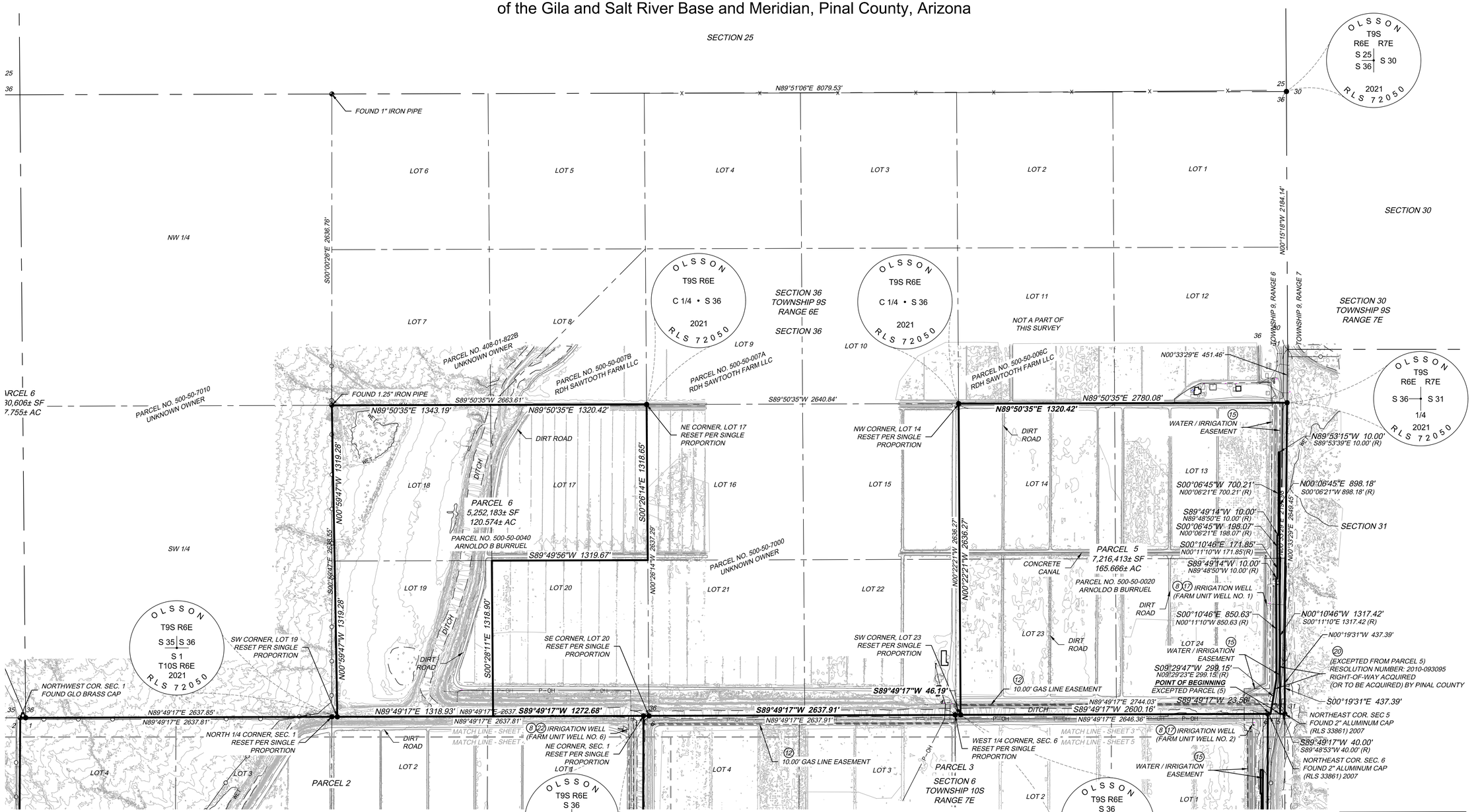
ALTA / NSPS Land Title Survey

A part of Section 36, Township 9 South, Range 6 East & Section 1 & 12, Township 10 South, Range 6 East &
Section 6, Township 10 South, Range 7 East
of the Gila and Salt River Base and Meridian, Pinal County, Arizona



TITLE COMMITMENT SCHEDULE A DESCRIPTION

Parcel 5: (500-50-0020)
Government Lots 13, 14, 23 and 24 in Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Except all gas, oil, metals and mineral rights as reserved to the state of Arizona in the Patent to said land; and Also, excepting a parcel of land situated in a portion of Section 36, Township 9 South, Range 6 East of Gila and Salt River Base and Meridian, Pinal County, Arizona, more particularly described as follows: commencing at the Southeast corner of said Section 36; thence South 89°48'53" West, along the South line of said Section 36, a distance of 40.00 feet to the point of beginning; thence continuing South 89°48'53" West, a distance of 80.28 feet; thence departing said South line, North 09°29'23" East, a distance of 299.15 feet; thence North 00°11'10" West, along a line parallel with and 70.00 feet West of the East line of Government Lot 24, a distance of 850.63 feet; thence North 89°48'50" East, a distance of 10.00 feet; thence North 00°11'10" West, a distance of 171.85 feet; thence North 0°06'21" East, along a line parallel with and 60.00 feet West of the East line of Government Lot 13, a distance of 198.07 feet; thence North 89°48'50" East, a distance of 10.00 feet; thence North 00°06'21" East, a distance of 700.21 feet; thence South 89°53'39" East, a distance of 10.00 feet to a point 40.00 feet West of the East line of said Government Lot 13; thence South 00°06'21" West, parallel to said East line, a distance of 898.18 feet; thence South 00°11'10" East, along a line parallel with and 40.00 feet West of the East line of said Government Lot 24, a distance of 1317.42 feet to the point of beginning.

Parcel 6 (500-50-0040)
Lots 17, 18 and 19, Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

LEGEND

AC=	Acres		Found Section Corner Monument (As Noted)
SQ. FT.=	Square Feet		Found Monument (As Noted)
Rec.=	Reception Number		Set Monument (#4 Rebar & 2" Alum. Cap RLS# 72050)
COR.	Corner		Easement, Permanent
SEC.	Section		Subject Property Boundary Line
ESMT.	Easement		Section Line
R/W	Right-of-Way		Quarter Section Line
		WET	Wetlands / Marshlands
		x	Barbed Wire Fence

NOT TO SCALE

SUNLAND GIN RD.

SEC. 36 T9S-R6E	
SEC. 1 T10S-R6E	SEC. 6 T10S-R7E
SEC. 12 T10S-R6E	SEC. 7 T10-R7E

W. ARIES DR.

olsson
7878 N. 16th Street, Suite 105
Phoenix, AZ 85020-5282
TEL 602.748.1000
www.olsson.com

Registered Land Surveyor
CERTIFICATE NO.
72050
NICHOLAS SCHRADER
Date Signed: 01/30/2022
ARIZONA, U.S.A.

REV. NO.	DATE	REVISIONS DESCRIPTION
1	2022/11/04	ADD TOPOGRAPHIC INFORMATION & PROPOSED LAYOUT

REVISIONS

ALTA / NSPS LAND TITLE SURVEY
Enel Green Power
Sonak Solar Site
PINAL COUNTY, ARIZONA
2022

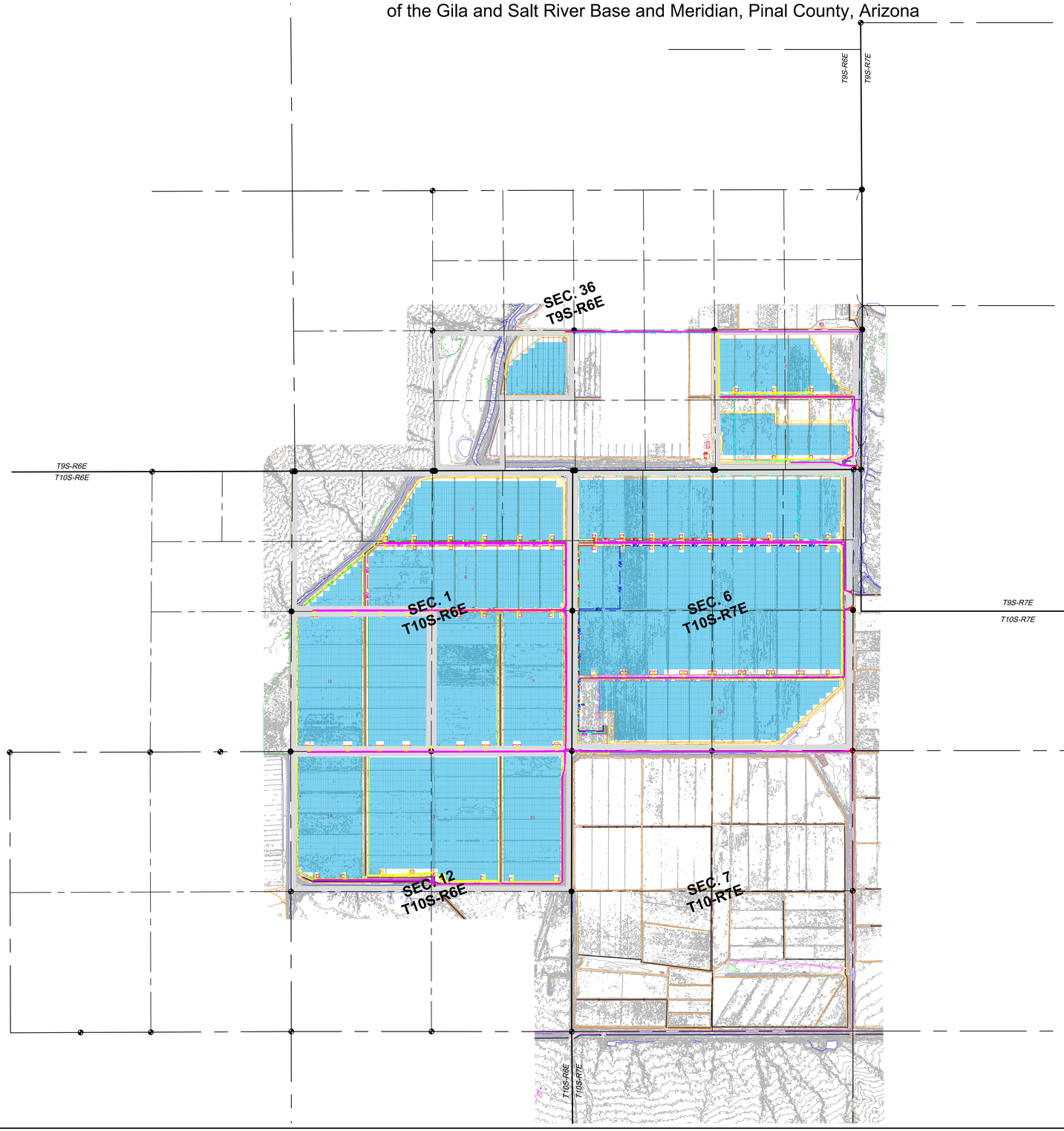
drawn by: DMW / NSS
designed by:
checked by: NSS
project no.: 021-05846
date: 01.21.2022

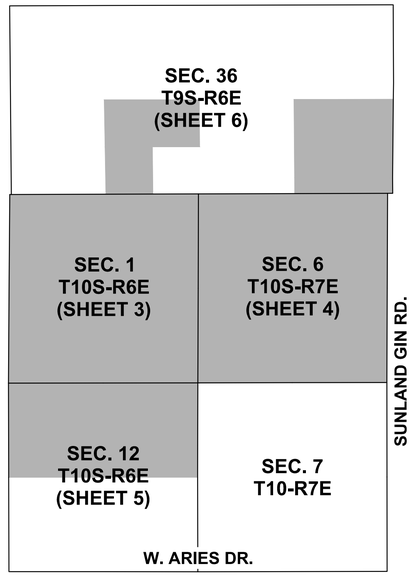
SHEET
6 of 7

DWG: F:\2021\05501-06000\021-05846\40-Design\Survey\SRVY\Xref\V_XALTA_02105846 (REV1) (MODIFIED SP GROUND).dwg USER: nschroder
DATE: Nov 04, 2022 3:57pm XREFS: V_XTOPO_02105846 (MODIFIED SP GROUND) V_XTBLK_02105846 62357_SONAK_AZ_C_INTFT_2D_OLSSON-LAYERS_GROUND 62357_SONAK_AZ_C_CONTOURS_GROUND (EDITED) Sonak Solar layout 1 BESS_Layout_143_Meggpacks Sonak – Proj

ALTA / NSPS Land Title Survey

A part of Section 36, Township 9 South, Range 6 East & Section 1 & 12, Township 10 South, Range 6 East &
Section 6, Township 10 South, Range 7 East
of the Gila and Salt River Base and Meridian, Pinal County, Arizona





N

0' 1000' 2000'
SCALE IN FEET

N

0' 500' 1000' 2000'
SCALE IN FEET

LEGEND

- Easement, Permanent
- Subject Property Boundary Line
- Section Line
- Quarter Section Line

GENERAL NOTES

1. This sheet is intended to show the proposed improvments and infrastructure for the Sonak Solar project.
2. Improvements shown hereon have been provided by Enel Green Power and represent a 30% design.
3. See the previuos sheets for specific boundary information of the subject property.

olsson
7878 N. 16th Street, Suite 105
Phoenix, AZ 85020-5282
TEL 602.748.1000
www.olsson.com

Registered Land Surveyor
CERTIFICATE NO.
72050
NICHOLAS
SCHRADER
Date Signed: 01/30/2022
ARIZONA, U.S.A.

REV. NO.	DATE	REVISIONS DESCRIPTION
1	2022/11/04	ADD TOPOGRAPHIC INFORMATION & PROPOSED LAYOUT

REVISIONS

ALTA / NSPS LAND TITLE SURVEY

Enel Green Power
Sonak Solar Site

PINAL COUNTY, ARIZONA

2022

drawn by: DMW / NSS
designed by:
checked by: NSS
project no.: 021-05846
date: 01.21.2022

SHEET
7 of 7

DWG: F:\2021\021-05846\CAD\ALTA\Sheets\SONAK_ALTA_SHEET_2022.dwg USER: nschroder
DATE: Nov 04, 2022 - 2:06pm XREFS: XREF_BOUNDARY_2021.dwg XREF_TOPO_2021.dwg SONAK_GROUNDMOUNT_ALTA_2022.dwg

EXHIBIT "A" – Rezone

DESCRIPTION OF THE PROPERTY

THE FOLLOWING REAL PROPERTY LOCATED IN THE COUNTY OF PINAL, STATE OF ARIZONA:

Tract 1: APN 409-01-001A

The Southwest Quarter of Section 1, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 2: APN 409-01-001B

Government Lots 1, 2, 3 and 4; The South Half of the North Half; and the Southeast Quarter of Section 1, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 3: APN 409-06-0040

Government Lots 1, 2, 3 and 4; the South Half of the North Half; and the South Half of Section 6, Township 10 South, Range 7 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

LESS AND EXCEPT:
A parcel of land situated in a portion of Section 6, Township 10 South, Range 7 East of Gila and Salt River Base and Meridian, Pinal County, Arizona, more particularly described as follows:
Commencing at the Northeast Corner of said Section 6; thence South 00 degrees 16 minutes 01 second West, along the East line of said Section 6, a distance of 474.75 feet; thence departing said East line, North 89 degrees 43 minutes 59 seconds West, a distance of 40.00 feet to the point of beginning; thence South 00 degrees 16 minutes 01 seconds, along a line parallel with and 40.00 feet West of said East line, a distance of 799.69 feet; thence North 89 degrees 43 minutes 59 seconds West, a distance of 10.00 feet; thence North 00 degrees 16 minutes 01 seconds East, along a line parallel with and 50.00 feet West of said East line, a distance of 599.69 feet; thence North 89 degrees 43 minutes 59 seconds West, a distance of 10.00 feet; thence North 00 degrees 16 minutes 01 seconds East, along a line parallel with and 60.00 feet West of said line, a distance of 200.00 feet; thence South 89 degrees 43 minutes 59 seconds East, a distance of 20.00 feet to the point of beginning.

Tract 4: APN 409-02-0010

The North Half of Section 12, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 5: APN 500-50-0020

Government Lots 13, 14, 23 and 24 in Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona,

LESS AND EXCEPT:
A parcel of land situated in a portion of Section 36, Township 9 South, Range 6 East of Gila and Salt River Base and Meridian, Pinal County, Arizona, more particularly described as follows:
Commencing at the Southeast Corner of said Section 36; thence South 89 degrees 48 minutes 53 seconds West along the South line of said Section 36, a distance of 40.00 feet to the point of beginning; thence continuing South 89 degrees 48 minutes 53 second West, a distance of 80.28 feet; thence departing said South line, North 09 degrees 29 minutes 23 seconds East, a distance of 299.15 feet; thence North 00 degrees 11 minutes 10 seconds West, along a line parallel with and 70.00 feet West of the East line of Government Lot 24, a distance of 850.63 feet; thence North 89 degrees 48 minutes 50 seconds East, a distance of 10.00 feet; thence North 00 degrees 11 minutes 10 seconds West, a distance of 171.85 feet; thence North 00 degrees 06 minutes 21 seconds East, along a line parallel with and 60.00 feet West of the East line of Government Lot 13, a distance of 198.07 feet; thence North 89 degrees 48 minutes 50 seconds East, a distance of 10.00 feet; thence North 00 degrees 06 minutes 21 seconds East, a distance of 700.21 feet; thence South 89 degrees 53 minutes 39 seconds East, a distance of 10.00 feet to a point 40.00 feet West of the East line of said Government Lot 13; thence South 00 degrees 06 minutes 21 seconds West, parallel to said East line, a distance of 898.18 feet; thence South 00 degrees 11 minutes 10 seconds East, along a line parallel with and 40.00 feet West of the East line of said Government Lot 24, a distance of 1317.42 feet to the point of beginning.

Tract 6: APN 500-50-0040

Lots 17, 18 and 19, Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

EXHIBIT "B" – PAD Overlay District

DESCRIPTION OF THE PROPERTY

THE FOLLOWING REAL PROPERTY LOCATED IN THE COUNTY OF PINAL, STATE OF ARIZONA:

Tract 1:

The Southwest Quarter of Section 1, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 2:

Government Lots 1, 2, 3 and 4; The South Half of the North Half; and the Southeast Quarter of Section 1, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 3:

Government Lots 1, 2, 3 and 4; the South Half of the North Half; and the South Half of Section 6, Township 10 South, Range 7 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

LESS AND EXCEPT:
A parcel of land situated in a portion of Section 6, Township 10 South, Range 7 East of Gila and Salt River Base and Meridian, Pinal County, Arizona, more particularly described as follows:
Commencing at the Northeast Corner of said Section 6; thence South 00 degrees 16 minutes 01 second West, along the East line of said Section 6, a distance of 474.75 feet; thence departing said East line, North 89 degrees 43 minutes 59 seconds West, a distance of 40.00 feet to the point of beginning; thence South 00 degrees 16 minutes 01 seconds, along a line parallel with and 40.00 feet West of said East line, a distance of 799.69 feet; thence North 89 degrees 43 minutes 59 seconds West, a distance of 10.00 feet; thence North 00 degrees 16 minutes 01 seconds East, along a line parallel with and 50.00 feet West of said East line, a distance of 599.69 feet; thence North 89 degrees 43 minutes 59 seconds West, a distance of 10.00 feet; thence North 00 degrees 16 minutes 01 seconds East, along a line parallel with and 60.00 feet West of said line, a distance of 200.00 feet; thence South 89 degrees 43 minutes 59 seconds East, a distance of 20.00 feet to the point of beginning.

Tract 4:

The North Half of Section 12, Township 10 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

Tract 5:

Government Lots 13, 14, 23 and 24 in Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona,

LESS AND EXCEPT:
A parcel of land situated in a portion of Section 36, Township 9 South, Range 6 East of Gila and Salt River Base and Meridian, Pinal County, Arizona, more particularly described as follows:
Commencing at the Southeast Corner of said Section 36; thence South 89 degrees 48 minutes 53 seconds West along the South line of said Section 36, a distance of 40.00 feet to the point of beginning; thence continuing South 89 degrees 48 minutes 53 second West, a distance of 80.28 feet; thence departing said South line, North 09 degrees 29 minutes 23 seconds East, a distance of 299.15 feet; thence North 00 degrees 11 minutes 10 seconds West, along a line parallel with and 70.00 feet West of the East line of Government Lot 24, a distance of 850.63 feet; thence North 89 degrees 48 minutes 50 seconds East, a distance of 10.00 feet; thence North 00 degrees 11 minutes 10 seconds West, a distance of 171.85 feet; thence North 00 degrees 06 minutes 21 seconds East, along a line parallel with and 60.00 feet West of the East line of Government Lot 13, a distance of 198.07 feet; thence North 89 degrees 48 minutes 50 seconds East, a distance of 10.00 feet; thence North 00 degrees 06 minutes 21 seconds East, a distance of 700.21 feet; thence South 89 degrees 53 minutes 39 seconds East, a distance of 10.00 feet to a point 40.00 feet West of the East line of said Government Lot 13; thence South 00 degrees 06 minutes 21 seconds West, parallel to said East line, a distance of 898.18 feet; thence South 00 degrees 11 minutes 10 seconds East, along a line parallel with and 40.00 feet West of the East line of said Government Lot 24, a distance of 1317.42 feet to the point of beginning.

LESS AND EXCEPT:

OPEN SPACE AREA NORTHEAST

A tract of land in Lot 13 of Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona, being more particularly described as follows:

BEGINNING at the Northeast corner of said Lot 13, being marked by an iron bar with an aluminum cap stamped “OLSSON RLS 72050”, from which the Southeast corner of Section 36 (also being the Southeast corner of Lot 24) bears South 00°24’41” West, a distance of 2635.33 feet to a found iron bar with a 2” aluminum cap stamped “RLS 33861 2007”, with all other bearings being relative hereto (said line does not follow the East line of Section 36 and is for reference only); Thence along the East line of said Lot 13 South 00°33’29” West, a distance of 1094.70 feet; Thence leaving said East line North 72°54’20” West, a distance of 54.32 feet to a point on the East line of a Pinal County right-of-way being recorded at instrument number 2010-093095 in the Pinal County Recorder’s Office; Thence along the East line of said right-of-way, North 00°06’45” East, a distance of 658.89 feet to the Northeast corner thereof; Thence along the North line of said right-of-way North 89°53’15” West, a distance of 10.00 feet to the Northwest corner thereof; Thence along the West line of said right-of-way, South 00°06’45” West, a distance of 655.84’; Thence leaving said right-of-way North 72°54’20” West, a distance of 278.40 feet; Thence North 29°58’29” West, a distance of 1144.34 to a point on the North line of said Lot 13; Thence along said North line 89°50’35”, a distance of 910.41 to the POINT OF BEGINNING.

Said tract contains 625,441 square feet or 14.358 acres of land, more or less.

Distances shown hereon are ground distances which have been scaled from grid

distances using the combined scale factor of 1.00016634 (reciprocal of 0.99983368).

Tract 6:

Lots 17, 18 and 19, Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona.

LESS AND EXCEPT:

OPEN SPACE AREA NORTHWEST

A tract of land in Lot 18 of Section 36, Township 9 South, Range 6 East of the Gila and Salt River Base and Meridian, Pinal County, Arizona, being more particularly described as follows:

BEGINNING at the Northwest corner of said Lot 18, being marked by a found 1.25" iron pipe, from which the Southwest corner of said Lot 19, being marked by an iron rebar with an aluminum cap stamped "OLSSON RLS 72050" bears South 00°59'47" East, a distance of 2638.55 feet, with all other bearings being relative hereto; Thence along the North line of said Lot 18, North 89°50'35" East, a distance of 831.12 feet; Thence leaving said North line South 50°05'32" West, a distance of 1068.00 feet to the West line of said Lot 18; Thence along said West line, North 00°59'47" West, a distance of 683.01 feet to the **POINT OF BEGINNING**.

Said tract contains 283,801 square feet or 6.515 acres of land, more or less.

Distances shown hereon are ground distances which have been scaled from grid distances using the combined scale factor of 1.00016634 (reciprocal of 0.99983368).

Sonak Solar Project – Neighborhood Meeting Minutes

October 20th, 2022

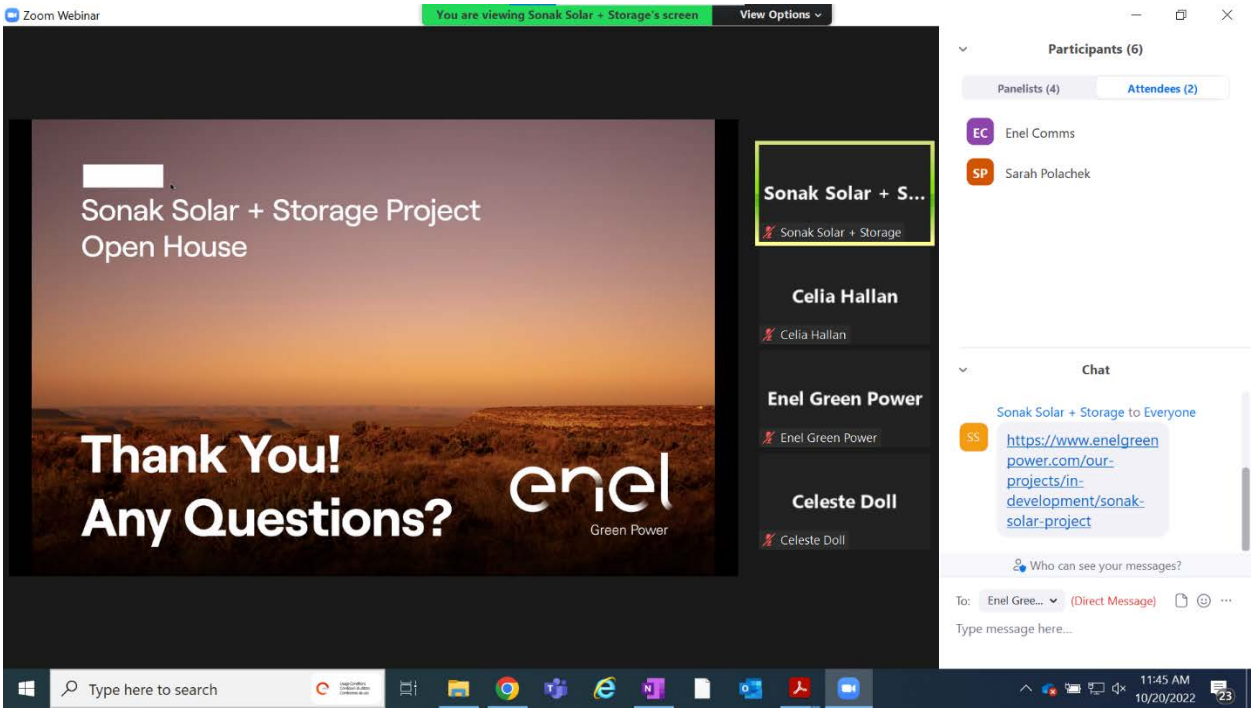
11:00 am – 12:00 pm: Virtual Neighborhood Meeting

- 11:00am: Zoom Webinar is opened for the Virtual Neighborhood Meeting. Community members can call in by phone, or join by computer from enelgreenpower.com/sonak, as informed by the neighborhood meeting invitation.
- 11:15am: No community members have joined the Virtual Neighborhood Meeting. Celia Hallan gives PowerPoint presentation on the Sonak Project. The presentation is recorded.
- 11:45am: PowerPoint presentation concludes. Floor is opened for Q&A. No community members have joined, but a link to the Sonak Project website is posted in the chat for any community members who do join to ask questions or leave comments.
- 12:00pm: Zoom Webinar is closed. Virtual Neighborhood Meeting ends. No community members in attendance.

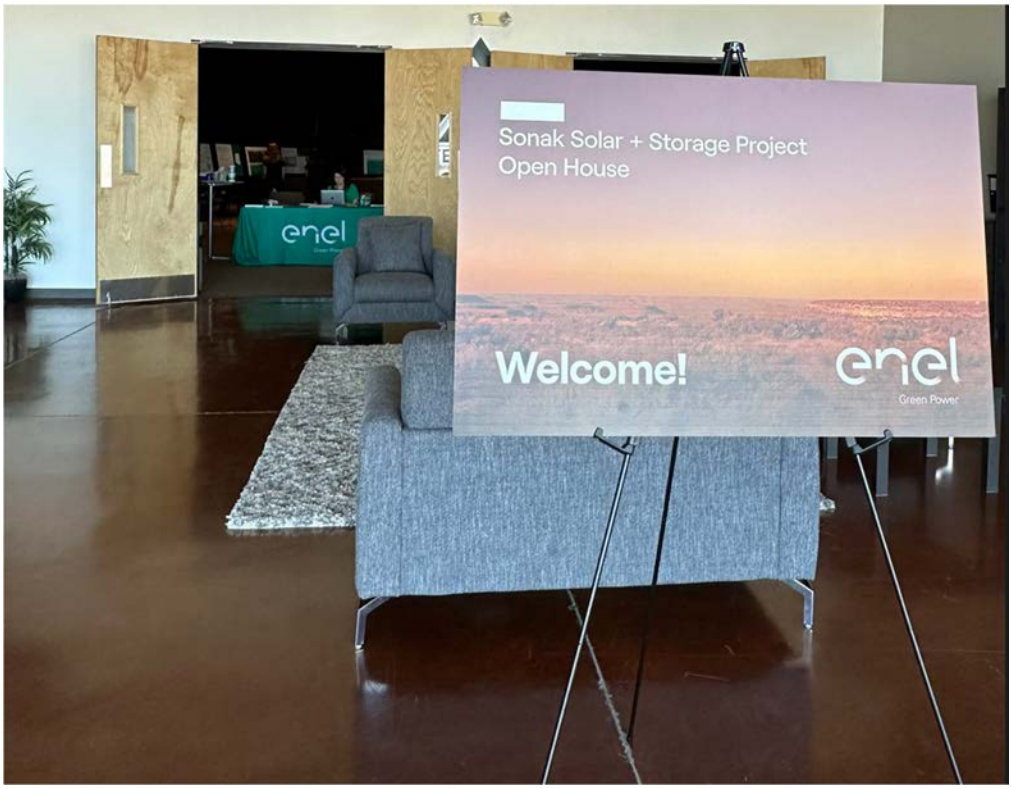
4:00 pm – 9:00 pm: In-Person Neighborhood Meeting

- 3:00pm: Sonak Project team arrives at After the One Church in Arizona City, AZ and sets up welcome table with sign-in sheets, project fact sheets, and contact information, project information boards, and comment card tables for the Neighborhood Meeting.
- 4:00pm: Doors opened for In-Person Neighborhood Meeting
- 4:00pm – 9:00pm: Sonak Project team greets community members arriving for Neighborhood Meeting. Team members bring community members around project information boards, answer questions, and provide comment cards. Total of three adult community members attend and sign in using sign-in sheet. Community members asked the following questions:
    - How will you deal with flooding on the site or along Sunland Gin Road?
    - Will construction and operation of the Project create dust?
    - How close is the Project to the Silverbell Estates? Will it affect the Silverbell Estates?
    - Will Enel be upgrading roads for the project?
    - How long will construction last?
    - We are not familiar with the Battery Storage technology. What are you planning?
    - How tall will the panels be?
    - Is this project a done deal? What are the next steps for the Project?
- 9:00pm: Doors closed for In-Person Neighborhood Meeting.

Attachment A: Virtual Neighborhood Meeting Screenshot, 11:45am, 10/20/2022



Attachment B: In-Person Neighborhood Meeting Photos, 10/20/2022




enel
Green Power


Enel Green Power

In-Person Meeting Attendee Sign In Sheet

enel

Green Power

First Name	Last Name	Address	Email	Phone	Do you want to receive email updates?	Signature
Pauline	Utecht Wright	14599W Moonchild Dr	flowerchilimom@hotmail.com	5207052900	☑	Pauline Utecht Wright
Martin Smith	Smith	13774W Scorpio Ave	martinsmith4957 Yahoo.com	260-273-0685	☑	
Debra	Potter	12802W Viejo Dr Play	—	—	☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	
					☐	

Created With Tiny Scanner

Landowner List

Obtained from Pinal County, AZ Assessor Website on August 16, 2023

Real Property Owner	Street	City	State	Parcel ID	1200 FEET
AHMADIYYA MOVEMENT IN ESLAM INC USA	4720 W COUNTRYSIDE WAY	TUCSON	AZ	408-11-036A	X
AUZA JOSEPH A	353 E WILEY WAY	CASA GRANDE	AZ	409-09-002G	X
AUZA JOSEPH A SHEEP CO LLC	353 E WILEY WAY	CASA GRANDE	AZ	409-09-0040	X
BARNES VERNON LESTER, BARNES PATRICIA G	3095 S TREKELL RD	CASA GRANDE	AZ	409-06-005B	X
BUELL SHARON LEE TR	4074 E PARK AVE	GILBERT	AZ	409-06-005F	X
BURRUEL ARNOLDO B & JUDITH K					X
DJ & R INVESTMENTS LLC	3537 E CAMINO CIR	MESA	AZ	409-02-002B	X
GREENE RESERVOIR FLOOD CONTROL DISTRICT	1 E WASHINGTON ST STE 1600	PHOENIX	AZ	409-39-0020	X
KHAN UROOJ SAYEED	8729 N MOONFIRE DR	TUCSON	AZ	409-02-002F	X
MAZZOLA ROBERT J & MAZZOLA JENNIFER M					
MUHAMMAD DENNIS & KELMER	6814 W GAR WAY	LAVEEN	AZ	409-02-002C	X
RDH SAWTOOTH FARM LLC	7114 E STETSON DR STE 400	SCOTTSDALE	AZ	500-50-006C	X
RDH SAWTOOTH FARM LLC	7114 E STETSON DR STE 400	SCOTTSDALE	AZ	500-50-007A	X
RDH SAWTOOTH FARM LLC	7114 E STETSON DR STE 400	SCOTTSDALE	AZ	500-50-007B	X
RDH SAWTOOTH FARM LLC	7114 E STETSON DR STE 400	SCOTTSDALE	AZ	500-50-006D	X
RDH SAWTOOTH FARM LLC	7114 E STETSON DR STE 400	SCOTTSDALE	AZ	500-50-0010	X
SALMONS BRANDON & SUNSHINE, BARNES CHRIS	11597 N BELLARIVA DR	CASA GRANDE	AZ	409-39-0010	X
SAWTOOTH MTN LLC	2028 S HIGHLAND MESA RD	FLAGSTAFF	AZ	409-02-002C	X
STATE TRUST LAND				500-50-7000	X
SUPERSTITION RING LLC	PO BOX 47638	PHOENIX	AZ	409-01-003E	X
SUPERSTITION RING LLC	PO BOX 47638	PHOENIX	AZ	409-01-003G	X

BUREAU OF LAND MANAGEMENT, ATTN: LESLIE A. UHR					
HERNANDEZ SABRINA	8477 W CORONADO DR	ARIZONA CITY	AZ	409-02-002H	X
DAWNAISHAREGINAKELMER DARK LLC	2002 E ROESER RD	PHOENIX	AZ	409-02-002J	X
KATEN MARKUS ANTHONY	10559 W ANGELS LN	PEORIA	AZ	409-02-002D	X
MUHAMMAD DENNIS	2002 E ROESER RD	PHOENIX	AZ	409-02-002K	X
AYOBYS SOLUTIONS LLC	2558 E WIER AVE	PHOENIX	AZ	409-02-002L	X
Real Property Owner	**Street**	**City**	**State**	**Parcel ID**	**600 FEET**
MUHAMMAD DENNIS	2002 E ROESER RD	PHOENIX	AZ	409-02-002K	X
AYOBYS SOLUTIONS LLC	2558 E WIER AVE	PHOENIX	AZ	409-02-002L	X

*Highlighted names were previously listed but no longer found on Pinal County Assessor Webpage.

Notice Mailer



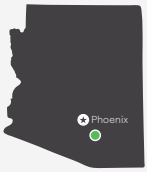




Sonak Solar + Storage Project
Open House

Enel Green Power North America
2175 NW Raleigh St., Suite 110
Portland, OR 97210

About Sonak Solar



- Located in rural Pinal County, 10 miles south of Arizona City
- Generates new tax revenue for schools and public services
- Creates jobs and generates local spending during construction
- Helps preserve Arizona's environment
- Supports America's energy independence

Scan with your smartphone to learn more.

We Want To Hear From You

Please join Enel Green Power for an Open House to learn more about the Sonak Solar Project in Pinal County. The event is come-and-go, and our team will be there to answer questions and discuss the project.

October 20, 2022
4–9 p.m.

After the One Church
13325 S Tacna Rd, Arizona City, AZ 85123

Can't make it in-person? We also have a virtual option:

October 20, 2022
11 a.m. – 12 p.m.

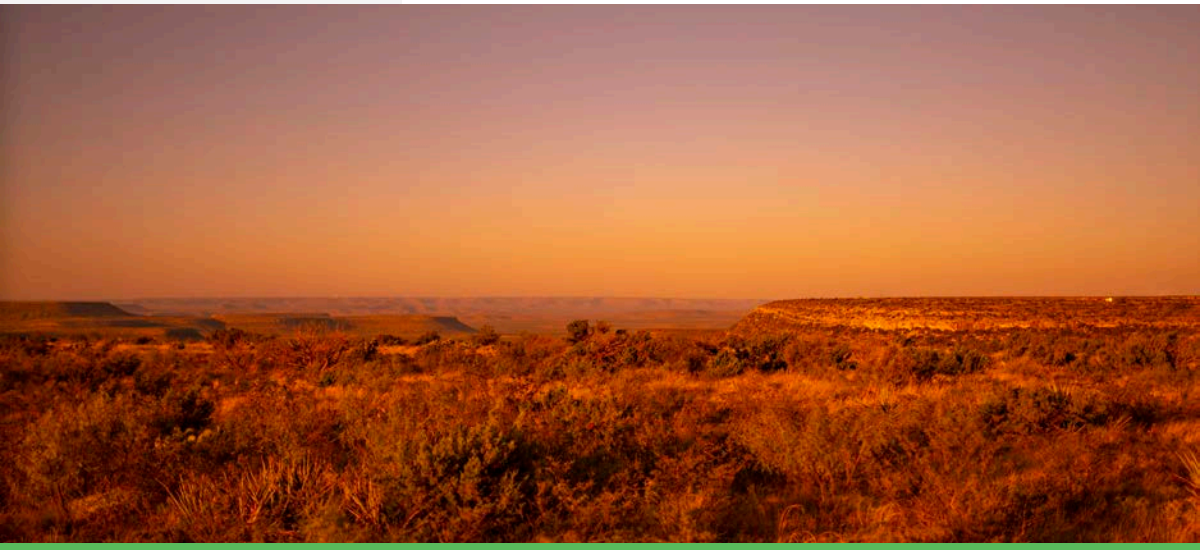
Virtual joining information will be available on enelgreenpower.com/sonak on the morning of Oct.20.

Your feedback is important to us as we aim to ensure this project benefits the county for years to come.

We hope to see you there!

Questions? Please contact:

Celia Hallan
Project Development Manager
Enel Green Power North America
(978) 806-6743
Celia.Hallan@enel.com



Enel Green Power

Enel Green Power in North America is a leading developer, long-term owner and operator of renewable energy plants with a presence in 14 U.S. states and one Canadian province. The company operates 64 plants with a managed capacity of over 8 GW powered by wind, geothermal and solar energy.

Stay Connected www.enelgreenpower.com/sonak

enel Green Power

ENEL

SONAK SOLAR PROJECT

PRELIMINARY DRAINAGE STUDY



This Photo by Unknown Author is licensed under CC BY-SA

SONAK SOLAR PROJECT

PRELIMINARY DRAINAGE STUDY

ENEL

PRELIMINARY DRAINAGE STUDY

PROJECT NO.: 31300042.K
DATE: DECEMBER 2022

WSP

WSP.COM

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Project Overview 1
1.2 Project Description 1
1.3 Existing Site Conditions 1
1.4 Proposed Site Conditions 2
1.5 Purpose of Report 2
2 PREVIOUS STUDIES 5
2.1 Flood Insurance Rate Maps 5
3 HYDROLOGIC AND HYDRAULIC METHODS 7
3.1 Data Sources 7
3.2 Site hydrology 7
3.2.1 Offsite Drainage 8
3.2.2 Land Use 8
3.2.3 Soils 8
3.3 Models 8
3.3.1 Precipitation 8
3.3.2 Storm Distribution 8
3.3.3 Grid Size and Nodes 8
3.3.4 Topography 9
3.3.5 Green-Ampt Loss Parameters 9
3.3.6 Manning's n 9
4 HYDROLOGIC AND HYDRAULIC ANALYSIS RESULTS 12
4.1 Pre-Development Condition Model Results 12
5 CONCLUSION 21
5.1 Conclusions and Recommendations 21
6 REFERENCES 22

TABLES

TABLE 3.1 DATA SOURCES 7
TABLE 3.2 SUMMARY OF LAND USES AND MANNING'S N FOR FLO-2D MODELS 9

FIGURES

FIGURE 1.1 – VICINITY MAP 3
FIGURE 1.2 – SITE MAP 4
FIGURE 2.1 – FEMA FLOODPLAIN MAP 6
FIGURE 3.1 – WATERSHED MAP 10
FIGURE 3.2 – TOPOGRAPHY MAP 11
FIGURE 4.1A – 100-YEAR STORM PRE-DEVELOPMENT CONDITION FULL MODEL FLOW DEPTH MAP 13
FIGURE 4.1B – 100-YEAR STORM PRE-DEVELOPMENT CONDITION FLOW DEPTH MAP 14
FIGURE 4.2A – 100-YEAR STORM PRE-DEVELOPMENT CONDITION FULL MODEL VELOCITY MAP 15
FIGURE 4.2B – 100-YEAR STORM PRE-DEVELOPMENT CONDITION VELOCITY MAP 16
FIGURE 4.3A – 10-YEAR STORM PRE-DEVELOPMENT CONDITION FULL MODEL FLOW DEPTH MAP 17
FIGURE 4.3B – 10-YEAR STORM PRE-DEVELOPMENT CONDITION FLOW DEPTH MAP 18
FIGURE 4.4A – 10-YEAR STORM PRE-DEVELOPMENT CONDITION FULL MODEL VELOCITY MAP 19
FIGURE 4.4B – 10-YEAR STORM PRE-DEVELOPMENT CONDITION VELOCITY MAP 20

APPENDICES

APPENDIX A **HYDROLOGIC AND HYDRAULIC PARAMETERS AND ANALYSIS**

A.1 NOAA ATLAS 14 RAINFALL DATA

A.2 TR-55 RAINFALL DISTRIBUTION MAP

A.3 GREEN-AMPT CALCULATIONS

A.3.1 LAND USE MAP

A.3.2 SOILS MAP

A.4 FLO-2D MANNING'S N VALUES

1 INTRODUCTION

1.1 PROJECT OVERVIEW

This Preliminary Drainage Report was prepared by WSP on behalf of ENEL to address drainage at the proposed Sonak Solar Project (SS Project). The project consists of a 323 megawatt alternating current (MWac) photovoltaic (PV) solar plant situated on approximately 1,867 acres of land within Pinal County, Arizona, approximately ten (10) miles south of Arizona City (Figure 1.1).

The purpose of this Preliminary Drainage Report is to establish the hydrology for the 100-year and 10-year storm events and provide flow depths and velocities that will be used to provide solar equipment elevations (panels, inverters, and pads) and O&M building pad elevation.

1.2 PROJECT DESCRIPTION

The Project site is located in Pinal County, Arizona, approximately 10 miles south of Arizona City. Access to the project site is via Sunland Gin Road on the east side and Pearce Road to the south. The site is located within portions of Township 9 South (T9S), Range 6 East (R6E), Section 36, T10S, R6E, Sections 1 and 12, and T10S, R7E, Section 6. The Project consists of a PV solar farm with a nameplate capacity of 323 MWac on approximately 1,867 acres of land. At present, the land is primarily cultivated crops.

The PV array facilities will be located within the project boundary and the entire facility will be enclosed by security fencing. Major components include;

- PV modules/arrays
- Solar trackers or fixed support structures
- Direct current (DC) or alternating current (AC) collection cable and combiner or switch boxes
- Solar power inverters and medium-voltage transformers
- Battery energy storage system (BESS)
- Electrical collection system
- Onsite substation
- Administration/operations and maintenance (O&M) building
- Revegetation of ground cover

1.3 EXISTING SITE CONDITIONS

The project site is currently in agricultural use. The overall slope of the land is less than 0.2% and drains generally north. Since a majority of the land is used for agricultural and individual fields are generally leveled for irrigation efficiency, the breaks between fields are terraced to accommodate the overall ground slope. This terracing also appears to be driven by the gravity-fed irrigation supply that is sourced by nearby irrigation canals such as the Central Main Canal. The proposed solar development intends to utilize the nearly level farm fields on the site for the layout of solar panel arrays. Site conditions can be found on Figure 1.2.

There is a Federal Emergency Management Agency (FEMA) designated Zone A (100-year) flood zone within Greene Wash as identified on Figure 1.2. The flood zone meanders southeast to northwest. The project site is outside the limits of the Zone A flood zone and development of the site is not anticipated to have any negative impacts on the flood zone.

1.4 PROPOSED SITE CONDITIONS

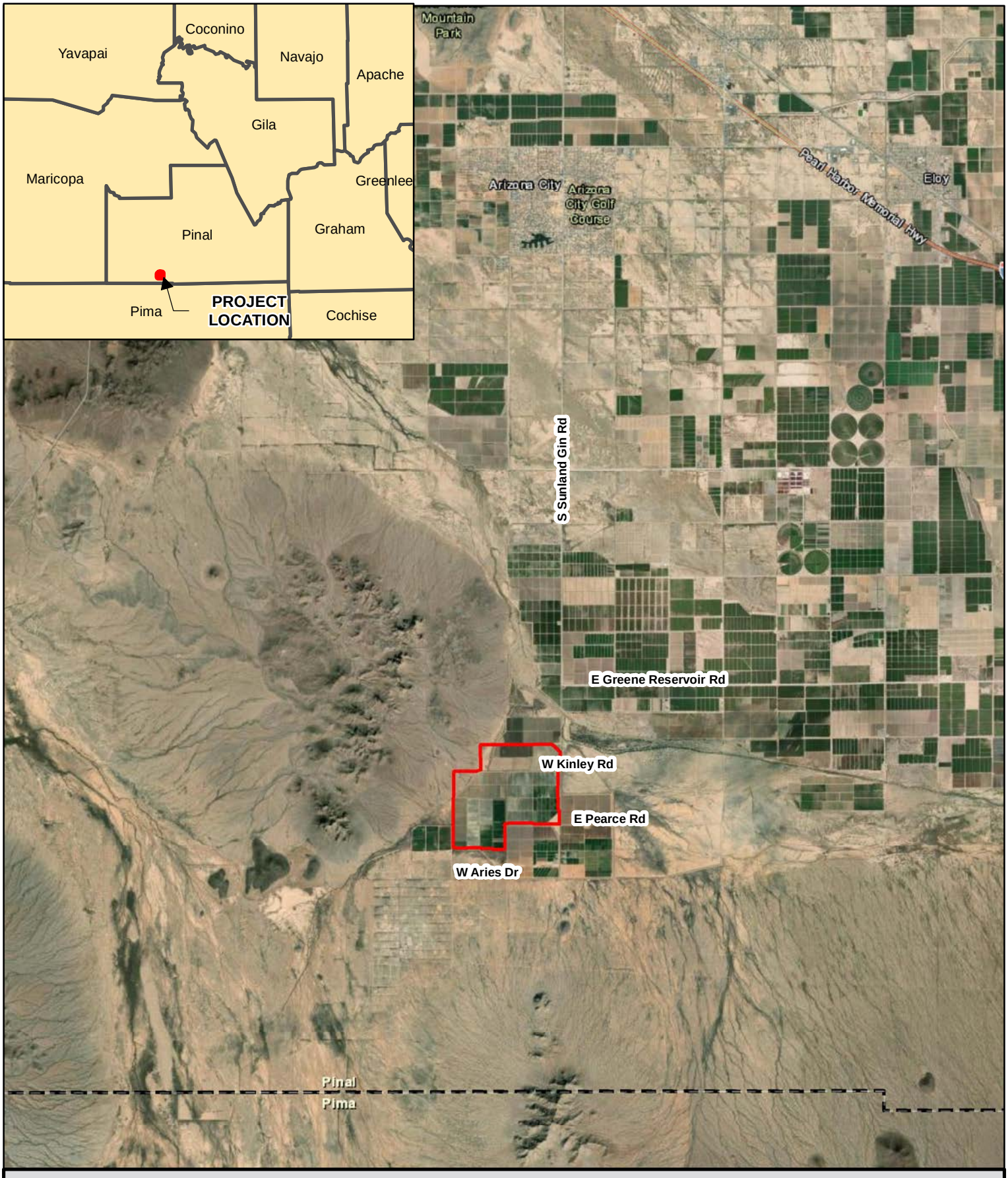
The Sonak Solar Project is a greenfield solar project that will connect to the existing transmission network. The Project will be constructed with bifacial PV modules. The solar panels will be mounted on racks, with the panels 2 to 3 feet above the ground. The ground surface beneath the panels will be open except for the foundation piles, with surface runoff flowing below and around the solar arrays. The areas under the panels will be seeded with low-maintenance native vegetation that will maintain and, in some areas, enhance the hydrologic characteristics of the site.

Rainfall landing on the panels will drip off the bottom edge and either infiltrate or travel overland as sheet flow. The flat topography and grass will reduce the velocity and scour potential. Upon completion, BESS, gravel roads, equipment pads, and other impervious surfaces will cover approximately 2 to 3% of the site, with the remainder of the site being grassed.

1.5 PURPOSE OF REPORT

The purpose of this report is to establish the 100-year and 10-year storm flow depths and velocities across the site and present a preliminary stormwater management plan for the SS Project. This report presents an overview of the hydrologic methods, input parameters, and 100-year and 10-year hydrologic and hydraulic model results. This report is organized as follows:

- Section 1 provides general project background;
- Section 2 presents previous studies related to the project;
- Section 3 discusses hydrologic & hydraulic analysis;
- Section 4 presents hydrologic and hydraulic results;
- Section 5 provides the conclusion; and,
- Section 6 lists the references.



Sonak Solar

Legend

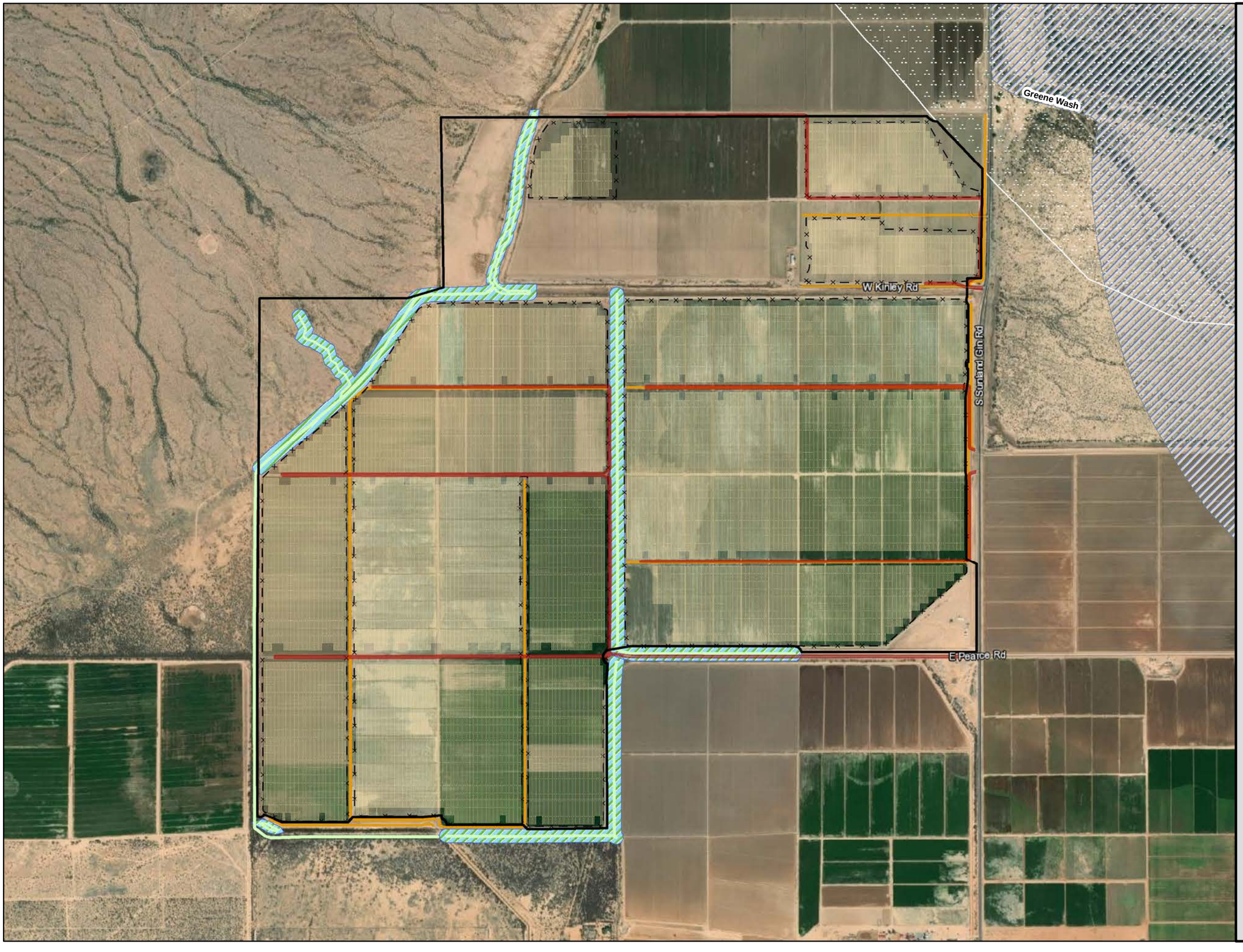
Project Limits

County Boundary

N

0 1 2 4 Miles

Vicinity Map
Figure 1.1



enel Green Power

Sonak Solar

Legend

- Project Limits
- Proposed Road
- Proposed Panels
- Proposed Fence
- Ditch
- Wetlands
- Wetlands Buffer
- Designated Major Open Space
- Zone A Flood Zone

N

0 500 1,000 2,000

Feet

wsp

Site Map
Figure 1.2

2 PREVIOUS STUDIES

2.1 FLOOD INSURANCE RATE MAPS

The FEMA publishes Flood Insurance Rate Maps (FIRM) that delineate special flood hazard areas (SFHAs) subject to flooding by the 1% annual chance (100-year) storm event. Other Flood Areas identified as Zone X (shaded) are defined by FEMA as areas of 0.2% annual chance (500-year) 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.

Figure 2.1 is a reproduction of the FIRM panels for Pinal County where the Project is located. According to FIRM Number 04021C2325E, Panel 2325 of 2575, effective date December 4, 2007, the Project is not within a Special Flood Hazard Area and is identified as unshaded Zone X, areas outside the 0.2% annual chance floodplain.

There is an existing Zone A (100-year) flood zone east of the site. The project site is outside the limits of the Zone A flood zone and development of the site is not anticipated to have any negative impacts on the flood zone.

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The community map repository should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' NAVD 88. Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations shown in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 12. The **horizontal datum** was NAD 83, GRS1980 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was derived from U.S. Geological Survey Digital Orthophoto Quadrangles produced at a scale of 1:12,000 from photography dated 1992 or later.

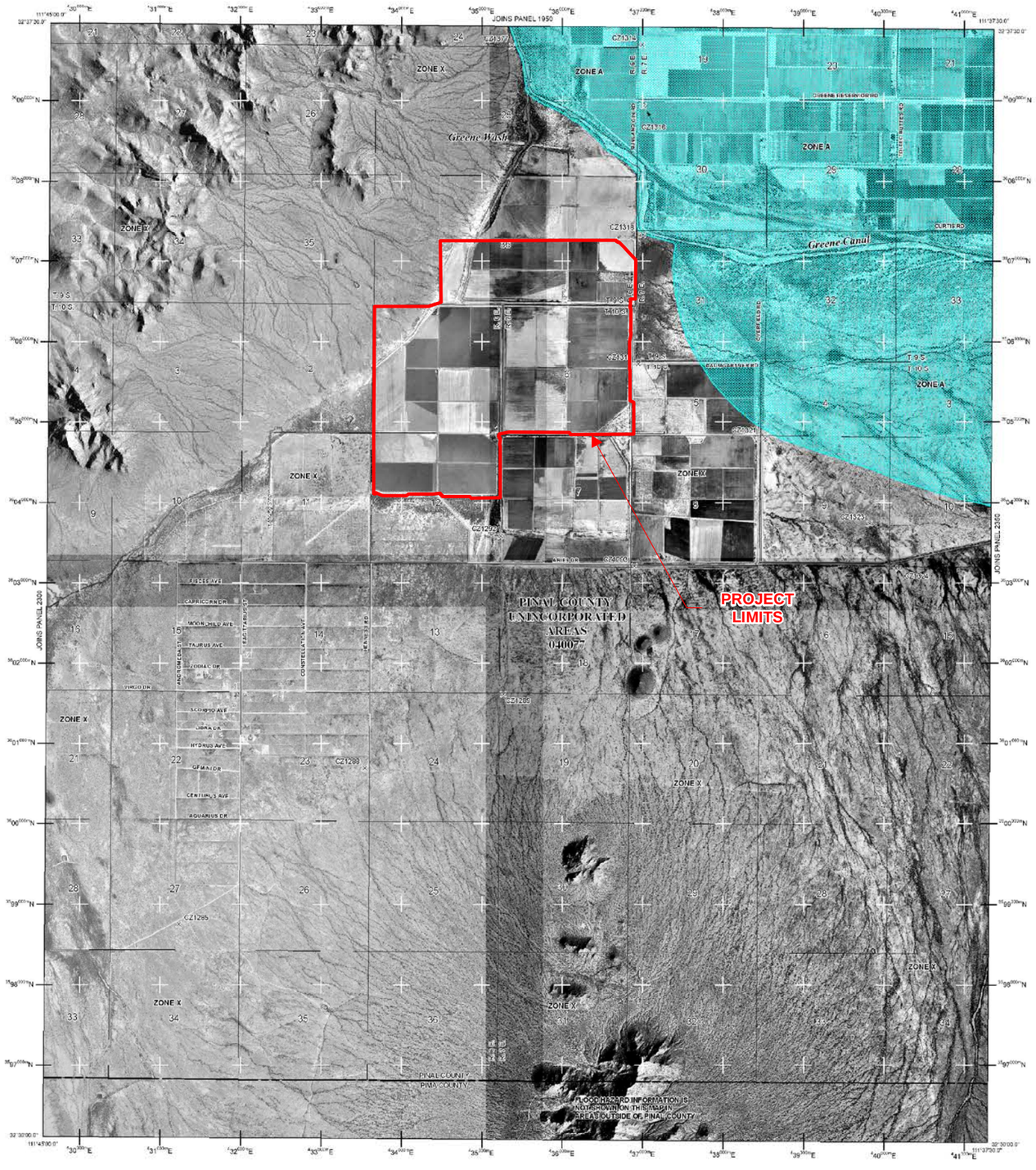
This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, an accompanying Flood Insurance Study Report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov.

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



LEGEND

SPECIAL FLOOD HAZARD AREAS 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** Area of Special Flood Hazard 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

- 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)
- 4228000 m — 1000-meter Universal Transverse Mercator grid values, zone 12
- 600000 FT — 5000-foot grid ticks: Arizona State Plane coordinate system, central zone (FIPSZONE 0202), Transverse Mercator
- DX5510 x — Bench mark (see explanation in Notes to Users section of this FIRM panel)
- M1.5 — River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
December 4, 2007

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

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" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 2325E

FIRM

FLOOD INSURANCE RATE MAP

PINAL COUNTY, ARIZONA AND INCORPORATED AREAS

PANEL 2325 OF 2575

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
PINAL COUNTY UNINCORPORATED AREAS	040077	2325	E

Figure 2.1

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
04021C2325E

EFFECTIVE DATE
DECEMBER 4, 2007

Federal Emergency Management Agency

3 HYDROLOGIC AND HYDRAULIC METHODS

The following sections describe the methods and criteria used to develop the model and input parameters. Results of the model and hydraulic calculations are presented in Section 4 of this report.

3.1 DATA SOURCES

Input data for the hydrologic and hydraulic models were obtained from a variety of sources. This information is summarized in Table 3.1 below:

Table 3.1 Data Sources

DATA	PURPOSE	SOURCE	FORMAT
Elevation	Development of FLO-2D model	LIDAR Survey (Provided by ENEL)	Survey
Elevation	Development of FLO-2D Model	USGS National Map Viewer Download (Publicly available)	Raster
Land use	Estimating precipitation losses (infiltration)	National Land Cover Database	Raster
Soil Types	Estimating precipitation losses (infiltration)	NRCS SSURGO Database (Web Soil Survey)	Shapefile
Preciptiation	100-year and 10-year precipitation depths	NOAA Atlas 14, Vol. 1	PDF
Project Boundary	Horizontal limits of FLO-2D model	ENEL	CAD Drawing
FEMA Flood Zones	Reference	NFHL Data-County	Shapefile
Aerial Photography	Reference	ArcGIS Map Service	Raster

3.2 SITE HYDROLOGY

The project site is located in Greene Wash watershed (HUC 12-150503030306), which drains northwest. Unnamed washes drain through the center of the project site from north to south, and east to west. Onsite runoff from the site is sheet flow draining to these unnamed washes and then to Greene Wash north of the project site. The site is also surrounded by unnamed ditches and berms which potentially intercept and redirect offsite flow.

3.2.1 OFFSITE DRAINAGE

Figure 3.1 shows five upstream subbasins that drain to the ditches in the vicinity of the project site. Offsite subbasins drain toward the project site from west, south, and east. Subbasin OFF1 drains from northwest to southeast. Subbasins OFF2 through OFF5 drain from south to north. The offsite subbasins consist mostly of shrub/scrub and herbaceous land that drain to several ditches and berms in the vicinity of the project site that intercept and potentially redirect offsite flow.

3.2.2 LAND USE

According to the National Land Cover Database (NLCD), the project is located on land designated as cultivated crops within the areas of the site that are proposed to be developed. Existing land use for the project site is shown in Figure A.4.1.

3.2.3 SOILS

Soil properties influence the relationship between rainfall and runoff because soils have differing rates of infiltration. The National Resources Conservation Service (NRCS) has divided soils into various soil associations for a set of soils and soil characteristics using map unit symbol (MUSYM). MUSYM is used to define infiltration parameters for a soil type. MUSYM for the project site is shown in Figure A.4.2.

3.3 MODELS

The hydrologic and hydraulic analysis were modeled using FLO-2D software. FLO-2D is a 2-dimensional software that allows for a rain-on-grid analysis. Two (2) models were prepared for this report to provide results for pre-development condition for the 100-year and 10-year storms.

The following subsections address input parameters used to develop the flood models.

3.3.1 PRECIPITATION

ENEL requested hydrologic and hydraulic analysis of the 100-year, 24-hour, and 10-year, 24-hour storm events. Precipitation values were obtained from NOAA Atlas 14 Point Precipitation Frequency Estimates: AZ. The approximate location of the site was located on the interactive map and rainfall depths were obtained in tabular and graphical form. Rainfall depths of 3.84 inches and 2.47 inches correspond to the 100-year, 24-hour, and 10-year, 24-hour storm events, respectively. PDF output from the NOAA Atlas 14 is included in Appendix A.1.

3.3.2 STORM DISTRIBUTION

For the rainfall-runoff model, a 24-hour event with a 15-minute time interval and Type II temporal distribution was used for the 100-year and 10-year storm events. The NRCS Type II distribution was selected based on Figure B-2 in TR-55 (United States Department of Agriculture, NRCS, 1986). Type II storms are characterized by low intensity rainfall at the beginning of the event, with less than 25% of the precipitation occurring during the first 11 hours. This is followed by an hour of heavy rainfall (approximately 40% of the total), with the remaining 1/3 of the total precipitation occurring over the next 12 hours. For all simulations, the precipitation is assumed to fall uniformly throughout the watershed at any given time step.

3.3.3 GRID SIZE AND NODES

A 50-foot by 50-foot grid size was modeled in FLO-2D. This results in sufficient model resolution to evaluate flow patterns within the site without runtime becoming excessive. Also, grid size smaller than 50-foot by 50-foot was computationally unfeasible. Outflow nodes were placed along the edge of the model to indicate flow leaving the model boundary.

3.3.4 TOPOGRAPHY

ENEL provided WSP with on-site elevation data. Figure 3.2 shows existing 5-foot contours based on the provided LIDAR survey. Supplemental elevation data was needed outside of the project boundary for the model. Elevation data (LIDAR) for outside the study area was obtained from the USGS National Map 3DEP Downloadable Data Collection (United States Geological Survey, 2022), using the 1/3 arc-sec data set. A Digital Elevation Model for the study area was developed from this data. All GIS data are in the NAD 1983 Arizona Central State Plane Coordinate System (feet). Unless noted otherwise, all elevation data in this report is based on the NAVD88 datum.

3.3.5 GREEN-AMPT LOSS PARAMETERS

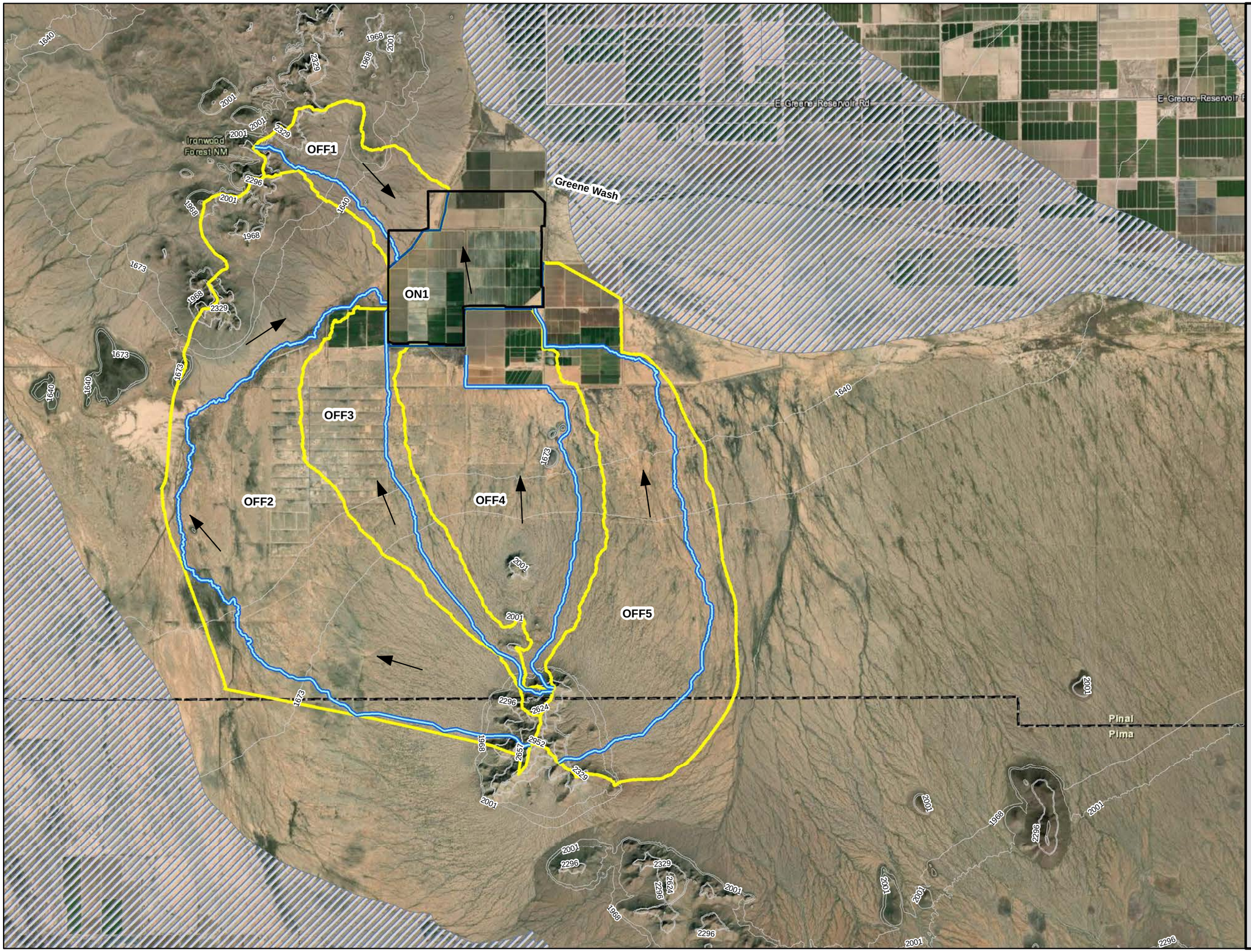
Green-Ampt method was used to compute rainfall loss. The loss parameters were based on soil and land use layers. Input parameters for the Green-Ampt loss calculations include hydraulic conductivity, soil suction, volumetric moisture deficiency, soil storage depth and the percent impervious area. These parameters were obtained from ADOT Highway Drainage Design Manual (HDDM) Appendix B (ADOT, 2014) and included in Appendix A.4.

3.3.6 MANNING'S N

FLO-2D uses Manning's n coefficients to account for the effects of surface roughness. The Manning's n values used in FLO-2D are specific to unsteady overland flow computations, which tend to be significantly higher than Manning's n values specific to steady state, open channel flow computations. Manning's n was applied based on the land use mentioned in **Error! Reference source not found.**. Flow resistance factors were obtained from Table 4 of the FLO-2D Reference Manual (Appendix A.6).

Table 3.2 Summary of Land Uses and Manning's n for FLO-2D Models

DESCRIPTION	LU VALUE	FLO-2D MANNING'S N RANGE	MODEL MANNING'S N
Open Water	11	N/A	0.80
Developed, Open Space	21	0.02 – 0.05	0.04
Developed, Low Intensity	22	0.02 – 0.05	0.04
Developed, Medium Intensity	23	0.02 – 0.05	0.04
Shrub/Scrub	52	0.30 – 0.40	0.35
Herbaceous	71	0.30 – 0.40	0.35
Hay/Pasture	81	0.05 – 0.25	0.15
Cultivated Crops	82	0.06 – 0.22	0.10
Woody Wetlands	90	0.17 – 0.48	0.4
Emergent Herbaceous Wetlands	95	0.17 – 0.48	0.40



Sonak Solar

Legend

- Project Limits
- Drainage Basin
- Longest Flowpath
- Zone A Flood Zone
- County Boundary

N

0 0.5 1 2

Miles

Watershed Map
Figure 3.1



Sonak Solar

Legend

- Project Limits
- 5' Contours
- Zone A Flood Zone

N

0 500 1,000 2,000

Feet

Topography Map
Figure 3.2

4 HYDROLOGIC AND HYDRAULIC ANALYSIS RESULTS

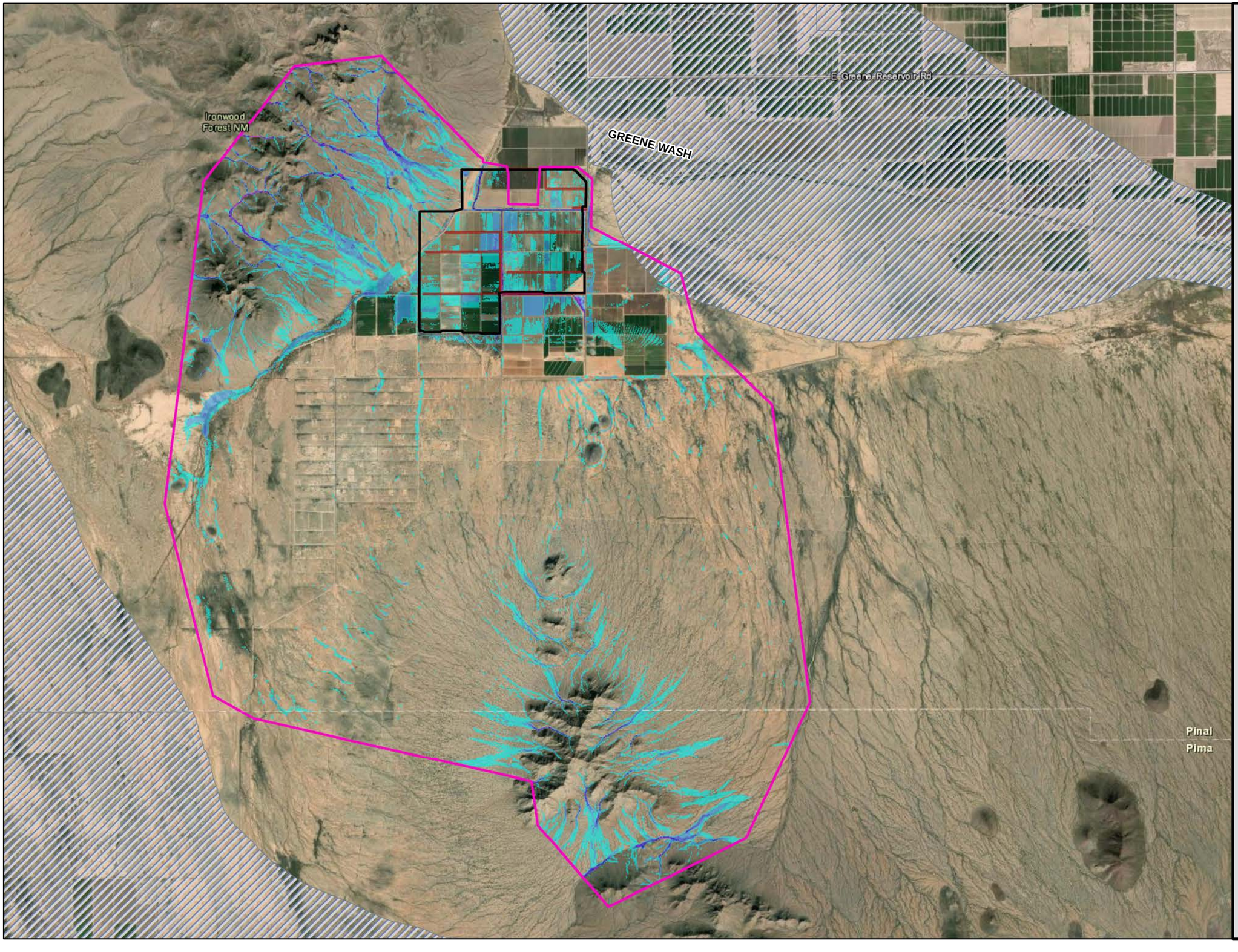
This section presents the results of the 100-year and 10-year hydrologic and hydraulic models. Multiple figures have been prepared to illustrate the pre-development model results.

4.1 PRE-DEVELOPMENT CONDITION MODEL RESULTS

Figures 4.1a-b and 4.2a-b present the 100-year flow depths and velocities at the project site, respectively. Figures 4.3a-b and 4.4a-b present the 10-year flow depths and velocities at the project site, respectively. Note that flow depths less than 0.25 feet and velocities less than 0.25 feet/second (ft/s) are not shown for clarity.

The development area is agricultural land that mildly slopes north. The ditches and berm in the vicinity of the project area keep most of the offsite flows out of the development area. Offsite flow from Subbasins OFF4 and OFF5 contributes to the ditch that drains west and then north through the center of the site. During 100-year event, some of the flows from this ditch enters into the project area resulting in a flow depth as high as 1.1 ft. The majority of the proposed array locations experience flooding to a depth of 1 foot or less. For the 10-year event, flow depths at the development area vary from zero to 0.6 feet. 10-year flow depths do not exceed 4-inches at the proposed access roads and do not exceed 8-inches within the development area.

Velocities for the 100-year storm are less than 1.0 ft/s within the development areas with maximum velocity reaching up to a non-erosive 0.7 ft/s. For the 10-year event, velocities at the development area vary from zero to 0.3 ft/s.



Sonak Solar

Legend

- Model Boundary
- Project Limits
- Proposed Road
- Zone A Flood Zone

Flow Depth (ft)

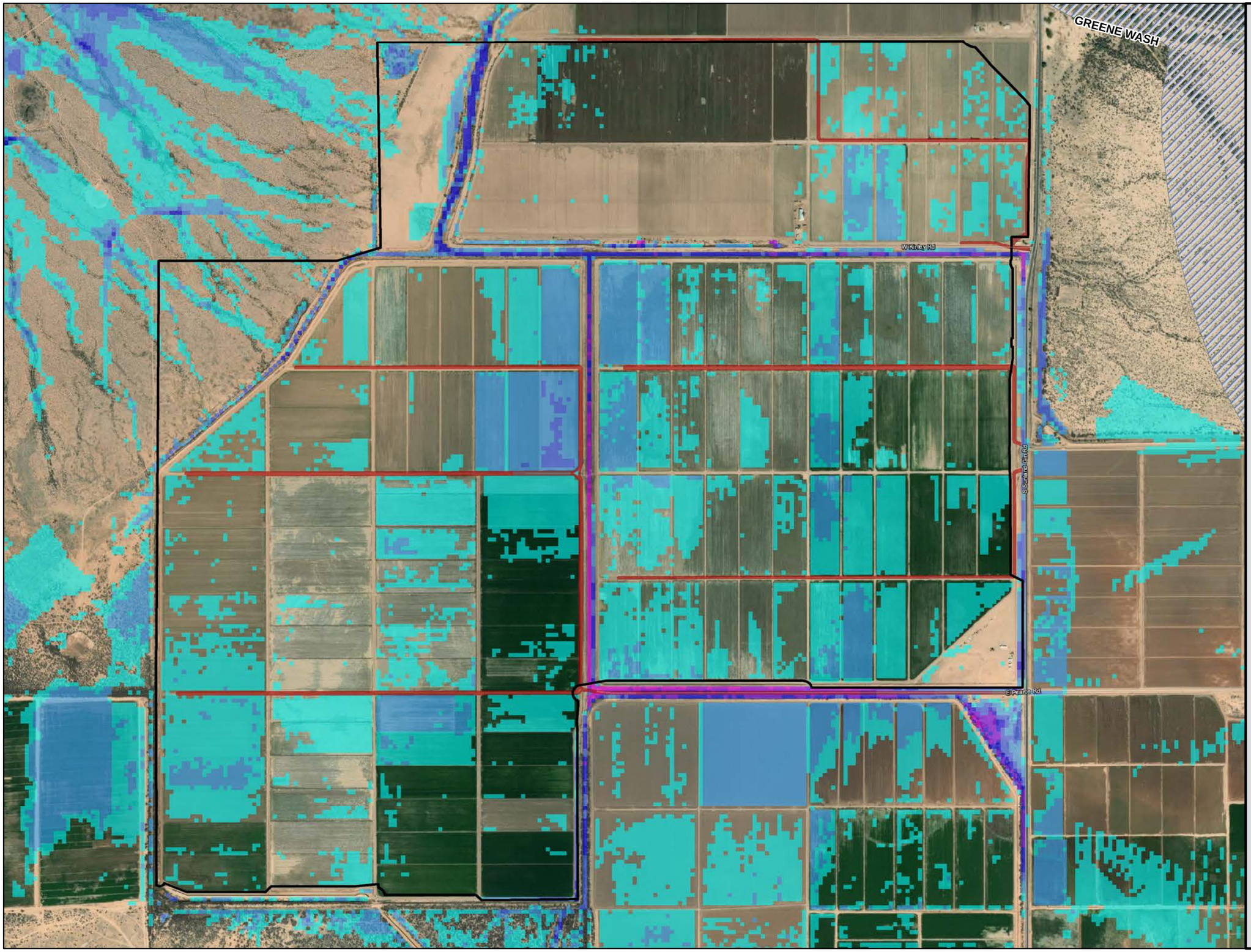
- 0.25 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

N

0 0.5 1 2

Miles

100-Year Storm
Pre-Development Conditions
Full Model Flow Depth Map
Figure 4.1A



enel Green Power

Sonak Solar

Legend

- Project Limits
- Proposed Road
- Zone A Flood Zone

Flow Depth (ft)

- 0.25 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

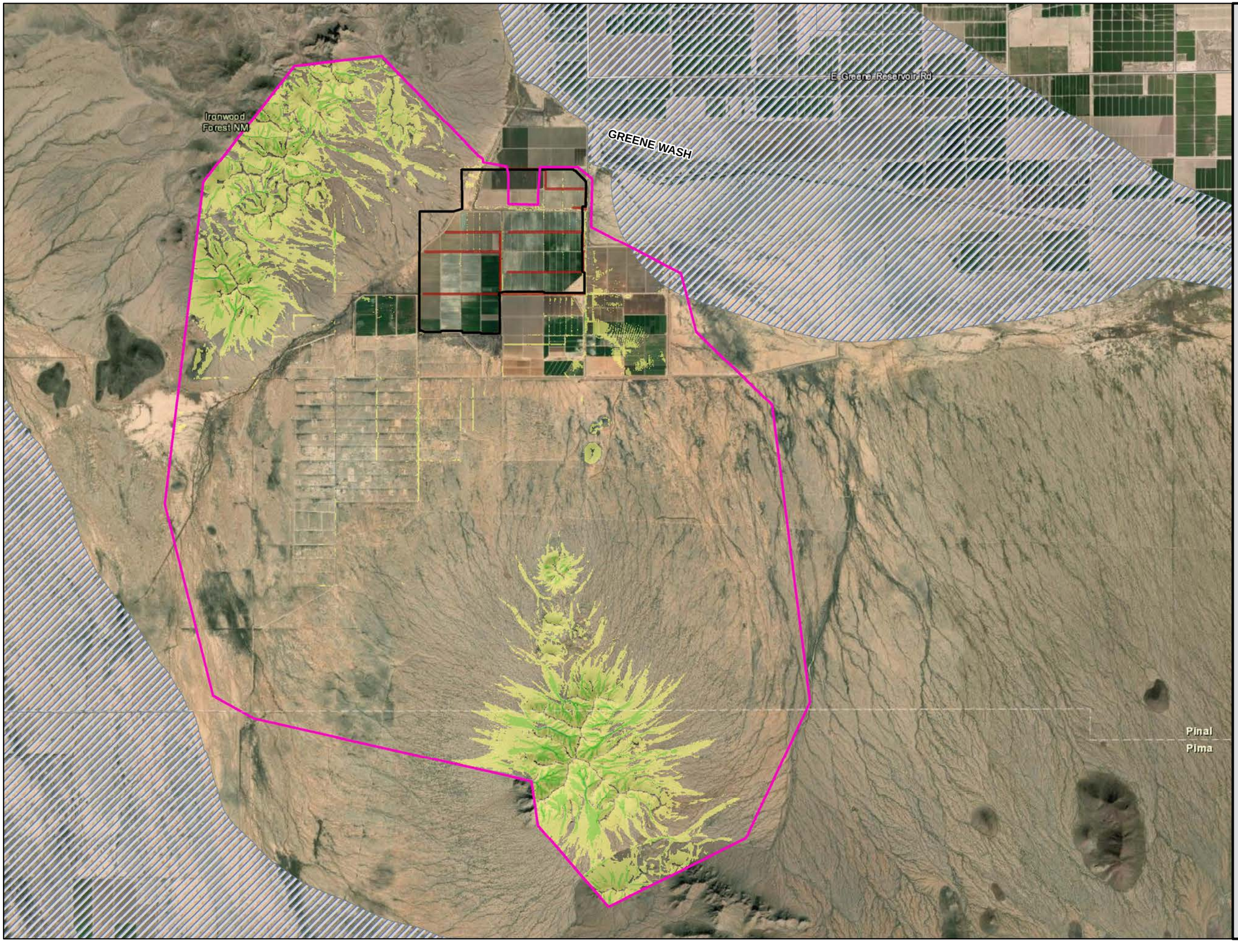
N

0 500 1,000 2,000

Feet

WSP

100-Year Storm
Pre-Development Conditions
Flow Depth Map
Figure 4.1B



Sonak Solar

Legend

- Model Boundary
- Project Limits
- Proposed Road
- Zone A Flood Zone

Velocity (fps)

- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- > 3.00

N

0 0.5 1 2

Miles

100-Year Storm
Pre-Development Conditions
Full Model Velocity Map
Figure 4.2A



Sonak Solar

Legend

- Project Limits
- Proposed Road
- Zone A Flood Zone

Velocity (fps)

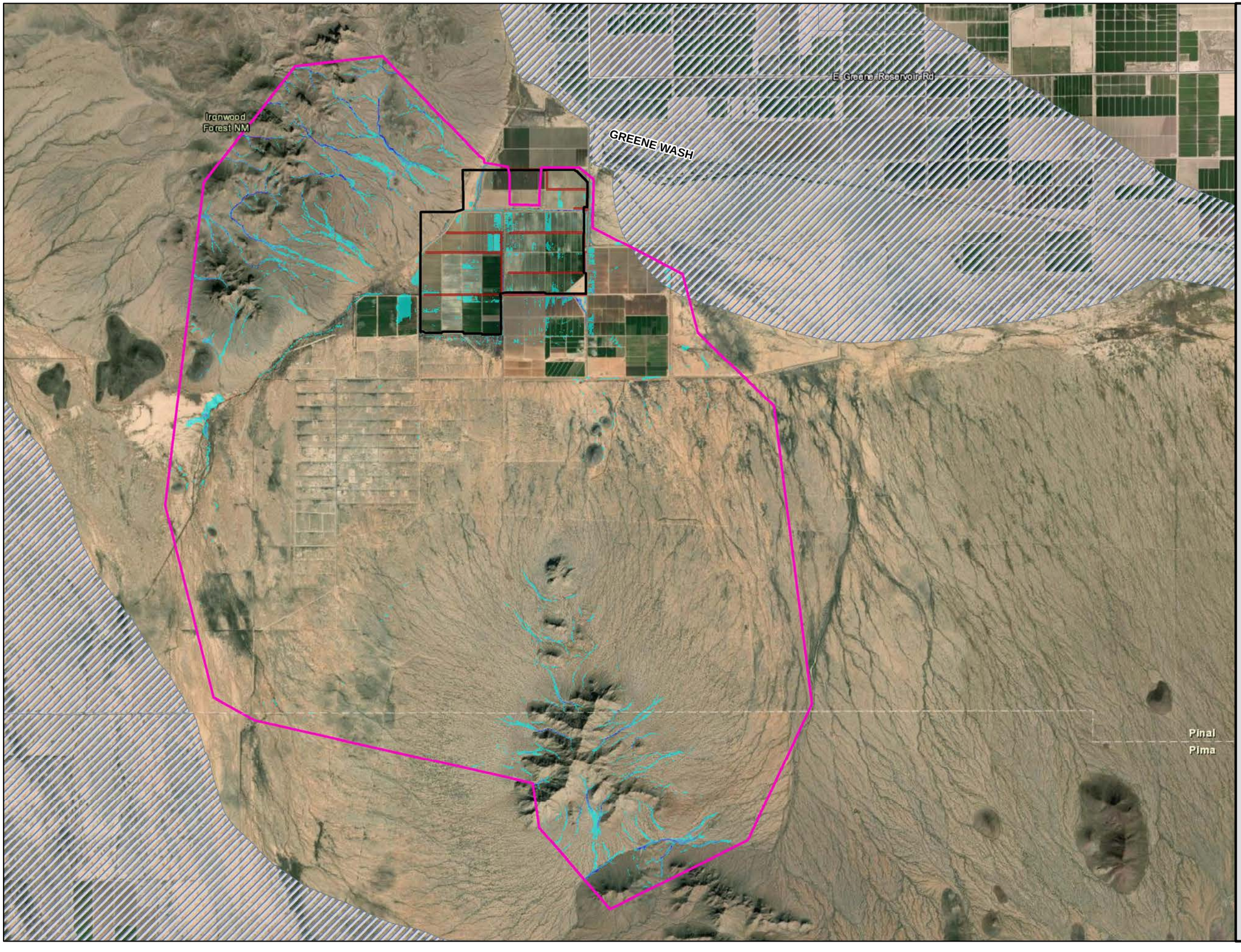
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- > 3.00

N

0 500 1,000 2,000

Feet

100-Year Storm
Pre-Development Conditions
Velocity Map
Figure 4.2B



Sonak Solar

Legend

- Model Boundary
- Project Limits
- Proposed Road
- Zone A Flood Zone

Flow Depth (ft)

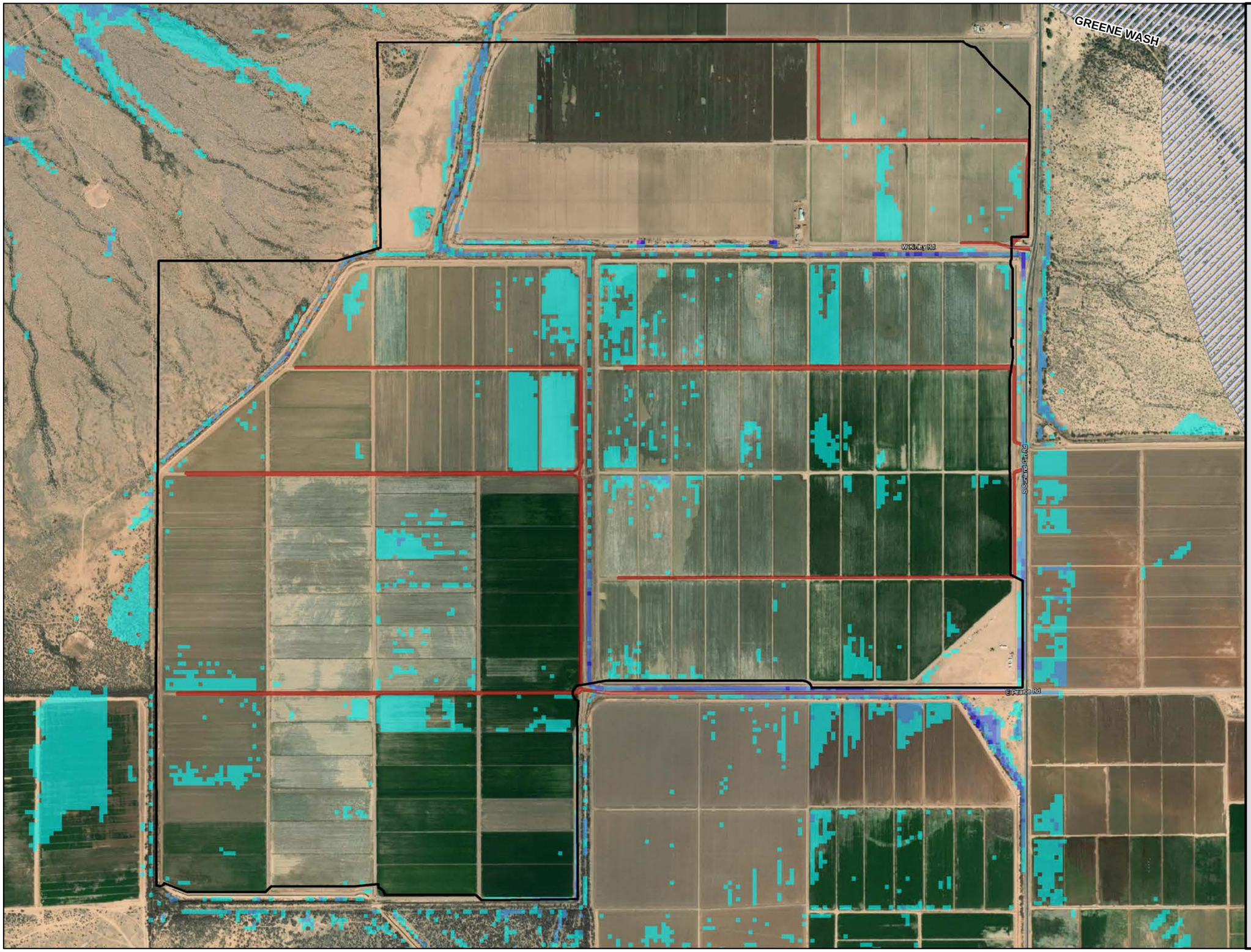
- 0.25 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

N

0 0.5 1 2

Miles

10-Year Storm
Pre-Development Conditions
Full Model Flow Depth Map
Figure 4.3A



Green Power

Sonak Solar

Legend

- Project Limits
- Proposed Road
- Zone A Flood Zone

Flow Depth (ft)

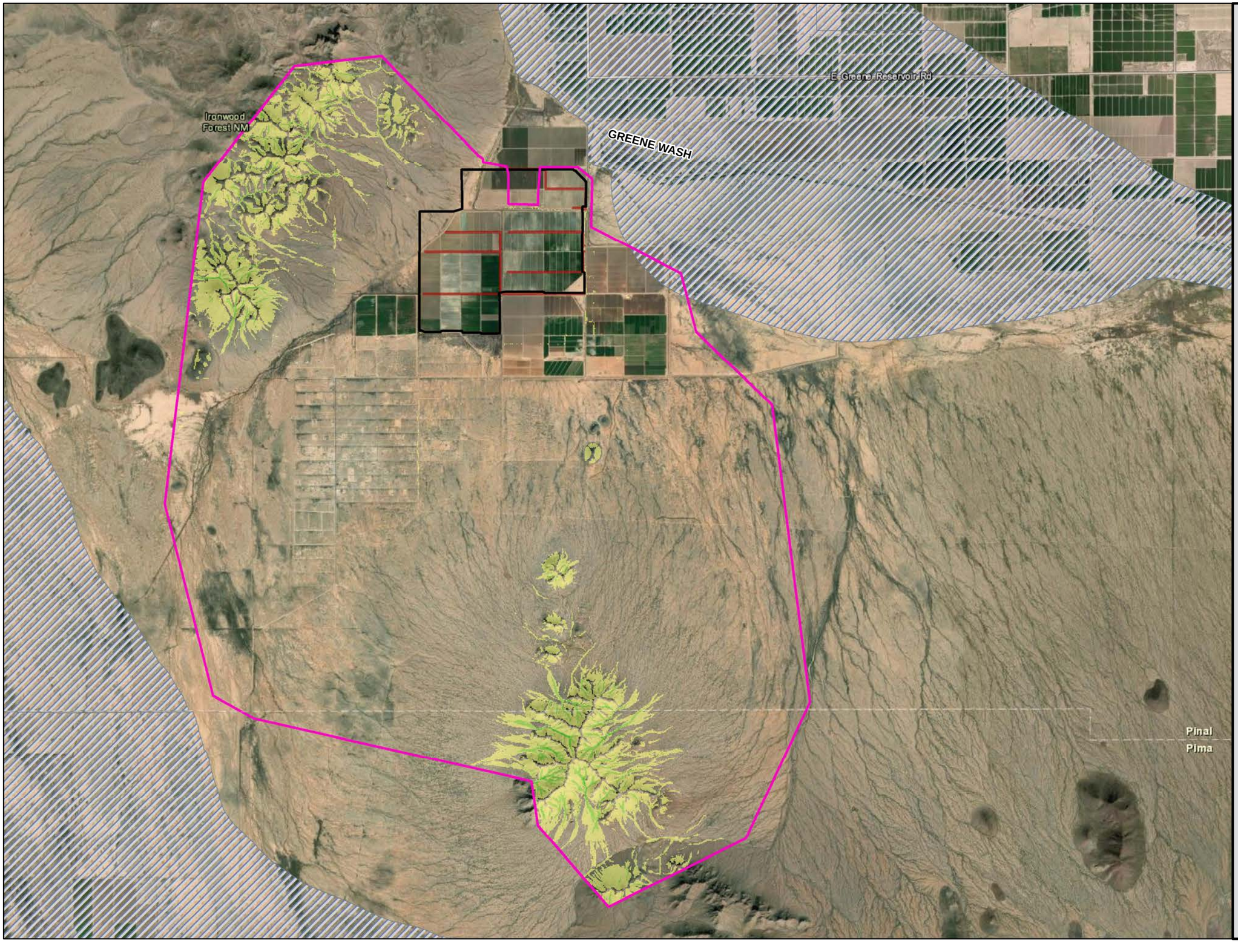
- 0.25 - 0.50
- 0.51 - 1.00
- 1.01 - 1.50
- 1.51 - 2.00
- 2.01 - 2.50
- 2.51 - 3.00
- > 3.00

N

0 500 1,000 2,000

Feet

10-Year Storm
Pre-Development Conditions
Flow Depth Map
Figure 4.3B



Sonak Solar

Legend

- Model Boundary
- Project Limits
- Proposed Road
- Zone A Flood Zone

Velocity (fps)

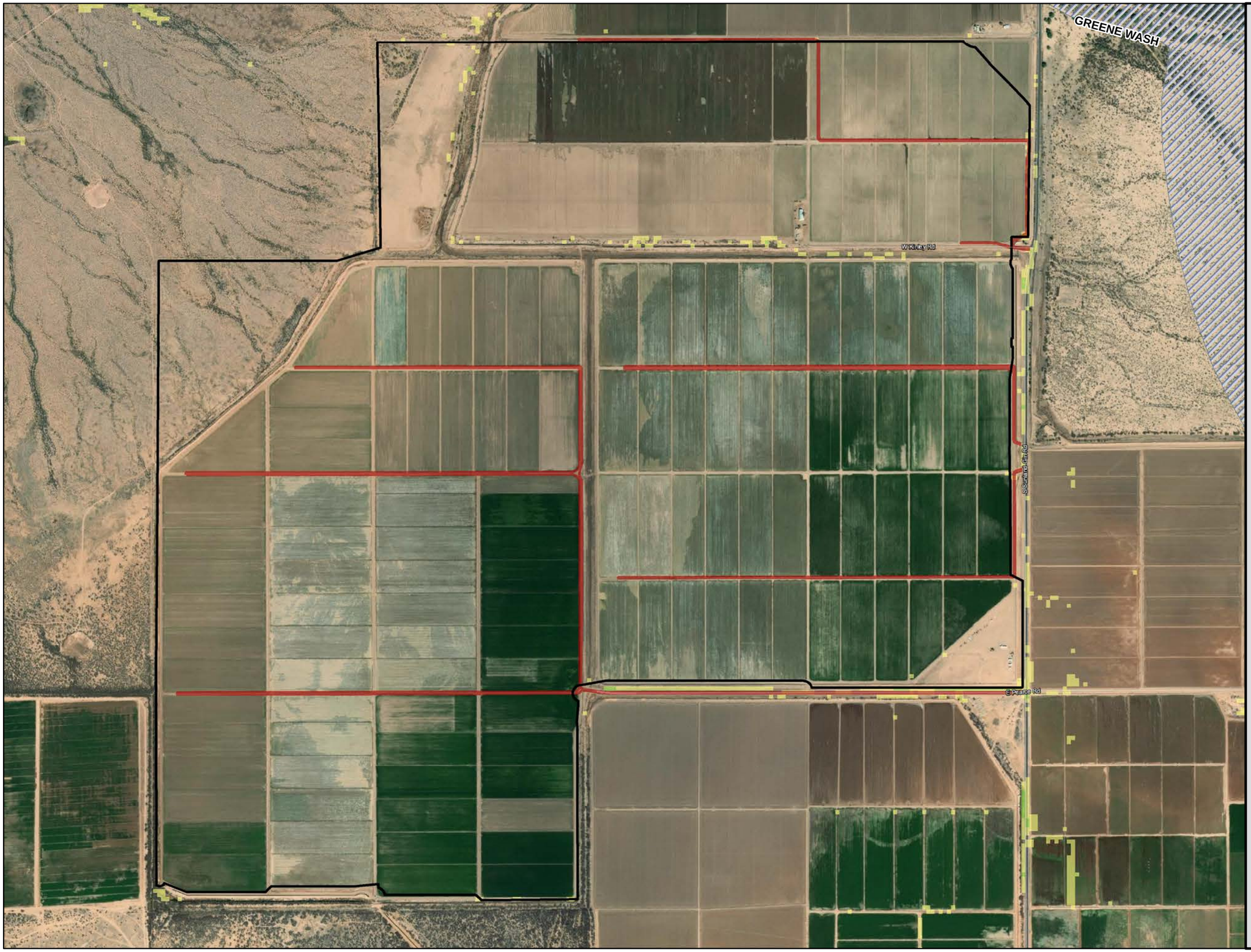
- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- > 3.00

N

0 0.5 1 2

Miles

10-Year Storm
Pre-Development Conditions
Full Model Velocity Map
Figure 4.4A



Green Power

Sonak Solar

Legend

- Project Limits
- Proposed Road
- Zone A Flood Zone

Velocity (fps)

- 0.25 - 0.50
- 0.50 - 1.00
- 1.00 - 1.50
- 1.50 - 2.00
- 2.00 - 2.50
- 2.50 - 3.00
- > 3.00

N

0 500 1,000 2,000

Feet

10-Year Storm
Pre-Development Conditions
Velocity Map
Figure 4.4B

5 CONCLUSION

5.1 CONCLUSIONS AND RECOMMENDATIONS

The Sonak Solar Project is being constructed on approximately 1,880 acres of land in Pinal County, Arizona. The purpose of this drainage study was to establish the 100-year and 10-year depths and velocities that will ultimately be used for determining solar equipment elevations (panels, inverter, and pads) and O&M building and substation pad elevations.

The Project is being developed primarily on agricultural land that will be revegetated with low maintenance native vegetation after development, presenting more favorable conditions for stormwater management in most instances. The storm events were modeled using FLO-2D for pre-development condition to evaluate flow depths and velocities throughout the site and potential impacts from development of the site.

All electrical equipment including, but not limited to, solar panels, inverters, transformers, and switch boxes are recommended to be elevated to a minimum of 12 inches above the flow depths. The project substation, O&M building, and construction offices should be elevated on fill a minimum of 12 inches above the flow depths established in this study.

6 REFERENCES

ADOT. (2014). Arizona Department of Transportation, Highway Drainage Design Manual.

Federal Emergency Management Agency. (2007). FIRM Flood Insurance Rate Map, Pinal County, Arizona and Incorporated Areas, Map Number 04021C2325E, Panel 2325 of 2575

National Oceanic and Atmospheric Administration. (2022). NOAA Atlas 14, Volume 1, Version 5. Point Frequency Data Server. Retrieved from https://hdsc.nws.noaa.gov/hdsc/pfds/pfds_map_cont.html

United State Department of Agriculture. (2022). National Resource Conservation Service. Retrieved from Web Soil Survey: https://websoilsurvey.sc.egov.usda.gov/App/WebSoilSurvey.aspx

United States Department of Agriculture, NRCS. (1986). Urban Hydrology for Small Watersheds Technical Release 55.

United States Geological Survey. (2022). The National Map - Data Delivery. Retrieved from https://apps.nationalmap.gov/downloader/#/

For additional data sources, see Table 3.1.

Appendix A – Hydrologic and Hydraulic Parameters and Analysis

- A.1 NOAA Atlas 14 Rainfall Data
- A.2 TR-55 Rainfall Distribution Map
- A.3 Green-Ampt Calculations
- A.4 FLO-2D Manning's n values

A.1 NOAA Atlas 14 Rainfall Data

NOAA Atlas 14, Volume 1, Version 5
Location name: Eloy, Arizona, USA*
Latitude: 32.5858°, Longitude: -111.6894°
Elevation: 1579.86 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for ON1

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.210 (0.181-0.246)	0.273 (0.237-0.321)	0.370 (0.317-0.432)	0.441 (0.377-0.514)	0.539 (0.454-0.626)	0.613 (0.510-0.711)	0.688 (0.563-0.798)	0.765 (0.615-0.888)	0.865 (0.678-1.01)	0.943 (0.724-1.11)
10-min	0.319 (0.276-0.375)	0.416 (0.360-0.489)	0.562 (0.483-0.658)	0.672 (0.574-0.783)	0.821 (0.691-0.953)	0.934 (0.776-1.08)	1.05 (0.857-1.22)	1.16 (0.936-1.35)	1.32 (1.03-1.54)	1.44 (1.10-1.69)
15-min	0.395 (0.342-0.465)	0.516 (0.446-0.607)	0.697 (0.599-0.816)	0.833 (0.711-0.970)	1.02 (0.856-1.18)	1.16 (0.962-1.34)	1.30 (1.06-1.51)	1.44 (1.16-1.68)	1.63 (1.28-1.91)	1.78 (1.37-2.09)
30-min	0.532 (0.461-0.626)	0.695 (0.601-0.818)	0.939 (0.806-1.10)	1.12 (0.958-1.31)	1.37 (1.15-1.59)	1.56 (1.30-1.81)	1.75 (1.43-2.03)	1.94 (1.56-2.26)	2.20 (1.72-2.57)	2.40 (1.84-2.81)
60-min	0.659 (0.570-0.775)	0.860 (0.744-1.01)	1.16 (0.998-1.36)	1.39 (1.19-1.62)	1.70 (1.43-1.97)	1.93 (1.60-2.24)	2.17 (1.77-2.51)	2.41 (1.93-2.79)	2.72 (2.13-3.18)	2.97 (2.28-3.48)
2-hr	0.754 (0.659-0.878)	0.977 (0.850-1.14)	1.30 (1.12-1.51)	1.55 (1.33-1.80)	1.88 (1.59-2.17)	2.14 (1.79-2.47)	2.41 (1.98-2.78)	2.68 (2.16-3.10)	3.05 (2.40-3.54)	3.34 (2.56-3.90)
3-hr	0.816 (0.713-0.949)	1.04 (0.914-1.22)	1.37 (1.19-1.59)	1.63 (1.41-1.88)	1.99 (1.69-2.29)	2.28 (1.91-2.62)	2.58 (2.12-2.97)	2.89 (2.33-3.34)	3.33 (2.60-3.86)	3.68 (2.80-4.29)
6-hr	0.979 (0.867-1.12)	1.24 (1.10-1.42)	1.58 (1.40-1.81)	1.86 (1.63-2.11)	2.25 (1.94-2.54)	2.55 (2.17-2.87)	2.86 (2.40-3.23)	3.19 (2.62-3.61)	3.64 (2.90-4.13)	3.99 (3.11-4.56)
12-hr	1.11 (0.998-1.25)	1.41 (1.26-1.58)	1.78 (1.59-2.00)	2.08 (1.84-2.32)	2.48 (2.18-2.77)	2.80 (2.43-3.12)	3.12 (2.67-3.49)	3.45 (2.91-3.88)	3.91 (3.20-4.43)	4.26 (3.42-4.87)
24-hr	1.27 (1.16-1.42)	1.62 (1.47-1.80)	2.10 (1.90-2.32)	2.47 (2.23-2.74)	3.00 (2.69-3.31)	3.41 (3.04-3.76)	3.84 (3.40-4.23)	4.29 (3.77-4.73)	4.91 (4.26-5.42)	5.39 (4.64-5.96)
2-day	1.37 (1.24-1.52)	1.75 (1.58-1.94)	2.29 (2.07-2.54)	2.73 (2.45-3.02)	3.33 (2.98-3.68)	3.82 (3.39-4.22)	4.32 (3.82-4.78)	4.86 (4.26-5.38)	5.60 (4.86-6.22)	6.20 (5.33-6.92)
3-day	1.45 (1.31-1.61)	1.85 (1.67-2.05)	2.42 (2.19-2.69)	2.89 (2.60-3.20)	3.54 (3.17-3.92)	4.07 (3.62-4.50)	4.62 (4.09-5.11)	5.21 (4.57-5.77)	6.04 (5.23-6.70)	6.70 (5.75-7.47)
4-day	1.53 (1.38-1.70)	1.95 (1.76-2.16)	2.56 (2.31-2.84)	3.05 (2.75-3.38)	3.76 (3.36-4.15)	4.32 (3.84-4.78)	4.93 (4.35-5.44)	5.57 (4.87-6.16)	6.47 (5.59-7.19)	7.21 (6.17-8.03)
7-day	1.71 (1.54-1.90)	2.18 (1.97-2.43)	2.87 (2.58-3.19)	3.43 (3.08-3.80)	4.21 (3.75-4.67)	4.85 (4.30-5.37)	5.53 (4.86-6.13)	6.24 (5.45-6.93)	7.26 (6.25-8.08)	8.08 (6.88-9.02)
10-day	1.88 (1.70-2.10)	2.41 (2.17-2.68)	3.16 (2.85-3.52)	3.77 (3.39-4.19)	4.63 (4.13-5.14)	5.32 (4.72-5.90)	6.05 (5.33-6.71)	6.81 (5.96-7.58)	7.89 (6.82-8.80)	8.76 (7.49-9.79)
20-day	2.33 (2.10-2.58)	2.99 (2.70-3.31)	3.93 (3.55-4.35)	4.65 (4.18-5.13)	5.62 (5.03-6.20)	6.37 (5.68-7.02)	7.13 (6.33-7.87)	7.90 (6.98-8.73)	8.95 (7.83-9.92)	9.75 (8.46-10.8)
30-day	2.75 (2.50-3.02)	3.53 (3.21-3.88)	4.63 (4.21-5.09)	5.47 (4.96-6.00)	6.60 (5.96-7.23)	7.47 (6.71-8.18)	8.35 (7.47-9.15)	9.25 (8.22-10.2)	10.5 (9.21-11.5)	11.4 (9.96-12.6)
45-day	3.23 (2.94-3.55)	4.16 (3.78-4.57)	5.45 (4.95-5.98)	6.41 (5.81-7.03)	7.67 (6.92-8.40)	8.62 (7.74-9.43)	9.57 (8.57-10.5)	10.5 (9.37-11.6)	11.8 (10.4-13.0)	12.7 (11.2-14.1)
60-day	3.59 (3.26-3.93)	4.63 (4.21-5.07)	6.05 (5.50-6.64)	7.10 (6.44-7.77)	8.45 (7.64-9.24)	9.46 (8.51-10.3)	10.5 (9.37-11.5)	11.4 (10.2-12.5)	12.7 (11.3-14.0)	13.7 (12.1-15.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

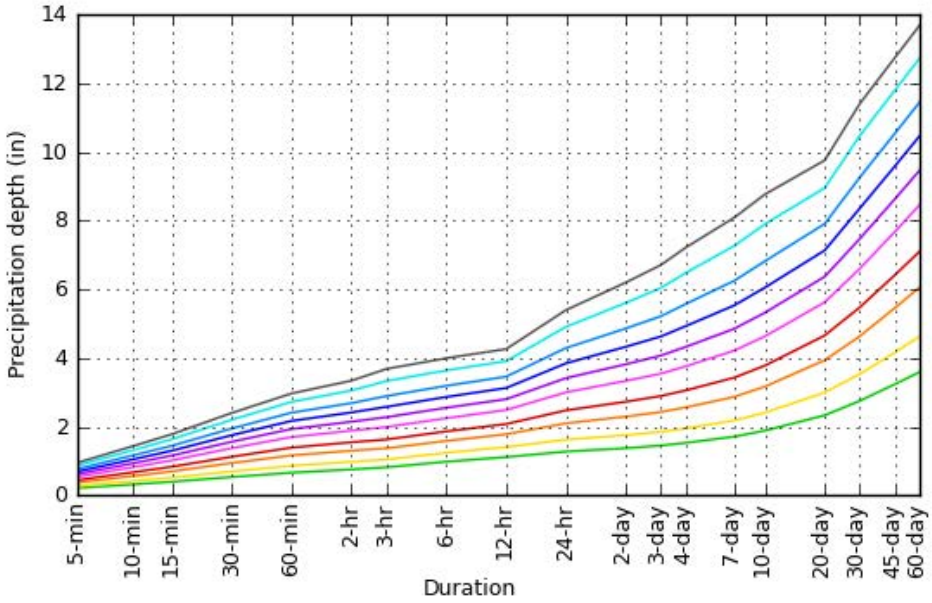
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

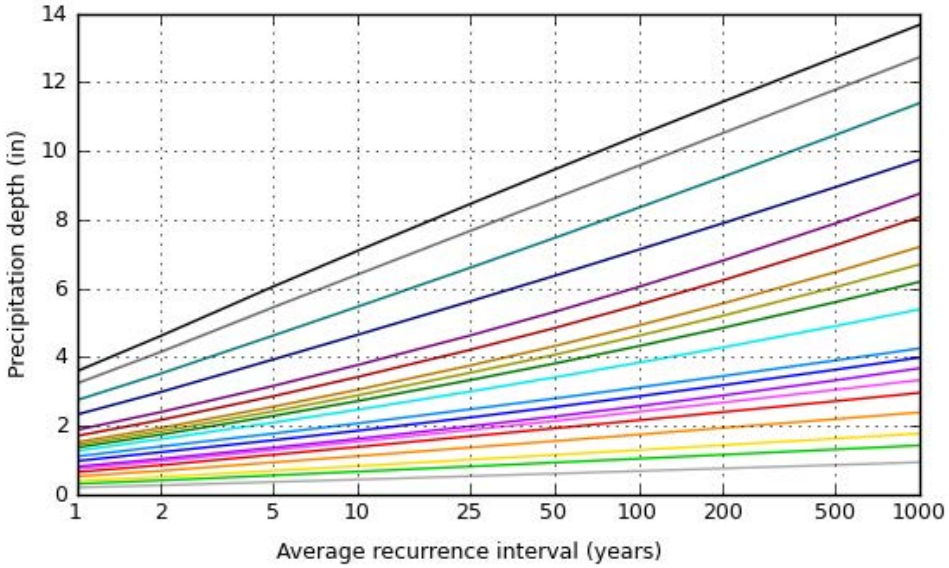
Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical

PDS-based depth-duration-frequency (DDF) curves
Latitude: 32.5858°, Longitude: -111.6894°



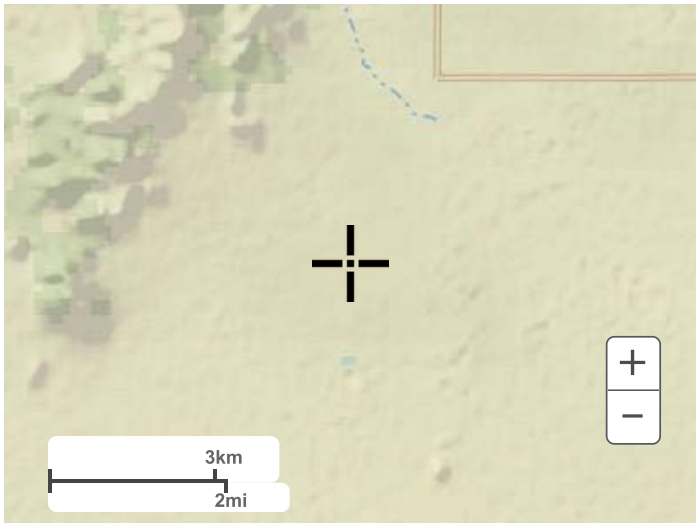


NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Thu Oct 13 23:09:02 2022

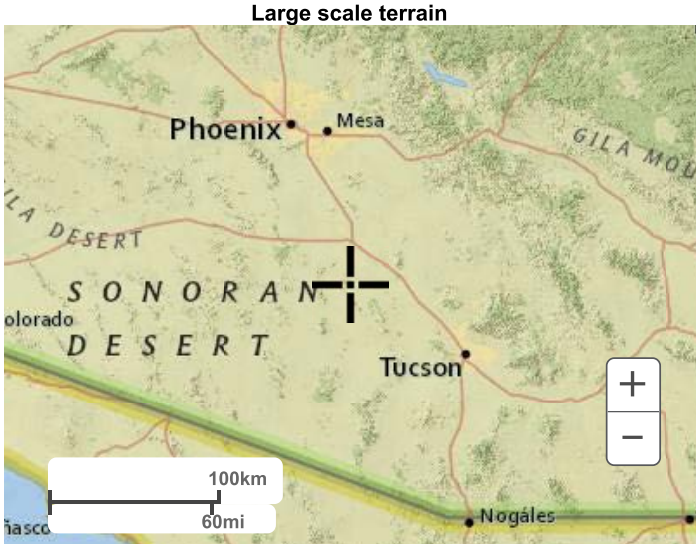
Back to Top

Maps & aerials

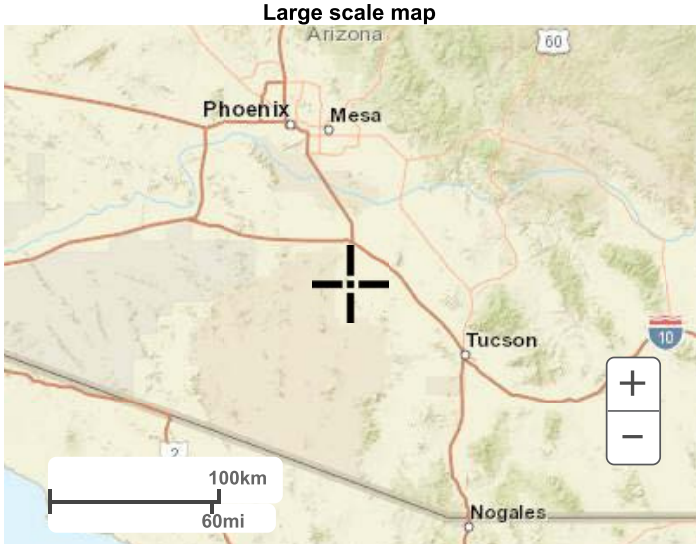
Small scale terrain



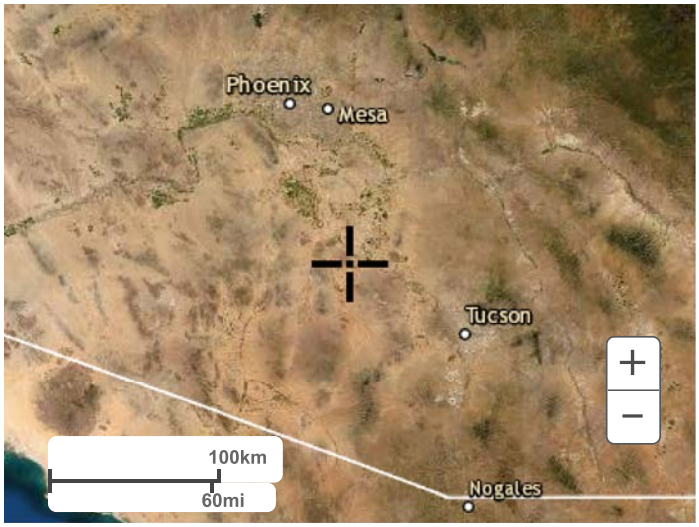
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Eloy, Arizona, USA*
Latitude: 32.6038°, Longitude: -111.7134°
Elevation: 1643.45 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for OFF1

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.211 (0.182-0.247)	0.275 (0.238-0.323)	0.371 (0.319-0.434)	0.444 (0.379-0.516)	0.542 (0.456-0.628)	0.616 (0.512-0.713)	0.691 (0.565-0.801)	0.768 (0.617-0.891)	0.868 (0.680-1.01)	0.945 (0.726-1.11)
10-min	0.320 (0.277-0.377)	0.418 (0.362-0.492)	0.565 (0.485-0.661)	0.676 (0.576-0.786)	0.825 (0.694-0.956)	0.938 (0.779-1.09)	1.05 (0.860-1.22)	1.17 (0.939-1.36)	1.32 (1.04-1.54)	1.44 (1.10-1.69)
15-min	0.397 (0.343-0.467)	0.518 (0.448-0.610)	0.701 (0.602-0.819)	0.838 (0.715-0.974)	1.02 (0.860-1.18)	1.16 (0.966-1.35)	1.30 (1.07-1.51)	1.45 (1.16-1.68)	1.64 (1.28-1.91)	1.78 (1.37-2.09)
30-min	0.535 (0.462-0.629)	0.698 (0.604-0.821)	0.944 (0.810-1.10)	1.13 (0.962-1.31)	1.38 (1.16-1.60)	1.57 (1.30-1.81)	1.76 (1.44-2.04)	1.95 (1.57-2.26)	2.21 (1.73-2.57)	2.40 (1.84-2.82)
60-min	0.662 (0.572-0.778)	0.864 (0.747-1.02)	1.17 (1.00-1.36)	1.40 (1.19-1.62)	1.71 (1.43-1.98)	1.94 (1.61-2.24)	2.18 (1.78-2.52)	2.42 (1.94-2.80)	2.73 (2.14-3.18)	2.97 (2.28-3.49)
2-hr	0.756 (0.660-0.880)	0.979 (0.852-1.14)	1.30 (1.13-1.51)	1.55 (1.33-1.80)	1.89 (1.60-2.17)	2.15 (1.80-2.47)	2.42 (1.99-2.78)	2.69 (2.17-3.10)	3.06 (2.40-3.55)	3.35 (2.57-3.90)
3-hr	0.818 (0.715-0.951)	1.05 (0.917-1.22)	1.37 (1.20-1.60)	1.63 (1.41-1.89)	2.00 (1.70-2.30)	2.28 (1.91-2.63)	2.58 (2.12-2.98)	2.90 (2.34-3.35)	3.34 (2.60-3.88)	3.69 (2.81-4.31)
6-hr	0.981 (0.869-1.12)	1.24 (1.10-1.42)	1.59 (1.40-1.81)	1.86 (1.64-2.12)	2.25 (1.95-2.54)	2.55 (2.18-2.88)	2.87 (2.40-3.24)	3.19 (2.63-3.61)	3.64 (2.91-4.14)	4.00 (3.11-4.57)
12-hr	1.12 (1.00-1.26)	1.41 (1.26-1.59)	1.78 (1.59-2.00)	2.08 (1.85-2.33)	2.49 (2.19-2.78)	2.81 (2.44-3.13)	3.14 (2.68-3.50)	3.47 (2.91-3.89)	3.92 (3.21-4.44)	4.28 (3.43-4.88)
24-hr	1.27 (1.16-1.41)	1.62 (1.47-1.80)	2.10 (1.90-2.32)	2.47 (2.23-2.73)	3.00 (2.69-3.30)	3.41 (3.04-3.76)	3.84 (3.40-4.23)	4.29 (3.77-4.73)	4.91 (4.27-5.42)	5.39 (4.64-5.96)
2-day	1.37 (1.24-1.52)	1.75 (1.58-1.94)	2.29 (2.07-2.54)	2.73 (2.46-3.02)	3.34 (2.98-3.68)	3.82 (3.40-4.22)	4.33 (3.83-4.79)	4.87 (4.27-5.39)	5.61 (4.88-6.24)	6.21 (5.34-6.93)
3-day	1.45 (1.31-1.61)	1.85 (1.67-2.05)	2.43 (2.19-2.69)	2.90 (2.61-3.20)	3.55 (3.18-3.92)	4.08 (3.63-4.51)	4.64 (4.10-5.13)	5.23 (4.58-5.79)	6.06 (5.25-6.73)	6.73 (5.77-7.50)
4-day	1.53 (1.38-1.70)	1.95 (1.76-2.17)	2.56 (2.32-2.85)	3.06 (2.76-3.39)	3.77 (3.37-4.17)	4.34 (3.86-4.80)	4.94 (4.36-5.47)	5.59 (4.89-6.19)	6.50 (5.61-7.22)	7.25 (6.19-8.07)
7-day	1.71 (1.54-1.90)	2.18 (1.97-2.43)	2.87 (2.59-3.19)	3.44 (3.08-3.81)	4.22 (3.77-4.68)	4.86 (4.31-5.39)	5.55 (4.89-6.15)	6.27 (5.47-6.96)	7.30 (6.29-8.12)	8.12 (6.92-9.06)
10-day	1.88 (1.70-2.10)	2.41 (2.18-2.68)	3.17 (2.86-3.53)	3.78 (3.40-4.20)	4.64 (4.15-5.15)	5.33 (4.74-5.92)	6.07 (5.36-6.74)	6.84 (5.98-7.60)	7.93 (6.85-8.84)	8.80 (7.53-9.84)
20-day	2.34 (2.11-2.58)	3.00 (2.71-3.32)	3.95 (3.56-4.36)	4.67 (4.20-5.16)	5.64 (5.06-6.23)	6.39 (5.70-7.06)	7.16 (6.36-7.92)	7.94 (7.02-8.79)	9.00 (7.87-9.99)	9.81 (8.51-10.9)
30-day	2.75 (2.50-3.03)	3.54 (3.22-3.89)	4.64 (4.22-5.10)	5.49 (4.98-6.02)	6.63 (5.98-7.26)	7.50 (6.74-8.22)	8.40 (7.50-9.20)	9.31 (8.26-10.2)	10.5 (9.26-11.6)	11.5 (10.0-12.7)
45-day	3.24 (2.95-3.56)	4.17 (3.79-4.58)	5.47 (4.97-6.00)	6.44 (5.84-7.06)	7.71 (6.96-8.44)	8.67 (7.79-9.49)	9.64 (8.62-10.6)	10.6 (9.44-11.6)	11.9 (10.5-13.1)	12.9 (11.3-14.2)
60-day	3.60 (3.27-3.95)	4.64 (4.22-5.09)	6.08 (5.52-6.67)	7.14 (6.47-7.82)	8.50 (7.68-9.30)	9.52 (8.56-10.4)	10.5 (9.43-11.5)	11.5 (10.3-12.7)	12.8 (11.4-14.1)	13.8 (12.2-15.2)

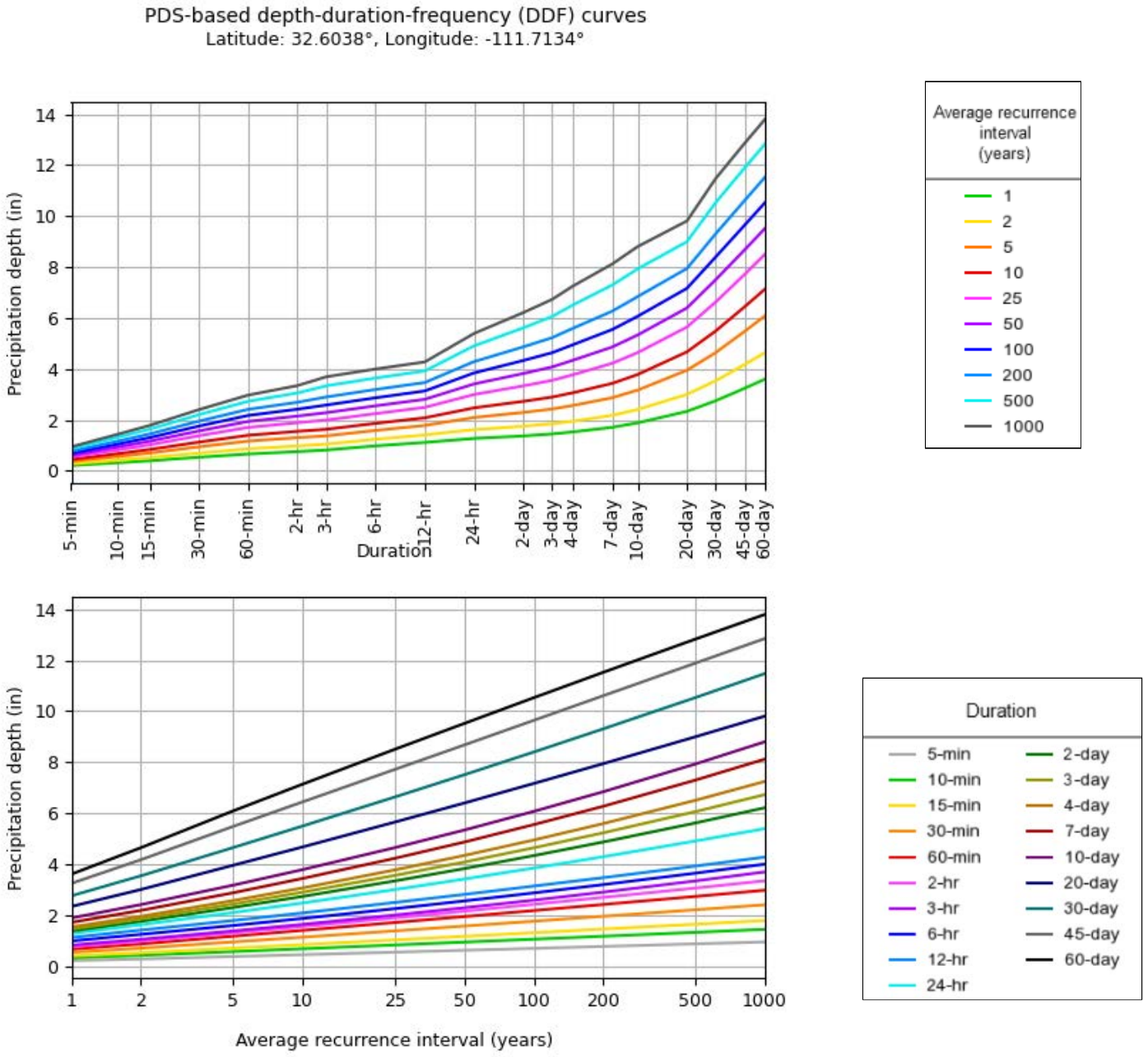
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



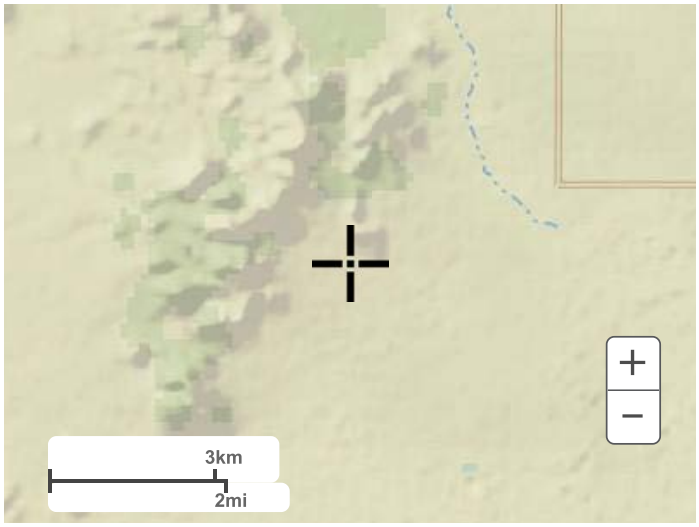
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Oct 27 18:39:11 2022

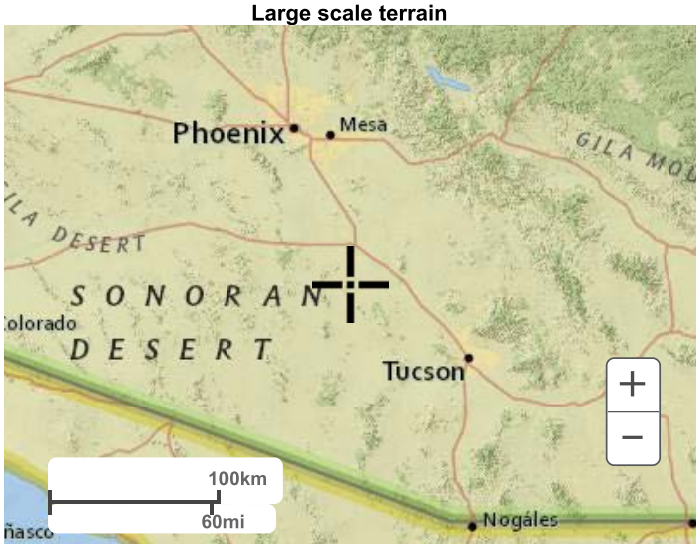
Back to Top

Maps & aerials

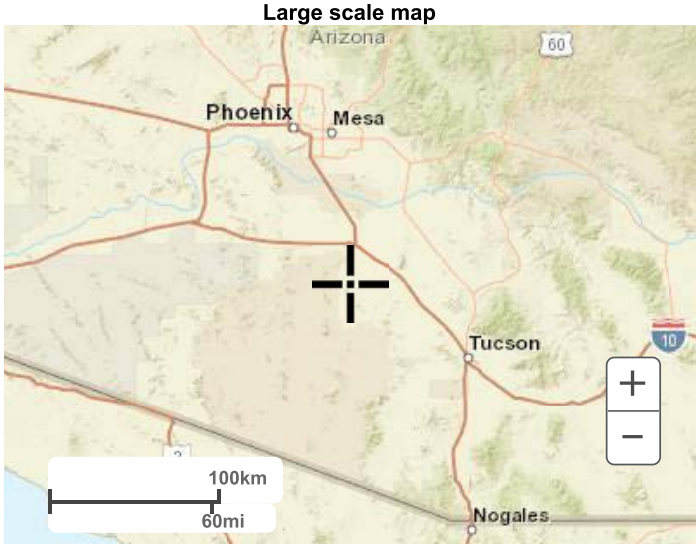
Small scale terrain



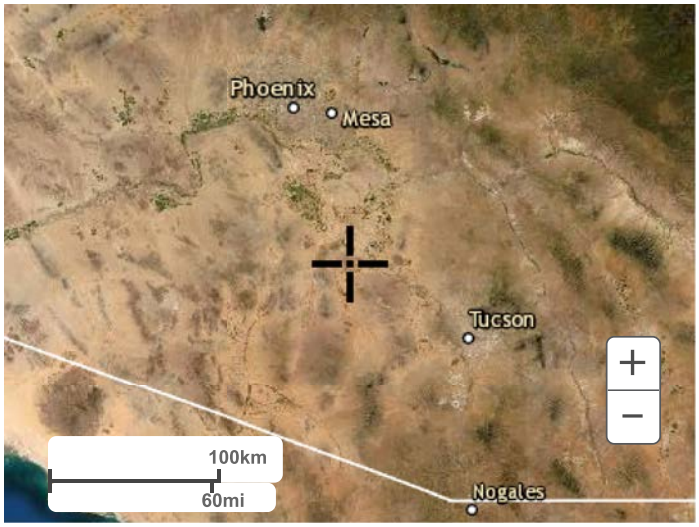
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Marana, Arizona, USA*
Latitude: 32.4709°, Longitude: -111.6702°
Elevation: 1912.95 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for OFF2

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.206 (0.179-0.242)	0.268 (0.233-0.315)	0.362 (0.312-0.423)	0.432 (0.370-0.503)	0.529 (0.447-0.613)	0.602 (0.503-0.698)	0.677 (0.556-0.786)	0.754 (0.609-0.877)	0.854 (0.672-0.999)	0.932 (0.718-1.10)
10-min	0.314 (0.272-0.368)	0.408 (0.355-0.480)	0.550 (0.475-0.643)	0.657 (0.564-0.766)	0.804 (0.681-0.933)	0.916 (0.766-1.06)	1.03 (0.846-1.20)	1.15 (0.926-1.33)	1.30 (1.02-1.52)	1.42 (1.09-1.67)
15-min	0.389 (0.338-0.456)	0.506 (0.440-0.595)	0.682 (0.589-0.798)	0.815 (0.699-0.950)	0.997 (0.844-1.16)	1.14 (0.949-1.32)	1.28 (1.05-1.48)	1.42 (1.15-1.65)	1.61 (1.27-1.89)	1.76 (1.35-2.07)
30-min	0.524 (0.455-0.613)	0.682 (0.593-0.801)	0.919 (0.793-1.07)	1.10 (0.942-1.28)	1.34 (1.14-1.56)	1.53 (1.28-1.77)	1.72 (1.41-2.00)	1.92 (1.55-2.23)	2.17 (1.71-2.54)	2.37 (1.82-2.78)
60-min	0.648 (0.563-0.759)	0.844 (0.734-0.991)	1.14 (0.981-1.33)	1.36 (1.16-1.58)	1.66 (1.41-1.93)	1.89 (1.58-2.20)	2.13 (1.75-2.47)	2.37 (1.91-2.76)	2.69 (2.11-3.14)	2.93 (2.26-3.45)
2-hr	0.740 (0.649-0.860)	0.956 (0.834-1.11)	1.27 (1.10-1.47)	1.51 (1.30-1.75)	1.84 (1.56-2.12)	2.10 (1.76-2.41)	2.36 (1.95-2.72)	2.63 (2.13-3.04)	3.00 (2.36-3.48)	3.29 (2.53-3.84)
3-hr	0.796 (0.698-0.925)	1.02 (0.892-1.18)	1.33 (1.16-1.55)	1.58 (1.37-1.83)	1.93 (1.65-2.23)	2.21 (1.86-2.54)	2.50 (2.06-2.89)	2.81 (2.28-3.26)	3.24 (2.54-3.78)	3.59 (2.74-4.21)
6-hr	0.962 (0.851-1.10)	1.22 (1.08-1.39)	1.55 (1.37-1.77)	1.82 (1.60-2.07)	2.20 (1.90-2.49)	2.50 (2.13-2.82)	2.81 (2.35-3.18)	3.14 (2.58-3.56)	3.59 (2.86-4.09)	3.95 (3.07-4.53)
12-hr	1.09 (0.982-1.23)	1.38 (1.24-1.55)	1.74 (1.56-1.95)	2.04 (1.81-2.27)	2.44 (2.14-2.71)	2.75 (2.38-3.05)	3.07 (2.62-3.42)	3.39 (2.85-3.81)	3.84 (3.15-4.35)	4.20 (3.36-4.79)
24-hr	1.33 (1.20-1.49)	1.69 (1.52-1.88)	2.16 (1.96-2.41)	2.54 (2.29-2.82)	3.07 (2.75-3.40)	3.48 (3.10-3.86)	3.91 (3.46-4.34)	4.36 (3.82-4.83)	4.97 (4.32-5.52)	5.44 (4.69-6.06)
2-day	1.44 (1.30-1.59)	1.82 (1.65-2.02)	2.36 (2.12-2.60)	2.79 (2.50-3.08)	3.39 (3.02-3.74)	3.87 (3.43-4.26)	4.36 (3.85-4.82)	4.89 (4.28-5.41)	5.61 (4.87-6.23)	6.19 (5.31-6.91)
3-day	1.52 (1.38-1.69)	1.93 (1.74-2.14)	2.50 (2.26-2.77)	2.96 (2.66-3.28)	3.61 (3.23-3.99)	4.13 (3.67-4.56)	4.68 (4.13-5.17)	5.26 (4.60-5.83)	6.07 (5.25-6.74)	6.72 (5.75-7.49)
4-day	1.61 (1.45-1.79)	2.04 (1.84-2.26)	2.65 (2.39-2.94)	3.14 (2.83-3.48)	3.84 (3.43-4.24)	4.40 (3.91-4.86)	5.00 (4.41-5.53)	5.63 (4.93-6.24)	6.52 (5.64-7.25)	7.24 (6.19-8.08)
7-day	1.82 (1.64-2.03)	2.31 (2.08-2.57)	3.00 (2.70-3.33)	3.56 (3.20-3.95)	4.34 (3.88-4.82)	4.98 (4.41-5.52)	5.65 (4.98-6.27)	6.35 (5.56-7.06)	7.35 (6.34-8.19)	8.14 (6.96-9.11)
10-day	2.02 (1.82-2.25)	2.56 (2.31-2.86)	3.32 (2.99-3.70)	3.94 (3.53-4.38)	4.79 (4.27-5.32)	5.47 (4.85-6.08)	6.19 (5.46-6.88)	6.94 (6.07-7.72)	7.98 (6.90-8.92)	8.82 (7.54-9.88)
20-day	2.50 (2.26-2.77)	3.19 (2.88-3.53)	4.14 (3.73-4.57)	4.86 (4.37-5.36)	5.83 (5.21-6.43)	6.57 (5.85-7.24)	7.32 (6.49-8.08)	8.07 (7.12-8.93)	9.09 (7.94-10.1)	9.86 (8.55-11.0)
30-day	2.98 (2.71-3.28)	3.80 (3.46-4.18)	4.92 (4.46-5.40)	5.76 (5.21-6.32)	6.88 (6.20-7.55)	7.73 (6.95-8.48)	8.60 (7.68-9.44)	9.47 (8.42-10.4)	10.6 (9.36-11.8)	11.5 (10.1-12.8)
45-day	3.52 (3.20-3.85)	4.49 (4.09-4.92)	5.79 (5.26-6.34)	6.74 (6.12-7.38)	7.99 (7.22-8.72)	8.91 (8.02-9.73)	9.83 (8.82-10.7)	10.7 (9.58-11.8)	11.9 (10.6-13.1)	12.8 (11.3-14.1)
60-day	3.91 (3.56-4.28)	5.00 (4.55-5.47)	6.42 (5.85-7.03)	7.46 (6.79-8.16)	8.80 (7.98-9.60)	9.78 (8.83-10.7)	10.7 (9.67-11.7)	11.7 (10.5-12.8)	12.9 (11.5-14.1)	13.8 (12.2-15.2)

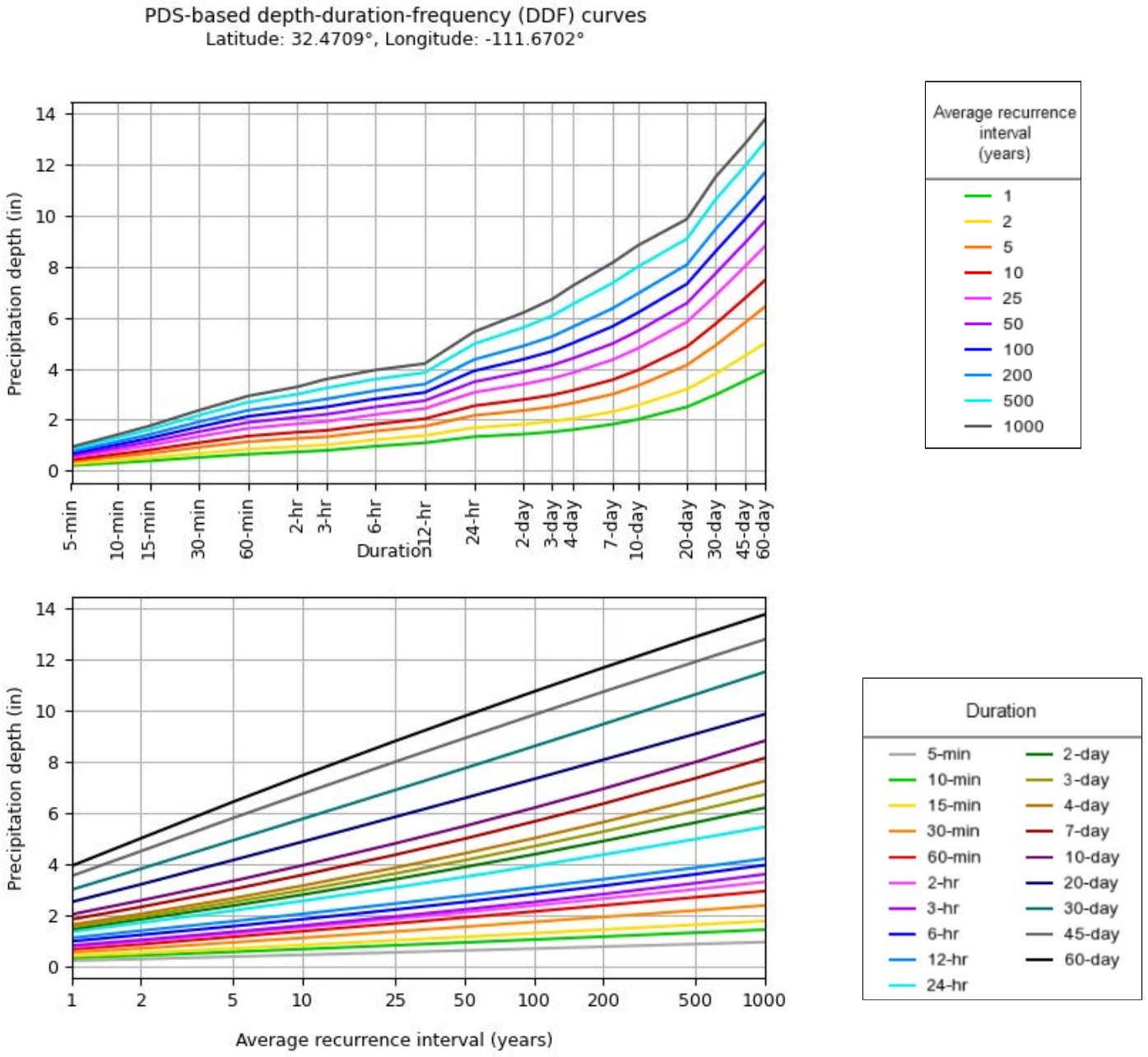
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



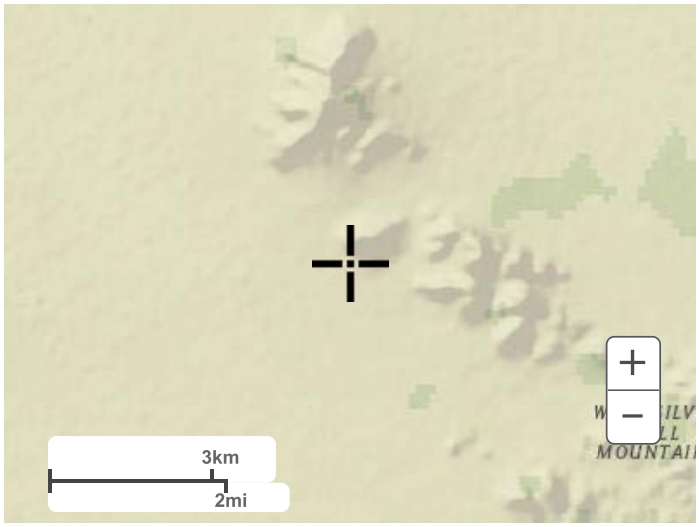
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Oct 27 18:43:12 2022

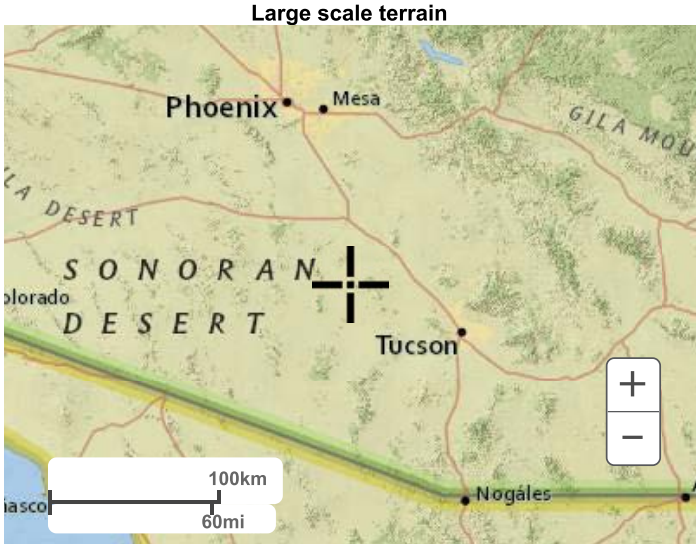
Back to Top

Maps & aerials

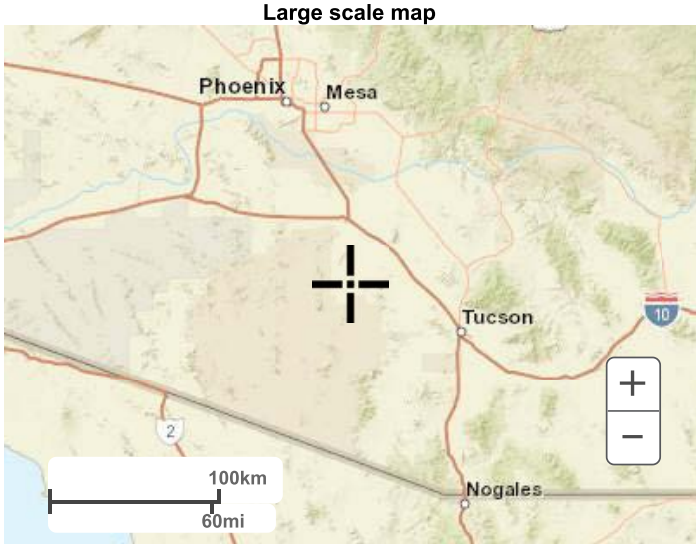
Small scale terrain



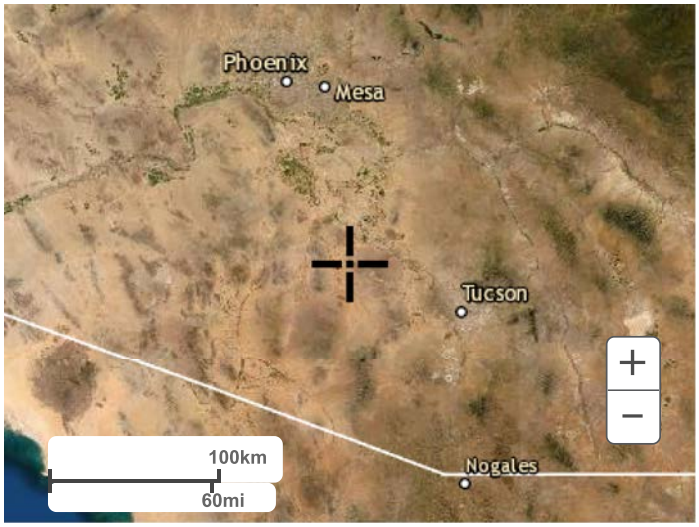
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Eloy, Arizona, USA*
Latitude: 32.5479°, Longitude: -111.7062°
Elevation: 1631.3 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for OFF3

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.209 (0.181-0.246)	0.273 (0.236-0.321)	0.369 (0.317-0.432)	0.441 (0.377-0.514)	0.538 (0.453-0.624)	0.612 (0.509-0.709)	0.687 (0.562-0.796)	0.763 (0.614-0.887)	0.863 (0.677-1.01)	0.941 (0.723-1.10)
10-min	0.318 (0.275-0.374)	0.415 (0.360-0.489)	0.561 (0.483-0.657)	0.671 (0.573-0.782)	0.819 (0.690-0.951)	0.932 (0.775-1.08)	1.05 (0.856-1.21)	1.16 (0.935-1.35)	1.31 (1.03-1.53)	1.43 (1.10-1.68)
15-min	0.395 (0.341-0.464)	0.515 (0.446-0.606)	0.696 (0.598-0.814)	0.832 (0.710-0.969)	1.02 (0.855-1.18)	1.16 (0.961-1.34)	1.30 (1.06-1.50)	1.44 (1.16-1.67)	1.63 (1.28-1.90)	1.78 (1.36-2.08)
30-min	0.532 (0.460-0.625)	0.693 (0.600-0.816)	0.937 (0.806-1.10)	1.12 (0.957-1.30)	1.37 (1.15-1.59)	1.56 (1.30-1.80)	1.75 (1.43-2.02)	1.94 (1.56-2.25)	2.19 (1.72-2.56)	2.39 (1.84-2.81)
60-min	0.658 (0.569-0.773)	0.858 (0.743-1.01)	1.16 (0.997-1.36)	1.39 (1.18-1.62)	1.69 (1.42-1.96)	1.93 (1.60-2.23)	2.16 (1.77-2.50)	2.40 (1.93-2.79)	2.72 (2.13-3.17)	2.96 (2.27-3.48)
2-hr	0.752 (0.658-0.876)	0.974 (0.847-1.14)	1.30 (1.12-1.51)	1.54 (1.32-1.79)	1.88 (1.59-2.16)	2.14 (1.79-2.46)	2.41 (1.98-2.77)	2.68 (2.16-3.09)	3.04 (2.39-3.53)	3.33 (2.56-3.89)
3-hr	0.813 (0.711-0.944)	1.04 (0.911-1.21)	1.36 (1.19-1.59)	1.62 (1.40-1.88)	1.98 (1.69-2.28)	2.27 (1.90-2.61)	2.57 (2.11-2.96)	2.88 (2.33-3.33)	3.32 (2.59-3.85)	3.67 (2.79-4.28)
6-hr	0.976 (0.864-1.12)	1.24 (1.10-1.41)	1.58 (1.40-1.80)	1.86 (1.63-2.11)	2.24 (1.94-2.53)	2.54 (2.17-2.86)	2.85 (2.39-3.22)	3.18 (2.62-3.60)	3.63 (2.90-4.12)	3.98 (3.10-4.55)
12-hr	1.11 (0.993-1.25)	1.40 (1.26-1.57)	1.77 (1.58-1.99)	2.07 (1.84-2.31)	2.48 (2.17-2.76)	2.79 (2.42-3.11)	3.11 (2.66-3.48)	3.44 (2.89-3.87)	3.90 (3.19-4.41)	4.25 (3.41-4.85)
24-hr	1.29 (1.17-1.43)	1.63 (1.48-1.82)	2.11 (1.90-2.34)	2.48 (2.23-2.75)	3.00 (2.69-3.31)	3.40 (3.03-3.76)	3.83 (3.39-4.23)	4.26 (3.75-4.72)	4.87 (4.23-5.40)	5.35 (4.60-5.93)
2-day	1.39 (1.26-1.53)	1.77 (1.60-1.95)	2.30 (2.08-2.54)	2.72 (2.45-3.01)	3.32 (2.97-3.66)	3.79 (3.38-4.18)	4.29 (3.79-4.73)	4.81 (4.22-5.32)	5.53 (4.81-6.14)	6.11 (5.25-6.81)
3-day	1.46 (1.33-1.62)	1.86 (1.69-2.06)	2.43 (2.20-2.69)	2.88 (2.60-3.19)	3.52 (3.15-3.89)	4.04 (3.60-4.46)	4.58 (4.05-5.06)	5.16 (4.52-5.70)	5.96 (5.16-6.61)	6.60 (5.66-7.35)
4-day	1.54 (1.40-1.71)	1.96 (1.78-2.18)	2.56 (2.32-2.84)	3.05 (2.74-3.37)	3.73 (3.34-4.12)	4.29 (3.81-4.73)	4.88 (4.31-5.38)	5.50 (4.82-6.08)	6.38 (5.52-7.08)	7.09 (6.07-7.89)
7-day	1.73 (1.56-1.92)	2.20 (1.99-2.45)	2.87 (2.59-3.19)	3.42 (3.08-3.80)	4.19 (3.74-4.64)	4.81 (4.27-5.32)	5.47 (4.83-6.06)	6.16 (5.39-6.83)	7.14 (6.17-7.94)	7.92 (6.78-8.84)
10-day	1.91 (1.72-2.12)	2.43 (2.20-2.70)	3.17 (2.86-3.53)	3.77 (3.38-4.18)	4.60 (4.11-5.10)	5.26 (4.68-5.84)	5.97 (5.27-6.62)	6.71 (5.87-7.45)	7.74 (6.70-8.63)	8.57 (7.34-9.58)
20-day	2.36 (2.13-2.61)	3.02 (2.73-3.34)	3.94 (3.56-4.35)	4.64 (4.18-5.12)	5.58 (5.00-6.15)	6.30 (5.63-6.94)	7.04 (6.26-7.77)	7.78 (6.88-8.59)	8.78 (7.69-9.72)	9.54 (8.30-10.6)
30-day	2.79 (2.54-3.06)	3.57 (3.24-3.92)	4.64 (4.22-5.09)	5.46 (4.95-5.98)	6.55 (5.92-7.17)	7.39 (6.64-8.08)	8.24 (7.37-9.02)	9.09 (8.09-9.98)	10.2 (9.03-11.3)	11.1 (9.73-12.3)
45-day	3.28 (2.99-3.60)	4.21 (3.83-4.61)	5.46 (4.97-5.98)	6.39 (5.81-6.99)	7.61 (6.88-8.30)	8.51 (7.67-9.29)	9.42 (8.46-10.3)	10.3 (9.21-11.3)	11.5 (10.2-12.6)	12.4 (10.9-13.6)
60-day	3.64 (3.32-3.98)	4.67 (4.26-5.12)	6.06 (5.52-6.63)	7.07 (6.43-7.72)	8.37 (7.59-9.14)	9.33 (8.43-10.2)	10.3 (9.25-11.2)	11.2 (10.0-12.3)	12.4 (11.0-13.6)	13.3 (11.8-14.6)

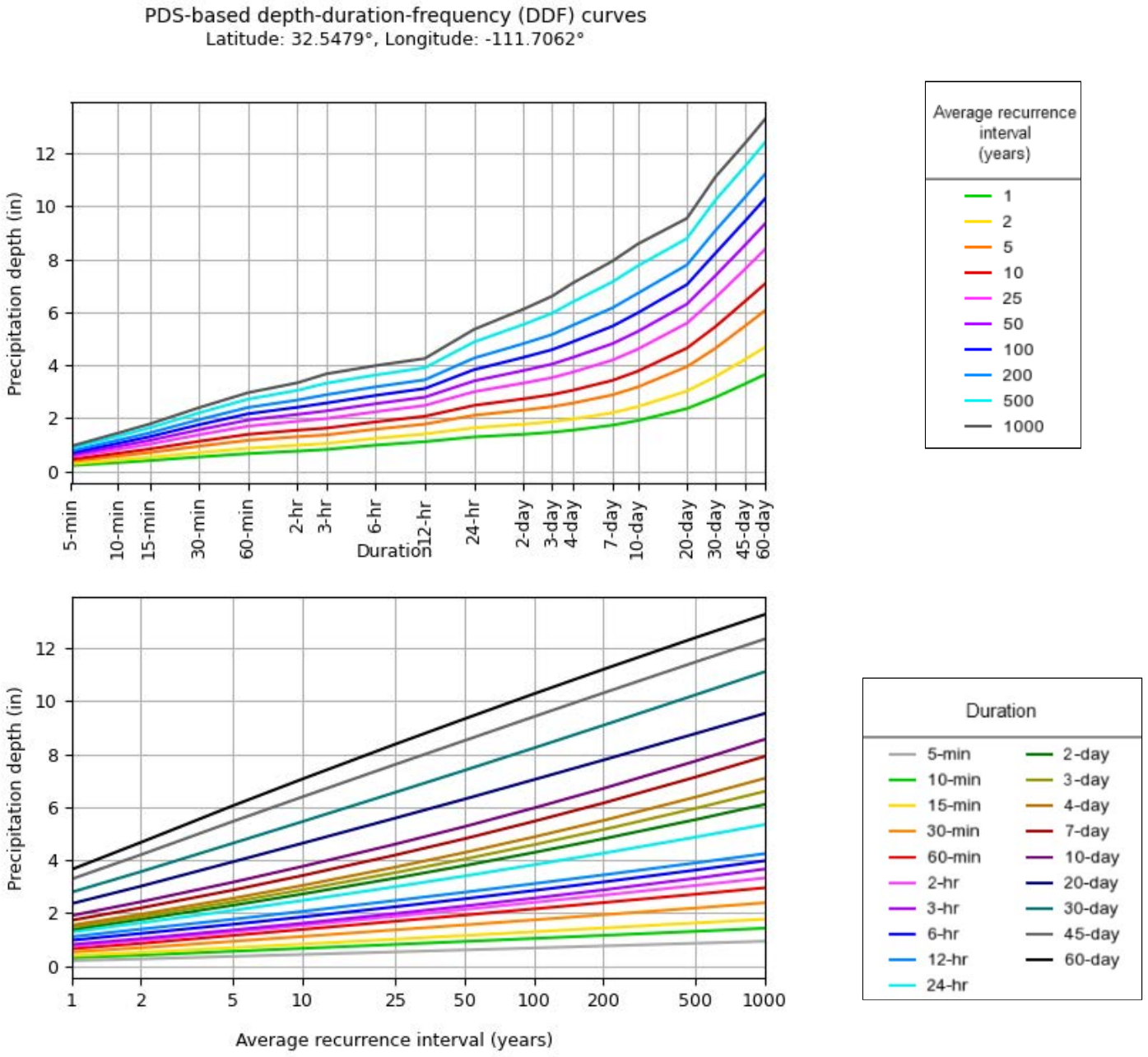
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



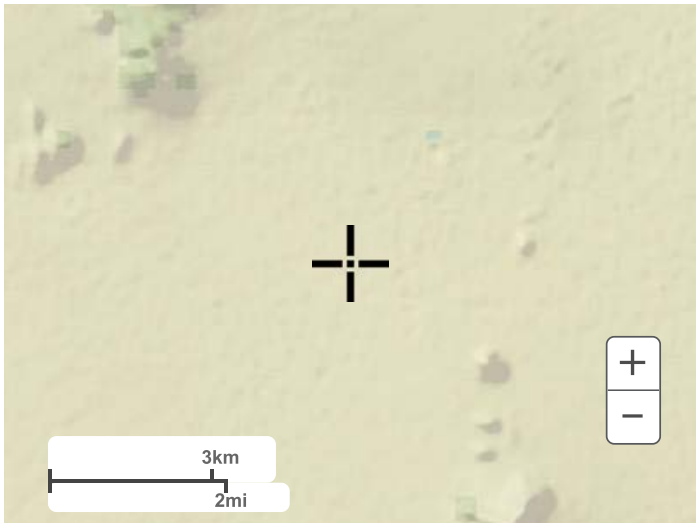
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Oct 27 18:44:31 2022

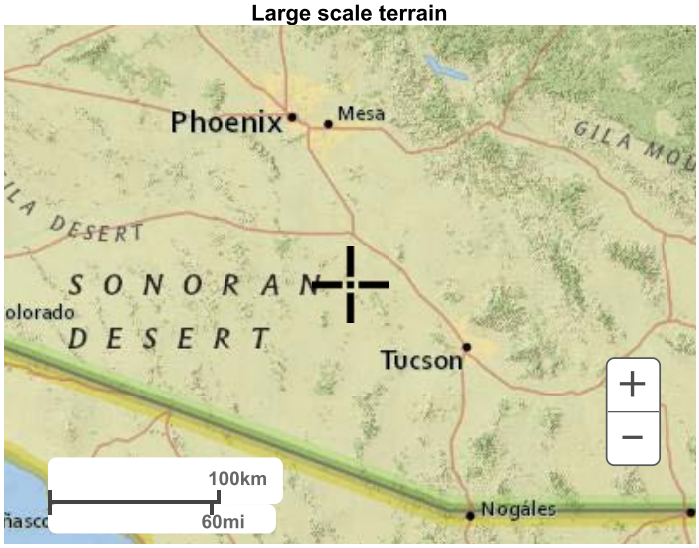
Back to Top

Maps & aerials

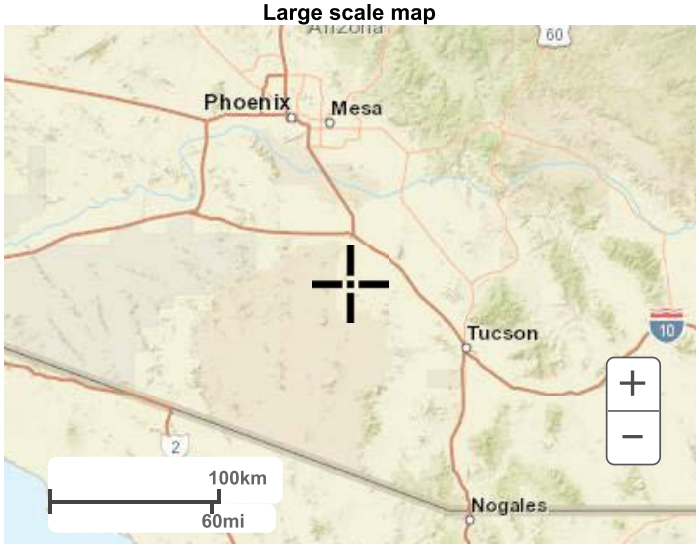
Small scale terrain



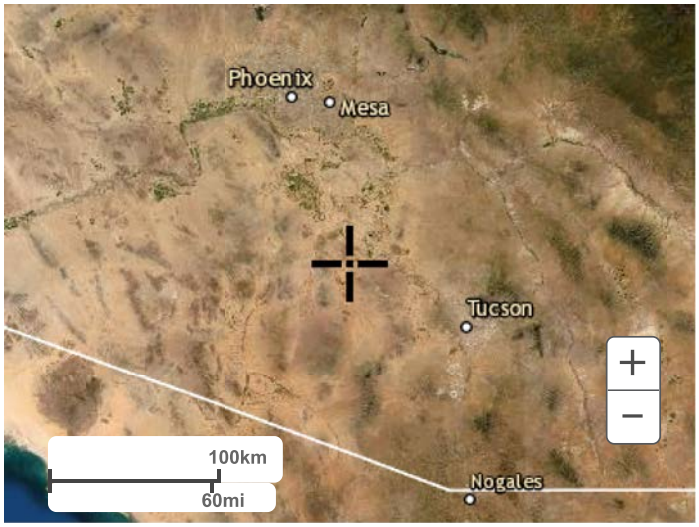
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Eloy, Arizona, USA*
Latitude: 32.5487°, Longitude: -111.6805°
Elevation: 1635.99 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for OFF4

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.209 (0.181-0.246)	0.273 (0.236-0.321)	0.369 (0.317-0.431)	0.440 (0.376-0.513)	0.538 (0.453-0.624)	0.612 (0.509-0.709)	0.687 (0.562-0.796)	0.763 (0.614-0.887)	0.863 (0.676-1.01)	0.941 (0.722-1.10)
10-min	0.318 (0.275-0.374)	0.415 (0.360-0.488)	0.561 (0.482-0.656)	0.670 (0.573-0.781)	0.819 (0.689-0.950)	0.931 (0.775-1.08)	1.04 (0.855-1.21)	1.16 (0.934-1.35)	1.31 (1.03-1.53)	1.43 (1.10-1.68)
15-min	0.395 (0.341-0.464)	0.515 (0.446-0.605)	0.695 (0.598-0.814)	0.831 (0.710-0.968)	1.02 (0.854-1.18)	1.16 (0.961-1.34)	1.30 (1.06-1.50)	1.44 (1.16-1.67)	1.63 (1.28-1.90)	1.78 (1.36-2.08)
30-min	0.532 (0.460-0.625)	0.693 (0.600-0.815)	0.936 (0.805-1.10)	1.12 (0.956-1.30)	1.37 (1.15-1.59)	1.56 (1.29-1.80)	1.75 (1.43-2.02)	1.94 (1.56-2.25)	2.19 (1.72-2.56)	2.39 (1.84-2.81)
60-min	0.658 (0.569-0.773)	0.858 (0.743-1.01)	1.16 (0.996-1.36)	1.38 (1.18-1.61)	1.69 (1.42-1.96)	1.92 (1.60-2.23)	2.16 (1.77-2.50)	2.40 (1.93-2.79)	2.72 (2.13-3.17)	2.96 (2.27-3.48)
2-hr	0.752 (0.658-0.876)	0.974 (0.847-1.13)	1.30 (1.12-1.50)	1.54 (1.32-1.79)	1.88 (1.59-2.16)	2.14 (1.79-2.46)	2.41 (1.98-2.76)	2.68 (2.16-3.08)	3.04 (2.39-3.53)	3.33 (2.56-3.88)
3-hr	0.813 (0.712-0.945)	1.04 (0.911-1.21)	1.36 (1.19-1.59)	1.62 (1.40-1.88)	1.98 (1.69-2.28)	2.27 (1.90-2.61)	2.56 (2.11-2.96)	2.88 (2.32-3.33)	3.31 (2.59-3.85)	3.66 (2.79-4.28)
6-hr	0.976 (0.864-1.12)	1.24 (1.10-1.41)	1.58 (1.40-1.80)	1.86 (1.63-2.11)	2.24 (1.94-2.53)	2.54 (2.17-2.86)	2.86 (2.39-3.22)	3.18 (2.62-3.60)	3.63 (2.90-4.12)	3.98 (3.10-4.55)
12-hr	1.11 (0.994-1.25)	1.40 (1.26-1.58)	1.77 (1.58-1.99)	2.07 (1.84-2.32)	2.47 (2.17-2.76)	2.79 (2.42-3.11)	3.11 (2.66-3.48)	3.44 (2.89-3.87)	3.90 (3.19-4.41)	4.25 (3.41-4.85)
24-hr	1.29 (1.17-1.44)	1.64 (1.48-1.82)	2.11 (1.91-2.34)	2.48 (2.24-2.75)	3.00 (2.69-3.32)	3.41 (3.04-3.76)	3.84 (3.40-4.23)	4.28 (3.76-4.72)	4.88 (4.24-5.40)	5.36 (4.62-5.94)
2-day	1.39 (1.26-1.54)	1.77 (1.60-1.96)	2.30 (2.08-2.54)	2.73 (2.46-3.02)	3.33 (2.98-3.67)	3.80 (3.38-4.19)	4.30 (3.80-4.74)	4.82 (4.23-5.33)	5.54 (4.82-6.15)	6.12 (5.27-6.82)
3-day	1.47 (1.33-1.63)	1.87 (1.69-2.07)	2.44 (2.20-2.70)	2.89 (2.61-3.20)	3.54 (3.16-3.90)	4.05 (3.61-4.47)	4.60 (4.06-5.07)	5.17 (4.53-5.72)	5.97 (5.18-6.62)	6.62 (5.68-7.37)
4-day	1.55 (1.40-1.72)	1.97 (1.78-2.18)	2.57 (2.32-2.85)	3.06 (2.76-3.38)	3.75 (3.35-4.13)	4.30 (3.83-4.74)	4.89 (4.32-5.40)	5.52 (4.84-6.10)	6.40 (5.54-7.10)	7.12 (6.09-7.92)
7-day	1.74 (1.57-1.93)	2.21 (2.00-2.46)	2.89 (2.60-3.20)	3.44 (3.09-3.81)	4.21 (3.76-4.66)	4.83 (4.29-5.34)	5.49 (4.85-6.08)	6.18 (5.41-6.86)	7.16 (6.20-7.97)	7.95 (6.80-8.88)
10-day	1.92 (1.73-2.13)	2.44 (2.20-2.72)	3.19 (2.87-3.54)	3.78 (3.40-4.20)	4.62 (4.13-5.12)	5.29 (4.70-5.87)	6.00 (5.30-6.65)	6.74 (5.90-7.49)	7.78 (6.73-8.66)	8.61 (7.37-9.62)
20-day	2.37 (2.14-2.62)	3.03 (2.74-3.35)	3.96 (3.57-4.37)	4.66 (4.20-5.14)	5.61 (5.03-6.18)	6.33 (5.65-6.98)	7.08 (6.29-7.80)	7.82 (6.91-8.64)	8.82 (7.73-9.77)	9.59 (8.34-10.7)
30-day	2.80 (2.55-3.08)	3.59 (3.26-3.94)	4.67 (4.24-5.12)	5.49 (4.98-6.02)	6.59 (5.95-7.21)	7.43 (6.68-8.13)	8.28 (7.41-9.06)	9.14 (8.13-10.0)	10.3 (9.07-11.3)	11.2 (9.78-12.4)
45-day	3.30 (3.01-3.62)	4.23 (3.85-4.63)	5.49 (5.00-6.01)	6.43 (5.84-7.03)	7.64 (6.92-8.34)	8.56 (7.72-9.34)	9.46 (8.51-10.3)	10.4 (9.27-11.3)	11.5 (10.3-12.7)	12.4 (11.0-13.7)
60-day	3.66 (3.34-4.01)	4.70 (4.28-5.14)	6.09 (5.55-6.66)	7.11 (6.47-7.76)	8.42 (7.63-9.18)	9.38 (8.47-10.2)	10.3 (9.30-11.3)	11.3 (10.1-12.3)	12.5 (11.1-13.7)	13.3 (11.8-14.7)

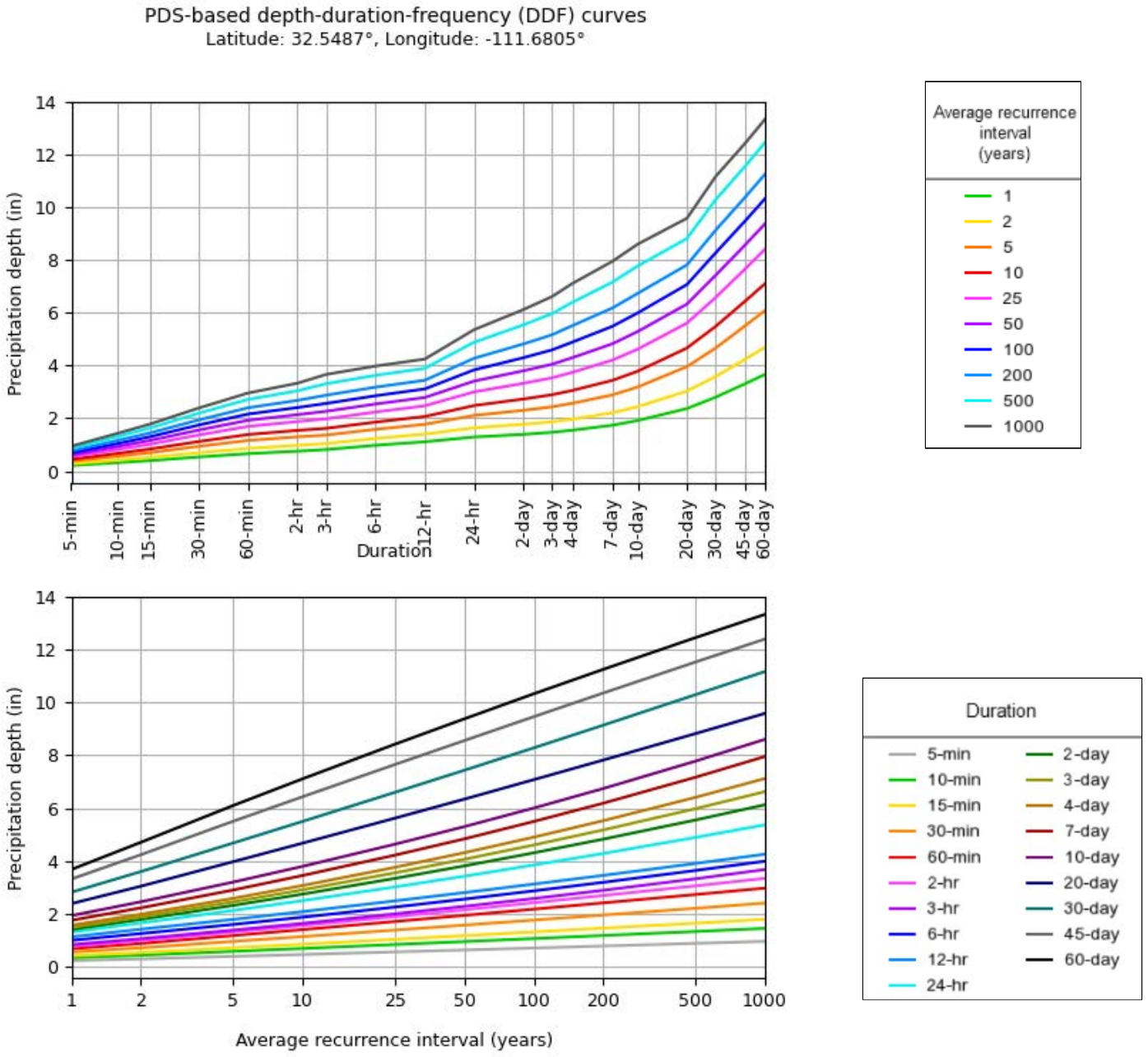
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



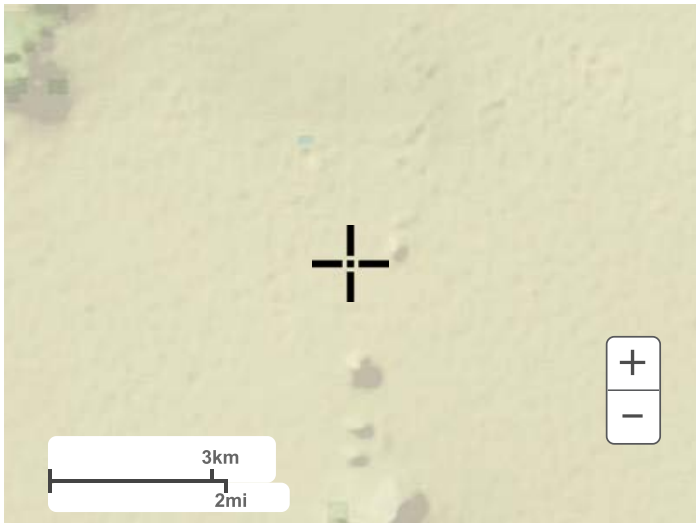
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Oct 27 18:46:09 2022

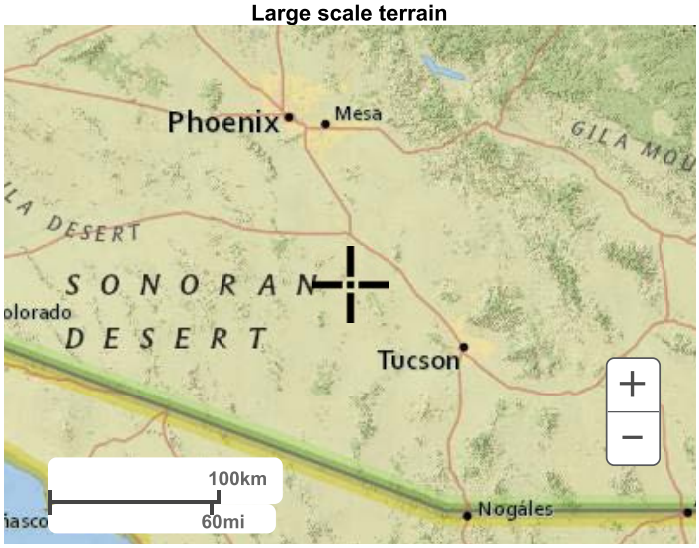
Back to Top

Maps & aerials

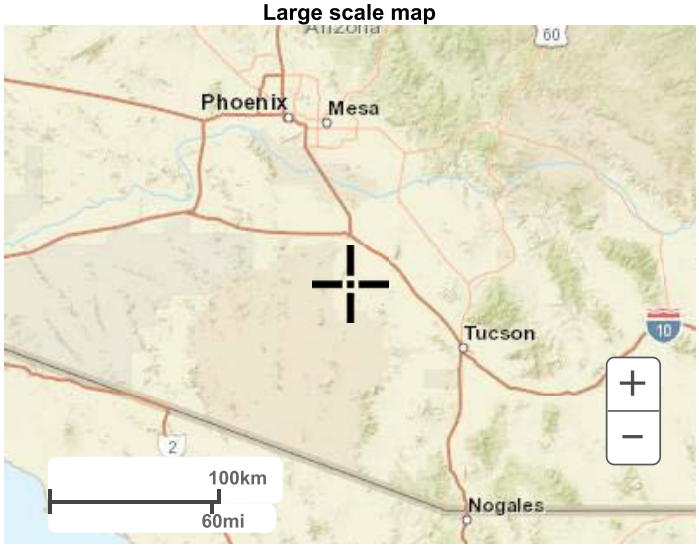
Small scale terrain



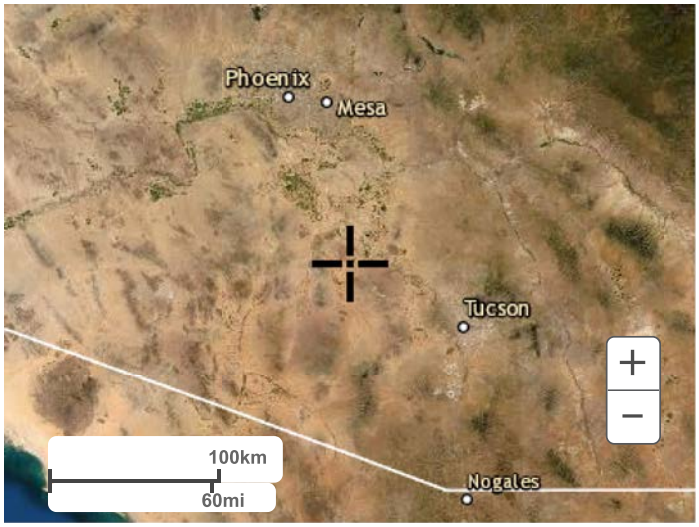
Large scale terrain



Large scale map



Large scale aerial



Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

NOAA Atlas 14, Volume 1, Version 5
Location name: Red Rock, Arizona, USA*
Latitude: 32.5317°, Longitude: -111.6525°
Elevation: 1706.19 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES for OFF5

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.209 (0.181-0.245)	0.272 (0.236-0.320)	0.368 (0.315-0.430)	0.439 (0.375-0.512)	0.537 (0.452-0.623)	0.611 (0.508-0.708)	0.686 (0.560-0.795)	0.763 (0.612-0.886)	0.863 (0.675-1.01)	0.940 (0.721-1.10)
10-min	0.318 (0.275-0.373)	0.414 (0.359-0.487)	0.560 (0.480-0.654)	0.669 (0.571-0.779)	0.817 (0.687-0.948)	0.930 (0.772-1.08)	1.04 (0.852-1.21)	1.16 (0.931-1.35)	1.31 (1.03-1.53)	1.43 (1.10-1.68)
15-min	0.394 (0.341-0.463)	0.513 (0.445-0.604)	0.694 (0.595-0.811)	0.829 (0.707-0.966)	1.01 (0.852-1.18)	1.15 (0.958-1.34)	1.30 (1.06-1.50)	1.44 (1.15-1.67)	1.63 (1.27-1.90)	1.77 (1.36-2.08)
30-min	0.530 (0.459-0.623)	0.691 (0.599-0.814)	0.934 (0.802-1.09)	1.12 (0.953-1.30)	1.36 (1.15-1.58)	1.55 (1.29-1.80)	1.74 (1.42-2.02)	1.94 (1.56-2.25)	2.19 (1.72-2.56)	2.39 (1.83-2.81)
60-min	0.656 (0.568-0.771)	0.855 (0.741-1.01)	1.16 (0.992-1.35)	1.38 (1.18-1.61)	1.69 (1.42-1.96)	1.92 (1.60-2.23)	2.16 (1.76-2.50)	2.40 (1.92-2.78)	2.71 (2.12-3.17)	2.96 (2.27-3.47)
2-hr	0.752 (0.657-0.875)	0.972 (0.846-1.13)	1.29 (1.12-1.50)	1.54 (1.32-1.78)	1.87 (1.59-2.16)	2.13 (1.79-2.45)	2.40 (1.98-2.76)	2.68 (2.16-3.08)	3.04 (2.39-3.52)	3.33 (2.56-3.88)
3-hr	0.811 (0.710-0.942)	1.04 (0.909-1.21)	1.36 (1.18-1.58)	1.61 (1.40-1.87)	1.97 (1.68-2.28)	2.26 (1.89-2.60)	2.56 (2.10-2.95)	2.87 (2.32-3.32)	3.30 (2.58-3.84)	3.66 (2.79-4.27)
6-hr	0.974 (0.863-1.11)	1.23 (1.09-1.41)	1.58 (1.39-1.80)	1.85 (1.62-2.10)	2.23 (1.93-2.52)	2.54 (2.16-2.86)	2.85 (2.38-3.21)	3.17 (2.61-3.59)	3.62 (2.89-4.12)	3.97 (3.09-4.55)
12-hr	1.11 (0.992-1.25)	1.40 (1.25-1.57)	1.77 (1.58-1.99)	2.06 (1.83-2.31)	2.47 (2.16-2.75)	2.78 (2.41-3.10)	3.10 (2.65-3.47)	3.43 (2.88-3.86)	3.88 (3.18-4.40)	4.24 (3.40-4.84)
24-hr	1.30 (1.18-1.45)	1.65 (1.50-1.84)	2.13 (1.92-2.36)	2.50 (2.25-2.77)	3.02 (2.71-3.34)	3.43 (3.06-3.79)	3.86 (3.41-4.26)	4.30 (3.78-4.75)	4.91 (4.26-5.43)	5.39 (4.64-5.97)
2-day	1.40 (1.27-1.55)	1.78 (1.61-1.97)	2.32 (2.09-2.56)	2.74 (2.47-3.03)	3.34 (2.99-3.69)	3.82 (3.40-4.21)	4.31 (3.81-4.76)	4.83 (4.24-5.35)	5.56 (4.83-6.17)	6.14 (5.28-6.85)
3-day	1.48 (1.34-1.64)	1.89 (1.71-2.09)	2.46 (2.22-2.72)	2.91 (2.62-3.22)	3.56 (3.18-3.92)	4.07 (3.62-4.50)	4.62 (4.08-5.10)	5.20 (4.56-5.75)	6.00 (5.20-6.66)	6.65 (5.70-7.41)
4-day	1.57 (1.42-1.74)	1.99 (1.80-2.21)	2.59 (2.34-2.87)	3.08 (2.78-3.41)	3.78 (3.38-4.16)	4.33 (3.86-4.78)	4.93 (4.35-5.44)	5.56 (4.87-6.14)	6.44 (5.57-7.14)	7.16 (6.13-7.96)
7-day	1.76 (1.59-1.96)	2.24 (2.02-2.49)	2.92 (2.64-3.24)	3.48 (3.13-3.85)	4.25 (3.80-4.70)	4.87 (4.33-5.39)	5.54 (4.89-6.14)	6.24 (5.46-6.92)	7.22 (6.25-8.04)	8.02 (6.86-8.95)
10-day	1.95 (1.76-2.17)	2.48 (2.24-2.76)	3.23 (2.91-3.59)	3.83 (3.44-4.25)	4.67 (4.18-5.18)	5.35 (4.75-5.93)	6.06 (5.35-6.72)	6.80 (5.96-7.56)	7.85 (6.79-8.74)	8.68 (7.43-9.70)
20-day	2.41 (2.17-2.66)	3.08 (2.78-3.40)	4.01 (3.62-4.42)	4.72 (4.25-5.20)	5.67 (5.08-6.25)	6.40 (5.71-7.04)	7.14 (6.34-7.88)	7.89 (6.97-8.71)	8.89 (7.79-9.85)	9.66 (8.40-10.7)
30-day	2.85 (2.60-3.14)	3.65 (3.32-4.01)	4.74 (4.31-5.20)	5.57 (5.05-6.11)	6.67 (6.02-7.31)	7.52 (6.76-8.23)	8.37 (7.49-9.18)	9.24 (8.22-10.2)	10.4 (9.16-11.5)	11.3 (9.87-12.5)
45-day	3.36 (3.07-3.68)	4.30 (3.92-4.72)	5.58 (5.08-6.11)	6.52 (5.92-7.13)	7.74 (7.01-8.45)	8.66 (7.81-9.45)	9.57 (8.60-10.5)	10.5 (9.36-11.5)	11.6 (10.3-12.8)	12.5 (11.1-13.8)
60-day	3.73 (3.40-4.08)	4.78 (4.36-5.23)	6.18 (5.63-6.76)	7.20 (6.56-7.86)	8.52 (7.73-9.29)	9.49 (8.58-10.3)	10.4 (9.41-11.4)	11.4 (10.2-12.4)	12.6 (11.2-13.8)	13.5 (11.9-14.8)

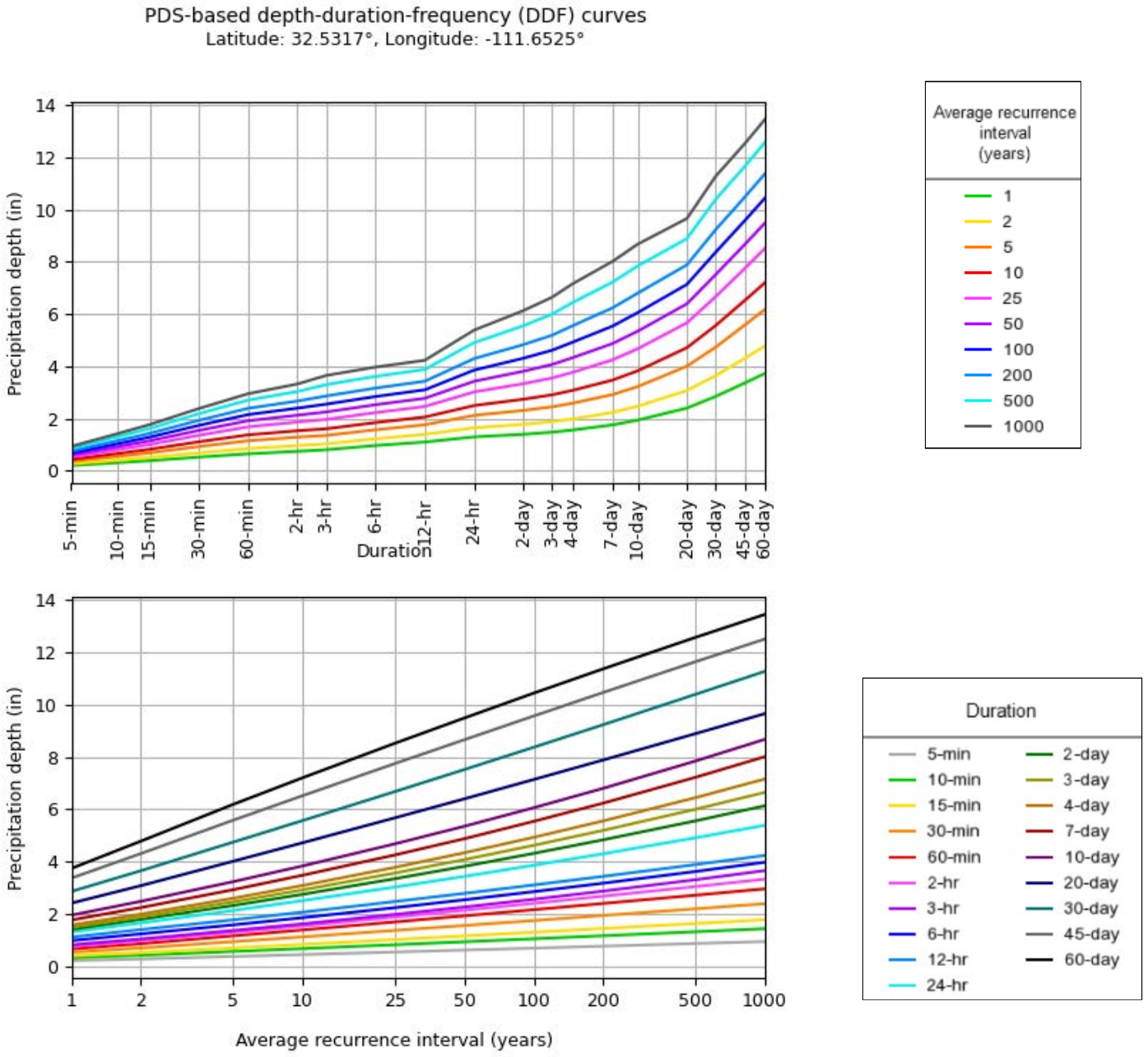
[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

Back to Top

PF graphical



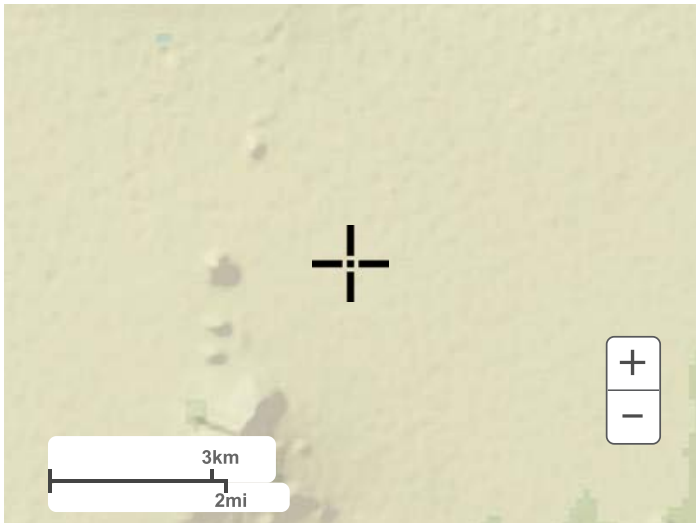
NOAA Atlas 14, Volume 1, Version 5

Created (GMT): Thu Oct 27 18:47:06 2022

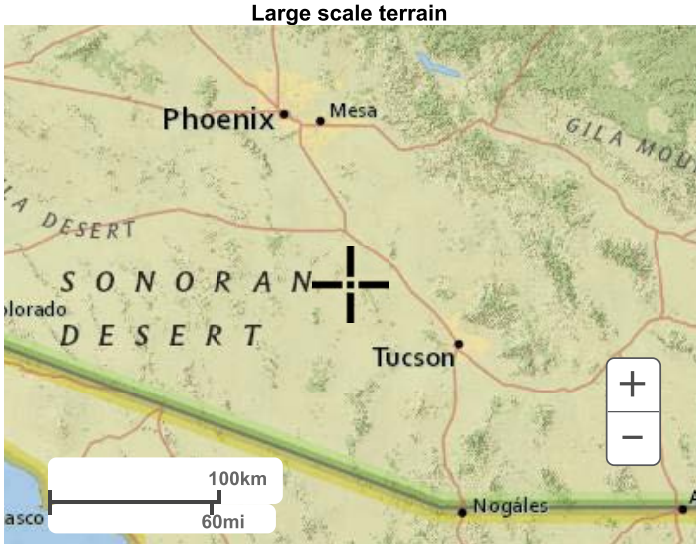
Back to Top

Maps & aerials

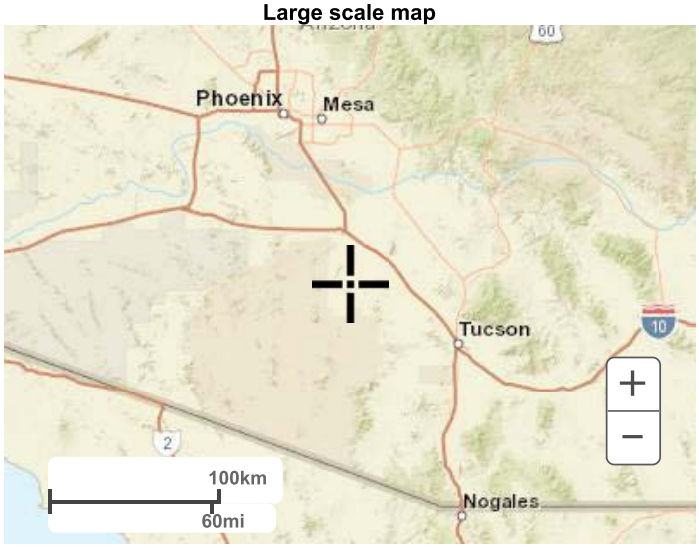
Small scale terrain



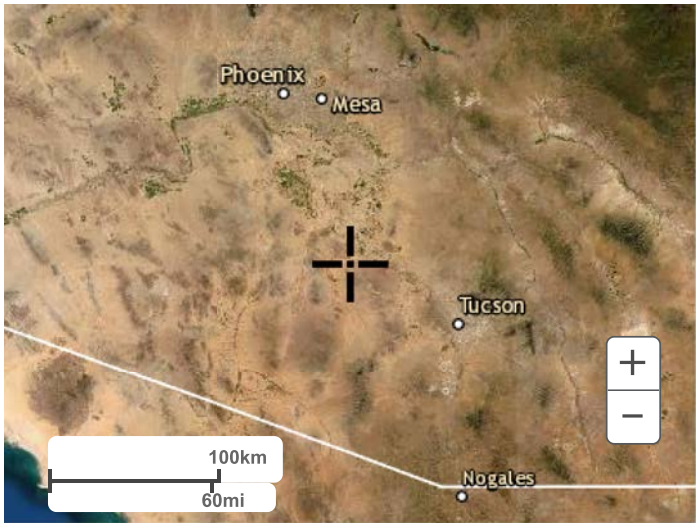
Large scale terrain



Large scale map



Large scale aerial



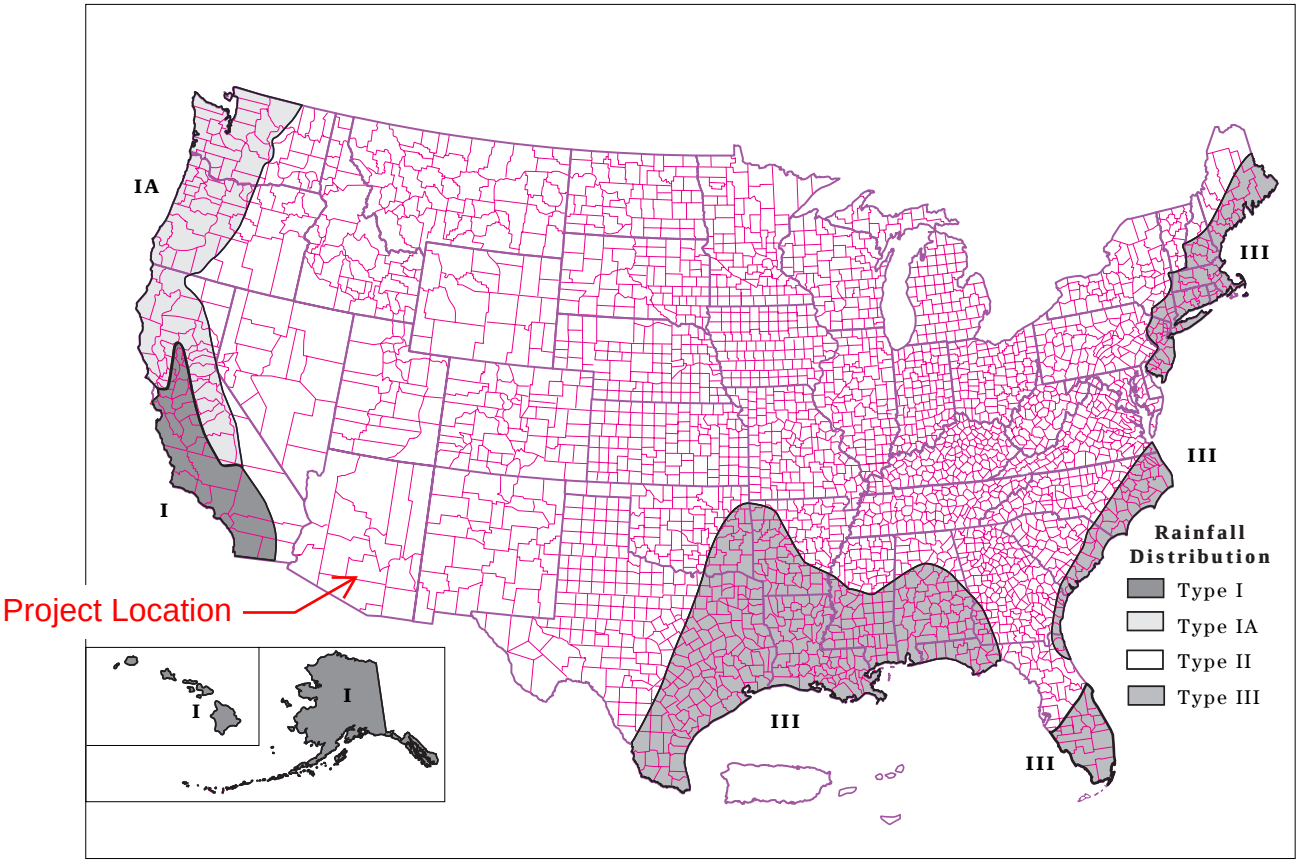
Back to Top

US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

A.2 TR-55 RAINFALL DISTRIBUTION MAP

Figure B-2 Approximate geographic boundaries for NRCS (SCS) rainfall distributions



Rainfall data sources

This section lists the most current 24-hour rainfall data published by the National Weather Service (NWS) for various parts of the country. Because NWS Technical Paper 40 (TP-40) is out of print, the 24-hour rainfall maps for areas east of the 105th meridian are included here as figures B-3 through B-8. For the area generally west of the 105th meridian, TP-40 has been superseded by NOAA Atlas 2, the Precipitation-Frequency Atlas of the Western United States, published by the National Ocean and Atmospheric Administration.

East of 105th meridian

Hershfield, D.M. 1961. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 40. Washington, DC. 155 p.

West of 105th meridian

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation-frequency atlas of the Western United States. Vol. I Montana; Vol. II, Wyoming; Vol III, Colorado; Vol. IV, New Mexico; Vol V, Idaho; Vol. VI, Utah; Vol. VII, Nevada; Vol. VIII, Arizona; Vol. IX, Washington; Vol. X, Oregon; Vol. XI, California. U.S. Dept. of Commerce, National Weather Service, NOAA Atlas 2. Silver Spring, MD.

Alaska

Miller, John F. 1963. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. of Commerce, Weather Bur. Tech. Pap. No. 47. Washington, DC. 69 p.

Hawaii

Weather Bureau. 1962. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 43. Washington, DC. 60 p.

Puerto Rico and Virgin Islands

Weather Bureau. 1961. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. U.S. Dept. Commerce, Weather Bur. Tech. Pap. No. 42. Washington, DC. 94 P.

A.3 Green-Ampt Calculations

- A.3.1 Land Use Map
- A.3.2 Soil Map

ADOT HYDROLOGY DESIGN MANUAL
GREEN AND AMPT PARAMETERS

Subbasin ID	Survey	Soil Map Unit #	Map Unit Area	Percent of Subbasin (%)	Initical Content (Dry) (Volume Ratio)	Area Weighted Initial Content	Composite Initial Content (Dry)	Initial Content (Normal) (Volume Ratio)	Area Weighted Initial Content	Composite Initial Content (Normal)	Saturated Content (Volume Ratio)	Area Weighted Saturated Content	Composite Saturated Content	Suction (in)	Area Weighted Suction	Composite Suction	Conductivity (in/hr)	Area Weighted Conductivity	Composite Conductivity (in/hr)	%Natural Impreviousness	Area Weighted %Natural Impreviousness	Composite %Natural Impreviousness
OFF5	AZ669	15	208.90	3.17%	0.15	0.005		0.24	0.008		0.41	0.013		7.08	0.027		0.13	-0.028		15	0.476	
OFF5		16	413.00	6.27%	0.18	0.011		0.28	0.018		0.41	0.026		9.37	0.061		0.08	-0.069		0	0.000	
OFF5		26	464.40	7.05%	0.05	0.004		0.13	0.009		0.39	0.028		3.77	0.041		0.82	-0.006		0	0.000	
OFF5		38	41.30	0.63%	0.08	0.001		0.19	0.001		0.4	0.003		8.58	0.006		0.29	-0.003		15	0.094	
OFF5		53	171.40	2.60%	0.07	0.002		0.15	0.004		0.39	0.010		4.52	0.017		0.68	-0.004		0	0.000	
OFF5	AZ659	1	134.10	2.04%	0.08	0.002		0.17	0.003		0.4	0.008		5.2	0.015		0.39	-0.008		30	0.611	
OFF5		3	56.10	0.85%	0.08	0.001		0.15	0.001		0.4	0.003		3.27	0.004		0.71	-0.001		0	0.000	
OFF5		4	77.10	1.17%	0.2	0.002		0.33	0.004		0.44	0.005		16.48	0.014		0.07	-0.014		0	0.000	
OFF5		9	649.00	9.86%	0.21	0.021		0.35	0.035		0.44	0.043		16.65	0.120		0.05	-0.128		0	0.000	
OFF5		10	129.90	1.97%	0.25	0.005		0.38	0.007		0.47	0.009		16.3	0.024		0.03	-0.030		0	0.000	
OFF5		15	900.70	13.68%	0.08	0.011		0.16	0.022		0.4	0.055		4.04	0.083		0.45	-0.047		0	0.000	
OFF5		16	1276.00	19.38%	0.09	0.017		0.17	0.033		0.39	0.076		5.44	0.143		0.44	-0.069		0	0.000	
OFF5		17	499.40	7.59%	0.09	0.007		0.18	0.014		0.4	0.030		4.97	0.053		0.52	-0.022		0	0.000	
OFF5		19	4.60	0.07%	0.2	0.000		0.3	0.000		0.46	0.000		2.54	0.000		0.06	-0.001		0	0.000	
OFF5		20	9.80	0.15%	0.31	0.000		0.43	0.001		0.51	0.001		13.34	0.002		0.02	-0.003		0	0.000	
OFF5		23	197.60	3.00%	0.29	0.009		0.4	0.012		0.49	0.015		14.18	0.035		0.02	-0.051		0	0.000	
OFF5		31	651.70	9.90%	0.14	0.014		0.28	0.028		0.42	0.042		15.37	0.117		0.15	-0.082		0	0.000	
OFF5		33	697.60	10.60%	0.08	0.008	**0.12**	0.17	0.018	**0.22**	0.4	0.042	**0.41**	4.69	0.071	**6.8**	0.55	-0.028	**0.25**	0	0.000	**1.18**
OFF4	AZ659	1	60.30	1.18%	0.08	0.001		0.17	0.002		0.4	0.005		5.2	0.008		0.39	-0.005		30	0.354	
OFF4		3	713.80	13.98%	0.08	0.011		0.15	0.021		0.4	0.056		3.27	0.072		0.71	-0.021		0	0.000	
OFF4		4	157.60	3.09%	0.2	0.006		0.33	0.010		0.44	0.014		16.48	0.038		0.07	-0.036		0	0.000	
OFF4		10	1.60	0.03%	0.25	0.000		0.38	0.000		0.47	0.000		16.3	0.000		0.03	0.000		0	0.000	
OFF4		15	888.80	17.41%	0.08	0.014		0.16	0.028		0.4	0.070		4.04	0.106		0.45	-0.060		0	0.000	
OFF4		16	575.90	11.28%	0.09	0.010		0.17	0.019		0.39	0.044		5.44	0.083		0.44	-0.040		0	0.000	
OFF4		20	142.50	2.79%	0.31	0.009		0.43	0.012		0.51	0.014		13.34	0.031		0.02	-0.047		0	0.000	
OFF4		23	155.80	3.05%	0.29	0.009		0.4	0.012		0.49	0.015		14.18	0.035		0.02	-0.052		0	0.000	
OFF4		25	1.80	0.04%	0.11	0.000		0.22	0.000		0.39	0.000		8.42	0.000		0.17	0.000		0	0.000	
OFF4		31	1306.00	25.58%	0.14	0.036		0.28	0.072		0.42	0.107		15.37	0.304		0.15	-0.211		0	0.000	
OFF4		33	724.40	14.19%	0.08	0.011		0.17	0.024		0.4	0.057		4.69	0.095		0.55	-0.037		0	0.000	
OFF4		39	150.50	2.95%	0.1	0.003		0.23	0.007		0.41	0.012		0.55	-0.008		2	0.009		0	0.000	
OFF4		46	179.00	3.51%	0.13	0.005		0.26	0.009		0.41	0.014		14.57	0.041		0.14	-0.030		20	0.701	
OFF4		47	47.70	0.93%	0.08	0.001	**0.12**	0.16	0.001	**0.22**	0.4	0.004	**0.41**	4.04	0.006	**6.48**	0.38	-0.004	**0.29**	30	0.280	**1.34**
OFF3	AZ659	1	0.07	1.53%	0.08	0.001		0.170	0.003		0.4	0.006		5.2	0.011		0.39	-0.006		30	0.458	
OFF3		3	0.75	16.71%	0.08	0.013		0.15	0.025		0.4	0.067		3.27	0.086		0.71	-0.025		0	0.000	
OFF3		4	0.10	2.14%	0.2	0.004		0.33	0.007		0.44	0.009		16.48	0.026		0.07	-0.025		0	0.000	
OFF3		15	0.30	6.57%	0.08	0.005		0.160	0.011		0.4	0.026		4.04	0.040		0.45	-0.023		0	0.000	
OFF3		16	0.37	8.16%	0.09	0.007		0.170	0.014		0.39	0.032		5.44	0.060		0.44	-0.029		0	0.000	
OFF3		20	0.12	2.57%	0.31	0.008		0.430	0.011		0.51	0.013		13.34	0.029		0.02	-0.044		0	0.000	
OFF3		25	0.32	7.05%	0.11	0.008		0.220	0.016		0.39	0.027		8.42	0.065		0.17	-0.054		0	0.000	
OFF3		28	0.30	6.70%	0.13	0.009		0.260	0.017		0.41	0.027		14.81	0.078		0.2	-0.047		0	0.000	
OFF3		31	1.11	24.58%	0.14	0.034		0.280	0.069		0.42	0.103		15.37	0.292		0.15	-0.203		0	0.000	
OFF3		32	0.05	1.12%	0.2	0.002		0.330	0.004		0.44	0.005		16.48	0.014		0.07	-0.013		0	0.000	
OFF3	AZ669	38	0.05	1.19%	0.08	0.001		0.190	0.002		0.4	0.005		8.58	0.011		0.29	-0.006		15	0.178	
OFF3	AZ659	39	0.08	1.70%	0.1	0.002		0.230	0.004		0.41	0.007		13.62	0.019		0.17	-0.013		35	0.596	
OFF3		43	0.79	17.45%	0.09	0.016		0.170	0.030		0.4	0.070		4.13	0.107		0.52	-0.050		0	0.000	
OFF3		46	0.11	2.53%	0.13	0.003	**0.11**	0.260	0.007	**0.22**	0.41	0.010	**0.41**	14.57	0.029	**7.38**	0.14	-0.022	**0.28**	20	0.506	**1.74**
OFF2	AZ659	1	0.074	0.45%	0.08	0.000		0.170	0.001		0.4	0.002		5.2	0.003		0.39	-0.002		30	0.135	
OFF2		15	0.788	4.79%	0.08	0.004		0.160	0.008		0.4	0.019		4.04	0.029		0.45	-0.017		0	0.000	
OFF2		16	1.659	10.10%	0.09	0.009		0.170	0.017		0.39	0.039		5.44	0.074		0.44	-0.036		0	0.000	
OFF2		20	0.161	0.98%	0.31	0.003		0.430	0.004		0.51	0.005		13.34	0.011		0.02	-0.017		0	0.000	

OFF2		25	0.466	2.84%	0.11	0.003		0.220	0.006		0.39	0.011		8.42	0.026		0.17	-0.022		0	0.000	
OFF2		28	0.118	0.72%	0.13	0.001		0.260	0.002		0.41	0.003		14.81	0.008		0.2	-0.005		0	0.000	
OFF2		3	5.220	31.78%	0.08	0.025		0.15	0.048		0.4	0.127		3.27	0.164		0.71	-0.047		0	0.000	
OFF2		31	2.036	12.39%	0.14	0.017		0.280	0.035		0.42	0.052		15.37	0.147		0.15	-0.102		0	0.000	
OFF2		32	0.287	1.75%	0.2	0.003		0.330	0.006		0.44	0.008		16.48	0.021		0.07	-0.020		0	0.000	
OFF2		37	1.911	11.63%	0.14	0.016		0.26	0.030		0.41	0.048		11.6	0.124		0.09	-0.122		0	0.000	
OFF2		4	0.728	4.43%	0.2	0.009		0.33	0.015		0.44	0.020		16.48	0.054		0.07	-0.051		0	0.000	
OFF2		43	0.345	2.10%	0.09	0.002		0.170	0.004		0.4	0.008		4.13	0.013		0.52	-0.006		0	0.000	
OFF2		47	1.045	6.36%	0.08	0.005		0.16	0.010		0.4	0.025		4.04	0.039		0.38	-0.027		30	1.909	
OFF2		48	0.408	2.48%	0.06	0.001		0.15	0.004		0.4	0.010		4.06	0.015		0.84	-0.002		0	0.000	
OFF2		7	0.035	0.21%	0.11	0.000		0.2	0.000		0.39	0.001		8.12	0.002		0.21	-0.001		25	0.053	
OFF2	AZ669	15	0.240	1.46%	0.15	0.002		0.24	0.004		0.41	0.006		7.08	0.012		0.13	-0.013		15	0.219	
OFF2		16	0.157	0.95%	0.18	0.002		0.28	0.003		0.41	0.004		9.37	0.009		0.08	-0.010		0	0.000	
OFF2		26	0.439	2.67%	0.05	0.001		0.13	0.003		0.39	0.010		3.77	0.015		0.82	-0.002		0	0.000	
OFF2		38	0.089	0.54%	0.08	0.000		0.19	0.001		0.4	0.002		8.58	0.005		0.29	-0.003		15	0.081	
OFF2		44	0.006	0.04%	0.15	0.000		0.29	0.000		0.42	0.000		16.67	0.000		0.13	0.000		0	0.000	
OFF2		53	0.213	1.30%	0.07	0.001	**0.11**	0.150	0.002	**0.2**	0.39	0.005	**0.41**	4.52	0.009	**6.05**	0.68	-0.002	**0.31**	0	0.000	**2.4**
OFF1	AZ659	3	0.15	6.24%	0.08	0.005		0.15	0.009		0.4	0.025		3.27	0.032		0.71	-0.009		0	0.000	
OFF1		16	0.42	17.83%	0.09	0.016		0.170	0.030		0.39	0.070		5.44	0.131		0.44	-0.064		0	0.000	
OFF1		20	0.11	4.47%	0.31	0.014		0.430	0.019		0.51	0.023		13.34	0.050		0.02	-0.076		0	0.000	
OFF1		24	0.00	0.21%	0.21	0.000		0.35	0.001		0.45	0.001		20.61	0.003		0.04	-0.003		0	0.000	
OFF1		25	0.29	12.21%	0.11	0.013		0.220	0.027		0.39	0.048		8.42	0.113		0.17	-0.094		0	0.000	
OFF1		37	0.88	37.14%	0.14	0.052		0.26	0.097		0.41	0.152		11.6	0.395		0.09	-0.388		0	0.000	
OFF1		47	0.52	21.89%	0.08	0.018	**0.12**	0.16	0.035	**0.22**	0.4	0.088	**0.41**	4.04	0.133	**7.2**	0.38	-0.092	**0.19**	30	6.568	**6.57**

GREEN AND AMPT PARAMETERS FOR ON1

FLO2D Soil Layer

AREA SYMBOL	MUSYM	xksat (in/hr)	rockout (%)	eff (%)	soildepth (ft)
AZ659	1	0.39	30	0	0.5
	10	0.03	0	0	0.5
	15	0.45	0	0	0.5
	16	0.44	0	0	0.5
	17	0.52	0	0	0.5
	19	0.06	0	0	0.5
	20	0.02	0	0	0.5
	22	0.05	0	0	0.5
	23	0.02	0	0	0.5
	24	0.04	0	0	0.5
	25	0.17	0	0	0.5
	28	0.2	0	0	0.5
	3	0.71	0	0	0.5
	31	0.15	0	0	0.5
	32	0.07	0	0	0.5
	33	0.55	0	0	0.5
	37	0.09	0	0	0.5
	39	0.17	35	0	0.5
	4	0.07	0	0	0.5
	43	0.52	0	0	0.5
	46	0.14	20	0	0.5
	47	0.38	30	0	0.5
	48	0.84	0	0	0.5
	5	0.03	0	0	0.5
	7	0.21	25	0	0.5
	9	0.05	0	0	0.5
AZ669	15	0.13	15	0	0.5
	16	0.08	0	0	0.5
	2	0.1	20	0	0.5
	26	0.82	0	0	0.5
	38	0.29	15	0	0.5
	44	0.13	0	0	0.5
	48	0.02	0	0	0.5
	49	0.05	0	0	0.5
	53	0.68	0	0	0.5
	58	0.03	0	0	0.5
	83	0.05	0	0	0.5

FLO2D Land Use Layer

landuse_id	Description	Saturation (w/d/n)	Abstraction (in)	Imprev. Area (%)
11	Open Water	normal	0.35	0
21	Developed, Open Space	normal	0.1	0
22	Developed, Low Intensity	normal	0.1	0
23	Developed, Medium Intensity	normal	0.1	0
24	Developed, High Intensity	normal	0.1	0
31	Barren Land	dry	0.35	0
52	Shrub/Scrub	dry	0.35	0
71	Herbaceous	dry	0.35	0
81	Hay/Pasture	dry	0.35	0
82	Cultivated Crops	wet	0.5	0
90	Woody Wetlands	dry	0.35	0
95	Emergent Herbaceous Wetlands	dry	0.35	0

APPENDIX B
RAINFALL LOSS PARAMETERS

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ658	36	Why-Brios complex, 0 to 2 percent slopes	0.04	0.09	0.41	0.22	1.41	0
AZ658	37	Yahana-Indio complex, saline-sodic, 0 to 3 percent slopes	0.17	0.34	0.48	18.71	0.13	0
AZ658	38	Yahana silty clay loam, 0 to 2 percent slopes	0.21	0.38	0.49	22.63	0.08	0
AZ659	1	Akela-Rock outcrop complex, 10 to 60 percent slopes	0.08	0.17	0.4	5.2	0.39	30
AZ659	2	Antho loamy fine sand	0.03	0.09	0.42	0.71	1.9	0
AZ659	3	Casa Grande fine sandy loam	0.08	0.15	0.4	3.27	0.71	0
AZ659	4	Casa Grande clay loam	0.2	0.33	0.44	16.48	0.07	0
AZ659	5	Cashion clay	0.27	0.4	0.48	14.49	0.03	0
AZ659	6	Cellar-Rock outcrop complex, 5 to 60 percent slopes	0.08	0.16	0.4	4.04	0.45	35
AZ659	7	Cherioni-Rock outcrop complex, 5 to 60 percent slopes	0.11	0.2	0.39	8.12	0.21	25
AZ659	8	Cipriano cobbly loam, 1 to 8 percent slopes	0.12	0.25	0.4	15.77	0.11	0
AZ659	9	Contine clay loam	0.21	0.35	0.44	16.65	0.05	0
AZ659	10	Contine clay	0.25	0.38	0.47	16.3	0.03	0
AZ659	11	Coolidge sandy loam	0.05	0.14	0.41	3.25	0.94	0
AZ659	12	Cuerda fine sandy loam	0.07	0.15	0.39	3.67	0.7	0
AZ659	13	Dateland fine sandy loam	0.09	0.17	0.39	4.53	0.51	0
AZ659	14	Dateland fine sandy loam, saline	0.09	0.17	0.39	4.53	0.51	0
AZ659	15	Denure very gravelly sandy loam, 1 to 8 percent slopes	0.08	0.16	0.4	4.04	0.45	0
AZ659	16	Denure sandy loam, 1 to 3 percent slopes	0.09	0.17	0.39	5.44	0.44	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ659	17	Denure fine sandy loam, 0 to 1 percent slopes	0.09	0.18	0.4	4.97	0.52	0
AZ659	18	Denure clay loam, 0 to 1 percent slopes	0.19	0.32	0.43	16.63	0.07	0
AZ659	19	Dumps-Pits association	0.2	0.3	0.46	2.54	0.06	0
AZ659	20	Gadsden clay	0.31	0.43	0.51	13.34	0.02	0
AZ659	21	Gilman fine sandy loam	0.09	0.17	0.39	4.53	0.52	0
AZ659	22	Gilman clay loam	0.19	0.32	0.43	17.52	0.05	0
AZ659	23	Ginland clay	0.29	0.41	0.49	14.18	0.02	0
AZ659	24	Glenbar clay loam	0.21	0.35	0.45	20.61	0.04	0
AZ659	25	Gunsight-Cipriano complex, 1 to 8 percent slopes	0.11	0.22	0.39	8.42	0.17	0
AZ659	26	Gunsight-Pinamt complex, 1 to 8 percent slopes	0.13	0.22	0.39	6.45	0.15	0
AZ659	27	La Palma fine sandy loam	0.08	0.15	0.4	3.35	0.76	0
AZ659	28	Laveen loam	0.13	0.26	0.41	14.81	0.2	0
AZ659	29	Marana silty clay loam	0.18	0.36	0.45	32.12	0.04	0
AZ659	30	Mohall sandy loam	0.08	0.16	0.4	4.04	0.69	0
AZ659	31	Mohall loam	0.14	0.28	0.42	15.37	0.15	0
AZ659	32	Mohall clay loam	0.2	0.33	0.44	16.48	0.07	0
AZ659	33	Mohall-Denure association	0.08	0.17	0.4	4.69	0.55	0
AZ659	34	Momoli-Carrizo complex, 1 to 8 percent slopes	0.1	0.18	0.39	4.91	0.28	0
AZ659	35	Pajarito-Sonoita complex	0.08	0.18	0.4	6.78	0.4	0
AZ659	36	Pimer silty clay	0.27	0.41	0.52	15.04	0.06	0
AZ659	37	Pinamt-Momoli complex, 1 to 8 percent slopes	0.14	0.26	0.41	11.6	0.09	0
AZ659	38	Pits	0	0.04	0.43	0.12	2	0
AZ659	39	Quilotosa-Rock outcrop complex, 5 to 60 percent slopes	0.1	0.23	0.41	13.62	0.17	35
AZ659	40	Rositas loamy fine sand	0.01	0.07	0.41	0.55	2	0
AZ659	41	Saminiego silty clay loam	0.31	0.44	0.51	14.15	0.02	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ659	42	Sasco silt loam	0.1	0.3	0.42	34.51	0.12	0
AZ659	43	Toltec fine sandy loam	0.09	0.17	0.4	4.13	0.52	0
AZ659	44	Tremant-Denure complex*	0.14	0.25	0.41	10.78	0.13	0
AZ659	45	Trix clay loam	0.21	0.35	0.44	16.65	0.05	0
AZ659	46	Vaiva-Rock outcrop complex, 2 to 15 percent slopes	0.13	0.26	0.41	14.57	0.14	20
AZ659	47	Vaiva-Rock outcrop complex, 15 to 50 percent slopes	0.08	0.16	0.4	4.04	0.38	30
AZ659	48	Valencia sandy loam	0.06	0.15	0.4	4.06	0.84	0
AZ659	49	Why sandy loam	0.07	0.15	0.39	4.52	0.6	0
AZ659	50	Water	0.3	0.42	0.48	11.42	0.01	100
AZ661	1	Agustin-Kokan-Queencreek complex, 1 to 8 percent slopes	0.08	0.15	0.4	3.24	0.5	0
AZ661	2	Ajo-Guvo-Rock outcrop complex, 15 to 60 percent slopes	0.18	0.32	0.43	16.47	0.06	20
AZ661	3	Beardsley-Hickiwan complex, 1 to 8 percent slopes	0.19	0.32	0.43	16.34	0.06	0
AZ661	4	Beardsley-Suncity complex, 1 to 10 percent slopes	0.19	0.32	0.43	16.61	0.07	0
AZ661	5	Beaumain-Rock outcrop-Cherrycow complex, 5 to 60 percent slopes	0.19	0.32	0.46	11.44	0.09	20
AZ661	6	Bodecker soils and riverwash, 0 to 5 percent slopes	0.04	0.13	0.41	3.54	0.87	0
AZ661	7	Brewster-Rock outcrop-Woodcutter complex, 10 to 60 percent slopes	0.15	0.28	0.45	12.11	0.14	30
AZ661	8	Brunkcow-Chiricahua complex, 10 to 60 percent slopes	0.18	0.31	0.45	14.89	0.09	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ669	15	Chimenea-Cellar-Rock outcrop complex, 15 to 50 percent slopes	0.15	0.24	0.41	7.08	0.13	15
AZ669	16	Chimenea very gravelly fine sandy loam, 5 to 15 percent slopes	0.18	0.28	0.41	9.37	0.08	0
AZ669	17	Chiricahua-Lampshire complex, 5 to 15 percent slopes	0.2	0.34	0.46	14.03	0.07	0
AZ669	18	Combate gravelly loamy coarse sand, 2 to 8 percent slopes	0.05	0.11	0.45	3.6	1.34	0
AZ669	19	Comoro sandy loam, 0 to 2 percent slopes	0.05	0.14	0.44	1.39	1.37	0
AZ669	20	Cortaro-Rock outcrop-Faraway complex, 15 to 45 percent slopes	0.09	0.18	0.4	4.5	0.31	20
AZ669	21	Dateland-Denure association, 1 to 3 percent slopes	0.06	0.14	0.39	3.71	0.75	0
AZ669	22	Delnorte-Stagecoach complex, 1 to 20 percent slopes	0.07	0.15	0.4	3.9	0.45	0
AZ669	23	Deloro-Andrada complex, 5 to 35 percent slopes	0.19	0.33	0.45	14.75	0.05	0
AZ669	24	Deloro-Rock outcrop complex, 15 to 60 percent slopes	0.24	0.37	0.46	16.39	0.02	15
AZ669	25	Deloro-Schrap association, 1 to 8 percent slopes	0.21	0.34	0.44	16.17	0.03	0
AZ669	26	Denure gravelly sandy loam, 1 to 5 percent slopes	0.05	0.13	0.39	3.77	0.82	0
AZ669	27	Diaspar sandy loam, 1 to 5 percent slopes	0.09	0.17	0.4	4.56	0.45	0
AZ669	28	Far-Spudrock-Rock outcrop complex, 35 to 85 percent slopes	0.1	0.19	0.44	2.41	0.59	25

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ669	29	Glendale-Bucklebar complex, 0 to 3 percent slopes	0.11	0.25	0.42	13.32	0.21	0
AZ669	30	Glendale silt loam, 0 to 3 percent slopes	0.13	0.32	0.44	34.01	0.09	0
AZ669	31	Graham-Pantak complex, 2 to 15 percent slopes	0.26	0.39	0.48	13.21	0.03	0
AZ669	32	Graham-Pantak-Rock outcrop complex, 15 to 45 percent slopes	0.27	0.4	0.49	12.98	0.03	15
AZ669	33	Guest fine sandy loam, 0 to 1 percent slopes	0.06	0.15	0.44	1.75	1.12	0
AZ669	34	Hantz loam, 0 to 1 percent slopes	0.15	0.29	0.42	16.67	0.13	0
AZ669	35	Hayhook sandy loam, 1 to 5 percent slopes	0.08	0.16	0.4	4.04	0.71	0
AZ669	36	Hayhook-Sahuarita complex, 1 to 5 percent slopes	0.08	0.16	0.4	4.08	0.55	0
AZ669	37	Keysto extremely gravelly fine sandy loam, 2 to 8 percent slopes	0.1	0.24	0.44	10.03	0.26	0
AZ669	38	Lajitas-Delthorny-Rock outcrop complex, 25 to 60 percent slopes	0.08	0.19	0.4	8.58	0.29	15
AZ669	39	Lampshire-Pantak-Rock outcrop complex, 25 to 60 percent slopes	0.15	0.26	0.44	7.13	0.13	20
AZ669	40	Lampshire-Romero-Rock outcrop complex, 10 to 65 percent slopes	0.1	0.22	0.42	8.6	0.27	15
AZ669	41	Lehmans-Delthorny-Lajitas complex, 15 to 50 percent slopes	0.13	0.25	0.42	10.13	0.12	0
AZ669	42	Mabray-Deloro-Rock outcrop complex, 20 to 65 percent slopes	0.17	0.31	0.45	13.09	0.08	15
AZ669	43	Mohall gravelly fine sandy loam, 1 to 5 percent slopes	0.11	0.19	0.4	4.74	0.34	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ669	44	Mohall loam, 0 to 2 percent slopes	0.15	0.29	0.42	16.67	0.13	0
AZ669	45	Mohall-Pahaka complex, 1 to 3 percent slopes	0.07	0.15	0.4	4.09	0.68	0
AZ669	46	Mohall-Trix complex, 0 to 1 percent slopes	0.08	0.17	0.4	4.73	0.62	0
AZ669	47	Mohave soils and urban land, 1 to 8 percent slopes	0.1	0.21	0.4	6.84	0.32	0
AZ669	48	Nahda-Pinaleno complex, 2 to 8 percent slopes	0.22	0.33	0.43	13.67	0.02	0
AZ669	49	Nahda-Stagecoach complex, 1 to 15 percent slopes	0.17	0.28	0.43	9.03	0.05	0
AZ669	50	Nahda very cobbly loam, 2 to 8 percent slopes	0.1	0.23	0.39	14.87	0.17	0
AZ669	51	Nolam-Tombstone complex, 8 to 30 percent slopes	0.15	0.27	0.42	11	0.11	0
AZ669	52	Oracle-Romero-Rock outcrop complex, 5 to 35 percent slopes	0.15	0.26	0.43	8.77	0.15	20
AZ669	53	Pahaka fine sandy loam, 1 to 5 percent slopes	0.07	0.15	0.39	4.52	0.68	0
AZ669	54	Palos Verdes-Jaynes complex, 2 to 8 percent slopes	0.07	0.15	0.4	4.27	0.6	0
AZ669	55	Palos Verdes-Sahuarita complex, 2 to 8 percent slopes	0.08	0.16	0.4	4.09	0.5	0
AZ669	56	Pantak-Deloro complex, 8 to 35 percent slopes	0.22	0.36	0.46	14.79	0.03	0
AZ669	57	Pantak-Rock outcrop complex, 25 to 50 percent slopes	0.22	0.35	0.46	14.2	0.04	20
AZ669	58	Pantano-Granolite complex, 5 to 25 percent slopes	0.19	0.31	0.42	13.73	0.03	0
AZ669	59	Pantano-Rock outcrop complex, 25 to 60 percent slopes	0.14	0.27	0.41	16.28	0.08	25

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ669	60	Pinaleno-Stagecoach complex, 5 to 16 percent slopes	0.13	0.22	0.4	6.57	0.15	0
AZ669	61	Pinaleno-Stagecoach-Palos Verdes complex, 10 to 35 percent slopes	0.11	0.2	0.4	5.89	0.21	0
AZ669	62	Pinaleno very cobbly sandy loam, 1 to 8 percent slopes	0.17	0.27	0.4	10.06	0.06	0
AZ669	63	Pinamt-Momoli complex, 1 to 10 percent slopes	0.12	0.21	0.4	6.77	0.16	0
AZ669	64	Pits, dumps	0.14	0.22	0.45	1.01	0.17	0
AZ669	65	Powerline-Kimrose family complex, 10 to 35 percent slopes	0.1	0.21	0.43	6.28	0.3	0
AZ669	66	Redington very gravelly fine sand, 3 to 50 percent slopes	0.02	0.05	0.42	3	1.6	0
AZ669	67	Redo very gravelly sand, 15 to 50 percent slopes	0.03	0.06	0.43	3.57	1.35	0
AZ669	68	Riveroad and Comoro soils, 0 to 2 percent slopes	0.13	0.25	0.47	4.32	0.42	0
AZ669	69	Romero-Lampshire-Rock outcrop complex, 15 to 65 percent slopes	0.1	0.19	0.42	4.26	0.34	30
AZ669	70	Romero-Oracle complex, 25 to 60 percent slopes	0.13	0.24	0.43	7.23	0.18	0
AZ669	71	Saguaro-Rock outcrop complex, 15 to 45 percent slopes	0.07	0.15	0.39	4.52	0.36	30
AZ669	72	Sahuarita soils, mohave soils and urban land, 1 to 5 percent slopes	0.1	0.2	0.4	5.78	0.34	0
AZ669	73	Sasabe-Caralampi complex, 1 to 15 percent slopes	0.13	0.23	0.41	8.49	0.18	0
AZ669	74	Schrap very channery loam, 5 to 30 percent slopes	0.15	0.28	0.42	15.76	0.08	0
AZ669	75	Spudrock-Boriana complex, 10 to 35 percent slopes	0.09	0.18	0.44	2.85	0.5	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ669	76	Spudrock-Far-Rock outcrop complex, 25 to 65 percent slopes	0.1	0.18	0.44	2.68	0.5	15
AZ669	77	Spudrock-Lemmon complex, 15 to 45 percent slopes	0.11	0.22	0.43	5.92	0.27	0
AZ669	78	Stagecoach-Sahuarita association, 1 to 8 percent slopes	0.08	0.16	0.4	4.07	0.42	0
AZ669	79	Tombstone very gravelly loam, 15 to 50 percent slopes	0.13	0.26	0.43	12.81	0.16	0
AZ669	80	Tubac complex, 0 to 2 percent slopes	0.12	0.25	0.4	15.77	0.16	0
AZ669	81	Tubac gravelly loam, 1 to 8 percent slopes	0.12	0.25	0.4	15.77	0.16	0
AZ669	82	Tubac sandy loam, 0 to 2 percent slopes	0.12	0.25	0.4	15.77	0.16	0
AZ669	83	Vecont clay loam, 0 to 1 percent slopes	0.21	0.35	0.44	16.65	0.05	0
AZ669	84	White House-Caralampi complex, 5 to 25 percent slopes	0.21	0.34	0.44	16.22	0.04	0
AZ669	85	White House gravelly loam, 1 to 8 percent slopes	0.29	0.41	0.49	13.79	0.02	0
AZ669	86	Yaqui fine sandy loam, 1 to 3 percent slopes	0.08	0.15	0.4	3.27	0.73	0
AZ669	87	Water	0.3	0.42	0.48	11.42	0.01	100
AZ671	1	Altar-Mallet complex, 0 to 8 percent slopes	0.06	0.15	0.41	3.82	0.88	0
AZ671	2	Anthony-Maricopa complex, 0 to 5 percent slopes	0.07	0.15	0.4	4.76	0.68	0
AZ671	3	Arizo family-Riverwash complex, 0 to 3 percent slopes	0.02	0.07	0.41	3.29	1.5	0
AZ671	4	Ashcreek-Stanford complex, 0 to 10 percent slopes	0.22	0.34	0.45	10.92	0.07	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ701	174	Yumtheska-Rock outcrop complex, 15 to 45 percent slopes	0.15	0.32	0.5	12.43	0.18	25
AZ701	175	Yumtheska-Toqui-Rock outcrop complex, 2 to 8 percent slopes	0.15	0.27	0.45	7.49	0.19	15
AZ701	176	Yumtheska-Toqui-Rock outcrop complex, 15 to 40 percent slopes	0.17	0.3	0.46	11.49	0.12	15
AZ701	177	Zibate family, 2 to 8 percent slopes	0.18	0.32	0.42	18.23	0.04	0
AZ703	1	Ajo-Pinamt, deep, complex, 3 to 15 percent slopes	0.12	0.21	0.4	6.71	0.18	0
AZ703	2	Anklam-Cellar-Rock outcrop complex, 15 to 55 percent slopes	0.12	0.21	0.4	6.28	0.18	20
AZ703	3	Anklam very gravelly sandy loam, 3 to 15 percent slopes	0.06	0.15	0.4	4.06	0.5	0
AZ703	4	Arizo-Riverwash complex, 0 to 3 percent slopes	0.03	0.09	0.4	0.72	1.36	0
AZ703	5	Baboquivari-Combate complex, 1 to 8 percent slopes	0.06	0.14	0.44	3	1.01	0
AZ703	6	Bucklebar-Hayhook-Tubac complex, 0 to 3 percent slopes	0.09	0.18	0.4	4.63	0.53	0
AZ703	7	Caralampi-Selevin-Kimrose complex, 5 to 50 percent slopes	0.2	0.31	0.43	9.5	0.04	0
AZ703	8	Casa Grande-Kamato complex, 0 to 1 percent slopes	0.13	0.25	0.41	12.75	0.19	0
AZ703	9	Casa Grande-Rositas-Valencia complex, 0 to 5 percent slopes	0.08	0.16	0.4	3.18	0.61	0
AZ703	10	Cellar-Lampshire-Rock outcrop complex, 15 to 60 percent slopes	0.08	0.17	0.41	3.93	0.44	25

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ703	11	Chiricahua-Lampshire complex, 15 to 45 percent slopes	0.11	0.22	0.42	8.4	0.22	0
AZ703	12	Chuichu-Rock outcrop complex, 15 to 45 percent slopes	0.14	0.27	0.42	15.43	0.1	25
AZ703	13	Chutum loam, 1 to 3 percent slopes	0.19	0.32	0.43	16.63	0.07	0
AZ703	14	Combate gravelly loamy coarse sand, 2 to 8 percent slopes	0.04	0.11	0.45	3.23	1.48	0
AZ703	15	Dateland-Denure association, 1 to 3 percent slopes	0.08	0.15	0.39	4.01	0.58	0
AZ703	16	Delnorte-Stagecoach complex, 1 to 20 percent slopes	0.09	0.2	0.4	8.43	0.27	0
AZ703	17	Delthorny-Caracara complex, 3 to 25 percent slopes	0.11	0.2	0.4	5.69	0.23	0
AZ703	18	Delthorny-Garzona-Rock outcrop complex, 15 to 60 percent slopes	0.1	0.23	0.41	13.57	0.17	20
AZ703	19	Denure-Momoli complex, 1 to 5 percent slopes	0.08	0.16	0.4	4.49	0.37	0
AZ703	20	Denure-Pahaka complex, 1 to 3 percent slopes	0.08	0.17	0.39	5.34	0.5	0
AZ703	21	Dixaleta-Rock outcrop complex, 15 to 70 percent slopes	0.09	0.18	0.4	4.97	0.29	30
AZ703	22	Far-Spudrock-Rock outcrop complex, 35 to 85 percent slopes	0.09	0.18	0.45	2.32	0.64	25
AZ703	23	Gachado-Lomitas-Rock outcrop complex, 15 to 45 percent slopes	0.09	0.22	0.39	14.68	0.16	15
AZ703	24	Gadsden silty clay loam, 0 to 1 percent slopes	0.18	0.34	0.45	24.45	0.07	0

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ703	25	Gilman very fine sandy loam, 0 to 1 percent slopes	0.09	0.25	0.39	24.16	0.19	0
AZ703	26	Ginland silty clay, 0 to 1 percent slopes	0.28	0.42	0.52	13.77	0.05	0
AZ703	27	Glenbar loam, 0 to 1 percent slopes	0.15	0.29	0.41	20.07	0.1	0
AZ703	28	Glendale clay loam, 0 to 2 percent slopes, flooded	0.2	0.34	0.45	19.83	0.06	0
AZ703	29	Glendale silt loam, 1 to 3 percent slopes	0.13	0.32	0.44	34.01	0.09	0
AZ703	30	Glendale-Pajarito complex, 1 to 3 percent slopes	0.11	0.26	0.42	14.56	0.18	0
AZ703	31	Grabe-Vado complex, 1 to 5 percent slopes	0.09	0.19	0.4	7.77	0.39	0
AZ703	32	Granolite-Rock outcrop complex, 15 to 65 percent slopes	0.25	0.38	0.47	16.3	0.02	30
AZ703	33	Gunsight-Rillito complex, 1 to 8 percent slopes	0.08	0.17	0.39	5.12	0.32	0
AZ703	34	Hantz clay loam, 0 to 1 percent slopes	0.21	0.35	0.44	16.65	0.04	0
AZ703	35	Hayhook sandy loam, 1 to 5 percent slopes	0.09	0.17	0.4	4.56	0.57	0
AZ703	36	Hickiwan-Gunsight-Momoli complex, 3 to 15 percent slopes	0.09	0.17	0.39	5.4	0.3	0
AZ703	37	Hyder-Rock outcrop-Guvo complex, 10 to 45 percent slopes	0.1	0.23	0.4	14.09	0.17	25
AZ703	38	Keysto-Riverwash complex, 0 to 5 percent slopes	0.07	0.16	0.43	2.96	0.69	0
AZ703	39	Kohatk-Rock outcrop complex, 10 to 45 percent slopes	0.09	0.22	0.4	13.07	0.24	25
AZ703	40	Lajitas-Bosa-Rock outcrop complex, 15 to 50 percent slopes	0.12	0.23	0.41	8.12	0.15	25

Table B-4 Recommended Green and Ampt Values

NRCS Soil Survey	MUSYM	Name	Initial Content (volume ratio)		Saturated Content (volume ratio)	Suction (in)	Conductivity (in/hr)	Natural Imp. %
			Wilting Point (dry)	Field Capacity (normal)				
AZ703	41	Lampshire-Pantak-Rock outcrop complex, 25 to 60 percent slopes	0.1	0.18	0.42	3.58	0.39	20
AZ703	42	Mohall loam, 0 to 2 percent slopes	0.16	0.3	0.42	16.9	0.11	0
AZ703	43	Mohall-Pahaka complex, 1 to 3 percent slopes	0.07	0.15	0.4	4.09	0.68	0
AZ703	44	Mohall-Trix complex, 0 to 1 percent slopes	0.08	0.17	0.4	4.73	0.61	0
AZ703	45	Nahda-Stagecoach complex, 1 to 15 percent slopes	0.17	0.27	0.41	7.76	0.05	0
AZ703	46	Oracle-Romero-Rock outcrop complex, 5 to 35 percent slopes	0.1	0.19	0.42	4.26	0.42	10
AZ703	47	Pajarito-Sahuarita complex, 1 to 3 percent slopes	0.06	0.15	0.39	4.48	0.75	0
AZ703	48	Pantano-Granolite complex, 5 to 25 percent slopes	0.16	0.25	0.41	7.44	0.07	0
AZ703	49	Pinamt-Momoli complex, 1 to 10 percent slopes	0.12	0.21	0.39	6.91	0.16	0
AZ703	50	Quilotosa extremely gravelly coarse sandy loam, 3 to 15 percent slopes	0.06	0.15	0.4	3.78	0.45	0
AZ703	51	Quilotosa-Rock outcrop-Vaiva complex, 15 to 45 percent slopes	0.1	0.2	0.4	5.75	0.23	30
AZ703	52	Romero-Lampshire-Rock outcrop complex, 15 to 65 percent slopes	0.1	0.19	0.42	4.26	0.37	30
AZ703	53	Romero-Rock outcrop complex, 10 to 40 percent slopes	0.08	0.17	0.41	4.34	0.38	25
AZ703	54	Rositas loamy fine sand, 2 to 5 percent slopes	0.03	0.09	0.4	1.17	1.6	0
AZ703	55	Sasco loam, 0 to 1 percent slopes	0.11	0.25	0.41	15.12	0.23	0

ADOT HYDROLOGY DESIGN MANUAL

SURFACE RETENTION LOSS & INITIAL STORAGE

Subbasin ID	Land Use	Area	Max Storage	Initial Srorage	Composite Max Storage	Composite Initial Storage
		(sq mi)	(in)	(%)	(in)	(%)
OFF1	Natural	2.38	0.35	0	**0.35**	**0**
OFF2	Natural	61.72	0.35	0	**0.35**	**0**
OFF3	Natural	4.19	0.35	0		
	Agricultural	0.36	0.50	100	**0.36**	**7.91**
OFF4	Natural	6.88	0.35	0		
	Agricultural	1.10	0.50	100	**0.37**	**13.79**
OFF5	Natural	8.99	0.35	0		
	Agricultural	1.29	0.50	100	**0.37**	**12.54**

ARIZONA DEPARTMENT OF TRANSPORTATION

Highway Drainage Design Manual



Volume 2

Hydrology

Second Edition, 2014

ADOT
Intermodal Transportation

significant and separable from surface depression losses, the "Canopy Method" may also be applicable. These circumstances might include heavily forested areas where significant tree canopy captures additional rainfall preventing it from reaching the ground. Separating the two types of initial losses may be necessary for continuous modeling or forensic modeling of storms with multiple rainfall bursts and periods of little or no rainfall in between. In these cases, HEC-HMS is able to drain the surface depression storage during a simulation and make it available again for subsequent rainfall losses as compared to interception (canopy) losses that are filled only once in a single simulation.

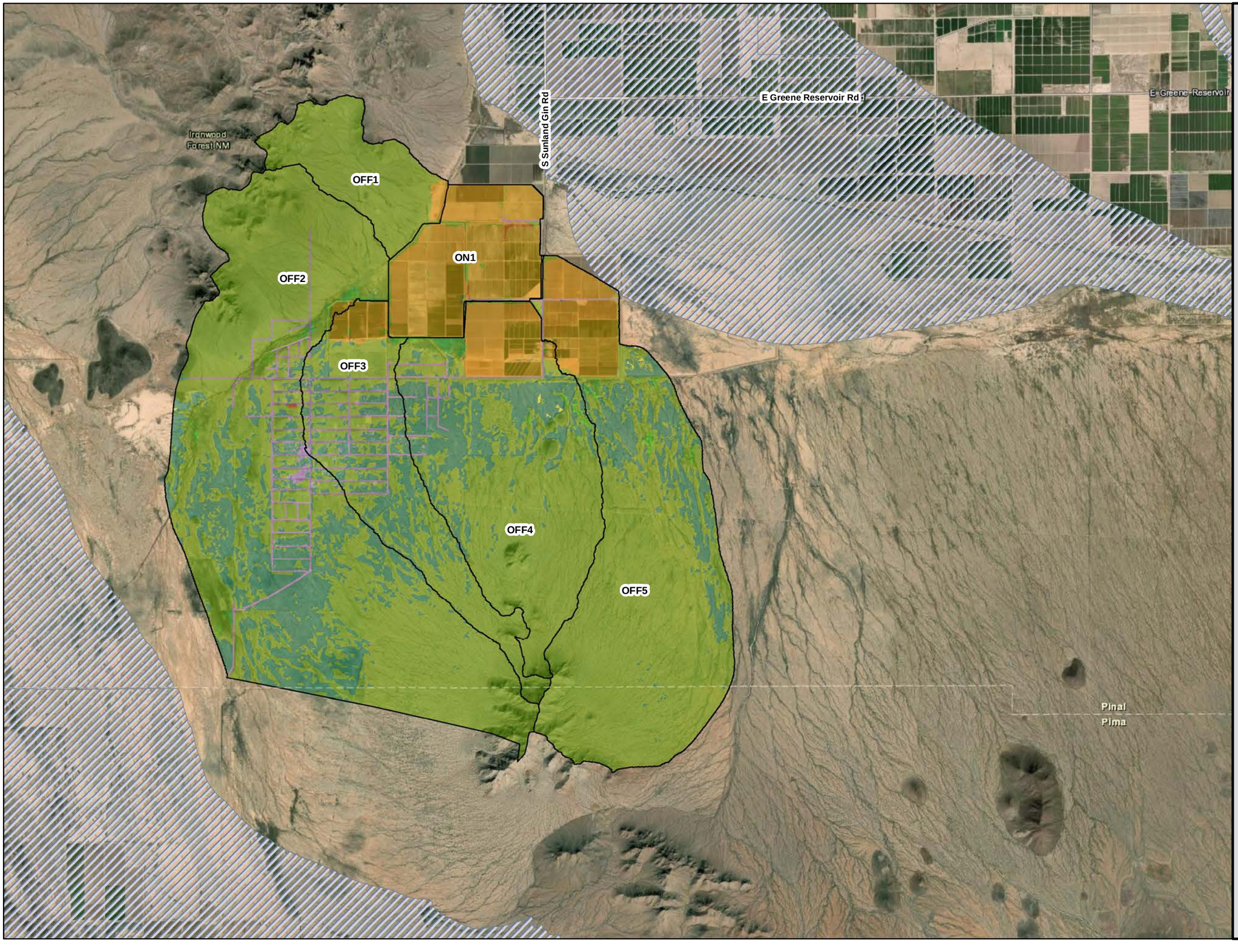
The "Initial Storage (%)" will generally be taken as zero (0) percent for drainage design applications. For saturated soil conditions such as agricultural fields, the initial storage should be set at 100 percent.

Surface loss parameters for use with this manual are provided in Table 3–1. Additional sources can be found in Table 6-1 in USACE EM 1110-2-1417 (USACE, 1996), Table 7.7 in the Drainage Design Manual for Mohave County (MCFCD, 2009), and Table 4.2 in Drainage Design Manual for Maricopa County, Hydrology (FCDMC, 2013).

Table 3–1 Surface Retention Loss (Max Storage) for Various Land Surfaces in Arizona.

Land-use and/or Surface Cover	Surface Retention Loss (Max Storage), inches
Natural	
Desert and rangeland, flat slopes	0.35
Desert and rangeland, hill slopes	0.15
Mountain, with vegetated surface	0.25
Developed (Residential and Commercial)	
Lawn and turf	0.20
Desert landscape	0.10
Pavement	0.05
Agricultural	
Tilled fields and irrigated pasture	0.50

A.3.1 Land Use Map



enel Green Power

Sonak Solar

Legend

- Drainage Basin
- Zone A Flood Zone

Land Use

- Barren Land
- Cultivated Crops
- Developed, Open Space
- Developed, Low Intensity
- Developed. Medium Intensity
- Developed, High Intensity
- Emergent Herbaceous Wetlands
- Hay/Pasture
- Herbaceous
- Open Water
- Shrub/Scrub
- Woody Wetlands

N

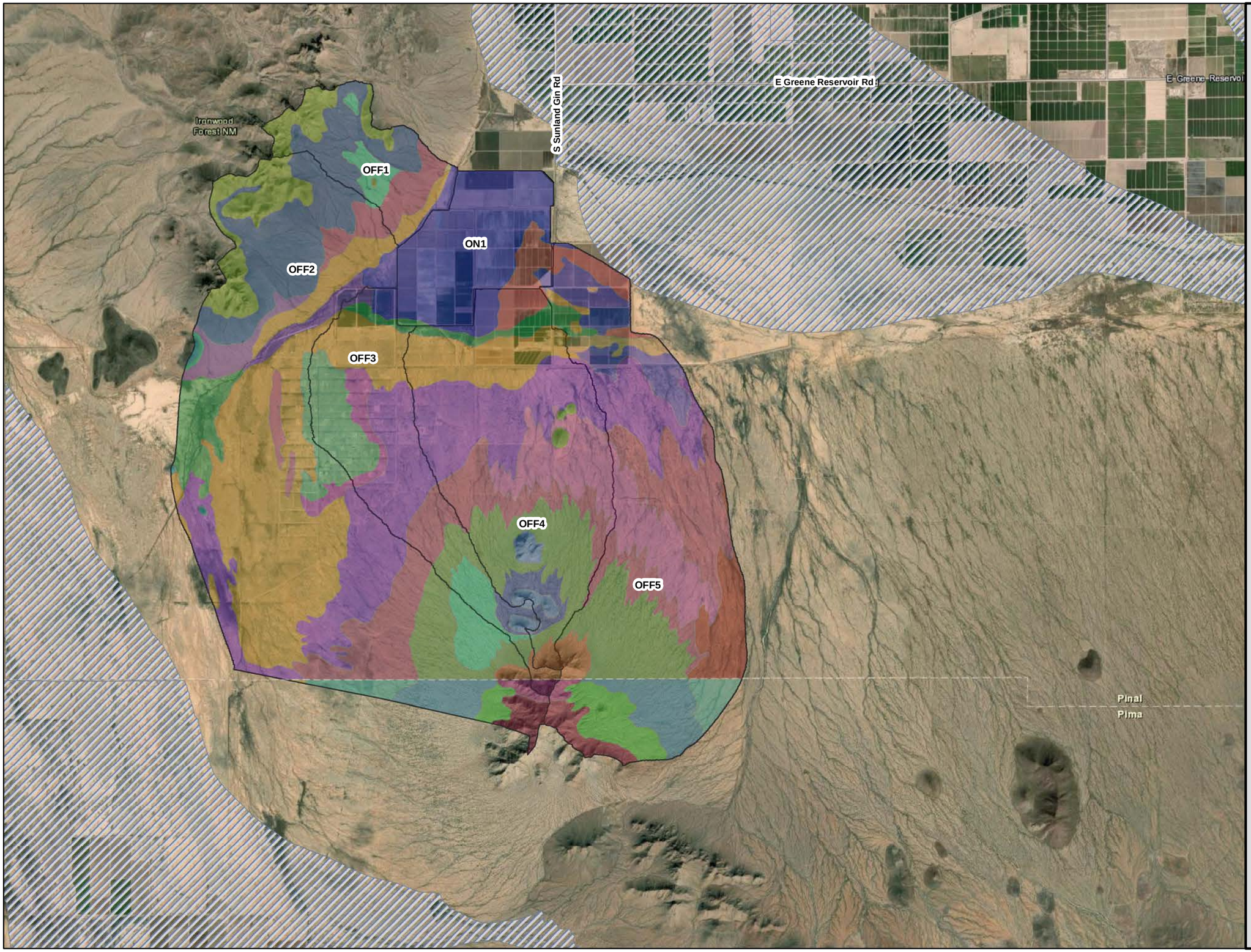
0 0.5 1 2

Miles

WSP

Land Use Map
Figure A.3.1

A.3.2 Soil Map



enel Green Power

Sonak Solar

Legend

- Drainage Basin
- Zone A Flood Zone

Soil Group

- 1, AZ659
- 10, AZ659
- 15, AZ659
- 15, AZ669
- 16, AZ659
- 16, AZ669
- 17, AZ659
- 19, AZ659
- 2, AZ669
- 20, AZ659
- 23, AZ659
- 24, AZ659
- 25, AZ659
- 26, AZ669
- 28, AZ659
- 3, AZ659
- 31, AZ659
- 32, AZ659
- 33, AZ659
- 37, AZ659
- 38, AZ669
- 39, AZ659
- 4, AZ659
- 43, AZ659
- 44, AZ669
- 46, AZ659
- 47, AZ659
- 48, AZ659
- 5, AZ659
- 53, AZ669
- 58, AZ669
- 7, AZ659
- 9, AZ659

N

0 0.5 1 2

Miles

WSP

Soil Map
Figure A.3.2

A.4 FLO-2D MANNING'S N VALUES

4.2 Overland Flow

The simplest FLO-2D model is overland flow on an alluvial fan or floodplain. Typical overland flow as reflects the water surface elevation, roughness and 8-direction flow path. The floodplain element attributes can be modified to add detail to the predicted area of inundation. The grid element surface storage area or flow path can be adjusted for buildings or other obstructions. Using the area reduction factors (ARFs), a grid element can be completely removed from receiving any inflow. Any of the eight flow directions can be partially or completely blocked to represent flow obstruction. The area of inundation can also be affected by levees, channel breakout flows, flow constriction at bridges and culverts, or street flow in urban areas. Rainfall and infiltration losses can add or subtract from the flow volume on the floodplain surface. These overland flow components are shown in a computational flow chart in Figure 20.

Overland flow velocities and depths vary with topography and the grid element roughness. Spatial variation in floodplain roughness can be assigned through the GDS pre-processor program. The assignment of overland flow roughness must account for vegetation, surface irregularity, non-uniform and unsteady flow. It is also a function of flow depth. Typical overland flow roughness values (Manning's n coefficients) are shown in Table 3.

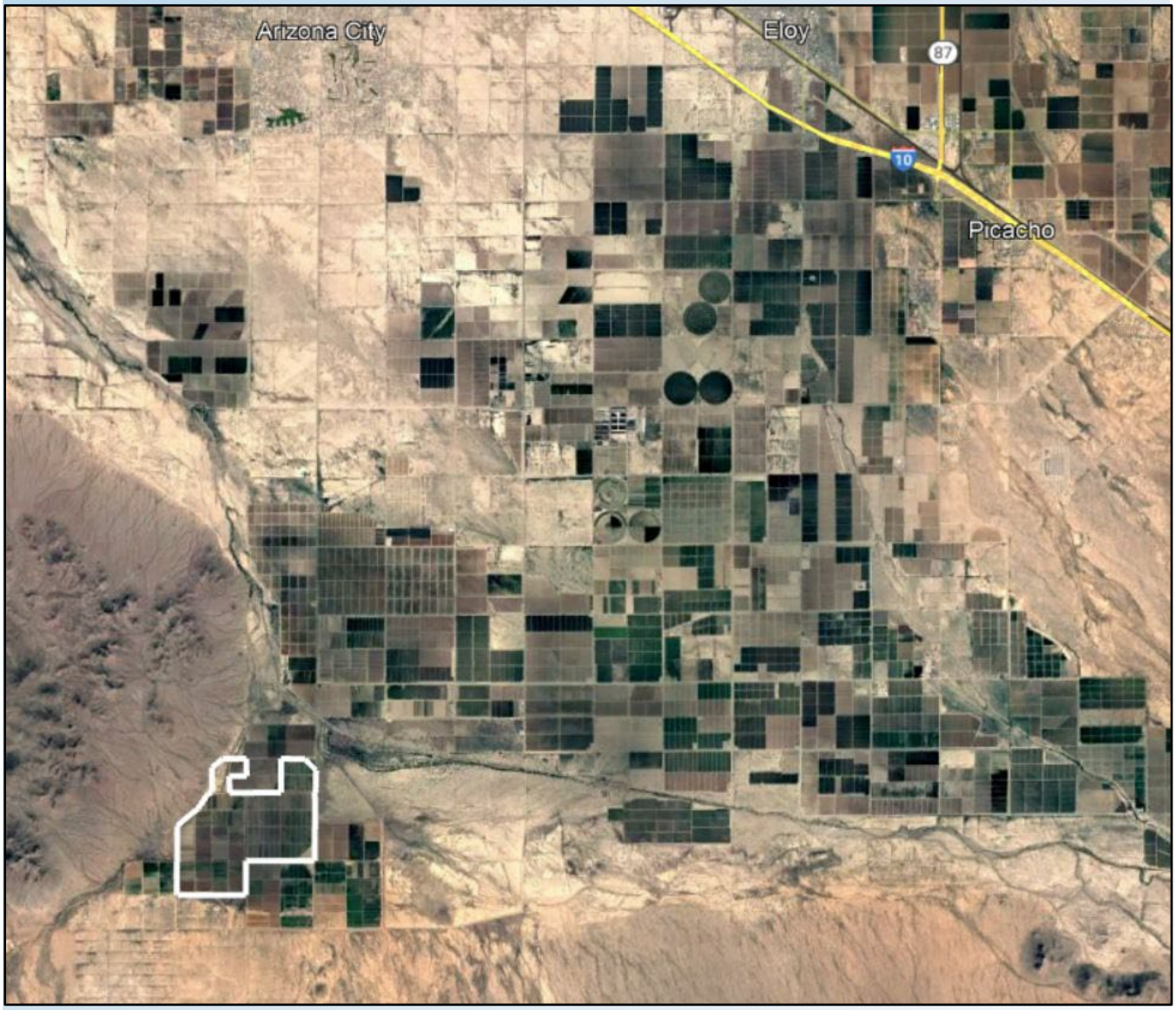
Table 3. Overland Flow Manning's n Roughness Values[1]

Surface	n-value
Dense turf	0.17 - 0.80
Bermuda and dense grass, dense vegetation	0.17 - 0.48
Shrubs and forest litter, pasture	0.30 - 0.40
Average grass cover	0.20 - 0.40
Poor grass cover on rough surface	0.20 - 0.30
Short prairie grass	0.10 - 0.20
Sparse vegetation	0.05 - 0.13
Sparse rangeland with debris	
0% cover	0.09 - 0.34
20 % cover	0.05 - 0.25
Plowed or tilled fields	
Fallow - no residue	0.008 - 0.012
Conventional tillage	0.06 - 0.22
Chisel plow	0.06 - 0.16
Fall disking	0.30 - 0.50
No till - no residue	0.04 - 0.10
No till (20 - 40% residue cover)	0.07 - 0.17
No till (60 - 100% residue cover)	0.17 - 0.47
Open ground with debris	0.10 - 0.20
Shallow glow on asphalt or concrete (0.25" to 1.0")	0.10 - 0.15
Fallow fields	0.08 - 0.12
Open ground, no debris	0.04 - 0.10
Asphalt or concrete	0.02 - 0.05

[1]Adapted from COE, HEC-1 Manual, 1990 and the COE, Technical Engineering and Design Guide, No. 19, 1997 with modifications.

SONAK SOLAR PROJECT

TRANSPORTATION STUDY



WSP PROJECT NO.: 31300042.K00
DATE: AUGUST 2023

FINAL

WSP
1700 MARKET STREET., SUITE 1050
PHILADELPHIA, PA 19103
PHONE: +1 215-209-1200
WSP.COM

APPROVED BY PINAL COUNTY:

PINAL COUNTY CASE NO.: Z-PA-157-22

SIGNATURES

PREPARED BY



Will Cowan, PE, PTOE
Traffic Engineer, WSP
Transportation

REVIEWED BY



Scott E. Thompson, PE, ENV SP
Manager, Business Development
Renewable Energy Services

WSP USA
One Penn Plaza, 4th Floor
New York, New York, 10119

This report was prepared by WSP, in accordance with the professional services agreement. The disclosure of any information contained in this report is the sole responsibility of the intended recipient. The material in it reflects WSP's best judgement in light of the information available to it at the time of preparation. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This limitations statement is considered part of this report.

The original of the technology-based document sent herewith has been authenticated and will be retained by WSP for a minimum of ten years. Since the file transmitted is now out of WSP's control and its integrity can no longer be ensured, no guarantee may be given with regards to any modifications made to this document.

TABLE OF CONTENTS

PROJECT OVERVIEW 1

SONAK SITE 1

PURPOSE 1

1. VEHICULAR GENERATION AND CONFIGURATIONS 4

DAILY TRIP GENERATION VEHICLE DATA 4

TRAILER DIMENSIONS AND CONFIGURATION 7

2. PROJECT SITE DATA 9

Pinal County, AZ 9

PRE-CONSTRUCTION SITE CHARACTERISTICS 11

3. TRANSPORTATION STRATEGY 13

OVERVIEW 13

TRUCK ROUTING 13

STANDARD VEHICLE ROUTING 14

PARKING AND DRIVEWAY ACCESS 14

4. ENVIRONMENTAL 15

WEATHER 15

FUGITIVE DUST 15

5. ROAD IMPROVEMENTS ON SITE 16

6. ROAD IMPROVEMENTS OFF SITE 17

7. TRAFFIC COUNTS 18

8. SUMMARY 19

APPENDIX 21

A-1. PICTURES 21

A-2. TRAFFIC DATA 22

A-3. DRIVEWAY AND INTERSECTION DISTANCES 23

TABLES

TABLE 1: VEHICLE TRIP GENERATION SUMMARY 5

TABLE 2: ESTIMATED WEIGHTS AND DIMENSIONS (MPT TRAILER CONFIGURATION) 8

FIGURES

FIGURE 1: REGIONAL ROUTING 2
FIGURE 2: SITE PARCEL ROUTING 3
FIGURE 3: MPT TRAILER CONFIGURATION 8
FIGURE 4: DAILY TEMPERATURE DATA, ROBSON RANCH, AZ (SOURCE: NWS) 10
FIGURE 5: ACCUMULATED PRECIPITATION, ROBSON RANCH, AZ (SOURCE: NWS) 10

PROJECT OVERVIEW

SONAK SITE

Remote Assessment: October 2022

PURPOSE

Sonak Solar Project, LLC is proposing to construct a 323 megawatt alternating current (MWac)/367 megawatt direct current (MWdc) interconnecting solar energy generation facility with a 162 MW Battery Electric Storage System (BESS), referred to as the Sonak Solar Project (the Solar Facility or Project), in Pinal County, Arizona (for regional access to the site location, see Figure 1, for parcel location and site access, see Figure 2). The proposed Solar Facility is located on several contiguous property parcels located off Sunland Gin Road between Pearce Road and W. Kinley Road 12.5 miles southwest of the Picacho exit on interstate I-10. The proposed Solar Facility covers approximately 1,866.6 acres on various groupings of parcels. The Project includes the solar PV array, an electrical collector system, a main power substation/transformer, BESS, and associated infrastructure improvements.

Construction is anticipated to begin approximately in December 2024 and be completed by around December 2025.

WSP was hired to perform a desktop transportation permit study for the Sonak Solar Project. This study is intended to provide transportation information for the Pinal County permit requirements. This document is provided as a reference document only.

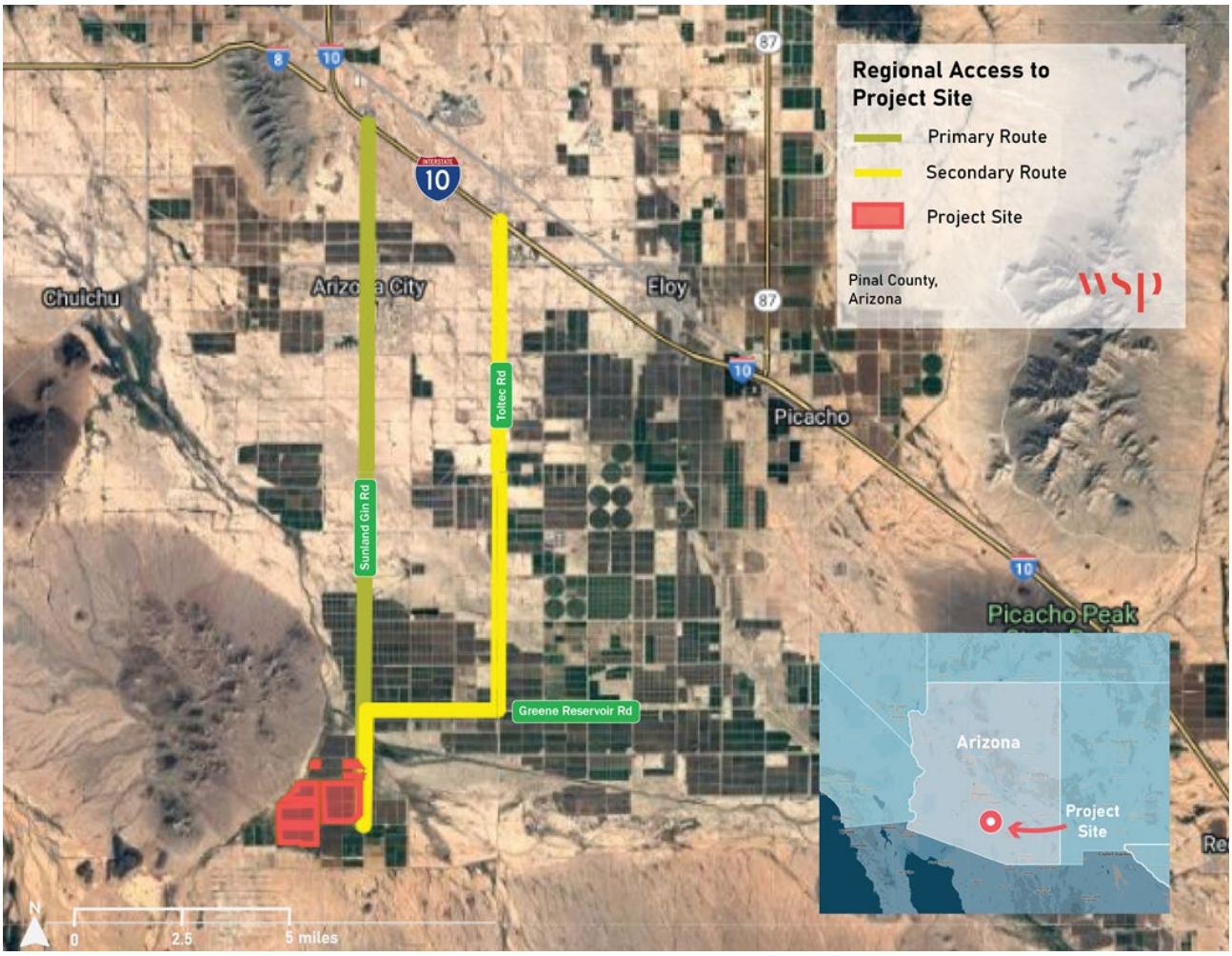


Figure 1: Regional Routing

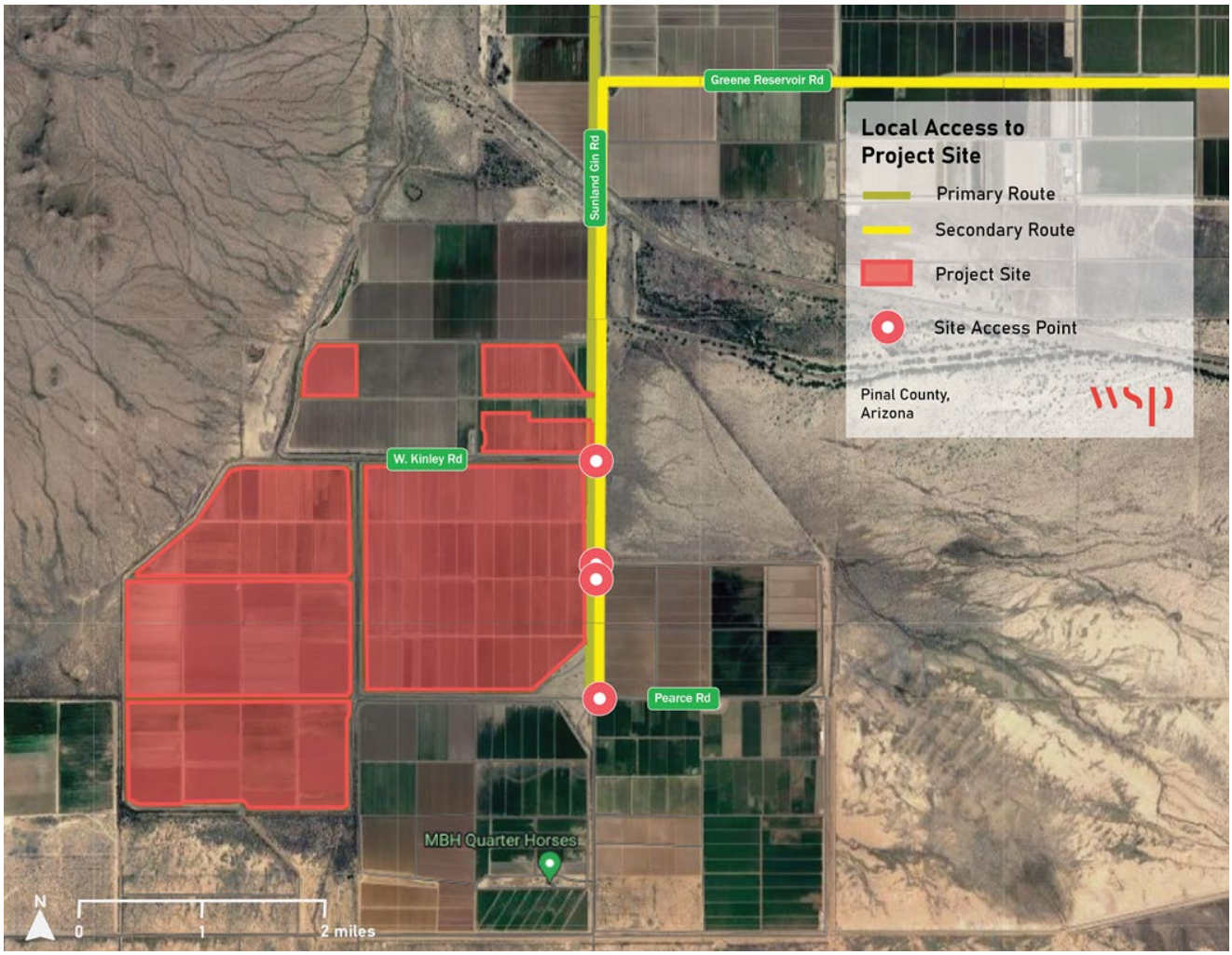


Figure 2: Site Parcel Routing

1. VEHICULAR GENERATION AND CONFIGURATIONS

DAILY TRIP GENERATION VEHICLE DATA

Traffic generation from the Solar Facility initially occurs in two phases. The first and most intensive is the construction phase while the second is the maintenance and operations phase. During the construction phase, vehicle trips will occur to prepare and clear the various parcels, construct the foundations and supporting infrastructure, and to supply and clear the site of the required construction materials and debris. Following construction, the operations move into a standard generation support type operation. While trip generation estimates are typically prepared using the Trip Generation Manual, published by the Institute of Transportation Engineers, solar facilities are not included as an option. Accordingly, trip estimates were based on information provided by the client, other similar projects, and engineering judgement. Since the operations of a solar energy center are relatively passive, only a minimal number of vehicular trips to and from the site are anticipated once normal generation operation commences. A decommissioning of the site to remove the solar panels and related equipment would occur at the end of the Project's design life in approximately 25 to 35 years. A summary of the anticipated traffic generated in the two phases for the Solar Facility is indicated in Table 1.

Vehicle Trip Generation Summary					
Project Phase	**Duration**	**Vehicle Type**	**Estimated Gross Vehicular Weight**	**Vehicles per Day**	**Maximum and Average Trips Per Vehicle per Day**
Construction					
Site Preparation / Clearing & Grubbing	10-15 Weeks	Passenger Vehicles	2,000 - 10,000 lbs.	10 cars/day	Max-6 / Ave-4
		Equipment Hauling Trucks	20,000 - 40,000 lbs.	8 trucks/day	Max-20 / Ave-16
Solar Facility Installation	35-40 weeks	Passenger Vehicles	2,000 - 10,000 lbs.	200 cars/day	Max-6 / Ave-4
		Connex and Delivery Trucks	30,000 - 80,000 lbs.	6 trucks/day	Max-2 / Ave-1
		Equipment Hauling Trucks	20,000 - 40,000 lbs.	8 trucks/day	Max-10 / Ave-6

		Fuel Truck	20,000 - 30,000 lbs.	1 truck/day	Max-1 / Ave-1
		Material Delivery Truck	20,000 - 30,000 lbs.	15 trucks/day	Max-2 / Ave-1
		Main Power Transformer Trailer	265,000lbs.	1 truck	1 Delivery
		O&M Building	80-000-150,000 lbs.	1 truck	1 Delivery
Maintenance & Operation					
Daily Operations	Weekdays	Utility Vehicle	2,000 - 10,000 lbs.	6 veh./day	Max-6 / Ave-4
Decommissioning					
Solar Facility Removal	30-35 Weeks	Passenger Vehicles	2,000 - 10,000 lbs.	200 cars/day	Max-6 / Ave-4
		Equipment Hauling Trucks	20,000 - 40,000 lbs.	5 trucks/day	Max-2 / Ave-1
		Connex and Delivery Trucks	30,000 - 80,000 lbs.	6 trucks/day	Max-4 / Ave-2
		Refuse/Recycling Trucks	30,000 - 80,000 lbs.	4 trucks/day	Max-10 / Ave-6

Table 1: Vehicle Trip Generation Summary

Construction Traffic Trip Generation

The majority of traffic generated as a result of the Solar Facility construction shall occur after the initial site preparation work during the 35-40 week facility construction period. During this time, material, and equipment delivery, along with panel installation, will be occurring. This traffic will primarily be site worker passenger vehicles along with more limited delivery and supply vehicles. The construction related traffic trips will be temporary in duration and will conclude as the phases of construction are completed.

As noted, the primary construction related traffic will be passenger vehicles (approximately 80%). Due to the numerous parcels, upwards of 200 passenger vehicles per day could be anticipated to the overall site with a combined maximum of six (6) and average four (4) trips per vehicle per day.

A breakdown of the delivery truck vehicular traffic includes Connex container delivery (6 Connex containers/delivery trucks per day) and equipment (rubber tire loader, pile driver, forklift, etc.). Delivery truck traffic to and from the Project is generally anticipated to occur outside of the traditional morning and evening peak traffic periods, which are not as pronounced near the Study Area due to the rural and agricultural land uses. Fuel delivery (1 truck per day) and material delivery trucks (15 per day) would be anticipated to the Project but would be vary in their delivery times during the day.

Special delivery vehicles for the main power transformer and the on-site O&M buildings are anticipated but would be limited to one delivery effort to the site when needed.

Project related traffic during all phases will not be significant during the traditional AM and PM peak periods (7:00–8:00 AM and 5:00-6:00 PM, respectively). Construction related passenger vehicle trips and delivery truck traffic are anticipated to occur mainly outside of the traditional roadway peak traffic periods. However, it is noted that roadways in the Study Area do not experience the traditional peaking hours. Given the low volume of traffic on the adjacent roadways even in the atypical peak periods, the portions of traffic that do overlap the peak periods would not be anticipated to significantly impact the traffic operations along these roadways during those times.

Accordingly, the traffic impacts on the roadway operating level of service during construction will be negligible. No detailed intersection or linear roadway analysis was conducted due to the minimal volumes of traffic anticipated to be generated by the Project. In addition, construction on Sunland Gin Road to increase capacity and safety by adding a center left turn lane through Arizona City is nearing completion. Sunland Gin Road is classified as a major arterial. The Federal Highway Administration classifies an arterial as a roadway that provides a high degree of mobility. They are a crucial link in the national transportation system for that regional mobility; trucks and freight are not an anomaly on roadways classified as such and trucks drivers are in fact encouraged to utilize freeways and arterials during trip planning. The anticipated construction and delivery traffic on Sunland Gin Road is an appropriate and typical usage for the associated classification.

Installation of solar field arrays do not require significant grading or topography modifications to be installed. Most grading on the Project site will be to support access road construction and required erosion and sedimentation measures. Any soil disturbance is anticipated to remain localized with grading and distribution of the borrow to remain within each parcel and on-site. No significant amounts of either cut or fill are anticipated to be required/generated by the Project.

Maintenance and Operations Traffic Trip Generation

The Solar Facility is anticipated to have up to six (6) full time operations personnel. Due to the limited personnel, the operations and maintenance of the Project will result in minimal vehicular traffic generation. Six (6) utility type maintenance vehicles would be anticipated to support the site operations. These vehicles would be anticipated to generate an average of four (4) trips per day with a maximum of six (6) trips per vehicle per day. The maintenance and operations work efforts would generally require vehicular trips to the site outside of the AM and PM peak traffic periods, but it can be assumed that a worst-case scenario would result in six (6) AM and PM peak hour trips. Typical operation and maintenance procedures for the facility would include:

- Informal site inspections and corrective maintenance for the Solar Facility occurring on an as-needed basis.
- Conducting ground maintenance of the Solar Facility during growing season months.

Due to the minimal trips generated by the maintenance and operations of the Solar Facility, the existing low volume of traffic along the site access roadways, and the rural nature of the Project site (not an urbanized congested location), the traffic impacts on the roadway operating level of service will be negligible. No detailed intersection or linear roadway analysis was conducted due to the minimal volumes of traffic anticipated to be generated by the site.

Decommissioning Traffic Trip Generation

The typical industry lifespan of a solar facility is approximately 25-35 years, at which point the facility may be decommissioned, or removed. During this removal process, all installed equipment and access road material is removed and either recycled, reused, or properly disposed of. Access roads are also typically removed. It is anticipated that the same number of passenger vehicles, upwards of 200 per day could be anticipated with a combined maximum of six (6) and average four (4) trips per vehicle per day as during construction.

The truck vehicular traffic is anticipated to consist of trucks for hauling equipment and Connex container delivery (11 per day) and refuse and recycling trucks (4 per day) for removing all equipment and material from the Project site.

Decommissioning related passenger vehicle trips and delivery truck traffic are anticipated to occur mainly outside of the traditional roadway peak traffic periods. However, it is noted that roadways in the Study Area do not experience the traditional peaking hours. Given the low volume of traffic on the adjacent roadways even in the peak periods, the portions of traffic that do overlap the peak periods would not be anticipated to significantly impact the traffic operations along these roadways during those times.

Accordingly, the traffic impacts on the roadway operating level of service during decommissioning will be negligible. No detailed intersection or linear roadway analysis was conducted due to the minimal volumes of traffic anticipated to be generated by the Project site.

TRAILER DIMENSIONS AND CONFIGURATION

During the construction phase of the project under study, there will be at least one oversized permitted delivery as well as legal loads deliveries. An oversized delivery is anticipated for the transformer. Details are provided on the estimated dimensions and weights of the loaded oversized specialized equipment (based on the largest component dimensions) in Table 2. Oversized truck dimensioning was then utilized to review turning movements at critical intersection locations along the delivery route(s). Truck configurations can and will be changed due to market demand and will be set by the Original Equipment Manufacturer (OEM). Once the specific type of trailer is known, then the turning templates can be refined. Prior to delivery of the MPT, applications for oversize/overweight permits will be processed through ADOT and Pinal County, at which point the exact dimensions and weight will be known. It was assumed, for analysis purposes, that the solar panels and other equipment would be delivered via a WB-67 truck and trailer combination.

1.1.1 MAIN POWER TRANSFORMERS (MPT) TRAILERS

The MPTs will be delivered from a yet to be determined location utilizing the I-8 or I-10 corridor. As the specific delivery vehicle is also not yet known, a possible trailer type was utilized in AutoTurn that may be able to carry the MPT. That vehicle, classified in AutoTurn as the Special Transport Booster Trailer B2, is shown in Figure 3.

ESTIMATED TOTAL WEIGHTS AND DIMENTIONS

	Width	Height	Length	Weight {lbs}
MPT Trailer	12'6"	15'8"	92'	150,000+

Table 2: Estimated Weights and Dimensions (MPT Trailer Configuration)

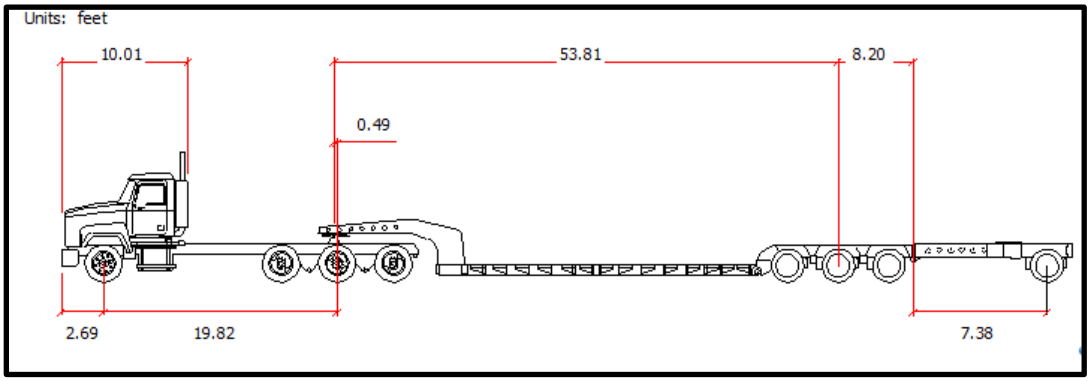


Figure 3: MPT Trailer Configuration

2. PROJECT SITE DATA

Pinal County, AZ

GPS COORDINATES:

32° 34' 45.3"N 111° 40' 21.9"W

TOPOGRAPHY:

The county includes most of the area between Phoenix and Tucson. Pinal County is among a number of counties that are part of the region known as South Central Arizona. The county can be considered to have two distinct geographic regions: the mountainous east and the low deserts with irrigated agricultural land to the west. Mountain ranges in the east include the Mineral Mountains and the Superstition Mountains and reach elevation of 6,000 ft. The western low desert is relatively flat with small hills and two smaller mountain ranges: Sacaton Mountains to the north and Waterman Mountains to the south. The desert floor elevation is between 1,500 ft and 1,600 ft. Most drainage in the county flows toward the Gila River, a tributary of the Colorado River which ultimately empties into the Gulf of California. Three tributaries of the Gila flow through the county, namely: the San Pedro River, Santa Cruz River, and Tom Mix Wash. There are also 13 major man-made waterways for irrigation of farmland throughout the desert lowlands. The soils in the county range from predominately well-drained loamy and sandy soils in the lowlands of the west to rocky in the east. With minimal rainfall, these well drained soils are predominately dry throughout the year with an exception for agricultural uses.

CLIMATE:

The Project site has hot, dry summers and generally mild winters.

ANNUAL RAINFALL:

7.75 inches

AVERAGE HIGH TEMPERATURE:

53 Degrees Fahrenheit in January

91 Degrees Fahrenheit in July

LAND USE:

According to the Pinal County's Major Comprehensive Plan Amendments, existing land uses on the Project site are Agriculture, Passive/Restricted Open Space, and Vacant/Undeveloped land. Land uses within 1 mile of the Project site include Agriculture, Passive/Restricted Open Space, Public Land, Single-Family Low Density, and Vacant as follows:

- West: Vacant/Undeveloped State Trust Land; one parcel designated for agricultural use.
- East: Agriculture and Vacant/Undeveloped land.
- North: State Trust Land
- South: Vacant/Undeveloped land, with scattered Single-family residences starting 0.5 mile to the south and southwest including residences along West Aries Drive and Sunland Gin Road.

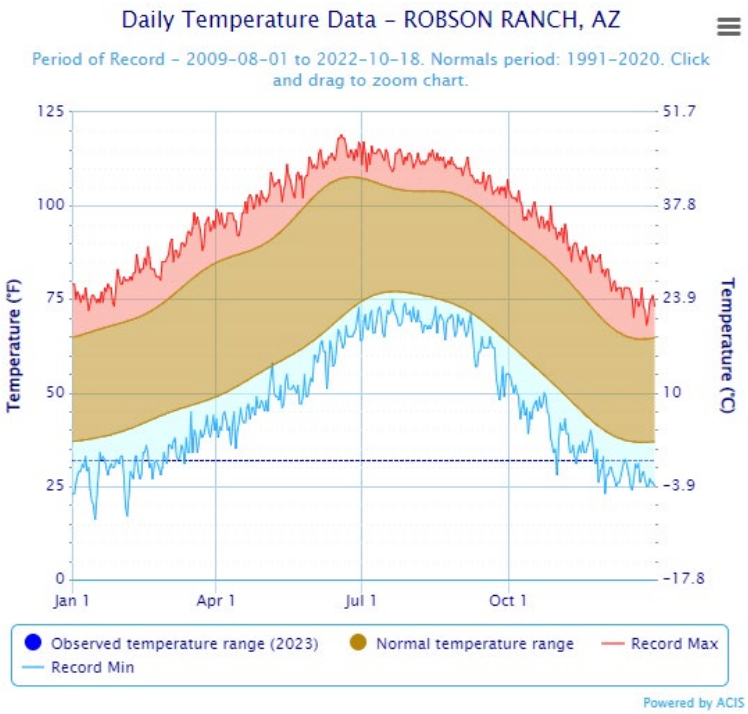


Figure 4: Daily temperature data, Robson Ranch, AZ (Source: NWS)

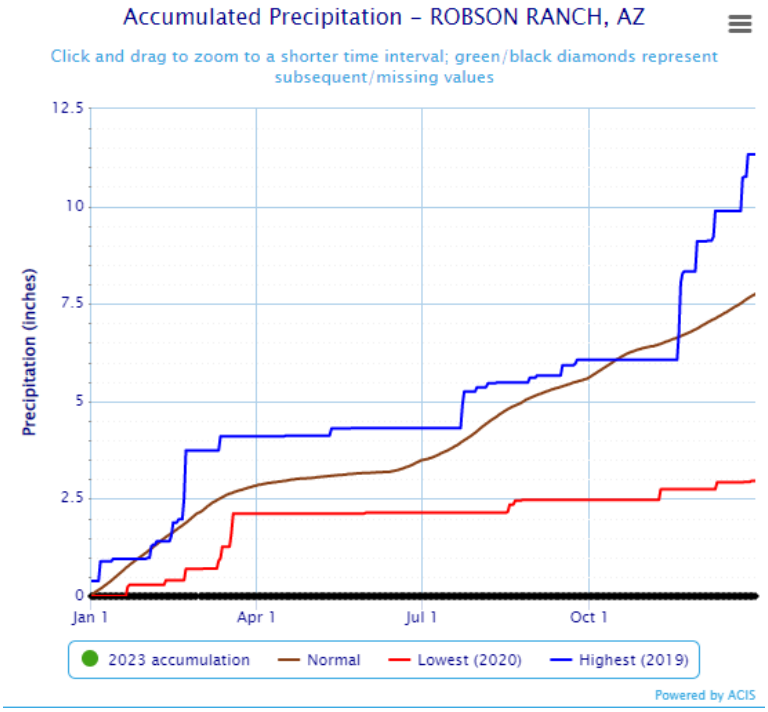


Figure 5: Accumulated Precipitation, Robson Ranch, AZ (Source: NWS)

PRE-CONSTRUCTION SITE CHARACTERISTICS

The Solar Facility parcels are all located in unincorporated sections of Pinal County, Arizona. The following is a description of the access roadway network to the parcels associated with the Project site:

Sunland Gin Road – Sunland Gin Road is a north/south arterial road from the Casa Grande-Picacho Highway and Mopar Road in the north, crosses I-10 and continues through Arizona City to its southern terminus at Aries Drive and Overfield Road. This road will be the primary delivery route to the Project site from I-10 and Phoenix/Tucson. The roadway carries around 11,000 ADT (ADOT AADT) near I-10 in 2019 and around 500 AADT in 2019 near the Project site. From I-10 and south the road is a two-lane two-direction arterial road with 12-foot lanes and limited shoulders of gravel. Posted speeds are 35 mph around the I-10 interchange, 50 mph between I-10 and Arizona City, 25 mph to 35 mph within the city and returning to 50 mph south of the city. Portions of the asphalt road within Arizona City are currently under construction (as of 2023). One completed, this section will have three 12-foot lanes, one in each direction with a center left turn lane. South of Harmon Road, Sunland Gin Road has been repaved within the last 10 years. The asphalt between I-10 and Arizona City and south of Arizona City to Harmon Road is older and in fair to poor condition as of 2019. There are no discernable peak periods, with the highest amount of traffic occurring midday. Volumes near the interchange do not exceed 810 vehicles in both directions.

Toltec Road – Toltec Road is a north/south arterial/local road from East Cornman Road in the north, crossing over I-10, and terminating south of Greene Reservoir Road in the South. This route will be the first segment on the secondary route from I-10 to the Project site. The roadway carries 3,800 ADT in 2019 near I-10 and 750 ADT about three miles south of I-10. This road is a two-lane two-way road with 12-foot lanes and limited gravel shoulders. The asphalt south of Cowboy Trail is in fair condition as of 2011 and the concrete from I-10 to Cowboy Trail is in fair to poor condition. Posted Speeds are 35 mph near I-10 that increase to 50 mph about a mile south of I-10. The AM peak period is from 7:00 am to 8:00 am and there is no discernable PM peak period.

Greene Reservoir Road – Greene Reservoir Road is an east/west local road that connects Sunland Gin Road in the west and Toltec Road before ending at South Wheeler Road in the east. It will be a segment of the secondary truck route to the site. Greene Reservoir Road is an approximately 24-foot unpaved dirt/gravel well-graded road with a posted speed limit of 50 mph. While there are no AADT or counts available, volumes are assumed to be low given the rural and agricultural nature of the nearby land uses.

Central Arizona Regional Transit (CART) (operated by The City of Coolidge Transit Department) and Maricopa Express Transit service areas mainly to the north of the Solar Facility. The eastbound CART route includes a stop at the Love's Travel Stop on Sunland Gin Road south of the I-10 interchange.

The Project parcels and access roadways are included in the Eloy Elementary School District, Toltec School District, Casa Grande Union High School District, and Santa Cruz Valley Union High School District. School bus routes in the area likely change yearly based on population needs, and they are not fixed. Contractors should coordinate with the school districts prior to commencing any work that may close roadways or impact possible school bus stops.

The Project site is outside of the fire districts, providing fire and EMS services. The closest fire districts are Eloy, Arizona City and Avra Valley.

Load- or height-restricted bridges and culverts, based on inspection reports, do not have the reserve capacity to accommodate vehicles over the identified posted weights or heights. Existing bridge posting data was acquired from AZGeo Open Data

Portal and cross referenced with ADOT *Weight Restrictions for State Highway Bridges, February 2022* list. Potential routes for the delivery of the power transformer have the following height weight restricted bridges near the Project:

- Bridge ID 01102 and 01103, the over-pass ramps from I-8 to I-10, restricted height to 15 ft 11 over I-10 southbound
- Bridge ID 00941 located along Sunland Gin Road and overcrossing I-10, restricted to 15 ft 8 in over I-10 southbound and 15 ft 10 in over I-10 NB
- Bridge ID 02152, located along Toltec Rd and overcrossing I-10, restricted to 15 ft 8 in over I-10 northbound.

No weight restricted bridges or culverts in the Study Area have been identified through the sources available online to the public. Arizona Administrative Code, Title 17, Chapter 6, Table 4 contains the most current information regarding height and weight restrictions along state routes. Sonak Solar plans to continue to coordinate with Pinal County Public Works and will coordinate with AZDOT as applicable to ensure compliance with relevant height and weight restrictions on the proposed routes.

The Project site is located in a rural part of Pinal County, off secondary roadways with no critical intersections, and not located in or near a congested urbanized area. Nearby access to Sunland Gin Road allows freeway/expressway routing from Phoenix and Tucson however requires routing through Arizona City. Sunland Gin Road is designated as a Regionally Significant Route (RSR) north of Baumgartner Road and is situated adjacent to the northeastern portion of the Project site. While Peart Road, a planned RSR runs diagonally through a portion of the Project site, Pinal County has agreed that the dedication of the right-of-way can be delayed until Project decommissioning. The alternate routes using Toltec Road and Greene Reservoir Road would route trucks through a less dense areas of Eloy and Arizona City.

3. TRANSPORTATION STRATEGY

OVERVIEW

As noted, the Project site is located on numerous parcels of property within unincorporated sections of Pinal County. Thus, access to each parcel can vary and is contingent on the location of the driveway site access connections to the adjacent roadway system. Main designated access routes to the parcels include Sunland Gin Road. Figure 1 and Figure 2 illustrate the parcel locations, proposed driveway connections, and existing connection points to the roadway network around those locations.

At this time, the origin of the MPTs and solar equipment is unknown, but it is assumed to originate from the I-8 or I-10 corridor. Preliminary routing begins at the I-10, which is the direct connecting Interstate between Phoenix and Tucson.

TRUCK ROUTING

Anticipated Route: From a location along the I-8 or I-10 corridor, utilizing I-10:

- Access the Project site directly From Sunland Gin Road.

As an emergency alternate to I-10, trucks can utilize Toltec Road to Greene Reservoir Road from I-10. Sunland Gin Road will allow for easier access due to pavement conditions and minimal turns. It is also noted I-10 bridges have height restrictions of 15’ 11” for the I-8 bridge and 15’10” for the bridge over Sunland Gin Road.

Road Improvements: Road improvements may be required based on existing roadway pavement conditions. Impact and remediation to be determined at a later date.

Holiday Restrictions: Yes (state)

Frost Law: No

Police Escorts: ADOT may require law enforcement escorts based on review of the permit.

Structures/Bridges: Three bridges on the primary route in the immediate vicinity of the Study Area have substandard vertical clearances per the Arizona Administrative Code. Bridges were only examined as far as I-8 on I-10. Once delivery routes are more defined, further examination can be completed. Alternate routes were considered however alternative routes have more unpaved mileage, and therefore infeasible.

DOT Constructions: At the time of this study, construction is noted to be underway or beginning soon at the following locations:

- Sunland Gin Road between Battaglia Drive and Monaco Blvd

Further information, including projects planned further in the future can be obtained from Pinal County website.

Risk Level: Low

Summary:

Initial turning templates indicate that deliveries can be made by an assumed special transport vehicle and WB-67s using the existing pavement width, except at the intersections of Toltec Road and Greene Reservoir Road and Greene Reservoir Road and Sunland Gin Road. If the secondary route is utilized, a WB-67 and the special transport vehicles cannot turn within the

existing limits of pavement/graded roadway at these intersections. Any changes to the transport vehicles will need to be analyzed since the existing roadway width at intersections may not be able to support turns by another type of vehicle.

The carrier shall coordinate with Arizona DOT for evaluation of the route and any required temporary improvements and/or traffic management. All carriers should run routes to verify measurements and routing at time of delivery. Specific construction impacts are unknown for the time frame of deliveries.

Permits/Approvals needed from: Arizona DOT, Pinal County.

STANDARD VEHICLE ROUTING

The construction and operation workforce will be sourced from the local labor pool of Pinal County as much as practicable. Other employees may come from the larger population areas of Phoenix and Tucson. All employees are expected to access the Project area from expressways and primary arterials in the vicinity of the Project site. In order to minimize increased traffic on local roads, the workforce should be instructed to utilize the same routing as the delivery vehicles, which is to access the Project site directly from Sunland Gin Road. An alternative route uses Toltec Road to Greene Reservoir Road to Sunland Gin Road.

PARKING AND DRIVEWAY ACCESS

During construction of the Solar Facility, staging areas will be provided to avoid vehicles parking on public roads. Due to the constrained nature of the public roads within the study area, parking on public right-of-way will not be allowed.

It is anticipated that a series of unpaved, 20-foot-wide internal, newly constructed roadways will connect to Sunland Gin Road through existing access points and thereby connect to the local roadway system. The driveway access points will be upgraded as needed to accommodate construction equipment.

The first driveway access utilizes the existing intersection of Sunland Gin Road and W. Kinley Road, which is 1,060 feet south of the nearest existing driveway and 1.59 miles south of the nearest public road intersection. The next driveway to the south is 2,370 feet, with another 300 feet further south. The southern-most driveway utilizes the existing intersection of Sunland Gin Road and Pearce Road, which is approximately 880 feet north of an existing driveway on the east side of the roadway and just under a mile north from the nearest public road intersection. Appendix A-3 includes a visual representation of these distances. While the spacing of the two center driveways is less than the minimum guideline of 360’ in the Pinal County Access Management Manual, all driveways use existing access points, rather than proposed. After construction these driveways will be infrequently used for maintenance purposes, rather than the higher use residential or commercial driveways that are more common. Based upon our desktop analysis review utilizing Google Streetview, it appears that sight distance is sufficient at all driveway locations. The driveways at existing access points meet the corner clearance requirements in the Pinal County Access Management Manual.

4. ENVIRONMENTAL

WEATHER

While local roadways in the vicinity of the Project site have not been recently affected by long term closures due to washouts caused by heavy rainfall during extreme events, the area is prone to flooding during tropical storms, winter rains and summer monsoons. Flooding risks are mitigated through natural and human-made earth drainage channels, washes, and channels. Future extreme precipitation events have the potential to disrupt delivery of the components to the Project site. Review ADOT and Pinal County restrictions prior to travel.

FUGITIVE DUST

Fugitive dust is particulate matter that enters the atmosphere without first passing through a stack or duct designed to direct or control its flow. Fugitive dust can occur due to unpaved internal access roads in the site or during installation and decommissioning activities. Sonak Solar and their contractor will apply water or an approved mineral or chemical dust suppressant on a regular basis, limit vehicle speeds, conduct inspections using visual emissions observations on the unpaved service roads to minimize fugitive dust, and follow other methods as legally required by the Pinal County Code of Ordinances. Sonak Solar and their contractor will also coordinate with the county on measures proposed to minimize fugitive dust due to the transportation of material to and from the Project site.

5. ROAD IMPROVEMENTS ON SITE

It is anticipated that a series of internal roadways will connect into a number of existing driveway access points on Sunland Gin Road to access the local roadway system. All newly constructed project roads will utilize existing access points to Sunland Gin Road, and the access points will be upgraded as needed. No new driveway access points will be created as part of this Project.

On-site roadway improvements were determined based on coordination with Sonak Solar regarding roadway construction standards and delivery vehicles. Improvements considered the weight, number, and size of vehicles, as well as provide sufficient temporary parking and loading areas for construction personnel and equipment. Consideration for design vehicles and required roadway curve radii and turning requirements at internal roadway intersections were included in the design. Due to existing swales alongside the public roadways, drainage was also a consideration in the design of the connections of the internal access roadways.

Roadway and infrastructure improvements are in accordance with the current Pinal County Subdivision Regulations, Subdivision and Infrastructure Design Manual, the Regionally Significant Routes for Safety and Mobility, and Regionally Significant Routes for Safety and Mobility Access Management Manual Update to the extent as documented in this submission.

6. ROAD IMPROVEMENTS OFF SITE

Utilizing the design vehicles as previously described, off-site roadway improvements to the radii at public roadway intersections along the primary route are not expected.

If the secondary route is utilized, a WB-67 and the special transport vehicles cannot turn within the existing limits of pavement/graded roadway at the intersections of Toltec Road and Greene Reservoir Road and Greene Reservoir Road and Sunland Gin Road. There are no posted weight restrictions on Sunland Gin Road however, it is possible that Pinal County may still require roadway improvements prior to or after the delivery of overweight equipment. Coordination with Pinal County will continue to determine if any road use and restoration agreements are required prior to using them for construction activities.

As previously noted, a number of existing driveway access points along Sunland Gin Road will be used to connect onto the local roadway system.

Driveway opening size and required radius of the pavement connection were determined based on the level of usage anticipated at each access point and the design requirements associated with the access roadway type. Driveway intersections along these higher speed roadways will need to ensure adequate sight distance and pavement area when constructed.

7. TRAFFIC COUNTS

Traffic data for roadways in the Project area is available through AZGeo Data Hub and ADOT websites. Locations either have a singular 24-hour count, or multiple 24-hour counts every several years. 2019 estimated Annual Average Daily Traffic (AADT) were calculated by ADOT using the latest data available. Data is presented below.

- Sunland Gin Road
    - Near I-10: 10,700 (2019)
    - Through Arizona City: 6,000 (2019)
    - Near Project Site: 750 (2019)
- Toltec Road
    - Near I-10: 3,800 (2019)
    - Near Greene Reservoir Road: 750 (2019)
- Greene Reservoir Road – Counts, if any, are not publicly available

8. SUMMARY

Changing the final condition use on the Project parcels from ranch/agricultural to a solar facility would have a de minimus effect on the number of vehicular trips on the adjacent roadways that are currently being generated to and from the properties within the study area. Based on the short-term duration construction generated traffic and then the long-term limited number of trips that the proposed Solar Facility would generate, we offer the following findings:

1. The Solar Facility construction is anticipated to begin in approximately December 2024 (site preparation then material and equipment delivery) and end in December 2025.

2. The initial site preparation work is anticipated to last for a period of 10 to 15 weeks. During this time a total of 18 passenger and equipment hauling vehicles will be expected to the site per day.

3. The Solar Facility construction is expected to generate an average of 30 heavy vehicles to the site per day during material and equipment delivery following the site preparation work. During construction, the Solar Facility will be anticipated to generate an average of 200 passenger vehicles to the site per day for the facility installation workers. Multiple trips to and from the site may occur from the construction related vehicles. The construction duration is anticipated to last for 35 to 40 weeks.

4. The site construction is not anticipated to require large amounts of earthwork and will not generate significant (if any) quantities of cut or fill.

5. The site construction will require at least one (1) over-sized load delivery. This will be to provide the main power transformers to the site at the central sub-station parcel. The over-sized deliveries would approach the site on the designated access routes as identified in Figure 1 and Figure 2; I-10 to Sunland Gin Road to the driveway access points. The delivery vehicle will utilize internal roadways to turn around and exit the site via the same routing. Utilizing the turning template for a Special Transport Booster Trailer B2 and WB-67 in AutoTurn, roadway improvements to the radii at public roadway intersections along the primary route are not expected. If the secondary access must be used, the vehicles cannot turn within the existing limits of pavement/graded roadway at the intersections of Toltec Road and Greene Reservoir Road and Greene Reservoir Road and Sunland Gin Road. The size of the delivery is an estimate and will be confirmed through the permitting process with ADOT and Pinal County.

6. Improvements to the intersection of Toltec Road and Greene Reservoir Road and Greene Reservoir Road and Sunland Gin Road will be required if a vehicle similar in size to a WB-67 is utilized for the delivery of materials on the secondary route. A WB-67 or special transport truck turn cannot be accommodated within the limits of existing pavement.

7. During the Solar Facility operation, an average of 24 passenger vehicle trips per day are anticipated.

8. Daily site generated traffic is not anticipated to impact school bus operations for either the Eloy Elementary, Toltec Elementary, Casa Grande Union High School, and Santa Cruz Valley Union High School Districts due to the limited number of vehicles generated by the site during standard operations and maintenance. Any roadway closures that need to occur during construction have the potential to impact school bus operations and the contractor should coordinate with Eloy Elementary, Toltec Elementary, Casa Grande Union High School, and Santa Cruz Valley Union High School Districts.

9. Newly constructed internal roadways will connect to Sunland Gin Road through existing access points. The driveway access points are dispersed throughout the Project eliminating concentration of vehicular movements at the individual access points. Sight distance for the proposed driveway access road designs for each parcel are designed to meet sight distance requirements.

10. While no roadways are weight restricted, Greene Reservoir Road is a gravel road. Pinal County will require an oversize/overweight load permit, in addition to the ADOT permit. Coordination with Pinal County will continue to determine if any road use and restoration agreements are required prior to using them for construction activities. If required, the road use and restoration agreements are expected to be obtained prior to the construction phase of the Project. The restoration agreements would document the rights and obligations for road use and repair during the Project's construction phase with the appropriate authority.

11. No new off-site traffic control devices would be required to accommodate the anticipated site traffic. On-site roadway intersections will only require stop or yield traffic control.

12. Due to the lack of passenger railroads, subways, fixed route buses and any other fixed route mass transit systems in the vicinity of the study area, there are no anticipated impacts to these types of facilities by the Project. The nearest public aviation facility to the Project is Pinal Airpark which is located more than 20 miles away. The low-level elevation of the solar panels will not require a Special Use Airspace designation from the Federal Aviation Administration (FAA).

13. Site access driveways were designed to conform to required design criteria based on adjacent roadway type and anticipated traffic volume. All driveway access points from public roadways will be reconstructed to ensure adequate sight distance, pavement widths and turning radii.

14. Carriers should run all routes prior to deliveries and coordinate with State and Local transportation officials when a route is confirmed and for the timeline on any oversize delivery.

15. As proposed, vehicle trips generated by Solar Facility construction and Solar Facility maintenance and operations is not anticipated to create adverse traffic related impacts on roadways within the Project area.

APPENDIX

A-1. PICTURES

Sunland Gin Road

Over I-10



(2022)

South of I-10



(2022, South Facing)



(2022, North Facing)

In Arizona City – 2022 Construction



(2022)

South of Arizona City



(2011 South Facing)

At Harmon Road



(2019)

South of Harmon Road – Newer Aerials and Street View (Above in the distance) shows newer pavement



(2022)



(2011)

Toltec Road

Near I-10



(2022)

Near Concordia Road



(2022)

Near Harmond Road



(2011)



(2011)

Near Greene Reservoir Road



(2011)

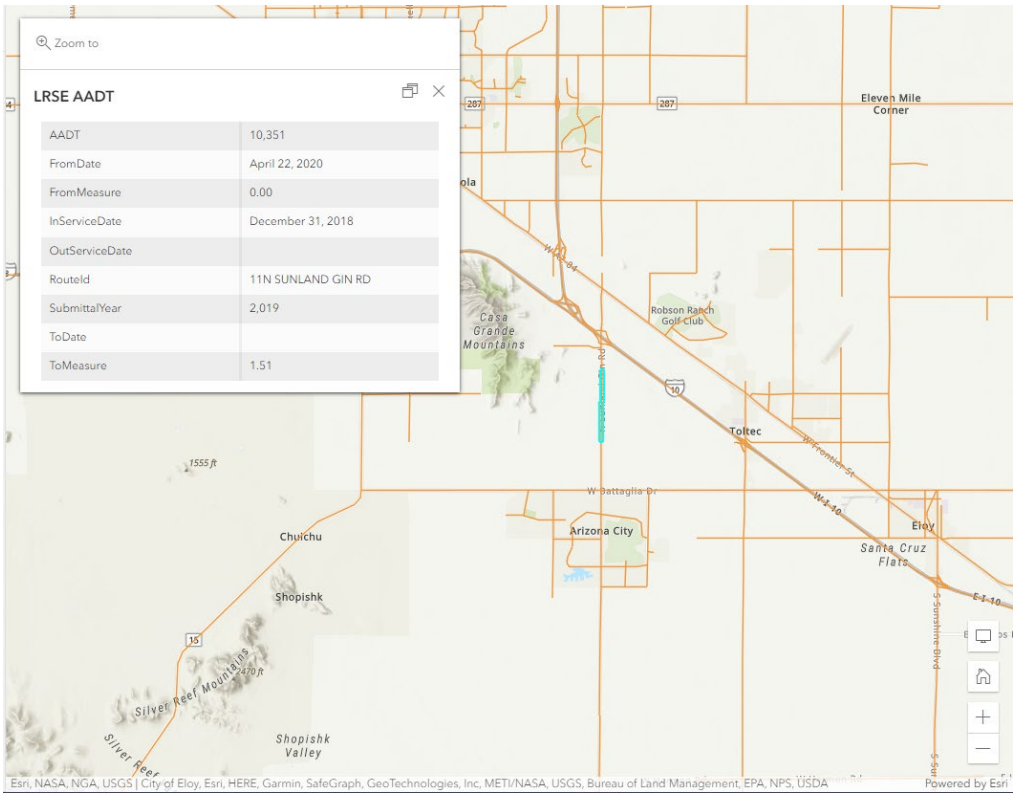
Greene Reservoir Road at Toltec Rd



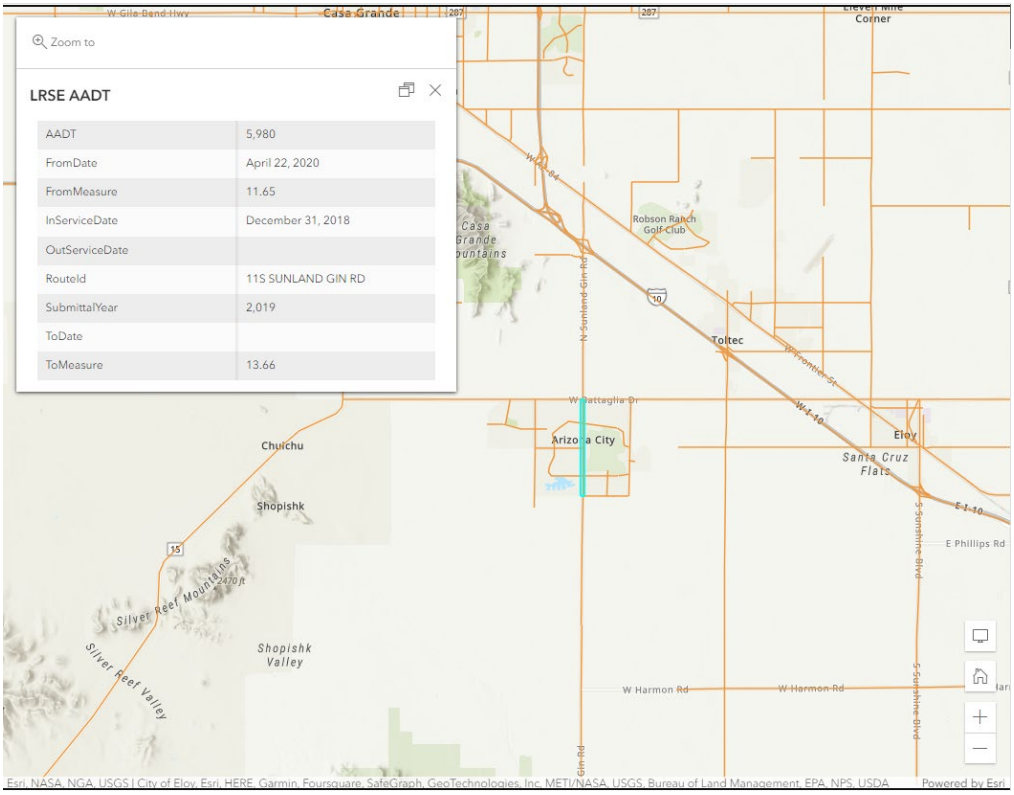
(2011)

A-2. TRAFFIC DATA

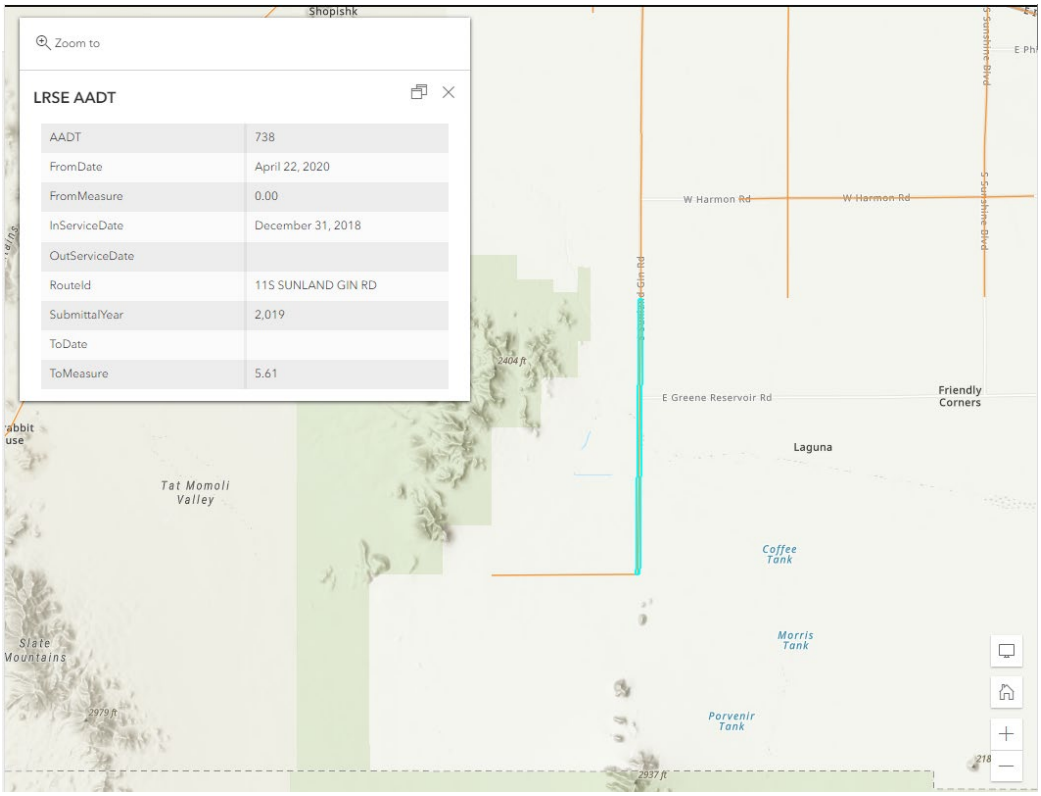
Sunland Gin Road – South of I-10



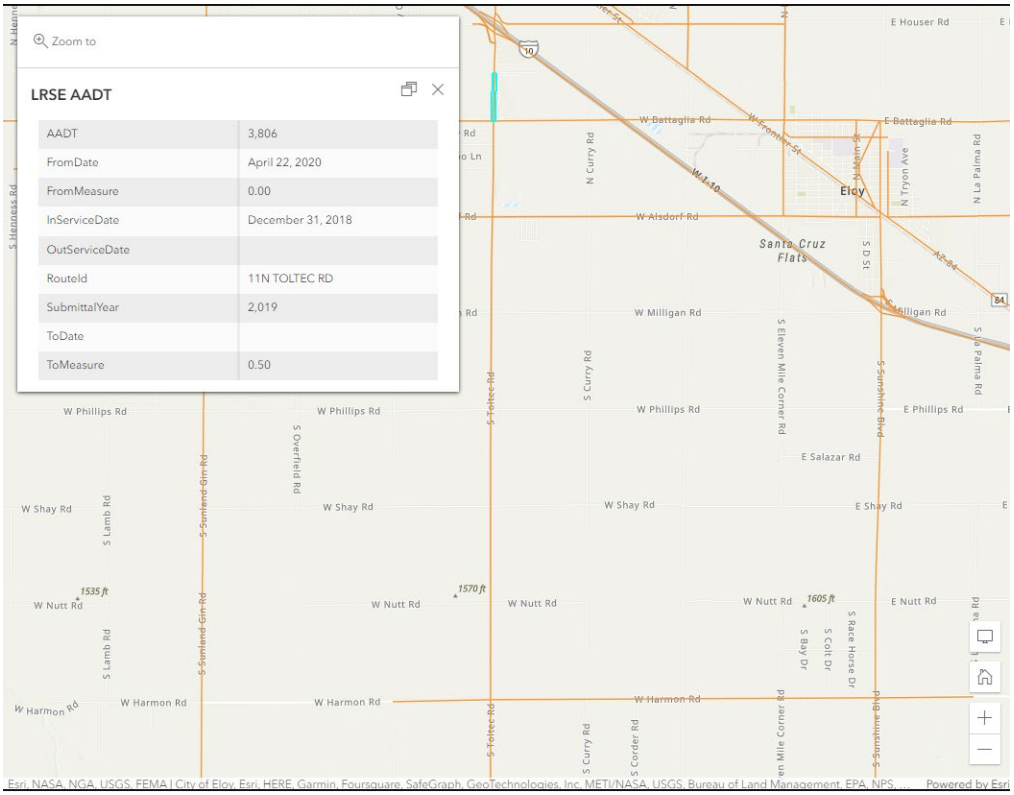
Sunland Gin Road- In Arizona City



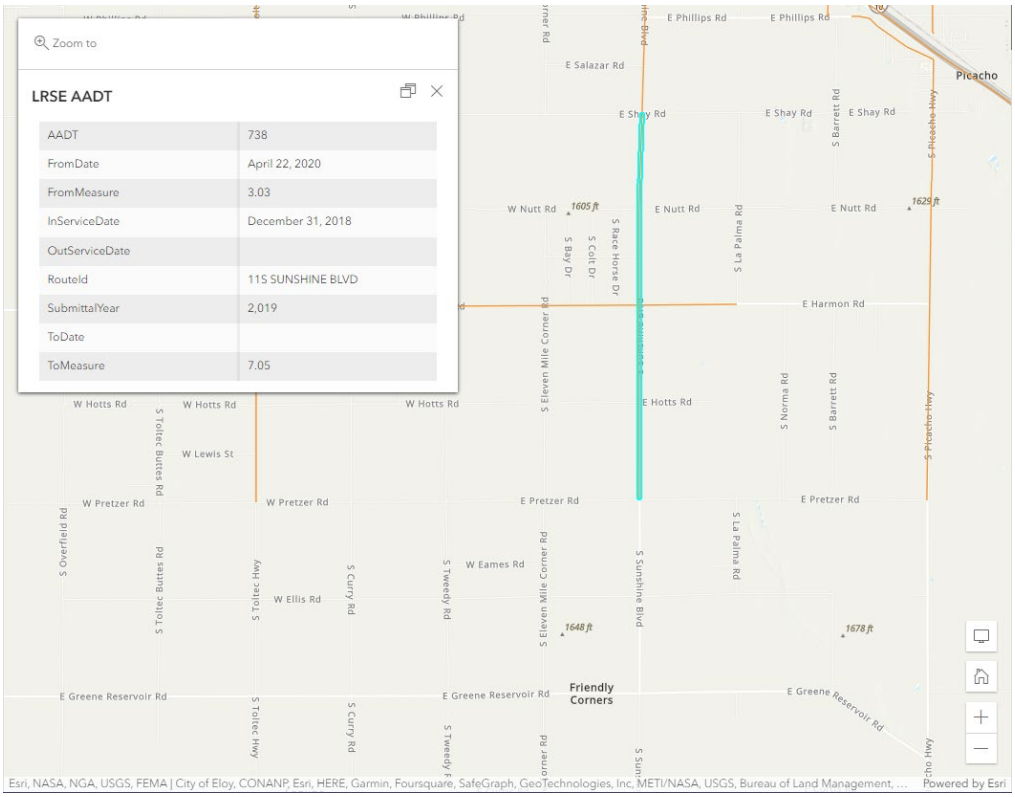
Sunland Gin Road – Near Project Site



Toltec Road – South of I-10



Toltec Road – North of Greene Reservoir Rd



A-3. DRIVEWAY AND INTERSECTION DISTANCES