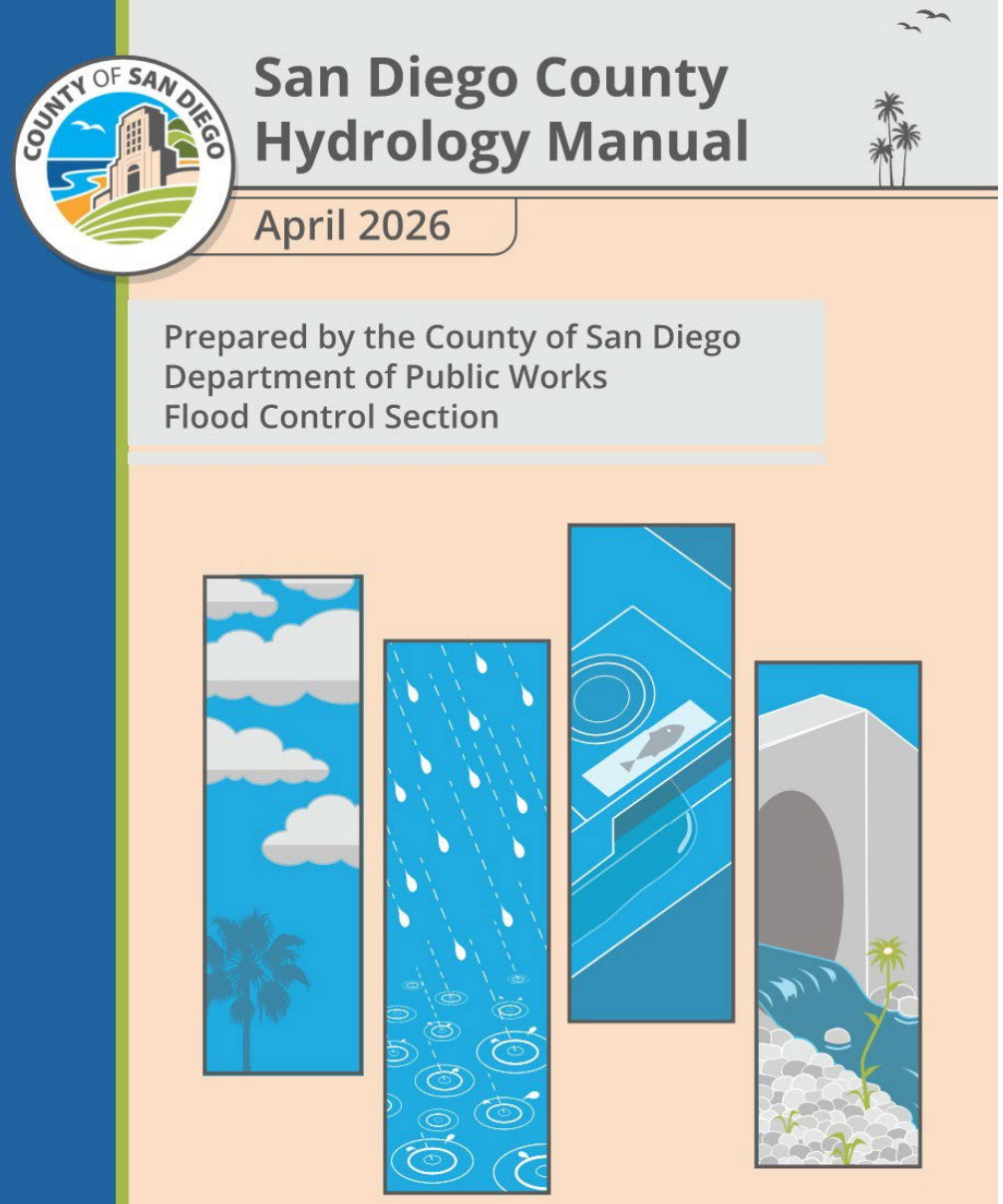


San Diego County Hydrology Manual Update

April 2026

Presentation June 17, 2026

RICK

RIVER FOCUS
WATER RESOURCE CONSULTANTS

Housekeeping

Parking

- Environmental Services Department Lot: Park in “City Employees Only” and visitor spots
- Additional street parking along Ridgehaven Ct.
- Do not park in neighboring lots

Questions

Please save all questions for the Q & A sessions.

Refreshments

Refreshments will be provided during the break.

Virtual Guests

- Please keep cameras and mics off during presentations
- Allowed to turn on during Q & A

Speakers

Sara Agahi *Flood Control District Manager*

County of San Diego

Ashkan Azarnia *Civil Engineer/Project Manager*

County of San Diego

Ash Paranthaman *Associate Project Manager*

RICK

Laura Henry *Associate Project Engineer*

RICK

Jon Viducich *Senior Hydraulic Engineer*

River Focus

AGENDA

Welcome and Introduction

Session 1

- Chapter by chapter overview
- Intensity change - NOAA Atlas 14
- Questions roundtable 1

Break

Session 2

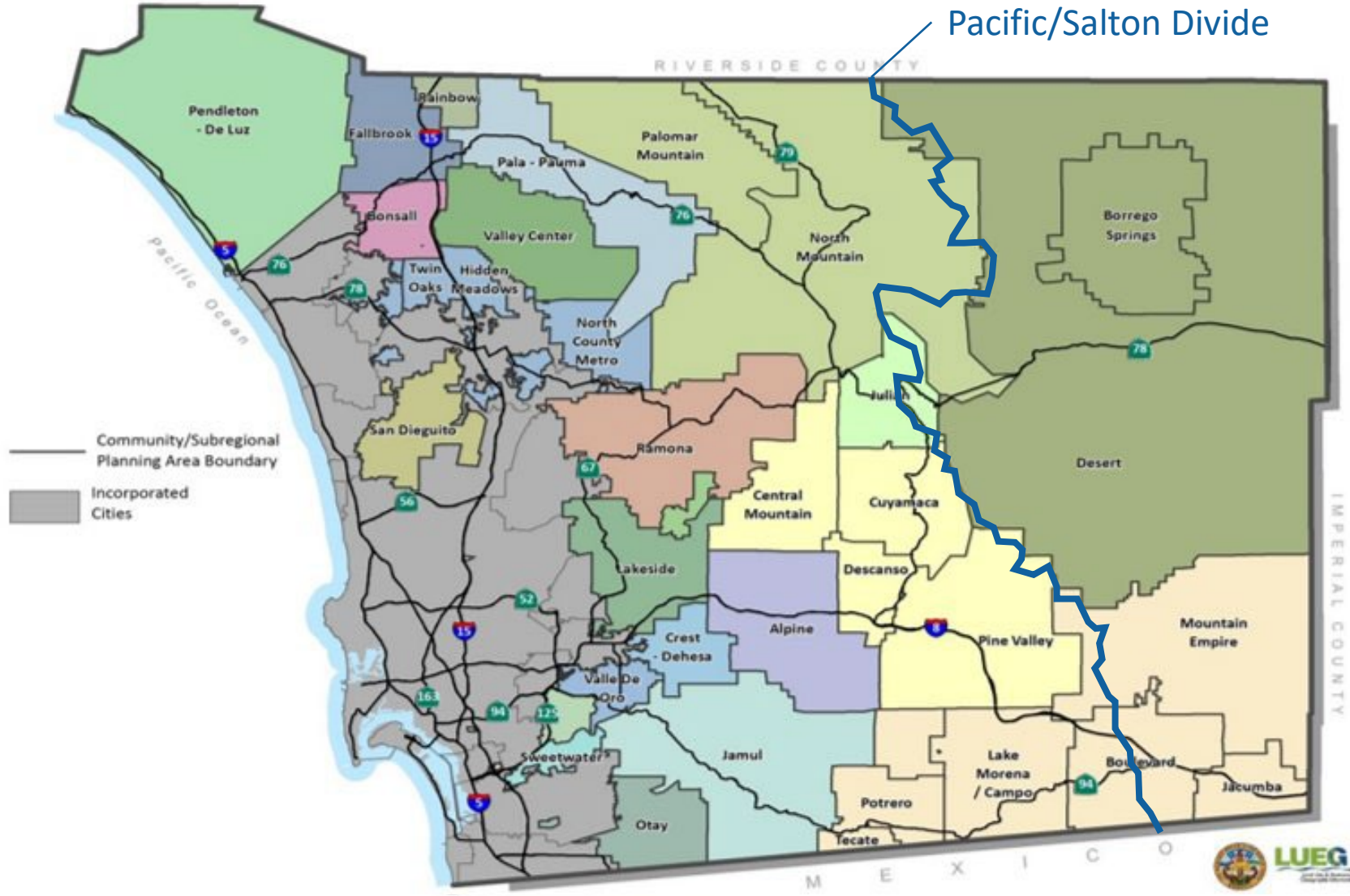
- Purpose and use of SDHydroTools
- Sediment bulking factor
- Grandfathering criteria
- How/where to get the manual
- Questions roundtable 2

Welcome/Introduction

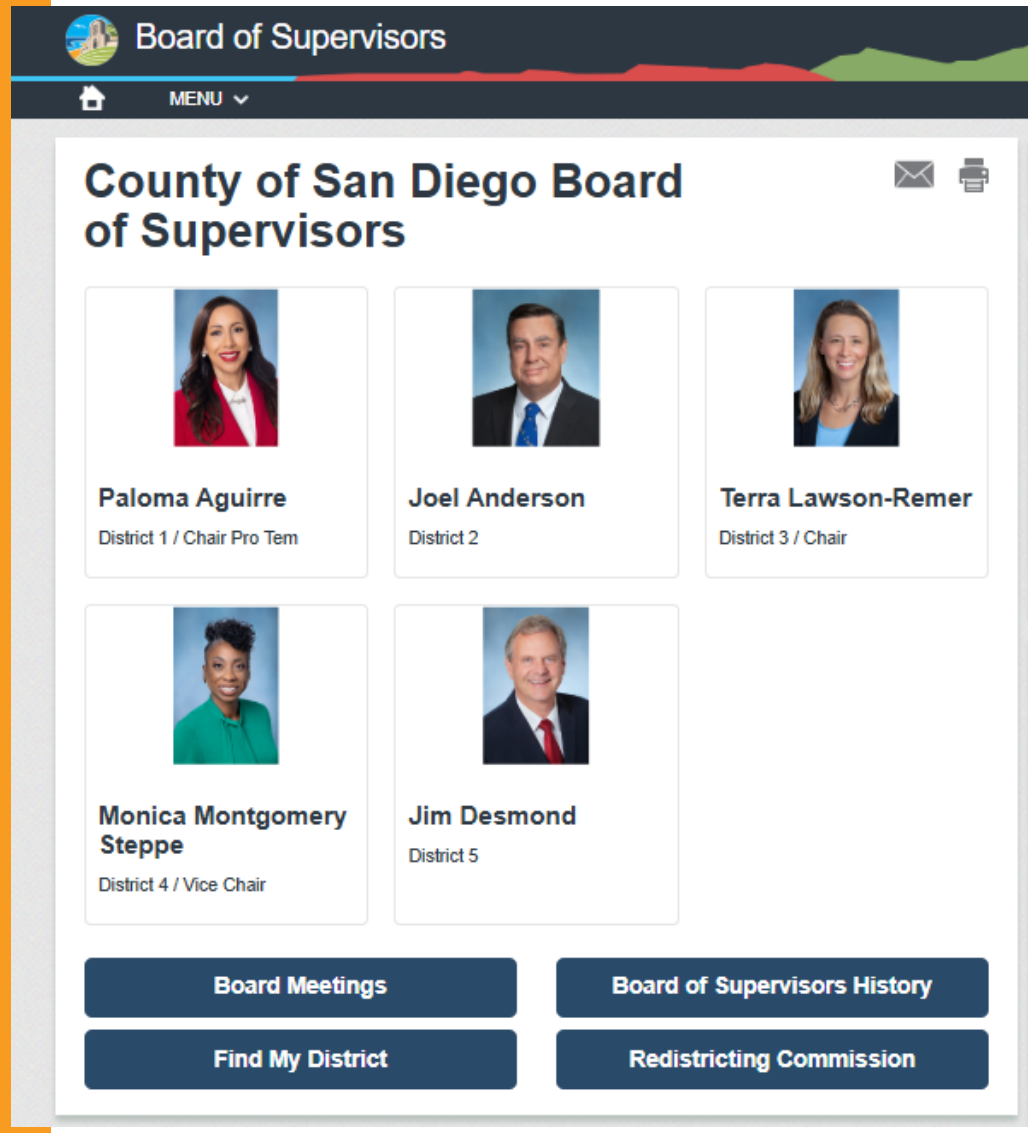
June 17, 2026

Sara Agahi, PE CFM
San Diego County Flood Control District Manager

County of San Diego Jurisdiction



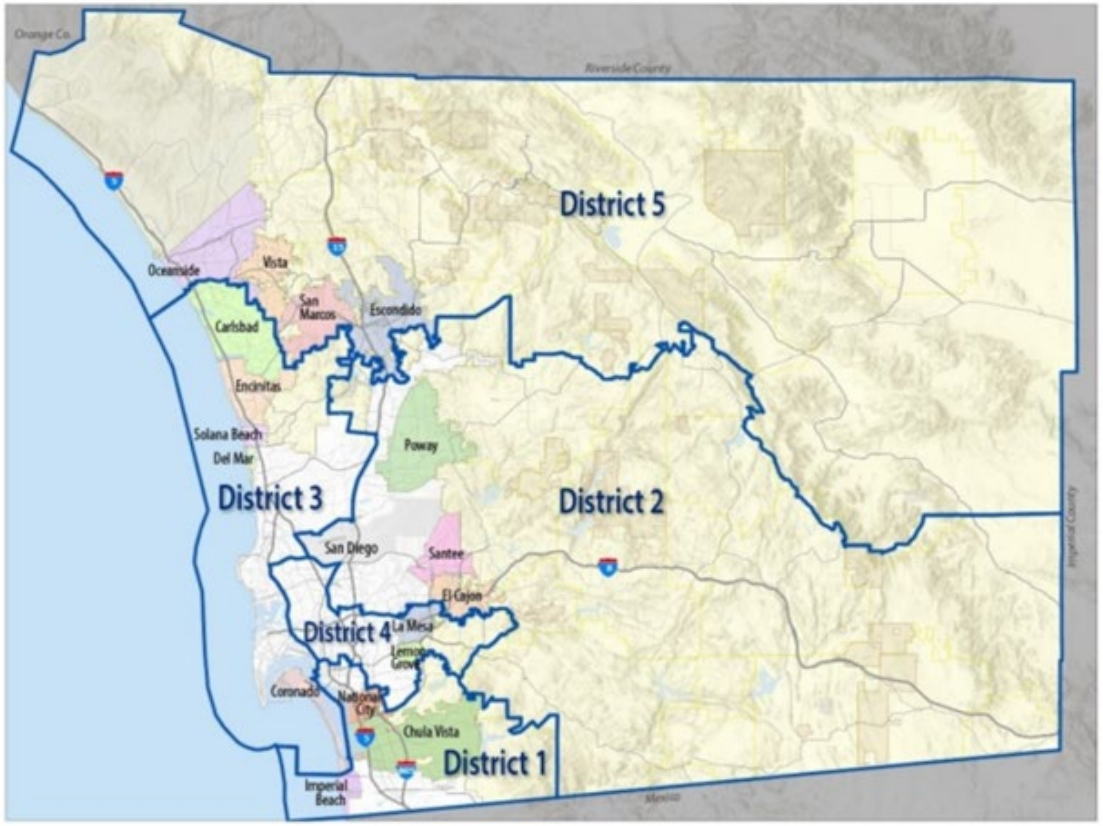
County Supervisorial Districts



Supervisorial District Boundaries

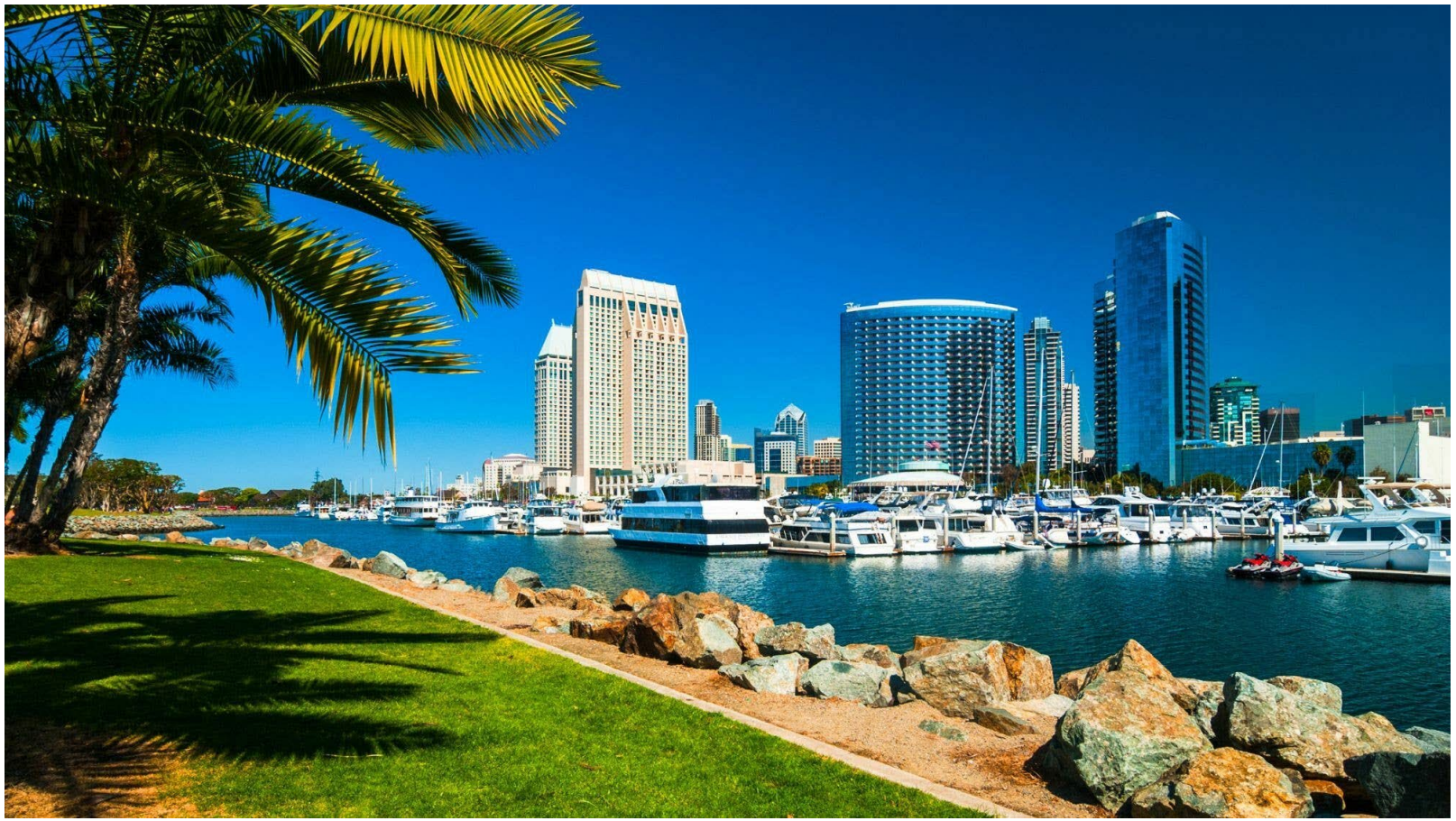
Supervisorial District boundaries were adjusted by the **County of San Diego Independent Redistricting Commission**. The new district boundaries became **effective January 15, 2022.**

Find My District



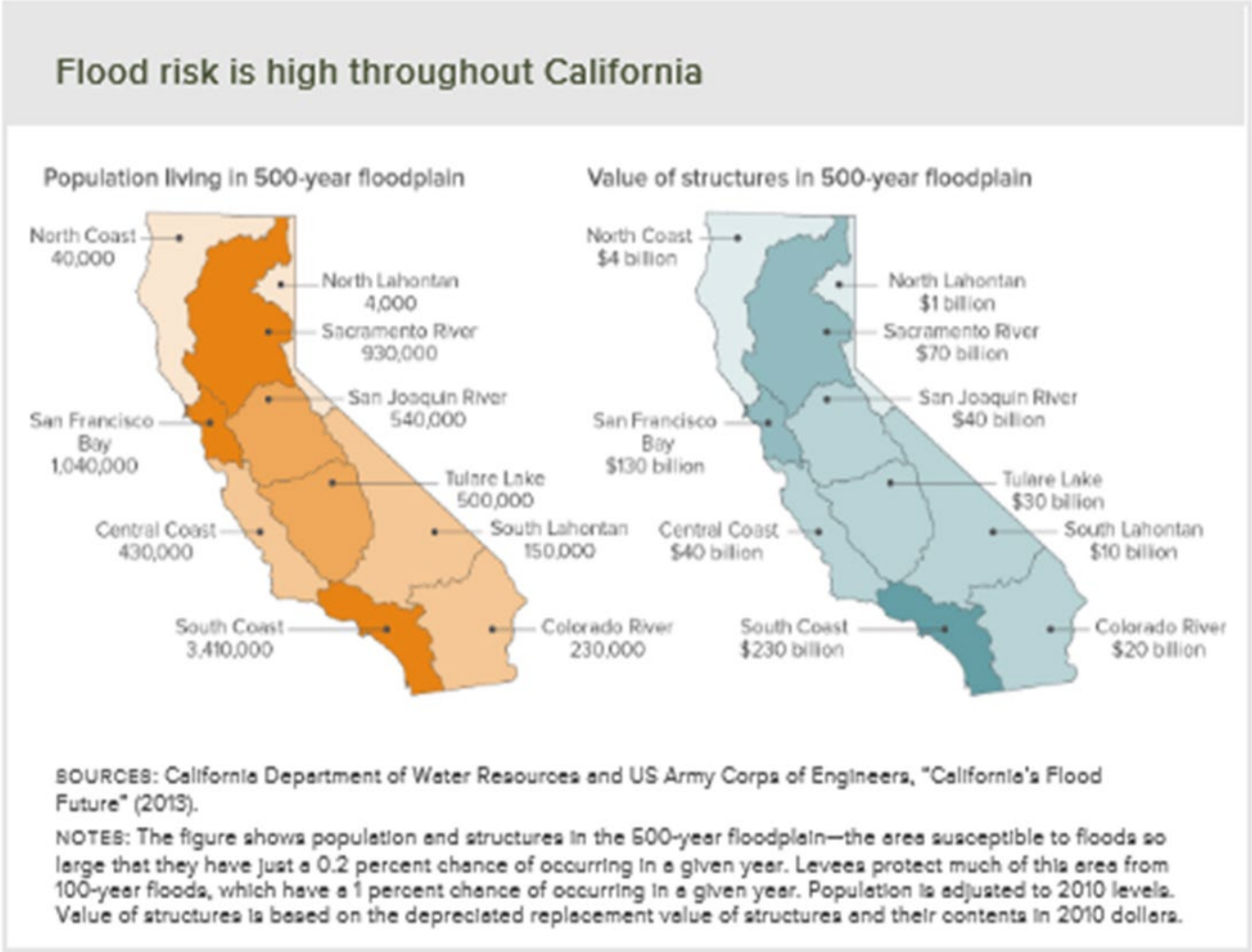
https://www.sandiegocounty.gov/content/sdc/general/bos.html

Does it actually flood in San Diego?

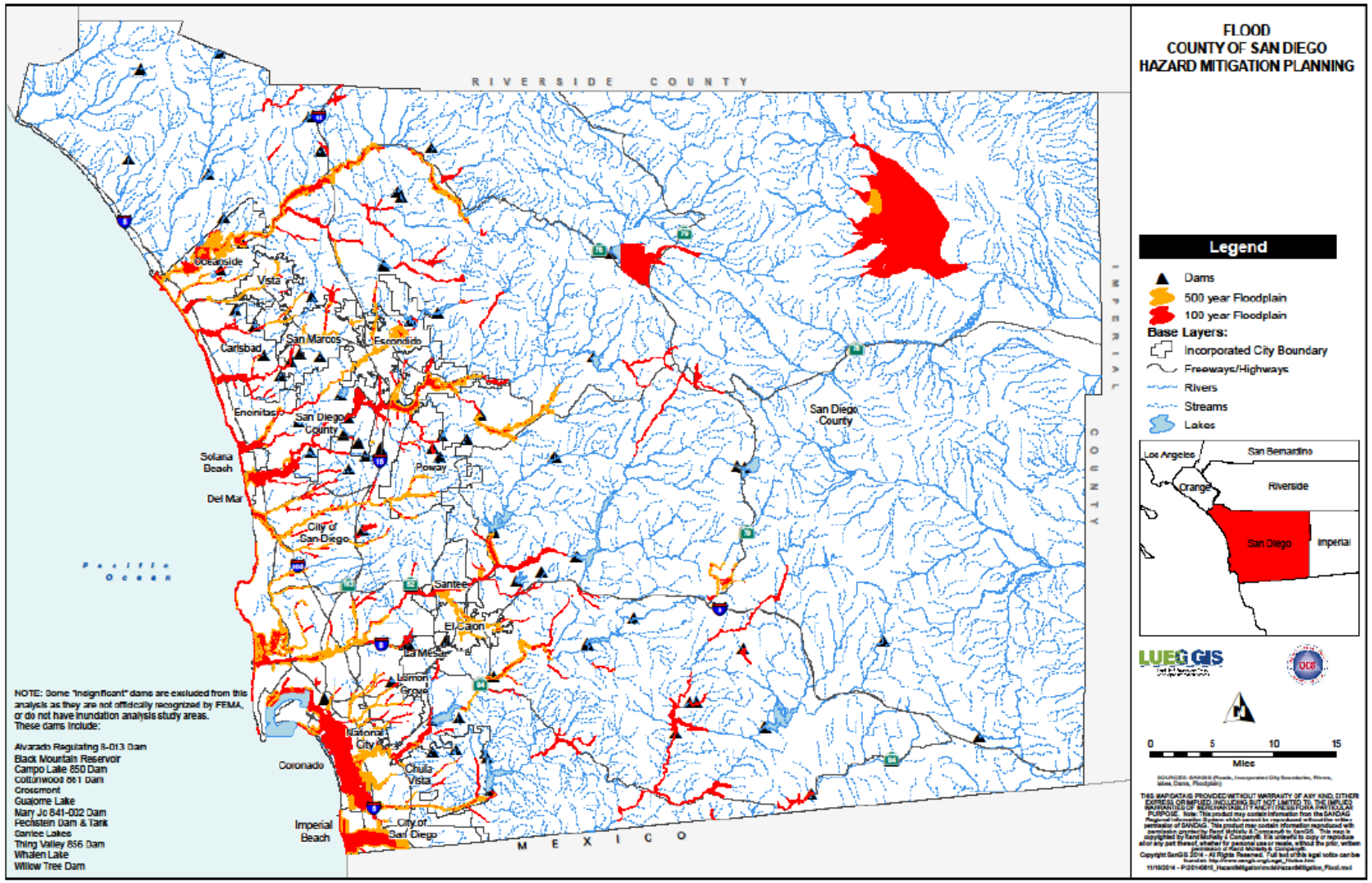


FLOOD RISK

1 in 5 Californians, $580+ Billion of infrastructure vulnerable to flooding



200,000+ acres of flood-prone property in San Diego County



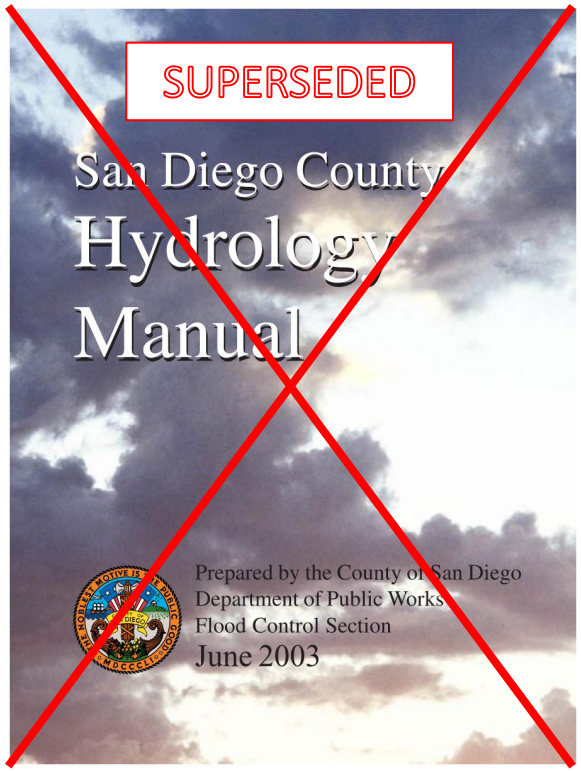
Chapter by Chapter Overview

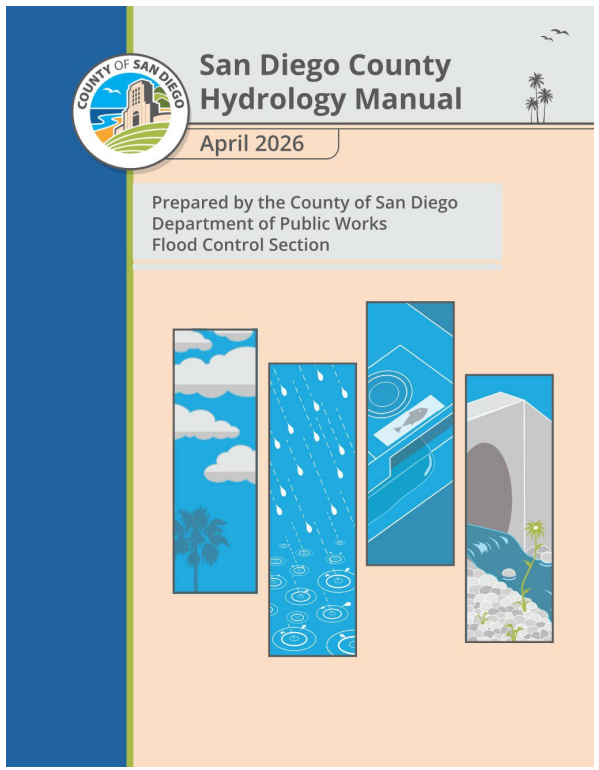
June 17, 2026

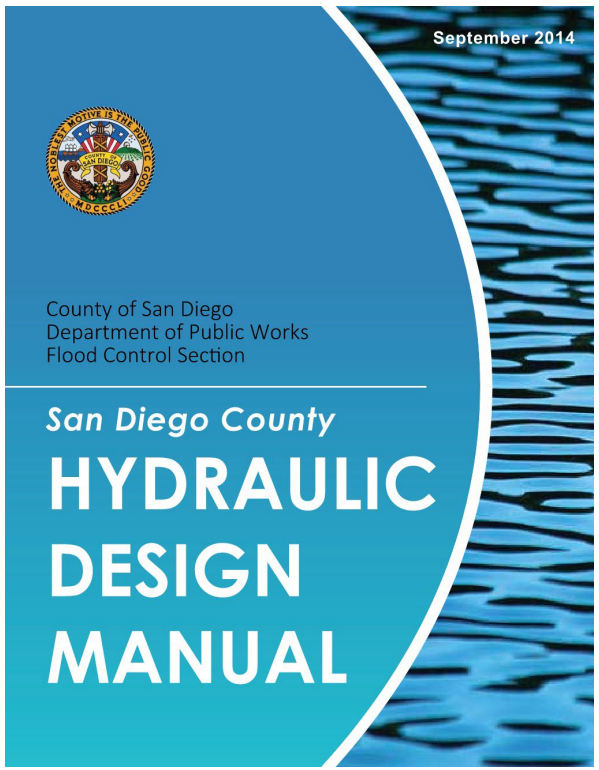
Ash Paranthaman, PE QSD QSP
Associate Project Manager

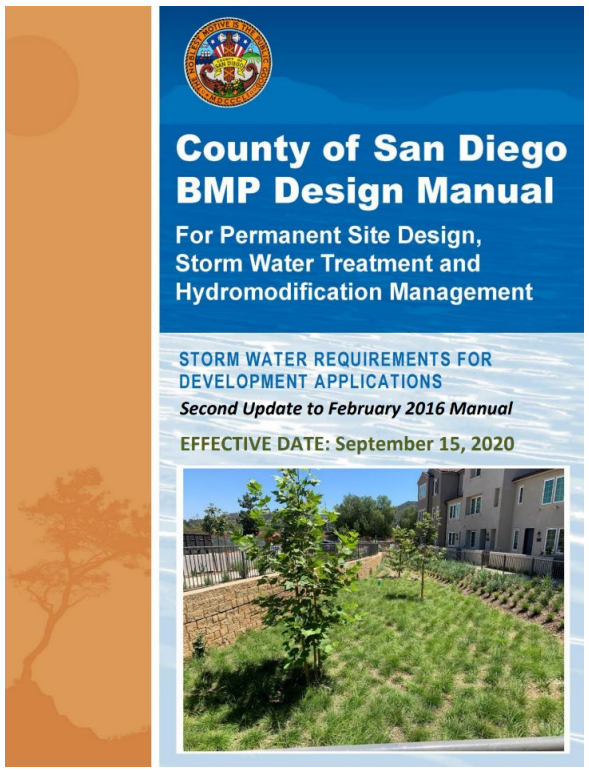
RICK

San Diego County Manuals









Section 1: Introduction

NEW SECTIONS

Seasonal Precipitation Patterns

- Cool-season frontal systems
- Warm-season North American monsoon
- Orographic effects: windward vs. leeward
- High-elevation snow accumulation

Weather Systems & Flooding

- Atmospheric rivers (ARs) mechanics
- Narrow cold-frontal rainbands (NCFRs)
- Jan 22, 2024 flash flood case study
- Updated tropical cyclone history (Kay ’22, Hilary ’23)
- Highlights high-intensity, short-duration rainfall risks

MAJOR REVISIONS

Policies

- New subsections: Application of Design Standards, Exceptions
- Watershed-wide planning study provisions

Maintenance Requirements

- Resource agency permits (USACE, CDFW, RWQCB)
- Funding mechanism & owner responsibility

Computer Programs

- New SDHydroTools program (5 modules)
- HEC-1 & TR-20 replaced with HEC-HMS

UPDATES & REFINEMENTS

Data Sources & References

- NOAA Atlas 14 as primary rainfall data
- Added SANGIS & NRCS resources

Figures & Maps

- New 30-year rainfall climatology maps
- ALERT station map updated (August 2025)

Purpose

- Clarifies manual use across agencies, consultants, and jurisdictions
- Reinforces that local jurisdictions may supersede County guidance

Section 2: Regional Flood Flow Information And Selection Of Hydrologic Method And Design Criteria

DESIGN CRITERIA OVERHAUL

Design Frequency

- Old: Dual 50-year (upstream) / 100-year (at major roadway) standard
- **New: Unified 100-year design frequency for all hydrologic analysis**
- Infrastructure-specific criteria (storm drains, inlets, culverts) deferred to Hydraulic Design Manual

Sediment Bulking

- New cross-reference to Section 5.5 for sediment/debris flow hazard methods

FLOW RATE REQUIREMENTS

FEMA FIS Flow Rates

- FIS rates limited to regulatory purposes (remapping, no-rise certification)
- All facility design must follow Hydrology Manual methodology

Engineer Certification

- If design is based on previously calculated flow rate, those analyses must be certified by current engineer of record
- Flow rate comparisons required; significant differences must be discussed

Master Plan Analyses

- Flagged as planning purposes *only*; design projects require independent site-specific analysis

UPDATES & REFINEMENTS

FEMA Map Resources

- Added NFHL Viewer as resource alongside SanGIS

Land Use Basis

- Clarified that FEMA studies reflect land use "at the time originally completed"

Section 3: Rational Method & Modified Rational Method

NOAA ATLAS 14 ADOPTION

Data Source

- Old P_6 and P_{24} isopluvial maps replaced by NOAA Atlas 14 precipitation data
- Appendix B updated with NOAA Atlas 14 access procedures

Removed Items

- Intensity-Duration Design Chart removed (old Figures 3-1, 3-2)
- P_6/P_{24} 45%-65% adjustment procedure eliminated

INTENSITY FORMULA

Old Method & Equation Removed

- $I = 7.44 \cdot P6 \cdot D^{-0.645}$ formula deleted

New Method: Log-Log Interpolation from NOAA Atlas 14

- New formula: $I_{Tc} = K \cdot Tc^n$ using NOAA Atlas 14 bounding data pairs
- Interpolates between NOAA Atlas 14 duration/intensity pairs (T_1, T_2)

SDHydroTools

- New interpolation module added for depth/intensity calculations

CLARIFICATIONS

Data & References

- Table 3-1 impervious % for planning level study. Use actual impervious % for project-level studies and design.
- SANGIS identified as soil type data source

Section 4: NRCS Hydrologic Method

NOAA ATLAS 14 ADOPTION

Rainfall Data Source

- Isopluvial maps (P_6 and P_{24}) replaced by NOAA Atlas 14 precipitation depths
- Depths for durations up to 24 hours now sourced from NOAA Atlas 14
- P_6/P_{24} 45%–65% adjustment eliminated

Hyetograph Computation

- Old $I = 7.44 \cdot P6 \cdot D^{-0.645}$ formula removed
- New log-log interpolation between NOAA Atlas 14 data pairs for sub-durations

SOFTWARE & TOOLS UPDATE

SDHydroTools Program

- SDUH Peak Discharge Program replaced by SDHydroTools
- SDUH module within SDHydroTools: single-basin hydrograph & peak flow
- HEC-HMS required for multi-basin routing & hydrograph combination

Retired References

- HEC TD-15 replaced by HEC-HMS Technical Reference Manual
- HEC-1 input/output references removed
- NOAA Atlas 2 citation updated

CLARIFICATIONS

Data Sources & Methods

- SanGIS identified as source for GIS soil & land cover data layers

Section 5: Erosion & Sedimentation

NEW: SEDIMENT BULKING

Bulking Factor Study

- TAC subcommittee formed 2020; study by River Focus (October 2022)
- Addresses sediment/debris yields, bulking factors, & post-fire runoff
- Draws on Southern California county practices & current research

Design Guidance

- Normal conditions: hazard area ID (Fig 5-8), mitigation flowchart (Fig 5-9)
- Post-fire conditions: emergency & 2 to10-year recovery guidance
- Example problem added (Workbook WB.4.3)

RUSLE 2

Soil Loss Updates

- USLE upgraded to RUSLE 2
- R factor: isopluvial maps replaced by NOAA Atlas 14 data for rainfall depths

Section 6: Rational Method Hydrograph Procedure

PROCEDURE REWRITE

Hydrograph Methodology

- Section substantially expanded with new 4-step procedure
- Detailed incremental rainfall block methodology added
- Triangular hydrograph construction explicitly described
- Peak time formally defined as Tp = 240 min + 1/2 Tc

RAINFALL & FORMULAS

NOAA Atlas 14 Integration

- Old intensity formula removed
- Rainfall depths now from NOAA Atlas 14 (5 min to 6 hr)
- Log-log interpolation for in-between durations
- Legacy equations (Eq. 6-2, 6-6, 6-7) all deleted

SOFTWARE UPDATE

SDHydroTools

- RATHYDRO program replaced by SDHydroTools
- Automates all 4 steps; outputs HEC-HMS-compatible hydrograph

Section 7: Water Quality Considerations

ADDED

Current Standards Reference

- Direct reference to County BMP Design Manual for water quality requirements
- Reference to DPW Watershed Protection Program stormwater regulations webpage
- Guidance to consult latest BMP Design Manual for current regulations

NET EFFECT

Minimal Changes

- Section 7 remains brief; water quality procedures still governed externally

Workbook & Other Sections

WORKBOOK

Updates to

- Reflect NOAA Atlas 14 change
- Switching to HEC-HMS from HEC-1
- Sediment bulking factor sample problem

OTHER SECTIONS

Updates to

- Table of Contents
- Acknowledgements
- Acronyms
- Glossary

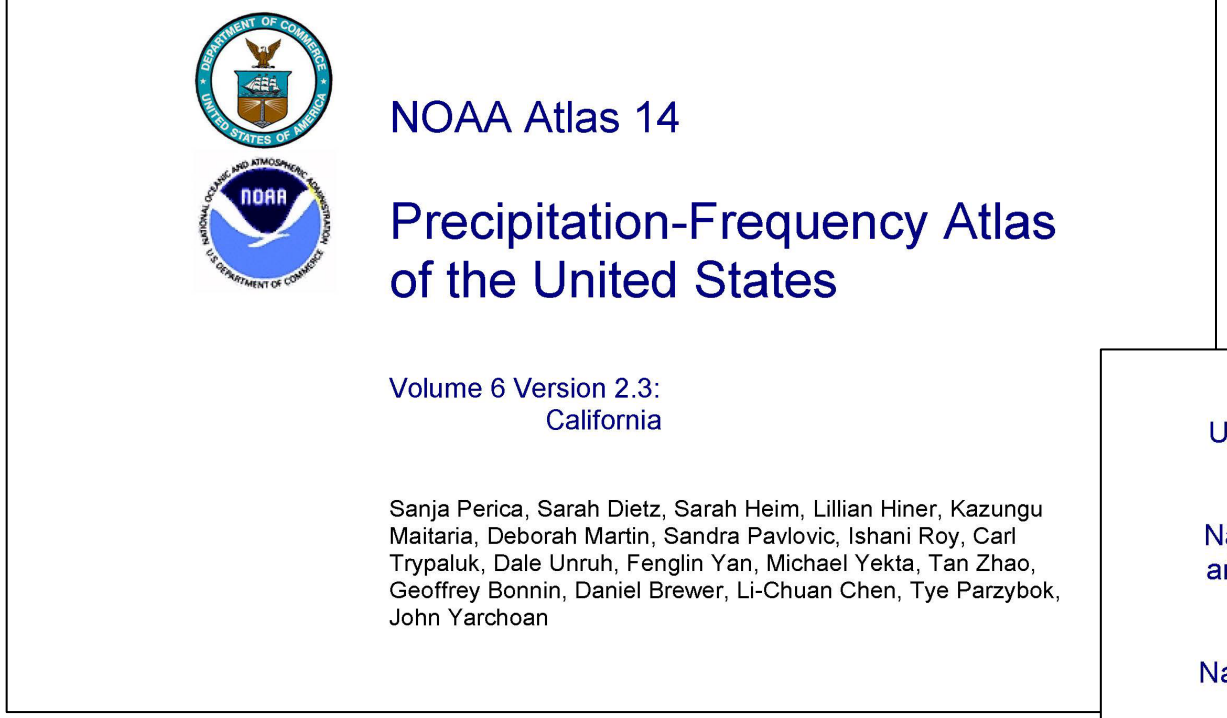
NOAA Atlas 14 Implementation

June 17, 2026

Laura Henry, PE
Associate Project Engineer

RICK

NOAA Atlas 14


NOAA Atlas 14

Precipitation-Frequency Atlas of the United States

Volume 6 Version 2.3:
California

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

U.S. Department of Commerce

National Oceanic and Atmospheric Administration

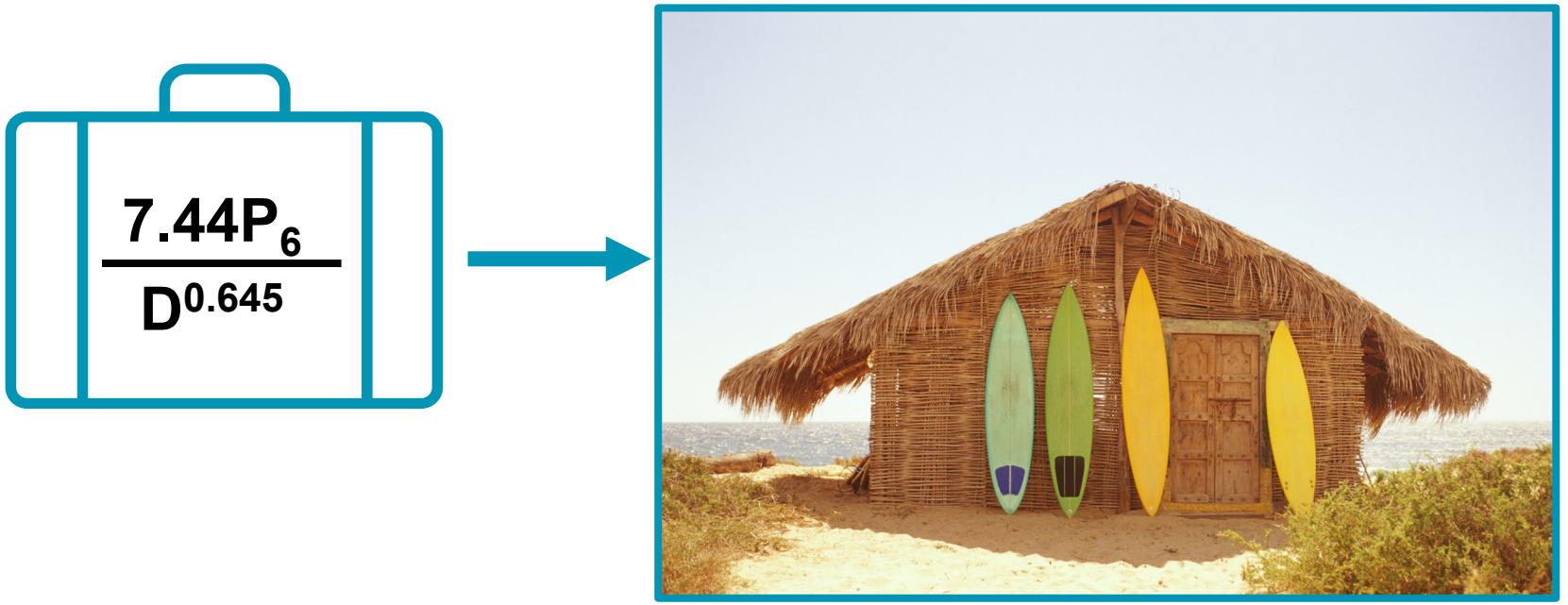
National Weather Service

Silver Spring, Maryland, 2011
revised 2014

- More current rainfall data
- Spatial variability of intensity slope across the County

NOAA Atlas 14 Implementation

- The intensity equation $7.44P_6/D^{\wedge 0.645}$ and isopluvial maps provided in the June 2003 Hydrology Manual will be retired



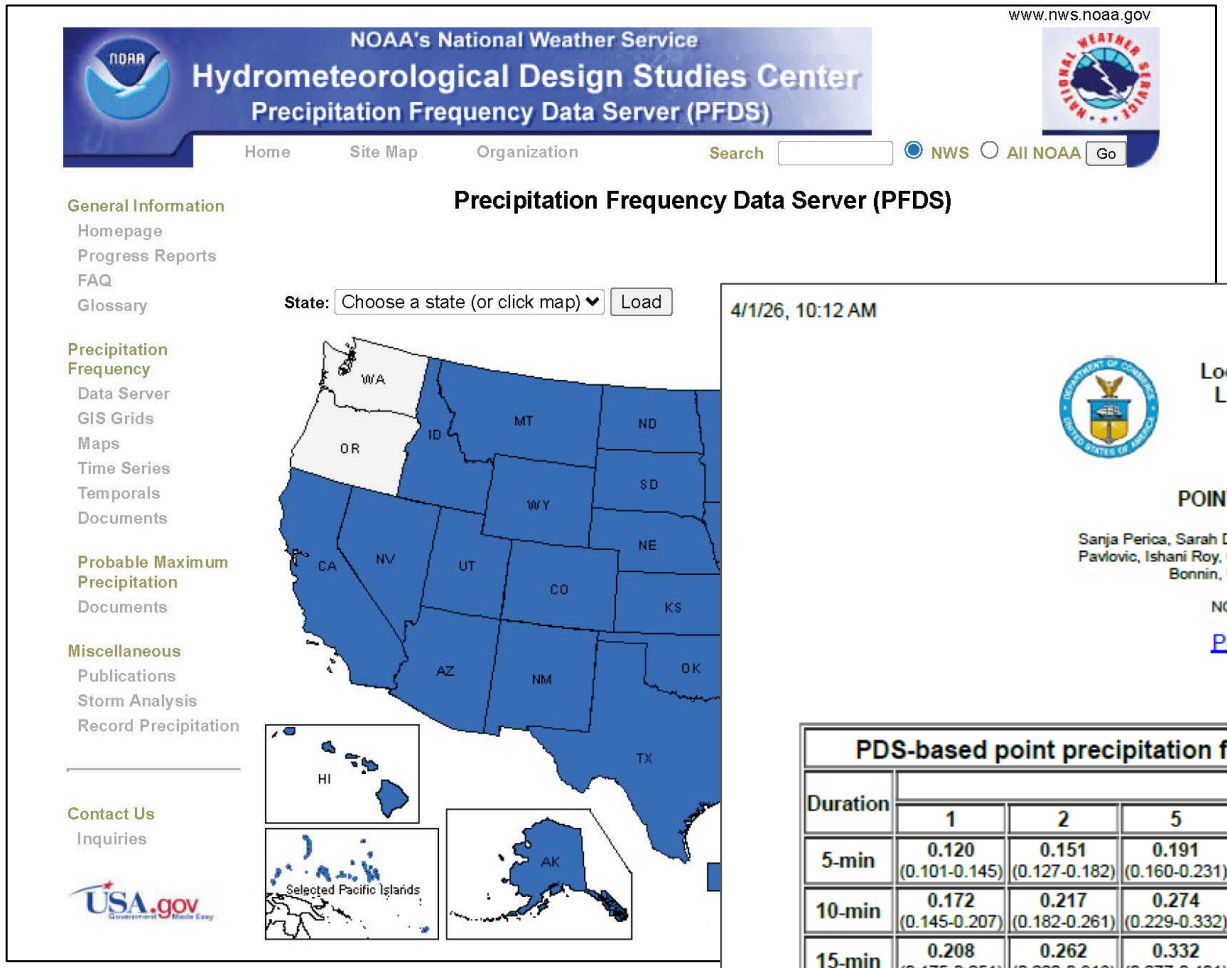
NOAA Atlas 14 Implementation

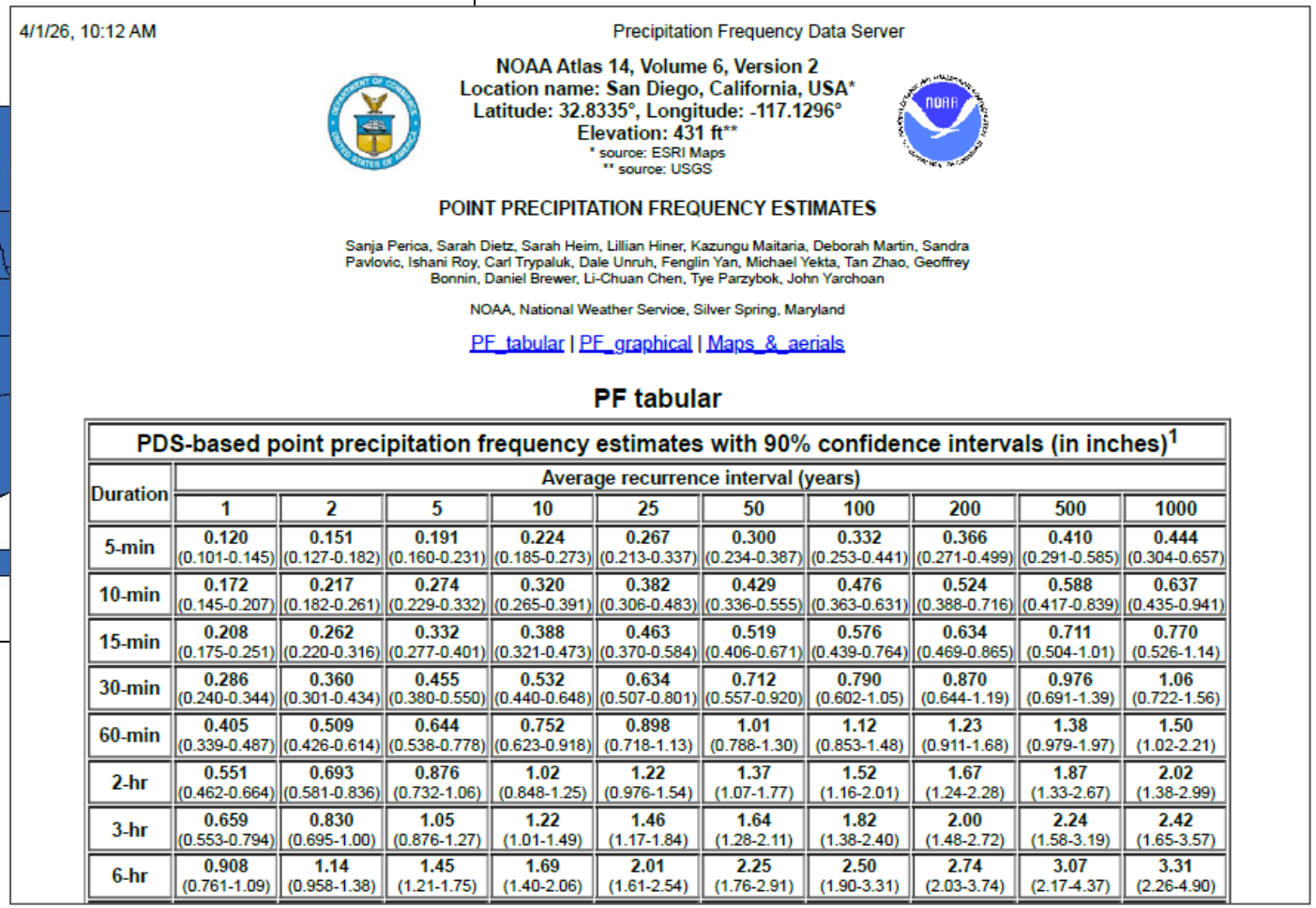
- Rainfall depths and rainfall intensity will be obtained from NOAA Atlas 14

- Precipitation Frequency Estimates are published through a Precipitation Frequency Data Server (PFDS)

http://hdsc.nws.noaa.gov/hdsc/pfds

NOAA Atlas 14 PFDS





4/1/26, 10:12 AM — Precipitation Frequency Data Server

NOAA Atlas 14, Volume 6, Version 2
Location name: San Diego, California, USA*
Latitude: 32.8335°, Longitude: -117.1296°
Elevation: 431 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

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	0.120 (0.101-0.145)	0.151 (0.127-0.182)	0.191 (0.160-0.231)	0.224 (0.185-0.273)	0.267 (0.213-0.337)	0.300 (0.234-0.387)	0.332 (0.253-0.441)	0.366 (0.271-0.499)	0.410 (0.291-0.585)	0.444 (0.304-0.657)
10-min	0.172 (0.145-0.207)	0.217 (0.182-0.261)	0.274 (0.229-0.332)	0.320 (0.265-0.391)	0.382 (0.306-0.483)	0.429 (0.336-0.555)	0.476 (0.363-0.631)	0.524 (0.388-0.716)	0.588 (0.417-0.839)	0.637 (0.435-0.941)
15-min	0.208 (0.175-0.251)	0.262 (0.220-0.316)	0.332 (0.277-0.401)	0.388 (0.321-0.473)	0.463 (0.370-0.584)	0.519 (0.406-0.671)	0.576 (0.439-0.764)	0.634 (0.469-0.865)	0.711 (0.504-1.01)	0.770 (0.526-1.14)
30-min	0.286 (0.240-0.344)	0.360 (0.301-0.434)	0.455 (0.380-0.550)	0.532 (0.440-0.648)	0.634 (0.507-0.801)	0.712 (0.557-0.920)	0.790 (0.602-1.05)	0.870 (0.644-1.19)	0.976 (0.691-1.39)	1.06 (0.722-1.56)
60-min	0.405 (0.339-0.487)	0.509 (0.426-0.614)	0.644 (0.538-0.778)	0.752 (0.623-0.918)	0.898 (0.718-1.13)	1.01 (0.788-1.30)	1.12 (0.853-1.48)	1.23 (0.911-1.68)	1.38 (0.979-1.97)	1.50 (1.02-2.21)
2-hr	0.551 (0.462-0.664)	0.693 (0.581-0.836)	0.876 (0.732-1.06)	1.02 (0.848-1.25)	1.22 (0.976-1.54)	1.37 (1.07-1.77)	1.52 (1.16-2.01)	1.67 (1.24-2.28)	1.87 (1.33-2.67)	2.02 (1.38-2.99)
3-hr	0.659 (0.553-0.794)	0.830 (0.695-1.00)	1.05 (0.876-1.27)	1.22 (1.01-1.49)	1.46 (1.17-1.84)	1.64 (1.28-2.11)	1.82 (1.38-2.40)	2.00 (1.48-2.72)	2.24 (1.58-3.19)	2.42 (1.65-3.57)
6-hr	0.908 (0.761-1.09)	1.14 (0.958-1.38)	1.45 (1.21-1.75)	1.69 (1.40-2.06)	2.01 (1.61-2.54)	2.25 (1.76-2.91)	2.50 (1.90-3.31)	2.74 (2.03-3.74)	3.07 (2.17-4.37)	3.31 (2.26-4.90)

Gathering NOAA Atlas 14 Data

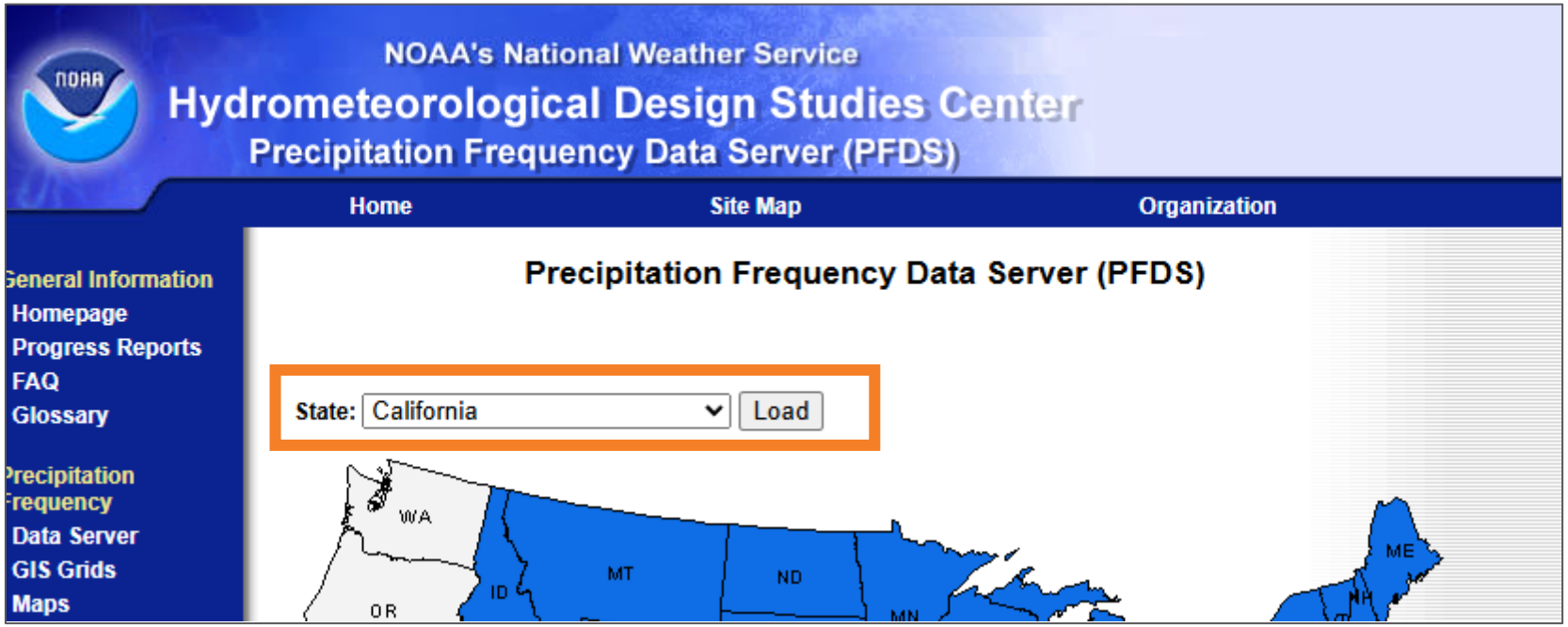
- Online PFDS interface
- GIS data available from PFDS website

- 100-year data embedded in SDHydroTools program

- Instructions for using the online PFDS interface and/or SDHydroTools are provided in Appendix B of the Hydrology Manual

Gathering NOAA Atlas 14 Data

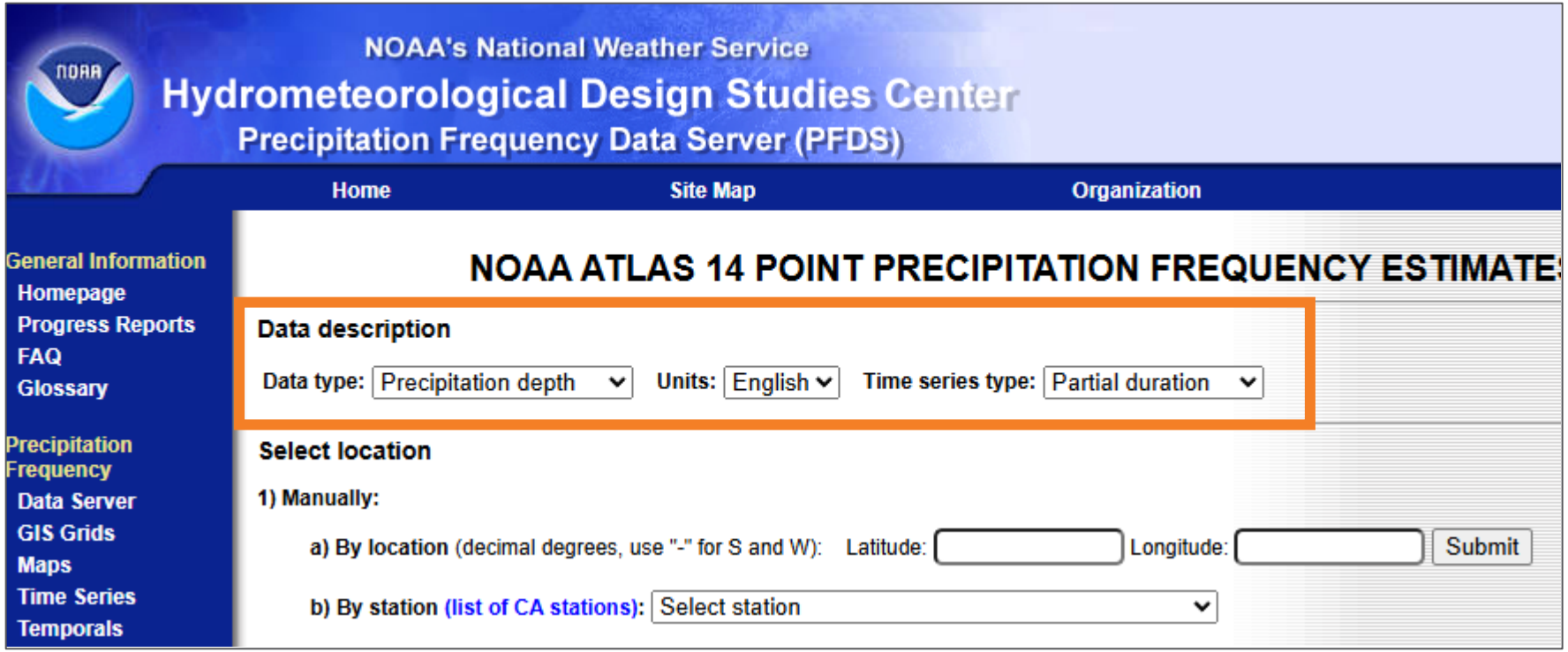
- Open the PFDS website and select California



http://hdsc.nws.noaa.gov/hdsc/pfds

Gathering NOAA Atlas 14 Data

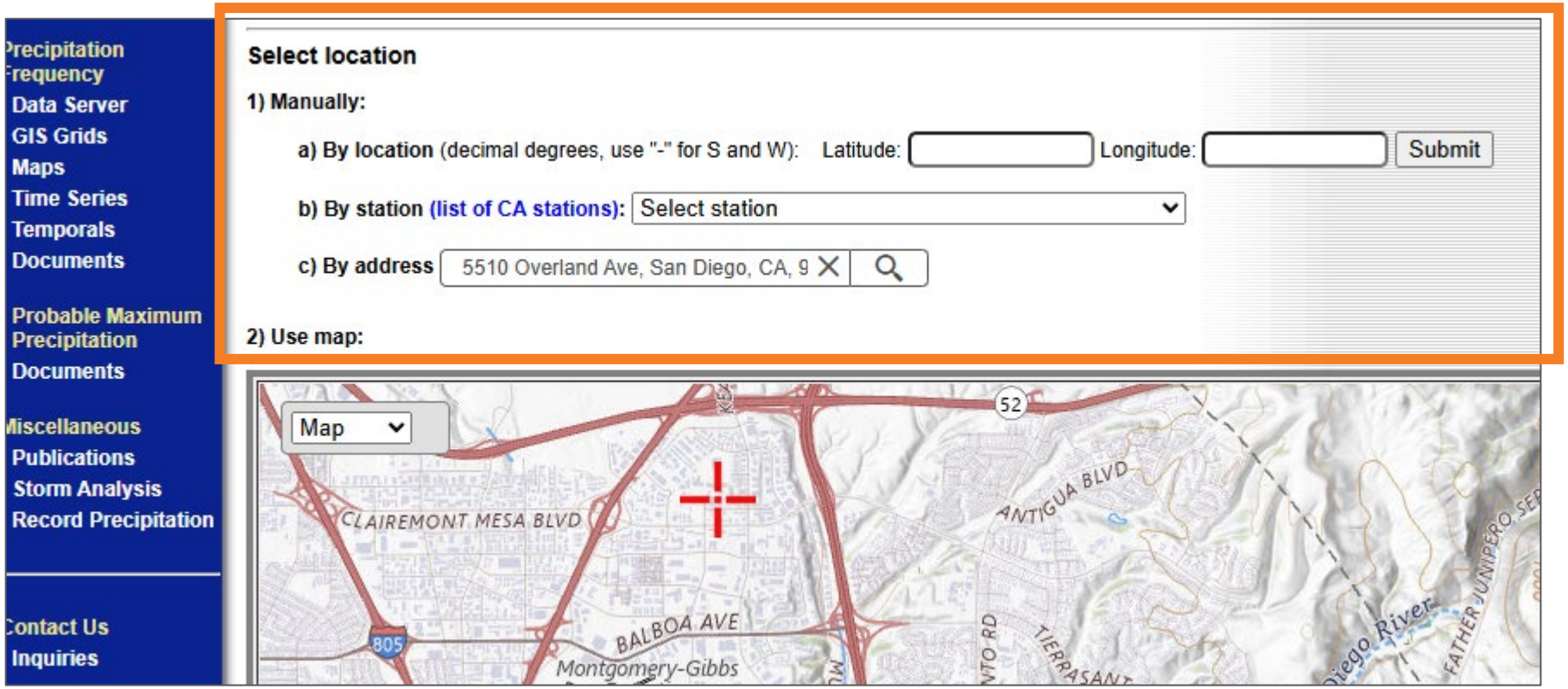
- Select the data type, units, and time series type



http://hdsc.nws.noaa.gov/hdsc/pfds

Gathering NOAA Atlas 14 Data

- Select the location for the data



http://hdsc.nws.noaa.gov/hdsc/pfds

Gathering NOAA Atlas 14 Data

- Print the data to store in your project file and to include in your drainage study report

POINT PRECIPITATION FREQUENCY (PF) ESTIMATES

WITH 90% CONFIDENCE INTERVALS AND SUPPLEMENTARY INFORMATION
NOAA Atlas 14, Volume 6, Version 2

PF tabular | PF graphical | Supplementary information | Print page

PDS-based 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	**0.120** (0.101-0.145)	**0.151** (0.127-0.182)	**0.191** (0.160-0.231)	**0.224** (0.185-0.273)	**0.267** (0.213-0.337)	**0.300** (0.234-0.387)	**0.332** (0.253-0.441)	**0.366** (0.271-0.499)	**0.410** (0.291-0.585)	**0.444** (0.304-0.657)
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Gathering NOAA Atlas 14 Data

- Gather NOAA Atlas 14 data specific to each project/study
  - Rational method / small watersheds –
    - Select the project location
  - NRCS hydrology / large watersheds –
    - Select the watershed centroid

- *Always record the latitude / longitude for the selected location to ensure data can be reproduced*

Using NOAA Atlas 14 Data

- NOAA Atlas 14 provides paired data
  - Time-Depth, Time-Intensity

POINT PRECIPITATION FREQUENCY ESTIMATES

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/hour)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	1.44 (1.21-1.74)	1.81 (1.52-2.18)	2.29 (1.92-2.77)	2.69 (2.22-3.28)	3.20 (2.56-4.04)	3.60 (2.81-4.64)	3.98 (3.04-5.29)	4.39 (3.25-5.99)	4.92 (3.49-7.02)	5.33 (3.65-7.88)
10-min	1.03 (0.870-1.24)	1.30 (1.09-1.57)	1.64 (1.37-1.99)	1.92 (1.59-2.35)	2.29 (1.84-2.90)	2.57 (2.02-3.33)	2.86 (2.18-3.79)	3.14 (2.33-4.30)	3.53 (2.50-5.03)	3.82 (2.61-5.65)
15-min	0.832 (0.700-1.00)	1.05 (0.880-1.26)	1.33 (1.11-1.60)	1.55 (1.28-1.89)	1.85 (1.48-2.34)	2.08 (1.62-2.68)	2.30 (1.76-3.06)	2.54 (1.88-3.46)	2.84 (2.02-4.06)	3.08 (2.10-4.55)
30-min	0.572 (0.480-0.688)	0.720 (0.602-0.868)	0.910 (0.760-1.10)	1.06 (0.880-1.30)	1.27 (1.01-1.60)	1.42 (1.11-1.84)	1.58 (1.20-2.09)	1.74 (1.29-2.37)	1.95 (1.38-2.78)	2.11 (1.44-3.12)
60-min	0.405 (0.339-0.487)	0.509 (0.426-0.614)	0.644 (0.538-0.778)	0.752 (0.623-0.918)	0.898 (0.718-1.13)	1.01 (0.788-1.30)	1.12 (0.853-1.48)	1.23 (0.911-1.68)	1.38 (0.979-1.97)	1.50 (1.02-2.21)

Using NOAA Atlas 14 Data

- Use log-log interpolation between paired data points
- New procedures are described in Sections 3, 4, 6, and Workbook

- The intensity equation $I = 7.44P_6D^{-0.645}$ provided in Figure 3-1 of the June 2003 version of the manual has been retired

Log-Log Interpolation

$I_{Tc} = K \cdot T_c^n$

with $K = I_1/T_1^n = I_2/T_2^n$

$n = \text{Log}(I_2/I_1)/\text{Log}(T_2/T_1)$

Or

$I_{Tc} = \text{Log}^{-1}(\text{Log}I_1 + (\text{Log}(T_c / T_1))\ (\text{Log}(I_2 / I_1)/(\text{Log}(T_2 / T_1))))$

Or

$I_{Tc} = I_1 \cdot (T_c / T_1)^n$

with $n = \text{Log}(I_2 / I_1)/(\text{Log}(T_2 / T_1))$

Equations for log-log interpolation are provided in Section 3

Where:

I_{Tc} = Intensity at T_c (inches per hour)

T_c = time of concentration (minutes)

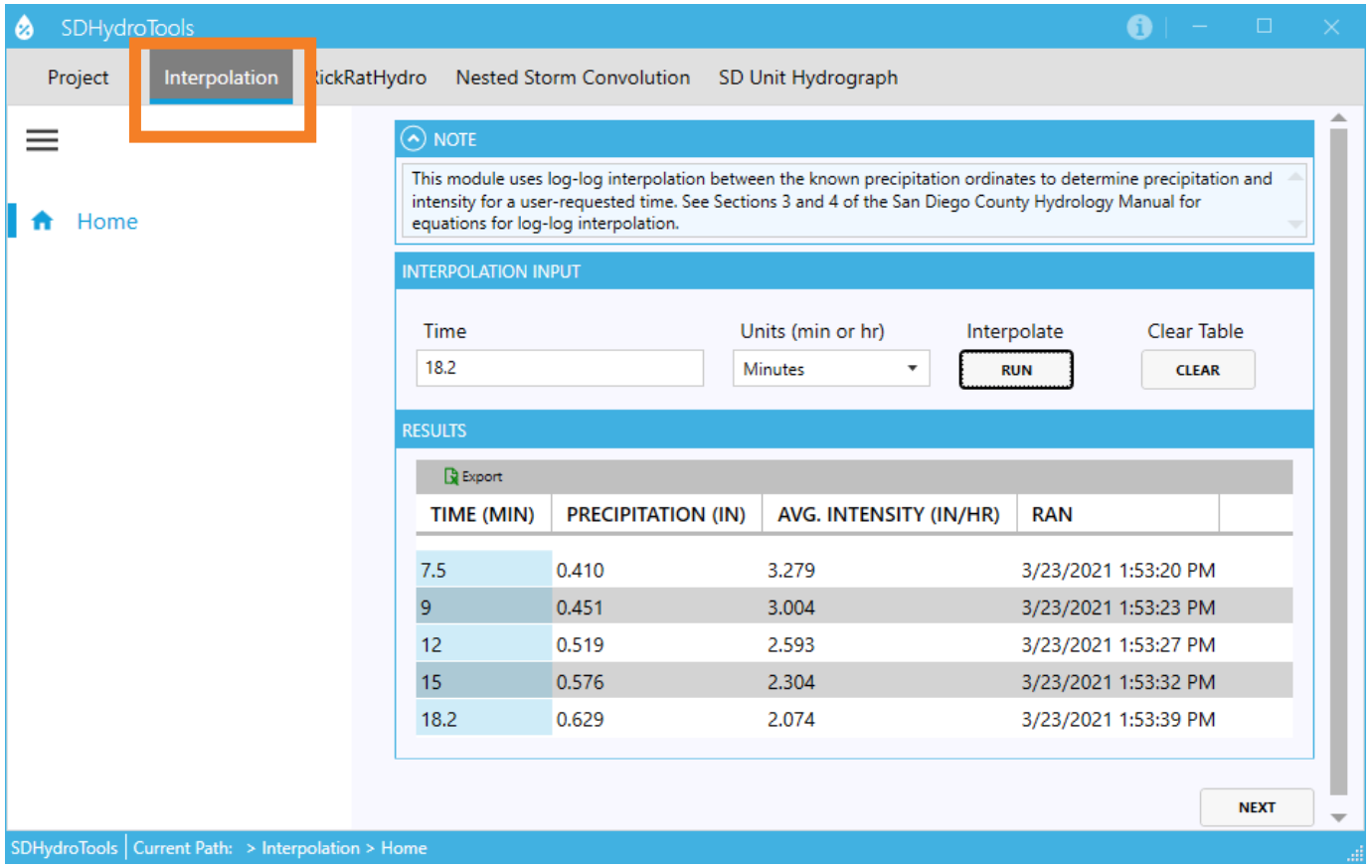
T_1 and T_2 are the bounding times (minutes) of given data points from NOAA Atlas 14 and $T_1 < T_c < T_2$

I_1 = Intensity at T_1 (inches per hour) from NOAA Atlas 14

I_2 = Intensity at T_2 (inches per hour) from NOAA Atlas 14

Log-Log Interpolation

- SDHydroTools provides an interpolation tool

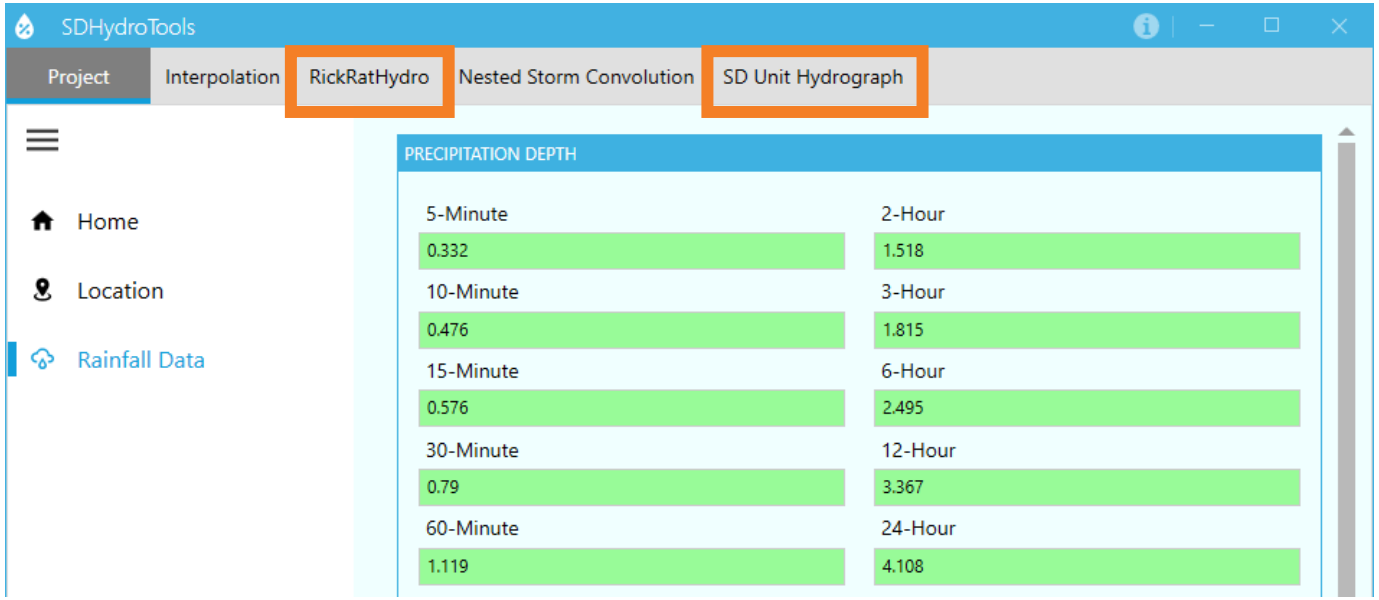


Updated Hydrologic Procedures

- Rational method (Section 3)
  - Intensity in the rational method equation Q = CIA
- NRCS method (Section 4)
  - Rainfall depths in the hyetograph
- Rational method hydrograph (Section 6)
  - Rainfall depths in each rainfall block

Updated Tools

- SDHydroTools computer program replaces
  - Rational Hydrograph (RATHYDRO) with “RickRatHydro” module
  - San Diego Unit Hydrograph (SDUH) with “SD Unit Hydrograph”



Updated Tools

- SDHydroTools computer program adds
  - "Nested Storm Convolution" to create a hyetograph for NRCS studies

Example Problems

- Example problems in the Hydrology Manual Workbook have been updated to reflect NOAA Atlas 14 intensity input

$I_{10.6\text{-min}} = \text{Log}^{-1}(\text{Log}(3.49) + (\text{Log}(10.6 / 10))\ (\text{Log}(2.82 / 3.49)/(\text{Log}(15 / 10))))$

$I_{10.6\text{-min}} = 3.4$ in/hr

Now calculate Q for node 0102 using the rational method equation.

$Q_{0102} = \Sigma(CA)I = 0.21\ (3.4) = 0.7$ cfs

Questions Roundtable 1

SDHydroTools

June 17, 2026

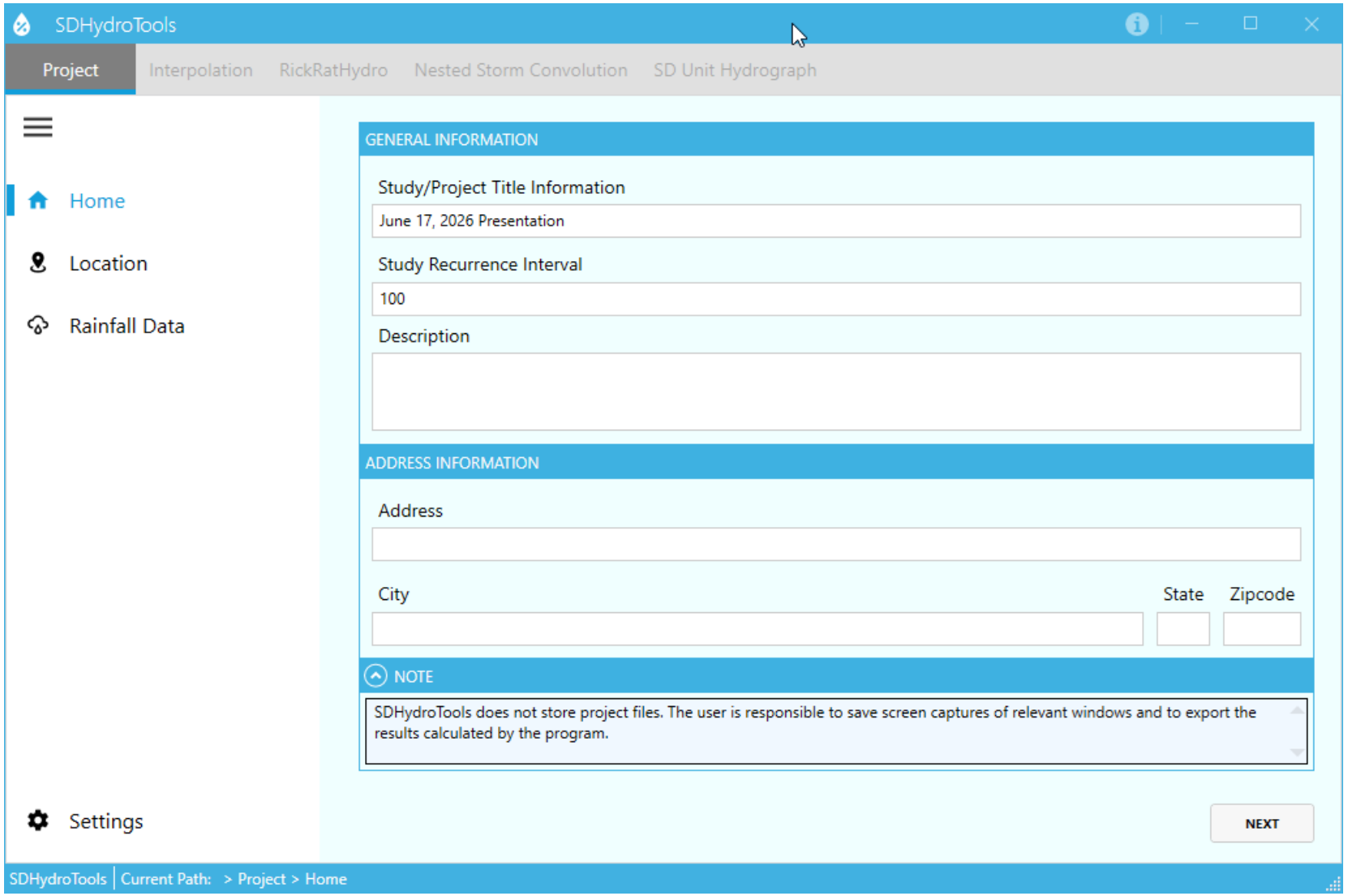
Laura Henry, PE
Associate Project Engineer

RICK

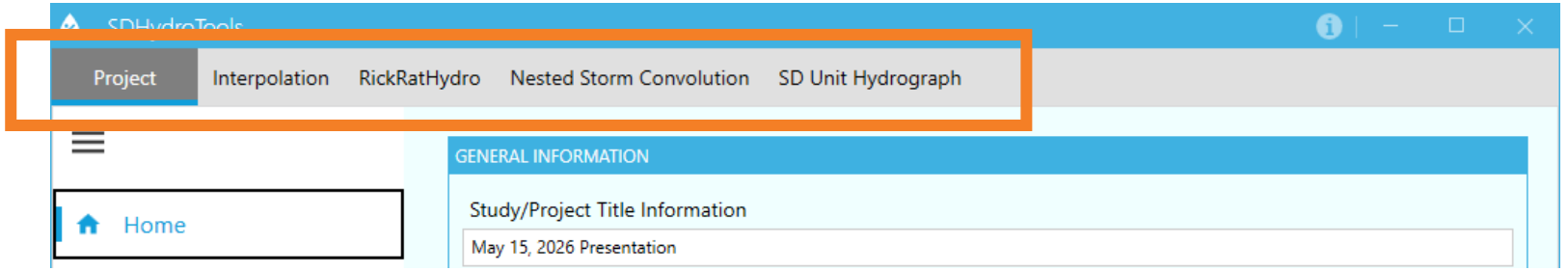
SDHydroTools

- Free tool provided by the County
- Replaces June 2003 Hydrology Manual Rational Hydrograph (RATHYDRO) and San Diego Unit Hydrograph (SDUH) programs
- Adds log-log interpolation utility and nested storm utility
- NOAA Atlas 14 100-year data embedded within program

SDHydroTools



SDHydroTools Modules

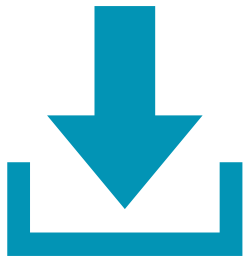


- Obtain NOAA Atlas 14 100-year rainfall depth data for locations within San Diego County
- Interpolate rainfall depths and intensities using log-log interpolation
- Prepare a rational method hydrograph (Section 6)
- Prepare a nested storm hyetograph (Section 4)
- Calculate a peak flow rate and generate a hydrograph using NRCS hydrologic method (Section 4)

SDHydroTools Location and Instructions

- Program and user instructions provided on County of San Diego Hydrology Manual website

https://www.sandiegocounty.gov/content/sdc/dpw/flood/hydrologymanual.html



- Download program and install on local machine
- Download user instructions

SDHydroTools User Instructions

- How to install the program
- Overview of the program layout
  - Program modules/tabs & windows within each module
- How to get started
  - Required input and actions to initiate program modules
- Description and purpose of each module
- How to use each module and export results

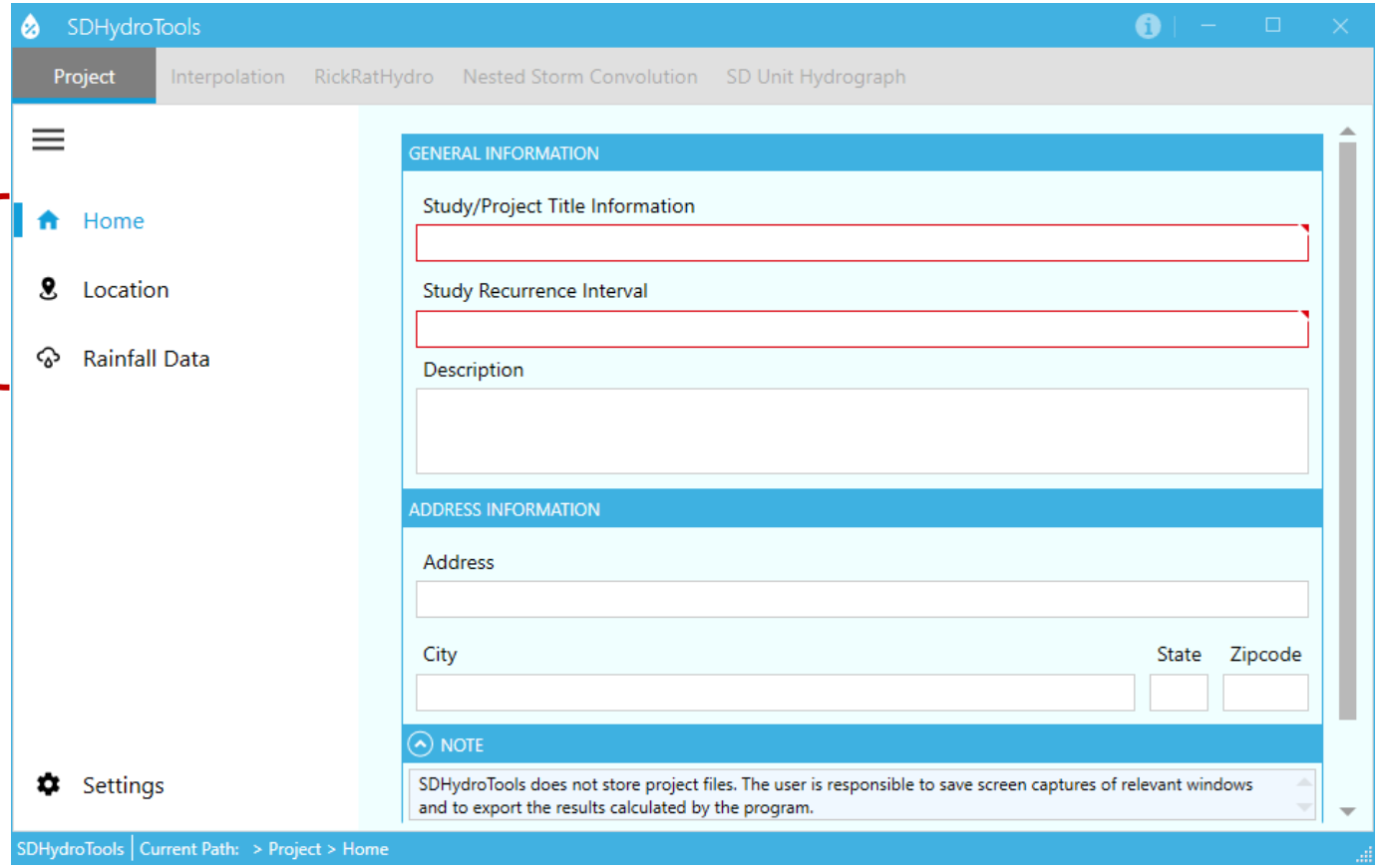
SDHydroTools Layout

- SDHydroTools includes 5 Modules shown in Tabs across the top.
- Each Module includes one or more Windows accessible along the left side.

Use Tabs on top to move between Modules.

Available Windows within each Module/Tab – Windows vary depending on the Module. Select these to move between Windows within a Module.

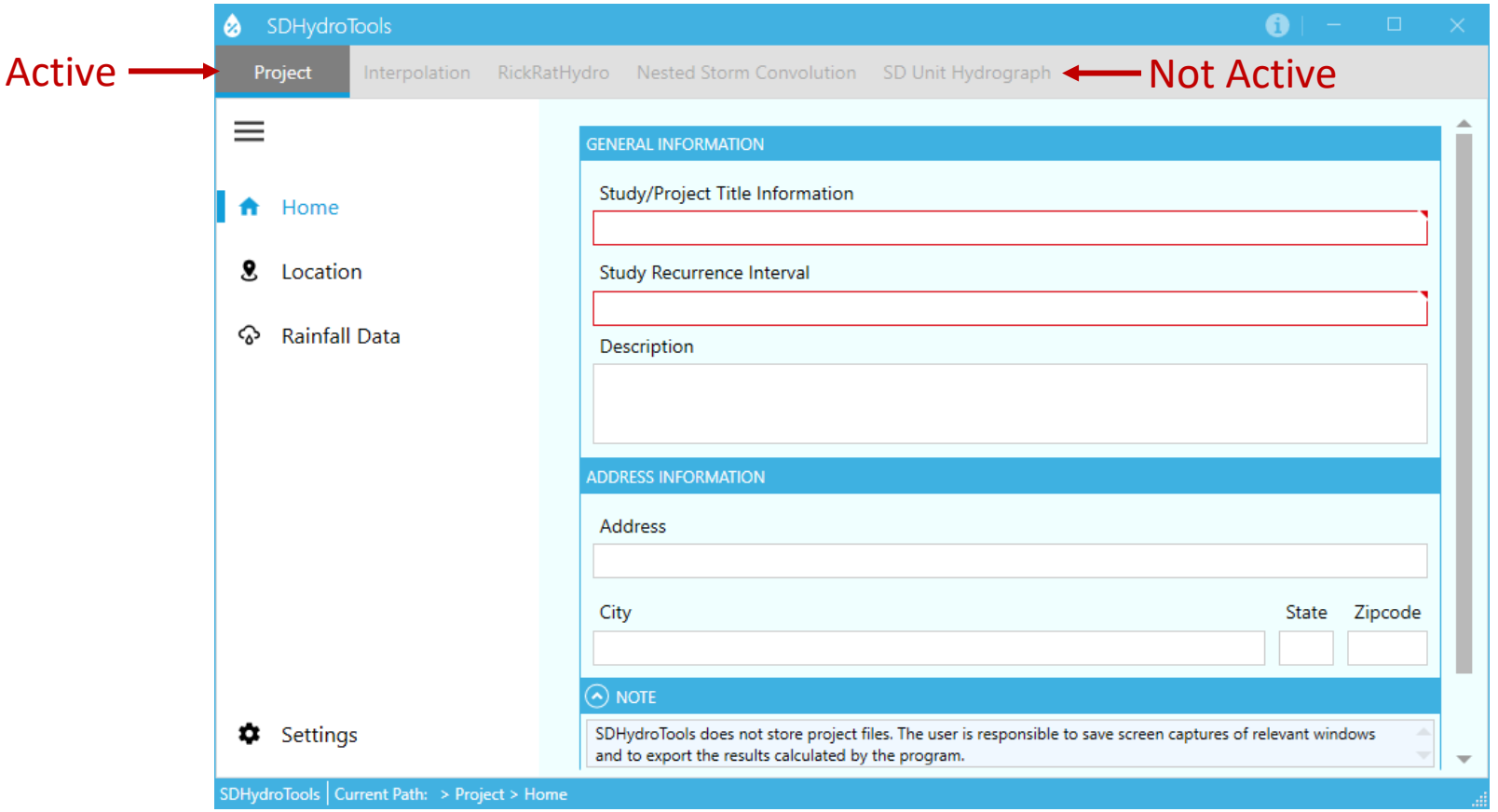
Settings (available in the Project Module) provides an option to access an offline map in the Location Window of the Project Module if no internet connection is available or if the online map does not load in the Location Window.



Starting SDHydroTools – Project Module

- When SDHydroTools is initially opened, only the Project Module is active.

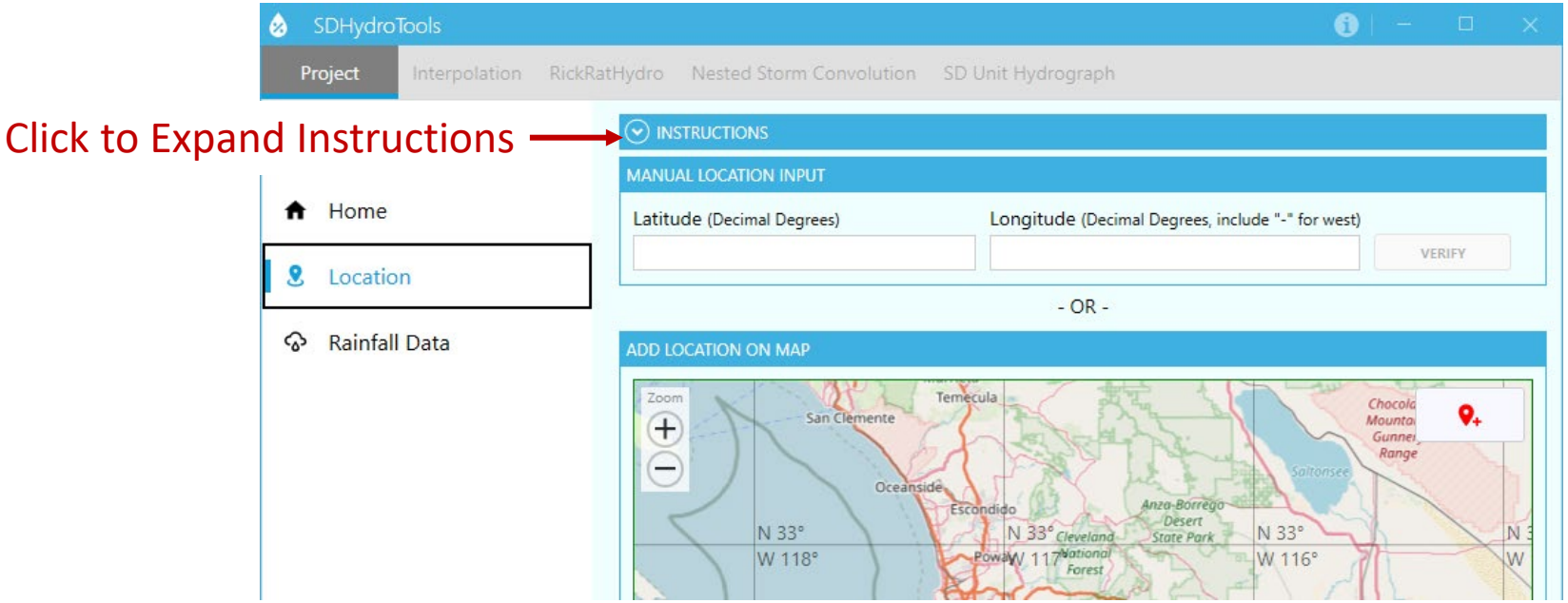
- To activate the other modules, rainfall data must be populated in the Rainfall Data Window based on a location provided in the Location Window of the Project Module.



Starting SDHydroTools – Project Module (Continued)

- A location must be provided for the program to get the embedded 100-year rainfall data. This step is mandatory to activate the computation modules, even when the user intends to substitute data from another source.

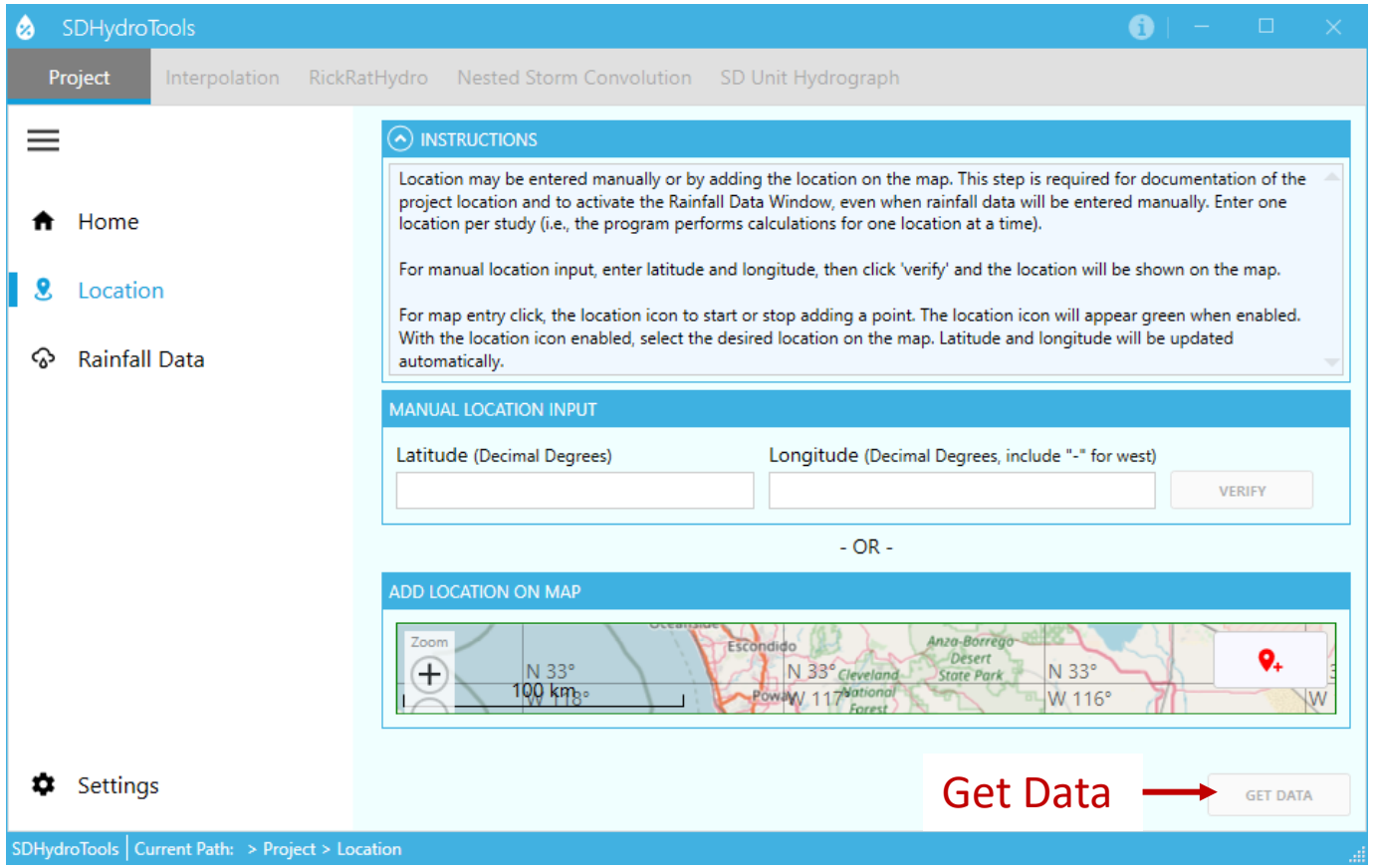
- If needed, expand the “Instructions” box to see instructions to select a location by entering a point or by entering latitude and longitude.



Starting SDHydroTools – Project Module (Continued)

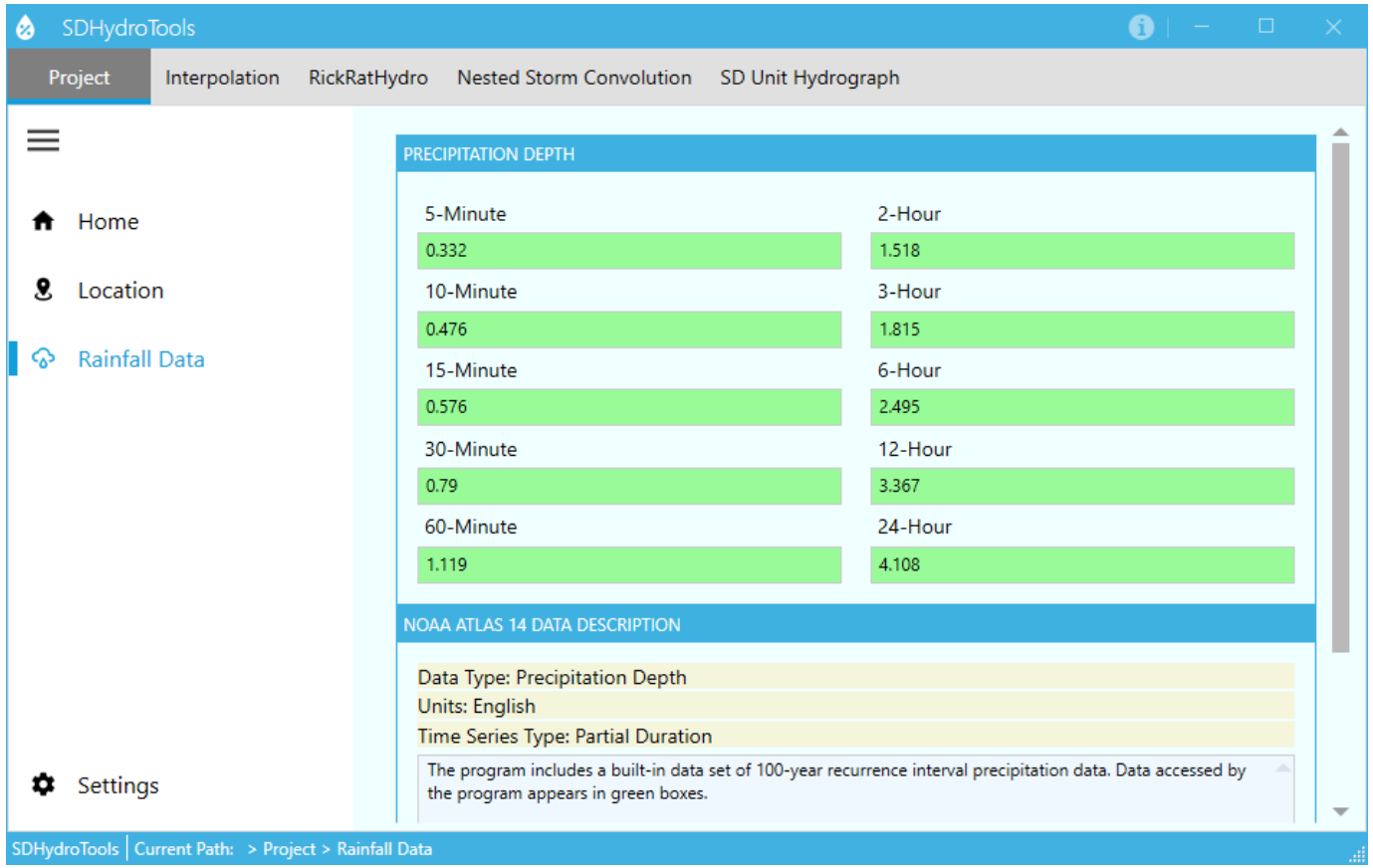
- Enter the project location in the Location Window of the Project Tab to get the embedded 100-year rainfall data.

1. Provide the project location per the instructions.
2. The “Get Data” button will be active after a valid (*i.e., within San Diego County*) project location has been entered.
3. (As Needed) Save a screen capture of the window for documentation. Note the latitude and longitude. Data can be reproduced by entering the same latitude and longitude.
4. Click on “Get Data” to move to the next Window.



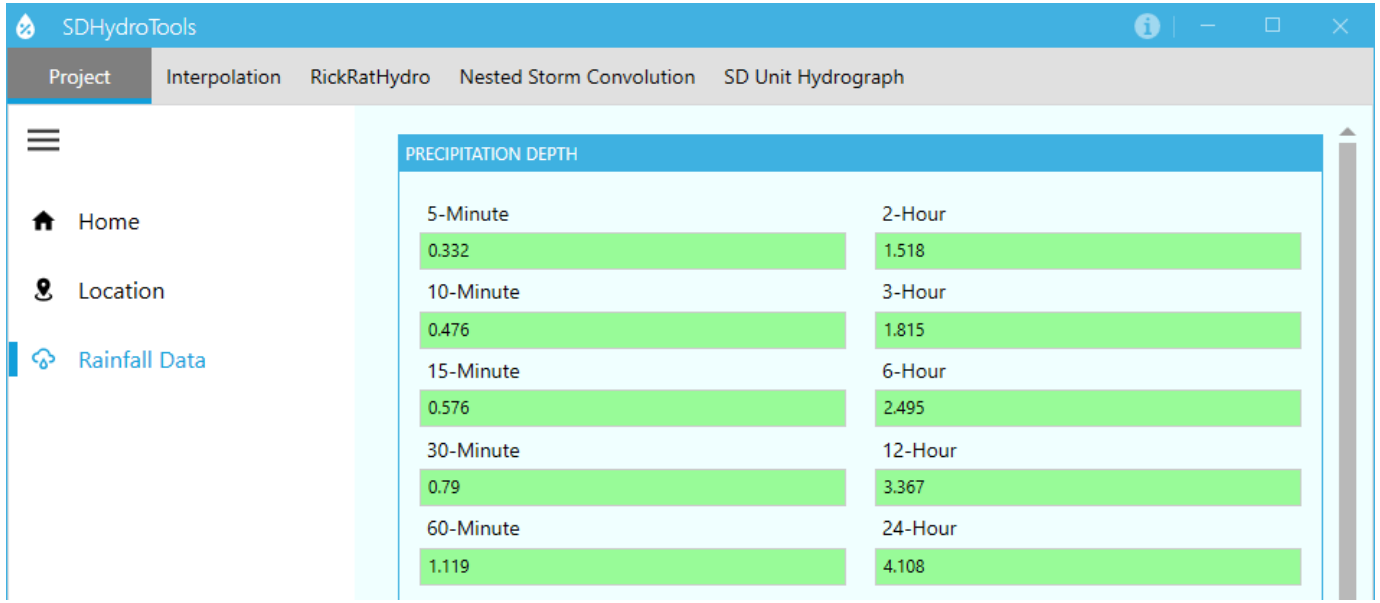
Starting SDHydroTools – Project Module (Continued)

- After clicking on “Get Data” in the Location Window, the data are presented in the Rainfall Data Window of the Project Module.
- 100-year rainfall data is provided in units of inches.
- (As Needed) Save a screen capture of the rainfall data.
- (As Needed) Data can be reproduced by re-entering the latitude and longitude of the project location in the Location Window (e.g., after closing the program, upon opening a new session).



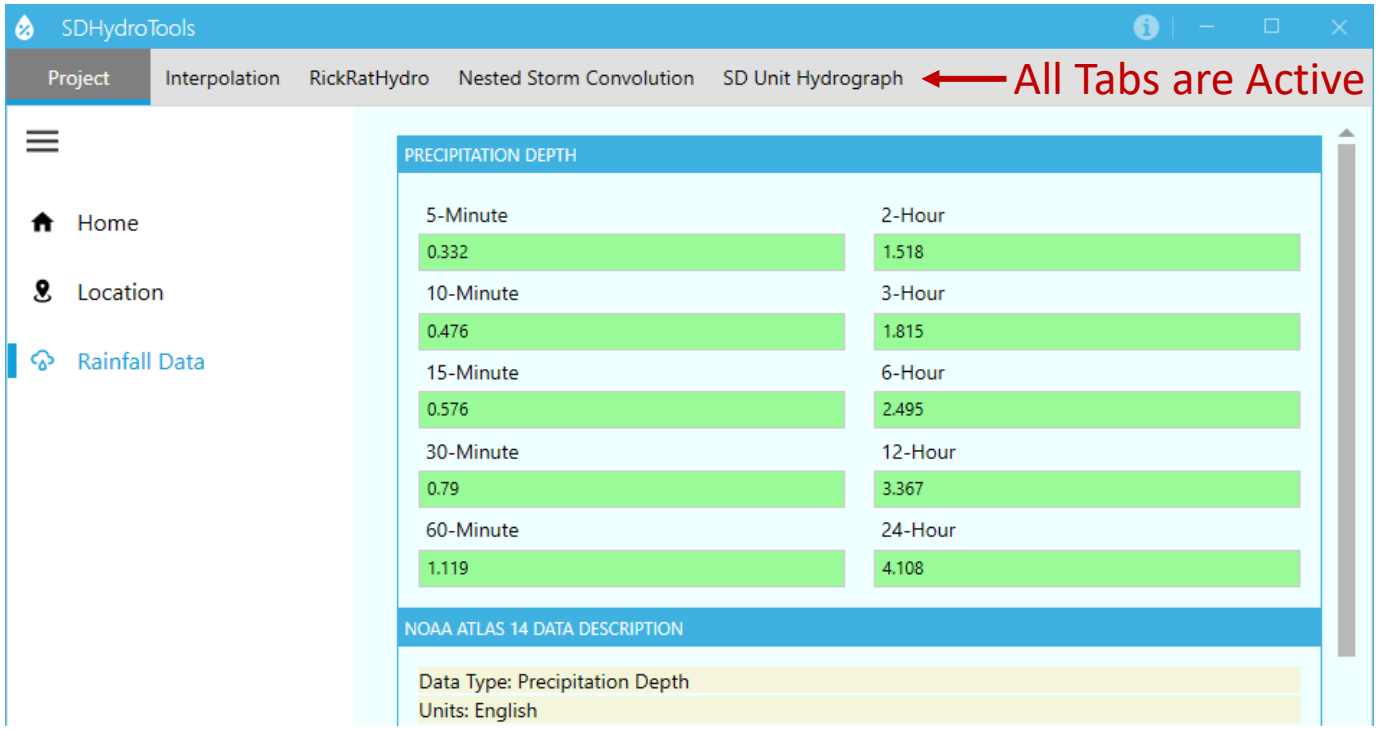
Starting SDHydroTools – Project Module (Continued)

- Once the embedded 100-year rainfall data has been populated by the program, the data will appear in green boxes.
- In this Window, the user may overwrite the embedded 100-year rainfall data with data obtained for a different storm event (e.g., 10-year) from an outside source (e.g., from the NOAA Atlas 14 website) if desired (optional).
- If the user overwrites the embedded data, the boxes will change color.
- The user-entered data will appear in red boxes.



Starting SDHydroTools – Project Module (Continued)

- After rainfall data has been populated in the Project Tab, the Tabs for the computation Modules become active.
- Select the Tab for the desired Module.
- It is not necessary to move through all Tabs within the program. Go directly to the Tab for the desired Module.
- More than one Module may be used in the same session with the same rainfall data.



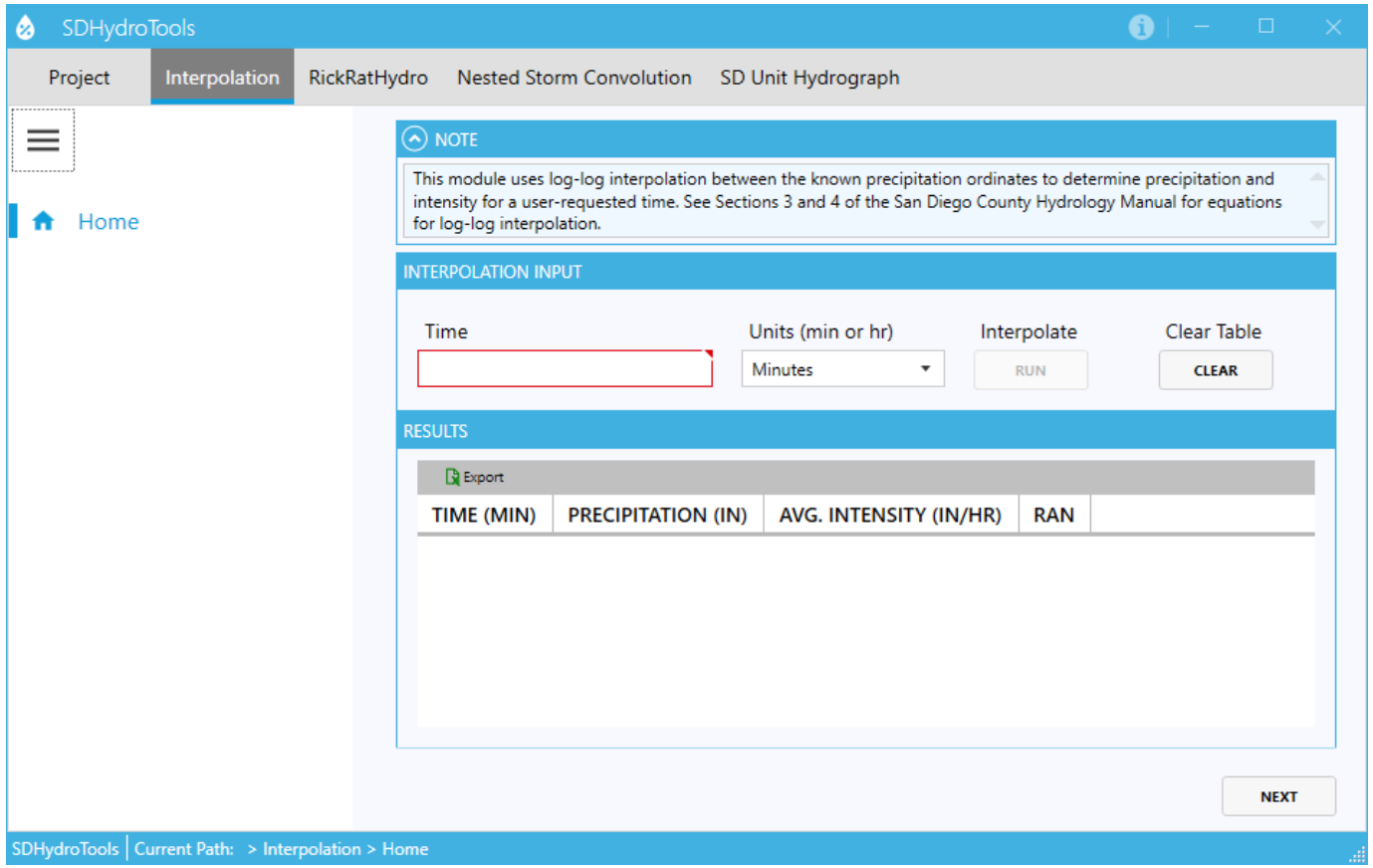
SDHydroTools Interpolation Module

- Performs log-log interpolation between rainfall data points
- Log-log interpolation equation presented in Section 3 of the 2026 Hydrology Manual
- Depths and intensities calculated
- Results may be exported

SDHydroTools Interpolation Module

- The **Interpolation Module** performs log-log interpolation between rainfall data points. For example, to obtain rainfall intensity for a given time of concentration for the purpose of rational method calculations.

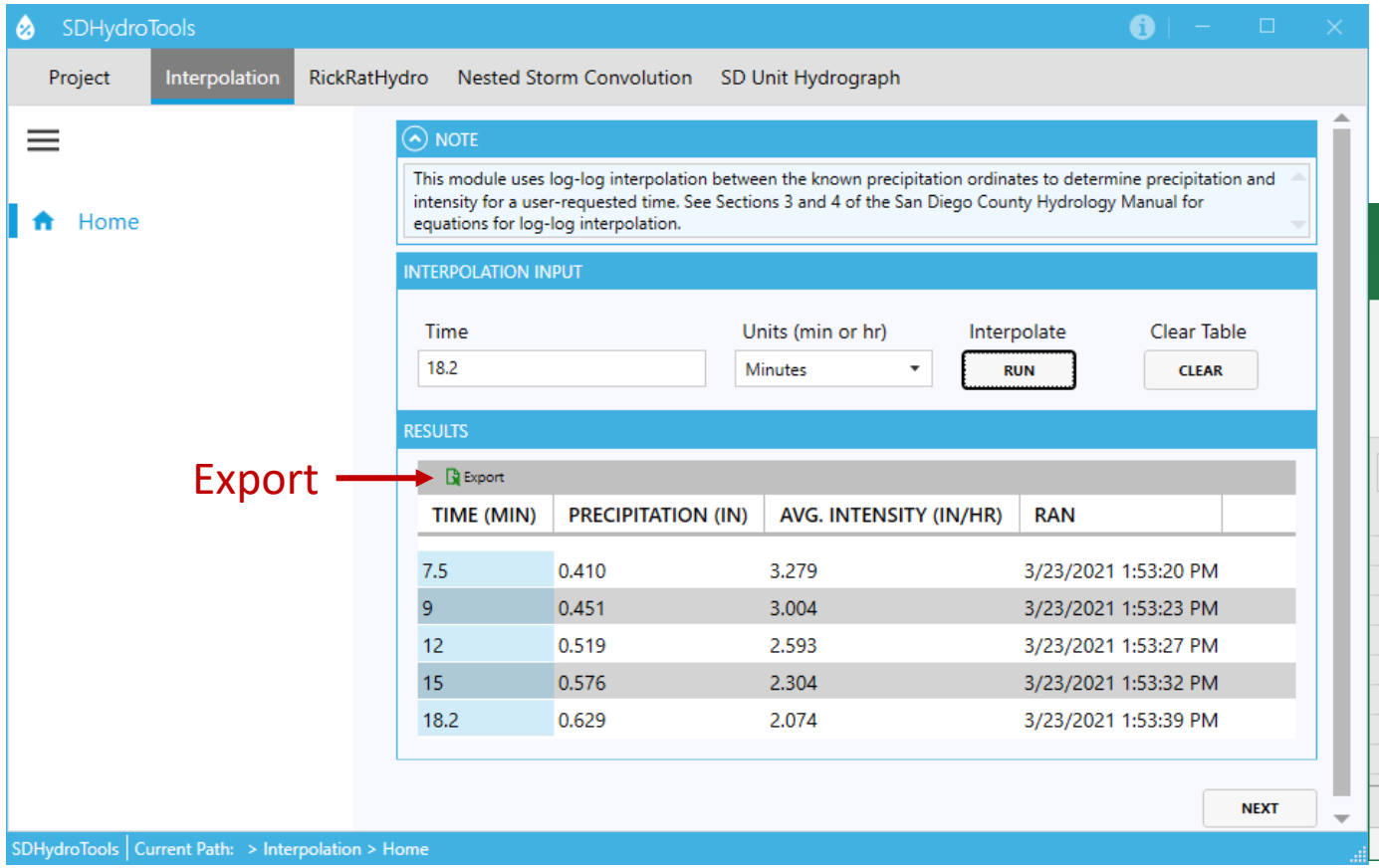
1. Enter the desired time (e.g., your rational method time of concentration) in minutes or hours.
2. Select the applicable units for the time that was entered (either minutes or hours).
3. Click “Run”
4. (As Needed) Repeat steps 1-3 for additional times.



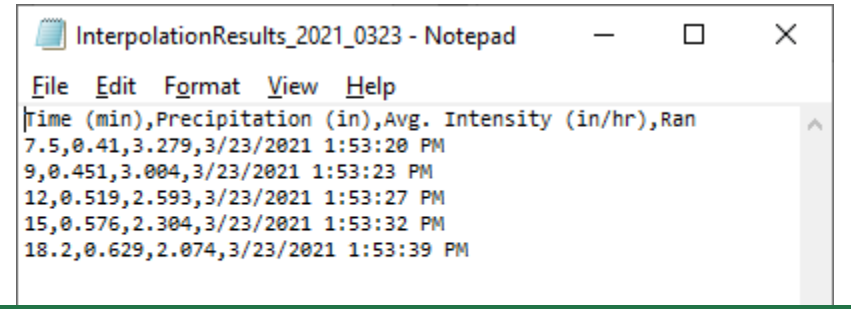
SDHydroTools Interpolation Module (Continued)

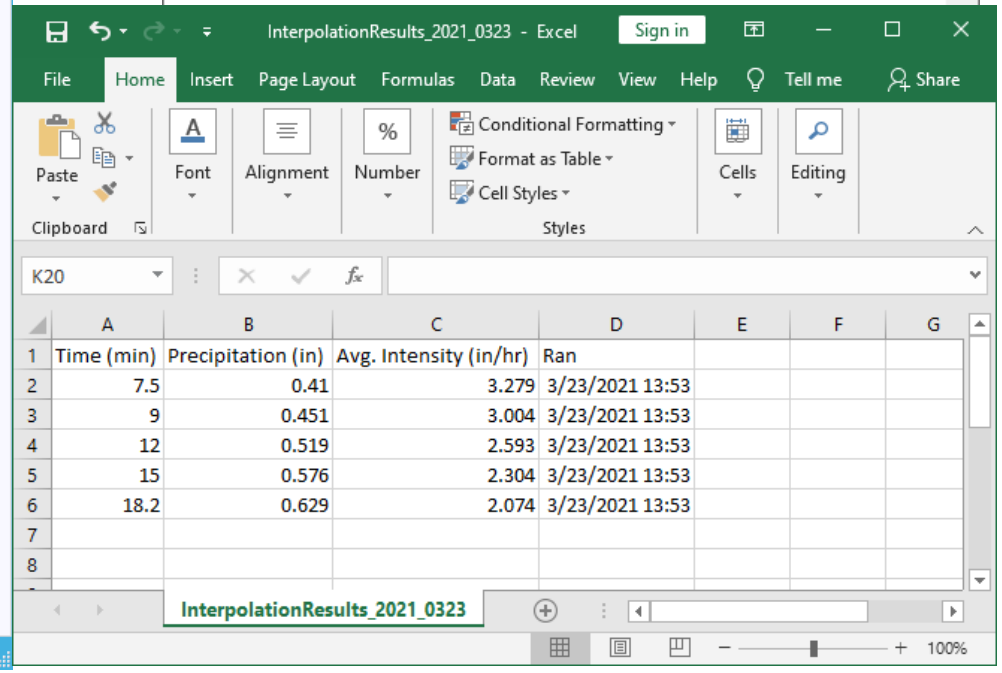
- Results from the Interpolation Module may be exported to a .csv file using the Export button and may be opened with an external program.

- (As Needed) Save a screen capture of SDHydroTools.



Export





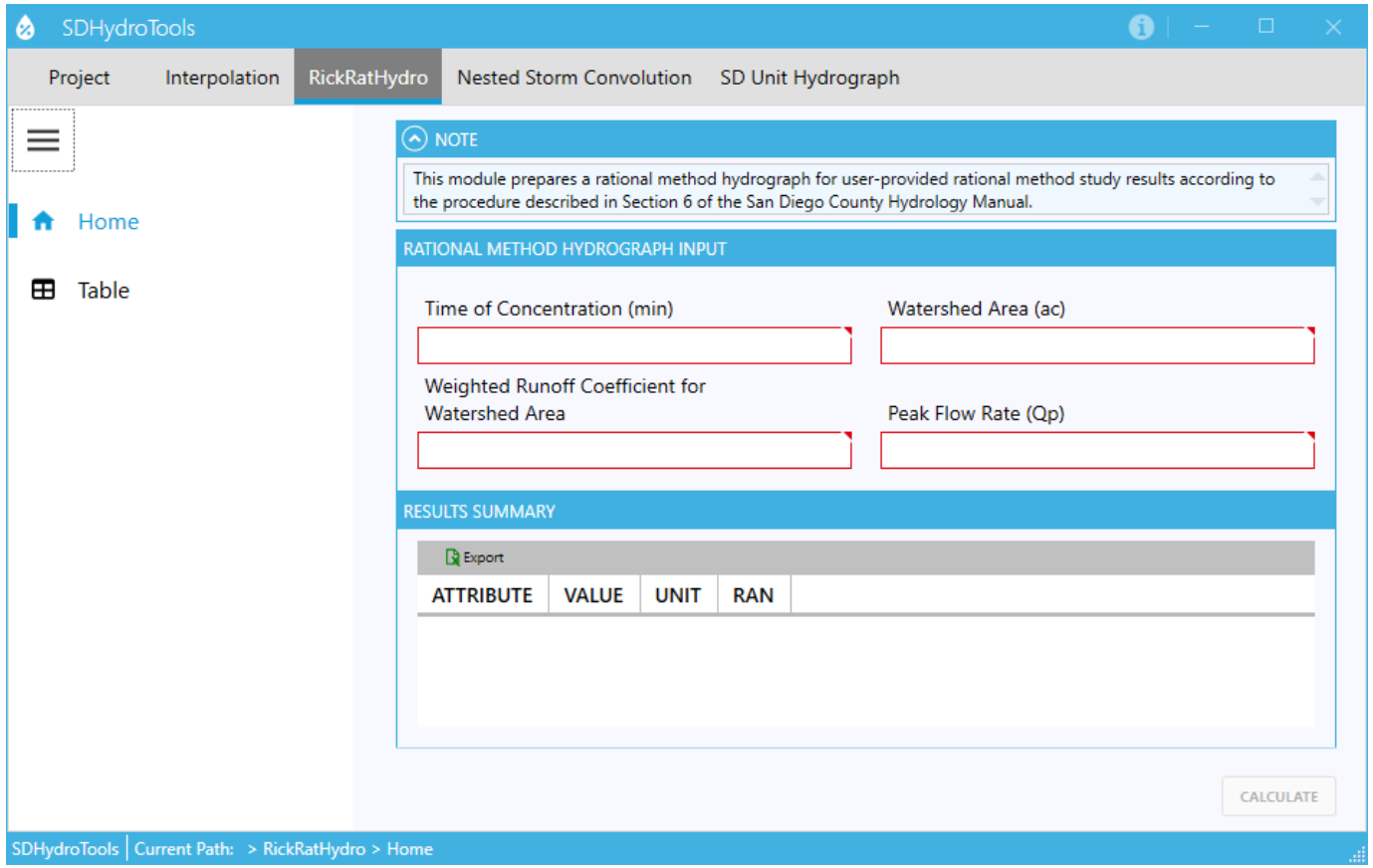
SDHydroTools RickRatHydro Module

- Prepares a rational method hydrograph using the procedure presented in Section 6 of the 2026 Hydrology Manual
- Replaces the 2003 Rational Hydrograph (RATHYDRO) program
  - Results from RickRatHydro are not expected to match 2003 RATHYDRO program due to NOAA Atlas 14 intensity process
- Results may be exported for use in other programs such as HEC-HMS

SDHydroTools RickRatHydro Module (Continued)

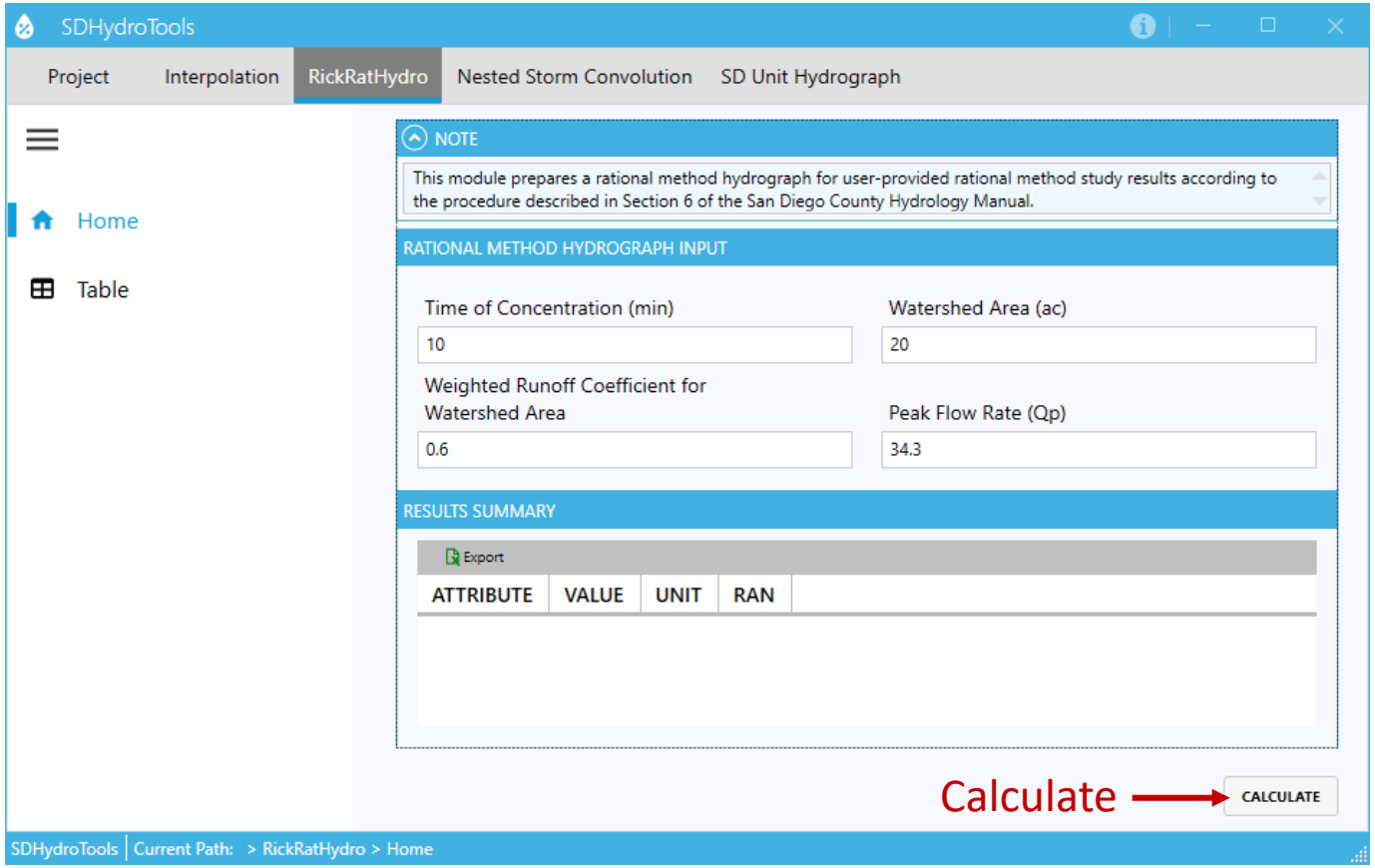
- To prepare a rational method hydrograph using the RickRatHydro Module, first complete your rational method calculations (calculations external to SDHydroTools) in accordance with Section 3 of the 2026 Hydrology Manual.

1. Provide the required input data in the red boxes.
2. The “Calculate” button will be active after the required data has been entered.
3. (As Needed) Save a screen capture of the window for documentation.
4. Click on “Calculate” to obtain the rational method hydrograph.



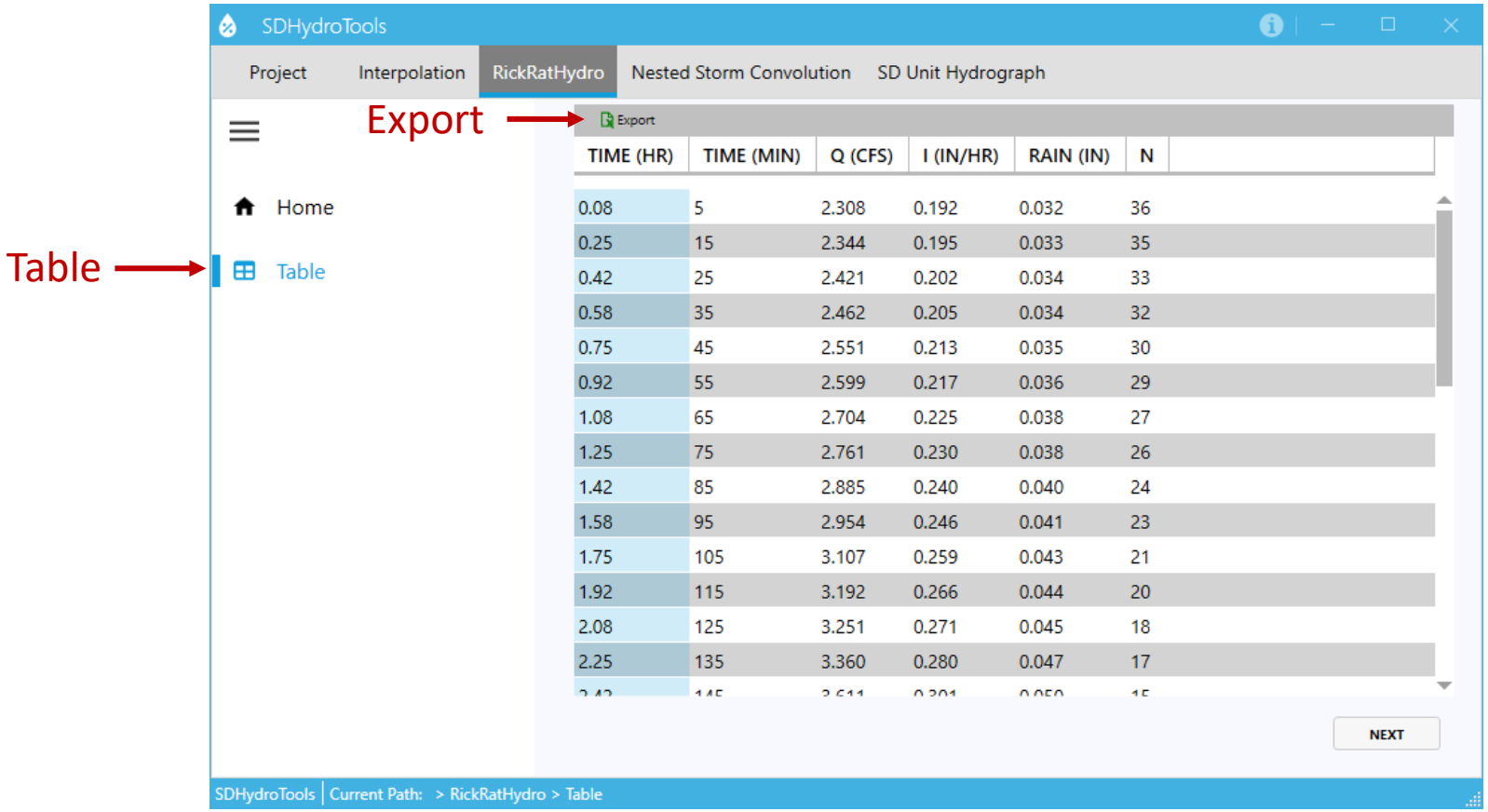
SDHydroTools RickRatHydro Module (Continued)

Example Data for the RickRatHydro Module:



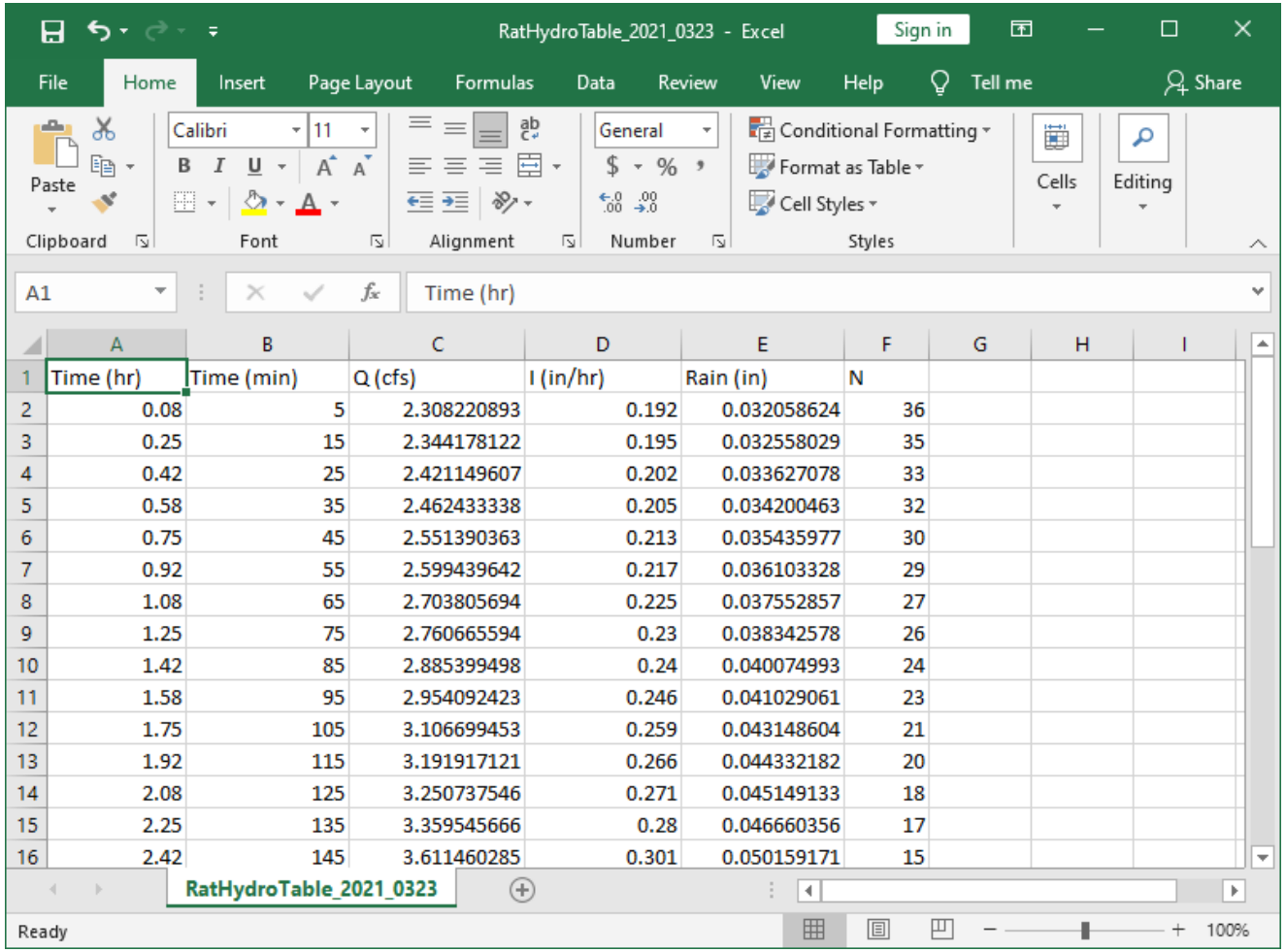
SDHydroTools RickRatHydro Module (Continued)

- After clicking on “Calculate” to obtain the rational method hydrograph, the results are presented in the Table Window of the RickRatHydro Module.
- Results from the RickRatHydro Module may be exported to a .csv file using the Export button and may be opened with an external program.

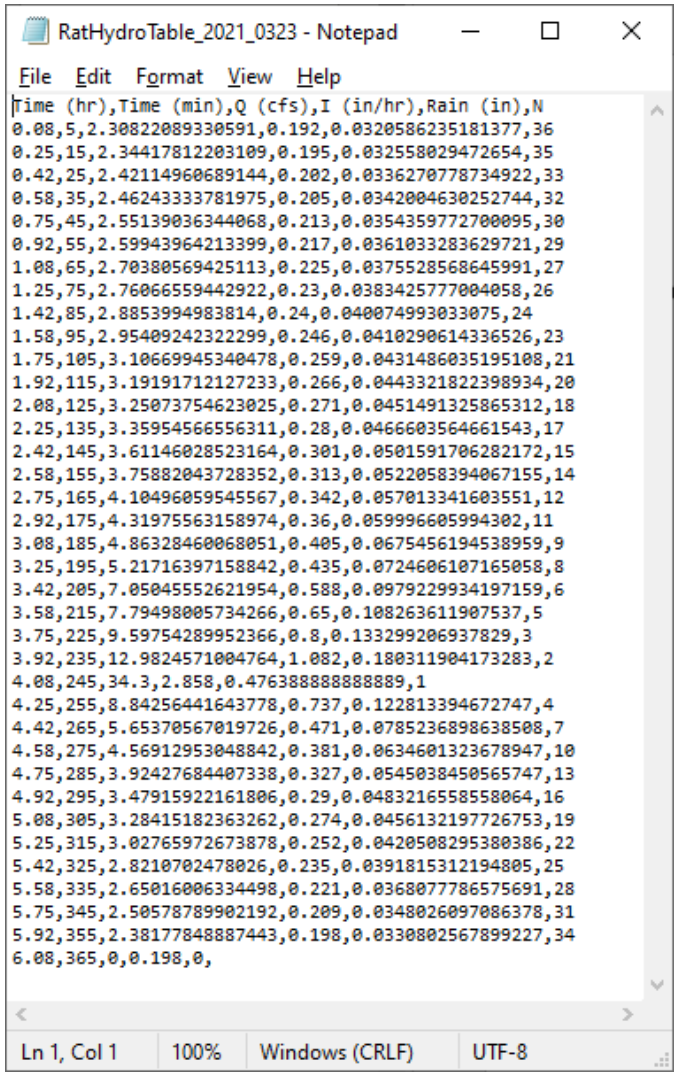


SDHydroTools RickRatHydro Module (Continued)

- Exported Results from the RickRatHydro Module may be opened with an external program.



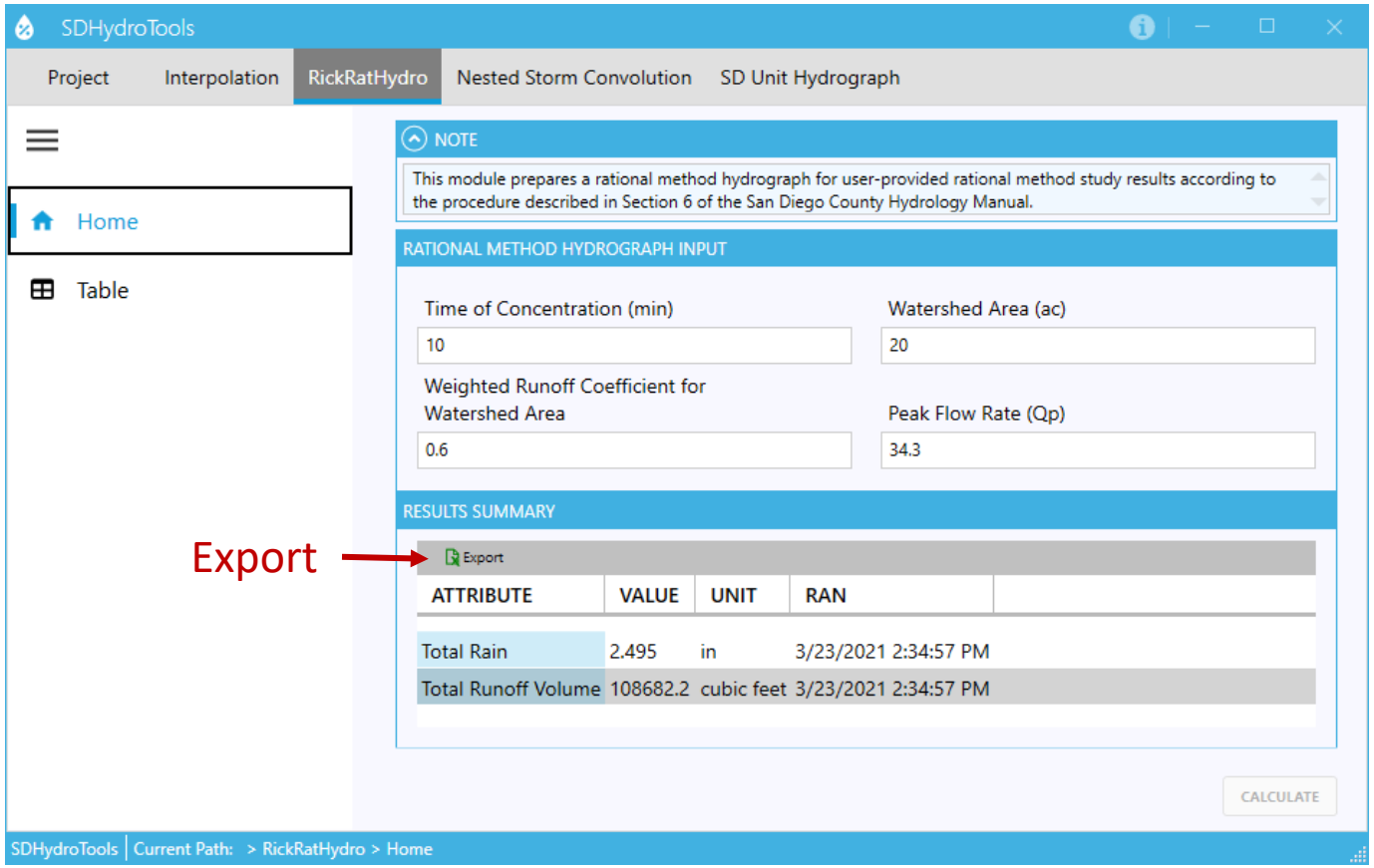
	A	B	C	D	E	F
1	Time (hr)	Time (min)	Q (cfs)	I (in/hr)	Rain (in)	N
2	0.08	5	2.308220893	0.192	0.032058624	36
3	0.25	15	2.344178122	0.195	0.032558029	35
4	0.42	25	2.421149607	0.202	0.033627078	33
5	0.58	35	2.462433338	0.205	0.034200463	32
6	0.75	45	2.551390363	0.213	0.035435977	30
7	0.92	55	2.599439642	0.217	0.036103328	29
8	1.08	65	2.703805694	0.225	0.037552857	27
9	1.25	75	2.760665594	0.23	0.038342578	26
10	1.42	85	2.885399498	0.24	0.040074993	24
11	1.58	95	2.954092423	0.246	0.041029061	23
12	1.75	105	3.106699453	0.259	0.043148604	21
13	1.92	115	3.191917121	0.266	0.044332182	20
14	2.08	125	3.250737546	0.271	0.045149133	18
15	2.25	135	3.359545666	0.28	0.046660356	17
16	2.42	145	3.611460285	0.301	0.050159171	15



SDHydroTools RickRatHydro Module (Continued)

- Return to the Home Window of the RickRatHydro Module to view the calculated volume of runoff.

- Total rain and total runoff volume results shown in the Home Window may also be exported.



Note: Total Runoff Volume = C P_6 A

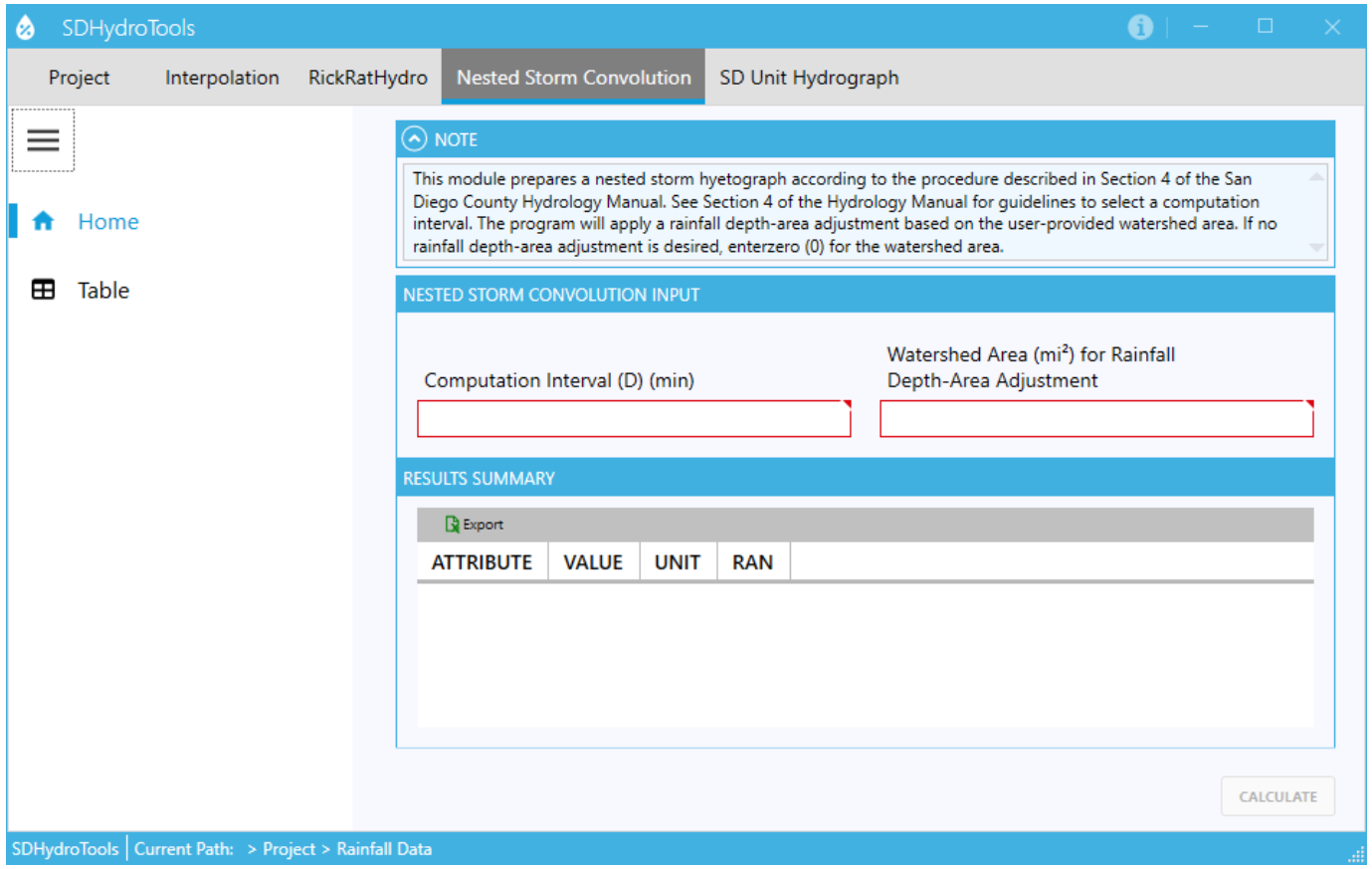
(0.6)(2.495 in)(1 ft/12 in)(20 ac)(43,560 ft^2/ac) = 108,682 ft^3

SDHydroTools Nested Storm Convolution Module

- Prepares a nested storm hyetograph according to the procedure presented in Section 4 of the 2026 Hydrology Manual
- Rainfall depth-area adjustment will be applied automatically
  - If no depth-area adjustment is desired, user may enter zero for the watershed area
- Results may be exported for use in other programs such as HEC-HMS

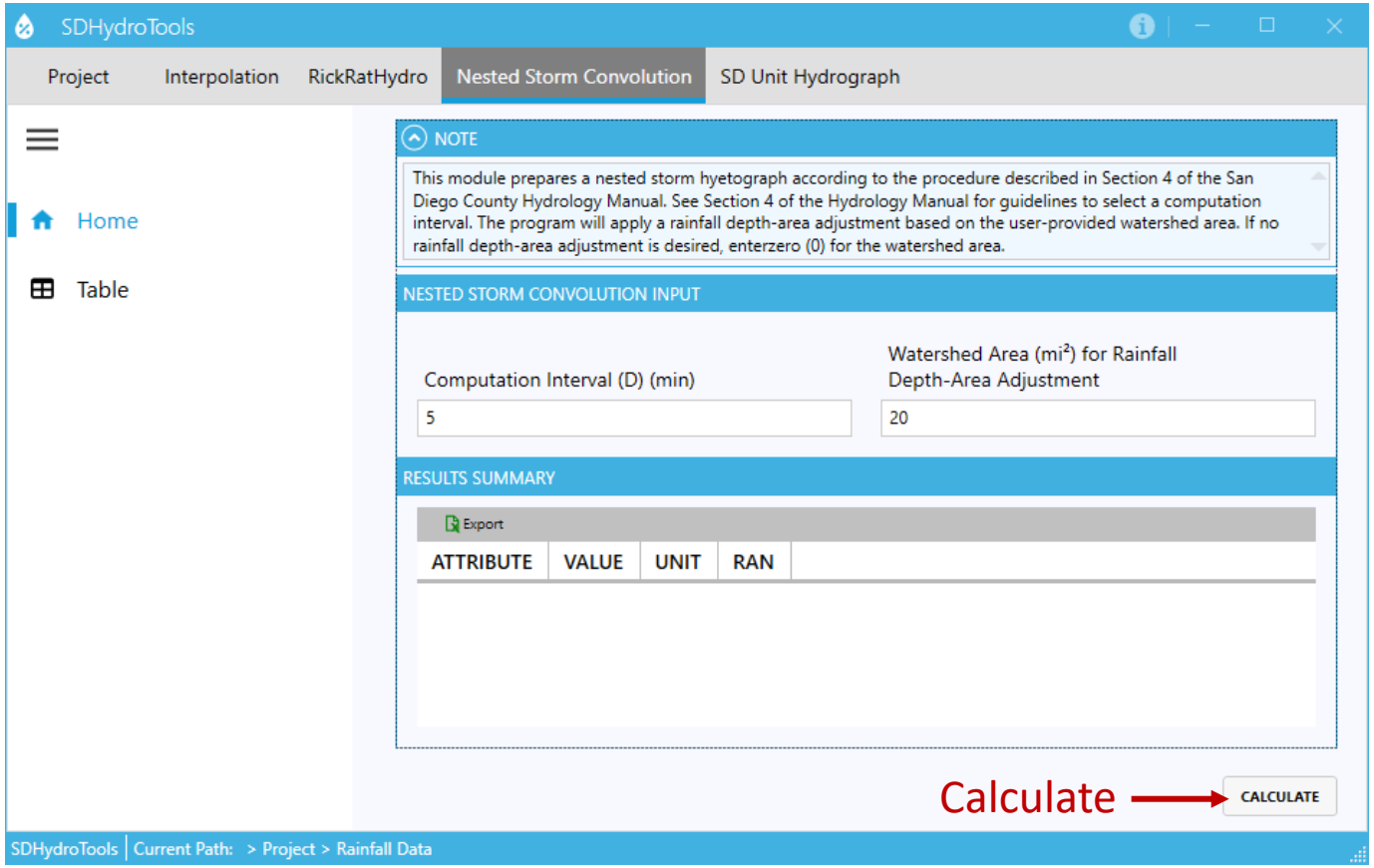
SDHydroTools Nested Storm Convolution Module (Continued)

1. Provide the required input data in the red boxes.
2. The “Calculate” button will be active after the required data has been entered.
3. (As Needed) Save a screen capture of the window for documentation.
4. Click on “Calculate” to obtain the nested storm hyetograph.



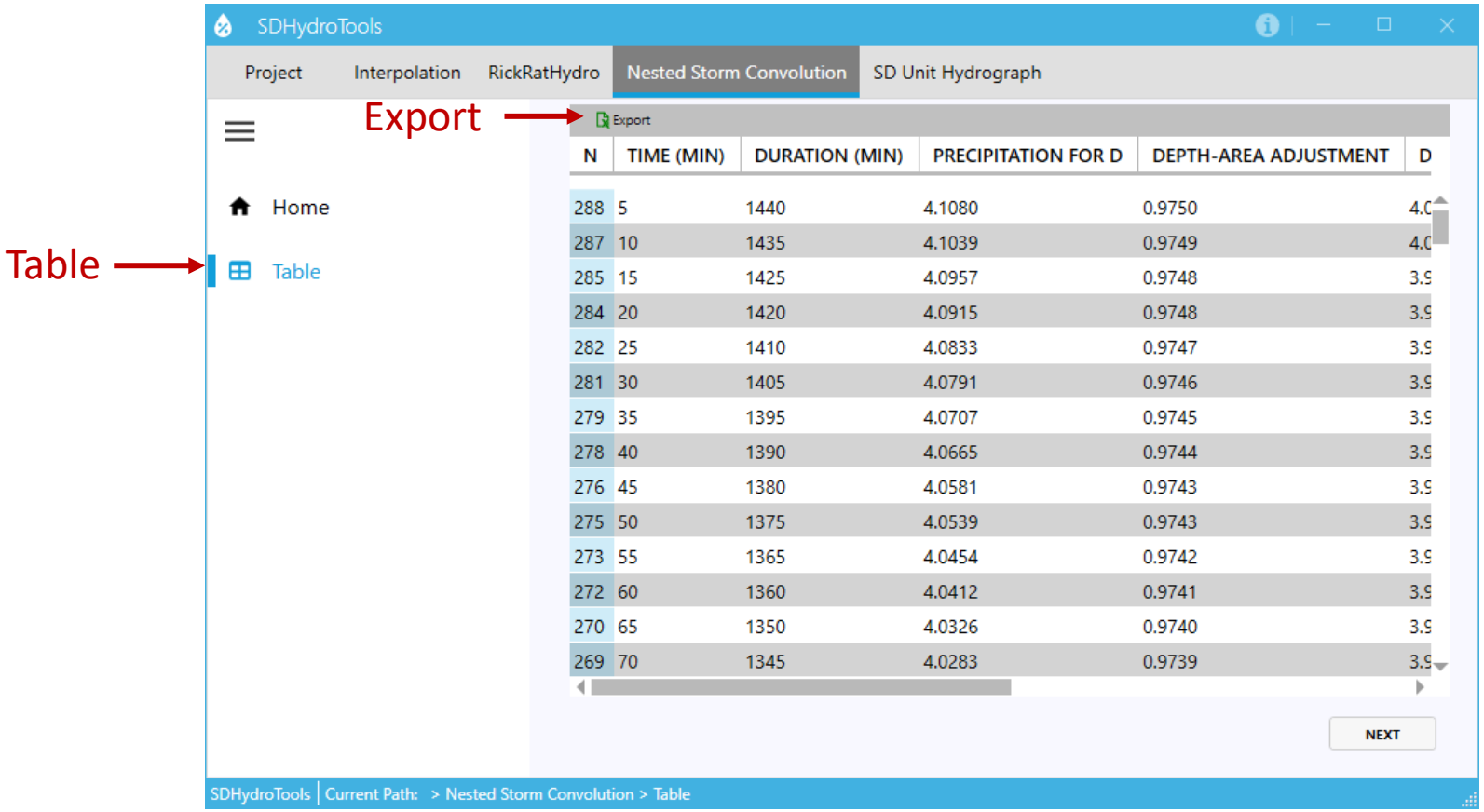
SDHydroTools Nested Storm Convolution Module (Continued)

Example Data for the Nested Storm Convolution Module:



SDHydroTools Nested Storm Convolution Module (Continued)

- After clicking on “Calculate” to obtain the nested storm hyetograph, the results are presented in the Table Window of the Nested Storm Convolution Module.
- Results from the Nested Storm Convolution Module may be exported to a .csv file using the Export button and may be opened with an external program.



SDHydroTools Nested Storm Convolution Module (Continued)

- Exported Results from the Nested Storm Convolution Module may be opened with an external program.

HyetographTable_2021_0324 - Notepad

File Edit Format View Help

```
N,Time (min),Duration (min),Precipitation for D,Depth-Area Adjustment,Depth-Area Adjusted P (in),Hyetograph
288,5,1440,4.108,0.975,4.0053,0.00422395451005197,0.00422395451005197
287,10,1435,4.10390157950989,0.974944444444444,4.0010760454899 5,0.00423343799591036,0.00845739250596234
```

HyetographTable_2021_0324 - Excel

Sign in

File Home Insert Page Layout Formulas Data Review View Help Tell me what you want to do Share

Paste Clipboard | Calibri 11 Font | Wrap Text Merge & Center Alignment | General Number | Conditional Formatting Format as Table Cell Styles Styles | Insert Delete Format Cells | Sort & Filter Find & Select Editing

A1 N

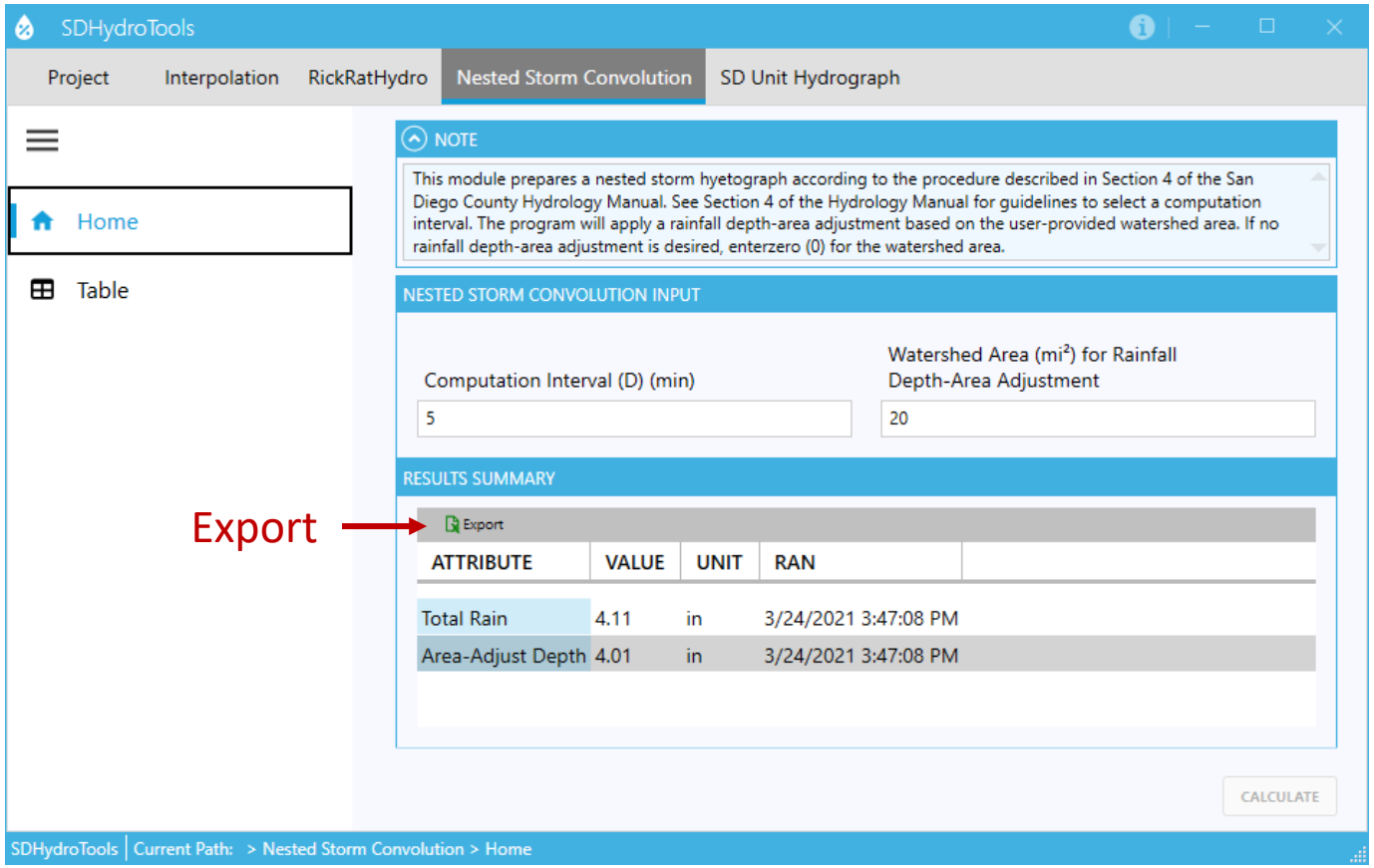
	A	B	C	D	E	F	G	H	I	J
1	N	Time (min)	Duration (min)	Precipitation for D	Depth-Area Adjustment	Depth-Area Adjusted P (in)	Hyetograph Ordinate (in)	Cumulative Rainfall (in)		
2	288	5	1440	4.108	0.975	4.0053	0.004223955	0.004223955		
3	287	10	1435	4.10390158	0.974944444	4.001076045	0.004233438	0.008457393		
4	285	15	1425	4.095674093	0.974833333	3.992599628	0.004252579	0.012709972		
5	284	20	1420	4.091544904	0.974777778	3.988347049	0.004262238	0.01697221		
6	282	25	1410	4.083255322	0.974666667	3.979812854	0.004281735	0.021253945		
7	281	30	1405	4.079094804	0.974611111	3.975531119	0.004291575	0.025545519		
8	279	35	1395	4.07074199	0.9745	3.966938069	0.004311438	0.029856957		
9	278	40	1390	4.066549565	0.974444444	3.962626632	0.004321463	0.03417842		

HyetographTable_2021_0324

100%

SDHydroTools Nested Storm Convolution Module (Continued)

- Return to the Home Window of the Nested Storm Convolution Module to view the total rainfall and calculated area-adjusted rainfall.
- Total rain and area-adjusted depth results shown in the Home Window may also be exported.

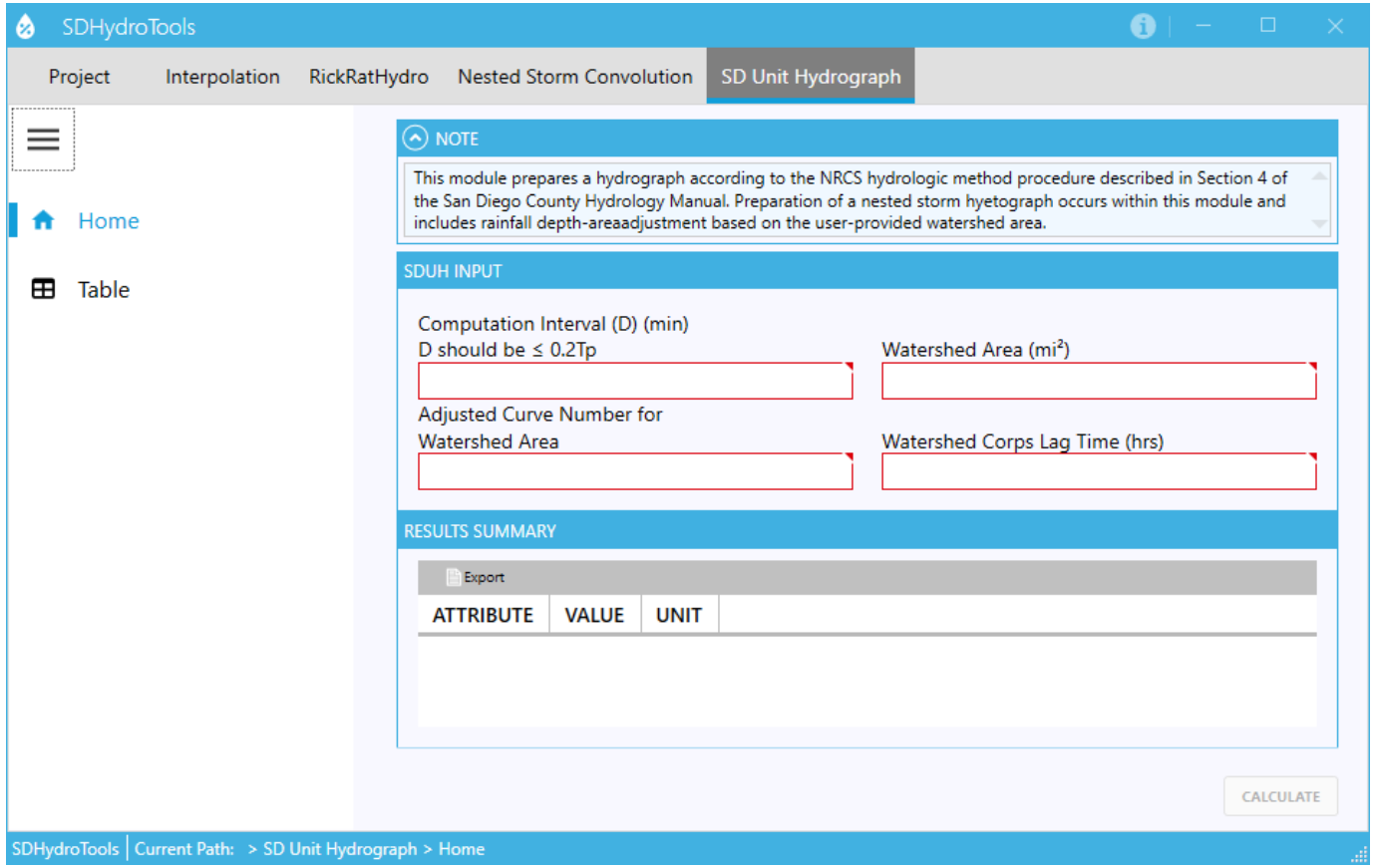


SDHydroTools SD Unit Hydrograph Module

- Calculates a peak flow rate for a single basin and generates a hydrograph using the NRCS hydrologic method
- Replaces the San Diego Unit Hydrograph (SDUH) software that was provided with the June 2003 Hydrology Manual
  - Results from the SD Unit Hydrograph Module are not expected to match results from the San Diego Unit Hydrograph software
- Rainfall depth-area adjustment will be applied automatically
- Results may be exported for use in other programs such as HEC-HMS

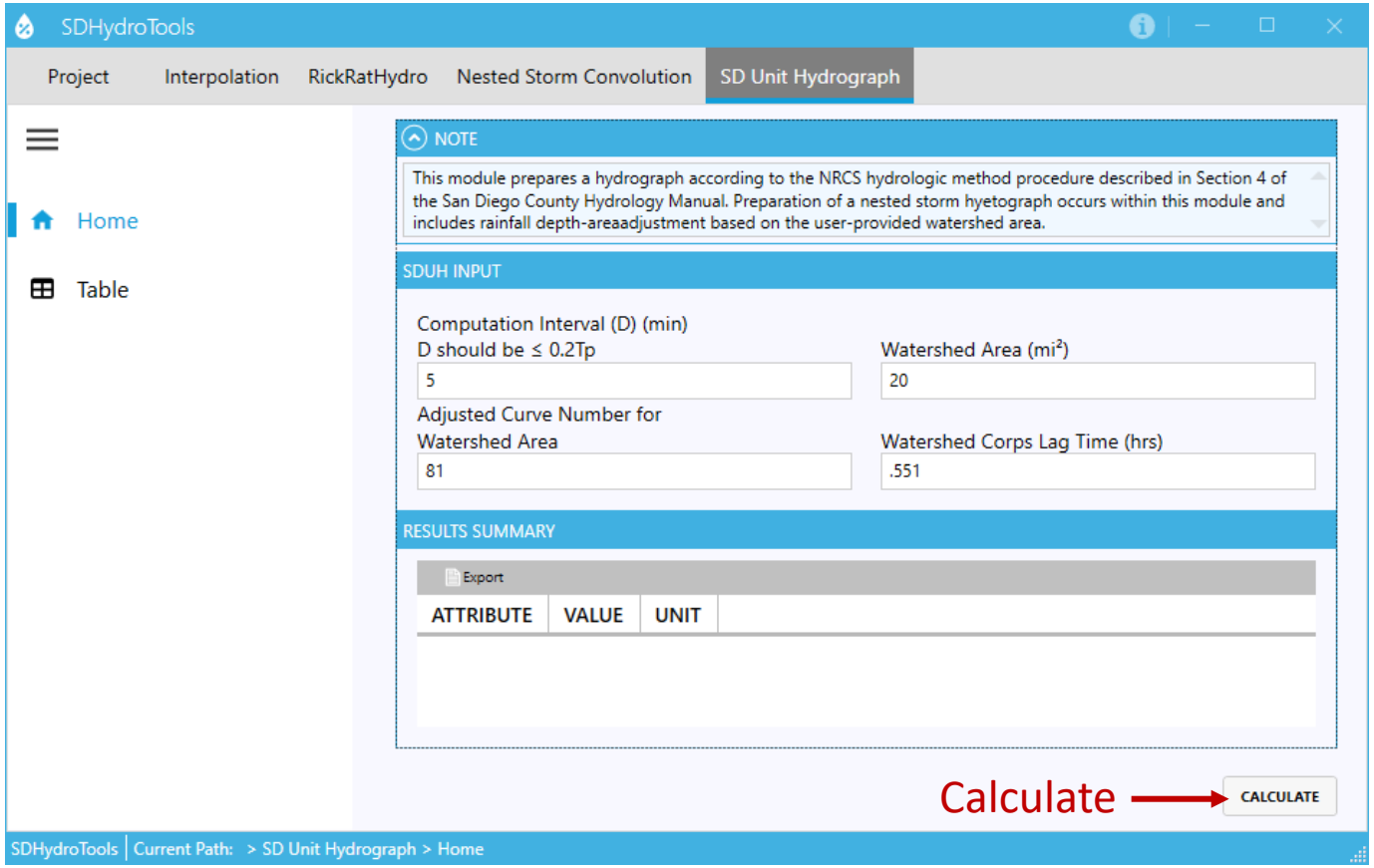
SDHydroTools SD Unit Hydrograph Module (Continued)

1. Provide the required input data in the red boxes.
2. The “Calculate” button will be active after the required data has been entered.
3. (As Needed) Save a screen capture of the window for documentation.
4. Click on “Calculate” to obtain the hydrograph.



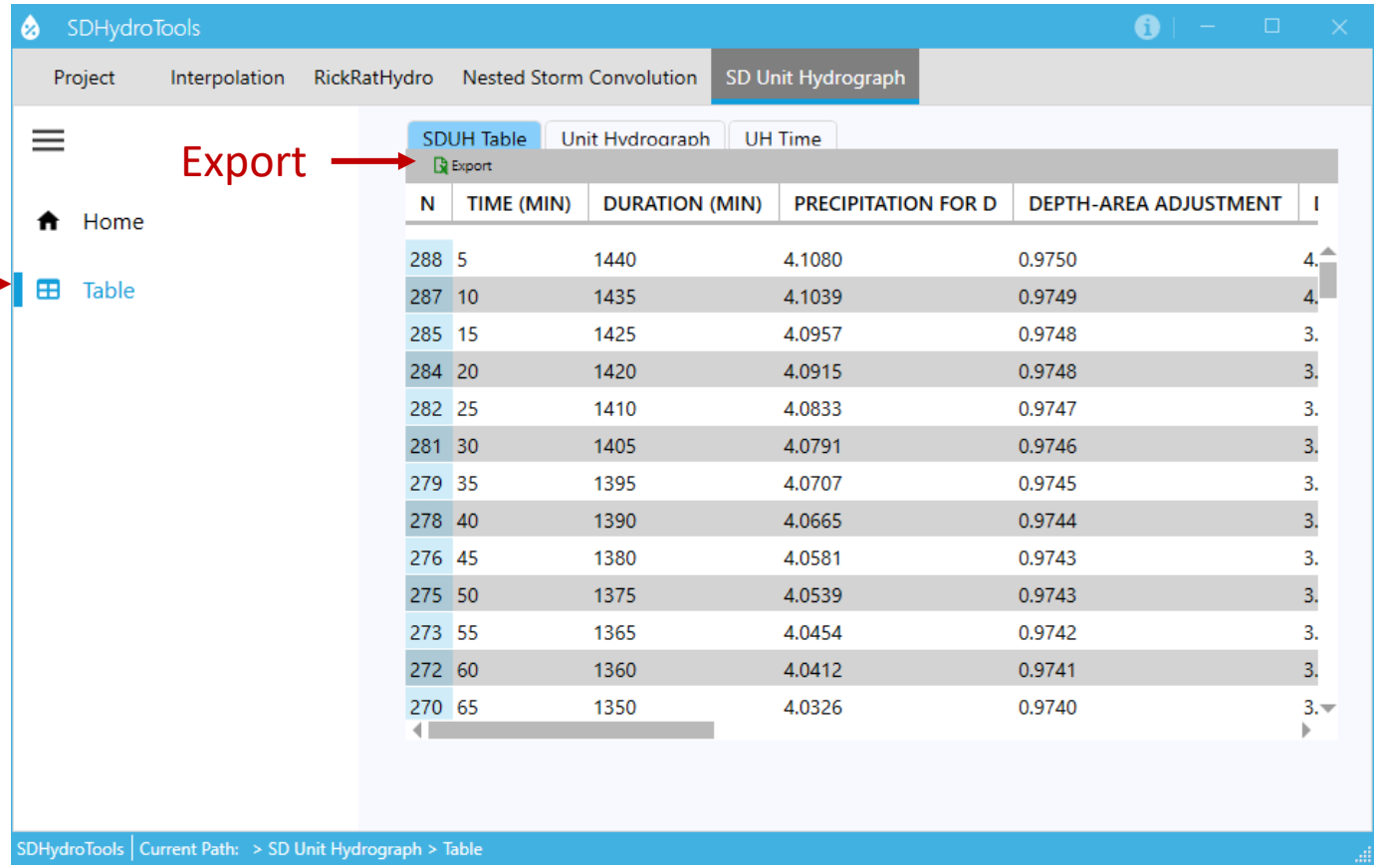
SDHydroTools SD Unit Hydrograph Module (Continued)

Example Data for the SD Unit Hydrograph Module:



SDHydroTools SD Unit Hydrograph Module (Continued)

- After clicking on “Calculate” to obtain the hydrograph, the results are presented in the Table Window of the SD Unit Hydrograph Module.
- Results from the SD Unit Hydrograph Module may be exported to a .csv file using the Export button and may be opened with an external program.



Note:
“SDUH Table” provides the hydrograph of direct runoff from the project area (the results).

“Unit Hydrograph” and “UH Time” provide the project unit hydrograph q ordinates based on the time to peak (T_p) and unit hydrograph q_p for the study area. These are provided for reference.

See Section 4 of the Hydrology Manual for discussion of the computation process, and see the Hydrology Manual Workbook for an example calculation.

SDHydroTools SD Unit Hydrograph Module (Continued)

- Exported Results from the SD Unit Hydrograph Module may be opened with an external program.

SDUHResultsTable_2021_0326 - Notepad

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```
N,Time (min),Duration (min),Precipitation for D,Depth-Area Adjustment,Depth-Area Adjusted P (in),Hyetograph Ordinate (in),Cumulative Rainfall (in),Cumulative Excess Rain (in),Incremental Excess Rain (in),Hydrograph Ordinate (cfs)
288,5,1440,4.108,0.975,4.0053,0.00422395451005197,0.00422395451005197,0,0,0
287,10,1435,4.10390157950989,0.974944444444444,4.00107604548995,0.00423343799591036,0.00845739250596234,0,0,0
285,15,1425,4.09567409277866,0.974833333333333,3.9925996281104,0.00425257922769484,0.0127099717336572,0,0,0
284,20,1420,4.0915449036754,0.974777777777778,3.9883470488827,0.00426223808981563,0.0169722098234728,0,0,0
282,25,1410,4.08325532242178,0.974666666666667,3.97981285425376,0.00428173515227481,0.0212539449757476,0,0,0
281,30,1405,4.07909480384351,0.974611111111111,3.97553111910149,0.00429157451355699,0.0255455194893046,0,0,0
279,35,1395,4.07074189012098,0.9745,3.96698896837289,0.00431143785668885,0.0298569573460935,0,0,0
```

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SDUHResultsTable_2021_0326 - Excel

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Paste | Cut | Copy | Format Painter | Clipboard | Calibri | 11 | Font | Wrap Text | Merge & Center | Alignment | General | Number | Conditional Formatting | Format as Table | Normal | Bad | Good | Neutral | Styles | Insert | Delete | Format | Cells | AutoSum | Fill | Clear | Sort & Filter | Find & Select | Editing

K7 | 0

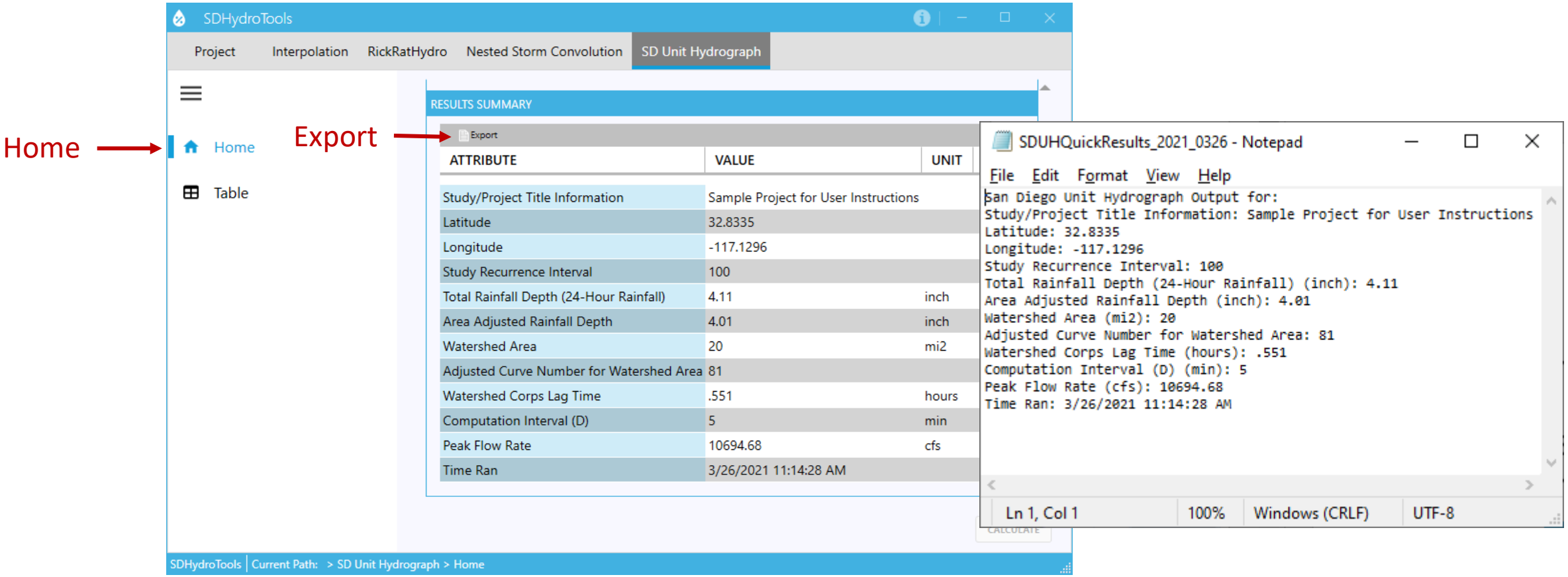
	A	B	C	D	E	F	G	H	I	J	K
1	N	Time (min)	Duration (min)	Precipitation for D	Depth-Area Adjustment	Depth-Area Adjusted P (in)	Hyetograph Ordinate (in)	Cumulative Rainfall (in)	Cumulative Excess Rain (in)	Incremental Excess Rain (in)	Hydrograph Ordinate (cfs)
2	288	5	1440	4.108	0.975	4.0053	0.004223955	0.004223955	0	0	0
3	287	10	1435	4.10390158	0.974944444	4.001076045	0.004233438	0.008457393	0	0	0
4	285	15	1425	4.095674093	0.974833333	3.992599628	0.004252579	0.012709972	0	0	0
5	284	20	1420	4.091544904	0.974777778	3.988347049	0.004262238	0.01697221	0	0	0
6	282	25	1410	4.083255322	0.974666667	3.979812854	0.004281735	0.021253945	0	0	0
7	281	30	1405	4.079094804	0.974611111	3.975531119	0.004291575	0.025545519	0	0	0

SDUHResultsTable_2021_0326

Ready | 100%

SDHydroTools SD Unit Hydrograph Module (Continued)

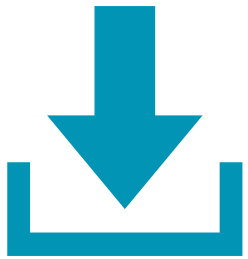
- Return to the Home Window of the SD Unit Hydrograph Module to view summary output including the peak flow rate.
- The summary output shown in the Home Window may also be exported. The summary output will be a .txt file.



SDHydroTools Location and Instructions

- Program and user instructions provided on County of San Diego Hydrology Manual website

https://www.sandiegocounty.gov/content/sdc/dpw/flood/hydrologymanual.html



- Download program and install on local machine
- Download user instructions

Sediment Bulking

June 17, 2026

Jon Viducich, PE
Senior Hydraulic Engineer

RIVER FOCUS
WATER RESOURCE CONSULTANTS

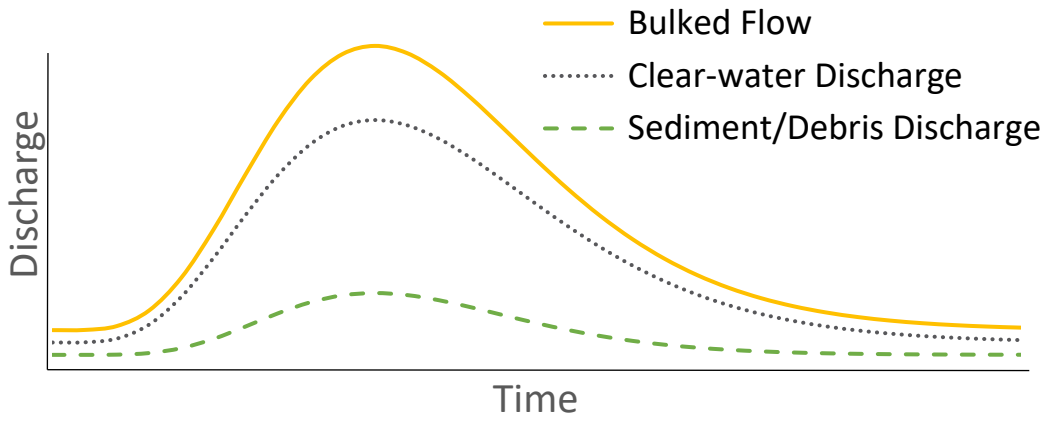
AGENDA

- Sediment bulking in SoCal
- Sediment/debris hazards in San Diego County
- New guidance for Normal Design Conditions
- New guidance for Post-Fire Conditions
- Manual resources

REGIONAL CONTEXT AND 2022 BULKING FACTOR STUDY

- **Key concepts:**
  - **Sediment/debris yield**
  - **Sediment bulking**

(County of Los Angeles, 2023)



Bulking Factor							
1	1.11	1.25	1.43	1.67	2.00	2.50	> 3.33
Sediment Concentration, % by Weight (100% by WT = 1 x 10^6 ppm)							
0	23	40	52	63	72	80	87 to 100
Sediment Concentration, % by Volume (specific gravity = 2.65)							
0	10	20	30	40	50	60	70 to 100
	Normal Streamflow		Hyperconcentrated Flow		Debris Flow/ Mud Flow		Landslide

(Gusman et. al, 2011)

REGIONAL CONTEXT AND 2022 BULKING FACTOR STUDY

- **Wildfire Impacts:**
  - **Effects on clear-water hydrology**
  - **Effects on sediment/debris**
  - **Elevated debris flow risk 0-3 yr post-fire, high sediment rates for ~10 yr**

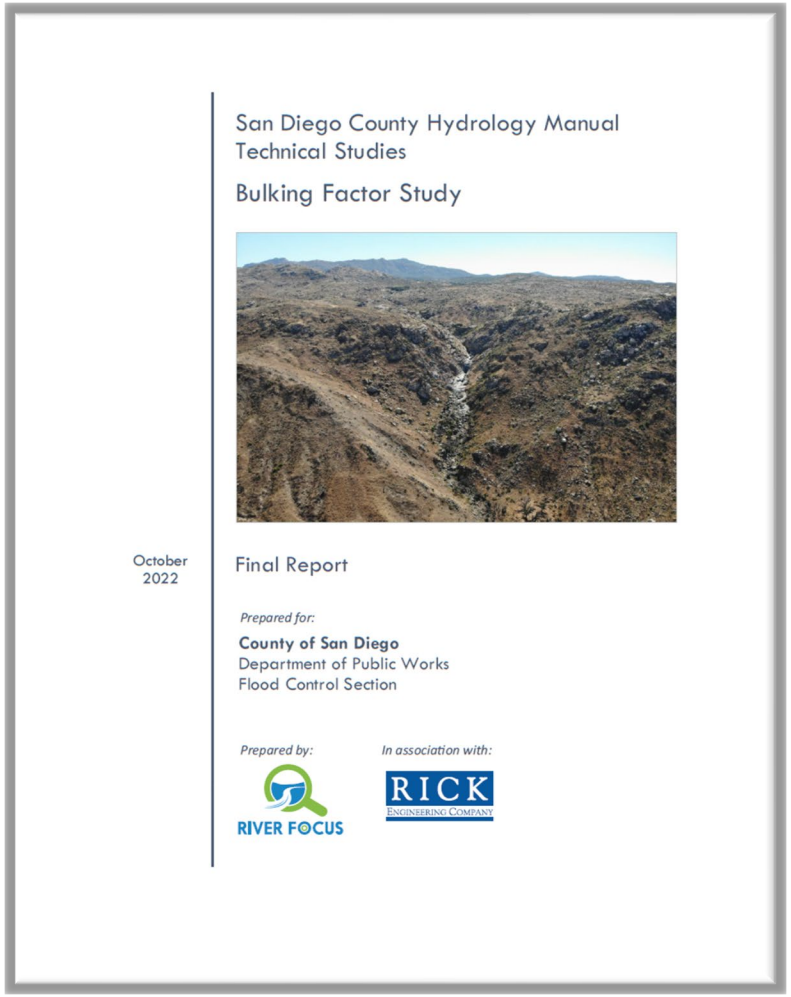
REGIONAL CONTEXT AND 2022 BULKING FACTOR STUDY

- **Sediment/debris in SoCal:**
  - **Event-based**
  - **Transverse Ranges and design basis in empirical regressions**
- **Previous approach in San Diego County**

(California Geological Survey, 2018, used with permission)

REGIONAL CONTEXT AND 2022 BULKING FACTOR STUDY

- **2022 Bulking Factor Study**
  - **How and where can existing methods be applied in less-erosive San Diego County?**
  - **Report available for download at County of San Diego Department of Public Works Flood Control Section website**
  - **Recommendations for three scenarios:**
    - **Normal Design Conditions**
    - **Post-Fire Conditions 0-2 Years Post-Fire**
    - **Post-Fire Conditions 2-10 Years Post-Fire**


San Diego County Hydrology Manual
Technical Studies

Bulking Factor Study

October
2022

Final Report

Prepared for:
County of San Diego
Department of Public Works
Flood Control Section

Prepared by: RIVER FOCUS

In association with: RICK ENGINEERING COMPANY

COUNTY OF SAN DIEGO

RIVER FOCUS
WATER RESOURCE CONSULTANTS

SEDIMENT BULKING IN THE UPDATED HYDROLOGY MANUAL

- **Section 5.6: Sediment Bulking**
- **Workbook 4.3: Example Sediment Bulking Problem**

WB.4.3 EXAMPLE SEDIMENT BULKING PROBLEM
(Reference Hydrology Manual Section 5.5)

A concrete drainage channel is planned for a hypothetical new development in the project location shown in Figure WB. 4-4, east of Ramona, CA. The project drains an undeveloped, 1-sq-mi watershed and it is not feasible to construct an upstream debris basin. A rainfall-runoff hydrologic model has been developed to compute the design clear-water flows at the project location, including the 100-year clear-water hydrograph, shown in Figure WB. 4-5. Evaluate whether sediment/debris bulking is required for this project, and if so, compute the bulked hydrograph and peak discharge.

Step 1: Review Sediment/Debris Hazard Map to Identify Known Risk

To start, refer to the sediment/debris hazard map in Figure 5-8 to assess whether the project watershed is located within an identified hazard area.

As shown in Figure WB. 4-6, the entire project watershed is located within the hazard area, so sediment/debris loading must be evaluated under normal conditions.

Step 2: Identify Whether Planned Infrastructure is at Risk

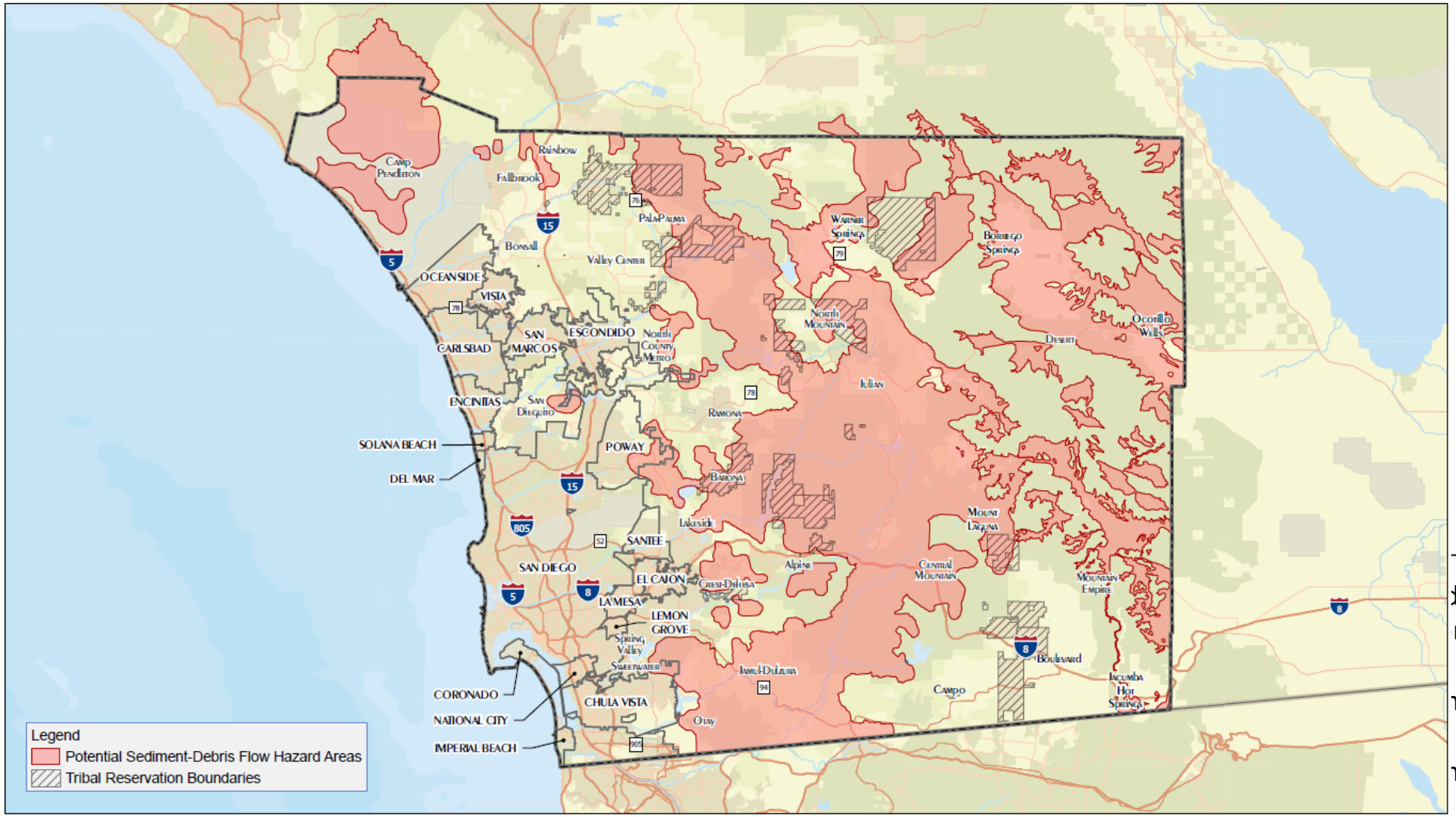
Next, evaluate whether the planned infrastructure associated with the project is truly at risk. For this case, the project is a flood control channel in the new development and the adequacy of its design will be directly affected by any flow bulking due to sediment/debris loading. While upstream channel slopes decrease from over 10 percent to approximately 5 percent at the upstream end of the project location, because these are larger than 2 percent, the channel may be affected by debris flows in the upper reaches and must be designed to mitigate these hazards.

SEDIMENT BULKING FOR NORMAL DESIGN CONDITIONS

Step 1: Is proj
in sediment/de
hazard area

No

No bulking
requirement
design hydrolc



dard
r without

nage areas

nage areas

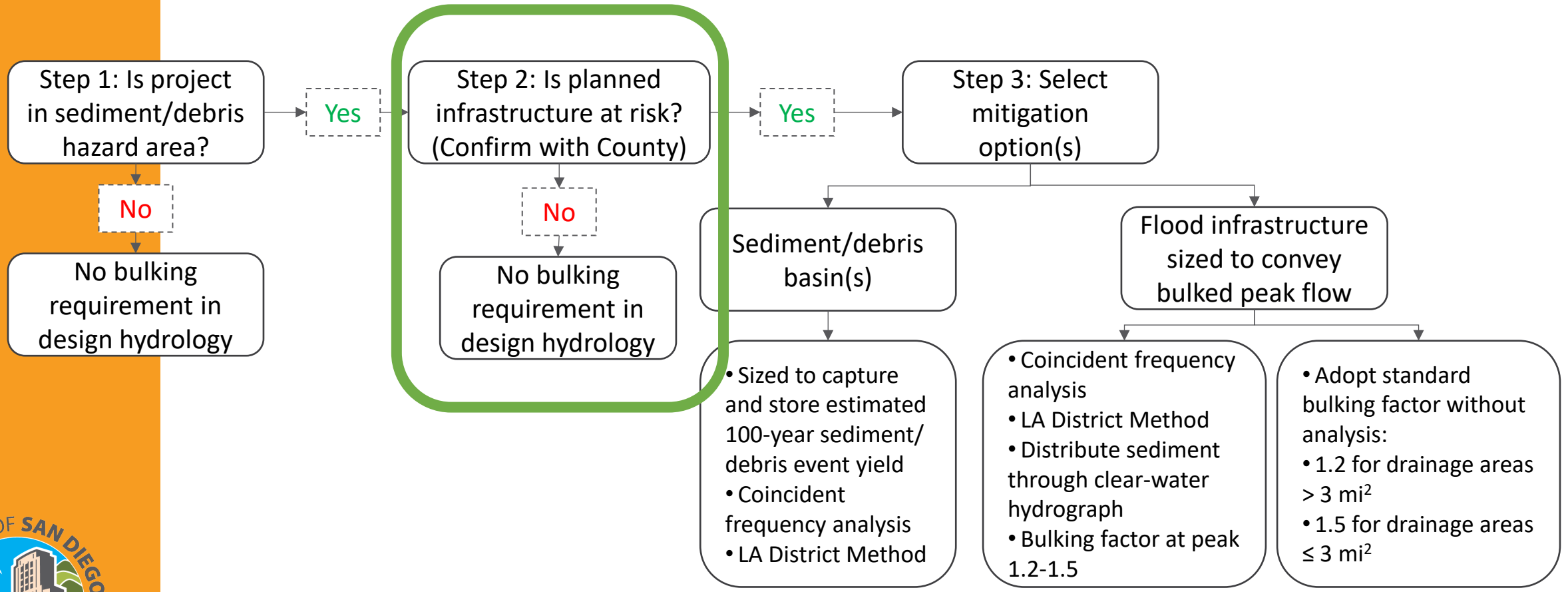
Refer to Section 5 of the 2022 Bulking Factor Study Report at
https://www.sandiegocounty.gov/content/sdc/dpw/flood/hydrologymanual.html
for more information on how the sediment/debris hazard areas were developed.

POTENTIAL SEDIMENT / DEBRIS FLOW HAZARD AREA

FIGURE
5-8

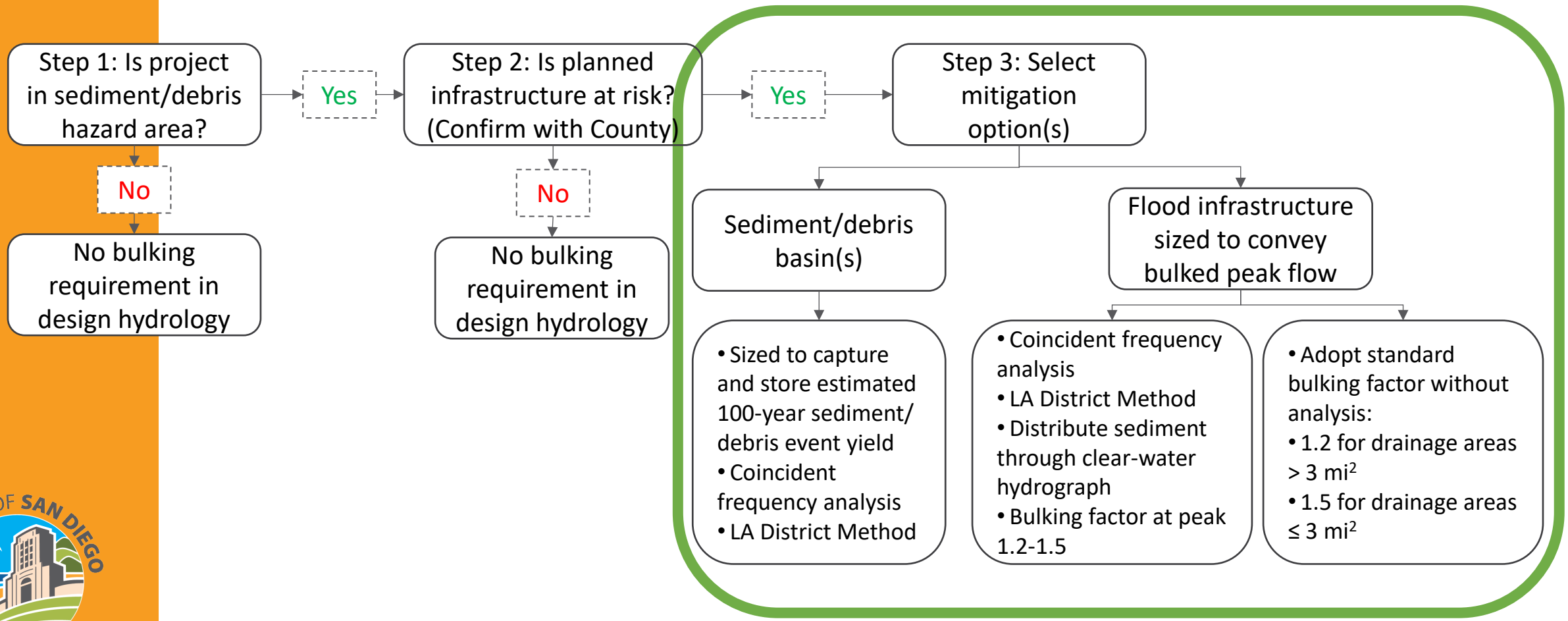
SEDIMENT BULKING FOR NORMAL DESIGN CONDITIONS

- **Case-by-case approach to bulking in high-risk areas**



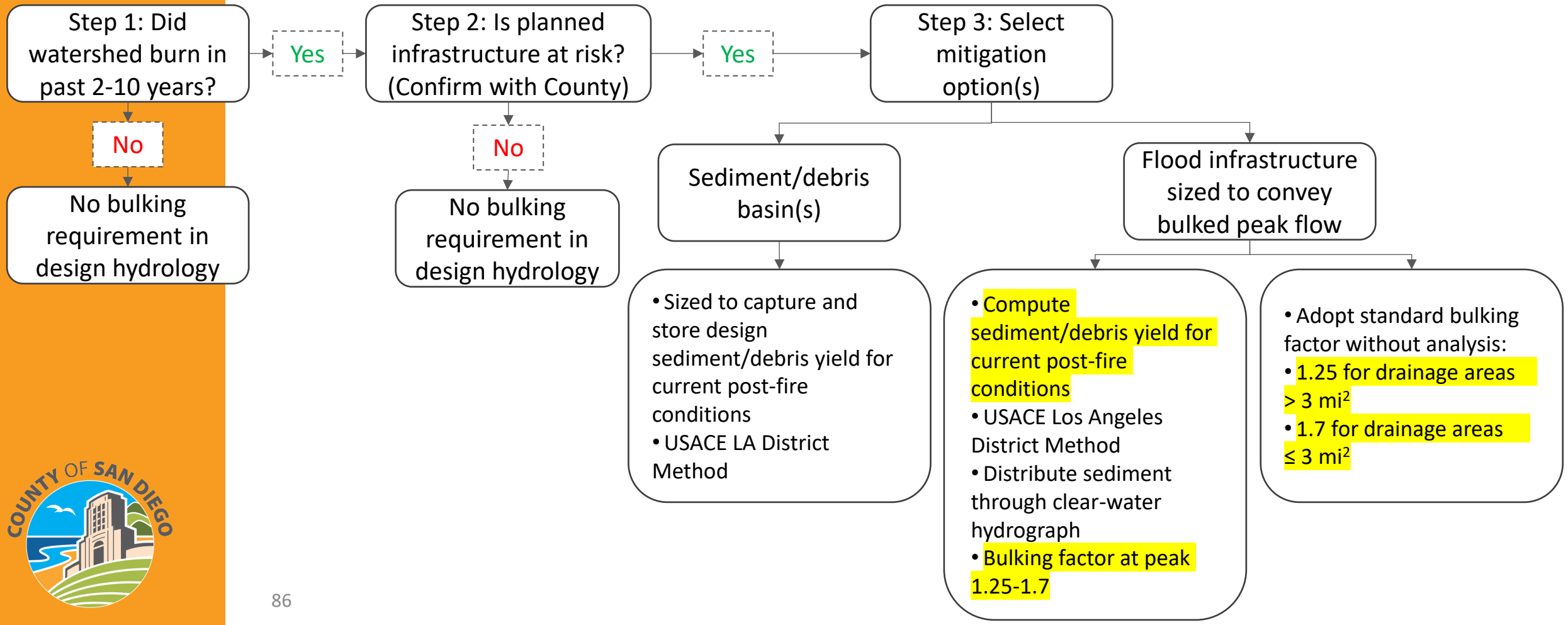
SEDIMENT BULKING FOR NORMAL DESIGN CONDITIONS

- **Case-by-case approach to bulking in high-risk areas**



SEDIMENT BULKING FOR POST-FIRE CONDITIONS

- **Emergency period (0-2 years post-fire)**
- **2-10 years post-fire**



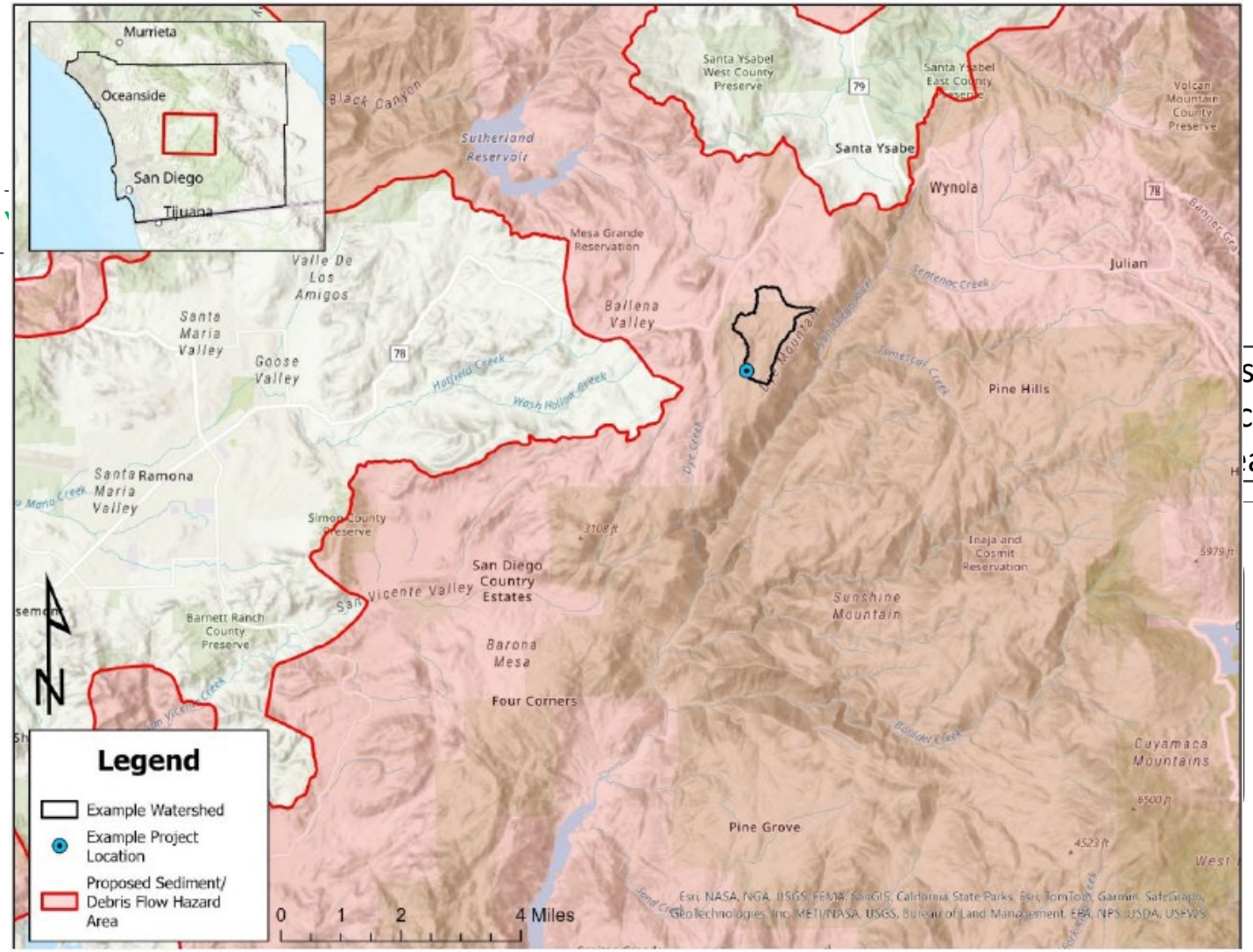
EXAMPLE PROBLEM – WORKBOOK SECTION WB.4.3

- **Step 1: Review sediment/debris hazard map**

Step 1: Is project in sediment/debris hazard area?

No

No bulking requirement in design hydrology

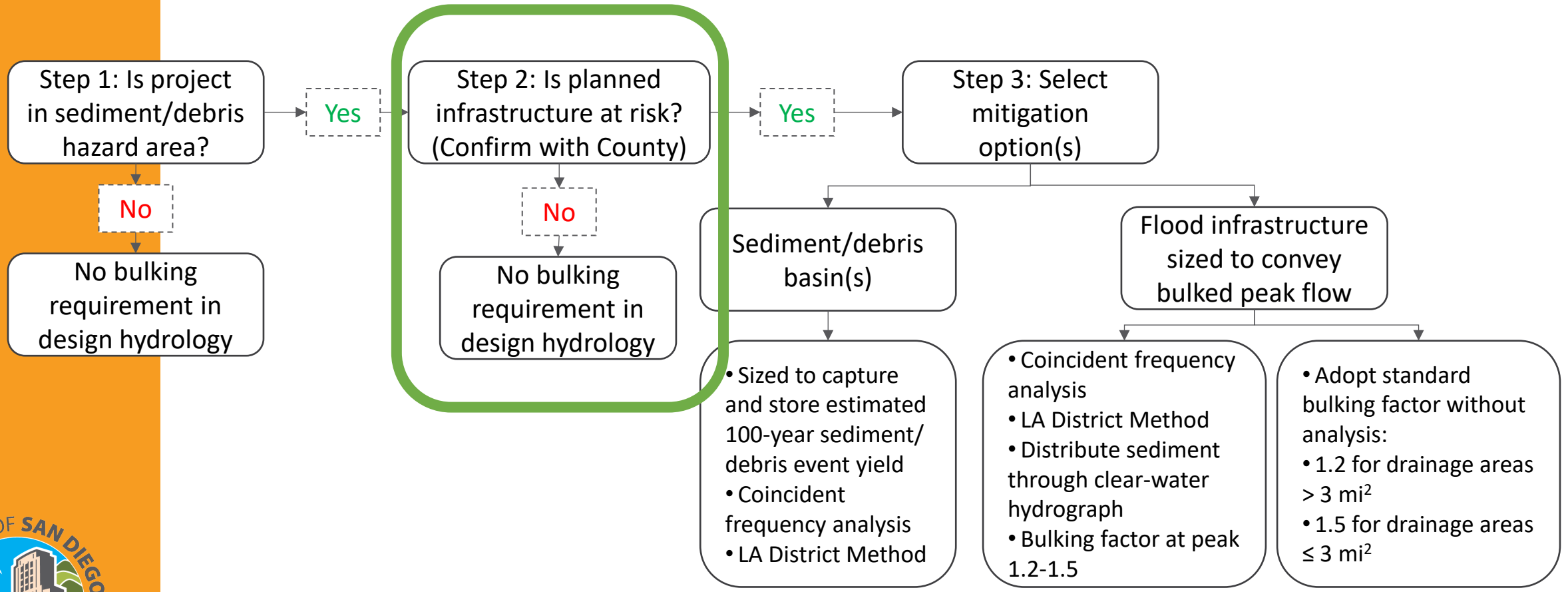


structure
convey
eak flow

- Adopt standard bulking factor without analysis:
  - 1.2 for drainage areas > 3 mi^2
  - 1.5 for drainage areas ≤ 3 mi^2

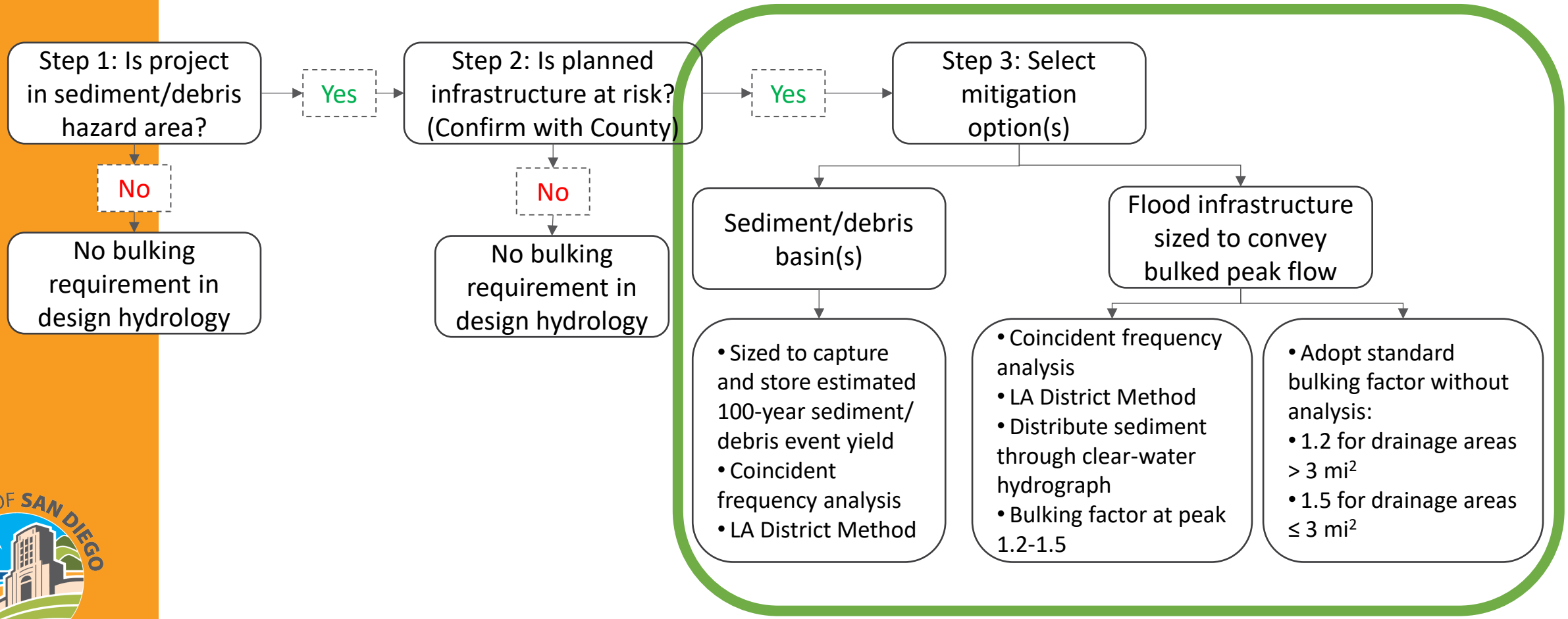
EXAMPLE PROBLEM – WORKBOOK SECTION WB.4.3

- **Step 2: Identify whether planned infrastructure is at risk**



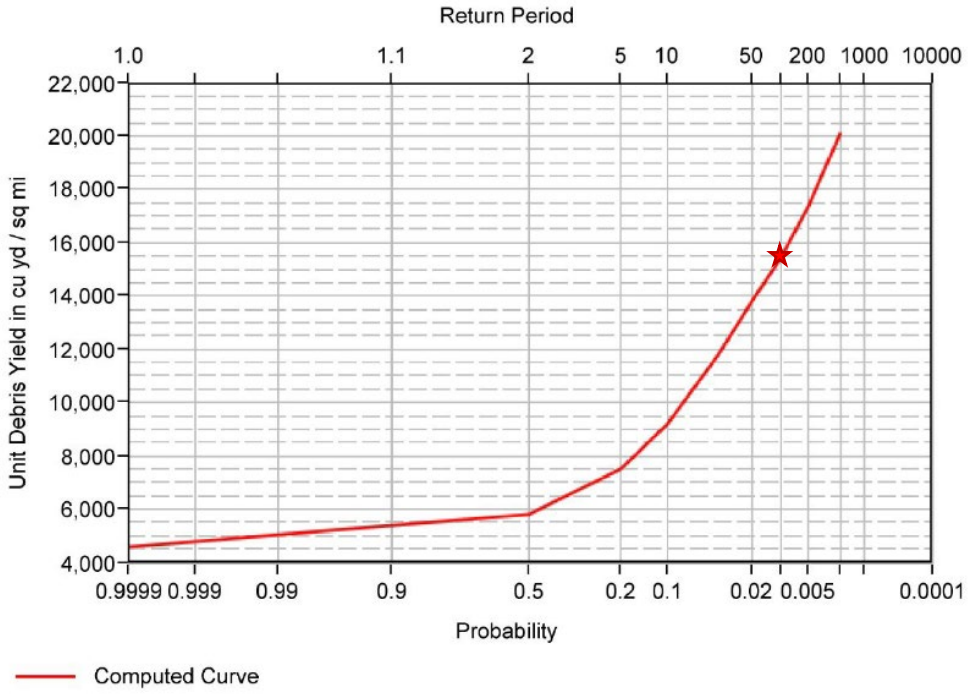
EXAMPLE PROBLEM – WORKBOOK SECTION WB.4.3

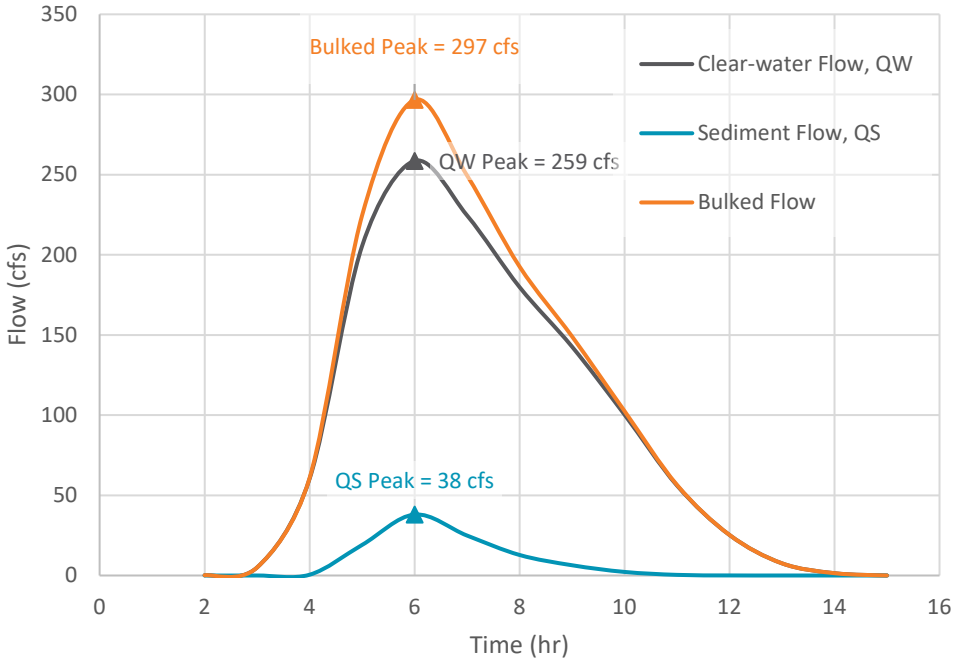
- **Step 3: Select appropriate mitigation option(s)**



EXAMPLE PROBLEM – WORKBOOK SECTION WB.4.3

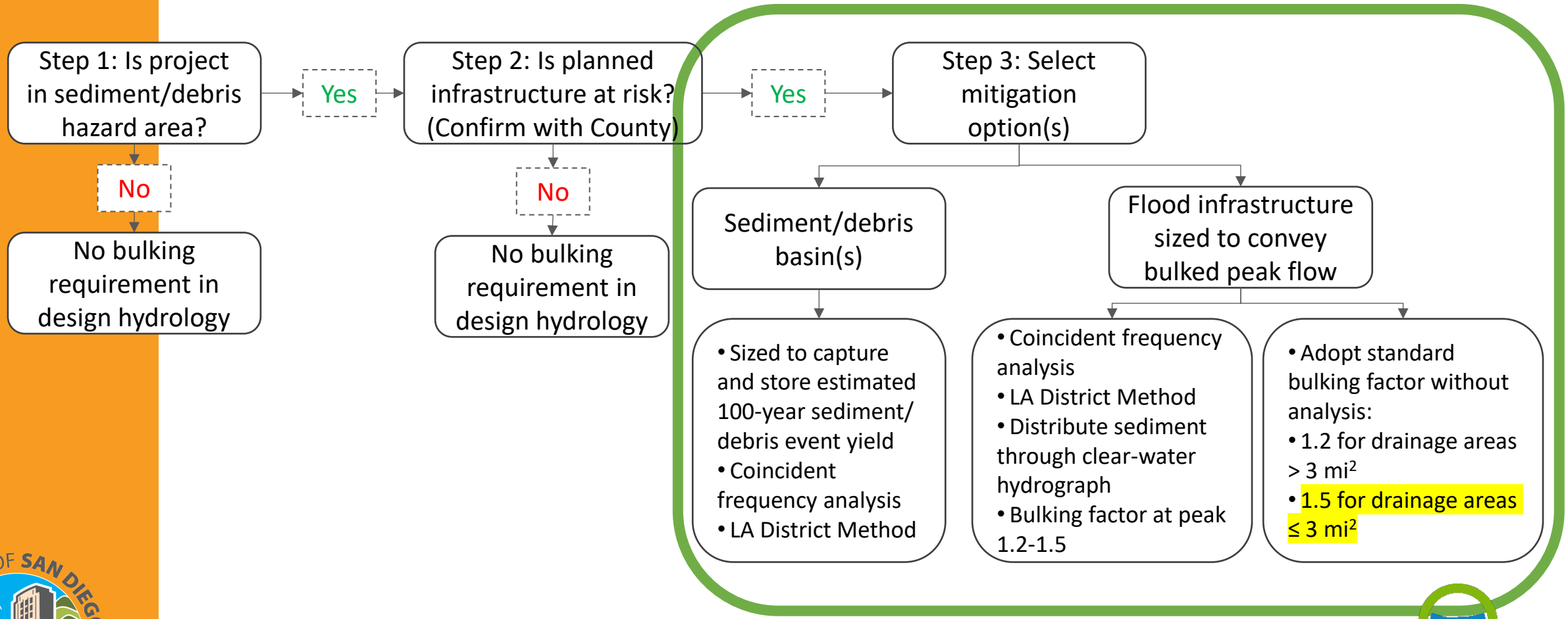
- **Option 1: Coincident frequency analysis → Distribute sediment/debris**
- **Result: Bulking factor = 1.2**





EXAMPLE PROBLEM – WORKBOOK SECTION WB.4.3

- **Option 2: Standard bulking factor = 1.5**



CONCLUSION

- Regional transition from event-driven response to more proactive policy
- Starting point for San Diego County amidst a growing body of research

THANK YOU

Jon Viducich, PE
Senior Hydraulic Engineer

RIVER FOCUS
WATER RESOURCE CONSULTANTS

References

California Geological Survey. (2018). Geology of California. Scale 1 : 2,000,000. Map Sheet 57. Retrieved from https://www.conservation.ca.gov/cgs/Documents/Publications/Map-Sheets/MS_057-2018-Geology-of-California.pdf

County of Los Angeles. (2023). *Debris Basins*. Department of Public Works. Retrieved on April 14, 2023 from https://dpw.lacounty.gov/lacfcd/sediment/debrisbasins.aspx

Gusman, A. J., Teal, M. J., Todesco, D., & Bandurraga, M. (2011). *Sediment/debris bulking factors and post-fire hydrology for Ventura County*. WEST Consultants Inc., San Diego, California.

Grandfathering Eligibility to Proceed Under Earlier Hydrology Manual Provisions

June 17, 2026

Ashkan Azarnia, PE CFM
Civil Engineer/Project Manager

Grandfathering Eligibility

Purpose

- Provide a clear and predictable transition to the 2026 Hydrology Manual
- Allow projects already in the review process to proceed without unnecessary rework
- Prevent repeated hydrology revisions driven solely by timing
- Allow projects to benefit from updated methodology where appropriate

Grandfathering Eligibility

The guidance document will be coming out shortly.

Effective Date: July 1st, 2026

Substantive Change

- Any modification to the project that results in a material impact on the approved hydrology or hydraulic analysis.
  - Examples
    - Underlying assumptions
    - Input parameters
    - Flow characteristics
    - Drainage patterns
    - System capacity
    - Results previously established in the approved study,

Grandfathering Eligibility

Project Status:

- **New projects**
  - First complete hydrology submittal accepted for review **after the effective date**
  - Shall comply with 2026 Manual

- **Projects with hydrology studies in review**
  - Complete hydrology submittal accepted for review prior to the effective date
    - Option A – Continue Under the 2003 Hydrology Manual
    - Option B – Elect to Use the 2026 Hydrology Manual

- **Projects with hydrology approval prior to effective date**
  - Flexibility will be provided within grace period

Grandfathering Eligibility – Grace Period

- A **one-year** grace period **begins** on the **effective date** of the 2026 Manual
  - Already in hydrology review with an Accela record number (requesting substantive changes)
  - Previously approved hydrology studies (requesting substantive changes)

Grandfathering Eligibility – Decision Authority

- The County shall determine hydrology manual applicability and grandfathering eligibility based on guideline document
- The determination shall be documented in the project record.
- Applicants are responsible for identifying their project status and requesting manual selection where applicable.

Questions Roundtable 2

Closing Remarks

Additional Questions?

Reach out to **Ashkan Azarnia**
ashkan.azarnia@sdcounty.ca.gov

Access the new Manual & Tools