MONTANA
Department of Transportation
Research

REMOTE OBSERVATION OVER TIME (Drone in a Box) – Phase I

FHWA/MT-26-004/10470-0897

Final Report

August 2026

prepared for

THE STATE OF MONTANA DEPARTMENT OF TRANSPORTATION

in cooperation with

THE U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

August 2026

prepared by

Jeremy Crowley

University of Montana
Missoula, Montana

TECHNICAL REPORT DOCUMENTATION PAGE

General instructions: To add text, click inside the form field below (will appear as a blue highlighted or outlined box) and begin typing. The instructions will be replaced by the new text. If no text needs to be added, remove the form field and its instructions by clicking inside the field, then pressing the Delete key twice. Please remove this field before completing form.

1. Report No. FHWA/MT-26-004/10470-0897	**2. Government Accession No.**	**3. Recipient's Catalog No.**
4. Title and Subtitle Remote Observation Over Time (Drone in a Box) – Phase 1		**5. Report Date** September 2026
7. Author(s) Jeremy Crowley (https://orcid.org/0000-0001-6725-2905)		**6. Performing Organization Code**
		8. Performing Organization Report No.
9. Performing Organization Name and Address University of Montana Interdisciplinary Science Building, Room 107 32 Campus Dr Missoula, MT 59812		**10. Work Unit No.**
		11. Contract or Grant No. MDT Project # 10470-0897
12. Sponsoring Agency Name and Address Research Programs Montana Department of Transportation (SPR) 2701 Prospect Avenue PO Box 201001		**13. Type of Report and Period Covered** Final Report (August 2024-July 2026)
		14. Sponsoring Agency Code 5401

15. Supplementary Notes

Conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration. This report can be found at https://doi.org/10.21949/8vxt-xj93

Recommend Citation: Crowley, J. (2026). Remote Observation Over Time (Drone in a Box) - Phase 1 (FHWA-MT-26-004/10470-0897). Montana Department of Transportation. https://doi.org/10.21949/8vxt-xj93

16. Abstract:

The Montana Department of Transportation (MDT) and the Autonomous Aerial Systems Office (AASO) at the University of Montana conducted a study evaluating the use of a drone in a box (DiaB) to evaluate natural disasters. Geographic Information System (GIS) was used to identify areas with high potential for natural disasters. A market survey was conducted to evaluate specifications and costs of systems. And a template was developed for a Federal Aviation Administration (FAA) beyond visual line of sight (BVLOS) waiver submission. The study evaluated system performance of various DiaB systems in extremes of temperature, cellular connectivity, and terrain. The MDT Traffic Management Center (TMC) and MDT staff provided feedback to evaluate use-cases which would streamline current workflows, reduce labor, and improve efficiency in operations.

17. Key Words		18. Distribution Statement	
UAS, UAV, Unmanned Aerial Systems, Drone in a Box, DiaB, Beyond Visual Line of Sight, BVLOS		No restrictions.	
19. Security Classif. (of this report) Unclassified	**20. Security Classif. (of this page)** Unclassified	**21. No. of Pages** 10	**22. Price**

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

Disclaimer Statement

This document is disseminated under the sponsorship of the Montana Department of Transportation (MDT) and the United States Department of Transportation (USDOT) in the interest of information exchange. The State of Montana and the United States assume no liability for the use or misuse of its contents.

The contents of this document reflect the views of the authors, who are solely responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the views or official policies of MDT or the USDOT.

The State of Montana and the United States do not endorse products of manufacturers.
This document does not constitute a standard, specification, policy or regulation.

Alternative Format Statement

Alternative accessible formats of this document will be provided on request. Persons who need an alternative format should contact the Office of Civil Rights, Department of Transportation, 2701 Prospect Avenue, PO Box 201001, Helena, MT 59620. Telephone 406-444-5416 or Montana Relay Service at 711.

REMOTE OBSERVATION OVER TIME (DRONE IN A BOX)- PHASE 1

Final Report

Prepared by
Jeremy Crowley, Director, Autonomous Aerial Systems Office (AASO)
University of Montana

Prepared for the
MONTANA DEPARTMENT OF TRANSPORTATION
in cooperation with the
U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
Helena, MT 59620-1001

August 28, 2026

Disclaimer Statement

Alternative Format Statement

Alternative accessible formats of this document will be provided on request. Persons who need an alternative format should contact the Office of Civil Rights, Department of Transportation, 2701 Prospect Avenue, PO Box 201001, Helena, MT 59620. Telephone 406-444-5416 or Montana Relay Service at 711.

Table of Contents

List of Figures

List of Tables

I. Background

One of the newest technologies in the Unmanned Aerial System (UAS) industry is a Drone in a Box (DiaB). This technology has been embraced by a few local and state law enforcement agencies and state Departments of Transportation. The main objective of this project was to evaluate DiaB technology performance in the extremes of temperature, cellular connectivity, and terrain encountered in Montana. The long term objective of the DiaB project is to utilize an off-grid mobile trailer system to semi-autonomously detect natural hazards (i.e. floods and rockfall) and use a DiaB system to survey the extent of the natural hazard.

A DiaB solution allows for the remote control (i.e. from a laptop at MDT Headquarters) of a UAS under beyond visual line of sight (BVLOS) operations. According to Federal Aviation Authority (FAA) 14 Code of Federal Regulations (CFR) Part 91, BVLOS is an advanced operation beyond the CFR Part 107 (FAA Certification of Remote UAS Pilot) and requires a waiver. The soon to be operational Part 108 Rule will enable entities and businesses to conduct advanced operations (i.e. DiaB, package delivery, etc.) such as BVLOS if certain criteria are met, but currently a waiver is required for DiaB BVLOS flights. The companies that manufacture DiaB solutions have been successful in FAA BVLOS waiver applications by incorporating an on-site weather station and a camera inside the box in order for the remote pilot in command (PIC) to be able to visually check the aircraft before BVLOS operations. As far as we know, there has not been a project to create an off-grid mobile solution (i.e. trailer) for DiaB that will function in nearly all weather conditions encountered in Montana and cellular “dead zones”.

We utilized Geographic Information System (GIS) analysis to identify the areas along roadways with the highest potential for natural disasters. We also conducted a market survey of costs and capabilities of current systems on the market. We provided a template for an FAA waiver submission to legally conduct beyond visual line of sight (BVLOS) operations utilizing DiaB technologies. We conducted test flights of various DiaB systems in extremes of temperature, cellular connectivity, and terrain. And we worked with the MDT Traffic Management Center (TMC) to evaluate use-cases which would streamline current workflows, reduce labor, and improve efficiency.

We envisioned this project to take shape in three phases, **Phase I** (which this current research addresses) identified appropriate deployment locations, initiated the process of obtaining BVLOS waivers, and explored scenarios that would enable the DiaB solution to interface with MDT maintenance operations and the TMC in response to natural hazards. A future **Phase II** will include the physical design of the remote off-grid DiaB trailer system, and **Phase III** will include field deployment of the system in locations where natural hazards may be present.

II. Methodology

Phase I identified appropriate deployment locations, initiated the process of obtaining BVLOS wavers, and explored scenarios that would enable the DiaB solution will interface with MDT maintenance operations and the traffic TMC response to natural hazards. Phase I was initiated in 5 separate tasks (for more context and details the reader can consult the reports for each task):

Task 1: GIS Analysis of Natural Hazards. The goal of this task was to centralize all of the current data on known or potential natural hazards and cellular "dead zones" that may impact transportation infrastructure. The datasets utilized in this analysis included seismic data and faults, historic floods, landslides, the rock slope assessment program, and cellular coverage. This analysis assisted in determining the placement for the DiaB system.

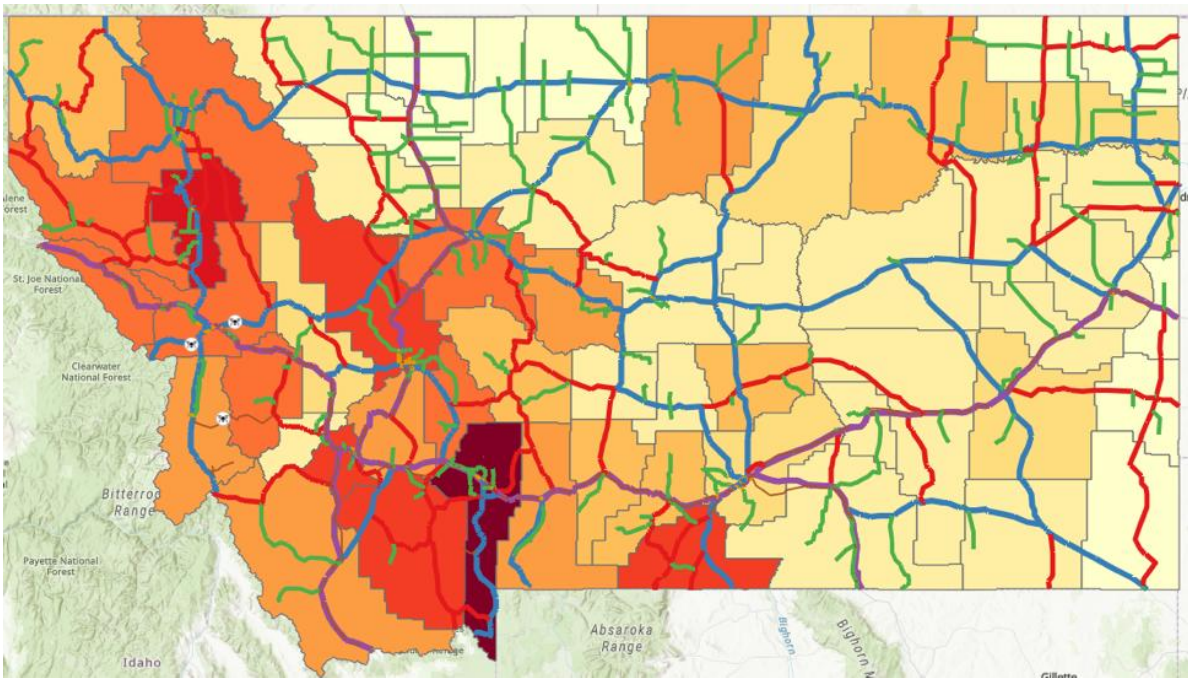

Figure 1. The interactive GIS online map of natural hazards to transportation infrastructure in MT. Counties with higher risk are shown in dark red and those with lower risk in light tan.

Task 2: Analysis on the current state of the industry/technology and costs for DiaB. This task involved conducting market research and interviewing vendors and researchers currently utilizing DiaB systems. Specifically, we interviewed multiple vendors and manufacturers to determine the DiaB solution status, assess the lessons learned, technology utilized, and determine pitfalls and potential solutions.

Table 1. DiaB System Comparison

Company/Product	Origin Country	Cost	Flight Time (min.)	Box Weight (lbs.)
Airobotics/Optimus	Israel	-	40	5412
Asylon/Guardian	USA	-	25	-
Atlas/AtlasNEST	Latvia	-	32	198
Azur/Skeyetech E2	France	-	27	-
Brinc/Station	USA	$100,000	42	340
Da-Jiang Innovations Dock	China	$34,000	41	231
Da-Jiang Innovations Dock2	China	$16,000	50	75
Da-Jiang Innovations Dock 3	China	$23,400	54	121
DroneMatrix/Yacob	Belgium	$67,000	25	-
DroneMatrix/Yeti	Belgium	$128,000	40	-
Percepto/Air Max	Israel	-	-	-
Percepto/Air Max OGI	Israel	-	-	-
Skycharge/Skyport	Germany	$52,000	-	-
Skydio/Dock	USA	$244,000	40	240
Sunflower Labs/ Beehive System	Switzerland	$10,000	15	77

Task 3: Preparation and submission of FAA waiver for BVLOS operations. The research group, in consultation with MDT reviewed successful BVLOS waivers, consulted with the FAA, and determined the best path forward to submit a BVLOS waiver to the FAA. We provided a template to fill out a BVLOS waiver based on a successful Autonomous Aerial Systems Office (AASO) waiver application. A requirement for the BVLOS waiver is a risk matrix (Table 2). The risk matrix scores individual scenarios (i.e. possibility of a conflict with another UAS) based on the likelihood of occurrence vs. the severity if an incident was to occur.

Table 2. Example of a mandatory Risk Matrix included in a BVLOS waiver application.

Severity Index	Extremely Improbable (1)	Improbable (2)	Remote (3)	Occasional (4)	Frequent (5)
Catastrophic (5)	5	10	15	20	25
Hazardous (4)	4	8	12	16	20
Major (3)	3	6	9	12	15
Minor (2)	2	4	6	8	10
Negligible (1)	1	2	3	4	5

Task 4: Staged testing of DiaB operations. The research group set up a tiered series of proof-of-concept flight operations of increasing complexity and documented these operations to provide to the MDT and the FAA in support of this research. The testing included connectivity using the cellular network and Starlink network in a variety of terrain and temperature conditions. Winter testing in February 2025 included flights at Blue Mountain (Fig. 2) and Bandy Ranch and summer testing in June 2025 included flights at McNamara (Fig. 3), Fort Fizzle, and Skalkaho Pass in the vicinity of Missoula, MT.

Figure 2. Winter DiaB field testing at Blue Mountain. From left to right: Trevor Hoggatt (Frontier Precision), Diandra Lewis (AASO), Jonathan Cordova (AASO), and Ian Hellman (AASO).

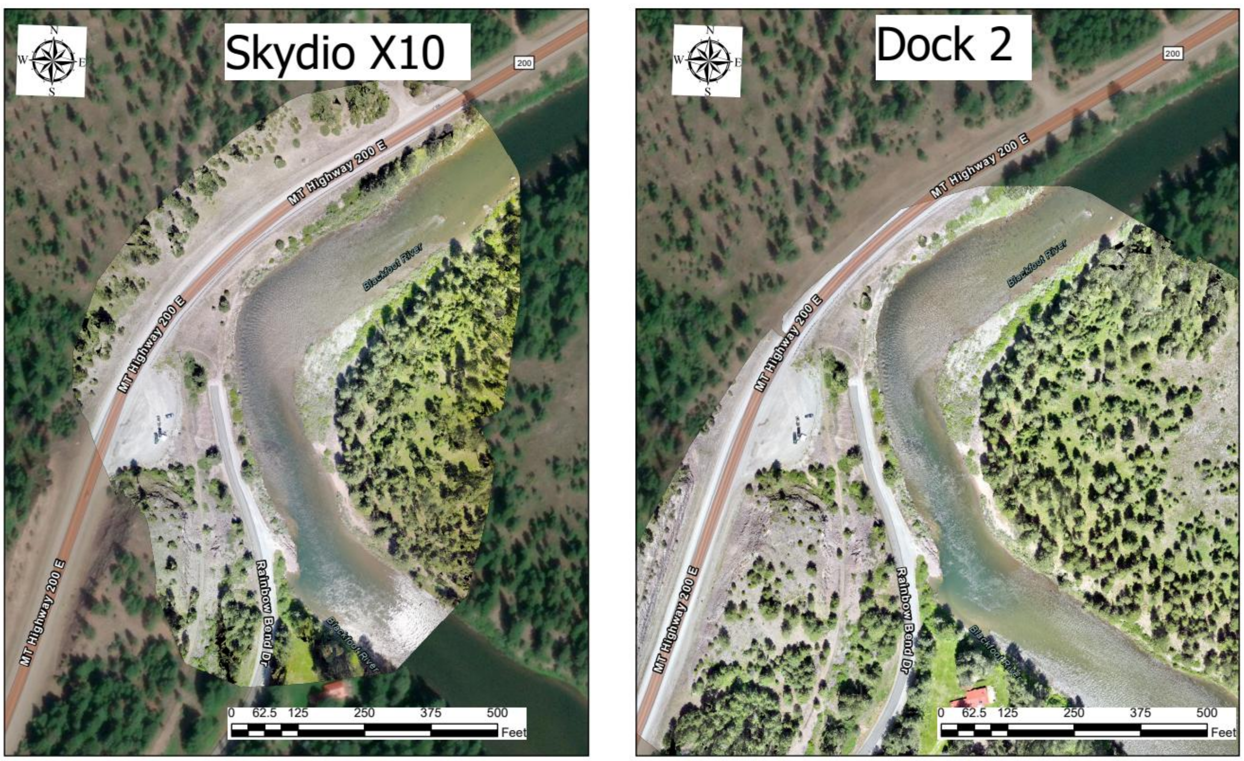

Figure 3. A side by side comparison of a RGB photogrammetry survey at McNamara, MT.

Task 5: Analysis of potential applied use-case scenarios incorporating MDT Maintenance, UAS Program, and the TMC. This task involved developing scenarios or use-cases in which the DiaB capabilities can provide efficiencies or benefits to both the Maintenance and TMC groups at MDT. We interviewed the TMC and UAS experts at MDT to identify applications and key benefits of TMC/DiaB integration.

Table 3. Applications, descriptions, and key benefits of TMC/DiaB integration.

Application	Description	Key Benefits
AI tracking vehicles, traffic, rockfall	A low-light pan, zoom, and tilt camera mounted on an off-grid trailer could be used for multiple purposes, tracking vehicles, traffic conditions, monitoring for rockfall. The use of artificial intelligence to determine normal conditions vs non-normal conditions (traffic slow down, accident, rockfall) could automate the detection. This could be a triggering of an automated text to the pilot to begin DiaB operations.	Staff efficiency, 24hr automated monitoring, decreased response times
Disasters	Rockfall, floods, snow, multivehicle accidents, culvert failures, hazmat incidents.	24hr automated monitoring, Decreased response times
Emergency response	Trailer/DiaB system could give responders critical situational awareness during incidents such as blizzard conditions shutting down emergency vehicle access. Potential to drop medical supplies.	Decreased response times, better disaster response planning
Construction monitoring	Could plan weekly or monthly flights to collect photogrammetry of construction site to monitor progress. Trailer could interact with video messaging systems and traffic control signaling systems.	Staff efficiency, streamlined UAS operations, streamlined message and control systems
Digital twin creation	3D photogrammetry provides a time-stamped digital archive of site status.	Improved change detection, 3D digital archive
Communication enhancements	Trailer could be equipped with Starlink to enhance cell denied communication and connectivity. DiaB could be used like a repeater or remote connectivity system. DiaB could be used as part of a mesh network system.	Improved communication, Improved situational awareness
Bridge surveys	Automated bridge inspections on a set timeline (i.e. weekly, monthly, quarterly).	Staff efficiency, streamlined UAS operations
Wildlife crossings	Trailer/DiaB system could be installed in known wildlife crossing areas, and areas with a history of animal/vehicle accidents. Potential to haze animals away from the roadway.	Reduced fatality/injury

III. Discussion and Conclusions

Task 1: GIS Analysis of Natural Hazards.

In general, the moderate to high risk of hazards to transportation infrastructure is elevated in Western Montana, where the larger elevation changes in the Rocky Mountains have increased precipitation and folding and faulting that creates higher seismic risk and potential for landslides and floods. There are some areas in north central and south central Montana that have elevated risk, primarily due to flood and landslide hazards. The areas of lowest natural hazard risk occur in far eastern MT and some counties in north central MT. An interactive GIS web map was created to allow stakeholders to explore the data on natural hazards to roadways in MT https://umontana.maps.arcgis.com/apps/mapviewer/index.html?webmap=651bf3ec4dcf4238b3cb03615b9d495c. (Hellman, 2025).

Task 2: Analysis on the current state of the industry/technology and costs for DiaB.

There are a number of considerations beyond just specifications and cost for current DiaB systems on the market. From talks with Skydio, it seems that their Dock system will not be broadly available on the market until Q2 of 2026. There may also be supply chain delays and/or cost increases due to the current import tariffs. Finally, there may be security concerns with certain non-allied country equipment. We investigated the network traffic from the DiaB systems with and without additional software that is advertised as containing the network traffic to domestic servers (For more details the reader can view the DiaB Data Management Plan Report).

In terms of specifications, performance, and cost, the combination of a Dock 2 or Dock 3 with network security software may be the most affordable and capable option. The cost is likely to increase a minimum of 10% in the near-term due to tariffs and current market supply demands. If MDT intends to acquire a system prior to Q3 of 2026 and the security and/or IT concerns dictate that non-allied system is inadvisable, then a short term solution may be to purchase a drone agnostic system such as the Skyport to use with MDT’s existing fleet of Skydio UAS.

Task 3: Preparation and submission of FAA waiver for BVLOS operations.

FAA 14 CFR Part 108 is expected to mandate communication links and detect-and-avoid (DAA) and BVLOS certification, as well as move the responsibility of the operations from the individual pilot (as in Part 107) to the organization. Part 108 is also expected to enable routine BVLOS flights without individual waivers by relying on advanced technologies (Command and Control Links-C2C, DAA, etc.) for UAS up to 1,320 lbs. The notice of proposed rulemaking (NPRM) for part 108 was released but was not finalized at the time of the report. The proposed Part 146, the new framework for unmanned aircraft system traffic management (UTM) and airspace services, will regulate the digital ecosystem (deconfliction, authorization, weather, traffic information, etc.) in which the UAS flies (Plaza, 2026).

Two executive orders relating to UAS were released in June 2025. One of these addresses Part 108, stating the FAA Administrator must issue a proposed rule enabling BVLOS within 30 days and a final rule withing 240 days. The order requires the FAA to identify performance and safety metrics for BVLOS within 30 days and identify regulatory barriers within 180 days. The other order directs federal agencies to prioritize US-manufactured UAS and publish a Covered Foreign Entity List that identifies companies that pose supply chain risks within 30 days, and to submit proposed rulemaking to secure the US drone supply against foreign exploitation within 90 days (McNabb, 2025).

Task 4: Staged testing of DiaB operations.

This research investigated the use of DiaB performance in extreme weather conditions and in cellular and cellular-denied environments, mapping abilities, and communications. We evaluated two commonly available DiaB systems (Dock 2 with Mavic 3D and Skydio X10) and determined that both performed well in all conditions. We did not evaluate the spatial or 3D model accuracy of the systems for photogrammetry, but we evaluated their performance in similar conditions. We investigated 3 systems for network communications: Dock 2 with FlightHub, Dock 2 with Flytbase, and Skydio X10 with Skydio Remote Ops. The network analysis revealed that all 3 were communicating with cloud service providers in the US (and in one case France). This research provides the groundwork for the Phase II DiaB project.

Task 5: Analysis of potential applied use-case scenarios incorporating MDT Maintenance, UAS Program, and the TMC.

As a result of the DiaB/TMC/AASO meetings we identified some of the key applications and benefits that could result from a coordinated DiaB/TMC alignment. All of these applications could be supported by an off-grid DiaB trailer system with an integrated pan-zoom-tilt (PZT) camera. The PZT camera in combination with artificial intelligence, can be used as a triggering mechanism to send a text to a pilot to begin DiaB operations, to provide an early warning system to identify natural hazards such as rockfalls and floods (Fig. 3), and to identify any irregularities in the traffic pattern (accidents, stranded vehicles, slowed traffic due to weather conditions). Additionally, the DiaB trailer system could be used to enhance or extend communications in areas that are cellular denied, provide a mobile mesh network, and provide support during emergency response. Other potential use cases include potential delivery of medical support supplies, communication systems (radios), and life-saving supplies to stranded drivers (water, food, sleeping bags).

Figure 4. Flooding near the north entrance of Yellowstone National Park. (Yellowstone National Park, 2022).

IV. Acknowledgements

The authors would like to sincerely thank the Montana Department of Transportation (MDT) and Technical Panel (TP) for their time and effort reviewing the work plan and timeline, providing guidance on the analysis and reports, providing logistical support, and steering the research. Without the TP support this research would not have been possible.

Technical Panel Members:
Emily Hawley, Research and Project Manager, MDT; Mike Kuni, Project Chair, MDT; Paul Hilchen, UAS Manager, MDT; Curtis Buckley, Technical Panel Member, MDT; Lee Grosch, Technical Panel Member, MDT; Justun Juelfs, Technical Panel Member, MDT; Cameron Kloberdanz, Technical Panel Member, MDT; Patrick McCann, Technical Panel Member, MDT; Ethan Ritzen, Technical Panel Member, MDT; Patrick Dryer, Technical Panel Member, AKDOT; Stephanie Brandenberger, Technical Panel Member, FHWA; Raja Nagisetty, Technical Panel Member, Montana Tech

V. References

Hellman, I., 2025. GIS Analysis of Natural Hazards to Roadways in MT, ArcGIS Web Map. https://umontana.maps.arcgis.com/apps/mapviewer/index.html?webmap=651bf3ec4dcf4238b3cb03615b9d495c

Plaza, J., 2026. How Part 108 will redefine aviation's relationship with technology. Commercial UAV News. https://www.commercialuavnews.com/part-108-bvlos-technology-ecosystems-aviation-regulation. Accessed July 3, 2026.

Yellowstone National Park, 2022. Yellowstone flood event: North entrance road washout. https://www.flickr.com/photos/yellowstonenps/52151724253/in/album-72177720299792347/. Accessed April 7, 2026.