ARTHUR CARHART NATIONAL WILDERNESS TRAINING CENTER

MINIMUM REQUIREMENTS DECISION GUIDE WORKBOOK

"…except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act…"

-- The Wilderness Act of 1964

Project Title: Impacts of Avian Malaria on Threatened and Endangered Forest Birds on Maui

MRDG Step 1: Determination

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

Description of the Situation

What is the situation that may prompt administrative action?

More than 30 species of forest birds known as Hawaiian honeycreepers have gone extinct over the last 20–200 years (Banko and Banko 2009, Elphick et al. 2010, USFWS 2021). Many of the remaining 17 species are considered at risk, with some populations exhibiting rapid and recent declines (Paxton et al. 2016, Judge et al. 2021). The primary cause of these declines is avian malaria, a non-native disease that is caused by a parasite (*Plasmodium relictum*) spread by the invasive southern house mosquito (*Culex quinquefasciatus*).

Hawaiian honeycreepers have little resistance to avian malaria and most cannot survive infection (Atkinson et al. 1995, LaPointe and Atkinson 2009). Until recently, honeycreepers were able to persist in high elevation forests where it was too cold for mosquitoes and the avian malaria parasite to reproduce. Recent climate changes have allowed mosquitoes and associated avian malaria to start invading these upper elevation forests on Maui, killing native forest birds in their last remaining locations. At least two endangered bird species on East Maui, kiwikiu (Maui Parrotbill, *Pseudonestor xanthophrys*) and ʻākohekohe (*Palmeria doeli*), are expected to become extinct within two to fifteen years if avian malaria is left unchecked (Mounce et al. 2018, Paxton et al. 2022).

There are currently fewer than 200 kiwikiu and fewer than 2,000 ʻākohekohe persisting in the wild, all of which are located on East Maui (Judge et al. 2021). Both species have declined by more than 70 percent over the last two decades. Four additional Hawaiian honeycreepers also reside on East Maui: the threatened ʻiʻiwi (*Drepanis coccinea*), Maui ʻalauahio (only lives on Maui; *Paroreomyza montana*), Hawaiʻi ʻamakihi (*Chlorodrepanis virens*), and ʻapapane (*Himatione sanginea*). These species are also affected by avian malaria.

Haleakalā National Park and The State of Hawaiʻi Department of Land and Natural Resources (DLNR) are concerned about native forest bird mortality and the risk of extinction caused by avian malaria introduced by southern house mosquito populations on East Maui. These non-native invasive mosquitoes are the only insect that transmits avian malaria in this area.

Options Outside of Wilderness

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

☐ YES **STOP – DO NOT TAKE ACTION IN WILDERNESS**

☒ NO **EXPLAIN AND COMPLETE STEP 1 OF THE MRDG**

Explain:

The NPS and DLNR identified an area through a collaborative process, during which all lands within much of the current and historic ranges of threatened and endangered forest birds on East Maui were evaluated for inclusion. The area includes locations downslope from many birds' current ranges that may serve as high-density mosquito breeding grounds from which mosquitoes may move upward in elevation into native forest bird habitat. The upper elevation limit of the area was defined by the boundary of the park along the north slope and Palikū Ridge between Pōhaku Pālaha and Kuiki, separating native forest from Haleakalā Crater. The lower limit of the area, 1,969 feet above sea level, is the low elevation range of vulnerable native forest birds, such as the ʻapapane and ʻiʻiwi (Judge et al. 2019) except within the boundaries of the park in the Lower Kīpahulu Valley and Kaʻapahu where the area extends to sea level.

A decline in distribution and abundance of the mosquito populations within the above-described area would ensure that there would be fewer remaining mosquitoes capable of biting and infecting threatened or endangered forest birds with avian malaria. Population densities of mosquitoes are dependent on precipitation patterns, habitat availability, and temperature. The project team used all available data, including statistical models for decline, to estimate the distribution of mosquitoes within the identified area. The current range of kiwikiu and ʻākohekohe (Judge et al. 2021) and mosquito movements were applied to identify areas where mosquitoes might occur and spread disease.

To achieve the greatest possible reduction in the mosquito population, activities would need to occur at a specific frequency within a specific area. The frequency, amount, and spatial coverage of action could decrease over time depending on success in declines of the mosquito population. Based on available data, statistical models for decline, and habitat range, all potential areas need to be included if action is taken to achieve success. As results are monitored, actions in areas of wilderness may be reduced and reduction will be prioritized through minimum requirements analysis.

The identified area includes approximately 64,666 acres, including NPS land (12,042 acres), DLNR lands in forest reserves and natural area reserves (37,989 acres), adjacent lands privately managed in a conservation easement by The Nature Conservancy (TNC) (8,606 acres), East Maui Irrigation Company, LLC (4,409 acres), Haleakala Ranch (393 acres), and Mahi Pono (1,227 acres) lands managed for conservation. Approximately 14 percent of the identified area is in wilderness, which is only present on NPS lands. Not all NPS land within the identified area is within designated wilderness. Within the park, kiwikiu and ʻākohekohe only occur within designated wilderness. Due to the current and historic ranges of threatened and endangered forest birds and breeding grounds and ranges of invasive mosquitoes within Haleakalā Wilderness, action needs to be taken within wilderness to effectively address threats to threatened and endangered forest birds.

Past attempts by park partnerships to save threatened and endangered forest bird populations on East Maui (i.e. translocation of birds) have not been successful due to many factors, but include the potential movement of mosquito population range due to changing climates.

Criteria for Determining Necessity

Is action necessary to meet any of the criteria below?

A. Valid Existing Rights or Special Provisions of Wilderness Legislation

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

☐ YES ☒ NO

Explain:

There is no wilderness legislation that mandates the suppression or elimination of non-native mosquitoes and thus avian malaria in threatened and endangered forest bird populations.

But, as outlined in Case Law: ***Wilderness Watch v. Vilsack*, Case No. 4:16-cv-12-BLW (D. Idaho Feb. 12, 2018)** *Wilderness Watch* , 629 F.3d at 1033, 1039–40 (recognizing that Congress "did not mandate that the Service preserve the wilderness in a museum diorama ... [i]nstead, Congress stated

that the wilderness was to be preserved as wilderness and made accessible to people, devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical uses.")…(the Act "could have directed that the area remain entirely wild and unmanaged, but it did not take that path"). In fact, the required analysis for Wilderness Act compliance allows an agency to determine that another purpose consistent with the Act is more important than maintaining pristine wilderness, but in doing so the agency must make the requisite findings. *High Sierra Hikers Ass'n* , 390 F.3d at 647.

The Wilderness Act of 1964 - Section 4(d)(1): "... In addition, such measures may be taken as may be necessary in the control of fire, insects, and diseases, subject to such conditions as the Secretary deems desirable."

The language of the law indicates that "such measures **may** be taken" (emphasis added) and no specific actions (such as inventory, monitoring, treatment, etc.) are identified. If action is necessary in wilderness the specific possible actions and their potential impacts will be addressed in Step 2.

The Wilderness Act of 1964 - Section 4(b): The language of the law states, "…wilderness areas shall be devoted to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use." Conservation of native species supports the public purpose of conservation. In this case, action is necessary to prevent the extirpation of some native forest bird species.

B. Requirements of Other Legislation

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

☒ YES ☐ NO

Explain:

Endangered Species Act 1973 (Public Law 93-205) as amended. Sec. 2 (c) POLICY.—(1) It is further declared to be the policy of Congress that all Federal departments and agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of this Act.

Federal Land Policy and Management Act of 1976, as amended, Public Law 94-579

Executive Order 13112, February 3, 1999, directs all agencies in the Executive Branch to: prevent the introduction of invasive species, detect and respond rapidly to and control populations of such species, provide for restoration of native species and habitat, conduct research and develop technologies, promote public education, and directs agencies not to authorize, fund, carry out actions that are likely to cause or promote the introduction or spread of invasive species. It also directs the creation of a federal invasive species council, directs the development of a national Invasive Species Management Plan and Invasive Species information clearinghouse, and directs federal agencies to participate in the council and to implement the Invasive Species Management Plan.

The Organic Act of the National Park Service (NPS):
"Sec.1. …. The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."
The Organic Act directs us "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The 1978 Amendment (a.k.a. Redwoods Act) strengthened the protective functions of NPS and influenced recent decisions regarding resource impairment. "…the protection, management, and administration of these areas shall be conducted in the light of the high public value and integrity of the NPS and shall not be exercised in derogation of the values and purposes for which these various areas have been established…"

C. Wilderness Character

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

UNTRAMMELED

☐ YES ☒ NO

Explain:

It is not necessary to take action to preserve this quality. Untrammeled means the "earth and its community of life" are essentially unhindered and free from modern human control or manipulation, "in contrast with those areas where man and his own works dominate the landscape."

Any action to aid in the decline of invasive mosquito populations to address the impacts of avian malaria on threatened and endangered forest birds on East Maui would be a manipulation of the natural processes of wilderness, and a trammeling, even though mosquito (*Culex quinquefasciatus*) is a highly adaptive and invasive mosquito that transmits avian malaria caused by the blood parasite *Plasmodium relictum* and the action may ultimately help restore natural conditions.

UNDEVELOPED

☐ YES ☒ NO

Explain:

It is not necessary to take action to preserve this quality. Preserving this quality keeps areas free from “expanding settlement and growing mechanization” and “with the imprint of man’s work substantially unnoticeable” and without structures, installations, temporary or permanent roads, or use of motorized equipment, mechanical transport, or landing or aircraft, as required by the Wilderness Act. The Undeveloped quality is preserved when wilderness retains its "primeval character and influence," and is essentially "without permanent improvements" or modern human occupation.

Any use of motors, mechanical transport, or structures or installations are a development. The landing of aircraft is a prohibited use and should only be considered “except as necessary to meet minimum requirements for the administration of the area for the purpose of this Act.” The potential impacts and mitigations should be considered to preserve wilderness and will be discussed in Step 2 alternatives.

NATURAL

☒ YES ☐ NO

Explain:

It is necessary to take action to preserve this quality. A wilderness area is to be "protected and managed so as to preserve its natural conditions" meaning that wilderness ecological systems are substantially free from the effects of modern civilization. To preserve this quality and address the Scenic and Conservation public purposes of wilderness, it may be necessary to take action to correct unnatural conditions even if they were present at the time of designation.

Avian diseases transmitted by non-native mosquitoes pose the greatest threat to the survival of Hawaiian honeycreepers. The cumulative effect of loss would severly alter the ecological system, including their roles in pollination and as drivers of ecological process. Native forest birds of Hawai‘i represent one of the greatest examples of variety and adaptation anywhere in the world and are important to the observational opportunities of Park visitors, native Hawaiians, and the birding community.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

☐ YES ☒ NO

Explain:

It is not necessary to take action to preserve this quality. The Wilderness Act defines wilderness as having “outstanding opportunities for solitude or a primitive and unconfined type of recreation.” This quality is preserved when the opportunity for people to experience wilderness in terms of the visitor's sense of solitude, and their expectation for an undeveloped environment with minimal restrictions is available.

Taking action would make only a slight contribution to preservation of this quality when compared to the need for action to preserve the Natural quality. Native Hawaiian forest bird calls are unique and they are significant species to the overall experience of wilderness. The sights and sounds of native forest birds adds to the visitor recreation experience in places of solitude.

The sounds created by some tools or methods to suppress invasive mosquito populations to address the impacts of avian malaria on threatened and endangered forest birds on Maui may be heard by park visitors in wilderness. Because the identified area for potential action occurs in areas that are closed to the public, only sound travel and distant visual disturbances will be considered. Efforts should be made to avoid instances of sound or visual disturbance.

OTHER FEATURES OF VALUE

☒ YES ☐ NO

Explain:

It is necessary to take action to preserve this quality. Hawaiian culture does not differentiate between natural and cultural resources, they are but the same. Hawaiian honeycreepers have a significant role in Hawaiian culture, including a connection to history, ancestry, and storytelling. Only 17 of the more than 50 honeycreeper species that once lived in Hawai‘i remain, with some of those remaining on the verge of extinction. The loss of multiple species continues to be devastating to Hawaiian culture and action needs to be taken.

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

Criteria for Determining Necessity

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

Is administrative action **necessary** in wilderness?

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

Explain:

The **Endangered Species Act** states “Federal agencies shall…utilize their authorities… by carrying out programs for the conservation of endangered species and threatened species.” Conservation, as defined in the Act, means “to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measure provided pursuant to the [Endangered Species] Act are no longer necessary. Such methods and procedures include, but are not limited to, all activities associated with scientific resources management."

Action is necessary to preserve this natural quality. A wilderness area is to be "protected and managed so as to preserve its natural conditions" meaning that wilderness ecological systems are substantially free from the effects of modern civilization. Avian diseases transmitted by non-native mosquitoes pose the greatest threat to the survival of Hawaiian honeycreepers. The cumulative effect of loss would severly alter the ecological systems on East Maui. Native forest birds of Hawai‘i represent one of the greatest examples of variety and adaptation anywhere in the world and are

important to the observational opportunities of Park visitors, native Hawaiians, and the birding community.

This project is critical to eliminate vectors of disease for critically endangered species on the brink of extinction and to sustain and possibly expand habitat for threatened and endangered Hawaiian forest bird species. Without action, mosquitoes would continue to spread avian malaria which would severely impact native forest birds leading to considerable mortality and likely extinction. Taking action supports the critical role Hawaiian native forest birds play in the natural quality.

MRDG Step 2

*Determine the **Minimum** Activity*

Other Direction

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

AND/OR

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

☒ YES **DESCRIBE OTHER DIRECTION**

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

Describe Other Direction:

Federal Register Vol. 67, No. 31 / Thursday, February 14, 2002 / Notices 6944: Notice of Conversion of Potential Wilderness as Designated Wilderness, Haleakala National Park
"It is noted that construction of fences to exclude feral animals and access into the wilderness via helicopter for fence maintenance, to control destructive invasive alien plants and non-native animals may be necessary to preserve wilderness resources and ecosystem processes." Fran P. Mainella, Director, National Park Service

Management Policies 2006:
6.3.5 Minimum Requirement When determining minimum requirements, the potential disruption of wilderness character and resources will be considered before, and given significantly more weight than, economic efficiency and convenience.
6.3.7 Natural Resources Management Management actions, including the restoration of extirpated native species, the alteration of natural fire regimes, the control of invasive alien species, the management of endangered species, and the protection of air and water quality, should be attempted only when the knowledge and tools exist to accomplish clearly articulated goals.

Wilderness Building Blocks 1 & 2, Wilderness Basics and Wilderness Character Assessment:
Haleakalā Wilderness "Birds are the primary wildlife resource here and, like Haleakalā's native plants, native bird species have evolved to occupy a range of specialized niches, making for an intriguing yet fragile diversity of bird life. For threatened and endangered birds such as the 'ua'u, nēnē, 'ākohekohe (crested honeycreeper) and kiwikiu (Maui parrotbill) the wilderness provides integral habitat and offers reduced danger of predation by invasive land mammals."

Haleakalā National Park Strategic Plan FY22-26
Essential Priorities for FY22-26: #1 Save forest birds from extinction, #5 Invest in managing wilderness for resources and visitors.

Director's Order 41: Wilderness Preservation and Management:
Section C.4. Cultural Resource Management in Wilderness
p. 38 "There has been extensive prior human use in most areas now designated as wilderness, resulting in archeological sites, historic structures, cultural landscapes and associated features, objects and traditional cultural properties that are contributing elements to wilderness. It is important to recognize that laws, . . . intended to preserve our cultural heritage, are applicable in wilderness . . . actions involving all cultural resource types in wilderness must comply with cultural resource laws, such as compliance actions and inventory requirements mandated by NHPA [National Historic Preservation Act]." Note: The Archeological Resources Protection Act (ARPA) also has mandated inventory requirements.
Section C.8. Scientific Activities in Wilderness
p. 42 "The Wilderness Act intended, and NPS policy provides for, the conduct of legitimate natural and cultural scientific use of wilderness . . . Scientific activities are to be encouraged in wilderness, provided that the benefits of what may be learned outweigh the negative impacts on other wilderness values."

1995 General Management Plan/EIS for Haleakalā National Park
"Kīpahulu Valley is one of the outstanding areas of the Hawaiian Islands for native birds. The opportunities for research in this unspoiled area are legion. This was the conclusion of the 1967 Kīpahulu Valley Expedition, which found four rare birds, one previously considered extinct...It was in the high elevation zone of the valley from 5,000 to 7,350 feet that the expedition observed the endangered crested honeycreeper [ʻākohekohe], the rare Maui creeper, the Maui parrotbill [kiwikiu], and the Maui nukupuʻu, this last species previously thought to be extinct.
Since the presence of rare and endangered birds in Kīpahulu is presumed to be due in large measure to its relatively pristine state, any significant change in that environment would, in all likelihood, quickly lead to the extinction of the nukupuʻu [now extinct] and the Maui parrotbill [kiwikiu]."

2006 USFWS Revised Recovery Plan for Hawaiian Forest Birds
Of the 21 bird taxa addressed in this plan, 19 are federally listed as endangered and include Maui parrotbill [kiwikiu] (*Pseudonestor xanthophrys*) and ʻākohekohe or crested honeycreeper (*Palmeria dolei*). "The Endangered Species Act (16 U.S.C. 1531 et seq.) (ESA) requires the development of recovery plans for listed species…Recovery plans help guide the recovery effort by describing actions considered necessary for the conservation of the species…This recovery will be accomplished through a variety of recovery actions including: measures to protect habitat where the taxa occur, restoration of degraded habitat, removal of feral ungulates from habitat areas, control of introduced rodents and feral cats that feed on forest birds, control of invasive plant species, reduction in numbers of mosquito breeding sites, captive propagation and translocation, and the development of means to address threats of avian disease."

House Resolution (HR) 95 passed the Hawaii State House in 2021, urging DLNR, DOA, DOH and University of Hawai‘i to implement a mosquito control program using *Wolbachia* to reduce mosquito population levels throughout the state

Watson, T.K., Maxwell, D., McKown, E., Au, J., Thetford, C., Maly, K.
2022. Cultural Impact Assessment for the Proposed Activities Associated with the Suppression of Non-Native Mosquito Populations to Reduce Transmission of Avian Malaria to Threatened and Endangered Forest Birds on East Maui, Prepared for Tetra Tech and U.S. National Park Service, Honua Consulting, Honolulu, Hawai‘i.

Hawaii Invasive Species Council adopted Resolution 17-2 in 2017, supporting research and evaluation of landscape-scale control technologies for mosquitoes, and encouraging researchers to approach this research in a way that could potentially benefit both native wildlife and human health in Hawai‘i.

Report to the 30th Legislature, 2020 Regular Session, State of Hawai‘i: Report on the Importation and use of *Aedes aegypti* with Wolbachia Bacteria for Landscape Scale Control of Mosquitos in a Vector Control Program ACT 106, SLH 2019
“…mosquitoes within Hawai‘i also significantly impact the health of our animals. The Hawaiian honeycreepers represent a spectacular biological radiation of birds, yet, they are among the most highly imperiled group of birds globally. Introduced diseases transmitted by non-native mosquitoes are responsible for much of the decline in Hawai‘i’s forest birds....avian malaria was introduced in the early 1900s. With no prior exposure or natural immunity, native forest birds are highly susceptible to these non-native pathogens. Avian malaria, which is transmitted by the southern house mosquito (*Culex quinquefasciatus*), is the most significant mortality factor for the majority of Hawaiian forest birds. Over the past 30 years, nine more species of forest birds have gone missing and are most likely extinct. The remaining native birds live at high elevations where there is still some healthy forest habitat with few mosquitoes. However, rising temperatures and drought are enabling mosquitoes and the associated pathogens to expand their distributions into these higher elevations.”

HB1546 – Hawai‘i State Legislature, A Bill for an Act relating to Environmental Protection, 2020
The purpose of this Act is to eradicate mosquitoes from Hawai‘i to protect public health, native species, and way of life by providing funds to the University of Hawaii to scale up research, coordinate with appropriate state agencies, and develop a plan to be implemented for the statewide eradication of mosquitoes. **(Still in committee)**

Birds Not Mosquitoes Partnership Guidance which includes three state agencies (Hawai‘i Department of Land and Natural Resources, Hawai‘i Department of Health, University of Hawai‘i), three federal agencies (U.S. Fish and Wildlife Service, National Park Service, U.S. Geological Survey), five nongovernmental organizations (American Bird Conservancy, Coordinating Group on Alien Pest Species, Island Conservation, The Nature Conservancy, and Pacific Rim Conservation), and MosquitoMate (private entity).

Time Constraints

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

Immediate or timely management action needs to be taken to prevent the extinction of threatened and endangered forest birds on East Maui and remaining populations within Haleakalā Wilderness. On-going range retractions and severe population declines are predicted and expected, putting East Maui species at risk of extinction within the next decade. Delay in action may result in further decline and extinction.

Summer and fall months are when mosquito populations in Hawai'i peak (LaPointe 2000; Gaudioso-Levita et al. 2005; Warren et al. 2020). These are months when the temperatures are suitable for avian malaria transmission within the greatest elevation extent, including areas above 4,300 feet in elevation (where most threatened and endangered birds currently live and breed). The breeding season of most native forest birds peaks during the colder months from December through April (Berlin and Vangelder 2020, Fancy and Ralph 2020a,b, Simon et al. 2020). Limited disturbance from any action to breeding forest birds should be ensured during this time.

Components of the Action

What are the discrete components or phases of the action?

Component X:	*Example: Transportation of personnel to the project site*
Component 1:	Transportation of personnel to project site
Component 2:	Transportation of material to project site
Component 3:	Mosquito suppression technique
Component 4:	Release method 1 (primary)
Component 5:	Release method 2 (back-up)
Component 6:	Monitoring and tools used at project site
Component 7:	Condition of site after project

Proceed to the alternatives.

Refer to the **MRDG Instructions** regarding alternatives and the effects to each of the comparison criteria.

MRDG Step 2: Alternatives

Alternative 1:

The NPS and DLNR propose to reduce native forest bird mortality from avian malaria by suppressing southern house mosquito populations on East Maui. These non-native invasive mosquitoes are the only insect that transmits avian malaria in this area. The proposed action consists of repeatedly releasing incompatible male southern house mosquitoes (hereafter "incompatible mosquitoes"), which would prevent mosquitoes within the project area from being able to reproduce. This approach employs the incompatible insect technique (IIT), which uses a naturally occurring bacteria called Wolbachia that is present in many insect species on Maui. When male mosquitoes with an incompatible strain of Wolbachia are introduced to a population of female mosquitoes, mating is unproductive, thereby suppressing mosquito populations (Atyame et al 2015). When releases are done repeatedly over time, they further suppress the mosquito population and, in turn, would suppress transmission of avian malaria.

The proposed action consists of repeatedly releasing incompatible male mosquitoes to reduce the reproductive potential of mosquitoes in the project area. This approach employs IIT, which uses a naturally occurring bacteria called Wolbachia that is present in the eggs and sperm of many insect species, including the southern house mosquito (Hilgenboecker et al. 2008, Bennett et al. 2012). Releases under the proposed action must be conducted repeatedly over time to achieve and maintain significant suppression of the mosquito population, and like other similar mosquito suppression projects, this project has the potential to suppress the mosquito population by 90 percent or more (Beebe et al. 2021, Crawford et al. 2020, and Zheng et al. 2019). Monitoring of mosquito populations would guide the frequency, number, and location of releases, and would need to continue for as long as the proposed action is implemented. The park would oversee implementation on federal lands and DLNR on state and private conservation lands or those managed by TNC. For the purposes of this document, we will only discuss the action on NPS Haleakalā Wilderness lands.

The proposed action would start with small scale on-the-ground or aerial releases of incompatible mosquitoes within the project area, where field teams would be able to monitor effectiveness of IIT implementation. Most of the project area is inaccessible by ground, and thus would require uncrewed aircraft systems (a.k.a. drones) to implement large-scale mosquito releases throughout the project area. Releases via helicopter may be required as a short-term (up to two months), temporary release method if drones are not available. Mosquito release technologies would resemble those established for IIT (or related techniques) suppression projects of the yellow fever mosquito (Aedes aegypti), which have been successfully implemented in the United States and other parts of the

world (Mains et al. 2016, Bouyer et al. 2020, Crawford et al. 2020, Moreira et al. 2009, Hoffman et al. 2011, Ritchie et al. 2014, Dutra et al. 2016). Releases would be expected to continue until southern house mosquito populations are significantly reduced and the status of threatened and endangered forest birds stabilizes, or until new mosquito population suppression techniques are developed. Releases may be conducted in a piecemeal fashion over the project area because of limitations in resources (e.g., availability of drones, personnel, or incompatible mosquitoes). The details of the proposed action are described below and include descriptions of the project area, frequency, timing, mosquito release methodology, and monitoring techniques.

During implementation, mosquitoes may be released directly from drones or handheld containers, or from small biodegradable packages that could be dispersed by drones or helicopters. Mosquito releases would be primarily conducted via drones. If there are obstacles to using drones for aerial releases in the core area, NPS would release incompatible mosquitoes from helicopters over the short term (up to two months), either from a release device attached to the belly of a helicopter or from a long cable affixed with a device that could allow release of mosquitoes closer to the forest canopy or floor (described below). It is expected that limited pedestrian releases and monitoring would be conducted simultaneously with broadscale aerial releases. Please see descriptions for each below.

Drones would operate somewhat automatically (monitored by an operator), flying a prescribed route and releasing incompatible mosquitoes at the pre-determined release locations in the core area. It is estimated that drones would fly approximately 50–100 feet above the tree canopy during mosquito releases but no higher than 500 feet above ground level (AGL) when ferrying between release locations and the operator. Some larger areas would require multiple days to conduct releases, while smaller areas may only require a few hours for each aerial release. Incompatible mosquitoes would likely be released in small biodegradable packages designed to open upon contact with the canopy or forest floor. All NPS land treatments (releasing mosquitoes at each location) could require from 5.9 to 11 hours of flight time per week, assuming that 2 treatments need to occur each week. Release frequency was determined by seasonal temperature patterns where warmer low elevation areas may require releases throughout the year, while high elevation areas would only require releases during warmer summer months.

Because of the steep topography and dense vegetation in the project area, helicopters are invaluable for transporting personnel and equipment to remote areas. Given the noise and visual impacts, logistics, and financial requirements of helicopters, the use of helicopters for releasing incompatible mosquitoes is proposed as a short-term (up to two months), temporary release method if drone releases are unavailable. In that event, helicopters could release incompatible mosquitoes for up to two months in management units where population suppression can be sustained. All NPS land treatments (releasing mosquitoes at each location) could require from 3.4 to 6.1 hours of flight time per month, assuming that 2 treatments need to occur each week. This would only be a temporary release method if drone releases are unavailable.

Pedestrian releases may only be possible within Haleakalā National Park on a quarterly basis simultaneous with ground-based mosquito monitoring. For the purposes of this document, pedestrian releases will be included under montoring. A helicopter would be required to transport crews into the field to reach LZs near monitoring and release locations in NPS lands. Field teams would conduct a variety of monitoring activities to measure the effectiveness of the proposed action. Field teams would trap mosquitoes in release areas to determine relative abundance of the mosquito population, dispersal distance of incompatible mosquitoes, and estimated hatch success. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing, e.g., for absence or presence of avian malaria. Sustained and regular mosquito trapping would be necessary to understand the proposed action's effectiveness and track seasonal fluctuations in population densities. Monitoring would likely occur quarterly (four times/year) within two locations in the park (in Kīpahulu Valley Biological Reserve). Field would need to use portable generators to charge the batteries in the mosquito traps at these 2 locations. Mosquito monitoring would involve field teams camping at established remote shelters or helicopter LZs for overnight stays for approximately one week at a time. Where needed, a helicopter would deliver field teams to established LZs within Haleakalā National Park. All NPS land monitoring could require up to 7 hours of flight time per quarter (3 months).

No vehicle support is needed for the proposed action in NPS lands/Haleakalā Wilderness.

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

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	Transportation of personnel to project site	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.
2	Transportation of materials to project site	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.
3	Mosquito suppression technique	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.
4	Release method 1 (primary)	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.

Comp #	Component of the Action	Activity for this Alternative
5	Release method 2 (backup)	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per month as a temporary (up to 2 months) replacement of drone release method.
6	Monitoring and tools used at project site	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in "transportation. Monitoring at these sites would involve field teams camping at established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.
7	Condition of site after project	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.

Wilderness Character

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

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.	☐	☐	☒
2	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.	☐	☐	☒
3	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.	☐	☒	☐
4	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.	☐	☐	☒
5	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per	☐	☐	☒

	month as a temporary (up to 2 months) replacement of drone release method.			
6	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in "transportation. Monitoring at these sites would involve field teams camping at established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.	☐	☒	☐
7	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.	☐	☐	☒
8		☐	☐	☐
9		☐	☐	☐
10		☐	☐	☐
		0	2	NE

Untrammeled Total Rating	- 2

Explain:

Releasing incompatible mosquitoes in wilderness is an intentional alteration of the biophysical environment and degrades the untrammeled quality. The Incompatible Insect Technique has been an effective method to limit mosquito populations around the world for disease trasmission. Trapping invasive mosquitoes in wilderness degrades the untrammel quality, yet is neccessary to inform the proposed action's effectiveness, track seasonal fluctuations in mosquito population densities, and test mosquitoes for presence of avian diseases. Naturalized invasive *Culex* mosquitoes are not native to Hawai'i and pose threats to humans and native species.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.	☐	☒	☐
2	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.	☐	☒	☐

3	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.	☐	☒	☐
4	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.	☐	☒	☐
5	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per month as a temporary (up to 2 months) replacement of drone release method.	☐	☒	☐
6	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in “transportation. Monitoring at these sites would involve field teams camping at established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.	☐	☒	☐
7	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.	☐	☐	☒
8		☐	☐	☐
9		☐	☐	☐
10		☐	☐	☐
Total Number of Effects		0	6	NE

Undeveloped Total Rating	- 6

Explain:

The Undeveloped quality is degraded by the use of helicopters, drones, motorized and mechanized equipment, and presence of biodegradable packages. Designated wilderness within the project area consists of critical habitat for threatened and endangered bird species, which is highly unaccessible on foot.

Using drones to release incompatible mosquitoes poses a negative impact to the undeveloped quality due to audible and visible presence, but were selected as the primary method due to lessened impact on wilderness character than the back-up method of helicopter release. Drone releases could utilize biodegrable packages, which would have temporary negative impact to the undeveloped quality with their presence in wilderness until they biodegrade.

Helicopter use with wilderness degrades the undeveloped quality due to the adverse impacts of generated noise and presence of mechanical transport. Helicopter as a release method would be used if drones are not available, only up to a 2-month period, and would not touch down on the ground. Helicopter use to transport monitoring crew and equipment into 2 wilderness locations would degrade the undeveloped quality and would need to touch down on the ground, yet would only be utilized 4x/year. During these monitoring events, generators would be used to charge batteries used in traps. Generators would likely be used for up to 3 hours per day for up to seven consecutive days during the monitoring trips.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.	☐	☐	☒
2	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.	☐	☐	☒
3	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.	☐	☐	☒
4	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.	☐	☒	☐
5	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per month as a temporary (up to 2 months) replacement of drone release method.	☐	☒	☐
6	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in “transportation. Monitoring at these sites would involve field teams camping at	☐	☒	☐

	established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.			
7	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.	☒	☐	☐
8		☐	☐	☐
9		☐	☐	☐
10		☐	☐	☐
Total Number of Effects		1	3	NE

Natural Total Rating	- 2

Explain:

Native Hawaiian forest bird species are an immensely important part of the overall Hawaiian ecosystem and provide intrinsic benefits to the wilderness. The unique variety and endemism of the threatened and endangered species is matched no where else in the world.

Although clearing and movement of personnel may impact the natural environment in the initial phases, the long term benefits to native forest bird habitat (especially those populations threatened by avian malaria) are expected over progression of the action. Existing paths will be used that generally avoid rare plants and have fern ground cover that can quickly recuperate.

While the use of helicopters, drones, and generators degrade the natural quality as it relates to native species disruptions, the overall benefits to the natual quality outweigh the temporary impacts. Peak release events and monitoring will be minimal during or completely avoid critical nesting seasons for threatened and endangered species birds in the area. The reduction in the mosquito population under the proposed action, and the subsequent reduction in native forest bird mortality from the transmission of avian malaria, would result in substantial beneficial impacts to the natural quality of wilderness character because of the resultant stabilization or increase in native forest bird populations over time.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

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

1	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.	☐	☒	☐
2	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.	☐	☒	☐
3	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.	☐	☐	☒
4	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.	☐	☒	☐
5	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per month as a temporary (up to 2 months) replacement of drone release method.	☐	☒	☐
6	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in "transportation. Monitoring at these sites would involve field teams camping at established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.	☐	☐	☒
7	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.	☐	☐	☒
Total Number of Effects		0	- 4	NE

Solitude or Primitive & Unconfined Rec. Total Rating	- 4

Explain:

The only NPS lands within the project area that are within desinated wilderness are closed to to public access and recreation. However, drone and helicopter flights to and from the project area over the Summit District portion of designated wilderness would occur on an intermittent basis (approximately once or twice per week), very briefly (perhaps 15 seconds to a few minutes) audibly and visibly impacting the primitive wilderness experience.

Direct adverse impacts on the primitive wilderness experience would result, though these would be rarely and intermittently perceptible to visitors in accessible wilderness areas. Project noise created within the Kīpahulu Valley Biological Reserve and Manawainui portion of designated wilderness that does not travel beyond that boundary would not affect opportunities for solitude and primitive experiences in wilderness areas open to public access.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	Personnel will travel by helicopter and land in 2 NPS wilderness locations 4x/year.	☐	☐	☒
2	Materials will be transported by helicopter and external loads will touch down in 2 NPS wilderness locations 4x/year.	☐	☐	☒
3	Incompatible mosquitoes will be released into wilderness directly from release mechanisms or handheld containers, or from small biodegradable packages.	☐	☐	☒
4	Drone release of incompatible mosquitoes within wilderness from 5.9 to 11 hours of flight time per week.	☐	☐	☒
5	Helicopter release of incompatible mosquitoes within wilderness from 3.4 to 6.1 hours of flight time per month as a temporary (up to 2 months) replacement of drone release method.	☐	☐	☒
6	Helicopter transport of crew to 2 wilderness locations 4x/year impacts assessed in “transportation. Monitoring at these sites would involve field teams camping at established remote shelters or LZs for approximately one week at a time. Field teams would place traps along existing trails and fence lines, collect mosquitoes from traps, and preserve the captured mosquitoes for additional testing. Portable generators are needed to charge the batteries in the mosquito traps at 2 locations.	☐	☐	☒
7	Successive releases of incompatible mosquitoes within wilderness are expected to reduce the population density of invasive mosquitoes and disease transmission. Forest bird populations and habitat see a reduction of this vector of disease.	☒	☐	☐
8		☐	☐	☐
9		☐	☐	☐
10		☐	☐	☐
Total Number of Effects		1	0	NE

Other Features of Value Total Rating	1

Explain:

Preventing the extiction of native Hawaiian forest birds would have a positive effect on the Other Features quality. “Hawaiian culture views natural and cultural resources as largely being one and the same: without the resources provided by nature, cultural resources could and would not be procured. From a Hawaiian perspective, all natural and cultural resources are interrelated, and all natural and cultural resources are culturally significant. We find in native traditions and beliefs, that Hawaiians shared spiritual and familial relationships with the natural resources around them.” (Watson et al. 2022)

"As stated in the [2022 Cultural Impact Assessment], native birds could be considered a cultural resource as they are entwined in both Hawaiian culture and tradition across the islands. The history of the birds in Hawai‘i is one of tremendous adaptive radiation due to geographic isolation resulting in numerous species of birds found nowhere else on earth. This project would directly impact native forest birds as a cultural resource, resulting in some periodic, short-term negative impacts due to increased air traffic, but long-term benefits by preventing the spread of avian malaria and in turn bird mortality. Current park operations, e.g., flight times and flight paths, will be planned to balance efficiency and any potential impacts." (Watson et al. 2022)

The proposed action would have no impact on physical historical resources within designated wilderness. The brief, intermittent drone flights or those of a helicopter as a short-term (up to two months), temporary release method would only very briefly impact other features of value. The proposed action would likely support a considerable recovery of native forest birds which are of cultural importance to Native Hawaiians, thus benefiting the cultural landscape and the other features of value quality of wilderness.

Summary Ratings for Alternative 1

Wilderness Character	Rating Summary
Untrammeled	- 2
Undeveloped	- 6
Natural	- 2
Solitude or Primitive & Unconfined Recreation	- 4
Other Features of Value	1
Wilderness Character Summary Rating	- 13

MRDG Step 2: Alternatives

Alternative 2: No action

Description of the Alternative

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

Under the no-action alternative, release of incompatible mosquitoes would not occur. Although ongoing conservation and other management activities would continue on East Maui (e.g., fencing, removal of non-native ungulates and predators, invasive plant control), native forest birds would continue to be adversely affected by their primary threat, avian malaria, because the mosquitoes that carry this disease would remain uncontrolled.

Component Activities

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

Comp #	Component of the Action	Activity for this Alternative
X	*Example: Transportation of personnel to the project site*	*Example: Personnel will travel by horseback*
1	No action	No suppression of invasive mosquito populations and avian malaria transmission.
2	Condition of site by taking no action	Native forest birds would continue to be adversely affected by their primary threat, avian malaria, because the mosquitoes that carry this disease would remain uncontrolled.
3		
4		
5		
6		
7		
8		
9		

Wilderness Character

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

UNTRAMMELED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	No suppression of *Culex* mosquito populations and avian malaria transmission	☐	☐	☒
2	*Culex* populations will continue to thrive, along with avian malaria transmission allowing continual decline of forest bird populations	☐	☐	☒
3		☐	☐	☐
Total Number of Effects				NE

Untrammeled Total Rating	0

Explain:

There is no effect on the untrammeled quality of wilderness character under the no action alternative.

UNDEVELOPED

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	No suppression of *Culex* mosquito populations and avian malaria transmission	☐	☐	☒
2	*Culex* populations will continue to thrive, along with avian malaria transmission allowing continual decline of forest bird populations	☐	☐	☒
3		☐	☐	☐
Total Number of Effects				NE

Undeveloped Total Rating	0

Explain:

There is no effect on the undeveloped quality of wilderness character under the no action alternative.

NATURAL

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	No suppression of *Culex* mosquito populations and avian malaria transmission	☐	☒	☐
2	*Culex* populations will continue to thrive, along with avian malaria transmission allowing continual decline of forest bird populations	☐	☒	☐
3		☐	☐	☐
Total Number of Effects			2	NE

Natural Total Rating	- 2

Explain:

Under the no-action alternative, the natural quality of wilderness would continue to severely degrade with the irreparable harm to native forest bird species. No action would be taken to protect multiple threatened and endangered forest birds susceptible to avian malaria, including creating a safer habitat for population numbers to be sustained or potentially expand. No action would allow the continual degradation of the Natural quality.

SOLITUDE OR PRIMITIVE & UNCONFINED RECREATION

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	No suppression of *Culex* mosquito populations and avian malaria transmission	☐	☐	☒
2	*Culex* populations will continue to thrive, along with avian malaria transmission allowing continual decline of forest bird populations	☐	☐	☒
3		☐	☐	☐
Total Number of Effects				NE

Solitude or Primitive & Unconfined Rec. Total Rating	0

Explain:

There is no effect on solitude and unconfined recreation under the no action alternative.

OTHER FEATURES OF VALUE

Activity #	Component Activity for this Alternative	Positive	Negative	No Effect
X	*Example: Personnel will travel by horseback*	☐	☐	☒
1	No suppression of *Culex* mosquito populations and avian malaria transmission	☐	☒	☐
2	*Culex* populations will continue to thrive, along with avian malaria transmission allowing continual decline of forest bird populations	☐	☒	☐
3		☐	☐	☐
Total Number of Effects			2	NE
Other Features of Value Total Rating		- 2		

Explain:

No action would allow the continual degradation of Other Features quality relating to Hawaiian culture and history in their relationship to native forest bird species. The significant loss of multiple forest bird species would diminish opportunities for Hawaiian cultural connection.

Summary Ratings for Alternative 2

Wilderness Character	Rating Summary
Untrammeled	0
Undeveloped	0
Natural	- 2
Solitude or Primitive & Unconfined Recreation	0
Other Features of Value	- 2
Wilderness Character Summary Rating	- 4

MRDG Step 2: Alternatives Not Analyzed

Alternatives Not Analyzed

What alternatives were considered but not analyzed? Why were they not analyzed?

ALTERNATIVES POTENTIALLY CONSIDERED BUT DISMISSED FROM FURTHER CONSIDERATION

During the development of the proposed action and refinement of the project's purpose and need statement, the NPS and DLNR considered numerous alternatives that were ultimately dismissed from detailed analysis. A summary of these alternatives and reasons for their dismissal from further consideration are provided below. The NPS and DLNR dismissed alternatives preliminarily determined to be infeasible and as such would not accomplish the purpose and need of the project, which is to substantially suppress or eliminate wild mosquito populations and thus avian malaria in threatened and endangered forest bird populations on East Maui. Therefore, the NPS and DLNR dismissed these alternatives from further consideration in the Environmental Assessment.

Sterile Insect Technique

The Sterile Insect Technique (SIT) aims to sterilize male insects and release them into the wild population to reduce reproductive output and suppress insect populations. The technique has been successfully applied globally to several species of pests, including some species of mosquito (Dyck et al. 2021). The primary method for sterilizing male mosquitoes is through gamma ray exposure, which induces random breaks in the DNA to cause infertility (Klassen and Curtis 2021). Captive reared gamma-irradiated males are released into a population to mate with wild females, which in turn would lay non-viable eggs. Initial *Culex* SIT field trials demonstrated success in inducing modest to high levels of sterility in wild females by releasing irradiated males in small areas of India and Florida (Patterson et al. 1975, 1977). Larger SIT field trials were complicated by mated female immigration (Yasuno et al. 1975) and several *Aedes* SIT trials indicated that irriadiated males had reduced mating competitiveness (Bellini et al. 2013, Yamada et al. 2014). Concerns regarding the quality of SIT males and their mating competitiveness were alleviated by several successful *Aedes* SIT trials (Ageep et al. 2014, Madakacherry et al. 2014), but uncertainties remained for *Culex*. During the "To Restore a Mosquito-Free Hawai'i" workshop in 2016, experts weighed the advantages and disadvantages of both the Insect Incompatibility Technique (IIT) and SIT methods and cited evidence of reduced fitness of SIT male *Aedes* mosquitoes when compared to IIT *Wolbachia* males (Atyame et al. 2016). The group expressed the need for additional laboratory research for identifying the irradiation dose that would fully sterilize males and maintain competitiveness with wild *Culex* males in Hawaiian rainforests. Elsewhere, SIT has been applied in conjunction with several *Aedes* IIT programs, primarily as a means for ensuring that no sterile *Wolbachia* females are released accidentally with *Wolbachia* males (Zhang et al. 2015, Bourtzis et al. 2016). Advancements in sex-sorting techniques reduced the need for integrated SIT and IIT programs and help propel IIT as the primary means for suppressing *Culex* populations in Hawai'i. Researchers are working to overcome the complication of reduced competitiveness in irradiated *Culex* males and their findings should determine if SIT will be a viable tool worth considering in the future, however for the purposes of this project, this alternative is considered but dismissed because it does not meet the purpose and need for action at this time and is technically infeasible.

Introducing Self-Limiting Male Mosquitoes with Edited Genes

Male mosquitoes may be engineered to contain a self-limiting gene that, when passed to offspring, prevents the offspring from developing into adulthood. This method has been proposed for implementation in Florida, and an Experimental Use Permit was issued by the Food and Drug Administration. However, this technology is not currently available for near-term implementation using *Culex* mosquitoes. Because this approach is still in experimental phase and the successfulness of the approach is unknown, this alternative is considered but dismissed because it does not meet the purpose and need and may have unknown environmental effects.

Gene Drive

The gene drive method involves introducing a novel DNA sequence that permanently transfers a useful trait into a wild population to eliminate the population or render it inert for the threat it poses. In this system, this would be done by engineering *Culex* mosquitoes to carry a certain gene and releasing those mosquitoes into the wild to spread that particular trait. The gene in the released mosquitoes may theoretically code for any number of traits including mutations resulting in mortality or even alter vector-parasite compatibility. This method has the ability to eliminate mosquito populations island-wide or alter the population in a lasting manner. Although there would be up-front development costs, there may be no need to repeatedly deploy treatment mosquitoes once introduced as this is not a self-limiting method. However, this technology is still approximately 10–20 years away from viability and has not been proven or tested in the field. Safeguards would also need to be developed and there may be some public resistance to a tool using genetic modification. For the purposes of this project, this alternative was considered but dismissed because it is technically infeasible at this time.

Mosquito Habitat Source Reduction

Alteration or removal of water bodies has long been used to control mosquito numbers through reduction in larval habitat. Draining or channelizing waterways has been an effective method of reducing standing water and thus suppressing mosquito reproduction for centuries. However, alteration of the natural hydrology of an area can have significant effects, impacting numerous species and entire ecosystems. The hydrology of the mountainous regions of Hawai‘i, including the project area considered here, is driven by rainfall patterns and little ground water is maintained for long periods in lakes, ponds, or wetlands that could act as breeding grounds for mosquitoes. Thus, there are few wetland/marsh habitats to drain or alter in the project area, even if such an action was considered. Additionally, enumerable species depend on the natural flow of water on the landscape and there is a high likelihood of significant adverse impacts to other listed species or species of concern. Therefore, this alternative was dismissed because it would have too great of an environmental effect on park resources.

Biological Larvicide Controls

Bacterial and other biological larvicides have been developed and are commercially available for the control of mosquito populations. One such bacterial control agent, *Bacillus thuringiensis* var. *israelensis* (Bti), can be effective for reducing mosquito larvae abundance. When applied to larval habitat, the microbe produces a toxin that is lethal when ingested by developing mosquito larvae. Bti larvicides (e.g., Vectomax® FG, Vectobac®, MosquitoDunks®) have demonstrated success for reducing *Culex* larvae abundance in areas of Kaua‘i Island, where pedestrian crews could access and apply the granular pesticide to standing pools of water (LaPointe et al. 2021). Because *Culex* are

capable of breeding in a variety of habitats, including habitats rich in organic matter, the species can take advantage of pooled water in tree wells, pig wallows, and stagnant ground pools far from streams; thus, it is difficult to locate and treat these sources that are diffusely spread throughout native forest bird habitat. *Culex* mosquitoes can travel up to 3 kilometers in less than 12 days (LaPointe 2008), thus individuals can infiltrate relatively small locally treated areas. In 2019, standing pools of water were treated with Vectomax® FG in a 170-ha area where 14 kiwikiu birds were translocated and nearly every individual bird suffered mortality because of exposure to avian malaria (Warren et al. 2021). Scaling up Bti treatments to a landscape level in wet and steep environments could be logistically infeasible. Bti has been aerially broadcasted in several parts of the world, but its application in densely forested areas of Hawai'i has not been tested. Additionally, Bti degrades under ultraviolet exposore (Zogo et al. 2019) and active ingredients can be flushed or diffused during rain events, thus the frequency of treatments could depend on local conditions and readily available resources, which may be impractical in most cases. Further, while Lapointe et al. (2021) observed no evidence of population level impacts to two non-target invertebrates, effects to several endemic flies, midges, and gnats have not been tested. Bti has potential for reducing larval abundance in combination with an IIT program, but the method alone is inadequate for suppressing mosquito populations within the entire East Maui project area. Therefore, this alternative is dismissed because it would not meet the purpose and need for the plan.

Chemical Controls

Successful control and eradication of disease-carrying mosquitoes has been accomplished globally using several pesticides, such as organophosphate or organochloride insecticides. Widescale application of insecticides, in addition to removal of larval habitat, is responsible for the eradication of human malaria throughout the United States. However, there are no mosquito-specific insecticides available and most of the available insecticides are indiscriminate and could cause mortality of non-target native and listed insects and arthropods in the treatment area. Insecticides have also proven to have higher adverse effects through bioaccumulation (e.g., DDT in raptor eggs). Organophosphate and pyrethroid adulticides are among the most used insecticides used to control mosquitoes. However, resistance to these chemical agents has been documented in *Culex* spp. mosquitoes over the past several decades, potentially reducing the efficacy of these chemicals (Pasteur et al. 1984, Raymond et al. 2001, Liu et al. 2009). Targeted application of larvicides would be expected to impact federally listed damselflies. Therefore, this alternative is considered but dismissed because it would have too great of an impact on federally listed species and due to the potential resistance to the chemical agents, does not meet the purpose and need for the plan.

Translocation of Birds to Mosquito-free Areas

Translocation is the intentional effort to transport organisms from their current range to distinct locations to establish a second sustaining population. The practice has been applied with variable success for a number of rare birds in Hawai'i. Successful translocations are primarily restricted to the northwest Hawaiian Islands where *Culex* mosquitoes and avian malaria are absent. The U.S. Fish and Wildlife Service successfully established new populations of the Laysan Finch (*Telespiza cantans*) and ulūlu (Nihoa Millerbird; *Acrocephalus familiaris*) on Pearl and Hermes Atoll and Laysan Island, respectively (Morin and Conant 2020 a, b). However, most translocations in the main Hawaiian Islands have failed, including the recent translocation of wild and captive kiwikiu to a restored area of Nakula Natural Area Reserve on Leeward Maui. Nearly every bird died of avian malaria shortly after being released (Warren et al. 2021). Several efforts to reintroduce the endangered Palila

(*Loxioides bailleui*) to former areas of its range in high montane and sub-alpine forests on Hawai'i Island failed, primarily because birds quickly returned to their native range where they had established pair bonds and territories (Banko et al. 2014). Because of the current conservation crisis, the translocation of four critically endangered honeycreepers (including kiwikiu and 'ākohekohe) to high elevation forests (>1,500 meters in elevation) on Hawai'i Island, where birds may be less vulnerable to disease because of cooler annual mean temperatures, was assessed by a group of translocation experts, cultural practitioners, and resource managers (Paxton et al. 2022). A panel of experts scored the probability of success for each species, and native Hawaiians, with strong connections to native birds, shared perspectives regarding moving birds from their endemic range to a separate island. The probability of success for each species ranged from 38 percent to 51 percent, meaning most experts predicted that the translocations would fail, except for the endangered 'ākohekohe, which had a near equal probability of failure and success. Cultural practitioners shared concerns about losing the cultural and familial connection to native avifauna and the potential suffering to individual birds during capture and transport efforts. The lack of remaining individuals in the wild to move and start a new population was one of the biggest factors in the decision process and there was little indication that translocated birds would be free from the threat of avian malaria, because of evidence that species vulnerable to the disease, such as the threatened 'i'iwi, were in decline throughout most of their range on Hawai'i island (Paxton et al. 2013, Kendall et al. 2022). Further, climate projections reduce current ranges of endangered birds on Hawai'i Island by more than 75 percent by years 2080–2100 and those species and translocated species would face similar challenges (Fortini et al. 2015). Translocation may be considered a complementary approach to the proposed action, potentially buying time for species in the wild while the threat of disease-carrying mosquitoes is being addressed, but the action would not meet the urgent need of preventing extinction of several endangered birds.

Treatment of Birds with Acute Infections using Anti-malarial Drugs

Vulnerable bird populations could be treated with injections of anti-malarial drugs (e.g., chloroquine, artesunate, primaquine, doxycycline). This approach could be effective in reducing the adverse effects of malaria in treated birds for a short period of time. The efficacy of anti-malarial drugs has been tested with variable success on poultry and captive penguins (Chitty 2011, Sohsuebngarm et al. 2014). Infected Hawaiian honeycreepers have also been successfully treated with these medications as well (Warren et al. 2021). This option is generally not feasible on a landscape or population scale because each individual bird would require repeated treatment. Individuals would need to be captured and identified for acute malaria with rapid testing techniques. Infected birds would be transported to a captive facility where a veterinarian could administer multiple doses of anti-malarial drugs. The birds' health and measures of malaria parasitemia would need to be monitored for several weeks until experts are confident to release individuals back into the wild, whereupon individuals would again be vulnerable to re-infection. The capture and transportation of infected birds, as well as the stress of captivity, could cause fatalities of sick individuals. It would be extremely labor intensive and impractical for reducing the impact of malaria among an entire community of threatened and endangered forest birds on East Maui. The approach could result in considerable environmental impact and possibly adverse impacts to threatened and endangered forest bird species. This approach was dismissed from further consideration because it does not meet the purpose and need and is technologically and economically infeasible.

Genetic Modification of Forest Birds

Under this scenario, forest bird genetic information would be modified to promote resistance to malarial infections. The practice of gene editing with CRISPR-Cas9 technology has been applied to domestic animals (Novak et al. 2018); for example, the genome of pigs was edited to enhance resistance to porcine reproductive and respiratory syndrome virus (Whitworth et al. 2016). Recently, the CRISPR-Cas9 tool was assessed in the conservation and recovery of the endangered black-footed ferret, a species vulnerable to sylvatic plague. The U.S. Fish and Wildlife Service approved an Endangered Species Recovery Permit for the foundational laboratory research for the genetic rescue of the species (Revive and Restore 2021), but the tool has not been applied to wild populations yet. Similarly, CRISPR-Cas9 could be applied to enhance resistance to avian malaria in Hawai'i. This facilitated adaptation through gene editing has been a modeled approach, but the tool has not been developed for honeycreepers in Hawai'i (Samuel et al. 2020). Technology for this approach is not available for near-term implementation. Genetic modification of culturally significant species could be highly controversial. This approach would not meet the purpose and need and is technologically infeasible at this time.

Release of Wolbachia-incompatible Mosquitoes using Cars, Trucks, or ATVs

Under this approach, *Wolbachia*-incompatible male mosquitoes are released into the wild via motor vehicles on the ground; wild female mosquitoes who mate with incompatible males lay eggs that do not hatch. Similar to the proposed action for this project, the regulatory path to obtain approval is defined and approvals are in place to use the approach to control mosquitoes of public health concern. The proposed project area covering the targeted birds' current and historic range is nearly entirely roadless. To release *Wolbachia*-incompatible male mosquitoes at the intervals necessary to achieve effective control, this approach would require construction of a vast network of roads that would be cost-prohibitive and would result in adverse environmental impacts to various natural and cultural resources. Roads and vehicles can create more larval habitat for mosquitoes as well as fragment critical habitat for endangered plants and animals present in the proposed project area. This approach, given current infrastructure, would not meet the project purpose and need and would likely result in significant adverse environmental impacts. This approach would significantly degrade wilderness and includes prohibited uses.

Pedestrian Release of Mosquitoes Without the Use of Helicopters

The project area in East Maui is 64,666 acres and is characterized by very remote, heavily forested, and exceptionally rugged terrain. Only a few roads penetrate this area and the only established trails accessible without the use of helicopters occur in Makawao Forest Reserve, Waikamoi Preserve, and the Lower Kīpahulu Valley comprising less than 2% of the overall project area. In order to release mosquitoes using only the pedestrian release method, a massive trail system would need to be developed over the entire East Maui project area at great cost and with resultant environmental impacts. In addition to the current lack of infrastructure that would potentially allow for mosquito releases without the use of helicopters, the short life span of the incompatible mosquitos would require rapid dispersal following shipment to Maui from the mainland, on the order of 24 hours. Pedestrian releases could not feasibly release mosquitoes throughout the project area within the required timeframe. Therefore, this alternative has been dismissed from detailed analysis.

Transporting Multiple Batteries Rather than Using a Portable Generator to Charge Batteries in the Field

The mosquito traps used to monitor mosquito populations require either a 6- or 12-volt battery to operate. Typically, more than one battery is needed per trap to be able to operate the traps for the entire monitoring period. As such, each monitoring occasion requires dozens of batteries, collectively weighing several hundred pounds. A portable generator in the field would allow for on-site charging and could allow for fewer batteries to be flown in and out of the field. Given the weight of the batteries, this would likely translate into fewer flights into the Wilderness per operation. Transporting multiple batteries into the field was dismissed due to a larger negative impact on wilderness from noise resulting from an increase of helicopter flights needed to support the additional weight from extra batteries. This alternative was dismissed since the footprint of noise from helicopter flights expand much farther than those of isolated small generator use and would degrade a broader range of wilderness qualities. The use of a battery bank charger instead of a generator to charge batteries was dismissed due to the batteries exceeding the capacity of the charger.

MRDG Step 2: Alternative Comparison

Alternative 1:	The NPS and DLNR propose to reduce native forest bird mortality from avian malaria by suppressing southern house mosquito populations on East Maui. These non-native invasive mosquitoes are the only insect that transmits avian malaria in this area. The proposed action consists of repeatedly releasing incompatible mosquitoes, which would prevent mosquitoes within the project area from being able to reproduce. This approach employs the incompatible insect technique (IIT), which uses a naturally occurring bacteria called Wolbachia that is present in many insect species on Maui. When male mosquitoes with an incompatible strain of Wolbachia are introduced to a population of female mosquitoes, mating is unproductive, thereby suppressing mosquito populations (Atyame et al 2015). When releases are done repeatedly over time, they further suppress the mosquito population and, in turn, would suppress transmission of avian malaria.
Alternative 2:	No action

	Alternative 1	Alternative 1	Alternative 2	Alternative 2	Alternative 3	Alternative 3	Alternative 4	Alternative 4
Wilderness Character	+	-	+	-	+	-	+	-
Untrammeled	0	2	0	0				
Undeveloped	0	6	0	0				
Natural	1	3	0	2				
Solitude/Primitive/Unconfined	0	4	0	0				
Other Features of Value	1	0	0	2				
Total Number of Effects	2	15	0	4				
Wilderness Character Rating	- 13		- 4					

MRDG Step 2: Determination

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

Selected Alternative

☒ Alternative 1:

The NPS and DLNR propose to reduce native forest bird mortality from avian malaria by suppressing southern house mosquito populations on East Maui. These non-native invasive mosquitoes are the only insect that transmits avian malaria in this area. The proposed action consists of repeatedly releasing incompatible mosquitoes, which would prevent mosquitoes within the project area from being able to reproduce. This approach employs the incompatible insect technique (IIT), which uses a naturally occurring bacteria called Wolbachia that is present in many insect species on Maui. When male mosquitoes with an incompatible strain of Wolbachia are introduced to a population of female mosquitoes, mating is unproductive, thereby suppressing mosquito populations (Atyame et al 2015). When releases are done repeatedly over time, they further suppress the mosquito population and, in turn, would suppress transmission of avian malaria.

☐ Alternative 2:

No action

Explain Rationale for Selection:

Allowing the perpetuation of a non-native invasive species vector for disease that is the leading cause of significant decline of Hawaiian honeycreepers, most who are threatened or endangered, violates a fundamental tenet of wilderness "where the earth and its community of life are untrammeled by man...retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions." Therefore the suppression of *Culex* mosquitoes and avian malaria transmission to native forest birds in Haleakalā Wilderness is essential to the preservation of wilderness character.

Alternative 1 has long-term beneficial impacts to the Natural and Other qualities of wilderness that significantly outweigh the short-term negative impacts to wilderness character. Alternative 1 was selected as the preferred alternative because all other alternatives, except no action, were considered but dismissed since they do not meet the purpose and need for action at this time, are considered technically infeasible, are more impactful to wilderness character, or are highly controversial and need more research.

Taking no action would violate The Endangered Species Act, which states "Federal agencies shall…utilize their authorities… by carrying out programs for the conservation of endangered species and threatened species." Conservation, as defined in the Act, means "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measure provided pursuant to the [Endangered Species] Act are no longer necessary." The continued decline of native forest birds has been well documented and projections are substantiated by consensus of experts involved and consulted. The loss of Hawaiian honeycreepers would create a tiering effect of cumulative negative impacts to the wilderness, natural environment and Other qualities of wilderness related to Hawaiian culture. The NEPA and Environmental Assessment processes have allowed a thoughtful and reasoned consideration of alternatives and impacts to wilderness which complement and provide thorough references to inform this document.

Alternative 1 allows the best support to the following six public puposes of wilderness as noted in section 4(3)(b) of the Wilderness Act: recreational, scenic, scientific, educational, conservation, and historical use.

Recreational: The suppression of non-native mosquito populations to address impacts of avian malaria on threatened and endangered forest birds would enhance recreational opportunites by allowing range and population recovery. More opportunites to view and hear the unique calls of Hawaiian honeycreepers inside and out of designated wilderness would preserve and enhance unimpaired recreational opportunites for all visitors to Haleakalā NP.

Scenic: Required analysis for Wilderness Act compliance allows an agency to determine that another purpose consistent with the Act is more important than maintaining pristine wilderness, which is the circumstance for multiple threatened and endangered Hawaiian forest birds. The scenic beauty of Haleakalā NP and Hawai'i is unique compared to the majority of national parks on the U.S. mainland. Visitors travel to Haleakalā NP to take in the vistas of wilderness and witness the special ecological ties created by the remoteness of the archipelago.

Scientific: The suppression of non-native mosquito populations to address impacts of avian malaria on threatened and endangered forest birds would provide an opportunity for other Hawaiian islands facing similar threats to investigate potential outcomes and evaluate feasibility of similar implementation in forest bird habitat. Any successes of this project would be a success for the state of Hawai'i and the National Parks within, as application could be replicated and opportunites to learn more about *Culex* mosquitoes may allow for improvement of currently dismissed technologies.

Educational and **Historical:** The diverse natural history of endemic Hawaiian forest birds, their prominence in Hawaiian culture, and the need for conservation are a topic of both historical and educational significance. "Before Western contact, native Hawaiians named most of the native bird species, and identified some as their 'aumakua (personal guardian)"(Ka'elele, Spring 2016). Different bird species could provide resource guidance to the location of a rotten tree for canoe builders or with their feathers used in many ways for traditional cultural practices. Although the species are federally protected today, the connection the wild species offer Hawaiian culture will be perpetuated by this alternative.

Conservation: Taking action to address the threats to forest birds has a cumulative on Hawaiian ecology as a whole. Hawaiian forest birds are uniquely adapted to the curvature of endemic plant species and keep the environment in check as a predator of insects. Successful implementation and results would be significant to Haleakalā Wilderness by protecting these ecosystems and suppressing a major threat.

Some of the components and methods proposed in Alternative 1 are uses prohibited in Section 4(c) of the Wilerness Act. However, these were found necessary to meet minimum requirements of the Act after thorough analysis. Alternatives that may have been less impactful to wilderness were considered and dismissed by an extensive panel of experts, due to a lack of feasibility or efficacy. Because of the remote nature of threatened and endangered Hawaiian forest birds, helicopter access is the only option to supply personnel and material. As stated in the Federal Register, Notice of Conversion of Potential Wilderness as Designated Wilderness, Haleakalā National Park, "It is noted that...access into the wilderness via helicopter for fence maintenance, to control destructive invasive alien plants and non-native animals may be necessary to preserve wilderness resources and ecosystem processes." Only skilled and highly trained personnel will perform tasks under these prohibited uses and mitigations will be made to allow for the least impact to the wilderness and highest level of safety.

Prepared:
Lindsay Moore, Environmental Protection Specialist HALE (Wilderness Committee)
Reviewed and evaluated:
Doug Wetmore, Project Manager WASO EQD
Chris Warren, Forest Bird Program Coordinator HALE
Paul Hosten, Integrated Resource Manager HALE (Wilderness Committee)
JT Bouknight, Facility Manager HALE (Wilderness Committee)
Roger Semler, National Wilderness Stewardship Program Manager, WASO

This is an appendix to the Environmental Assessment PEPC#102795, References are available within the EA document.

Describe Monitoring & Reporting Requirements:

Approvals

Which of the prohibited uses found in Section 4(c) of the Wilderness Act are approved in the selected alternative and for what quantity?

Approved?	Prohibited Use	Quantity
☐	Mechanical Transport:	
☒	Motorized Equipment:	Drone and temporary helicopter methods for mosquito release. Helicopter use for mosquito monitoring personnel and gear transport. Gasoline powered generator for mosquito trapping.
☐	Motor Vehicles:	
☐	Motorboats:	
☒	Landing of Aircraft:	Using landing zones and external sling loads touching down.
☐	Temporary Roads:	
☐	Structures:	
☒	Installations:	Mosquito traps placed in the wilderness (temporary)

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

Refer to agency policies for the following signature authorities:

Prepared:

Name Lindsay Moore Position Environmental Protection Specialist

Signature LINDSAY MOORE Digitally signed by LINDSAY MOORE Date: 2022.12.06 13:44:16 -10'00' Date _____

Recommended:

Name Paul Hosten Position Integrated Resource Manager

Signature PAUL HOSTEN Digitally signed by PAUL HOSTEN Date: 2022.12.06 14:38:47 -10'00' Date _____

Recommended:

Name JT Bouknight Position Facility Manager

Signature James Bouknight Digitally signed by James Bouknight Date: 2022.12.06 16:32:48 -10'00' Date _____

Approved:

Name Natalie B. Gates Position Superintendent

Signature NATALIE GATES Digitally signed by NATALIE GATES Date: 2022.12.06 17:29:06 -10'00' Date _____