LIFE SAFETY RISK INDICATOR

APPLICATION IN PLANNING

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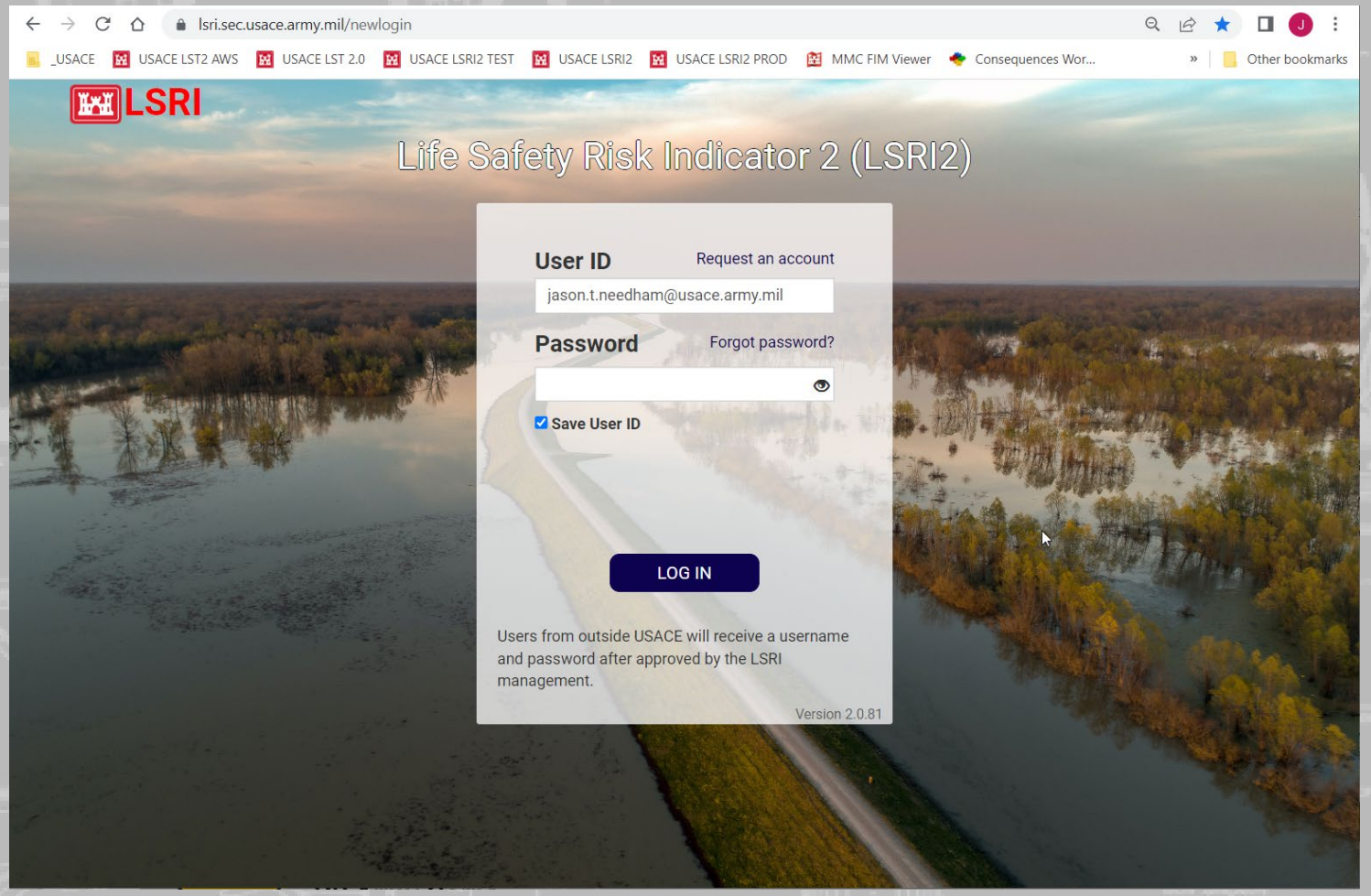
USACE Risk Management Center



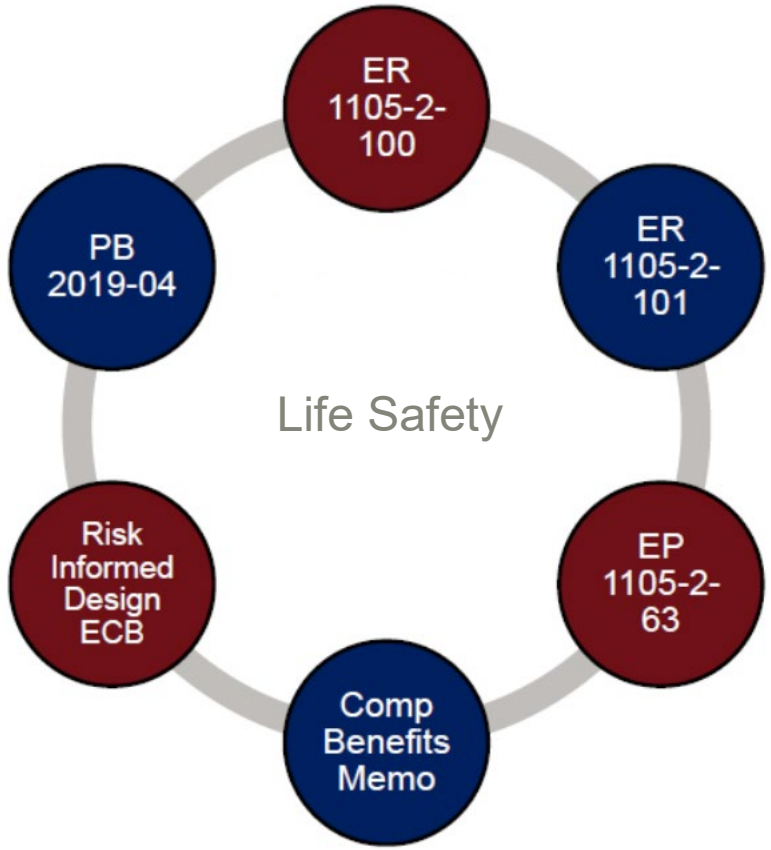
US Army Corps of Engineers®

OVERVIEW

- Life Safety Risk Indicator (LSRI) Methodology
- LSRI Structure
- Application overview
- Validation example
- Q & A

LSRI APPLICATION

- The budget development process will use LSRI results to screen ongoing feasibility studies, PED and construction work packages to identify those for which *life safety benefits* might play a role in justifying funding.
  - Not a new requirement
    - LSRI or LSHI (Life Safety Hazard Indicator) has been required for budgeting* for many years
    - Consistent, defendable results were difficult to obtain from previous methods
  - Results in recommendation for additional study
- LSRI 2.0 leverages consequence methodology and framework of LST 2.0.
- Support initial understanding of life safety in flood and coastal storm risk management studies



LSRI METHODOLOGY OVERVIEW

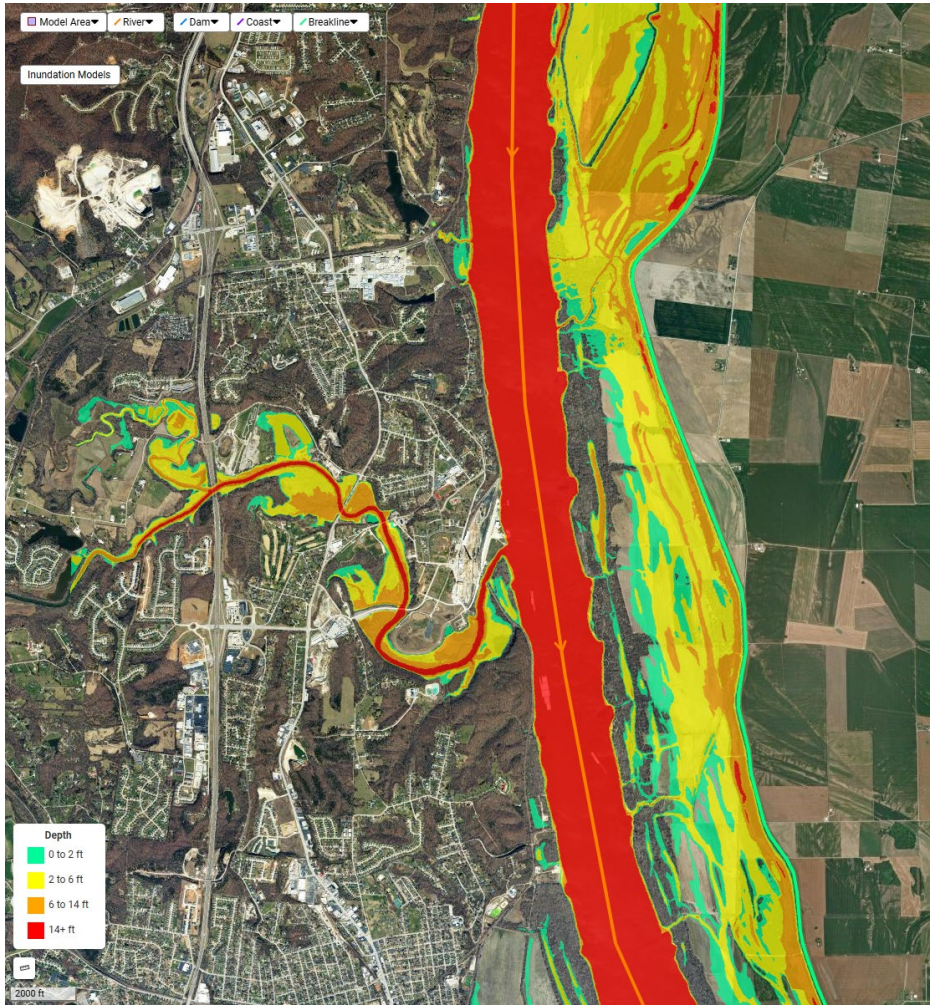
Life Safety Risk Indicator (LSRI)

Purpose: Efficient methodology to "answer" the question:
How much will a proposed project reduce risk to life and property?

LSRI: A web-based application utilizing cloud computing for risk analysis that employs state-of-the art methods and tools.

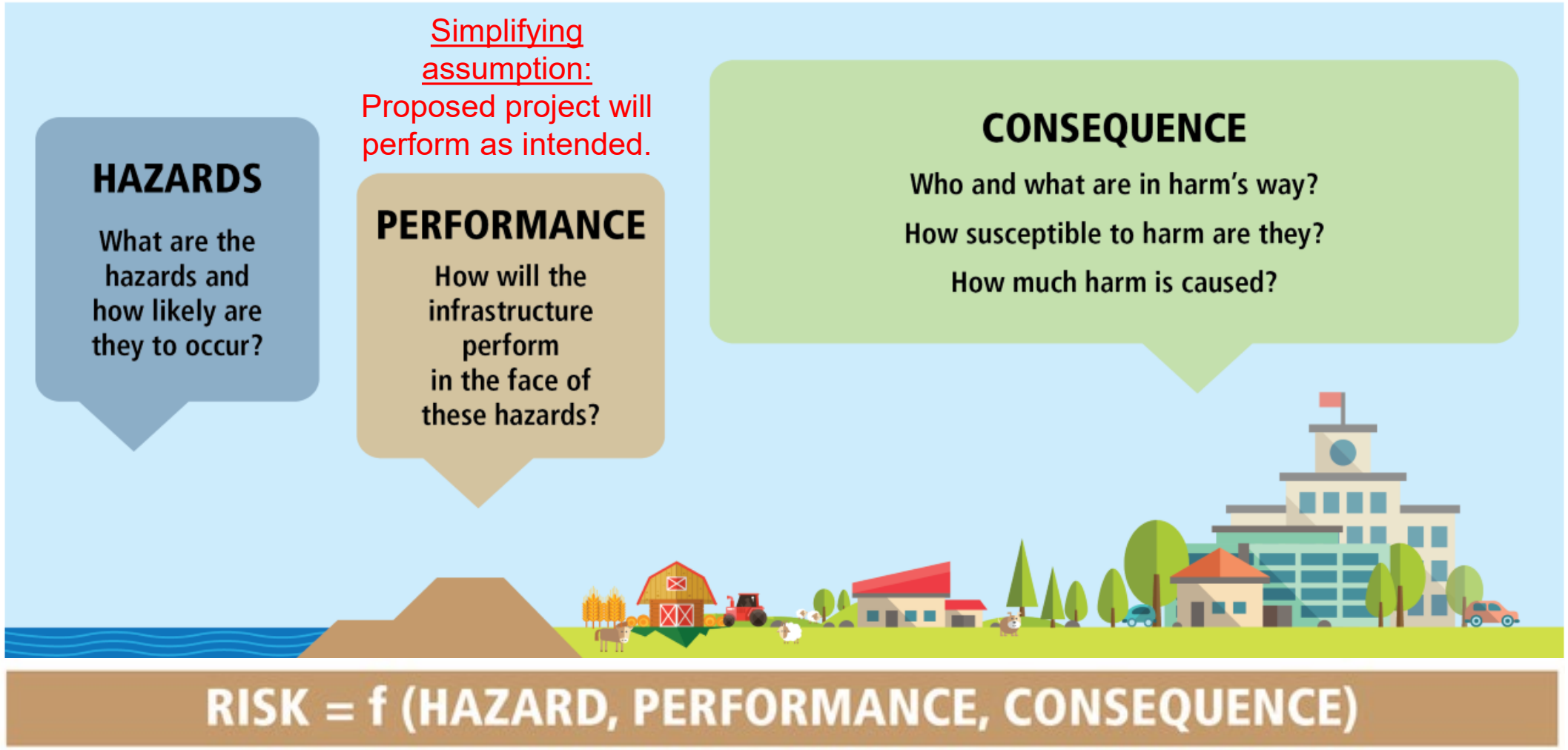
HEC-RAS

LifeSim



Part of a suite of web-based screening tools including the Levee Screening Tool and Dam Screening Tool

RISK AND THE LSRI



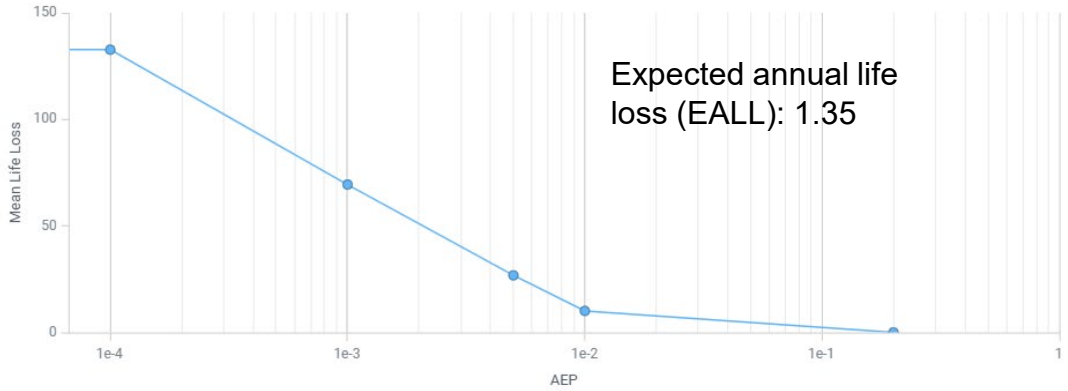
Problem Statement:

What is the lowest level-of-effort that can be applied to generate credible risk results?

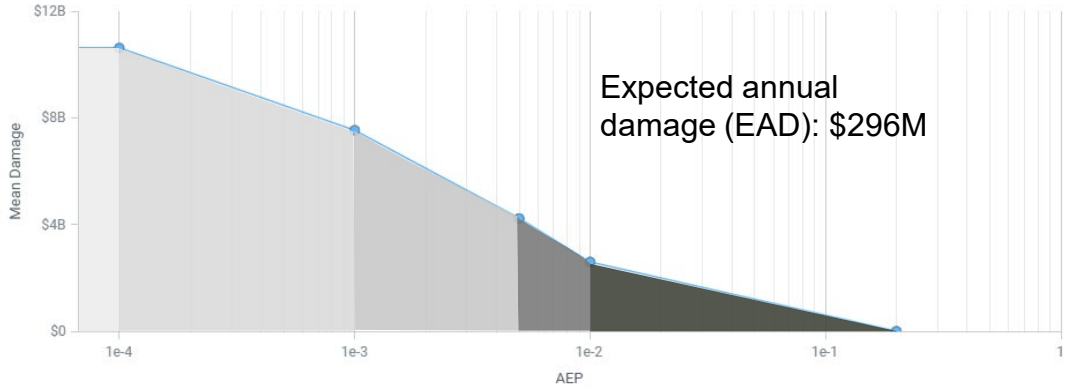
RISK CALCULATION

Estimate difference between "existing" and "with project" risk

Existing

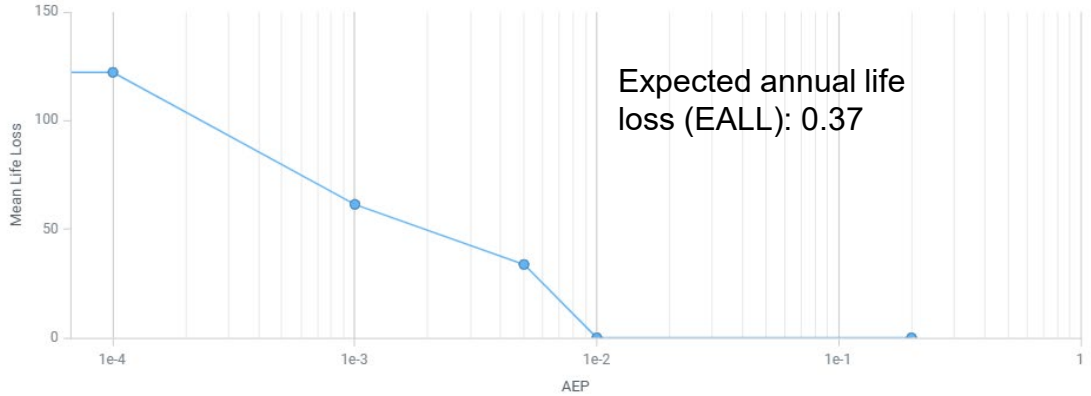


Expected annual life loss (EALL): 1.35

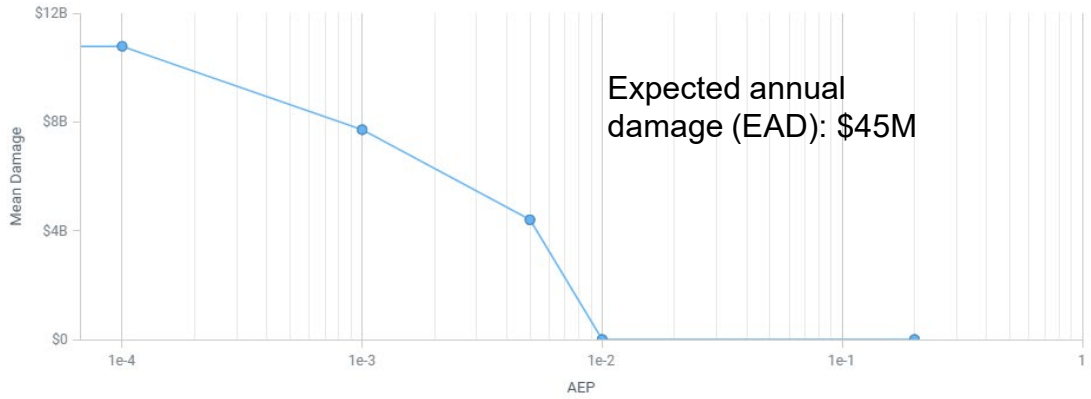


Expected annual damage (EAD): $296M

With Project



Expected annual life loss (EALL): 0.37



Expected annual damage (EAD): $45M

Expected Annual Life Loss Reduced = 1.35 – 0.37 = 0.98

LIFE LOSS ESTIMATION BASICS

Life loss calculation essential elements:

- Initial distribution of people
- Redistribution of people
  - Warning
  - Response
  - Evacuation potential
- Flood characteristics
  - Arrival time, depth, velocity
- Shelter provided by final location
- Fatality rates
- Indirect life loss

LIFE LOSS ESTIMATION BASICS

Life loss calculation essential elements:

- Initial distribution of people → National Structure Inventory (NSI)
- Redistribution of people → User inputs for:
  1. Evacuation Planning
  2. Community Awareness
  3. Flood Warning Effectiveness
  4. Hazard Advance Notice
  - Warning
  - Response
  - Evacuation potential
- Flood characteristics → HEC-RAS
  - Arrival time, depth, velocity
- Shelter provided by final location → LifeSim
- Fatality rates

LSRI APPLICATION

ACCESS AND MAIN PROJECT WINDOW

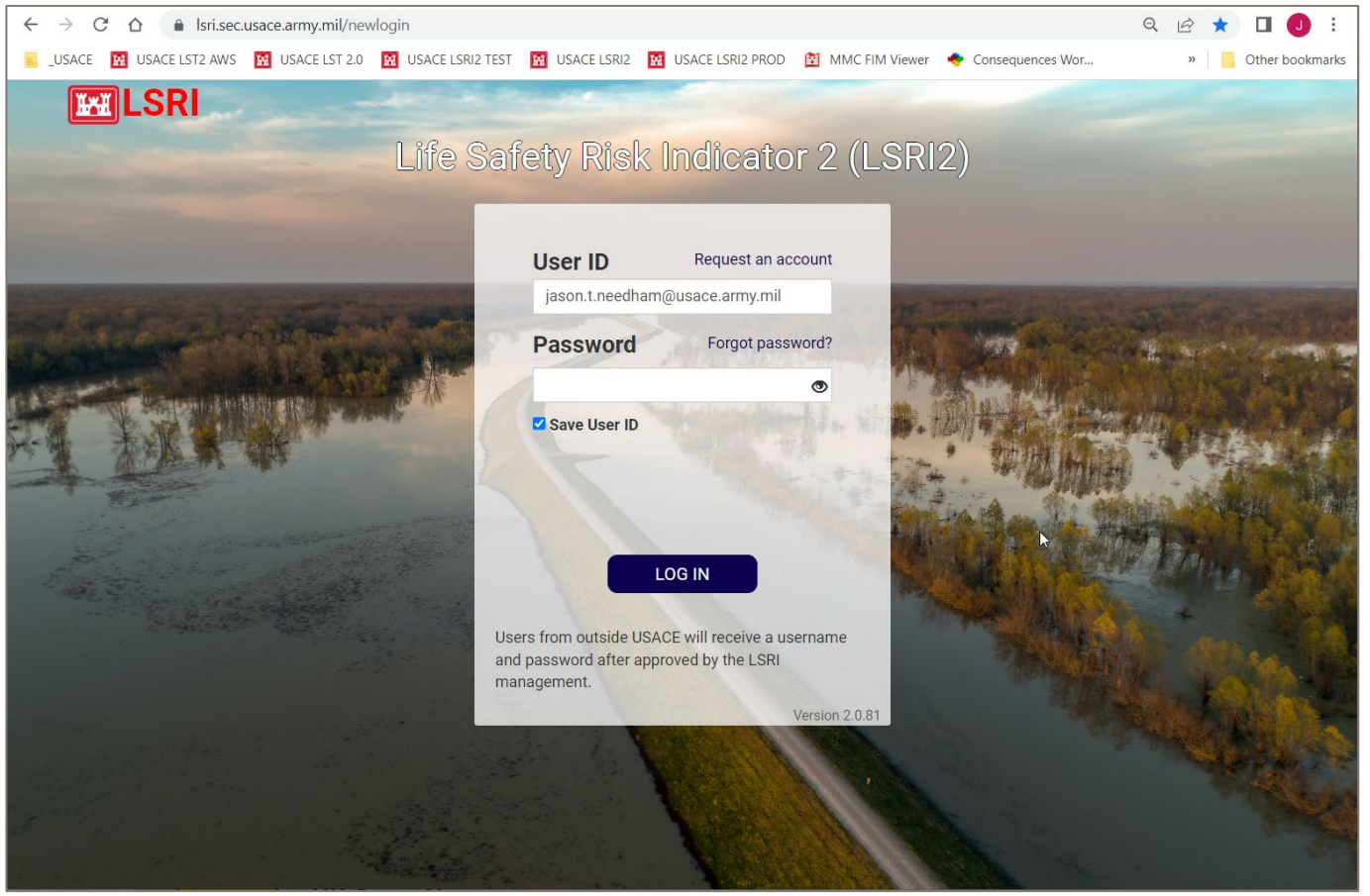
ACCESS LSRI

URL: https://lsri.sec.usace.army.mil/

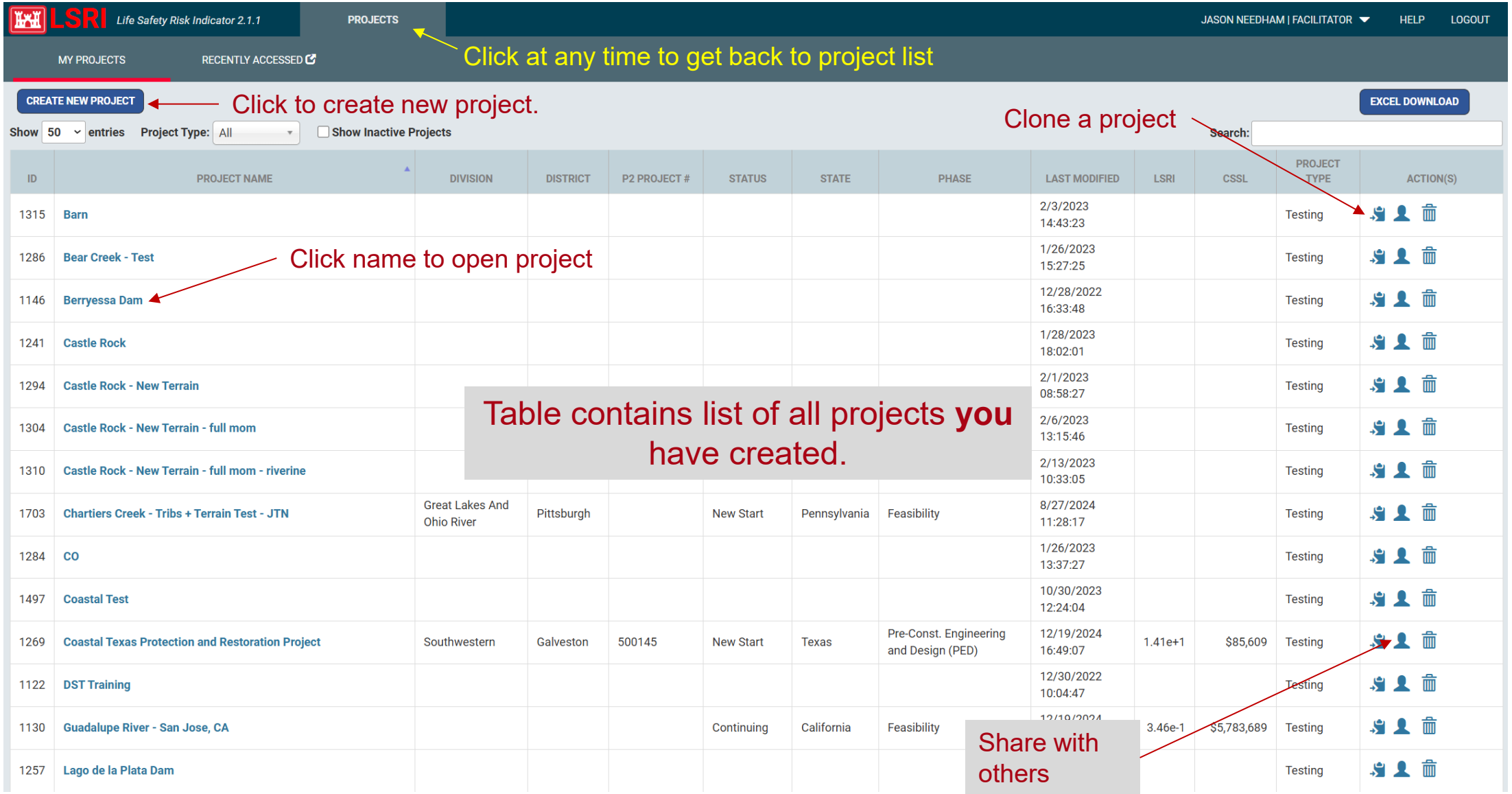
To get an account, send request to:
dll-cwbi-lsri-support@usace.army.mil

Enter Username and Password at login screen

- Username: your email address
- Password: Provided in email

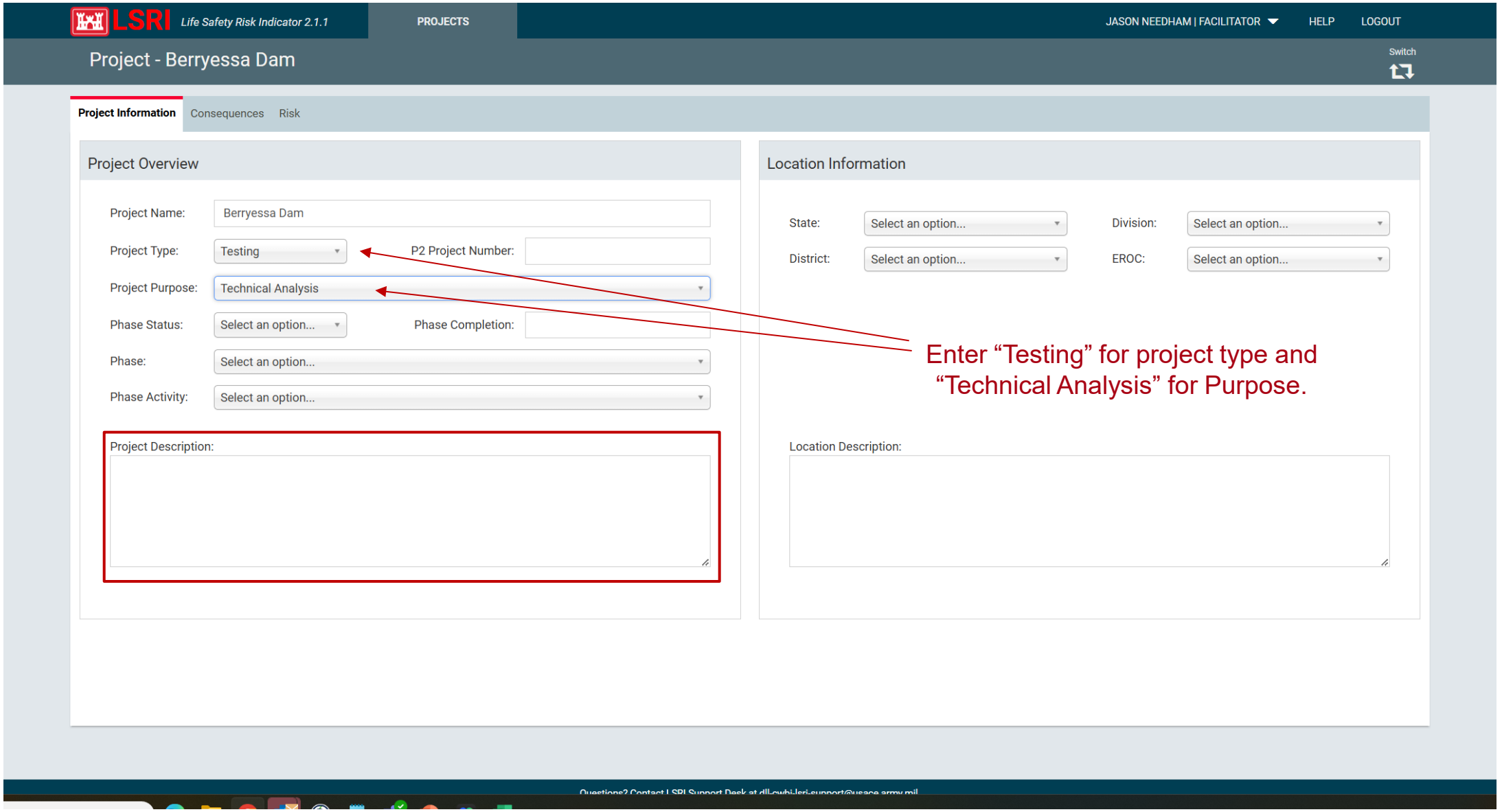


MAIN PROJECT BROWSING WINDOW



ID	PROJECT NAME	DIVISION	DISTRICT	P2 PROJECT #	STATUS	STATE	PHASE	LAST MODIFIED	LSRI	CSSL	PROJECT TYPE	ACTION(S)
1315	Barn							2/3/2023 14:43:23			Testing	
1286	Bear Creek - Test							1/26/2023 15:27:25			Testing	
1146	Berryessa Dam							12/28/2022 16:33:48			Testing	
1241	Castle Rock							1/28/2023 18:02:01			Testing	
1294	Castle Rock - New Terrain							2/1/2023 08:58:27			Testing	
1304	Castle Rock - New Terrain - full mom							2/6/2023 13:15:46			Testing	
1310	Castle Rock - New Terrain - full mom - riverine							2/13/2023 10:33:05			Testing	
1703	Chartiers Creek - Tribs + Terrain Test - JTN	Great Lakes And Ohio River	Pittsburgh		New Start	Pennsylvania	Feasibility	8/27/2024 11:28:17			Testing	
1284	CO							1/26/2023 13:37:27			Testing	
1497	Coastal Test							10/30/2023 12:24:04			Testing	
1269	Coastal Texas Protection and Restoration Project	Southwestern	Galveston	500145	New Start	Texas	Pre-Const. Engineering and Design (PED)	12/19/2024 16:49:07	1.41e+1	$85,609	Testing	
1122	DST Training							12/30/2022 10:04:47			Testing	
1130	Guadalupe River - San Jose, CA				Continuing	California	Feasibility	12/19/2024	3.46e-1	$5,783,689	Testing	
1257	Lago de la Plata Dam										Testing	

PROJECT INFORMATION TAB



LSRI APPLICATION

CONSEQUENCES – INUNDATION TAB

Goal: Create inundation that “roughly” represents the extents, depths, velocities and timing of flooding for user defined scenarios.

CONSEQUENCES TAB – INUNDATION

Project Information | **Consequences** | Risk

Inundation | Structure Inventory | LifeSim Compute | Consequence Results

System Features

NAME	TYPE	ACTION(S)
Model Area	2D Flow Area	
Levee System 5605170001	2D Breakline	
Mississippi River	River Reach	

Terrain Parameters

Prepare Terrain Data: (•) LSRI Terrain ( ) User Uploaded Terrain

Download NED Terrain to LSRI — Download Complete

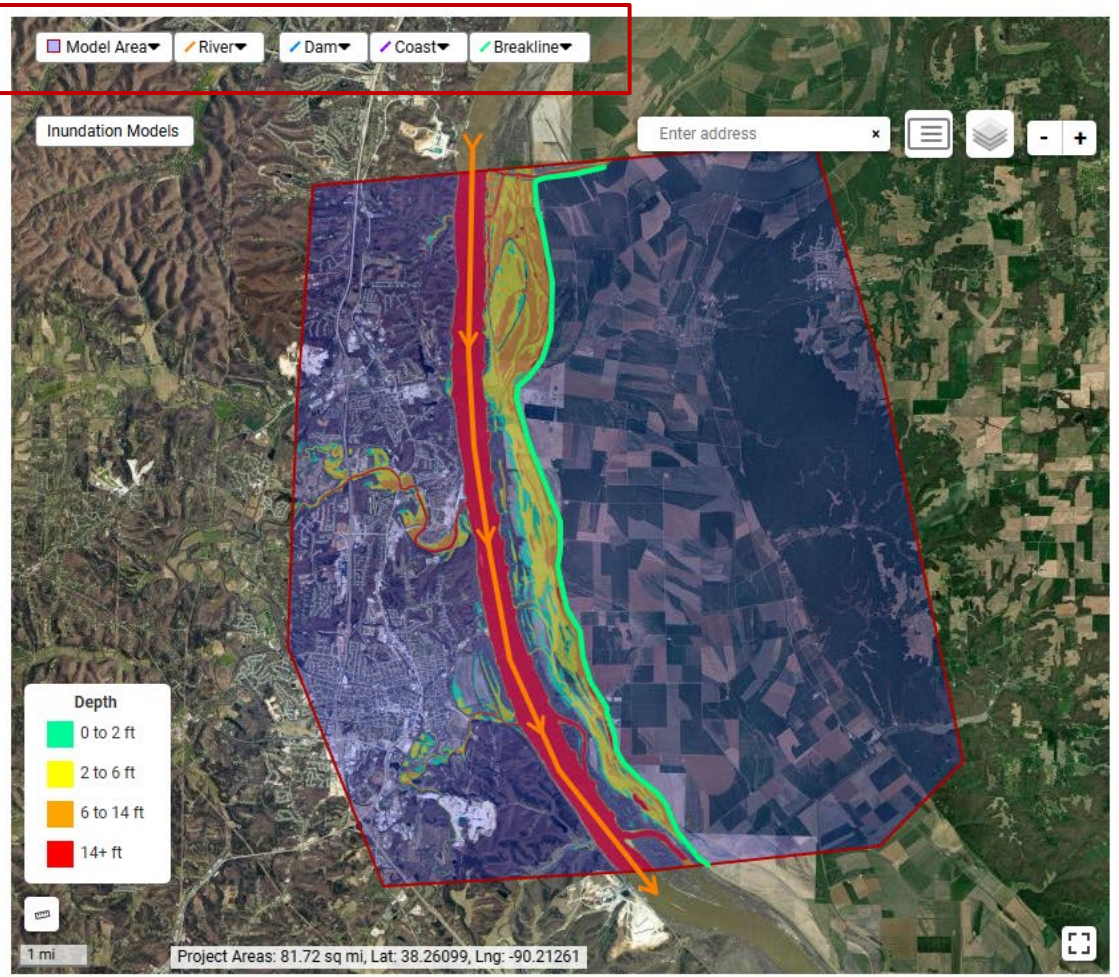
+ ADD NEW TERRAIN MOD

TERRAIN MOD NAME	LAST PROCESSED	ACTION(S)
Base	Success: 1/8/2025 10:38:49	

Flood Scenarios

+ ADD NEW | UPLOAD | RAS QUEUE | DOWNLOAD

FLOOD SCENARIO NAME	MODEL CREATION	LAST COMPUTED	ACTION(S)
10K cfs	LSRI Data Entry	Success: 1/22/2025 16:52:19	
100K cfs	LSRI Data Entry	Success: 1/22/2025 18:26:55	
500K cfs	LSRI Data Entry	Success: 1/22/2025 18:34:26	



CONSEQUENCES TAB – INUNDATION

Project Information | **Consequences** | Risk

Inundation | Structure Inventory | LifeSim Compute

Terrain options:
1. Download 10 meter from 3DEP
2. Upload terrain (HEC-RAS or GeoTiff)
3. Modify existing 3DEP or GeoTiff

System Features

NAME		
Model Area	2D Flow Area	
Levee System 5605170001	2D Breakline	
Mississippi River	River Reach	

Terrain Parameters

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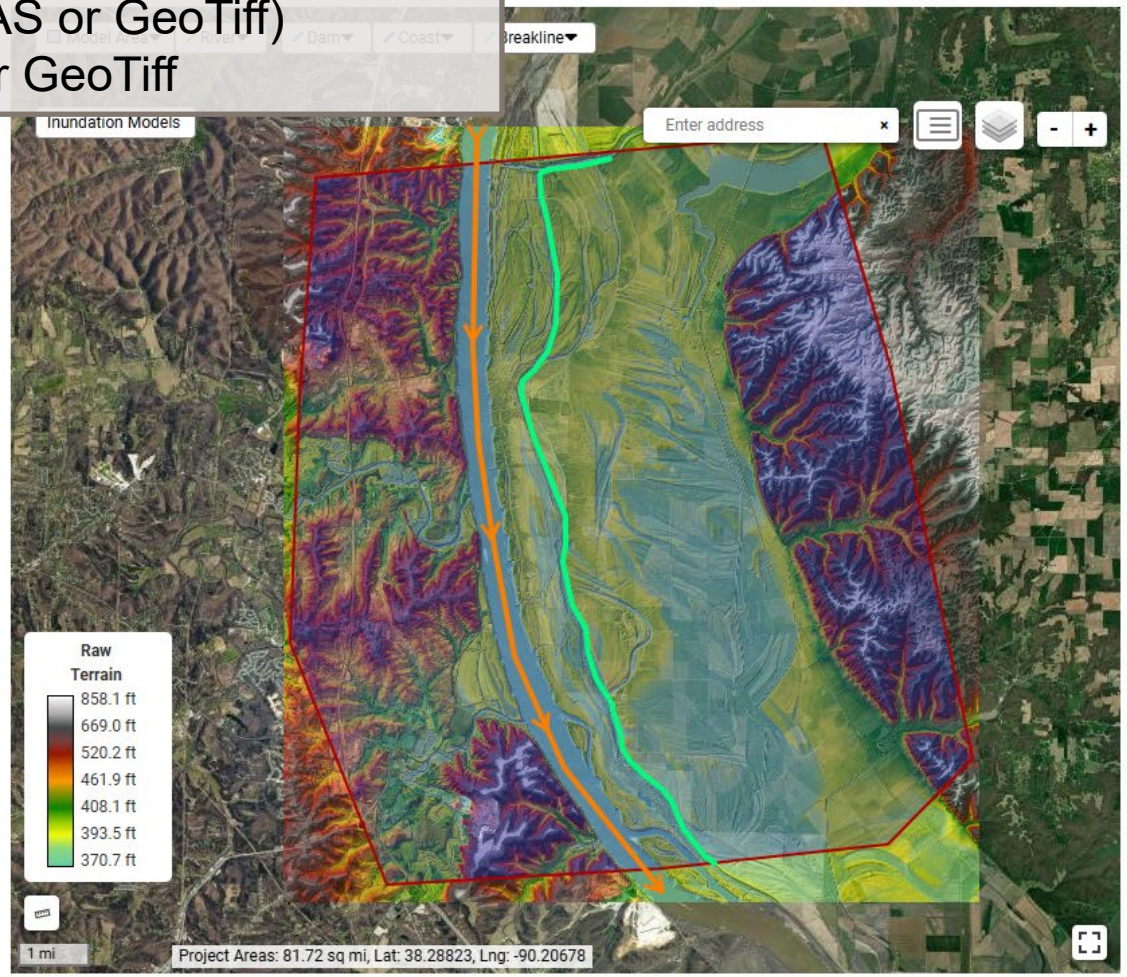
500K cfs	LSRI Data Entry	Success: 1/22/2025 18:34:26	



CONSEQUENCES TAB – INUNDATION

TERRAIN MODIFICATIONS

Terrain Modifications

Name: Base

Description:

Feature: Levee System 5605170001

Modification Method: Raise

Width: 20

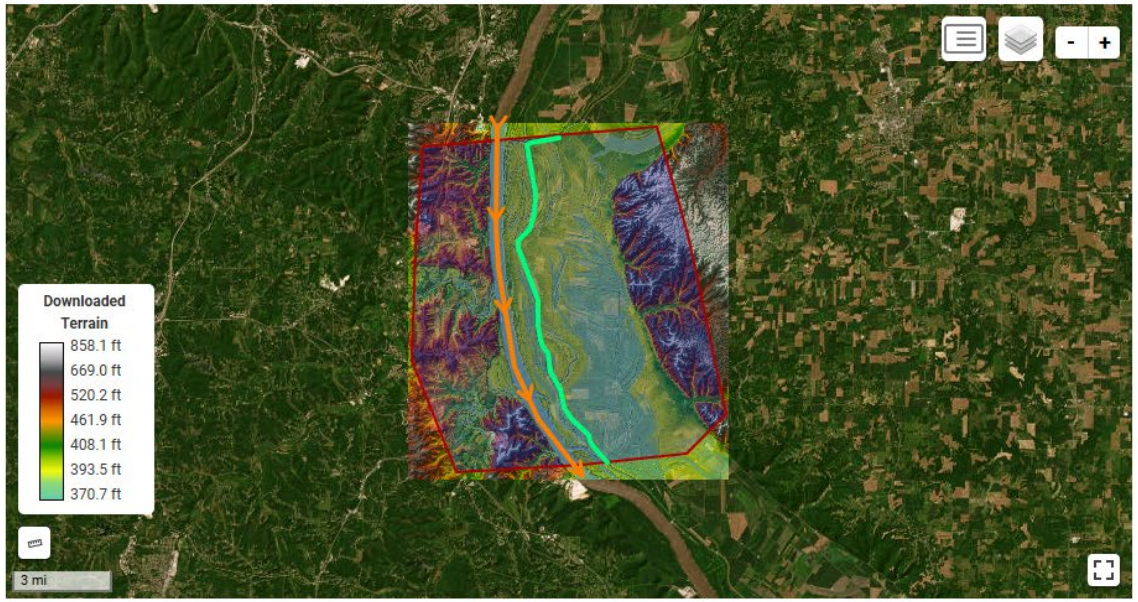
Side Slope: 2

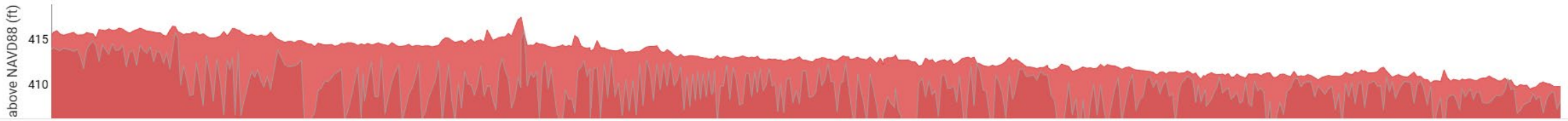
Max Extent Width: 100

EXPORT IMPORT INTERPOLATE RESET

STATION (FT)	TERRAIN ELEVATION	MINIMUM TERRAIN ELEVATION
26535.65	408.96	412.68
26591.92	411.45	412.78
26711.23	405.71	413.09
26833.06	409.68	412.80
26957.24	409.74	412.98
27084.22	412.04	412.91
27211.51	408.23	412.82
27338.83	411.78	412.77
27468.09	410.43	412.88
27597.69	407.61	412.91
27727.47	407.78	413.05
27853.56	411.06	412.90
27974.74	411.09	412.83
28092.45	408.53	412.91
28205.35	411.25	412.83

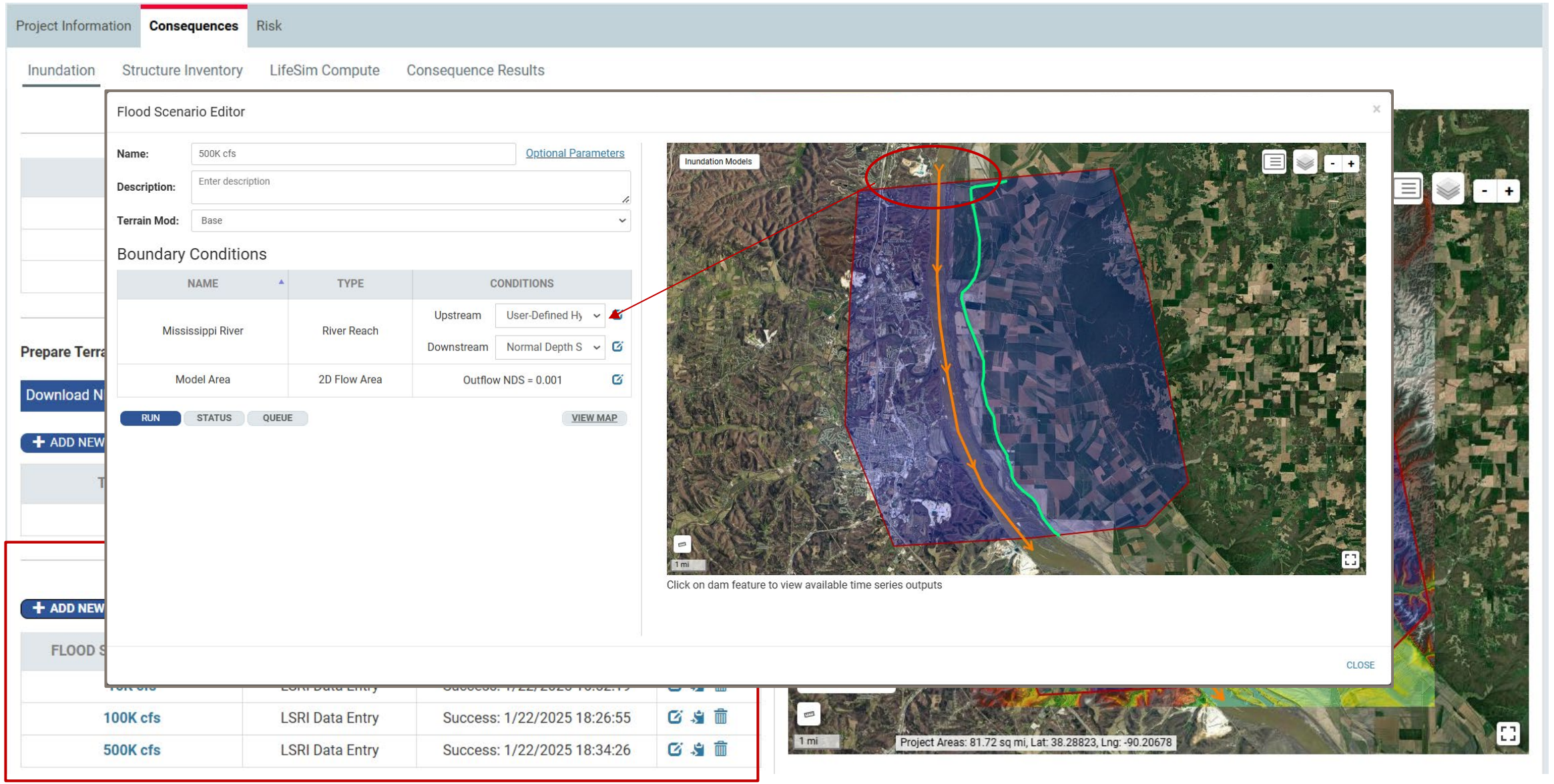
Showing 211 to 225 of 484 entries Previous 1 ... 14 15 16 ... 33 Next





PROCESS TERRAIN CLOSE

CONSEQUENCES TAB – INUNDATION



CONSEQUENCES TAB – INUNDATION

Flood Scenario Editor

Name: 500K cfs Optional Parameters

Description: Enter description

Terrain Mod: Base

Boundary Conditions

NAME	TYPE	CONDITIONS
Mississippi River	River Reach	Upstream: User-Defined Hy; Downstream: Normal Depth S
Model Area	2D Flow Area	Outflow NDS = 0.001

RUN STATUS QUEUE VIEW MAP

Trapezoidal Complex

Type: Flow

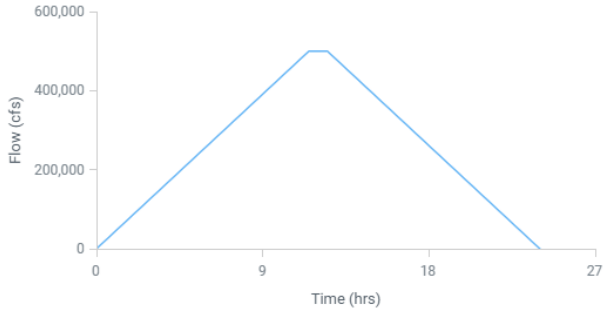
Base (cfs): 100

Total Duration (hrs): 24

Peak (cfs): 500000

Peak Duration (hrs): 1

Critical Flow for Hazard Time (cfs): (Optional)



Flood Scenario Editor

Name: 500K cfs Optional Parameters

Description: Enter description

Terrain Mod: Base

Boundary Conditions

NAME	TYPE	CONDITIONS
Mississippi River	River Reach	Upstream: User-Defined Hy; Downstream: Normal Depth S
Model Area	2D Flow Area	Outflow NDS = 0.001

RUN STATUS QUEUE VIEW MAP

Trapezoidal Complex

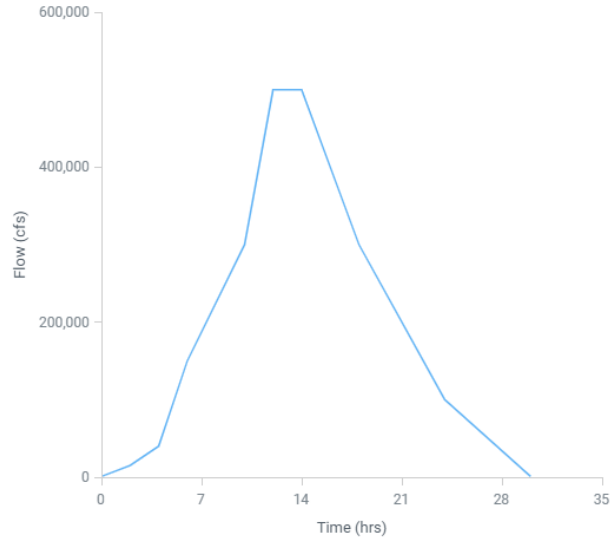
Type: Flow Time Unit: Hours

#	Time (hrs)	Flow(cfs)
5	10	300000
6	12	500000
7	14	500000
8	18	300000
9	24	100000
10	30	1000
11		
12		

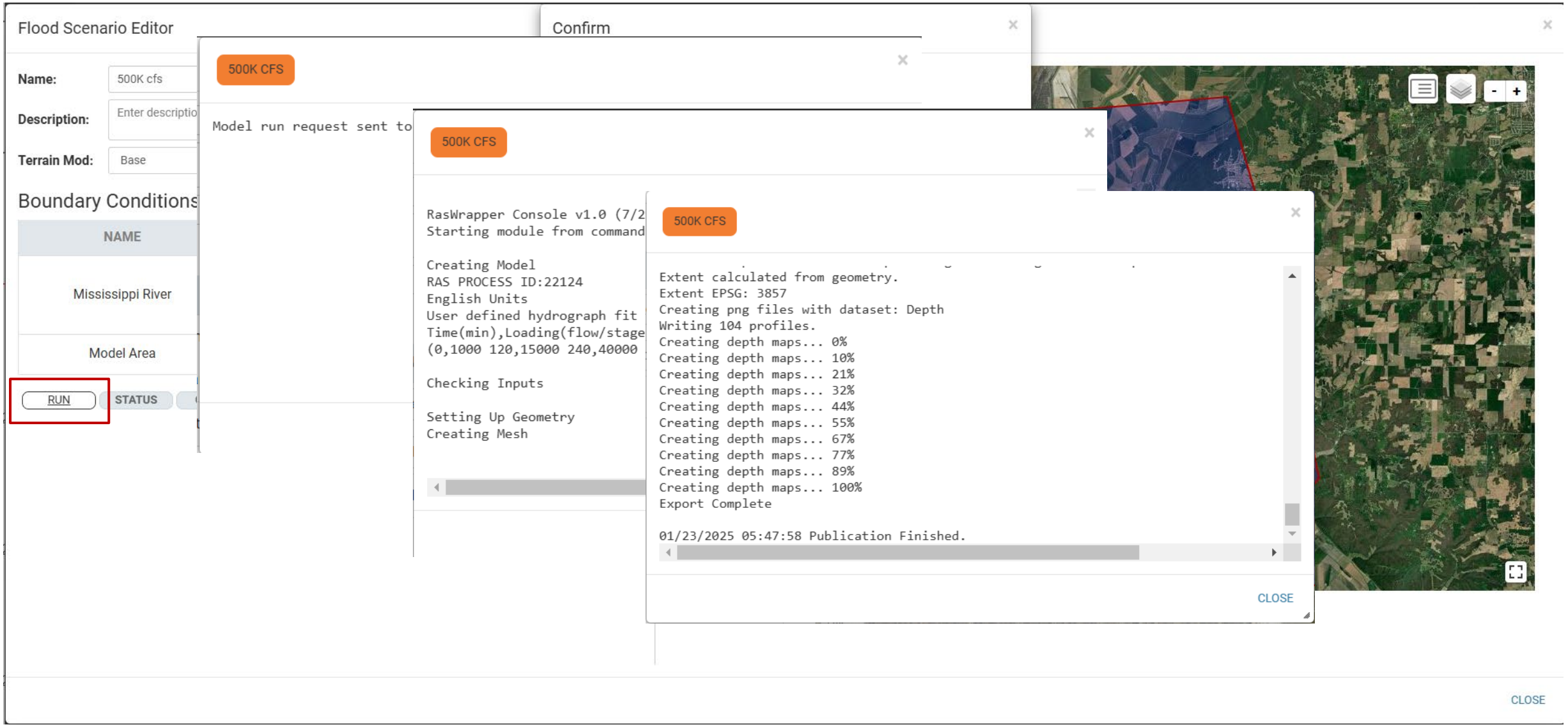
Add Row Add 10 Rows Clear All Rows

Paste Excel cells here:

Critical Flow for Hazard Time (cfs): (Optional)



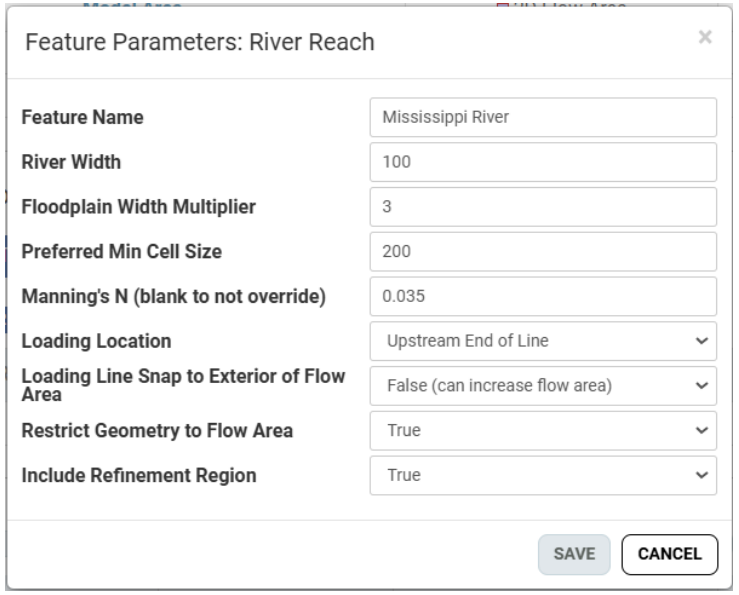
CONSEQUENCES TAB – INUNDATION

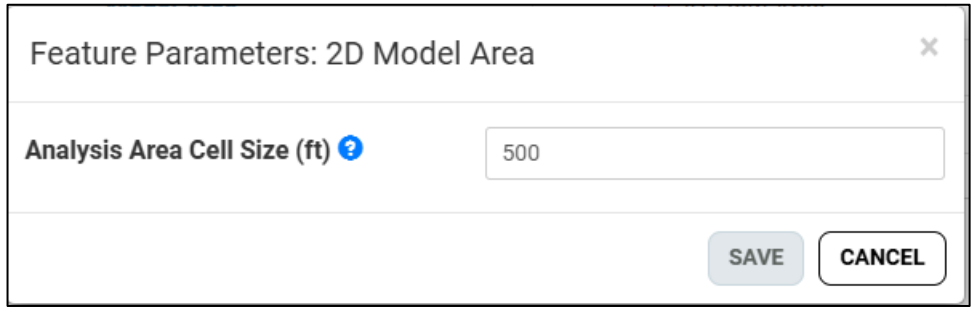


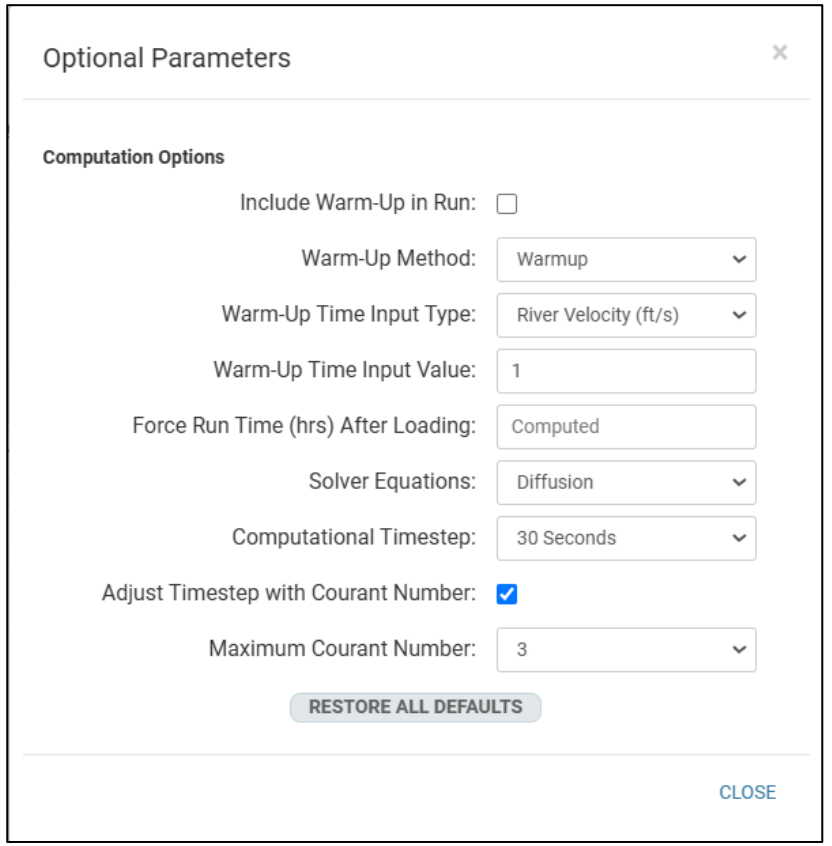
ADVANCED USERS – INUNDATION REFINEMENTS

There are various tips and tricks on how to setup inundation to make it more accurate and efficient, including but not limited to:

- Model area mesh cell size
- River alignment cell size, Manning's N value override
- Optional parameters including time steps, Courant #, etc







CONSEQUENCES TAB – INUNDATION RESULTS

Inundation | Structure Inventory | LifeSim Compute | Consequence Results

System Features

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Download NED Terrain to LSRI Download Complete

+ ADD NEW TERRAIN MOD

TERRAIN MOD NAME	LAST PROCESSED	ACTION(S)
Base	Success: 1/8/2025 10:38:49	

Flood Scenarios

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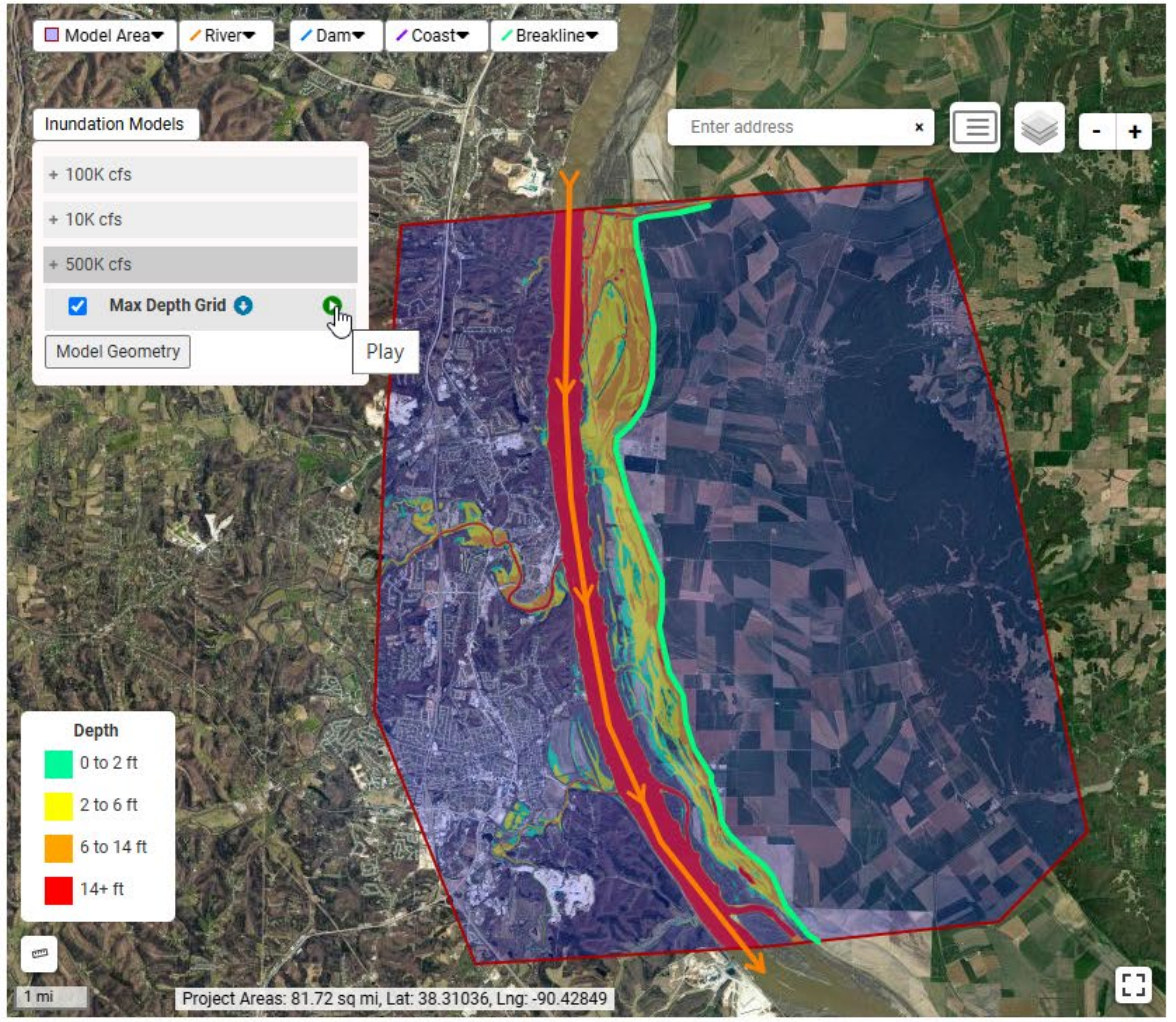

LSRI APPLICATION

CONSEQUENCES – STRUCTURE INVENTORY TAB

CONSEQUENCES TAB – STRUCTURE INVENTORY

Project Information | **Consequences** | Risk

Inundation | Structure Inventory | LifeSim Compute | Consequence Results

+ ADD NEW STRUCTURE INVENTORY

Base Inventory (Updated 1/22/2025 22:01:58)

Project Area Information

Base Data

Day population in Project Area	23,597
Night population in Project Area	24,900
Number of Structures in Project Area	10,326
Property Value in Project Area ($1000s)	6,552,291

Index Factors

Population Day Index Factor *	1
Population Night Index Factor *	1
Property Value Index Factor *	1

Indexed Data (Used In Compute)

Daytime Population Estimate	23,597
Nighttime Population Estimate	24,900
Number of Structures in Project Area	10,326
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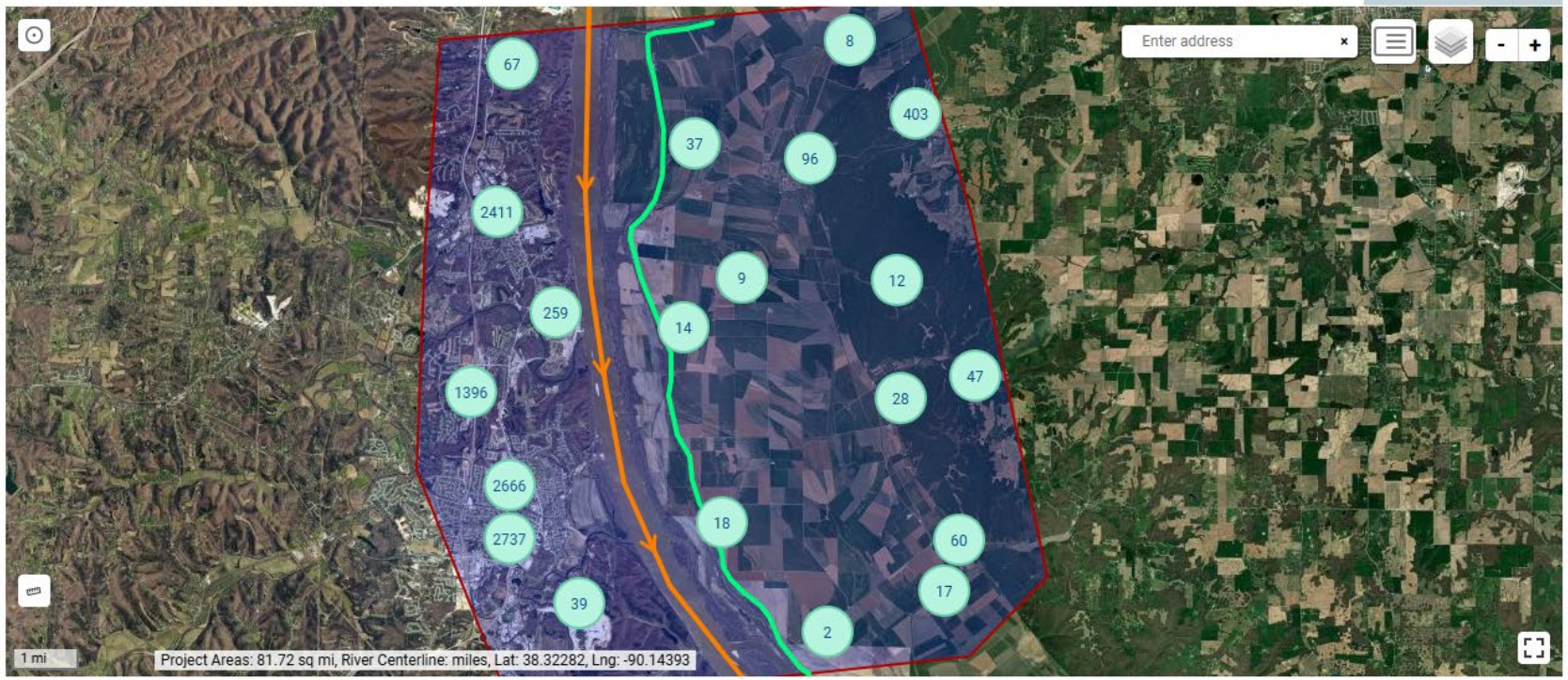
Map | Structure Summary

Structure Inventory



Comments

Enter Comment

CONSEQUENCES TAB – STRUCTURE INVENTORY

Project Information | **Consequences** | Risk

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Enter Comment

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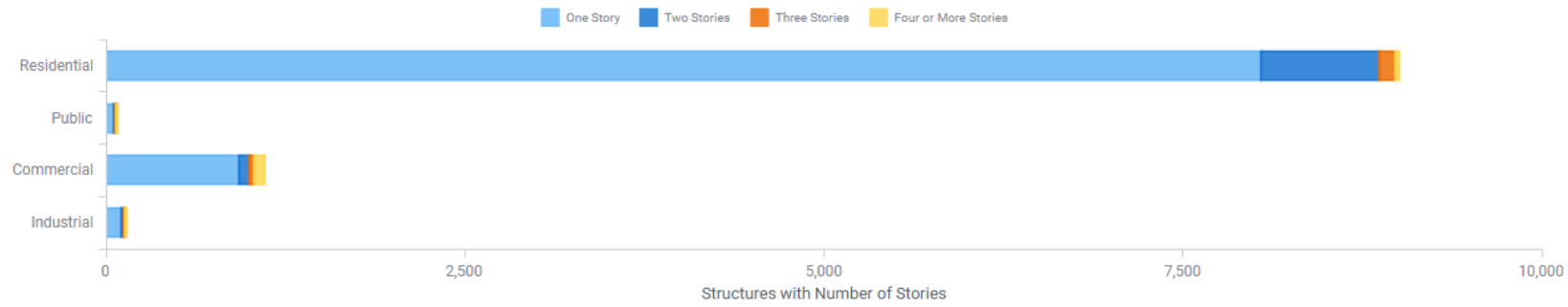
Map | Structure Summary

Structure Inventory

DAMAGE CATEGORY	POPULATION				STRUCTURE		
	UNDER 65 DAY	OVER 65 DAY	UNDER 65 NIGHT	OVER 65 NIGHT	# STRUCTURES	STRUCTURAL VALUE ($1000)	CONTENT VALUE ($1000)
Residential	8,468	2,817	20,856	2,817	9,006	1,851,349	925,675
Public	3,408	24	21	0	79	175,840	181,391
Commercial	7,110	952	510	664	1,101	1,374,604	1,424,326
Industrial	780	38	32	0	140	255,000	364,107
Total	**19,766**	**3,831**	**21,419**	**3,481**	**10,326**	**3,656,793**	**2,895,498**

Number of Stories | Construction Type | Foundation Height



Comments

Enter Comment

NATIONAL STRUCTURE INVENTORY (NSI)

- Developed by USACE to support damage assessments
- Based on data from nationally available data sources
  - Microsoft building footprints, Longitudinal Employer-Household Dynamics, National Center for Education Statistics, etc.
- Freely available

- Details here:
  - https://www.hec.usace.army.mil/confluence/nsi/technicalreferences/latest/technical-documentation

LSRI APPLICATION

CONSEQUENCES – LIFESIM COMPUTE

Estimate potential loss of life and direct property damages for the flood scenarios created on the inundation tab

CONSEQUENCES TAB – LIFESIM COMPUTE

Project Information | **Consequences** | Risk

Inundation | Structure Inventory | LifeSim Compute | Consequence Results

+ ADD NEW EM SCENARIO — Base EM Scenario (Updated 1/22/2025 21:48:29)

EXPAND ALL

Evacuation Planning

Which category best describes the emergency evacuation planning for the community or communities located in the impacted area? — Unknown

Comments (0 characters)

Community Awareness

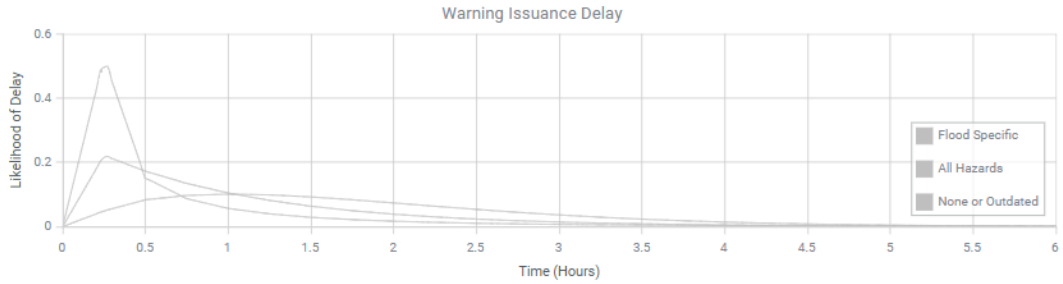
Which category best describes the flood risk awareness of the community or communities located in the impacted area? — Unknown

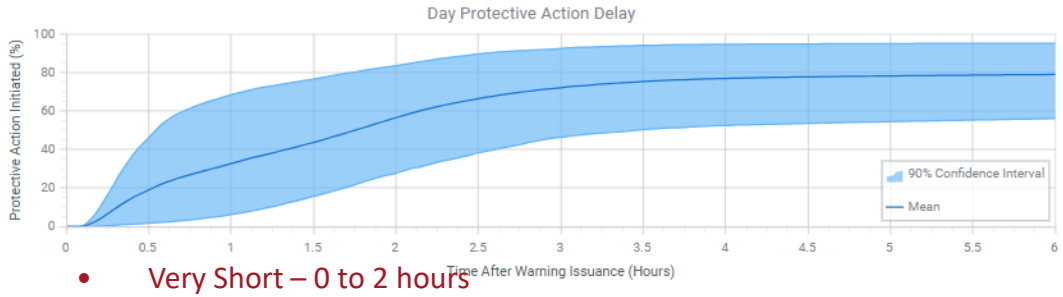
Comments (0 characters)

Flood Warning Effectiveness

Which category best describes the flood warning capabilities of the community or communities in the impacted area? — Unknown

Comments (0 characters)





Hazard Advanced Notice

How would you describe the amount of warning time available prior to first structure getting wet? — Moderate

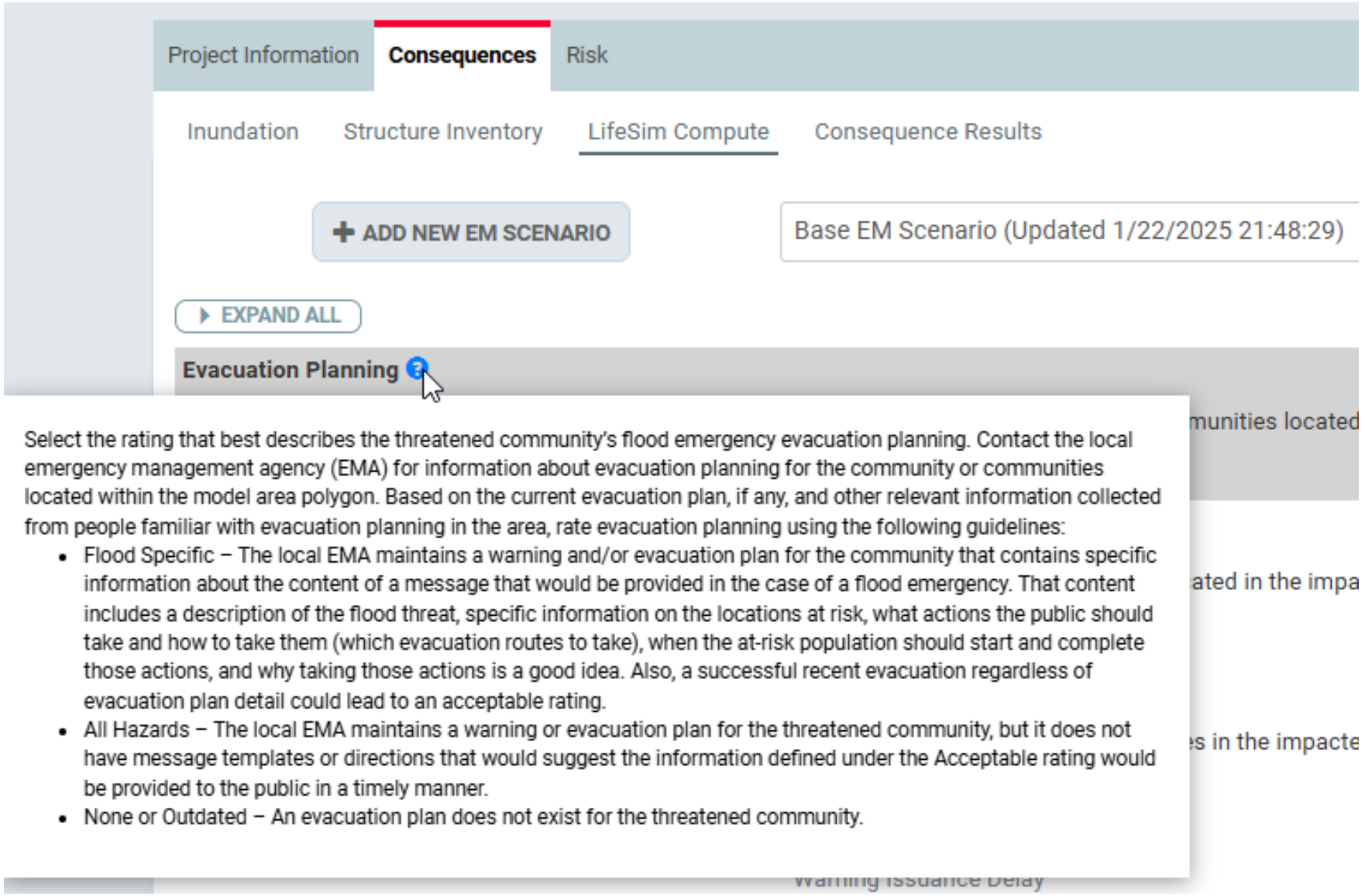
Comments (0 characters)

- Very Short – 0 to 2 hours
- Short – 2 to 4 hours
- Moderate – 4 to 8 hours
- Long – 8 to 24 hours
- Very Long – 24 to 48 hours

+ ADD NEW LIFESIM COMPUTE | RUN LIFESIM | STATUS | LIFESIM QUEUE

LIFESIM COMPUTE NAME	FLOOD SCENARIO	LAST HEC-RAS RUN	STRUCTURE INVENTORY	EM SCENARIO	INCLUDE IN LIFESIM	ACTION(S)
Base Lifesim Compute	Select an option...	N/A	Select an option...	Select an option...	Not Run	

CONSEQUENCES TAB – LIFESIM COMPUTE



CONSEQUENCES TAB – LIFESIM COMPUTE

Project Information | **Consequences** | Risk

Inundation | Structure Inventory | LifeSim Compute | Consequence Results

+ ADD NEW EM SCENARIO — Base EM Scenario (Updated 1/22/2025 21:48:29)

EXPAND ALL

Evacuation Planning

Which category best describes the emergency evacuation planning for the community or communities located in the impacted area? — Unknown

Comments (0 characters)

Community Awareness

Which category best describes the flood risk awareness of the community or communities located in the impacted area? — Unknown

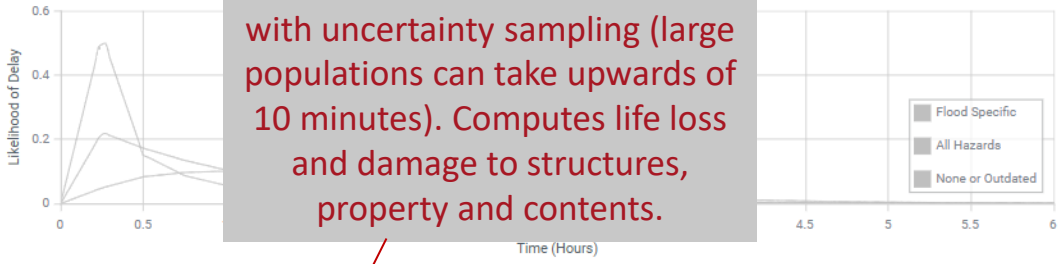
Comments (0 characters)

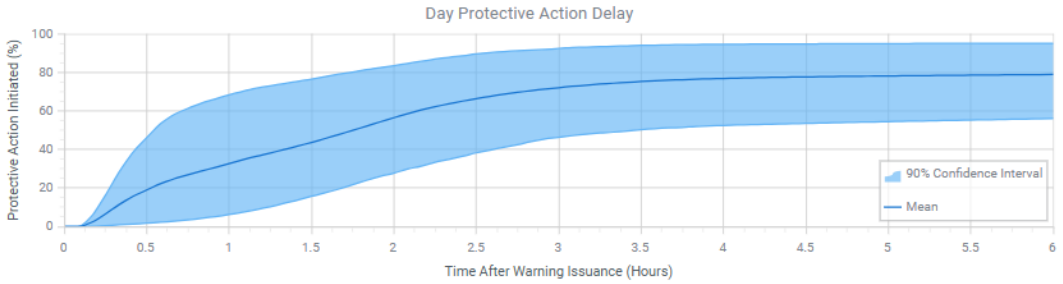
Flood Warning Effectiveness

Which category best describes the flood warning capabilities of the community or communities in the impacted area? — Unknown

Comments (0 characters)

Runs 1000 iterations of LifeSim with uncertainty sampling (large populations can take upwards of 10 minutes). Computes life loss and damage to structures, property and contents.





Hazard Advanced Notice

How would you describe the amount of warning time available prior to first structure getting wet? — Moderate

Comments (0 characters)

+ ADD NEW LIFESIM COMPUTE | RUN LIFESIM | STATUS | LIFESIM QUEUE

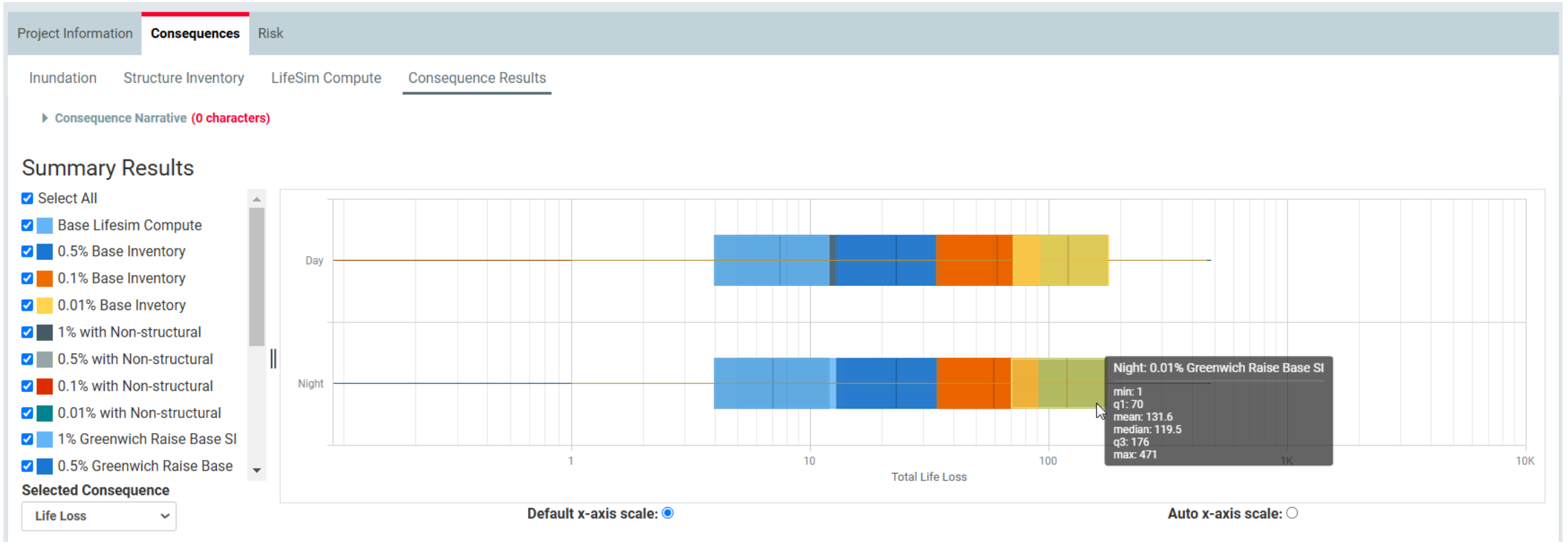
LIFESIM COMPUTE NAME	FLOOD SCENARIO	LAST HEC-RAS RUN	STRUCTURE INVENTORY	EM SCENARIO	INCLUDE IN LIFESIM	ACTION(S)
Base Lifesim Compute	Select an option...	N/A	Select an option...	Select an option...	Not Run	

LSRI APPLICATION

CONSEQUENCES – CONSEQUENCE RESULTS

Review LifeSim Results

CONSEQUENCES TAB – CONSEQUENCE RESULTS



LSRI APPLICATION

RISK TAB

RISK TAB

Project Information | Consequences | **Risk**

+ ADD NEW RISK

RISK CALCULATION NAME	EXPECTED ANNUAL LIFE LOSS	EXPECTED ANNUAL DAMAGE	COMPARE WITH	EALL REDUCED	EAD REDUCED	ACTION(S)
Existing conditions	1.35	$296,509,019.64	Select one...	N/A	N/A	
Greenwich Road Raise	1.19	$234,236,433.97	Existing conditions	0.16	$62,272,585.68	
Raised buildings near Battery	1.21	$291,197,296.06	Existing conditions	0.14	$5,311,723.58	
SBMs to 13'	0.37	$44,632,745.68	Existing conditions	0.98	$251,876,273.96	

+ ADD LSRI

RISK CALCULATION NAME	EXPECTED ANNUAL LIFE LOSS REDUCED	EXPECTED ANNUAL DAMAGE REDUCED	EXPECTED PROJECT COST	CSSL	SUBMIT FOR LSRI	ACTION(S)
Z - LSRI Submit - 1% Proposed Design	0.96	$246,714,843.71	$151,013,000.00	$157,037,345.15	☑	

LSRI risk table. It is a slightly modified approach to quickly calculate potential risk reduction.

RISK TAB

Add additional rows for each flood scenario. Need at least 2.

First row is the annual exceedance probability of event for when damages start to occur in project area. If unknown, 0.1 (10-year) is usually a reasonable estimate.

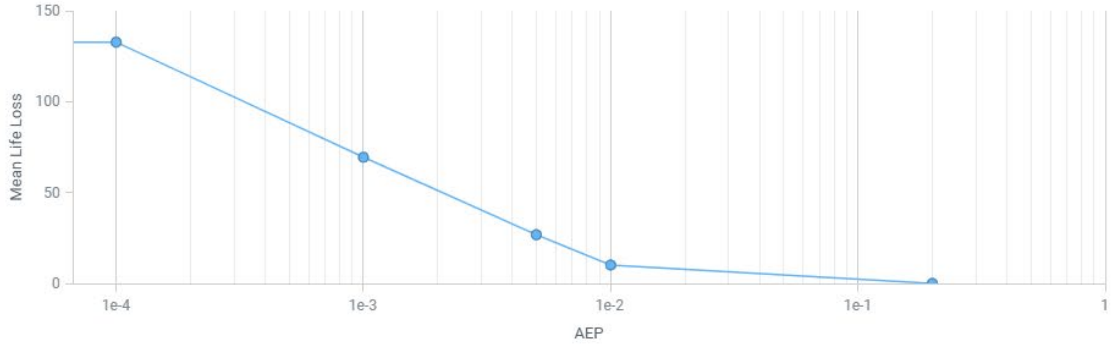
Risk Calculation

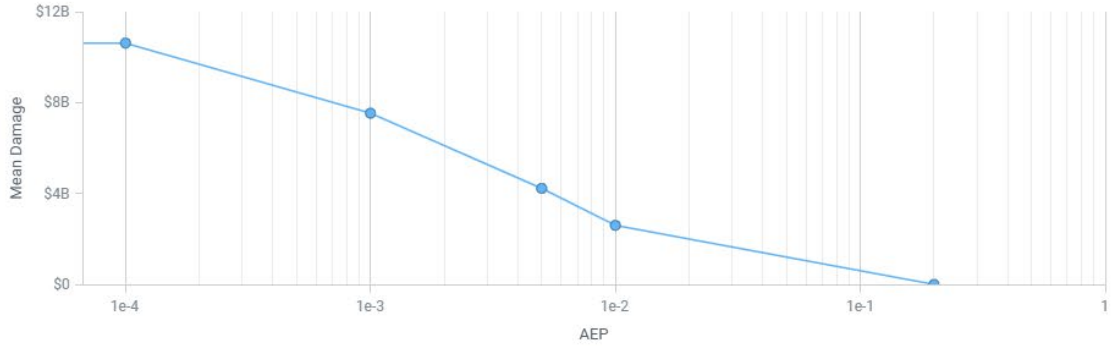
Risk Calculation Name

Existing conditions

+ ADD ROW EALL: 1.35 EAD: $296,509,019.64

AEP	LIFESIM COMPUTE	MEAN LIFE LOSS	MEAN DAMAGE	ACTIONS
0.2	N/A	0	$0.00	
0.01	Base Lifesim Compute	10.12	$2,596,998,354.84	
0.005	0.5% Base Inventory	26.80	$4,223,661,450.84	
0.001	0.1% Base Inventory	69.43	$7,532,495,827.37	
0.0001	0.01% Base Invetory	132.73	$10,619,252,253.36	





Annual exceedance probability associated with user defined inundation scenario.

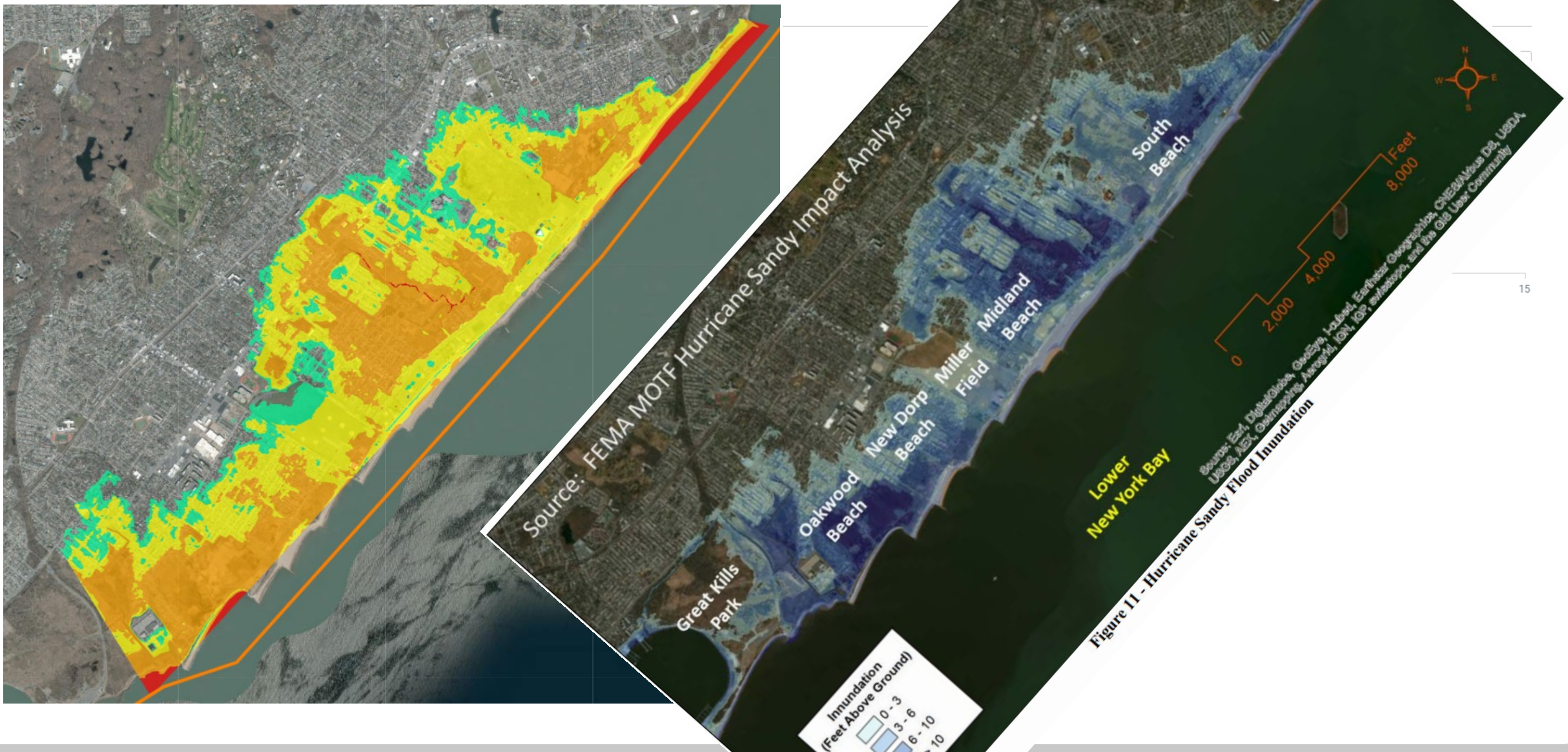
Automatically populated from LifeSim results.

SAVE AND CLOSE

LSRI APPLICATION

EXAMPLE VALIDATION STUDY

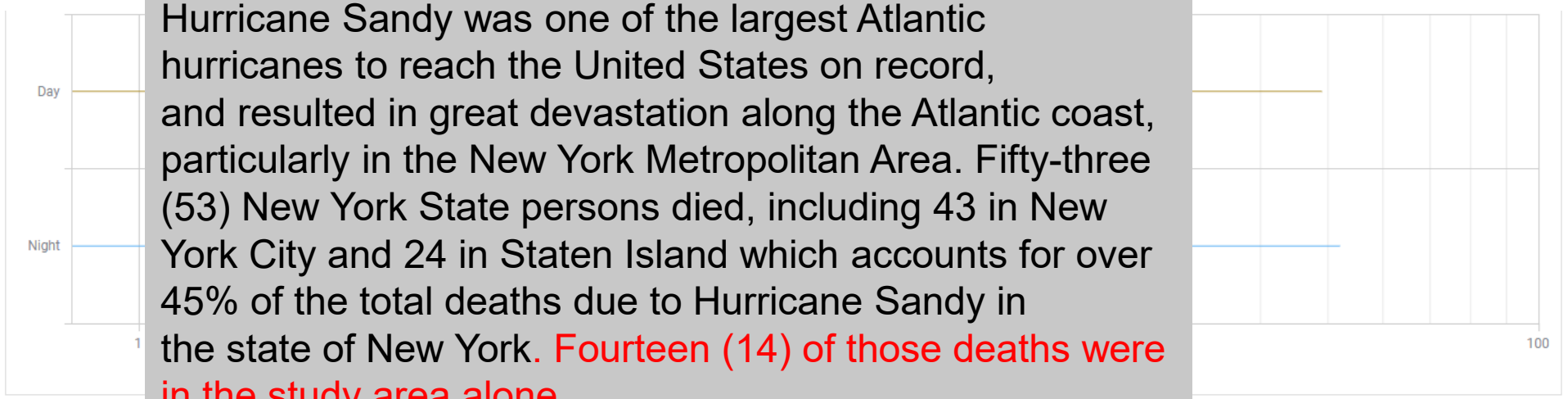
SOUTH SHORE STATEN ISLAND



SOUTH SHORE STATEN ISLAND

Selected Consequence

Life Loss



Hurricane Sandy was one of the largest Atlantic hurricanes to reach the United States on record, and resulted in great devastation along the Atlantic coast, particularly in the New York Metropolitan Area. Fifty-three (53) New York State persons died, including 43 in New York City and 24 in Staten Island which accounts for over 45% of the total deaths due to Hurricane Sandy in the state of New York. Fourteen (14) of those deaths were in the study area alone.

nundation Group Results

PARAMETER	DAY	NIGHT
PAR	30,793	30,793
Exposed Population	1,629	1,627
% of PAR Exposed	5.29%	5.28%
Median Life Loss	9	9
Fatality Rate	0.55%	0.55%
Mean Life Loss (Exposure Weighted)	11.23	
Mean Life Loss as % of PAR	0.04%	
Weighted Fatality Rate (% of Exposed PAR)	0.60%	
Property Damages	$1.50B	
# Structures Inundated	9,273	

SOUTH SHORE STATEN ISLAND

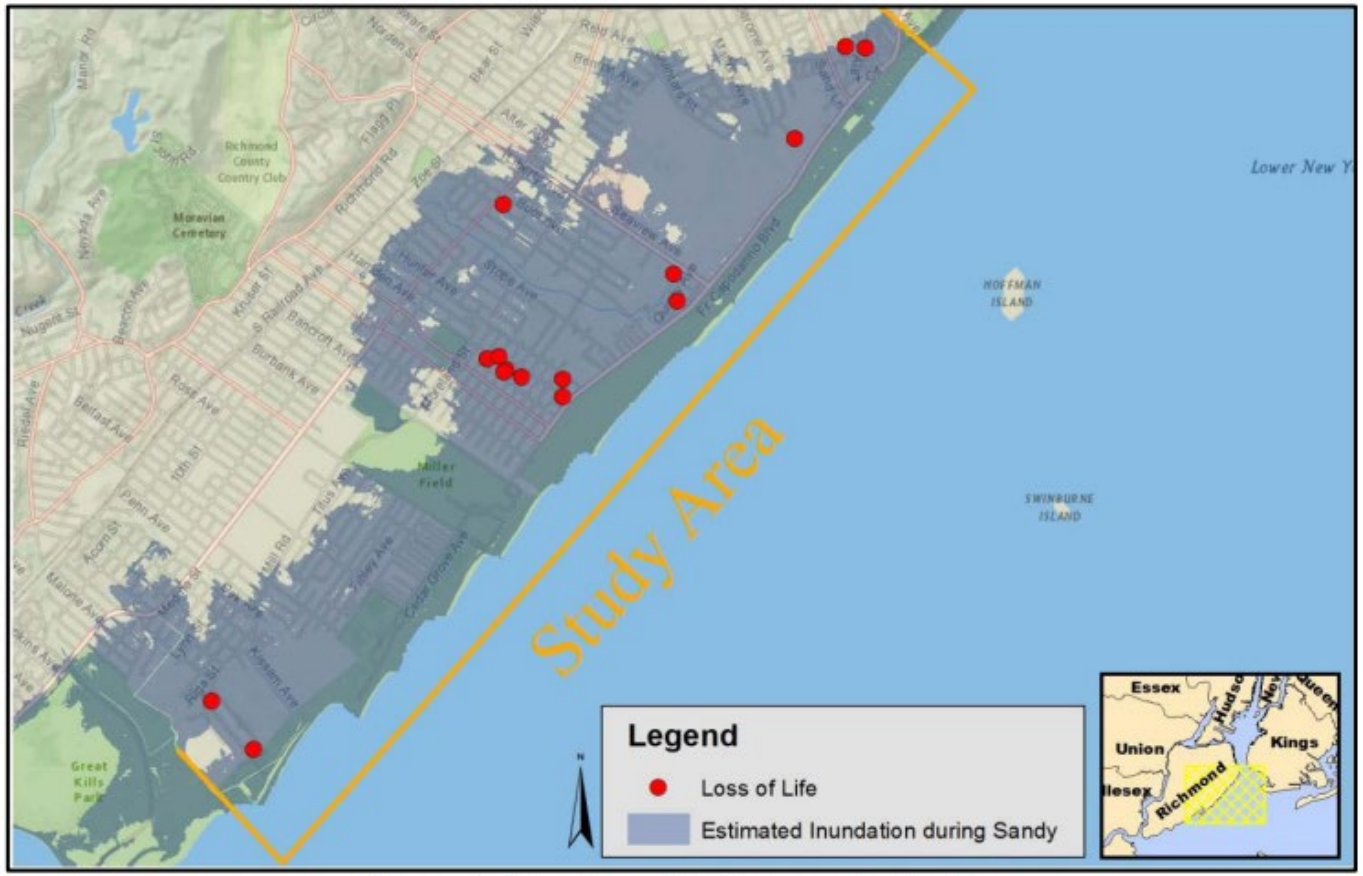
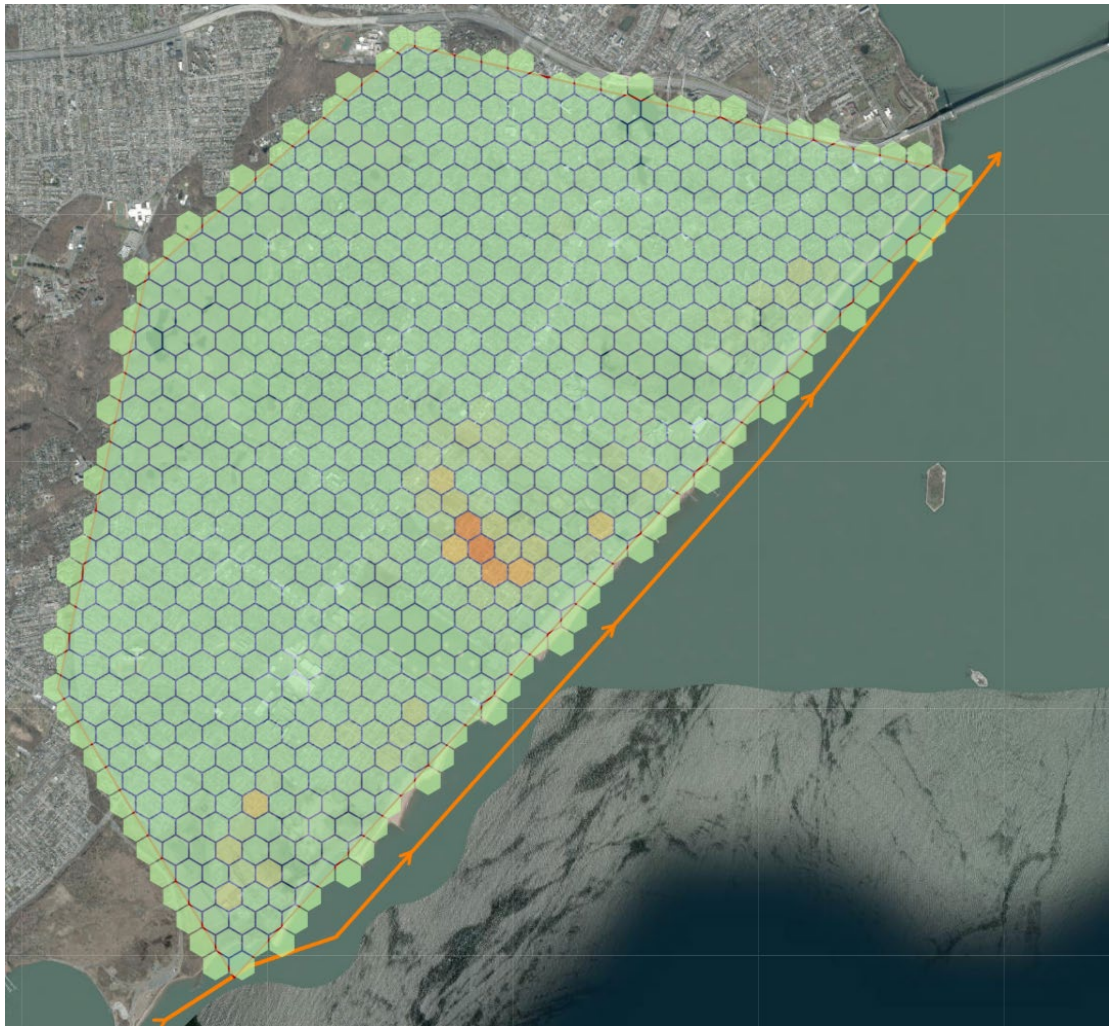


Figure 5 - Hurricane Sandy Loss of Life Map



LSRI BENEFITS

Accessibility
- Web-based application (no installation or downloads required)
- Username and password is only requirement to access
- Collaboration - easy to allow other users to view and/or edit screenings

Scalability
- Complete screening-level risk assessment with minimal data requirements in less than a day
- Allows for more refined, detailed user input to reduce uncertainty
- HEC-RAS models and LifeSim data can be downloaded and refined to support traditional analysis in later phases

Transparency
- Applies industry standard tools and processes to develop components of risk estimate
  - HEC-RAS for inundation mapping
  - NSI and LifeSim for estimating potential economic damage and life loss
- Users can download models from tools above for review outside of the LSRI
- Users can upload results from existing HEC-RAS models for use within LSRI