USGS-Cascades Volcano Observatory
sUAS Project Aviation Safety Plan and Signatures

Project Name:	Mount St. Helens multiGAS survey		
Mission:	sUAS flights collecting volcanic gas measurements		
Unit in Charge:	USGS-Cascades Volcano Observatory		
Anticipated Project Dates:	*September 25-26, 2018*	Start Time:	0900 (PT)
		End Time:	1800 (PT)
Project Location: (Description and coordinates)	Mount St. Helens: 1) 2004-2008 Dome	1) 46.195773 N, 122.190500 W (DD)	
Project Plan Prepared by:		Date Prepared:	
Inspector Note:	Signature of preparer verifies that all personnel have the required training for the mission.		

Review and Approval		
Inspect	Name and Title	Signature and Date
PASP Prepared By:	*Geologist, sUAS Pilot*	
PASP Reviewed by (1):	*Geochemist*	
PASP Reviewed by (2):		
PASP Reviewed by (3):		
PASP Approved by:	NW Regional Aviation Manager	

Personnel		
Project Aviation Manager:		
Pilot in Charge (PIC):		
Mission Remote Pilots:		
Visual Observers:		
On-Site Emergency Contact:	911	Note: In the event of an emergency, all actions will be organized by the Pilot in Charge (PIC).

Project Description / General Information

The primary objective of this plan is to ensure all small Unmanned Aircraft Systems (sUAS) flight operations are well planned, and conducted in a safe, effective manner. All sUAS flight operations will be approved and coordinated through USGS-CVO and the USGS Aviation Safety Programs and will follow Department of the Interior (DOI) policy and protocols established for sUAS operations.

The purpose of this survey is to fly a low altitude multiGAS sensor package to detect H2O, CO2, SO2, and H2S in gas plumes at Mount St. Helens (MSH). We will use the sUAS to map and measure gas emissions from the 1986 and 2004-2008 lava domes in the crater of MSH. Despite the obvious visual presence of small gas plumes emanating from the domes, present-day gas emissions from MSH are quite weak and traditional airborne gas surveys have been unable to detect any volcanic gases above atmospheric background levels since the end of the 2008 eruption. Ground-based surveys have shown these plumes consist mainly of water vapor and CO2, but such surveys are arduous and ultimately do not achieve full coverage of the domes because some vents cannot be accessed safely due to the rugged and unstable character of the terrain. Moreover, ground-based campaigns can only make point measurements of water vapor and CO2, whereas airborne techniques make possible the calculation of the emission rates of these species. Gas emission rates are more valuable as a monitoring parameter than simple gas composition measurements because the magnitude of gas emission rates roughly scale to the quantity of magma that is degassing. The sUAS presents a tool that is well-matched to the problem of surveying the relatively small area of the MSH crater and will provide an effective bridge between ground-based campaigns and helicopter-borne airborne measurements during periods of background degassing at MSH.

Organization

1. Project Aviation Manager:
    a. All DOI Operators on site have ultimate go/no-go authority.
2. Project Coordinators:
    a. Name (phone number)
    b. Name (phone number)
3. *Nearest Airport Manager:* ***PILOTS SHOULD MONITOR 122.90***
    a. Strom Field Airport - no tower
        i. CTAF: 122.900
        ii. AWOS-3 at CLS: 118.025 (360-740-5164)
4. Flights are planned for 25-26 September 2018. sUAS operations will be centered over coordinates listed below. Additional flight area details are included in Appendix A.
    a. Aerial operations will be centered at the coordinates listed below within the Mount St. Helens National Volcanic Monument which is marked as a special conservation area in aeronautical charts. Permission to fly sUAS has been granted by the land manager area and is listed in point 5 under Points of Contact.
        i. 2004-2008 lava dome in the crater of Mount St. Helens:
            1. DD 46.195773 N, 122.190500 W
5. Points of Contact:
    a. Project Cooperator and Land Manager POC, Mount St. Helens National Volcanic Monument, Gifford Pinchot National Forest
        i. (w) (phone number) (e-mail)

Safety Provisions

1. Visual observers will be utilized at all times (all participants should maintain vigilance while on site).
2. sUAS pilots will maintain a safe operating distance from all aircraft.
3. sUAS Remote Pilots are responsible for determining the airworthiness of their aircraft in accordance with the appropriate standard.
4. sUAS operators must be credentialed to operate their aircraft by the FAA or their Agency.
5. sUAS operators who are not current in the aircraft must be supervised by an appropriately designated inspector.
6. One Pilot in Command (PIC) will be designated for each flight and will be responsible for the safety of the aircraft and persons and property along the sUAS flight path.
7. First aid kit will be on site and emergency response information is identified in Appendix A and Appendix B.
8. Any injuries due to aircraft, lost aircraft, damage to aircraft, system anomalies, or sustained loss of link will be reported via the SAFECOM system.
9. All participants will take part in the preflight briefing and the briefing checklist must be completed at the start of each operational period.

sUAS Flight Airspace Description

Flights will be conducted in uncontrolled Class G airspace within the Mount St. Helens National Volcanic Monument special conservation area under the provisions of the Federal Aviation Administration (FAA)-DOI Blanket COA (2018-AHQ-808-COA) and with permission of the Mount St. Helens National Volcanic Monument.

1. Airspace is uncontrolled Class G at all field sites, sUAS flights will fly at 500ft AGL or below.
2. Locations are in the crater of Mount St. Helens, launching from the 2004-2008 lava dome.
3. The closest public airport to the Mount St. Helens field site is the Strom Field Airport (39P), located in Morton, WA, and is 25 nautical miles north of the field site. All sUAS operations will be limited to within the crater of Mount St. Helens and will only require pilot to pilot communication with localized aircraft that are involved in our mission during activities.
4. The nearest private air field to the field site is included below:
    a. Mount St. Helen's Aero Ranch Airport (WN10) is 15 nautical miles southwest.

Aircraft Information

sUAS by definition are considered aircraft and will be managed in accordance with all the policies, guidelines and established procedures that are in place for DOI and USGS fleet or contracted aircraft.

sUAS to be flown under the provisions of this PASP (check all that apply):

□	**Make/Model - description:**	**FAA Registration#**
X		
X		
X		
X		
	Other (describe)	

Flight Following Procedures: Flight following will be conducted using the DJI app on the ground control unit. Loss of Link (LOL) setting will be return to the home waypoint and land. Good radio communication and situational awareness between each crew member is imperative to maintain safe and clear operations for each flight. Pilot and crew will announce the commencement and completion of flight sessions do Vancouver flight following.

Pilot Information

Pilots flying under the provisions of this PASP:

Pilot Name (Last, First):	**OAS Carded?**
	□Yes, □ No, □ Trainee
	□Yes, □ No, □ Trainee
	□Yes, □ No, □ Trainee

Personal Protective Equipment Requirements

1. All on-site personnel should dress appropriately for weather conditions (temperatures could range from 32° - 100° F), use sunscreen, and drink plenty of fluids.
2. Eye and hearing protection is encouraged.

Additional Information

Justification Statement for sUAS Flights: These sUAS flights are necessary to provide high resolution multiGAS surveys at low altitudes above the ground and slow flights. Gas plumes are very diffuse at Mount St. Helens and sUAS provide a platform that may be able to detect volcanic gas in these plumes.

Special Instructions Related to this Mission: Personnel should be prepared to spend long days in variable weather conditions. Sun screen, rain protection, food, and warm/cool clothing are likely most important. Personnel will be monitored for signs of heat/cold distress. Caution should be taken to stay hydrated and under shelter from the various weather conditions.

Emergency Medical Attention and Evacuation Plan: Emergency procedures to be followed while at each field site can be found in Appendix B. Helicopter support is available in case of emergency. Helicopter ops are launching from the south side of Mount St. Helens, and emergency centers are identified via routes from this launching site. The person on-site with the highest level of medical training will be identified prior to the start of flight operations. Any medical evacuation will be coordinated through the local emergency services (via 911). The nearest medical facility to the field site is included in Appendix B and listed below for reference:

1. Legacy Salmon Creek Hospital (360) 487-1000, 2211 NE 139th St, Vancouver, WA 98686, approximately 55 miles from the field site (1 hour 14 min drive).

Risk Management and Safety

Reference the Aviation Risk Mgmt. Workbook, JHAs, etc., to assist completion of Risk Assessment Matrix

Risk Assessment Matrix				
	Severity			
Likelihood	IV Negligible	III Marginal	II Critical	I Catastrophic
Frequent A	2	3	4	4
Probable B	2	3	4	HIGH
Occasional C	1	2	SERIOUS	4
Remote D	1	MEDIUM	2	3
Improbable E	LOW	2	2	2

Assess the risks involved with the proposed operation. Use additional sheets if necessary.			
Describe the Hazard:	Pre-Mitigation hazards rate out as:		
	Likelihood A-E	Severity I-IV	Risk Level
1. Mid-air collision with another aircraft	D	I	3
2. Collision with fixed aerial hazard (radio tower, power lines, trees, etc)	E	III	2
3. Collision with personnel or the general public	C	II	3
4. Collision with vehicles or boats	E	III	2
5. Collision with birds	C	III	2
6. Operating Aircraft outside of approved area	B	III	3
7. Operating aircraft outside of manual limitations	B	III	3
8. Fire	D	III	2
9. Cold/Heat Injury	C	II	3
10. Loss of Link with aircraft. (LOL)	B	III	3
11. Injury to fingers/hands due to spinning blades on aircraft	C	II	3
12. Hazardous wildlife (spiders, snakes, bees/wasps, etc)	C	II	3
Pre-Mitigation Overall Rating:			3 - Serious
Mitigation Description and Rating:	Post Mitigation hazards rate out as:		
Describe mitigation strategies and final risk rating following migration implementation. Multiple mitigations may be listed for each risk.	Likelihood A-E	Severity I-IV	Risk Level
1. All sUAS flights occur after NOTAM is filed. Flights are conducted while monitoring communications channel 122.9. Observers will be placed to maintain visual line of site on the aircraft and other aircraft at all times.	E	II	2
2. Prior to flights, all fixed aerial hazards will be identified and flight route avoidance planned.	D	III	2
3. Flight patterns will be planned to avoid people on the ground when approaching for landings. Non-participating personnel will remain clear of the ground control station so as not to be a distraction to the operators. Landing areas will be established that minimize risk of impact to people. Overflight of personnel will be avoided.	D	II	2
4. Helicopter if staged at field site will be located clear of any approach or departure.	D	IV	1

5. If a bird is encountered attempting to come in contact with the sUAS then the pilot shall land as soon as practical in order to prevent injury to the animal or aircraft.	D	III	2
6. Aircraft will be programmed to stay within the operating areas in the event of LOL. Boundaries will be briefed and maps will be uploaded into the operator control units if they have the capability.	D	IV	1
7. Payloads and flight procedures are OAS approved and weather and wind conditions will be normal allowing for staying within aircraft limitations.	D	IV	1
8. Fire extinguishers will be available from the helicopter support if required. Risk of fire in field area is very low.	E	III	2
9. Personnel will be briefed on the possible weather conditions and advised to bring proper clothing and equipment. Anyone showing signs of cold stress or hypothermia will be moved to a warm location and if necessary EMS will be notified.	D	III	2
10. Prior to launching any aircraft, the LOL settings will be verified. LOL setting will be set to have the aircraft return to its point of launch and auto land. If Link cannot be reestablished and we have a fly away, local aviation will be notified via comms and an Interagency Aviation Mishap Response (888-464-7427) will be notified with the last known location and heading of the sUAS.	D	II	2
11. Checklist procedures will be followed to ensure that personnel ensure that their hands stay clear of rotating blades.	D	II	2
12. Personnel will be briefed on local hazards and advised to look where they are going and maintain situational awareness at all times.	D	III	2
Success Probability/Benefits Statement: A high probability of success is expected. Overall risk will be reduced to an acceptable level by the use of various controls. Substantial coordination with local air traffic support will be completed to ensure separation of other air traffic. Additionally, the design of the field sites and the flight patterns will minimize the chance that personnel will be struck by the air vehicle. Post-Mitigation Overall Rating:			2 Med

Appropriate Management Level for Risk Decisions		
Risk Level	Project	Incident
HIGH	OAS Associate Director	Incident Commander or Ops Chief
SERIOUS	OAS Division Chief	Incident Commander or Ops Chief
MEDIUM	Project Aviation Manager	Air Operations
LOW	sUAS Pilot In Command	Air Operations

Military Training Route (MTR) Information

MTR	Route Legs-Altitude	Activity	Time		Time Zone
			Start	Stop	
	None in operating area.	☐ Hot ☐ Cold			☐ UTC ☐ Local
		☐ Hot ☐ Cold			☐ UTC ☐ Local

Mission Planning/Preflight Briefing Checklist:

Review with all participants as part of preflight briefing

General Safety			
1. Chain of command, individual roles and responsibilities are identified to all participants?	☐ Yes	☐ No	☐ NA
2. Project Aviation Safety Plan is approved and signed at the appropriate levels?	☐ Yes	☐ No	☐ NA
3. Review the emergency evacuation plan.	☐ Yes	☐ No	☐ NA
4. Locate the nearest 1st aid kits.	☐ Yes	☐ No	☐ NA
5. Locate nearest fire extinguishers.	☐ Yes	☐ No	☐ NA
6. Discuss communications plan and review cell coverage, and radio tests for field site.	☐ Yes	☐ No	☐ NA
7. Have ground hazards and safety been identified to all participants?	☐ Yes	☐ No	☐ NA
8. Do all personnel have the required PPE?	☐ Yes	☐ No	☐ NA
9. Participants briefed on landing announcements and sUAS recovery requirements.	☐ Yes	☐ No	☐ NA
10. Participants briefed on sterile cockpit expectations.	☐ Yes	☐ No	☐ NA
UAS Operators and Personnel			
11. Are all agency personnel qualified for the mission?	☐ Yes	☐ No	☐ NA
12. Is the pilot carded and experienced for the mission to be conducted?	☐ Yes	☐ No	☐ NA
13. Are pilot flight and duty times compromised?	☐ Yes	☐ No	☐ NA
14. Is the aircraft properly carded?	☐ Yes	☐ No	☐ NA
15. Is the aircraft capable of performing the mission with a margin of safety?	☐ Yes	☐ No	☐ NA
16. Are there enough (qualified) agency personnel to accomplish the mission safely?	☐ Yes	☐ No	☐ NA
UAS Flight Operations			
17. Are all aerial hazards identified and known to all participants?	☐ Yes	☐ No	☐ NA
18. Can terrain, altitude, temperature or weather that could have an adverse effect be mitigated?	☐ Yes	☐ No	☐ NA
19. Have mitigating measures been taken to avoid conflicts with military or civilian aircraft?	☐ Yes	☐ No	☐ NA
20. Have adequate landing areas been identified and or improved to minimum standards?	☐ Yes	☐ No	☐ NA
21. Have ditch point locations been discussed in event of a power loss?	☐ Yes	☐ No	☐ NA
22. Have the proper approvals been given by FAA?	☐ Yes	☐ No	☐ NA
23. If flying in restricted airspace, has notification been made with controlling authority prior to launching sUAS?	☐ Yes	☐ No	☐ NA
24. Have the retrieval instructions been discussed in the event of a loss of aircraft?	☐ Yes	☐ No	☐ NA
25. Will adequate briefings be conducted prior to flight with all participants?	☐ Yes	☐ No	☐ NA
26. Is there an alternative method that would accomplish the mission more safely?	☐ Yes	☐ No	☐ NA
Other Special Cases			
27. EXAMPLE: NOTAM on file?	☐ Yes	☐ No	☐ NA
28. EXAMPLE: Is crew aware of sensitive bird habitat in area?	☐ Yes	☐ No	☐ NA
29. EXAMPLE: Does crew have handheld radios, cell phones, and maps of the area?	☐ Yes	☐ No	☐ NA
Identify Corrections (if any):			
PIC Signature:		Date:	Operator/Observe Signature:

Project Aviation Safety Briefing

This checklist will be completed for each operation/currency/training event.
Briefing Leader: _____

Briefing Date:__Time:__Location: _____

Discussion Items:

_____A. Hazard Analysis (as outlined in plan)
_____B. Safety Air Ops (Ground)
_____C. Safety Air Ops (Flight)
_____D. Military Training Routes/Restricted Airspace Deconflicted
_____E. Flight Following
_____F. Frequencies and Communication Plan
_____G. Lost Link Procedures
_____H. Emergency Evacuation Plan
_____I. Authorities (Airspace and Land owner)
_____J. Weather Considerations
_____K. Review applicable JHAs/Risk Assessments
_____L. NOTAM on file
_____M. Other

All briefing attendees sign beside their name to indicate concurrence.

Name (print):	Signature:

Appendix A: Project Location, Launch and Recover

Flight Area: Aerial operations will be centered over the coordinates for the field site listed below.

Description:
All sUAS flights will occur within the red polygon shown in the figure below with the central location of flights indicated by a yellow star. Flights will be at 500 ft AGL or below.

Flight Area Coordinates: yellow star shown in Figure A

2004-2008 lava dome:

- DD 46.195773 N, 122.190500 W

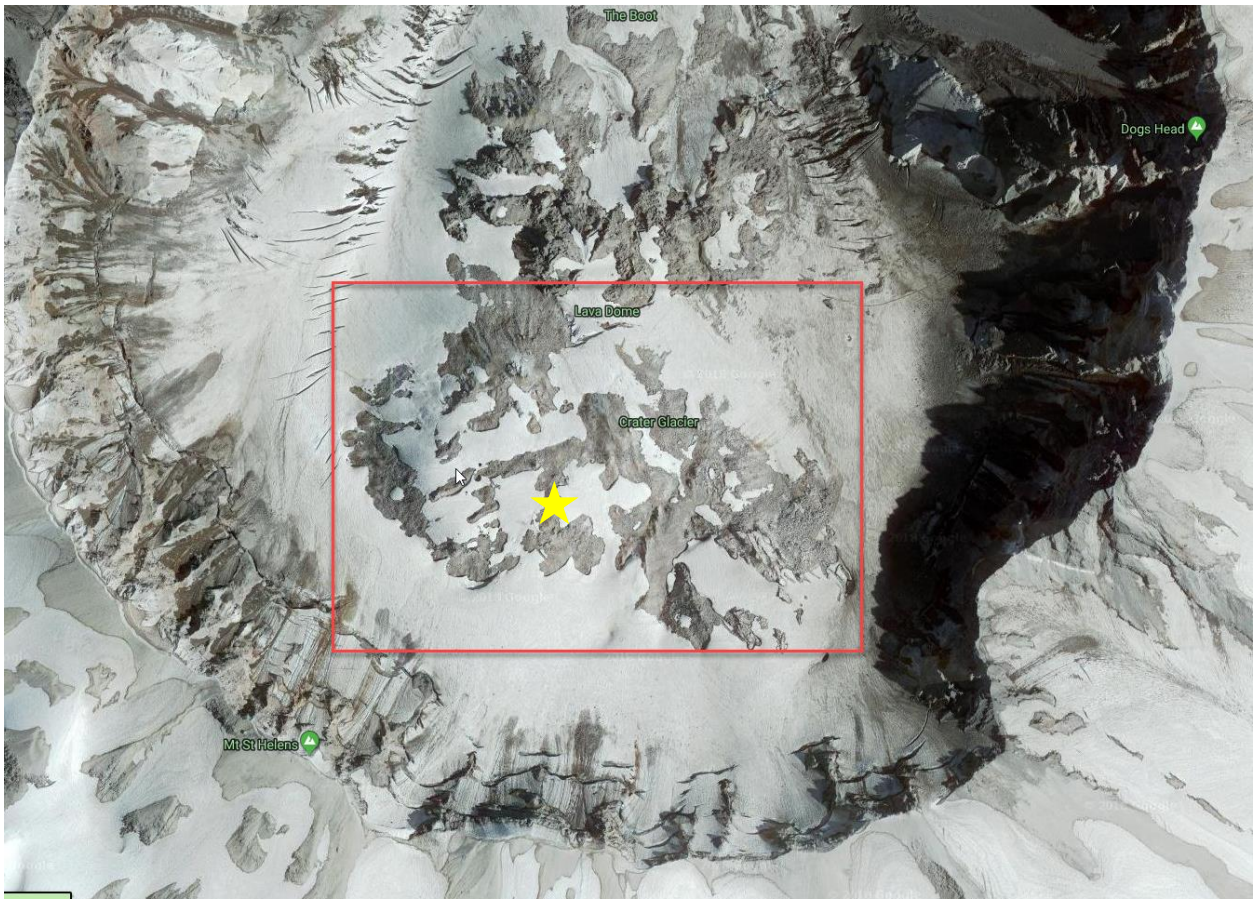


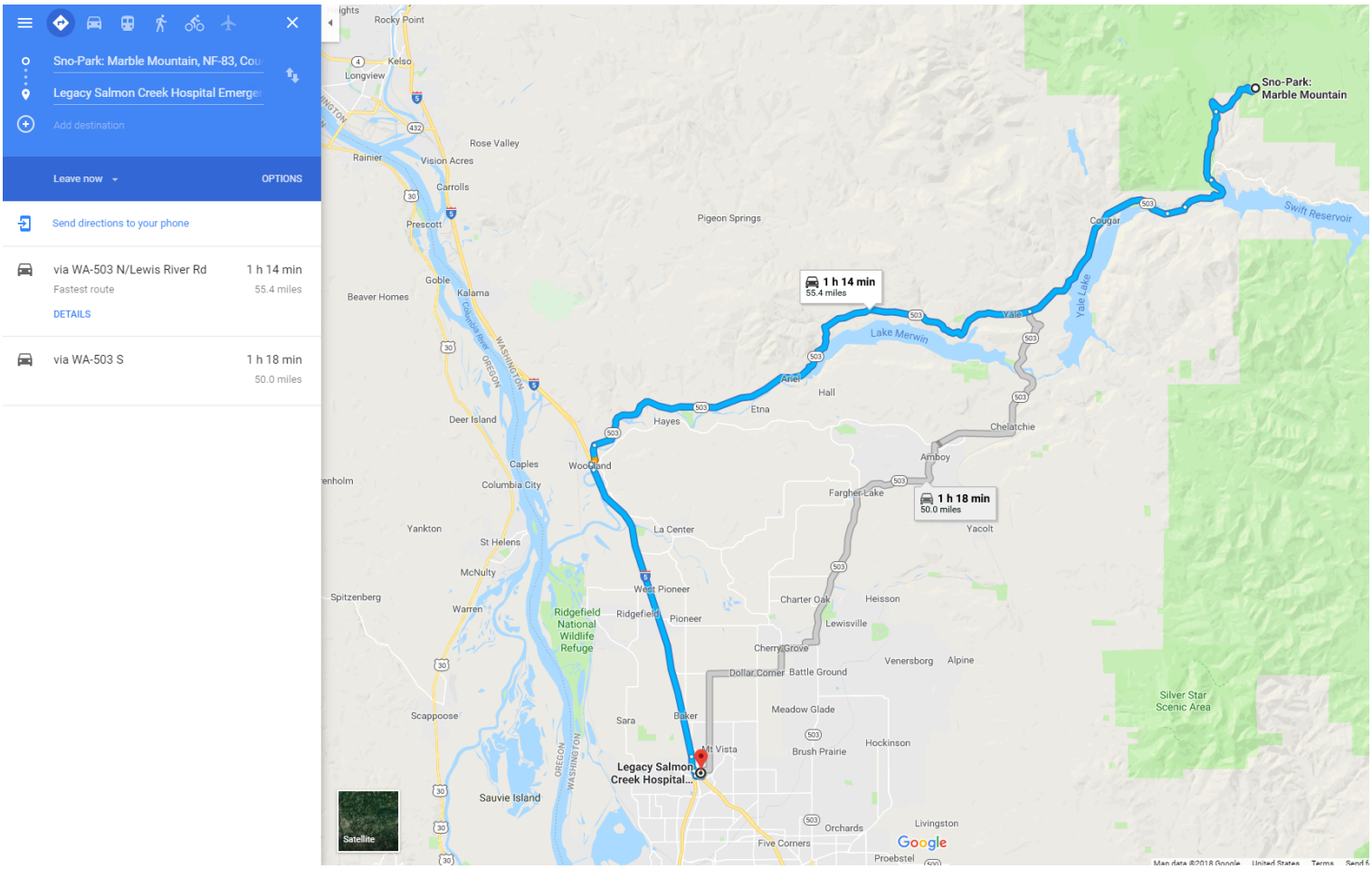
Figure A. Location of sUAS multiGAS survey, within the crater of Mount St. Helens, launching and surveying the 2004-2008 lava dome.

Appendix B: Emergency Response Plan

Personnel Emergencies

Any medical evacuation will be coordinated through the local emergency services. Personnel on site have first-aid and CPR training. Note: Any needed medical evacuation during project operations will be coordinated through the local emergency medical providers (via 9II). The nearest medical facility is described below with driving directions and maps included.

Legacy Salmon Creek Hospital (360) 487-1000, 2211 NE 139th St, Vancouver, WA 98686, approximately 55 miles from the field site (1 hour 14 min drive).



Appendix C: Sectional Maps

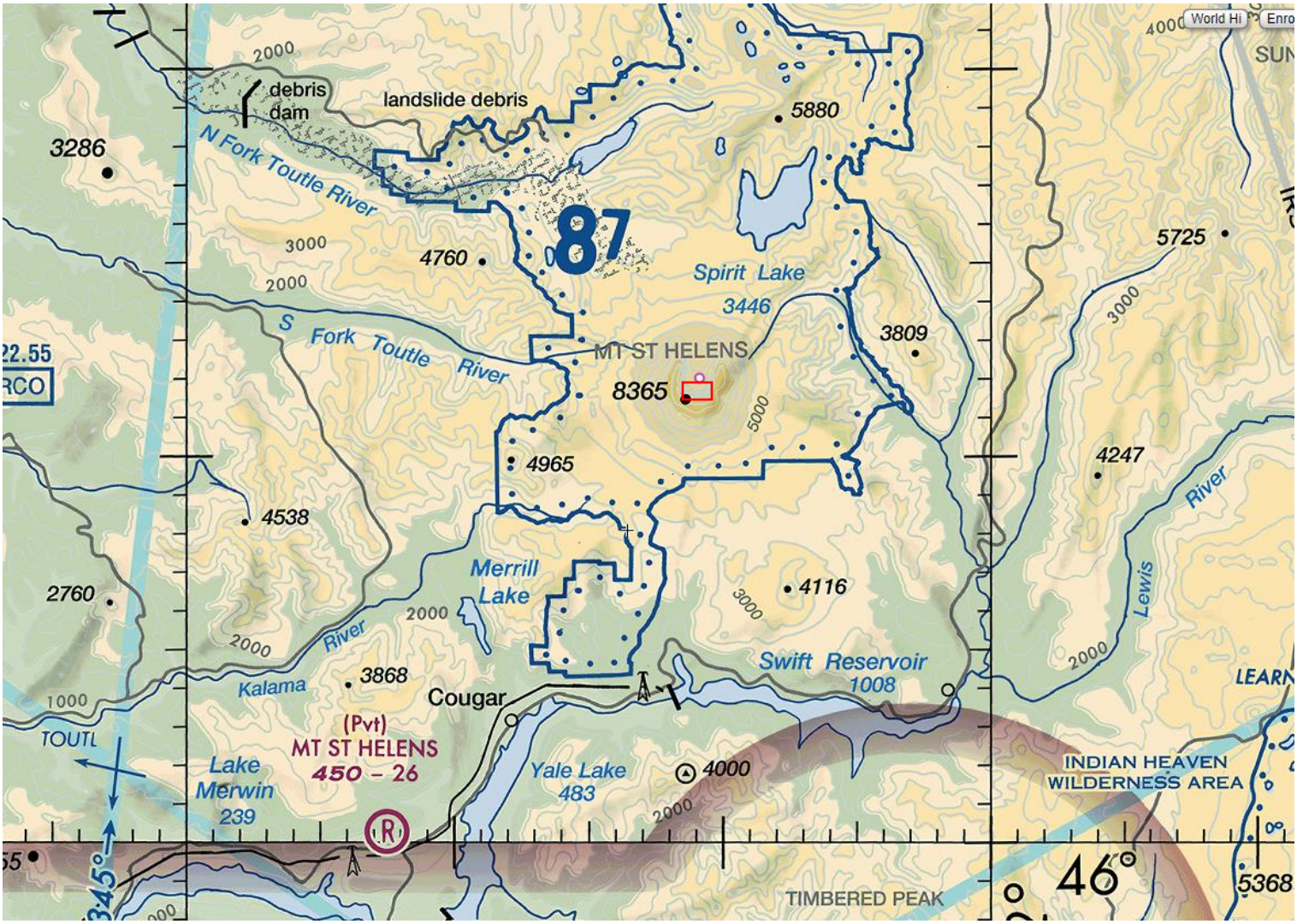


Figure C. FAA aeronautical chart showing the location of the field site (red rectangle).

Appendix D: M600 Checklist

Flight Safety Considerations

Beyond Visual Line of Site Considerations

❏ Confirm obstruction free environment 360 degrees prior to movement without video forward.
❏ Be aware of required flight path back to base in the event of video / map loss.
❏ Discuss ditch points for each mission.
❏ Remember winds aloft will be 10-100% higher than on the ground. Consider head winds in your battery management.

Minimum battery levels

❏ 30% Battery - Have line of site on aircraft
❏ 25% - Begin landing sequence
❏ 20% - Be on the ground

Pre-Flight Checklist

❏ System batteries fully charged
❏ Controller fully charged
❏ Landing gear switch down
❏ Prop arms latched
❏ Motor covers removed
❏ Batteries fully seated
❏ Spread props
❏ Thorough walk-around of aircraft:
❏ Props
❏ Motors
❏ Prop Arms
❏ Prop Arm Latches
❏ Batteries
❏ GPS
❏ Top Cover
❏ Payload plate
❏ Payload
❏ Leg hinges
❏ Legs
❏ Feet clamps
❏ Feet
❏ Prepare Payloads
❏ Check video cards
❏ Check optics
❏ Bad Elf verify time display and start logging
❏ Emplace Aircraft
❏ Connect Tablet to Controller
❏ Set Controller to Mode P
❏ Position Antennas up and V out
❏ **Power on Controller**
❏ **Power on Tablet** and open GCS App.
❏ Trigger Intervalometer (Ricoh if necessary - verify shutter sound)
❏ **Power on Aircraft**
❏ Verify gas sensor green (sensors require 5-10 minutes to calibrate and power on)
❏ Confirm connection between Controller and Aircraft
❏ Confirm GPS
❏ Confirm green flashing on Aircraft

Take-off Checkist
❏ Announce “Arming!”
❏ Announce “Taking off!”

Post - Launch Checklist
❏ 20 / 20 Checks (launch aircraft 20ft up and 20ft out: check roll, pitch, yaw)
❏ Telemetry Checks (GPS, RSSI, Video, Controls)
❏ Landing gear switch Up
❏ Launch time recorded
❏ Start recording video

Flight Planning Checklist
❏ Fly to start of plan
❏ Accept/begin mission
❏ Verify altitude and speed
❏ Monitor telemetry and battery levels

Pre-Landing Checklist
❏ Nose-out orientation
❏ Gimbal set to 90°
❏ Lower landing gear
❏ Make sure landing area is clear
❏ Announce “landing!”

Post-Landing Checklist
❏ Power down Aircraft
❏ Power down Controller
❏ Power down Tablet
❏ Landing time recorded

Appendix E: Mavic Checklist

Flight Safety Considerations

Beyond Visual Line of Site Considerations
- ☐ Confirm obstruction free environment 360 degrees prior to movement without video forward.
- ☐ Be aware of required flight path back to base in the event of video / map loss.
- ☐ Discuss ditch points for each mission.
- ☐ Remember winds aloft will be 10-100% higher than on the ground. Consider head winds in your battery management.

Minimum battery levels
- ☐ 30% Battery - Have line of site on aircraft
- ☐ 25% - Begin landing sequence
- ☐ 20% - Be on the ground

Aircraft Set-Up
- ☐ Unfold prop arms
- ☐ Install System batteries
- ☐ Spread props
- ☐ Ensure Controller is fully charged
- ☐ Check SD card and confirm WiFi/RC switch is on RC

Pre-Flight Checklist
- ☐ Thorough walk-around of aircraft:
    - Props
    - Prop Arms
    - Battery - Fully seated
    - Gimbal clear plastic cover and support removed
    - Feet on front arms
- ☐ Emplace Aircraft
- ☐ **Power on Tablet and put in Airplane mode**
- ☐ Connect Samsung Tablet to controller via USB
    - DJI micro usb on left side of controller disconnected
- ☐ Position Antennas up and V out
- ☐ **Power on Controller**
- ☐ **Power on aircraft**
- ☐ **Open "DJI Go 4"**
- ☐ Select "Mavic Pro" in upper left drop down
- ☐ Select blue "GO FLY"
- ☐ Format SD card on opening menu
- ☐ Confirm Aircraft Settings
    - RTH altitude: at least 10 m above tallest obstacle
    - Max altitude: about 10 m above intended ceiling
    - Enable multiple flight modes: currently disabled
- ☐ Confirm video feed
- ☐ Confirm connection, telemetry
- ☐ Set-up map with reference waypoints, etc.
- ☐ Clear the area

Take-off Checkist
- ☐ Announce "Arming!"
- ☐ Announce "Taking off!"

Post - Launch Checklist
- ☐ 20 / 20 Checks (launch aircraft 20ft up and 20ft out: check roll, pitch, yaw)
- ☐ Telemetry Checks (Battery, GPS, RSSI, Video, Controls)
- ☐ Record launch time
- ☐ Start video recording

Flight Planning Checklist

- ☐ Fly to start of plan
- ☐ Begin mission
- ☐ Verify altitude and speed
- ☐ Monitor telemetry and battery levels

Pre-Landing Checklist

- ☐ Nose-out orientation
- ☐ Gimbal set to 90°
- ☐ Make sure landing area is clear
- ☐ Announce “landing!”

Post-Landing Checklist

- ☐ Power down Aircraft
- ☐ Power down Controller
- ☐ Click off Tablet screen
- ☐ Landing time recorded