Environmental Assessment

Wing Aviation
Drone Package Delivery Operations
Christiansburg, VA

December 2021

United States Department of Transportation
Federal Aviation Administration

Washington, D.C.

FAA MISSION STATEMENT

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Cover Image: Wing Aviation, LLC

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1.0 PURPOSE AND NEED

1.1 Introduction

Wing Aviation, LLC (Wing), a subsidiary of Alphabet Inc., is seeking to amend its air carrier Operations Specifications (OpSpecs) for unmanned aircraft (UA) commercial package delivery operations that are currently taking place in Christiansburg, VA. Wing will use its Hummingbird 7000W-A UA that has a maximum takeoff weight of 15 pounds. The UA is a multicopter that uses electric power from rechargeable lithium ion batteries. Operations take place from one "nest" at 160 Welcome Street North East, Christiansburg, VA 24073.[1] In order for Wing to conduct UA package deliveries up to a specific pilot to aircraft ratio, it must receive an FAA approval. Wing has requested that FAA amend the OpSpec in its Part 135 air carrier certificate to allow operations with up to a pilot to aircraft ratio of 1:8. Wing is currently approved to operate at a 1:2 pilot to aircraft ratio.

Under this expanded approval, Wing projects that it would operate a maximum of approximately 100 flight operations per operating day from its Christiansburg nest. The operations would occur during daytime hours only, typically on five days of the week, and generally excluding holidays unless related to a community event or holiday-related promotion.The OpSpec amendment is the FAA approval that ultimately would enable the pilot ratio change for operations in Christiansburg, VA. The A003 OpSpec*, Airplane/Aircraft Authorization*, will be amended to include a reference to an approved pilot to vehicle ratio of 1:8. The approval of the amendment to Wing's OpSpecs to include this new ratio is considered a major federal action subject to NEPA review requirements.

This Environmental Assessment (EA) is being prepared by the FAA to evaluate the potential environmental impacts that may result from FAA's approval of the proposed action, which would increase the number of UAs that pilots may operate for commercial delivery operations in Christansburg, VA. The FAA has prepared this EA pursuant to the National Environmental Policy Act of 1969 (NEPA) [42 United States Code (U.S.C.) § 4321 et seq.] and its implementing regulations (40 Code of Federal Regulations (CFR) §§1500-1508)). The NEPA requires federal agencies to consider the environmental effects of proposed federal actions and to disclose to decision-makers and the interested public a clear and accurate description of the potential environmental impacts of proposed major federal actions. Under NEPA, federal agencies are required to consider the environmental effects of a proposed action, the reasonable alternatives to the proposed action, and a no action alternative (assessing the potential environmental effects of not implementing the proposed action). The FAA has established a process to ensure compliance with the provisions of NEPA through FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures* and FAA Order 1050.1F Desk Reference.

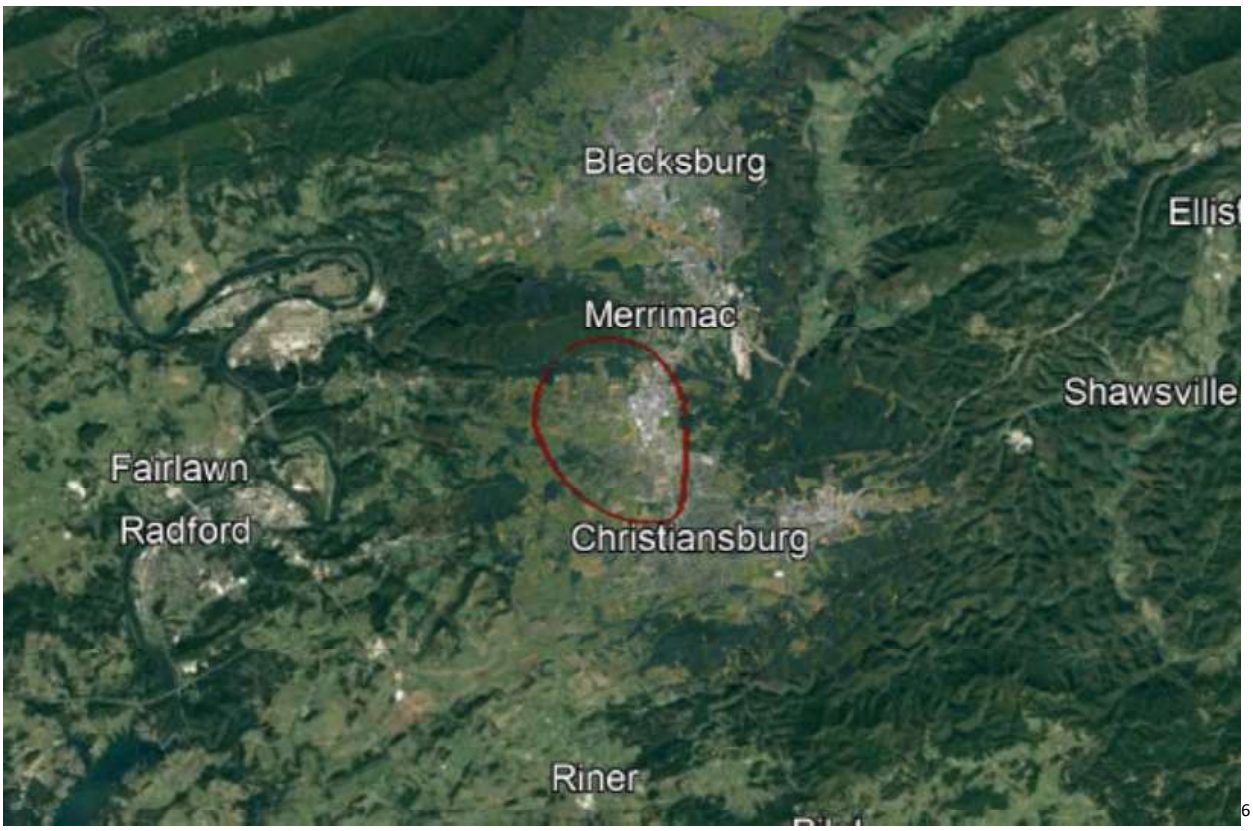
1.2 Background and Location

In 2012, Congress first charged the FAA with integrating unmanned aircraft systems (UAS) into the National Airspace System (NAS).[2] The FAA has engaged in a phased, incremental approach to integrating UAS into the NAS and continues to work toward full integration of UAS into the NAS. Part of that approach involves providing safety review and oversight of proposed operations to begin commercial UA delivery in the NAS.

[1] A nest is a ground based service area where UA are assigned and where flights originate and return.
[2] 49 U.S.C. 44802; FAA Modernization and Reform Act of 2012, Pub. L. No. 112-95, Sec. 332. 126 Stat. 11, 73 (2012).

Over the past five years Wing has been working under various FAA programs, including the UAS Integration Pilot Program (IPP),[3] the Partnership for Safety Plan Program (PSP),[4] and the BEYOND program,[5] as well as FAA's established processes to bring certificated commercial UA delivery into practice. Participants in these programs are among the first to prove their concepts, including package delivery by UA, through the use of current regulations and exemptions and waivers from some of these regulatory requirements.

Wing was one of the first to obtain an FAA Part 135 certificate, which allows it to carry the property of another for compensation or hire Beyond Visual Line of Sight (BVLOS). Wing has a standard Part 135 air carrier certificate and that certificate contains a stipulation that operations must be conducted in accordance with the provisions and limitations specified in its OpSpecs. Wing's current request for an amended OpSpecs to increase the pilot to aircraft ratio would enable the continued commercial delivery operations in the communities of Christiansburg, VA. In Figure 1, the operating area is outlined in red.



[6]

Figure 1 Study Area in Christiansburg, Virginia

[3] The UAS IPP was announced on October 25, 2017 via a Presidential Memorandum, which has the force and effect of law on executive agencies. https://www.faa.gov/uas/programs_partnerships/completed/integration_pilot_program/
[4] https://www.faa.gov/uas/programs_partnerships/psp/
[5] https://www.faa.gov/uas/programs_partnerships/beyond/
[6] Image: Google Earth, as modified by the FAA

1.2.1 Christiansburg Nest Location

The nest location at Christiansburg is on private property, zoned for commercial use. See Figures 2 and 3. It is near restaurants and other businesses with whom Wing has established partnerships. Wing's partners are able to deliver products to customers using Wing's UA as long as the customer was located within the delivery area and the package is approved for delivery.

[7]

Figure 2 Satellite View of Wing's Nest Location


[8]

Figure 3 Ground View of Wing's Nest Location

[7] Image: Google Earth, as modified by the FAA
[8] Image: Wing Aviation, LLC.

1.3 Purpose and Need

As described in the FAA Order 1050.1F, *Environmental Impacts: Policies and Procedures*, the Purpose and Need section of an EA briefly describes the underlying purpose and need for the proposed federal action. It presents the problem being addressed and describes what the FAA is trying to achieve with the proposed action.

1.3.1 FAA Purpose and Need

Wing's request to amend its OpSpecs to increase the pilot to aircraft ratio to 1:8 requires FAA review and approval. The FAA issuance of the amendment to the OpSpecs ultimately increases the number of UAs each pilot is allowed to operate in the NAS at any given time for commercial delivery operations in this area.

The FAA has a statutory obligation to review Wing's request to amend the OpSpecs and determine whether the amendment would affect safety in air transportation or air commerce and whether the public interest requires the amendment. In general, Congress has charged the FAA to encourage the development of civil aeronautics and the safety of air commerce in the United States. 49 U.S.C. §40104.

In addition, the FAA has specific statutory and regulatory obligations related to its issuance of a Part 135 certificate and the related OpSpecs. The FAA is required to issue an operating certificate to an air carrier when it "finds, after investigation, that the person properly and adequately is equipped and able to operate safely under this part and regulations and standards prescribed under this part." 49 U.S.C. §44705. An operating certificate also specifies "terms necessary to ensure safety in air transportation; and (2)…the places to and from which, and the airways of the United States over which, a person may operate as an air carrier." *Id*. Also included in air carrier certificates is a stipulation that the air carrier's operations must be conducted in accordance with the provisions and limitations specified in OpSpecs. 14 CFR §119.5 (g), (l). The regulations also specify that a Part 135 certificate holder may not operate in a geographical area unless its OpSpecs specifically authorize the certificate holder to operate in that area. 14 CFR 119.5(j). The regulations implementing Section 44705 specify that an air carrier's approved OpSpecs must include, among other things, "authorization and limitations for routes and areas of operations." 14 CFR §119.49(a)(6). An air carrier's OpSpecs may be amended at the request of an operator if the FAA "determines that safety in air commerce and the public interest allows the amendment." 14 CFR §119.51(a); see also 49 U.S.C. §44709. After making this determination, the FAA must take an action on the OpSpecs amendment.

1.3.2 Wing's Purpose and Need

The purpose of Wing's request is to increase the number of aircraft a pilot is allowed to operate in the air at any time, which, in its business judgment, Wing has determined is appropriate for their operations. Wing's requested amendment to increase the pilot to aircraft ratio could help Wing gauge its ability to meet public demand for UA delivery services and evaluate whether scalable and cost-effective UA delivery expansion is possible in the area. In addition, the increase could provide an opportunity to assess community response to commercial delivery operations in the area.

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 Proposed Action

In order for Wing to amend the OpSpecs in its Part 135 air carrier certificate it must receive an approval from FAA. The OpSpecs amendment is the FAA approval that ultimately would enable air operations in Christiansburg, VA to be increased from the current 1:2 pilot to aircraft ratio to a 1:8 pilot to aircraft ratio.

The A003 OpSpec*, Airplane/Aircraft Authorization*, includes a reference under the configuration and operations table. The amendment to this reference section –to increase the pilot to aircraft ratio – is the proposed federal action for this EA.

The UA commercial delivery operations will continue to transport consumer goods from local businesses to homes and other locations centered in the Carma Heights and Windmill Hills neighborhoods in Christiansburg, VA. In Figure 1 above, the study area is outlined in red, with the nest location identified using a blue dot. Wing's OpSpecs restrict their Part 135 delivery operations to this particular location; any future expansion beyond the authorization and limitations for routes and areas of operations described in the amended OpSpecs will require additional OpSpec amendments from the FAA and will receive appropriate NEPA review at that time.

The FAA anticipates that Wing would operate less than approximately 100 flights per operating day from the current nest, although the number could be considerably lower.[9] The operations would occur during daytime hours only, typically on five days of the week, and generally excluding holidays unless related to a community event or holiday-related promotion. Night operations would not be conducted under the proposed action. The Hummingbird UA is shown in Figure 4 below.

[9] See Section 2.1 of the Noise Analysis Report in Appendix C

 [10]

Figure 4 Wing Hummingbird UA with Package

The alternative to the proposed action is the no action alterative, where FAA would not issue the amendment to the OpSpecs to allow Wing to increase its pilot to aircraft ratio from 1:2 to 1:8 for commercial package delivery operations in Christiansburg, VA. This alternative does not support the stated purpose and need. However, it was retained as required by CEQ regulations (40 CFR 1502.14(c)).

[10] Image: Wing Aviation, LLC.

3.0 AFFECTED ENVIRONMENT and ENVIRONMENTAL CONSEQUENCES

This section provides a description of the environmental resources that would be affected by the proposed action, as required by the CEQ regulations and FAA Order 1050.1F. The level of detail provided in this section is commensurate with the importance of the impact on these resources (40 CFR § 1502.15). The general study area for each resource is the entire area within the red-lined boundaries of Figure 1 in this report. As required by FAA Order 1050.1F, this EA presents an evaluation of impacts for the environmental impact categories listed below.

- Air Quality
- Biological Resources (including Fish, Wildlife, and Plants)
- Climate
- Coastal Resources
- Department of Transportation Act, Section 4(f) Resources
- Farmlands
- Hazardous Materials, Solid Waste, and Pollution Prevention
- Historical, Architectural, Archaeological, and Cultural Resources
- Land Use
- Natural Resources and Energy Supply
- Noise and Compatible Land Use
- Socioeconomic, Environmental Justice, and Children's Environmental Health and Safety Risks
- Visual Effects (Light Emissions)
- Water Resources (including Wetlands, Floodplains, Surface Waters, Groundwater, and Wild and Scenic Rivers)

For each of the resources covered in this section, the following information is provided:

- Regulatory Setting
- Affected Environment
- Environmental Consequences

3.1 Resources Not Analyzed in Detail

This EA does not analyze potential impacts on the following environmental impact categories in detail, for the reasons explained below:

- **Air Quality and Climate** – The UA is battery-powered will not generate emissions that could result in air quality impacts or climate impacts. Electricity consumed for battery charging at the nest will be minimal, especially for the limited scope of these operations. Electricity consumed for the proposed action is not expected to cause a significant impact to the electrical grid.

- **Coastal Resources** –The proposed operation would not directly affect any shorelines or change the use of shoreline zones and be inconsistent with any NOAA-approved state Coastal Zone Management Plan (CZMP) since there are no coastal zones or shorelines in the area of operations.

- **Farmlands** –The proposed action will not involve the development or disturbance of any land regardless of use, nor would it have the potential to convert any farmland to non-agricultural uses.

- **Hazardous Materials, Solid Waste, and Pollution Prevention** –The proposed action will not result in any construction or development or any physical disturbances of the ground. Therefore, the potential for impact in relation to hazardous materials, pollution prevention, and solid waste is not anticipated. Additionally, each Wing drone is made from recyclable and biodegradable materials and will be properly managed at the end of its operating life in accordance with 14 CFR Part 43.

- **Land Use** – The proposed action will not involve any changes to existing, planned, or future land uses within the area of operations.

- **Natural Resources and Energy Supply –** The proposed action will not require the need for unusual natural resources and materials, or those in short supply. Wing's aircraft will be battery powered and will not consume fuel resources.

- **Socioeconomic Impacts and Children's Environmental Health and Safety Risks** – The proposed action will not involve acquisition of real estate, relocation of residents or community businesses, disruption of local traffic patterns, loss in community tax base, or changes to the fabric of the community. Executive Order (EO) 13045, *Protection of Children from Environmental Health Risks and Safety Risks*, requires federal agencies to ensure that children do not suffer disproportionately from environmental or safety risks. The proposed action will not affect products or substances that a child would be likely to come into contact with, ingest, use, or be exposed to, and would not result in environmental health and safety risks that could disproportionately affect children. Additionally, Wing's proposal includes generally avoiding operations near schools and playgrounds during operational hours, which could help reduce any potential environmental health or safety impacts to children.

- **Visual Effects (Light Emissions Only)** – The proposed action will not result in significant light emission impacts because flights will be limited to daytime hours only.

- **Water Resources (Wetlands, Floodplains, Groundwater, and Wild and Scenic Rivers)** –The proposed operation will not result in the construction of facilities and would therefore not encroach upon areas designated as navigable waters or directly impact wetlands. The proposed operation will not encroach upon areas designated as a 100-year flood event area as described by the Federal Emergency Management Agency (FEMA). The proposed action will not result in any changes to existing discharges to water bodies, create a new discharge that would result in impacts to surface waters, or modify a water body. The proposed action does not involve land acquisition or ground disturbing activities that would withdraw groundwater from underground aquifers or reduce infiltration or recharge to ground water resources through the introduction of new impervious surfaces. The proposed action would not foreclose or downgrade the Wild, Scenic, or Recreational river status of a river or river segment included in the Wild and Scenic River System. There are no river segments within the operational area.

3.2 Biological Resources (Including Fish, Wildlife and Plants)

3.2.1 Regulatory Setting

Biological resources include plant and animal species and their habitats, including special status species (federally listed or state-listed threatened or endangered species, species proposed for listing, species that are candidates for federal listing, marine mammals, and migratory birds) and environmentally sensitive or critical habitat. Biological resources provide aesthetic, recreational, and economic benefits to society.

Threatened and Endangered Species

The Endangered Species Act (ESA) of 1973 [16 U.S.C. § 1531 et seq.] requires the evaluation of all federal actions to determine whether a proposed action is likely to jeopardize any proposed, threatened, or endangered species or proposed or designated critical habitat. Critical habitat includes areas that will contribute to the recovery or survival of a listed species. Federal agencies are responsible for determining if an action "may affect" listed species, which determines whether formal or informal consultation with the U.S. Fish and Wildlife Service (USFWS) and/or the National Marine Fisheries Service (NMFS) is needed. If the FAA determines that the action will have no effect on listed species, consultation is not required. If the FAA determines that the action may affect listed species, consultation with the USFWS must be initiated.

A significant impact to federally-listed threatened and endangered species would occur when the USFWS or NMFS determines that the proposed action would be likely to jeopardize the continued existence of a federally-listed threatened or endangered species, or would be likely to result in the destruction or adverse modification of federally-designated critical habitat. An action need not involve a threat of extinction to federally listed species to meet the NEPA standard of significance. Lesser impacts including impacts on non-listed or special status species could also constitute a significant impact.

Migratory Birds

The Migratory Bird Treaty Act (16 U.S.C. §§ 703-712) protects migratory birds, including their nests, eggs, and parts, from possession, sale, purchase, barter, transport, import, export, and take. The USFWS is the federal agency responsible for the management of migratory birds as they spend time in habitats of the U.S. For purposes of the Migratory Bird Treaty Act, "take" is defined as "to pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect" (50 CFR § 10.12). The Migratory Bird Treaty Act applies to migratory birds identified in 50 CFR § 10.13 (defined hereafter as "migratory birds").

Bald and Golden Eagles

The Bald and Golden Eagle Protection Act prohibits anyone from "taking" a bald or golden eagle, including their parts, nests, or eggs, without a permit issued by the USFWS. Implementing regulations (50 CFR § 22), and USFWS guidelines as published in the National Bald Eagle Management Guidelines, provide for additional protections against "disturbances." Similar to take, "Disturb" means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, injury to an eagle or causes either a decrease in its productivity or nest abandonment due to a substantial interference with breeding, feeding, or sheltering. A permitting process provides limited exceptions to the Bald and Golden Eagle Protection Act's prohibitions. The USFWS has issued regulations for the permitting process in 50 CFR § 22. The National Bald Eagle Management Guidelines state that aircraft should remain at

least 1,000 feet from known bald eagle nests during the breeding season unless operated by a trained wildlife biologist.

3.2.2 Affected Environment

This section describes the existing biological environment of the Christianburg, VA operating area. Christiansburg, VA is located in the Ridge and Valley ecoregion, characterized as relatively low-lying, with ridges, rolling valleys, and low irregular hills.[11] The aircraft nest is in a lot that has already been developed. Wing's aircraft will not touch the ground in any other place than the nest (except during emergency landings) since it remains aerial while conducting deliveries.

The proposed action would take place over mostly suburban and commercially-developed properties. These areas provide habitat for the smaller, more common and ubiquitous bird and mammal species of the eastern U.S., including mammals such as white-tailed deer, black bear, fox, raccoon, skunk, and squirrel.[12] Volant species include bats, songbirds, and insects. Wing's nests would be close to roads and human activity centers and would not be located in a place where "quiet" is a unique attribute of the habitat.

Special Status Species

Federally Listed Species. The potential for impacts to federally-listed species was assessed using the USFWS Information for Planning and Consultation (IPaC) map tool and reports. The study area covered the entire Christiansburg, VA operating area, outlined in red in the earlier Figure 1 of this EA. The IPaC report is included as Appendix A.

Based on the IPaC report, there are two bat species that could be present in the study area. The endangered Indiana Bat (Myotis sodalis) and threatened Northern Long-eared Bat (Myotis septentrionalis) have the potential to occur within the operating area. There are no ESA-listed bird species in the operating area.

The Monarch Butterfly is a candidate for federal listing and could occur in the operating area. There is no critical habitat that has been designated for this species.

There is no critical habitat within the operating area.

State Listed Species. The Virginia Department of Wildlife Resources lists the freshwater fishes, amphibians, reptiles, birds, mammals, mollusks, freshwater crustaceans, millipdes, arachnids, insects, and marine mammals considered as state endangered or threatened within the Commonwealth of Virginia.[13] This list includes several species of state endangered bats that could be present in the Christiansburg area, including the Virginia big-eared bat (*Corynorhinus townsendii virginianus*), little brown bat (*Myotis lucifugus*), and tri-colored bat (*Perimyotis subflavus*). The state threatened Peregrine falcon (*Falco peregrinus*), state endangered Bewick's wren (*Thryomanes bewickii*), state threatened

[11] EPA Ecoregions of North America. US Level III CEC Descriptions Word Document. 2010. https://www.epa.gov/eco-research/ecoregions-north-america
[12] ibid
[13] Virginia Department of Wildlife Resources. 2021. Special Status Faunal Species in Virginia. Available at: https://dwr.virginia.gov/wp-content/uploads/media/virginia-threatened-endangered-species.pdf. Accessed December 16, 2021.

loggerhead shrike (*Lanius ludovicianus*), state threatened Henslow's Sparrow (*Centronyx henslowii*) could also be present in the operating area.[14]

Migratory Birds

Migratory bird species found within the operating area will vary throughout the year. Many dozens of resident bird species – also protected under the Migratory Bird Treaty Act – will inhabit the fragmented woodlands and neighborhoods in the operating area all year long. During certain weeks in the spring and fall, hundreds of species of songbirds, raptors, and waterfowl from the northern U.S. and Canada may potentially pass through the operating area, mostly traveling at night. Some of these migratory birds could have winter territories in the operating area.

The IPaC report identifies eight Birds of Conservation Concern (BCC) that could occur, and potentially be nesting in the area. The Red-headed Woodpecker (*Melanerpes erythrocephalus*) is the only BCC listed in the operating area that could potentially build nests at heights within the range of UA flights. They typically build nests in tall, dead trees near marshes and open bodies of water between May 10 and September 10.

The Bald Eagle (Haliaeetus leucocephalus) is not a BCC in the operating area, but it is a special status species that could establish nests in forested areas near surface waters such as the New River west of the operating area. As stated in the National Bald Eagle Management Guidelines [15], aircraft should stay at least 1,000 feet from Bald Eagle nests during its breeding season from September 1 through July 31, unless the aircraft is operated by a trained wildlife biologist.

3.2.3 Environmental Consequences

There will be no ground construction or habitat modification associated with the proposed action, as the aircraft nest is in a lot that is already developed. Wing's aircraft will not touch the ground in any other place than the nest (except during emergency landings), since it remains aerial while conducting deliveries. Wing's deliveries will initiate from the nest, and fly at an en route altitude generally between 150 and 400 feet AGL. The UA will lower to around 23 feet AGL and hover for a brief time to make a delivery. Then, the UA will transition back to en route flight mode for a return to the nest.

The operations will be taking place within airspace, and typically well above the tree line and away from sensitive habitats. The low number of daily operations and nature of the flights are not expected to significantly influence wildlife in the area.

Special Status Species

The federally endangered Indiana Bat (*Myotis sodalis*) and threatened Northern Long-eared Bat (*Myotis septentrionalis*), as well as several state protected bat species, have the potential to occur within the operating area. While these bat species may occur within the operating area, they are unlikely to encounter the aircraft as Wing's proposed operations will be limited to daytime hours. In the event that flights do overlap with dawn or dusk bat emergence, bats may exhibit disturbance behaviors and change

[14] Virginia Department of Game and Inland Fisheries. 2021. VaFWIS Search Report for species Known or likely to occur within a 10 mile radius around point Christiansburg Populated Place Montgomery (at 37,07,47.4 -80,24,32.1) in 063 Floyd County, 121 Montgomery County, 155 Pulaski County, 750 Radford City, VA. Accessed December 16, 2021.
[15] U.S. Fish and Wildlife Service. 2007. National Bald Eagle Management Guidelines. Available: https://www.fws.gov/northeast/ecologicalservices/pdf/NationalBaldEagleManagementGuidelines.pdf. Accessed: October 19, 2021.

their flight paths to avoid drones.[16] However, research also suggests that drones have "minimal impact on bat behavior"[17] and do not appear to be disturbed by drones.[18] As a result, the FAA has determined that the proposed action will cause no significant impact to bats.

The Monarch Butterfly, a candidate for federal listing, has the potential to occur in the operating area. Insects could be struck by drones en route to delivery. Information regarding drone impacts on insects is limited and there have been no widespread negative impacts identified in the scientific literature. Therefore, based on the information available and the limited scale of operations, the action is not expected to have significant impacts to insect populations.

Protected bird species may display disturbance behaviors towards drones, such as fleeing or attack maneuvers; however, due to the limited scale of operations and the altitude of overflights, no impacts to state protected bird species are expected.

Migratory Birds

Wing has stated to the FAA that it will monitor the operating area for any active Bald Eagle nests that may occur, and that it can keep aircraft at least 1,000 feet from the nest during its breeding season. Bald Eagle nests are typically very conspicuous, and Wing will be able to visually identify any nests that may be present in the area.

Red-headed Woodpecker nest locations should not be disturbed during the breeding period so as to avoid any potential impacts to the nest activity, such as nest abandonment. If Wing learns of any active Red-headed Woodpecker nests within the operating area, it has indicated it would plan to keep aircraft a reasonable distance from the nesting tree to avoid any disturbance during its breeding season. However, occasional drone overflights at 150-400 feet AGL are not expected to impact any critical lifecycle of these birds or their ability to survive.

Our analysis finds that the proposed action is not expected to cause any of the following impacts:

- A long-term or permanent loss of unlisted plant or wildlife species, i.e., extirpation of the species from a large project area;
- Adverse impacts to special status species (e.g., state species of concern, species proposed for listing, migratory birds, bald and golden eagles) or their habitats; or
- Substantial loss, reduction, degradation, disturbance, or fragmentation of native species' habitats or their populations; or
- Adverse impacts on a species' reproductive success rates, natural mortality rates, non-natural mortality (e.g., road kills and hunting), or ability to sustain the minimum population levels required.

[16] Fewer bat passes are detected during small, commercial drone flights. Available: https://www.nature.com/articles/s41598-021-90905-0. Accessed: October 21, 2021

[17] The Chirocopter: A UAV for recording sound and video of bats at altitude. Methods in Ecology and Evolution. Available: https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/2041-210X.12992. Accessed: October 21, 2021

[18] Autonomous drones are a viable tool for acoustic bat surveys. Available: https://www.biorxiv.org/content/10.1101/673772v1.full.pdf Accessed: October 21, 2021

3.3 Department of Transportation Act, Section 4(f) Resources

3.3.1 Regulatory Setting

Section 4(f) of the DOT Act [codified at 49 U.S.C. § 303(c)] protects significant publicly owned parks, recreational areas, wildlife and waterfowl refuges, and public and private historic sites. Section 4(f) states that, subject to exceptions for de minimis impacts[19]: "The Secretary may approve a transportation program or project requiring the use of [4(f) resources]…only if—(1) there is no prudent and feasible alternative to using that land; and (2) the program or project includes all possible planning to minimize harm to the park, recreation area, wildlife and waterfowl refuge, or historic site resulting from the use."

The term "use" includes both direct or physical and indirect or "constructive" impacts to Section 4(f) resources. Direct use is the physical occupation or alteration of a Section 4(f) property or any portion of a Section 4(f) property. A constructive use does not require direct physical impacts or occupation of a Section 4(f) resource. A constructive use would occur when a proposed action would result in substantial impairment of a resource to the degree that the protected activities, features, or attributes of the resource that contribute to its significance or enjoyment are substantially diminished. The determination of use must consider the entire property and not simply the portion of the property used for a proposed project.[20]

Section 4(f) resources where a quiet setting is a generally recognized feature or attribute receive special consideration. In assessing constructive use, FAA Order 1050.1F, Appendix B, page B-11, requires that the FAA "…must consult all appropriate federal, state, and local officials having jurisdiction over the affected Section 4(f) properties when determining whether project-related impacts would substantially impair the resources." Parks, recreation areas, and wildlife refuges that are privately owned are not subject to Section 4(f) provisions.

A significant impact would occur pursuant to NEPA when a proposed action either involves more than a minimal physical use of a section 4(f) property or is deemed a "constructive use" based on an FAA determination that the proposed action would substantially impair the 4(f) property, and mitigation measures do not eliminate or reduce the effects of the use below the threshold of significance.

3.3.2 Affected Environment

The FAA used data from federal, state, and other public-access sources to identify Section 4(f) resources within the operating area. The FAA identified only a few properties that could meet the definition of a Section 4(f) resource, such as local public parks. There are no wildlife or waterfowl refuges within the operating area.

As discussed more in Section 3.4 – Historical, Architectural, Archaeological, and Cultural Resources, there is one historic site within the operating area as listed on the Virginia SHPO website, although the site is considered for architectural or other purposes that will not typically be affected by UA operations.

[19] The FAA may make a de minimis impact determination with respect to a physical use of Section 4(f) property if, after taking into account any measures to minimize harm, the result is either: (1) a determination that the project would not adversely affect the activities, features, or attributes qualifying a park, recreation area, or wildlife or waterfowl refuge for protection under Section 4(f); or (2) a Section 106 finding of no adverse effect or no historic properties affected. See 1050.1F Desk Reference, Paragraph 5.3.3

[20] Federal Highway Administration (FHWA) Section 4(f) Policy Paper. (Note: FHWA regulations are not binding on the FAA; however, the FAA may use them as guidance to the extent relevant to aviation projects. See 1050.1F Desk Reference, Section 5.1.) Available: https://www.environment.fhwa.dot.gov/legislation/section4f/4fpolicy.pdf. Accessed: February 2, 2021

Also, as discussed in the next section devoted to Historical, Architectural, Archaeological, and Cultural Resources, the FAA consulted with the Virginia SHPO to determine whether historic and traditional cultural properties would be affected by the proposed action.

In addition to FAA's analysis, Wing indentifies properties such as parks, recreation areas, and schools in its flight planning system. Wing calls these "fly less" areas, which can be automatically avoided based on the type of resource, time of day, and other factors. Wing has committed in its operational proposal to the FAA that it will generally avoid overflights of these "fly less" resources in the Christiansburg, VA operation area during the scope of operations covered by the proposed action.

3.3.3 Environmental Consequences

The FAA has determined that infrequent UA overflights as described in the proposed action will not cause substantial impairment to any Section 4(f) resources in the operating area, and would not be considered a constructive use of any Section 4(f) resource. There will be no physical use of Section 4(f) resources. Noise and visual effects from Wing's occasional overflights are not expected to diminish the activities, features, or attributes of the resources that contribute to their significance or enjoyment. Additionally, Wing has identified Section 4(f) resources in its flight planning procedures, and has confirmed to the FAA that it will generally not conduct operations over these "fly less" properties during the scope of operations covered by this proposed action. There will be no significant impacts to Section 4(f) resources as a result of the proposed action.

3.4 Historical, Architectural, Archaeological, and Cultural Resources

3.4.1 Regulatory Setting

Section 106 of the National Historic Preservation Act (NHPA) of 1966 [54 U.S.C. § 306108] requires federal agencies to consider the effects of their undertakings on properties listed or eligible for listing in the National Register of Historic Places (NRHP). This includes properties of traditional religious and cultural importance to an Indian tribe or Native Hawaiian organization that meets the NRHP criteria. Regulations related to this process are contained in 36 CFR Part 800, Protection of Historic Properties. Compliance with Section 106 requires consultation with the SHPO and other applicable parties, including Indian tribes.

Major steps in the Section 106 process include identifying the Area of Potential Effects (APE), identifying historic and cultural resources within the APE, consulting with the SHPO and any Tribal Historic Preservation Office (THPO) that is identified as potentially having traditional cultural interests in the area, and determining the potential impacts to historic properties as a result of the action.

The FAA has not established a significance threshold for this impact category; however, the FAA has identified a factor to consider when evaluating the context and intensity of potential environmental impacts for historical, architectural, archeological, and cultural resources. A factor to consider in assessing significant impact is when an action would result in a finding of adverse effect through the Section 106 process. However, under 36 CFR § 800.8(a), a finding of adverse effect on a historic property does not necessarily result in a significance finding under NEPA.

3.4.2 Affected Environment

The APE for the proposed action is the entire operating area where Wing is planning to conduct UA package deliveries, as shown in Figure 1 in this EA. The FAA identified one historic property in its initial review of the operating area: the Edgar A. Long Building, which is a two-and-a-half-story brick structure

built in 1927 on the 20th-century campus of the Christiansburg Industrial Institute. The nature of this site is such that they typically would not be affected by infrequent UA operations.

In accordance with 36 CFR § 800.4(a)(1), the FAA consulted with the Virginia SHPO and with three THPOs who may potentially attach religious or cultural significance to resources in the APE.[21] The FAA sent consultation letters to the following three tribes on October 29, 2020; (1) Delaware Nation – Oklahoma; (2) Eastern Band of Cherokee Indians; (3) Monacan Indian Nation.

On November 23, 2020, the FAA received confirmation from the Delaware Nation, Oklahoma, that the approval for an earlier proposed action by Wing in this operating area would not endanger cultural or religious sites of interest to the Delaware Nation, and that they have no objections to the proposed action.

Consultation with the SHPO was initiated on October 29, 2020 regarding FAA's approval of operating exemptions and authorities that would permit Wing to transport consumer goods from local businesses to homes in the Carma Heights and Windmill Hills neighborhoods in Christiansburg, Virginia. At that time, FAA determined that the undertaking did not have the potential to affect historic properties, but that it was initiating consultation because UAS technology was new to most people. FAA proposed a finding of no adverse effects and on November 24, 2020, the FAA received confirmation from the Virginia State Historic Preservation Office (SHPO) that historic properties within the affected area would not be adversely affected by the proposed UA operations.[22] The FAA's tribal and historic outreach letters are included as Appendix B.

3.4.3 Environmental Consequences

The nature of UAS effects on historic properties is limited to non-physical, reversible impacts (i.e., the introduction of audible and/or visual elements). The number of daily flights projected means that any historic or cultural resource would be subject to only a small number of overflights per day, if any.

Additionally, the FAA conducted a noise exposure analysis for the proposed action – as described in the next section – which concluded that noise levels would be well below the FAA's threshold for significance, even in areas with the highest noise exposure. Based on a review of the information available and FAA's knowledge with respect to the level of environmental impacts from UAS operations, FAA has determined that the requested approval has no potential to effect historic properties. FAA notified the SHPO of its determination. A copy of this letter is included in Appendix B. Additionally, there would be no known effect on known cultural resources from this action.

3.5 Noise and Noise-Compatible Land Use

3.5.1 Regulatory Setting

Aircraft noise is often the most noticeable environmental effect associated with any aviation project. Several federal laws, including the Aviation Safety and Noise Abatement Act of 1979, as amended (49 U.S.C. §§ 47501-47507) regulate aircraft noise. Through 14 CFR Part 36, the FAA regulates noise from aircraft.

[21] FAA utilized the Housing and Urban Development (HUD) Tribal Directory Assessment Tool (TDAT) to identify tribes with ancestral ties or other interests within Christiansburg, VA APE.
[22] Given the limited scope and numbers of the reasonably foreseeable operations, FAA believes that the consultation is representative of the level of impact that would occur due to the proposed action.

FAA Order 1050.1F, Appendix B, Paragraph B-1.3 requires the FAA to identify the location and number of noise sensitive areas that could be significantly impacted by noise. As defined in Paragraph 11-5b of Order 1050.1F, page 11-3, a noise sensitive area is "[a]n area where noise interferes with normal activities associated with its use. Normally, noise sensitive areas include residential, educational, health, and religious structures and sites, and parks, recreational areas, areas with wilderness characteristics, wildlife refuges, and cultural and historical sites."

Sound is measured in terms of the decibel (dB), which is the ratio between the sound pressure of the sound source and 20 micropascals, which is nominally the threshold of human hearing. Various weighting schemes have been developed to collapse a frequency spectrum into a single dB value. The A-weighted decibel, or dBA, corresponds to human hearing accounting for the higher sensitivity in the mid-range frequencies.

To comply with NEPA requirements, the FAA has issued requirements for assessing aircraft noise in FAA Order 1050.1F, Appendix B. FAA's primary noise metric for aviation noise analysis is the yearly Day-Night Average Sound Level (DNL) metric. The DNL metric is a single value representing the logarithmically average aircraft sound level at a location over a 24-hour period, with a 10 dB adjustment added to those noise events occurring from 10:00 p.m. and up to 7:00 a.m. the following morning. A significant noise impact is defined in Order 1050.1F as an increase in noise of DNL 1.5 dB or more at or above 65 dB DNL noise exposure or a noise exposure at or above the 65 dB level due to a DNL 1.5 dB or greater increase.

3.5.2 Affected Environment

Human perception of noise depends on a number of factors, including overall noise level, number of noise events, the extent of audibility above the background ambient noise level, and frequency content (pitch). UAS noise generally has high frequency content which can be described as a lawnmower-type pitch.

The approximate land area within the study area is 6.5 square miles and the estimated population within the area is 7,722 per 2018 estimates. The population density of the area is approximately 1,190 persons per square mile.[23]

Existing noise levels in the Christiansburg, VA operating area are expected to be well below 65 DNL. The ambient noise environment throughout the operating area is affected mainly by automobile traffic.

3.5.3 Environmental Consequences

To ensure that noise would not cause a significant impact to any noise sensitive resource within the operating area, the FAA initiated an analysis of the potential noise exposure in the area that could result from implementation of the proposed action. The noise analysis of the proposed activity was conducted based upon computer simulations of projected delivery operations from the Christiansburg nest, along with available noise measurement data collected for the Wing UA in various operating states. Results of the noise analysis are presented in terms of the required Day-Night Average Sound Level (DNL) as well as a supplemental Number of Events Above 60 dB LAmax (NA60) for Average Annual Daily Operations (AAD).

Three data sets formed the basis of the noise assessment for the proposed Wing UA delivery operations. The data sets included a full year's worth of computer-simulated flight/delivery operations from the

[23] Environmental Protection Agency's (EPA) Environmental Justice Screening Tool (EJSCREEN). Available: https://www.epa.gov/ejscreen. Accessed: November 30, 2021

Christiansburg nest; noise measurement data collected for aircraft certification; and noise measurement data collected during field simulations of package deliveries.

The DNL noise exposure analysis concluded that even in areas with the highest noise exposure, levels would still be well below FAA's DNL 65 dB threshold for noise compatible land use. Additionally, when operational uncertainty had to be considered in the analysis, conservative assumptions which would overpredict the noise levels produced by the UA activity were used. The resulting DNL at the Christiansburg nest was estimated to only reach a potential DNL of 53.0 dB. These levels would occur at the nest location.

FAA also conducted a supplemental analysis to analyze the the number of times over a 24-hour period the UA operations would exceed LAmax 60 dB. Similar to the results of the required DNL metric noise analysis, this supplemental metric analysis illustrated that the highest number of events occurred at or in close proximity to the nest, with a limited and much smaller number of events occuring farther away from the nest.

The comprehensive noise analysis can be found in Appendix C.

Based in FAA's noise analysis, the proposed action will not have a significant impact.

3.6 Environmental Justice

3.6.1 Regulatory Setting

Executive Order (EO) 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations*, Section 1-101 requires all federal agencies to the greatest extent practicable and permitted by law, to make achieving environmental justice part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations.

The DOT Order 5610.2(a) defines minority as "individuals who are Black; Hispanic or Latino; Asian American; American Indian and Alaskan Native; Native Hawaiian and other Pacific Islander".

The FAA Order 1050.1F provides guidance for the preparation of environmental justice analysis in support of an EA. Section 4-3.3, Exhibit 4-1 of the Order indicates that FAA should consider whether the action would have the potential to lead to a disproportionately high and adverse impact, i.e., a low-income or minority population, due to: significant impacts in other environmental impact categories; or impacts on the physical or natural environment that affect an environmental justice population in a way that the FAA determines are unique to the environmental justice population and significant to that population. If a significant impact would affect low income or minority populations at a disproportionately higher level than it would other population segments, an environmental justice issue is likely.

The FAA has not established a significance threshold for environmental justice. In assessing significance, the FAA considers the following factors: : (1) significant impacts in other environmental impact categories; or (2) impacts on the physical or natural environment that affect an environmental justice population in a way that the FAA determines are unique to the environmental justice population and significant to that population.

3.6.2 Affected Environment

Based on the EJSCREEN report prepared for the proposed action (Appendix E), approximately 18 percent of the population within the operating area would be considered low-income, and approximately 17 percent of the population would be considered a person of color. Both of these metrics are lower than the low-income and people-of-color percentages overall in Virginia. The EJSCREEN report states that approximately 7,722 people reside within the operating area.

3.6.3 Environmental Consequences

The proposed action would not result in adverse impacts in any environmental resource category. As noted in Section 3.5, *Noise and Noise-Compatible Land Use*, and the Noise Analysis Report in Appendix C, the UA's noise emissions could be perceptible in areas within the operating area, but will stay well below the level determined to constitute a significant impact. Since the proposed action would not result in a disproportionately high and adverse effect on any population, it would not result in an adverse effect on a low-income or a minority population.

3.7 Visual Effects (Visual Resources and Visual Character)

3.7.1 Regulatory Setting

Visual resources and visual character impacts deal with the extent to which the proposed action would result in visual impacts to resources in the Christiansburg, VA operating area. Visual impacts can be difficult to define and evaluate because the analysis is generally subjective, but are normally related to the extent that the proposed action would contrast with, or detract from, the visual resources and/or the visual character of the existing environment. In this case, visual effects would be limited to the introduction of a visual intrusion – a UA in flight – which could be out of character with the suburban or natural landscapes.

The FAA has not developed a visual effects threshold of significance similar to noise impacts. Factors FAA considers in assessing significant impacts include the degree to which the action would have the potential to: (1) affect the nature of the visual character of the area, including the importance, uniqueness, and aesthetic value of the affected visual resources; (2) contrast with the visual resources and/or visual character in the study area; or (3) block or obstruct the views of visual resources, including whether these resources would still be viewable from other locations.

3.7.2 Affected Environment

The proposed action would take place over mostly suburban and commercially-developed properties. As noted in Section 3.3, *DOT Act Section 4(f) Resources*, there are some public parks that could be valued for aesthetic attributes within the study area. However, Wing's proposal is to generally avoid overflights of Section 4(f) properties during the scope of the proposed action.

When making a delivery, the UA will depart from a nest and travel en route at an altitude generally between 150 and 400 feet AGL. Deliveries will mostly take place at residences. A two-square meter clear space is required for delivery; however, this space can include clear spaces surrounding multi-family dwellings. The duration of delivery from the time the customer approves the delivery to the transition back to en route flight mode is expected to last approximately 15 seconds. The FAA estimates that at typical operating altitude and speeds the UA enroute would be observable for approximately six seconds by an observer on the ground.

3.7.3 Environmental Consequences

The proposed action makes no changes to any landforms, or land uses, thus there would be no effect to the visual character of the area. The proposed action involves airspace operations that could result in visual impacts on sensitive areas such as Section 4(f) properties where the visual setting is an important resource of the property. However, the short duration that each UA flight could be seen from any particular resource in the operating area, and the low number of proposed flights per day, would minimize any potential for significant visual impacts.

3.8 Water Resources (Surface Waters)

3.8.1 Regulatory Setting

Surface water resources generally consist of oceans, wetlands, lakes, rivers, and streams. Surface water is important for its contribution to the economic, ecological, recreational, and human health of a community. The Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) program, which regulates the discharge of point sources of water pollution into waters of the United States and requires a permit under Section 402 of the Clean Water Act. Waters of the United States are defined by the Clean Water Act and are protected by various regulations and permitting programs administered by the EPA and the U.S. Army Corps of Engineers. An action would be considered significant to surface waters when it would (1) exceed water quality standards established by Federal, state, local, and tribal regulatory agencies; or (2) contaminate public drinking water supply such that public health may be adversely affected.

3.8.2 Affected Environment

Approximately 0.01 square miles of surface waters occur within Christiansburg operating area, based on the EJSCREEN report for this proposed action (Appendix E). The only surface waters within the operating area are two creeks; Slate Branch in the north and Crab Creek in the south. There are no large surface waters within the operating area; however, the New River is approximately four miles west (outside of the operating area).

3.8.3 Environmental Consequences

Wing has conducted thousands of UA flight operations, and the FAA does not anticipate any accidents or incidents under the proposed action. While it is highly unlikely for one of Wing's aircraft to crash, and even less likely for a crash to happen within Slate Branch or Crab Creek, this EA considers the potential effects of a drone crashing into surface waters covered by the Clean Water Act.

Wing is a certificated air carrier and complies with all applicable regulatory requirements. This includes compliance with regulatory requirements to notify the FAA and/or National Transportation Safety Board (NTSB) in the event of an aircraft accident. Wing's FAA-accepted checklists include procedures to notify local emergency services in the event of an accident or incident. In accordance with 14 CFR Part 135.23(d), Wing is required to locate and secure any downed aircraft pending guidance from the FAA or NTSB. The Lithium-ion battery packs are well-secured within the aircraft, and are not expected to detach from the aircraft or become lost in the event of an incident.

There will be no construction activities associated with the proposed action that could impact surface waters. For this reason, and for the reasons described above relating to potential accidents, the proposed action would not have the potential to exceed water quality standards established by federal, state, local, and tribal regulatory agencies; or contaminate public drinking water supply such that public

health may be adversely affected. Therefore, the potential for impacts to surface waters is not significant.

4.0 LIST OF PREPARERS and CONTRIBUTORS

Table 4-1 lists the principal preparers, reviewers, and contributors to this EA.

Table 4-1. List of Preparers and Contributors

Name and Affiliation	Years of Industry Experience	EA Responsibility
Mike Millard, Flight Standards, FAA Aviation Safety	40	Flight Standards Environmental Specialist and Document Review
Christopher Couture, FAA Aviation Safety	15	Program Management, Environmental Science, and Document Review
Shawna Barry, FAA Office of Environment and Energy	15	NEPA SME, Biological Resources, and Document Review
Sean Doyle, FAA Office of Environment and Energy	16	Noise Analysis and Document Review
Contractor Preparers		
Jodi Jones, FAA Aviation Safety, PrimCorp, LLC	12	NEPA SME, Research, and Document Review
Brad Thompson, FAA Aviation Safety, Science Applications International Corporation (SAIC)	7	NEPA SME, Research, and Document Review

The contractor contributors to the noise analysis report are identified in Appendix C.

5.0 LIST of AGENCIES CONSULTED

State Agencies

Virginia Department of Historic Resources

Tribes

Delaware Nation – Oklahoma

Eastern Band of Cherokee Indians

Monacan Indian Nation

Appendix A

IPaC Report

IPaC **U.S. Fish & Wildlife Service**

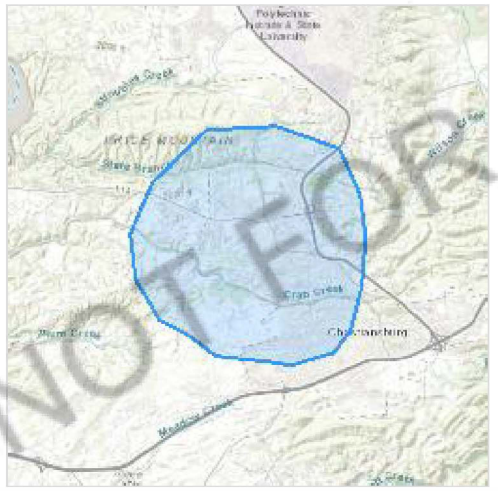
IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Montgomery County, Virginia



Local office

Virginia Ecological Services Field Office

(804) 693-6694
(804) 693-9032

6669 Short Lane
Gloucester, VA 23061-4410

http://www.fws.gov/northeast/virginiafield/

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS

Indiana Bat Myotis sodalis — Endangered
Wherever found
There is **final** critical habitat for this species. The location of the critical habitat is not available.
https://ecos.fws.gov/ecp/species/5949

Northern Long-eared Bat Myotis septentrionalis — Threatened
Wherever found
No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/9045

Insects

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/9743	Candidate

Flowering Plants

NAME	STATUS
Smooth Coneflower Echinacea laevigata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/3473	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

THERE ARE NO CRITICAL HABITATS AT THIS LOCATION.

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act[1] and the Bald and Golden Eagle Protection Act[2].

Any person or organization who plans or conducts activities that may result in impacts to migratory birds, eagles, and their habitats should follow appropriate regulations and consider implementing appropriate conservation measures, as described below.

1. The Migratory Birds Treaty Act of 1918.

2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are birds of particular concern either because they occur on the USFWS Birds of Conservation Concern (BCC) list or warrant special attention in your project location. To learn more about the levels of concern for birds on your list and how this list is generated, see the FAQ below. This is not a list of every bird you may find in this location, nor a guarantee that every bird on this list will be found in your project area. To see exact locations of where birders and the general public have sighted birds in and around your project area, visit the E-bird data mapping tool (Tip: enter your location, desired date range and a species on your list). For projects that occur off the Atlantic Coast, additional maps and models detailing the relative occurrence and abundance of bird species on your list are available. Links to additional information about Atlantic Coast birds, and other important information about your migratory bird list, including how to properly interpret and use your migratory bird report, can be found below.

For guidance on when to schedule activities or implement avoidance and minimization measures to reduce impacts to migratory birds on your list, click on the PROBABILITY OF PRESENCE SUMMARY at the top of your list to see when these birds are most likely to be present and breeding in your project area.

NAME	BREEDING SEASON (IF A BREEDING SEASON IS INDICATED FOR A BIRD ON YOUR LIST, THE BIRD MAY BREED IN YOUR PROJECT AREA SOMETIME WITHIN THE TIMEFRAME SPECIFIED, WHICH IS A VERY LIBERAL ESTIMATE OF THE DATES INSIDE WHICH THE BIRD BREEDS ACROSS ITS ENTIRE RANGE. "BREEDS ELSEWHERE" INDICATES THAT THE BIRD DOES NOT LIKELY BREED IN YOUR PROJECT AREA.)
Bald Eagle *Haliaeetus leucocephalus* This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities. https://ecos.fws.gov/ecp/species/1626	Breeds Sep 1 to Aug 31

Black-billed Cuckoo Coccyzus erythropthalmus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska. https://ecos.fws.gov/ecp/species/9399	Breeds May 15 to Oct 10
Black-capped Chickadee Poecile atricapillus practicus This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds Apr 10 to Jul 31
Canada Warbler Cardellina canadensis This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 20 to Aug 10
Prairie Warbler Dendroica discolor This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 1 to Jul 31
Prothonotary Warbler Protonotaria citrea This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds Apr 1 to Jul 31
Red-headed Woodpecker Melanerpes erythrocephalus This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Sep 10
Rusty Blackbird Euphagus carolinus This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA	Breeds elsewhere
Wood Thrush Hylocichla mustelina This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.	Breeds May 10 to Aug 31

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds. Please make sure you read and understand the FAQ "Proper Interpretation and Use of Your Migratory Bird Report" before using or attempting to interpret this report.

Probability of Presence (■)

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be

used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season ( )
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

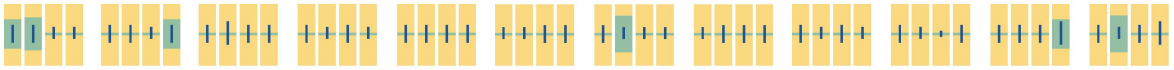
No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

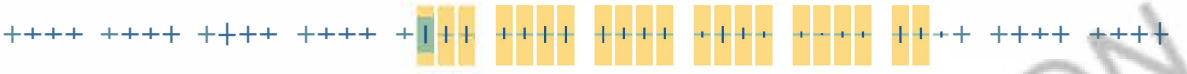
probability of presence breeding season survey effort no data

SPECIES	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC

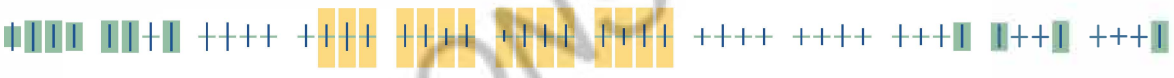
Bald Eagle
Non-BCC Vulnerable (This is not a Bird of Conservation Concern (BCC) in this area, but warrants attention because of the Eagle Act or for potential susceptibilities in offshore areas from certain types of development or activities.)



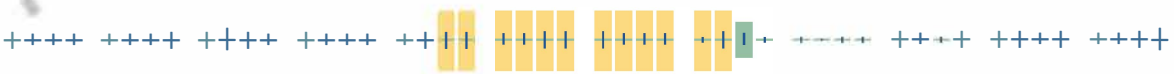
Black-billed Cuckoo
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



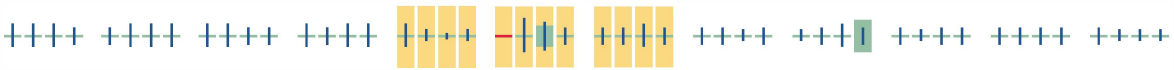
Black-capped Chickadee
BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)



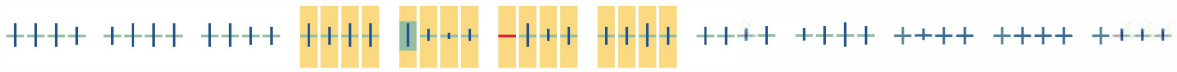
Canada Warbler
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



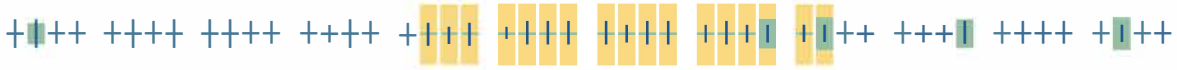
Prairie Warbler
BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Prothonotary Warbler BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)

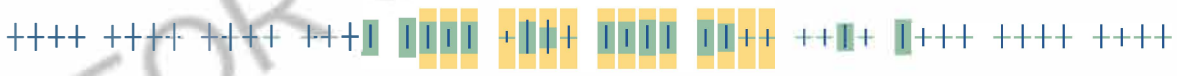


Red-headed Woodpecker BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Rusty Blackbird BCC - BCR (This is a Bird of Conservation Concern (BCC) only in particular Bird Conservation Regions (BCRs) in the continental USA)

Wood Thrush BCC Rangewide (CON) (This is a Bird of Conservation Concern (BCC) throughout its range in the continental USA and Alaska.)



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Implementation of these measures is particularly important when birds are most likely to occur in the project area. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is a very helpful impact minimization measure. To see when birds are most likely to occur and be breeding in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are a BCC species in that area, an eagle (Eagle Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, please visit the AKN Phenology Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets .

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird on your migratory bird species list has a breeding season associated with it, if that bird does occur in your project area, there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Eagle Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to try to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially eagles and BCC species of rangewide concern. For more information on conservation measures you can implement to help avoid and minimize migratory bird impacts and requirements for eagles, please see the FAQs for these topics.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Bird tracking data can also provide additional details about occurrence and habitat use throughout the year, including migration. Models relying on survey data may not include this information. For additional information on marine bird tracking data, see the Diving Bird Study and the nanotag studies or contact Caleb Spiegel or Pam Loring.

What if I have eagles on my list?

If your project has the potential to disturb or kill eagles, you may need to obtain a permit to avoid violating the Eagle Act should such impacts occur.

Proper Interpretation and Use of Your Migratory Bird Report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated, and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please also look carefully at the survey effort (indicated by the black vertical bar) and for the existence of the "no data" indicator (a red horizontal bar). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list helps you know what to look for to confirm presence, and helps guide you in knowing when to implement conservation measures to avoid or minimize potential impacts from your project activities, should presence be confirmed. To learn more about conservation measures, visit the FAQ "Tell me about conservation measures I can implement to avoid or minimize impacts to migratory birds" at the bottom of your migratory bird trust resources page.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGE LANDS AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

WETLAND INFORMATION IS NOT AVAILABLE AT THIS TIME

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix B

Tribal and Historic Resource Outreach Letters

U.S. Department
of Transportation
**Federal Aviation
Administration**

Aviation Safety

800 Independence Ave., S.W.
Washington, DC 20591

October 29, 2020

Virginia Department of Historic Resources
Attention: Project Review
2801 Kensington Avenue
Richmond, VA 23221

Via electronic submission to https://epix.dhr.virginia.gov

To whom it may concern:

The purpose of this letter is to inform you of a proposal under consideration by the Federal Aviation Administration (FAA) for the extension of an existing approval of a Certificate of Waiver and/or Exemption for a Hummingbird 7000 V2 Unmanned Aircraft System (UAS) operation conducted by Wing Aviation LLC in Christiansburg, VA. The FAA has determined that this proposed action is a Federal undertaking as defined in 36 CFR § 800.16 (y). Therefore, the FAA is initializing consultation with the State Historic Preservation Officer (SHPO) pursuant to § 800.11 (d).

Proposed Activity Description
The Federal Aviation Administration (FAA) has been asked to approve an extension of waivers and/or exemptions to aeronautical regulations, thereby approving the continued existing UAS operation in the area depicted below. FAA approval of the UAS operation in the area is an undertaking subject to regulations pursuant to the National Historic Preservation Act.

The UAS operation will be transporting consumer goods from local businesses to homes in the Carma Heights and Windmill Hills neighborhoods in Christiansburg, VA. It will be flown by a Hummingbird aircraft that will takeoff and quickly rise to a cruising altitude of 65-300 feet above ground level (AGL). Once at the delivery site, the Hummingbird will hover in place while a retractable cord lowers the package to the ground. The cord then retracts back to the aircraft, which flies off to return to the Wing "nest" at 160 Welcome Street North East, Christiansburg, VA 24073. The estimated total travel distances vary depending upon the pickup and dropoff locations in the operating area. The purpose is for package delivery, consisting of approximately 13 flights per day with each flight taking a package from one customer business location and delivering it to another customer location before returning to the nest. There is variability in the number of flights per day based on customer demand and weather conditions. The dimension of the UAS area defines the Area of Potential Effect (APE). According to the National Park Service online database of the National Register of

Historic Places, one historic property was identified in the review of the operating area: the Edgar A. Long Building, which is a two-and-a-half-story brick structure built in 1927 on the 20th-century campus of the Christiansburg Industrial Institute. The FAA determined that the undertaking does not have the potential to affect historic properties; however, since this UAS technology is new to most people, consultation with the SHPO is initiated. The UAS operation will have no affects to the ground.

Consultation
The FAA seeks concurrence from the SHPO of its no historic properties affected [§ 800.11 (d)] determination for the proposed UAS operating area. Your response over the next 30 days will greatly assist us in incorporating your concerns into our environmental review of the operation.

If you have any comments or questions or need additional information regarding the UAS operation, please do not hesitate to contact Mr. Mike Millard, in writing at: FAA, AFS-800, 800 Independence Ave., S.W., Washington, D.C. 20591; by telephone: (202) 267-7906; or by email: 9-AWA-AVS-AFS-ENVIRONMENTAL@faa.gov.

Sincerely,

Mark E. Giron
Aviation Safety
Manager, General Aviation Operations Branch,
Flight Standards Service

Enclosure

U.S. Department
of Transportation
**Federal Aviation
Administration**

Aviation Safety

800 Independence Ave., S.W.
Washington, DC 20591

October 29, 2020

Principal Chief Richard Sneed
Eastern Band of Cherokee Indians
P.O. Box 455
Cherokee, NC 28719

Dear Chief Sneed:

The purpose of this letter is to initiate formal government-to-government consultation regarding issuance by the Federal Aviation Administration (FAA) for the extension of an existing approval of a Certificate of Waiver and/or Exemption for a Hummingbird 7000 V2 Unmanned Aircraft System (UAS) operation conducted by Wing Aviation LLC in Christiansburg, VA. We wish to solicit your views regarding potential effects on tribal interests in the area.

Proposed Activity Description
The Federal Aviation Administration (FAA) has been asked to approve an extension of waivers and/or exemptions to aeronautical regulations, thereby approving the continued existing UAS operation in the area depicted below. FAA approval of the UAS operations in the area is an undertaking subject to regulations pursuant to the National Historic Preservation Act.

The UAS operation will be transporting consumer goods from local businesses to homes in the Carma Heights and Windmill Hills neighborhoods in Christiansburg, VA. It will be flown by a Hummingbird aircraft that will takeoff and quickly rise to a cruising altitude of 65-300 feet above ground level (AGL). Once at the delivery site, the Hummingbird will hover in place while a retractable cord lowers the package to the ground. The cord then retracts back to the aircraft, which flies off to return to the Wing "nest" at 160 Welcome Street North East, Christiansburg, VA 24073. The estimated total travel distances vary depending upon the pickup and dropoff locations in the operating area. The purpose is for package delivery, consisting of approximately 13 flights per day with each flight taking a package from one customer business location and delivering it to another customer location before returning to the nest. There is variability in the number of flights per day based on customer demand and weather conditions. The dimension of the UAS area defines the Area of Potential Effect (APE). According to the National Park Service online database of the National Register of Historic Places, one historic property was identified in the review of the operating area: the Edgar A. Long Building, which is a two-and-a-half-story brick structure built in 1927 on the 20th-century campus of the Christiansburg Industrial Institute. The FAA determined that the

undertaking does not have the potential to affect historic properties; however, since this UAS technology is new to most people, tribal consultation is initiated. The UAS operation will have no affects to the ground.

Consultation
The FAA is soliciting the opinion of the tribe(s) concerning any tribal lands, or sites of religious or cultural significance that may be affected by the proposed operation area. Your response over the next 30 days will greatly assist us in incorporating your concerns into our environmental review of the operation.

If you have any comments or questions or need additional information regarding the UAS operation, please do not hesitate to contact Mr. Mike Millard, in writing at: FAA, AFS-800, 800 Independence Ave., S.W., Washington, D.C. 20591; by telephone: (202) 267-7906; or by email: 9-AWA-AVS-AFS-ENVIRONMENTAL@faa.gov.

Sincerely,

Mark E. Giron
Aviation Safety
Manager, General Aviation Operations Branch,
Flight Standards Service

Enclosure

U.S. Department
of Transportation
**Federal Aviation
Administration**

Aviation Safety

800 Independence Ave., S.W.
Washington, DC 20591

October 29, 2020

President Deborah Dotson
Delaware Nation, Oklahoma
P.O. Box 825
Anadarko, OK 73005

Dear President Dotson:

The purpose of this letter is to initiate formal government-to-government consultation regarding issuance by the Federal Aviation Administration (FAA) for the extension of an existing approval of a Certificate of Waiver and/or Exemption for a Hummingbird 7000 V2 Unmanned Aircraft System (UAS) operation conducted by Wing Aviation LLC in Christiansburg, VA. We wish to solicit your views regarding potential effects on tribal interests in the area.

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undertaking does not have the potential to affect historic properties; however, since this UAS technology is new to most people, tribal consultation is initiated. The UAS operation will have no affects to the ground.

Consultation
The FAA is soliciting the opinion of the tribe(s) concerning any tribal lands, or sites of religious or cultural significance that may be affected by the proposed operation area. Your response over the next 30 days will greatly assist us in incorporating your concerns into our environmental review of the operation.

If you have any comments or questions or need additional information regarding the UAS operation, please do not hesitate to contact Mr. Mike Millard, in writing at: FAA, AFS-800, 800 Independence Ave., S.W., Washington, D.C. 20591; by telephone: (202) 267-7906; or by email: 9-AWA-AVS-AFS-ENVIRONMENTAL@faa.gov.

Sincerely,

Mark E. Giron
Aviation Safety
Manager, General Aviation Operations Branch,
Flight Standards Service

Enclosure

U.S. Department
of Transportation
**Federal Aviation
Administration**

Aviation Safety

800 Independence Ave., S.W.
Washington, DC 20591

October 29, 2020

Chief Kenneth Brenham
Monacan Indian Nation
P.O. Box 960
Amherst, VA 24521

Dear Chief Brenham:

The purpose of this letter is to initiate formal government-to-government consultation regarding issuance by the Federal Aviation Administration (FAA) for the extension of an existing approval of a Certificate of Waiver and/or Exemption for a Hummingbird 7000 V2 Unmanned Aircraft System (UAS) operation conducted by Wing Aviation LLC in Christiansburg, VA. We wish to solicit your views regarding potential effects on tribal interests in the area.

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The UAS operation will be transporting consumer goods from local businesses to homes in the Carma Heights and Windmill Hills neighborhoods in Christiansburg, VA. It will be flown by a Hummingbird aircraft that will takeoff and quickly rise to a cruising altitude of 65-300 feet above ground level (AGL). Once at the delivery site, the Hummingbird will hover in place while a retractable cord lowers the package to the ground. The cord then retracts back to the aircraft, which flies off to return to the Wing "nest" at 160 Welcome Street North East, Christiansburg, VA 24073. The estimated total travel distances vary depending upon the pickup and dropoff locations in the operating area. The purpose is for package delivery, consisting of approximately 13 flights per day with each flight taking a package from one customer business location and delivering it to another customer location before returning to the nest. There is variability in the number of flights per day based on customer demand and weather conditions. The dimension of the UAS area defines the Area of Potential Effect (APE). According to the National Park Service online database of the National Register of Historic Places, one historic property was identified in the review of the operating area: the Edgar A. Long Building, which is a two-and-a-half-story brick structure built in 1927 on the 20th-century campus of the Christiansburg Industrial Institute. The FAA determined that the

undertaking does not have the potential to affect historic properties; however, since this UAS technology is new to most people, tribal consultation is initiated. The UAS operation will have no affects to the ground.

Consultation
The FAA is soliciting the opinion of the tribe(s) concerning any tribal lands, or sites of religious or cultural significance that may be affected by the proposed operation area. Your response over the next 30 days will greatly assist us in incorporating your concerns into our environmental review of the operation.

If you have any comments or questions or need additional information regarding the UAS operation, please do not hesitate to contact Mr. Mike Millard, in writing at: FAA, AFS-800, 800 Independence Ave., S.W., Washington, D.C. 20591; by telephone: (202) 267-7906; or by email: 9-AWA-AVS-AFS-ENVIRONMENTAL@faa.gov.

Sincerely,

Mark E. Giron
Aviation Safety
Manager, General Aviation Operations Branch,
Flight Standards Service

Enclosure

From:	Adrienne Birge-wilson
To:	9-AWA-AVS-AFS-ENVIRONMENTAL (FAA)
Subject:	Christiansburg VA Unmanned Aircraft System Delivery Routes (DHR File No. 2020-4722) | e-Mail #03330
Date:	Tuesday, November 24, 2020 8:26:41 AM

Mike,

Thank you for requesting comments from the Department of Historic Resources on the referenced project. Based upon the documentation provided, it is our opinion that the historic properties within the Area of Potential Effects will not be adversely affected by the proposed undertaking.

Implementation of the undertaking in accordance with the finding of No Adverse Effect as documented fulfills the Federal agency's responsibilities under Section 106 of the National Historic Preservation Act. If for any reason the undertaking is not or cannot be conducted as proposed in the finding, consultation under Section 106 must be reopened.

If you have any questions or if we may provide any further assistance at this time, please do not hesitate to contact me.

Sincerely,

Adrienne Birge-Wilson, Architectural Historian
Office of Review and Compliance
Division of Resource Services and Review
Phone: (804) 482-6092
Adrienne.Birge-Wilson@dhr.virginia.gov

The Delaware Nation
Historic Preservation Department
31064 State Highway 281
Anadarko, OK 73005
Phone (405)247-2448

November 23, 2020

To Whom It May Concern:

The Delaware Nation Historic Preservation Department received correspondence regarding the following referenced project(s).

Project(s): Hummingbird 7000 V2 Unmanned Aircraft System Operation by Wing Aviation LLC in Christiansburg, VA

Our office is committed to protecting tribal heritage, culture and religion with particular concern for archaeological sites potentially containing burials and associated funerary objects.

The Lenape people occupied the area indicated in your letter prior to European contact until their eventual removal to our present locations. According to our files, the location of the proposed project does not endanger cultural, or religious sites of interest to the Delaware Nation. **Please continue with the project as planned** keeping in mind during construction should an archaeological site or artifacts inadvertently be uncovered, all construction and ground disturbing activities should immediately be halted until the appropriate state agencies, as well as this office, are notified (within 24 hours), and a proper archaeological assessment can be made.

Please note the Delaware Nation, the Delaware Tribe of Indians, and the Stockbridge Munsee Band of Mohican Indians are the only Federally Recognized Delaware/Lenape entities in the United States and consultation must be made only with designated staff of these three tribes. We appreciate your cooperation in contacting the Delaware Nation Historic Preservation Office to conduct proper Section 106 consultation. Should you have any questions, feel free to contact our offices at 405-247-2448 ext. 1403.

Erin N. Paden

Erin Paden
Director of Historic Preservation
Delaware Nation
31064 State Highway 281
Anadarko, OK 73005
Ph. 405-247-2448 ext. 1403
epaden@delawarenation-nsn.gov

Appendix C

Noise Analysis Report

Noise Assessment for Wing Aviation Proposed Package Delivery Operations in Christiansburg, Virginia

In support of U.S. Code of Federal Regulations Title 14, Part 135

Final

HMMH Report No. 309990.003-3

December 9, 2021

Prepared for:

JD RoVolus, LLC
121 Pearl Street
Ypsilanti, MI 48197

Federal Aviation Administration
Aviation Safety, Flight Standards Service
Office of Environment and Energy
Policy, Engineering, Analysis, and Research (PEARS II)
693KA9-18-D-00005

Noise Assessment for Wing Aviation Proposed Package Delivery Operations in Christiansburg, Virginia

In support of U.S. Code of Federal Regulations Title 14, Part 135

Final

HMMH Report No. 309990.003-3

December 9, 2021

Prepared for:

JD RoVolus, LLC
121 Pearl Street
Ypsilanti, MI 48197

Federal Aviation Administration
Aviation Safety, Flight Standards Service
Office of Environment and Energy
Policy, Engineering, Analysis, and Research (PEARS II)
693KA9-18-D-00005

Prepared by:

Brandon Robinette
Justin Divens

HMMH
700 District Avenue, Suite 800
Burlington, MA 01803
T 781.229.0707
F 781.229.793

Contents

Figures

Tables

1 Introduction and Background

This document presents the methodology and results for the estimation of noise exposure related to proposed small Unmanned Aircraft Systems (sUAS) package delivery operations conducted in the Christiansburg, Virginia metropolitan area. The proposed operations would be conducted by Wing Aviation LLC (Wing), a subsidiary of Alphabet Inc. that develops and operates technology for sUAS package delivery.

In order for Wing to conduct Unmanned Aircraft (UA) package deliveries up to a specific pilot to vehicle ratio, it must receive FAA approval. Wing has requested that FAA amend the OpSpec in its Part 135 air carrier certificate to allow operations with up to a pilot to vehicle ratio of 1:8. The OpSpec amendment is the FAA approval that ultimately would enable the pilot ratio change for operations in Christiansburg, VA.

The A003 OpSpec, AIRPLANE/AIRCRAFT AUTHORIZATION will be amended to include a reference to an approved pilot to vehicle ratio of 1:8.

The proposed action will take place in the community of Christiansburg, VA. The proposed operations assessed in this document include UA delivery flights using a 15-pound Hummingbird 7000W-A UA, originating from one base of operations, referred to as the Nest, as shown in Figure 2.

The Wing UA is a multi-rotor vehicle weighing under 15 pounds when combined with its max payload weight of 1.2kg (2.65 pounds). It would generally be operated at an altitude of 300 feet Above Ground Level (AGL) and always below an altitude of 400 feet AGL while enroute to and from delivery locations. At a delivery location, the UA would vertically descend from its enroute cruise altitude to a stationary hover at 23 feet AGL, and an externally carried package would be lowered to the ground by cable for delivery. Once a package has been lowered to the ground, the UA would then retract the cable, ascend vertically to a cruise altitude, and depart the delivery area enroute back to the Nest. Figure 1 depicts the Wing Hummingbird UA.

Figure 1. Wing Small Unmanned Aircraft with Package Attached
Source: Wing Delivery Concept of Operations, November 16, 2020

Noise analysis of the proposed activity was conducted based upon computer simulations of projected delivery operations from the Christiansburg Nest produced by Wing, along with available noise measurement data collected for the Wing UA in various operating states. Results of the noise analysis are presented in terms of the Day-Night Average Sound Level (DNL) and Numbers of Events Above 60 dB LA_{max} (NA60) for Average Annual Daily Operations (AAD).

Section 2 of this document provides further description of the data sources utilized as the basis of the noise analysis, Section 3 describes the approach undertaken to develop noise exposure estimates for the study area from the available data, and Section 4 presents the resulting required DNL and supplemental NA60 noise exposure estimates.

2 Unmanned Aircraft Delivery Operations and Noise Measurement Data Set Descriptions

Three data sets formed the basis of the noise assessment for the proposed Wing UA delivery operations. The data sets included a twenty-day sample of computer-simulated flight/delivery operations from the Christiansburg Nest, noise measurement data collected for aircraft certification, and noise measurement data collected during field simulations of package deliveries. The following three subsections provide additional detail on each data source.

2.1 Computer-Simulated Delivery Data

Wing developed delivery simulation data consisting of 20 days of notional projected package deliveries averaging approximately 30 deliveries per day from the Nest location. This data was developed to provide FAA with information on which to base this analysis. The output of the delivery simulations consisted of point-to-point flight path data consisting of latitude, longitude, altitude, and time stamp at numerous points along each delivery route provided in Google Earth Keyhole Markup Language (KML) file format. Single KML files were provided for each flight day from the Nest. In total, the simulation data set consisted of 20 individual KML files containing flight paths for 600 delivery operations. All deliveries would occur during the DNL metric environmental daytime period of 7 a.m. to 10 p.m. local time.

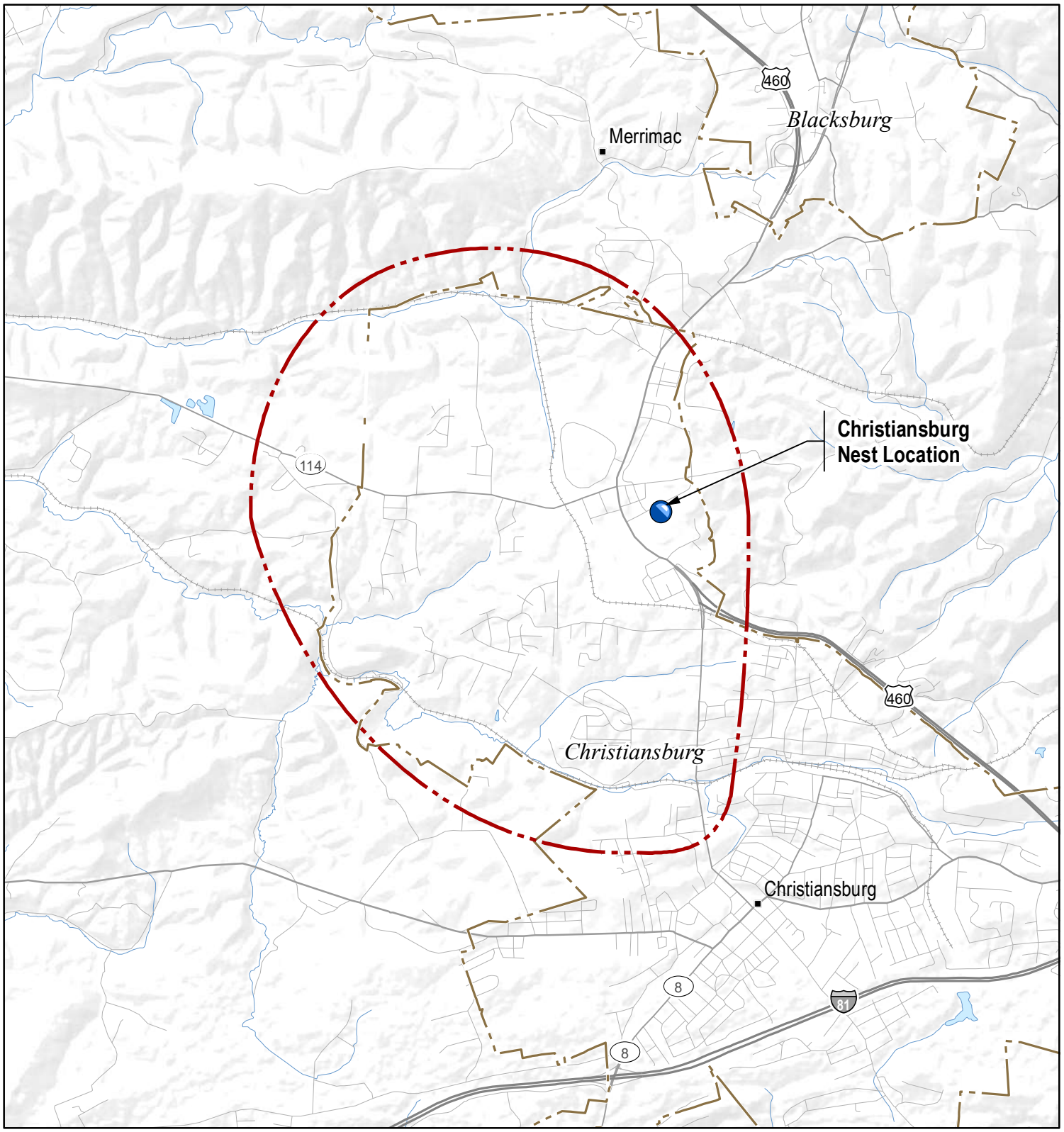
The simulation data received did not include a full year of operations, so the data set was scaled up to represent a full year of operations based on Wing's current CATEX, which cited 13 deliveries per day over 250 operating days, or 3,250 yearly deliveries. The data received also represents a pilot-to-aircraft ratio of 1:2, as cited in their current CATEX. The proposed pilot-to-aircraft ratio for this analysis is 1:8, so the deliveries were also scaled conservatively by a factor of 4, assuming a direct relationship between deliveries and the pilot-to-aircraft ratio. This brings the total annual deliveries to 13,000 for this analysis or 52 deliveries per operating day. Table 1 presents a summary of the contents of the simulation data and the scaled total used for this analysis.

Table 1. Wing Delivery Simulation Data for Christiansburg Nest Location

Source: Wing, 2021

Nest	Daily KML Files	Total Simulated Deliveries	Unique Delivery Locations	Total Scaled Annual Deliveries
Christiansburg	20	600	539	13,000

The location of the Nest and the study area boundary within which simulated deliveries were distributed are presented in Figure 2.



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Study Area
City Limits
Major / Minor Roads
Railroad
Water / Stream
Nest locations

0 1 2 Miles

Christiansburg, Virginia
Nest Location Operations

Figure: 2

Nest Locations and Study Area

2.2 Aircraft Certification Noise Measurement Data

Aircraft certification noise measurements were collected for Wing's UA by JR Engineering in April of 2021[1]. These noise measurements were taken in accordance with an issue paper developed by FAA and Wing to create a noise certification basis for this aircraft. Further rulemaking action on the paper is expected in the future. This data set included measurements of multiple passes of level straight line overflights at 100 feet and 200 feet AGL. Overflight measurements were taken with the UA operating at Maximum Takeoff Weight (MTOW) with payload at a target cruise airspeed of 56 knots (29 m/s) and without payload at a target max airspeed of 70 knots (36 meters/second). Supplementary measurements were also collected for multiple instances of stationary hovers at 20 feet AGL. Table 2 presents a summary of the average measured Maximum A-weighted Sound Levels (LA_{max}) and Sound Exposure Levels (SEL) for overflights and stationary hovers.

Table 2. Aircraft Certification Noise Measurement Data Summary

Source: JR Engineering, 2021

Type	Altitude (AGL)	Package	Average LA_{max} (dB)	Average SEL (dB)
Overflight	100 ft	No	63	66
		Yes	64	67
	200 ft	No	59	63
		Yes	60	64
Hover*	20 ft	Yes	73	-

**UA at 20 ft AGL and 20 ft laterally from the microphone position*

2.3 Aircraft Survey Noise Measurement Data

Aircraft noise measurements for Wing's UA were also collected by WSP[2] in Australia in June of 2019. These measurements consisted of delivery simulations conducted at a Wing test site and additional supplemental simulated deliveries conducted at a single residential site. This data set included measurements of multiple instances of full delivery procedures at both locations. An excerpt from the WSP report describing the measured simulated delivery procedure is included below:

1. *UA flies into the testing area in a stable position laterally at a cruise height of 40m above ground.*
2. *The UA then descends vertically to a position directly above the origin point of the measurement surface (40m above ground) and maintains a 'hover' position at a fixed delivery height of 6.8m above ground.*
3. *The payload is then delivered from hovering at the fixed delivery height, in accordance with Wing's standard operating procedure.*
4. *Once the payload is delivered, the UA ascends vertically to cruise height (40m) and departs the testing area.*

[1] Engineering Coordination Memo and Data Files, Subject: "Data Submittal for AEE", JR Engineering 2021.
[2] Report: "Wing Aviation Unmanned Aircraft Noise Survey", WSP 2019.

Table 3 presents a summary of the average measured noise levels for simulated deliveries.

Table 3. Aircraft Survey Noise Measurement Data Summary

Source: WSP, 2019

Type	Altitude (AGL)	Package	Location	Average LA_{max} (dB)	Average SEL (dB)
Delivery*	Variable	Yes	Test Site	73	83
			Residential Site	73	84

**UA delivery hover at 7.5 meters (25 ft) laterally from the microphone position*

3 Data Reduction and Noise Analysis Methodology

The previously described data sets were used to estimate community noise exposure that could result from Wing UA delivery operations originating from the Christiansburg Nest, operating 250 days out of the year, and conducting an average of 52 deliveries per day. There are currently no standardized tools or processes in place to conduct a noise assessment for the proposed operational scenario and UA. HMMH, with detailed technical guidance from the FAA Office of Environment and Energy, developed a customized noise exposure prediction processes based on the available data to conduct this analysis. The following subsections describe the noise analysis methodology.

3.1 Computer Simulation Data Reduction

As described in Section 2.1, the Wing UA delivery computer simulation data was provided as 20 separate KML files for the Nest location representing potential days of operation. Each KML file contained flight path data for approximately 30 simulated deliveries. The point-to-point flight path data for each delivery route was segmented into approximately 10 sets of points consisting of around 100 points each, meaning each delivery route consisted of roughly 1,000 data points.

Data Reformatting and Organization

HMMH first developed a Python script to parse the segmented delivery route data into continuous flight paths covering the entirety of each delivery operation. That modified data was then compiled into a single Comma Separated Values (CSV) file containing all data from the 20 associated KML files. Further processing was then conducted on the CSV file to separate the data into three flight phase groups. The phase of flight was determined by the coordinates (XYZ) and elements of the segmentation from the original KML files. The three resulting flight phase datasets included:

1. Enroute flight from the Nest out to the delivery location
2. Enroute flight from the delivery location back to the Nest
3. Vertical ascent and descent to and from enroute flight altitude at both the Nest and delivery locations

Due to the high density of points for each track, HMMH also applied the Ramer-Douglas-Peucker data reduction algorithm[3,4] with a very small tolerance of five feet. This maintained a high level of detail but removed the many duplicate and unnecessary points, reducing the overall size of the data set and making subsequent data processing less computationally intensive.

[3] Douglas, D. H., & Peucker, T. K. (1973). *Algorithms for the reduction of the number of points required to represent a digitized line or its caricature.* The Canadian Cartographer, Volume 10, No 2.
[4] Ramer, U. (1972). *An iterative procedure for the polygonal approximation of plane curves.* Computer Graphics and Image Processing, Volume 1, Issue 3.

Spatial Distribution Analysis

The next step in the data reduction process required the development of a means to quantify the three-dimensional spatial distribution of the data into a format conducive to making noise exposure calculations. This was accomplished by developing a customized Python script to evaluate flight events within a two-dimensional grid of 1/16 acre-sized cells covering the study area.

For the enroute phases of flight, the script iterated over the grid and counted the flights that intersected with each cell boundary. In addition to counts of flight events per cell, the average altitude of traversal across the cell for each flight path was computed and recorded. Altitudes in the source KML files were indicated in feet above Mean Sea Level (MSL). MSL altitudes were converted to AGL altitudes to determine noise propagation path distances by obtaining terrain elevation data for the study area from U.S. Geological Survey (USGS) Nation Map website[5]. A script read in the terrain data to determine the ground elevation of each grid cell, and the ground elevation was then subtracted from the MSL altitudes of the flight paths intersecting each cell. The final dataset for enroute flights consisted of flight counts crossing each grid cell segregated into feet AGL altitude range bins based on the acoustic criteria discussed below in Section 3.2. The resulting feet AGL range for each altitude bin is illustrated in Figure 3.

For the vertical ascent and descent flight phases, the script iterated over the grid and counted the vertical flight paths contained with each cell. Altitude distribution information was not recorded for the Nest and delivery events, as flight procedures dictate a common lower bound altitude for all. The final resulting Nest and delivery locations dataset consisted of counts of deliveries or Nest launch and recovery events within each grid cell.

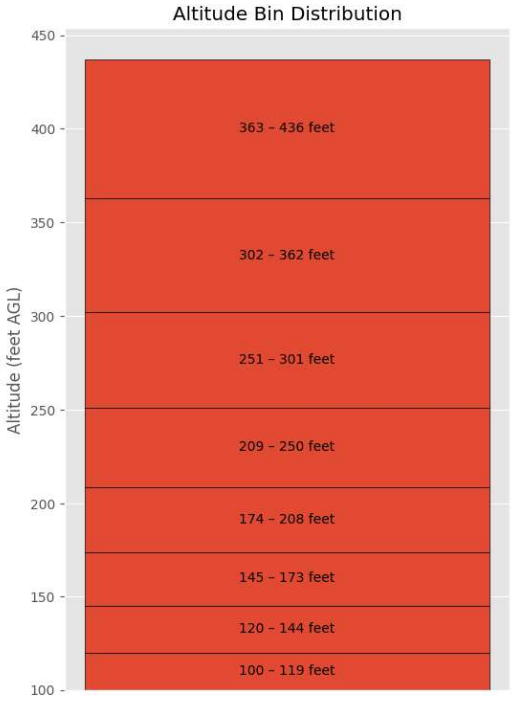

Figure 3. Grid Cell Enroute Flight Altitude Bin Ranges

[5] https://apps.nationalmap.gov/viewer/

3.2 Noise Analysis Methodology

The fully reduced data set provided counts of UA enroute flight, delivery, and Nest events laterally across an XY grid of cells and enroute flight vertically within the altitude bins shown in Figure 3. Based upon this data and available noise measurements, the associated noise contribution from all activity occurring within a cell was computed and summed to give a resulting total noise exposure level on the ground. This section describes the noise calculation processes used to determine the noise contribution for each phase of a delivery flight.

DNL for Enroute Flight

DNL noise exposure calculations for enroute flight were based on the measured aircraft SEL presented in Section 2.2. The SEL value was adjusted for flight at altitudes other than the measured altitude by applying the "delta J1" adjustment from *14 CFR Part 36 Appendix J, Section J36.205(b) Detailed Data Correction Procedures* as follows in Equation 1:

$$\Delta J_1 = 12.5 \times log_{10}\left(\frac{H_A}{H_T}\right), \text{dB} \quad (1)$$

Where ΔJ_1 is the quantity in decibels that must be algebraically added to the measured SEL to adjust for a level flight path at an altitude differing from the measured altitude; H_T is the height, in feet, of the test vehicle when directly over the noise measurement point; H_A is the new adjusted height (or reference height), and the constant (12.5) accounts for the effects on spherical spreading and duration from the off-reference altitude.

Additionally, the altitude bin ranges shown in Figure 3 were developed based on the SEL-distance-duration relationship of Equation 1 to determine the AGL altitudes from 100 feet to 400 feet AGL that would result in a 1 dB change in SEL between each bin floor. This allowed for a consistent resolution in noise level across the range of possible enroute flight altitudes. The altitude bin floor is given by Equation 2:

$$AGL_{Bin\ Floor} = 100 \times 10^{\left(\frac{\Delta SEL}{12.5}\right)}, \text{ft} \quad (2)$$

SEL noise calculations utilized the bin floor altitude as the applicable AGL altitude for all enroute flight events within a given bin range. For example, all flights occurring within the 120 feet – 144 feet AGL bin were considered to be at 120 feet AGL when applying Equation 1 to determine the associated SEL at ground level for that flight. While this yields a somewhat conservative estimate of aircraft noise level on the ground directly below an aircraft flight path, any potential overestimation that would result would be limited to less than 1 dB SEL.

An analysis of enroute ground speed was conducted based on the flight path point time stamps contained in the simulation data. The results of this analysis showed that the UA was generally moving at a speed of 50 knots or greater during enroute flight. Figure 4 presents a histogram of average UA ground speed by grid cell.

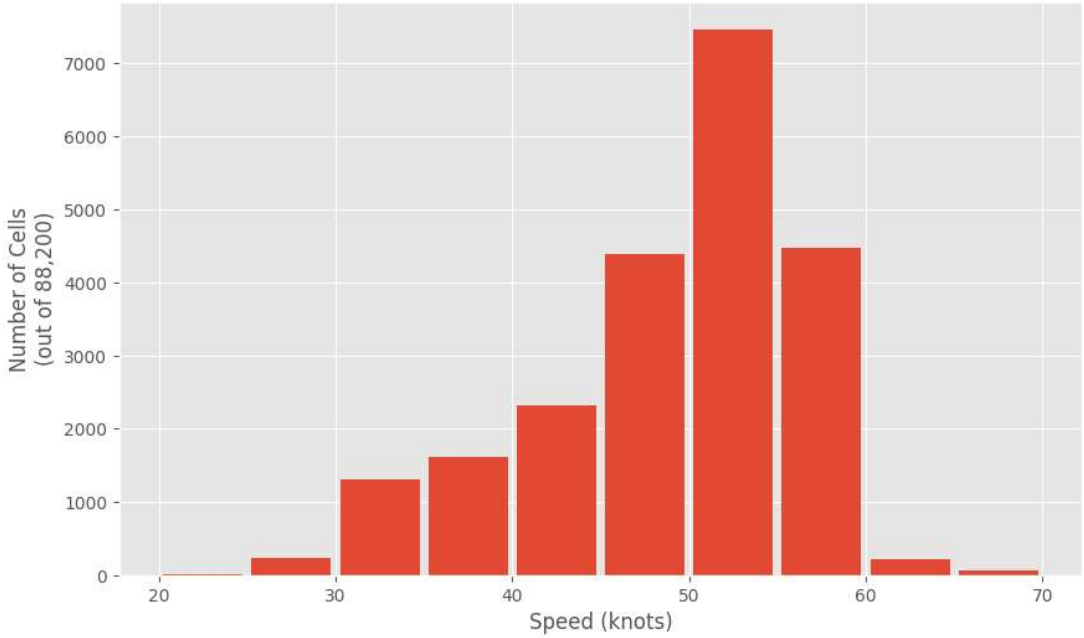

Figure 4. Histogram of UA Enroute Average Ground Speed by Grid Cell

Based on this analysis, a ground speed of 50 knots was used for all phases of enroute flight. To accommodate this in the noise calculation, SEL measurements from the data set discussed in Section 2.2 were adjusted from their actual measured ground to speed to 50 knots by applying the "delta J3" adjustment from *14 CFR Part 36 Appendix J, Section J36.205(b) Detailed Data Correction Procedures* as follows in Equation 3:

$$\Delta J_3 = 10 \times log_{10}\left(\frac{V_{RA}}{V_R}\right), \text{dB} \quad (3)$$

Where ΔJ_3 is the quantity in decibels that must be algebraically added to the measured SEL noise level to correct for the influence of the adjustment of the reference speed on the duration of the measured flyover event as perceived at the noise measurement station, V_R is the reference speed, and V_{RA} is the adjusted reference speed.

After adjusting the measured SELs to a speed of 50 knots, average SEL values were computed for each measured altitude and weight configuration. Equation 1 was then applied to the average SELs to compute the resulting SELs for flight at the altitude bin floors from Figure 3. From this assessment, it was determined that the measured SEL associated with overflight at 200 feet AGL with a package yielded the highest SEL values across the range of enroute flight altitudes. This data point was selected for use in all enroute flight noise calculations. Table 4 presents the resulting enroute overflight SELs for each altitude bin floor.

Table 4. Speed and Altitude Adjusted SELs Used for Enroute Flight Noise Calculations

AGL Altitude (ft)	100	120	145	174	209	251	302	363
SEL (dB)	69	68	67	66	65	64	63	62

Note: Based on JR Engineering measurement data for level flight at 200 feet AGL at MTOW

Enroute DNL for each cell was then calculated by energy summation of all individual enroute flight SELs for all eight altitude bins as follows in Equation 4:

$$DNL_{Cell\ Enroute} = 10\,log_{10}\left[\frac{Bin_{100}\sum_i^n 10^{\left(\frac{SEL_i}{10}\right)}+Bin_{120}\sum_i^n 10^{\left(\frac{SEL_i}{10}\right)}+Bin_{n\cdots}}{365}\right] - 49.4,\ \text{dB} \quad (4)$$

DNL at Delivery and Nest Locations

DNL calculations at the delivery and Nest locations were based on the measured aircraft SEL presented in Section 2.3. The measured SEL used for noise calculation of all simulated delivery and Nest events was 84 dB at 7.5 meters (25 feet). Noise measurements for the flight procedures conducted at a Nest were not available; as such, it was assumed that total noise produced at the Nest for each delivery was equivalent to the noise produced at a delivery location. With that assumption, both Nest and delivery location DNLs could be computed by energy summation of the SEL for a single delivery multiplied by the number of deliveries or associated Nest events occurring in any grid cell, as shown in Equation 5:

$$DNL_{Cell\ delivery/Nest} = 10\,log_{10}\left[\frac{N_{events}\times 10^{\left(\frac{84}{10}\right)}}{365}\right] - 49.4,\ \text{dB} \quad (5)$$

Grid Cell Total DNL

With the DNL computed separately for enroute flight and delivery/Nest events, energy summation was applied once more to calculate the combined DNL resulting from all activity occurring within the lateral bounds of each grid cell as follows in Equation 6:

$$Combined\ DNL_{Cell} = 10log_{10}\left[10^{\left(\frac{DNL_{cell\ enroute}}{10}\right)} + 10^{\left(\frac{DNL_{cell\ delivery/Nest}}{10}\right)}\right],\ \text{dB} \quad (6)$$

As previously stated, the dimensions used for the grid cells was 1/16 acre (52 feet x 52 feet). Additionally, this analysis approach assumed that the noise contribution of a flight within any portion of the cell was constant throughout the cell. For this assumption to be valid, the lateral cell dimensions had to be small enough that the range of possible noise source to ground receiver distances would not result in an appreciable difference in noise propagation distance over the range of applicable altitudes. An allowable source to receiver distance variance equivalent to 1 dB LA_{max} via spherical spreading was chosen as the constraint for determining the grid cell dimensions. A geometric analysis was conducted to determine the relationship between cell size and the possible range of noise source to ground receiver propagation distances. The results of the analysis, depicted in Figure 5, showed that a cell dimension of 50 feet x 50 feet would achieve the target limit of approximately 1 dB of variance in propagation distance for enroute flight at the lower altitude range present in the simulation data set.

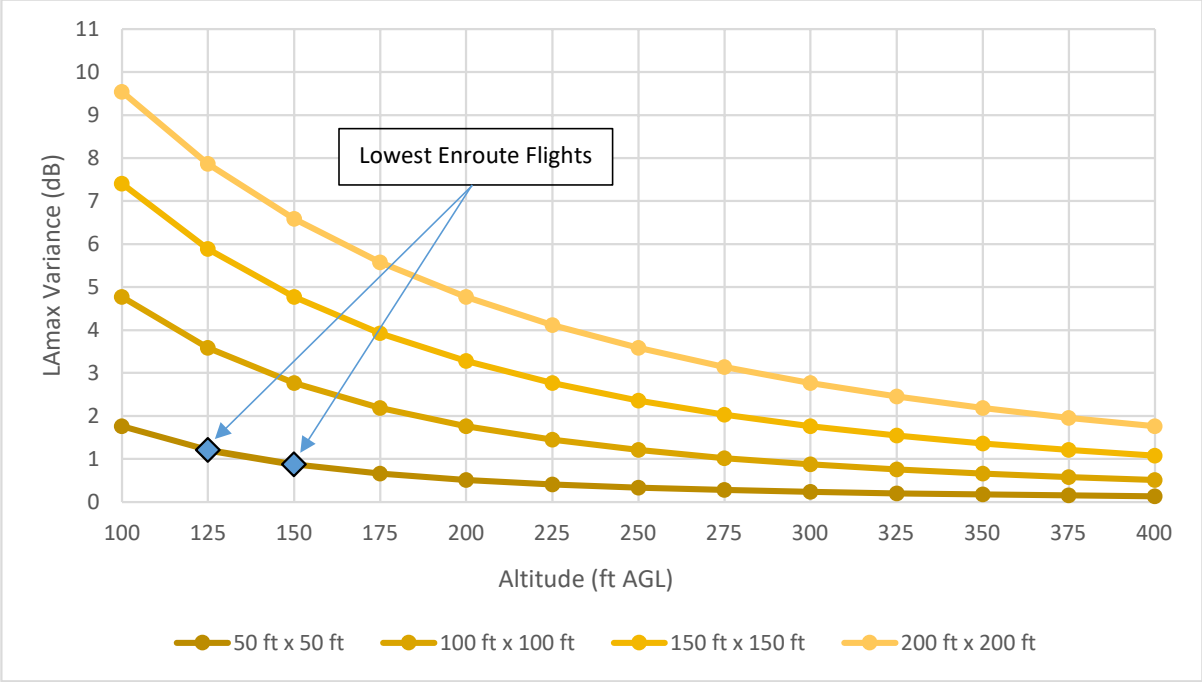

Figure 5. Possible LA_{max} dB Variance by Altitude for Various Cell Dimensions

Utilizing a cell size of 1/16 acre (52 feet x 52 feet) helps minimize uncertainty in the noise exposure throughout the cell resulting from those events occurring within the cell. However, noise from activity occurring in adjacent cells would also contribute to the total noise level on the ground and must be accounted for in calculating the total noise level for each grid cell. The noise contribution resulting from the nearest neighboring cells is accounted for by summing the energy average level of the eight surrounding cells to the $Combined\ DNL_{Cell}$ value from Equation 6. This nearest neighbor noise contribution addition is carried out iteratively over the entire grid cell set as a final step to produce the total DNL estimate for each grid cell.

Number of Events Above 60 dB LA_{max} (NA60)

In addition to DNL, a supplemental NA60 noise metric was also calculated for the study area. NA60 noise calculations utilize the measured LA_{max} values from the overflight measurements in Section 2.2 and the simulated delivery measurements in Section 2.3. As with the DNL calculations, the enroute NA60 calculation also uses the measured level for UA overflight at 200 feet AGL with a package. A simple spherical spreading relationship is applied to the 60 dB LA_{max} value at 200 feet AGL to determine the LA_{max} of enroute flight events at other altitudes as follows in Equation 7:

$$\mathrm{LA}_{max} = 20 \times log_{10}\left(\frac{200}{Bin_{alt}}\right) + 60, \text{ dB} \qquad (7)$$

Table 5 presents LA_{max} for enroute flight at the bin altitudes from Figure 3. NA60 for enroute flight is determined for each grid cell by a count of the number of flight events at or below 209 feet AGL.

Table 5. LA_{max} Used for Enroute Flight Noise Calculations

AGL Altitude (ft)	100	120	145	174	209	251	302	363
LA_{max} (dB)	66	65	63	62	60	58	57	55

The measured LA_{max} used for noise calculation of all simulated delivery and Nest events was 73 dB at 7.5 meters (25 feet). Since all delivery and Nest events would generate an LA_{max} above 60 dB within the cells that they occur, NA60 for each cell is simply the total of the delivery and Nest events occurring within the cell. Total NA60 for each grid cell is determined by the addition of total enroute flights occurring at or below 209 feet AGL and total delivery and Nest events occurring within each grid cell.

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4 Noise Exposure Estimate Results

This section presents the estimated noise exposure for Wing's proposed UA package delivery operations from the Christiansburg Nest. The Nest location and its immediately surrounding areas would have the highest noise exposure levels since it serves as the hub of Wing's UA activity; however, those levels would still be well below the FAA's DNL 65 dB threshold for noise-compatible land use. Areas of DNL 45 dB or greater only occur at the Nest location. Grid cells of DNL 45 dB or greater at the Nest ranged from approximately DNL 45 to DNL 50 dB.

Since the Nest consists of multiple UA launch and recovery pads, the flight activity at a Nest is distributed across multiple of the grid cells used for this analysis. To provide a conservative view of possible outcomes, it is useful to consider the potential DNL that could result if all pads fell within a single grid cell, i.e., worst case. In that case, for the level of activity assessed in this document, the resulting DNL at the Nest would be 50.2 dB. Table 6 presents the estimated DNL range and potential DNL at the Christiansburg Nest.

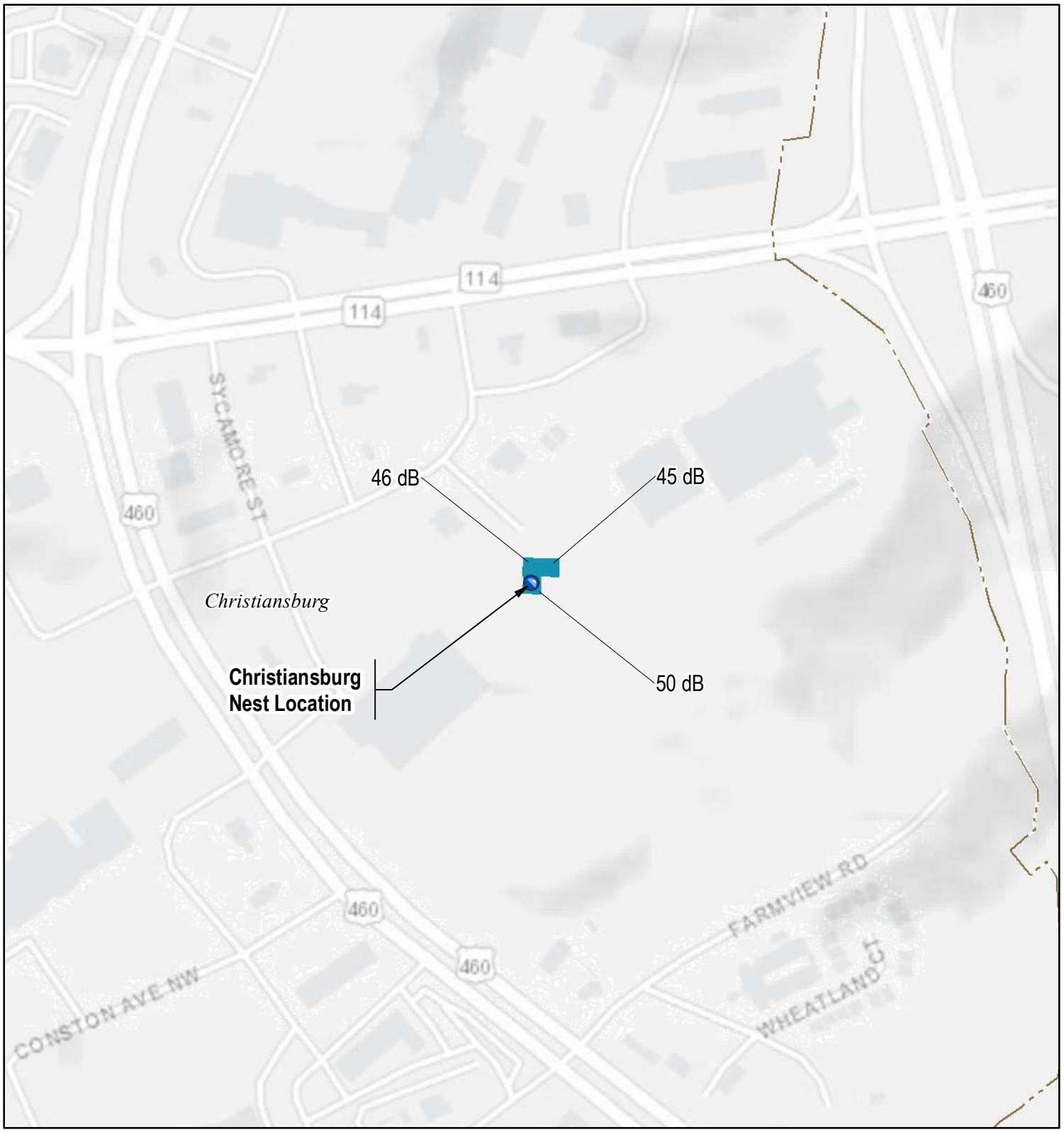
Table 6. AAD DNL at Christiansburg Nest Location

Nest	Total Annual Deliveries Assessed	DNL Range (dB)	Potential DNL (dB)
Christiansburg	13,000	45.4 – 49.9	50.2

NA60 would range up to 90 average daily events at the Nest location. Because the NA60 calculation considers four events for every delivery, it is possible for the NA60 results of a cell to be higher than the average daily number of deliveries. For the NA60 calculation, an event has been defined as the following:

- Departure/Arrival at a Nest
- Enroute flight out to a delivery location
- The package drop-off at a delivery location
- Enroute flight back to a Nest

Figure 6 presents the DNL for any grid cells with an AAD DNL of 45 dB or greater. Figure 7 presents the AAD NA60 for any grid cells with one event or greater.



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City Limits
Major / Minor Roads
Railroad
Water / Stream

45 - 50 dB DNL

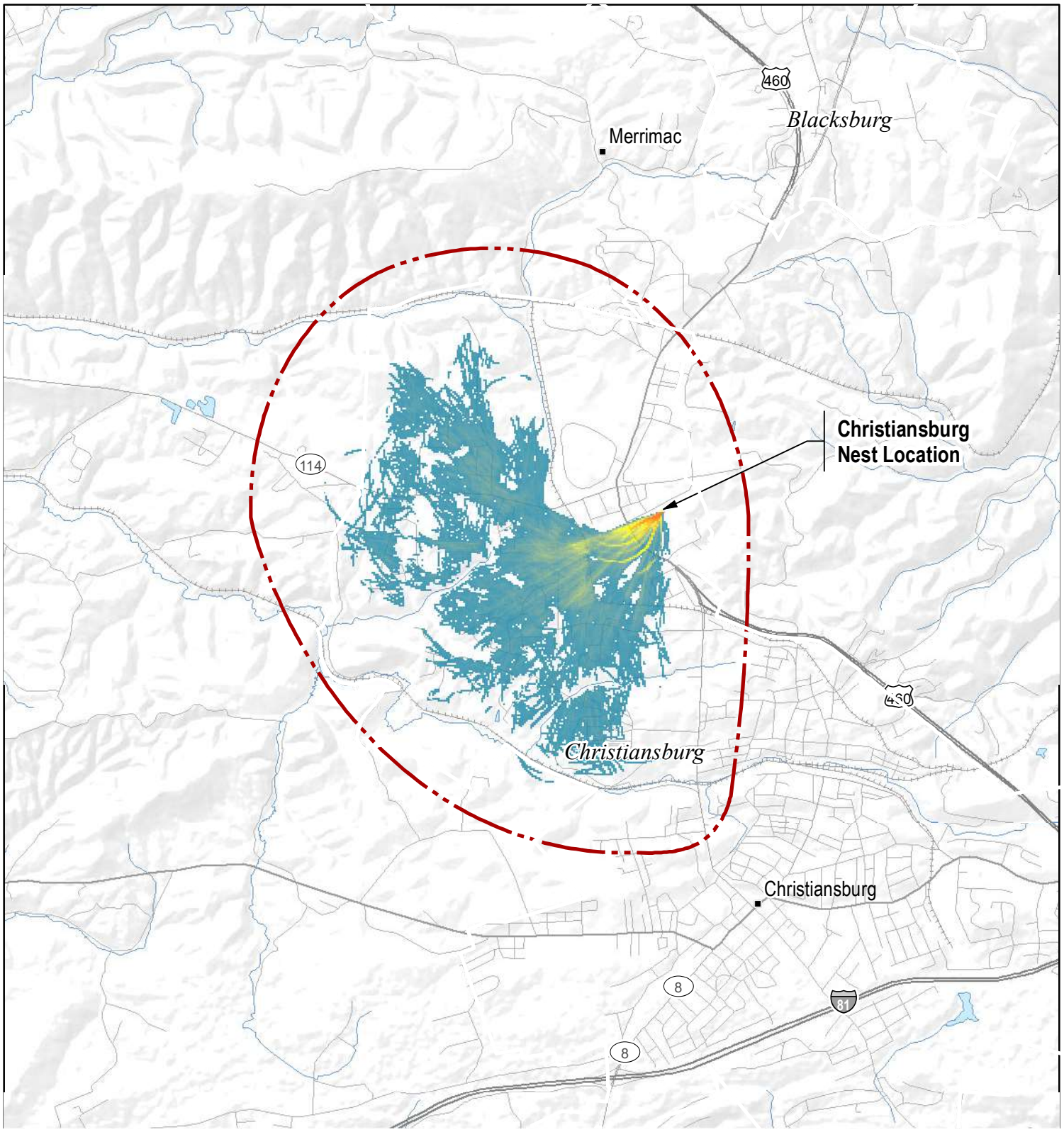
Analysis Grid Cell Size =
1/16 Acre (52 ft x 52 ft)

0 400 800 Feet

Christiansburg, Virginia
Nest Location Operations

Figure: 6

Areas with DNL 45 dB or Greater



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Study Area
City Limits
Major / Minor Roads
Railroad
Water / Stream

90 Events (NA60)

Analysis Grid Cell Size =
1/16 Acre (52 ft x 52 ft)

1 Event (NA60)

Christiansburg, Virginia
Nest Location Operations

Figure: 7

Average Annual Daily Number of Events Above 60 dB LA_{max} (NA60)

0 1 2 Miles

Appendix D

Noise Methodology Memos

Federal Aviation Administration

Memorandum

Date: December 8, 2021

To: Don Scata, Office of Environment and Energy (AEE)

From: Mike Millard, Flight Standards (AFS), General Aviation Operations Branch, AFS-830

Subject: Environmental Assessment (EA) Noise Methodology Approval Request for Hummingbird 7000W-A UA Operations in Christiansburg, VA

AFS requests AEE approval of the noise methodology to be used for the Environmental Assessment (EA) for Wing Aviation LLC (Wing) operations using the Hummingbird 7000W-A unmanned aircraft (UA) in Christiansburg, VA to provide package delivery services as a 14 CFR Part 135 operator as described below.

As the FAA does not currently have a standard approved noise model for UA, this letter serves as a request for written approval from AEE to use the methodology proposed in the following sections to support the noise analysis for the EA.

Description of Aircraft and Proposed Operations

AFS is evaluating Wing operations using the Hummingbird 7000W-A UA in Christiansburg, VA to deliver packages, including prescription medication to analyze the potential environmental impacts of approving amendments to the Wing Aviation air carrier Operations Specifications (OpSpecs) to increase the current pilot to aircraft ratio to 1:8. The amendment would allow Wing to have one pilot operate up to eight aircraft in the air when customer demand is high. The Hummingbird 7000W-A aircraft weighs 15 pounds, including the maximum package weight of 3.3 pounds. Typical operations of the aircraft will consist of a departure from the Nest where the aircraft will quickly rise to an approximate cruising altitude between 150-250 feet above ground level (AGL), fly to the delivery location, then transition to hover mode and lower its altitude to approximately 23 feet AGL, where it will lower the package on its retractable cord to the ground. Following delivery, the aircraft will rise back to cruise altitude, and return back to the Nest for landing.

Noise Analysis Methodology

AFS is proposing to use the noise analysis methodology developed in HMMH Report No. 309990.003-3 for the "Noise Assessment for Wing Aviation Proposed Package Delivery Operations in Christiansburg, VA" dated December 8, 2021. Key elements of the methodology developed in the report include:

Operations Data Analysis:

Flight paths will be parsed into flight phases representing:

- En-route flight from Nest to delivery location
- En-route flight from delivery location back to Nest
- Vertical ascent and descent from en-route altitudes to Nest and delivery locations

Flight track operations distributions will then be determined based on representative simulations of UA activity provided by Wing. The operational and flight track data will then be spatially analyzed over 1/16 acre sized grid cells over the extent of Wing's proposed operating areas from each nest location to determine counts of operations and altitude distributions within each cell for en-route, delivery, and nest activities for use in noise calculations

Acoustic Data Analysis

UA source noise will be derived from a combination of:

- Overflight and hover measured Maximum A-weighted Sound Levels (LAmax) and Sound Exposure Levels (SEL) from aircraft noise certification measurements collected for Wing's UA by JR Engineering in April of 2021[1]
- Delivery measurements from Wing noise survey data collected in Australia in June 2019[2]

Noise Exposure Calculations

Day Night Average (DNL) Sound Levels will be calculated for each flight phase based on a combination of the SEL values from the acoustic data and operations data analysis. The resulting DNL for all flight phases will then be calculated based on the energy summation of DNL values for all en-route, delivery, and Nest operations occurring within each grid cell

As a final step, the noise contributions from surrounding cells will be considered to generate the total DNL estimate for each grid cell based on summing the energy average level of the eight surrounding grid cells to the DNL levels calculated from all flight phases and iterating over each grid cell within Wing's proposed operating area.

To provide additional supplemental noise results, Number of Events Above 60 dB LAmax (NA60) will also be calculated for each flight phase based on a combination of the LAmax values from the acoustic data and operations data analysis. The resulting NA60 for all flight phases will then be calculated based on the summation of the count of NA60 for all en-route, delivery, and Nest operations occurring within each grid cell.

[1] Engineering Coordination Memo and Data Files, Subject: "Data Submittal for AEE", JR Engineering 2021.
[2] Report: "Wing Aviation Unmanned Aircraft Noise Survey", WSP 2019.

Federal Aviation Administration

Memorandum

Date: December 9, 2021

To: Mike Millard, Flight Standards (AFS), General Aviation Operations Branch, AFS-830

From: Don Scata, Manager, Noise Division, Office of Environment and Energy (AEE-100)

Subject: Environmental Assessment (EA) Noise Methodology Approval Request for Hummingbird 7000W-A Operations at Christiansburg, Virginia

The Office of Environment and Energy (AEE) has reviewed the proposed non-standard noise modeling methodology to be used for Wing Aviation LLC (Wing) operations using the Hummingbird 7000W-A unmanned aircraft (UA) in Christiansburg, Virginia. This request is in support of an Environmental Assessment (EA) for the allowance of operations of the UA with a pilot to vehicle ratio of up to 1:8 in conjunction with an amendment to the Operations Specifications (OpSpec) for existing Wing 14 CFR Part 135 package delivery operations at Christiansburg, VA.

The Proposed Action is to use the Hummingbird 7000W-A to deliver packages from a single launch and recovery location referred to as a "Nest". Typical operations of the UA will consist of a departure from the Nest where the aircraft will quickly rise to an approximate cruising altitude between 150-250 feet above ground level (AGL), fly to the delivery location, then transition to hover mode and lower its altitude to approximately 23 feet AGL, where it will lower the package on its retractable cord to the ground. Following delivery, the aircraft will rise back to cruise altitude, and return back to the Nest for landing.

As the FAA's approved noise models and methodologies are not currently suitable for analysis of the Proposed Action, in accordance with FAA Order 1050.1F, all non-standard noise analysis in support of the noise impact analysis for the National Environmental Policy Act (NEPA) must be approved by AEE. This letter serves as AEE's response to the method developed in HMMH Report No. 309990.003-3 on the "Noise Assessment for Wing Aviation Proposed Package Delivery Operations in Christiansburg, Virginia" dated December 8, 2021.

The proposed methodology appears to be adequate for this analysis; therefore, AEE concurs with the methodology proposed for this project. Please understand that this approval is limited to this particular Environmental Review, location, vehicle, and circumstances. Any additional projects using this or other methodologies or variations in the vehicle will require separate approval.

Appendix E

EJSCREEN Report

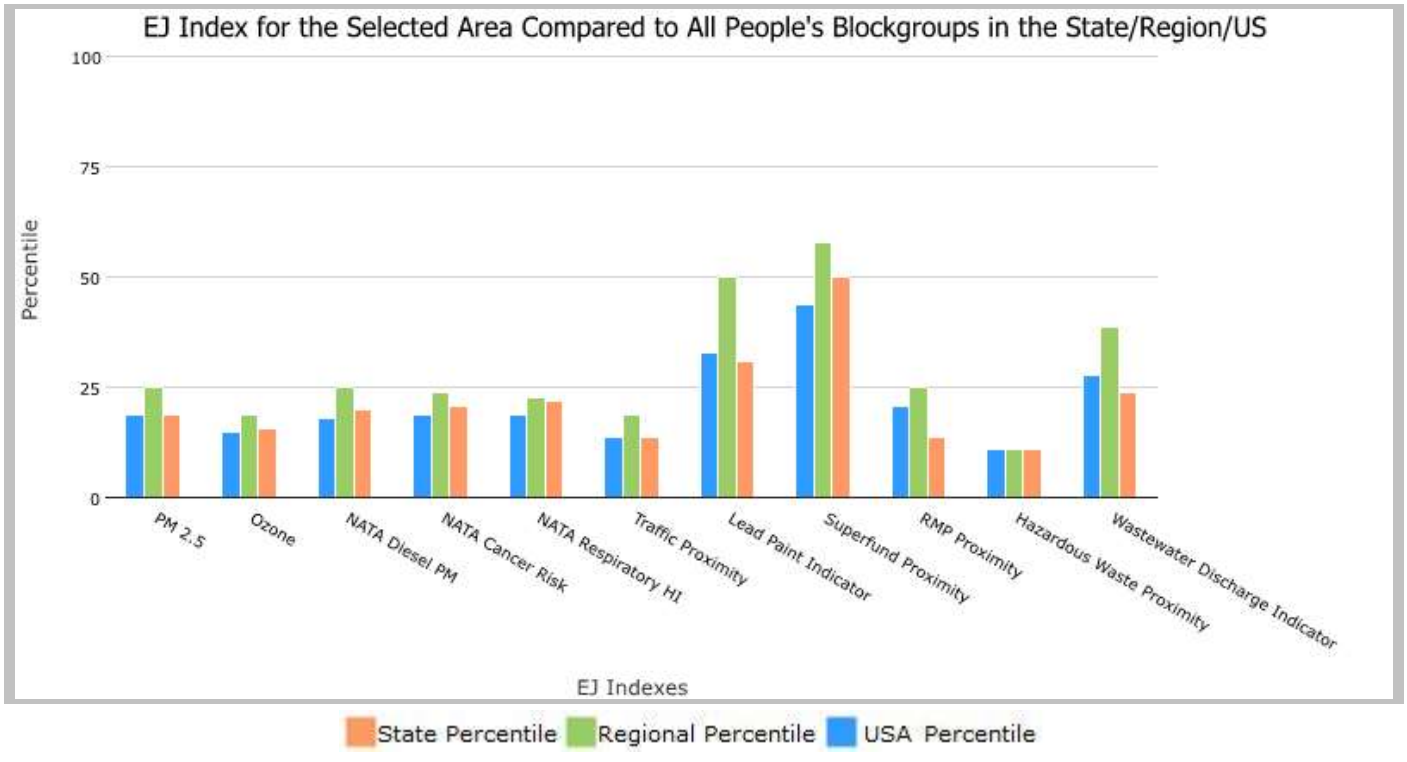
EJSCREEN Report (Version 2020)

the User Specified Area, VIRGINIA, EPA Region 3

Approximate Population: 7,722

Input Area (sq. miles): 7.19

Selected Variables	State Percentile	EPA Region Percentile	USA Percentile
EJ Indexes			
EJ Index for PM2.5	19	25	19
EJ Index for Ozone	16	19	15
EJ Index for NATA* Diesel PM	20	25	18
EJ Index for NATA* Air Toxics Cancer Risk	21	24	19
EJ Index for NATA* Respiratory Hazard Index	22	23	19
EJ Index for Traffic Proximity and Volume	14	19	14
EJ Index for Lead Paint Indicator	31	50	33
EJ Index for Superfund Proximity	50	58	44
EJ Index for RMP Proximity	14	25	21
EJ Index for Hazardous Waste Proximity	11	11	11
EJ Index for Wastewater Discharge Indicator	24	39	28



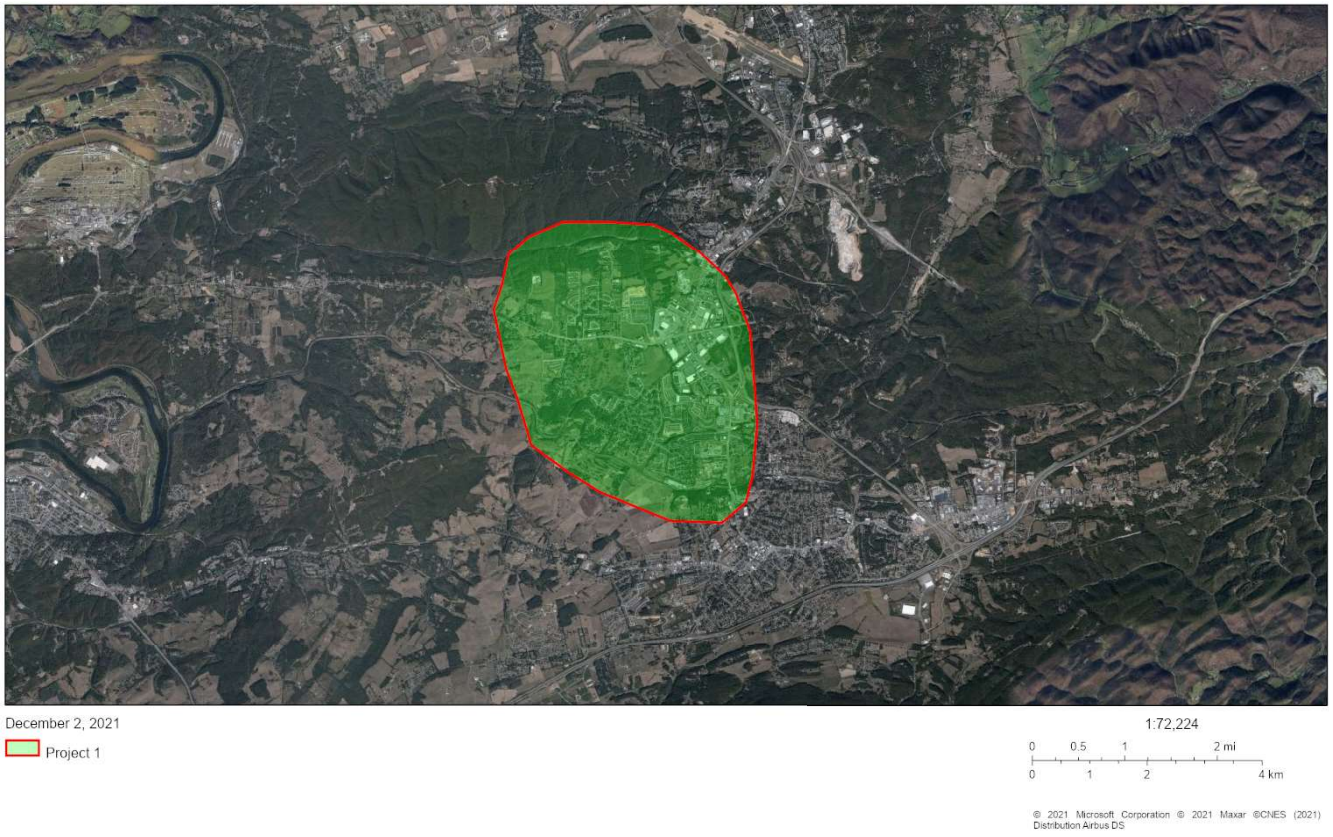
This report shows the values for environmental and demographic indicators and EJSCREEN indexes. It shows environmental and demographic raw data (e.g., the estimated concentration of ozone in the air), and also shows what percentile each raw data value represents. These percentiles provide perspective on how the selected block group or buffer area compares to the entire state, EPA region, or nation. For example, if a given location is at the 95th percentile nationwide, this means that only 5 percent of the US population has a higher block group value than the average person in the location being analyzed. The years for which the data are available, and the methods used, vary across these indicators. Important caveats and uncertainties apply to this screening-level information, so it is essential to understand the limitations on appropriate interpretations and applications of these indicators. Please see EJSCREEN documentation for discussion of these issues before using reports.

EJSCREEN Report (Version 2020)

the User Specified Area, VIRGINIA, EPA Region 3

Approximate Population: 7,722

Input Area (sq. miles): 7.19



Sites reporting to EPA	
Superfund NPL	0
Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	2

EJSCREEN Report (Version 2020)

the User Specified Area, VIRGINIA, EPA Region 3

Approximate Population: 7,722

Input Area (sq. miles): 7.19

Selected Variables	Value	State Avg.	%ile in State	EPA Region Avg.	%ile in EPA Region	USA Avg.	%ile in USA
Environmental Indicators							
Particulate Matter (PM 2.5 in µg/m^3)	7.24	7.87	10	8.63	4	8.55	16
Ozone (ppb)	43.3	42.4	74	43.2	46	42.9	54
NATA* Diesel PM (µg/m^3)	0.331	0.425	42	0.477	<50th	0.478	<50th
NATA* Cancer Risk (lifetime risk per million)	26	31	10	31	<50th	32	<50th
NATA* Respiratory Hazard Index	0.34	0.41	11	0.4	<50th	0.44	<50th
Traffic Proximity and Volume (daily traffic count/distance to road)	240	570	55	650	49	750	52
Lead Paint Indicator (% Pre-1960 Housing)	0.053	0.21	35	0.36	17	0.28	29
Superfund Proximity (site count/km distance)	0.011	0.11	1	0.15	0	0.13	6
RMP Proximity (facility count/km distance)	0.25	0.38	64	0.62	49	0.74	44
Hazardous Waste Proximity (facility count/km distance)	1.6	1.6	62	2	62	5	60
Wastewater Discharge Indicator (toxicity-weighted concentration/m distance)	4.2E-05	3.1	57	34	43	9.4	50
Demographic Indicators							
Demographic Index	17%	32%	23	30%	32	36%	24
People of Color Population	17%	38%	24	33%	41	39%	32
Low Income Population	18%	25%	41	27%	37	33%	29
Linguistically Isolated Population	0%	3%	52	3%	55	4%	45
Population With Less Than High School Education	7%	11%	43	10%	43	13%	39
Population Under 5 years of age	6%	6%	59	6%	62	6%	58
Population over 64 years of age	16%	15%	59	16%	51	15%	59

* The National-Scale Air Toxics Assessment (NATA) is EPA's ongoing, comprehensive evaluation of air toxics in the United States. EPA developed the NATA to prioritize air toxics, emission sources, and locations of interest for further study. It is important to remember that NATA provides broad estimates of health risks over geographic areas of the country, not definitive risks to specific individuals or locations. More information on the NATA analysis can be found at: https://www.epa.gov/national-air-toxics-assessment.

For additional information, see: www.epa.gov/environmentaljustice

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

Summary of ACS Estimates	2014 - 2018
Population	7,722
Population Density (per sq. mile)	1,190
People of Color Population	1,286
% People of Color Population	17%
Households	3,136
Housing Units	3,424
Housing Units Built Before 1950	94
Per Capita Income	31,882
Land Area (sq. miles) (Source: SF1)	6.49
% Land Area	100%
Water Area (sq. miles) (Source: SF1)	0.01
% Water Area	0%

	2014 - 2018 ACS Estimates	Percent	MOE (±)
Population by Race			
Total	7,722	100%	826
Population Reporting One Race	7,678	99%	1,401
White	6,640	86%	827
Black	643	8%	176
American Indian	14	0%	22
Asian	379	5%	313
Pacific Islander	0	0%	12
Some Other Race	2	0%	51
Population Reporting Two or More Races	44	1%	32
Total Hispanic Population	246	3%	128
Total Non-Hispanic Population	7,476		
White Alone	6,436	83%	835
Black Alone	614	8%	176
American Indian Alone	14	0%	22
Non-Hispanic Asian Alone	379	5%	313
Pacific Islander Alone	0	0%	12
Other Race Alone	0	0%	12
Two or More Races Alone	33	0%	32
Population by Sex			
Male	3,604	47%	415
Female	4,118	53%	439
Population by Age			
Age 0-4	498	6%	139
Age 0-17	1,810	23%	218
Age 18+	5,912	77%	421
Age 65+	1,208	16%	327

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2014 - 2018 .

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

	2014 - 2018 ACS Estimates	Percent	MOE (±)
Population 25+ by Educational Attainment			
Total	5,469	100%	789
Less than 9th Grade	139	3%	97
9th - 12th Grade, No Diploma	229	4%	101
High School Graduate	951	17%	227
Some College, No Degree	1,329	24%	203
Associate Degree	401	7%	111
Bachelor's Degree or more	2,821	52%	216
Population Age 5+ Years by Ability to Speak English			
Total	7,224	100%	816
Speak only English	6,472	90%	826
Non-English at Home[1+2+3+4]	752	10%	199
[1]Speak English "very well"	582	8%	171
[2]Speak English "well"	53	1%	61
[3]Speak English "not well"	115	2%	103
[4]Speak English "not at all"	1	0%	39
[3+4]Speak English "less than well"	117	2%	103
[2+3+4]Speak English "less than very well"	170	2%	103
Linguistically Isolated Households*			
Total	1	100%	28
Speak Spanish	1	100%	25
Speak Other Indo-European Languages	0	0%	12
Speak Asian-Pacific Island Languages	0	0%	12
Speak Other Languages	0	0%	12
Households by Household Income			
Household Income Base	3,136	100%	209
< $15,000	163	5%	88
$15,000 - $25,000	185	6%	83
$25,000 - $50,000	523	17%	174
$50,000 - $75,000	640	20%	149
$75,000 +	1,626	52%	174
Occupied Housing Units by Tenure			
Total	3,136	100%	209
Owner Occupied	2,132	68%	173
Renter Occupied	1,004	32%	160
Employed Population Age 16+ Years			
Total	6,137	100%	803
In Labor Force	4,239	69%	346
Civilian Unemployed in Labor Force	148	2%	113
Not In Labor Force	1,898	31%	759

Data Note: Datail may not sum to totals due to rounding. Hispanic population can be of anyrace.
N/A means not available. **Source:** U.S. Census Bureau, American Community Survey (ACS)
*Households in which no one 14 and over speaks English "very well" or speaks English only.

EJSCREEN ACS Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

	2014 - 2018 ACS Estimates	Percent	MOE (±)
Population by Language Spoken at Home*			
Total (persons age 5 and above)	6,984	100%	539
English	6,241	89%	593
Spanish	85	1%	72
French	33	0%	14
French Creole	N/A	N/A	N/A
Italian	N/A	N/A	N/A
Portuguese	N/A	N/A	N/A
German	0	0%	17
Yiddish	N/A	N/A	N/A
Other West Germanic	N/A	N/A	N/A
Scandinavian	N/A	N/A	N/A
Greek	N/A	N/A	N/A
Russian	N/A	N/A	N/A
Polish	N/A	N/A	N/A
Serbo-Croatian	N/A	N/A	N/A
Other Slavic	N/A	N/A	N/A
Armenian	N/A	N/A	N/A
Persian	N/A	N/A	N/A
Gujarathi	N/A	N/A	N/A
Hindi	N/A	N/A	N/A
Urdu	N/A	N/A	N/A
Other Indic	N/A	N/A	N/A
Other Indo-European	2	0%	14
Chinese	239	3%	249
Japanese	N/A	N/A	N/A
Korean	21	0%	34
Mon-Khmer, Cambodian	N/A	N/A	N/A
Hmong	N/A	N/A	N/A
Thai	N/A	N/A	N/A
Laotian	N/A	N/A	N/A
Vietnamese	0	0%	17
Other Asian	0	0%	17
Tagalog	0	0%	17
Other Pacific Island	N/A	N/A	N/A
Navajo	N/A	N/A	N/A
Other Native American	N/A	N/A	N/A
Hungarian	N/A	N/A	N/A
Arabic	151	2%	194
Hebrew	N/A	N/A	N/A
African	N/A	N/A	N/A
Other and non-specified	111	2%	114
Total Non-English	743	11%	801

Data Note: Detail may not sum to totals due to rounding. Hispanic popultion can be of any race.
N/A meansnot available. **Source:** U.S. Census Bureau, American Community Survey (ACS) 2014 - 2018.
*Population by Language Spoken at Home is available at the census tract summary level and up.

EJSCREEN Census 2010 Summary Report

Location: User-specified polygonal location
Ring (buffer): 0-miles radius
Description:

Summary	Census 2010
Population	7,422
Population Density (per sq. mile)	1,141
People of Color Population	940
% People of Color Population	13%
Households	3,005
Housing Units	3,261
Land Area (sq. miles)	6.50
% Land Area	100%
Water Area (sq. miles)	0.01
% Water Area	0%

Population by Race	Number	Percent
Total	7,422	
Population Reporting One Race	7,265	98%
White	6,588	89%
Black	449	6%
American Indian	15	0%
Asian	163	2%
Pacific Islander	3	0%
Some Other Race	47	1%
Population Reporting Two or More Races	157	2%
Total Hispanic Population	175	2%
Total Non-Hispanic Population	7,247	98%
White Alone	6,482	87%
Black Alone	439	6%
American Indian Alone	12	0%
Non-Hispanic Asian Alone	162	2%
Pacific Islander Alone	3	0%
Other Race Alone	6	0%
Two or More Races Alone	142	2%

Population by Sex	Number	Percent
Male	3,570	48%
Female	3,852	52%

Population by Age	Number	Percent
Age 0-4	592	8%
Age 0-17	1,776	24%
Age 18+	5,646	76%
Age 65+	753	10%

Households by Tenure	Number	Percent
Total	3,005	
Owner Occupied	2,202	73%
Renter Occupied	804	27%

Data Note: Detail may not sum to totals due to rounding. Hispanic population can be of any race.
Source: U.S. Census Bureau, Census 2010 Summary File 1.

Appendix F

Acronyms and Abbreviations

Appendix F. Acronyms and Abbreviations

AGL – Above Ground Level

APE - Area of Potential Effects

BCC - Birds of Conservation Concern

BVLOS - Beyond Visual Line of Sight

CFR - Code of Federal Regulations

COA - Certificate of Waiver or Authorization

CZMP - Coastal Zone Management Plan

dB – Decibel

DNL - Day-Night Average Sound Level

DOT – Department of Transportation

EA - Environmental Assessment

EJSCREEN - Environmental Justice Screening Tool

EO - Executive Order

EPA - Environmental Protection Agency

ESA - Endangered Species Act

FAA - Federal Aviation Administration

FHWA – Federal Highway Administration

FEMA - Federal Emergency Management Agency

GA - General Aviation

HUD - Housing and Urban Development

IPaC - Information for Planning and Consultation

IPP - UAS Integration Pilot Program

NAS - National Airspace System

NEPA - National Environmental Policy Act

NHPA - National Historic Preservation Act

NMFS - National Marine Fisheries Service

NOA - Notice of Availability

NRHP - National Register of Historic Places

NTSB – National Transportation Safety Board

OpSpecs - Operations Specifications

PSP - Partnership for Safety Program

RPIC - Remote Pilot in Command

SHPO - State Historic Preservation Office(r)

TDAT - Tribal Directory Assessment Tool

THPO - Tribal Historic Preservation Office

UA - Unmanned Aircraft

UAS - Unmanned Aircraft Systems

USC – United States Code

USFWS - United States Fish and Wildlife Service

Wing – Wing Aviation, LLC