APPENDIX A: MITIGATION AND BEST MANAGEMENT PRACTICES

The following practices would be implemented under the Selected Alternative.

Geology and Soils

- U.S. Geological Survey (USGS) staff would travel on existing maintained and way trails when possible.
- USGS staff would travel cross-country over nonwoody plants using minimum impact/diffuse travel techniques and would walk on rock to the degree possible to avoid creating a new trail or widening impact areas in places where trails do not already exist or where they have been decommissioned (restored).
- Sites have been designed to be the minimum necessary size to enable installation of a functioning station.
- Helicopter landings would be the minimum number needed to safely insert personnel and equipment (as determined appropriate per site location).
- Helicopters would land on bare rock or snow wherever possible.
- Burying of seismometers would include naturalization of the surface to minimize the appearance of disturbance and potential added soil erosion.
- Seismic stations would be located on barren areas where possible.
- Walking on the site and temporary storage of supplies would be on rock or barren ground rather than on plants or soil.
- Excavated rock and soil would be scattered to blend with the site.

Vegetation

- Site selection would avoid areas of intact vegetation with continuous cover.
- Where intact vegetation must be disturbed by digging, it would be carefully dug up and immediately replanted in a nearby barren area of similar habitat and thoroughly watered, or replaced as the excavated area was filled in and thoroughly watered (if transplanting, the vegetation would cause no additional impacts on vegetation and soil).
- Equipment used for digging would be cleaned prior to entry into the Mount Rainier National Park (park) and before being used at other sites within the park to avoid the potential introduction of nonnative plants or pathogens or the transfer of soil organisms between sites. Example cleaning protocols include the Clean Equipment Protocol developed by Ontario Ministry of Natural Resources and Forestry (2016) and the U.S. Forest Service's Vehicle Cleaning guidelines (U.S. Forest Service 2005).
- Staff would clean all personal equipment and personal gear (e.g., boots, pack, and pant cuffs) following a park-approved protocol before entering the park and before moving between sites.

- Access trails to sites that are near areas of heavy existing seasonal visitor use would be camouflaged to discourage visitors from approaching the sites.
- If access to the sites requires travel through a recently revegetated area, then trampling of plants that have been planted would be avoided. Instead, access would avoid formerly existing user-defined (social) trails and would instead be cross-country over nonwoody, un-revegetated areas using minimum impact/diffuse travel techniques.
- On sites where surface rocks would be disturbed, rocks would be replaced in their original orientation after installation to retain lichen and nonvascular plant habitat with the least amount of disturbance.
- When working in a vegetated area, park vegetation specialists would be advised as sites are delineated to provide input on salvage and recovery from plant disturbance.
- Trenching would avoid the root zones of trees, as possible. The root zones of trees would be defined as the canopy edge of trees plus 3 feet (1 meter) (for trees larger than 20-inch (50-centimeter)-diameter) or the canopy edge of trees for smaller trees. The root zone for whitebark pine and greater than 40-inch-diameter trees is defined as the critical root zone or approximately 1.5 feet for every 1 inch of tree diameter.
- Park vegetation staff would be on-site during installation to ensure avoidance of impacts on whitebark pine.
- Vegetation staff would be provided with a detailed map of extent of site ground disturbances to follow up on treatments for any potential weed introductions in those areas.

Wildlife

- To the extent possible, installation and maintenance activities would be timed to avoid sensitive periods, such as nesting seasons.
- Aircraft will attempt to avoid disturbance to wildlife. If animals are observed within 500 feet of a station (this is the usual elevation for elk surveys), the team will evaluate postponement of the site visit and measures to ensure the safety of staff and wildlife.
- To avoid the potential for disturbance, USGS staff would generally hike in for repairs to the lahar monitoring sites, except for rare occasions when emergency repairs may be necessary.
- In addition to meeting all Federal Aviation Administration and National Park Service (NPS) helicopter policy and aircraft requirements, mitigation common to all alternatives for both fixed-wing and helicopter flight paths would include maintaining a 2,000 foot vertical or horizontal clearance whenever feasible and no hovering, circling, harassing, or pursuing wildlife in any way.
- If an active wolf den or rendezvous site becomes established, no ground-disturbing work or helicopter landings would occur within 0.25 mile, as needed, until wolves are no longer using the area.

Special Status Species

- Helicopter transport of equipment, materials, and personnel to the sites would occur after Labor Day, at the end of the nesting season for both marbled murrelets and northern spotted owls, after most juveniles have fledged.
- For sites below 3,800 feet in elevation (Mount Wow and Tahoma Vista Overlook) and for helicopter flights from the Kautz Helipad, project activities would begin two hours after official sunrise and cease two hours before official sunset to avoid potential disruption to marbled murrelets during peak activity periods for feeding and incubation exchanges. This restriction would apply to the marbled murrelet nesting period from April 1 through September 23.
- Helicopter flights would avoid the Carbon, Puyallup, and Mowich river valleys by flying at 2,000 feet and would begin flying after Labor Day to avoid impacts on both visitors and reduce the potential for impacts on nesting marbled murrelets and northern spotted owls.
- Sites below 4,800 feet in elevation (Mount Wow, Tahoma Bridge, and Tahoma Vista Overlook/Tahoma Vista Ridge) would be installed after September 23 to minimize impacts on nesting spotted owls and marbled murrelets.
- Helicopter flights would occur a minimum of 2,000 feet above ground level except during takeoff, approach, and landing in accordance with park recommendations for avoiding impacts.
- After sites are installed, routine and other maintenance would occur either by foot or, in the event of equipment malfunction at a site, by helicopter, with helicopter-based maintenance occurring only after Labor Day.
- Construction personnel would be informed of the occurrence and status of special status species (including federally listed species) and would be advised of the potential impacts on the species and potential penalties for taking or harming a special status species.
- Feeding or approaching wildlife would be prohibited.
- To the extent possible, current year spotted owl surveys would be performed and preliminary results provided in early June of that year. Active owl territories would be based on the most recent information available and may change during a season as new information is gained. If surveys reveal activity centers have shifted, then construction limitations would be adjusted accordingly.

Archeological Resources

- Archeological monitoring would occur during installation of equipment where prior archeological investigations indicate this need (i.e., Copper Mountain, Ararat, Tahoma Vista, and Emerald Ridge).
- Should unknown archaeological resources be uncovered during construction, work would be halted in the discovery area, the park archaeologist contacted, the site secured, and the park would be consulted according to 36 Code of Federal Regulations 800.11 and, as appropriate, provisions of the Native American Graves Protection and Repatriation Act of 1990. In compliance with this act, the NPS would also notify and consult concerned tribal representatives for the proper treatment of human remains,

funerary objects, and sacred objects should these be discovered during the course of the project.

Historic Structures / Cultural Landscapes

- Equipment would be placed to minimize visibility within or into the Mount Rainier National Historic Landmark District (NHLD) to the extent practicable.
- Where possible, the antenna on the seismic stations would be installed in such a way as to not protrude beyond the silhouette/horizon of the ridge.
- Antennas and equipment boxes would be painted with appropriate colors to blend in with each environment in consultation with the park historical landscape architect.
- The equipment boxes would be painted a neutral color (as selected by the park historical landscape architect) to blend into most landscapes including a variety of steep, rocky, alpine settings.
- Because the project may affect historic structures that contribute to the NHLD, the NPS must consider the effects of the undertaking on historic properties and afford the State Historic Preservation Office (SHPO) an opportunity to comment on the potential effects of the project on the NHLD and contributing structures. If consultation results in a determination of adverse effect, the NPS, in consultation with the SHPO and other consulting parties, would work to minimize or mitigate the effects of the undertaking on historic properties.

Visitor Use and Experience

- Helicopter installation flights would occur after Labor Day and would be a minimum of 2,000 feet AGL in accordance with park recommendations for avoiding impacts.
- An approved Helicopter Use Plan and Aviation Safety Plan will be completed by the USGS at least two weeks prior to any helicopter flights occurring.
- As appropriate, flight path suggestions or requirements would be made by the park to minimize impacts on wildlife and visitors.
- Monitoring stations would be located or concealed away from primary visitor use areas to the extent possible.
- USGS-contracted flights would be under USGS helibase management but would be supported by NPS communications center operations and staffing (crews) as appropriate.
- Signs would be posted on the station equipment explaining its purpose and listing a person to contact if visitors to the site have any questions.
- As appropriate, areas exposed on the surface would be covered with rocks gathered from the vicinity of the station, or with excavated rocks.
- A USGS flight manager would be onsite during all flight operations, and all personnel involved in helicopter operations would be fully trained to USGS and Department of the Interior (DOI) standards. The helicopter and pilot would be DOI Office of Aviation Services certified for working in mountainous terrain, snow landings, working with external loads, and other aspects specific to working at Mount Rainier.

- See also measures listed under *Wilderness* below.

Wilderness

- The USGS will submit an Aviation Safety Plan and Operations Plan to the park for approval as part of this project, specifying the number of landings and hours of flight time over wilderness.
- Guidelines set forth by the Aviation Safety Plan and Operations Plan would be followed.
- Flights would only be authorized consistent with an approved wilderness minimum requirements analysis and decision.
- Access to sites will be by foot unless specific hazards exist that prevent safe access (e.g., considerable or higher avalanche danger; exposure to steep icy slopes or crevasses). Physical fitness will not be a primary consideration for authorizing crew transport by aircraft.
- In planning flight paths, all feasible measures would be undertaken to avoid and/or minimize impacts on wilderness visitors, including no flights on weekends and restricting planned flights to fall after Labor Day. However, the USGS estimates up to two helicopter flights may be needed annually for emergency maintenance, based on their experience with other installations.
- Observation flights (i.e., site orientation; project showcasing) not directly in support of installation or maintenance are not authorized by the Environmental Assessment (EA) and must be authorized through a separate Minimum Requirements Analysis.
- A park liaison role would be used to ensure coordination between the USGS and NPS.
- Researchers would use the principles of Leave No Trace impact minimization techniques in installing the sites.
- No rock shelters or other evidence of camping at the monitoring stations would be added or used.
- Travel and camping would be on snow-hardened or nonvegetated surfaces to the extent possible.
- Annual reviews of helicopter operations would be conducted jointly by the NPS and USGS.

References

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APPENDIX B: INDIVIDUAL ROLES IN LAHAR DETECTION AND PROJECT PROPOSAL REVIEWS

USGS Proposed Rainier Lahar Detection System Monitoring Stations – Individual Roles in Lahar Detection

Introduction

The primary design goal of the USGS' proposed Rainier Lahar Detection System (RLDS) is to create a system that allows for the rapid detection of a large lahar stemming from Mount Rainier with the potential reach populated areas in 10s of minutes. In order to provide downstream communities as much time as possible to react, detection must happen rapidly – on the order of minutes – to allow time for alarms to be sent by emergency management agencies to people in threatened areas and for those people to have time to move to high ground.

Although most large lahars have occurred in association with Mount Rainier eruptions (e.g., Sisson and Vallance, 2009; Scott et al., 1995), recent scientific studies have shown that the west flank of Mount Rainier is potentially vulnerable to a large-scale collapse that could occur without eruption and that could produce a large lahar down the Puyallup, Mowich, and/or Tahoma Creek drainages (Finn et al., 2001; Reid et al., 2001). The upper west flank is susceptible to collapse because it contains the greatest area of weak, strongly hydrothermally altered rock (John et al., 2008).

The primary large-lahar-generation scenario that has influenced the design of the RLDS is a spontaneous (i.e., not associated with eruptive activity) collapse of a part of the west flank (Sunset Amphitheater), which has been shown by several studies to be the weakest flank of Mount Rainier and most susceptible to a spontaneous collapse (the west flank was the source area for the circa 1500 A.D. Electron Mudflow that was initiated by a large landslide and not associated with an eruption). In this scenario, we assume that the large landslide would generate a tremendous amount of seismic energy in the earth and acoustic (sound) energy in the atmosphere, which would be easily detected by the existing 13-station seismic network. However, in the minutes following the landslide, there would be tremendous urgency to determine whether a large lahar has been generated (large landslides can occur at volcanoes without generating large lahars; see for example the 2010 Mount Meager landslide in British Columbia (Allstadt et al., 2013), and, if so, which drainage(s) are impacted by the lahar, how fast the lahar is moving, and how soon it will reach populated areas.

The current volcano-monitoring network would be severely challenged to provide any data helpful for answering these questions, for several reasons:

1. The current network stations are optimized to detect activity beneath Mount Rainier, not along its drainages.
2. The current network has very few sites with infrasound sensors (infrasound, or subaudible acoustic waves that travel through the atmosphere, has been shown to be important for detecting surface flows like avalanches, rockfalls, and lahars). Of the five sites that do have infrasound, only one is closer than 5 miles to Rainier and none have topographically unobstructed views (topography can block infrasound) of the west flank nor of the drainages stemming from the west flank. This makes these sites unreliable for detection of lahars in the first few minutes of their formation.
3. The two closest stations on the west flank of Rainier, St. Andrews Rock (STAR) and Emerald Ridge (RER), would likely be destroyed by the landslide. The next nearest stations (Camp Muir (RCM) and Camp Schurman (RCS)) are on the northeast and southeast flanks of the volcano. Although they would record substantial seismic energy, since they are on the opposite side of the volcano from the source area there would be no ability to record infrasound signals due to topographic blocking and, because any lahar would be flowing away from RCS and RCM in basically the same direction, there would be minimal if any ability to use seismic signals to determine whether a lahar had been generated and/or which drainage(s) it was flowing down.

Modeling and geologic studies show that the drainages vulnerable to lahars created by a west-flank landslide are Tahoma Creek and the Puyallup River valley. Modeling results indicate that a large lahar moving down Tahoma Creek could reach the Nisqually Entrance of Mount Rainier National Park (MRNP) in 10 minutes and low-lying residential areas near Ashford in 20 minutes; a lahar flowing down the Puyallup River valley could reach heavily populated areas, such as the city of Orting, in 50-60 minutes. The RLDS is designed to provide data that will help scientists quickly determine whether a large lahar has been generated following a large landslide and, if so, which drainage(s) it is flowing down and how fast, so as to give authorities as much time as possible to send out alarms to affected areas and initiate evacuations.

RLDS Network Design Process

USGS scientists began designing the RLDS network in early 2017, the same year that Congress first appropriated funding for the RLDS project. Initial discussions centered around a 40-station network with roughly half the stations located inside MRNP. The network design called for 3-4 stations inside MRNP along each of the major drainages (East and West Forks of White River, Ohanapecosh, Nisqually, Puyallup, and Carbon), as well as additional stations at fire lookouts to serve as telemetry repeaters. Most sites were to be close to rivers and were to feature a seismometer, an infrasound sensor, and a ~300'-500'-long tripwire array.

The resulting network would have given similar lahar detection and warning capabilities for all drainages. In subsequent discussions, USGS scientists debated whether this capability was critical for all drainages given that only the Puyallup River and Tahoma Creek drainages are vulnerable to spontaneous collapse-driven large lahars; the other drainages are only vulnerable to lahars occurring during unrest and eruption, which could be mitigated by rapid station installation after unrest began. Adopting the minimum tool concept, in the end the decision was made to only propose installing a full suite of stations along the Nisqually drainage with particular focus on Tahoma Creek. For the Carbon, White, and Ohanapecosh Rivers, only three telemetry backbone nodes (on fire lookouts) would be proposed to enable future rapid installation of real-time stations along those drainages should Mount Rainier start showing signs of unrest. USGS scientists also adopted the minimum tool concept in deciding to not propose any new stations inside MRNP along the Puyallup and Mowich Rivers -- although stations inside MRNP on those drainages could theoretically improve our detection capabilities, USGS scientists determined that lahar detection was sufficient with station installations on those drainages outside MRNP because of the longer travel time to the Orting Valley.

The minimum tool concept was also involved in USGS scientists ultimately deciding to not propose tripwire arrays for sites inside MRNP. Tripwires are highly effective for lahar detection because they can provide information about lahar timing and lahar inundation at multiple elevations. However, they also have a large footprint (~300-500 feet in length), need to be installed along steep slopes, and, because such areas are heavily forested in MRNP, would require more frequent maintenance to keep batteries fresh. Also, to ensure redundancy and minimize potential of false alarms, multiple closely spaced tripwires would be needed. In addition, due to the rugged nature of MRNP topography and the need to install tripwires along river banks, tripwires would also require additional dedicated repeaters in order to transmit the data in real time. In order to minimize impact on the landscape, USGS scientists opted to move away from using tripwires inside MRNP and instead rely upon a mix of stations with seismometers and/or infrasound arrays and/or webcam (1 station) to provide detection capabilities, as well as placing several sites near Tahoma Creek that would likely be knocked offline by a large lahar.

The development of the network considered and dismissed a range of other types of technologies used elsewhere in the world for the detection and/or characterization of surface flows. One example is radar, which is used in Europe for avalanche and rockfall detection. Ultimately, this technology was dismissed because of the power requirements, which would need a very large footprint for batteries and solar panels (much larger than our current sites) and would be easily visible at any potential site within the wilderness. A more extensive distribution of webcams was also considered but dismissed due to the potential impacts on the lookout structures. Lastly, tiltmeters, high-rate GPS receivers, and gravimeters were also considered, since all have shown potential for lahar detection and characterization. However, all were dismissed due to the technologies not being well-developed-enough to rely upon for lahar detection and to the expansion of site footprints that would be required to facilitate each instrument type.

The resulting network design consists of 17 stations inside MRNP; 5 that were permitted by MRNP through a categorical exemption and installed in 2020, and 12 sites that are part of the proposed network. Below is a site-by-site description of each station's role in lahar detection at Mount Rainier.

Station Roles in the RLDS

Mount Ararat (ARAT):

The Mount Ararat (ARAT) site would feature a seismometer and infrasound array, and also serve as a telemetry repeater for station TAWO (Mount Wow) along Tahoma Creek. ARAT's roles would include:

1. One of ARAT's primary roles would be to provide infrasound detection capabilities for a lahar moving down Tahoma Creek, both to confirm that a lahar is moving down the drainage and to determine location and/or velocity of the flow front. ARAT's location has an unobstructed view of the west flank and the uppermost reaches of Tahoma Creek, as well as lower down Tahoma Creek from Tahoma Vista southwards. Between the ARAT, COPP, and TAVI sites, at least one infrasound array would be able to "see" and provide lahar-detection capabilities along the entire Tahoma Creek drainage.
2. ARAT's seismometer would also play an important lahar-detection role. As the front of a lahar moves downstream, seismic amplitudes will increase and then decrease as the front approaches and then moves past individual seismic stations. Ratios of seismic amplitude between station pairs located near a drainage can be used to track the movement of a lahar front as it progresses downstream. For Tahoma Creek, ratios between ARAT, COPP, GOBB, GTWY, KAUT, MILD, RER, TAVI, TABR, and TAWO would be particularly important for detecting a lahar and tracking its motion in the first 10-20 minutes after its formation.
3. If stations STAR and RER are destroyed by a landslide and/or lahar, ARAT and COPP would then become the closest stations to the west flank and upper reaches of Tahoma Creek that would still be operational. In that scenario, ARAT, COPP, and GOBB would be the only sites capable of providing data for detecting and tracking subsequent lahars along Tahoma Creek, with ARAT and COPP the only remaining sites with infrasound arrays. Such lahars could be triggered either by further landslides or by water released from temporary blockages formed by the initial lahar. This was a primary concern for those involved in search and rescue efforts in the aftermath of the Oso landslide in 2014.
4. ARAT would improve volcano monitoring capabilities of the Mount Rainier volcano-monitoring network through addition of a seismometer and infrasound array close to the summit. The seismometer would improve the precision and accuracy of earthquake locations beneath Mount Rainier, and the infrasound array would improve the ability of the network to detect explosions and pyroclastic flows.

5. The infrasound array and seismometer at ARAT would also improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows, events on the south and west flanks of the volcano, events that happen every year in MRNP (there have been more than 30 confirmed debris flow events on Tahoma Creek since 1985, most recently in 2019). This information would improve MRNP's situational awareness about such events, potentially reducing response time for search and rescue efforts.
6. Lastly, ARAT would serve as a repeater for station TAWO (Mount Wow), a site located near the banks of Tahoma Creek. Without ARAT, there would be no way to transmit real-time data from TAWO, making that site unusable for real-time lahar monitoring.

Copper Mountain (COPP): Seismometer, infrasound array, GPS, webcam

The Copper Mountain (COPP) site would feature a seismometer, infrasound array, webcam, and GPS receiver. COPP's roles would include:

1. One of COPP's primary roles would be to provide infrasound detection capabilities for a lahar moving down Tahoma Creek, both to confirm that a lahar is moving down the drainage and to determine location and/or velocity of the flow front. COPP's location has an unobstructed view of the west flank and the uppermost reaches of Tahoma Creek down to the Tahoma Bridge (TABR) site. Between ARAT, TAVI, and COPP, at least one infrasound array would be able to "see" and provide lahar-detection capabilities along the entire Tahoma Creek drainage.
2. Because of the unobstructed view, COPP would also have a webcam. In clear weather, the webcam would play a key role in confirming the location of a landslide and the formation of a lahar.
3. Similar to ARAT, COPP's seismometer would also play an important lahar-detection role (see ARAT description above).
4. If stations STAR and RER are destroyed by a landslide and/or lahar, ARAT and COPP would then be the closest stations to the west flank and upper reaches of Tahoma Creek that would still be operational (see ARAT description above).
5. COPP would improve volcano monitoring capabilities of the Mount Rainier volcano-monitoring network through addition of a seismometer, infrasound array, and GPS receiver close to of the summit. The GPS receiver would fill a significant gap in the 6-station Rainier GPS network, since the current network has no GPS receiver on the southwest flank. The seismometer would improve the precision and accuracy of earthquake locations beneath Mount Rainier, and the infrasound array would improve the ability of the network to detect and locate explosions and other eruptive phenomenon such as pyroclastic flows.
6. The infrasound array and seismometer at COPP would also improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows on the south and west flanks of the volcano (see ARAT description above).

Fremont Lookout (FRMT):

The Fremont Lookout (FRMT) site would function solely as a telemetry node (station FMW (a seismic station operated by the University of Washington) is close to FRMT, so no seismometer is needed at FRMT). It would not repeat data from any current or proposed stations. Instead, its installation would be part of a telemetry backbone (along with Tolmie Peak and Shriner Peak) that would enable rapid installation of new real-time monitoring stations along the White River drainage, something that would be required to help mitigate lahar hazards along the White River if Mount Rainier were to start exhibiting signs of volcanic unrest.

Gobblers Knob (GOBB):

The Gobblers Knob Lookout (GOBB) site would feature a seismometer and would also serve as a telemetry repeater for stations COPP, TABR, and TAVI. GOBB's roles would include:

1. Similar to ARAT and COPP, GOBB's seismometer would also play an important lahar-detection role (see ARAT description above). Although the seismometer at GOBB would provide data important for tracking lahars along the entire Tahoma Creek drainage, it would be particularly important for tracking lahars down the lower part of Tahoma Creek (along with TAWO, TAVI, and existing stations KAUT and GATE). In addition, if a lahar destroys stations GTWY, KAUT, RER, TABR, TAVI, and TAWO, GOBB would be the only station still in operation that could provide data necessary for detecting and tracking subsequent lahars and debris flows moving along the lower part of Tahoma Creek.
2. GOBB would serve as a repeater for stations Copper Mountain (COPP), Tahoma Bridge (TABR) and Tahoma Vista (TAVI). Without GOBB, there would be no way to transmit real-time data from COPP, TABR and TAVI, making those sites unusable for real-time lahar monitoring.

Mildred Point (MILD):

The Mildred Point (MILD) site would feature a seismometer and infrasound array. MILD's roles would include:

1. One of MILD's primary roles would be to provide infrasound detection capabilities for a lahar or debris flow moving down the Kautz Creek and Nisqually Creek drainages, both to confirm that a lahar is moving down the drainages and to determine location and/or velocity of the flow front.
2. MILD's seismometer would also play an important lahar-detection role through use of seismic amplitude ratios (see ARAT description above).
3. Like ARAT and COPP, MILD would improve volcano monitoring capabilities of the Mount Rainier volcano-monitoring network through addition of a seismometer and infrasound array close to the summit. The seismometer would improve the precision and accuracy of earthquake locations beneath Mount Rainier, and the infrasound array would

improve the ability of the network to detect and locate explosions and other eruptive phenomenon.

4. The infrasound array and seismometer at MILD would also improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows on the south flank of the volcano including the Nisqually glacier, events that happen every year in MRNP (for example, a large debris flow occurred on the Kautz Creek drainage in 1947, covering MRNP road in 28 feet of mud. Other notable debris flows in this drainage occurred in 1932, 1955 and 2001). This information would improve MRNP's situational awareness about such events, potentially improving response time for search and rescue efforts.

PTOW (Paradise Parking Lot Tower):

The Paradise Parking Lot Tower (PTOW) site would serve as a telemetry repeater for stations ARAT, MILD, and TAWO (repeated through ARAT).

RER (Emerald Ridge – Upgrade of existing site):

The Emerald Ridge (RER) site is an existing seismic station operated by the University of Washington. It would be upgraded to include both a modern seismometer and an infrasound array. RER's roles would include:

1. RER's location has an unobstructed view of the west flank and the uppermost reaches of Tahoma Creek and the Puyallup River. One of RER's primary roles would be to provide infrasound detection capabilities for a lahar moving down Tahoma Creek and Puyallup River, both to confirm that has been created and to help determine which drainage(s) it is moving down.
2. RER is the second-closest station to the source area for a landslide on the west flank (St. Andrews Rock (STAR) is the closest), and also sits on a ridge that divides the Puyallup River and Tacoma Creek drainages. This location is important in two ways:
    a. If a large landslide occurs in the northern part of the presumed source area, recent modeling indicates that any large lahar would be confined to the Puyallup River valley and RER would likely survive; however, the closest station (STAR) would likely not survive, so RER would then become the closest station to the source area and would provide information critical to tracking the initial moments of the landslide event and possible transition to lahar.
    b. If a large landslide occurs the southern part of the presumed source area, modeling indicates that a large lahar would be split by Emerald Ridge and go down both the Puyallup and Tahoma Creek Drainages. Modeling also indicates that a large lahar would reach RER in 1-2 minutes and likely destroy it, providing early confirmation that a large lahar had been created and was moving down Tahoma Creek.

3. Historically RER has been the only seismic station in the Rainier monitoring network to clearly record small debris flows going down Tahoma Creek. However, telemetry from the site is unreliable at times and the seismometer is out of date. Upgrading the site will improve telemetry reliability and also the fidelity and quality of seismic recordings of debris flows and lahars.
4. RER is a critical site in the Mount Rainier volcano monitoring network. It is the closest site to the summit on the southwestern flank, and since its installation in 1991 the site has proven to be quiet and highly sensitive to small earthquakes near the summit. Upgrading the seismometer and improving the reliability of the station would improve the precision and accuracy of earthquake locations beneath Mount Rainier, and the infrasound array would improve the ability of the network to detect explosions.
5. The site will operate as a ShakeAlert station (https://www.shakealert.org/), enhancing the earthquake early warning capability at the volcano. Depending on the lahar trigger, a detection from the ShakeAlert system may be one of the earliest signs of a developing landslide.

SHRI (Shriner Peak):

The Shriner Peak (SHRI) site would feature a seismometer and would also function as a telemetry node for future stations installed along the Ohanapecosh drainage in the event of future volcanic unrest at Mount Rainier. SHRI's roles would include:

1. SHRI's primary role would be as a repeater. It would not repeat data from any current or proposed stations. Instead, its installation would enable rapid addition of telemetered real-time monitoring stations along the Ohanapecosh drainage that would repeat through SHRI to a receive site outside MRNP. Addition of stations along the Ohanapecosh River would be required to help mitigate lahar hazards to downstream communities if Mount Rainier were to start exhibiting signs of volcanic unrest.
2. The seismometer at SHRI would improve the ability of the seismic network to detect smaller lahars and debris flows down the Ohanapecosh River.
3. The seismometer would also significantly improve the accuracy of earthquake locations at Mount Rainier, particularly in the southeast quadrant of MRNP which at present has only two seismic stations (RCM (Camp Muir) and OPCH (Ohanapecosh Visitor Center)). The east side of MRNP is an active seismic area, most recently hosting the M4.5 Cowlitz Chimneys earthquake in 2006 that was widely felt in MRNP (Hartog et al., 2008).

TABR (Tahoma Bridge):

The Tahoma Bridge (TABR) site would feature a seismometer and a single infrasound sensor. TABR's roles would include:

1. A large lahar would likely destroy TABR within 1-3 minutes of initiation, providing independent confirmation that a lahar was moving down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
2. TABR would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. Such information would improve MRNP's situational awareness about such events, potentially improving response time for search and rescue efforts.

TAVI (Tahoma Vista):

The Tahoma Vista (TAVI) site would feature a seismometer and an infrasound array. TAVI's roles would include:

1. If TAVI is located at Tahoma Vista along the Westside Road, a large lahar would likely destroy TAVI within 3-5 minutes of initiation, providing independent confirmation that a lahar was continuing to move down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
2. If located at the alternate Tahoma Vista site, a large lahar would not destroy the site; in that event, TAVI would join GOBB, ARAT, and COPP as the only sites that could provide data necessary for detecting and tracking subsequent lahars and debris flows moving along Tahoma Creek in the aftermath of the large lahar. In addition, the alternate site would also provide infrasound coverage for the Puyallup River drainage.
3. Either location has a unique view of the Tahoma Creek that is optimal for infrasound detection. Coupled with infrasound arrays at COPP and ARAT, the TAVI infrasound array would provide complete infrasound coverage of the Tahoma Creek drainage down to its confluence with the Nisqually River.
4. TAVI would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. Such information would improve MRNP's situational awareness about such events, potentially improving response time for search and rescue efforts.

TLME (Tolmie Peak):

The Tolmie Peak Lookout (TLME) site would feature a seismometer and would also function as a telemetry node for future stations installed along the Carbon and Mowich River drainages in the event of future volcanic unrest at Mount Rainier. TLME's roles would include:

1. TLME's primary role would be as a repeater. It would not repeat data from any current or proposed stations; instead, its installation would enable rapid addition of telemetered real-time monitoring stations along the Carbon and Mowich River drainages, which would repeat through TLME to a receive site outside MRNP. Addition of stations along the Carbon and Mowich would be required to help mitigate lahar hazards to downstream communities if Mount Rainier were to start exhibiting signs of volcanic unrest.

2. The seismometer at TLME would significantly improve the accuracy of earthquake locations at Mount Rainier, particularly in the northwest quadrant of MRNP which at present has only two seismic stations (Carbon Ranger Station (CRBN) and Observation Rock (OBSR)).

TAWO (Mt. Wow):

The Mt. Wow (TAWO) site would feature a seismometer and a single infrasound sensor. TAWO's roles would include:

1. A large lahar would likely destroy TAWO within 5-7 minutes of initiation, providing independent confirmation that a lahar was continuing to move down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
2. TAWO would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. In particular, the TAWO location is in the area where many recent debris flows have come close to and/or damaged the Westside Road; it is therefore uniquely situated to provide the MRNP with situational awareness about events that may have impacted the Westside Road, potentially improving response time for repairs as well as search and rescue efforts.

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PROJECT PROPOSAL REVIEWS

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Mount Ararat Monitoring Site
Project Location	46.80994, -121.85793
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to

	emergency managers and Park personnel with sufficient time to allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Ararat Site are: • Southern exposure for solar panels • Line-of-sight telemetry to radio repeater (Paradise Tower) • Line-of-sight telemetry to Mount Wow site (Ararat repeats Mount Wow). • Seismometer/Infrasound on south side of Tahoma Creek Drainage The Mount Ararat site is critical as a repeater for the Mount Wow site. This location has line-of-sight to Mount Wow and another repeater (Paradise Tower). This site is the best combination of operational requirements and low visibility from local trails and named peaks. In addition, Tahoma Creek bends around Mount Ararat providing an excellent location for recording seismic and infrasonic signals arising from debris flows and lahars in the Tahoma Creek drainage. Lastly, the Ararat site provides robustness to the detection system in the case of a short-term outage at the Copper Mountain site. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods elsewhere in the park. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations

	will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentation that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and other processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries, with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. A solar panel will extend above the top of the hut, but the overall height will not exceed 9 feet. Attached to the respective sides of the hut will be two poles (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface that will provide a support frame for the upper solar panel and have two flat panel antennas (~1'x1') placed near the top (one per pole to maintain appropriate separation to minimize RF interference). Solar controllers and lead acid batteries housed within the hut will power the equipment on site. Prior to placing the enclosure on the ground, six holes are dug approximately 2 feet deep and filled with concrete to make a sturdy foundation for the hut and for the two antenna/solar support poles. The ground between the holes must also be leveled using hand tools such as a shovel and rake. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut using hand tools to provide protection from static discharge. The hut and exposed equipment (except the solar panels, radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park.

	A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 60 feet from the enclosure (Figure 2). The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ inch plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground near the enclosure, the other two units and windscreens will extend out no more than 100 feet away from the enclosure. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter slingloads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done.

	If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the seismometer and infrasound cables. The area of disturbance for the enclosure will be approximately 10x10x1 foot or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. The footings will be about 2 cubic feet each. We will also drive in a 5/8” copper grounding rod to a depth of 8 feet within the 10’x10’ footprint. Only the top couple of inches of the grounding rod will protrude above the surface. The area of soil disturbance for the seismometer will be no more than 4’x4’. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.

Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Site is located in the Wilderness.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No impact on cultural resources and cultural landscapes.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Visitors are unlikely to see the enclosure due to the limited exposure. The Mount Ararat site is in a remote area far removed from any major trail. The site is located in an area that is very difficult to see from the Westside Road and from the summit of Mount Ararat. The social paths to the summit of Mount Ararat are dispersed and do not obviously pass within view of the proposed site. Thus we do not believe that there will be any impact on visitors or park staff.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety

	directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There are no viable alternatives for the requirements of this site.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

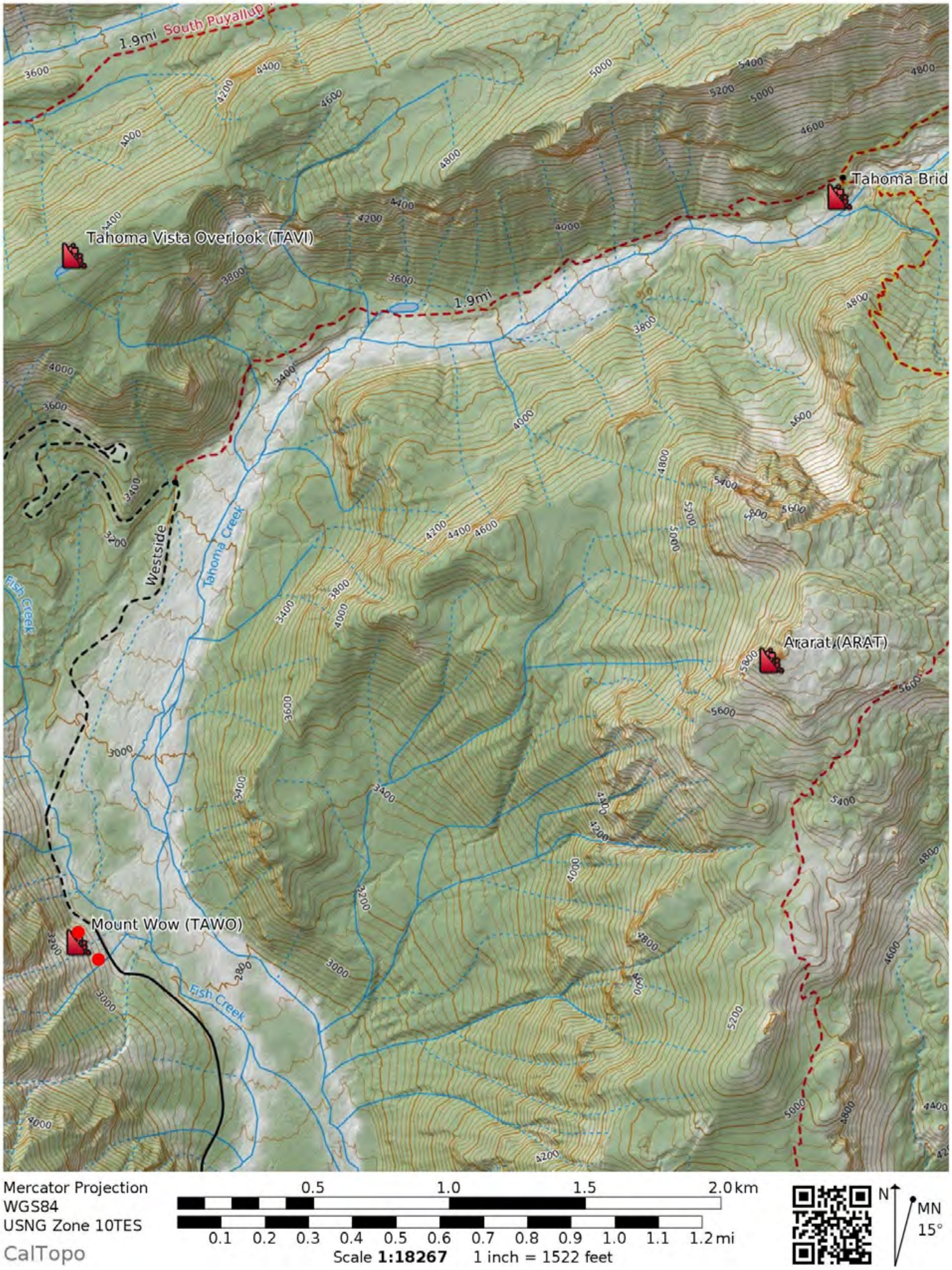

Figure 1: Location map of Mount Ararat (middle right) with Mount Wow to the left of the map. Notice how Tahoma Creek bends around Mount Ararat, providing the ability to observe a surface flow down a significant reach of the river.

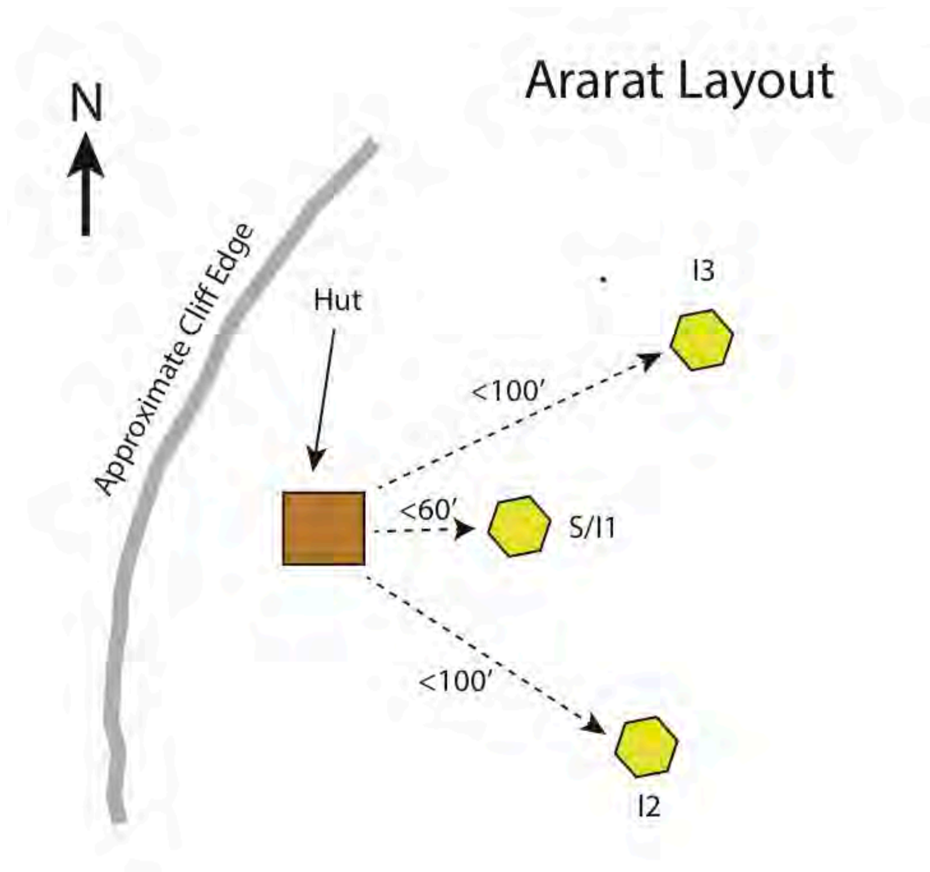

Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.


Figure 3: View from the proposed enclosure site toward the Mount Wow site and Westside Road.

Figure 4: View toward Mount Rainier and the upper Tahoma Creek and Puyallup River drainage from the proposed enclosure site.


Figure 5: Proposed site for infrasound (I3) looking from the enclosure. I3 will be in the trees on the left of the photo. The seismometer (S) and infrasound (I1) will be in the foreground past the purple flowers.


Figure 6: View looking back toward the enclosure. Infrasound site I2 will be in the small trees in the center of the photo.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

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Project Originator	U.S. Geological Survey
Project Title	Copper Mountain Monitoring Station
Project Location	46.79804, -121.82919
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Copper Mountain Site are: • Southern exposure for solar panels • Line of sight to repeater (Gobblers Knob) • Line of sight into Tahoma Creek Headwaters from the south (for webcam and infrasound) • Seismometer on south side of Tahoma Creek Drainage • Bedrock close to the surface for GPS antenna. The Copper Mountain site is well placed to detect a debris flow and/or lahar, but it is also well poised to detect the volcanic unrest that increases the risk of those types of flows. In particular, it has bedrock close to the surface and a direct view into the upper Tahoma Creek drainage. These site features make the installation of a webcam and GNSS receiver necessary in addition to the typical seismometer and infrasound setup. Its location on the south side of the Tahoma Creek Drainage will be useful in delineating flows in the Tahoma Creek Drainage from those in the Kautz Creek Drainage using seismic and infrasound data during times when webcam views are not available. The GNSS monument will provide critical monitoring for surface deformation that could indicate unrest that would increase the lahar hazard. In addition to the less-frequent large lahars, data collected using this station and others in the proposed network will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park, which is important both for situational awareness and hazard mitigation within the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area

	due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare and will help our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentation that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ~~e~~ ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable the park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially more. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries, with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. A solar panel will extend above the top of the hut, but the overall height will not exceed 9 feet. Attached to the respective sides of the hut will be two poles (2.375-inch outer diameter) that extend~~s~~ 12 feet or less above the local ground surface that provide a support frame for the upper solar panel and will have a flat panel antenna (~1'x1') placed near the top of one pipe. The other pipe will then be cut on-site to a maximum of 9 feet above the ground surface. Solar controllers and lead acid batteries housed within the hut will power the equipment on site. Prior to placing the enclosure on the ground, six holes are dug approximately 2 feet deep and filled with concrete to make a sturdy foundation for the hut and for the two antenna/solar support poles. The ground between the holes must also be leveled using hand tools such as a shovel and rake. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut using hand tools (or drilled if the shallow surface is rock) to provide protection from static discharge. The

	hut and exposed equipment (except the solar panels, radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. Below the top of the antenna will be a webcam (7”x6”x16”) pointed approximately northeast toward the upper Tahoma Creek drainage. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 60 feet from the enclosure. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. A GNSS monument will be installed in bedrock near the edge of the cliff to the NW of the proposed site, approximately 100 feet away from the hut. The proposed monument is a USGS/SCIGN short drilled-braced monument or similar. Installation will require a powered rock drill to install the 5 supporting legs to a depth of 6 ft in bedrock and a generator for welding the stainless steel bracing legs to the center support of the monument. A GNSS antenna will be installed at approximately 7 feet above the local ground surface. The GNSS antenna has a diameter of 15 inches and a height of about 17 inches including a protective cover or radome. The GNSS site is used to detect very small changes in the shape of the volcano, sometimes caused by the intrusion of magma into the plumbing system underneath Mount Rainier. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ in plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground less than 60 feet from the enclosure and the other two units and windscreens will extend out no more than 100 feet away from the enclosure.

	Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance.. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a "tuning" visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance. A generator, rock drill, and welder will be required for GNSS monument installation.
Will imported fill be used?	*If yes, list volume(s) and source (if known).*

	Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the seismometer, infrasound and GNSS cables. The area of disturbance for the enclosure will be approximately 10'x10'x1' or less. The enclosure is smaller, but we are including the disturbed area for the footings, pipe frame, and the foot traffic around the enclosure. The footings will be about 2 cubic feet each. We will also drive a 5/8" diameter copper rod into the ground to a depth of 8 feet within the 10'x10' footprint. Only a couple of inches of the copper rod will protrude above the surface. The area of soil disturbance for the seismometer will be no more than 4'x4'. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist. There should be none-to-minimal soil disturbance associated with installing the GNSS monument as drilling will occur in already exposed bedrock.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Site is located in the Wilderness.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No impact on cultural resources and cultural landscapes.

Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. The Copper Mountain site is in a remote area far removed from any major trail. The site is located in an area that is impossible to see from below and difficult to see from the summit of Copper Mountain. The social path that is typically taken to reach the summit of Copper Mountain does not pass by the proposed site. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* <u>Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?</u> The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing

	of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

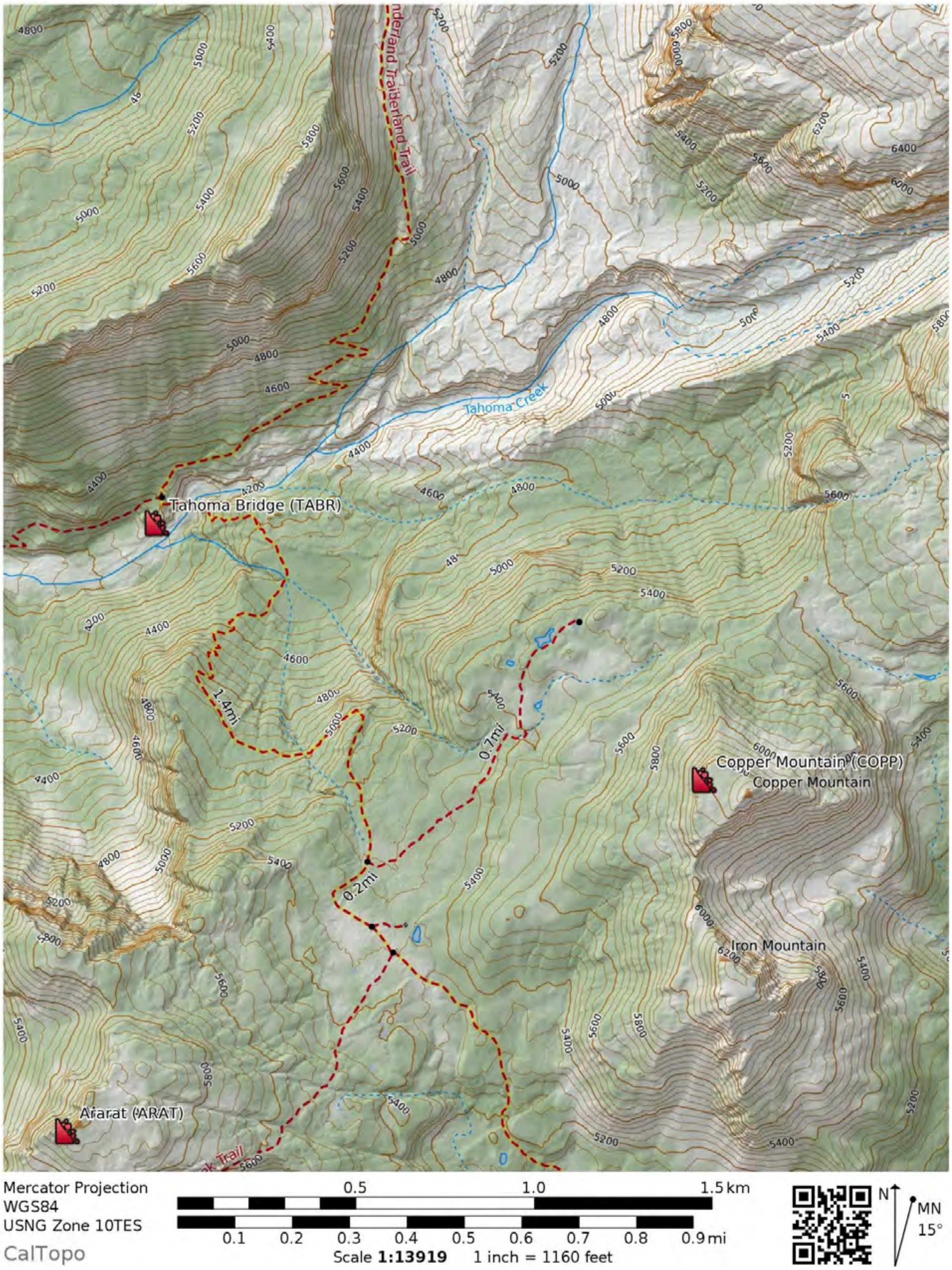

Figure 1: Location map.

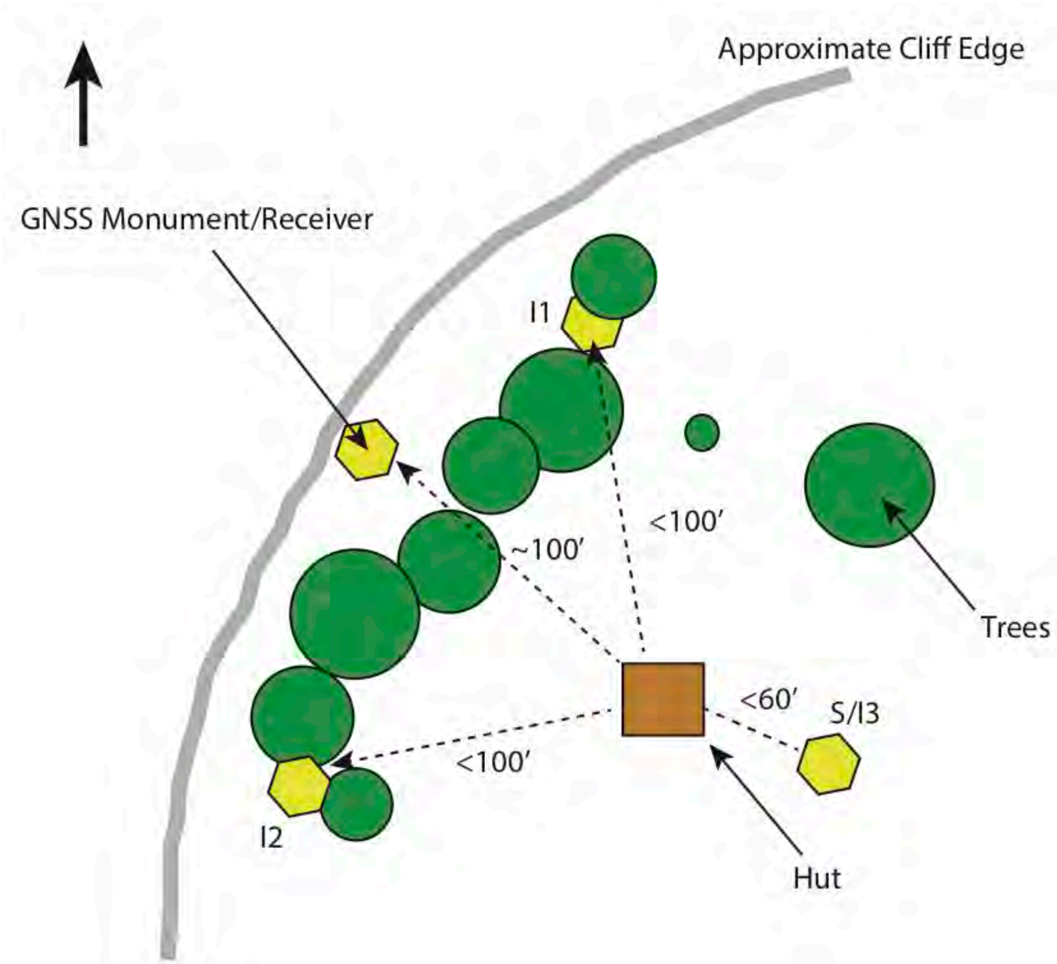

Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.


Figure 3: View looking SW from proposed enclosure site of looking toward Gobblers Knob and proposed infrasound site I2. Infrasound wind screen would be placed under one of the trees. The site is obscured from view of the trails below.

Figure 4: View looking E towards proposed site for seismometer and infrasound site (S/I3). The summit of Copper Mountain sits behind the trees in the center left background.

Figure 5:View look WNW to the upper Tahoma Creek Drainage showing webcam viewshed and potential GNSS site. Infrasound site, I1, will be placed under the trees to the right in the picture.

Figure 6: An example of a Drilled-Braced GNSS Monument (source: UNAVCO)

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Emerald Ridge Site
Project Location	46.8186, -121.8426
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to allow affected populations to evacuate to high ground before a lahar arrives.

The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages.

Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact.

The requirements for the Emerald Ridge Site are:

- Southern exposure for solar panels
- Line-of-sight telemetry to repeater (Gobblers Knob or Storm King Mountain)
- Seismometer high on Emerald Ridge
- Infrasound array high on Emerald Ridge

The Emerald Ridge site is an upgrade of an existing seismometer site operated by the Pacific Northwest Seismic Network since 1989. The upgrade is needed because the site has out-of-date equipment that goes off-scale for moderate (M > 2) earthquakes, is susceptible to wind noise and also suffers from periodic outages due to sub-standard radio telemetry. This project proposes to upgrade the equipment to more modern and sensitive instrumentation appropriate for detecting and localizing surface flows, and also upgrading the telemetry system so that the site will function 24/7. The site is also part of the volcanic unrest network and ShakeAlert, requiring a quieter seismometer vault than proposed at other stations. The Emerald Ridge site is especially critical because of its location between the South Fork of the Puyallup River and the Tahoma Creek Drainage. Recordings from the seismometer and infrasound array wills be critical in determining which (or both) drainages are being impacted by a lahar event.

Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods elsewhere in the park. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of

	such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentations that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If this site is not upgraded, the existing site monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner. This means that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation of above ground equipment will include an aluminum enclosure with dimensions of 64"W x52"L x69"H. The enclosure will contain a solar controller, air cell and lead acid batteries, digital radio, and the instrument digitizer. The enclosure will have 2x 190W solar panels mounted on the south side of its body, and have an attached mast for a total height of no more than 15 feet, which will mount a 400MHz band antenna and a small GPS antenna. The enclosure will be painted brown to minimize visibility. Two grounding rods will be driven through the base of the enclosure to secure it in place. All equipment on site will be properly grounded according to electrical code and NPS specifications. A 6 inch wide and 24 inch deep trench with an estimated length of 20 feet (no more than 30 feet) will be made to the west of the enclosure, toward the seismic vault. This trench will house 2 inch conduit containing power and data cables, and will be completely filled in with the materials removed from the trench after the conduit has been installed. The seismometer will be placed in an 8 inch diameter PVC post hole vault. A hole with a size of no more than 3 feet in diameter and 5 feet in depth will be cleared to install the seismic vault, and will be filled in with local materials

	removed from the hole after the vault and seismometer are installed. This post hole vault provides the highest quality seismic data which is critical for accurate detection of volcanic activity, lahars, debris flow and earthquakes. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ inch plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground less than 30 feet from the enclosure and the other two units and windscreens will extend out no more than 100 feet away from the enclosure. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter slingloads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out)), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done. Anytime helicopter support to the site is deemed to be essential, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled

	murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatche Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS/PNSN crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a "tuning" visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	No. The PNSN has a slightly different procedure for installing seismometers, which is why this site differs somewhat from the other hut sites.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	Yes. Minimal soil disturbance will be necessary to prepare the surface for the enclosure, dig the holes for the vault, and trench between the vault and the enclosure. Prior to installing the enclosure, site prep will be required and will be accomplished by leveling a 64"x52" area of land for the enclosure. The seismometer will be buried approximately 20 feet West of the enclosure, in a 4 foot deep by 2 foot wide hole which will be filled back in with material removed from the hole. An 8" PVC vault in the center of the hole will be held in place with 0.75 cu. ft of concrete around its base to couple the vault with the ground. Shovels and garden hoes will be used to dig the 6" wide by 18" deep trench between the seismic vault and the enclosure, which will be replaced with the natural materials removed from the trench. Trenches will be hand dug to the two infrasound instruments to the SSE and W of the enclosure.
Will there be vegetation disturbance?	There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS/PNSN will avoid digging or trenching near any large tree roots during the operation. The USGS/PNSN will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	No, station site exists along a ridgeline far from local rivers or any viable aquatic habitat.
Is the location in Wilderness or Potential Wilderness?	Yes.

Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	No impact on cultural resources and cultural landscapes.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. The Emerald Ridge site is in a remote area removed from any major trail. The site is located in an area that is impossible to see from below and difficult to see until you get across the Tahoma Creek drainage near Copper Mountain. There is a social path that leads from the wonderland to the original site. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No, site is in the backcountry.
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be)

	6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. Several other locations in the area were assessed as alternatives, however this site was the best combination of solar exposure, low snow load, lack of visibility and excellent viewshed to the repeater.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

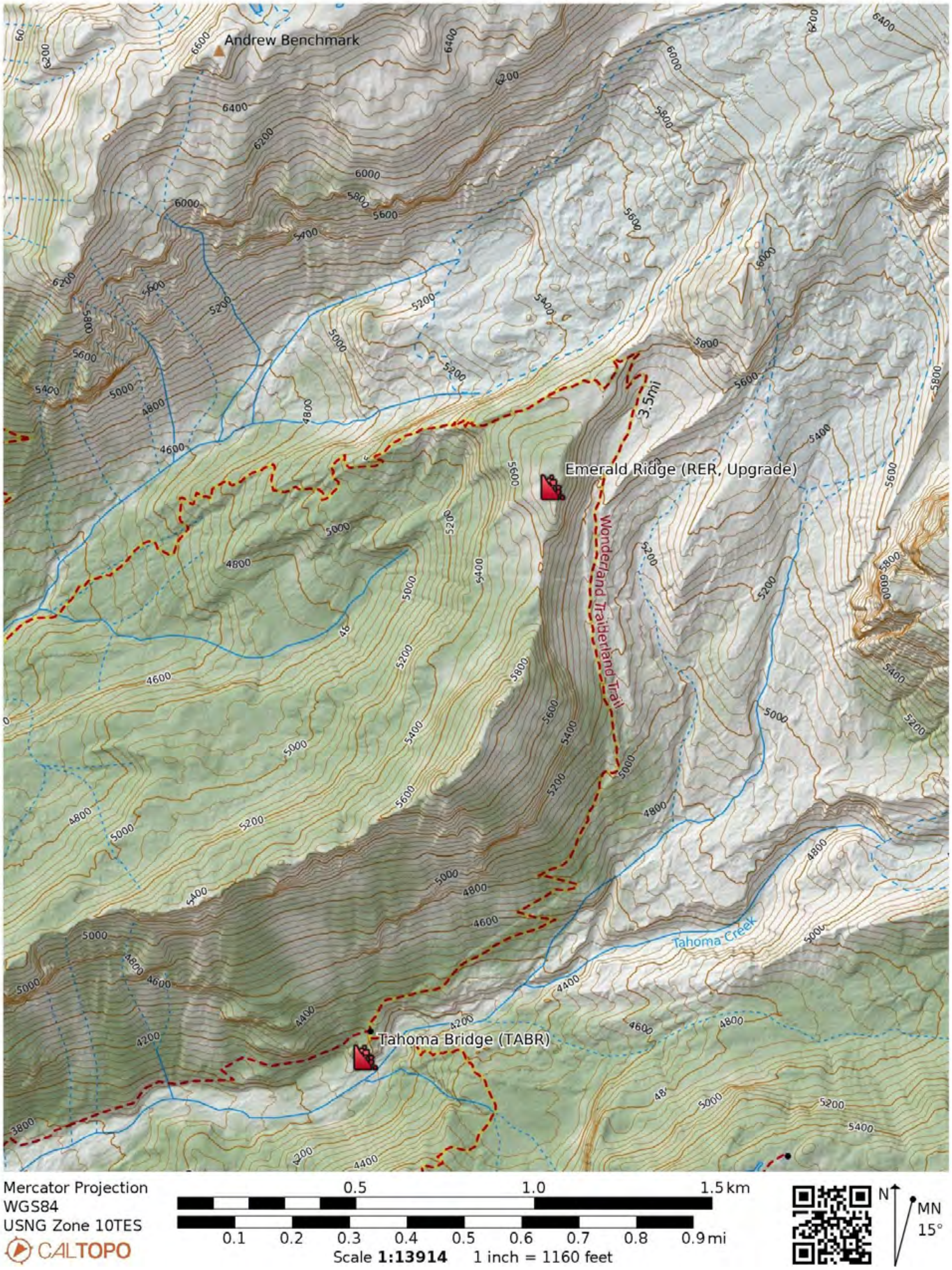

Figure 1: Location map.

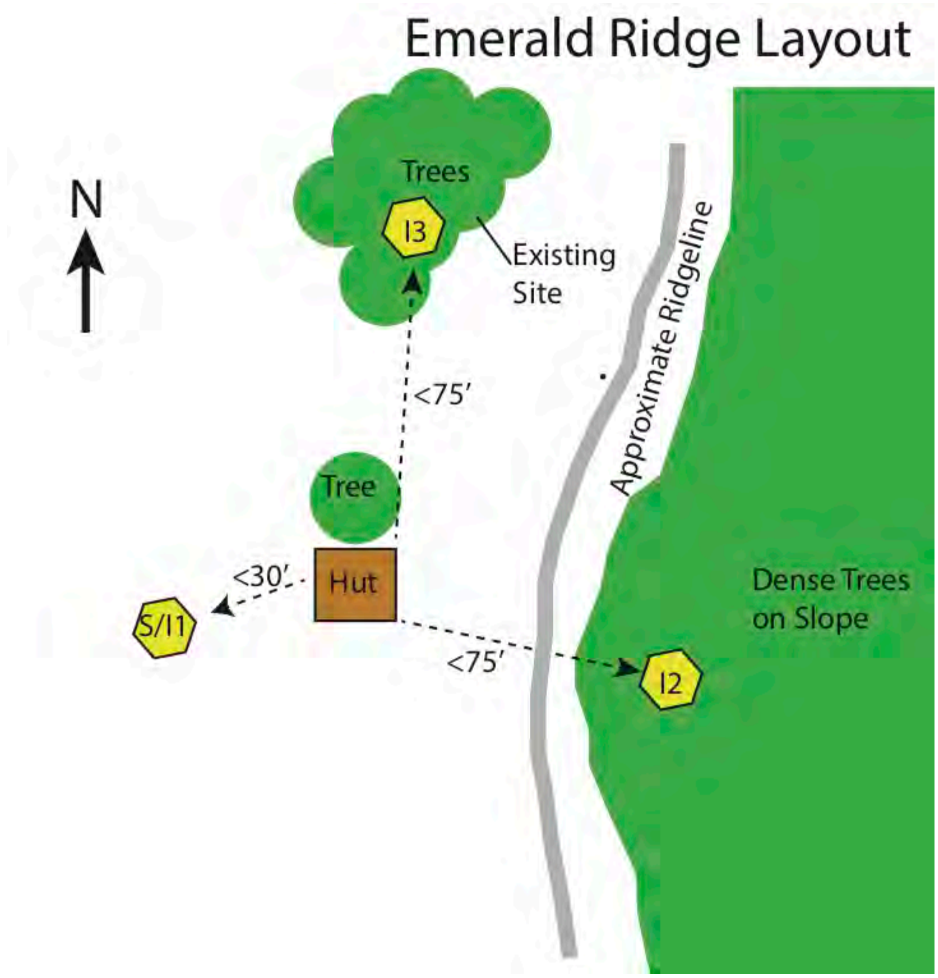

Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.

Figure 3: Photo looking North up the ridge toward old RER and new site location. The red circle to the left represent approximate seismic vault location and infrasound site I1 location. The red rectangle approximates the enclosure location, sitting 3 feet down off the ridge. The enclosure will sit just south of the grouping of trees. Infrasound site I2 will be right of the photo in the trees and infrasound site I2 will be in the trees near the existing monitoring site.

Figure 4: Photo taken from the cluster of trees at proposed enclosure location, looking SSE down the ridge line. Solar availability should be high even in winter, with the expection of snow burial.

Figure 5: Photo taken from ridgeline looking West. Pink flags on the right in the forground represent the approximate enclosure location, set just out of the trees. Ranger Tyler Kenyon stands at approximate seismic vault location. Also shows multiple possible radio POIs. Peaks from left to right: Mt. Wow, Storm King (231.9°), Gobblers Knob, LMW (Ladd Mt) (244.1°), Cougar Mt.(252.7°)

Figure 6: A similar enclosure to the proposed RER enclosure, looking at it's north side. Solar panels will be mounted on the back, with an aluminum pipe acting as a mast will be mounted to the right side, as oriented in this photo.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Fremont Peak Alternative Site
Project Location	46.93133, -121.67371
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. In high-hazard drainages, such as the Puyallup River and Tahoma Creek, a permanent dense network is proposed to protect against a spontaneous collapse. Other drainages are proposed to have sparser networks composed largely of repeaters at high points in order to rapidly expand monitoring if the hazard assessment of a drainage were to increase. A bulge of the volcano during unrest is one example of how the lahar hazard in a drainage could increase. This site is an example of one of those repeaters. The requirements for the Fremont Site are: • Southern exposure for solar panels • Large viewshed into West Fork of the White River • Line-of-sight telemetry to repeater (Crystal Mountain Summit House) The Fremont site is important as a robust radio repeater to enable rapid expansion of the network in the case of a change in hazard on the northeast side of Mount Rainier feeding the White River. This site requires radio antennas pointed into the upper reaches of the West Fork of the White River. This allows a state of preparedness in the case of an unforeseen change in lahar or debris flow hazard. Without this site, if the lahar hazard were to change on the northeast side of the volcano, a repeater would need to be established before an acceptable detection network was installed. This would be impossible from late Fall to early Spring when heavy snowfall is present.
Project Description—What work activities are proposed—the	Installation will include a 6’x6’x6’ enclosure with a footprint of 10’x10’. Mounted on top of the structure will be 3 solar panels, making the total height of the structure approximately 12’. On one

what, how, where of the project. (attach a map of project area, drawings, and photographs)	side of the structure, a mast (4" pole) will extend up to 20' above the local ground surface. On the mast, no more than four antennas (maximum dimensions ~1'x1'x6" flat panel, yagi, or omnidirectional) will be mounted near the top of the mast to stay clear of snow in the winter. Contained within the enclosure will be lead acid and air cell batteries, along with solar controllers and electronics to enable power distribution and monitoring. The enclosure and exposed equipment (except the solar panels, radio antennas) will be painted brown to minimize visibility. The structure has a tolerance of 18" for leveling purposes and thus it may be required to level the area within the footprint with a shovel and/or rake to meet that specification. The structure itself sits on four concrete pads on top of the ground; however metal baskets on top of the pads help weigh the structure down. Rock to fill the baskets will be sourced at the local site if needed. The self-supporting structure was selected as the design minimizes ground disturbance. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.

	The initial installation of this repeater sites may require the use of a Type 2 helicopter.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by a professional enclosure installer and USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe to level ground for the enclosure. Battery powered hand tools may be required during installation and maintenance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* No
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure. The area of disturbance for the enclosure will be approximately 12’x12’x1’ or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. We will also be driving a 5/8” copper rod to a depth of 8’ within the footprint of the site. Heavy rocks may be locally sourced to fill the baskets on top of the concrete pads.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Yes
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No. The site should be concealed from view from the Fremont Lookout to the north and the trail below. It is impossible to know

	if the top of the mast will be visible from the lookout or local trail until we install the site, however since we project that the snow load here is low, we can trim the mast to be as short as 15 feet to conceal the site from visitors. There are distant views to the Wonderland Trail near the saddle under Skyscraper Mountain and Burroughs Mountain.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life’s amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources

	(understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There is an alternative site that is presented (Fremont Peak Lookout) that meets all of the requirements of the site. Because of the high winds and potential for icing in the area, the lookout site is much preferred. The existing seismic site (FMW; see map) was also assessed as an alternative and not found to have a sufficient viewshed of the White River Drainage or a view to the repeater at Crystal Mountain.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

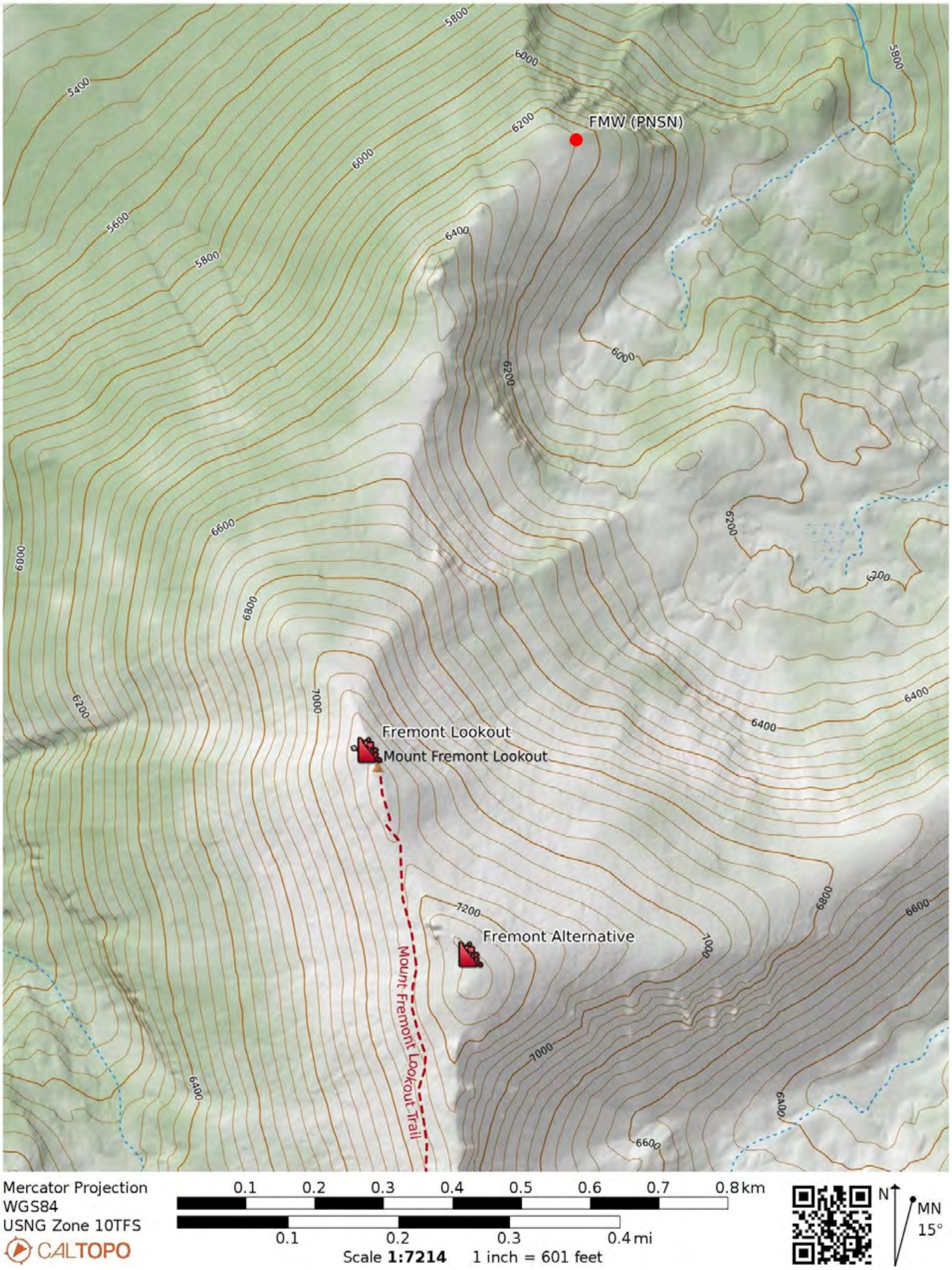

Figure 1: Location map.

Figure 2: Proposed enclosure site looking NW. The trail lies on the hillside below.

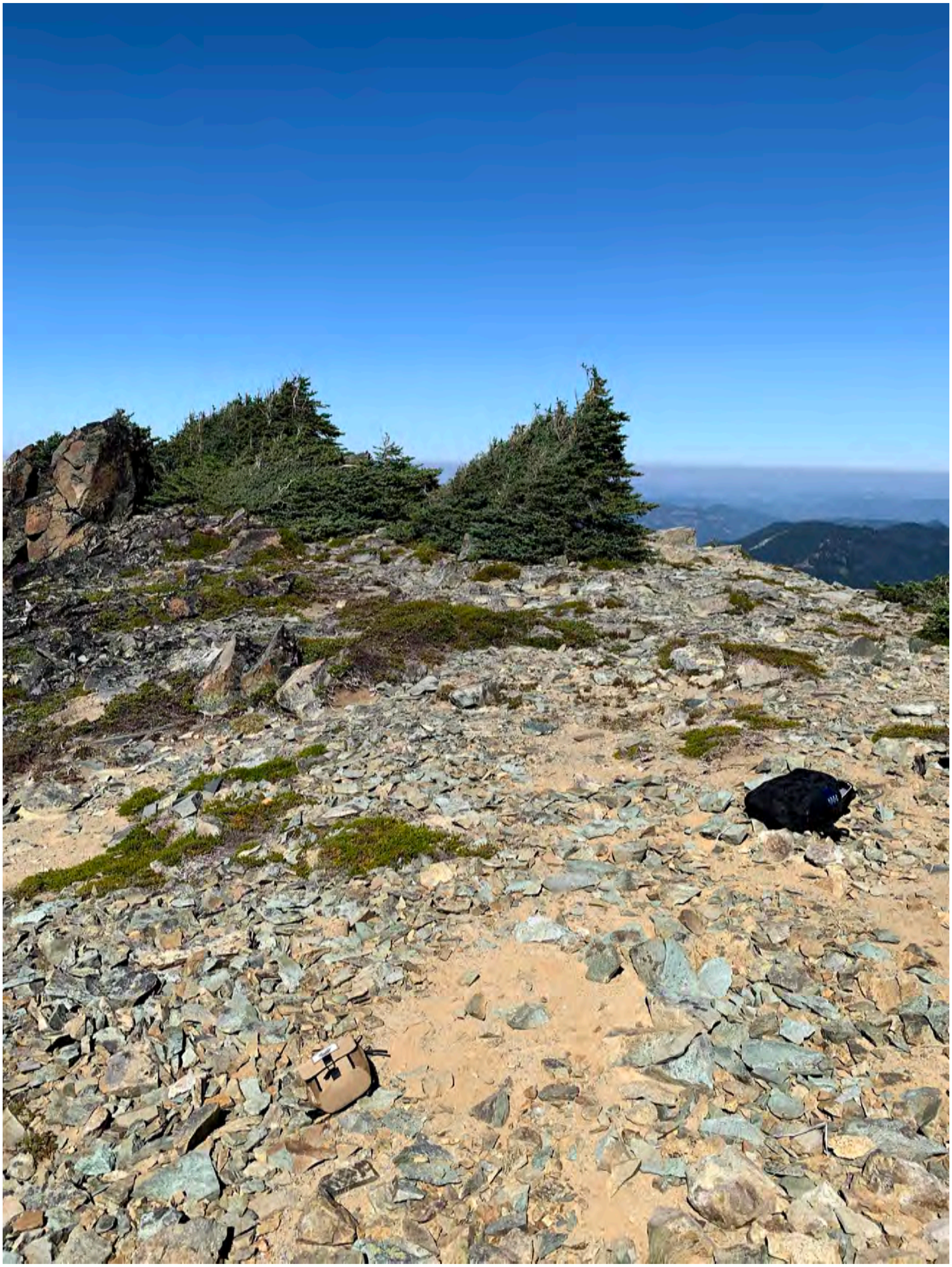

Figure 3: Proposed enclosure site looking north toward the Fremont Lookout.

Figure 4: View from the enclosure site looking west with distant views of the Wonderland Trail as it passes Skyscraper Mountain and the Burroughs Trail.

Figure 5: A Pepro LLC structure installed in a similar configuration to what is being proposed.

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MOUNT RAINIER NATIONAL PARK

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Project Originator	U.S. Geological Survey
Project Title	Fremont Peak Lookout Site
Project Location	46.9340, -121.6756
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

allow affected populations to evacuate to high ground before a lahar arrives.

The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages.

Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact.

In high-hazard drainages, such as the Puyallup River and Tahoma Creek, a permanent dense network is proposed to protect against a spontaneous collapse. Other drainages are proposed to have sparser networks composed largely of repeaters at high points in order to rapidly expand monitoring if the hazard assessment of a drainage were to increase. A bulge of the volcano during unrest is one example of how the lahar hazard in a drainage could increase. This site is an example of one of those repeaters.

The requirements for the Fremont Site are:

- Southern exposure for solar panels
- Large viewshed into West Fork of the White River
- Line-of-sight telemetry to repeater (Crystal Mountain Summit House)

The Fremont site is important as a robust radio repeater that would enable rapid expansion of the network in case significant volcanic unrest occurred at Mount Rainier – an event that would significantly increase the likelihood of a large lahar down multiple drainages of Mount Rainier, including the White River. To act as a repeater, the Fremont site requires radio antennas pointed into the upper reaches of the West Fork of the White River.

Without this site, in the event of volcanic unrest the USGS would require days, weeks, or even months to establish a repeater on the northeast side of the volcano, particularly if unrest occurred from late Fall to early Spring when heavy snowfall is present. This would result in a potentially significant delay in the USGS installing instrumentation needed to give Park personnel and visitors, as

	well as communities in the White River drainage, timely warnings of impending hazardous events, including large lahars.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation would include mounting two 160W solar panels to the south roof face of the lookout structure. This will require mounting unistrut or Unirac flush mount rails too the roof. The rails or strut will be through-bolted to rafters under the lookout roof. Each solar panel has dimensions of approximately 58x26x2 inches. The mounting brackets would elevate the panels up to 5 inches above the roof surface but the panels would remain in the same plane as the roof face. Solar panel conductors will be insulated 2-conductor wire strapped to already-in-place copper conductors that run down the roof, under the rafters, and down the side of the building. The insulated solar wires will then enter the basement of the building through pre-existing cracks or holes between the upper and lower levels of the building. If an entry point does not exist we will drill a small (approx. 1 inch diameter) hole in a location between the upper and lower levels near the deck that is not clearly visible from the building's exterior. We also propose adding flexible solar panels to temporary shutters that are placed on the exterior of the lookout during winters. The vertical orientation and shielding from the roof eaves mean that panels in this location could survive harsh snow and icing conditions that may minimize the effectiveness of panels on the roof for some periods of time. The mounting and cabling would exactly mimic the park's installation of winter solar panels for their use. We propose mounting two 110W solar panels on shutters for the south side and two for shutters on the east side of the lookout. We propose installing a mast for antennas on the Northeast corner of the lookout. The mast would be a pipe up to 2 inches in diameter secured to the floor of the deck with a flange and with bracing extending from the exterior roof rafters. This replicates park antenna installations at other lookout sites (Tolmie, Gobblers Knob.) We propose mounting two 900 MHz antennas (maximum dimensions approx. 12x12x6 inches flat panel or yagi.) This will require finding entry points for two LMR400 coaxial cables in the side of the structure. If there is not a pre-existing gap a hole no larger than 1.25 inches will be drilled to allow cable entry/exit in a minimally visible location by the deck. Cables will be run beside or under the deck to remain invisible. Any holes or cracks will be filled from the interior with insulating foam. All batteries, charge controllers, and electronic equipment will be housed in a 49x25x27 inch lockable aluminum enclosure in the basement of the lookout. The enclosure will not be visible to park guests. All exterior power and telemetry equipment will have in-line lightning protection and everything will be grounded to a master ground point in the enclosure that will then be grounded

	to a location determined by NPS staff to meet electrical code at the site. The physical installation of equipment will be adjusted spatially as needed to avoid any interference with NPS equipment and to minimize impact on the lookout structure. If desired we are willing to extend the solar panel mounting bracket installations to accommodate park solar panels, helping to minimize overall impact and visual discrepancy between multiple users' installations. Additionally the added antenna mast would be available for park use. We would advocate testing for any RF interference between users and taking steps including adjusting antennas and adding filters to radios and modems to minimize such interference. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two

	days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Battery powered construction equipment such as drills and hand tools common in carpentry.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* No
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* No
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* No
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Yes
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* Yes. The proposed site uses the lookout structure, which is a historic structure.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions. Visitors will see the mast and antennas installed on the lookout. It will not hinder the use of the lookout. Our installation will mimic masts installed at other lookouts and will be familiar to visitors that visit other lookouts.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park)

	3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There is an alternative site that is presented (Fremont Peak Alternative Site) that meets all of the requirements of the location. Because of the high winds and potential for icing in the area, the lookout site is much preferred. We believe that the use of the lookout will minimize the amount of maintenance required for this site over the alternative.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

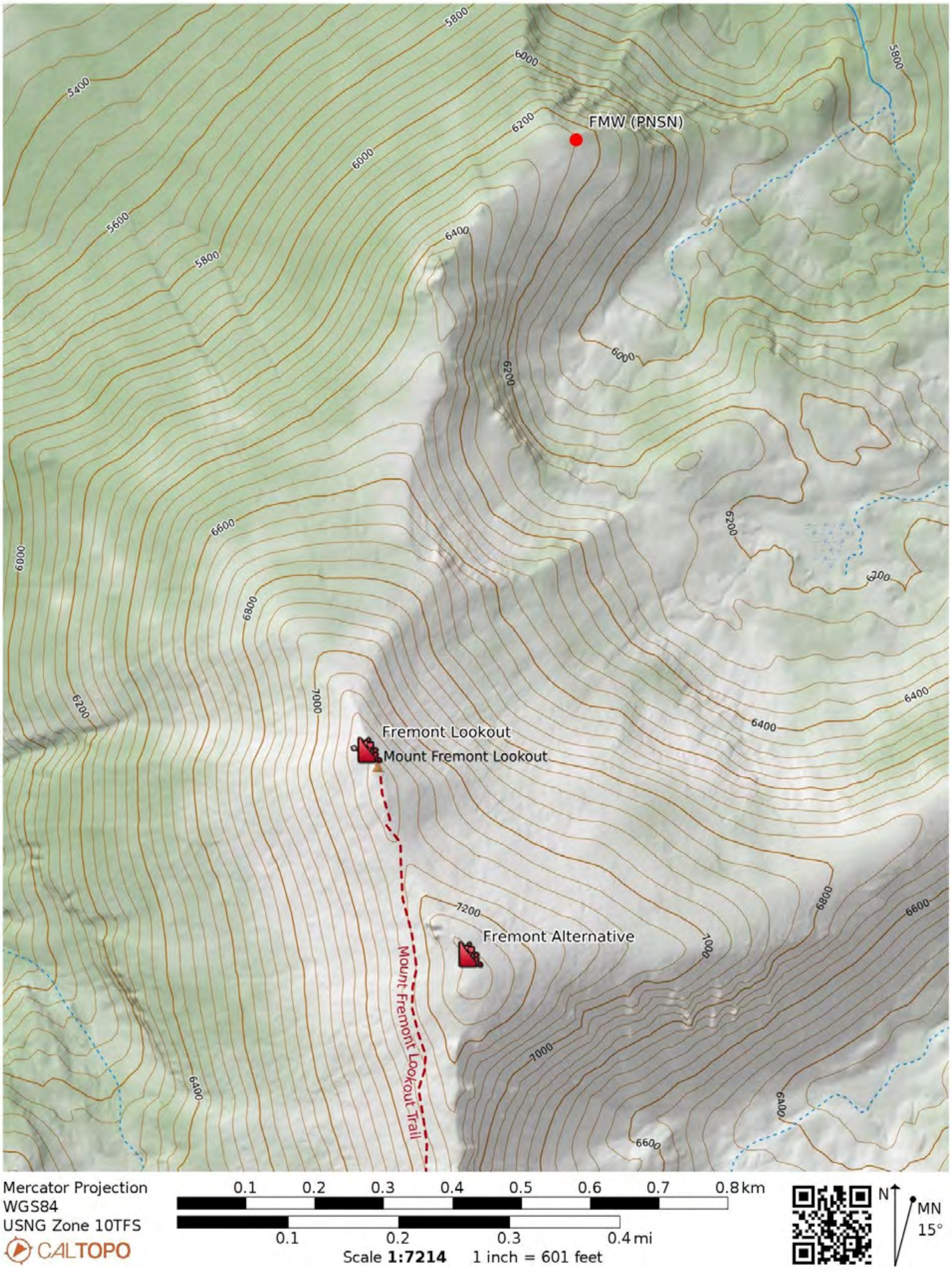


Figure 1: Location map.

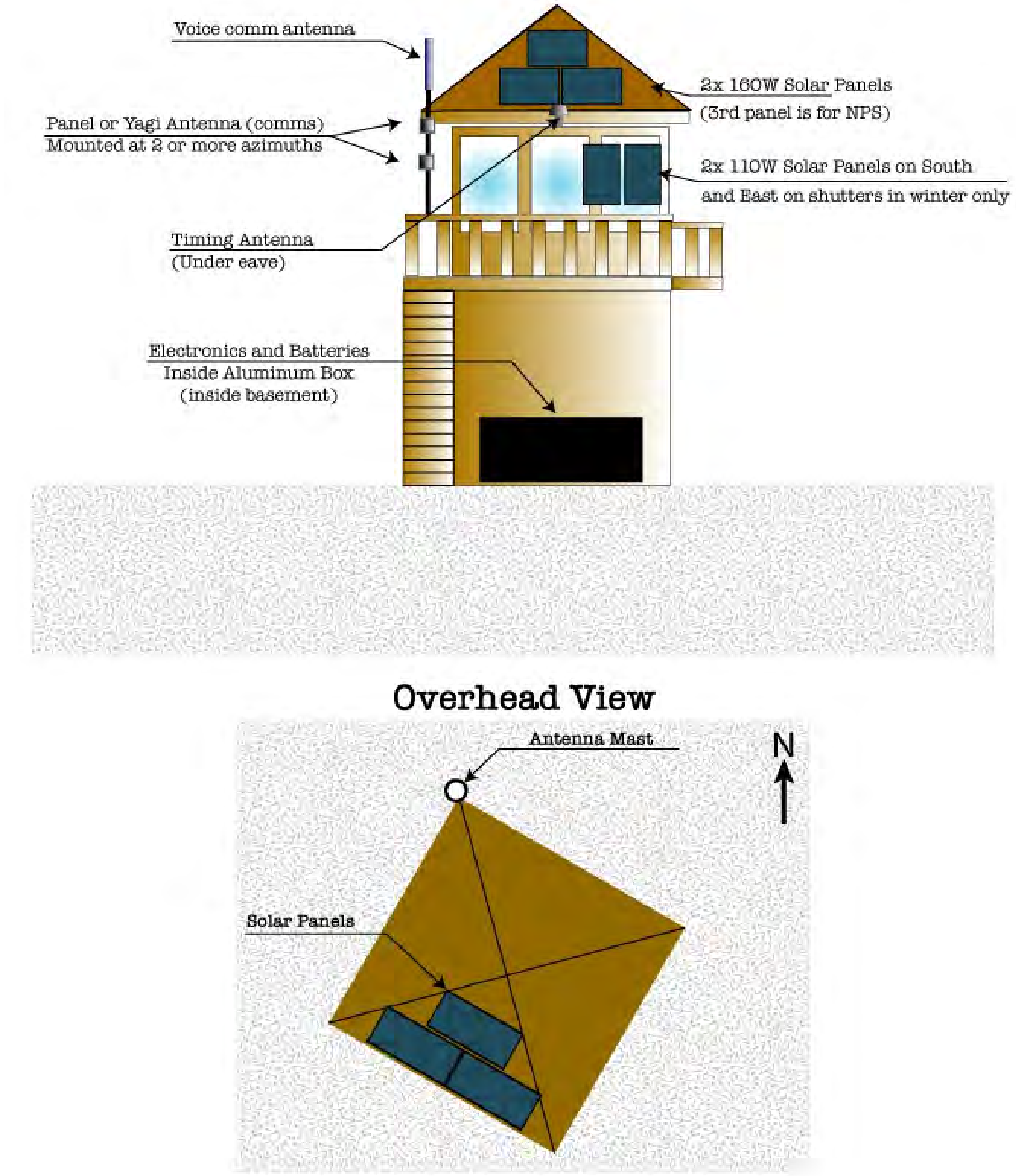


Figure 2: Schematic representation of proposal on the Fremont Lookout.

Figure 3: Photo of lookout looking North.


Figure 4: Viewshed into the West Fork of the White River from Fremont Lookout (looking approximately NNW).

Figure 5: Viewshed toward Mount Rainier from Fremont Lookout (looking approximately SW).

Figure 5: Photo of the antenna mast installed by the park at Tolmie Lookout. Bracing extends from the exterior roof rafters and the pipe is attached to the deck corner by a flange pipe mount. It is out of the way of the primary walkway on the deck. We propose a similar mast installation on the Northeast corner of Fremont Lookout.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Gobblers Knob Lookout
Project Location	46.79414, -121.91438
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Gobblers Knob Site are: • Southern exposure for solar panels • Robust structure that is resistant to heavy snow and high winds • Line-of-sight to Tahoma Bridge, Tahoma Vista, and Copper Mountain monitoring sites • Line-of-sight telemetry to existing repeater outside the Park (Puyallup Lookout or Tacoma Power Tower near Elbe) • Seismometer for improved surface flow localization Of all the proposed sites in Mount Rainier National Park, the Gobblers Knob site is the most critical, since its primary role is to serve as a radio repeater for three other proposed sites on the Tahoma Creek drainage that are each critical for early detection of lahars and debris flows. In addition, a seismometer at the site will help constrain surface flows down either the Tahoma Creek or Puyallup drainages. Without the Gobblers Knob repeater, there would be no other way to receive data from the other three sites without installing multiple additional stations to serve the same repeater function. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller

	debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instruments that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ~~o~~ ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other surface and subsurface processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation would include mounting two 160W solar panels to the south roof face and two 160W solar panels to the east roof face of the lookout structure. This will require mounting unistrut or Unirac flush mount rails too the roof. The rails or strut will be through-bolted to rafters under the lookout roof. Each solar panel has dimensions of approximately 58x26x2 inches. The mounting brackets would elevate the panels up to 5 inches above the roof surface but the panels would remain in the same plane as the roof face. Solar panel conductors will be insulated 2-conductor wire strapped to already-in-place copper conductors that run down the roof, under the rafters, and down the side of the building. The insulated solar wires will then enter the basement of the building through pre-existing cracks or holes between the upper and lower levels of the building. If an entry point does not exist we will drill a small (approx. 1 inch diameter) hole in a location between the upper and lower levels near the deck that is not clearly visible from the building's exterior. We also propose adding flexible solar panels to temporary shutters that are placed on the exterior of the lookout during winters. The vertical orientation and shielding from the roof eaves mean that panels in this location could survive harsh snow and icing conditions that may minimize the effectiveness of panels on the roof for some periods of time. The mounting and cabling would exactly mimic the park's installation of winter solar panels for their use. We propose mounting two 110W solar panels on shutters for

	the south side and two for shutters on the east side of the lookout when the shutters are installed on the structure. Additionally a very small 3x3x2.5 inch GNSS timing antenna (which provides accurate sub-second times necessary for usable seismic data) will be mounted under an eave of the lookout. It will be placed in a location that is not clearly visible unless directly under or adjacent to it. The cable will follow the solar panel conductors into the basement. We propose installing a mast for antennas on the Southeast corner of the lookout. The mast would be a pipe up to 2 inches in diameter secured to the floor of the deck with a flange and with bracing extending from the exterior roof rafters. This replicates park antenna installations at Gobblers Knob and other lookout sites. The mast would be available for park use. We propose mounting one-to-two 900MHz and/or cellular antennas on the pre-existing antenna mast on the N side of the lookout deck at the top of the stairs. We propose mounting two-to-three 900 MHz antennas to the newly installed mast in the SE corner. The maximum antenna dimensions will be approx. 12x12x6 inches (flat panel or yagi.) We will mount no more than four antennas total. This will require finding entry points for up to four LMR400 coaxial cables in the side of the structure. If there is not a pre-existing gap a hole no larger than 1.25 inches will be drilled to allow cable entry/exit in a minimally visible location by the deck. Cables will be run beside or under the deck to remain invisible. Any holes or cracks will be filled from the interior with insulating foam. We propose to install a seismometer in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the structure, preferably to the east, to remain invisible to park visitors. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the lookout to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. If an existing hole is present to run the cable into the basement of the lookout, then we will utilize it, otherwise we propose to drill a 2 inch hole as close to ground level as possible. The hole will be filled from the inside with insulating foam. All batteries, charge controllers, and electronic equipment will be housed in a 49x25x27 inch lockable aluminum enclosure in the basement of the lookout. The enclosure will not be visible to park guests. All exterior power and telemetry equipment will have in-line lightning protection and everything will be grounded to a master ground point in the enclosure that will then be grounded

	to a location determined by NPS staff to meet electrical code at the site. The physical installation of equipment will be adjusted spatially as needed to avoid any interference with NPS equipment and to minimize impact on the lookout structure. If desired we are willing to extend the solar panel mounting bracket installations to accommodate park solar panels, helping to minimize overall impact and visual discrepancy between multiple users' installations. We also advocate testing for any RF interference between users and taking steps including adjusting antennas and adding filters to radios and modems to minimize such interference. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will

	hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Battery operated power tools and hand tools commonly used in carpentry. Shovels, hoes, picks and breaker bars to dig the seismometer hole and trench for the seismometer cable.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. The area of soil disturbance for the seismometer will be no more than 4’x4’. Plus the area that is trenched between the seismometer and the lookout. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* Yes. The area that the seismometer is buried in and the trench that leads to the seismometer have the potential to disturb vegetation. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* No
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* Yes, the Gobblers Knob lookout is a historical structure.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions. Installation and maintenance of the station will be coordinated with the NPS. Visitors to the lookout would likely notice the antennas mounted on the mast on the structure, however the antennas and mast would not impact the lookout usage. The solar panels on the roof

	are very hard to see because of the steep topography around the lookout.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the

	proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. Despite an exhaustive search, there are no alternative sites in the area of Gobblers Knob that have an acceptable viewshed for incoming and outgoing data, large flat platform and excellent solar exposure. We searched to the north and south on the ridge that Gobblers Knob is situated on.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

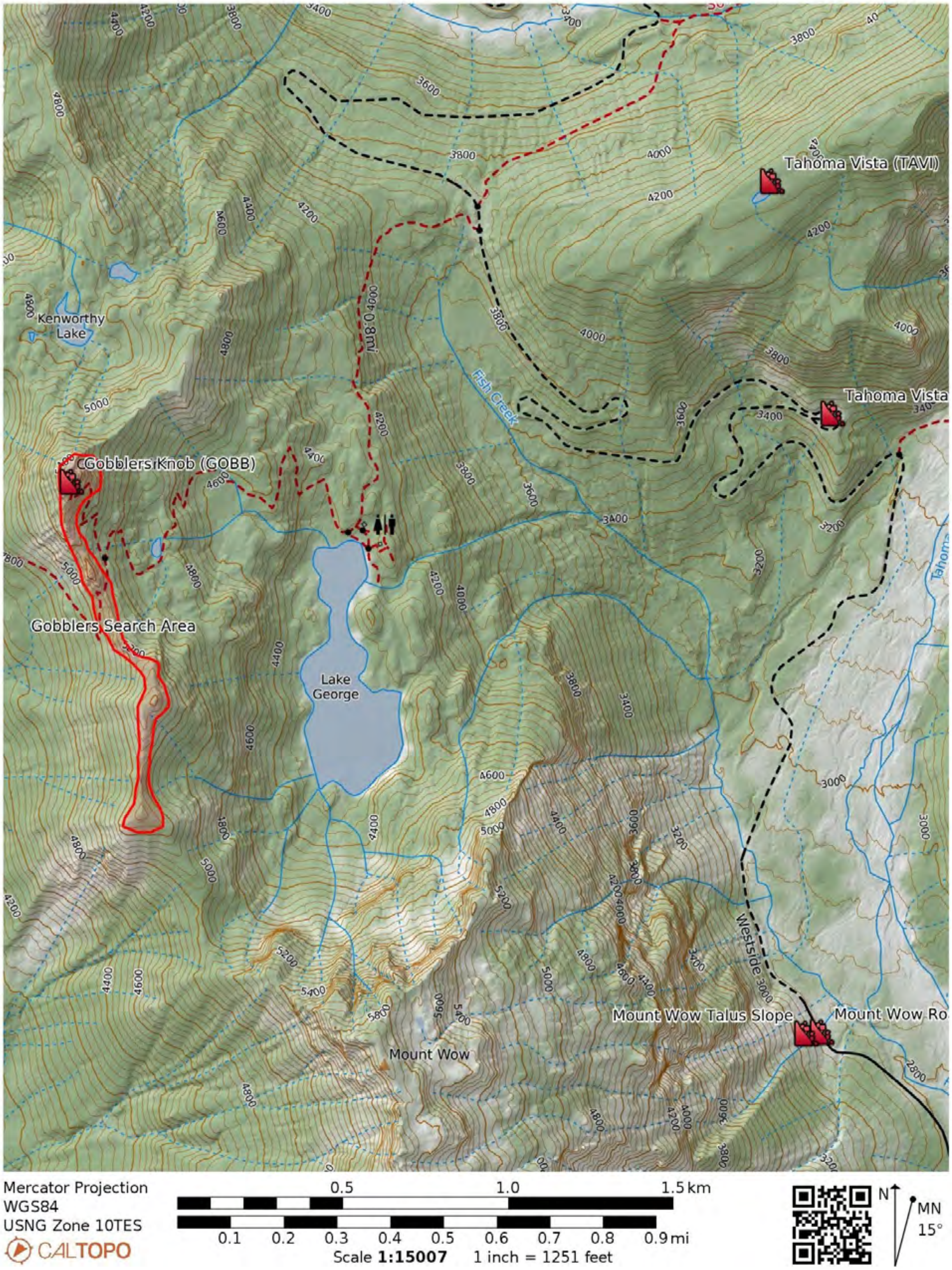
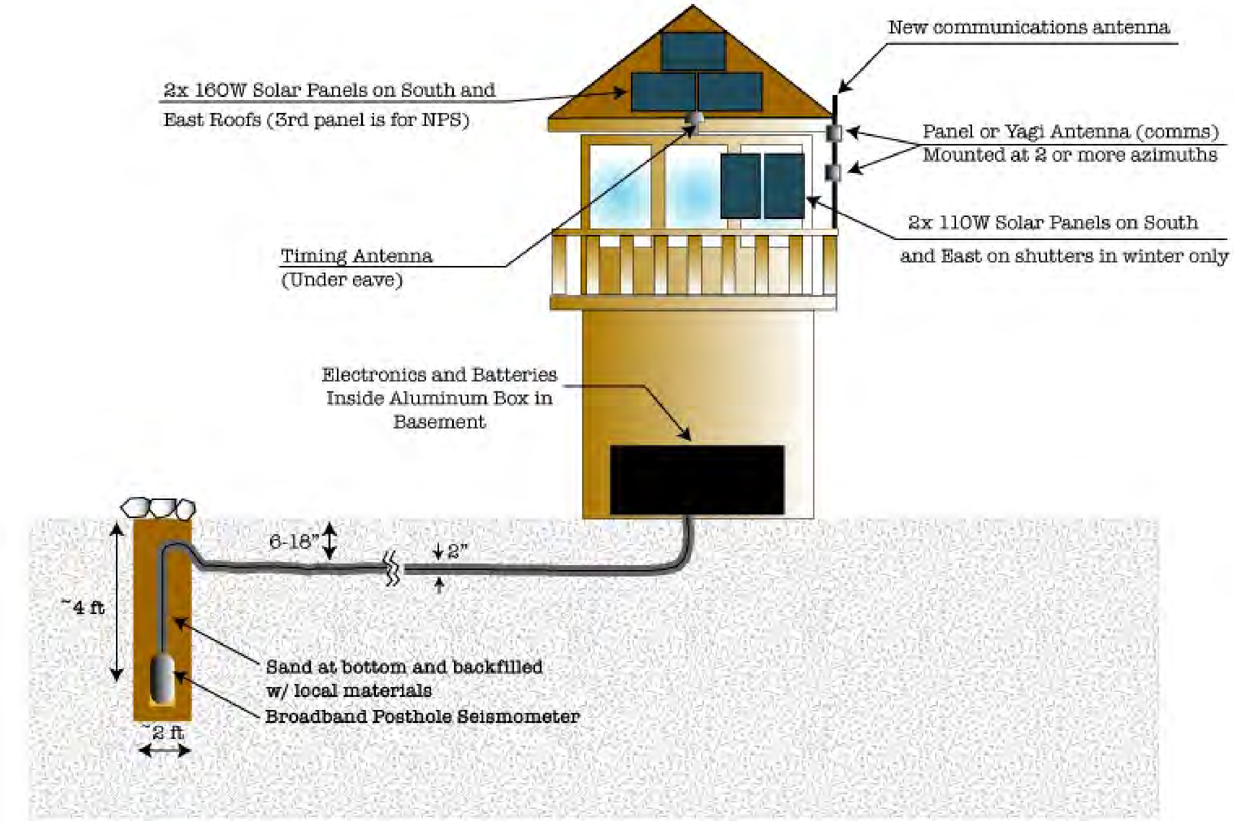


Figure 1: Location map with red shaded polygon showing the area that was physically searched for alternatives. A much larger search area was assessed using GIS before focusing on the red shaded polygon.



Overhead View

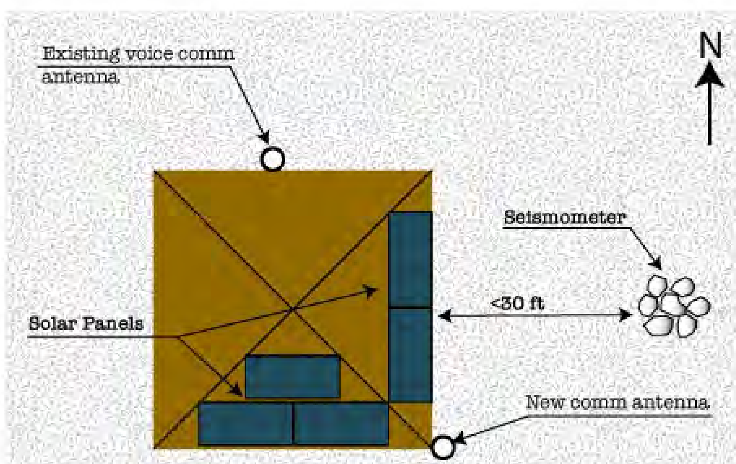


Figure 2: Schematic diagram of proposed installations on lookout.

Figure 3: Gobblers Knob lookout from the North. Note the existing antenna mast at the top of the stairs. The proposed seismometer location is to the left (east) among the trees in this picture.

Figure 4: The SE corner of the deck – proposed installation site for an additional antenna mast. Not all antennas can be mounted on the north side of the building because the structure blocks radio shots to remote sites.

Figure 5: View of Gobblers Knob lookout from trail approach to the south. The South and East roof faces (proposed locations of solar panel installations) are not clearly visible from any vantage point on the approach trail.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Mildred Point Monitoring Site
Project Location	46.8082, -121.7756
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Mildred Point Site are: • Southern exposure for solar panels • Line-of-sight to repeater (Paradise Tower) • Seismometer in vicinity of Kautz Creek and Van Trump Creek • Line-of-sight into Kautz Creek and Van Trump Creek for infrasound detection The Mildred Point Site is an important location in the detection system for the information that it provides for a debris flow or lahar down the Kautz Creek or Van Trump Creek drainages. Along with other data from nearby stations (Copper Mountain, Paradise Precip Tower, Longmire, Kautz), this site will provide critical information on a developing debris flow or lahar that could very quickly impact visitors and infrastructure downstream. Without this site, the detection of a debris flow could be ambiguous with respect to the drainage that is impacted, hampering emergency response. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods elsewhere in the park. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows is of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help researchers improve our understanding of their initiation

	and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentation that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other surface and subsurface processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner. This means that events would impact use areas within the park with effectively no warning and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries, with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. A solar panel will extend above the top of the hut, but the overall height will not exceed 9 feet. Attached to the respective sides of the hut will be two-poles (2.375-inch outer diameter) that extend 12 feet or less above the local ground surface that provide a support frame for the upper solar panel and will have a flat panel antenna (~1'x1') placed near the top of one pipe. The other pipe will then be cut on-site to a maximum of 9 feet above the ground surface. Solar controllers and lead acid batteries housed within the hut will power the equipment on site. Prior to placing the enclosure on the ground, six holes are dug approximately 2 feet deep and filled with concrete to make a sturdy foundation for the hut and for the two antenna/solar support poles. The ground between the holes must also be leveled using hand tools such as a shovel and rake. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut using hand tools to provide protection from static discharge. The hut and exposed equipment (except the solar panels, radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park.

	A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the enclosure. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ in aluminum or plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground near the seismometer, the other two units and windscreens will extend out no more than 100 feet away from the enclosure. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter slingloads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance.. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done.

	If helicopter access to the site is deemed to be essential, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatened and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the infrasound cables. The area of disturbance for the enclosure will be approximately 10 feet x10 feet x1 foot or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. The footings will be about 2 cubic feet each. We will also drive in a 5/8" copper grounding rod to a depth of 8 feet. Only the very top of the grounding rod will protrude above the local ground surface. The area of soil disturbance for the seismometer will be no more than 4'x4'. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.*

	There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* The site lies approximately 300 m from both the Kautz Creek and Van Trump Creeks.
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* The site lies in the Wilderness, however it is not accessible from any trail (major or otherwise). There is no visibility from Mildred Point and limited visibility from Van Trump Park. The site can likely be seen from above.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. Climbers may be able to see the station from above, but only from a great distance. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park)

	3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

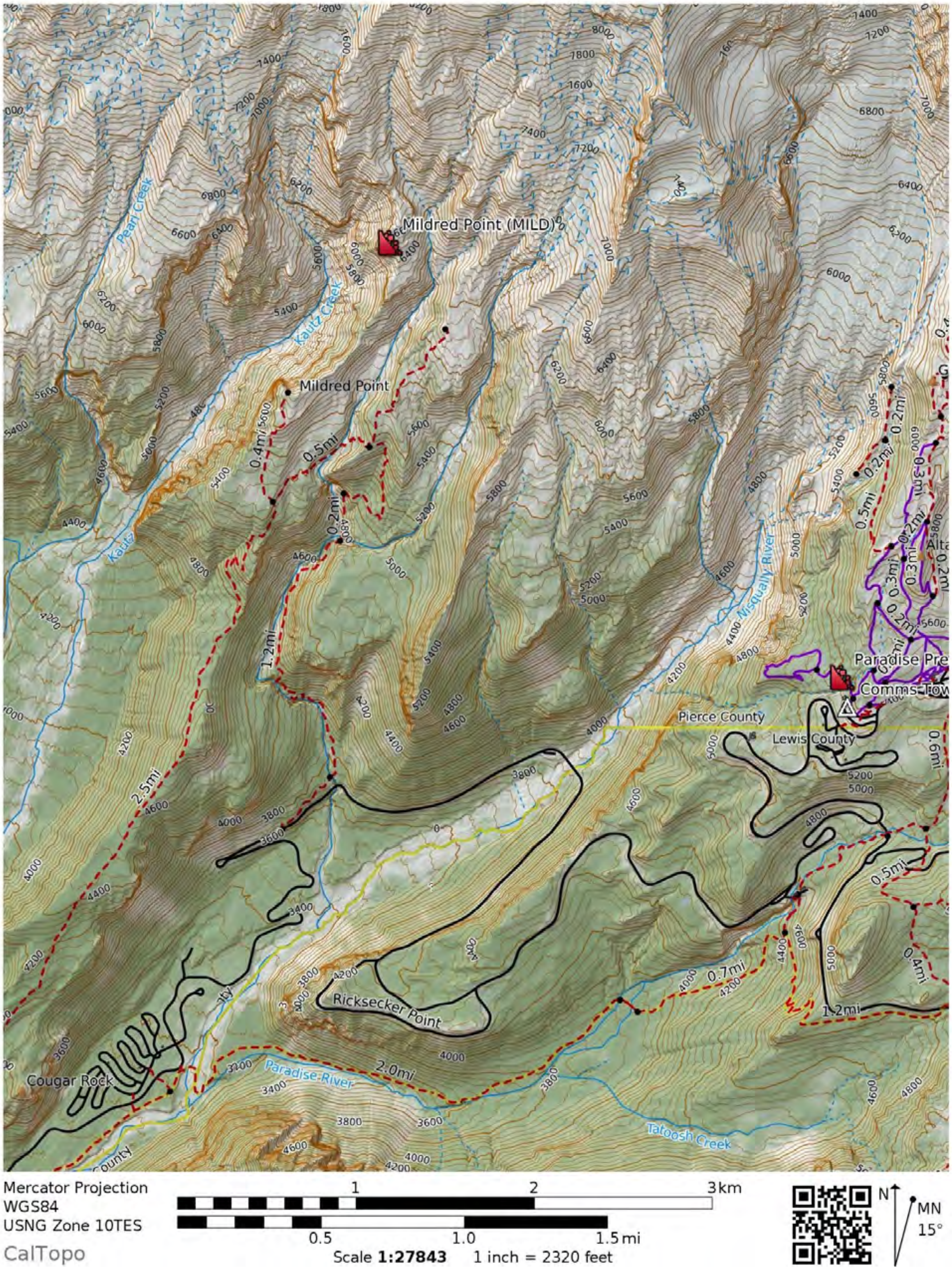


Figure 1: Mildred Point Site Location map. The site transfers data via the Comms Tower at Paradise at the middle right of the map.

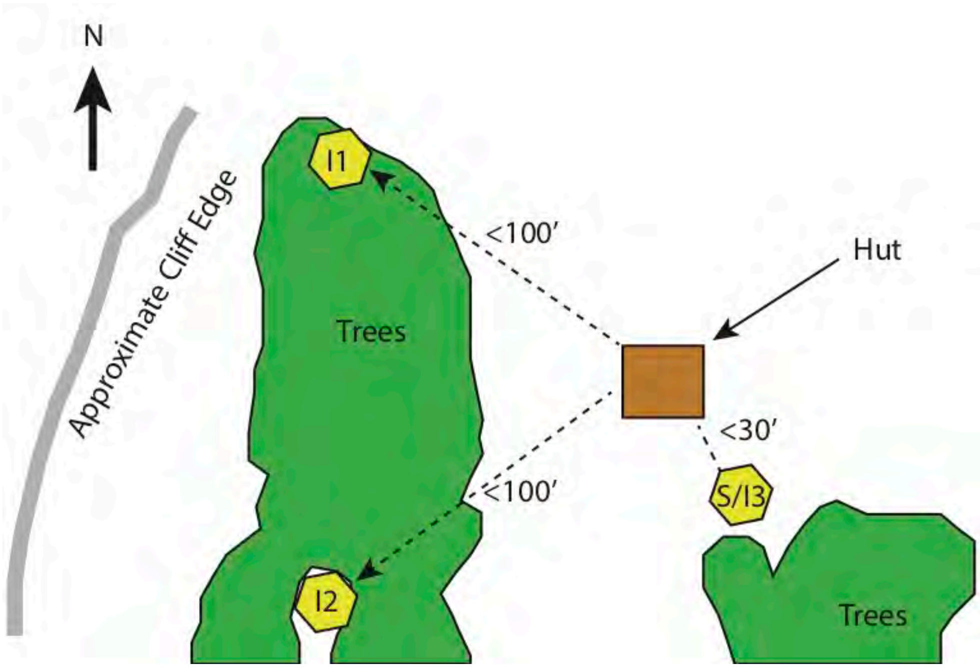


Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.

Figure 3: Proposed enclosure site near the location of the tripod looking to the southeast toward Paradise. The seismometer (S) and infrasound (I1 site) are proposed near the flat downhill from the tripod. Notice that the trees in the middle of the photo block views from much of Van Trump Park.

Figure 4: Proposed site for infrasound (I2) in the trees at the left of the photo. On the other side of the trees is the canyon that drops into the Kautz Creek Drainage.

Figure 5: Proposed site for infrasound (I3) looking from above back toward the enclosure. Infrasound windscreen will be tucked into trees at the right of the photo.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Mount Wow Monitoring Station (Road)
Project Location	46.77971, -121.88484
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to allow affected populations to evacuate to high ground before a lahar arrives.

	The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Mount Wow Site are: • Southern exposure for solar panels • Line-of-sight telemetry to repeater (Mount Ararat) • Seismometer along North-South reach of Tahoma Creek The Mount Wow site is important to be able to track the progress of a lahar advancing down the Tahoma Creek drainage. This site will be able to give us our last observation of the flow front before it begins to impact infrastructure and populations downstream. Having a site at or near this location will help us refine our arrival times downstream and provide relevant information to emergency managers for the purposes of evacuations. Without this site, our estimates of arrival times of the flow to the Gateway Entrance Station and Ashford would be less accurate. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instruments that will provide even higher fidelity datasets that are critical for

	informing models of debris flow generation and movement. Such models will ultimately lead to an improved ~~o~~ ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other surface and subsurface processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner. This means that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries and with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. Attached to the hut will be a pipe (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface that will have a flat panel antenna (~1'x1') placed near the top. Within the hut, solar controllers and lead acid batteries will power the equipment on site. The hut will be secured by driving 1 inch rebar through the flanges of the hut into the road, one on each corner. The goal is to drive the rebar to a depth of 2 feet. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut to provide protection from static discharge. Four 7/8" diameter 1-foot long pieces of rebar or bolts will be driven into the road to secure a pipe flange to stabilize the antenna pipe. The hut and exposed equipment (except the solar panels and radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. The seismometer will be placed on the ground inside the hut for security purposes. A single infrasound sensor will be placed inside the enclosure with air ports to the outside. The infrasound will not change the footprint of the station nor require any additional digging.

	Maintenance will be done by vehicle and by foot in coordination with the NPS. In the case of an emergency winter repair, snowmobile access may be required along the westside road.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	September/October 2021 & 2022, depending on compliance, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels and garden hoes for in order to level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	No
Will there be soil disturbance (e.g., trenching, digging, excavating)?	Yes. Soil disturbance will be necessary to prepare the surface for the enclosure. The area of disturbance for the enclosure will be approximately 10’x10’x1’ or less. The enclosure is smaller, but we are including the disturbed area for the foot traffic around the enclosure. We will also drive a ground rod within that footprint and drive shorter rebar into the ground at the corners of the hut and at the pipe flange to secure the hut and pipe to the ground.
Will there be vegetation disturbance?	Grass on the side of the Westside Road would be disturbed.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	The site is < 100 m from the Tahoma Creek drainage, but would reside on a slope elevated above the floodplain or any aquatic habitat.
Is the location in Wilderness or Potential Wilderness?	No
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	The proposed site is on the Westside Road and thus in the NHLD. It would be highly visible for all visitors using the Westside Road to recreate. The high visibility gives us an opportunity to educate visitors on the hazards in the area they are about to enter.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	Visitors and park staff would be impacted during the 1-2 day installation of the site. The site is on the side of the Westside Road and would be visible for any visitor using that road. As it is proposed in a wide spot on the side of the road, access will not be affected. Interpretive information or exhibits should be included in the project to ensure park visitors are informed of the purpose of the station. The site has been selected in consultation with the geology and road maintenance crews. The site is beyond the area used to store spoils from the nearby drainage. It is also beyond the area plowed in the winter.
Is utility locate required?	No. While location is a park road there are no active utilities in the area.
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices)

	2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There are other sites along the road that may work, especially north of the gate, however they have the potential to interfere with the work of the road crew. There are other sites in the talus cone to the West that meet the requirements stated above. The most feasible site is proposed as

	an alternative, “Mount Wow Monitoring Station (Talus Slope)”. Our preference is a site that is on the road as it will eliminate the need for helicopter support to install and maintain the site. It is also less likely to be impacted by any rock slides or falls or snow avalanches that occur on the talus slope and associated avalanche chute. These hazards could also present a danger to crew during maintenance visits to the site on the talus slope.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

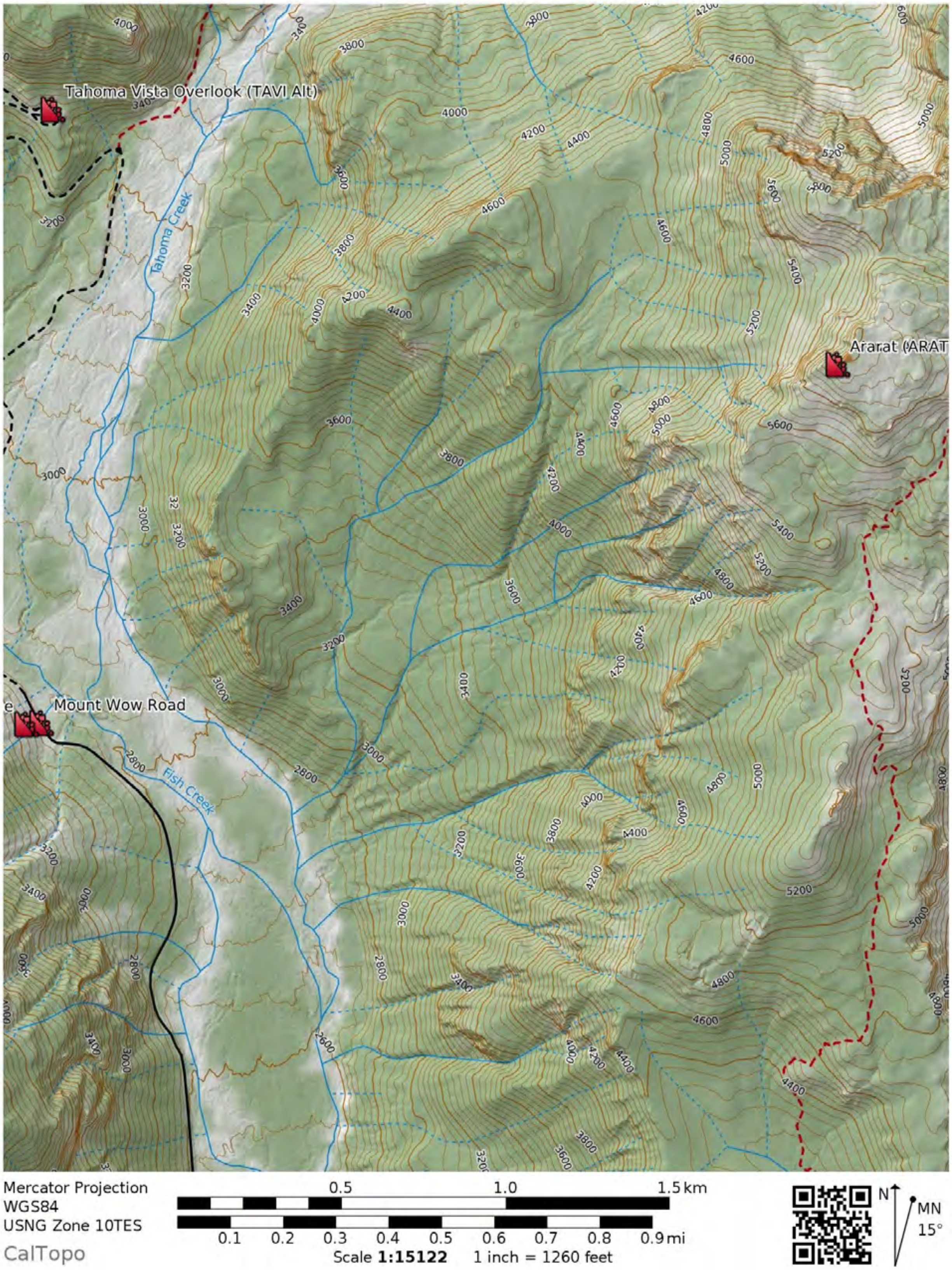


Figure 1: Location map showing the Ararat repeater to the east.

Figure 2: Location map showing the Mount Wow Road site (proposed here) and the Mount Wow Talus Slope site (proposed as an alternative).

Figure 3: Image of proposed site just in front of model. The seismometer will be placed on the road surface inside the footprint of the hut. An infrasound sensor would also be placed inside the footprint of the hut. Note gate in distant background.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Mount Wow Monitoring Station (Talus Slope)
Project Location	46.7791, -121.8852
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Mount Wow Site are as stated in the Mount Wow Road Site: • Southern exposure for solar panels • Line-of-sight telemetry to repeater (Mount Ararat) • Seismometer along North-South reach of Tahoma Creek The Mount Wow site is important to be able to track the progress of a lahar advancing down the Tahoma Creek drainage. This site will be able to give us our last observation of the flow front before it begins to impact infrastructure and populations downstream. Having a site at or near this location will help us refine our arrival times downstream and provide relevant information to emergency managers for the purposes of evacuations. Without this site, our estimates of arrival times of the flow to the Gateway Entrance Station and Ashford would be less accurate. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations

	will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentations that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner. This means that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries and with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. (2.375" outer diameter) that extends 12 feet or less above the local ground surface that will have a flat panel antenna (~1'x1') placed near the top. The pipe will be stabilized at the base with a pipe flange that will be bolted to the rock using four 8" long, 7/8" diameter bolts and epoxy. Prior to placing the enclosure at its final location, four additional 8" long ½" diameter bolts must be drilled in the rock and glued (epoxied) in to fix the hut flanges to the rock. Four 5/8" diameter holes and four 1" diameter holes will be drilled no deeper than 9" into the rock using a battery operated SDS Max rock drill. The rock between the holes must also be leveled and de-vegetated using tools such as a sledgehammer, battery operated drill or rock hammer. To provide grounding for the site, a faraday cage will be constructed between the mast and the ground, requiring drilling of up to four additional 5/8" diameter holes for additional rock bolting. The hut and exposed equipment (except the solar panels and radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park.

	A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 80 feet from the enclosure. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be run over and between rocks or in a hand dug trench to a depth of up to 2 feet. A single infrasound sensor will be placed inside the enclosure with air ports to the outside. The infrasound will not change the footprint of the station nor require any additional digging. Because of the rugged location of the site, a helicopter will be required to transport equipment for the initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, accept helicopter loads. In the case of an emergency fix in the dead of winter, personnel may require snowmobile transit to the base of the slope and a helicopter for equipment transport. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance.. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a "tuning" visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. A battery powered rock drill will be used to install bolts to secure the enclosure and antenna pipe to the rock surface and construct the

	faraday cage by adding rock bolts for bonding metal parts and DC ground components together.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. The area of soil disturbance for the seismometer will be no more than 4'x4'. There will be some additional surface disturbance while leveling the rock surface for the enclosure.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* The site is < 200 m from the Tahoma Creek drainage.
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Yes
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* The proposed site is highly visible from the Westside Road (NHLD). It would be highly visible for all visitors using the Westside Road to recreate.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Visitors and park staff would be impacted during the 1-2 day installation of the site. The site is highly visible from the Westside Road and would be visible for any visitor using that road.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices)

	2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. This site is presented as an alternative to the Mount Wow road site, however installation would be much more impactful because of the use of helicopters, and maintenance much more difficult because of the challenging terrain. Local rock slides and avalanche

	hazards could endanger crews and station infrastructure. Our strong preference would be the road site.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

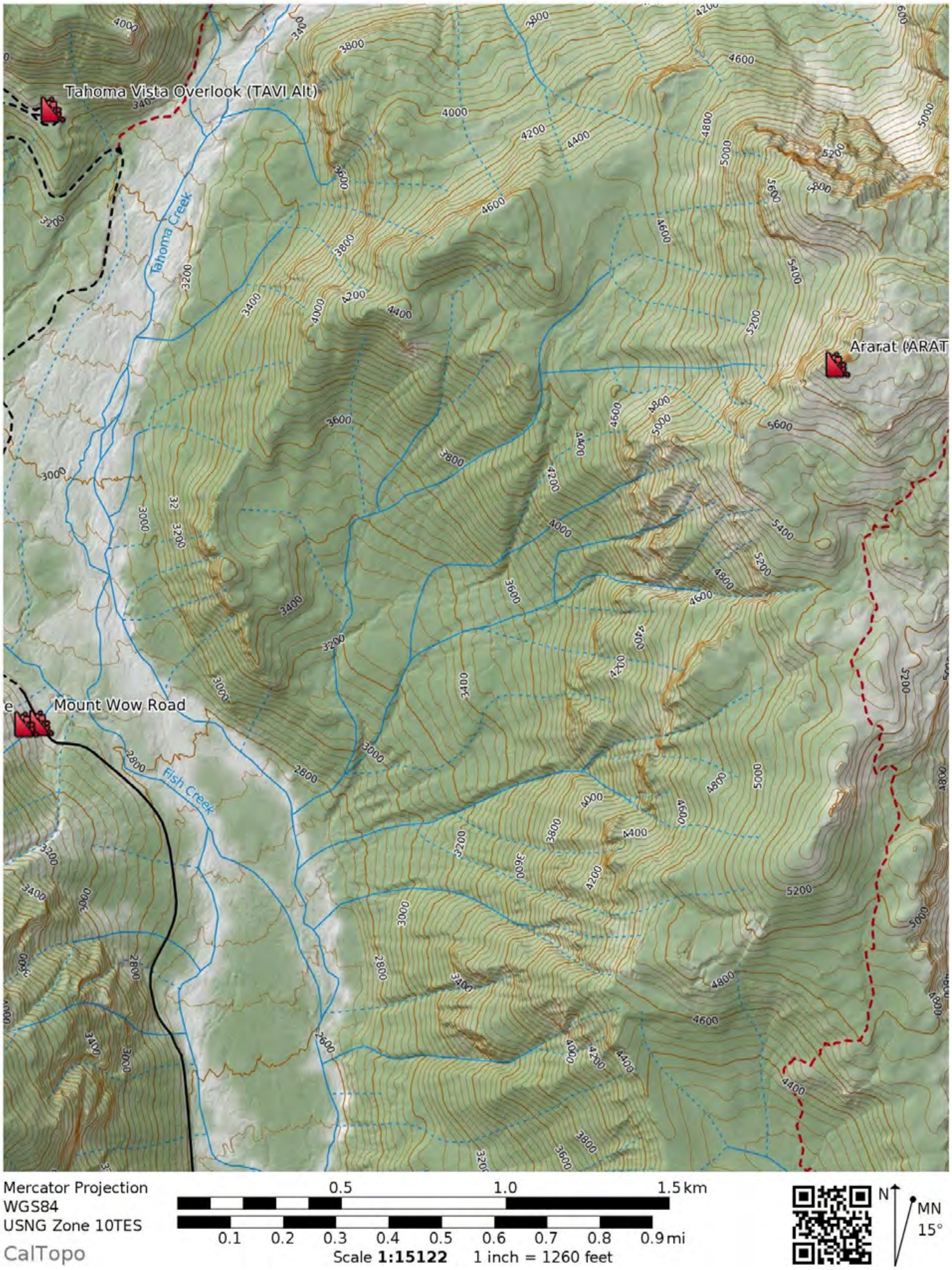


Figure 1: Location map showing the Ararat repeater to the east.

Figure 2: Location map showing the Mount Wow Road site and the Mount Wow Talus Slope site (proposed here as an alternative).

Figure 3: Image of proposed site looking down at the Westside Road gate. The seismometer will be buried in a location within 40 feet of the enclosure. An infrasound sensor would be placed inside the footprint of the hut.

Figure 4: Image of proposed location as viewed from gate on Westside road.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Paradise Communications Tower
Project Location	46.7848, -121.7419
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

allow affected populations to evacuate to high ground before a lahar arrives.

The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages.

Specifically, the USGS is proposing to install an modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact.

The requirements for the Paradise Communications Tower Site are:

- Line-of-sight to Mildred Point Monitoring Site
- Line-of-sight to Mount Ararat Monitoring Site
- Line power
- Network connection

The Paradise Communications Tower is critical for acquiring data from the Mildred Point site, Mount Ararat site and Mount Wow site. This proposal makes use of the existing infrastructure to acquire remote sites in a robust fashion.

In addition to the less-frequent large lahars, data collected using this station and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park, which is important both for situational awareness and hazard mitigation within the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare and will help our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instrumentations that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ~~o~~

	ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially more. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas within the park with effectively no warning, and ~~reducing~~ the warning time would be reduced for areas outside the park.. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged. Maintenance will be by vehicle and coordinated with the NPS.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include two 900MHz yagi antennas mounted to the Rohn 45 tower that already exists in the median of the parking lot. Antennas will be mounted below Northwest Avalanche Center (NWAC) and National Park antennas and boxes. The yagi antennas will be oriented toward Mildred Point and Mount Ararat. The antennas will most likely be mounted about 15 feet high on the North leg of the tower with adjustments to exact mount location to be made as necessary on installation. After remote installations are completed it is possible that only one antenna will be needed and the second can be removed to reduce load on the tower. Below the antennas we will mount a small NEMA enclosure to the tower. The enclosure will contain the 900 MHz radios and either an Ethernet extender or a cellular modem. The NEMA enclosure will have power coming in via park power already run under the road to the nearby maintenance building. The coaxial cables from the two yagi antennas will terminate at the box and have in-line lightning protection. Additionally, an enclosure (approximately 12”x9”x7”) will sit at the base of the tower and house a backup battery to keep telemetry equipment live during brief power outages. This mimics the installation used by NWAC. Should existing Century Link Internet be determined to be the best option for transmitting data to CVO, an Ethernet extender in the NEMA enclosure will connect to one end of a copper pair run

	from the generator building with an Ethernet extender at that end as well. This will provide a link to Jackson Visitor Center internet. If the cellular modem option is selected this additional copper run will not be needed. Ultimately both options will have the same visual impact on the tower. We would advocate testing for any RF interference between users and taking steps including adjusting antennas and adding filters to radios and modems to minimize such interference. If tower stability becomes a concern as part of this installation or in the future with aging and wind/ice loads we propose installing guy wires from the tower to points in the ground contained in the same median that the tower is located in. This would consist of either 3 or 4 guy anchor locations located about 25 feet horizontally from the base of the tower and spaced evenly around the tower (either 120 or 90 degrees apart, respectively). Each anchor would require a concrete footing to be dug and poured. Exact locations of the footings/anchors would best be determined by a tower engineer.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance and crew availability. One day to complete full installation by USGS crew of 2 to 3, who will drive to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels and hoes to prepare the area at the base of the tower for our box. If guy lines are used, mechanical devices may be used to dig the holes for the footings.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes, concrete if guy wires are required
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes, if guy wires are required.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* Potentially, if guy wires are required.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* No
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No

Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Park staff may be affected during the installation of the antennas on the tower and installation of the guy wires if deemed necessary. Park staff may choose to be present during installation and maintenance to provide guidance for mounting locations that minimize impact on other users. Park staff involvement will be required for connecting to line power at the tower location (and for network connection, if park Internet is used.) Otherwise, our proposal uses an existing tower and thus we are not adding new infrastructure except for small antennas on the tower and a box at the base.
Is utility locate required?	Yes, if guy wire anchor footings must be installed.
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources

	and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

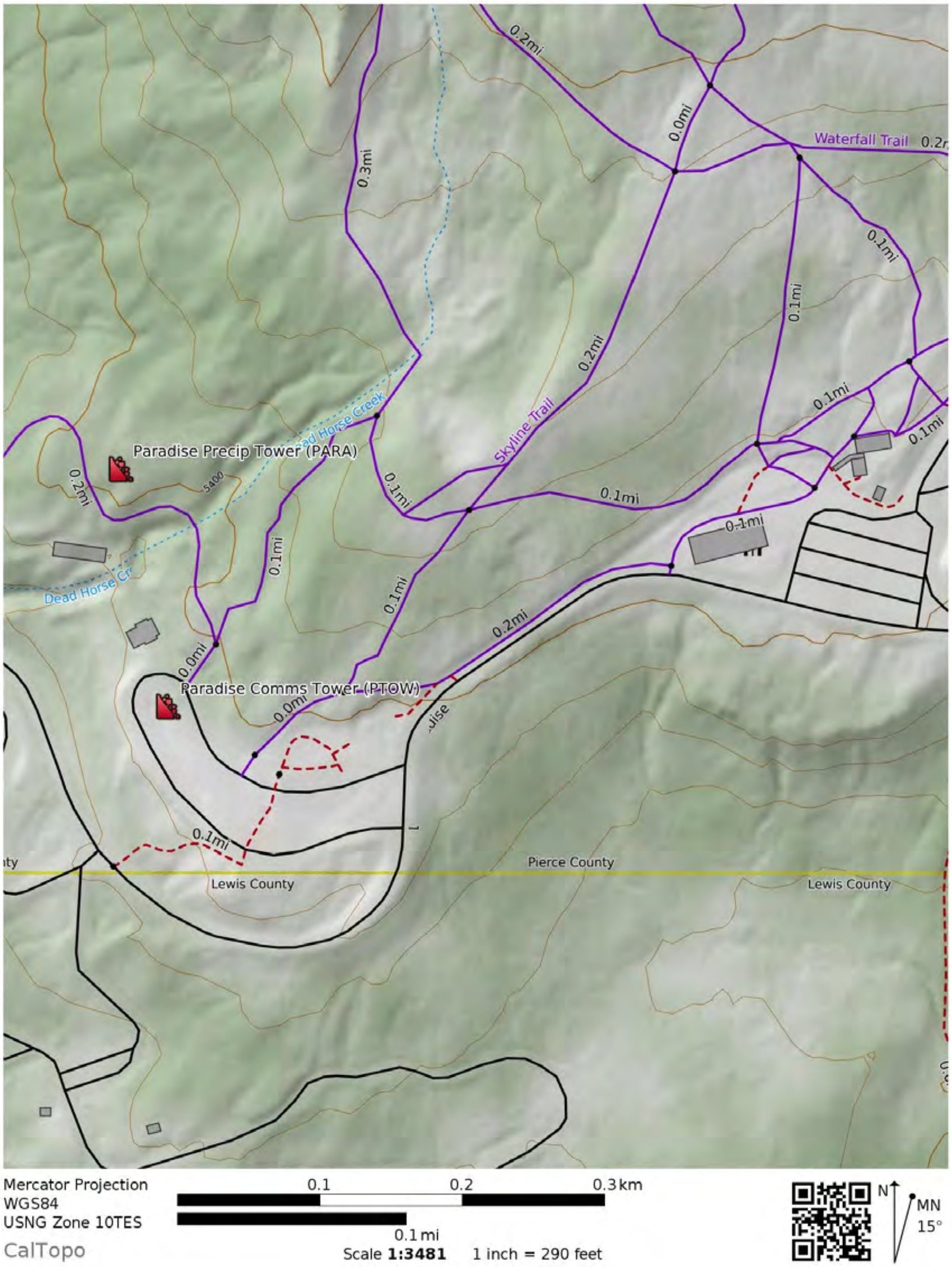


Figure 1: Location map. The Paradise Comms Tower (PTOW) is located between the upper and lower overnight lot.

Figure 2: Picture of tower from parking lot. Our proposed box would be located on the ground and proposed antennas mounted just above the tops of the trees.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Shriner Peak Alternative Site
Project Location	46.8112, -121.5300
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. In high-hazard drainages, such as the Puyallup River and Tahoma Creek, a permanent dense network is proposed to protect against a spontaneous collapse. Other drainages are proposed to have sparser networks composed largely of repeaters at high points in order to rapidly expand monitoring if the lahar hazard assessment of a drainage were to increase. A bulge of the volcano during unrest is one example of how the lahar hazard in a drainage could increase. This site is an example of one of those repeaters. The requirements for a Shriner Peak Site are: • Southern exposure for solar panels • Large viewshed into SE side of Mount Rainier and Ohanepecosh drainage • Seismometer on E side of Ohanapecosh River • Line-of-sight telemetry to existing repeater (White Pass) or LTE cellular signal for a data backhaul The Shriner Peak site is important as a robust radio repeater that would enable rapid expansion of the network in case significant volcanic unrest occurred at Mount Rainier – an event that would significantly increase the likelihood of a large lahar down multiple drainages of Mount Rainier, including the Ohanepesh River. To act as a repeater, the Shriner Peak site requires radio antennas pointed into the upper reaches of the Ohanapecosh River and Backbone Ridge. In addition, the seismometer that would be a part of the Shriner Peak site would significantly improve volcano monitoring capabilities of the existing network, which has only two seismometers on the southeast quadrant of the volcano and Park. The seismometer would also provide data important for

	constraining the location of surface flows on the east side of the volcano. Without this site, in the event of volcanic unrest the USGS would require days, weeks, or even months to establish a repeater on the east side of the volcano, particularly if unrest occurred from late Fall to early Spring when heavy snowfall is present. This would result in a potentially significant delay in the USGS installing instrumentation needed to give Park personnel and visitors, as well as communities in the Cowlitz River drainage, timely warnings of impending hazardous events, including large lahars.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a 6'x6'x6' enclosure with a footprint of 10'x10'. Mounted on top of the structure will be 3 solar panels, making the total height of the structure approximately 12'. On one side of the structure, a mast (4" pole) will extend up to 20' above the local ground surface. On the mast, no more than four antennas (maximum dimensions ~1'x1'x6" flat panel, yagi, or omnidirectional) will be mounted near the top of the mast to stay clear of snow in the winter. Contained within the enclosure will be lead acid and air cell batteries, along with solar controllers and electronics to enable power distribution and monitoring. The enclosure and exposed equipment (except the solar panels, radio antennas) will be painted brown to minimize visibility. The structure has a tolerance of 18 inches for leveling purposes and thus it may be required to level the area within the footprint with a shovel and/or rake to meet that specification. The structure itself sits on four concrete pads on top of the ground; however, metal baskets on top of the pads help weigh the structure down. The self-supporting structure was selected as the design minimizes ground disturbance. We will also drive a 5/8" copper rod to a depth of 8' for grounding purposes. Other visibility mitigation measures, such as ghillie netting, will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the enclosure (Figure 3). The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the

	sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ inch plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground near the seismometer (~30 feet away), the other two units and windscreens will extend out no more than 100 feet away from the enclosure. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow this guidance in order to minimize our impact on sensitive animal species: Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed. The initial installation of this sites may require the use of a Type 2 helicopter because of the weight of the chosen enclosure.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by an enclosure installer and USGS crew of 3 to 4, who will hike to the site. Maintenance will be

	performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. Battery powered tools may also be required during installation and/or maintainance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the seismometer and infrasound cables. The area of disturbance for the enclosure will be approximately 12’x12’x1’ or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. We will also be driving a 5/8” copper rod to a depth of 8’ within the footprint of the site. Heavy rocks may be locally sourced to fill the baskets on top of the concrete pads. The area of soil disturbance for the seismometer will be no more than 4’x4’. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* *Yes*

Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources

	and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. This site is presented as an alternative to the Shriner Peak Lookout. Both sites fit the requirements of a site in this area. Because of the high winds and snow in this area, the lookout site is much preferred. It is our estimation that the use of the lookout will require less maintenance than the this alternative site.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

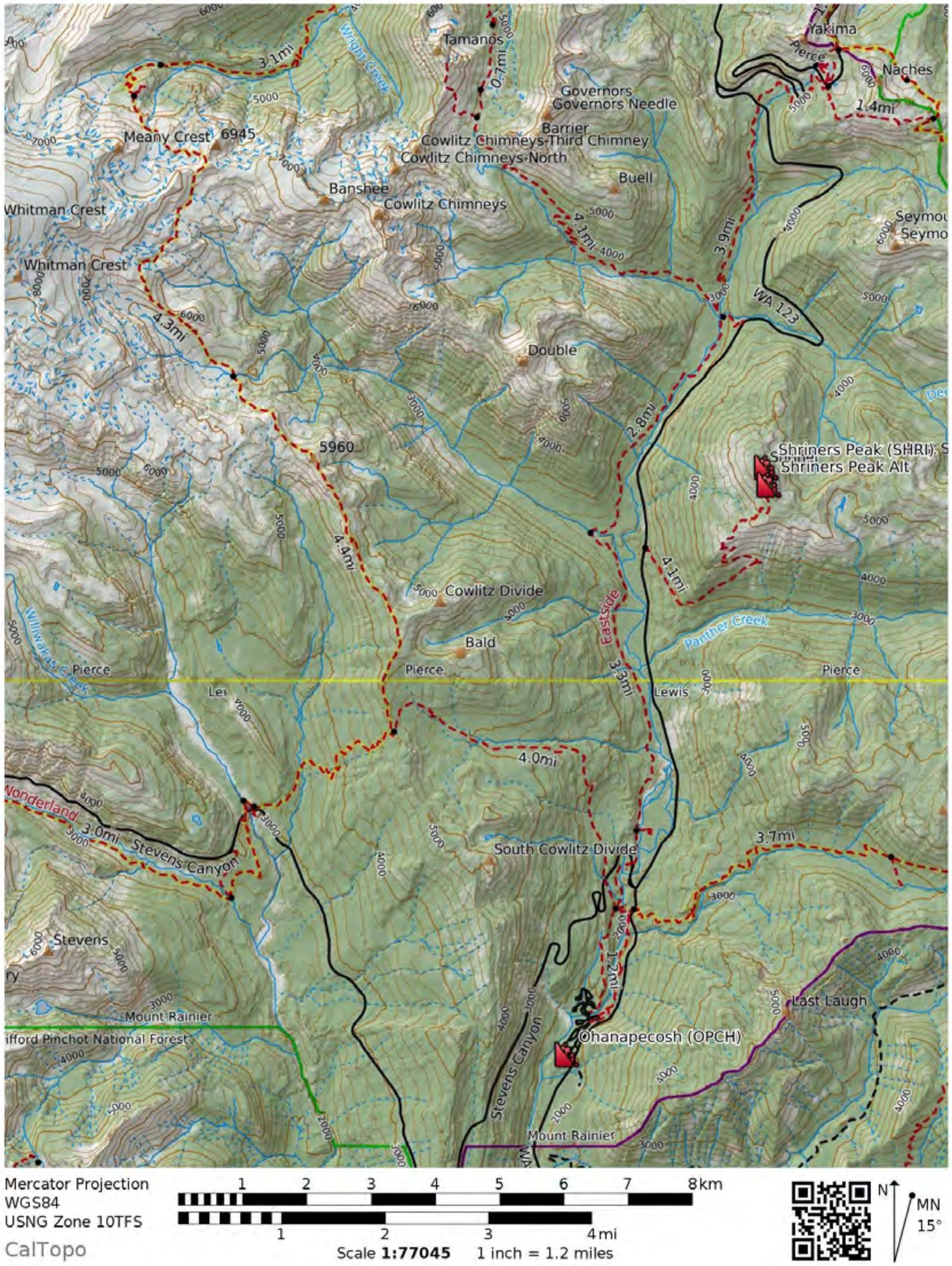


Figure 1: Location map. Shriner Peak Lookout and alternative site are shown on the east side of the Ohanapecosh River.

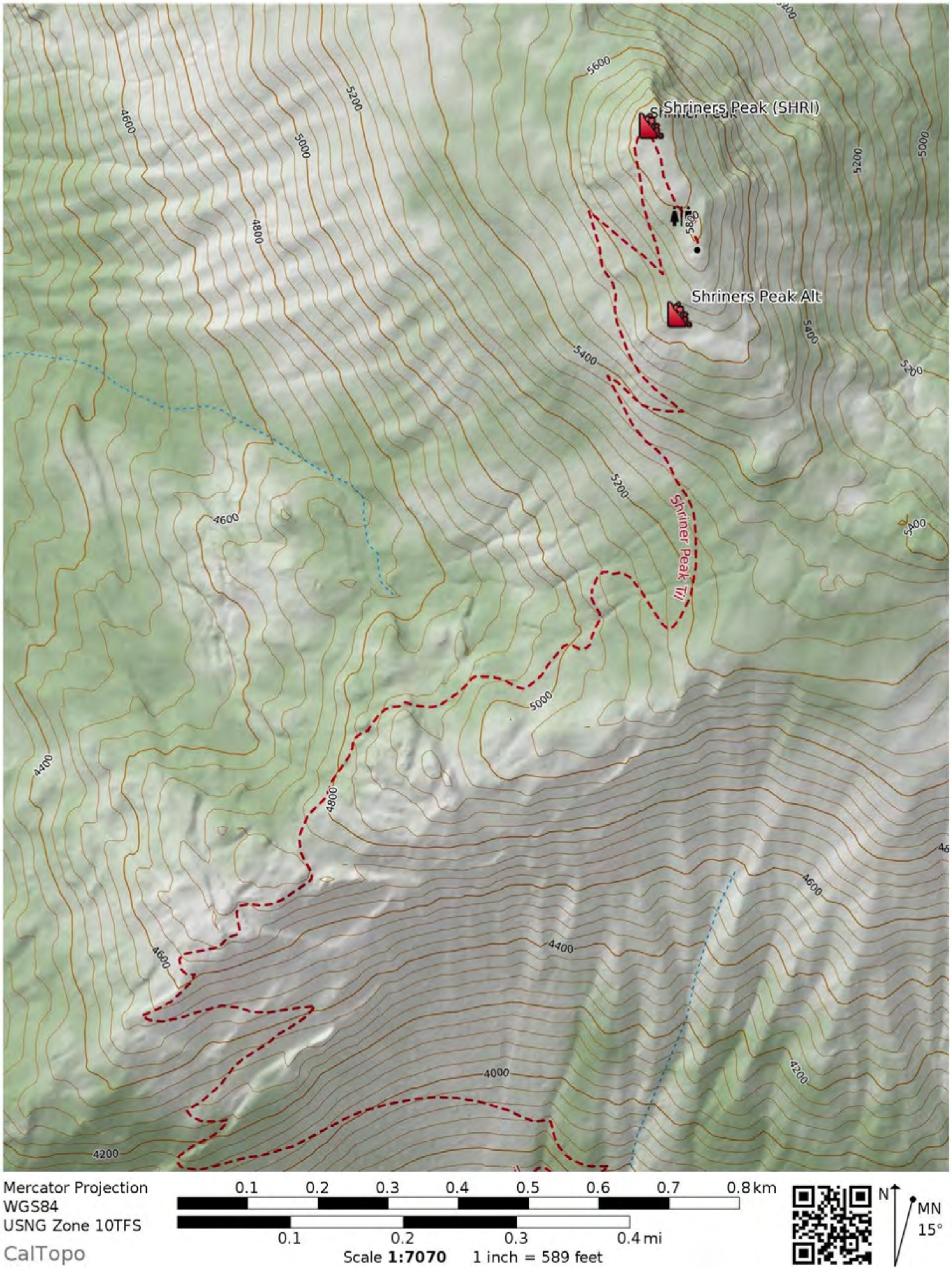


Figure 2: Zoomed in map of Shriner Peak Lookout (SHRI) and Shriner Peak Alternative site.

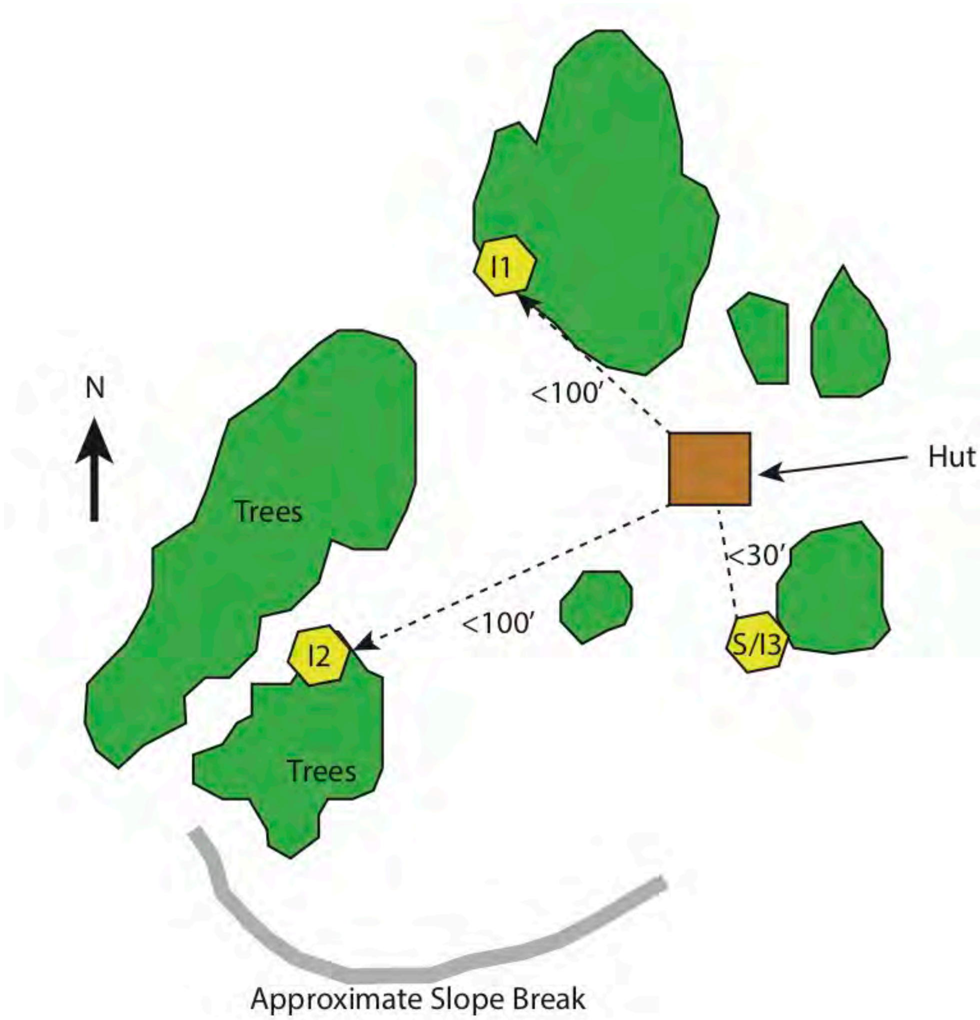


Figure 3: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.

Figure 4: Proposed enclosure site location.

Figure 5: Proposed site for infrasound (I1) looking from enclosure. Site will be placed under the live trees.

Figure 6: Proposed site for infrasound (I2) looking from the enclosure. Infrasound will be placed in the trees on the right. In the background is Backbone Ridge and the Tatoosh Range.

Figure 7: A Pepro LLC structure installed in a similar configuration to what is being proposed.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Shriner Peak Lookout Site
Project Location	46.8137, -121.5305
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. In high-hazard drainages, such as the Puyallup River and Tahoma Creek, a permanent dense network is proposed to protect against a spontaneous collapse. Other drainages are proposed to have sparser networks composed largely of repeaters at high points in order to rapidly expand monitoring if the lahar hazard assessment of a drainage were to increase. A bulge of the volcano during unrest is one example of how the lahar hazard in a drainage could increase. This site is an example of one of those repeaters. The requirements for a Shriner Peak Site are: • Southern exposure for solar panels • Large viewshed into SE side of Mount Rainier and Ohanepecosh drainage • Seismometer on E side of Ohanapecosh River • Line-of-sight telemetry to existing repeater (White Pass) or LTE cellular signal for a data backhaul The Shriner Peak site is important as a robust radio repeater that would enable rapid expansion of the network in case significant volcanic unrest occurred at Mount Rainier – an event that would significantly increase the likelihood of a large lahar down multiple drainages of Mount Rainier, including the Ohanepcosh River. To act as a repeater, the Shriner Peak site requires radio antennas pointed into the upper reaches of the Ohanapecosh River and Backbone Ridge. In addition, the seismometer that would be a part of the Shriner Peak site would significantly improve volcano monitoring capabilities of the existing network, which has only two seismometers on the southeast quadrant of the volcano and National Park. The seismometer would also provide data important

	for constraining the location of surface flows on the east side of the volcano. Without this site, in the event of volcanic unrest the USGS would require days, weeks, or even months to establish a repeater on the east side of the volcano, particularly if unrest occurred from late Fall to early Spring when heavy snowfall is present. This would result in a potentially significant delay in the USGS installing instrumentation needed to give Park personnel and visitors, as well as communities in the Cowlitz River drainage, timely warnings of impending hazardous events, including large lahars.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation would include mounting two 160W solar panels to the south roof face of the lookout structure. This will require mounting Unistrut or Unirac flush mount rails too the roof. The rails or strut will be through-bolted to rafters under the lookout roof. Each solar panel has dimensions of approximately 58x26x2 inches. The mounting brackets would elevate the panels up to 5 inches above the roof surface but the panels would remain in the same plane as the roof face. Solar panel conductors will be insulated 2-conductor wire strapped to already-in-place copper conductors that run down the roof, under the rafters, and down the side of the building. The insulated solar wires will then enter the basement of the building through pre-existing cracks or holes between the upper and lower levels of the building. If an entry point does not exist we will drill a small (approx. 1 inch diameter) hole in a location between the upper and lower levels near the deck that is not clearly visible from the building's exterior. Any exposed conduit and solar panel frames will be painted brown. We also propose adding flexible solar panels to temporary shutters that are placed on the exterior of the lookout during winters. The vertical orientation and shielding from the roof eaves mean that panels in this location could survive harsh snow and icing conditions that may minimize the effectiveness of panels on the roof for some periods of time. The mounting and cabling would exactly mimic the park's installation of winter solar panels for their use. We propose mounting two 110W solar panels on shutters for the south side and two for shutters on the east side of the lookout. Additionally a very small 3x3x2.5 inch GNSS timing antenna (which provides accurate sub-second times necessary for usable seismic data) will be mounted under an eave of the lookout. It will be placed in a location that is not clearly visible unless directly under or adjacent to it. The cable will follow the solar panel conductors into the basement. We propose mounting three antennas on the telephone pole to the south of the lookout. This will include two cellular antennas (maximum dimensions 12x8.5x3 inches yagi and/or

	omnidirectional) and a flat panel 900 MHz antenna (approx. 12x12x2 inches.) This will require finding entry points for three LMR400 coaxial cables in the side of the structure. If there is not a pre-existing gap a hole no larger than 2.5 inches will be drilled to allow cable entry/exit. Any holes or cracks will be filled from the interior with insulating foam. If the telephone pole is ever moved or removed we propose moving our antennas in conjunction with those of other users to a new shared location. Cables will be run along the ground in flexible aluminum conduit that will be trenched up to 2 feet underground. We propose to install a seismometer in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the structure, preferably to the east, to remain invisible to park visitors. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the lookout to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. We propose to use the same entry as the antennas from the phone pole. The hole will be filled from the inside with insulating foam. All batteries, charge controllers, and electronic equipment will be housed in a 49x25x27 inch lockable aluminum enclosure in the basement of the lookout. The enclosure will not be visible to park guests. All exterior power and telemetry equipment will have in-line lightning protection and everything will be grounded to a master ground point in the enclosure that will then be grounded to a location determined by NPS staff to meet electrical code at the site. The physical installation of equipment will be adjusted spatially as needed to avoid any interference with NPS equipment and to minimize impact on the lookout structure. If desired we are willing to extend the solar panel mounting bracket installations to accommodate park solar panels, helping to minimize overall impact and visual discrepancy between multiple users' installations. We also advocate testing for any RF interference between users and taking steps including adjusting antennas and adding filters to radios and modems to minimize such interference. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with

	Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Lithium-powered hand tools will be used to drill holes for solar panel mounts and any needed building entries. Standard digging tools will be used for the trenching and seismometer burial (if permitted). This includes shovels, picks, pry bars, etc.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. The area of soil disturbance for the seismometer will be no more than 4’x4’. Trenching will take place between the phone pole and the structure, and between the structure and the seismometer hole. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.*

	There may be some minor vegetation disturbance during the trenching process to bury the instrument and communication cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* *No*
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* Yes. We are proposing to use the existing infrastructure of the Shriner Peak lookout structure to mount our equipment.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure inside the base of the lookout. The Park Engineer may be able to contribute guidance on solar panel placement. The solar panels are visible on top of the lookout, similar to the current visibility of solar panels on the roof of the lookout. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. There is a preference for having NPS cultural resources staff and maintenance staff available for the planning and installation stages to minimize impact to the lookout structure and ensure that the installation does not interfere with park operations. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions and building access. All coordination with park staff will be initiated in advance by respective supervisory staff at the USGS Cascades Volcano Observatory and the National Park.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-

	term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There is an alternative site that is presented (Shriner Peak Alt) that fits all of the requirements of the site. Because of the high

	winds and snow depths in this area, the lookout site is much preferred and in our estimation would require less maintenance.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

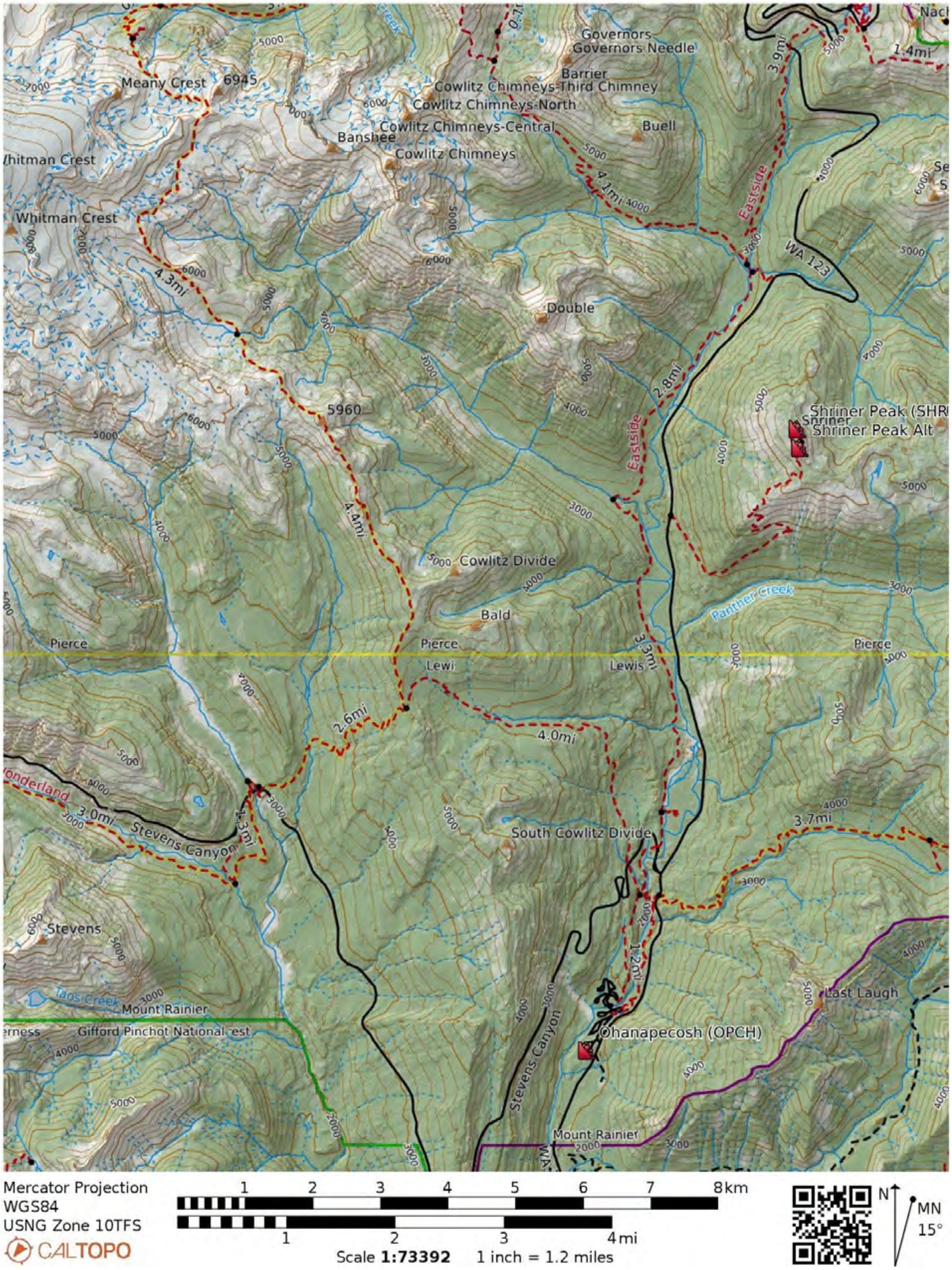


Figure 1: Location map. Shriner Peak Lookout and alternative site are shown on the east side of the Ohanapecosh River.

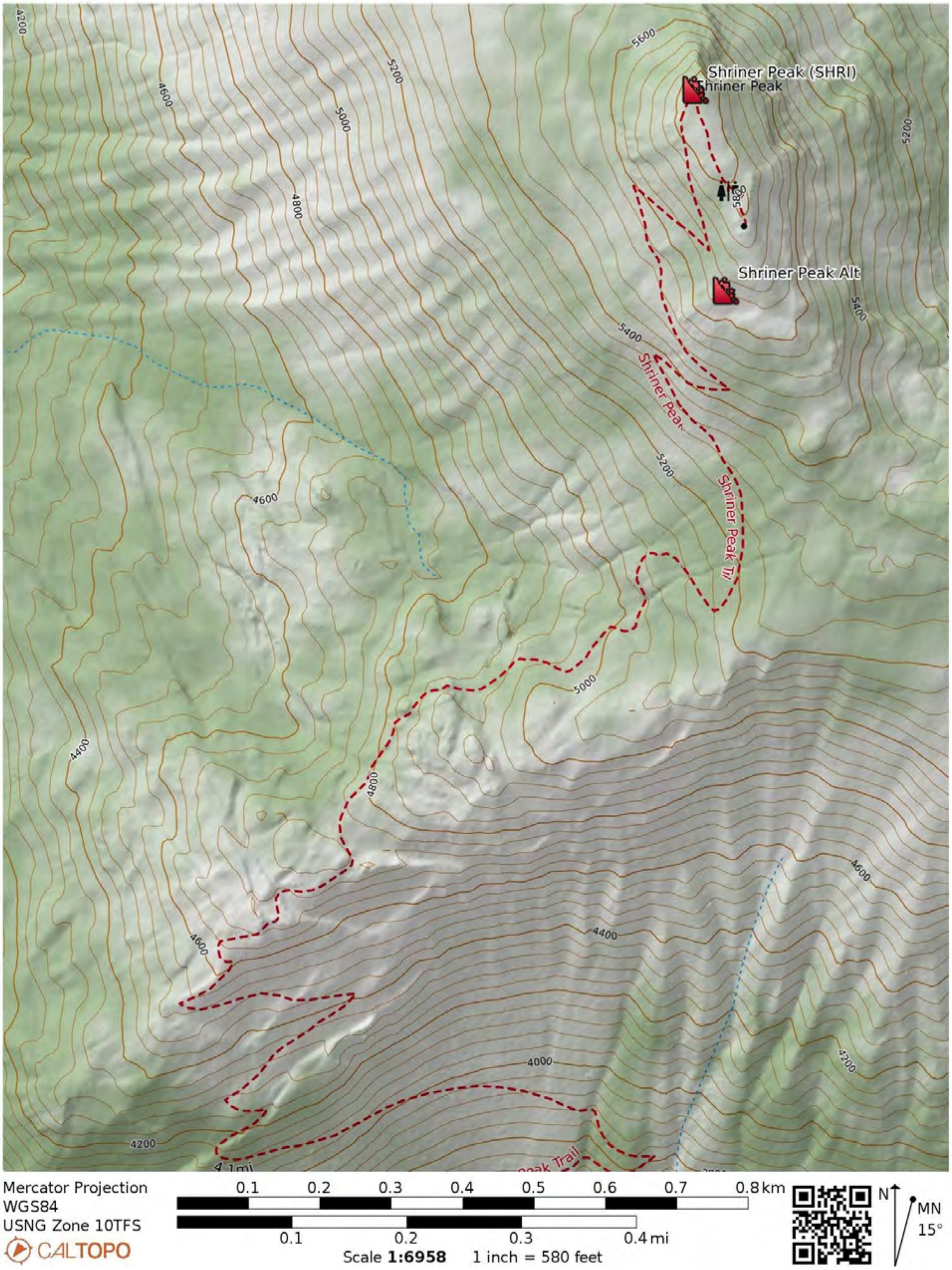
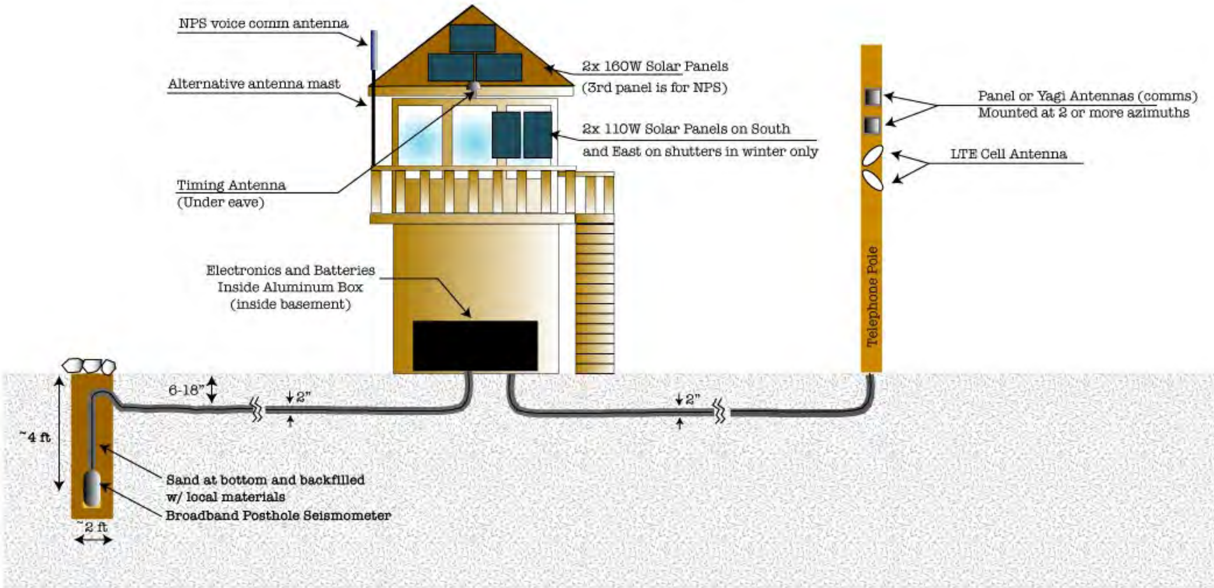


Figure 2: Zoomed in map of Shriner Peak Lookout (SHRI) and Shriner Peak Alternative site.



Overhead View

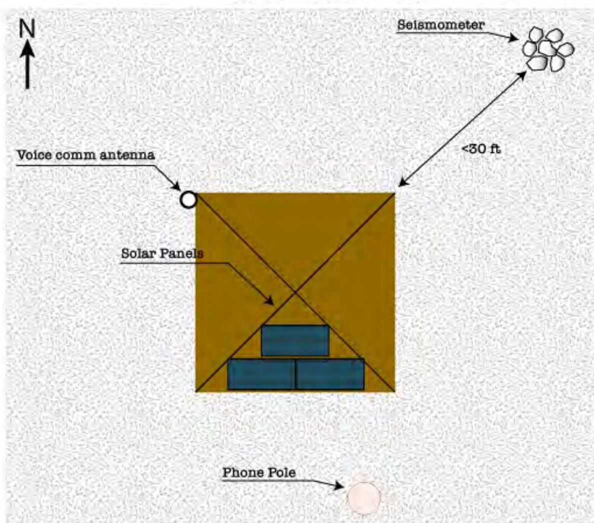


Figure 3: Schematic representation of the proposed work.

Figure 4: Photo of the lookout from the south. Solar panels can be seen on the roof. The acess door to the first floor is hidden from view under the walkway and behind the tree.

Figure 5: Proposed seismometer site location to the Northeast of the lookout structure. Site is between the trees in the middle of the photo.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Tahoma Bridge Monitoring Station
Project Location	46.8042, -121.8494
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Tahoma Bridge Site are: • Southern exposure for solar panels • Line-of-sight telemetry to repeater (Gobblers Knob) • Seismometer/infrasound sensors installed along narrow reach of creek The Tahoma Bridge site is a critical site in the detection network because of its unique location in a constriction in the Tahoma Creek drainage. A significant lahar will be well recorded by this site and eventually be enveloped by the flow, providing an unequivocal signal of the occurrence of a lahar in the Tahoma Creek drainage. This station is a required element of a timely warning to protect infrastructure and people downstream. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term

	backbone for denser temporary deployments of instrumentations that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ~~o~~ ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially other surface and subsurface processes. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning. This means that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries and with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. A single pipe (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface ~~that~~ will be secured to one side of the hut and have a flat panel antenna (~1'x1') placed near the top. The pipe will be stabilized at the base with a pipe flange that will be bolted to the rock using four 8" long, 7/8" diameter bolts and epoxy. Four additional 8" long ½" diameter bolts be drilled and epoxied into the rock to secure the corners of the hut flange to the surface. In total four 5/8" diameter holes and four 1" diameter holes will be drilled no deeper than 9" into the rock using a battery operated SDS Max rock drill. The rock between the holes must also be leveled and de-vegetated using tools such as a sledgehammer, battery operated drill or rock hammer. An 8 foot long 5/8 inch diameter copper ground rod will be driven into soil near the rock or be drilled into the rock to provide protection from static discharge. The hut and exposed equipment (except the solar panels and radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than

	100 feet from the enclosure (Figure 2). The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. A single infrasound sensor will be placed inside the enclosure with air ports to the outside. The infrasound will not change the footprint of the station nor require any additional digging. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land nearby with personnel. Helicopter operations will be coordinated with Mount Rainier National Park and will adhere to seasonal restrictions. We have a goal to provide routine maintenance to this station every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather and work to be done. If helicopter access to the site is required, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and

	routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. A battery powered drill will be used to install bolts in the rock to secure the enclosure and antenna pipe to the surface. The use of other battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the seismometer cables. The area of disturbance for the enclosure will be approximately 10'x10'x1' or less. The enclosure is smaller, but we are including the disturbed area for the foot traffic around the enclosure. In addition, a 5/8 inch diameter copper ground rod will be driven in up to 8 feet. At this site, the ground rod will be installed in the forest and protrude just above the local ground surface.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* The Tahoma Creek lies approximately 150' away from the site.
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* The site lies in the wilderness, but is obscured except for a short segment of the Wonderland Trail.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* The enclosure is in the viewshed of a short segment of the Wonderland Trail.

Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure due to the limited exposure. The location of the site is not close to any major trail. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources

	and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

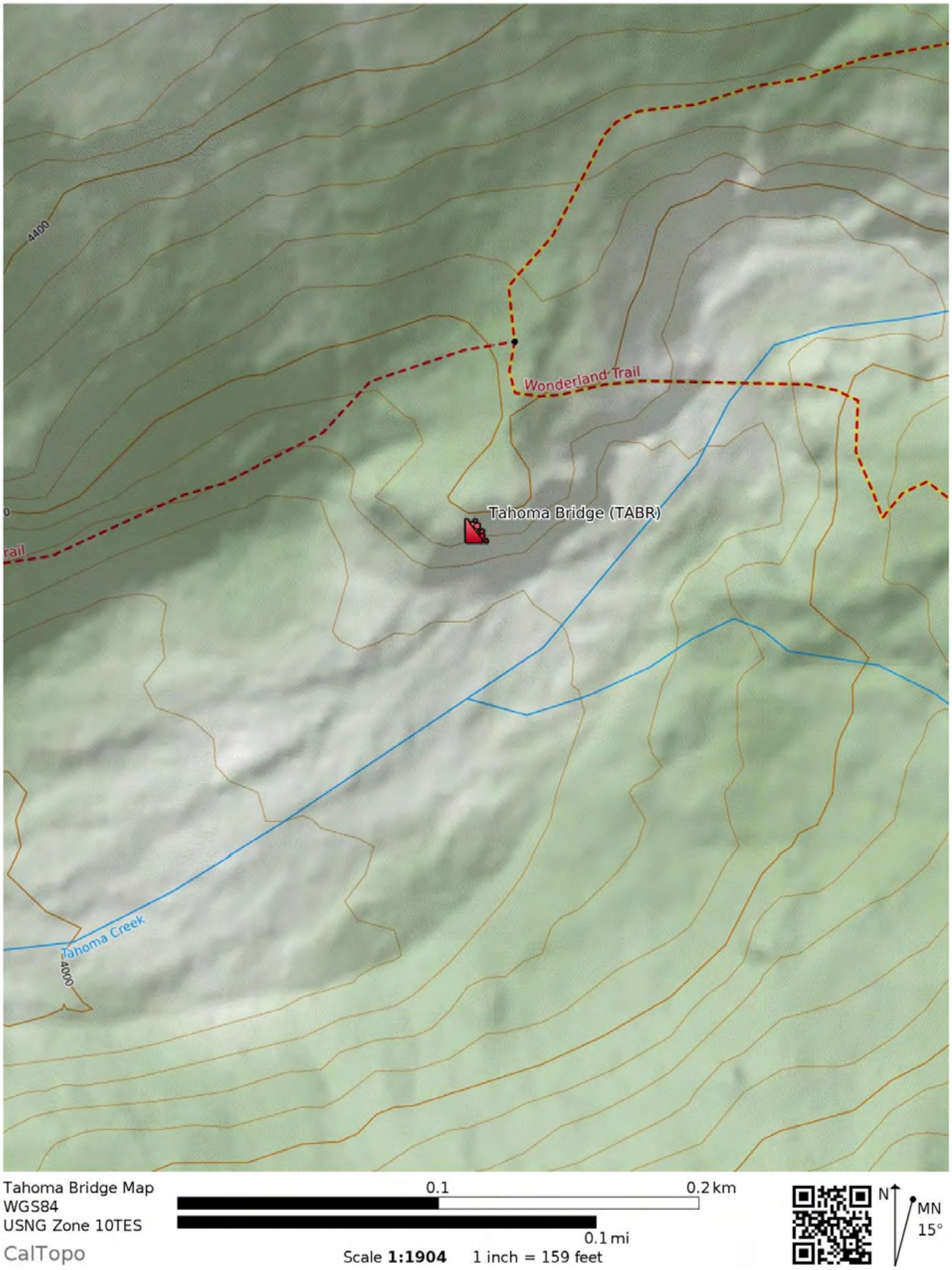


Figure 1: Location map.

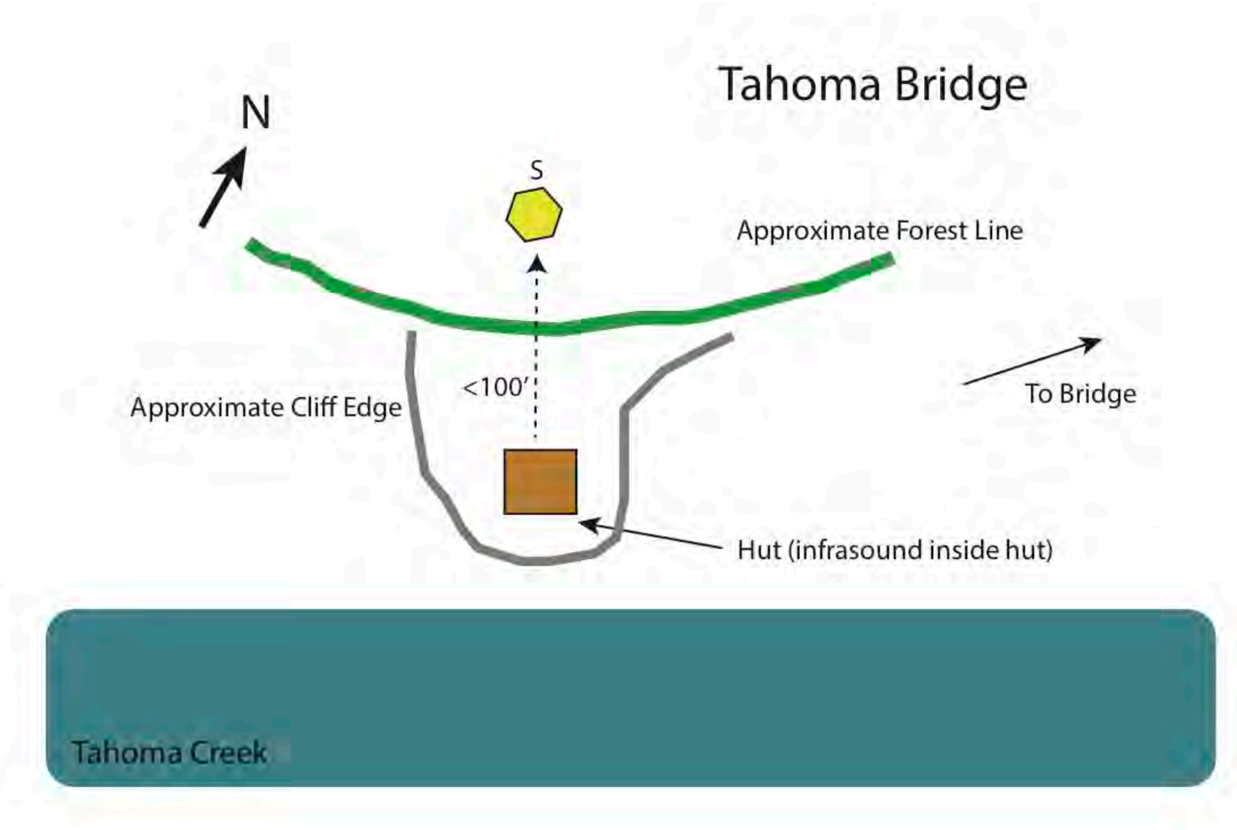


Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. Dotted lines show approximate areas where conduit will be trenched in.

Figure 3: Proposed enclosure site view to the SE. Location on the promontory is required for solar exposure and telemetry. Seismometer location (S) is to the left in this picture.

Figure 4: Proposed site for enclosure looking east. The suspension bridge is not visible from the site, but a short segment of the Wonderland Trail is present in the forest above the bank in the middle right of the photo.

Figure 5: Proposed site for seismometer (S) approximately 25 m NW of the promontory.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Tahoma Vista Ridge Monitoring Site
Project Location	46.8023, -121.8865
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Tahoma Vista Ridge Site are: • Southern exposure for solar panels • Line-of-sight telemetry to repeater (Gobblers Knob) • Seismometer/infrasound near bend in Tahoma Creek The Tahoma Vista site is an important location in the detection network because of its position at a bend in the Tahoma Creek from Northeast-Southwest to North-South. This bend will allow for an estimate of velocity of the flow, which in preliminary studies, is related to the volume of the flow. With an estimate of volume, the extent of downstream inundation can be inferred, which is important for decision making by emergency managers. The seismometer at this site, along with other seismometers in the detection system will provide early detection and localization of a failure on the edifice of the volcano and corroborating information on the leading edge of a debris flow or lahar. In addition, this particular site is likely to be able to record signals from flows going down the South Fork of the Puyallup River and will be important for differentiating the impacted drainage(s) during smaller flows. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller

	debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term backbone for denser temporary deployments of instruments that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially more. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries, with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and are 80 inches high. Attached to the hut will be a pole (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface that will have a flat panel antenna (~1'x1') placed near the top. Solar controllers and lead acid batteries housed within the hut will power the equipment on site. Prior to placing the enclosure on the ground, five holes are dug approximately 2 feet deep and filled with concrete to make a sturdy foundation for the hut and provide stability for the antenna pipe. The ground between the holes must also be leveled using hand tools such as a shovel and rake. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut using hand tools (or drilled if the shallow surface is rock) to provide protection from static discharge. The hut and exposed equipment (except the solar panels, radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not

	cover the antennas or solar panels at the direction of the National Park. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 40 feet from the enclosure (Figure 2). The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ inchplastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground near the seismometer, the other two units and windscreens will extend out no more than 100 feet away from the enclosure. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter slingloads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to “tune” the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial “tuning” maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance.. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips

	will depend on the type of helicopter, station elevation, weather and work to be done. If helicopter access to the site is deemed to be essential, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatened and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. We will also use battery powered hand tools only when absolutely necessary.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the infrasound and seismometer cables. The area of disturbance for the enclosure will be approximately 10’x10’x1’ or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. The footings will be about 2 cubic feet each. An 8 foot copper ground rod will also be driven into the ground as deep as possible and will protrude a couple of inches above the local ground surface. The area of soil disturbance for the seismometer will be no more than 4’x4’. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.*

	There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* The site lies approximately 800 m from the Puyallup River and 900 m from the Tahoma Creek drainage.
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* The site lies in the Wilderness, however it is not accessible from any trail (major or otherwise) and cannot be seen from anywhere outside the immediate forest clearing.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Visibility of this site is extremely limited and the site is far from any park resources (roads, trails, etc). If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety

	directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. An alternative site is being proposed at the Tahoma Vista Overlook. This site and the Tahoma Vista Overlook site meet the same requirements for the Lahar Detection System but have different impacts. Our preference is for this site over the Tahoma Vista Overlook site.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

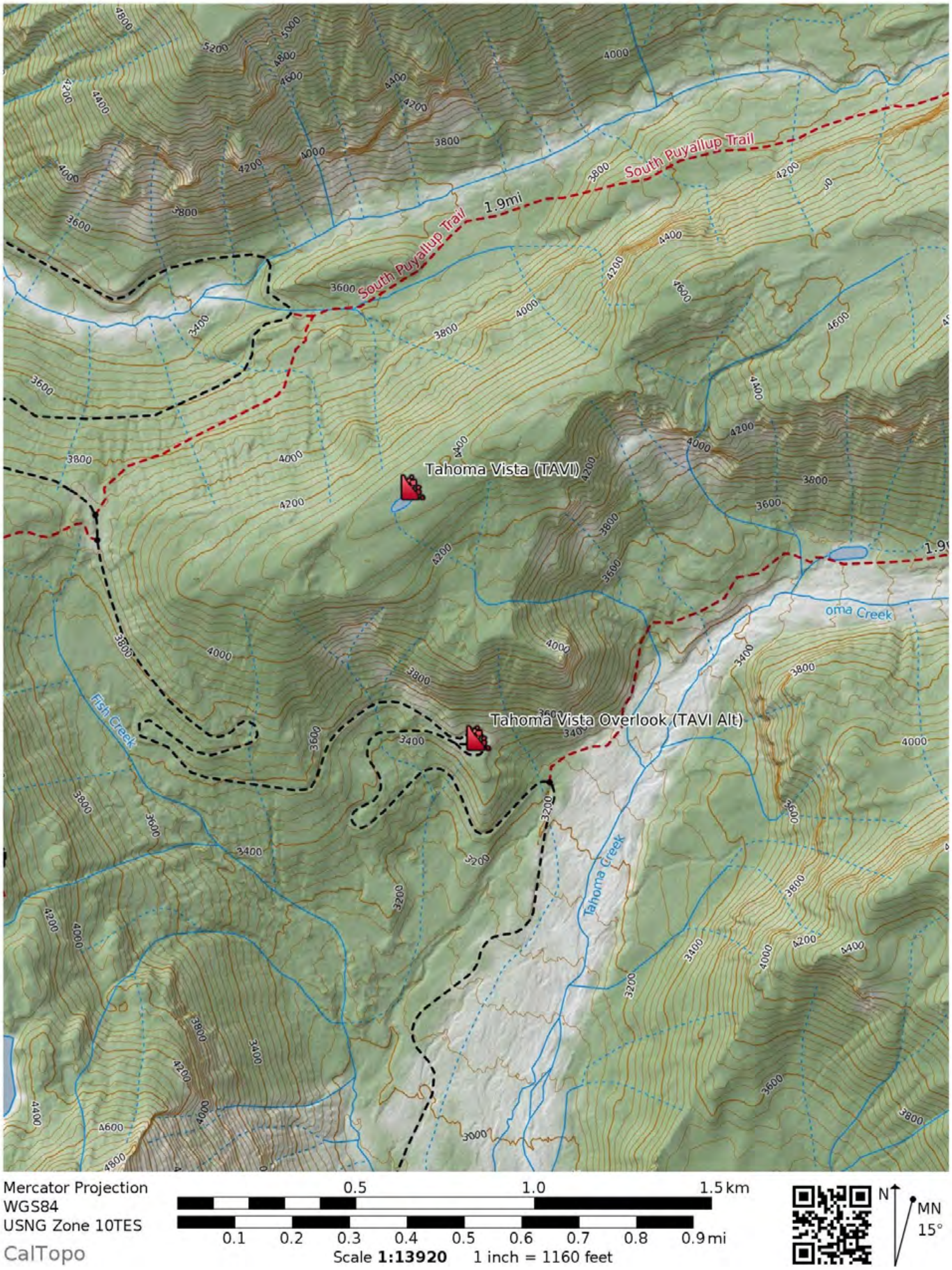


Figure 1: Location map.

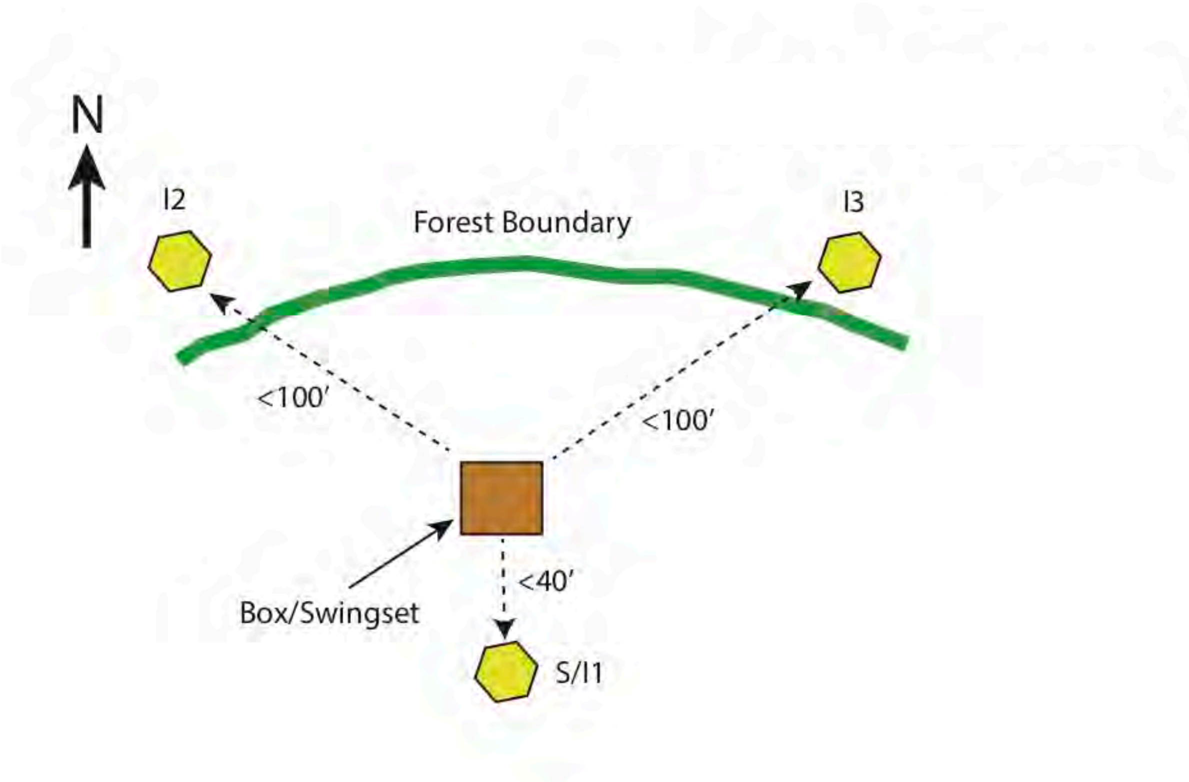


Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in.

Figure 3: Proposed enclosure site looking WNW. Enclosure is proposed to be in the clearing in the foreground. Infrasound site I2 is proposed to be denser forest in the background.

Figure 4: Proposed site for enclosure (clearing in center of the photo) looking to the NE. Infrasound site I3 will be placed in the denser forest in the background. Seismometer and infrasound site I1 will be to the right in this photo.

Figure 5: Proposed site for infrasound (I1) and seismometer (S) looking south from the enclosure. Location will be past the brush in the foreground and before the boggy meadow in the middleground.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Tahoma Vista Overlook Monitoring Site
Project Location	46.7958, -121.8842
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to allow affected populations to evacuate to high ground before a lahar arrives.

	The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The requirements for the Tahoma Vista Overlook Site are: • Southern exposure for solar panels • Line-of-sight telemetry to repeater (Gobblers Knob) • Seismometer/infrasound near bend in Tahoma Creek The Tahoma Vista Overlook site is an important location in the detection network because of its position at a bend in the Tahoma Creek from Northeast-Southwest to North-South. This bend will allow for an estimate of velocity of the flow, which in preliminary studies, is related to the volume of the flow. With an estimate of volume, the extent of downstream inundation can be inferred, which is important for decision making by emergency managers. The seismometer at this site, along with other seismometers in the detection system will provide early detection and localization of a failure on the edifice of the volcano and corroborating information on the leading edge of a debris flow or lahar. Data collected using this station, and others in the proposed network, will also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road, and an excellent natural laboratory to further scientific understanding of debris flows. In addition to the less-frequent large lahars, detection of the more-frequent smaller debris flows are of importance to the park for hazard mitigation and situational awareness. Recordings of debris flows are also of importance to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare. As a result, any debris-flow recordings on the newly installed stations will help improve our understanding of their initiation and dynamics. The proposed network will also provide a long-term

	backbone for denser temporary deployments of instruments that will provide even higher fidelity datasets that are critical for informing models of debris flow generation and movement. Such models will ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and will enable to park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits which cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially more. Finally, the proposed stations will also improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption. If not installed, the existing monitoring network would be unable to detect events until several minutes after they initiate and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas within the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.
Project Description—What work activities are proposed—the what, how, where of the project. (attach a map of project area, drawings, and photographs)	Installation will include a fiberglass hut containing most of the electronics and all of the batteries and with solar panels attached to the outside. The huts have a square base approximately 60 inches wide, and 80 inches high. Attached to the hut will be a pipe (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface that will have a flat panel antenna (~1'x1') placed near the top. Within the hut, solar controllers and lead acid batteries will power the equipment on site. The hut will be secured by driving 1 inch rebar through the flanges of the hut into the road, one on each corner. The goal is to drive the rebar to a depth of 2 feet. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut to provide protection from static discharge. Four 7/8" diameter 1-foot long pieces of rebar or bolts will be driven into the road to secure a pipe flange to stabilize the antenna pipe. The hut and exposed equipment (except the solar panels and radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of Mount Rainier National Park. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the enclosure (Figure 2). The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A

	seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Additionally, the station will consist of a 3-component infrasound array. The infrasound units are placed in a small watertight plastic box that is 8x8x6 inches in area and placed directly on the ground and covered with an aluminum windscreen that is secured to the ground with 12-18 inch pieces of 1 inch diameter rebar. Rebar will be pounded into the ground to be flush with the local ground surface. The windscreen is approximately 45 inches across, approximately 24 inches high, and is painted brown. Typically, the sensors and windscreen are placed near or under vegetation. We will strive to keep the sensors and windscreens out of the open to reduce visibility if possible. The infrasound data cables will be placed in ½ in aluminum or plastic conduit and will run from the USGS enclosure and plug in to the infrasound boxes. The conduit will be buried in the ground up to 2 feet deep. One infrasound unit and windscreen will be placed on the ground near the enclosure, the other two units and windscreens will extend out no more than 100 feet away from the enclosure. We propose, by default, to bury the conduit and seismometer in the ground, but if it is deemed less impactful, the conduit could lay on top of the ground and the seismometer could be installed at the ground surface, constructing a rock pile above it for protection and thermal isolation. In the case of an emergency outage during the winter, the USGS may request the use of a snowmobile on the Westside Road to access the site.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	September/October 2021 & 2022, depending on compliance, and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will drive to the site. Maintainance will be completed as needed. Assuming a normal maintainance schedule and barring catastrophic failure, the USGS might expect an initial visit after 2 years and battery swaps every 5 years.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. We will also use battery powered hand tools only when absolutely necessary.
Will imported fill be used?	Yes. If a seismometer hole is dug, approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the infrasound and seismometer cables. The area of

	disturbance for the enclosure will be approximately 10’x10’x1’ or less. The enclosure is smaller, but we are including the disturbed area for driven rebar for the footings, pipe flange, and the foot traffic around the enclosure. There will also be an 8 foot 5/8” diameter copper grounding rod driven into the ground near the site. If the rod is not driven to a full 8 feet, then the top will be cut so that the rod sticks out of the ground about 4 inches. The area of soil disturbance for the seismometer will be no more than 4’x4’. If there are cultural concerns, then the hole could be made smaller, or mounted on the surface with a stack of rocks above the seismometer for thermal isolation. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	The site lies approximately 400 m from the Tahoma Creek drainage and over 1 km from the Puyallup River drainage.
Is the location in Wilderness or Potential Wilderness?	No
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	Yes, the site is located at the former Tahoma Vista, which used to serve as an overlook into the Tahoma Creek Drainage when the Westside Road was open to the public. The area around the proposed site consists of short rock walls and a small outbuilding. Our installation does not propose to alter those structures in any way, however our installation would be easily visible from the Westside Road and from anywhere in the clearing of the former Tahoma Vista overlook.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	The proposed site is visible from the Westside Road and thus would have impacts on the visitors using the Westside Road to access other trails, such as to Gobblers Knob. The proposed layout would not block or disturb the existing roads that traverse the area. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period.
Is utility locate required?	No. While on a park roadway, the proximal area does not have any active utilities.
Is the project consistent with the park's General Management	The proposed installation is consistent with the MRNP General Management Plan in several respects,

Plan? Is the project specifically approved or "prohibited" by any approved plans?	1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings.

	An alternative site is being proposed at a site approximately 800 m to the north in the wilderness (called Tahoma Vista Ridge). This site and the Tahoma Vista Ridge site meet the same requirements for the Lahar Detection System but have different impacts. We prefer the Tahoma Vista Ridge site.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

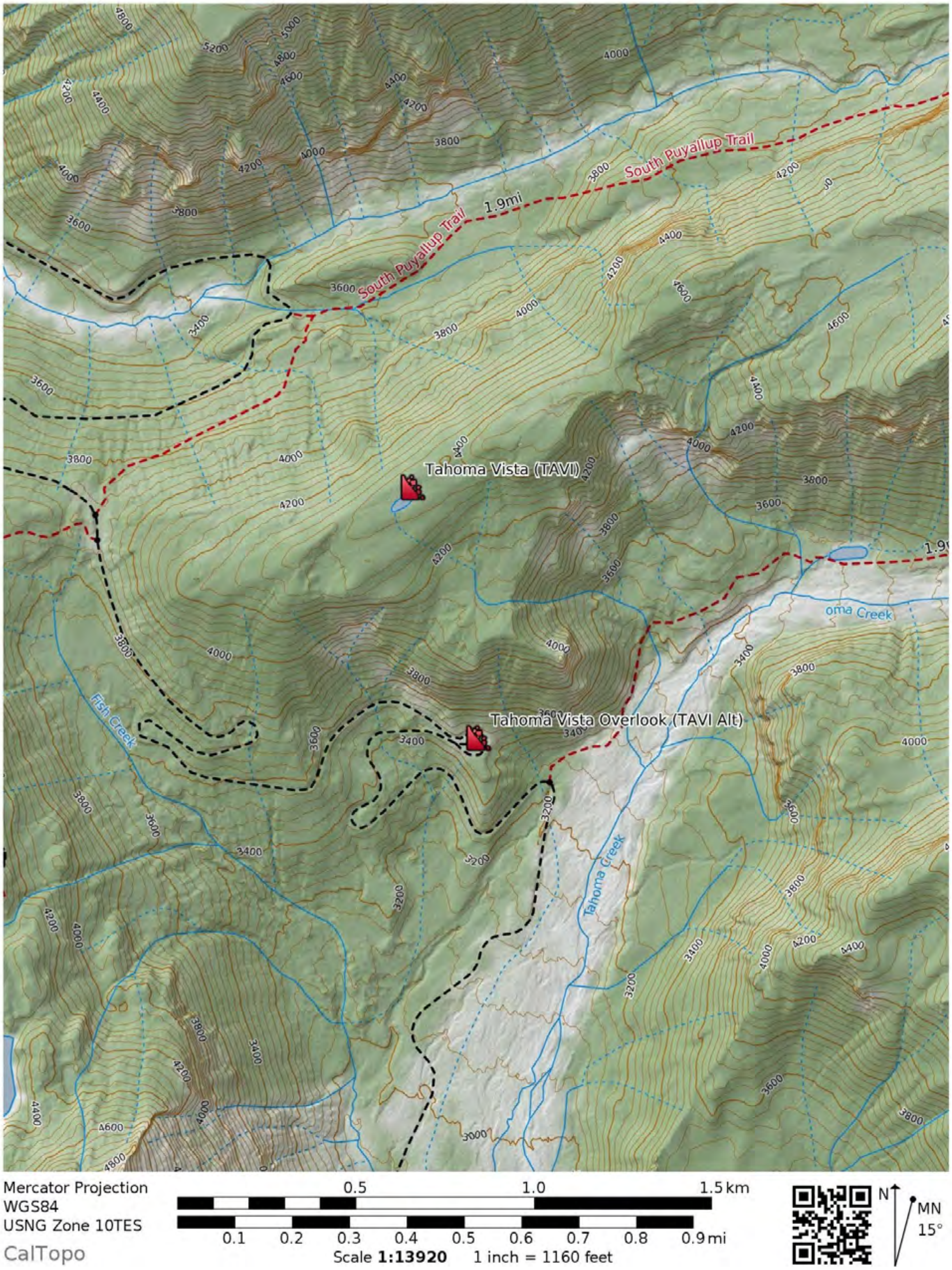


Figure 1: Location map.

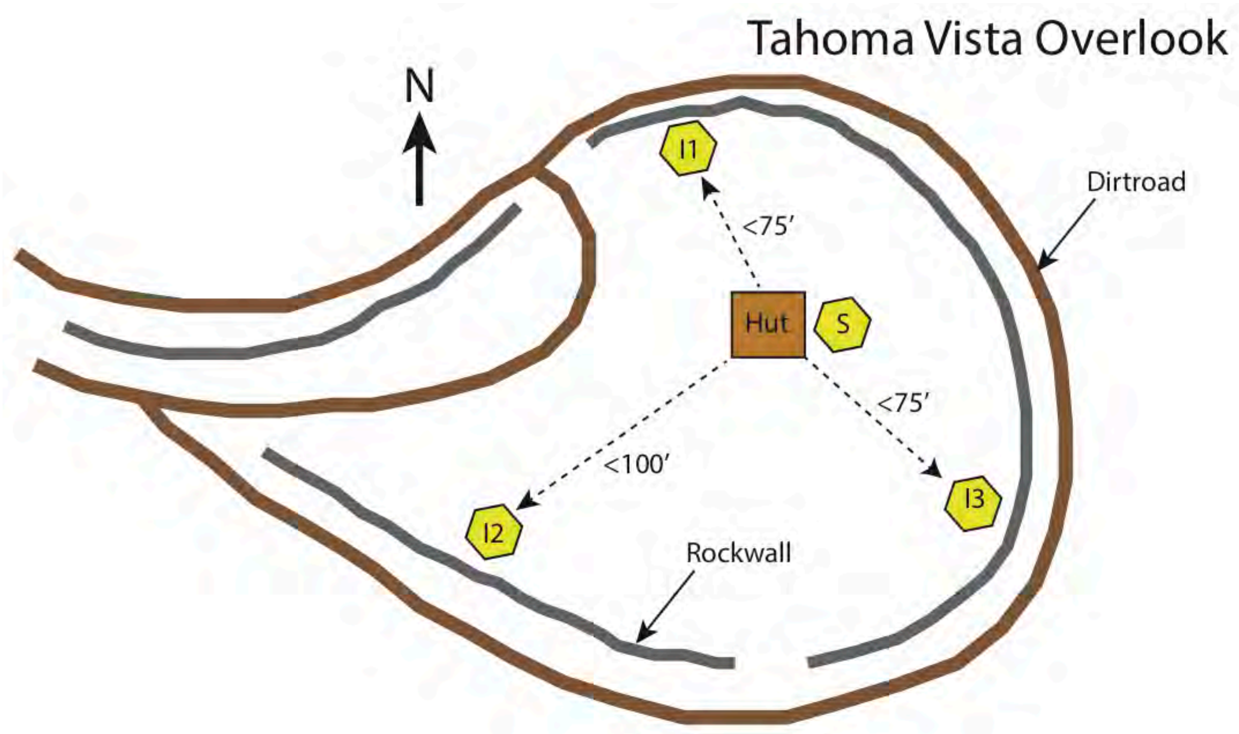


Figure 2: Schematic layout of site with respect to other landmarks. S refers to the seismometer. I1, I2 and I3 refer to the infrasound instruments. Dotted lines show approximate areas where conduit will be trenched in. Brown lines show the Westside Road and the Tahoma Vista Overlook Loop. Gray lines show rock walls.

Figure 3: View from proposed enclosure toward Gobblers Knob across the hairpin turn in the Westside Road. The infrasound I1 is to be placed inside the rockwall on the right side of the photo.

Figure 4: Proposed site for infrasound site I2 as seen from the enclosure. Infrasound is proposed to be placed near the rock wall in the middle of the picture.


Figure 5: Proposed site for infrasound (I3) looking from the proposed enclosure site. Infrasound will be placed just inside the rock wall.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Tolmie Peak Alternative Site
Project Location	46.9561, -121.8845
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the “Electron Mudflow”) that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the events as they are happening rather than hours/days after the fact. The Tolmie Peak site has the following requirements: • Southern exposure for solar panels • Large viewshed into Upper Carbon and Upper Mowich Drainages (North and Northwest side of Mount Rainier) • Seismometer between Carbon and Mowich Drainages • Line-of-sight telemetry to existing repeater (The Divide or Carbon Repeater) The Tolmie Peak site is important as a robust radio repeater that would enable rapid expansion of the network in case significant volcanic unrest occurred at Mount Rainier – an event that would significantly increase the likelihood of a large lahar down multiple drainages of Mount Rainier. To act as a repeater, the Tolmie Peak site requires radio antennas pointed into the upper reaches of the Carbon River. In addition, a seismometer is required on the ridge between the Mowich and Carbon rivers to provide data critical for determining the location of surface flows in each drainage. Without this site, in the event of volcanic unrest the USGS would require days, weeks, or even months to establish a repeater on the northwest side of the volcano, particularly if unrest occurred from late Fall to early Spring when heavy snowfall is present. This would result in a potentially significant delay in the USGS installing instrumentation needed to give Park personnel and visitors, as well as downstream communities, timely warnings of impending hazardous events, including large lahars.
Project Description—What work activities are proposed—the	Installation will include a fiberglass hut containing most of the electronics and all of the batteries, with solar panels attached to the outside. The huts have a square base approximately 60 inches

what, how, where of the project. (attach a map of project area, drawings, and photographs)	wide, and 80 inches high. A solar panel will extend above the top of the hut, but the overall height will not exceed 9 feet. Attached to the respective sides of the hut will be two pipes (2.375-inch outer diameter) that extends 12 feet or less above the local ground surface that provide a support frame for the upper solar panel and will have a 900 MHz antenna (maximum dimensions ~1'x1'x6" flat panel, yagi, or omnidirectional) placed near the top of one pipe. The other pipe will then be cut on-site to a maximum of 9 feet above the ground surface. Solar controllers and lead acid batteries housed within the hut will power the equipment on site. Prior to placing the enclosure on the ground, sixfour holes are dug approximately 2 feet deep and filled with concrete to make a sturdy foundation for the hut and for the two antenna/solar panel support poles. The ground between the holes must also be leveled using hand tools such as a shovel and rake. An 8 foot long 5/8 inch diameter copper ground rod will be driven adjacent to the hut using hand tools to provide protection from static discharge. The hut and exposed equipment (except the solar panels, radio antenna) will be painted brown to minimize visibility. Other visibility mitigation measures, such as ghillie netting will also be employed in places that do not cover the antennas or solar panels at the direction of the National Park. A seismometer will be buried in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 50 feet from the enclosure. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic data cable in 2-inch aluminum conduit will extend from the enclosure to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling-loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent

	battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done. If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., "2 weeks in late July or August 2020")	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a "tuning" visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Hand tools to include shovels, pickaxe/Pulaski, posthole digger, rock breaking bar, sledgehammer and garden hoe for digging seismic hole and trench to bury seismometer and instrument cables/conduits, as well as level ground for the enclosure. The use of battery-powered tools may also be required for the initial installation and maintenance.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer. No fill will be needed or put in the ground during the placement of the infrasound and windscreens. One or two bags of concrete is used per footing. Bags are 0.45 cubic feet.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. Soil disturbance will be necessary to prepare the surface for the enclosure and dig the posthole for the seismometer and trench for the seismometer cable. The area of disturbance for the enclosure will be approximately 10'x10'x1' or less. The enclosure is smaller, but we are including the disturbed area for the footings and the foot traffic around the enclosure. The footings will be about 2 cubic feet each. We will also drive in a 5/8" copper grounding rod to a depth of 8 feet within the 10'x10' footprint. Only the top couple of inches of the grounding rod will protrude above the surface. The area of soil disturbance for the seismometer will be no more than 4'x4'. Some soil may be disturbed around the edges of the infrasound windscreen in order to have the windscreen and ground be flush. The USGS will also avoid any cultural resources

	or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* There may be some minor vegetation disturbance during the enclosure platform preparation, and the trenching process to bury the instrument cables. See the soil disturbance statement for the maximum size of the disturbance. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* Yes.
Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* No. The alternative site is out of view from the nearby lookout.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Hikers are unlikely to see the enclosure unless they use the social trail that leads to the proposed site. If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions. There is significant evidence at the site of day use by visitors. The hut would clearly impact that day use.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early

	warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There site is presented as an alternative to the Tolmie Peak Lookout site. This site meets all of the requirements of the location. Because of the high winds and potential for icing in the area the lookout site is much preferred.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____ Date

(For Superintendent's Use Only)

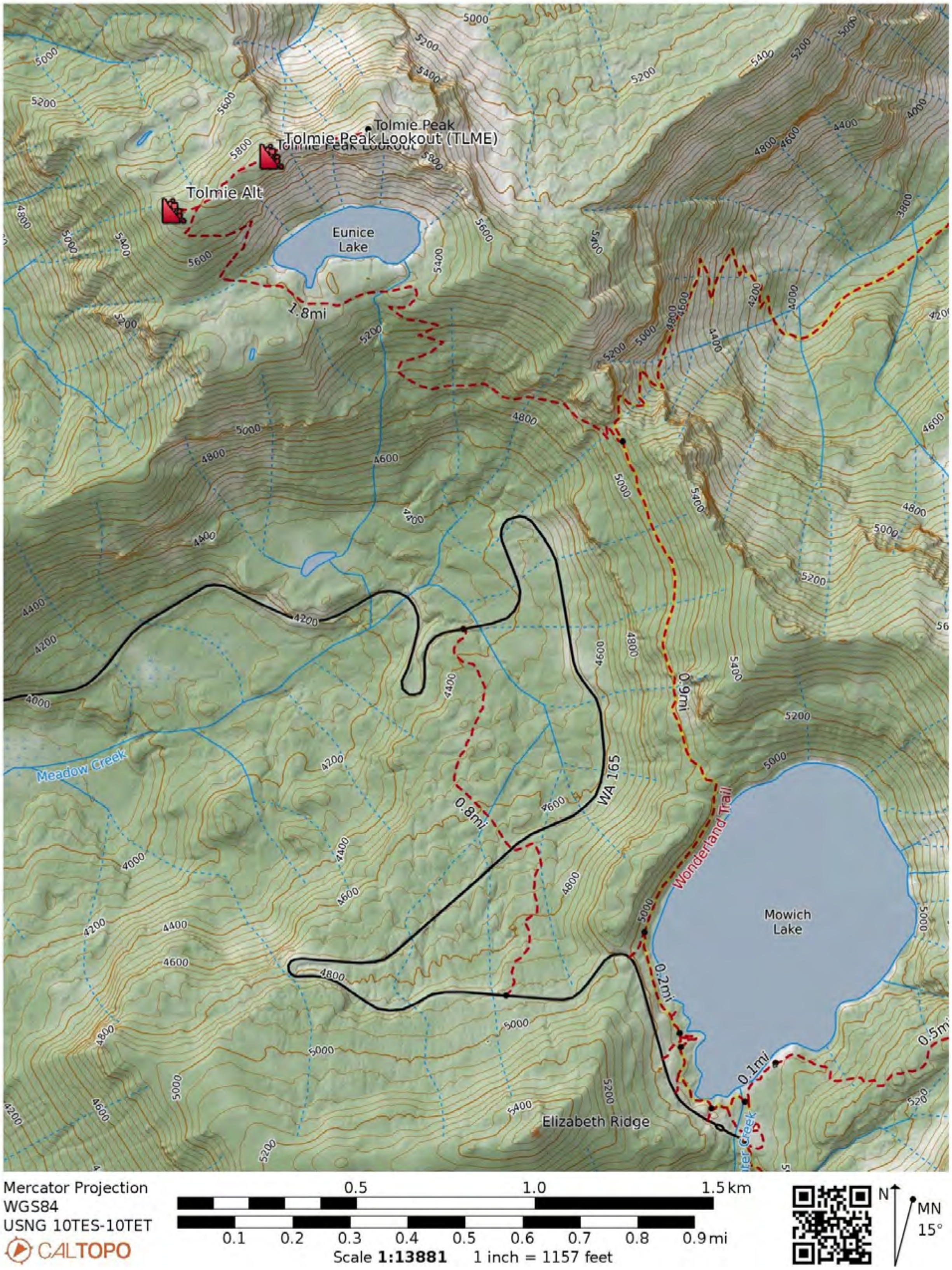


Figure 1: Location map.

Figure 2: View from path adjacent to proposed enclosure location looking West.

Figure 3: View from proposed enclosure location to the South. Footpath runs adjacent to suggested site. Approximate coordinates are 46.9561, -121.8845.

PROJECT PROPOSAL REVIEW FORM (PPR)
MOUNT RAINIER NATIONAL PARK

Complete this form (providing attachments as required) and submit to your division chief for management team review and signature. Once the form is signed, contact the Planning and Compliance office to schedule a presentation at an Interdisciplinary Planning Team meeting. This information will help expedite the review process and entry into PEPC if the project is approved.

Project Originator	U.S. Geological Survey
Project Title	Tolmie Peak Lookout Site
Project Location	46.9575, -121.8809
Division	Cascades Volcano Observatory
Date	October 5, 2020
Target project start/end dates	September/October 2021 & 2022
NEPA decision/compliance approval needed-by date	*(Consider contracting or procurement needs)*
PMIS number if applicable	
Funding source	USGS PO G20PG00082 for permitting, USGS fully funded by DOI to install and maintain station long term.
Purpose/need: What is the underlying need for and purpose of the project? What would happen if the project was not implemented?	*(What are the issues, concerns, deficiencies, opportunities that are being addressed by the project?)* The uniquely rugged and dynamic nature of the landscape in Mount Rainier National Park is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout is ~500,000 year history. Over the last 6,000 years geologists have found evidence for a number of eruptions, most recently 1,000 years before present. They have also found evidence for at least 8 large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption. Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers isa possibility and a hazard that needs to be taken into account in addition to hazards associated with future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a repeat of the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to Mount Rainier National Park within 10 minutes, and parts of Ashford within 20. In such a scenario, the principle mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and Park personnel with sufficient time to

	allow affected populations to evacuate to high ground before a lahar arrives. The USGS, in cooperation with Pierce County, is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve both the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System)), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988), and also would enable the capability to detect a large lahar within minutes of initiation, with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages. Specifically, the USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to preemptively provide warning to areas of impact and initiate a response to the event as they are happening rather than hours/days after the fact. The Tolmie Peak site has the following requirements: • Southern exposure for solar panels • Large viewshed into Upper Carbon and Upper Mowich Drainages (North and Northwest side of Mount Rainier) • Seismometer between Carbon and Mowich Drainages • Line-of-sight to existing repeater (The Divide or Carbon Repeater) The Tolmie Peak site is important as a robust radio repeater that would enable rapid expansion of the network in case significant volcanic unrest occurred at Mount Rainier – an event that would significantly increase the likelihood of a large lahar down multiple drainages of Mount Rainier. To act as a repeater, the Tolmie Peak ~~This~~ site requires radio antennas pointed into the upper reaches of the Carbon River. In addition, a seismometer is required on the ridge between the Mowich and Carbon rivers to provide data critical for determining the location of surface flows in each drainage. Without this site, in the event of volcanic unrest the USGS would require days, weeks, or even months to establish a repeater on the northwest side of the volcano, particularly if unrest occurred from late Fall to early Spring when heavy snowfall is present. This would result in a potentially significant delay in the USGS installing instrumentation needed to give Park personnel and visitors, as well as downstream communities, timely warnings of impending hazardous events, including large lahars.
Project Description—What work activities are proposed—the	Installation would include mounting two 160W solar panels to the south roof face of the lookout structure. This will require mounting

what, how, where of the project. (attach a map of project area, drawings, and photographs)	unistrut or Unirac flush mount rails too the roof. The rails or strut will be through-bolted to rafters under the lookout roof. Each solar panel has dimensions of approximately 58x26x2 inches. The mounting brackets would elevate the panels up to 5 inches above the roof surface but the panels would remain in the same plane as the roof face. Solar panel conductors will be insulated 2-conductor wire strapped to already-in-place copper conductors that run down the roof, under the rafters, and down the side of the building. The insulated solar wires will then enter the basement of the building through pre-existing cracks or holes between the upper and lower levels of the building. If an entry point does not exist we will drill a small (approx. 1 inch diameter) hole in a location between the upper and lower levels near the deck that is not clearly visible from the building's exterior. We also propose adding flexible solar panels to temporary shutters that are placed on the exterior of the lookout during winters. The vertical orientation and shielding from the roof eaves mean that panels in this location could survive harsh snow and icing conditions that may minimize the effectiveness of panels on the roof for some periods of time. The mounting and cabling would exactly mimic the park's installation of winter solar panels for their use. We propose mounting two 110W solar panels on shutters for the south side and two for shutters on the west side of the lookout. Additionally a very small 3x3x2.5 inch GNSS timing antenna (which provides accurate sub-second times necessary for usable seismic data) will be mounted under an eave of the lookout. It will be placed in a location that is not clearly visible unless directly under or adjacent to it. The cable will follow the solar panel conductors into the basement. We propose mounting two antennas on the pre-existing antenna mast on the S corner of the lookout deck. This will include two 900 MHz antennas (maximum dimensions approx. 12x12x6 inches flat panel or yagi.) This will require finding entry points for two LMR400 coaxial cables in the side of the structure. If there is not a pre-existing gap a hole no larger than 1.25 inches will be drilled to allow cable entry/exit in a minimally visible location by the deck. Cables will be run beside or under the deck to remain invisible. Any holes or cracks will be filled from the interior with insulating foam. We propose to install a seismometer in the ground in a 4-foot-deep hole that is no more than 2-foot-wide and will be located no more than 30 feet from the structure, preferably to the northwest, to remain invisible to park visitors. The hole will be dug by hand using shovels and filled back in with the materials removed from the hole after the seismometer is placed in the hole. A seismic

	data cable in 2-inch aluminum conduit will extend from the lookout to the seismometer and will be placed in a hand dug trench to a depth of up to 2 feet. If an existing hole is present to run the cable into the basement of the lookout, then we will utilize it, otherwise we propose to drill a 2 inch hole as close to ground level as possible. The hole will be filled from the inside with insulating foam. All batteries, charge controllers, and electronic equipment will be housed in a 49x25x27 inch lockable aluminum enclosure in the basement of the lookout. The enclosure will not be visible to park guests. All exterior power and telemetry equipment will have in-line lightning protection and everything will be grounded to a master ground point in the enclosure that will then be grounded to a location determined by NPS staff to meet electrical code at the site. The physical installation of equipment will be adjusted spatially as needed to avoid any interference with NPS equipment and to minimize impact on the lookout structure. If desired we are willing to extend the solar panel mounting bracket installations to accommodate park solar panels, helping to minimize overall impact and visual discrepancy between multiple users' installations. We also advocate testing for any RF interference between users and taking steps including adjusting antennas and adding filters to radios and modems to minimize such interference. Because of the remote location of the site, a helicopter will be required for initial installation and subsequent maintenance. In the case of routine maintenance, USGS staff will hike to the site and, if necessary, receive helicopter sling loads. In the case that an urgent need to visit the site is required to return it to a functional status and the site is not easily accessible by foot (due to, for example, deep snow cover), a helicopter may be required to land with personnel. Helicopter operations will be coordinated with Mount Rainier National Park, and will adhere to seasonal restrictions. We have a goal to provide routine maintenance of these stations every 5 years, including battery swaps. Our experience shows that a site visit is typically required after the first or second winter to "tune" the station to local snow and/or wind conditions. Initial installation will require approximately 7 helicopter sorties with sling-loads per site (5 in, 2 out). Routine maintenance including battery swaps will require approximately 4 helicopter sorties per site (2 in, 2 out). The initial "tuning" maintenance may require sorties as well (3 trips/site (2 in, 1 out), depending on the nature of the maintenance. These estimates are based on recent new installations on Mount Hood and recent battery swaps at Newberry Volcano. The actual number of trips will depend on the type of helicopter, station elevation, weather, and work to be done.

	If helicopter access to the site is required, for example for an emergency repair, we will follow these rules in order to minimize our impact on sensitive animal species. Stay above 333 feet over suitable habitat, or 500 AGL (4800 feet and below for northern spotted owls, 3800 and below for marbled murrelets) on approach and departure to and from helispots, including Kautz Creek and Klapatchie Point. We will avoid goats to the degree possible and stay above 333 feet over goats if observed.
Months/dates the work would occur and the duration of the work (e.g., “2 weeks in late July or August 2020”)	*(This is important for us to know for evaluating effects on Threatenend and Endangered Species, park operations, etc.)* September/October 2021 & 2022, depending on compliance, helicopter availability, species sensitivity and crew availability. Two days to complete full installation by USGS crew of 3 to 4, who will hike to the site. Maintenance will be performed on an as needed basis, with a “tuning” visit 1-2 years after initial installation and routine battery swaps every 5 years. Unexpected outages may require emergency repairs.
List types of equipment that will be used.	Lithium-powered hand tools will be used to drill holes for solar panel mounts and any needed building entries. Standard digging tools will be used for the trenching and seismometer burial (if permitted). This includes shovels, picks, pry bars, etc.
Will imported fill be used?	*If yes, list volume(s) and source (if known).* Yes. Approximately 0.15 cubic feet of fine-grained commercial grade paver sand free of exotic plants and animals will be placed in the bottom of the seismometer post hole to properly level the seismometer.
Will there be soil disturbance (e.g., trenching, digging, excavating)?	*If yes, provide map and dimensions.* Yes. The area of soil disturbance for the seismometer will be no more than 4’x4’. Plus the area that is trenched between the seismometer and the lookout. The USGS will also avoid any cultural resources or sensitive vegetation in trenching and/or site selection if any exist.
Will there be vegetation disturbance?	*If yes, list vegetation type(s), amounts (e.g., sq ft). For trees, list number, species, and diameters.* Yes. The area that the seismometer is buried in and the trench that leads to the seismometer have the potential to disturb vegetation. No trees will be cut down or removed. The USGS will avoid digging or trenching near any large tree roots during the operation. The USGS will also avoid vegetation disturbance and surface erosion to the greatest extent possible when traveling to and from the site, and follow any specific instructions provided by the Park Vegetation Division regarding site installations.
Will the work occur in or near waterbodies, wetlands, flood plains, riparian areas?	*If yes, name affected resource.* No
Is the location in Wilderness or Potential Wilderness?	*If yes, Minimum Requirement Analysis worksheet (MRA) may be required).* *No*

Does project involve or affect cultural resources such as historic structures, the NHLD, cultural landscapes, etc.?	*If yes, list affected resource(s).* Yes. The Tolmie Lookout is a historical structure.
Would this project affect visitors or park staff, and if so, how would they be informed of the project?	*Provide communication plan, e.g., signs, notices, press release, employee e-mail.* Initial installation and some maintenance will require helicopters slinging gear in, which will affect visitors in the vicinity during the time of the mission. Solar panels on the roof are only visible from select vantage points on the access trail about 500 feet (elevation) below the site. The Park Engineer may be able to contribute guidance on solar panel placement._If it is determined that NPS staff be present for installations at culturally or agriculturally sensitive sites, then there would be an impact during the installation time period. There is a preference for having NPS cultural resources staff and maintenance staff available for the planning and installation stages to minimize impact to the lookout structure and ensure that the installation does not interfere with park operations. After the initial installation, there will no impact on NPS Staff outside of coordination of helicopter missions and building access.
Is utility locate required?	No
Is the project consistent with the park's General Management Plan? Is the project specifically approved or "prohibited" by any approved plans?	*Name plans.* The proposed installation is consistent with the MRNP General Management plan in several respects, 1. Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations (initiation of long-term monitoring and study to improve preparedness and management practices) 2. Assure for all Americans a safe, healthful, productive, and aesthetically and culturally pleasing surroundings (early warning systems to support broad regional health and safety directives, and better ways to know and inform visitors of hazards native to the park) 3. Attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences (warning systems which improve the net risk to safety and will provide broad increases to scientific understanding with carefully thought out and mitigated impacts) 4. Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, and environment which supports diversity, and variety of individual choice (systems which add to an understanding of controlling natural processes such as these directly influence the ability of the park to plan, construct, manage, and mitigate risks to all impacted infrastructure) 5. Achieve a balance between population and resource use which will permit high standards of living and a wide sharing

	of life's amenities (an understanding of available hazards is needed to determine what an optimal population vs. resource use threshold would be) 6. Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources (understanding these processes also lends to an understanding of impacts to and longevity of water resources and municipal concerns downstream of the park [i.e. sedimentation of Alder Dam]) This proposal is therefore consistent with the park GMP, and the included methods are not specifically prohibited by the GMP.
Is agency consultation and/or permit required?	*Provide name of agency and permit(s), e.g., SHPO, Tribes, FWS, USACE* NPS input needed here.
What are some alternative ways to resolve the issues or concerns, or take advantage of the opportunity?	The proposed instrumentation represents our assessment of the minimum amount of monitoring required for this particular site as it contributes to the overall Lahar Detection System. If the proposed set of instrumentation was changed at this site, the capabilities of the system would be impaired and additional instrumentation would need to be installed at other stations or sites to keep the same capabilities. In some cases, the capabilities could not be accounted for with changes in instrumentation at other sites and a degradation of the capabilities of the system would result, impacting the warning time and accuracy of lahar warnings. There is an alternative site that is presented (Tolmie Peak Alternative Site) that meets all of the requirements of the location. Because of the high winds and potential for icing in the area the lookout site is much preferred.

Division Chief Project Review	
I have reviewed this project proposal and have determined that it meets the overall goals of Mount Rainier National Park and can be included in my divisional work plan. I have designated a project coordinator below to represent my division as the project proponent.	
Project Proponent/Title	Date
Division Chief signature	Date

___Approved - convene IDT to formulate conceptual alternatives for PMIS or internal implementation
___Not Approved - project not necessary at this time
___Conditional support pending further analysis
___Other (please explain)

IDT Members:

Comments:

Superintendent ____
Date

(For Superintendent's Use Only)

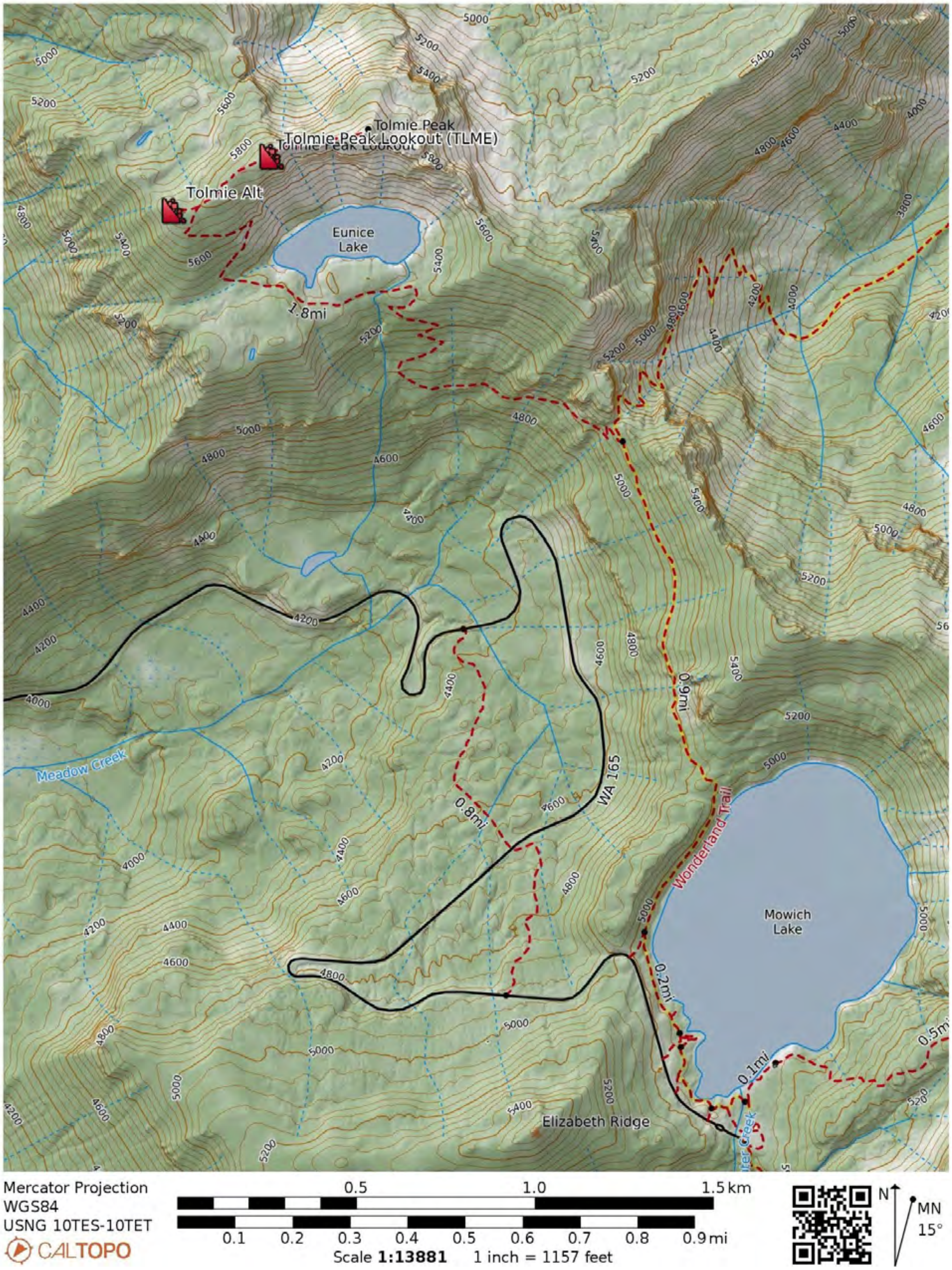


Figure 1: Location map.

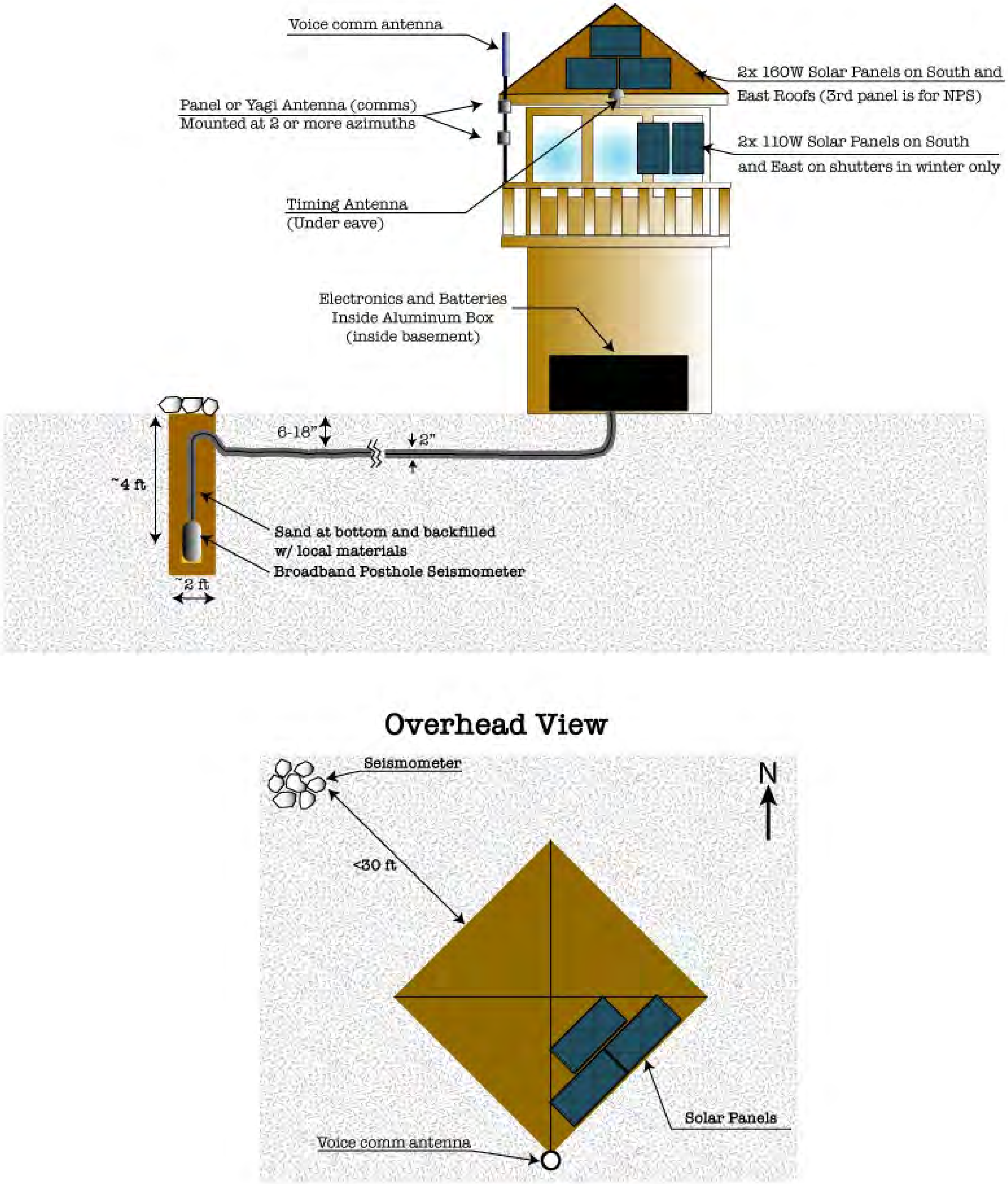


Figure 2: Schematic representation of the proposed installation.

Figure 3: Photo of the lookout with a view to the West. Seismometer is proposed to be installed to the right side of this photo near the trees.

Figure 4: Proposed antenna mounting pole. The pole already exists on the South corner of the structure so no further disturbance will be required. We will coordinate with park staff on utilizing the mast.

Appendix C: Issues Identified for and Dismissed from Further Analysis

The interdisciplinary team discussed environmental issues associated with the Proposed Action and alternatives using the National Park Service (NPS) Environmental Screening Form. "Issues" or "environmental issues" can be problems, concerns, conflicts, obstacles, or benefits that would result if the Proposed Action or alternatives, including the no action alternative, are implemented. Five topics were identified as issues needing further analysis, while several topics were dismissed from further analysis. These topics are described below, in addition to the reasons for dismissal.

Issues Identified for Further Analysis

Based on internal scoping, the following issue statements were developed for topics identified for further analysis:

- **Special Status Species** – The analysis area includes project locations within the elevation range for habitat for northern spotted owl (*Strix occidentalis caurina*) and marbled murrelet (*Brachyramphus marmoratus marmoratus*) (below 4,800 feet for the northern spotted owl and below 3,800 feet for the marbled murrelet). Habitat or presence of special status species including the northern spotted owl and marbled murrelet may occur in the proposed locations of monitoring stations and the flight paths for project helicopters. Whitebark pine (*Pius albicaulis*), which was recently proposed for listing as a threatened species, is addressed under *Vegetation*, below.
- **Historic Structures and Cultural Landscapes** – Mount Rainier National Park (park or MRNP) is a designated National Historic Landmark District (NHLD listed in the National Register of Historic Places (NRHP), which is considered the most complete and best-preserved example of NPS master planning in the first half of the 20th century (NPS 2015). Four proposed monitoring stations would involve mounting equipment on four fire lookouts, which are contributing structures to the NHLD. Two monitoring stations are proposed along or visible from Westside Road, a cultural landscape listed in the NRHP and contributing to the NHLD.
- **Public Health and Safety** – Mount Rainier poses a threat to public health and safety as volcanic eruptions and lahars may affect nearby communities, park staff, and visitors to the park. Installation of monitoring station equipment also poses a risk to those completing the installations because of rough terrain, remoteness of locations, and use of helicopters.
- **Wilderness Character (includes Visitor Experience, Soundscapes and Viewsheds)** – Most of the proposed monitoring stations are within designated wilderness. In addition, helicopter flights would traverse and land within designated wilderness. The analysis area for wilderness character includes the sites within wilderness, the viewsheds from which the sites could be visible to visitors within wilderness, and flight paths for project helicopters. The Mount Rainier Wilderness was congressionally designated on November 16, 1988 by Title III of the Washington Park Wilderness Act, which required that the land be protected and managed in accordance with the Wilderness Act of 1964. The Wilderness Act identifies specific prohibitions that may only be authorized as

necessary to meet minimum requirements for administration of the area for the purpose of the Wilderness Act (including measures required in emergencies involving the health and safety of persons in the area). Several elements included in the Proposed Action are subject to a minimum requirements analysis and decision.

Issues Dismissed from Further Analysis

The following issues were dismissed because there would be no effects, or the effects would be discountable. Per the NPS National Environmental Policy Act Handbook (NPS 2015), issues were retained for consideration and discussed in detail if:

- the environmental impacts associated with the issue are central to the proposal or of critical importance;
- a detailed analysis of environmental impacts related to the issue is necessary to make a reasoned choice between alternatives;
- the environmental impacts associated with the issue are a big point of contention among the public or other agencies; or
- there are potentially significant impacts on resources associated with the issue.

If none of the considerations above apply to an issue or impact topic, it was dismissed from detailed analysis.

Vegetation

Installation of lahar monitoring stations would result in impacts on vegetation. Vegetation communities in the project area range from barren rocky areas with primarily lichen and nonvascular plant communities to grassy meadows and forested areas. The affected plant communities are described in greater detail in the rare plant survey report prepared by the park (NPS 2020). Whitebark pine, recently proposed for listing as federally threatened, is known to occur near the Mildred Point, Fremont Lookout, and Fremont Lookout Alternative sites.

Impacts on vegetation would vary by site and would typically include permanent impacts on an area about 10 feet by 10 feet, with temporary impacts from trenches to install data cables in buried conduit. Trenches would be about 2 feet wide and would be routed to minimize disturbance to vegetation. At most sites, surface disturbance would result in about 100 square feet of permanent impacts and about 500 square feet of temporary impacts. Site recovery would depend on site conditions such as elevation and type of vegetation. Most sites would be expected to recover within a few years, with implementation of post-installation restoration, as described in the mitigation measures in Appendix A. Overall, installation of the lahar monitoring stations would permanently remove a total of less than 700 square feet (0.016 acre) of vegetation and temporarily disturb less than 6,000 square feet (0.14 acre) of vegetation for all proposed sites. Installation would permanently remove a total of less than 1,000 square feet (0.023 acre) of vegetation and temporarily disturb less than 6,000 square feet (0.14 acre) of vegetation if the alternative sites were used. Impacts would be minimized by using hand tools for digging and avoiding areas of vegetation where possible. No trees would be removed at any of the sites, and the critical root zones of trees would be avoided when digging trenches to the extent possible. Additional mitigation measures would be implemented (see Appendix A) to prevent the spread of exotic plant species as the result of vegetation and soil disturbance and to avoid or minimize impacts on existing vegetation near the project area. No new impacts on vegetation are expected under the No Action Alternative, with the exception of vegetation disturbance for previously approved sites.

Direct impacts on whitebark pines at Fremont Lookout and Mildred Point would be avoided. No mature trees of any species would be removed because of project activities. Impacts on the root zones of whitebark pines would be avoided by taking care to identify known whitebark pines near the Fremont Lookout and Mildred Point sites and avoiding impacts on the trees by carefully digging with hand tools and avoiding disturbance to the critical root zones of the trees. Considering the small area of disturbance (less than 0.1 acre for all sites), avoidance of disturbance to the critical root zones, and implementation of the additional mitigation measures for vegetation described in Appendix A, impacts on whitebark pine are expected to be insignificant. The NPS has submitted a biological assessment (BA) to the U.S. Fish and Wildlife Service to document in detail the potential impacts and proposed mitigation measures to protect northern spotted owls. The BA is expected to include a determination of "no jeopardy" for whitebark pine.

A rare endemic plant, Mount Rainier lousewort (*Pedicularis rainierensis*), occurs at the Copper Mountain site. Impacts on this species would be reduced by monitoring this site during construction to ensure that there are no direct impacts on sensitive or threatened plant species and implementing additional mitigation measures to protect vegetation as outlined in Appendix A.

Based on the expectation of minimal impacts, combined with the capability of resource mitigation measures to avoid, reduce, or eliminate unacceptable impacts, no significant effects would occur. Because of this, vegetation was dismissed from additional analysis in the Environmental Assessment (EA).

Wildlife

Installation and operation of lahar monitoring stations would have the potential to affect wildlife. The park supports a variety of wildlife species including many mammal, bird, amphibian, reptile, and invertebrate species due to the variety of habitats present. Permanent and temporary loss of habitat would be minimal as described above in *Vegetation* and would be very small relative to the total amount of wildlife habitat available in the park. Project activities would result in temporary disturbances to wildlife due to human presence and noise generation from equipment that may displace some wildlife during the installation and operation of the lahar monitoring system. Potential impacts on birds and mammals would result primarily from noise resulting from the use of helicopters. Potential effects on wildlife from increased noise could include increased physiological stress, changed behavior such as less time foraging and more time watching the surroundings, and changed movement patterns (displacement to nearby habitat). White-tailed ptarmigan, mountain goats, and wolverines occur at the high elevations near some of the proposed sites and could alter their behavior if helicopters pass nearby while travelling to the project sites. Small amounts of ptarmigan habitat (less than 0.1 acre for all sites combined) could also be affected by the project. Loss of ptarmigan habitat would be insignificant give the large amount of alpine habitat in the park. Mitigation measures to reduce helicopter impacts would include flying at 2,000 feet above suitable habitat for spotted owl and marbled murrelet (except for takeoff and landing) and avoiding mountain goats and wolverines when possible. These mitigation measures, described in greater detail in Appendix A, would reduce the impacts of helicopter flights on most bird and mammal species to the point where only minimal impacts would be expected. No impacts on amphibian, reptile or invertebrate species are expected under any of the alternatives because the affected areas are upland areas, and no riparian areas or water bodies that provide habitat for these species would be affected. No new impacts on wildlife are expected under the No Action Alternative with the exception of temporary disturbances to wildlife due to construction of the previously approved sites. Because impacts on habitat would be minimal and impacts from helicopter use would be expected to be discountable with implementation of mitigation measures, wildlife was dismissed from additional analysis in the EA.

Special Status Species (other than Northern Spotted Owl, Marbled Murrelet, and Whitebark Pine)

Special status species are federal- or state-listed species of concern, or other species the park has identified as warranting special monitoring or management. Federally listed threatened, endangered, proposed, and candidate species that are known or have the potential to occur in the park include Canada lynx (*Lynx canadensis*), gray wolf (*Canis lupus*), North American wolverine (*Gulo gulo*), western yellow-billed cuckoo (*Coccyzus americanus*), bull trout (*Salvelinus confluentus*), Chinook salmon (*Oncorhynchus tshawytscha),* and steelhead (*Oncorhynchus mykiss*). Mitigation measures would be implemented to avoid and minimize impacts on these species, as described in Appendix A. A BA has been prepared for the Preferred Alternative, which will contain full species descriptions, habitat information, and a determination of effects regarding these federally listed and proposed species. Although recently delisted, the BA includes a determination of "may affect, not likely to adversely affect" for gray wolves because wolves are not known to occur in the park currently, and project activities would occur in September and October, when young can travel with adults. The BA also includes a determination of "no effect" for the Canada lynx, western yellow-billed cuckoo, bull trout, Chinook salmon, and steelhead because there is no habitat for these species in the project area.

The park also provides habitat for several state special status wildlife species, including several bats, amphibians, and fish species. Impacts on state special status species and other special status species would be avoided because habitat removal would be minimal, because no impacts would occur on riparian or aquatic sites, and because the mitigation measures described in Appendix A would be implemented to avoid impacts from helicopter overflights. For these reasons, special status species, except for northern spotted owl and marbled murrelet, were dismissed from additional analysis in the EA.

Archeological Resources

All proposed monitoring locations were surveyed for cultural resources using a 4-acre area of potential effect surrounding the equipment. The survey resulted in the identification of one historical site at the Tolmie Peak Lookout (Beyer and Diaz 2020), which would be avoided during monitoring station installation. Unknown subsurface archeological deposits could be inadvertently impacted during equipment installation. Archeological monitoring would occur during all excavation or ground-disturbing activities at three locations: Copper Mountain, Tahoma Vista Alternative, and Emerald Ridge. The other locations are not recommended for monitoring based on steep terrain and minimal soil deposition.

In accordance with the project Archaeological Monitoring Plan (NPS 2021), if archeological resources are uncovered during installation, all work in the immediate vicinity of the discovery would be halted until the discovery could be documented and evaluated for significance. If the discovery is found to be significant and cannot be preserved in situ, an appropriate mitigation strategy would be developed in consultation with the State Historic Preservation Officer and, as necessary, affiliated American Indian tribes. Any data recovery would be completed before any further construction disturbance to the archeological resources could occur. With implementation of the Archaeological Monitoring Plan (NPS 2021), adverse impacts on archeological resources would be avoided or minimized; therefore, archeology was dismissed from additional analysis in the EA.

Ethnographic Resources

The park is culturally significant to six affiliated Native American tribes: the Muckleshoot Indian Tribe, the Puyallup Tribe of Indians, the Nisqually Indian Tribe, the Cowlitz Indian Tribe, the Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation (Boxberger 1998; NPS 2015). Mount Rainier, known as "Tahoma" or "Takhoma" and other spelling variants among the tribes, is ethnographically significant as a landmark and traditional place to the tribes. As is the case for most mountain environments, the landscape surrounding Mount Rainier was visited seasonally, primarily late summer, as a place to hunt, gather plant resources, fish, and for religious use and ceremony. However, permanent or even semipermanent band-level camps were not established in the rugged environment, which was confirmed by the lack of evidence found during archeological survey (Burtchard 2003); winter villages were established at lower elevations and along major riverways (Boxberger 1998; Smith 2006). The region's rich natural resources were used for food, clothing, medicine, and other purposes.

Affiliated tribes have many stories related to Mount Rainier and surrounding peaks and valleys. However, specific ethnographies do not exist for all of the tribes with traditional affiliation to Mount Rainier (Boxberger 1998). Based on ethnographic work conducted by Smith (2006) (Smith's ethnographic study was actually compiled in 1964 but was not published until 2006), the eastern tribes such as the Yakama incorporated the landscape on Mount Rainier's eastern slope for hunting and gathering purposes more consistently than the coastal Salish tribes and have a more bounded concept of traditional territory associated with the mountain.

Although the ethnographic study compiled by Smith (2006) provides an abundance of information on traditional use of Mount Rainier and its lower slopes and drainages, specific data on the use of specific places is generally lacking except for noting traditional hunting and gathering localities such as Mount Wow for mountain goats. As sovereign nations, tribes have rights to traditional resources as provided by treaty, including the treaties of Medicine Creek, Point Elliott, and Yakama (Boxberger 1998).

The introduction of detection equipment would have no effect on traditional ethnographic resources because hunting is not allowed within the park and there are no existing agreements to allow traditional resource gathering. Other than the Mount Wow location (mountain goat hunting), none of the other locations are known to have been specific traditional hunting and gathering locations for the six affiliated tribes. Rather, the entire park was used seasonally by the six affiliated tribes to hunt and gather berries and other resources. The Proposed Action would not restrict traditional access or travel into the park, and none of the proposed monitoring station locations under any alternative are known to be used for ceremonial purposes or are considered traditional cultural properties.

The six affiliated tribes were consulted on the project, including an invitation to provide early input, which was requested via letter on December 14, 2020. To date, no ethnographic resource concerns have been identified by the affiliated tribes for the project. Some tribes did express a preference for new installations to be located in previously developed areas where possible. Because there would be no effects on ethnographic resources and no tribes expressed concerns regarding ethnographic resources in the project area, ethnographic resources was dismissed from detailed analysis in the EA.

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APPENDIX D: USFWS GUIDANCE ON DISTURBANCE, DISRUPTION, AND/OR PHYSICAL INJURY DISTANCE THRESHOLDS FOR SPOTTED OWLS AND MARBLED MURRELETS

Tables 1 and 2 - 13410-2009-F-0388 ONF Programmatic

Table 1. Disturbance, disruption and/or physical injury distance thresholds for **spotted owls**. Distances are to a known occupied spotted owl nest tree or suitable nest trees in unsurveyed nesting habitat.

Project Activity	**No Effect** **(Mar 1 – Sept. 30)**	**NLAA** "may affect" disturbance Distance **(Mar 1 – Sept. 30)**	**LAA** early nesting season disruption distance (**Mar 1–Jul 15**)	**LAA** late nesting season disruption distance (**Jul 16–Sep 30**)	**LAA** direct injury and/or mortality (**Mar 1 – Sept. 30)**
Light maintenance (e.g., road brushing and grading) at campgrounds, administrative facilities, and heavily-used roads	>0.25 mile	≤0.25 mile	NA	NA	NA
Log hauling on heavily-used roads (FS maintenance levels 3, 4, and 5)	>0.25 mile	≤0.25 mile	NA	NA	NA
Chainsaws (includes felling hazard/danger trees)	>0.25 mile -	66 yards to 0.25 mile -	≤ 65 yards	NA	NA
Heavy equipment for road construction, roadrepairs, bridge construction, culvert replacements, etc.	>0.25 mile	66 yards to 0.25 mile	≤ 65 yards	NA	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	120 yards to 0.25 mile	≤ 120 yards	NA	≤5 yards (injury)
Blasting	>1 mile	0.25 mile to1 mile	≤ 0.25 mile	NA	≤100 yards (injury)
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤ 265 yards	≤ 100 yards (hovering only)	NA
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤ 150 yards	≤ 50 yards (hovering only)	NA
Helicopters: K-MAX, Bell 206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	≤ 50 yards (hovering only)	NA
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤ 110 yards	NA	NA
Tree Climbing	>66 yards	26 yards to 65 yards	≤ 25 yards	NA	NA
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤ 0.25 mile	NA	NA

NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect", ≥ is greater than or equal to, ≤ is less than or equal to.

Table 2. Disturbance, disruption, and/or physical injury distance thresholds for **marbled murrelet** during the nesting season **(April 1 to September 23).** Distances are to a known occupied marbled murrelet nest tree or suitable nest trees in unsurveyed nesting habitat.

Project Activity	No Effect	NLAA "may affect" disturbance distance	LAA - disruptiondistance	LAA - direct injury and/or mortality
Light maintenance (e.g., road brushing and grading) at campgrounds, administrative facilities, and heavily-used roads	>0.25 mile	≤0.25 mile	NA	NA
Log hauling on heavily- used roads (FS maintenance levels 3, 4, and 5)	>0.25 mile	≤0.25 mile	NA	NA
Chainsaws (includes felling hazard/dangertrees)	>0.25 mile	111 yards to 0.25 mile	≤110 yards	Potential for mortality if trees felled contain platforms
Heavy equipment for road construction, road repairs, bridge construction, culvert replacements, etc.	>0.25 mile	111 yards to 0.25 mile	≤110 yards	NA
Pile-driving (steel H piles, pipe piles) Rock Crushing and Screening Equipment	>0.25 mile	121 yards to 0.25 mile	≤120 yards	≤5 yards (injury)
Blasting	>1 mile	0.25 to 1 mile	≤0.25 mile	100 yards (injury)
Helicopter: Chinook 47d	>0.5 mile	266 yards to 0.5 mile	≤265 yards	≤100 yards (injury/mortality)
Helicopter: Boeing Vertol 107, Sikorsky S-64 (SkyCrane)	>0.25 mile	151 yards to 0.25 mile	≤150 yards	50 yards (injury/mortality)
Helicopters: K-MAX, Bell206 L4, Hughes 500	>0.25 mile	111 yards to 0.25 mile	≤110 yards	50 yards (injury/mortality)
Small fixed-wing aircraft (Cessna 185, etc.)	>0.25 mile	111 yards to 0.25 mile	≤110 yards	NA
Tree Climbing	>0.25 mile	111 yards to 0.25 mile	≤110 yards	NA
Burning (prescribed fires, pile burning)	>1 mile	0.25 mile to 1 mile	≤0.25 mile	NA

NLAA = "not likely to adversely affect." **LAA** = "likely to adversely affect" ≥ is greater than or equal to, ≤ is less than or equal to.

MOUNT RAINIER NATIONAL PARK WILDERNESS MINIMUM REQUIREMENTS WORKSHEET

Project Title:	Mount Rainier Lahar Detection System Expansion **Draft**

MRDG Step 1: Determination

Determine if Administrative Action is ***Necessary***

Description of the Situation
What is the situation that may prompt administrative action?

Mount Rainier is an active volcano located in Mount Rainier National Park (MRNP or park) near the growing Seattle-Tacoma metropolitan area.

The uniquely rugged and dynamic nature of the landscape in MRNP is among the most beautiful in the National Park system. However, that same landscape also produces some of the greatest measurable hazards in North America. Mount Rainier has experienced episodic volcanic activity throughout its approximately 500,000-year history. Geologists have found evidence for a number of eruptions over the last 6,000 years, most recently 1,000 years before present. They have also found evidence for at least eight large lahars (or volcanic mudflows) produced by eruptions at the summit that reached into areas of the Puget Lowlands that today are populated by thousands of people. In addition, a ninth large lahar (the "Electron Mudflow") that occurred around 1500 A.D. and reached into areas now occupied by Orting and Sumner was initiated by a landslide, not an eruption.

Recent geologic and geophysical studies have found evidence of weak rock on the western flank around Sunset Amphitheater of Mount Rainier, suggesting that a future landslide-caused lahar down the Puyallup and/or Nisqually Rivers is a potential hazard that needs to be taken into account in addition to hazards associated with lahars that may be triggered by future eruptions of the volcano. Since the onset of landslides is inherently unpredictable, it is conceivable that a collapse-driven lahar like the Electron Mudflow could occur with little or no warning. In such an event, recent modeling indicates that a large lahar could reach Orting within 60 minutes along the Puyallup River, the Nisqually entrance to MRNP within 10 minutes, and parts of Ashford within 20. In such a scenario, the principal mitigation strategy is to have a lahar detection system in place that can provide alerts to emergency managers and park personnel to provide as much time as possible for potentially affected populations to evacuate to high ground before a lahar arrives and to inform emergency response needs. To provide reliable early warning in the event of future volcanic unrest and eruption, the United States Geological Survey (USGS) issued a recommendation in 2008 that Very High Threat volcanoes like Mount Rainier should have 12-20 seismic and Global Positioning System (GPS) stations located within 20 kilometers of the summit. The actual number of required stations within that broad range depends on many factors that are specific to each volcano, especially the size of the volcano. For example, to achieve the same capabilities at Mount Rainier as at Mount St. Helens, more stations would be required because Mount Rainier is a larger volcano. In addition to the need to improve the volcano monitoring capabilities of the Mount Rainier volcano monitoring network, the capability to rapidly detect debris flows and lahars without producing false alarms is needed so that authorities inside and outside the park have as much time to act as possible to get people out of harm's way.

Lastly, Mount Rainier is the most heavily glaciated peak in the lower 48 and presents an unparalleled natural laboratory for the study of volcanic and glacial processes. As glaciers recede, unpredictable events such as glacial outburst floods may become more frequent in all park drainages. Such events threaten park infrastructure, including roads, trails, bridges, campgrounds, administrative areas, and other facilities, and pose a hazard to park visitors. Little is known about the initiation and propagation of these smaller events, but they are a key consideration in planning for sustainable visitor access to the park, its facilities, and recreational opportunities in wilderness. Research on processes in Mount Rainier has applications around the world, wherever similar geologic and volcanic features threaten the built environment and downstream communities.

As of December 2020, the Mount Rainier network of monitoring stations consists of 18 seismic and 6 GPS installations located within 20 kilometers (12 miles) of the summit, including 13 seismic and 6 GPS sites inside the park (some seismic and GPS stations are collocated; there are 15 total volcano monitoring sites in MRNP). Five of these sites are in designated wilderness. The current network has been sited and equipped to monitor unrest associated with a volcanic eruption and detect large lahars on several major drainages at points near the park boundaries (more detail on the drainages can be found in the EA, page 4). However, real-time information that would be critical for early detection and tracking of Lahars and debris flows, including which drainages are affected, the volume of material, how fast it is moving, how far it will go downstream, and how soon it might reach residential areas, is not available from the existing network, nor is the ability to detect a spontaneous collapse-driven lahar in the higher risk area of weak rock on the western flank around Sunset Amphitheater of Mount Rainier.

Options Outside of Wilderness
Can action be taken outside of wilderness that adequately addresses the situation?

☐ YES	**STOP – DO NOT TAKE ACTION IN WILDERNESS**
☒ NO	**EXPLAIN AND COMPLETE STEP 1 OF THE MRDG**

Explain:
The existing volcano monitoring network would be unable to detect lahar events until several minutes after they initiate, and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas in the park with effectively no warning, and the warning time would be delayed for areas outside the park.

The improvements to lahar detection necessary for emergency managers to initiate evacuation of visitors and staff inside the park, as well as for residential areas near the park entrance, could not be gained by adding more monitoring stations outside of wilderness. In particular, infrasound instruments, which have been shown to be effective in detecting subaudible sound waves created by moving surface flows such as debris flows and lahars, can be significantly disrupted by topography, so multiple stations within each drainage are needed for reliable detection. Real-time data from stations is sent by digital radio signal, which requires line-of-sight to radio repeaters on high points around the drainages of interest. Most of these high points are also in designated wilderness.

Criteria for Determining Necessity
Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

*Is action necessary to satisfy valid existing rights or a special provision in wilderness legislation (the Wilderness Act of 1964 or subsequent wilderness laws) that **requires** action? Cite law and section.*

☐ YES ☒ NO

B. Requirements of Other Legislation

*Is action necessary to meet the requirements of **other federal laws**? Cite law and section.*

☒ YES ☐ NO

Explain:

John D. Dingell, Jr. Conservation, Management, and Recreation Act of 2019, Title V-Hazards and Mapping, Section 5001. National Volcano Early Warning and Monitoring System.

This legislation directs the USGS to establish a national volcano early warning and monitoring system. The legislation states that Secretary of the Interior “shall establish within the United States Geological Survey a system, to be known as the National Volcano Early Warning and Monitoring System, to monitor, warn, and protect citizens of the United States from undue and avoidable harm from volcanic activity.” The purposes of the volcanic monitoring system are to organize, modernize, standardize, and stabilize the monitoring systems of the volcano observatories in the United States, including the Cascades Volcano Observatory; and to unify the monitoring systems of volcano observatories in the United States into a single interoperative system.

The objective of the system is to monitor all the volcanoes in the United States at a level commensurate with the threat posed by the volcanoes by (1) upgrading existing networks on monitored volcanoes, (2) installing new networks on unmonitored volcanoes, and (3) employing geodetic and other components. Modernization activities under the system shall include the comprehensive application of emerging technologies, including digital broadband seismometers, real-time continuous GPS receivers, satellite and airborne radar interferometry, acoustic pressure sensors, and spectrometry to measure gas emissions.

Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act)

The Stafford Act is a 1988 amended version of the Disaster Relief Act of 1974. Section 202(a) states that “the President shall insure that all appropriate Federal agencies are prepared to issue warnings of disasters to State and local officials.” In addition, Section 202(b) states that “the President shall direct appropriate Federal agencies to provide technical assistance to State and local governments to insure that timely and effective disaster warning is provided.” The director of the USGS, through the Secretary of the Interior, has been delegated the responsibility to issue disaster warnings “for an earthquake, volcanic eruption, landslide, or other geologic catastrophe.”

Earthquake Hazards Reduction Act of 1977

The Earthquake Hazards Reduction Act of 1977 sets as a national goal the reduction in the risks of life and property from future earthquakes in the United States through the establishment and maintenance of a balanced earthquake program encompassing prediction and hazard assessment research, seismic monitoring, and information dissemination. P.L. 101-614 reauthorizes the act.

C. Wilderness Character

Is action necessary to preserve one or more of the five qualities of wilderness character?

UNTRAMMELED

☐ YES ☒ NO

UNDEVELOPED

☐ YES ☒ NO

NATURAL

☐ YES ☒ NO

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☒ NO

OTHER FEATURES OF VALUE

☐ YES ☒ NO

Step 1 Determination
*Is administrative action **necessary** in wilderness?*

Criteria for Determining Necessity

A. Existing Rights or Special Provisions	☐ YES	☒ NO
B. Requirements of Other Legislation	☒ YES	☐ NO
C. Wilderness Character		
Untrammeled	☐ YES	☒ NO
Undeveloped	☐ YES	☒ NO
Natural	☐ YES	☒ NO
Solitude/Primitive/Unconfined	☐ YES	☒ NO
Other Features of Value	☐ YES	☒ NO

Is administrative action **necessary** in wilderness?

☒ YES	**EXPLAIN AND COMPLETE STEP 1 OF THE MRDG**
☐ NO	**STOP – DO NOT TAKE ACTION IN WILDERNESS**

Explain:
The USGS is proposing a substantial upgrade to the present-day volcano monitoring network at Mount Rainier. The upgrade would improve the capabilities to detect unrest leading to an eruption (following the standards put forward in the NVEWS (National Volcanic Early Warning System), pursuant to Title II of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988) and would enable the capability to detect a large lahar within minutes of initiation,

with particular focus on a landslide-generated lahar down the Puyallup River and Tahoma Creek drainages.

The USGS is proposing to install modern monitoring stations that consist of multiple types of sensors in order to provide early detection capabilities of surface events such as lahars, debris flows, and outburst floods. Prioritizing the rapid detection of such events is intended to enable the NPS and the USGS to provide warning to areas of impact and initiate a response to the events as they are happening rather than minutes or hours after the fact.

In addition to the less-frequent large lahars, data collected using stations in the proposed network would also be useful in detecting smaller debris flows and outburst floods in Tahoma Creek and elsewhere in the park, which is important for both situational awareness and hazard mitigation in the park. The Tahoma Creek drainage itself has experienced over 33 debris flows since 1967, making it both a high-input management area due to the Westside Road and an excellent natural laboratory to further scientific understanding of debris flows. Recordings of debris flows are also important to the broader scientific community, as recordings of such flows on multiple high-quality stations are relatively rare and would help our understanding of their initiation and dynamics. The proposed network would also provide a long-term backbone for denser temporary deployments of instrumentation that would provide even higher-fidelity datasets that are critical for informing models of debris flow generation and movement. Such models would ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other places around the world, and would enable the park to better inform visitors, including wilderness users, of local hazards and how the park itself handles such events. Additional benefits that cannot yet be quantified are likely to result from the installation of the system, including enhancing our detection ability and understanding of rockfall, glacial dynamics, flooding, and potentially more. Finally, the proposed stations would improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and ground deformation that often precede eruptions, and also to detect explosions that often accompany volcanic unrest and eruption.

If the proposed stations are not installed, the existing monitoring network would be unable to detect events until at least several minutes after they initiate, and the impacted drainage would be more difficult to discern in a timely manner, meaning that events would impact use areas in the park with effectively no warning, and the warning time would be reduced for areas outside the park. No installation would also eliminate any potential benefits to science and park planning, and the volcano monitoring capabilities at Mount Rainier would remain unchanged.

MRDG Step 2

*Determine the **Minimum** Activity*

Other Direction

*Is there "special provisions" language in legislation (or other Congressional direction) that explicitly **allows** consideration of a use otherwise prohibited by Section 4(c)?*

AND/OR

Has the issue been addressed in agency policy, management plans, species recovery plans, or agreements with other agencies or partners?

☒ YES **DESCRIBE OTHER DIRECTION**

☐ NO **SKIP AHEAD TO TIME CONSTRAINTS BELOW**

Describe Other Direction:

2006 NPS Management Policies

Section 6.3.6, Scientific Activities in Wilderness: "Scientific activities are to be encouraged in wilderness. Even those scientific activities (including inventory, monitoring, and research) that involve a potential impact to wilderness resources or values (including access, ground disturbance, use of equipment, and animal welfare) should be allowed when the benefits of what can be learned outweigh the impacts on wilderness resources or values. However, all such activities must also be evaluated using the minimum requirement concept and include documented compliance that assesses impacts against benefits to wilderness. This process should ensure that the activity is appropriate and uses the minimum tool required to accomplish project objectives. Scientific activities involving prohibitions identified in section 4(c) of the Wilderness Act (16 USC 1133(c)) may be conducted within wilderness when the following occur:

- The desired information is essential for understanding the health, management, or administration of wilderness, and the project cannot be reasonably modified to eliminate or reduce the nonconforming wilderness use(s); or if it increases scientific knowledge, even when this serves no immediate wilderness management purposes, provided it does not compromise wilderness resources or character. The preservation of wilderness resources and character will be given significantly more weight than economic efficiency and/or convenience.

- Compliance with the National Environmental Policy Act (including completion of documented categorical exclusions, environmental assessments/findings of no significant impact, or environmental impact statements/records of decision) and other regulatory compliance (including compliance with section 106 of the National Historic Preservation Act (16 USC 470f)) are accomplished and documented.

- All scientific activities will be accomplished in accordance with terms and conditions adopted at the time the research permit is approved. Later requests for exceptions to the Wilderness Act will require additional review and approval.

- The project will not significantly interfere with other wilderness purposes (recreational, scenic, educational, conservation, or historical) over a broad area or for a long period of time.

- The minimum requirement concept is applied to implementation of the project.

Research and monitoring devices (e.g., video cameras, data loggers, meteorological stations) may be installed and operated in wilderness if (1) the desired information is essential for the administration and preservation of wilderness and cannot be obtained from a location outside wilderness without significant loss of precision and applicability; and (2) the proposed device is the minimum requirement necessary to accomplish the research objective safely.

Park managers will work with researchers to make NPS wilderness area research a model for the use of low-impact, less intrusive techniques. New technology and techniques will be encouraged if they are less intrusive and cause less impact. The goal will be for studies in NPS wilderness to lead the way in 'light on the resource' techniques.

Devices located in wilderness will be removed when determined to be no longer essential. Permanent equipment caches are prohibited within wilderness. Temporary caches must be evaluated using the minimum requirement concept.

All scientific activities, including the installation, servicing, removal, and monitoring of research devices, will apply minimum requirement concepts and be accomplished in compliance with Management Policies, director's orders, and procedures specified in the park's wilderness management plan."

Section 8.4, Overflights and Aviation Uses: "Although there are many legitimate aviation uses, overflights can adversely affect park resources and values and interfere with visitor enjoyment. The Service will take all necessary steps to avoid or mitigate unacceptable impacts from aircraft overflights."

Section 8.2.3, Use of Motorized Equipment: "The Service will strive to preserve or restore the natural quiet and natural sounds associated with the physical and biological resources of parks. To do this, superintendents will carefully evaluate and manage how, when, and where motorized equipment is used by all who operate equipment in the parks, including park staff. Uses and impacts associated with the use of motorized equipment will be addressed in park planning processes. Where such use is necessary and appropriate, the least impacting equipment, vehicles, and transportation systems should be used, consistent with public and employee safety."

Mount Rainier National Park Wilderness Management Plan 1992

Administrative Use of Aircraft: "Permission to use helicopters in Wilderness is granted by the Superintendent. Helicopter use in Wilderness, for other than emergencies, will generally not be approved between July 1 and Labor Day and use is restricted to weekdays. Approval for use of helicopters in non-emergency situations will be granted only if it has been determined to be the minimum tool to achieve the purposes of the area or for protection of Wilderness values."

Research: "Monitoring devices for hydrological, seismic, hydrothermal or other purposes may be installed and operated in Wilderness only when park management has determined that the information is essential and cannot be obtained from a location outside of the Wilderness and the proposed device is the 'minimum tool' necessary to accomplish the study objective. Devices used for monitoring or research purposes are removed when they are no longer essential. All areas are restored to natural conditions at the completion of studies."

Mount Rainier National Park General Management Plan 2002

Geologic Hazards: The plan states, "Increased efforts would be made under the preferred alternative to educate and inform visitors and employees about the threat of geologic hazards and what to do if a debris flow or other event occurred. Such efforts might include…cooperating with the U.S. Geological Survey and others in monitoring geologic hazards in the park."

Time Constraints

What, if any, are the time constraints that may affect the action?

Time constraints on helicopter flights would be required for safety reasons and would include flying during daylight hours and avoiding flying during bad weather. Installation work, including helicopter flights, would be limited to September and October. Flights would begin after Labor Day to minimize impacts on visitors and to minimize impacts on nesting northern spotted owls and marbled murrelets. Installations would be completed before November to avoid winter conditions.

Components of the Action

What are the discrete components or phases of the action?

Component 1: Selection of the lahar monitoring locations
Component 2: Transportation of material to the monitoring sites
Component 3: Transportation of personnel to the monitoring sites
Component 4: On-site installation of the monitoring stations
Component 5: Maintenance of the monitoring stations
Component 6: Periodic equipment replacement
Component 7: Emergency repairs to aviation-dependent monitoring sites

MRDG Step 2: Alternatives

Alternative 1: USGS Proposed Action

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

The goal of the USGS Lahar Detection System proposal is to mitigate human risk by reducing the amount of time it takes for an alert to be sent out to potentially affected populations and communities after a lahar has been generated.

The expansion would also increase the number of total drainage areas covered by the alert system to include the Tahoma Creek and the Nisqually River drainages, which, along with the Puyallup River valley, are vulnerable to future non-eruptive landslide-caused lahars from Mount Rainier. An additional benefit of the expanded monitoring system would be to improve detection capabilities for smaller debris flow events, particularly along Tahoma Creek, which has experienced multiple debris flows since the late 1980s.

Under this alternative, lahar detection stations would be installed at 12 sites in the park, of which 9 would be in wilderness. The sites in wilderness would be Ararat South, Copper Mountain, Emerald Ridge (upgrade to an existing University of Washington site), Fremont Lookout, Gobblers Knob Lookout, Mildred Point, Shriner Peak Lookout, Tahoma Bridge, and Tolmie Peak Lookout. As described below and in Appendix B of the EA, the Fremont Lookout, Shriner Peak, and Tolmie Peak stations would function primarily as telemetry nodes for future stations installed along the Carbon, White, Ohanepecosh/Cowlitz, and Mowich River drainages in the event of future volcanic unrest at Mount Rainier and would not repeat data from any current or proposed stations. Instead, these installations would be part of a telemetry backbone that would enable rapid installation of new real-time monitoring stations along the White River drainage, something that would be required to help mitigate lahar hazards along the White River if Mount Rainier were to start exhibiting signs of volcanic unrest. The remaining nine stations would be installed to increase rapid detection along the west flank of Mount Rainier, which is the most vulnerable to a large lahar down the Puyallup River, Mowich, or Tahoma Creek drainages.

Role of Individual Stations in the Lahar Detection System

Ararat South

The Ararat South site would feature a seismometer and infrasound array and serve as a telemetry repeater for station Mount Wow along Tahoma Creek. Ararat South's roles would include:

- The Ararat South station would provide infrasound and seismometer detection capabilities for a lahar moving down Tahoma Creek, both to confirm that a lahar is moving down the drainage and to determine the location and velocity of the flow front.

- This station would provide redundancy if the monitoring stations at St. Andrews Rock and Emerald Ridge are destroyed by a landslide or lahar.
- The Ararat South station would improve volcano monitoring capabilities of the Mount Rainier volcano monitoring network through addition of a seismometer and infrasound array close to the summit.
- This station would improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows, and events on the south and west flanks of the volcano.
- Ararat South would serve as a repeater for station Mount Wow. Without Ararat South, there would be no way to transmit real-time data from Mount Wow, making that site unusable for real-time lahar monitoring.

<u>Copper Mountain</u>

The Copper Mountain site would feature a seismometer, infrasound array, webcam, and GPS receiver. Copper Mountain's roles would include:

- Copper Mountain would provide infrasound detection capabilities for a lahar moving down Tahoma Creek, both to confirm that a lahar is moving down the drainage and to determine the location and velocity of the flow front.
- The webcam at Copper Mountain would play a key role in confirming the location of a landslide and the formation of a lahar.
- Similar to Ararat South, Copper Mountain's seismometer would play an important lahar detection role (see the Ararat South description above).
- Copper Mountain would provide redundancy if the monitoring stations at St. Andrews Rock and Emerald Ridge are destroyed by a landslide or lahar.
- Copper Mountain would improve volcano monitoring capabilities of the Mount Rainier volcano monitoring network through addition of a seismometer, infrasound array, and GPS receiver close to the summit.
- The infrasound array and seismometer at Copper Mountain would also improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows on the south and west flanks of the volcano (see the Ararat South description above).

<u>Emerald Ridge – Upgrade of Existing Site</u>

The Emerald Ridge site is an existing seismic station operated by the University of Washington. It would be upgraded to include both a modern seismometer and an infrasound array. Emerald Ridge's roles would include:

- Emerald Ridge would provide infrasound and seismometer detection capabilities for a lahar moving down Tahoma Creek and Puyallup River, both to confirm that a lahar has been created and to help determine which drainage(s) it is moving down.
- Emerald Ridge is the second-closest station to the source area for a landslide on the west flank (St. Andrews Rock is the closest), and also sits on a ridge that divides the Puyallup River and Tacoma Creek drainages. This location is important in two ways:
    - If a large landslide occurs in the northern part of the presumed source area, the closest station (St. Andrews Rock) would likely not survive, so Emerald Ridge

    would then become the closest station to the source area and would provide information critical to tracking the initial moments of the landslide event and possible transition to a lahar.
    - If a large landslide occurs the southern part of the presumed source area, modeling indicates that a large lahar would be split by Emerald Ridge and go down both the Puyallup and Tahoma Creek drainages. Modeling also indicates that a large lahar would reach Emerald Ridge in 1 to 2 minutes and likely destroy it, providing early confirmation that a large lahar had been created and was moving down Tahoma Creek.
- Historically, Emerald Ridge has been the only seismic station in the Mount Rainier volcano monitoring network to clearly record small debris flows going down Tahoma Creek. However, telemetry from the site is unreliable at times and the seismometer is out of date. Upgrading the site will improve telemetry reliability and also the fidelity and quality of seismic recordings of debris flows and lahars.
- Emerald Ridge is a critical site in the Mount Rainier volcano monitoring network. It is the closest site to the summit on the southwestern flank and, since its installation in 1991, the site has proven to be quiet and highly sensitive to small earthquakes near the summit. Upgrading the seismometer and improving the reliability of the station would improve the precision and accuracy of earthquake locations beneath Mount Rainier, and the infrasound array would improve the ability of the network to detect explosions.
- Emerald Ridge would operate as a ShakeAlert station (https://www.shakealert.org/), enhancing the earthquake early warning capability at the volcano. Depending on the lahar trigger, a detection from the ShakeAlert system may be one of the earliest signs of a developing landslide.

Fremont Lookout

The Fremont Lookout site would function solely as a telemetry node. A station at Mount Fremont operated by the University of Washington is close to Fremont Lookout, so no seismometer is needed at Fremont Lookout. It would not repeat data from any current or proposed stations. Instead, its installation would be part of a telemetry backbone (along with Tolmie Peak and Shriner Peak) that would enable rapid installation of new real-time monitoring stations along the White River drainage, something that would be required to help mitigate lahar hazards along the White River if Mount Rainier were to start exhibiting signs of volcanic unrest.

Gobblers Knob

The Gobblers Knob Lookout site would feature a seismometer and would also serve as a telemetry repeater for stations Copper Mountain, Tahoma Bridge, and Tahoma Vista. Gobblers Knob's roles would include:

- Similar to Ararat South and Copper Mountain, the Gobblers Knob's seismometer would play an important lahar detection role (see the Ararat South description above). Although the seismometer at Gobblers Knob would provide data important for tracking lahars along the entire Tahoma Creek drainage, it would be particularly important for tracking lahars down the lower part of Tahoma Creek (along with Mount Wow, Tahoma Vista, and existing stations KAUT and GATE). In addition, if a lahar destroys stations GTWY, KAUT, Emerald Ridge, Tahoma Bridge, Tahoma Vista, and Mount Wow, Gobblers Knob

would be the only station still in operation that could provide data necessary for detecting and tracking subsequent lahars and debris flows moving along the lower part of Tahoma Creek.
- Gobblers Knob would serve as a repeater for stations Copper Mountain (Copper Mountain), Tahoma Bridge, and Tahoma Vista. Without Gobblers Knob, there would be no way to transmit real-time data from Copper Mountain, Tahoma Bridge, and Tahoma Vista, making those sites unusable for real-time lahar monitoring.

Mildred Point

The Mildred Point site would feature a seismometer and infrasound array. Mildred Point's roles would include:

- Mildred Point would provide infrasound detection capabilities for a lahar or debris flow moving down the Kautz Creek and Nisqually Creek drainages, both to confirm that a lahar is moving down the drainages and to determine the location and velocity of the flow front.
- Mildred Point's seismometer would also play an important lahar detection role through use of seismic amplitude ratios (see the Ararat South description above).
- Similar to Ararat South and Copper Mountain, Mildred Point would improve volcano monitoring capabilities of the Mount Rainier volcano monitoring network through addition of a seismometer and infrasound array close to the summit.
- The infrasound array and seismometer at Mildred Point would also improve the network's ability to detect and locate "surface events" such as avalanches, rockfalls, and debris flows on the south flank of the volcano including the Nisqually glacier.

Paradise Parking Lot Tower

The Paradise Parking Lot Tower site would serve as a telemetry repeater for stations Ararat South, Mildred Point, and Mount Wow (repeated through Ararat South).

Shriner Peak

The Shriner Peak site would feature a seismometer and would also function as a telemetry node for future stations installed along the Ohanapecosh drainage in the event of future volcanic unrest at Mount Rainier. Shriner Peak's roles would include:

- Shriner Peak's primary role would be as a repeater. It would not repeat data from any current or proposed stations. Instead, its installation would enable rapid addition of telemetered real-time monitoring stations along the Ohanapecosh drainage that would repeat through Shriner Peak to a receive site outside MRNP. Addition of stations along the Ohanapecosh River would be required to help mitigate lahar hazards to downstream communities if Mount Rainier were to start exhibiting signs of volcanic unrest.
- The seismometer at Shriner Peak would improve the ability of the seismic network to detect smaller lahars and debris flows down the Ohanapecosh River.
- The seismometer at Shriner Peak would also significantly improve the accuracy of earthquake locations at Mount Rainier, particularly in the southeast quadrant of MRNP, which at present has only two seismic stations (RCM (Camp Muir) and OPCH

(Ohanapecosh Visitor Center)). The east side of MRNP is an active seismic area, most recently hosting the M4.5 Cowlitz Chimneys earthquake in 2006 that was widely felt in MRNP (Hartog et al. 2008).

Tahoma Bridge

The Tahoma Bridge site would feature a seismometer and a single infrasound sensor. Tahoma Bridge's roles would include:

- A large lahar would likely destroy Tahoma Bridge within 1 to 3 minutes of initiation, providing independent confirmation that a lahar was moving down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
- Tahoma Bridge would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. Such information would improve MRNP's situational awareness about such events, potentially improving response time for search and rescue efforts.

Tahoma Vista

The Tahoma Vista site would feature a seismometer and an infrasound array. Tahoma Vista's roles would include:

- If Tahoma Vista is located at Tahoma Vista along the Westside Road, a large lahar would likely destroy Tahoma Vista within 3 to 5 minutes of initiation, providing independent confirmation that a lahar was continuing to move down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
- If located at the alternate Tahoma Vista site, a large lahar would not destroy the site; in that event, Tahoma Vista would join Gobblers Knob, Ararat South, and Copper Mountain as the only sites that could provide data necessary for detecting and tracking subsequent lahars and debris flows moving along Tahoma Creek in the aftermath of the large lahar. In addition, the alternate site would provide infrasound coverage for the Puyallup River drainage.
- Either location has a unique view of the Tahoma Creek that is optimal for infrasound detection. Coupled with infrasound arrays at Copper Mountain and Ararat South, the Tahoma Vista infrasound array would provide complete infrasound coverage of the Tahoma Creek drainage down to its confluence with the Nisqually River.
- Tahoma Vista would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. Such information would improve MRNP's situational awareness about such events, potentially improving response time for search and rescue efforts.

Tolmie Peak

The Tolmie Peak Lookout site would feature a seismometer and would also function as a telemetry node for future stations installed along the Carbon and Mowich River drainages in the event of future volcanic unrest at Mount Rainier. Tolmie Peak Lookout's roles would include:

- Tolmie Peak Lookout's primary role would be as a repeater. It would not repeat data from any current or proposed stations; instead, its installation would enable rapid addition of telemetered real-time monitoring stations along the Carbon and Mowich River drainages, which would repeat through Tolmie Peak Lookout to a receive site outside MRNP. Addition of stations along the Carbon and Mowich Rivers would be required to help mitigate lahar hazards to downstream communities if Mount Rainier were to start exhibiting signs of volcanic unrest.
- The seismometer at Tolmie Peak Lookout would significantly improve the accuracy of earthquake locations at Mount Rainier, particularly in the northwest quadrant of MRNP, which at present has only two seismic stations (Carbon Ranger Station (CRBN) and Observation Rock (OBSR)).

Mount Wow

The Mount Wow site would feature a seismometer and a single infrasound sensor. Mount Wow's roles would include:

- A large lahar would likely destroy Mount Wow within 5 to 7 minutes of initiation, providing independent confirmation that a lahar was continuing to move down Tahoma Creek and also providing information important for determining the velocity and size of the lahar.
- Mount Wow would also provide seismic and infrasound data important for constraining the timing and velocity of smaller lahars and debris flows. In particular, the Mount Wow location is in the area where many recent debris flows have come close to or damaged the Westside Road; it is therefore uniquely situated to provide MRNP with situational awareness about events that may have impacted the Westside Road, potentially improving response time for repairs as well as search and rescue efforts.

A summary of the design process for the Mount Rainier lahar detection system and a detailed description of each site's individual role in the lahar detection system is included in the EA as Appendix B. Additional construction details are found in the EA.

Power Tool Use for Installation

The USGS requires the use of the following power tools during the installation of the proposed Mount Rainier lahar detection infrastructure at stations located in the areas designated as wilderness. Additionally, the USGS requires the use of many of the same tools to conduct maintenance at these stations as needed. The tools include:

- Battery-powered drill (e.g., DeWalt 20v lithium battery ½-inch drill) for drilling holes in pipes, enclosures, and solar panel frames as needed.
- Battery-powered rock drill for drilling up to 1-inch-diameter holes at the Mount Wow alternative site (e.g., the "talus" site) and Tahoma Bridge to anchor enclosures.
- Battery-powered sawzall (e.g., DeWalt 20v lithium battery 1 1/8-inch stroke reciprocating saw) for cutting pipe, damaged hardware, and 2-inch U-bolts that become cross-threaded during installation or subsequent maintenance.
- Battery-powered bandsaw (e.g., DeWalt 20v lithium battery cordless band saw) for cutting pipe on-site during installation or subsequent maintenance.

- For installing the GPS monument at Copper Mountain, the following power tools are required:
  - A 4000W gas-powered generator to operate corded power tools needed for building the short-braced GPS monument.
  - An AC-powered handheld hammer drill to drill four 1.5-inch-diameter and 6-foot-deep holes into bedrock.
  - An AC-powered 1-gallon air compressor for powering a pneumatic epoxy dispenser.
  - A small portable AC-powered welder to tack weld the three angled legs of the GPS monument to the central vertical rod (required for stabilizing the monument).
  - A battery-powered vacuum (DeWalt 20v lithium battery) for removing fine dust out of the 6-foot-deep GPS monument holes.
  - A battery-powered hand grinder with cut off wheel (DeWalt 20v lithium battery).

All Stations

The proposed fiberglass enclosures are designed to be streamlined, self-efficient, and almost entirely prebuilt off-site prior to installation. Power tool use during installation of the fiberglass enclosures would be on an as-needed basis and would be limited to minutes-long durations only.

Mount Wow Alternative (Mount Wow Talus) and Tahoma Bridge

The hut enclosures must be secured to the ground to a shallow depth to prevent any movement on sloping terrain. Because the Mount Wow Talus and Tahoma Bridge station enclosures are, by necessity, installed on a rock surface, this requires drilling holes in the rock to install J bolts that secure the base (flange) of the hut to the ground using compact cordless SDS Max rotary hammer drills. (Note: The Mount Wow site along the road would not require use of an SDS Max drill.)

Copper Mountain

Installation of the GPS monument at the Copper Mountain site will require additional motorized equipment – specifically, a generator, a welder, a small air compressor, a pneumatic adhesive dispenser, and a hammer drill as described above.

Power Tool Use for Maintenance

Short- and long-term ice, snow, and wind damage may create unanticipated situations where additional modifications to the solar panel frames and telemetry infrastructure will be necessary to repair damaged equipment. Such repairs may require the use of the same power tools noted above, except for those needed only for the installation the GPS monument at Copper Mountain. Modifications to metal infrastructure, especially steel and aluminum, without power drills and saws can be time prohibitive or impossible depending on the type and thickness of the metal.

Specific examples where power tools will be required during maintenance include:

- Replacement of lightning protection that has failed or was damaged at a location near a ground rod attached to the enclosure.
- Drilling precision holes in the solar panels or the enclosure to adjust or repair damaged solar panel mounting.
- Removal of or cutting off large stainless steel bolts that have been damaged by snow and ice conditions or are rusted, seized, or cross-threaded.
- Adjustments and replacement of metal pipes or angle brackets used for solar panel framing damaged by ice, snow, or wind loading. In this case, both a drill and saw would be used in very limited durations to remove old rusted or damaged hardware and secure new pipe and hardware as needed.

A description of the power tools to be used and a detailed rationale for power tool use is provided in Attachment A.

Helicopter Use for Installation

The sites within wilderness would require the use of helicopters for initial installation and subsequent maintenance. Installation would require up to seven round trips to each project location by a small helicopter carrying sling loads. Helicopters used would be small (such as A-Stars, Bell Jet Rangers, or Hughes 500 series). Helicopters would take off from the Kautz helibase or the Sunrise parking area (available only in late September/October). The total number of helicopter flights would be about 63 during installation over a 2-month period (September and October), with installations potentially extending into September/October 2022 if weather or other conditions do not allow for completion of installations in 2021. Sites would be evaluated one year post-installation to determine if active restoration is needed to restore natural conditions at monitoring sites. Should revegetation be necessary, helicopter flights may be required to transport seedlings to areas where transport on foot is infeasible. This would require up to two flights per site where active revegetation is needed – one flight to deliver seedlings and one flight to remove supplies after planting. With the addition of potential flights for revegetation, up to eight total round-trip flights would be needed for each site for installation, and the total number of round-trip flights associated with installation would be about 72. Flight time for installation would be about 1 to 2 hours per day at each site over a period of 2 days, or about 32 to 63 hours of total flight time during installation over a 2-month period (September and October) each year for 2 years.

Helicopter Use for Maintenance

Sites would typically be accessed by foot for routine tuning and maintenance, but additional helicopter flights would be required for anticipated equipment and battery replacement, requiring four round trips per site every 5 years. Tuning refers to unexpected adjustments or repairs to stations within the first two years after installation. The USGS has found that that some sites require tuning after installation, which sometimes requires helicopter use to deliver heavy or bulky equipment, or to remove damaged equipment. Additional flights may also be needed if urgent repairs are required and foot access is not available, for example during winter months.

About 243 maintenance flights would be performed over a period of 30 years. Flight time for maintenance would be about 22 to 243 hours for maintenance flights over a period of 30 years. Flights for tuning and emergency repairs are included in this total. Flights for emergency repairs could potentially occur in months other than September and October.

For comparison, the total number of flight hours in the park from 2015 to 2019 averaged 142 flight hours per year, consisting mostly (about 95 percent) of small helicopters, and a small proportion (less than 5 percent) consisting of large helicopters such as CH-47 Chinook and Blackhawk. Helicopter use for Alternative 1 and the other alternatives is summarized in Step 2: Alternatives Comparison in Table 1.

Component Activities
How will each of the components of the action be performed under this alternative?

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Selection of the lahar monitoring locations	Nine out of 12 stations would be within wilderness.
2	Transportation of material to the monitoring sites for installation	All materials and equipment would be transported by helicopters.
3	Transportation of personnel to the monitoring sites during installation	Personnel would hike to and from the sites.
4	On-site installation of the monitoring stations	Installation would use power tools.
5	Maintenance of the monitoring stations	Access sites on foot for routine tuning and maintenance work.
6	Periodic equipment replacement	Transport replacement batteries and other large or heavy components by helicopter.
7	Emergency repairs to aviation-dependent monitoring sites	Access sites by aircraft when objective hazards preclude access on foot.

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒

1	Nine out of 12 stations would be within wilderness	☐	☐	☒
2	All materials and equipment would be transported with helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
Alternative 1 would not adversely affect the untrammeled quality. The lahar detection stations would not increase human manipulation or control of the components or processes of ecological systems inside wilderness; therefore, the untrammeled quality of wilderness would be preserved.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Nine out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☒	☐
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Alternative 1 would have both permanent and temporary effects on the undeveloped quality of wilderness. Construction activities would introduce noise and sights of additional human occupation, which would adversely affect the undeveloped quality of the wilderness. Use of

mechanized equipment, such as power tools, and use of a helicopter for material delivery would introduce unnatural sounds during installation and maintenance work. Use of power tools is described in Attachment A. Impacts on the undeveloped quality during construction would generally be low, and disturbance would be mostly contained to a brief construction period at each site. Elevated noise levels from the use of mechanized equipment would occur during construction for a period lasting 2-3 days at each site. Use of a helicopter to transport material would result in a temporary increase in noise that would affect the undeveloped quality of wilderness for about one to two hours per day over a period of about two days at each site. The total number of helicopter flights would be about 72 during installation over a 2-month period (which would occur September –October 2021 and possibly extend into September-October 2022 depending on weather conditions and other factors) and about 243 maintenance flights over a period of 30 years. This would represent an increase of about 25 to 50 percent in flight time during the 1 to 2-year installation period and an increase of about 3 to 6 percent in flight time compared to the existing number of flights over the 30-year maintenance period. Helicopters would deliver materials to the project sites via sling loads during installation. Maintenance flights would also involve sling loads to deliver and remove heavy equipment. Crews would hike to the sites to reduce the number of flights for both installation and maintenance. Maintenance flights could also involve landings in the wilderness if critical outages occur when sites are not accessible by foot.

After installation, the presence of new structures and installations at Emerald Ridge, Ararat South, Copper Mountain, Mildred Point, and Tahoma Bridge would degrade the undeveloped wilderness quality by introducing visible signs of human occupation. Under this alternative, the number of standalone seismic installations in wilderness would increase from 5 to 9. The other installations would be collocated with existing developments and installations. The number of stations dependent on aircraft would increase from 5 to 13. As previously described, the physical footprint of all installations in wilderness would be less than 0.1 acre within the Mount Rainier Wilderness, which totals 228,400 acres. The installation locations were designed to minimize visibility to the greatest extent practicable by using screening from vegetation and topography. Stations would be painted to reduce their visibility and placed strategically to minimize detection by the casual visitor; however, several of the sites would be potentially visible to the public from nearby as well as from a distance, including popular peaks and viewpoints. Installation of the sites at Emerald Ridge, Ararat South, Copper Mountain, and Mildred Point would affect relatively unimpacted sites with large viewsheds within designated wilderness, mostly within the upper Tahoma Creek watershed. These sites would be situated so they would be hard to see from established trails; however, visitors travelling off trail could come across these facilities or see them from a distance. Wilderness users encountering these facilities could feel that their wilderness experience has been degraded by the presence of these signs of human occupation.

The installation on Ararat South would be encountered by some hikers climbing to the summit, and would tend to dominate the experience of the highest point on the summit; however, the summit is broad and visitors exploring the summit area could find places where the installation is not visible. The installation at Mildred Point would be out of sight of the majority of hikers who do not venture past the end of the maintained trail; however, for some hikers continuing up the ridge to experience the area without the aid of recreational developments, the installation would be encountered and dominate the experience of the area within several hundred feet. The Mildred Point site would also be visible from a distance from many of the higher elevations of Van Trump Park.

The Copper Mountain site would be partially visible to climbers attempting the summit, but would not dominate the experience of the undeveloped summit or interfere with views of Mount Rainier or the surrounding landscape. The installation at Emerald Ridge would not be visible to the majority of on-trail hikers, but would be encountered by visitors exploring the area without the aid of recreational developments, and would tend to dominate the experience of the location within 100 to 200 feet or greater. These impacts would persist for as long as the lahar detection sites are present in the wilderness, potentially indefinitely. The Tahoma Bridge site would be mostly screened from view by vegetation and would not likely be seen by visitors but would completely dominate the experience of a visitor who ventured a short distance off trail to the outcrop, which currently provides an elevated view of the Tahoma Creek drainage out of sight of the more highly visited Wonderland Trail and suspension bridge.

The Fremont Lookout, Gobblers Knob, Shriner Peak, and Tolmie Lookout sites would be collocated with existing lookout structures, thus reducing the impacts to the undeveloped wilderness quality. The fire lookouts have been evaluated for necessity through the park's Wilderness Management Plan, and satisfy the minimum requirement as historic features, but also for their necessity for administration of the wilderness through the provision of communication infrastructure and other administrative uses. The additional impact of adding solar panels or buried seismometers at these sites would be consistent with those administrative uses.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Nine out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☒	☐
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒

7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
Alternative 1 would alter less than 0.1 acre of vegetation within the 228,400-acre wilderness, and impacts are expected to recover to a natural state over time. Due to the small scale and widely separated nature of the proposed sites, and the implementation of mitigation measures to reduce impacts, Alternative 1 would have only minimal adverse effects on plants, animals, air, water, or ecological processes. There would be some site-specific negative impacts on natural resources (soils, vegetation, and soundscape) during installation, and potentially maintenance, of structures in currently undeveloped wilderness. It is also possible that foot traffic from maintenance visits or curious visitors could cause the development of social trail impacts where they do not currently exist. Noise and activity from construction and helicopters have the potential to affect breeding and roosting behaviors of spotted owls and marbled murrelets; however, with implementation of mitigation measures, the project is not expected to adversely affect these species.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Nine out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Helicopter trips to install monitoring stations would affect solitude when aircraft are flying over or landing in wilderness. Impacts would affect individuals encountering aircraft as well as those who could hear the aircraft from distant locations. These effects would vary among individuals, depending on where visitors encountered the helicopter use, and would be temporary, limited to about 63 trips during installation over a 2-month period (September and October) in 2021 with extension into September/October 2022 if installations are not completed in 2021. With the

addition of potential flights for revegetation, up to eight total round-trip flights would be needed for each site for installation, and the total number of round-trip flights associated with installation could be up to 72. About 243 maintenance flights would occur over a period of 30 years.

After installation, the structures would have small effects on solitude or unconfined recreation. The presence of the monitoring stations would negatively affect the primitive nature of the wilderness. Individuals who came across a site could have their wilderness experience negatively affected by the feeling of being monitored and by the feeling that modern humans have occupied and will return to the site. The stations might serve as curiosities that attract more users to the sites but would not reduce opportunities for solitude or primitive and unconfined recreation overall. As described under the undeveloped quality, stations would be painted to reduce their visibility and placed to minimize being detected by the casual visitor. However, the greatest impact would be experienced by the visitor who expends the greatest effort to pursue the opportunity for solitude, and therefore has a higher expectation of solitude.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Nine out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
The four proposed monitoring stations on the Fremont, Gobblers Knob, Shriner Peak, and Tolmie Peak fire lookouts would affect contributing features to the National Historic Landmark District. Impacts on these features are described in detail in the Historic Districts, Structures, and Cultural Landscapes section of the EA. These historical structures predate the wilderness designation and contribute to wilderness character to the extent that they tell the story of historical use of the wilderness area. Modern installations and modifications contribute to a shift in visitor perception of the structures as historic features toward a perception as modern administrative facilities. Instruments would be painted to reduce their visibility and placed

strategically to minimize detection by the casual visitor; however, several of the instruments would be potentially visible to the public.

The dynamic glacial and volcanic features of Mount Rainier contribute to wilderness character as a geologic feature of value, as identified in the park's Wilderness Character Narrative. While Alternative 1 would not have a positive or negative effect on this quality, study of these unique features would fulfill the public purposes of scientific and educational use. Data collected using the detection sites would be useful to the park for hazard mitigation and situational awareness for wilderness users. The data collected could ultimately lead to an improved ability to detect and characterize debris flows on Mount Rainier as well as other volcanoes around the world, and would enable the park to better inform visitors, including wilderness users, of local hazards. Data collected would benefit the broader scientific community, including enhancing detection ability and understanding of rockfall, glacial dynamics, flooding, and other processes. Finally, the proposed stations would improve volcano monitoring capabilities, including the ability to detect anomalous small earthquakes and small amounts of surface deformation that often precede eruptions and also to detect explosions that often accompany volcanic unrest and eruption.

MRDG Step 2: Alternatives

Alternative 2: No Action Alternative

Description of the Alternative

What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

Under the No Action Alternative, the NPS would not approve the USGS permit to install additional lahar monitoring stations. Monitoring of volcanic activity at MRNP would be conducted at existing monitoring stations (see Figure 1 of the EA). Current monitoring stations include the following:

- Camp Schurman
- Camp Muir
- Carbon River Ranger Station
- Emerald Ridge
- Kautz Creek
- Longmire
- Mount Fremont (approximately 0.7 mile northeast of the lookout)
- Nisqually Gateway
- Observation Rock
- Ohanapecosh
- Panhandle Gap
- Paradise
- Paradise Precipitation Tower
- St. Andrews Rock (located inside the Sunset Amphitheater)
- Sunrise

The USGS would continue to monitor volcanic activity at the seismic and GPS monitoring sites listed above and maintain these sites as needed. From 2009 to 2019, the USGS flew 47 total helicopter sling loads to 6 sites, which is about 8 flights per site over 11 years. The USGS estimates that about 3 to 4 maintenance trips per site would be needed every 5 years for the six existing monitoring sites that are helicopter dependent, for a total of about 144 flights over 30 years.

Component Activities

How will each of the components of the action be performed under this alternative?

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*

1	Maintenance of the existing monitoring stations	Access sites on foot for routine tuning and maintenance work.
2	Periodic equipment replacement	Transport replacement batteries and other large or heavy components by helicopter.
3	Emergency repairs to aviation-dependent monitoring sites	Access sites by aircraft when objective hazards preclude access on foot.

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
2	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
3	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
This alternative would not adversely affect the untrammeled quality. Continued maintenance of the existing stations would not increase human manipulation or control of the components or processes of ecological systems within wilderness; therefore, the untrammeled quality of wilderness would be preserved.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
2	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
3	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Maintenance of existing stations would have temporary effects on the undeveloped quality of wilderness. Use of mechanized equipment, such as power tools, and use of helicopters for

material delivery would introduce unnatural sounds during installation and maintenance work. No new monitoring sites would be constructed in wilderness.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
2	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
3	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
The No Action Alternative would have negligible new impacts on vegetation within the 228,400-acre wilderness, resulting in minimal adverse effects on plants, animals, air, water, or ecological processes. As described for Alternative 1, noise and activity from construction and helicopters have the potential to affect behaviors of spotted owls and marbled murrelets; however, with implementation of mitigation measures, the project is not expected to adversely affect these species.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
2	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
3	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Helicopter trips to install monitoring stations would affect solitude when aircraft are flying over or landing in wilderness. As described for Alternative 1, helicopter use would be temporary. Helicopter use would be less than under Alternative 1, involving an estimated 144 maintenance flights over a period of 30 years.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒

1	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
2	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
3	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
No new impacts would occur to historic structures. No new data would be collected using the new detection sites because the new sites would not be installed. The benefits to the park and USGS for hazard mitigation and situational awareness for wilderness users described for Alternative 1 would not occur.

MRDG Step 2: Alternatives

Alternative 3	USGS proposal with alternative sites

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

This alternative would be the same as the USGS Proposed Action, except for specific locations where a modification to the proposal is included to avoid or minimize potential for adverse effects on historic properties. Alternative sites were identified for Fremont Lookout, Mount Wow, Shriner Peak, Tahoma Vista, and Tolmie Peak. This alternative is described in greater detail in the EA.

Component Activities
How will each of the components of the action be performed under this alternative?

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Selection of the lahar monitoring locations	Eleven out of 12 stations would be within wilderness.
2	Transportation of material to the monitoring sites for installation	All materials and equipment would be transported with helicopters.
3	Transportation of personnel to the monitoring sites during installation	Personnel would hike to and from the sites.
4	On-site installation of the monitoring stations	Installation would use power tools.
5	Maintenance of the monitoring stations	Access sites on foot for routine tuning and maintenance work.
6	Periodic equipment replacement	Transport replacement batteries and other large or heavy components by helicopter.
7	Emergency repairs to aviation-dependent monitoring sites	Access sites by aircraft when objective hazards preclude access on foot.

Wilderness Character
What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Eleven out of 12 stations would be within wilderness	☐	☐	☒
2	All materials and equipment would be transported with helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
This alternative would not adversely affect the untrammeled quality. The lahar detection stations would not increase human manipulation or control of the components or processes of ecological systems inside wilderness; therefore, the untrammeled quality of wilderness would be preserved.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Eleven out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☒	☐
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
The alternative station sites would have both permanent and temporary effects on the undeveloped quality of wilderness. Use of mechanized equipment, such as power tools, and use of helicopters for material delivery would introduce unnatural sounds during installation and maintenance work. Under this alternative, both Mount Wow and Tahoma Ridge would be installed and maintained by aircraft. This increases the number of aircraft-dependent sites in wilderness from 5 to 15.

As described for the USGS Proposed Action, impacts on the undeveloped quality during construction would generally be low, and elevated noise levels from the use of mechanized equipment would occur during construction over a two-week period each year over two years while use of a helicopter to transport material would result in a temporary increase in noise that would affect the undeveloped quality of wilderness for about one to two hours per day over a period of about two days at each site. The total number of helicopter flights would be greater than under the USGS Proposed Action, with about 88 trips (16 more than the USGS Proposed Action) during installation over a two-month period (September and October) and about 297 maintenance flights over a period of 30 years (54 more than the USGS Proposed Action). This would represent an increase of about 31 to 62 percent in flight time during the 2-year installation period and an increase of about 4 to 7 percent in flight time compared to the existing number of flights over the 30-year maintenance period.

All five of the alternative sites at Fremont Peak, Mount Wow Talus, Shriner Peak Alternative, Tahoma Vista Ridge, and Tolmie Peak Alternative would introduce visible signs of human disturbance to the wilderness. The Mount Fremont station would not be visible from the Fremont Lookout, but would be visible in the distance from the Wonderland Trail, and would be highly visible to anyone venturing beyond the end of the maintained Mount Fremont trail. The Mount Wow Talus station would be highly visible from Westside Road. The Shriner Peak Alternative would be screened from view from the Lookout Tower by vegetation, but would have the potential to dominate the experience of a visitor venturing beyond the end of the maintained trail or navigating to the summit before the trail is melted out. The Tahoma Vista Ridge site would be in a location that is rarely visited and is not accessed by any routes or way trails. The Tolmie Peak Alternative site would not be visible from the Tolmie Lookout; however, it would have a large viewshed into the upper Carbon and upper Mowich drainages and would be located on a social trail accessed from the main trail leading to the lookout, with a high likelihood of being encountered by visitors (several hundred per day during peak periods).

The total footprint of the installations in wilderness would be greater than under Alternative 1 but would still be less than 0.1 acre. Under this alternative, the number of standalone installations in currently pristine wilderness would increase from 5 to 15, twice as many new, standalone installations as Alternative 1. The alternative installation locations were designed to minimize visibility to the greatest extent practicable by using screening from vegetation and topography. The Tahoma Vista Ridge site would be unlikely to be encountered by visitors due to its remote location away from any way trails, named peaks, or travel routes. Wilderness users encountering Mount Fremont, Mount Wow Talus, Shriner Peak Alternative, or Tolmie Peak Alternative facilities could feel that their wilderness experience has been degraded by the presence of these signs of human occupation. These impacts would persist for as long as the lahar detection sites are present in the wilderness, potentially indefinitely.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Eleven out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☒	☐
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
This alternative would alter less than 0.1 acre of vegetation within the 228,400-acre wilderness, and impacts are expected to recover to a natural state over time. Due to the small scale and widely separated nature of the proposed sites, and the implementation of mitigation measures to reduce impacts, the action would have minimal adverse effects on plants, animals, air, water, or ecological processes, but greater effects than Alternative 1. However, there is a possibility that foot traffic from maintenance visits or curious visitors could cause the development of social trail impacts where they do not currently exist. As described for Alternative 1, noise and activity from construction and helicopters has the potential to affect behaviors of spotted owls and marbled murrelets; however, with implementation of mitigation measures, the project is not expected to adversely affect these species.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Eleven out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒

5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Helicopter trips to install monitoring stations would affect solitude when aircraft are flying over or landing in wilderness. As described for Alternative 1, helicopter use would be temporary. Helicopter use would be greater than under Alternative 1, increasing to 77 trips during installation, up to 11 trips for revegetation, and about 297 maintenance flights over a period of 30 years.

After installation, the structures would have greater effects on solitude or unconfined recreation relative to Alternative 1. The presence of the monitoring stations would negatively affect the primitive nature of the wilderness. Individuals who came across a site could have their wilderness experience negatively affected by the feeling of being monitored and by the feeling that modern humans have occupied and will return to the site. The presence of the stations might serve as curiosities that attract more users to the sites. Sites would be located close to popular destinations and would therefore be more likely to be encountered by the casual visitor. However, the greatest impact would be experienced by the visitor who expends the greatest effort to pursue the opportunity for solitude, and therefore has a higher expectation of solitude. The opportunity for solitude in an unmodified setting, without the aid of recreational developments, is uniquely protected by the wilderness designation, when compared to other public lands. In this alternative, the difficulty of finding a pristine site to experience solitude away from the frequently visited lookout structures would be increased, and opportunities for solitude would be reduced relative to the USGS Proposed Action.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Eleven out of 12 stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported with helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒

7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
One proposed monitoring station on Gobblers Knob, would affect a contributing feature to the National Historic Landmark District. Impact to this feature are described in detail in the Historic Districts, Structures, and Cultural Landscapes section of the EA. This historical structure predates the wilderness designation and contributes to wilderness character to the extent that it tells the story of historical use of the wilderness area. Modern installations and modifications contribute to a shift in visitor perception of the structure as a historic feature toward a perception as a modern administrative facility. As described above under the undeveloped quality, stations could potentially have adverse effects on scenic quality, especially the Mount Wow Talus and Tolmie Peak Alternative sites, which would be highly visible. Instruments would be painted to reduce their visibility and placed strategically to minimize detection by the casual visitor; however, several of the instruments would be potentially visible to the public. In addition, the Mount Wow alternate site would not be within the footprint of the historic West Side Road corridor but would be visible on the talus slope nearby.

As in Alternative 1, study of Mount Rainier's geologic features would fulfill the scientific and educational purposes of wilderness. Data collected using the detection sites would also be useful to the park for hazard mitigation and situational awareness for wilderness users. These benefits would be the same as described for Alternative 1.

MRDG Step 2: Alternatives

Alternative 4: Modified Lahar Detection and Volcano Monitoring with deferred installation at three locations (Fremont, Tolmie, Shriner) contingent on future evidence of volcanic unrest

Description of the Alternative
What are the details of this alternative? When, where, and how will the action occur? What mitigation measures will be taken?

This alternative would reduce the number of installations by eliminating the Tolmie Peak, Fremont and Shriner Peak monitoring sites from the proposal. The primary role at these three locations is to function as a repeater for future stations in the event of future volcanic unrest at Mount Rainier. Elimination of these three installation sites would reduce the total number of new installations in wilderness in the near term by deferring installation to a later date after volcanic unrest has been detected. This would require rapid deployment of both additional real-time monitoring stations and repeaters in the event volcanic unrest at Mount Rainier were to occur in the future. Elimination of the Tolmie Peak and Shriner Peak sites would also eliminate the addition of seismometers that would otherwise improve the accuracy of earthquake locations at Mount Rainier and the ability to detect smaller lahars and debris flows down the Carbon, White, Ohanepecosh/Cowlitz, and Mowich River drainages. Elimination of these sites would also reduce volcano monitoring capabilities. A summary of the design process for the Mount Rainier lahar detection system and a detailed description of each site's individual role in the lahar detection system is included in the EA as Appendix B.

Component Activities
How will each of the components of the action be performed under this alternative?

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Selection of the lahar monitoring locations	Six out of nine stations would be within wilderness.
2	Transportation of material to the monitoring sites for installation	All materials and equipment would be transported by helicopters.
3	Transportation of personnel to the monitoring sites during installation	Personnel would hike to and from the sites.
4	On-site installation of the monitoring stations	Installation would use power tools.
5	Maintenance of the monitoring stations	Access sites on foot for routine tuning and maintenance work.
6	Periodic equipment replacement	Transport replacement batteries and other large or heavy components by helicopter.
7	Emergency repairs to aviation-dependent monitoring sites	Access sites by aircraft when objective hazards preclude access on foot.

Wilderness Character

What is the effect of each component activity on the qualities of wilderness character? What mitigation measures will be taken?

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Six out of nine stations would be within wilderness	☐	☐	☒
2	All materials and equipment would be transported by helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☒	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☒	☐	☒

Explain:
Alternative 4 would not adversely affect the untrammeled quality. The lahar detection stations would not increase human manipulation or control of the components or processes of ecological systems in wilderness; therefore, the untrammeled quality of wilderness would be preserved.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Six out of nine stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported by helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☒	☐
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Construction activities would introduce noise and sights of additional human occupation, which would adversely affect the undeveloped quality of the wilderness. Use of mechanized equipment, such as power tools, and use of a helicopter for material delivery would introduce unnatural sounds during installation and maintenance work. Use of power tools is described in Attachment A. Impacts on the undeveloped quality during construction would generally be low, and disturbance would be mostly contained to a brief construction period at each site. Elevated noise levels from the use of mechanized equipment would occur during construction over a two-week period each year over two years while use of a helicopter to transport material would result in a temporary increase in noise that would affect the undeveloped quality of wilderness for about one to two hours per day over a period of about two days at each site. The total number of helicopter flights would be less than under the USGS Proposed Action, with about 48 trips (24 fewer than the USGS Proposed Action) during installation over a 2-month period (September and October) and about 189 maintenance flights over a period of 30 years (54 fewer than the USGS Proposed Action). This would represent an increase of about 17 to 34 percent in flight time during the 2-year installation period and an increase of about 3 to 6 percent in flight time compared to the existing number of flights over the 30-year maintenance period. Crews would hike to the sites to reduce the number of flights for both installation and maintenance.

After installation, the presence of new structures and installations at Emerald Ridge, Ararat South, Copper Mountain, Mildred Point, and Tahoma Bridge would degrade the undeveloped wilderness quality by introducing visible signs of human occupation. Under this alternative, the number of standalone seismic installations in wilderness would increase from 5 to 9. The other installations would be collocated with existing developments and installations. The number of stations dependent on aircraft would increase from 5 to 10. Installation of the sites at Emerald Ridge, Ararat South, Copper Mountain, and Mildred Point would affect relatively unimpacted sites with large viewsheds within designated wilderness, mostly within the upper Tahoma Creek watershed. These sites would be situated so they would be hard to see from established trails; however, visitors travelling off trail could come across these facilities or see them from a distance. Wilderness users encountering these facilities could feel that their wilderness experience has been degraded by the presence of these signs of human occupation.

As previously described, the installation on Ararat South would be encountered by some hikers climbing to the summit and would tend to dominate the experience of the highest point on the summit; however, the summit is broad and visitors exploring the summit area could find places where the installation is not visible. The Gobblers Knob Lookout site would be collocated with an existing lookout structure, thus reducing the number of installations and visual impacts on the undeveloped wilderness quality. The installation at Mildred Point would be out of sight of most hikers who do not venture past the end of the maintained trail; however, for some hikers continuing up the ridge to experience the area without the aid of recreation developments, the installation would be encountered and dominate the experience of the area within several hundred feet. The Mildred Point site would also be visible from a distance from many of the higher elevations of Van Trump Park. These impacts would persist for as long as the lahar detection sites are present in the wilderness, potentially indefinitely.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Six out of nine stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported by helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
Alternative 4 would alter less than 0.1 acre of vegetation within the 228,400-acre wilderness, and impacts are expected to recover to a natural state over time. Due to the small scale and widely separated nature of the proposed sites, and the implementation of mitigation measures to reduce impacts, Alternative 4 would have only minimal adverse effects on plants, animals, air, water, or ecological processes. However, there is a possibility that foot traffic from maintenance visits or curious visitors could cause the development of social trail impacts where they do not currently exist. As described for Alternative 1, noise and activity from construction and helicopters has the potential to affect behaviors of spotted owls and marbled murrelets; however, with implementation of mitigation measures, the project is not expected to adversely affect these species.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Six out of nine stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported by helicopters	☐	☒	☐
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☒	☐
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☒	☐

Explain:
Helicopter trips to install monitoring stations would affect solitude when aircraft are flying over or landing in wilderness. Impacts would affect individuals encountering aircraft as well as those who could hear the aircraft from distant locations. These effects would vary among individuals, depending on where visitors encountered the helicopter use, and would be temporary and limited to about 42 trips during installation over a 2-month period (September and October) each year for 2 years, up to 6 flights for revegetation, and about 189 maintenance flights over a period of 30 years.

After installation, the structures would have small effects on solitude or unconfined recreation. The presence of the monitoring stations would negatively affect the primitive nature of the wilderness. Individuals who come across a site could have their wilderness experience negatively affected by the feeling of being monitored and by the feeling that modern humans have occupied and will return to the site. The stations might serve as curiosities that attract more users to the sites but would not reduce opportunities for solitude or primitive and unconfined recreation overall. As described under the undeveloped quality, stations would be painted to reduce their visibility and placed to minimize being detected by the casual visitor. However, the greatest impact would be experienced by the visitor who expends the greatest effort to pursue the opportunity for solitude, and therefore has a higher expectation of solitude.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Six out of nine stations would be within wilderness	☐	☒	☐
2	All materials and equipment would be transported by helicopters	☐	☐	☒
3	Personnel would hike to and from the sites	☐	☐	☒
4	Installation would use power tools	☐	☐	☒
5	Access sites on foot for routine tuning and maintenance work	☐	☐	☒
6	Transport replacement batteries and other large or heavy components by helicopter	☐	☐	☒
7	Access sites by aircraft when objective hazards preclude access on foot	☐	☐	☒

Explain:
The proposed monitoring station on the Gobblers Knob fire lookout would affect contributing features to the National Historic Landmark District. Impacts on these features are described in detail in the Historic Districts, Structures, and Cultural Landscapes section of the EA. These historical structures predate the wilderness designation and contribute to wilderness character to the extent that they tell the story of historical use of the wilderness area. Modern installations and modifications contribute to a shift in visitor perception of the structures as historic features toward a perception as modern administrative facilities. Instruments would be painted to reduce their visibility and placed strategically to minimize detection by the casual visitor; however, several of the instruments would be potentially visible to the public.

The dynamic glacial and volcanic features of Mount Rainier contribute to wilderness character as a geologic feature of value, as identified in the park's Wilderness Character Narrative. While Alternative 4 does not have a positive or negative effect on this quality, study of these unique features would fulfill the public purposes of scientific and educational use.

Data collected using the detection sites would be useful to the park for hazard mitigation and situational awareness for wilderness users, as described for the other alternatives. Elimination of the Tolmie Peak and Shriner Peak sites would eliminate the addition of seismometers that would otherwise improve the accuracy of earthquake locations at Mount Rainier and the ability to detect smaller lahars and debris flows down the Ohanapecosh River. Other than the elimination of data from these two sites, the data collected under Alternative 4 would be the same as the other alternatives.

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed
What alternatives were considered but not analyzed? Why were they not analyzed?

Install USGS Monitoring Stations as Originally Proposed

The original USGS proposal that was submitted to the NPS in December 2019 (see Appendix B of the EA) proposed several sites, five of which were approved and installed in 2020. As described above under the USGS Proposed Action (Alternative 1), MRNP and USGS staff worked collaboratively to refine the USGS proposal for the remaining 12 locations to further mitigate the potential for adverse effects. Although some elements of the original proposal were retained in Alternative 1, the overall proposal was resubmitted and incorporates modifications to several of the proposed monitoring stations as described in the attached PPRs.

Locate All New Long-Term Seismic/GPS Monitoring Stations Outside Wilderness

Because the intent of the proposed project is to more effectively determine the cause of and to monitor the hazards associated with the Mount Rainier volcano, placing the stations outside wilderness would mean locating them off the volcano and would therefore not meet the purpose and need of the project (except the five monitoring stations addressed under a separate clearance process, as described above in Alternative 1: USGS Proposed Action). The short amount of time between the initiation of an event on the west side of the volcano and downstream impacts requires instrumentation within the potentially impacted drainages. Surrounding instrumentation is required (e.g., Mildred Point) to assess the extent of the hazard, such as whether one or multiple drainages are being impacted. Infrasound in particular is most effective when placed near the impacted drainage, as pressure waves in the atmosphere have been shown to be distorted or shadowed by local topography.

Increase the Number of Stations Proposed by the USGS

The USGS provided a summary of the larger system that was considered but not included in the proposal. An overall summary regarding the development of the proposal has been provided by the USGS, and specific language about a more robust system is included in the EA under *Alternatives Considered but Dismissed*. However, as descried in the EA, additional sites were not considered for this proposal because a) current scientific understanding is that these other drainages are not as vulnerable to spontaneous non-eruptive landslide-caused lahars, b) the primary purpose of this project is to improve lahar detection capabilities, not volcano-monitoring capabilities, and c) the impact on wilderness would be far greater. A summary of the design process for the Mount Rainier lahar detection system, including an initial proposal for as many as 40 stations, with about half of the stations within the park, is included in Appendix B of the EA.

Nonmotorized Transport of Materials to the Project Sites

Hiking or horseback transport of materials to and from the project site was not considered given the weight and dimensions of the equipment and the time constraints. The monitoring stations are too heavy to carry to the site via nonmotorized means.

Installation Using Only Nonmotorized Tools

This alternative is the same as the USGS Proposed Action (Alternative 1) except that no power tools would be used during installation; only hand tools would be used for installation. Helicopters would be used to transport materials and equipment to the project site. Use of hand tools would require additional time for installation, and could potentially require additional helicopter flights, or require flights to extend over a longer period.

This alternative was eliminated from consideration because it would not be practical to eliminate all power tools from the Proposed Action. It would not be possible to achieve the needed precision drilling holes in metal pipe with manual tools. In addition, although cutting metal materials such as trim, bolts, and conduit with a handheld hacksaw may be possible, some cuts would be in areas that are awkward or constricted by other structural elements and would require a different approach to design. Installation would take longer and require a longer weather window, and possibly repeat visits, increasing the duration of temporary impacts on solitude and severity of trampling on vegetation. Finally, hand drilling deep holes, without power tools, would require additional laborers and multiple days of work. The technique was historically used to split, blast, or otherwise destroy rock, and precision drilling for the type of anchors needed for these installations would require an experienced team, which is not available. Manual hand drilling was abandoned in the early 20th century in favor of pneumatic drilling. Hand drilling is used today for wilderness trail maintenance (breaking rock) or placement of small (several inch long) structural anchors, but is not a viable option for the proposed installations. A detailed summary of the power tools proposed for use and justification for their use is found in Attachment A.

MRDG Step 2: Alternatives Comparison

Alternative 1:	USGS Proposed Action
Alternative 2:	No Action Alternative
Alternative 3:	USGS proposal with alternative sites
Alternative 4:	Modified Lahar Detection and Volcano Monitoring with installation at three locations (Fremont, Tolmie, Shriner) deferred pending evidence of volcanic unrest

Factors to be considered in comparing the alternatives include the effects of each alternative on the qualities of wilderness character and prohibited uses under Section 4(c) of the Wilderness Act. Differences between the alternatives would primarily result from differences in effects on the undeveloped, solitude and opportunities for unconfined recreation, and other features of value qualities of wilderness character.

Prohibited Uses

Alternatives 1, 3, and 4 would include construction of new installations in wilderness and landing of aircraft within wilderness, which are prohibited uses under the Wilderness Act. Each helicopter trip would include a landing via sling load to deliver materials. The number of helicopter trips and new installations would vary between the alternatives, as summarized in Table 1.

Untrammeled

None of the alternatives would affect the untrammeled quality of wilderness character.

Natural

The action alternatives (Alternatives 1, 3, and 4) would have similar, very minor impacts on the natural quality of wilderness. The No Action Alternative (Alternative 2) would not result in new impacts on this quality.

Undeveloped

Use of mechanized equipment, such as power tools, and use of helicopters for material delivery would affect the undeveloped quality of wilderness by introducing unnatural sounds during installation and maintenance work. Use of helicopters would vary between alternatives, as shown in Table 1 below. Power tools would be used for Alternatives 1, 3, and 4. The undeveloped quality of wilderness would also be affected under the action alternatives by the presence of new installations in wilderness. The impacts of the new installations would be similar between the alternatives but would be proportional to the number of new stand-alone stations in wilderness and the number of new stations in undeveloped wilderness (Table 1).

Solitude and Opportunities for Unconfined Recreation

The alternatives would result in small differences in temporary impacts on solitude when aircraft are flying over or landing in wilderness, which would be proportional to the number of helicopter flights for each alternative (Table 1). In addition, the structures would have small effects on solitude and opportunities for unconfined recreation after installation, which would vary between Alternatives 1, 3, and 4, depending on the number of new stand-alone stations in wilderness and the number of new stations in undeveloped wilderness (Table 1).

Other Features of Value

New stations would be collocated with existing historic fire lookouts at four sites (Alternative 1) or one site (Alternatives 3 and 4). No new stations would be collocated with existing historic fire lookouts in Alternative 2 (No Action Alternative). Modern installations and modifications would affect the other features of value quality of wilderness character by contributing to a shift in visitor perception of the structures as historic features toward a perception as modern administrative facilities.

Scientific Purpose/Benefit

Study of Mount Rainier's geologic features would fulfill the scientific and educational purposes of wilderness. Data collected using the detection sites would also be useful to the park for hazard mitigation and situational awareness for wilderness users. These benefits would be the same under all three action alternatives, except elimination of the Tolmie Peak and Shriner Peak stations in Alternative 4 would eliminate the addition of seismometers that would otherwise improve the accuracy of earthquake locations at Mount Rainier and the ability to detect smaller lahars and debris flows down the Ohanapecosh River. No change to current data collection would occur under Alternative 2 (No Action).

Table 1. Comparison of Alternatives

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Existing sites requiring helicopter use	6	6	6	6
New sites requiring helicopter use	9	0	11	6
Helicopter flights for maintenance of existing sites over 30 years (24 trips per site)[1]	144	144	144	144
Helicopter trips for installation of new sites (7 trips per site, plus 1 trip per site for revegetation)	72	0	88	48
Additional helicopter trips for tuning and maintenance of new sites over 30 years (27 trips per site)[2]	243	0	297	189
New stand-alone stations in wilderness	4	0	9	4
New stations in undeveloped wilderness	8	0	10	5
New stations collocated with historic fire lookouts	4	0	1	1

[1]Assumes up to four maintenance trips per site every 5 years for 30 years.

[2]Assumes three trips for tuning after 1 to 2 years plus four trips every 5 years (24 flights) over 30 years for maintenance.

MRDG Step 2: Determination

Refer to the **MRDG Instructions** before identifying the selected alternative and explaining the rationale for the selection.

Selected Alternative

☐ Alternative 1:	USGS Proposed Action
☐ Alternative 2:	No Action Alternative
☐ Alternative 3:	USGS proposal with alternative sites
☐ Alternative 4:	Modified Lahar Detection and Volcano Monitoring with installation at three locations (Fremont, Tolmie, Shriner) deferred pending evidence of volcanic unrest

Explain Rationale for Selection:

Mitigation measures are found in Appendix A of the EA.

References

Hartog et al. 2008

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity? [To be completed after review of public comments on draft MRDG]

Approved?	Prohibited Use	Quantity
☒	Mechanical Transport:	
☒	Motorized Equipment:	
☐	Motor Vehicles:	
☐	Motorboats:	
☒	Landing of Aircraft:	
☐	Temporary Roads:	
☐	Structures:	
☒	Installations:	

Record and report any authorizations of Wilderness Act Section 4(c) prohibited uses according to agency policies or guidance.

Refer to agency policies for the following signature authorities:

Prepared:

Name ______ Position ______

Signature ______ Date ______

Recommended:

Name ______ Position ______

Signature ______ Date ______

Recommended:

Name ______ Position ______

Signature ______ Date ______

Approved:

Name

Position

Signature ______________________________

Date ____________________

Attachment A
Description and Rationale for Power Tool Use

Attachment A

UGSS Power Tool Needs for Rainer Lahar Detection System Station Installations and Maintenance

The USGS requires the use of the following power tools during the installation of the proposed Rainier Lahar Detection infrastructure at stations located in the areas designated as wilderness. Additionally, the USGS requires the use of many of the same tools to conduct maintenance at these stations as needed. The tools include:

1.) Battery-powered drill (for example, DeWalt 20v Lithium Battery ½ inch drill) for drilling holes in pipe, enclosure, and solar panel frames as needed.
2.) Battery-powered rock drill for drilling up to 1-inch diameter holes at the Mount Wow alternative (e.g., the “talus” site) and Tahoma Bridge to anchor enclosures.
3.) Battery-powered sawzall (for example, DeWalt 20v Lithium Battery 1 1/8-inch stroke reciprocating saw) for cutting pipe, damaged hardware, and 2-inch U-bolts that become cross threaded during installation or subsequent maintenance.
4.) Battery-powered bandsaw (for example, DeWalt 20v Lithium Battery Cordless Band Saw) for cutting pipe onsite during installation or subsequent maintenance.
5.) For installing the GPS monument at Copper Mountain, the following power tools are required:
    a. A 4000W gas-powered generator to operate corded power tools needed for building the short-braced GPS monument. Primary need is to power an AC-powered air compressor, an AC-powered hammer drill, and an AC-powered welder (described below), all of which are essential to building a stable and rigid GPS monument. The generator will be run during daylight hours for up to 12 hours total over the 2-3 days required to install the site.
    b. An AC-powered hand-held hammer drill to drill four 1.5”-diameter and 6-foot-deep holes into bedrock, including 3 holes for angled legs and 1 for the central leg of the GPS short-braced monument. Stainless steel rods will be placed into these holes and then welded together to achieve the required stability for the GPS monument. Depending on the strength of bedrock, the drilling would last up to 8 hours spread out over the 2-3 days required to install the site.
    c. An AC-powered 1-gallon air compressor for powering a pneumatic epoxy dispenser that is required for placing highly viscous epoxy down to the bottom of the four 6-foot-deep holes that will be filled with stainless steel rods that make up the GPS monument. An air hose will be connected to the compressor and a pneumatic epoxy dispenser will be attached to the other end of the air hose. The dispenser uses high pressure air to drive epoxy through a nozzle and into the holes drilled into rock before the stainless-steel rods for the GPS monument are inserted. The epoxy dispenser does not make any noise; however, the air compressor will generate noise when it is running and pressurizing air to be stored in the tank. The air compressor will run for 10 minutes for each of the 4 holes.
    d. A small, portable AC-powered welder to tack weld the three angled legs of the GPS monument to the central vertical rod (required for stabilizing the monument).

e. A battery-powered vacuum (DeWalt 20vl Lithium battery) for removing fine dust out of the 6-foot-deep GPS monument holes.
f. A battery-powered hand grinder with cut off wheel (DeWalt 20v Lithium battery). The grinder can accommodate both a cut-off wheel and grinder wheel. The cut-off wheel will be used to make precision cuts of the excess length for each of the four stainless-steel rods that form the legs of the GPS monument. The grinder attachment will be used to grind the end of each rod down to a scallop point, which is required in order for the ends to be tack welded on to the central stainless-steel rod of the GPS monument. Cumulative time using the grinder tool will not exceed about ten minutes.

<u>Installations</u>:

All stations: The proposed fiberglass enclosures are designed to be streamlined, self-efficient, and almost entirely prebuilt off-site prior to installation. Power-tool usage during installation of the fiberglass enclosures would be used on an as-needed basis and would be limited to minutes-long durations only. Use cases for the battery-powered drill include drilling additional precision holes on the enclosure as needed and to secure critical lightning protection and grounding equipment. Use case for the battery-powered sawzall and bandsaw include cutting pipe as needed during the installation to ensure proper fitting.

Stations WOW alternative (Mount Wow Talus) and TABR (Tahoma Bridge): The hut enclosures must be secured to the ground to a shallow depth to prevent any movement on sloping terrain. Because the Mount Wow Talus and Tahoma Bridge station enclosures are, by necessity, installed on a rock surface, this requires drilling holes in the rock to install J bolts that secure the base (flange) of the hut to the ground. This is of extra importance at these sites as the enclosures are close to the edge of very steep terrain. At both sites there will be 4 holes drilled (maximum depth 9”) for these bolts. Additionally, there will be up to 4 holes drilled (maximum depth 9”) into the rock adjacent to the sides of the hut for a pipe flange that will secure the antenna mast. The hole depth and diameter are considerably greater than a traditional climber’s rock bolt. Specifically, the diameter is at least double a traditional anchor hole; the lack of available tools, combined with the scaling in force necessary to drive the bit, render hand drilling impractical and likely impossible. In the past drilling these holes required a generator and corded rotary SDS Max rock hammer drill. With modern advancements in battery-powered tools these relatively shallow holes can be drilled with much quieter and more compact cordless SDS Max rotary hammer drills; therefore, a generator is not required. The holes will not exceed 1” in diameter or 9” in depth. Each hole should take under 10 minutes to drill. When not drilling, the drill is not noticeably louder than a standard 20V or comparable lithium-battery hand drill. The noise level while drilling depends on the hole size and rock type, but in general it is quieter than a low-flying helicopter. The drill weighs 15lbs with additional weight for bits and batteries. The set of drilling equipment is compact and will not require any additional helicopter support above the maximum number of proposed slings. (Note: The Mount Wow site along the road would not require use of an SDS Max drill).

Station COPP: Installation of the GPS monument at the Copper Mountain (COPP) site will require additional motorized equipment – specifically, a generator, a welder, a small air compressor, a pneumatic adhesive dispenser, and a hammer drill. For the GPS monument to be useable for volcano monitoring, it needs to be robust enough to withstand snow/ice creep and freeze-thaw cycles as well as wind abrasion; if the monument is deformed by even an inch, it becomes much less usable for volcano monitoring. There is broad experience in best-practices for GPS monument design that has been achieved courtesy of trial-and-error monument designs, and scientists today have a good understanding of design and construction requirements for a stable GPS monument (https://kb.unavco.org/kb/article.php?id=301). This includes being able to drill a precise vertical hole 6 feet into rock, as well as additional holes required for bracing legs that all have to be drilled to a specified depth and at a specified angle. There is no hand-tool that can perform this task to the precision required for a stable monument – a corded, powered hammer drill is required for this task. Substantial air pressure that cannot be achieved in a non-mechanized manner is required to clear the 6-foot holes and fill them with non-shrink epoxy. A battery-powered vacuum is needed to clear the holes after drilling, and a small, corded AC-powered air compressor with a pneumatic adhesive dispenser attachment is required to pump epoxy in the drilled holes that support the GPS monument legs. In addition, field-welding of the bracing legs to the central monument is required; there is no non-motorized way to achieve welding in the field. Since there is no battery-powered equivalent for an air compressor, welder, or hammer drill, a generator is needed to power these tools. Lastly, because the monument legs are solid stainless-steel rods, a battery-powered hand grinder is required to cut the rods to an exact length and at the necessary angle for proper welds at the center point. It is prohibitively difficult to precisely cut and scallop the ends of stainless rods for precise welds with a non-mechanized tool.

Maintenance:

Short- and long-term ice, snow, and wind damage may create unanticipated situations where additional modifications to the solar panel frames and telemetry infrastructure will be necessary to repair damaged equipment. Such repairs may require the use of the same power tools noted above, with the exception of those needed only for the installation the GPS monument at COPP. Modifications to metal infrastructure, especially steel and aluminum, without power drills and saws can be time-prohibitive or impossible depending on the type and thickness of the metal.

Specific examples where power tools will be required during maintenance include:

1.) Replacement of lightening protection that has failed or was damaged at a location near a ground rod attached the enclosure.
2.) Drilling precision holes in the solar panels or the enclosure to adjust or repair damaged solar panel mounting.
3.) Removal or cutting off of large stainless-steel bolts that have been damaged by snow and ice conditions and/or are rusted, seized, or cross-threaded.
4.) Adjustments and replacement of metal pipes or angle brackets used for solar panel framing damaged by ice, snow, and/or wind loading. In this case, both a drill and saw would be used in very limited durations to remove old rusted or damaged hardware and secure new pipe and hardware as needed.

Motorized tool alternatives:

Drilling holes in metal pipe: These are modern installations, constructed of modern materials, that require precision construction. We are not aware of a practice of drilling precision holes in metal pipe with a manual hand drill as a discipline of traditional tool use. The torque, pressure, and precision required would be difficult, if not impossible, to achieve using a manual drill, freehand.

Cutting metal pipe: Metal trim, pipes, bolts, and conduit can be cut using a manual hacksaw. The time required varies according to the gauge of the metal, but we estimate an order of magnitude difference in the time required for each cut. Some cuts would be in areas that are awkward or constricted by other structural elements and would require a different approach to design. Installation would take longer and require a longer weather window and possibly repeat visits, increasing the duration of temporary impacts to solitude and severity of trampling on vegetation. Hacksaws will be used for installation and maintenance when practical.

Drilling holes in rock: Deep holes can be driven in rock with a manual hammer drill. Holes this deep would require a technique called double-jacking. This slow, very physical process can be dangerous for inexperienced users, as there is a higher potential for significant injury. Hand-drilling of deep holes would require additional laborers and multiple days of work. The technique was historically used to split, blast, or otherwise destroy rock, and precision drilling for the type of anchors needed for these installations would require an experienced team, which is not available. Manual hand drilling was abandoned in the early 20th century in favor of pneumatic drilling. Hand drilling is used today for wilderness trail maintenance (breaking rock) or placement of small (several inch long) structural anchors but is not a viable option for the proposed installations.