Shephard Wesnitzer, Inc.

110 West Dale Avenue
Flagstaff, AZ 86001

928.773.0354
928.774.8934 fax

www.swiaz.com

Engineering an environment of excellence.

City of Flagstaff
Attention: Douglas Slover
211 W. Aspen Ave.
Flagstaff, AZ 86001

Originally Prepared: August 30, 2022
SWI # 22045

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Re: LIV Timber Sky - Drainage Impact Analysis Letter (COF #PZ-21-00271-02)

Dear Mr. Slover:

This Drainage Impact Analysis Letter is being provided for the proposed LIV Timber Sky multi-family development (Project). The Project consists of approximately 13 acres located at the intersection of S. Woody Mountain Road and West Route 66. The project will include 214 multi-family dwelling units along with associated infrastructure. The Project is comprised of 13.01 acres of Coconino County Assessor's Parcel no. 112-01-019B zoned Rural Residential (RR) and General 10-acre minimum (G). Approximately 1.5 acres of the site is outside City limits and will be annexed. The proposed zoning of the Project will be high density residential (HR). This letter has been prepared to support the Site Plan submittal for this project.

The intent of the Drainage Impact Analysis (DIA) is to determine any potential adverse downstream drainage impacts and to identify mitigation options. DIA scoping coordination was completed via email on July 12, 2022 with the City of Flagstaff Stormwater Division where the City presented Shephard-Wesnitzer, Inc. (SWI) with two options for mitigation. Both options included calculating the difference in runoff volume between the pre-development and post-development conditions for the Project. Option one consisted of analyzing downstream infrastructure with the increase in runoff volume from the project, and option two consisted of retaining the increase in runoff volume and mitigating the runoff rates. Based on discussion with the City, option two has been chosen for this Project.

Based on City of Flagstaff Drainage Basin maps and FEMA mapping, the site is located in the South Fork of Clay Wash watershed. The north portion of the site, Basin 1 (B1), drains to the east/northeast to an existing 24" CMP at the intersection of S. Woody Mountain Road and W. Route 66. The existing storm drain system along W. Route 66 ultimately discharges into the South Fork Clay Wash. The south portion of the site, Basin 2 (B2) drains to the east/southeast to

an existing 4' x 3' concrete box culvert which conveys the stormwater to an existing storm drain system within Presidio in the Pines. This existing storm drain system ultimately discharges into Sinclair Wash. The basin delineation remains similar for the post-development conditions.

The drainage basin was analyzed to compare 100-year hydrograph volumes for the pre- and post-development conditions. Bentley's *PondPack* computer program, utilizing the SCS Unit Hydrograph method and Type II rainfall distribution, was used to determine the hydrograph volumes during the 100-year, 24-hour storm event. The SCS runoff Curve Numbers were weighted based on cover in the pre- and post-development conditions. A runoff curve number of 98 was used for the impervious areas, a curve number of 65 was used for the existing cover, consisting of pine tree cover in a 'C' hydrologic soil group, and a curve number of 75 was used for the existing cover, consisting of pine tree cover in a 'D' hydrologic soil group. The rainfall depth of 4.6" used in the analysis was taken from the City of Flagstaff Stormwater Management Design Manual (CFSMDM). Pre-development basin areas were based on the existing topography, and the post-development basin areas were based on the proposed site layout and preliminary grading. The *PondPack* analysis and Pre- and Post-Development Drainage Exhibits are included with this letter.

Below is a table summarizing the pre- and post-development drainage basin characteristics for the Project.

Table 1 – Pre- and Post-Development Condition

Pre-Development Conditions				
Basin ID	Area (acres)	Tc (min)	Curve Number	Runoff Volume (cf)
B1	12.87	22	70	79,733
B2	6.66	25	65	32,796
Post-Development Conditions				
Area (acres)	Area (acres)	Tc (min)	Curve Number	Runoff Volume (cf)
B1	12.46	23	83.00	125,248
B2	7.06	28	83.00	70,898

The proposed underground chamber systems will be designed to retain the difference between the 100-year pre- and post-development runoff volume.

Low Impact Development (LID) facilities will be designed to capture the first 1 inch of stormwater runoff from the proposed impervious surfaces to meet the requirements of the City of Flagstaff Low Impact Development Manual (LIDM). The LID facilities will be designed to provide water quality treatment of the runoff from the new development before it is discharged downstream. The underground chamber system meets the water quality component by providing a row of chambers that has been wrapped with a filter fabric, called the isolator row. While

water is able to pass through the fabric and flow to the adjacent chambers, sediment and other debris will captured in the isolator row. The basin will be designed to release the LID Runoff Capture Volume (ROCV) between 24-36 hours after the storm event. Based on the proposed impervious cover, the total calculated LID/Runoff Capture Volume (ROCV) required is 36,632 cubic feet. The ROCV will be included within the required runoff volume retained within the proposed basins. Below is a table summarizing the impervious cover analysis:

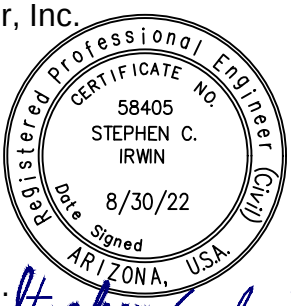
Table 2 –Impervious Area Analysis

Impervious Area & LID Analysis						
						LID Required Depth (ft)
						0.0833
Basin ID	Existing Basin Area (sf)	Proposed Basin Area (sf)	Existing Basin Impervious Area for LID (sf)	Proposed Basin Impervious Area for LID (sf)	Net Impervious Area (sf)	Required LID Volume (cf)
B1	560,512	542,918	33,378	241,767	275,145	22,929
B2	289,990	307,584	4,232	160,212	164,443	13,704
TOTAL	850,502	850,502	37,610	401,979	439,589	36,632
1. Gross required 1" LID volume is for impervious area including proposed half street improvements (Woody Mtn and Route 66), onsite drive aisles, parking, sidewalks, and buildings.						

Although option one was not analyzed, the analysis can still be performed during final design if it is determined that retention of the runoff volume is not feasible at any of the proposed locations. This will need to be coordinated and approved with City Stormwater Staff prior to the analysis.

Please call if you have any questions, comments, or need any additional information.

Sincerely,
Shephard – Wesnitzer, Inc.



Stephen C. Irwin, P.E.
Project Engineer

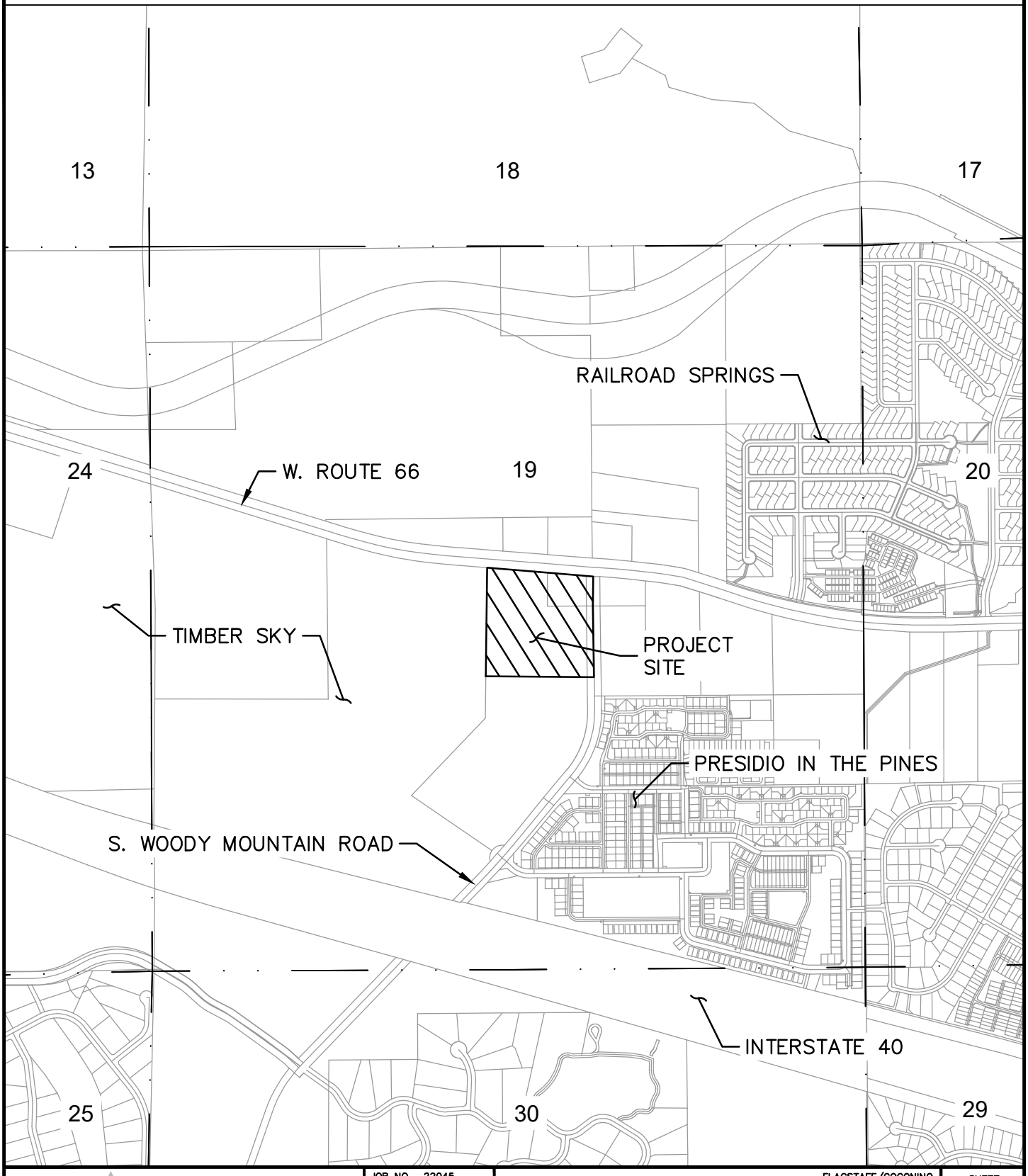
Attachments:
- Vicinity Map
- Drainage Exhibits
- *PondPack* Output

PLOTTED: Aug 25, 2022–8:10pm

FILE: P:\2022\22045\DRAWINGS\DRAINAGE\22045 – VICINITY MAP.DWG KBAYER

NORTH

LOCATED IN SECTION 19, TOWNSHIP 21 NORTH, RANGE 7 EAST, GILA AND SALT BASE MERIDIAN, COCONINO COUNTY, FLAGSTAFF, ARIZONA



SWI
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JOB NO.	22045
DATE	AUG 22
SCALE	1"=1000'
DRAWN	KMF
DESIGN	KMF
CHECKED	SCI

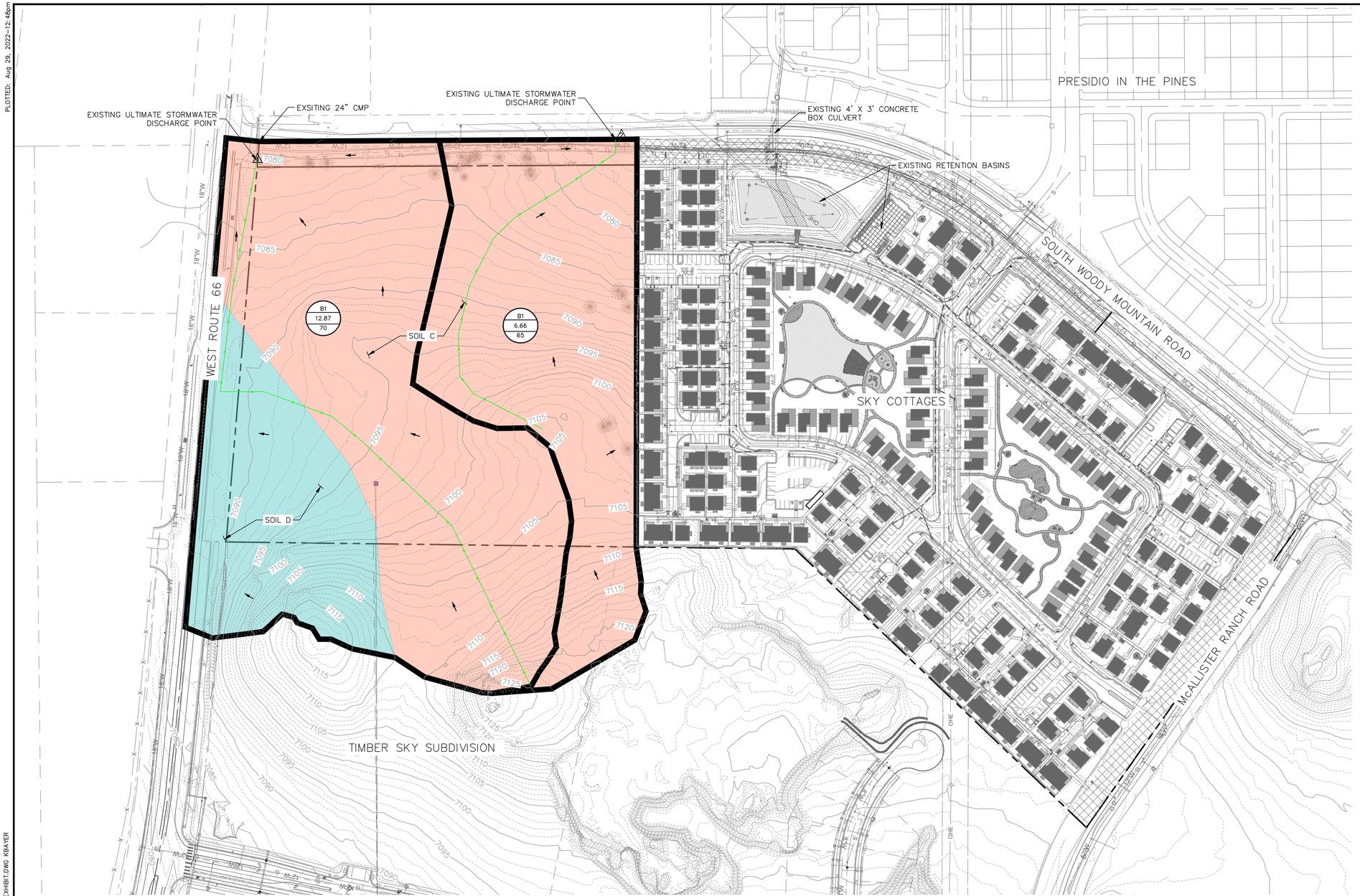
LIV TIMBER SKY

FLAGSTAFF/COCONINO
ARIZONA

VICINITY MAP

SHEET
1
OF 1

PLOTTED: Aug 29, 2022 - 12:48pm



LEGEND

- PRE –DEVELOPMENT TIME OF CONCENTRATION FLOW PATH
- FLOW DIRECTION
- PROPERTY BOUNDARY
- PRE–DEVELOPMENT BASIN BOUNDARY
- ID = BASIN IDENTIFICATION; A = AREA IN ACRES; CN = SCS CURVE NUMBER
- CONCENTRATION POINT

Pre-Development Condition Summary Table

Basin ID	Area (acres)	Tc (min)	CN	Runoff Flows (cfs)
				Q100
B1	12.87	22	70	21.72
B2	6.66	25	65	7.87

SCALE 1" : 100'
0 50 100

PRELIMINARY

NOT FOR CONSTRUCTION, BIDDING OR RECORDING

FLAGSTAFF ARIZONA

LIV TIMBER SKY

PRE-DEVELOPMENT DRAINAGE EXHIBIT

JOB NO:	22045
DATE:	AUG 22
SCALE:	AS SHOWN
DRAWN:	KMF
DESIGN:	KMF
CHECKED:	SCI

REVISIONS

NO.	DESCRIPTION	DATE	BY

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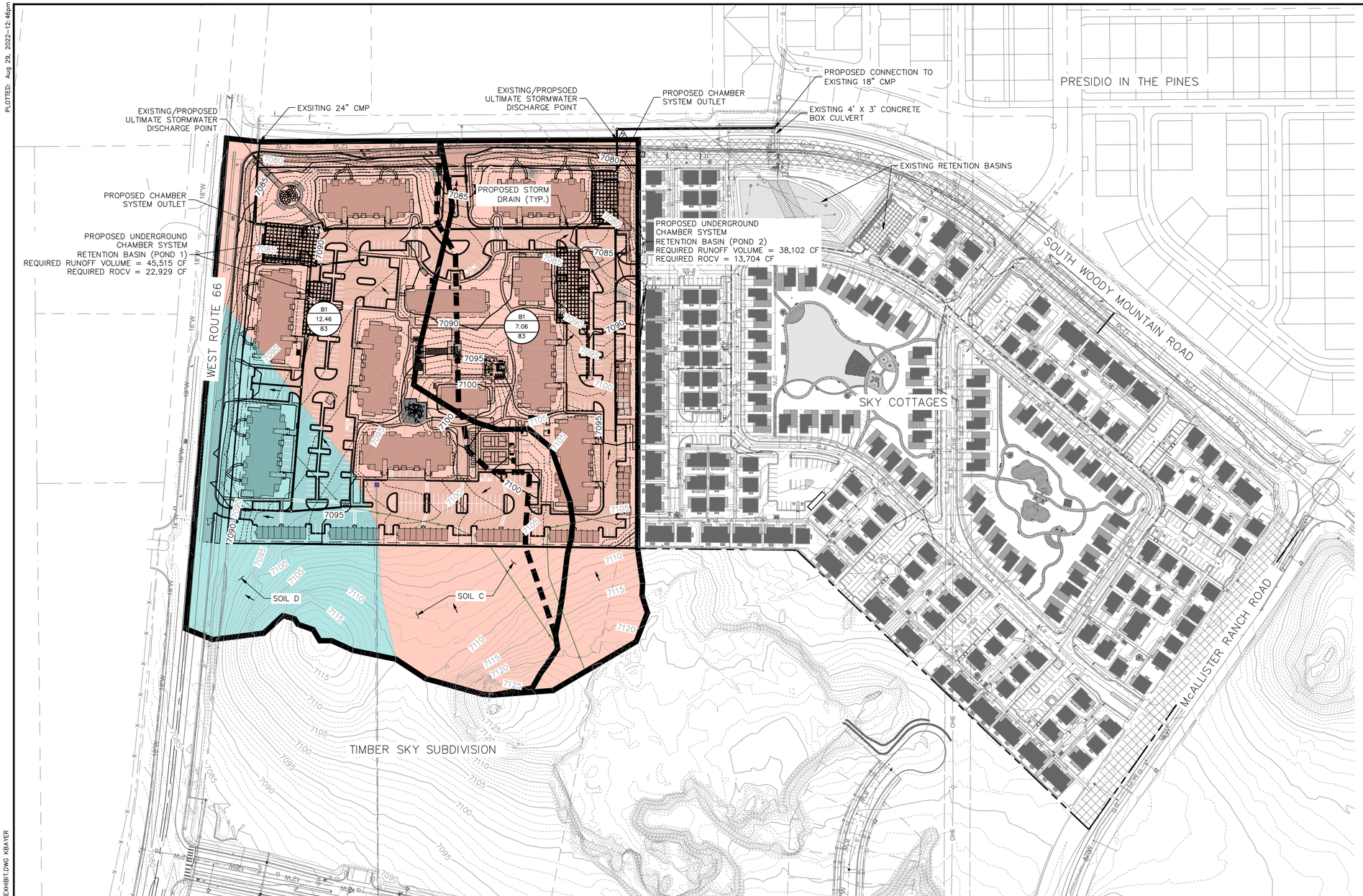
SWI
Shephard Wesnitzer, Inc.

Call at least two full working days before you begin excavation
ARIZONA811 Arizona Blue Stake, Inc.
Dial 8-1-1 or 1-800-STAKE-IT (782-5348)

DRAWING NO.
DR01

SHT NO. 1 OF 2

FILE: P:\2022\22045\DRAWINGS\DRAINAGE\22045 - PRE-DEVELOPMENT DRAINAGE EXHIBIT.DWG KBAYER



Post-Development Condition Summary Table

Basin ID	Area (acres)	Tc (min)	CN	Runoff Flows (cfs)
				Q100
B1	12.46	23	83	34.58
B2	7.06	28	83	17.47

Pre-Development Conditions				
Basin ID	Area (acres)	Tc (min)	Curve Number	Runoff Volume (cf)
B1	12.87	22	70	79,733
B2	6.66	25	65	32,796
Post-Development Conditions				
Area (acres)	Area (acres)	Tc (min)	Curve Number	Runoff Volume (cf)
B1	12.46	23	83.00	125,248
B2	7.06	28	83.00	70,898
			B1 Required Runoff Volume (cf)	**45,515**
			Provided Volume (cf)	**47,500**
			B2 Required Runoff Volume (cf)	**38,102**
			Provided Volume (cf)	**40,000**

Impervious Area & LID Analysis

						LID Required Depth (ft)
						0.0833
Basin ID	Existing Basin Area (sf)	Proposed Basin Area (sf)	Existing Basin Impervious Area for LID (sf)	Proposed Basin Impervious Area for LID (sf)	Net Impervious Area (sf)	Required LID Volume (cf)
B1	560,512	542,918	33,378	241,767	275,145	22,929
B2	289,990	307,584	4,232	160,212	164,443	13,704
TOTAL	850,502	850,502	37,610	401,979	439,589	36,632

1. Gross required 1" LID volume is for impervious area including proposed half street improvements (Woody Mtn and Route 66), onsite drive aisles, parking, sidewalks, and buildings.

SCALE 1" : 100'
0 50 100

PRELIMINARY

NOT FOR CONSTRUCTION, BIDDING OR RECORDING

FLAGSTAFF ARIZONA

LIV TIMBER SKY

PRE-DEVELOPMENT DRAINAGE EXHIBIT

JOB NO:	22045
DATE:	AUG 22
SCALE:	AS SHOWN
DRAWN:	KMF
DESIGN:	KMF
CHECKED:	SCI

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REVISIONS

NO.	DESCRIPTION	DATE	BY

Call at least two full working days before you plan to excavate.
ARIZONA811 Arizona Blue Stake, Inc.
Dial 8-1-1 or 1-800-STAKE-IT (782-5348)

DRAWING NO.
DR01

SHT NO. 1 OF 2

PLOTTED: Aug 29, 2022–12:46pm
FILE: P:\2022\22045\DRAWINGS\DRAINAGE\22045 – POST-DEVELOPMENT DRAINAGE EXHIBIT.DWG KBAYER

Project Summary	
Title	Sky Cottages
Engineer	KMF
Company	Shephard-Wesnitzer, Inc.
Date	8/30/2021

Notes

Table of Contents

Subsection: Master Network Summary

Catchments Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
Basin B1	Post-Development 100 year	100	125,248.000	12.100	34.58
Basin B1	Pre-Development 100 year	100	79,733.000	12.100	21.72
Basin B2	Post-Development 100 year	100	70,898.000	12.150	17.47
Basin B2	Pre-Development 100 year	100	32,796.000	12.150	7.87

Node Summary

Label	Scenario	Return Event (years)	Hydrograph Volume (ft^3)	Time to Peak (hours)	Peak Flow (ft^3/s)
O-1	Post-Development 100 year	100	125,248.000	12.100	34.58
O-1	Pre-Development 100 year	100	79,733.000	12.100	21.72
O-2	Post-Development 100 year	100	70,898.000	12.150	17.47
O-2	Pre-Development 100 year	100	32,796.000	12.150	7.87

Subsection: Time-Depth Curve
Label: Time-Depth - 2
Scenario: Post-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Time-Depth Curve: 100-yr 24 hr	
Label	100-yr 24 hr
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.4
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.4	0.4	0.4	0.4	0.4
7.000	0.5	0.5	0.5	0.5	0.5
7.500	0.5	0.5	0.5	0.5	0.5
8.000	0.5	0.6	0.6	0.6	0.6
8.500	0.6	0.6	0.6	0.6	0.7
9.000	0.7	0.7	0.7	0.7	0.7
9.500	0.7	0.8	0.8	0.8	0.8
10.000	0.8	0.8	0.9	0.9	0.9
10.500	0.9	1.0	1.0	1.0	1.0
11.000	1.1	1.1	1.1	1.2	1.2
11.500	1.3	1.4	1.6	2.0	2.6
12.000	3.0	3.1	3.2	3.3	3.3
12.500	3.4	3.4	3.4	3.5	3.5
13.000	3.5	3.5	3.6	3.6	3.6
13.500	3.6	3.7	3.7	3.7	3.7
14.000	3.7	3.8	3.8	3.8	3.8
14.500	3.8	3.8	3.8	3.9	3.9
15.000	3.9	3.9	3.9	3.9	3.9
15.500	4.0	4.0	4.0	4.0	4.0
16.000	4.0	4.0	4.0	4.0	4.1
16.500	4.1	4.1	4.1	4.1	4.1
17.000	4.1	4.1	4.1	4.1	4.1

Subsection: Time-Depth Curve
Label: Time-Depth - 2
Scenario: Post-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	4.2	4.2	4.2	4.2	4.2
18.000	4.2	4.2	4.2	4.2	4.2
18.500	4.2	4.2	4.3	4.3	4.3
19.000	4.3	4.3	4.3	4.3	4.3
19.500	4.3	4.3	4.3	4.3	4.3
20.000	4.3	4.3	4.4	4.4	4.4
20.500	4.4	4.4	4.4	4.4	4.4
21.000	4.4	4.4	4.4	4.4	4.4
21.500	4.4	4.4	4.4	4.4	4.4
22.000	4.5	4.5	4.5	4.5	4.5
22.500	4.5	4.5	4.5	4.5	4.5
23.000	4.5	4.5	4.5	4.5	4.5
23.500	4.5	4.5	4.5	4.5	4.6
24.000	4.6	(N/A)	(N/A)	(N/A)	(N/A)

Subsection: Time-Depth Curve
Label: Time-Depth - 2
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Time-Depth Curve: 100-yr 24 hr	
Label	100-yr 24 hr
Start Time	0.000 hours
Increment	0.100 hours
End Time	24.000 hours
Return Event	100 years

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
0.000	0.0	0.0	0.0	0.0	0.0
0.500	0.0	0.0	0.0	0.0	0.0
1.000	0.0	0.1	0.1	0.1	0.1
1.500	0.1	0.1	0.1	0.1	0.1
2.000	0.1	0.1	0.1	0.1	0.1
2.500	0.1	0.1	0.1	0.1	0.2
3.000	0.2	0.2	0.2	0.2	0.2
3.500	0.2	0.2	0.2	0.2	0.2
4.000	0.2	0.2	0.2	0.2	0.2
4.500	0.3	0.3	0.3	0.3	0.3
5.000	0.3	0.3	0.3	0.3	0.3
5.500	0.3	0.3	0.3	0.3	0.4
6.000	0.4	0.4	0.4	0.4	0.4
6.500	0.4	0.4	0.4	0.4	0.4
7.000	0.5	0.5	0.5	0.5	0.5
7.500	0.5	0.5	0.5	0.5	0.5
8.000	0.5	0.6	0.6	0.6	0.6
8.500	0.6	0.6	0.6	0.6	0.7
9.000	0.7	0.7	0.7	0.7	0.7
9.500	0.7	0.8	0.8	0.8	0.8
10.000	0.8	0.8	0.9	0.9	0.9
10.500	0.9	1.0	1.0	1.0	1.0
11.000	1.1	1.1	1.1	1.2	1.2
11.500	1.3	1.4	1.6	2.0	2.6
12.000	3.0	3.1	3.2	3.3	3.3
12.500	3.4	3.4	3.4	3.5	3.5
13.000	3.5	3.5	3.6	3.6	3.6
13.500	3.6	3.7	3.7	3.7	3.7
14.000	3.7	3.8	3.8	3.8	3.8
14.500	3.8	3.8	3.8	3.9	3.9
15.000	3.9	3.9	3.9	3.9	3.9
15.500	4.0	4.0	4.0	4.0	4.0
16.000	4.0	4.0	4.0	4.0	4.1
16.500	4.1	4.1	4.1	4.1	4.1
17.000	4.1	4.1	4.1	4.1	4.1

Subsection: Time-Depth Curve
Label: Time-Depth - 2
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

CUMULATIVE RAINFALL (in)
Output Time Increment = 0.100 hours
Time on left represents time for first value in each row.

Time (hours)	Depth (in)	Depth (in)	Depth (in)	Depth (in)	Depth (in)
17.500	4.2	4.2	4.2	4.2	4.2
18.000	4.2	4.2	4.2	4.2	4.2
18.500	4.2	4.2	4.3	4.3	4.3
19.000	4.3	4.3	4.3	4.3	4.3
19.500	4.3	4.3	4.3	4.3	4.3
20.000	4.3	4.3	4.4	4.4	4.4
20.500	4.4	4.4	4.4	4.4	4.4
21.000	4.4	4.4	4.4	4.4	4.4
21.500	4.4	4.4	4.4	4.4	4.4
22.000	4.5	4.5	4.5	4.5	4.5
22.500	4.5	4.5	4.5	4.5	4.5
23.000	4.5	4.5	4.5	4.5	4.5
23.500	4.5	4.5	4.5	4.5	4.6
24.000	4.6	(N/A)	(N/A)	(N/A)	(N/A)

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.074 ft/ft
2 Year 24 Hour Depth	1.9 in
Average Velocity	0.10 ft/s
Segment Time of Concentration	0.275 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	139.00 ft
Is Paved?	False
Slope	0.055 ft/ft
Average Velocity	3.78 ft/s
Segment Time of Concentration	0.010 hours

Segment #3: TR-55 Shallow Concentrated Flow	
Hydraulic Length	1,109.00 ft
Is Paved?	True
Slope	0.025 ft/ft
Average Velocity	3.21 ft/s
Segment Time of Concentration	0.096 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.381 hours

==== SCS Channel Flow

Tc = R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Subsection: Time of Concentration Calculations
Label: Basin B1
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.116 ft/ft
2 Year 24 Hour Depth	1.9 in
Average Velocity	0.12 ft/s
Segment Time of Concentration	0.230 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	249.00 ft
Is Paved?	False
Slope	0.049 ft/ft
Average Velocity	3.57 ft/s
Segment Time of Concentration	0.019 hours

Segment #3: TR-55 Shallow Concentrated Flow	
Hydraulic Length	542.00 ft
Is Paved?	False
Slope	0.025 ft/ft
Average Velocity	2.55 ft/s
Segment Time of Concentration	0.059 hours

Segment #4: TR-55 Shallow Concentrated Flow	
Hydraulic Length	196.00 ft
Is Paved?	False
Slope	0.012 ft/ft
Average Velocity	1.77 ft/s
Segment Time of Concentration	0.031 hours

Segment #5: TR-55 Shallow Concentrated Flow	
Hydraulic Length	265.00 ft
Is Paved?	False
Slope	0.032 ft/ft
Average Velocity	2.89 ft/s
Segment Time of Concentration	0.026 hours

Time of Concentration (Composite)

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.365 hours

==== SCS Channel Flow

Tc = R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.038 ft/ft
2 Year 24 Hour Depth	1.9 in
Average Velocity	0.08 ft/s
Segment Time of Concentration	0.359 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	98.00 ft
Is Paved?	False
Slope	0.079 ft/ft
Average Velocity	4.53 ft/s
Segment Time of Concentration	0.006 hours

Segment #3: TR-55 Shallow Concentrated Flow	
Hydraulic Length	59.00 ft
Is Paved?	False
Slope	0.042 ft/ft
Average Velocity	3.31 ft/s
Segment Time of Concentration	0.005 hours

Segment #4: TR-55 Shallow Concentrated Flow	
Hydraulic Length	914.00 ft
Is Paved?	True
Slope	0.020 ft/ft
Average Velocity	2.87 ft/s
Segment Time of Concentration	0.088 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.459 hours

==== SCS Channel Flow

Tc = R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Time of Concentration Results

Segment #1: TR-55 Sheet Flow	
Hydraulic Length	100.00 ft
Manning's n	0.400
Slope	0.040 ft/ft
2 Year 24 Hour Depth	1.9 in
Average Velocity	0.08 ft/s
Segment Time of Concentration	0.352 hours

Segment #2: TR-55 Shallow Concentrated Flow	
Hydraulic Length	273.00 ft
Is Paved?	False
Slope	0.050 ft/ft
Average Velocity	3.61 ft/s
Segment Time of Concentration	0.021 hours

Segment #3: TR-55 Shallow Concentrated Flow	
Hydraulic Length	286.00 ft
Is Paved?	False
Slope	0.035 ft/ft
Average Velocity	3.02 ft/s
Segment Time of Concentration	0.026 hours

Segment #4: TR-55 Shallow Concentrated Flow	
Hydraulic Length	158.00 ft
Is Paved?	False
Slope	0.019 ft/ft
Average Velocity	2.22 ft/s
Segment Time of Concentration	0.020 hours

Time of Concentration (Composite)	
Time of Concentration (Composite)	0.419 hours

==== SCS Channel Flow

Tc = R = Qa / Wp
V = (1.49 * (R**(2/3)) * (Sf**-0.5)) / n

(Lf / V) / 3600

Where:
R= Hydraulic radius
Aq= Flow area, square feet
Wp= Wetted perimeter, feet
V= Velocity, ft/sec
Sf= Slope, ft/ft
n= Manning's n
Tc= Time of concentration, hours
Lf= Flow length, feet

==== SCS TR-55 Shallow Concentration Flow

Tc = Unpaved surface:
V = 16.1345 * (Sf**0.5)

Paved Surface:
V = 20.3282 * (Sf**0.5)

(Lf / V) / 3600

Where:
V= Velocity, ft/sec
Sf= Slope, ft/ft
Tc= Time of concentration, hours
Lf= Flow length, feet

Subsection: Runoff CN-Area
Label: Basin B1
Scenario: Post-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
SOIL D- PONDEROSA PINE	75.000	2.120	0.0	0.0	75.000
IMPERVIOUS AREA	98.000	6.320	0.0	0.0	98.000
SOIL C- PONDEROSA PINE	65.000	4.030	0.0	0.0	65.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	12.470	(N/A)	(N/A)	83.425

Subsection: Runoff CN-Area
Label: Basin B1
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Soil C-Pine	65.000	8.220	0.0	0.0	65.000
Soil D-pine	75.000	3.880	0.0	0.0	75.000
Impervious Area	98.000	0.770	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	12.870	(N/A)	(N/A)	69.989

Subsection: Runoff CN-Area
Label: Basin B2
Scenario: Post-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Soil C - Pine	65.000	3.290	0.0	0.0	65.000
Impervious	98.000	3.780	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	7.070	(N/A)	(N/A)	82.644

Subsection: Runoff CN-Area
Label: Basin B2
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

Runoff Curve Number Data

Soil/Surface Description	CN	Area (acres)	C (%)	UC (%)	Adjusted CN
Soil C - Pine	65.000	6.560	0.0	0.0	65.000
Impervious Area	98.000	0.100	0.0	0.0	98.000
COMPOSITE AREA & WEIGHTED CN --->	(N/A)	6.660	(N/A)	(N/A)	65.495

Storm Event	100-yr 24 hr
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.381 hours
Area (User Defined)	12.470 acres

Computational Time Increment	0.051 hours
Time to Peak (Computed)	12.099 hours
Flow (Peak, Computed)	34.59 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	34.58 ft³/s

Drainage Area	
SCS CN (Composite)	83.000
Area (User Defined)	12.470 acres
Maximum Retention (Pervious)	2.0 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.8 in
Runoff Volume (Pervious)	125,794.274 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	125,248.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.381 hours
Computational Time Increment	0.051 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	37.06 ft³/s

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.254 hours
Unit receding limb, Tr	1.017 hours
Total unit time, Tb	1.271 hours

Storm Event	100-yr 24 hr
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.365 hours
Area (User Defined)	12.870 acres

Computational Time Increment	0.049 hours
Time to Peak (Computed)	12.105 hours
Flow (Peak, Computed)	21.89 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.100 hours
Flow (Peak Interpolated Output)	21.72 ft³/s

Drainage Area	
SCS CN (Composite)	70.000
Area (User Defined)	12.870 acres
Maximum Retention (Pervious)	4.3 in
Maximum Retention (Pervious, 20 percent)	0.9 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.7 in
Runoff Volume (Pervious)	80,185.934 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	79,733.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.365 hours
Computational Time Increment	0.049 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	39.99 ft³/s

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.243 hours
Unit receding limb, Tr	0.972 hours
Total unit time, Tb	1.215 hours

Storm Event	100-yr 24 hr
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.459 hours
Area (User Defined)	7.070 acres

Computational Time Increment	0.061 hours
Time to Peak (Computed)	12.167 hours
Flow (Peak, Computed)	17.61 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	17.47 ft³/s

Drainage Area	
SCS CN (Composite)	83.000
Area (User Defined)	7.070 acres
Maximum Retention (Pervious)	2.0 in
Maximum Retention (Pervious, 20 percent)	0.4 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	2.8 in
Runoff Volume (Pervious)	71,320.397 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	70,898.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.459 hours
Computational Time Increment	0.061 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	17.47 ft³/s

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.306 hours
Unit receding limb, Tr	1.223 hours
Total unit time, Tb	1.529 hours

Storm Event	100-yr 24 hr
Return Event	100 years
Duration	24.000 hours
Depth	4.6 in
Time of Concentration (Composite)	0.419 hours
Area (User Defined)	6.660 acres

Computational Time Increment	0.056 hours
Time to Peak (Computed)	12.181 hours
Flow (Peak, Computed)	7.91 ft³/s
Output Increment	0.050 hours
Time to Flow (Peak Interpolated Output)	12.150 hours
Flow (Peak Interpolated Output)	7.87 ft³/s

Drainage Area	
SCS CN (Composite)	65.000
Area (User Defined)	6.660 acres
Maximum Retention (Pervious)	5.4 in
Maximum Retention (Pervious, 20 percent)	1.1 in

Cumulative Runoff	
Cumulative Runoff Depth (Pervious)	1.4 in
Runoff Volume (Pervious)	33,075.432 ft³

Hydrograph Volume (Area under Hydrograph curve)	
Volume	32,796.000 ft³

SCS Unit Hydrograph Parameters	
Time of Concentration (Composite)	0.419 hours
Computational Time Increment	0.056 hours
Unit Hydrograph Shape Factor	483.432
K Factor	0.749
Receding/Rising, Tr/Tp	1.670
Unit peak, qp	18.01 ft³/s

Subsection: Unit Hydrograph Summary
Label: Basin B2
Scenario: Pre-Development 100 year

Return Event: 100 years
Storm Event: 100-yr 24 hr

SCS Unit Hydrograph Parameters	
Unit peak time, Tp	0.279 hours
Unit receding limb, Tr	1.118 hours
Total unit time, Tb	1.397 hours

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