

NATURAL DISASTERS AND CRITICAL FACILITIES: A GIS FRAMEWORK FOR RAPID EMERGENCY RESPONSE IN PUYALLUP, WASHINGTON



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OUTLINE

- Introduction to the City of Puyallup
- Hazards of concern for Puyallup
- Emergency Management in Puyallup and introduction to the project
- City's desired workflow in response to an emergency
- Methods and proposed work
- Summary of deliverables and measure of project success

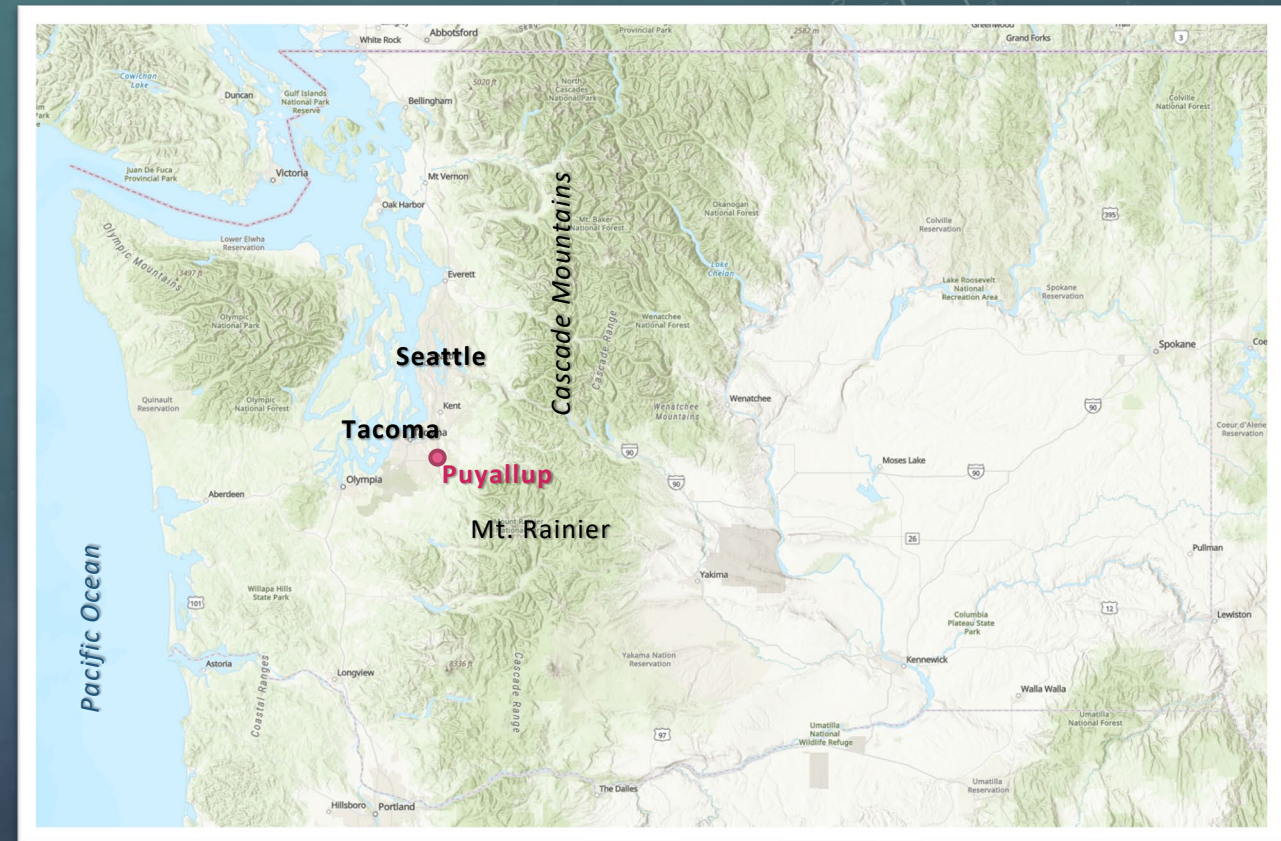


Mount Rainier as seen from Puyallup, Washington

Image courtesy of USGS <https://www.usgs.gov/media/images/mount-rainier-seen-puyallup-washington>

CITY OF PUYALLUP, WASHINGTON

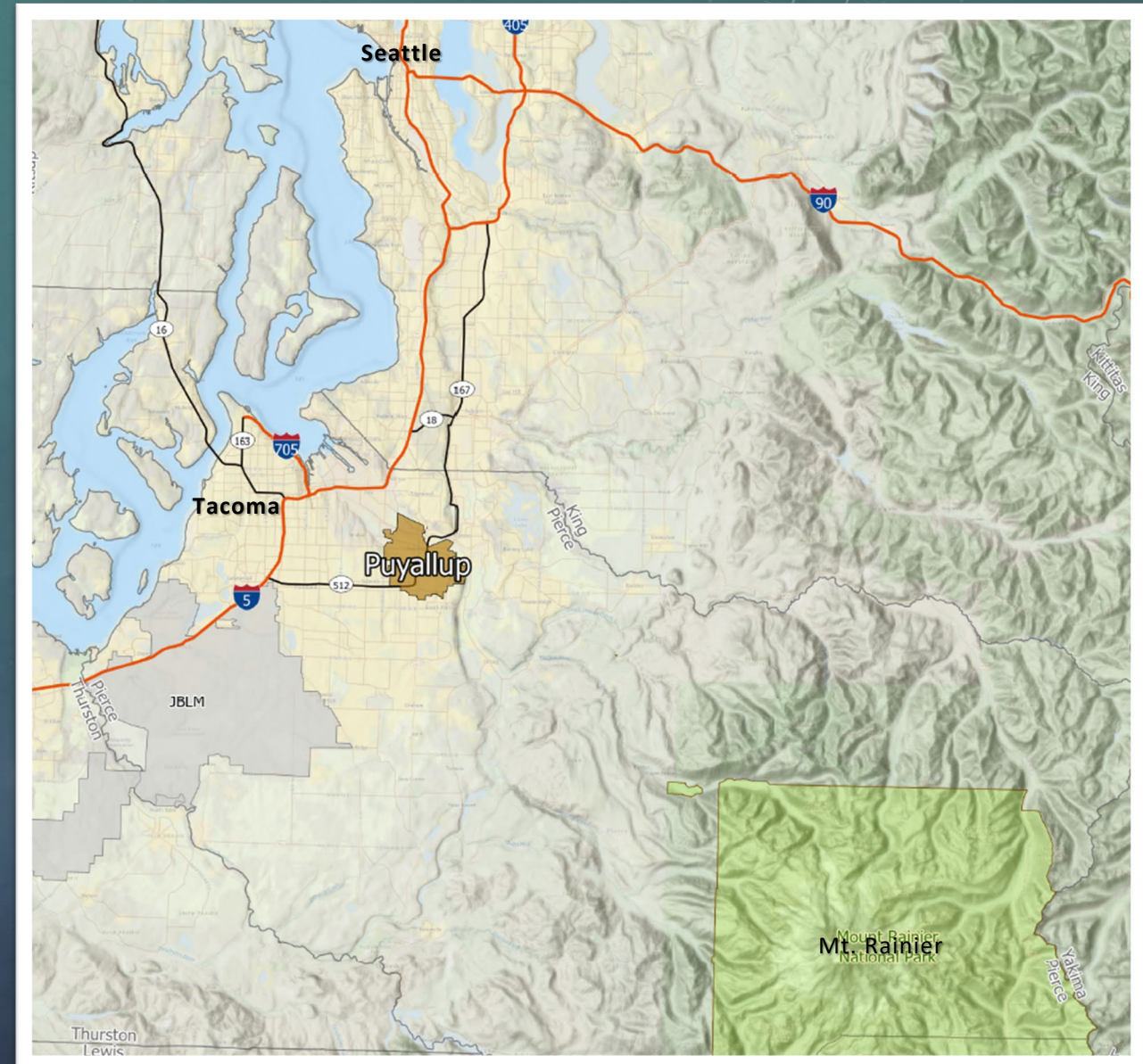
- Small-medium city in the Puget Lowlands
- Located between Tacoma and Mt. Rainier, south of Seattle
- Demographics
 - 43,000 people
 - Median age 34
 - Median home price - \$375,000k
 - Median household income - \$73k
- Socioeconomic info
 - Washington State Fair, April and September, over 1 million visitors
 - Other major employers: Puyallup school district, local hospital, chain grocery distribution center, Comcast, Costco



Regional geography for the City of Puyallup
Map courtesy of The City of Puyallup

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PUYALLUP GEOGRAPHY AND GEOLOGY

- Mount Rainier
 - 30 miles southeast of Puyallup
 - Semi-active stratovolcano – the explosive kind
 - Most recent volcanic activity
 - 2,000 ya– Summerland eruptive period
 - 1,500 ya – Twin Creek eruptive episode
 - 1,000 ya – Fryingpan Creek eruptive period
 - 500 ya – Electron mudflow/lahar
 - 25 glaciers cover 35 mi² of Mt Rainier’s flanks and supply water to 5 major rivers

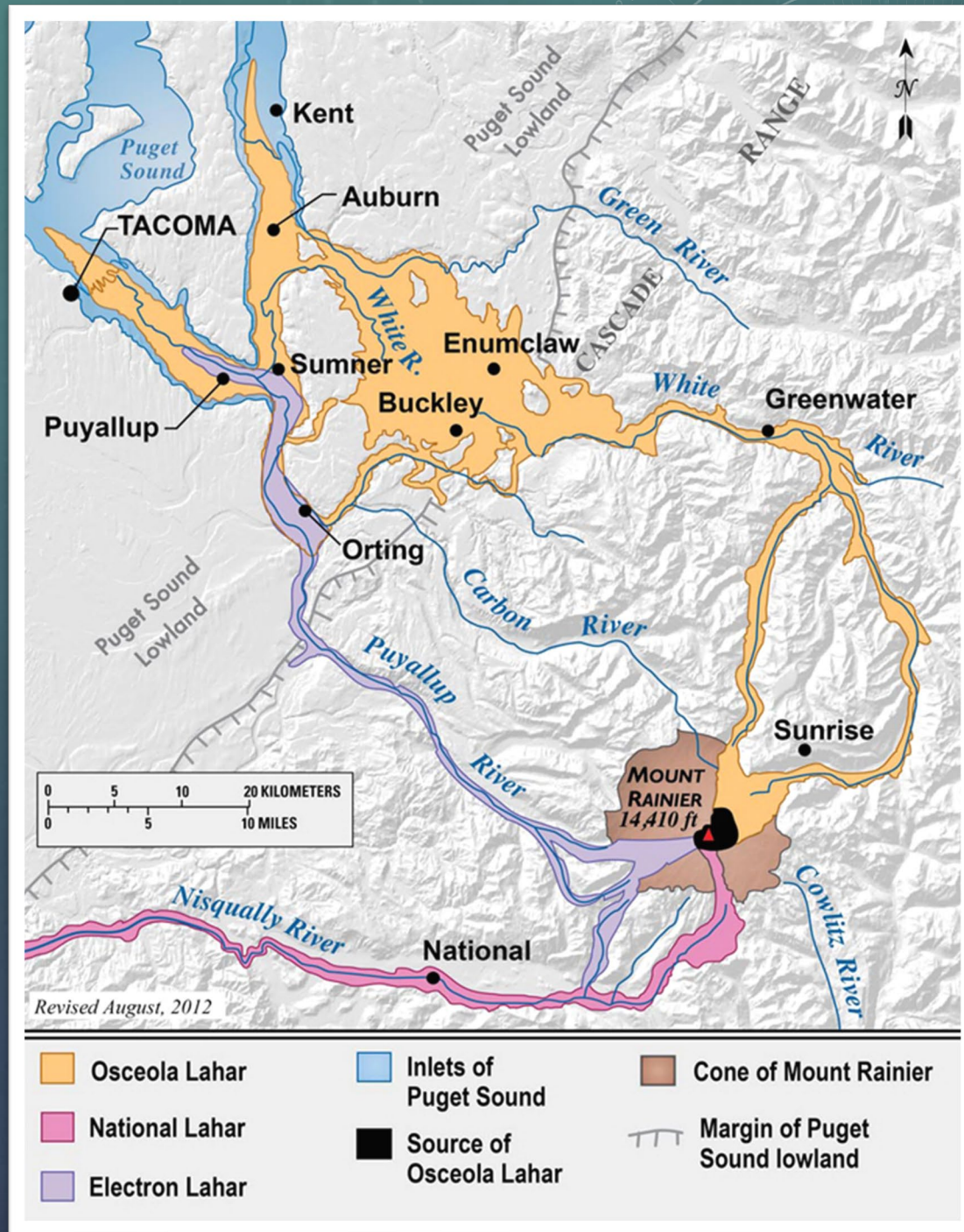


A distant view of Mount Rainier volcano over Puyallup Valley, near Orting, Washington.
<https://www.usgs.gov/media/images/mount-rainier-national-park>

PUYALLUP GEOGRAPHY AND GEOLOGY

- Mount Rainier hazards
 - Lava is highly unlikely to reach Puyallup
 - Not close enough for volcanic bombs
 - Wind is likely to blow ash east, across the Cascades and away from the city
- Primary concern – Lahars
 - Massive debris flows of volcanic mud from melting snow and glaciers – flowing cement
 - Leave deposits of mud and debris tens of meters thick

Lahar pathways from events heading on Mount Rainier – map showing three major events from last 10,000 years.
<https://www.usgs.gov/media/images/lahar-pathways-events-heading-mount-rainier-map-showing-t>



PUYALLUP GEOGRAPHY AND GEOLOGY

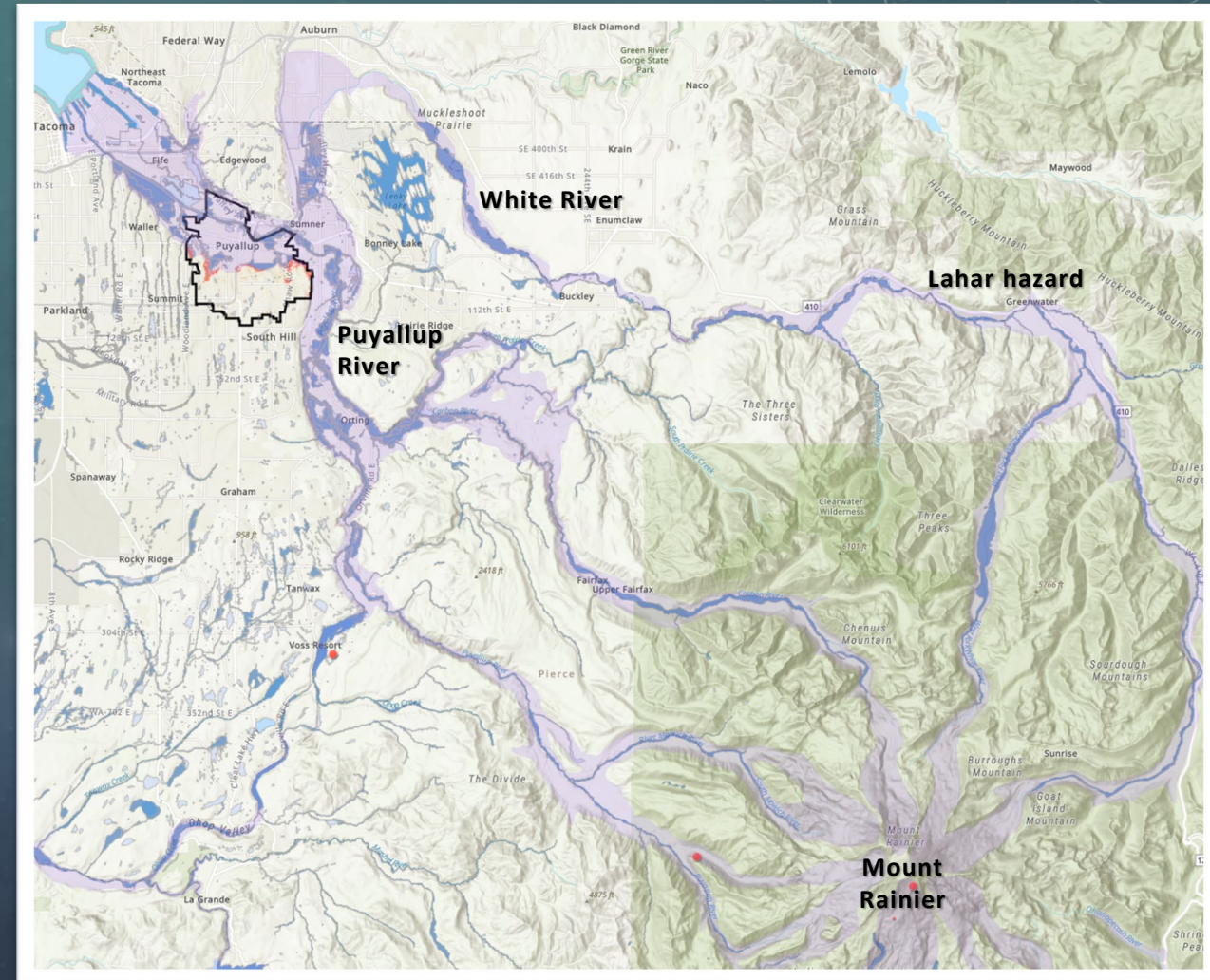
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The aftermath of a lahar from the 1982 eruption of Galunggung, Indonesia
Robin Holcomb, U.S. Geological Survey

PUYALLUP GEOGRAPHY AND GEOLOGY

- At the confluence of the White and Puyallup Rivers, both originating from Mt. Rainier glaciers
- North half of city in river valley, built on historic volcanic lahar deposits and prone to flooding
- South half of city on bluffs of glacial deposits prone to landslides
- Bisected by State Route 512

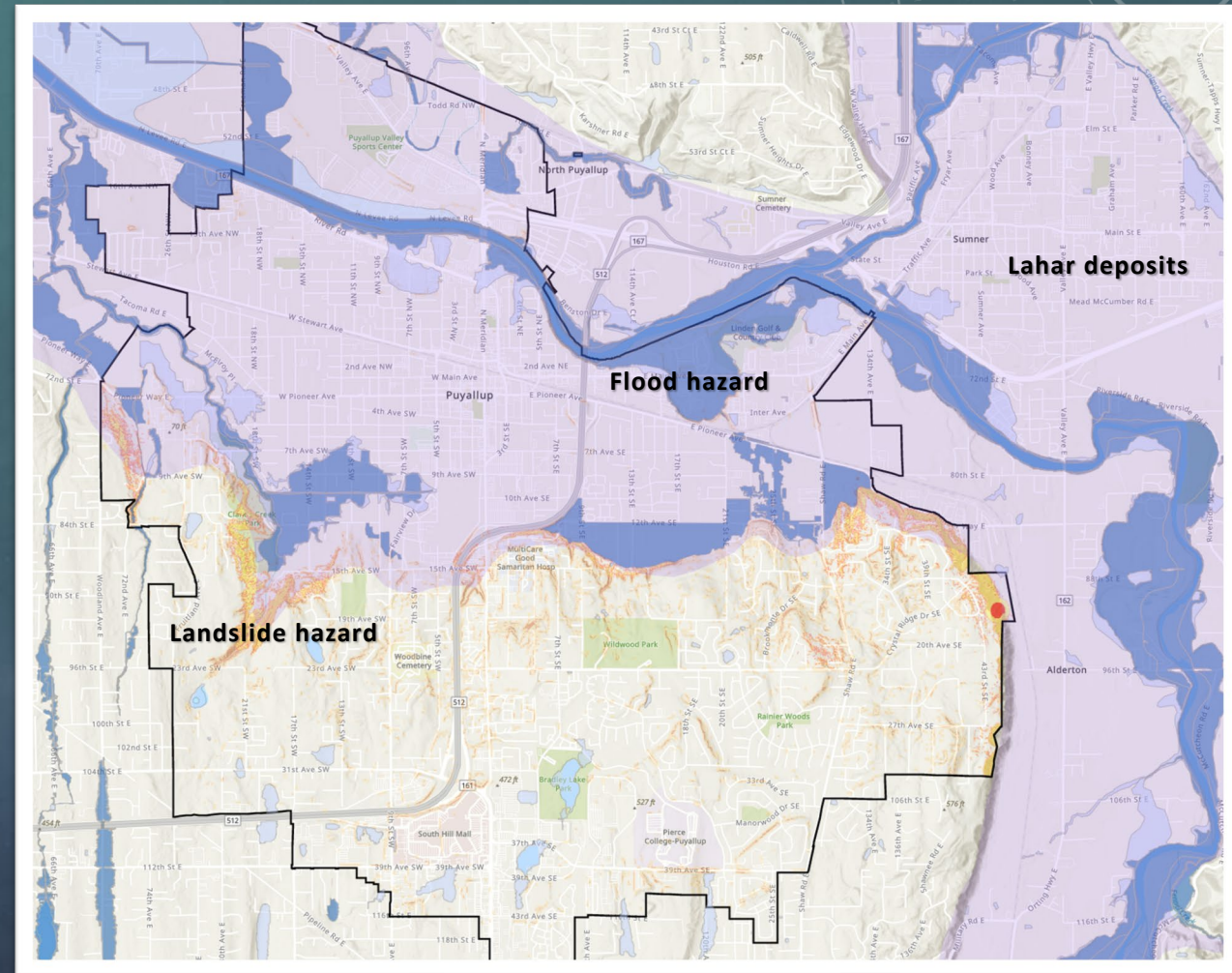


Map courtesy of the City of Puyallup Hazard App

<https://puyallup.maps.arcgis.com/apps/webappviewer/index.html?id=b7669b258f704838aa29c9607477bc08>

PUYALLUP GEOGRAPHY AND GEOLOGY

- At the confluence of the White and Puyallup Rivers, both originating from Mt. Rainier glaciers
- North half of city in river valley, built on historic volcanic lahar deposits (purple) and prone to flooding (blue)
- South half of city on bluffs of glacial deposits prone to landslides (orange)
- Bisected by State Route 512

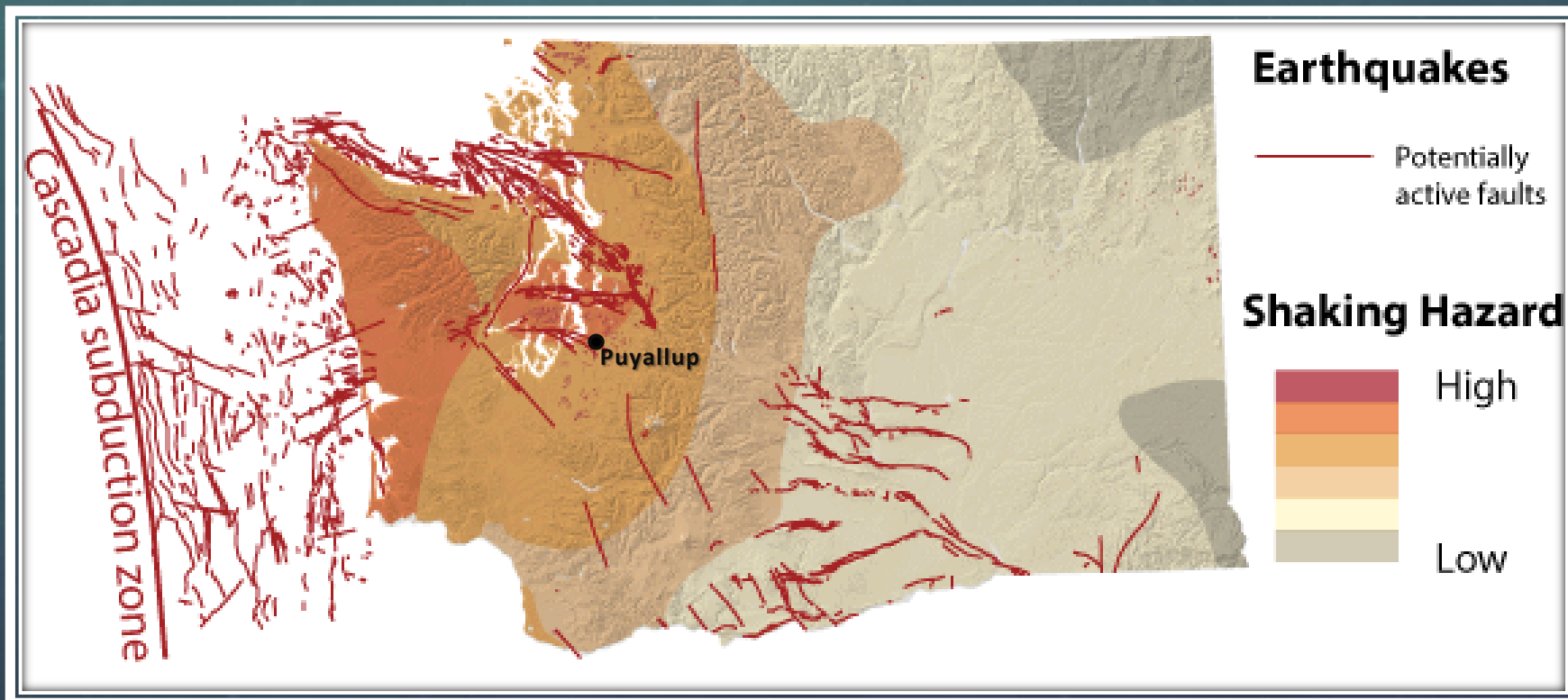


Map courtesy of the City of Puyallup Hazard App

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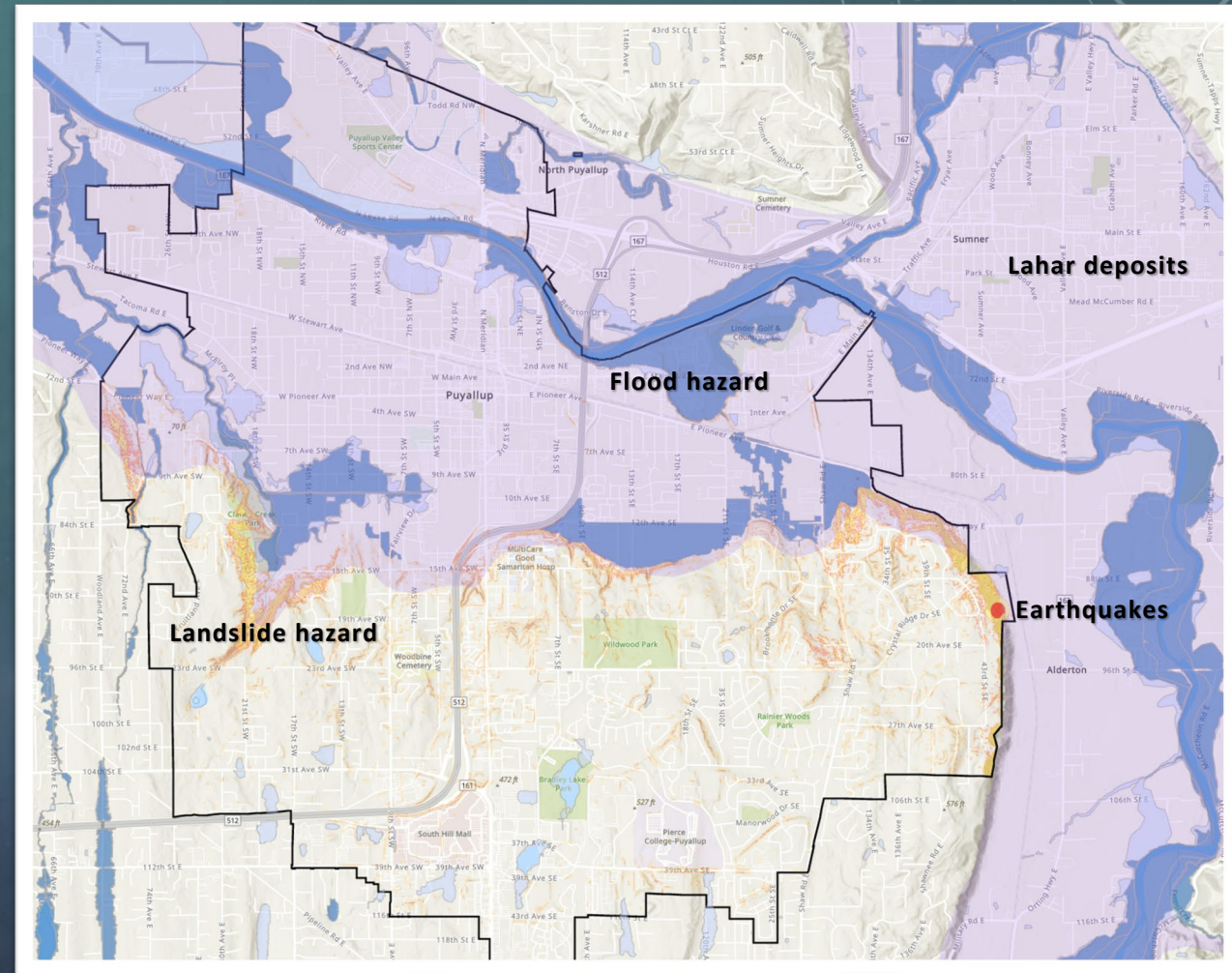
PUYALLUP GEOGRAPHY AND GEOLOGY

- Pacific Coast is seismically active
- Earthquakes – less frequent than California but potentially larger magnitude



REVIEW: HAZARDS OF CONCERN IN PUYALLUP

- Volcanic Lahar from Mount Rainier
- Severe weather and flooding
- Landslides
- Earthquakes
 - Major – Cascadia Subduction Zone
 - Minor – local faults
- Fire and wildfire
- Hazardous material containment breach
- Human health



EMERGENCY MANAGEMENT IN PUYALLUP

- At risk for devastating hazards with little to no warning
- Building on existing emergency management framework
- Factors coming together to breathe new life into planning efforts
 - New staff
 - Puyallup EOC manager
 - Puyallup GIS coordinator
 - New enterprise GIS capabilities
 - Puyallup leading new East Pierce county Interlocal Coalition (EPIC) Emergency Operations Center, 7 cities and towns with similar hazards (<https://www.epiceoc.com/>)



CRITICAL FACILITIES PROJECT

- When a disaster hits – what do we need to know about first?
 - “Critical facilities include schools, nursing homes, hospitals, police, fire and emergency response installations, and installations which produce, use, or store hazardous materials or hazardous waste.” (Puyallup Municipal Code)
 - Shelter and staging locations
- How do we get facility status from the field to Emergency Operations Center?



Image from cold storage fire incident in Puyallup, WA, August 2021
<https://twitter.com/PuyallupPD/status/1429075276663717892/photo/1>

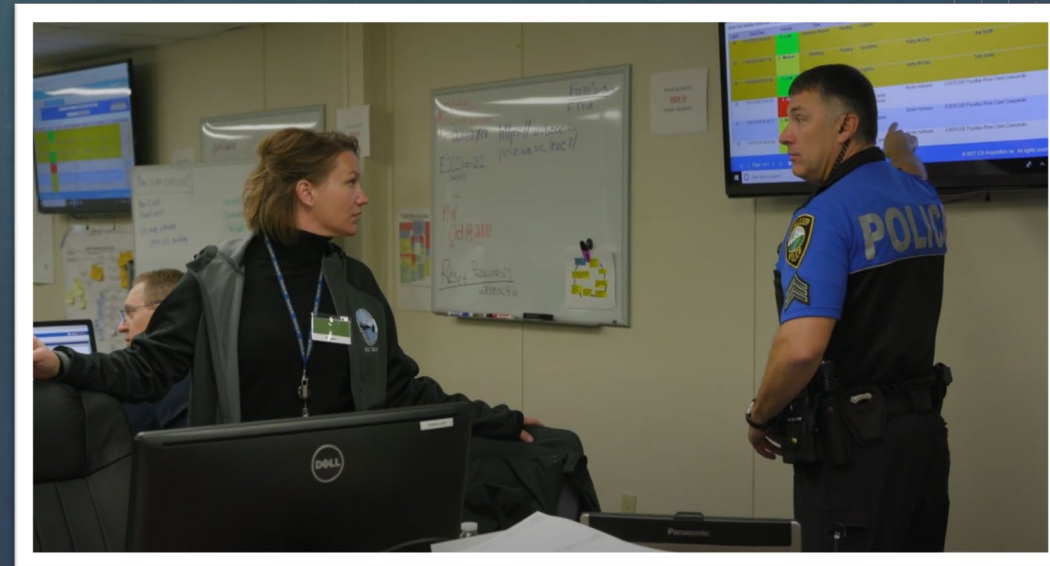
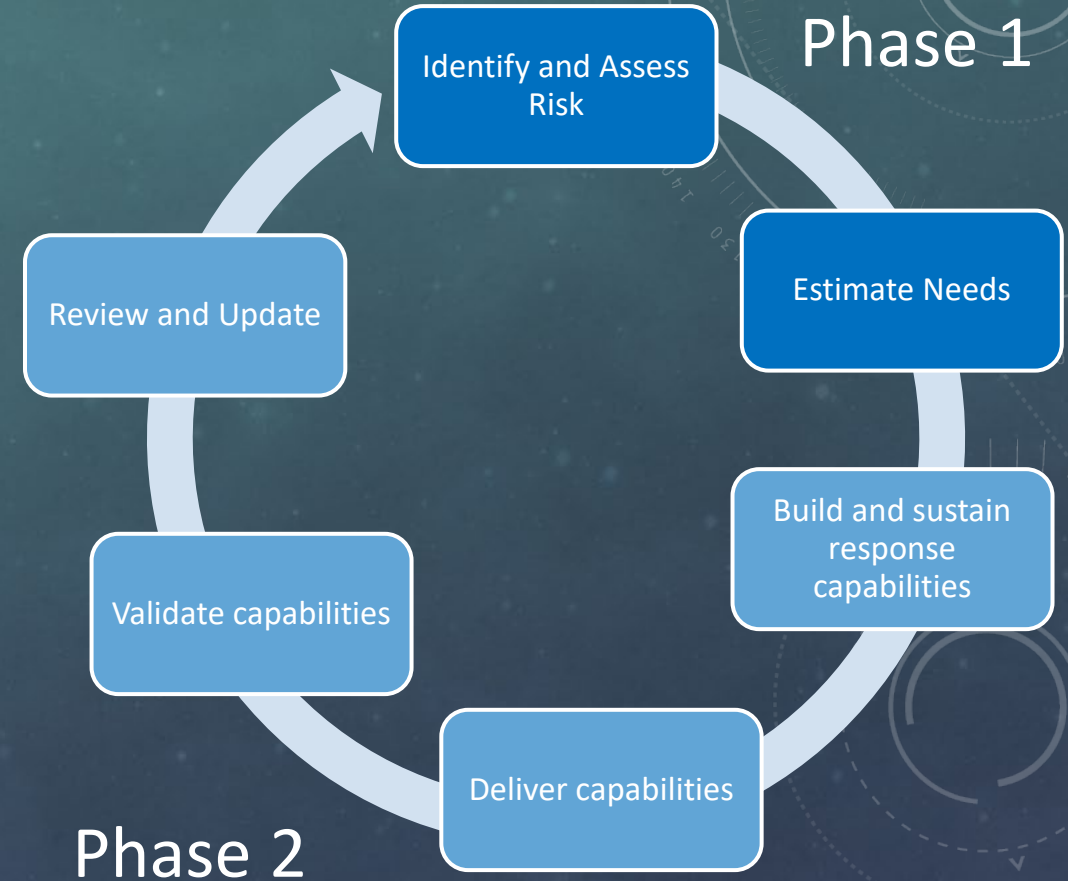


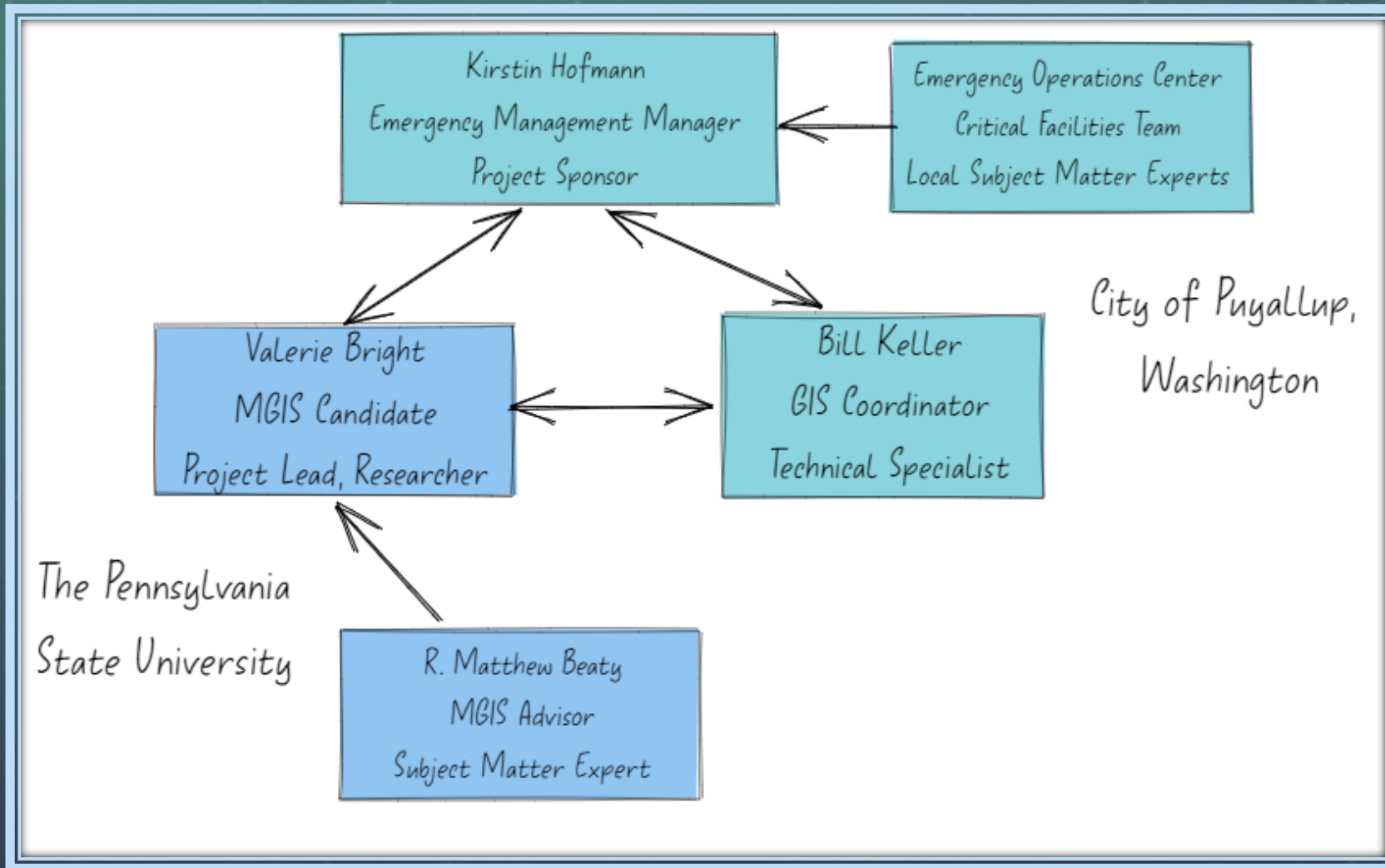
Image from “City of Puyallup Shelter Exercise,” December 5, 2018
https://www.youtube.com/watch?v=mu_JQ7Z24Yg

CRITICAL FACILITIES PROJECT

- Existing project – Started in 2018, shelved for other priorities
 - Critical facilities within City identified
 - Draft shapefile of CF parcels
 - PDF map created
 - Critical facilities categorized into priority response tiers
- Current project goals
 - Integrate critical facilities monitoring into new emergency response GIS framework
 - Create a way to get facility status from field to emergency operations center in the event of a disaster
 - Field test with full scale lahar evacuation exercise



CRITICAL FACILITIES PROJECT TEAM



BENEFITS OF GIS FOR EMERGENCY RESPONSE

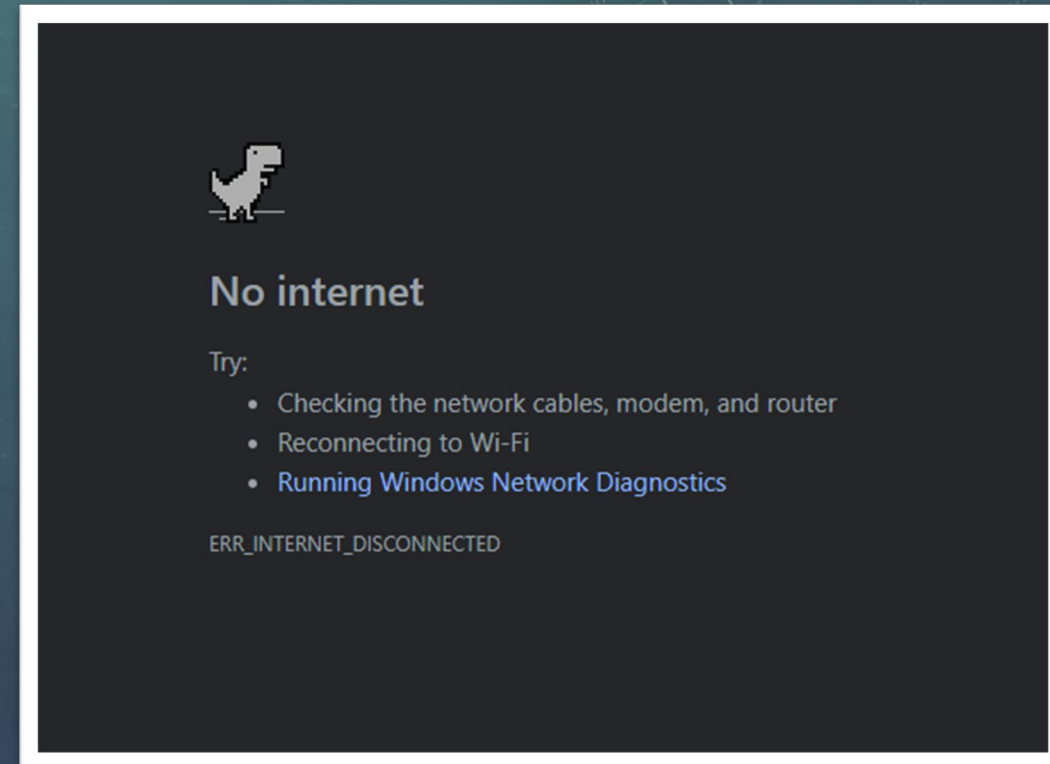
- Easily see all available information in one place and in standardized format
- Query on the fly for flexible response
- Reduces number of phone calls and contacts, improves response time
 - Don't need to call Public Works to find out if there's a drinking water well in the chemical fire hazard zone
 - Existing GIS incorporates Authoritative data from City, county, and state
- Quickly disseminate information for internal and public consumption
- Future additions could include live data feeds and cloud-hosted GIS

Snapshot of Puyallup public emergency management dashboard, with road closures

www.cityofpuyallup.org/eocdashboard

RISKS OF GIS FOR EMERGENCY RESPONSE

- GIS requires power for servers and devices (computers, tablets, phones) and internet connection -
 - ArcGIS Online - hosted on Amazon Web Services servers with multiple redundancies, off-location
 - Build in ability for offline data collection with in-office sync
 - FirstNet - Emergency Services cell network, restricted use, provides mobile data and hot spots, built to be reliable when other cell networks aren't
 - "FirstNet network will be a single, nationwide, interoperable LTE network dedicated to public safety communications." <https://www.firstnet.com/power-of-firstnet/why-firstnet/reliable-network.html>



"No internet" error message from Chrome web browser

DESIRED CRITICAL FACILITIES WORKFLOW



DISASTER OCCURS

- Emergency operations center activated by EOC Coordinator
- Immediate maps and messaging by EOC GIS team
 - EOC Rapid Response app
 - Public Dashboard
 - Twitter
- Status: **Currently functional**

Public Response Dashboard

PIERCE COUNTY ALERT!
Register today...
• www.piercecountywa.gov/ALERT
• text PICALERT to 888-777
• call 253-790-6595

Public Safety Officials can send emergency messages to traditional landlines and cell phones that are registered with Pierce County Emergency Management.

Tweets by @CityofPuyallup

City of Puyallup
@CityofPuyallup

Thank you to all of the residents who joined us for the Shaw Road Open House last evening. We appreciate your feedback! For those who missed the Open House, you can watch the video on our Facebook page or on our project page here: bit.ly/3xPU3es

Dec 10, 2021

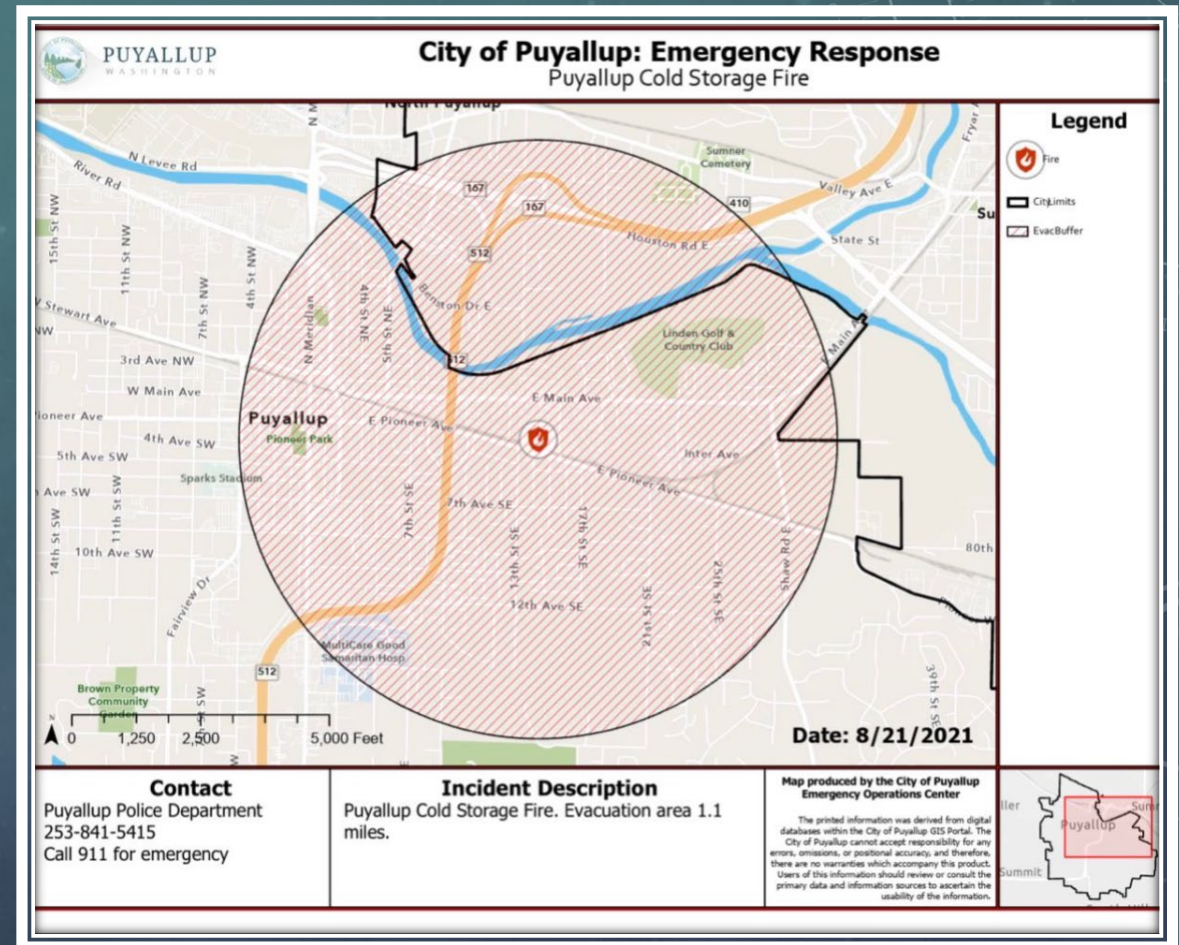
N Meridian will be closed for night work starting December 13 through 17, 2021. From 5 pm to 5 am BNSF will be repairing sections of the rail crossing.
Last updated: 12/10/2021

Map showing road closures in Puyallup, WA. Closures are indicated by orange and blue lines on the map. Key locations include Sparks Stadium, Sounder Station, and various streets like 1st Ave SW, 2nd Ave SW, 3rd Ave SW, 4th Ave SW, 5th Ave SW, 6th Ave SW, 7th Ave SW, 8th Ave SW, 9th Ave SW, 10th Ave SW, 11th St SW, 12th St SW, 13th St SW, 14th St SW, 15th St SW, 16th St SW, 17th St SW, 18th St SW, 19th St SW, 20th St SW, 21st St SW, 22nd St SW, 23rd St SW, 24th St SW, 25th St SW, 26th St SW, 27th St SW, 28th St SW, 29th St SW, 30th St SW, 31st St SW, 32nd St SW, 33rd St SW, 34th St SW, 35th St SW, 36th St SW, 37th St SW, 38th St SW, 39th St SW, 40th St SW, 41st St SW, 42nd St SW, 43rd St SW, 44th St SW, 45th St SW, 46th St SW, 47th St SW, 48th St SW, 49th St SW, 50th St SW, 51st St SW, 52nd St SW, 53rd St SW, 54th St SW, 55th St SW, 56th St SW, 57th St SW, 58th St SW, 59th St SW, 60th St SW, 61st St SW, 62nd St SW, 63rd St SW, 64th St SW, 65th St SW, 66th St SW, 67th St SW, 68th St SW, 69th St SW, 70th St SW, 71st St SW, 72nd St SW, 73rd St SW, 74th St SW, 75th St SW, 76th St SW, 77th St SW, 78th St SW, 79th St SW, 80th St SW, 81st St SW, 82nd St SW, 83rd St SW, 84th St SW, 85th St SW, 86th St SW, 87th St SW, 88th St SW, 89th St SW, 90th St SW, 91st St SW, 92nd St SW, 93rd St SW, 94th St SW, 95th St SW, 96th St SW, 97th St SW, 98th St SW, 99th St SW, 100th St SW.

Snapshot of Puyallup public emergency management dashboard, with road closures
www.cityofpuyallup.org/eocdashboard

DETERMINE AREAS OF LIKELY DAMAGE

- EOC GIS team identifies area of concern within the City
 - EOC internal dashboard
 - Hazard map
 - Initial reports
- Output: Area of concern polygon
- Status: **Currently functional**



Print template output from City of Puyallup EOC internal dashboard

IDENTIFY CRITICAL INFRASTRUCTURE WITHIN LIKELY DAMAGED AREAS

- Select critical facilities of concern (EOC GIS)
 - Spatial query for infrastructure within hazard area
- Status: **Needs work**
 - Critical infrastructure shapefile needs cleaning
 - Some facilities (6 total) are in multiple response tiers – overlapping polygons significantly complicate the GIS
 - Currently duplicates other city data (parcels)
 - Upload Critical Infrastructure to ArcGIS Online, not reliant on City servers and intranet
 - Build in spatial query functionality into existing EOC internal app

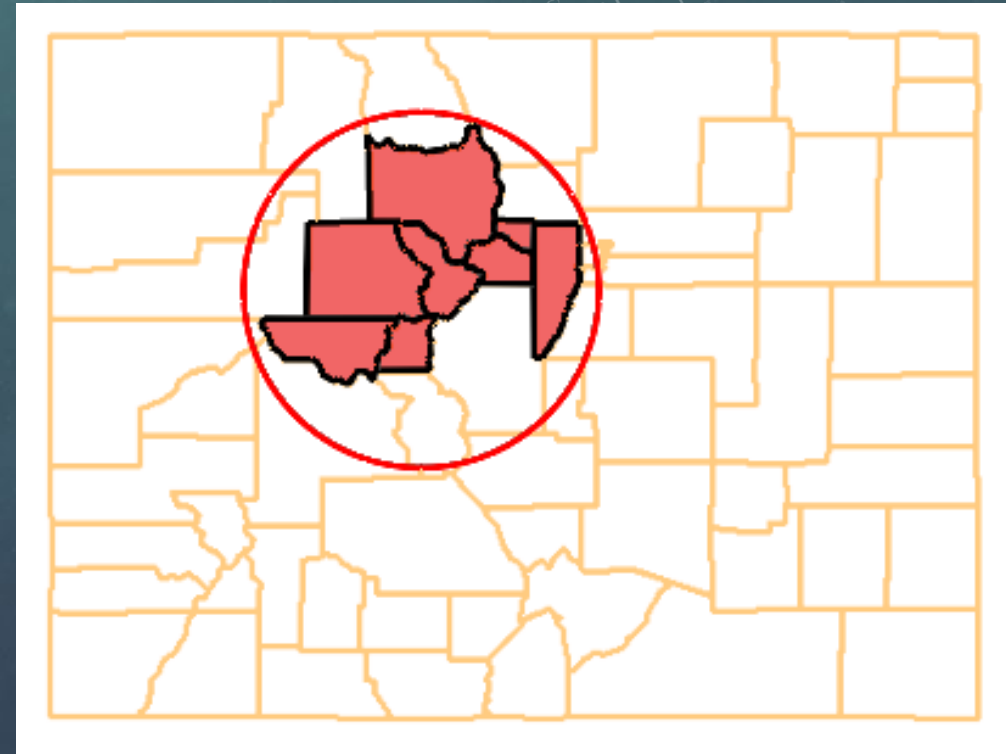


Image credit: esri, "Spatial Query"
https://webhelp.esri.com/arcgisexplorer/2500/en/spatial_query.htm

TRIAGE AFFECTED FACILITIES FOR INSPECTION

- Create list of facilities for inspection, with order of priority (EOC Coordinator + EOC GIS)
 - Use list/map of affected facilities from previous step to determine if inspection is needed, and triage order of inspection
 - Update “Current Status” of critical facilities as information is available on EOC dashboard:
 - No inspection needed
 - Inspection needed
 - Inspection pending
 - Inspected – safe
 - Inspected – restricted
 - Inspected – unsafe
- Status: **Needs work**
 - Add “Current status” to critical facilities layer with domains to restrict input

DISPATCH CREW TO COLLECT DATA ABOUT CRITICAL FACILITY STATUS

- Dispatch crew (EOC) to affected parts of city
- EOC field staff conducts critical facility inspections (EOC field staff)
 - Incorporate official WAsafe building inspections and unofficial field status
- Status: **Needs work**
 - Identify data to be collected
 - Use WAsafe (WAshington Safety Assessment of Facilities Evaluators) Rapid Evaluation safety Assessment Form as basis for Survey123 survey
 - Build database structure for data collection
 - Build mobile survey for data collection
 - Build mobile map for data collection
 - Note: mobile map and survey will also be usable on web or in office
- Update EOC internal dashboard to include critical facilities map

Rapid Evaluation Safety Assessment Form

Inspection
 Inspector ID: _____ Inspection Date and Time _____
 Affiliation: _____ Areas Inspected: Exterior Interior

Building Description

Building name: _____ Type of Construction
 Address: _____ Wood Frame Concrete Shear Wall
 _____ Steel Frame Unreinforced Masonry
 Contact Phone: _____ Tilt-up Concrete Reinforced Masonry
 _____ Conc. Frame Other _____

No. Stories above ground: _____ below: _____
 Approx. "footprint area" (s.f.): _____ Primary Occupancy
 No. Residential units: _____ Dwelling Commercial Government
 No. Res. units not habitable _____ Other Res. Office Historic
 _____ Assembly Industrial School
 _____ Emerg. Services Other _____

Evaluation Est. Building Damage (excluding contents)
 Investigate the building for the conditions below and check the appropriate column

Observed Conditions:	Minor/none	Moderate	Severe	None
Collapse, Partial collapse, off foundation	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 0-1%
Building or story leaning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 1-10%
Racking to walls, other structural damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 11-30%
Chimney, parapet, other falling hazard	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 31-60%
Ground slope movement or cracking	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 61-99%
Other (specify) _____	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/> 100%

Comments: _____

Posting
 Choose a posting based on the evaluation and team judgment. Severe conditions endangering the overall building are grounds for an Unsafe posting. Localized severe and overall moderate conditions may allow a Restricted posting. Post INSPECTED placard at main entrance. Post RESTRICTED USE and UNSAFE placards at all entrances

Inspected (Green placard) **Restricted Use** (Yellow placard) **Unsafe** (Red placard)

Record any use/entry restrictions exactly as written on placard: _____

Further Actions Check the boxes below only if further actions are needed.

Barricades needed in the following areas _____

Detailed Evaluation Recommended: Structural Geotechnical Other: _____

Other recommendations: _____

Comments: _____

RETURN DATA TO EOC FOR RESPONSE PLANNING

- Upload data automatically with cell or internet connection using ArcGIS Online
- Collect data offline and sync manually when in office
- Collect field observations from messages and phone calls and update database from EOC office
- Status: **Needs work**
 - Ensure data integrates with City EOC database
 - Note: Data may also need to be compatible with higher level EOC operations (state or federal gov, FEMA, etc)
 - Create flexible system that can take multiple inputs

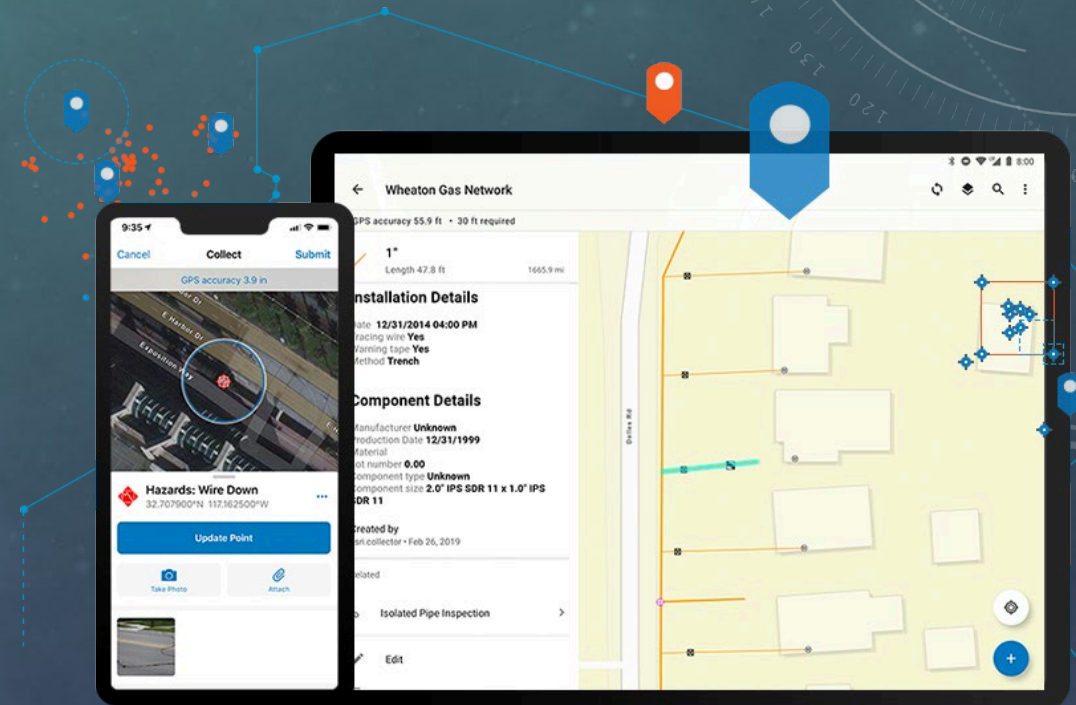


Illustration of mobile data collection, Esri
<https://www.esri.com/en-us/arcgis/products/arcgis-collector/overview>

SUMMARY OF DELIVERABLES

- Feature Layer of critical facilities hosted on enterprise GIS
- Database structure to store critical facility data and status,
 - Ideally with ability to store update history
- Interactive map with critical facility parcels showing facility tier and current status (safe, restricted use, unsafe, unknown)
- Mobile survey to collect facility data
 - Official digital version of Rapid Evaluation Safety Assessment form
 - Unofficial simplified survey that can be used by City volunteers and EOC staff
- Documentation and training materials for EOC staff
- Template for other jurisdictions to follow
- Presentation at Washington GIS Association Conference in May 2022

MEASURING SUCCESS

- Ongoing meetings with EOC coordinator and GIS coordinator
- Meeting with wider Puyallup EOC staff in January to present plan, solicit feedback
- Project will be stress-tested at full-scale lahar evacuation exercise in April 2022, including 7 cities and multiple school districts



Students from Meeker Elementary walk their lahar evacuation route in downtown Puyallup. Lahar evacuation exercise, 2019.

<https://mil.wa.gov/news/largest-volcano-evacuation-drill-in-us-took-place-here-in-washington-state>



View from Downtown Puyallup with Mount Rainier on the horizon, looking southeast. <https://www.cityofpuyallup.org/748/About->