# STORM SCREENING PROTOCOL TO EVALUATE THE ADEQUACY OF PMP DEPTHS AT HYDROPOWER FACILITIES

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Room 301

# STORM SCREENING PROTOCOL

**Quick Recap**

Numerous “high hazard” hydropower dams are required to safely pass the Probable Maximum Flood (PMF), which is based on the Probable Maximum Precipitation (PMP) event as part of the project’s license.

The PMP, per the National Weather Service, is the “theoretically greatest depth of precipitation for a given duration that is physically possible over a given storm area at a particular geographic location at a certain time of year.”

# STORM SCREENING PROTOCOL

**Site Specific PMP Values**

As discussed in FERC's Chapter 2 Engineering Guidelines, "it is appropriate to refine PMP estimates with **site specific** or **regional studies** performed by a qualified hydrometeorologist with experience in determining PMP."

Areas that warrant such attention and study include areas with:

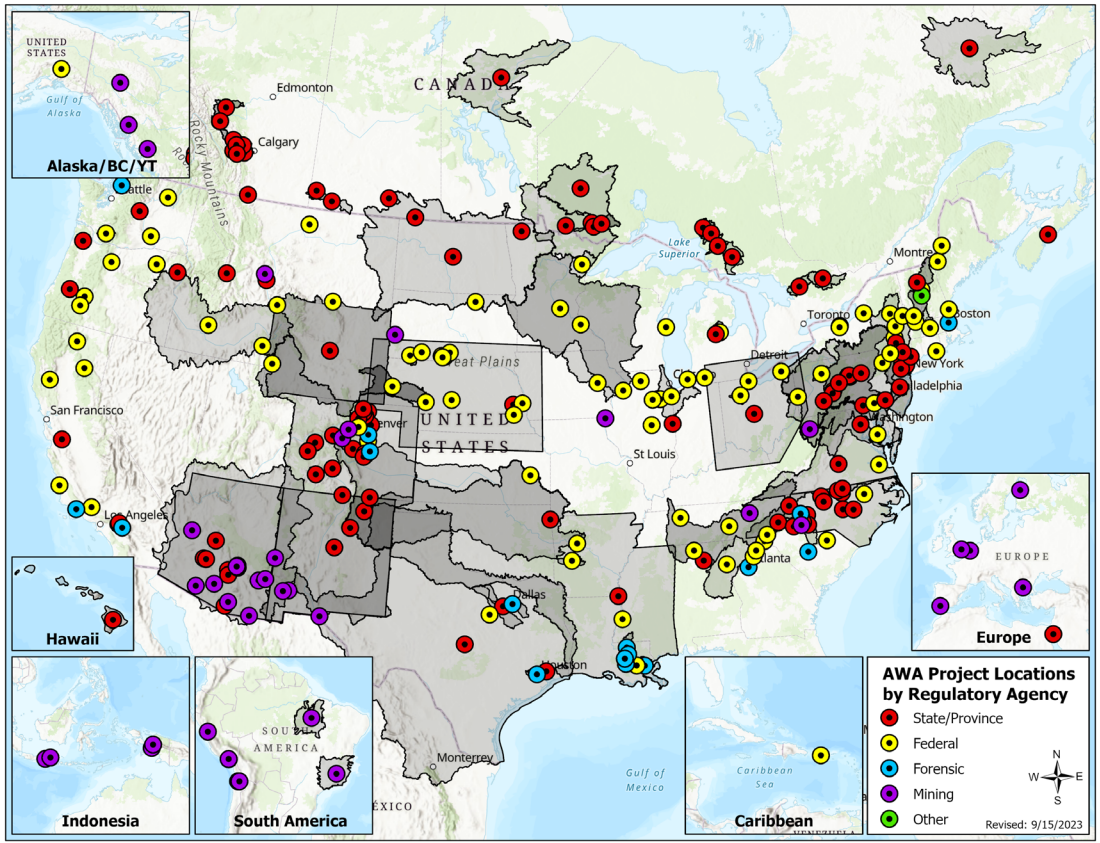
- Areas with orographic (mountain) effects
- Areas with substantial moisture barriers/limited moisture sources
- Improved analysis of prior rainfall events
- Available NEXRAD data from NOAA (Doppler weather radars)
- Potential rain-on-snow events exceeding the maximum all-season event
- Areas with dams in need of substantial improvements and the IDF=PMF

# STORM SCREENING PROTOCOL

**How Common?**

Very!

Statewide and Site-Specific



# Rapid and Simplified Flood Hazard Analysis

**The Problem**

In the past, site-specific studies were treated like NOAA HMRs and not thoroughly reviewed during the FERC Part 12D inspections or following major storm events. Additionally, they were rarely updated even following large storm events.

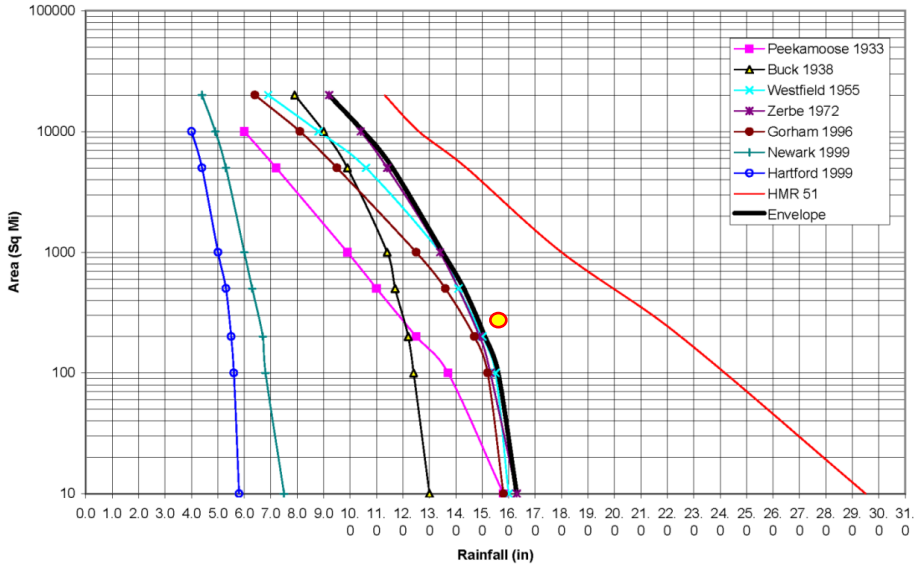
However, in the new Engineering Assessment (EA) process from FERC, per Chapter 16-6.4.3.3, "…**any significant storm events** that occurred **within the transposition limits** of the project since the last review should be identified and **evaluated/screened** for their potential impact to the (site specific) PMP…such events also offer a valuable opportunity for the IC Team to compare real-life observations with model predictions…"

# Rapid and Simplified Flood Hazard Analysis

## Why Worry?

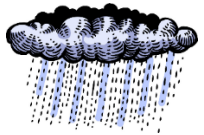
For instance, Hurricane Irene (2011), when maximized (increasing available moisture to the storm), exceeded the enveloping line for a site-specific study in the New England area for small (approx. 350 square mile) basins **but did not** exceed the original HMR.

| Percent Reduction | | Duration | | | | |
|---|---|---|---|---|---|---|
| | Area ($mi^2$) | 6 hour | 12 hour | 24 hour | 48 hour | 72 hour |
| | 10 | 60% | 55% | 47% | 44% | 45% |
| | 200 | 50% | 44% | 35% | 29% | 33% |
| | 1000 | 43% | 36% | 28% | 24% | 25% |
| | 5000 | 36% | 26% | 19% | 17% | 19% |
| | 10000 | 30% | 22% | 20% | 13% | 17% |
| | 20000 | 31% | 15% | 19% | 16% | 19% |



# Rapid and Simplified Flood Hazard Analysis

## A Solution



We recommend that “triggers” be added to existing studies during the EA process **and** to new studies that would initiate the screening of a storm of concern against the site-specific PMP study storm magnitudes.

An example screening protocol, which was developed by meteorologists and reviewed by FERC, is included here.

# Rapid and Simplified Flood Hazard Analysis

**The Tool**

This three-stage methodology outlines a procedure for updating the Site-Specific Probable Maximum Precipitation (SSPMP) study to assess post-SSPMP study storm events which could potentially change the current PMP depths.

The methodology originated from similar protocols at other FERC-regulated SSPMP studies. It is anticipated that this procedure will be followed as part of the recurring FERC Part 12D Safety Inspections and/or when an extreme storm event occurs that could be important for comparing to this updated PMP analysis.

**Note! This works with state-wide PMP studies as well (and there are a lot now)**

# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 1 -** Screening of an Identified Storm Event

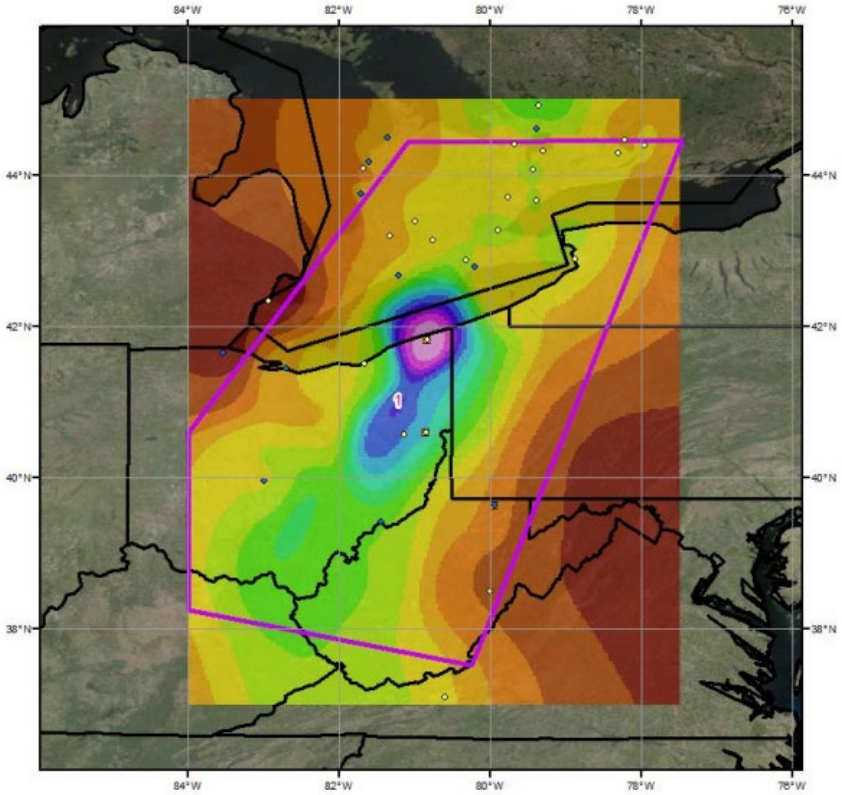
This methodology uses publicly available data to determine whether a recent storm event was significant enough to be considered for additional investigation.
The **websites** identified in the following steps may change over time, but the root source will remain NOAA/NWS.

Identify a significant storm and/or flooding event that occurred during the preceding evaluation period within the SSPMP storm search region.

- Potential storms identified would generally be one that makes local or national headlines.
- Storms that are considered “noteworthy” or had “profound” impacts should also be investigated at this stage.

# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 1 -** Screening of an Identified Storm Event



# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 1 -** Screening of an Identified Storm Event

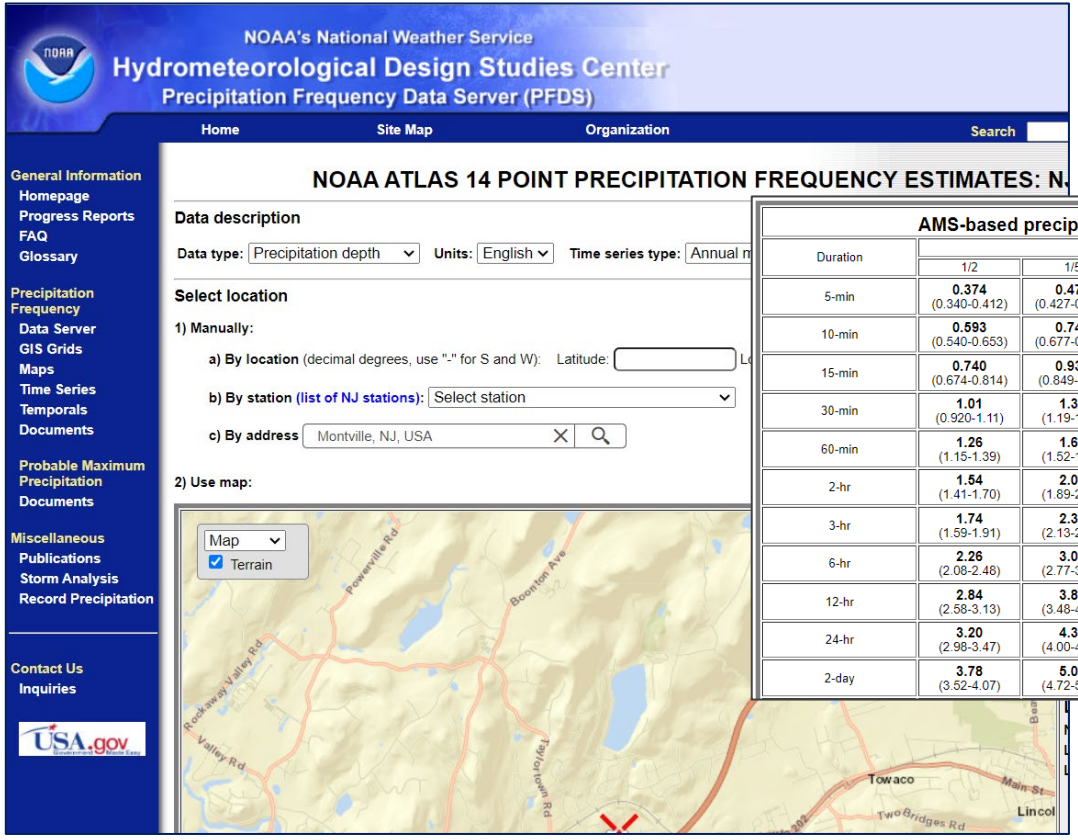
- Compare maximum point rainfall depth and duration of the storm event against the basin-specific precipitation frequency estimates developed in the study and/or NOAA Atlas 14 Precipitation Frequency data for regions **nearby**.

- Determine if the maximum point rainfall of the storm exceeds the **1000-year** recurrence interval from the basin specific precipitation frequency or from NOAA Atlas 14 for storm durations relevant to your project.

- If the storm precipitation value is less than the **1000-year** recurrence interval value at area sizes and durations relevant to the basin, the project is screened out.
    - If greater for any duration from 6-hours to 48-hours, **continue to Stage 2**.

# Rapid and Simplified Flood Hazard Analysis

## The Tool: Stage 1 - Screening of an Identified Storm Event (NOAA PFDS)




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

| Duration | Annual exceedance probability (1/years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1/2 | 1/5 | 1/10 | 1/25 | 1/50 | 1/100 | 1/200 | 1/500 | 1/1000 |
| 5-min | **0.374** (0.340-0.412) | **0.470** (0.427-0.517) | **0.530** (0.481-0.582) | **0.600** (0.542-0.659) | **0.646** (0.581-0.708) | **0.690** (0.618-0.756) | **0.733** (0.653-0.804) | **0.785** (0.694-0.863) | **0.820** (0.720-0.903) |
| 10-min | **0.593** (0.540-0.653) | **0.745** (0.677-0.821) | **0.837** (0.759-0.919) | **0.943** (0.851-1.03) | **1.01** (0.912-1.11) | **1.08** (0.967-1.18) | **1.14** (1.01-1.25) | **1.21** (1.07-1.33) | **1.26** (1.11-1.39) |
| 15-min | **0.740** (0.674-0.814) | **0.934** (0.849-1.03) | **1.05** (0.952-1.15) | **1.18** (1.07-1.30) | **1.27** (1.14-1.40) | **1.36** (1.21-1.49) | **1.43** (1.27-1.57) | **1.52** (1.34-1.67) | **1.58** (1.39-1.74) |
| 30-min | **1.01** (0.920-1.11) | **1.31** (1.19-1.44) | **1.50** (1.36-1.65) | **1.73** (1.56-1.90) | **1.88** (1.70-2.07) | **2.04** (1.83-2.24) | **2.18** (1.94-2.39) | **2.37** (2.09-2.60) | **2.49** (2.19-2.74) |
| 60-min | **1.26** (1.15-1.39) | **1.67** (1.52-1.84) | **1.94** (1.76-2.13) | **2.28** (2.06-2.50) | **2.53** (2.28-2.78) | **2.78** (2.49-3.05) | **3.03** (2.70-3.32) | **3.36** (2.97-3.69) | **3.60** (3.16-3.96) |
| 2-hr | **1.54** (1.41-1.70) | **2.07** (1.89-2.27) | **2.44** (2.22-2.68) | **2.93** (2.64-3.20) | **3.32** (2.97-3.62) | **3.71** (3.30-4.05) | **4.12** (3.64-4.49) | **4.68** (4.10-5.12) | **5.13** (4.45-5.61) |
| 3-hr | **1.74** (1.59-1.91) | **2.34** (2.13-2.56) | **2.75** (2.51-3.02) | **3.30** (2.99-3.61) | **3.74** (3.36-4.08) | **4.18** (3.74-4.56) | **4.64** (4.12-5.06) | **5.28** (4.63-5.76) | **5.78** (5.02-6.32) |
| 6-hr | **2.26** (2.08-2.48) | **3.03** (2.77-3.31) | **3.59** (3.27-3.91) | **4.35** (3.94-4.73) | **4.97** (4.47-5.39) | **5.62** (5.01-6.10) | **6.32** (5.58-6.85) | **7.32** (6.37-7.96) | **8.15** (7.01-8.87) |
| 12-hr | **2.84** (2.58-3.13) | **3.82** (3.48-4.21) | **4.56** (4.13-5.01) | **5.60** (5.03-6.12) | **6.47** (5.76-7.06) | **7.41** (6.53-8.07) | **8.45** (7.35-9.20) | **9.98** (8.52-10.9) | **11.3** (9.48-12.3) |
| 24-hr | **3.20** (2.98-3.47) | **4.30** (4.00-4.65) | **5.12** (4.74-5.53) | **6.29** (5.78-6.77) | **7.25** (6.63-7.80) | **8.30** (7.53-8.92) | **9.45** (8.50-10.2) | **11.1** (9.87-12.0) | **12.6** (11.0-13.5) |
| 2-day | **3.78** (3.52-4.07) | **5.07** (4.72-5.45) | **6.01** (5.59-6.46) | **7.32** (6.77-7.85) | **8.38** (7.70-8.99) | **9.52** (8.70-10.2) | **10.7** (9.73-11.5) | **12.5** (11.2-13.5) | **14.0** (12.4-15.1) |

# Rapid and Simplified Flood Hazard Analysis

## **The Tool: Stage 1** - Screening of an Identified Storm Event (NOAA PFDS)

NOAA's National Weather Service
Hydrometeorological Design Studies Center
Precipitation Frequency Data Server (PFDS)

Home | Site Map | Organization | Search

**General Information**
- Homepage
- Progress Reports
- FAQ
- Glossary

**Precipitation Frequency**
- Data Server
- GIS Grids
- Maps
- Time Series
- Temporals
- Documents

**NOAA ATLAS 14 POINT PRECIPITATION FREQUENCY ESTIMATES: N**

Data description

Data type: Precipitation depth | Units: English | Time series type: Annual maximum

Select location

1) Manually:

a) By location (decimal degrees, use "-" for S and W): Latitude: Longitude: Submit

b) By station (list of NJ stations): Select station

c) By address: Montville, NJ, USA

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

| Duration | Annual exceedance probability (1/years) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
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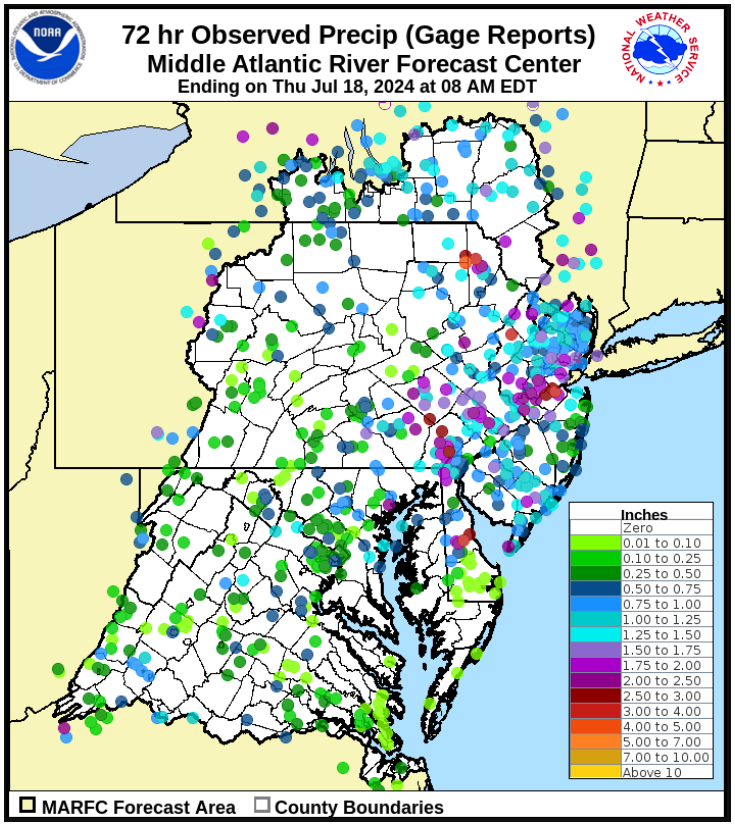

# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 2 -** Depth-Area-Duration Analysis to Determine a Qualifying Storm Event

- This stage serves as an additional filter to analyze new storms which pass Stage 1. This stage utilizes the final SSPMP estimate to develop a threshold for better understanding the magnitude of the new storm event.

- Identify publicly available depth-area-duration (DAD) values or derive DAD values for the storm identified in stage 1

- These may be provided by AWA or other public or private entities producing similar storm analysis DAD results.

| Percent Reduction | Duration | | | | |
|---|---|---|---|---|---|
| Area ($mi^2$) | 6 hour | 12 hour | 24 hour | 48 hour | 72 hour |
| 10 | 60% | 55% | 47% | 44% | 45% |
| 200 | 50% | 44% | 35% | 29% | 33% |
| 1000 | 43% | 36% | 28% | 24% | 25% |
| 5000 | 36% | 26% | 19% | 17% | 19% |
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| 20000 | 31% | 15% | 19% | 16% | 19% |

# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 2 -** Depth-Area-Duration Analysis to Determine a Qualifying Storm Event

- Multiply the DAD values of the newly identified storm by the Total Adjustment Factors (TAFs) calculated during the site-specific study.

- If the resulting modified DAD values now exceed those developed during the PMP at any area size or duration, this would qualify for additional analysis (**stage 3**).

- If the new storm does not exceed current PMP depths for any duration and area size up to the total basin area size, then the storm is screened out. The results of the stage 2 analysis should be documented.

# Rapid and Simplified Flood Hazard Analysis

**The Tool: Stage 3 -** A Full-Scale Assessment of a New Storm's Impact on the SSPMP

- Stage 3 includes all of the transpositioning and maximization steps from the development of the SSPMP study.

- This will include federal review of the new storm event and the modified (if necessary) enveloping line. This may also require the services of a Board of Consultants (BOC) at the discretion of FERC.

# THANK YOU

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