates peak flow and runoff volume. The hydrology uses the SCS unit hydrograph method which routes peak flows through a defined basin area. GIS data is used in the ArcMap 10.5 software to develop the hydrologic and hydraulic parameters for use in HEC-HMS. The drainage basin overlain on local topography for existing and proposed conditions are illustrated in Exhibits 2 and 3, respectively.

Parameters for peak storm flow and runoff volume estimates are determined using the CCMC. The TMRDM and/or the other appropriate sources and software user manuals are used to augment the CCMC. Parameter calculations for peak storm flow and runoff volume estimates are determined using the methodologies specified within the CCMC and the TMRDM and are contained in Appendix A. These parameters are reflected in Exhibits 2 and 3. Rainfall data for Carson City is obtained from the NOAA database website that can be found at the following link and included in Appendix A:

- https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html?bkmrk=nv

Rainfall depths are distributed using a frequency storm for the 5-, 15-minute, 1-, 2-, 3-, 6-, 12-, and 24-hour durations.

Table 2-1: NOAA Storm Depths for Plateau

Storm Event	*Rainfall Depth (in)*
5yr-24hr	1.76
10yr-24hr	2.05
25yr-24hr	2.46
100yr-24hr	2.78

2.2 Existing and Proposed Conditions Sub-Basin Delineation

Exhibits 2 and 3 show the drainage basin delineation for the existing and proposed conditions, respectively. The catchment boundary is delineated as all land area on which rain falls that flows out through the developed area. Onsite existing drainage patterns are estimated from pre-2006 aerial mapping and the patterns that currently exist. The 2017 USGS Reno-Carson-Lyon LIDAR DEM is used to develop 2-foot contours for catchment delineation and drainage patterns.

HEC-HMS is utilized to model stormwater runoff for the existing and proposed conditions. The hydrologic modeling uses the SCS methodology per the CCMC and TMRDM, which estimates runoff based on drainage area, lag time or time of concentration, the HSG, land cover/use, and rainfall. The method used to determine rainfall abstraction and runoff method within the model is the SCS curve number method. The SCS curve number method uses the runoff curve number (CN) loss rate, related to potential abstraction.

$$CN = \frac{1000}{S + 10}$$

where: S (in.) = initial abstraction

The CN represents the "runoff potential" of a given land use/cover and HSG within the drainage basin. The CN is determined based on the HSG per the *USDA National Cooperative Soil Survey*. This soil report is contained in Appendix B. The basin that drains through the Plateau development is composed almost entirely of HSG D soils with high runoff potential. Appendix A contains the parameter calculations for area weighted CNs, lag time, and the relevant TMRDM references. Soil HSG data is obtained from the NRCS database (https://gdg.sc.egov.usda.gov/) from shapefiles of the sub-basins exported from ArcMap. The CN uses the sagebrush with grass understory in good condition for undeveloped areas. Other CN determinations are per the calculations in Appendix A and assume an antecedent moisture condition (AMC) 2.

Lag time is defined as the time elapsed between the center of mass rainfall excess to the center of mass of the resulting runoff hydrograph. This method uses the calculated lag time to determine the runoff hydrograph and peak runoff for each sub-basin. The lag time is calculated using two different methods as shown in Appendix A.

2.3 Hydraulic Methods

Hydraulic calculations are performed for open channel flow in the street sections using the software package Bentley FlowMaster. The proposed development contains street ROW with widths of 50 and 60 feet. Flow conditions are analyzed for both ROWs for slopes that are representative of the proposed streets. FlowMaster is used to determine the maximum allowable flow rate for each ROW that ensures the CCMC requirement of maintaining a 12-foot-wide dry lane across the crown of the road. The FlowMaster results are presented in Appendix D. These results are also used to determine the maximum area a catch basin can drain according to the rational method. A summary of the maximum area a catch basin can drain for a given street slope and rainfall depth are included in Appendix E. The placement of catch basins to meet required dry lane width meet or exceeded the 5-year and 100-year storm events required per section *14.2 Technical Criteria* of the CCMC.

3 HYDROLOGY RESULTS

This section presents the results of the hydrologic analysis for the existing and proposed conditions.

3.1 Existing Drainage Results

Rainfall on the pre-development drainage basin flows in a western or north-western direction. A hillslope located on the south and west quadrants of the basin direct flow away from the Carson River and towards US Highway 50. The existing basin and a representative flow path are illustrated in Figure 3-1 and Exhibit 2. To demonstrate how existing runoff drains from the catchment, a 24-hour duration rain event for the 10- and 100-year recurrence intervals is estimated for this site. The NOAA rainfall record used for this study is in Appendix A and summarized in Table 2-1.

Figure 3-1: Existing Conditions HEC-HMS Basin and Routing

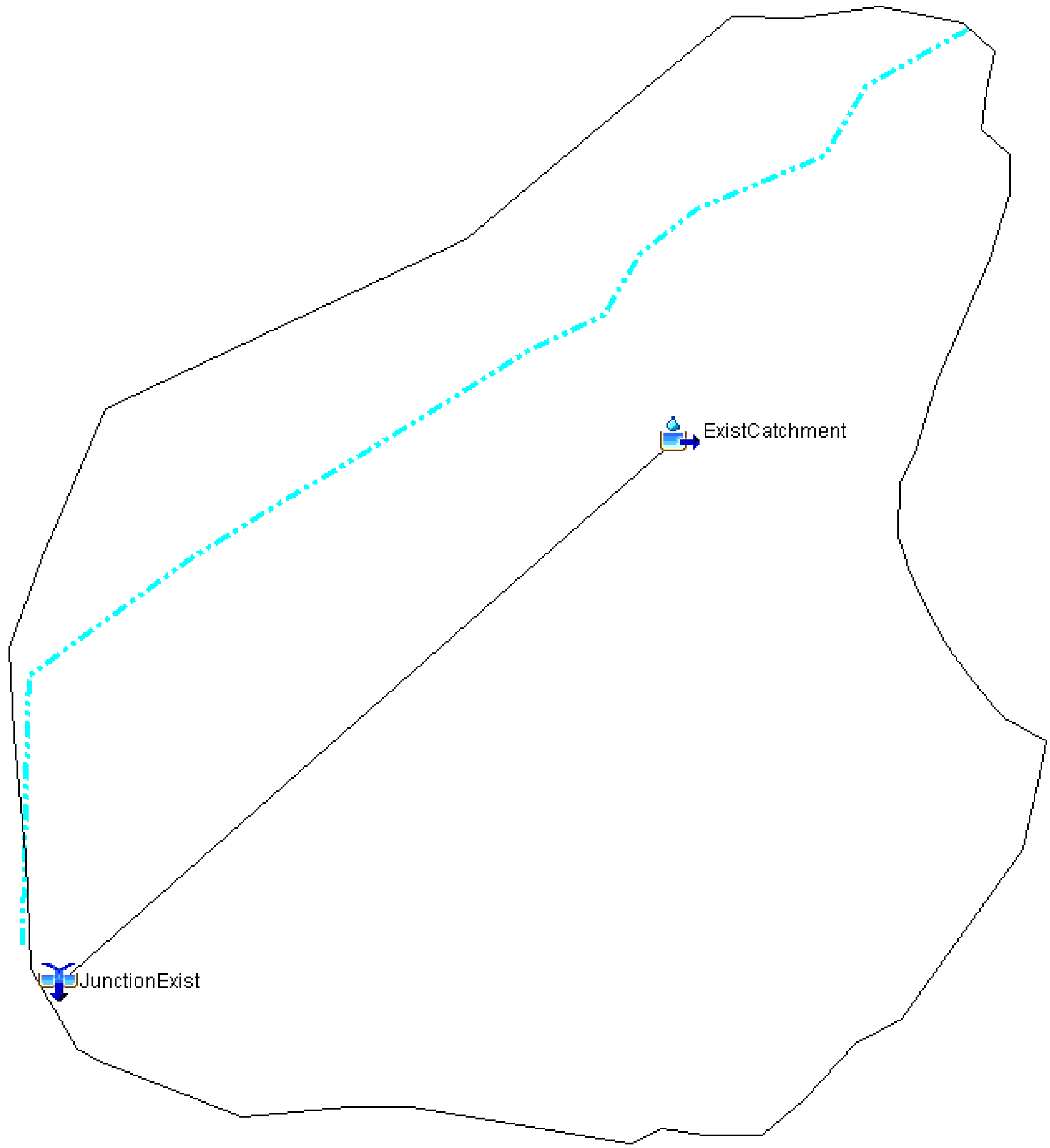


Table 3-1 summarizes the peak flow for existing and proposed conditions. Reference Appendix E for the complete hydrologic parameter estimates.

Table 3-1: Existing and Proposed Conditions Peak Flow Summary

Sub-Basin	*10-Yr (cfs)*	*100-Yr (cfs)*
EXIST-1	97.8	290.9
PROP-1	101.0	281.0

Table 3-2 summarizes the pre- and post-project runoff volume.

Table 3-2: Existing and Proposed Conditions Runoff Volume Summary

Sub-Basin	*10-Yr (ac-ft)*	*100-Yr (ac-ft)*
EXIST-1	*13.8*	*30.4*
PROP-1	*15.8*	*33.4*

3.2 Proposed Drainage Results

The proposed onsite drainage is modeled for identical storm conditions. To represent the proposed conditions in HEC-HMS, a weighted CN and modified time of concentration accounting for the existing and proposed land cover and increased impervious area is used. Results are presented in Table 3-1 and Table 3-2.

Per the CCMC, detention facilities are required to mitigate the proposed conditions peak flow to the existing conditions peak flow according to the following criteria (CMC Section 14.8):

1. Onsite detention storage shall be sized to detain enough runoff to limit flows from a five (5) year storm (Q5) to their predevelopment condition

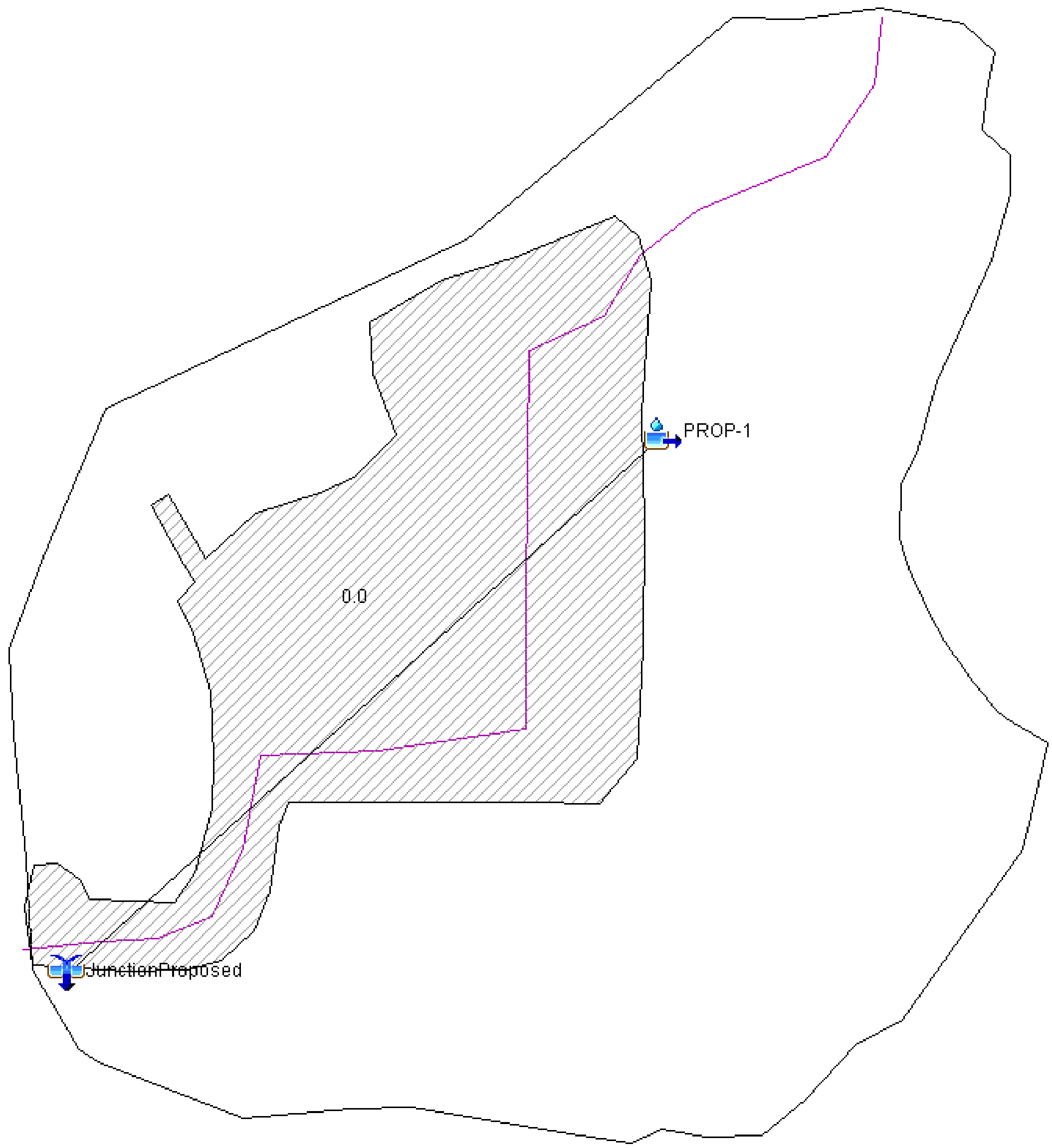
2. Design Storm Events. Drainage facilities shall be designed to convey the run off for the twenty-four (24) hour duration storm with a recurrence interval for a minor storm (5-year) and major storm event (100-year).

This study, modeling, and improvements assume use the 10-year storm input data in place of the 5-year storm in anticipation of a future change to the CCMC. Design consideration is given to the 100-year storm event. Refer to Appendix A and Appendix C for all data and supporting calculations using the HEC-HMS model.

Figure 3-2 shows the proposed conditions HEC-HMS basin and routing.

Appendix C contains the global summary from the existing and proposed conditions HEC-HMS models.

Figure 3-2: Proposed Conditions HEC-HMS Basin and Routing



4 HYDRAULIC RESULTS

This section presents the hydraulic calculations for the prosed conditions street flow and catch basin placement.

4.1 Street Flow Results

Table 14.2 - Design Storm Street Capacity Limitations of the CCMC requires that street capacity for the 5-year storm results in a dry twelve (12) foot land across the road crown. Street flow capacity estimates to convey the 100-year flows are computed using the Bentley FlowMaster software. A range of street slopes representative of the proposed development roadways are analyzed to determine the maximum carrying capacity of the roadway while maintaining the dry lane centered on the road crown. The results show that the proposed street slopes and catch basin locations convey flows while preserving the dry center lane for 5-year and 100-year storm events.

The hydraulic results summarized in Appendix E and the FlowMaster output is contained in Appendix D.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 General Considerations

This study is intended to be a conceptual drainage analysis in support of the Plateau Development and rezoned remainder parcels. Further progress towards a final design of the Plateau Development or rezoned remainder parcel sites will include a technical drainage report specific to the final civil design.

The hydrologic analysis and hydraulic calculations presented in this report shows that the proposed storm water facilities meet or exceed the drainage performance required to mitigate post-project flows to below the pre-project conditions.

5.2 Regulations

The proposed improvements and the analyses presented herein are in accordance with drainage regulations and guidance presented in the CCMC, the TMRDM. Other appropriate sources and software user manuals are used to the standard of care in the engineering industry.

5.3 Impacts to Adjacent Properties

The performance of the proposed conceptual improvements, roadways, and storm water conveyance facilities should not adversely impact upgradient or downstream properties adjacent to this site within the context of the CCMC requirements and limitations of this conceptual report. The development of the site for the uses proposed should not significantly increase upstream or downstream storm flow runoff rates, volumes, velocities, depths, and should not influence floodplain boundaries. A future technical drainage report will address pre- and post-project potential impacts in greater detail.

5.4 Standards of Practice

This conceptual drainage report has been prepared using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable professional engineers practicing in this and similar localities.

6 REFERENCES

Carson City Government (2005). *Carson City Municipal Code*. Retrieved from: https://library.municode.com/nv/carson_city/codes/code_of_ordinances?nodeId=CANEMUCO2005

Truckee Meadows Water Authority (2009). *Truckee Meadows Regional Drainage Design Manual*. Retrieved from: http://documents.wrwc.us/files/Truckee%20Meadows%20Regional%20Drainage%20Manual.pdf

USDA (June 1986). *Urban Hydrology for Small Watersheds TR-55*. Retrieved from: https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1044171.pdf

Exhibit 1: FEMA FIRM

NOTES TO USERS

use in administering the National Flood Insurance Program. It ...arily identify all areas subject to flooding, particularly from local ... of small size. The **community map repository** should be ...ssible updated or additional flood hazard information.

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... **Flood Elevations** shown on this map apply only landward ... American Vertical Datum of 1988 (NAVD 88). Users of this ... aware that coastal flood elevations are also provided in the ...illwater Elevations table in the Flood Insurance Study report ...on. Elevations shown in the Summary of Stillwater Elevations ... used for construction and/or floodplain management purposes ...igher than the elevations shown on this FIRM.

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...Services

...Survey

...Highway
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... elevation, description, and/or location information for **bench marks** ... map, please contact the Information Services Branch of the ...ic Survey at **(301) 713-3242**, or visit its website at ...aa.gov/.

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...**estions about this map** or questions concerning the National ...Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) ...A website at http://www.fema.gov/.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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.

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A)	Cross section line
(23)- - - -(23)	Transect line
97°07'30", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275000 N	1000-meter Universal Transverse Mercator grid ticks, zone 11
6000000 M	5000-foot grid ticks: Nevada State Plane coordinate system, west zone (FIPSZONE 2703), Transverse Mercator
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Carson City Planning Dept, 2621 Northgate Lane, Suite 62, Carson City, Nevada 89706 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE
May 24, 1974
FLOOD HAZARD BOUNDARY MAP REVISIONS
January 7, 1977
FLOOD INSURANCE RATE MAP EFFECTIVE
March 4, 1986
FLOOD INSURANCE RATE MAP REVISIONS
March 16, 1989 September 30, 1993 October 16, 1996
January 16, 2009 - to add and update roads and road names, to update map format, to change Special Flood Hazard Areas based on updated topographic information, to convert to a new vertical datum, and to incorporate previously issued Letters of Map Revision.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0104E

FIRM
FLOOD INSURANCE RATE MAP

CARSON CITY, NEVADA
INDEPENDENT CITY

PANEL 104 OF 275
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CARSON CITY	320001	0104	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
32000101 04E

MAP REVISED
JANUARY 16, 2009

Federal Emergency Management Agency

NOTES TO USERS

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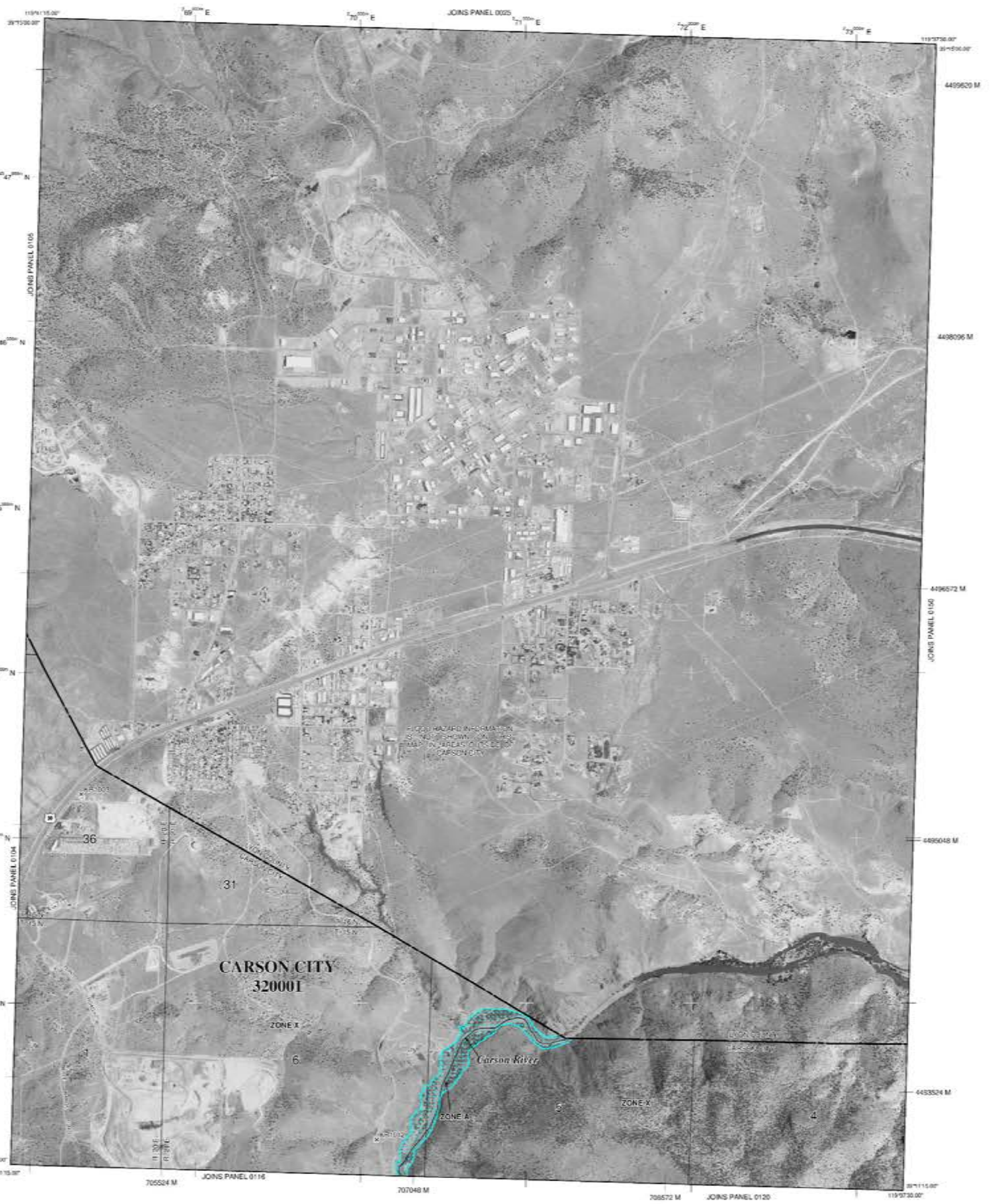

LEGEND

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ZONE A — No Base Flood Elevations determined.

ZONE AE — Base Flood Elevations determined.

ZONE AH — Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO — Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR — Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 — Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V — Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE — Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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.

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~~ 513 ~~~~ Base Flood Elevation line and value; elevation in feet*

(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)——(A) Cross section line

(23)- - - -(23) Transect line

97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)

$^{42}75^{000m}$N 1000-meter Universal Transverse Mercator grid ticks, zone 11

6000000 M 5000-foot grid ticks: Nevada State Plane coordinate system, west zone (FIPSZONE 2703), Transverse Mercator

DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)

• M1.5 River Mile

MAP REPOSITORY
Carson City Planning Dept, 3621 Northgate Lane, Suite 62, Carson City, Nevada 89706 (Maps available for reference only, not for distribution.)

INITIAL NFIP MAP DATE
May 24, 1974
FLOOD HAZARD BOUNDARY MAP REVISIONS
January 7, 1977
FLOOD INSURANCE RATE MAP EFFECTIVE
March 4, 1986
FLOOD INSURANCE RATE MAP REVISIONS
March 16, 1989 September 30, 1993 October 16, 1996

January 16, 2009 – to add and update roads and road names, to update map format, to change Special Flood Hazard Areas based on updated topographic information, to convert to a new vertical datum, and to incorporate previously issued Letters of Map Revision.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0110E

FIRM
FLOOD INSURANCE RATE MAP

CARSON CITY,
NEVADA
INDEPENDENT CITY

PANEL 110 OF 275
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CARSON CITY	[illegible]	[illegible]	[illegible]

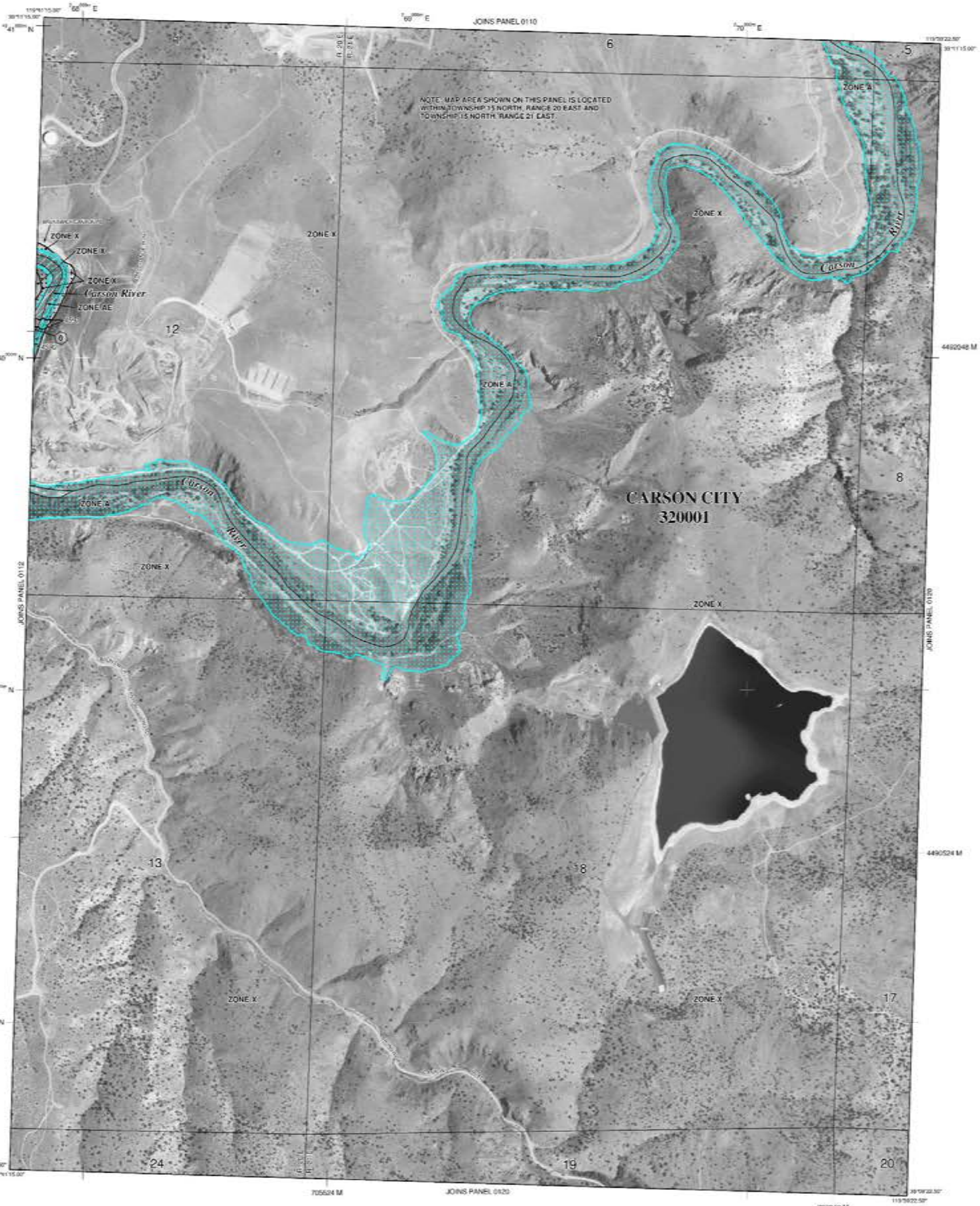
Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
32000101110E

MAP REVISED
JANUARY 16, 2009

Federal Emergency Management Agency
~~~~

NOTES TO USERS



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

OTHER AREAS

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

MAP SCALE 1" = 500'

PANEL 0116E

NATIONAL FLOOD INSURANCE PROGRAM

NFIP

FIRM

FLOOD INSURANCE RATE MAP

CARSON CITY,
NEVADA
INDEPENDENT CITY

PANEL 116 OF 275

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX

MAP NUMBER
320001 0116E

MAP REVISED
JANUARY 16, 2009

Federal Emergency Management Agency

NOTES TO USERS

use in administering the National Flood Insurance Program. It arily identify all areas subject to flooding, particularly from local of small size. The **community map repository** should be ssible updated or additional flood hazard information.

detailed information in areas where **Base Flood Elevations oodways** have been determined, users are encouraged to consult es and Floodway Data and/or Summary of Stillwater Elevations within the Flood Insurance Study (FIS) report that accompanies rs should be aware that BFEs shown on the FIRM represent foot elevations. These BFEs are intended for flood insurance only and should not be used as the sole source of flood ation. Accordingly, flood elevation data presented in the FIS be utilized in conjunction with the FIRM for purposes of or floodplain management.

Flood Elevations shown on this map apply only landward American Vertical Datum of 1988 (NAVD 88). Users of this aware that coastal flood elevations are also provided in the llwater Elevations table in the Flood Insurance Study report on. Elevations shown in the Summary of Stillwater Elevations used for construction and/or floodplain management purposes igher than the elevations shown on this FIRM.

floodways were computed at cross sections and interpolated ections. The floodways were based on hydraulic considerations equirements of the National Flood Insurance Program. Floodway er pertinent floodway data are provided in the Flood Insurance this jurisdiction.

t in Special Flood Hazard Areas may be protected by **flood res**. Refer to Section 2.4 "Flood Protection Measures" of ance Study report for information on flood control structures n.

used in the preparation of this map was Universal Transverse zone 11. The **horizontal datum** was NAD83, GRS1980 ences in datum, spheroid, projection or UTM zones used in f FIRMs for adjacent jurisdictions may result in slight positional map features across jurisdiction boundaries. These differences accuracy of this FIRM.

on this map are referenced to the North American Vertical . These flood elevations must be compared to structure and rs referenced to the same **vertical datum**. For information rsion between the National Geodetic Vertical Datum of 1929 American Vertical Datum of 1988, visit the National Geodetic at http://www.ngs.noaa.gov/ or contact the National Geodetic llowing address:

Services

Survey

Highway
-20910-3282

elevation, description, and/or location information for **bench marks** map, please contact the Information Services Branch of the ic Survey at **(301) 713-3242**, or visit its website at aa.gov/.

ation shown on this FIRM was provided in digital format by the griculture Imagery Program (NAIP). This information etrically compiled at a scale of 1:12,000 from aerial photography

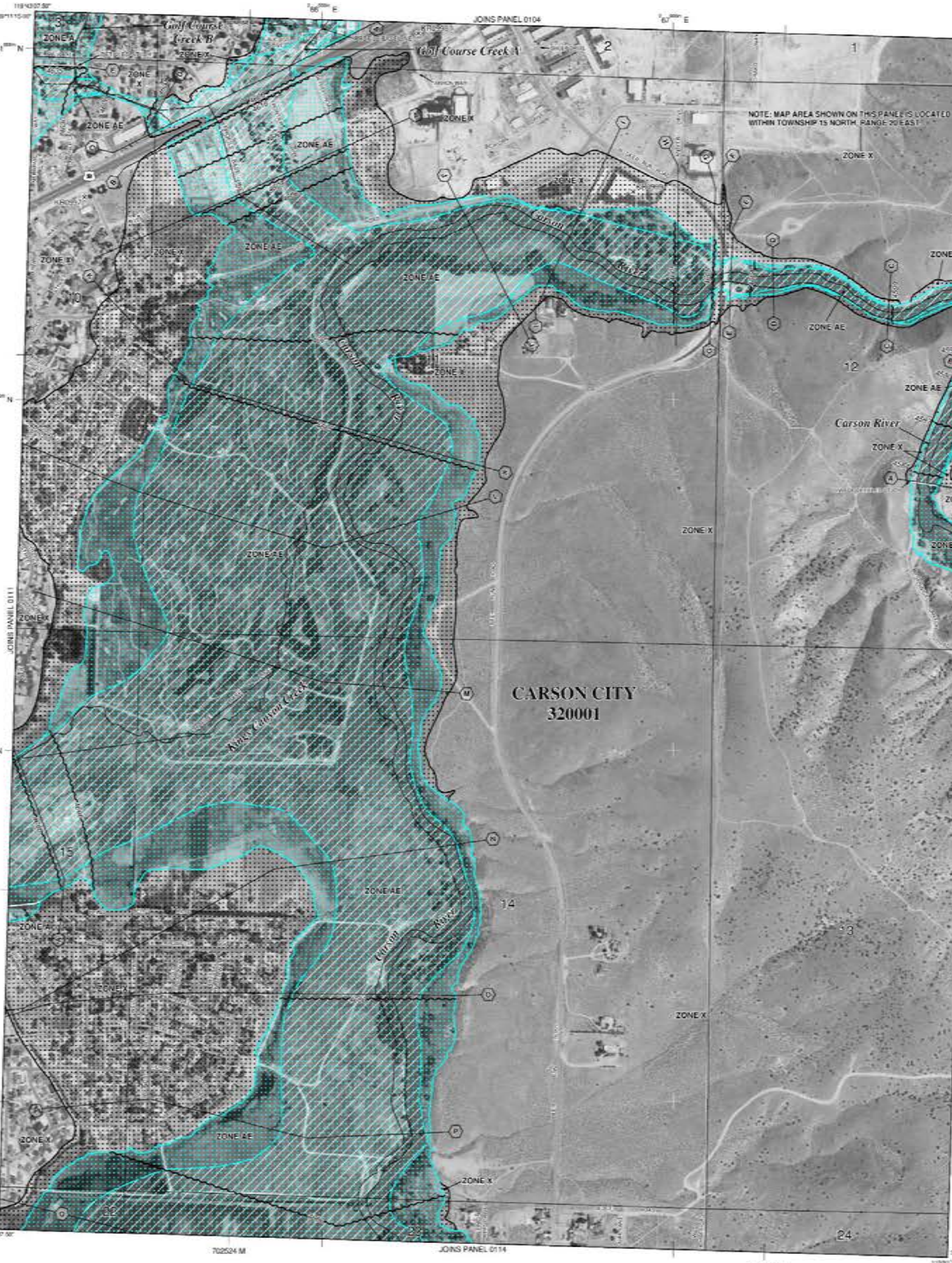
more detailed and up-to-date **stream channel configurations** on the previous FIRM for this jurisdiction. The floodplains that were transferred from the previous FIRM may have been nform to these new stream channel configurations. As a d Profiles and Floodway Data tables in the *Flood Insurance* hich contains authoritative hydraulic data) may reflect stream s that differ from what is shown on this map.

s shown on this map are based on the best data available blication. Because changes due to annexations or de-annexations rred after this map was published, map users should contact munity officials to verify current corporate limit locations.

the separately printed **Map Index** for an overview map showing p panels for this jurisdiction.

MA Map Service Center at 1-800-358-9616 for information on ts associated with this FIRM. Available products may include d Letters of Map Change, a *Flood Insurance Study* report, rsions of this map. The FEMA Map Service Center may also be at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

estions about this map or questions concerning the National Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) A website at http://www.fema.gov/.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

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.

OTHER FLOOD AREAS

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

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~~ 513 ~~~ Base Flood Elevation line and value; elevation in feet*
(EL 987) Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

(A)———(A) Cross section line
(23)- - - -(23) Transect line
97°07'30", 32°22'30" Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N 1000-meter Universal Transverse Mercator grid ticks, zone 11
6000000 M 5000-foot grid ticks: Nevada State Plane coordinate system, west zone (FIPSZONE 2703), Transverse Mercator
DX5510 × Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5 River Mile

MAP REPOSITORY
Carson City Planning Dept, 3801 Northgate Lane, Suite 62, Carson City, Nevada 89706 (Maps available for reference only, not for distribution.)

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To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000 FEET
150 0 150 300 METERS

NFIP
NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0112E

FIRM
FLOOD INSURANCE RATE MAP

CARSON CITY,
NEVADA
INDEPENDENT CITY

PANEL 112 OF 275
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
CARSON CITY	320001	0112	E

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
32000101112E

MAP REVISED
JANUARY 16, 2009

Federal Emergency Management Agency
~~~

Exhibit 2: Existing Conditions Hydrology Map

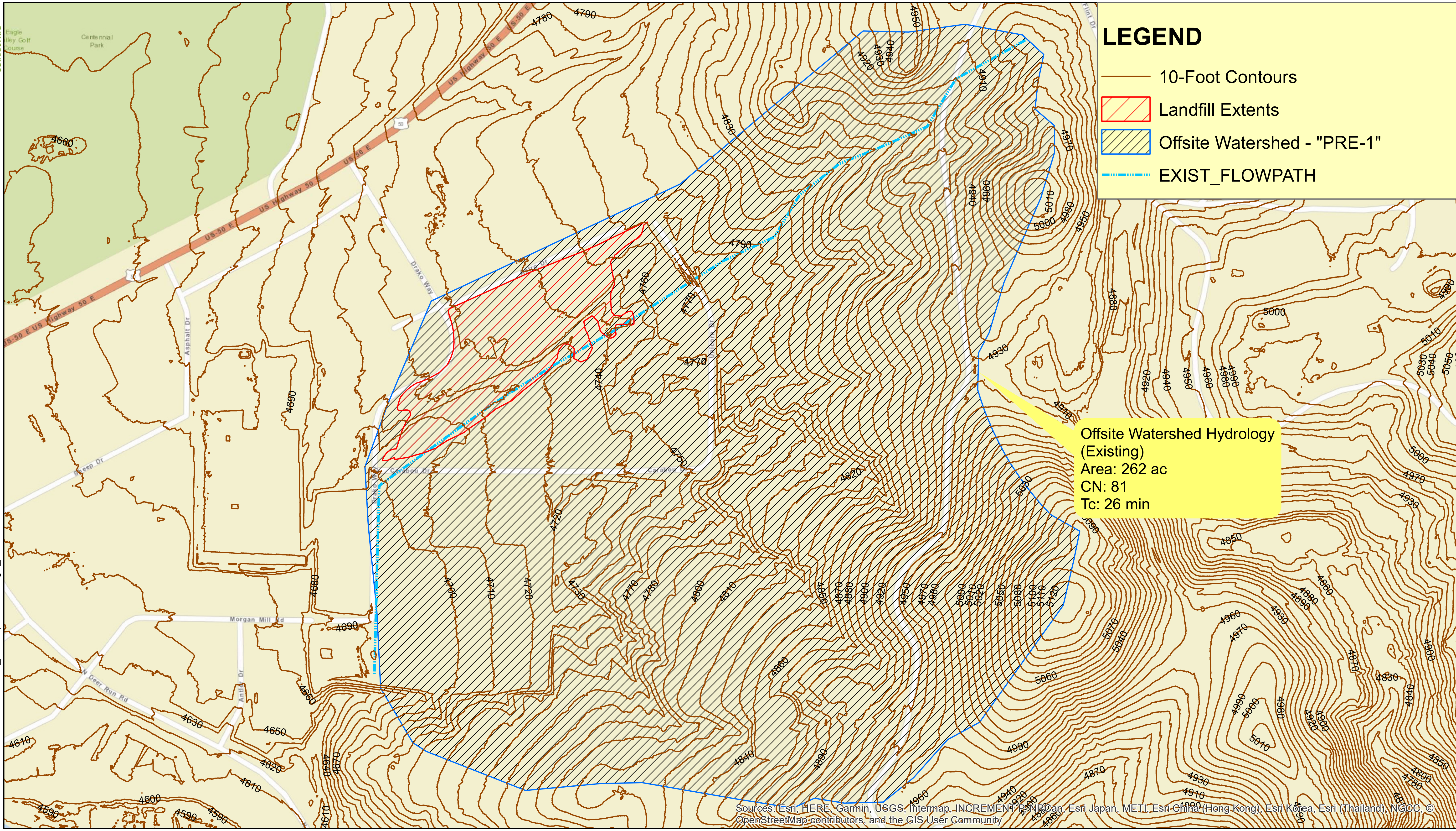

EXHIBIT 2: EXISTING CONDITIONS - HYDROLOGY

Plateau Development
Carson City | Nevada

Date Created: 10/17/2018

Prepared for:
Mr. Keith Serpa
Tahoe IV, LLC.
P.O. Box 1724
Carson City, Nevada 89702

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Exhibit 3: Proposed Conditions Hydrology Map

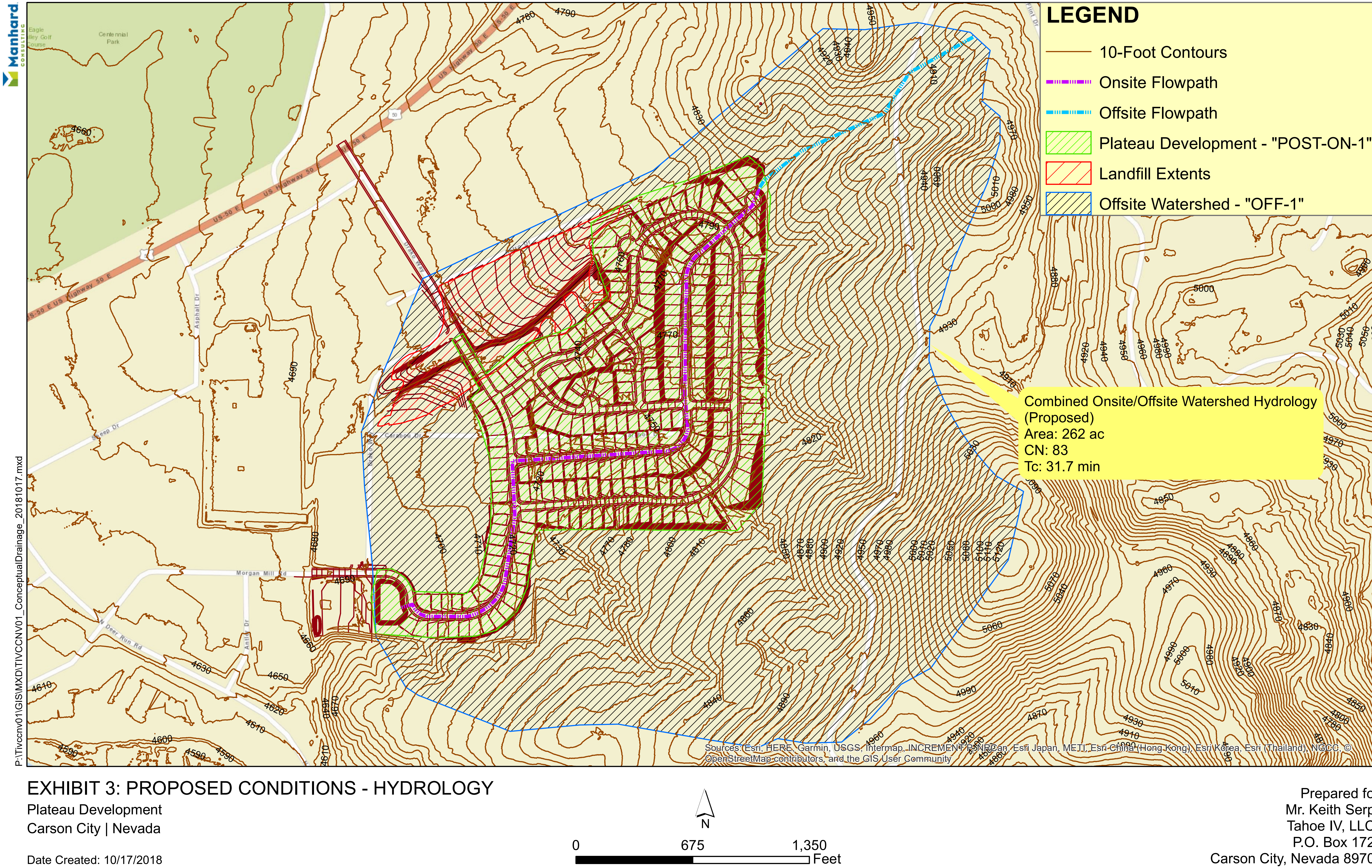


EXHIBIT 3: PROPOSED CONDITIONS - HYDROLOGY

Plateau Development
Carson City | Nevada

Date Created: 10/17/2018

Prepared for:
Mr. Keith Serpa
Tahoe IV, LLC.
P.O. Box 1724
Carson City, Nevada 89702

Appendix A: HEC-HMS Parameter Calculations

APPENDIX A - HEC-HMS Parameters

Manhard CONSULTING LTD
241 Ridge Street, Suite 400, Reno, Nevada 89501
(775)746-3500

Project: PLATEAU DEVELOPMENT
Subject: Tentative Map Conceptual Hydrology
Client: Tahoe IV LLC
Job Code: TIV.CCNV01.00
Date: 10/10/2018
By: KANKENBAUER
Checked: CANDERSON

PLATEAU EXISTING DRAINAGE

HEC-HMS INPUT DATA

Assumptions:

- Soil cover conditions is Fair with average 50% vegetation cover
- Hydrologic Soil Groups (HSG) are 99.7% group D, 0.3% group C; assume HSG D for all
- Directly connected impervious is negligable and 0% of offsite catchment areas
- Directly connected impervious is incorporated as lumped parameter in developed and proposed areas
- Depth Area Reduction Factor is not applicable
- For methodology not included in the Carson City Code, the Truckee Meadows Regional Drainage Manual (TMRDM) is used
- TLAG method is not applicable and use $0.6t_c$ LagTime estimate

Curve Number Estimates

SUB-BASIN	Area (ac)	Area (mi^2)	% Area	% HSG A	CN HSG A	% HSG B	CN HSG B	% HSG C	CN HSG C	% HSG D	CN HSG D	Weighted	Land Use CN's
PRE-1	104.8	0.164	40%	0%	51	0%	51	0%	63	100%	70	70	40% Sagebrush -Grass Soil Complex AMC II
PRE-1	131.0	0.205	50%	0%	71	0%	71	0%	81	100%	89	89	50% Herbaceous Soil Complex AMC II
PRE-1	26.2	0.041	10%	0%	58	0%	58	0%	73	100%	80	80	10% Pinyon Juniper Soil Complex AMC II
Total	**262.0**	**0.409**										**81**	**Weighted CN**

LAG TIME (TLAG) CALCULATION (Basins > 1 $mile^2$ and Slope >10%)

SUB-BASIN	Kn	L (ft)	L (mi)	L_c (ft)	L_c (mi)	Upper El. (ft)	Lower El. (ft)	S (ft/mi)	TLAG (hr) [1]	TLAG (min)	CURVE NUMBER (CN)	
PRE-1											81	<-----N/A

[1] TLAG EQUATION: 22.1*Kn(L*Lc/S^0.5)^0.33
LAG CALCULATIONS BASED ON TMRDM STANDARDS

PLATEAU EXISTING DRAINAGE
HEC-HMS INPUT DATA
LAG TIME CALCULATION (Basins < 1 mile^2)
Calculate TLAG=0.6t_c

SUB-BASIN DATA			INITIAL/OVERLAND TIME (t_i)				SHALLOW CONC. FLOW TRAVEL TIME (t_t)				t_c (t_i+t_t)	TLAG	
Desig.	CN	R	Area (ac)	Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Velocity (fps)	t_t (min)	t_c (min)	(min)	(hr)
(1)	(2A)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
PRE-1	81	**0.67**	262.00	200.00	15.0	**4.5**	5,076	4.0	4.00	**21.2**	**26**	**15**	**0.26**

(2) R = .0132 CN - 0.39 for SCS Unit Hydrograph Method
(2A) CN=weighted curve number
(3) Catchment area
(4) L_o = length of overland flow (feet, 500 feet maximum)
(5) S = average overland flow slope (percent)
(6) t_i=(1.8(1.1-R)$L_o^{1/2}$)/($S^{1/3}$)
(7) Concentrated flow path length
(8) Estimated concentrated flow path slope=100*((Upper Elev-Lower Elev)/Length)
(9) From Figure 701
(10) t_t=Length*Velocity
(11) $t_c = t_i + t_t$
(12) TLAG = 0.6*t_c for small drainage basins less than 1 square mile
(13) TLAG in hours

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c, by the following empirical relationship:

$$TLAG = 0.6\, t_c \qquad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$TLAG = 22.1\, K_n\, (L\, L_c/S^{0.5})^{0.33} \qquad (710)$$

where K_n = Roughness factor for the basin channels
L = Length of longest watercourse (miles)

L_c = Length along longest watercourse measured upstream to a point opposite the centroid of the basin (miles)
S = Representative (average) slope of the longest watercourse (feet per mile)

This lag equation is based on the United States Bureau of Reclamation (USBR)'s analysis of the above parameters for several drainage basins in the Southwest desert, Great Basin, and Colorado Plateau area (USBR, 1989). Since the SCS and the USBR define lag differently, this equation was developed by modifying the USBR's S-graph lag equation to correspond to the SCS's definition of the dimensionless unit hydrograph lag equation.

In order to obtain comparable results between the t_c calculation and the TLAG calculation, it is recommended that either method be used as a check of the other method for drainage areas around one square mile in size.

where:

- C = 1560 (174)
- L_g = Lag Time, min (sec)
- L = Length of longest watercourse, measured as approximately 90% of the distance from the point of interest to the headwater divide of the basin, miles (m)
- L_c = Length along the longest watercourse measured upstream from the point of interest to a point close to the centroid of the basin, miles (m)
- S = Overall slope of the longest watercourse between the headwaters and concentration point, ft/mile (m/m)
- n = Basin "n" from Table 7-1.

RUNOFF CURVE NUMBERS FOR ARID AND SEMIARID RANGELANDS[1]

Cover Description	Hydrologic Condition[2]	Soil Comp A[3]	Soil Comp B	Soil Comp C	Soil Comp D
Herbaceous – mixture of grass, weeds, and low-growing brush, with brush the minor element.	Poor		80	87	93
	Fair		71	81	89
	Good		62	74	85
Oak-aspen – mountain brush mixture of oak brush, aspen, mountain mahogany, bitter brush, maple, and other brush	Poor		66	74	79
	Fair		48	57	63
	Good		30	41	48
Pinyon-juniper – pinyon, juniper, or both; grass understory	Poor		75	85	89
	Fair		58	73	80
	Good		41	61	71
Sagebrush with grass understory	Poor		67	80	85
	Fair		51	63	70
	Good		35	47	55
Desert shrub – major plants include saltbrush, greasewood, creosotebush, blackbrush, bursage, palo verde, mesquite, and cactus	Poor	63	77	85	88
	Fair	55	72	81	86
	Good	49	68	79	84

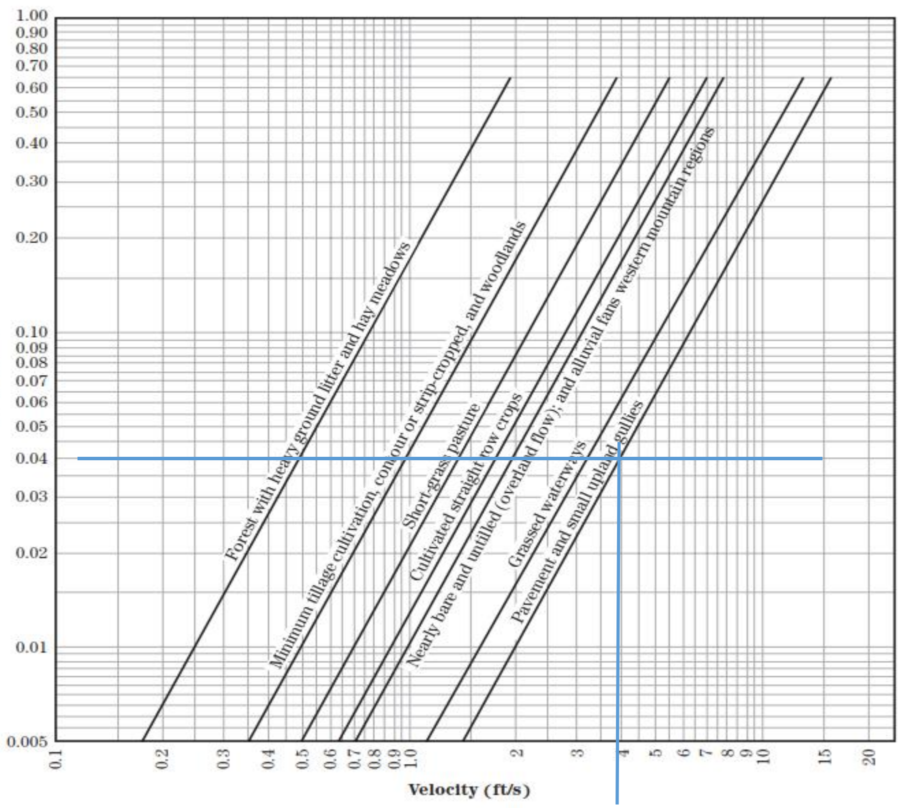
[1]Average runoff condition, and $I_a = 0.2S$. For range in humid regions, use Table 702 - 3 of 4.

[2]*Poor*: < 30% ground cover (litter, grass, and brush overstory)
Fair: 30 to 70% ground cover
Good: > 70% ground cover

[3]Curve numbers for group A have been developed only for desert shrub.

VERSION: April 30, 2009 WRC ENGINEERING INC	REFERENCE: 210-VI-TR-55, Second Edition, June 1986	TABLE 702 4 of 4

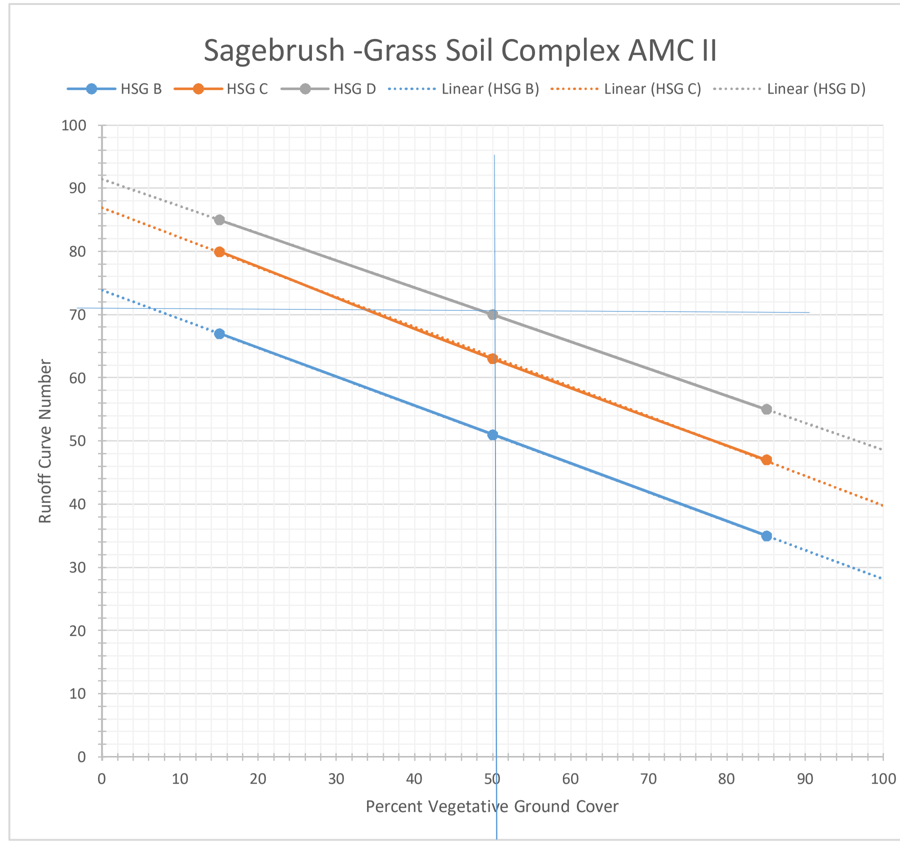
Figure 15–4 Velocity versus slope for shallow concentrated flow



Sage-Grass CN[1]

	% Cover	HSG B	HSG C	HSG D
POOR	15	67	80	85
FAIR	50	51	63	70
GOOD	85	35	47	55

[1] Values are the median between the Poor/Fair/Good ground cover density. Refer too Figure 9-2 of the NRCS NEH Chapter 9



Manhard CONSULTING LTD
241 Ridge Street, Suite 400, Reno, Nevada 89501
(775)746-3500

Project: PLATEAU DEVELOPMENT
Subject: Tentative Map Conceptual Hydrology
Client: Tahoe IV LLC
Job Code: TIV.CCNV01.00
Date: 10/10/2018
By: KANKENBAUER
Checked: CANDERSON

PLATEAU PROPOSED DRAINAGE
HEC-HMS INPUT DATA

Assumptions:
- Soil cover conditions is Fair with average 50% vegetation cover
- Hydrologic Soil Groups (HSG) are 99.7% group D, 0.3% group C; assume HSG D for all
- Sub-basins are segregated for the purpose of estimating a weighted CN
- All sub-basins are lumped into one basin called PROP-1 for HEC-HMS
- Assume OFF-1 CN is same as for Exist Conditions
- Directly connected impervious is negligable and 0% of offsite catchment areas
- Directly connected impervious is incorporated as lumped parameter in developed and proposed areas
- Depth Area Reduction Factor is not applicable
- For methodology not included in the Carson City Code, the Truckee Meadows Regional Drainage Manual (TMRDM) is used
- TLAG method is not applicable and use $0.6t_c$ LagTime estimate

Curve Number Estimates

SUB-BASIN	Area (ac)	Area (mi^2)	% Area	% HSG A	CN HSG A	% HSG B	CN HSG B	% HSG C	CN HSG C	% HSG D	CN HSG D	Weighted	Land Use CN's
OFF-1	179.6	0.281	69%									81	Sagebrush -Grass Soil Complex AMC II
POST-ON-1	67.9	0.106	26%	0%	61	0%	75	0%	83	100%	87	87	1/4 acre Single Family AMC II
LAND-1	14.5	0.023	6%	0%	63	0%	77	0%	85	100%	88	88	Natural desert landscape Group D
Total	**262.0**	**0.409**										**83**	**Weighted CN**

LAG TIME CALCULATION (Basins < 1 mile^2)

LAG TIME (TLAG) CALCULATION (Basins > 1 mile^2 and Slope >10%)

SUB-BASIN	Kn	L (ft)	L (mi)	L_c (ft)	L_c (mi)	Upper El. (ft)	Lower El. (ft)	S (ft/mi)	TLAG (hr) [1]	TLAG (min)	CURVE NUMBER (CN)	
PRE-1												<-----N/A

Check TLAG=0.6t_c

SUB-BASIN DATA			INITIAL/OVERLAND TIME (t_i)				OFFSITE TRAVEL TIME (t_t)				ONSITE TRAVEL TIME (t_t)				t_c (t_i+t_t)	TLAG	TLAG
Desig.	CN	R	Area (ac)	Length (ft)	Slope (%)	t_i (min)	Length (ft)	Slope (%)	Velocity (fps)	t_t (min)	Length (ft)	Slope (%)	Velocity (fps)	t_t (min)	t_t (min)	(min)	(hr)
(1)	(2A)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
PROP-1	83	0.70	262.00	200.00	15.0	4.2	1,356	8.1	5.50	4.1	4072	2.80	2.9	23.4	31.67	19.0	0.32

(2) R = .0132 CN - 0.39 for SCS Unit Hydrograph Method
(2A) CN=weighted curve number
(3) Catchment area
(4) L_o = length of overland flow (feet, 500 feet maximum)
(5) S = average overland flow slope (percent)
(6) $t_i=(1.8(1.1-R)L_o^{1/2})/(S^{1/3})$
(7) Concentrated flow path length
(8) Estimated concentrated flow path slope=100*((Upper Elev-Lower Elev)/Length)
(9) From Figure 701
(10) t_t=Length*Velocity
(11) $t_c = t_i + t_t$
(12) TLAG = 0.6*t_c for small drainage basins less than 1 square mile
(13) TLAG in hours

705.3 LAG TIME

Input data for the Soil Conservation Service dimensionless unit hydrograph method (SCS, 1985) consists of a single parameter, TLAG, which is equal to the lag (in hours) between the center of mass of rainfall excess and the peak of the unit hydrograph. For small drainage basins (less than one square mile) and basin slopes less than ten percent the lag time may be related to the time of concentration, t_c, by the following empirical relationship:

$$TLAG = 0.6\ t_c \qquad (709)$$

The t_c is computed as presented in Section 702.

For larger drainage basins (greater than one square mile) and basins with a basin slope equal to or greater than ten percent, the lag time (and t_c) is generally governed mostly by the concentrated flow travel time, not the initial overland flow time. In addition, as the basin gets increasingly larger, the average flow velocity (and associated travel time) becomes more difficult to estimate. Therefore, for these basins, the following lag equation is recommended for use in computing TLAG:

$$TLAG = 22.1\ K_n\ (L\ L_c/S^{0.5})^{0.33} \qquad (710)$$

where K_n = Roughness factor for the basin channels
L = Length of longest watercourse (miles)

April 30, 2009 Storm Runoff 709

TRUCKEE MEADOWS REGIONAL DRAINAGE MANUAL

L_c = Length along longest watercourse measured upstream to a point opposite the centroid of the basin (miles)
S = Representative (average) slope of the longest watercourse (feet per mile)

This lag equation is based on the United States Bureau of Reclamation (USBR)'s analysis of the above parameters for several drainage basins in the Southwest desert, Great Basin, and Colorado Plateau area (USBR, 1989). Since the SCS and the USBR define lag differently, this equation was developed by modifying the USBR's S-graph lag equation to correspond to the SCS's definition of the dimensionless unit hydrograph lag equation.

In order to obtain comparable results between the t_c calculation and the TLAG calculation, it is recommended that either method be used as a check of the other method for drainage areas around one square mile in size.

where:

- C = 1560 (174)
- L_g = Lag Time, min (sec)
- L = Length of longest watercourse, measured as approximately 90% of the distance from the point of interest to the headwater divide of the basin, miles (m)
- L_c = Length along the longest watercourse measured upstream from the point of interest to a point close to the centroid of the basin, miles (m)
- S = Overall slope of the longest watercourse between the headwaters and concentration point, ft/mile (m/m)
- n = Basin "n" from Table 7-1.

RUNOFF CURVE NUMBERS FOR URBAN AREAS[1]

Cover Type and Hydrologic Condition	Aver. % Impervious Area[2]	Runoff Curve Numbers Soil Comp A	Soil Comp B	Soil Comp C	Soil Comp D
Fully developed urban area (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.)[3]					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50 to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only)[4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious only, no vegetation)[5]		77	86	91	94
Idle lands (CNs are determined using cover types similar to those Table 702 - 3 of 4)					

[1] Average runoff condition, and $I_a = 0.2S$

[2] The average percent impervious area shown was used to develop the composite CNs. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CNs for other combinations of conditions may be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986).

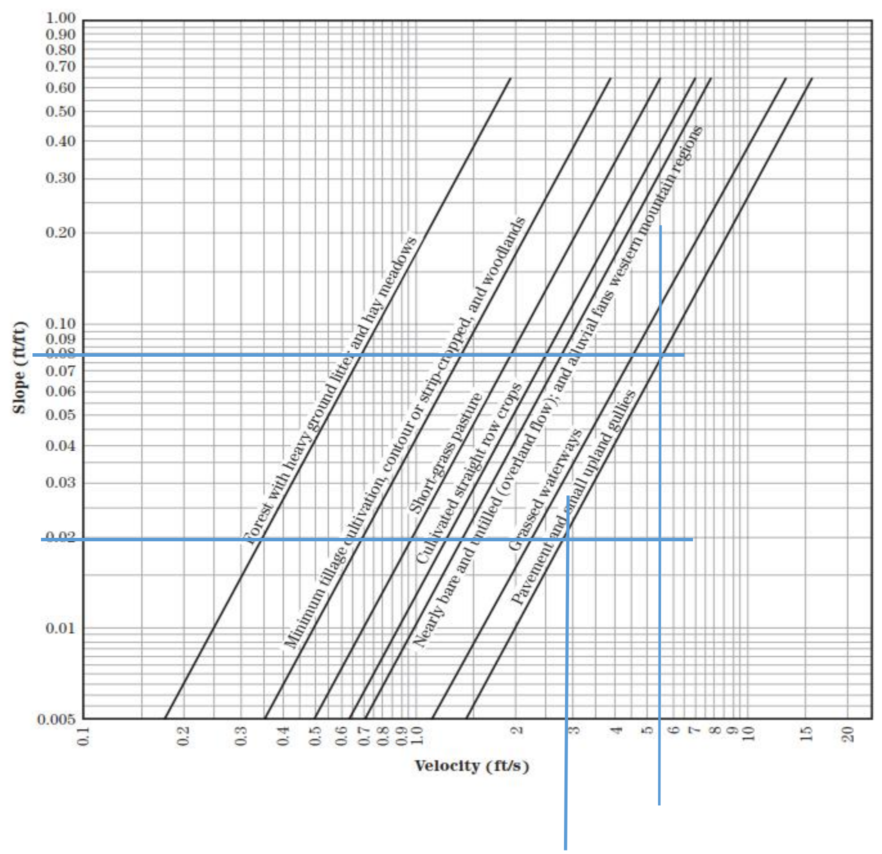
[3] CNs shown are equivalent to those of pasture. Composite CNs may be computed for other combinations of open space cover type.

[4] Composite CNs for natural desert landscaping should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CNs are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CNs to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 in TR-55 (SCS, 1986) based on the degree of development (impervious area percentage) and the CNs for the newly graded pervious areas.

VERSION: April 30, 2009	REFERENCE:	TABLE
WRC ENGINEERING INC	210-VI-TR-55, Second Edition, June 1986	702 1 of 4

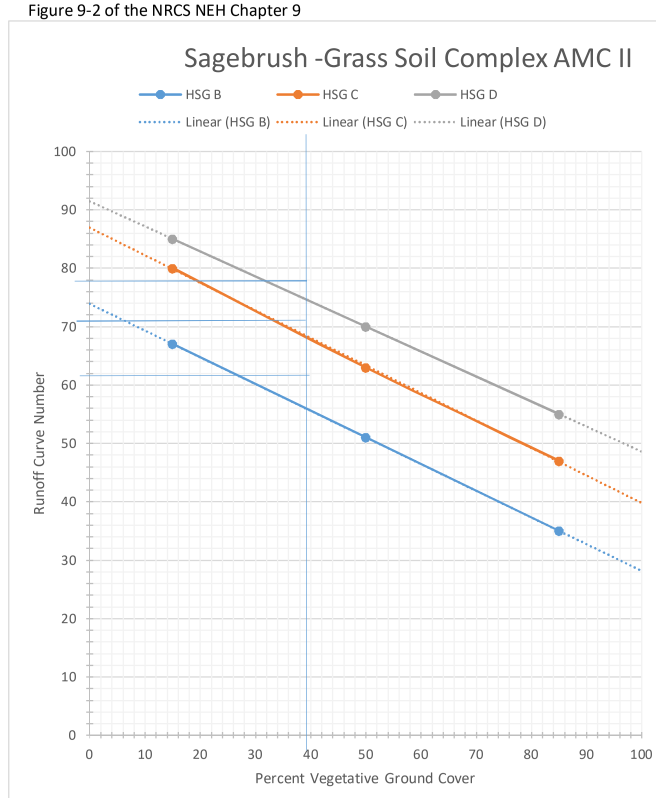
Figure 15–4 Velocity versus slope for shallow concentrated flow



Sage-Grass CN[1]

	% Cover	HSG B	HSG C	HSG D
POOR	15	67	80	85
FAIR	50	51	63	70
GOOD	85	35	47	55

[1] Values are the median between the Poor/Fair/Good ground cover density. Refer too Figure 9-2 of the NRCS NEH Chapter 9



241 Ridge Street, Suite 400, Reno, Nevada 89501
(775)746-3500

Project: PLATEAU DEVELOPMENT
Subject: Tentative Map Conceptual Hydrology
Client: Tahoe IV LLC
Job Code: TIV.CCNV01.00
Date: 10/10/2018
By: KANKENBAUER
Checked: CANDERSON

PLATEAU PROPOSED DRAINAGE
HEC-HMS INPUT DATA

Point precipitation frequency estimates (inches)
NOAA Atlas 14 Volume 1 Version 5
Data type: Precipitation depth
Time series type: Partial duration
Project area: Southwest
Location name (ESRI Maps): Cars Nevada USA
Station Name: -
Latitude: 39.1895°
Longitude: -119.6891°
Elevation (USGS): 4762.02 ft

PRECIPITATION FREQUENCY ESTIMATES

by duration for ARI (years):	1	2	5	10	25	50	100	200	500	1000
5-min:	0.098	0.122	0.163	0.202	0.265	0.322	0.391	0.473	0.604	0.722
10-min:	0.149	0.185	0.247	0.306	0.403	0.491	0.596	0.72	0.919	1.1
15-min:	0.184	0.23	0.306	0.38	0.499	0.609	0.738	0.893	1.14	1.36
30-min:	0.248	0.309	0.413	0.512	0.672	0.82	0.994	1.2	1.53	1.84
60-min:	0.307	0.382	0.511	0.633	0.832	1.02	1.23	1.49	1.9	2.27
2-hr:	0.41	0.51	0.651	0.776	0.963	1.13	1.32	1.55	1.94	2.31
3-hr:	0.49	0.61	0.767	0.895	1.08	1.23	1.41	1.63	1.99	2.34
6-hr:	0.674	0.842	1.05	1.21	1.43	1.61	1.78	1.99	2.29	2.55
12-hr:	0.886	1.12	1.41	1.63	1.94	2.18	2.42	2.67	3	3.27
24-hr:	1.12	1.4	1.76	2.05	2.46	2.78	3.12	3.46	3.94	4.31
2-day:	1.32	1.65	2.09	2.45	2.94	3.34	3.75	4.18	4.77	5.24
3-day:	1.44	1.81	2.31	2.71	3.28	3.73	4.21	4.71	5.41	5.97
4-day:	1.57	1.97	2.52	2.98	3.61	4.13	4.67	5.24	6.05	6.71
7-day:	1.82	2.29	2.96	3.48	4.22	4.8	5.41	6.04	6.92	7.61
10-day:	2.01	2.55	3.3	3.88	4.67	5.3	5.93	6.59	7.47	8.16
20-day:	2.43	3.08	3.97	4.64	5.54	6.22	6.91	7.59	8.49	9.16
30-day:	2.74	3.47	4.46	5.19	6.17	6.91	7.65	8.38	9.34	10
45-day:	3.22	4.09	5.24	6.08	7.16	7.93	8.67	9.37	10.2	10.8
60-day:	3.7	4.7	6.02	6.96	8.12	8.94	9.7	10.4	11.2	11.7

Date/time (GMT): Thu Oct 11 00:13:13 2018
pyRunTime: 0.0253670215607

a) Select location
Move crosshair or double click

b) Click on station icon
Show stations on map

Location information:
Name: Carson City, Nevada, USA*
Latitude: 39.1895°
Longitude: -119.6891°
Elevation: 4762.02 ft **

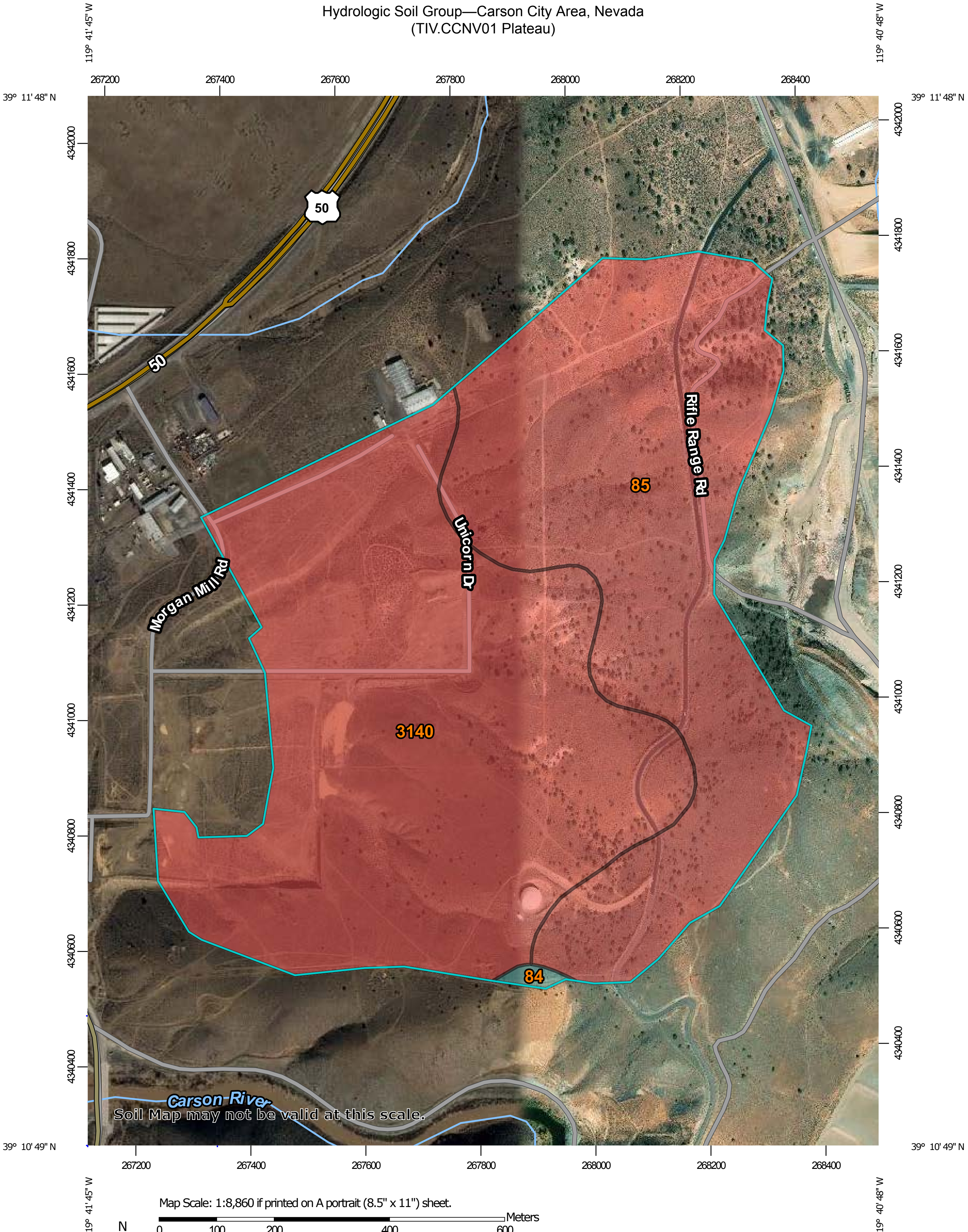
* Source: ESRI Maps
** Source: USGS

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES
WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 1, Version 5

Appendix B: NRCS Hydrologic Soils Group Rating

APPENDIX B

Hydrologic Soil Group—Carson City Area, Nevada
(TIV.CCNV01 Plateau)



Map Scale: 1:8,860 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 100, 200, 400, 600

Feet: 0, 400, 800, 1600, 2400

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Carson City Area, Nevada
Survey Area Data: Version 12, Sep 17, 2018

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

Date(s) aerial images were photographed: Mar 26, 2015—Oct 26, 2017

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
84	Ister-Reywat-Koontz association	C	0.8	0.3%
85	Devada-Rock outcrop association	D	104.1	43.3%
3140	Fulstone-Reno complex, 2 to 30 percent slopes	D	135.8	56.4%
Totals for Area of Interest			**240.7**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

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

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

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

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

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix C: HEC-HMS Output

Global Summary Results for Run "10yr Exist"

Project: TIVCCNV01 Plateau   Simulation Run: 10yr Exist

Start of Run: 01Jan2019, 00:00   Basin Model: Exist Catchment
End of Run: 02Jan2019, 00:00   Meteorologic Model: 02_Met 10-Year
Compute Time: 10Oct2018, 17:35:46   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN (•) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
ExistCatchment	0.41	97.8	01Jan2019, 12:20	13.8
JunctionExist	0.41	97.8	01Jan2019, 12:20	13.8

Global Summary Results for Run "Prop 10-Year"

Project: TIVCCNV01 Plateau   Simulation Run: Prop 10-Year

Start of Run: 01Jan2019, 00:00   Basin Model: PROP-1
End of Run: 02Jan2019, 00:00   Meteorologic Model: 02_Met 10-Year
Compute Time: 10Oct2018, 17:45:42   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN (•) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
PROP-1	0.41	101.0	01Jan2019, 12:25	15.8
JunctionProposed	0.41	101.0	01Jan2019, 12:25	15.8

Global Summary Results for Run "100yr Exist"

Project: TIVCCNV01 Plateau   Simulation Run: 100yr Exist

Start of Run: 01Jan2019, 00:00   Basin Model: Exist Catchment
End of Run: 02Jan2019, 00:00   Meteorologic Model: 04_Met 100-Year
Compute Time: 10Oct2018, 17:35:57   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN (•) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
ExistCatchment	0.41	290.9	01Jan2019, 12:20	30.4
JunctionExist	0.41	290.9	01Jan2019, 12:20	30.4

Global Summary Results for Run "Prop 100-Year"

Project: TIVCCNV01 Plateau   Simulation Run: Prop 100-Year

Start of Run: 01Jan2019, 00:00   Basin Model: PROP-1
End of Run: 02Jan2019, 00:00   Meteorologic Model: 04_Met 100-Year
Compute Time: 10Oct2018, 17:45:53   Control Specifications: Control 1

Show Elements: All Elements   Volume Units: IN (•) AC-FT   Sorting: Hydrologic

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
PROP-1	0.41	281.0	01Jan2019, 12:25	33.4
JunctionProposed	0.41	281.0	01Jan2019, 12:25	33.4

Appendix D: FlowMaster Output

Cross Section for Plateau 50 ft ROW

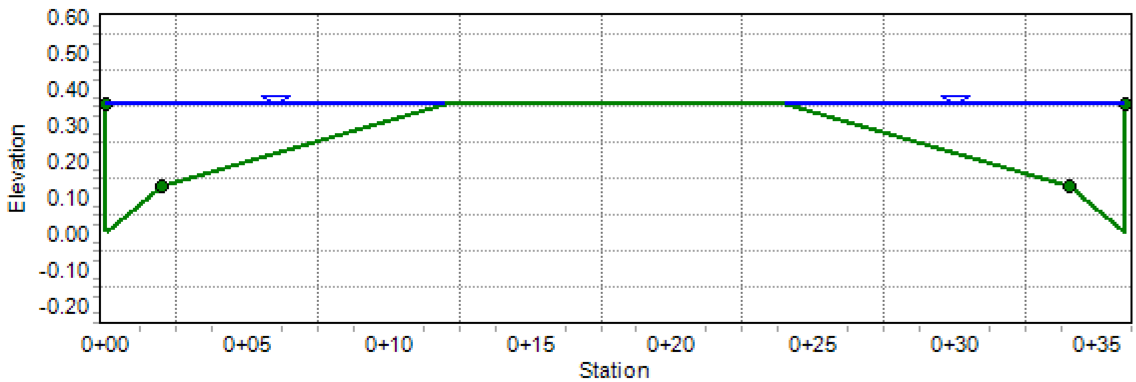
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.08000	ft/ft
Normal Depth	0.36	ft
Discharge	27.69	ft³/s

Cross Section Image



Worksheet for Plateau 50 ft ROW - 0.5 Percent

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	0.36	ft

Section Definitions

Station (ft)	Elevation (ft)
0+00	0.36
0+00	0.00
0+02	0.13
0+12	0.36
0+24	0.36
0+34	0.13
0+36	0.00
0+36	0.36

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.36)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+34, 0.13)	0.016
(0+34, 0.13)	(0+36, 0.36)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	6.92	ft³/s
Elevation Range	0.00 to 0.36 ft	
Flow Area	3.48	ft²

Worksheet for Plateau 50 ft ROW - 0.5 Percent

Results

Wetted Perimeter		24.73	ft
Hydraulic Radius		0.14	ft
Top Width		24.00	ft
Normal Depth		0.36	ft
Critical Depth		0.37	ft
Critical Slope		0.00649	ft/ft
Velocity		1.99	ft/s
Velocity Head		0.06	ft
Specific Energy		0.42	ft
Froude Number		0.92	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.37	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00649	ft/ft

Worksheet for Plateau 50 ft ROW - 3 Percent

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.03000	ft/ft
Normal Depth	0.36	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.36
0+00	0.00
0+02	0.13
0+12	0.36
0+24	0.36
0+34	0.13
0+36	0.00
0+36	0.36

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.36)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+34, 0.13)	0.016
(0+34, 0.13)	(0+36, 0.36)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	16.96	ft^3/s
Elevation Range	0.00 to 0.36 ft	
Flow Area	3.48	ft^2

Worksheet for Plateau 50 ft ROW - 3 Percent

Results

Wetted Perimeter	24.73	ft
Hydraulic Radius	0.14	ft
Top Width	24.00	ft
Normal Depth	0.36	ft
Critical Depth	0.45	ft
Critical Slope	0.00535	ft/ft
Velocity	4.87	ft/s
Velocity Head	0.37	ft
Specific Energy	0.73	ft
Froude Number	2.26	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.45	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.00535	ft/ft

Worksheet for Plateau 50 ft ROW - 5 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.05000	ft/ft
Normal Depth	0.36	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.36
0+00	0.00
0+02	0.13
0+12	0.36
0+24	0.36
0+34	0.13
0+36	0.00
0+36	0.36

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.36)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+34, 0.13)	0.016
(0+34, 0.13)	(0+36, 0.36)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	21.89	ft³/s
Elevation Range	0.00 to 0.36 ft	
Flow Area	3.48	ft²

Worksheet for Plateau 50 ft ROW - 5 Percent Slope

Results

Wetted Perimeter		24.73	ft
Hydraulic Radius		0.14	ft
Top Width		24.00	ft
Normal Depth		0.36	ft
Critical Depth		0.49	ft
Critical Slope		0.00507	ft/ft
Velocity		6.29	ft/s
Velocity Head		0.61	ft
Specific Energy		0.97	ft
Froude Number		2.91	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.49	ft
Channel Slope	0.05000	ft/ft
Critical Slope	0.00507	ft/ft

Worksheet for Plateau 50 ft ROW - 6 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.06000	ft/ft
Normal Depth	0.36	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.36
0+00	0.00
0+02	0.13
0+12	0.36
0+24	0.36
0+34	0.13
0+36	0.00
0+36	0.36

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.36)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+34, 0.13)	0.016
(0+34, 0.13)	(0+36, 0.36)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	23.98	ft^3/s
Elevation Range	0.00 to 0.36 ft	
Flow Area	3.48	ft^2

Worksheet for Plateau 50 ft ROW - 6 Percent Slope

Results

Wetted Perimeter	24.73	ft
Hydraulic Radius	0.14	ft
Top Width	24.00	ft
Normal Depth	0.36	ft
Critical Depth	0.50	ft
Critical Slope	0.00497	ft/ft
Velocity	6.89	ft/s
Velocity Head	0.74	ft
Specific Energy	1.10	ft
Froude Number	3.19	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.50	ft
Channel Slope	0.06000	ft/ft
Critical Slope	0.00497	ft/ft

Worksheet for Plateau 50 ft ROW - 8 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.08000	ft/ft
Normal Depth	0.36	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.36
0+00	0.00
0+02	0.13
0+12	0.36
0+24	0.36
0+34	0.13
0+36	0.00
0+36	0.36

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.36)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+34, 0.13)	0.016
(0+34, 0.13)	(0+36, 0.36)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	27.69	ft^3/s
Elevation Range	0.00 to 0.36 ft	
Flow Area	3.48	ft^2

Worksheet for Plateau 50 ft ROW - 8 Percent Slope

Results

Wetted Perimeter	24.73	ft
Hydraulic Radius	0.14	ft
Top Width	24.00	ft
Normal Depth	0.36	ft
Critical Depth	0.53	ft
Critical Slope	0.00482	ft/ft
Velocity	7.96	ft/s
Velocity Head	0.98	ft
Specific Energy	1.34	ft
Froude Number	3.68	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.36	ft
Critical Depth	0.53	ft
Channel Slope	0.08000	ft/ft
Critical Slope	0.00482	ft/ft

Cross Section for Plateau 60 ft ROW

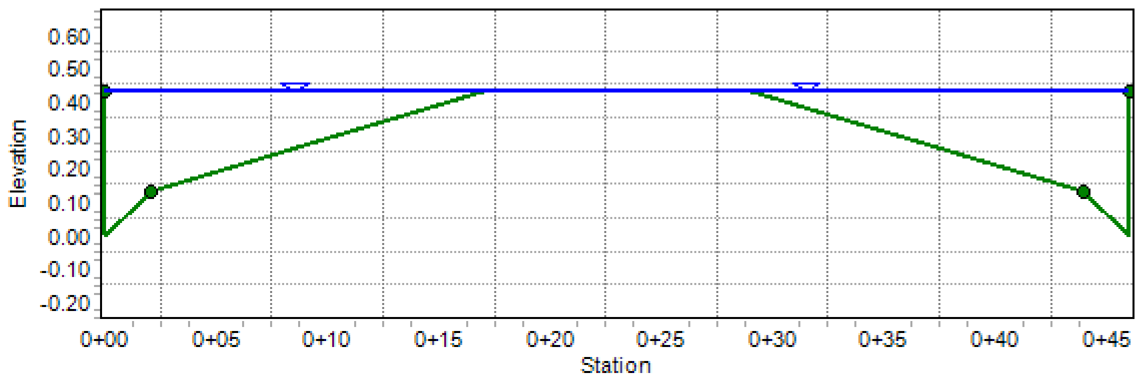
Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.08000	ft/ft
Normal Depth	0.43	ft
Discharge	46.00	ft³/s

Cross Section Image



Worksheet for Plateau 60 ft ROW-0.5 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.00500	ft/ft
Normal Depth	0.43	ft

Section Definitions

Station (ft)	Elevation (ft)
0+00	0.43
0+00	0.00
0+02	0.13
0+17	0.43
0+29	0.43
0+44	0.13
0+46	0.00
0+46	0.43

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.43)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+44, 0.13)	0.016
(0+44, 0.13)	(0+46, 0.43)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	11.50	ft³/s
Elevation Range	0.00 to 0.43 ft	
Flow Area	6.03	ft²

Worksheet for Plateau 60 ft ROW-0.5 Percent Slope

Results

Wetted Perimeter		46.87	ft
Hydraulic Radius		0.13	ft
Top Width		46.00	ft
Normal Depth		0.43	ft
Critical Depth		0.40	ft
Critical Slope		0.00545	ft/ft
Velocity		1.91	ft/s
Velocity Head		0.06	ft
Specific Energy		0.49	ft
Froude Number		0.93	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.40	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00545	ft/ft

Worksheet for Plateau 60 ft ROW-3 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.03000	ft/ft
Normal Depth	0.43	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.43
0+00	0.00
0+02	0.13
0+17	0.43
0+29	0.43
0+44	0.13
0+46	0.00
0+46	0.43

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.43)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+44, 0.13)	0.016
(0+44, 0.13)	(0+46, 0.43)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	28.17	ft³/s
Elevation Range	0.00 to 0.43 ft	
Flow Area	6.03	ft²

Worksheet for Plateau 60 ft ROW-3 Percent Slope

Results

Wetted Perimeter		46.87	ft
Hydraulic Radius		0.13	ft
Top Width		46.00	ft
Normal Depth		0.43	ft
Critical Depth		0.53	ft
Critical Slope		0.00485	ft/ft
Velocity		4.67	ft/s
Velocity Head		0.34	ft
Specific Energy		0.77	ft
Froude Number		2.28	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.53	ft
Channel Slope	0.03000	ft/ft
Critical Slope	0.00485	ft/ft

Worksheet for Plateau 60 ft ROW-5 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.05000	ft/ft
Normal Depth	0.43	ft

Section Definitions

Station (ft)	Elevation (ft)
0+00	0.43
0+00	0.00
0+02	0.13
0+17	0.43
0+29	0.43
0+44	0.13
0+46	0.00
0+46	0.43

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.43)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+44, 0.13)	0.016
(0+44, 0.13)	(0+46, 0.43)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	36.37	ft^3/s
Elevation Range	0.00 to 0.43 ft	
Flow Area	6.03	ft^2

Worksheet for Plateau 60 ft ROW-5 Percent Slope

Results

Wetted Perimeter		46.87	ft
Hydraulic Radius		0.13	ft
Top Width		46.00	ft
Normal Depth		0.43	ft
Critical Depth		0.57	ft
Critical Slope		0.00459	ft/ft
Velocity		6.03	ft/s
Velocity Head		0.57	ft
Specific Energy		1.00	ft
Froude Number		2.94	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.57	ft
Channel Slope	0.05000	ft/ft
Critical Slope	0.00459	ft/ft

Worksheet for Plateau 60 ft ROW-6 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.06000	ft/ft
Normal Depth	0.43	ft
Section Definitions		

Station (ft)	Elevation (ft)
0+00	0.43
0+00	0.00
0+02	0.13
0+17	0.43
0+29	0.43
0+44	0.13
0+46	0.00
0+46	0.43

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.43)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+44, 0.13)	0.016
(0+44, 0.13)	(0+46, 0.43)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	39.84	ft^3/s
Elevation Range	0.00 to 0.43 ft	
Flow Area	6.03	ft^2

Worksheet for Plateau 60 ft ROW-6 Percent Slope

Results

Wetted Perimeter		46.87	ft
Hydraulic Radius		0.13	ft
Top Width		46.00	ft
Normal Depth		0.43	ft
Critical Depth		0.58	ft
Critical Slope		0.00450	ft/ft
Velocity		6.61	ft/s
Velocity Head		0.68	ft
Specific Energy		1.11	ft
Froude Number		3.22	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.58	ft
Channel Slope	0.06000	ft/ft
Critical Slope	0.00450	ft/ft

Worksheet for Plateau 60 ft ROW-8 Percent Slope

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Channel Slope	0.08000	ft/ft
Normal Depth	0.43	ft

Section Definitions

Station (ft)	Elevation (ft)
0+00	0.43
0+00	0.00
0+02	0.13
0+17	0.43
0+29	0.43
0+44	0.13
0+46	0.00
0+46	0.43

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+00, 0.43)	(0+02, 0.13)	0.013
(0+02, 0.13)	(0+44, 0.13)	0.016
(0+44, 0.13)	(0+46, 0.43)	0.013

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Discharge	46.00	ft³/s
Elevation Range	0.00 to 0.43 ft	
Flow Area	6.03	ft²

Worksheet for Plateau 60 ft ROW-8 Percent Slope

Results

Wetted Perimeter		46.87	ft
Hydraulic Radius		0.13	ft
Top Width		46.00	ft
Normal Depth		0.43	ft
Critical Depth		0.61	ft
Critical Slope		0.00437	ft/ft
Velocity		7.63	ft/s
Velocity Head		0.91	ft
Specific Energy		1.34	ft
Froude Number		3.72	
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.43	ft
Critical Depth	0.61	ft
Channel Slope	0.08000	ft/ft
Critical Slope	0.00437	ft/ft

Appendix E: FlowMaster and Hydraulic Calculations Summary

Design Storm Street Capacity Limitations of Catchbasins and Roadways

50 ft ROW Street Cross Section

Flowmaster (Mannings Eq.)		Rational Formula Results				
Street Slope [ft/ft]	Flowmaster Mannings Q [cfs]	C	i [in/hr] Q5	i [in/hr] Q100	5yr Potential Drainage Area [acres]	100yr Potential Drainage Area [acres]
0.08	27.69	0.6	1.480	3.560	31.2	13.0
0.06	23.98				27.0	11.2
0.05	21.89				24.7	10.2
0.03	16.96				19.1	7.9
0.005	6.92				7.8	3.2

60 ft ROW Street Cross Section

Flowmaster (Mannings Eq.)		Rational Formula Results				
Street Slope [ft/ft]	Flowmaster Mannings Q [cfs]	C	i [in/hr] Q5	i [in/hr] Q100	5yr Potential Drainage Area A5 [acres]	100yr Potential Drainage Area [acres]
0.08	46	0.6	1.480	3.560	51.8	21.5
0.06	39.84				44.9	18.7
0.05	36.37				41.0	17.0
0.03	28.17				31.7	13.2
0.005	11.5				13.0	5.4

Appendix F: Site Photographs

APPENDIX F - Site Photographs