



NATIONAL WEATHER SERVICE

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National Weather Service Hazard-Based Training Course

Hazard: **FLOODING**

The course will begin at 10:02 am



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Motivation

In Washington, the costs of flooding exceed all other natural hazards. [-WA Dept of Ecology](#)



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Course Outline



[Hazard Climatology](#)



[Forecast Tools & Situational Awareness](#)



[Available Decision Support Services](#)



[Watch/Warning/Advisory Products](#)



[Public Information Resources](#)



[Vulnerable Populations](#)



[Event Reporting](#)



[Public Outreach](#)



[Recognition Programs](#)



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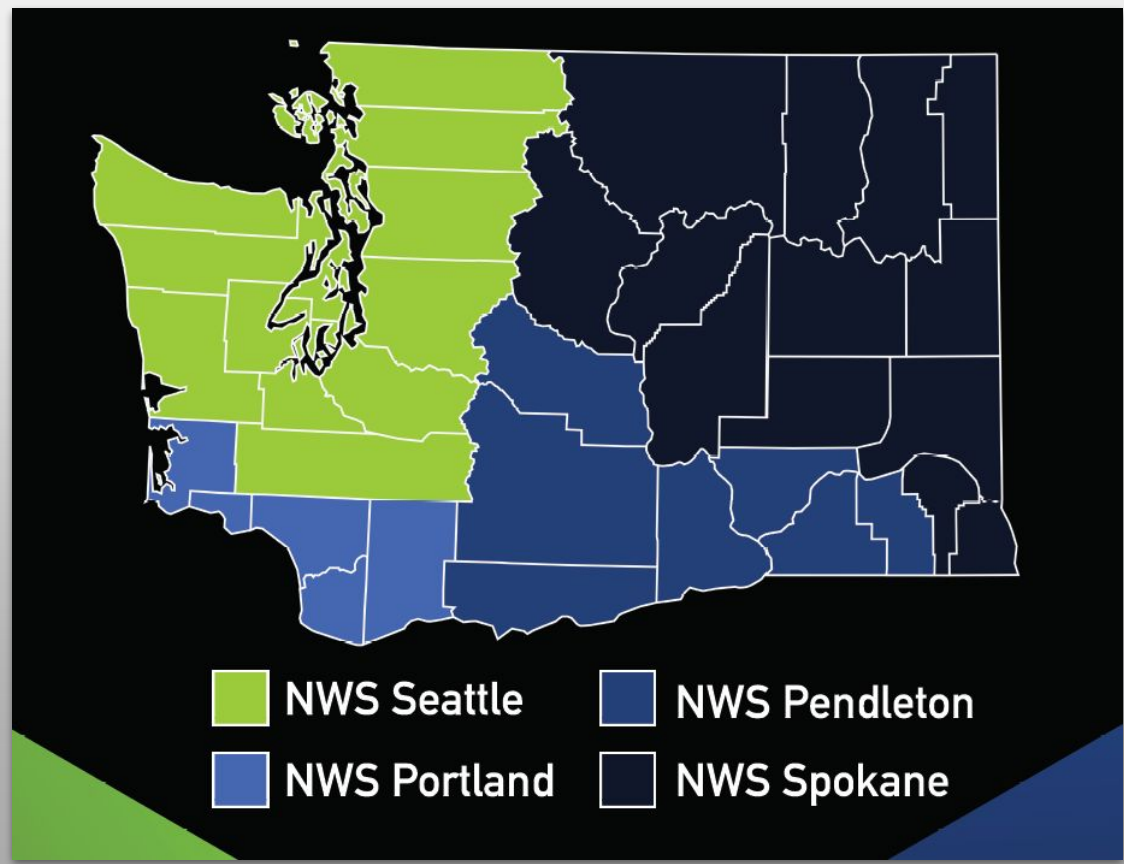
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National Weather Service

Details within this presentation will focus on the NWS Seattle area of responsibility.

However, the general concepts and content can be applied across the state.

Some small differences in operations may apply.





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Hydrologic Services

Floods
Drought
Water Supply



Course
Focus



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Climatology





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Climatology

This module includes:

- Hazard Description
- Climatology
- Climate Change Implications



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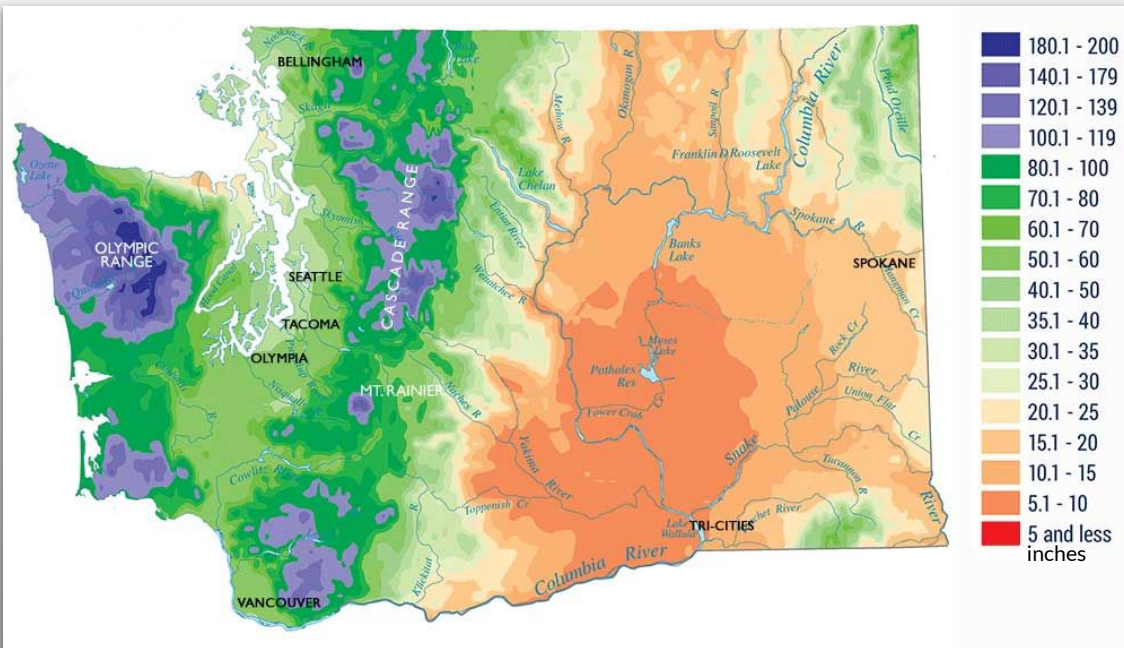
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Hazard Description

Precipitation Climatology

Annual precipitation exhibits wide regional variations across the state. Portions of the Olympic Peninsula receive upwards of 150 inches of precipitation annually.

Most of Washington's precipitation falls during the winter months.

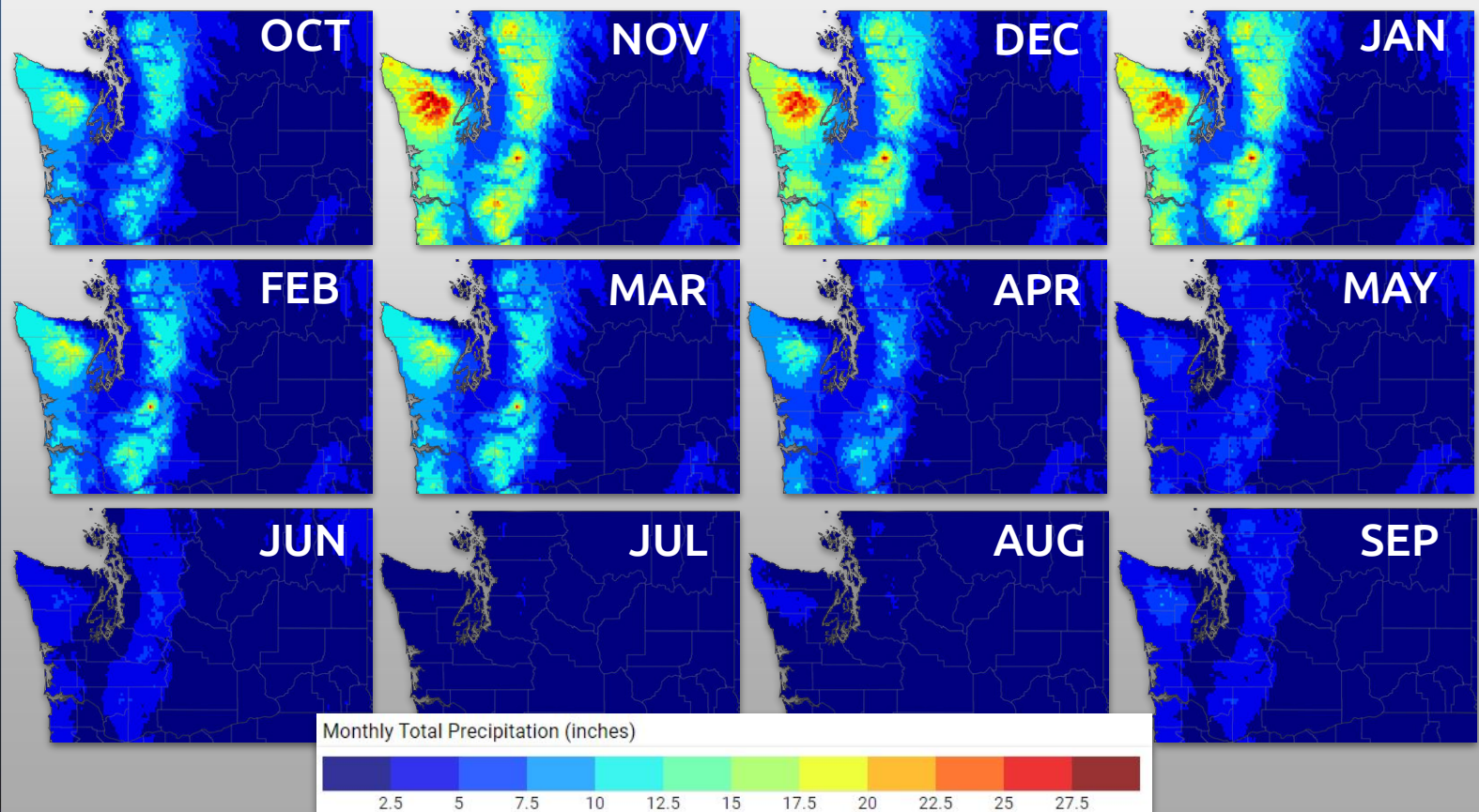




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Water Year Normals (Oct - Sep)

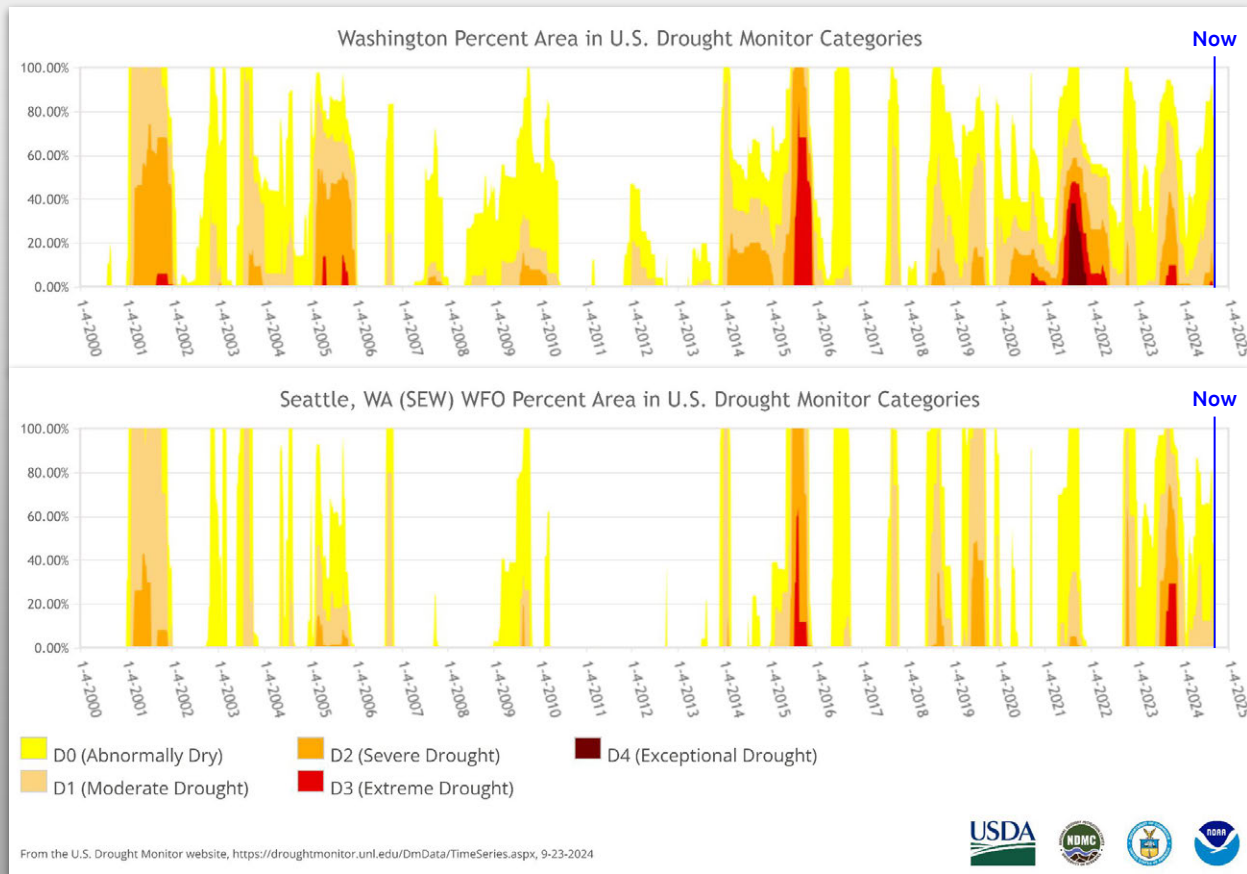




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Drought Time Series





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Drought/Drought Services

NWS does not declare droughts

- Main function is relaying conditions
- Climate/Drought information [webpage](#)
- Drought Information Statement (new) ([DGT](#))

Causes of drought

- Less than normal precipitation
- Normal or above rainfall, less than normal snow
- Normal or above precipitation, fast, early snow melt

Drought Information Statement for Western Washington
Valid July 3, 2024
Issued By: NWS Seattle, WA
Contact Information:
• This product will be updated by or around August 9, 2024 or sooner if drought conditions change significantly.
• Please see all currently available products at <https://drought.gov/drought-information-statements>
• Please visit <https://www.weather.gov/sew/DroughtInformationStatement> for previous statements.

• [STATEWIDE DROUGHT EMERGENCY](#) in effect (see link)

Department of Commerce // National Oceanic and Atmospheric Administration

U.S. Drought Monitor
Link to the [latest U.S. Drought Monitor](#) for western Washington

U.S. Drought Monitor
Drought intensity and extent
• **D1 (Moderate Drought):** North Washington Cascades, northeast Olympic Peninsula
• **D0 (Abnormally Dry):** North and east sides of the Olympic Peninsula, most areas Puget Sound and eastward

U.S. Drought Monitor
Abnormally Dry (D0) Moderate Drought (D1) Severe Drought (D2) Extreme Drought (D3) Exceptional Drought (D4)
Source(s) NOAA, USDA, image courtesy of Drought.gov Data valid: 06/25/24

National Oceanic and Atmospheric Administration
National Weather Service
Seattle, WA

Recent Change in Drought Intensity
Link to the [latest 4-week change map](#) for western Washington

U.S. Drought Monitor Class Change - Washington 4 Week
• Four Week Drought Monitor Class Change
• Drought improved: D1 to D0 or D0 to None for parts of the Washington Cascades

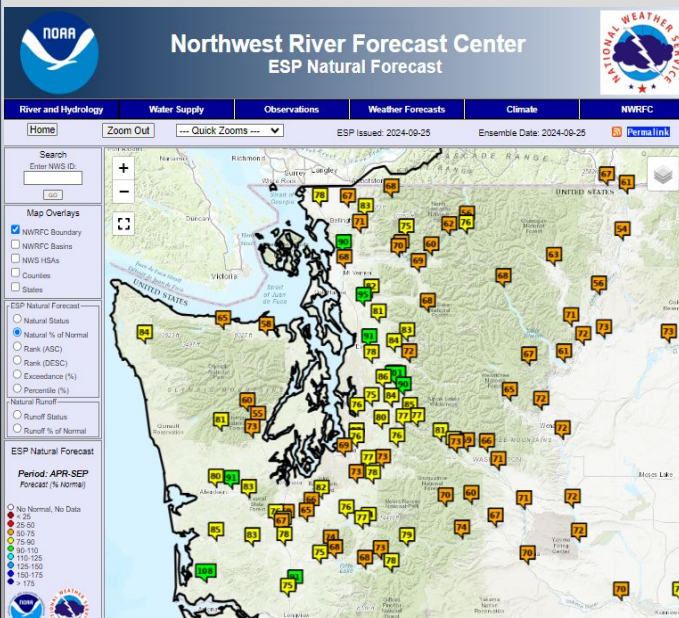
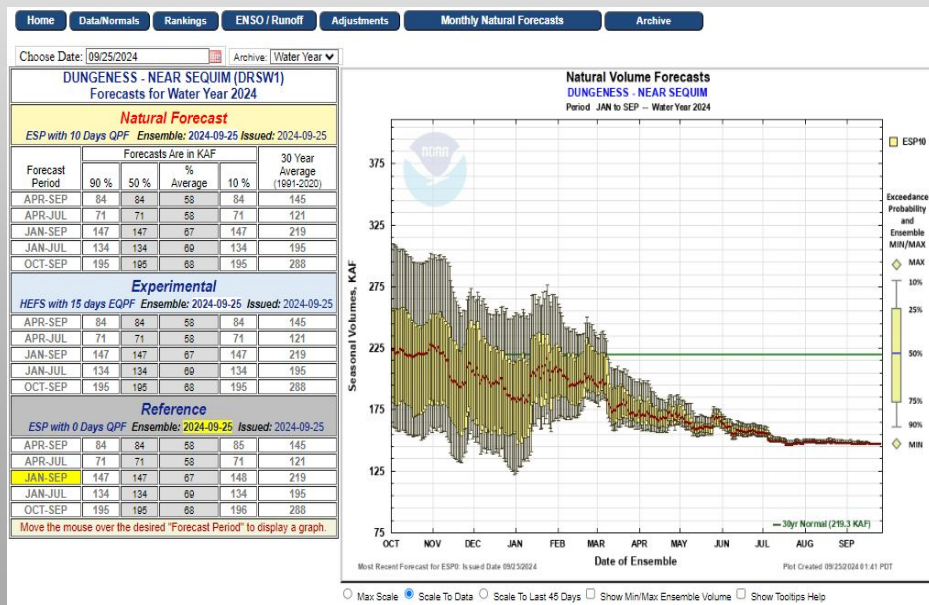


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Water Supply

- Water Supply/Spring Flood Outlook
- Water Supply Forecasts from NWRFC
 - Rank, Exceedance, Percentile, Snow, Runoff, Interactive ENSO





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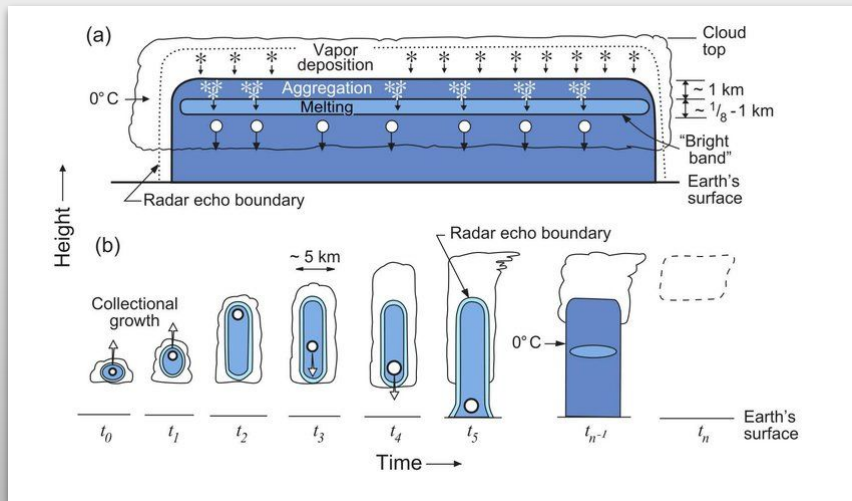
Terminology

Stratiform

- Extensive horizontal development
- Cover large areas
- Stratiform precipitation, in general, is relatively continuous and uniform in intensity (i.e. steady rain/snow).
- Peak intensity generally lower than convective precipitation.

Convective

- Vertical development
- Cover small areas
- Convective precipitation, in general, is variable in intensity (i.e. rain showers and thunderstorms).
- Very strong peak intensity.



Characteristics of (a) stratiform and (b) convective precipitation. Shading shows higher intensities of radar echo, with the medium blue indicating the strongest echo. In (b) cloud is shown at a succession of times $t_0, \dots, t_n$. Growing precipitation is carried upward by strong updrafts until t_2 and then falls relative to the ground, reaching the surface just after t_5 . After t_5 , the cloud may die or continue for a considerable time in a steady state before dissipation sets in at t_{n-1} and t_n . The dashed boundary indicates an evaporating cloud, from Houze (1981).



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Hazard Description

Extreme Precipitation Events

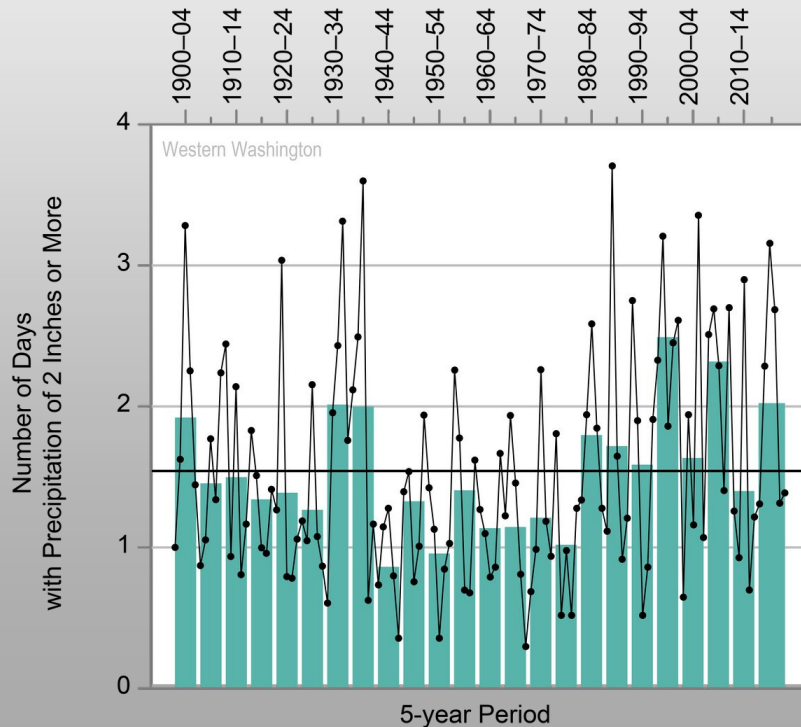
A typical station in Western Washington experiences between one and two 2-inch+ events per year.

These events are most commonly associated with strong Atmospheric Rivers.

Occasionally, one or more potent thunderstorms can produce heavy rainfall over localized areas.

Observed # of Days with >2" Rainfall

GHCN-Daily from long-term stations





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The science behind atmospheric rivers

An atmospheric river (AR) is a flowing column of condensed water vapor in the atmosphere responsible for producing significant levels of rain and snow, especially in the Western United States. When ARs move inland and sweep over the mountains, the water vapor rises and cools to create heavy precipitation. Though many ARs are weak systems that simply provide beneficial rain or snow, some of the larger, more powerful ARs can create extreme rainfall and floods capable of disrupting travel, inducing mudslides and causing catastrophic damage to life and property. Visit www.research.noaa.gov to learn more.

A strong AR transports an amount of water vapor roughly equivalent to 7.5–15 times the average flow of water at the mouth of the Mississippi River.

ARs are a primary feature in the entire global water cycle and are tied closely to both water supply and flood risks, particularly in the Western U.S.

On average, about 30-50% of annual precipitation on the West Coast occurs in just a few AR events and contributes to the water supply — and flooding risk.

ARs move with the weather and are present somewhere on Earth at any given time.

ARs are approximately 250–375 miles wide on average.

Scientists' improved understanding of ARs has come from roughly a decade of scientific studies that use observations from satellites, radar and aircraft as well as the latest numerical weather models. More studies are underway, including a 2015 scientific mission that added data from instruments aboard a NOAA ship.

3/2015

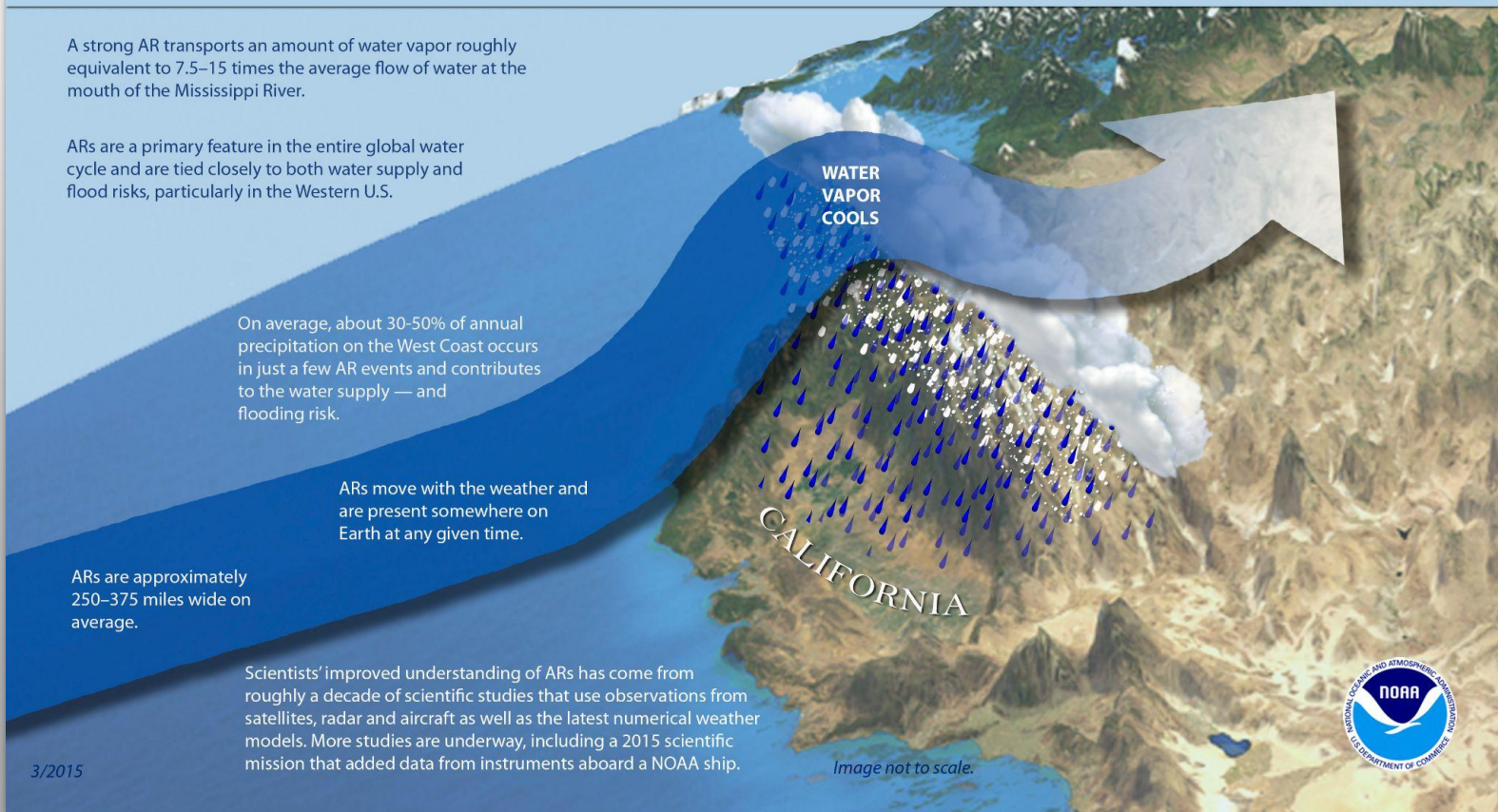


Image not to scale.





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River Flood Contributing Factors

Primary Contribution

**Intense Mountain
Precipitation**



Small Contributions

- Intense Lowland Rain
- High Snow Levels
- Rain on Snow
(especially low elevation snow)
- Saturated soils



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Urban Flood Contributing Factors

Primary Contribution

**Intense Lowland
Precipitation**



Small Contributions

- **Rain on Snow**
(especially low elevation snow)
- **Poor/Blocked Urban
Drainage**
- **Saturated soils**



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Flood Frequency

Flooding is not an uncommon occurrence in western WA.

Flood frequency varies considerably for each river & warning point.

NWS Seattle has 45 flood warning points.

Rivers in western Washington tend to be “flashy”. In other words, they are highly sensitive to rainfall and respond quickly compared to other places in the US.

Q2



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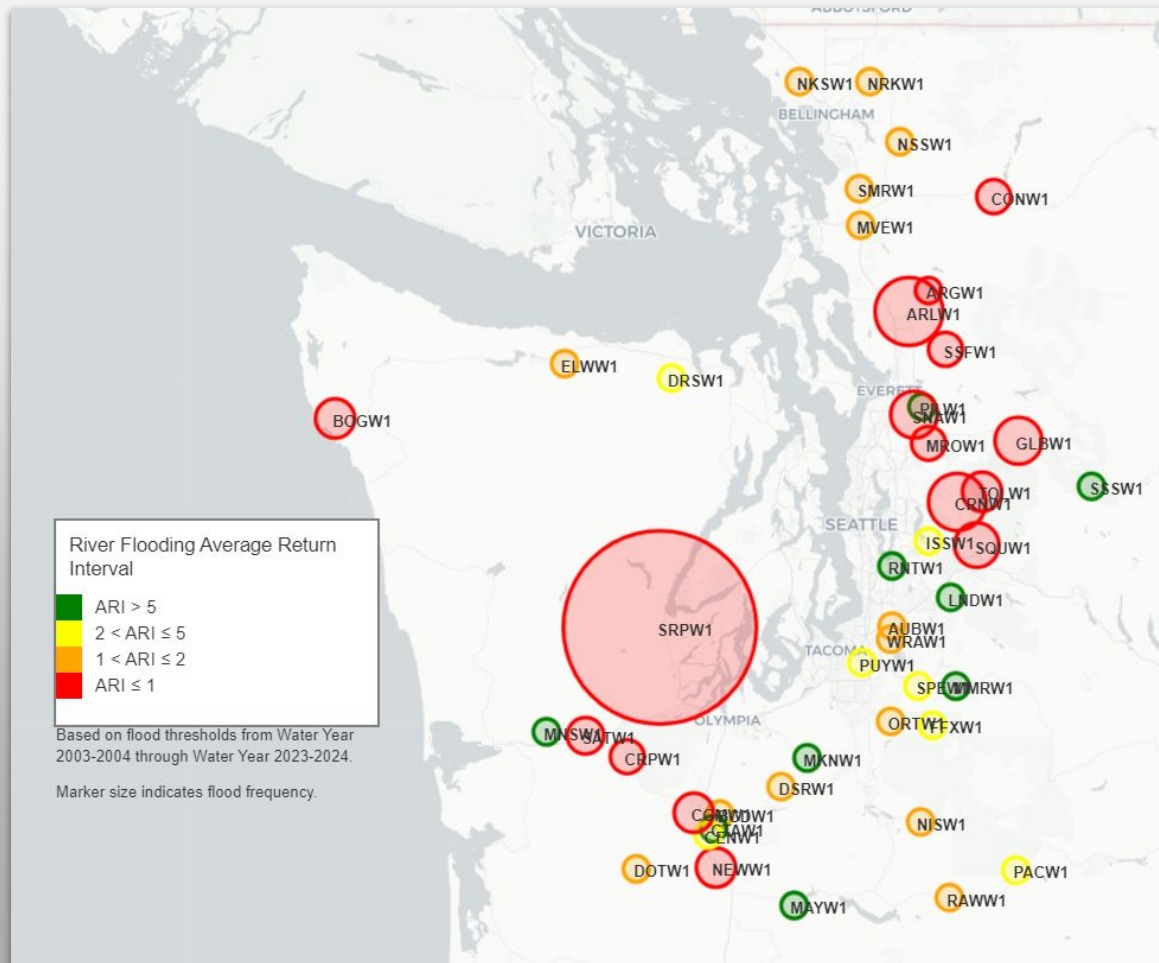
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Rain-Driven Landslides

The combination of the following factors often result in elevated landslide risk in western Washington:

- saturated soils
- steep slopes
- intense rainfall

While individual landslides are extremely difficult to predict, NWS Seattle monitors weather and [USGS landslide metrics](#) and will disseminate a Special Weather Statements when conditions are expected to become favorable for rain-driven landslides.

November 2021 landslide along WA-112 near Clallam Bay, WA. Photo Credit: WSDOT



February 2020 landslide at Fairfax Forest Reserve Road in Pierce County. Photo: East Pierce Firefighters IAFF 3520

Flood After Fire



FEMA



Did you know wildfires dramatically alter the terrain and increase the risk of floods? Excessive amounts of rainfall can happen throughout the year. And properties directly affected by fires and those located below or downstream of burn areas are most at risk for flooding.

1 During normal conditions, vegetation helps absorb rainwater.

2 But after an intense wildfire, burned vegetation and charred soil form a water repellent layer, blocking water absorption.

3 During the next rainfall, water bounces off of the soil.

Degree of Land Slope

Higher degrees of land slope speed up water flow and increase flood risk.

4 As a result, properties located below or downstream of the burn areas are at an increased risk for flooding.

Flash Floods

Intense rainfall can flood low-lying areas in less than six hours. Flash floods roll boulders, tear out trees and destroy buildings and bridges.

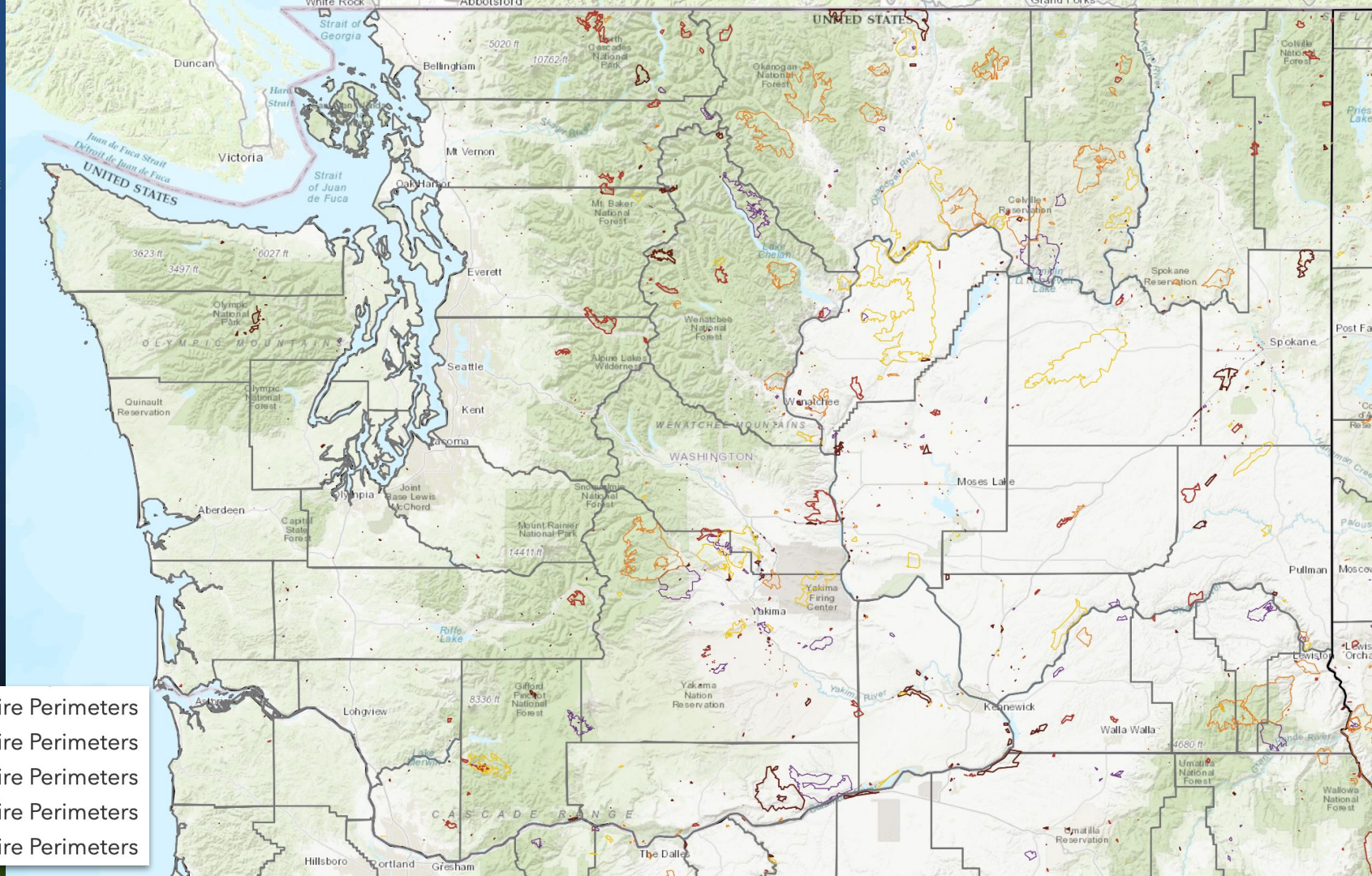
Mudflows

Rivers of liquid and flowing mud are caused by a combination of brush loss and subsequent heavy rains. Rapid snowmelt can also trigger mudflows.



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Climate Change - Washington State

[See NOAA NCEI State Climate Summary 2022 for more information](#)

1. Temperatures in Washington have **risen almost 2°F** since the beginning of the 20th century. Winter warming has been evident in the below average number of freezing days and very cold nights since 1990. Under a higher emissions pathway, historically **unprecedented warming is projected to continue** through this century.
2. Rising temperatures will lead to **earlier melting of the snowpack**, which plays a critical role in spring and summer water supplies. The combination of this earlier melting and **more precipitation falling as rain instead of snow** may lead to an increase in springtime flooding.



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Climate Change - Washington State

[See NOAA NCEI State Climate Summary 2022 for more information](#)

1. Rainfall is expected to be the dominant form of precipitation across the majority of the state by the end of this century.
2. Higher spring temperatures will also result in earlier melting of the snowpack, with average snowpack projected to decline by up to 70% by the end of this century. This will further decrease water availability during the already dry summer months, and due to earlier spring peak flows, it will increase the risk of spring flooding.
3. Projected increases in heavy rainfall events by midcentury could further increase flood risk.
4. Reductions in summer flow (projected to occur in 80% of the state's watersheds) will have important ecological implications and are a particular concern for hydropower and irrigation water supplies.
5. Sea level rise has caused an increase in tidal floods associated with nuisance-level impacts. Some areas of the coast are rising, which has mitigated the impacts of recent sea level rise and will reduce somewhat the local projected sea level rise.



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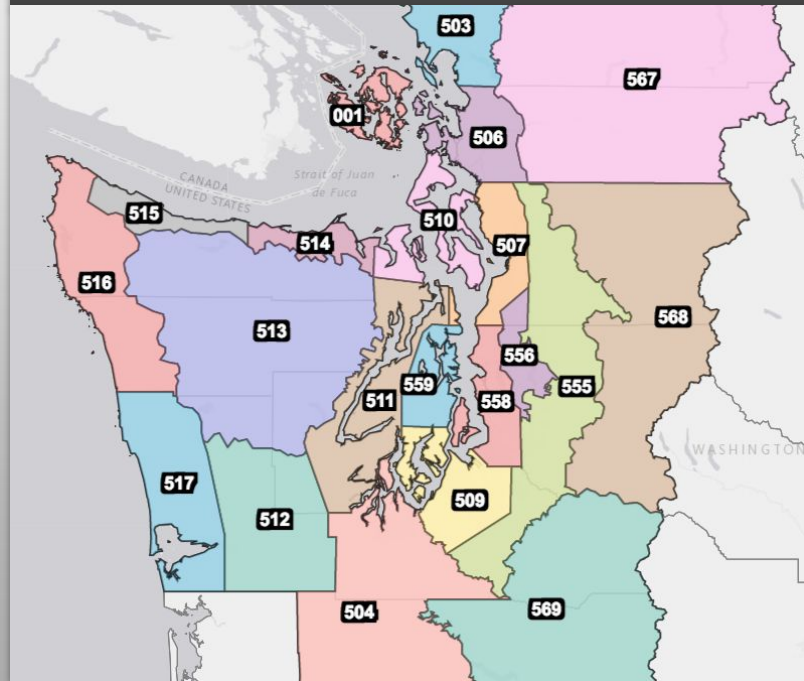
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Resources for Hazard Mitigation Plans

- [NWS/NCEI Storm Events Database](#)
(includes narratives, impacts, injuries/fatalities, damages that were known)
- [NOAA OneStop](#)
(A NOAA Data Search Platform. Geophysical, oceans, coastal, weather and climate data discovery all in one place)
- [NWS HeatRisk Climatology](#)
- [NWS HeatRisk Forecasts/Information](#)
(Click the More Information button for a much more detailed explanation of HeatRisk)
- [Automated Data Plotter](#)
(get charts of warning frequency - search by zone/county**)
- [Search NWS Watches/Warnings/Advisories by County/Zone](#)
(get the actual products that were issued - search by zone/county**)
- [NOAA NCEI State Climate Summaries 2022](#)
- [NOWData Climate Records](#)

**For Tornado, Severe Thunderstorm, and Flood products, you can search by County. For all other hazards, you will need to search by zone.

Western Washington Public Zone Map



Note: zone areas & numbers will be [changing](#) within 6 months.



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Forecast Tools & Situational Awareness (SA)





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Forecast Tools & SA

This module includes:

- Probabilistic Forecasts & Decision Making
- Local/Regional/National Tools
- National Water Model
- Flood Inundation Mapping
- GIS Resources



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Behind The Scenes

Ongoing Coordination and Outreach

- State, County, City Emergency Management
- WA Ecology - Water Supply Availability Committee
- Dam operators (USACE, Counties, Cities, utilities)
- USGS Water Science Center
- USGS Cascades Volcano Observatory
- Washington Silver Jackets (WA/USACE)
- Post-fire Burned Area Emergency Response Teams (Federal, State)



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□ Terminology

QPF - Quantitative Precipitation Forecast

- Forecast Precipitation

QPE - Quantitative Precipitation Estimate

- Estimated Observed Precipitation



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Deterministic vs. Probabilistic Forecasts

Deterministic Forecasts

- Can be derived from a single weather model or an ensemble of many models
- Provides one forecast value for a location and time
- Example forecasts:
 - High of 42° and low of 34°
 - 24-hour snowfall of 3 inches
 - River cresting at 30.76 feet
- Does not convey information related to other possible outcomes, confidence, etc.

Probabilistic Forecasts

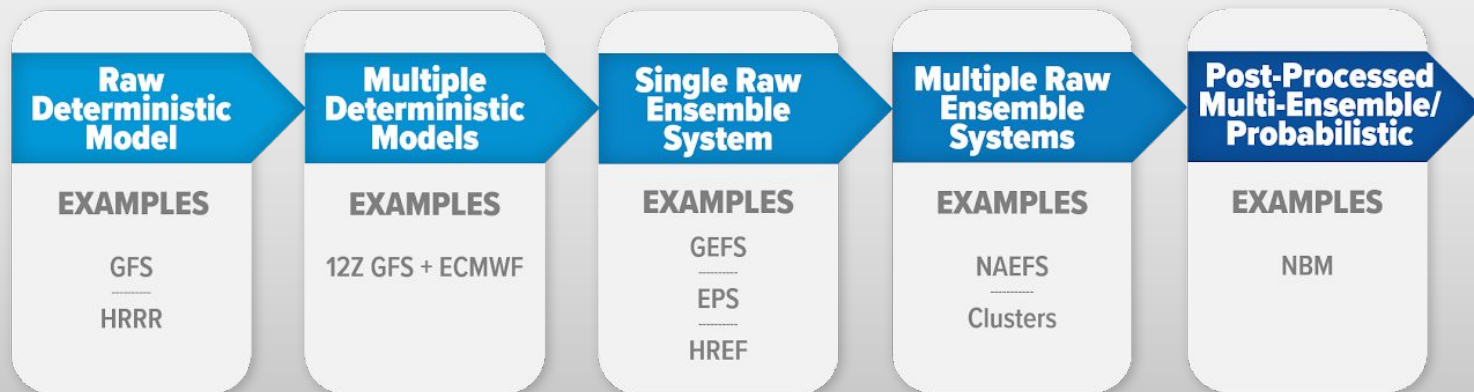
- Derived from one or more ensembles of weather models
- Provides statistics & probabilities of weather events, including
 - Probability of exceedance
 - Percentile ranges (e.g. 10th-90th percentiles)
- Example forecasts:
 - 40% chance of low temperature at or below 32°
 - Reasonable low end (10th percentile) 1 in. of snow, reasonable high end (90th percentile) 8 in. of snow
 - 15% chance of river cresting at or above minor flood level



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Probabilistic Data - Available Data



National Blend of Models (NBM)

The NBM is a multi-model, ensemble-based, and calibrated forecast tool that the NWS leverages to provide probabilistic forecast information.



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Probabilistic Data - Available Guidance

Precipitation Guidance (NBM)

- QPF (Precipitation) Percentiles (5, 10, 25, 50, 75, 90, 95)
- QPF (Precipitation) Probability of Exceedance (e.g. 0.25", 0.5", 0.75", 1.0", 1.5", etc.)
- QPF (Precipitation) Spread
- 1hr, 6hr, 24hr, 48hr, 72hr accumulation periods
- Precipitation Type & Snow Level

Flooding Guidance (HEFS) ⚠ Use with caution

- Flood Stage Percentiles & Probability of Exceedance

Most commonly communicated

- Reasonable low end (10th percentile), most likely (50th percentile), & reasonable high end (90th percentile)
 - 80% of the time, the forecast will fall in this range
 - 10% will fall above, 10% will fall below
- Probability of Exceedance (threshold varies)

Q3



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Probabilistic Data in Decision-Making

Cost/Loss Decision Method

Method used to understand how the predicted probability of adverse events affects the decision of whether to take a costly precautionary measure to protect oneself against losses from that event.

Cost = Cost of taking precautionary action

Loss = Cost incurred by not taking action if event occurs

probability = probability of the event occurring

IF

$$\text{probability} > \frac{\text{Cost}}{\text{Loss}}$$

It makes sense to take action

Equivalent calculations:

$$\text{probability} \times \text{Loss} > \text{Cost}$$

$$\text{probability} \times \text{Loss} - \text{Cost} > 0$$



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Probabilistic Data in Decision-Making

Simple Example

- A \$500 outdoor tent is rated for 40 MPH wind gusts.
- It will cost \$100 in labor to disassemble and reassemble the tent.
- The probability of wind gusts in excess of 40 MPH is 25%.
- Should action be taken to protect the tent?

Cost = Cost of taking precautionary action

Loss = Cost incurred by not taking action if event occurs

probability = probability of the event occurring

IF

$$probability > \frac{Cost}{Loss}$$

It makes sense to take action



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Q4

Probabilistic Data in Decision-Making

Simple Example

- A \$500 outdoor tent is rated for 40 MPH wind gusts.
Loss = \$500
- It will cost \$100 in labor to disassemble and reassemble the tent.
Cost = \$100
- The probability of wind gusts in excess of 40 MPH is 25%.
probability = 25%
- Should action be taken to protect the tent?

$$probability > \frac{Cost}{Loss}$$

$$25\% > \frac{\$100}{\$500}$$

$$25\% > 20\%$$

Take action!

Breaking it down...

If this forecast with a 25% probability occurs 12 times over a season, gusts in excess of 40 MPH will likely have occurred 3 times (12 x 25%).

Without mitigation, the total loss would be \$1500 (3 tents @ \$500).

With mitigation, the total cost would be \$1200 (12 events x \$100 in labor)



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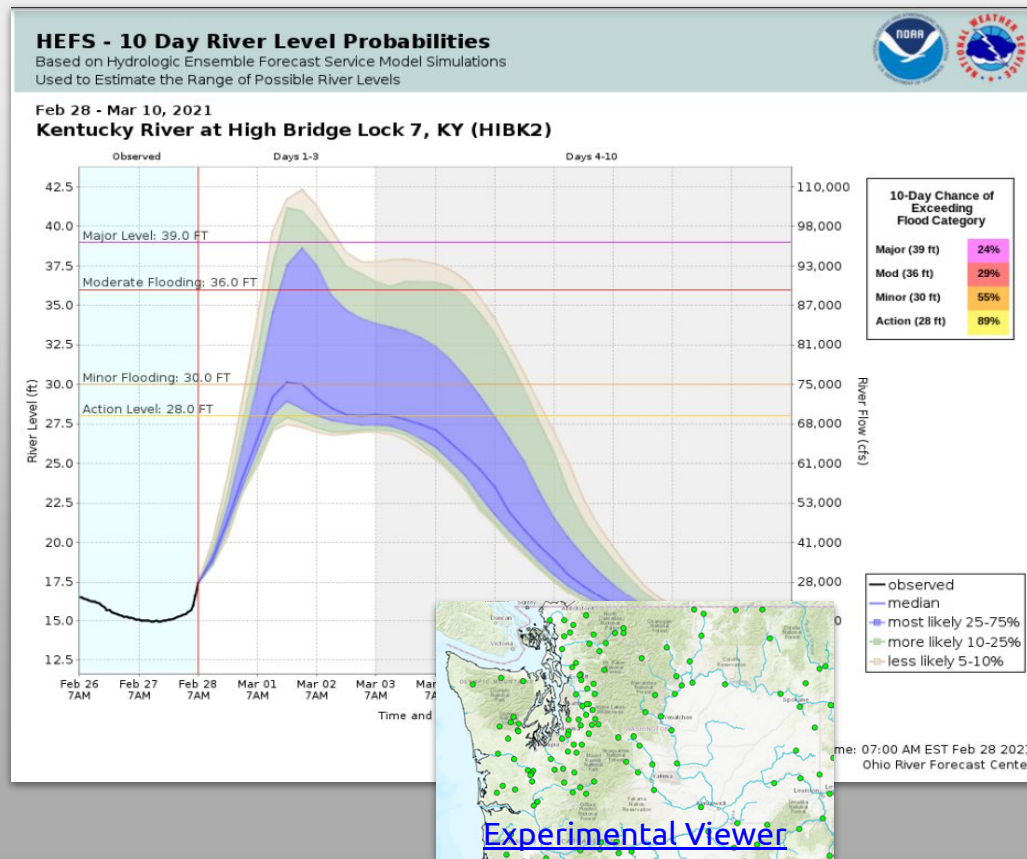
Hydrologic Ensemble Forecast System (HEFS)

Strengths

- Can provide an estimate of forecast confidence & most likely timing
- Available at most locations with an official forecast
- Available within [NWPS](#)

Weaknesses

- Current version considers weather uncertainty, not hydrologic uncertainty
- Local observation: Tends to underestimate water level probabilities (observed conditions are usually on the high end of the envelope)
- Probabilities uncalibrated. May not be useful for cost-loss calculations.





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Terminology

Flood Stages	Typical Description
Major	Extensive inundation of structures and roads. Significant evacuations of people and/or transfer of property to higher elevations.
Moderate	Some inundation of structures and roads near stream.
Minor	Minimal or no property damage, but possibly some public threat.
Action	The level which, when reached by a rising stream, represents the level where the NWS or a customer/partner needs to take some type of mitigation action in preparation for possible significant hydrologic activity.

Q5



Like rivers, flood levels can and do change. Flood impact statements for each river warning point come from your input. Your feedback is extremely critical in order for future alerts to match expected impacts.



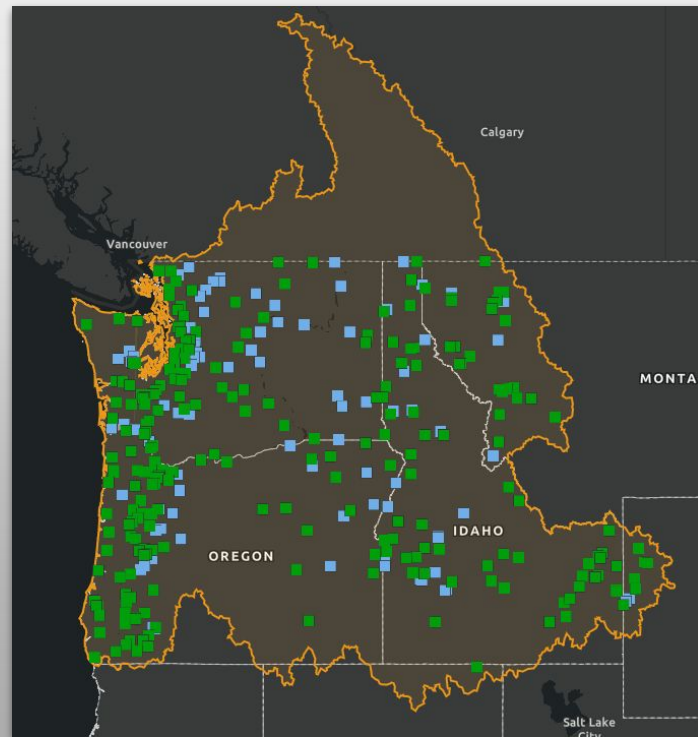
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River Forecast Center

Washington State is served by the [Northwest River Forecast Center](#) (NWRFC) located in Portland, OR.

NWRFC produces river forecasts for 43 of the 45 flood warning points within the NWS Seattle area of responsibility plus additional points that don't have warning thresholds. *(SRPW1 & BOGW1 forecasts are created by NWS Seattle)*





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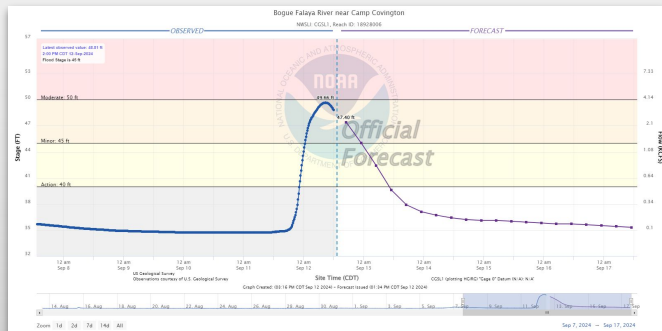
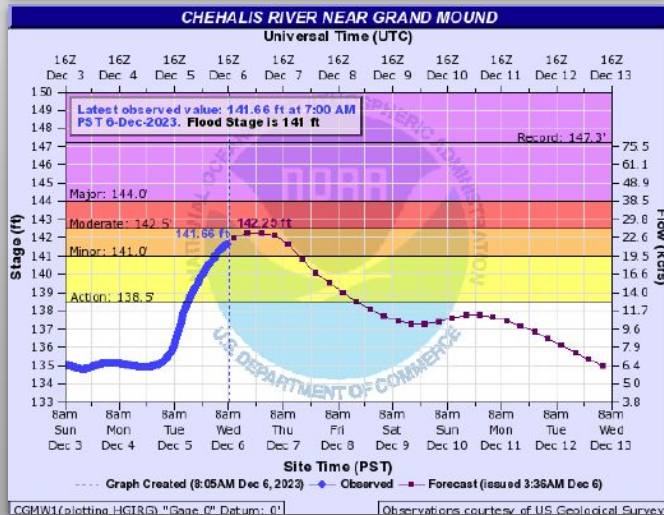
River Forecast Center Forecasts

NWRFC Official Forecasts are for river stage and flow at 6-hour time steps out to ~10 days.

- Routine forecasts updated 2x daily, and as needed during flood events produced by hydrologic models
- Based on latest observed flow, forecast temperature, and precipitation (QPF); turns precipitation into streamflow
- Other considerations include soil moisture, snowpack, snow level, reservoirs, channel loss, routing downstream
- All parameters are averaged to a single value for each basin

Important Notes on River Forecasts:

- Forecasts are highly sensitive to basin-specific QPF
- At greater lead times, the range of potential outcomes can wash out basin details and results in a gradual ramp up in river forecasts, starting low then getting higher as the event nears





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Sources Of River Forecast Error/ Uncertainty

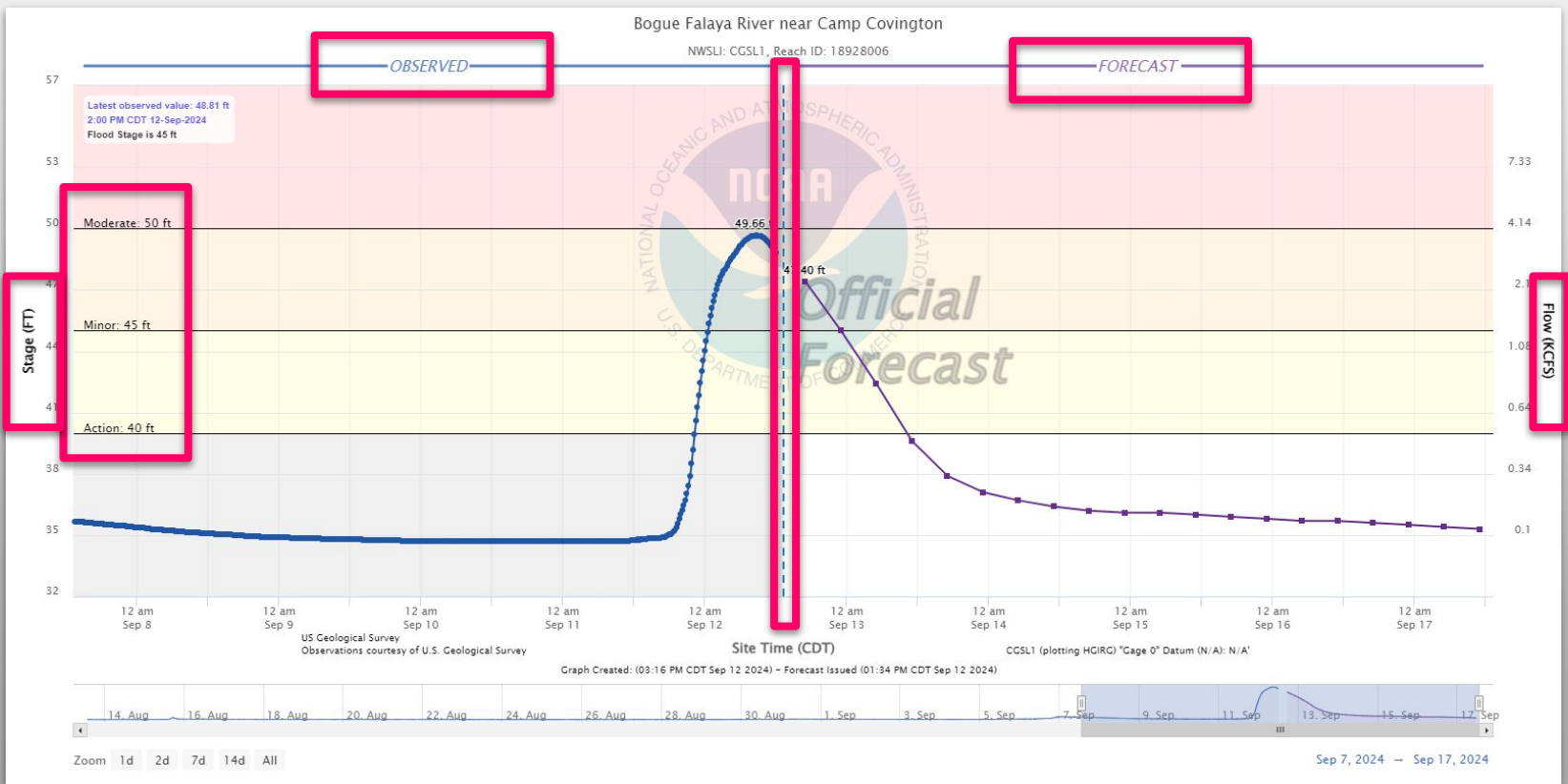
- **Weather Forcings**
 - Accuracy of temp and precip forecasts
 - Observations: gauge issues, ratings
 - Differences across basin in event from lumped parameters
 - Observed and forecast
- **Calibration**
 - Forecast points calibrated to full season volume and storms
 - Mean daily flow, not peak flow
- **Parameterization, model states**
 - Averages over all years
 - How different values are in actual event from averages



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Anatomy of a Hydrograph

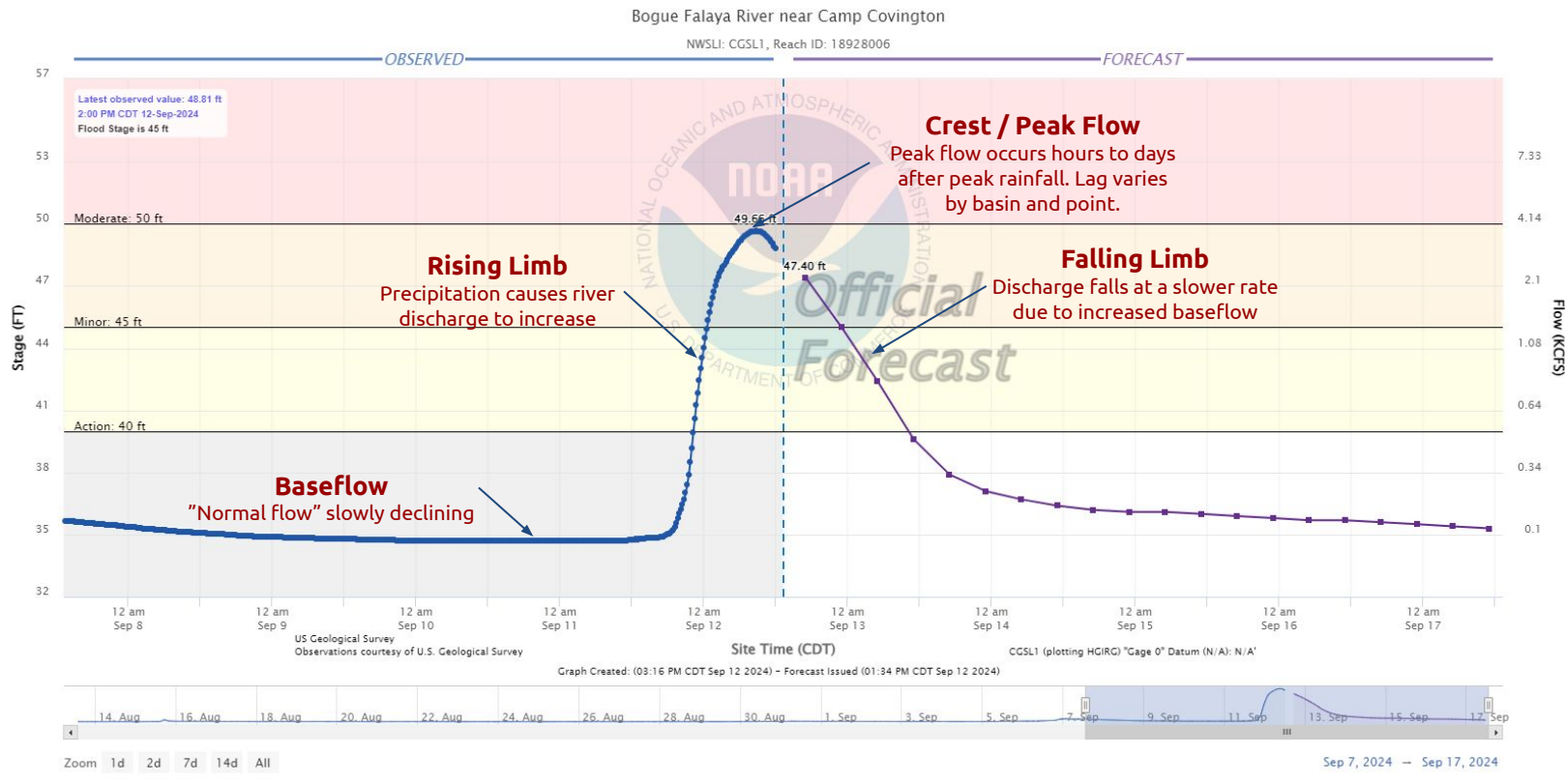




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Anatomy of a Hydrograph





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Gauges

- **Streamgages are primarily operated and maintained by the USGS.**
- Most are funded in partnership with one or more of about 1,800 Federal, State, local, and Tribal agencies or organizations.
- This unique cooperation results in nationally consistent and impartial data that also aids local decision making.
- The shared costs result in the operation of far more streamgages than would be possible if financed solely by USGS appropriations, which provide less than one-third of the needed funding. These partnerships also enable fixed costs (such as costs associated with data storage and delivery infrastructure) to be broadly distributed, resulting in more economical streamgaging information for all.
[More Information](#)
- Gauges are also operated by WA Dept. of Ecology, USACE, and counties (e.g. Snohomish) and we use a number of those as well



Sources/Usage: Public Domain. [View Media Details](#)
USGS streamgage with rainbow in the background. (Credit: Robert Swanson)



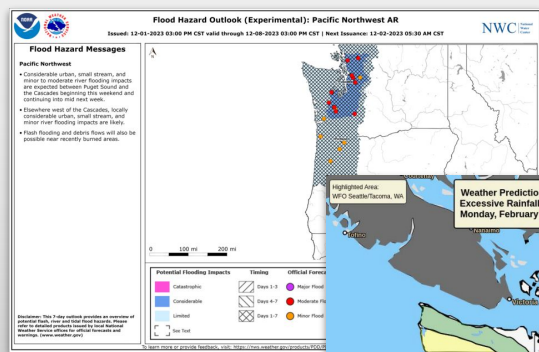
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National Center Tools

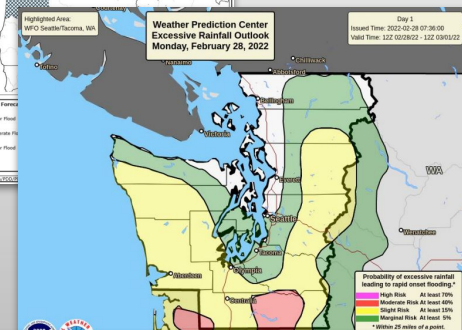
National Water Center (NWC)

- [National Water Prediction Service \(NWPS\)](#)
- [Flood Hazard Outlook \(Experimental\)](#)
- [Area Hydrologic Discussion](#) (Experimental)
- [Visualization Services](#)



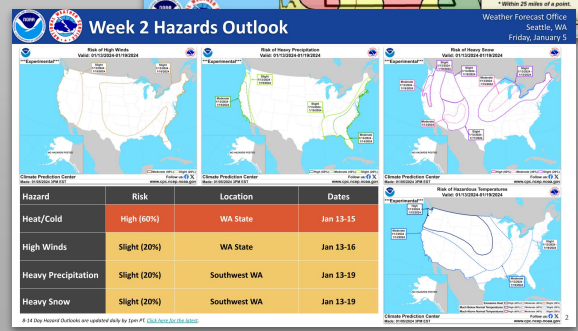
Weather Prediction Center (WPC)

- [Excessive Rainfall Outlook](#)
- [Mesoscale Precipitation Discussion](#)
- [3-7 Day Hazards Outlook](#)
- [Other WPC Forecast Tools](#)



Climate Prediction Center (CPC)

- [6-10 Day Outlook](#) | [8-14 Day Outlook](#) | [Week 3-4 Outlook](#)
- [Week 2 Hazards Outlook](#)



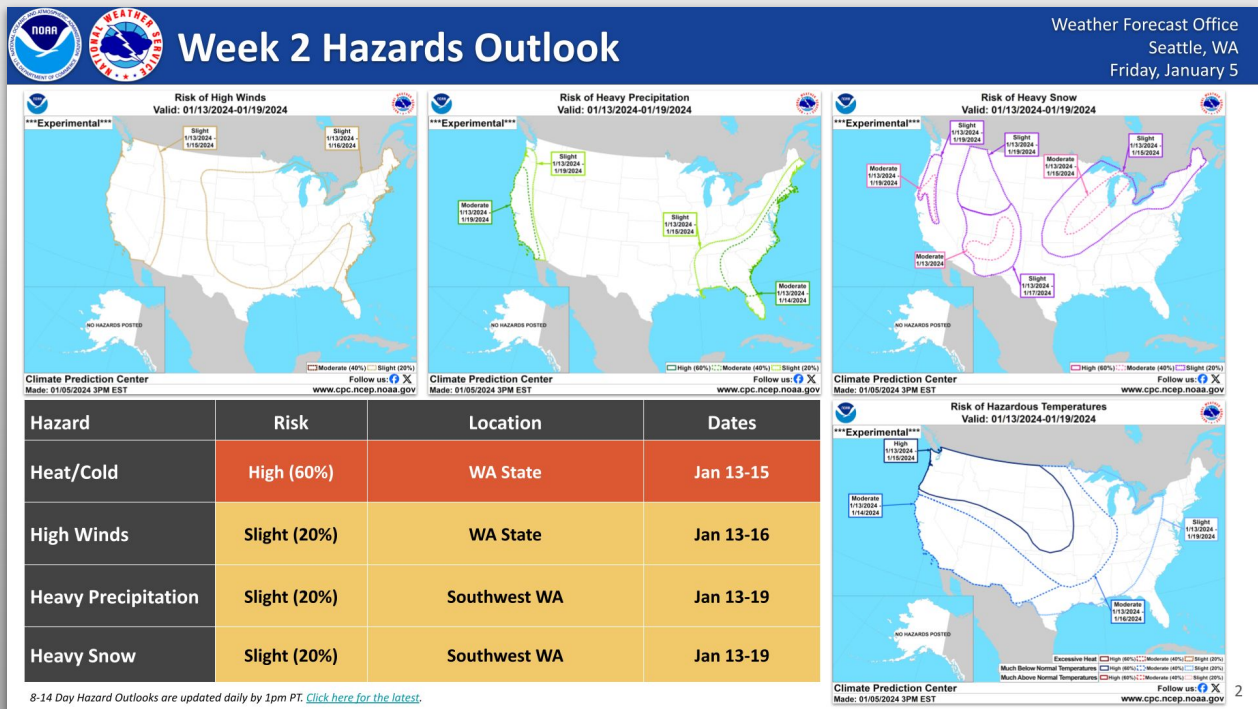


CPC Week 2 Hazards Outlook

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What hazards should I be monitoring in the 8-14 day time frame?



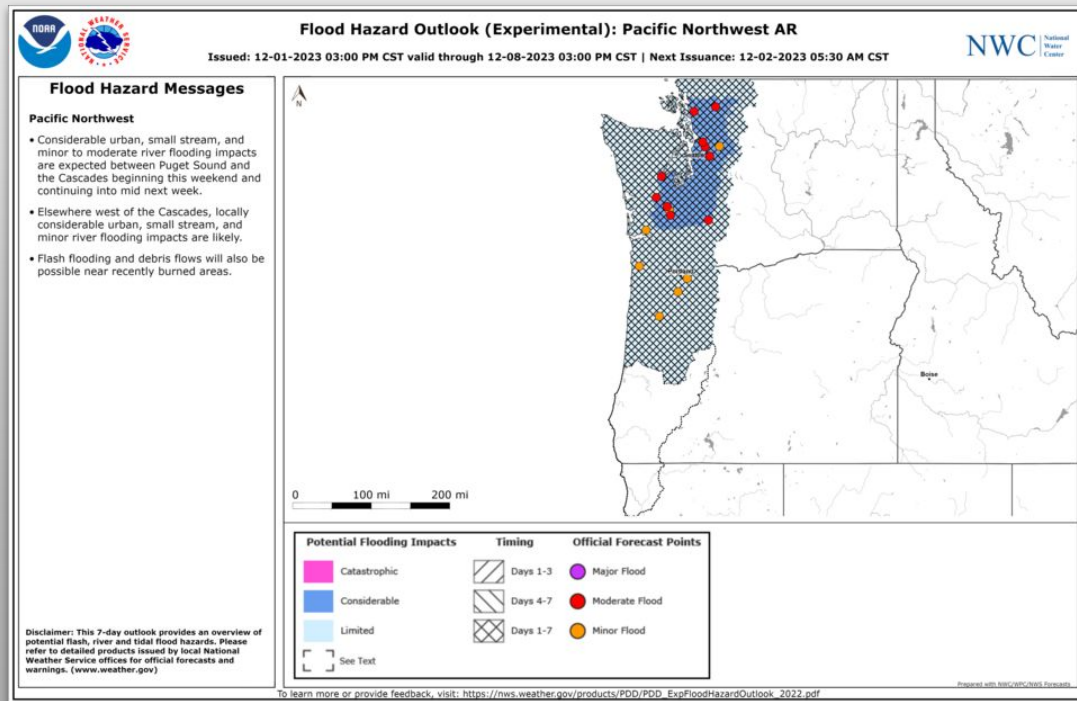


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NWC Flood Hazard Outlook

Which basins/streams have the highest risk of flooding over the next 7 days?



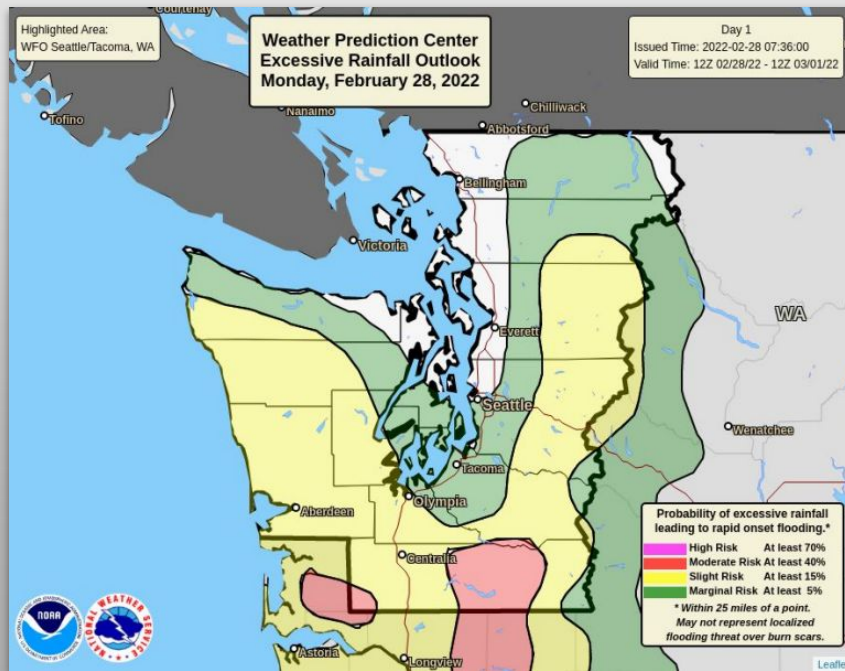


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WPC Excessive Rainfall Outlook

Where is the most intense rainfall expected that could result in rapid onset flooding (and in some cases, landslides)?





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National Water Prediction Service (NWPS)

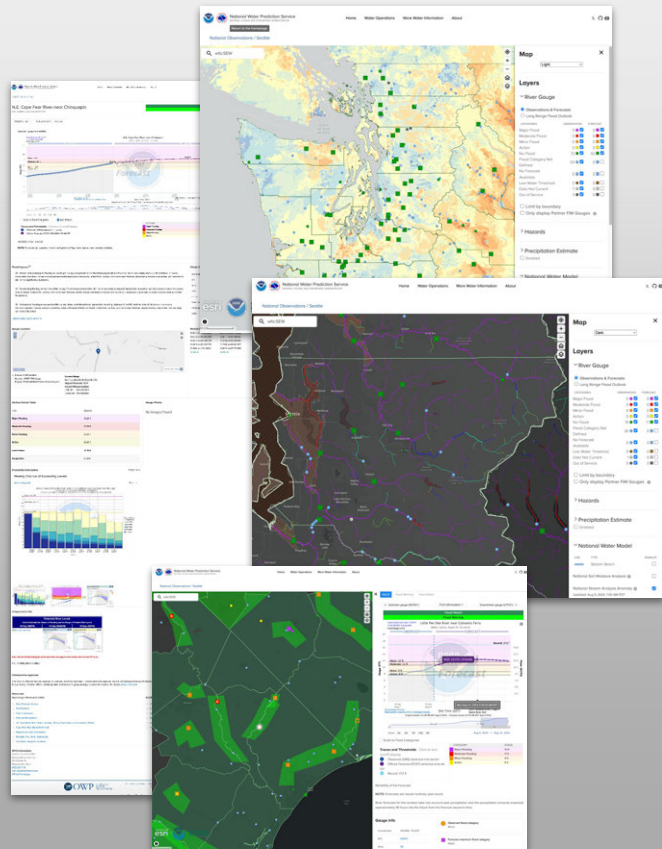
Replaced AHPS March 2024

- [NWS Seattle View](#) (customizable)
- [NWPS Quick Start Guide](#)
- Static hydrographs are available at:
https://water.noaa.gov/resources/hydrographs/xxx#_hg.png
where **xxxxx#** is the station identifier

Features:

- Customizable Mapping
- Permalinks
- Dynamic & Sampling Hydrographs
- Flood Inundation Mapping
- Official, NWM, and Ensemble Forecasts

Live Demo!

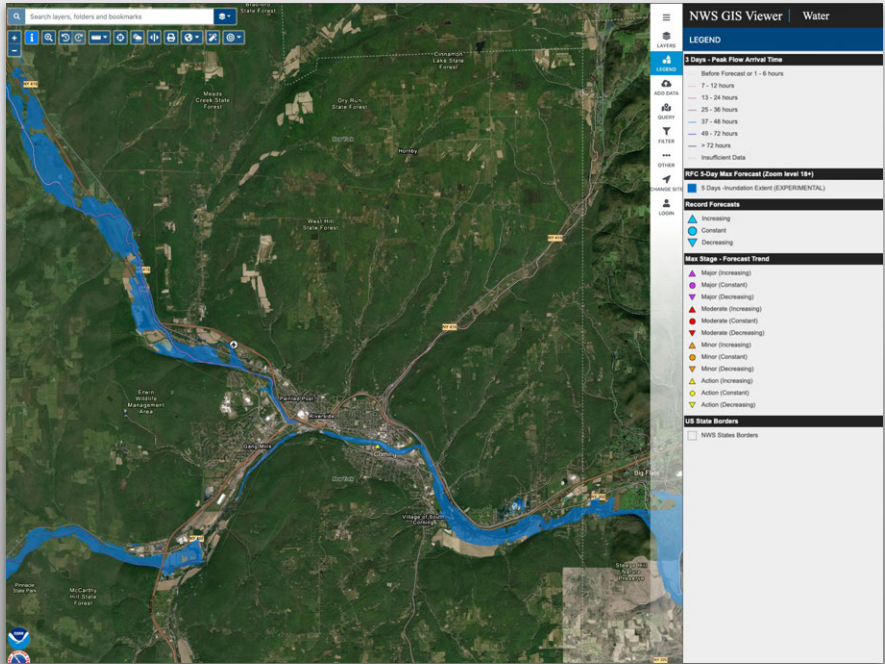


NWS GIS Viewer - Water

- viewer.weather.noaa.gov/water
- Service to view outputs from the National Water Model (NWM), including:
 - Analysis of current and recent streamflows
 - Short and medium range NWM forecasts for river/stream reaches
- Flood inundation mapping
- TONs of other GIS layers

Request an account to gain access to features (e.g. bookmarking)

Live Demo!





NATIONAL WEATHER SERVICE

Seattle

National Water Model (NWM)

Important Terms

Annual Exceedance Probability (AEP)

Percent chance of an event occurring during a year.

Based on a multi-decadal (44+ year) NWM climatology. **NOT Observations (i.e. not calibrated).**

Average Return Interval (ARI)

Average number of years between an event occurrence.

Based on a multi-decadal (44+ year) NWM climatology. **NOT Observations (i.e. not calibrated).**

High Water

“High Water” is the threshold used for many NWM services.

As of summer 2024, the current iteration of the NWM has a 34% AEP (2.2 year ARI) as the High Water threshold for the majority of western WA. We are working with the National Water Center to improve this service.

Annual Exceedance Probability (AEP)	Return Period Interval
1%	100-year
10%	10-year
20%	5-year
25%	4-year
33%	3-year
50%	2-year



NATIONAL WEATHER SERVICE

Seattle

National Water Model (NWM)

Important Terms

Short Range Forecast (SRF)

Forecasts for within 18 hours

Probabilities derived from 7 most recent NWM runs (equally weighted)

Medium Range Forecast (MRF)

Forecasts within 10 days

Primarily uses NBM precipitation forecasts

Probabilities derived from 6 most recent GFS QPF runs (equally weighted)

Rapid Onset Flooding

Criteria:

Flow must **double** within 1 hour

AND

Reach the “**high water**” threshold within 6 hours of the initial doubling

Only computed for smaller creeks & rivers (stream order 4 or lower). These are less likely to have flood control structures and may be more prone to flash flooding.



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National Water Model (NWM)

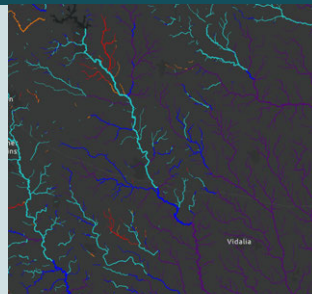
Analysis Products

Avg Streamflow Anomaly Analysis

“Where have the water levels been over the past [7 or 14 days] compared to the climatology for this time of year?”

Presented as percentile range

Based on a multi-decadal (40+ year) NWM climatology. **NOT Observations.**



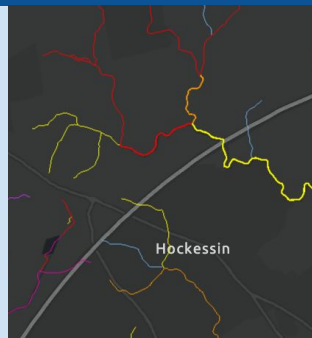
- High (> 95th)
- Much Above Normal (91st - 95th)
- Above Normal (76th - 90th)
- Below Normal (11th - 25th)
- Much Below Normal (6th - 10th)
- Low (<= 5th)
- Insufficient Data Available

High Flow Magnitude Analysis

“What is the percent chance the streamflow [now, past 7 day peak, past 14 day peak] exceeds level in a given year based on the climatology?”

Presented as Annual Exceedance Probability (AEP)

Based on a multi-decadal (40+ year) NWM climatology. **NOT Observations.**



- 2%
- 4%
- 10%
- 20%
- 50%
- > 50% AND > High Water
- Insufficient Data



NATIONAL WEATHER SERVICE

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National Water Model (NWM)

Forecast Products

High Water Probability Forecast

“What is the probability that the water level will exceed the “high water” threshold?”

Related to “What is the probability of NWM services becoming available?”

Presented as percent chance

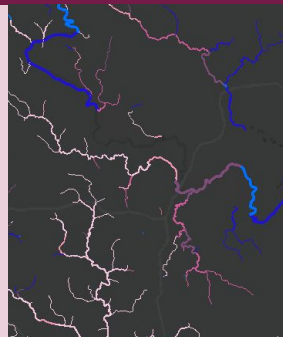


- 76% - 100%
- 51% - 75%
- 26% - 50%
- < 25%
- Insufficient Data

High Water Arrival Time Forecast

“When will the water level reach the “high water” threshold?”

Presented as hours in the future



- Ongoing or 3 - 6 hours
- 7 - 12 hours
- 13 - 24 hours
- 25 - 36 hours
- 37 - 48 hours
- 49 - 72 hours
- Insufficient Data



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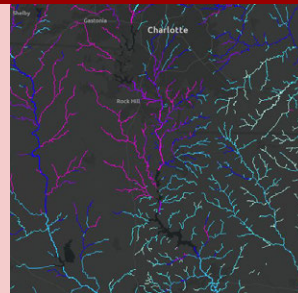
National Water Model (NWM)

Forecast Products

Max High Flow Magnitude Forecast

“What is the maximum streamflow during the forecast period?”

Presented as Annual Exceedance Probability (AEP)

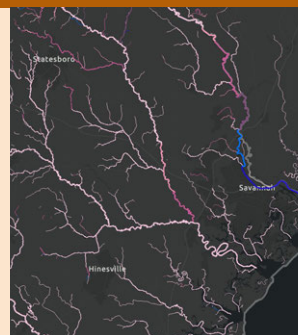


- 2%
- 4%
- 10%
- 20%
- 50%
- > 50% AND > High Water Threshold
- Insufficient Data

Peak Flow Arrival Time Forecast

“When will the water level reach its peak flow value?”

Presented as hours in the future



- Ongoing or 3 - 6 hours
- 7 - 12 hours
- 13 - 24 hours
- 25 - 36 hours
- 37 - 48 hours
- 49 - 72 hours
- Insufficient Data



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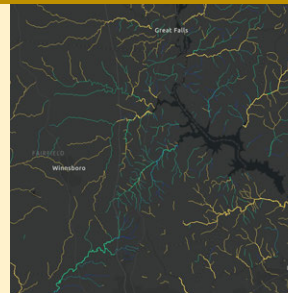
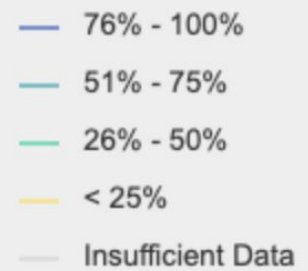
National Water Model (NWM)

Forecast Products

Rapid Onset Flooding Probability Forecast

“What is the probability that the stream reach will exceed the “rapid onset flooding” criteria?”

Presented as a percent chance



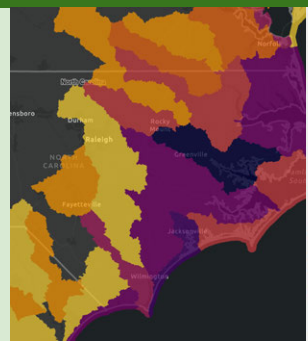
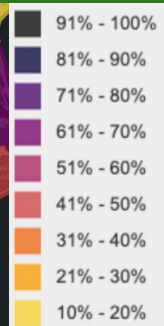
Rapid Onset Flooding Forecast (multiple products)

“When will the stream reach exceed the “rapid onset flooding” criteria?”

“How long will the stream reach be in this condition?”

“How much of the waterway will exceed this criteria?”

Waterway length expressed as a percentage using hotspots



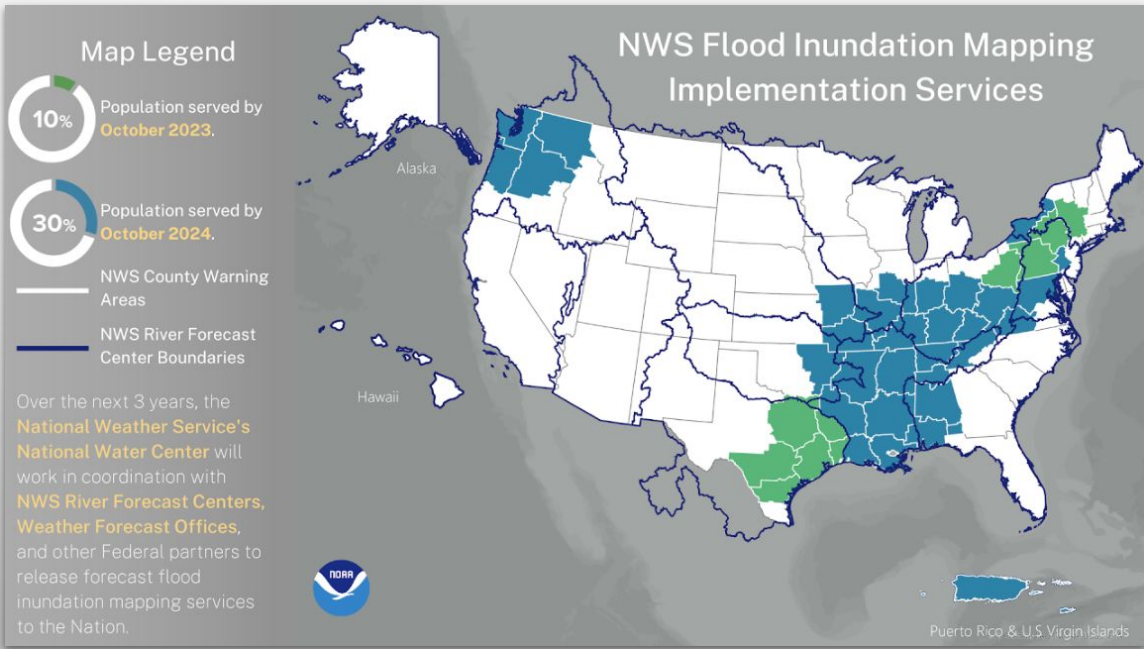
Q6



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Introducing Experimental Flood Inundation Mapping (FIM)





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Flood Inundation Mapping (FIM)

What is NWS FIM?

FIM is an estimation tool to “put water on a map.” It provides the estimated extent of water inundation. However, it is NOT a silver bullet.

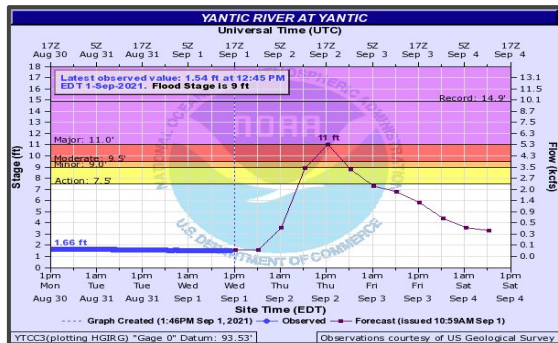
Advantages

- Availability
 - FIM based on NOAA/NWS River Forecast Center forecasts for **100,000+ river miles**
 - FIM based on National Water Model forecasts for **3.4 million river miles**
- Inundation based on forecast max river levels within a 5-day window
- Initial implementation. Very active development to continue improving service

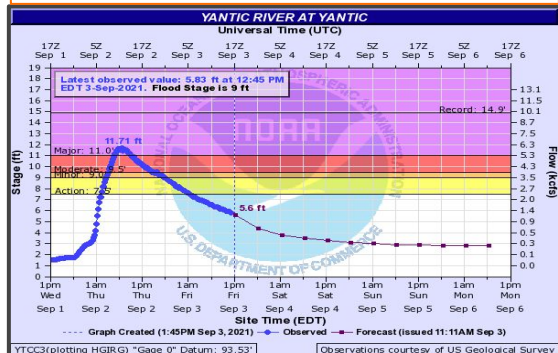
Limitations (as of summer 2024)

- Not a hydraulic model with long term study
- Assumes infinite time to inundate area
- No depth information (future plans)
- Unavailable for large water bodies (e.g. lakes/reservoirs)
- Cannot simulate breaching/overtopping of levees/dams
- National Levee Database is included but local levees and removable barriers may not be well represented
- DEM 10m resolution (not LIDAR-based)
- Uses synthetic rating curves, not direct measurement
- No DEM bathymetry
- Omission of backwater effects

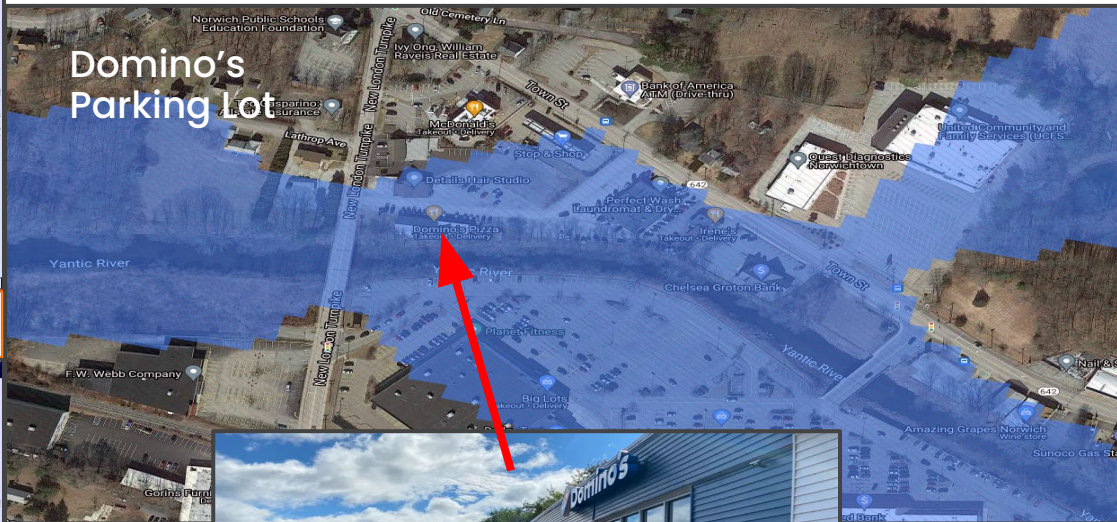
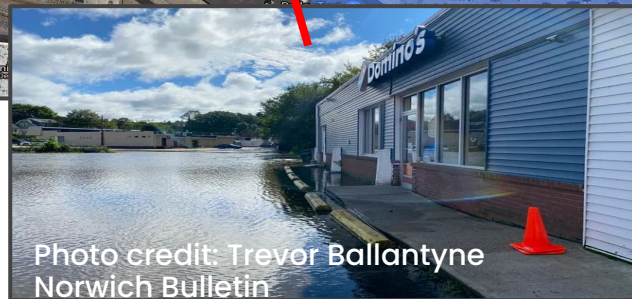
Visualizing FIM: Remnants of Ida in Connecticut



Official NERFC forecast issued on September 1st, 2021



Observed crest above Major on September 2nd, 2021





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Flood Inundation Mapping (FIM)

Streamflow Forecast
(if above High Water Threshold OR if RFC forecast is above Action Stage)



[Synthetic Rating Curve]



Stage Forecast



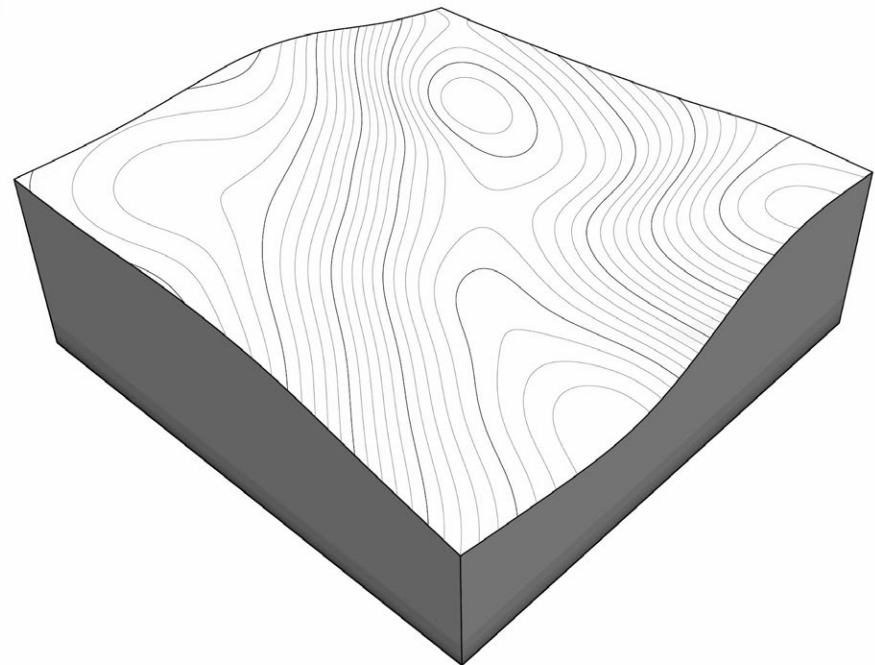
[HAND FIM]



Flood Inundation Mapping

Height Above Nearest Drainage

**DEM Representation
of Earth's Surface**

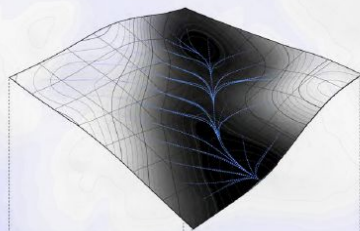




NATIONAL WEATHER SERVICE

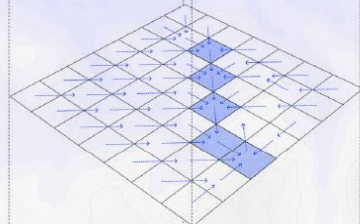
Seattle

HAND Method



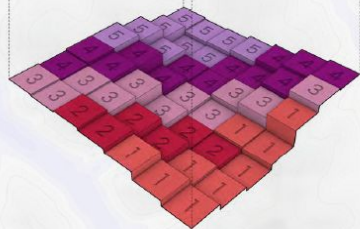
01.

The HAND Method begins with a DEM produced by USGS. Currently, DEMs used to generate the HAND model have a 10m resolution.



02.

The DEM then undergoes geoprocesing techniques also known as hydroconditioning, which helps identify drainage cells and surface waterflow.



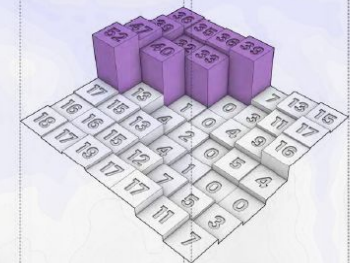
03.

Cells in this 10m grid matrix are grouped according to their nearest drainage cell forming a drainage network.



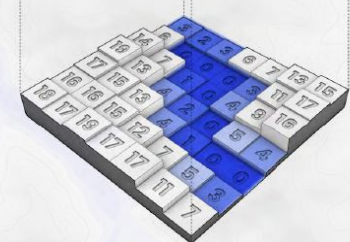
04.

The elevation values of the drainage cells are normalized to a 0 value.



05.

The topography is then normalized with respect to the drainage network by converting elevations above MSL into relative elevations [vertical difference of each cell in the terrain relative to its nearest draining cell].



06.

The HAND Method converts DEM data into a Relative Elevation Model [REM] or HAND grid used to create FIM.





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Flood Inundation Mapping (FIM)

Public NWS FIM Types

NWM Analysis FIM

Provides current snapshot based on current NWM Analysis (not observations)

Available for stream reaches exceeding “High Water” threshold

Updated Hourly

Latency: ~55 min

RFC 5-Day FIM

Provides peak 5-day inundation near and downstream of RFC forecast points. Based on RFC forecast.

Available at forecast points at or above action (near flood) stage

Available 1-2 hours after RFC forecast update

Best Quality

NWM 5-day FIM

Provides peak 5-day inundation for all NWM modeled stream reaches exceeding “High Water” threshold. Uses NBM precipitation.

Updated

- Hourly within the first 18 hours
- Every 6 hours out to 5 days.

Best Availability

Other NWS FIM Services: NWM Retrospective FIM and some CatFIM not publicly available



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Flood Inundation Mapping (FIM)

Internal NWS FIM Types

NWM NRP FIM

**NWM Retrospective FIM (NRP)
Static**

Provides a representation of frequency of flow magnitudes.

These methods produce AEP percentage values [2%, 4%, 10%, 20%, 50%] that represent the statistical probability of a flow occurring in any given year

Same limitations as NWM FIM.

NWM CatFIM

**Categorical FIM
Static**

Provides a representation of inundation for given flood stages (action, minor, moderate, etc.)

Same limitations as NWM FIM

Stage-Based CatFIM

Available for sites with <1ft vertical datum error.

Independent of synthetic rating curves. Uses vertical datums to convert to water surface levels.

May not be representative to real-time FIM.

*Limited Public Availability
(quality dependent)*

Flow-Based CatFIM

Uses official threshold flows with synthetic rating curves

Representative of what real-time FIM could look like.

Not Publicly Available





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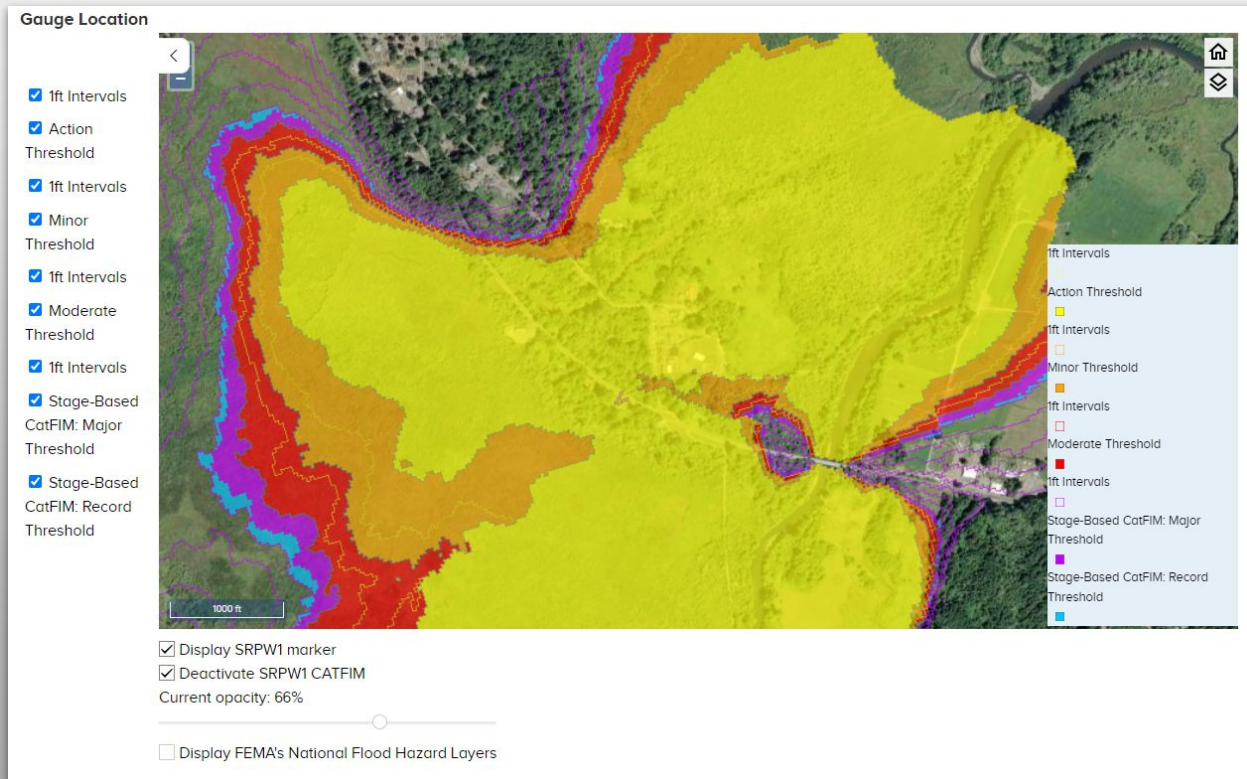
Seattle

Stage-Based CatFIM

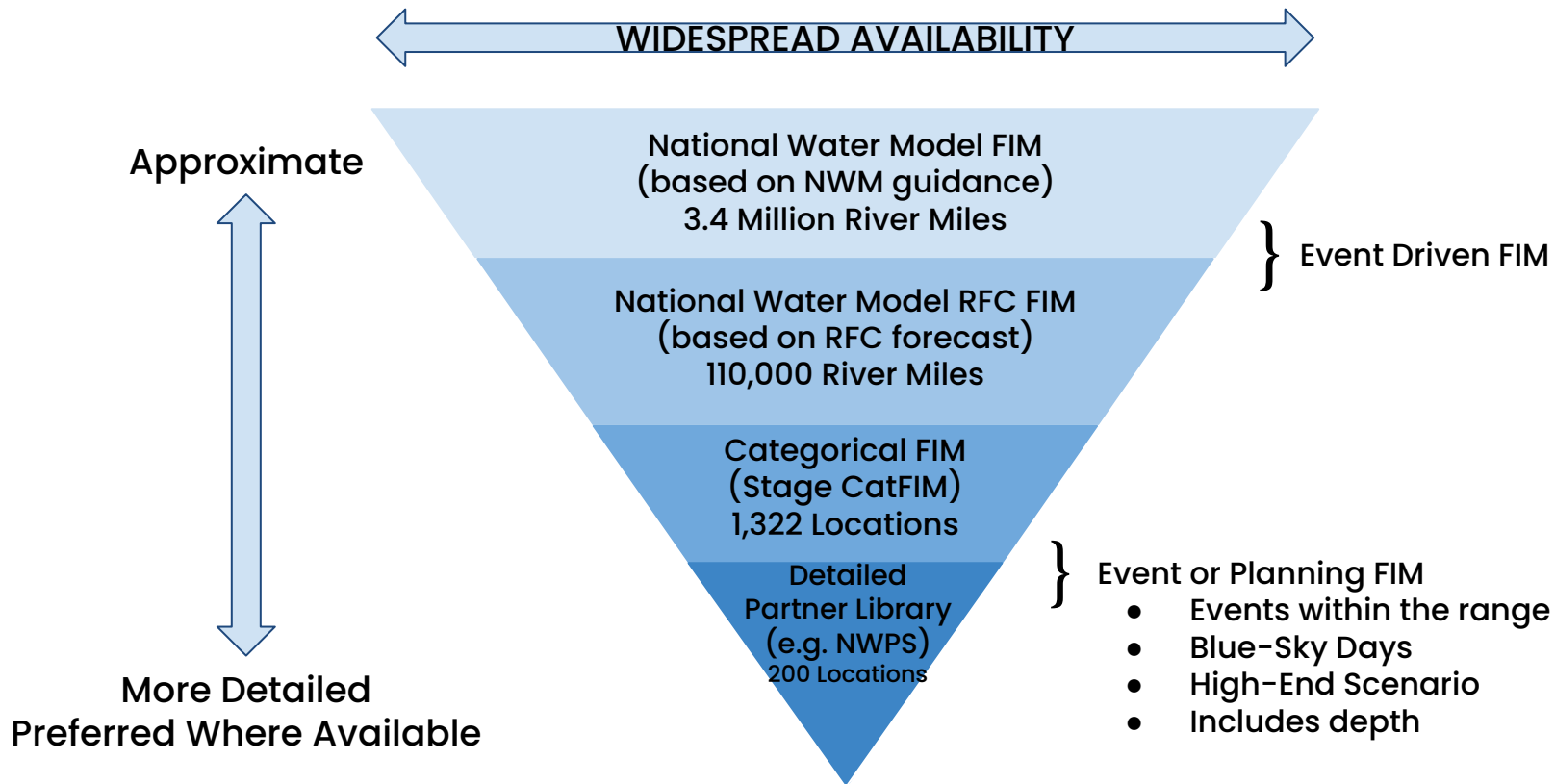
Where available, can be viewed in NWPS Gauge "Full Information" page.

Example:

<https://water.noaa.gov/gauges/SRPW1>



Confidence and Flood Inundation Mapping





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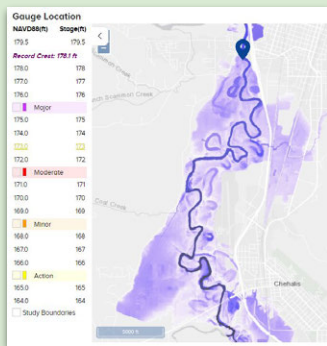
Flood Inundation Mapping (FIM)

External/Partner FIM

Partner FIM Available on NWPS

High-quality static FIM at pre-determined stage intervals.

Only location in WA:
CENW1 - Chehalis River at Centralia



Other FIM

US Army Corps of Engineers, FEMA, USGS, etc.

- Usually high-quality with sophisticated modeling
- Limited availability now
- Sometimes Access controlled
- Additional future availability to be determined

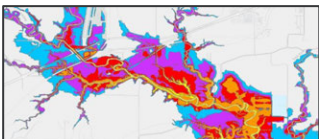
Bottom Line: Use them when available and applicable!

NWS FIM Capabilities

Static



AHPS FIM Libraries (AHPS FIM) ~ 200 RFC forecast locations. Shows the flood extent & depth based on a river crest of X feet. This is a hydraulic-based FIM which can be used with high confidence.



NWS Flood Categorical HAND FIM Libraries (CatFIM) ~3,000 RFC forecast locations. Maps derived from 10m Height Above Nearest Drainage (HAND) solution. *(not yet publicly available)*

Dynamic



Forecast River Forecast Center Flood Maps (RFC 5-Day Max Forecast) downstream of ~ 3,600 RFC forecast locations. Maps derived from RFC forecast and 10-m Height Above Nearest Drainage (HAND) solution.



Forecast National Water Model Flood Maps (NWM 5-Day Max Forecast) along NHDPlus reach locations. Maps derived from NWM forecast and 10-m Height Above Nearest Drainage (HAND) solution.



National Water Model Latest Analysis Flood Maps – utilizing observed rain and stream data to depict current flood extent. Maps derived from 10-m Height Above Nearest Drainage (HAND) solution.

Coverages

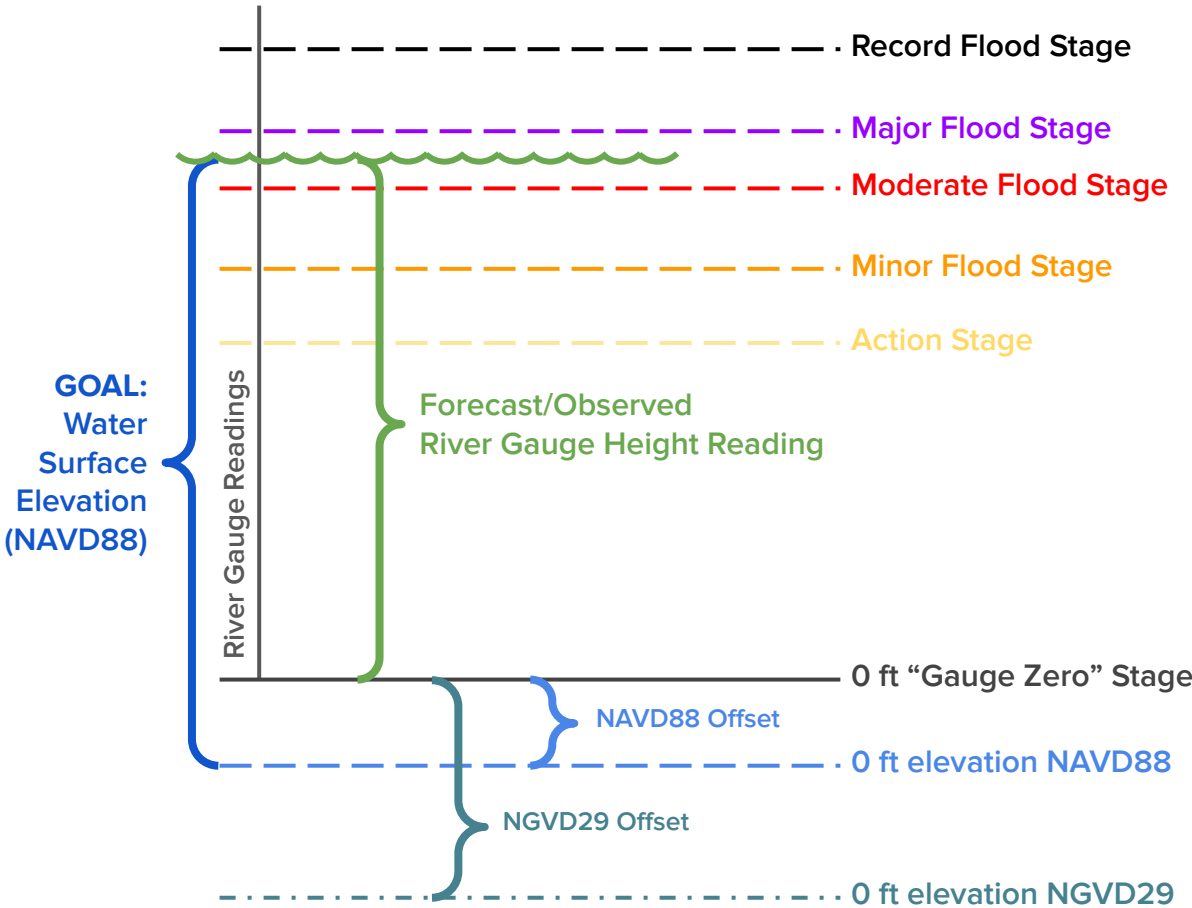
< 1,000 miles

~ 30,000 miles

~ 110k miles

~ 3.4M miles

~ 3.4M miles



Comparing FIM Water Levels to NAVD88 References

To compare water surface elevation from FIM, forecast/observed stage height must be converted to the datum used by the references of comparison. For USGS 3DEP Elevations and many other references, this will be in terms of NAVD88. **Note: this only works very close to the gauge location.**

1. Determine the gauge offset in feet from the **station metadata**. This will usually be in either **NAVD88** or **NGVD29**. *Notes: the offset may be negative which indicates the 0 ft elevation NAVD88 line is above the 0 ft Gauge Zero Stage. If the offset is 0 ft NAVD88, no calculation is needed.*

Gauge Info	
Coordinates	478374, -121667
RFC	NWRFC
State	WA
WFO	SEW
County	Snohomish
Data Provider(s)	
U. S. Geological Survey	USGS—Water Resources of the United States
USGS	12134500 Click for metadata

- a. If the offset is in terms of NGVD29, you must convert the offset to NAVD88.
2. Add the **River Stage (ft)** and the offset. This will be the **Water Surface Elevation in terms of NAVD88**.
 3. You may then need to convert this Water Surface Elevation (NAVD88) from feet to meters to compare to the reference information (e.g. USGS 3DEP Elevations are in meters).



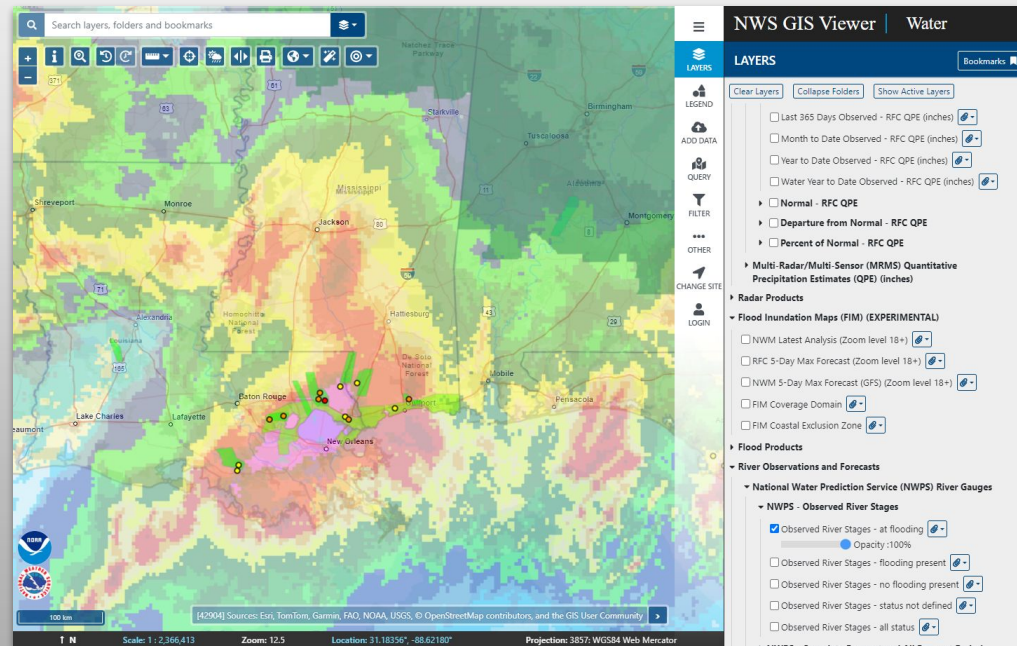
FIM Mapping/GIS Resources

NWPS

NWS Viewer

NWS GIS Portal

- Shapefiles
- KML Files
- Web Services (REST)
- Basemaps





NATIONAL WEATHER SERVICE

Seattle

NWPS & FIM Documentation

Resources Available: weather.gov/owp/operations



!NEW! - National Water Prediction Service (NWPS) - !NEW!

On March 27, 2024, the National Water Prediction Service (NWPS) website hosted at <https://water.noaa.gov> was launched replacing the legacy Advanced Hydrologic Prediction Service (AHPS) page previously located at <https://water.weather.gov>. Resources and more information are listed below.

Public Notification Statement: November 16, 2023
Service Change Notice (SCN): January 12, 2024
SCN: March 6, 2024

NWPS Quick Start Guide
Accessing Hydrographs on a Mobile Device through NWPS
NWPS Flyer
NWPS API Flyer
NWPS Fact Sheet
NWPS Overview (Story Map)
NWPS Product and User Guide
Recording of NWPS Partner Webinar
Recording of NWPS API Webinar
Service Description Document (SDD)

Contact: nwps.webmaster@noaa.gov



!NEW! - Flood Inundation Mapping (FIM) Services - !NEW!

Experimental FIM services are now available for 30% of the U.S. population including Puerto Rico and the U.S. Virgin Islands via NWPS. These services will be expanded to nearly 100% of the U.S. population by 2026. Experimental services depict the extent of predicted inundation, as derived from River Forecast Center forecasts and National Water Model analyses and forecasts. Services are available via the "Viewer", or directly via URLs hosted on the Hydrologic Visualization and Information Services (HydroVIS) cloud system. Additional informational resources are available below.

Public Notification Statement (PNS)
FIM Fact Sheet
Stage-based CatFIM Service Summary
Frequently Asked Questions (FAQs)
FIM Service Description Document (SDD)
Viewer Access Instructions
API Access Instructions

[CLICK HERE](#) to Provide Feedback



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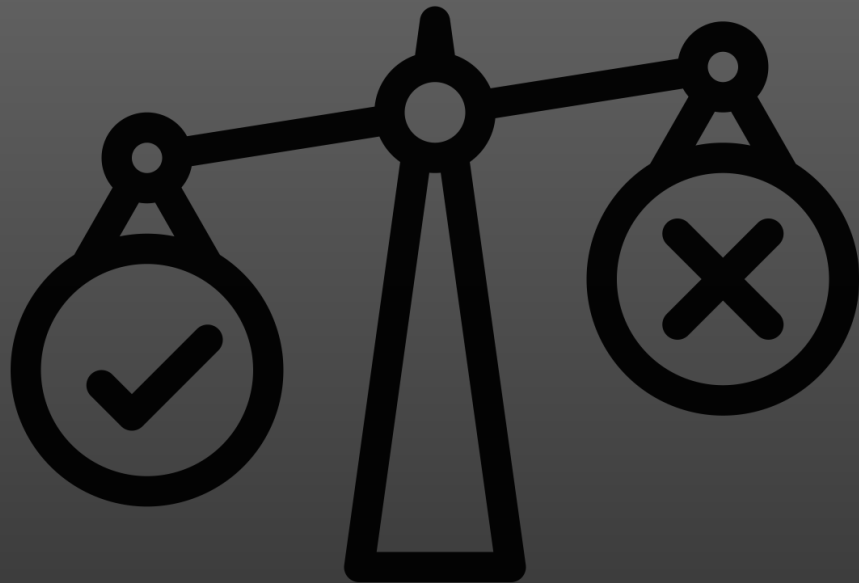
LUNCH BREAK

We will resume at 1250 PM

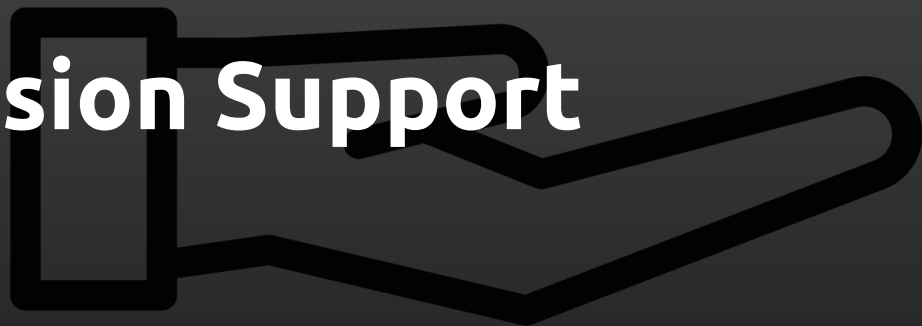


NATIONAL WEATHER SERVICE

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Available Decision Support Services





NATIONAL WEATHER SERVICE

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Decision Support Services

This module includes:

- Direct NWS Contact
- Briefings
- Spot Forecasts
- Flood Inundation Mapping (FIM) Reviews
- EOC/ICP Support



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Direct NWS Contact

Partner to NWS Contact (Available 24/7):

- **Recommended:**
 - NWSSChat (#wfo-seattle-wa)
 - 206-526-6857
 - nws.seattle@noaa.gov
- **Other channels:**
 - Twitter: @NWSSeattle (tweet/direct message)

NWS to Partner Contact:

- NWS may reach out to partners **as resources/time allow** to provide a heads up of imminent short-fused significant weather (e.g. tornado, severe thunderstorm, etc.)
- However, the primary way of alerting for these events are official NWS Warnings/Advisories



NATIONAL WEATHER SERVICE

Seattle

NWSChat 2.0

- NWSChat connects forecasters and partners in real time to support the highest level of collaboration and communication.

Thread

NWS - Seattle - Harrison Rademacher Mar 2nd at 12:29 PM
Good afternoon everyone! Just wanted to give a brief update on weather this afternoon. We're watching the potential for convection with the shower activity ongoing (and developing) along the coast. Some of this has reached as far inland as Kitsap county already (did receive a small hail/graupe report in Allyn and Burlington). Activity is expected to last through early evening. If you have any reports please feel free to slack them to us. Main threats with the strongest convection showers/storms are lightning strikes, small hail/graupe/snow, and gusty winds. (edited)

5 replies

DOT - WSDOT Northwest Region - Sean Quinn Mar 2nd at 2:01 PM
Hi Harrison! Reporting some slightly smaller than pea sized hail on Mercer Island. Moved through about 20 minutes ago. Passed through about 5 minutes.

NWS - Seattle - Harrison Rademacher Mar 2nd at 2:06 PM
Got it thanks Sean!

MEDIA - KING TV Seattle WA - Ashley Ruiz Mar 2nd at 2:21 PM
A viewer from Skagit Valley sent this photo in. She said it's still coming down and completely coated the roads

IMG_6732



NWS - Seattle - Matthew Cullen 4:36 PM
A quick update on the thunderstorms near the Cascade crest this afternoon. One cluster of storms has been persistent over US 2 near Stevens Pass, with around 0.25" of rain and some lightning observed. This cluster of thunderstorms is one of several along the Cascade crest that will slowly move to the east this afternoon into tonight.

image.png



USCG - Sector Puget Sound - Chris Butters 5:13 PM
Thank You for issuing the Freezing Spray Advisory and helping keep folks off the water! Luckily we had no major SAR incidents due to ice accumulation. Our crews in the San Juan's had to break a fair amount of ice off the bow on the cutter.

2 files



NWS - Seattle - Reid Wolcott 4:06 PM
Weather nerds huddling around the weather balloon data that's coming in this afternoon

IMG_4019



EM - Skagit County DEM (WA) - Julie de Losada Dec 3rd, 2023 at 9:26 AM
The Skagit crew is watching closely. Are you continuing to see no signals for coastal flooding?

1 reply

NWS - Seattle - Logan Howard Dec 3rd, 2023 at 9:30 AM
That's right Julie, we do not have concerns for coastal flooding through next week.

EM - Snohomish County DEM (WA) - Jarrod Dibble 12:58 PM
Raining hard at the Evergreen State Fair in Monroe!

2 files





NATIONAL WEATHER SERVICE

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Who Can Use NWSChat 2.0?

Members of the emergency management (EM) community

- Public safety officials at the federal, state, local, tribal, or territorial level

Members of the water resources management (WRM) community

- Public officials at the federal, state, local, tribal, or territorial level and are charged with managing the nation's water resources for the public good, including infrastructure (e.g., dams, levees, reservoirs, etc.)

Government partners

- Federal, state, local, tribal, or territorial government partners who have missions that require close coordination with the NWS to support the operational linkages of an allied mission of public safety or critical interdependency on each other's data

Members of Real-time media

- Members of Real-time media are entities that operate systems that routinely and rapidly relay weather and water watches, advisories, warnings and forecast information to a significant part of the population served by an NWS office

Examples & definitions are outlined in [NWS Directive 10-24](#).

Similar to our email briefing list, we have to be judicious with approving NWSChat 2.0 accounts



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Flood Decision Support

Who/What?

Emergency managers can request information on possibility of streams becoming flooded that are not part of the official river forecasts, whether or not covered by FIM.

When?

When there is concern about flooding of a particular stream that could impact roads, structures, or emergency activities like search and rescue.

Available information: Typically - relative streamflow increases, decreases, and timing



NATIONAL WEATHER SERVICE

Seattle

Significant Weather Briefings (email) & Virtual Office Hours (webinar)

Risk Levels			Little to None	Minor	Moderate	Major	Extreme
	Significant Weather Briefing	Virtual Office Hours					
Initiation	Usually for minor or higher risk for populated areas	Usually for moderate or higher risk for populated areas or when the event is expected to be complex					
Delivery	Late morning to afternoon, by 4:00 PM	Usually 11:00 AM					
Frequency	Daily within 3 days. Every other day or as the forecast changes 4+ days in advance.	As the forecast changes, up to and including the day of the event					



NATIONAL WEATHER SERVICE

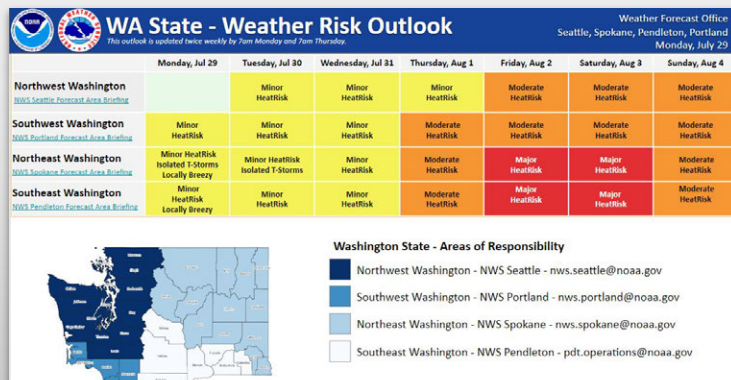
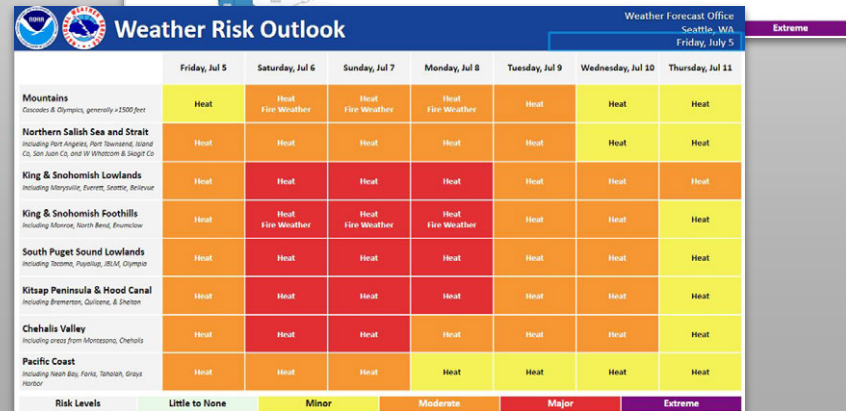
Seattle

Weather Risk Outlook

The statewide and local Weather Risk Outlook are determined by NWS meteorologists based on examination of both:

- The impact level of potential weather scenarios
- AND
- The associated probability of those scenarios.

The resulting outlook displays the highest risk for each day.





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Essential Elements of Information (EEl)s

The most critical information requirements regarding a hazard that are needed by a decision-maker at a particular time in order to reach a logical decision.

Heavy Rain

Element	Description/Guidance
Timing	Beginning, end, most intense period
Accumulation	Total
Rate/Intensity	Rainfall rates (15 min, 1 hr, etc.)
Flood Potential	river flooding, urban flooding, flash flooding, etc.
Potential Compounding/Cascading Impacts	Urban inundation, lowland snowmelt, landslides, road closures, debris flows

River Flooding

Element	Description/Guidance
Timing	beginning, end, crest
Category	Minor, moderate, major, record
Stage/Flow	height/CFS
Alternate Scenarios	Most likely, reasonable high/low-end estimates
Potential Compounding/Cascading Impacts	residential/commercial inundation, road closures, erosion, tidal interaction



NATIONAL WEATHER SERVICE

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Spot Forecasts

[Spot Forecast Requests/Monitor Page](#)

Spot forecasts are generally designed for:

- Wildfires/Prescribed Burns
- Search & Rescue Operations
- HAZMAT Incidents

They may be used for other urgent, no-notice emergencies.

After submitting a Spot request, a NWS meteorologist may call to gather more information and recommend a different support mechanism.

Spot Forecast for Unknown UGA...Washington Department of Natural Resources
National Weather Service Seattle WA
808 AM PST Tue Feb 15 2022

Forecast is based on ignition time of 0900 PST on February 15.
If conditions become unrepresentative, contact the National Weather Service.

Please contact our office at (206) 526-6095, if you have questions or concerns with this forecast.

.DISCUSSION...A few light showers remain in over the location this Tuesday morning, snow levels are expected to be above 2500 feet through Wednesday. Showers should taper off through the day, but conditions will remain damp through the forecast period. Westerly winds 5-10 knots will remain in place through the remainder of the forecast period.

.REST OF TODAY...

Sky/weather.....Mostly cloudy (70-80 percent). Slight chance of rain late in the morning. Chance of rain in the afternoon.

CWR.....6 percent.

LAL.....1.

Max temperature.....Around 43.

Min humidity.....93 percent.

Wind (20 ft).....Northwest winds 5 to 7 mph.

Mixing height.....1700 ft AGL.

Transport winds.....West around 3 mph.

Haines Index.....4 or low potential for large plume dominated fire growth.

Rainfall amount.....0.00 inches.

.TONIGHT...

Sky/weather.....Mostly cloudy (80-90 percent). Chance of rain.

CWR.....6 percent.

LAL.....1.

Min temperature.....Around 34.

Max humidity.....100 percent.

Wind (20 ft).....Light winds becoming north around 5 mph overnight.

Mixing height.....500 ft AGL.

Transport winds.....West around 2 mph.

Haines Index.....2 or very low potential for large plume dominated fire growth.

Rainfall amount.....0.02 inches.

.WEDNESDAY...

Sky/weather.....Mostly cloudy (65-75 percent). Chance of rain in the morning.

CWR.....0 percent.

LAL.....1.

Max temperature.....Around 44.

Min humidity.....90 percent.

Wind (20 ft).....West winds 5 to 9 mph.

Mixing height.....1600 ft AGL.

Transport winds.....West around 2 mph.

Haines Index.....4 or low potential for large plume dominated fire growth.

Rainfall amount.....0.00 inches.

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NATIONAL WEATHER SERVICE

Seattle

Specialized Briefings

Specialized briefings can be requested on an event- or incident-driven basis if specific decision thresholds are identified.

Examples include:

- Support for a large, planned outdoor event (fairs, festivals, parades, etc.)
- Support for the unique needs of a HAZMAT incident or Search & Rescue
- Support for post-event recovery when significant damage occurred
- Exercises

A [custom forecast page](#) can be created for events without specific thresholds.

Exercise

NOAA-NWS Seattle, WA I KCCZ Pacific Storm Prediction Centre, Vancouver, BC

Forecast for Grey Fox Exercise Operations

Issued: 2:00 PM PT Wednesday, October 16, 2019

Next Update Scheduled: Final briefing for the exercise will be released upon request

Point of Contact: NWS Operations (2477) 206-526-6857

KCCZ Support Desk (2477) 206-684-5585

FORECAST VALID FOR: Sumas Border Crossing - October 16-17, 2019

OVERVIEW

Winds are expected to increase from the south this afternoon, with gusts 10-20 MPH with gusts to 30 MPH. Steady moderate to occasionally heavy rainfall is expected to arrive between 2 continue for 3-8 hours before diminishing this evening. Southerly winds will be precipitation diminishes, a light drizzle of intermittent showers will remain in light and may shift to the west at 2-3 MPH after midnight. Rain showers and increase again Thursday morning after 0500 and continue through Thursday evening.

WEATHER IMPACTS

HIGH Confidence

- Rain and gusty winds could cause drone rain
- Gusty winds this evening could down tree
- Shifting winds this overnight could result in the event of additional risks.

LOW Confidence

FORECAST DETAILS

	Wednesday 10/16/2019	1500-1800	1800-2100
Weather	Moderate-Heavy Rain Increasing	Moderate-Heavy Rain Decreasing	
Precipitation Amount	0.10 - 0.40 in. 2 - 10 mm	0.05 - 0.20 in. 1 - 5 mm	
Temperatures	54-54°F 12-13.3°C	52-54°F 11-13.2°C	
Winds	Southeast 10-20 MPH gusts to 20-30 MPH	South 6-10 MPH	
	Southeast 10-12 km/h gusts to 32-48 km/h	South 10-16 km/h	

Forecast for Whatcom County - King Tide Operations

National Weather Service - Seattle

Issued: 2:00 PM PT Monday, January 8, 2022

Next Update Scheduled: 2:00 PM PT Tuesday, January 9, 2022

Point of Contact: NWS Operations (2477) 206-526-6857

FORECAST VALID: 01/04/2022-01/06/2022

OVERVIEW

Shoal conditions are lingering behind last night's cold front. Winds this afternoon are generally out of the south at 10-15 mph. Weather conditions will generally improve Tuesday and Wednesday ahead of the next system that will be moving into the area. However, faster surface winds beginning Tuesday morning could bring easterly to northeasterly winds between 20-25 mph with gusts over 30 mph. A Gale Watch has been posted for the Northern Inland waters for easterly winds beginning Tuesday morning.

WEATHER IMPACTS

HIGH Confidence

East/Northeast winds Tuesday and Wednesday may be strong enough for significant waves to form during high tide.

MODERATE Confidence

LOW Confidence

CURRENT LAND/MARINE HAZARDS IN EFFECT

HAZARDS

WATCHES

Gale Watch (beginning Tuesday at 4 AM-1 PM)

ADVISORIES

Small Craft Advisories in effect until 4 AM Tuesday.

FORECAST DETAILS

Forecast for Everson and Sumas in Whatcom County AR Response Operations

National Weather Service - Seattle

Issued: 1:00 PM PT Thursday, December 30, 2021

Next Update Scheduled: 1:00 PM PT Friday, December 31, 2021

Point of Contact: NWS Operations (2477) 206-526-6857

OVERVIEW

Cold weather through at least Friday with warming into Sunday. Dry weather through Friday with a weather system bringing light snow to the area on Saturday. Temperatures will warm into Sunday with snow transitioning to rain Saturday night. Rain through Sunday with the potential for additional rain/snow on or near Monday into early next week. The winds will be breezy through tonight with gusts of 15-40 MPH, with wind chills near zero expected tonight. Temperatures in the 20s for high through Saturday with lows of 10-15 in this area.

WEATHER IMPACTS

HIGH Confidence

- Very cold temperatures this week will impact vulnerable populations such as the homeless, pets, and those without adequate access to heating. Exposed pipes may be damaged by freezing conditions.
- The winds will be breezy through tonight.
- New Year's Day celebrations will start off with leaded snow before transitioning to rain by that evening.

MODERATE Confidence

LOW Confidence

FORECAST DETAILS FOR EVERSON AND SUMAS

	Friday 12/31/2021	0000-0800	0800-1600	1600-2400
Weather	Partly Cloudy	Mostly Sunny	Partly Cloudy	
Rainfall/Snowfall		24-Hour Rainfall: 0.0 24-Hour Snow Amount: 0"		
Temperatures	12-18°F -10-27°C	18-27°F -8-27°C	18-22°F -8-22°C	
Winds	Northeast 20-30 mph Gusts to 35 mph	Northeast 20-25 mph Gusts to 30 mph	Northeast 10-15 mph Gusts to 20 mph	

	Saturday 1/1/2022	0000-0800	0800-1600	1600-2400
Weather	Cloudy, Increasing Snow	Light Snow	Light Rain	
Rainfall/Snowfall		24-Hour Rainfall: 0.00-0.10" 24-Hour Snow Amount: 0-1"		
Temperatures	10-22°F -11-5°C	22-35°F -5-2°C	33-37°F 1-3°C	
Winds	East 5-15 mph.	East 5-15 mph.	Southeast 5-15 mph.	

Tuesday 1/4/2022

	Surface Pressure (at highest tide)	1000 mb	Cherry Point Highest Tide	10:30 @ 7:43 AM
	Estimated 24hr Barometer	1010-1030"		
		0.10-0.30"		
				11:20 @ 7:43 AM

	Point Roberts	Blaine	Elch Bay	Sandy Point
0500-0800	Winds: E 25-30 MPH Gusts to 35	E 20-25 MPH Gusts to 30	NE 15-20 MPH Gusts to 30	NE 15-20 MPH Gusts to 30
	Waves: 4-5 ft.	2-4 ft.	2-4 ft.	2-4 ft.
0800-1100	Winds: E 25-30 MPH Gusts to 40	E 25-30 MPH Gusts to 35	NE 20-25 MPH Gusts to 30	NE 15-20 MPH Gusts to 30
	Waves: 4-5 ft.	2-4 ft.	2-4 ft.	2-4 ft.

Forecast for City of Tacoma Emergency Management - Trident Seafood Vessel Fire

National Weather Service - Seattle

Issued: 10:30 AM PT Thursday, February 18, 2021

Next Update Scheduled: As Requested/Required

Point of Contact: NWS Operations (2477) 206-526-6857

Modelled Dispersion-Ammonia

ASS-0: Disabling/Invisible Effects

Assumptions: This model demonstrates the dispersion if the ammonia were to be released instantaneously and completely within 1 minute. -Assumed direct release of all material, 15 feet above ground

ASS-1: Temporary Effects

FORECAST DETAILS

Day: 02/18/2021	0900-1100	1100-1300	1300-1500	1500-1700
Weather	Rain Increasing	Rain	Rain	Rain
Temperatures	40-41°F	40-41°F	41-42°F	42-43°F
Relative Humidity	85-90%	85-90%	90-95%	90-95%
Winds	SE 3-7 MPH	E/SE 3-7 MPH	ENE 3-7 MPH	ENE becoming NW 3-7 MPH



NATIONAL WEATHER SERVICE

Seattle

Flood Inundation Mapping (FIM) Review

A “Spot Forecast” for FIM

Who/What?

Emergency managers can request a review/analysis of the available FIM for a particular location (e.g. asset/critical infrastructure).

When?

In order for a review to be conducted, a bona fide need must exist. For example, there is concern about the flood extent impacting particular structures or critical infrastructure. FIM must also be available to review (RFC FIM at or above moderate flood stage or NWM above “High Water”).

Feedback Loop

The requesting agency must be willing to solicit and provide detailed feedback from those on the ground to determine the accuracy of the provided information.

- This ensures that the feedback loop is closed. Feedback can be used to both improve the model in the future as well as provide input to the next time the forecast reaches a given level.



NATIONAL WEATHER SERVICE

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Flood Inundation Mapping (FIM) Review

FIM Review Process

1. **EM Duty Officer makes a review request** via NWsChat (#wfo-seattle-wa-em-only), email, or phone
 - a. All requests should be submitted by or be coordinated with an EM Duty officer (state, county, city, or tribe).
 - b. Must include bona fide justification for FIM review (what is the purpose/asset(s) at risk)?
2. NWS Seattle assigns & conducts FIM review (see considerations)
Note: FIM reviews will leverage internal and mutual aid resources depending on capacity.
3. NWS Seattle delivers & verbally briefs FIM review slide(s) to partner
Target turnaround time is 90 minutes, but will be dependent on capacity & complexity.
4. [Post-flood] Partner provides verification feedback on observed flooding & the FIM Review

FIM Review Considerations

- Reference time
- Catchment boundary Issues
- Buildings/Infrastructure (i.e. bridges)
- Representativeness of levees, culverts, etc. (anything smaller than 10m)
- Reservoir Outflow
- Backwater effects (e.g. confluences)
- Coastal Zones (flat terrain, tidal effects, & surge can impact inundation)
- Background forecast representativeness
- Water Surface Elevation (comparing rating curves)
- Impact Statements
- FEMA National Flood Hazard areas



Flood Inundation Mapping (FIM) - Extent Approximation

Weather Forecast Office
Seattle, WA
Monday, November 4

FOR OFFICIAL USE ONLY

Disclaimer: This map shows an approximation of the flood extent based on a forecast river crest from the FIM source noted below routed through the National Weather Model stream network. This data should be used conservatively

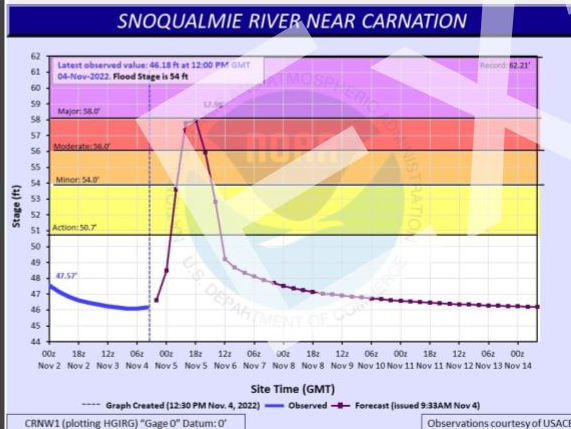
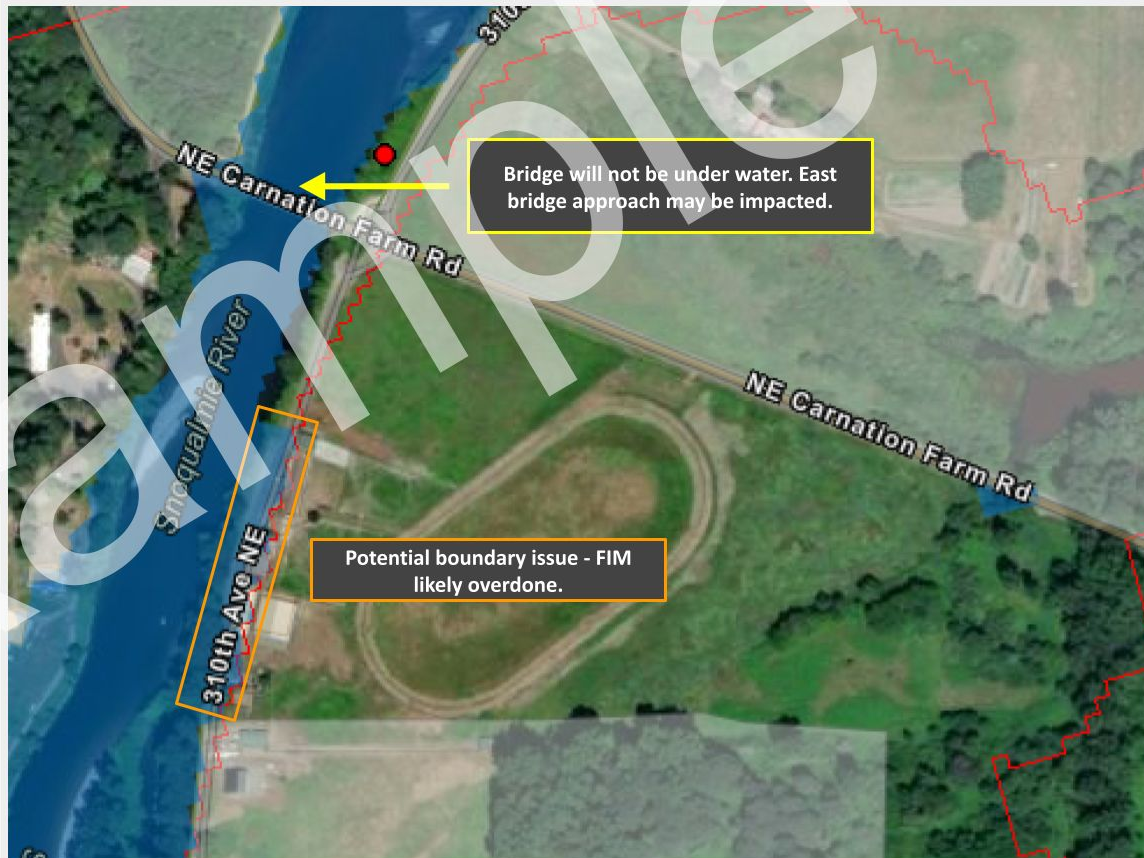
River/Area
Snoqualmie River
Near Carnation (CRNW1)

Forecast Details
Crest Time: 10:00 AM PT, Nov 5
Crest Height: 58.0 ft

FIM Details
FIM Map Height: 58.0 ft
FIM Source: RFC FIM
FIM Type: Dynamic
FIM Created: 5:00 AM PT, Nov 4

Hydrograph

Refer to [NWPS](#) for the latest river forecasts.





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Deployment-Ready Meteorologists

- Cadre of 12 Meteorologists (7 qualified, 5 trainees) with **specialized training** to provide support **on-site within an EOC/ICP**.
- Training consists of 120 hours of coursework including
 - 14 hours of module-based training
 - 50 hours of residence training (including a high-stress boot camp)
 - 54 hours of exercises or supervised support
 - Must be signed-off by evaluator and Meteorologist-In-Charge
- Cadre also assists with plan reviews/development, exercise development & play
- Now includes the capability work from vehicle/battery power as well as deploy a weather station
- **Action:** Please add reid.wolcott@noaa.gov and nws.seattle@noaa.gov to EOC activation notices



Q10
Q11



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Watch/Warning/Advisory (WWA) Products





NATIONAL WEATHER SERVICE

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WWA Products

This module includes:

- Products & Criteria
- Dissemination



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WWA Products

TYPE	DEFINITION	THREAT	ACTION
WARNING	Hazard is occurring, imminent, or very likely	Threat to life & property	Take protective action
WATCH	Conditions are <u>favorable</u> for hazard to occur	Threat to life & property	Have a plan of action
ADVISORY	Hazard is occurring, imminent, or very likely	Threat of significant inconvenience	Use caution



TACO WATCH



TACO WARNING



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WWA Products

Watch, Warning, & Advisory products are each associated with a minimum confidence threshold.

Note: Tsunami WWA products do not use confidence thresholds.

Warning Threshold

or

Advisory Threshold

Hazard is imminent or occurring.

Hazard occurrence confidence is $\geq 80\%$

Watch Threshold

Conditions are expected to be favorable for hazard to occur.

Hazard occurrence confidence is $\geq 50\%$

Outlook Threshold

Conditions may become favorable for hazard to occur.

Hazard occurrence confidence is $\geq 30\%$

Idealized Example

Note: times, confidence path varies for each event. (e.g confidence grows much earlier for heat events than for snow events)





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What's the Difference?

Flood	Flash Flood
Water where it should not be that can cause damage to property or threat to life.	<u>Rapid rise</u> of water into areas where it could not be that <u>requires immediate action</u> to protect life and property.
Onset: Usually >6 Hours to Days	Onset: Usually <6 Hours
Typically associated with moderate to heavy rainfall over a significant duration of time. Impacts to rivers and areas with poor drainage.	Typically associated with heavy rainfall and thunderstorms. However, other cases include: <ul style="list-style-type: none">• Burn Scar Debris Flows/Flash Flooding• Dam/Levee Failure• Failure of Stream Obstruction (landslide debris, ice jam, etc.)• Lahar/Volcanic Mudflow



NATIONAL WEATHER SERVICE

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River Flooding Alerts

PRODUCT	Target Lead Time	Confidence	Area	Description
Hydrologic Outlook	Up to 7 Days	30-50%	County	Issued to bring awareness to a risk of flooding within the next 7 days
Flood Watch	6-72 Hours	50-80%	County	Risk of flooding has reached at least 50%. May be issued when official river forecasts are near but may not yet be exceeding flood stage.
Flood Warning	0-24 Hours	80-100%	River Forecast Point Polygon	Flooding is occurring or imminent at a river forecast point.



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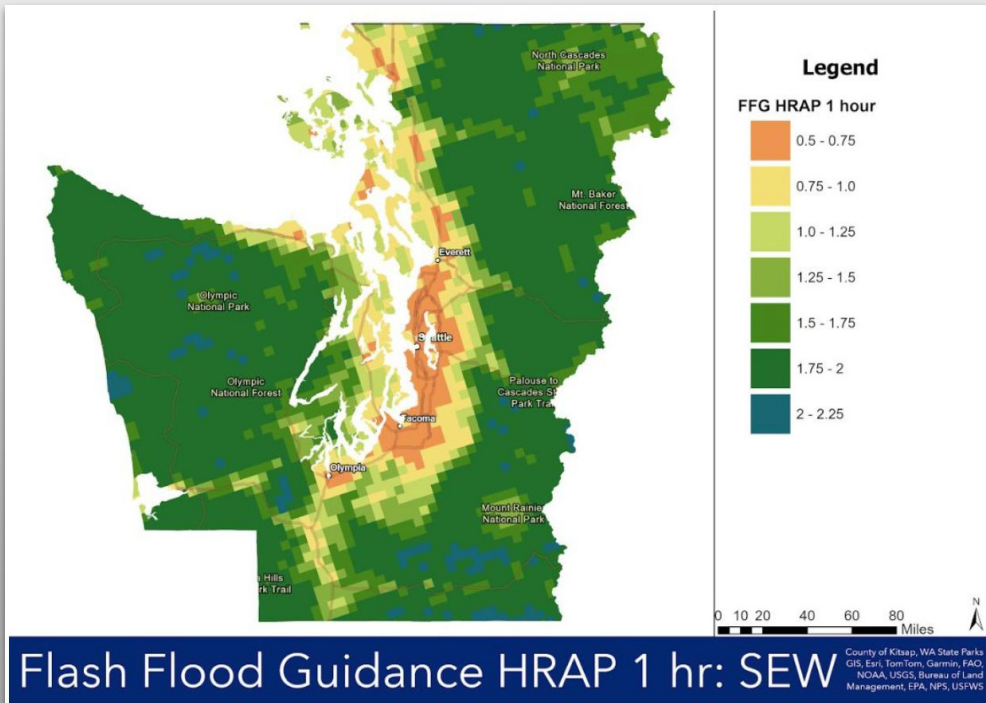
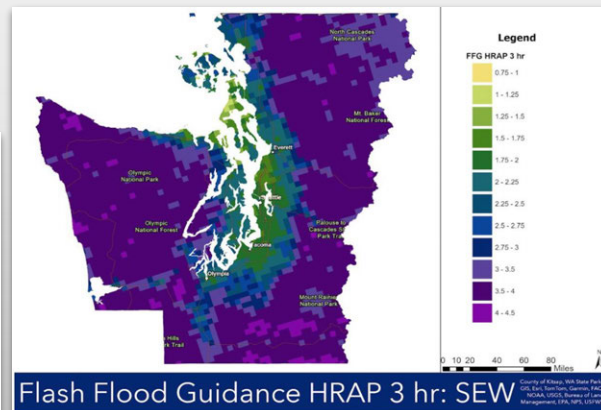
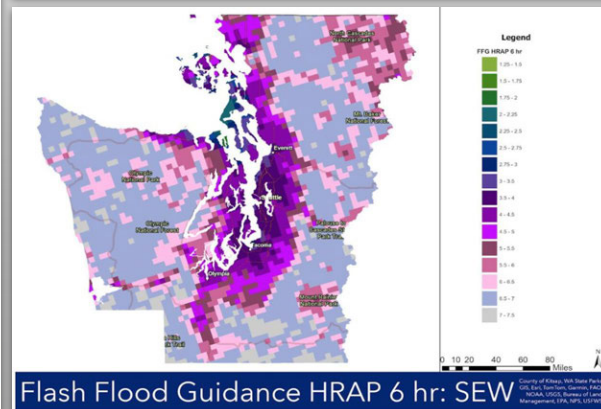
Other Flooding Alerts

PRODUCT	Area	Description
Flood Advisory	Polygon	Nuisance flooding is imminent or occurring which warrants public notification. Conditions could become life-threatening if improper actions are taken.
Flood Warning	Polygon	Significant flooding that could pose a threat to life/property is occurring or imminent in areas that cannot be covered by a Flood Warning for a river forecast point.
Flash Flood Watch	Varies	Chance of flash flooding, dam or levee failure, debris flow, or lahar.
Flash Flood Warning	Polygon	Flash flooding (requiring immediate actions to protect life and property) is imminent/occurring due to precipitation, dam or levee failure, sudden failure of natural stream obstruction; precipitation indicated capable of producing debris flows; indicated by modeling; or volcanic activity likely to produce a lahar (volcanic mudflow/debris flow).
Flash Flood Emergency	Polygon	Flash Flood Warning criteria + <ul style="list-style-type: none">• State of Emergency declared due to life-threatening rapidly rising water• Flash flood water rises to level rarely ever seen or much higher than typical flash floods;• Multiple swift water rescue teams required;• Total failure of high hazard dam with catastrophic impacts.



Flash Flood Guidance

These gridded datasets provide meteorologists a starting point in terms of threshold rainfall totals in 1, 3, and 6 hours that could result in flash flooding. Note: burn scar thresholds are not included.





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Uncommon Situations

NWS Seattle has Response Plans for many no/limited notice events such as:

- Sudden failure of natural stream obstruction (ice jam, landslide debris, etc.)
- Dam Failure
- Lahar/Volcanic Mudflow

LANDSLIDE

NWS Seattle Response Plan

Updated 8/3/2020

IMMEDIATE ACTIONS REQUIRED

- Determine extent of landslide
 - Location, time of event, trigger or failure? Property damaged, roads blocked? Is there an ongoing threat?
- Are there any witnesses/bystanders to assist?
- Follow-up: **Do not take later based on a slide**

	Significant Slide with No Blocked Waterways	Significant Slide with Blocked Waterways
FIRST STEPS	<ul style="list-style-type: none">Call local emergency management and determine if any or what support is needed, determine if threat is still ongoing	<ul style="list-style-type: none">Call local emergency management and determine if any or what support is needed, determine if threat is still ongoing
Product Considerations	<ul style="list-style-type: none">None	<ul style="list-style-type: none">Flash Flood watches/warnings/advisories for upstream & downstream areas
Notifications	<ul style="list-style-type: none">Call MCM/MLC, ask MCM to notify other managementCall WCM & SDO if no MCM responseCall NWRC - can assist with modelingCall NW SDO to notify of details, request Call for Public High Release	<ul style="list-style-type: none">Call SDO - relay details, can assistCall MCM/MLC, ask MCM to notify other managementCall WCM & SDO if no MCM responseCall NWRC - can assist with modelingCall NW SDO to notify of details, request Call for Public High Release
HE Report & Documentation	<ul style="list-style-type: none">Submit HE Log DOD activities, coordination calls, and incoming reports/impacts in STREAMIssue LSR - Do not release any property information until authorities have done so	<ul style="list-style-type: none">Submit HE Log DOD activities, coordination calls, and incoming reports/impacts in STREAMIssue LSR - Do not release any property information until authorities have done so
On-Site Support	<ul style="list-style-type: none">If it is safe to do so, Deployment-ready personnel may provide on-site support. Coordinate with NW SDO.	<ul style="list-style-type: none">If it is safe to do so, Deployment-ready personnel may provide on-site support. Coordinate with NW SDO.

RECOMMENDED OPERATIONS STRATEGY

Ops Level	Staff	Definition
Yellow	2+	Significant landslide with no blocked waterways
Orange	3+	Significant landslide with blocked waterways
Red	7+	Flash Flood Emergency

	COORD	SW	PD	OVER	HTSD	AW	UPDR
Yellow							
Orange							
Red							

ESSENTIAL ELEMENTS OF INFORMATION

Exclusion or Evacuation Information

- Location
- Time
- Severity
- USGS Alert Level
- Assess Other Cuts

Lahar Information

- Direction of flow
- Dispersal to direct impact
- Dispersal reach of Lahar flow
- Depth and speed of Lahar flow (as modified by CWD in area)
- Buried valleys and communities with debris

Potential Impacts

- Direction to direct impact
- Increased deposition of sediments/debris
- Blocked tributary streams
- Buried valleys and communities with debris

FLOOD - DAM FAILURE

NWS Seattle Response Plan

Updated 8/17/2022

IMMEDIATE ACTIONS REQUIRED

- Initial Call/Notification: Confirm report and gather essential incident information. Consult Dam Failure Procedure Log.
 - Report should be significant if dam owner/operator or city, county, state emergency manager, otherwise call dam operator as listed on DAF notification sheet.
- Issue Dam Failure Emergency Alert (DFA) for evacuation.
 - Flash Flood watch if failure is possible but uncertain, might be integrated, or will take 12+ hours to occur
 - Flash Flood warning if failure is occurring or is imminent, for area impacts only - 8 hours
 - Flash Flood emergency for catastrophic damage threat, impacting significant population, coordination with local emergency management officials is ongoing. Recommended:
 - Evacuate and river flood warnings for area downstream after initial flash flood threat
- Initial Notifications
 - Call SDO - relay details, can assist
 - Call MCM/MLC, ask MCM to notify other management personnel. Call WCM and SDO if no MCM response
 - Call NWRC - they can assist with modeling
 - Call NW SDO - relay details
- Create & Populate STREAM
 - Log DOD activities, coordination calls, and incoming reports/impacts
- Develop Partner & Public Message
 - Use Essential Elements of Information and Public CTA sections.

RECOMMENDED OPERATIONS STRATEGY

Ops Level	Staff	Definition
Yellow	2+	Flash Flood Warning
Orange	3+	Flash Flood Emergency
Red	7+	Flash Flood Emergency

	COORD	SW	PD	OVER	HTSD	AW	UPDR
Yellow							
Orange							
Red							

CRITICAL COORDINATION CONTACTS

Dam Failure Information

- Location
- Time of failure or potential failure
- Is threat ongoing?
- Size and speed of breach
- Waterways affected
- Downstream reach of flood waters impacting river banks
- Property or infrastructure affected

Expected Impacts

- Flash Flood watches/warnings/advisories for upstream & downstream areas
- Flash Flood watches/warnings/advisories for upstream & downstream areas
- Flash Flood watches/warnings/advisories for upstream & downstream areas

VOLCANO - Lahar

NWS Seattle Response Plan

Updated 3/06/2024

IMMEDIATE ACTIONS REQUIRED

- Confirm Lahar or Lahar Threat with Cascade Science Observatory (CSO) DOD.
 - Coordinate with USGS DOD Duty Scientist who can confirm Lahar threat, size, volume if available, and what time, and what support is needed, determine if threat is still ongoing
- Issue Flash Flood Warning, Watch, & Relay Other Non-Weather Emergency Messages (NWEs)
 - Flash Flood Warning (FFW) for area downstream of the Lahar threat
 - Flash Flood Watch (FFW) for area downstream of the Lahar threat
 - Flash Flood Emergency (FDE) for area downstream of the Lahar threat
- Initial Notifications
 - Call SDO - relay details, can assist
 - Call MCM/MLC, ask MCM to notify other management personnel. Call WCM and SDO if no MCM response
 - Call NWRC - they can assist with modeling
 - Call NW SDO - relay details
- Create & Populate STREAM
 - Log DOD activities, coordination calls, and incoming reports/impacts. Populate HE. Share information with NW SDO.
- Develop Partner & Public Message
 - Use Essential Elements of Information and Public CTA sections.
- Coordinate Calls
 - Log DOD activities, coordination calls, and incoming reports/impacts. Populate HE. Share information with NW SDO.

RECOMMENDED OPERATIONS STRATEGY

Ops Level	Staff	Definition
Yellow	2+	Flash Flood Warning
Orange	3+	Flash Flood Emergency
Red	7+	Flash Flood Emergency

	COORD	SW	PD	OVER	HTSD	AW	UPDR
Yellow							
Orange							
Red							

CRITICAL COORDINATION CONTACTS

Lahar Information

- Direction of flow
- Dispersal to direct impact
- Dispersal reach of Lahar flow
- Depth and speed of Lahar flow (as modified by CWD in area)
- Buried valleys and communities with debris

Potential Impacts

- Direction to direct impact
- Increased deposition of sediments/debris
- Blocked tributary streams
- Buried valleys and communities with debris



NATIONAL WEATHER SERVICE

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Hydrologic WWA Product Dissemination

PRODUCT	Services*	NAWAS	EAS	WEA	Auto-Tweet
Hydrologic Outlook	Yes				
Flood Watch	Yes				
Flood Advisory	Yes				
Flood Warning (Other)	Yes	Flooding impacting Urban Areas	Major Flood OR Onset within 6 hr & not preceded by a watch		
Flood Warning (River)	Yes	Major Flood OR not preceded by watch	Major Flood OR Onset within 6 hr & not preceded by a watch		
Flash Flood Watch	Yes	Yes	Extreme event & onset within 6 hr		
Flash Flood Warning	Yes	Yes	Yes	When Considerable Damage/Catastrophic Damage is expected	Yes
Flash Flood Emergency	Yes	Yes	Yes	Yes	Yes

* Services include: Website, iNWS, NWSChat, API, NWWS, EMWIN, NOAA Weather Radio, etc.

Q12



NATIONAL WEATHER SERVICE

Seattle

Alert & Warning: Lead Agency & Non-Weather Emergency Messages (NWEMs)

- The NWS is the lead agency in alerting for urgent weather information.
- The NWS is NOT the lead agency in alerting cascading impacts (e.g. human health, evacuation, shelter-in-place, etc.)
- The NWS can assist in putting weather context around NWEM messages (e.g. urgency related to cooling center openings)
- The NWS can relay NWEMs sent via IPAWS over NOAA Weather Radio if the NWEM/NWS/NWR channel is selected when the CAP message is created. Weather Radios are alerted based on SAME (FIPS/County) codes.

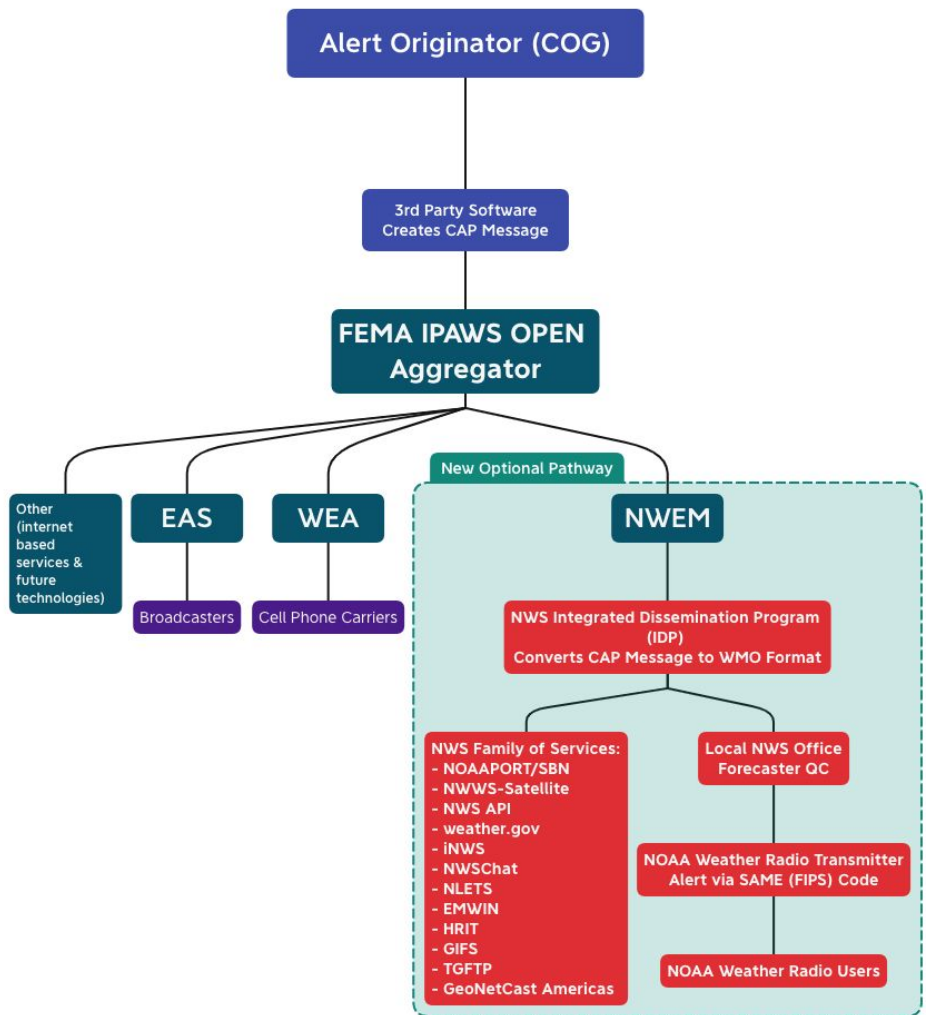
ID	Message Name
ADR	Administrative Message
AVA	Avalanche Watch
AVW	Avalanche Warning
BLU	Blue Alert
CAE	Child Abduction Emergency
CDW	Civil Danger Warning
CEM	Civil Emergency Message
EQW	Earthquake Warning
EVI	Evacuation Immediate
FRW	Fire Warning
HMW	Hazardous Materials Warning
LAE	Local Area Emergency
LEW	Law Enforcement Warning
NUW	Nuclear Power Plant Warning
RHW	Radiological Hazard Warning
SPW	Shelter-In-Place Warning
TOE	911 Telephone Outage Emergency
VOW	Volcano Warning
DMO	Practice/Demo Warning



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Q13



Quality Control

- Requesting Agency
- Special/Unexpected characters
 - Can happen when cutting/pasting into CAP message
- Punctuation
- Grammar/spelling
- Phone numbers

NWS may edit alert prior to broadcast.

NWS may call you to confirm message or content.



NATIONAL WEATHER SERVICE

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Public Information Resources



NATIONAL WEATHER SERVICE

Seattle

Public Information Resources

This module includes:

- Safety & Calls To Action Resources
- Social Media Strategy



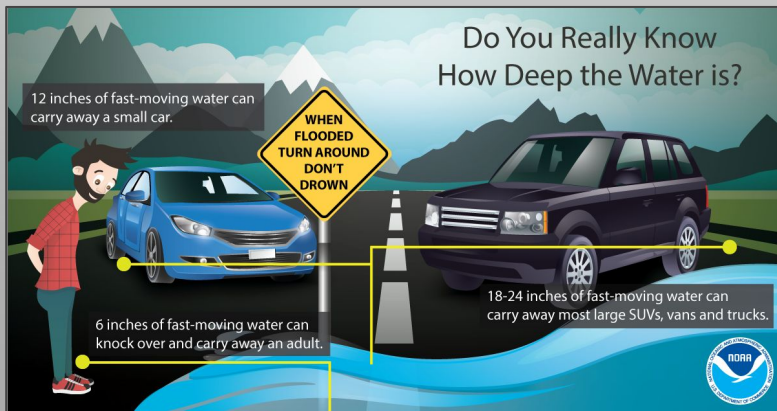
NATIONAL WEATHER SERVICE

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Safety & Calls to Action Resources

Fall Safety Resources & Winter Safety Resources

- Social Media Plans - canned graphics as well as Twitter/Facebook captions
- Infographics
- Videos, Presentations
- Spanish Content
- Deaf & Hard of Hearing Content
- [Hazard Based Safety Resources](#), including burn scar safety graphics





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NWS Social Media Strategy



- X is used as a “stream of consciousness” from the NWS - especially during weather events
- During weather events there can be in excess of 20 tweets/day (upwards of 50-100 for major events)
- X receives the most attention from the NWS
- X Direct Messages are a good way to reach the NWS with questions regarding messaging
- One of the best ways to receive reports from the public



Facebook

- Facebook is often used to post the weather headline(s) of the day
- During weather events, posts may be issued every 2-4 hours
- Facebook Live is sometimes used to provide real-time information for significant events
- The Facebook algorithm does not favor rapid-fire NWS updates
- Often several Twitter posts are summarized into a single Facebook post



Instagram

- In an experimental phase at a limited number of NWS offices (Seattle not included)
- Future expansion is TBD. Would likely be similar to Facebook strategy.

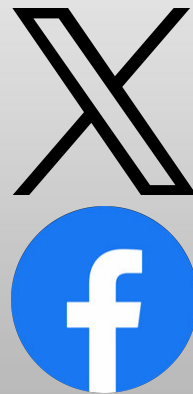


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NWS Social Media Strategy

- One of our top goals is to keep the interaction going during quiet weather periods in order to maintain & grow our followership
- Leverage the share/retweet/quote features to highlight noteworthy public reports as well as key messages from our neighboring offices and core partners.
 - **Collaboration Opportunity!**
Do no hesitate to reach out to us to request message amplification.



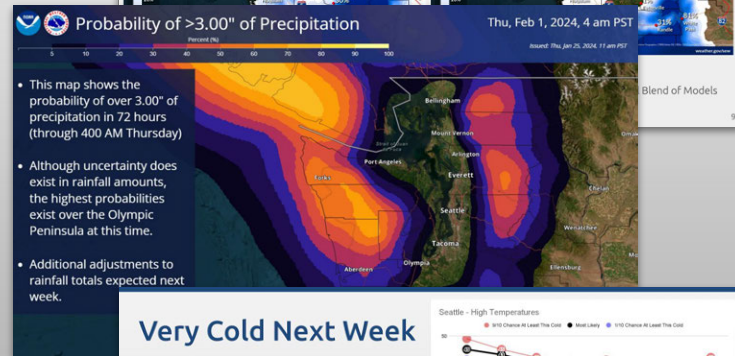


NWS Social Media Strategy

Probabilistic Forecast Information on Social Media

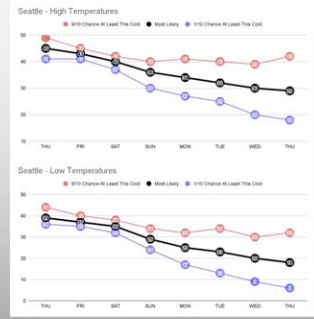
- The sharing of probabilistic forecast information has **significantly** reduced the negative feedback with respect to weather forecasts. It takes away the element of surprise.
- Social media has proven an excellent means of testing new probabilistic data messaging methodologies
- **RUMOR CONTROL:** The sharing of probabilistic forecast information has allowed the NWS to put raw model output (often shared via members of the public) into context.

Snow Probabilistic Forecast: Thursday Night & Friday



Very Cold Next Week

- Coldest air of the season so far
- Highs may struggle to reach freezing Sunday into next week across most of the lowlands
- Very cold temperatures will impact vulnerable populations such as the homeless, pets, and those without adequate access to heating. Exposed pipes may be damaged by freezing conditions. Sensitive crops/plants may be killed.





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Social Media & NWS FIM Guidance

- Experimental RFC FIM, NWM FIM, and NWM Analysis FIM are publicly available.
- However, the NWS Western Region approach to sharing NWS FIM on social media will be extremely cautious.
 - **Internal Guidance:** *FIM should NOT be posted to social media unless it is coordinated with NWC/ROC/NWRFC via Slack and helps relay an imminent threat to life/property. If time allows, coordinate messaging with local emergency management/public information officials.*
 - Any social media FIM posts will have the appropriate disclaimer wording attached to it.



NATIONAL WEATHER SERVICE

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Vulnerable Populations





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Vulnerable Populations

This module includes:

- Why?
- Who is vulnerable?
- What causes inaction?
- Mitigation Strategies



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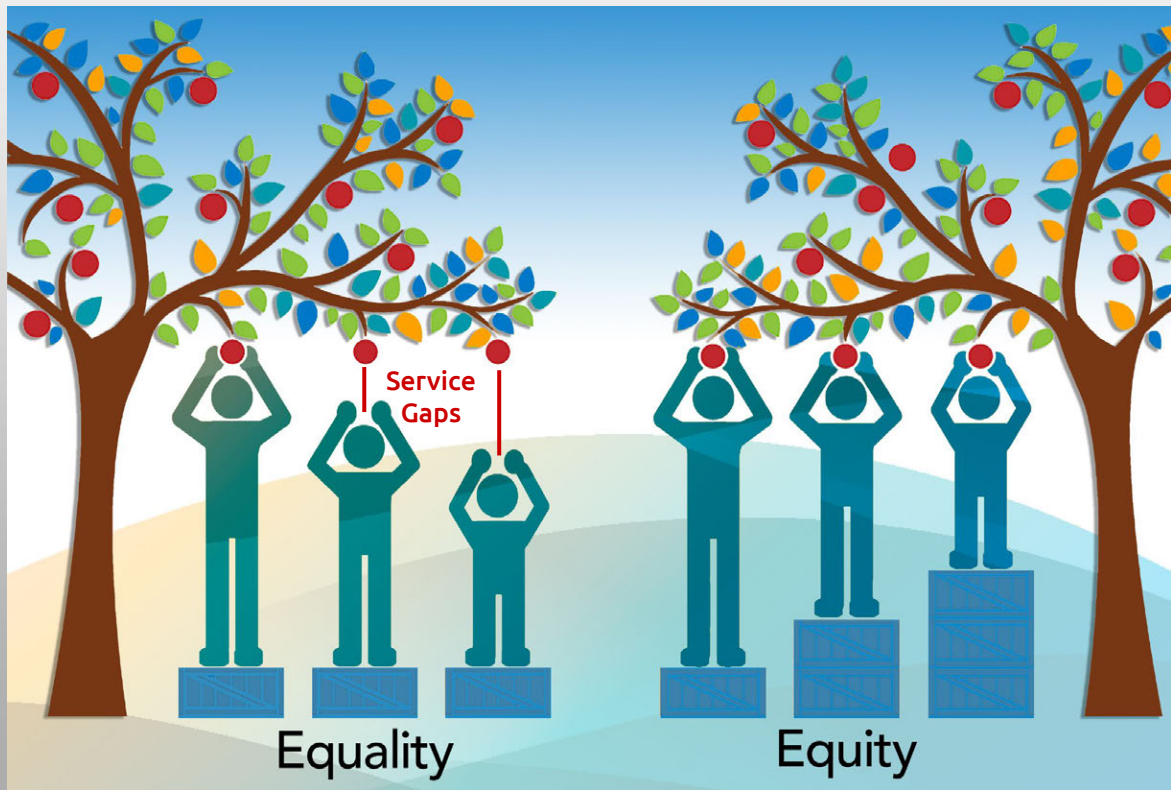
Why?



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Equitable Services for a Weather-Ready Nation



“One-Size” Services
→ Unequal Outcomes

Equitable Services
→ Equality of Outcomes



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Who is vulnerable?

In western Washington, populations vulnerable to river flooding are often found in low-lying areas near rivers and along the coast. Additional factors like geographic location, socio-economic status, and access to infrastructure affect vulnerability levels.

Hazard-Specific Vulnerable Populations

- Have an increased sensitivity to a specific hazard as a result of geographic location and demographic factors
- Population specific messaging is often available

Socially Vulnerable Populations

- Have an increased sensitivity to many or all hazards due to social or behavioral context
- Historically underserved
- Population specific messaging may be overlooked

We must reach both!



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Who is vulnerable?

Specific Vulnerable Populations



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Vulnerable Populations

Low-Income Populations

Often reside in flood-prone areas with minimal flood protections and limited resources

Face financial constraints that hinder evacuation, alternative housing, and insurance

Can lack access to reliable transportation for evacuation and emergency services

Tribal Communities

Many tribal lands are situated along rivers, making them vulnerable to flooding

Flooding can sever road access, isolating Tribal communities from emergency services and delaying responses

Underfunding can lead to a lack of critical infrastructure used for flood resilience

Migrant & Agricultural Workers

Direct exposure and physical demands of field workers increase risk

May lack access to emergency alerts due to language barriers or limited access to technology

Economic insecurity can hinder evacuation efforts

Older Adults & Those with Disabilities

Social isolation can hinder access to emergency notifications and assistance

Mobility, cognitive, or sensory impairments can make evacuation challenging without help

Dependence to electricity for medical devices means power outages can be life-threatening

Children and Families

Flooding disrupts schooling and childcare services, leading to long-term instability for families



NATIONAL WEATHER SERVICE

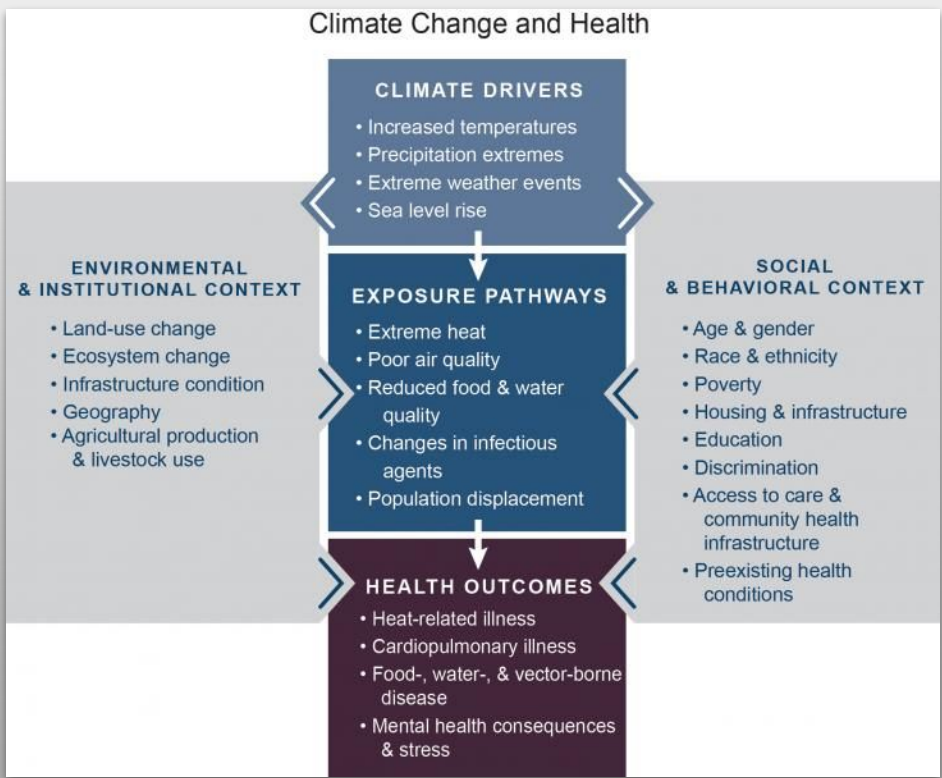
Seattle

Causes of Social Vulnerability

Identifying specific factors that increase risk for some populations gives us a way to reduce exposure and vulnerability through adaptive actions.

In some cases, simply increasing awareness of the risks that extreme heat poses to health can encourage people to take adaptive actions, such as going indoors or getting to a cooling center.

[More information](#)





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Population Identification

Available Tools

CDC Social Vulnerability Index (SVI)* - examine potential negative effects on communities caused by external stresses on human health. Such stresses include natural or human-caused disasters, or disease outbreaks.

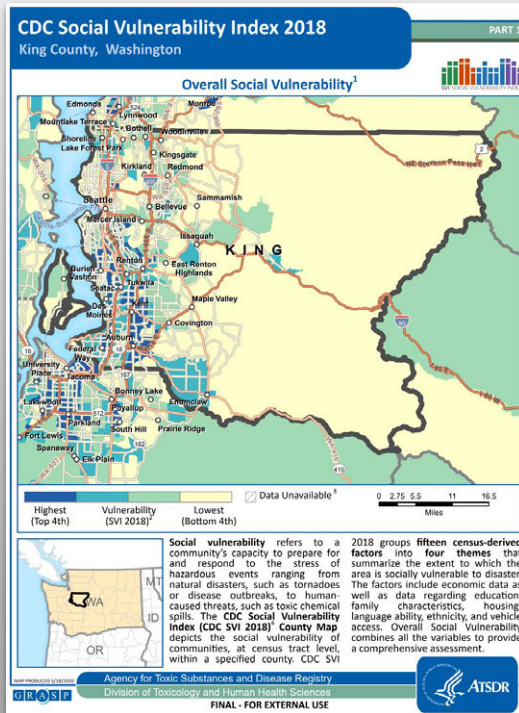
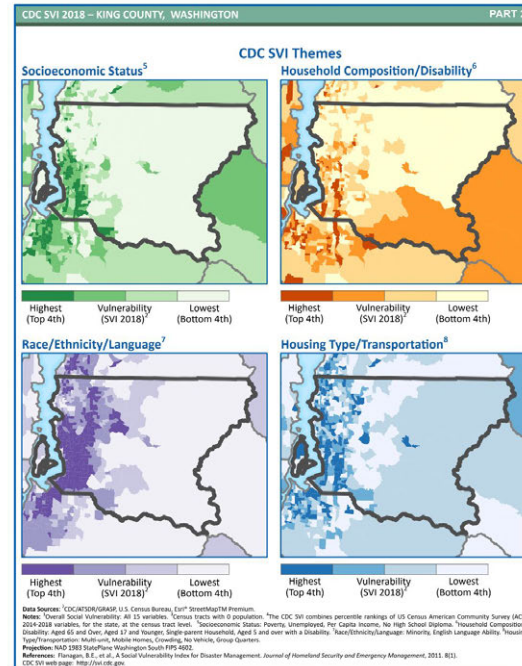
FEMA National Risk Index (NRI) - examine the United States communities most at risk for 18 natural hazards

FEMA Resilience Analysis & Planning Tool (RAPT) - examine the interplay of census data, infrastructure locations, and hazards, including real-time weather forecasts, historic disasters and estimated annualized frequency of hazard risk

EPA EJSCREEN Tool - environmental justice mapping and screening tool that provides EPA with a nationally consistent dataset and approach that combines environmental and demographic indicators in maps and reports

DHHS emPOWER Map - examine number of at-risk electricity-dependent Medicare beneficiaries in a geographic area. (updated monthly)

* CDC SVI is the primary tool used in NWS applications.





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What causes inaction?

Unable to adequately...

ACCESS | INTERPRET | ACT UPON

Information



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Vulnerable Populations: Weather Information

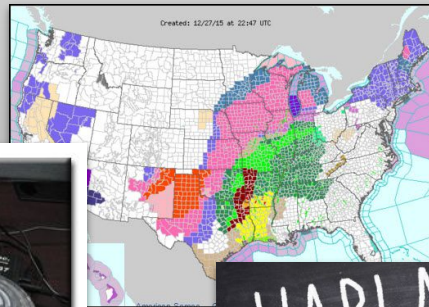
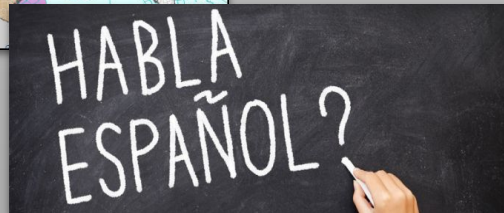
Unable to ACCESS Information

- Lack of telecommunications service
- Experiencing Homelessness
- Information not available via community channels
- Information not accessible (e.g. deaf & hard of hearing)



Unable to INTERPRET Information

- Poorly worded/communicated
- Not available in native language
- Message was confusing/conflicting





Vulnerable Populations: Weather Information

Unable to **ACT UPON** Information

Seattle

Don't know how to take action

- Not familiar with threats
- Lack of understanding instructions
- Lack of access to calls-to-action
- Afraid to communicate with supervisors

Don't want to take action

- Poor prior experience
- Lack of trust
- Can't afford to leave work
- Leaving pets or home
- Had to care for someone
- Warning fatigue
- Don't perceive themselves as vulnerable
- Concern over immigration status at government-sponsored shelter
- Concerns over shelter safety
- Psychological anxiety about going to a shelter
- Feel because the previously lived in a hot climate, they are fully acclimated

Can't take action

- Lack of money
- Lack of support system
- Lack of transportation
- Disabled
- Lack windows that open
- Lack ability to install A/C in rental property
- Closure of facilities

Taking the wrong action

- Waiting to hydrate until thirsty
- Consuming sugary/cafeinated beverages
- Wearing dark, heavy, or tight fitting clothing
- Improper use of fans and heating/cooling systems
- Not registering the heat due to psychotropic medications



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Vulnerable Populations

Mitigation Strategies



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Safety & Calls to Action Resources

Seasonal Safety Resources

- Social Media Plans - canned graphics as well as Twitter/Facebook captions
- Infographics
- Videos
- Presentations
- Spanish Content
- Deaf & Hard of Hearing Content

[weather.gov/safety](https://www.weather.gov/safety)

- Hazard-based safety resources



Safety & Calls to Action Resources

- [WA State Dept of Health - Floods](#) (bilingual)
- [Ready.gov - Floods](#) (multilingual)
- [FEMA Flood Actions](#) (multilingual)
- [Floodsmart.gov](#)
- [American Red Cross Flood Safety](#) (multilingual)

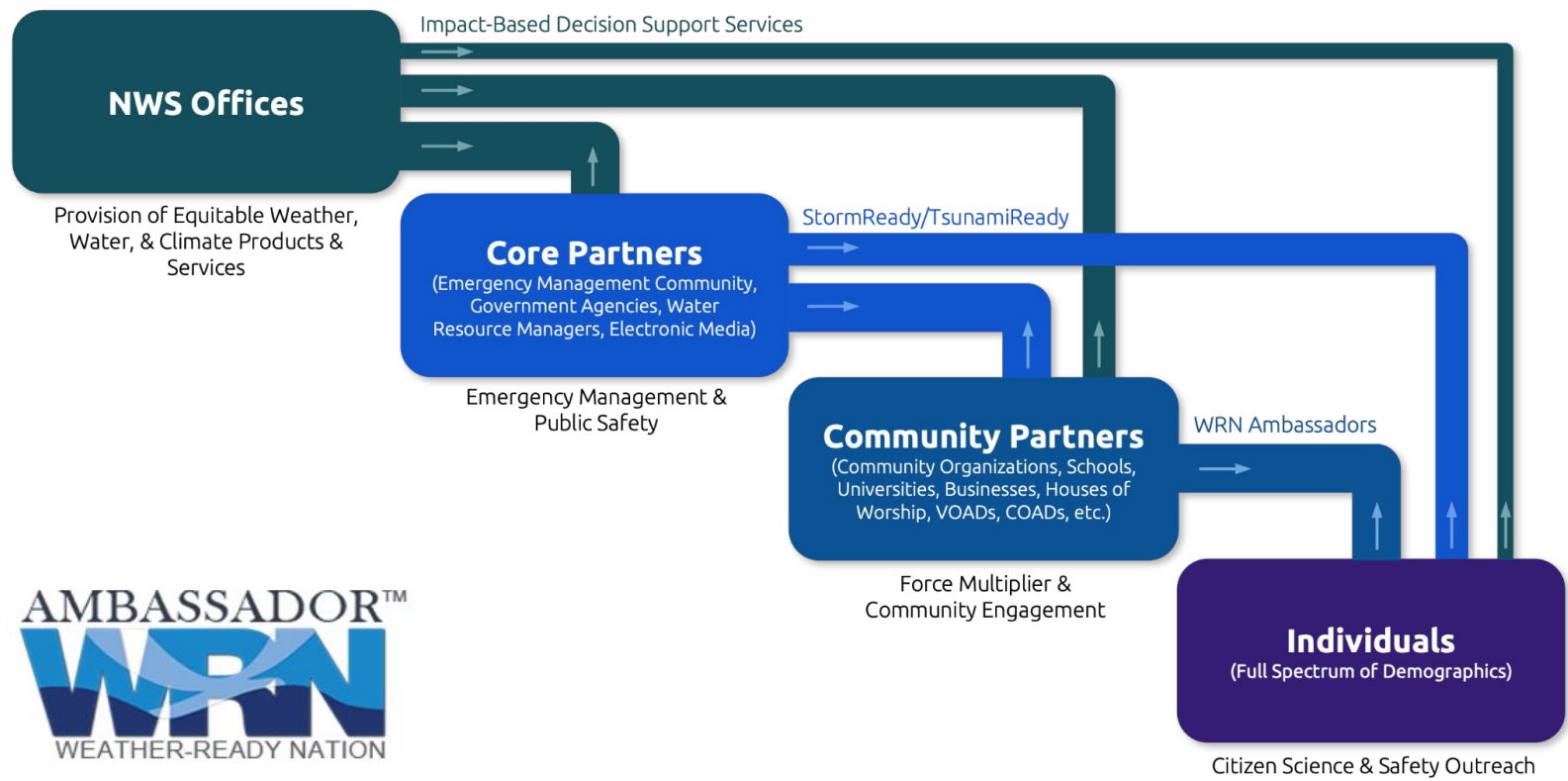
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Whole Community Engagement Model





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NWS Information Strategy Ideas

Build & Evolve our local Weather-Ready Nation (WRN) Ambassador Program

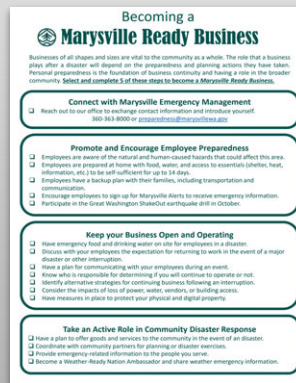
- **Increase our ambassador reach to community partners**
 - Ethnic & Local Media Sources
 - Local Weather Influencers
 - Schools
 - Faith-Based Organizations
 - Non-Governmental Organizations
- **Develop WRN Embassies as a community resource**
- **Engage/"Activate" WRN Ambassadors before significant weather events**
 - NWS Seattle maintains an email list of WRN Ambassadors
 - Provide simple, easy-to-translate calls-to-actions
 - Encourage active sharing of resources within their community



Q14

Marysville Ready Business

Integrating the WRN Ambassador Program into their Marysville Ready Business Initiative

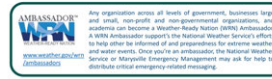


Marysville Ready Business Resources

Marysville Emergency Management can help

- Provide informational material and templates
- Deliver training and presentations to your employees
- Provide information about disaster assistance and other resources
- Connect your business with other City and community resources like Police, Utilities, or Fire.

Contact us to get started
Marysville Emergency Management
(360) 343-8000
emergency@marysvillewa.gov





NATIONAL WEATHER SERVICE

Seattle

Event Reporting





NATIONAL WEATHER SERVICE

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Event Reporting

This module includes:

- Reporting Damages, Injuries, Fatalities
- Damage Surveys
- Public Reporting



NATIONAL WEATHER SERVICE

Seattle

Reporting Damages, Injuries, Fatalities

Why?

Local Storm Reports (LSRs)

Used locally & nationally in verification (including congressional reporting), reviews, and training for future weather events. Local storm reports are used by other NWS centers/offices, NWS partners, the media, the public to maintain situational awareness regarding an ongoing event.

FEMA/Presidential Disaster Declarations

Used as in aiding NWS meteorologists in writing Executive Weather Summaries in support of the FEMA major disaster declaration process for Individual and/or Public Assistance (IA/PA) as well as FHWA disaster assistance.

Enhanced Support

Local NWS meteorologists may follow up on notable reports to see if additional weather support is needed.

Verification & Validation

Used to verify/validate forecasts and guidance, including watches, warnings, and advisories as well as guidance such as Flood Inundation Mapping (FIM).

Used to review & update impact statements & messaging (e.g. flood levels).

Used locally & nationally in verification (including congressional reporting).

NCEI Storm Events Database & Publication

Official NWS publication which documents significant weather events having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce.

This database is often used in creating/updating Hazard Mitigation Plans.



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Reporting Damages, Injuries, Fatalities

How?

Include
nws.seattle@noaa.gov
on situation reports

OR

Call/email NWS Seattle
when details are known

OR

Send details in via the
AAR form for large
events

PREFERRED

Fatality Information

It is important that the NWS receive accurate cause of death and ER visit information from healthcare providers, coroner offices, etc.

 If fatality information has not been released to the public, the NWS will keep the data internal until it is made public information.



NATIONAL WEATHER SERVICE

Seattle

NWS Damage Surveys

NWS Damage Surveys are used primarily as the official means of determining a tornado rating on the Enhanced Fujita (EF) Scale.

Damage surveys can also be conducted for straight-line winds associated with severe thunderstorms and damage/impacts caused by flash flooding.



National Weather Service

Seattle, Washington

Issued: 8:30 PM October 19, 2019

Event: Shelton, Washington Tornado - October 18, 2019

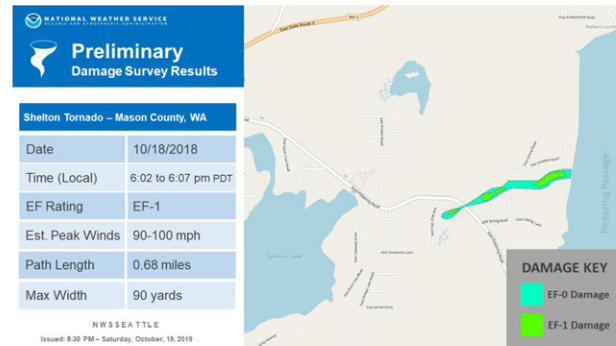
Preliminary Rating: EF-1

Peak Wind: 90-100 MPH

Event Summary

Between approximately 6:02 - 6:07 PM on the evening of October 18, a tornado touched down near Shelton in Mason County, Washington and traveled approximately 0.68 miles before moving over the water of Pickering Passage and dissipating as a waterspout. The first video evidence and reports from area fire officials prompted the NWS to send a damage survey team to the area during the afternoon of October 19, 2019. Preliminary evaluation of the damage by the team concluded that the tornado reached an EF-1 rating on the Enhanced Fujita scale, with estimated maximum winds of 90-100 MPH. The damage path was up to 90 yards in width and the tornado was estimated to be on the ground for approximately 5 minutes.

Fortunately, no injuries were reported with this tornado. Most of the damage was in the form of uprooted or snapped soft wood fir and cedar trees. Falling trees did impact at least two houses along the damage path, including one house that had two trees fall on the roof.





NATIONAL WEATHER SERVICE

Seattle

NWS Damage Surveys

Criteria:

Any credible reports of one or more of the following that could be a result of a tornado, severe thunderstorm, or flash flood:

- Any injuries or fatalities that may be directly attributable to the hazard
- Significant damage to structures or infrastructure
- Video/photographic evidence of the hazard in which it appears significant damage to structures or infrastructure may have occurred





NATIONAL WEATHER SERVICE

Seattle

Partner Damage Surveys

The NWS is also interested in gathering damage information from partner damage surveys associated with any other weather-related hazard.

For heat, examples include:

- Transportation infrastructure
- Utility infrastructure
- Fire damage
- Rapid snow/glacial melt





NATIONAL WEATHER SERVICE

Seattle

Public Reporting

NWS Seattle monitors the following resources for public reports:

- Social Media - [Facebook](#) & [X](#) (NWSSeattle)
- Phone calls/emails from trained spotters & general public
- Traditional Media Outlets
- mPing (rain, hail, wind, water spout, tornado, flood)
- CoCoRaHS (rain, hail)
- Cooperative Weather Observers (COOP)
- Citizen Weather Observing Program (CWOP)
- Online Reporting Form

We will describe many of these platforms in more detail in the Public Outreach section.



SKYWARN
WEATHER.GOV®





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Public Outreach





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Public Outreach

This module includes:

- Citizen Science/Volunteer Opportunities
- Available NWS Resources
- Safety & Awareness Campaigns



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Citizen Science/Volunteer Opportunities

NWS Opportunities

- [mPing](#)
- [SKYWARN Spotter Training](#)
- [NWS Cooperative Observer](#)
- [Online Reporting Form](#)



Other Opportunities

- [CoCoRaHS Observer](#)
- [Citizen Weather Observing Program \(CWOP\)](#)
- Special Partner Programs (e.g. King County Heat Mapping)
- [citizenscience.gov](#)





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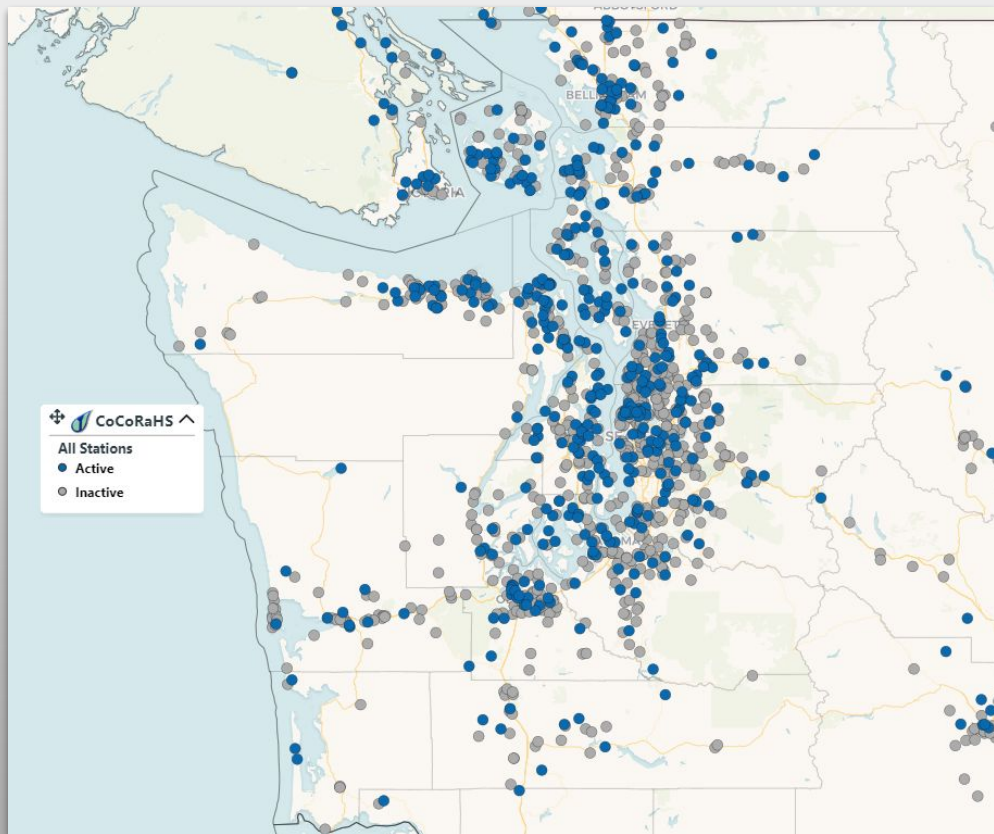
Seattle

CoCoRaHS

Daily reports of:

- Precipitation
- Snowfall
- Snowfall SWE
- Snowpack Depth
- Snowpack SWE ← Rarely reported, but very helpful!
- Significant Weather
- Hail
- Flooding
- Condition Monitoring

[CoCoRaHS Training Playlists](#)



Q16



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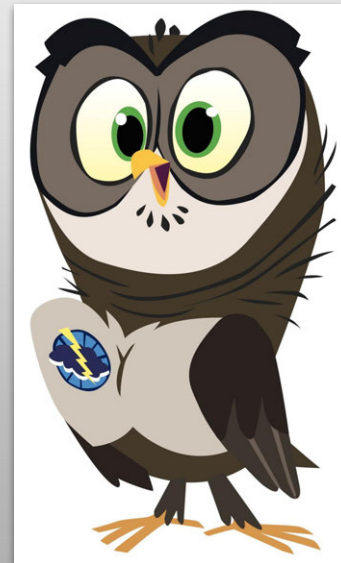
Safety & Education Resources

weather.gov/safety

- Safety information & resources

weather.gov/education

- JetStream Online School for Weather
- Student Opportunities & Careers
- Educator Resources
- Outreach Activities & Materials
- Weather Safety & Other Resources
- NWS National School Outreach: Virtual School Talks
- Some materials for vulnerable populations including
 - LEP (primarily Spanish translation)
 - Weather safety for deaf & hard of hearing
 - Weather safety for individuals with intellectual disabilities





NATIONAL WEATHER SERVICE

Seattle

Safety & Awareness Campaigns

Washington State ([NWS Calendar](#))



Winter: December - February

- Snow, Ice, Flooding, Wind, & Cold



Spring: April-May

- Severe Weather & Flooding



Summer: June - September

- Heat, Air Quality, Severe Weather, Wildfire, & Dust



Fall: October - November

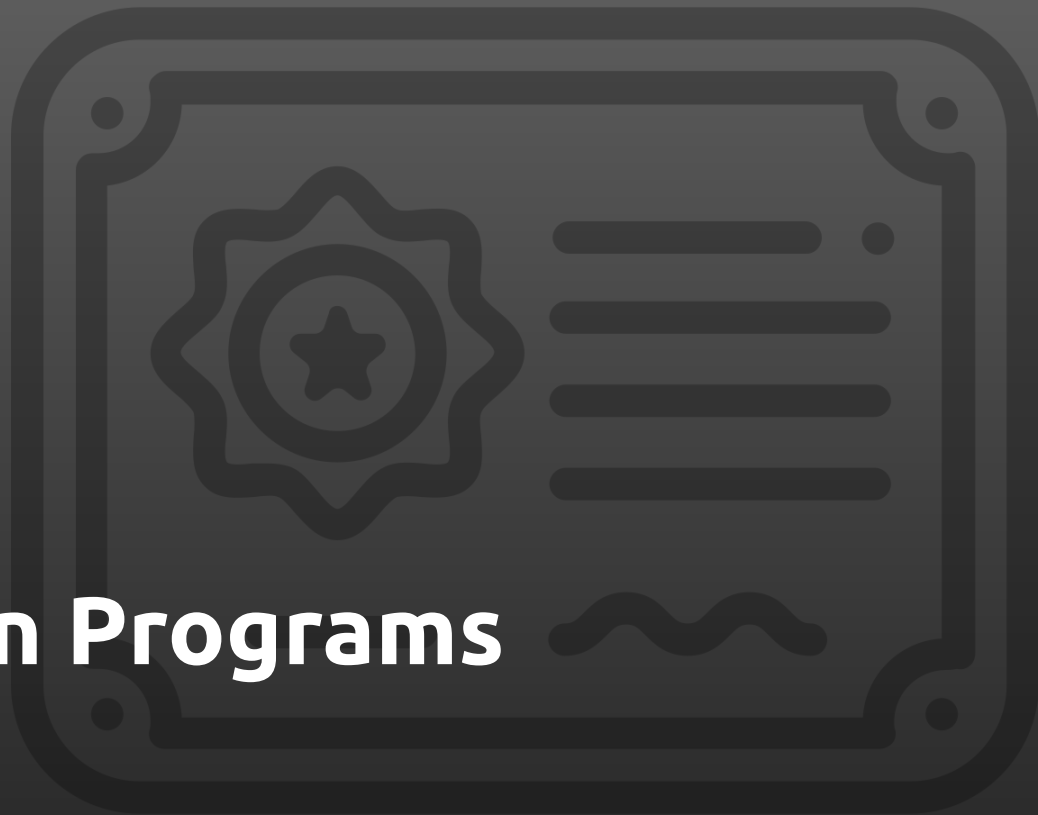
- Snow, Flooding, & Wind
- Great Washington ShakeOut



NATIONAL WEATHER SERVICE

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Recognition Programs





NATIONAL WEATHER SERVICE

Seattle

Recognition Programs

This module includes:

- StormReady
- TsunamiReady
- StormReady/Tsunami Ready Supporter
- Weather-Ready Nation Ambassador



NATIONAL WEATHER SERVICE

Seattle

Recognition Programs



StormReady Community (4-Years)

The StormReady program helps arm America's communities with the communication and safety skills needed to save lives and property--before, during and after the event. StormReady helps community leaders and emergency managers strengthen local safety programs.

StormReady Benefits

- Organized approach to hazardous weather planning and preparedness
- Access to technical support from the NWS.
- Develop close relationships with NWS staff
- StormReady sign & certificate
- StormReady recognition ceremony (optional)
- Use of the StormReady logo
- Eligibility for credit points from FEMA's Community Rating System, which provides discounts on flood insurance in participating communities



NATIONAL WEATHER SERVICE

Seattle

Recognition Programs



TsunamiReady Community (4-Years)

The TsunamiReady program promotes tsunami hazard preparedness as an active collaboration among federal, state/territorial and local emergency management agencies, community leaders and the public.

The main goal of the program is to improve public safety before, during and after tsunami emergencies.

TsunamiReady Benefits

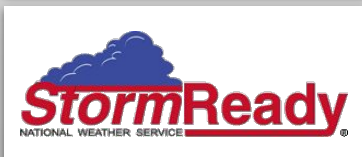
- Access to technical support from the NWS, WA EMD, and NTHMP partners
- Eligibility for credit points from FEMA's Community Rating System, which provides discounts on flood insurance in participating communities
- Justification for costs associated with tsunami preparedness
- Improved positioning to receive state/territorial and federal financial support
- Improved preparedness for other hazards
- Organized approach to hazardous weather planning and preparedness
- TsunamiReady sign & certificate. Optional recognition ceremony
- Use of the TsunamiReady logo



NATIONAL WEATHER SERVICE

Seattle

Recognition Programs



TsunamiReady and/or StormReady Supporter (5-Years)

A Supporter is an organization, business, facility or local government entity actively engaged in weather and/or tsunami safety and preparedness that is unable to meet all the requirements of the full StormReady or TsunamiReady program.



NATIONAL WEATHER SERVICE

Seattle

Recognition Programs



Weather-Ready Nation Ambassador

Formally recognize organizations (any group, business, agency, etc.) who are improving the nation's readiness, responsiveness, and overall resilience against extreme weather, water, and climate events.

WRN Ambassador Benefits

- Added to email distribution for news and long-range outlooks from the NWS (separate from email briefing distribution)
- NWS outreach content about creating a Weather-Ready Nation
- Explore innovative approaches for collaboration with the NWS
- NWS Recognition as a WRN Ambassador
- Use of the WRN Ambassador logo



NATIONAL WEATHER SERVICE

Seattle

Hazardous Weather & Tsunami Recognition Program Requirements

	TsunamiReady	StormReady	TsunamiReady Supporter	StormReady Supporter	WRN Ambassador
Conduct training/preparedness activities	○	○	○	○	○
Partnership with Local NWS Office	○	○	○	○	○
Forecast & Warning reception & dissemination infrastructure	○	○	○	○	
Updated Emergency Operations Plan that includes weather/tsunami hazards	○	○	○	○	
Promote public readiness	○	○			○
24-Hour Warning Point & EOC	○	○			
Request weather support for events/incidents		○			
Relay weather information within jurisdiction		○			
Shelter location				○	
Tsunami Evacuation Procedures			○		
Make tsunami evacuation maps available	○		○		
Designate, map, & sign tsunami hazard zones	○				
Evacuation drills for schools in tsunami evacuation zone	○				

Q17



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Seattle

End of Day 1



NATIONAL WEATHER SERVICE

Seattle

Thank You

On-Duty Meteorologists - 24/7 Support

NWSChat 2.0: @nwsseattle / #wfo-seattle-wa
Phone: 206-526-6857
Email: nws.seattle@noaa.gov

Non-Urgent Coordination

Reid Wolcott
Warning Coordination Meteorologist

NWSChat 2.0: @NWS - Seattle - Reid Wolcott
Phone: O: 206-526-6095 x223
C: 206-795-1519
Email: reid.wolcott@noaa.gov

Hydrologic Coordination

Brent Bower
Senior Service Hydrologist

NWSChat 2.0: @NWS - Seattle - Brent Bower
Phone: O: 206-526-6095 x228
C: 206-390-4309
Email: brent.bower@noaa.gov