Report to the Committees on Armed Services of the Senate and the House of Representatives

Feasibility Assessment Regarding a Potential Red Hill Epidemiological Health Outcomes Study

Prepared by the University of Hawai‘i

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ABBREVIATIONS

ACE - Assessment of Chemical Exposures
AFFF - Aqueous Film Forming Foam
ATSDR - Agency for Toxic Substances and Disease Registry
CCPA -California Consumer Privacy Act
CDC - Centers for Disease Control and Prevention
CI - Confidence Intervals
DBPs - Disinfection byproducts
DHA - Defense Health Agency
DoD - Department of Defense
EPA - Environmental Protection Agency
FY24 NDAA - Fiscal Year 2024 National Defense Authorization Act
GDPR - General Data Protection Regulation
HDOH - Hawai‘i State Department of Health
HIPAA - Health Insurance Portability and Accountability Act
IRB - Institutional Review Board
JBPHH - Joint Base Pearl Harbor-Hickam
JP-5 - Jet Propellant-5
JP-8 - Jet Propellant-8
NAVFAC - Naval Facilities Engineering Systems Command
NCDMPH - National Center for Disaster Medicine and Public Health
OHRP - Office for Human Research Protections
PFAS - Per-and Polyfluoroalkyl Substances
UH - University of Hawai‘i
USUHS - Uniformed Services University of the Health Sciences

I. OVERVIEW AND SCOPE

A. OVERVIEW

On December 22, 2023, Congress passed the Fiscal Year 2024 National Defense Authorization Act (FY24 NDAA). Section 1092, on Red Hill Health Impacts, which requires that the U.S. Secretary of Defense submit both a general report on topics related to Federal programs and services, research needs, and other data (Section 1092(a)), as well as a feasibility assessment for a Red Hill Epidemiological Health Outcomes Study. Specifically, Section 1092(b)(2) requires the submission to Congress within one year of enactment of the FY24 NDAA of the results of a "*feasibility assessment to determine the necessity of an epidemiological health outcomes study and to inform the design of the potential epidemiological study or studies to assess health outcomes for impacted individuals.*" Section 1092(b)(1) provides that this study may be provided via a contract with certain independent entities.

B. FEASIBILITY ASSESSMENT

On June 11, 2024, the National Center for Disaster Medicine and Public Health (NCDMPH) under the Uniformed Services University of the Health Sciences (USUHS) awarded the University of Hawai‘i (UH) System a cooperative agreement to establish the Red Hill Independent Health Registry ("Registry"). This feasibility assessment is one of the tasks supported by that award.
Specifically, this feasibility assessment will take the following approach:

1. Background: Further context will be provided about the November 20, 2021 Red Hill Incident; timeline of known exposures from the Red Hill Bulk Storage Facility at Joint Base Pearl Harbor-Hickam (JBPHH); known health effects of jet fuels; immediate health effects related to the Red Hill Incident; and the new Registry.
2. Specific Responses to FY24 NDAA Requirements: Section 1092 of the FY24 NDAA outlines specific statutory requirements, which are replicated below. This report will address each element in turn.
3. Summary Recommendation: This report will provide a summary recommendation on the feasibility and necessity of epidemiological health outcomes studies to assess health outcomes for impacted individuals related to the Red Hill Incident.

C. FY24 NDAA SECTION 1092(B) STATUTORY LANGUAGE

(b) RED HILL EPIDEMIOLOGICAL HEALTH OUTCOMES STUDY.—

(1) CONTRACTS.—The Secretary may contract with independent research institutes or consultants, nonprofit or public entities, laboratories, or medical schools, as the Secretary considers appropriate, that are not part of the Federal Government to assist with the feasibility assessment required by paragraph (2).

(2) FEASIBILITY ASSESSMENT.—Not later than one year after the date of the enactment of this Act, the Secretary shall submit to the appropriate congressional committees the results of a feasibility assessment to determine the necessity of an epidemiological health outcomes study and to inform the design of the potential

epidemiological study or studies to assess health outcomes for impacted individuals, which may include—

(A) a strategy to recruit impacted individuals to participate in the study or studies, including incentives for participation;

(B) a description of protocols and methodologies to assess health outcomes from the Red Hill Incident, including data management protocols to secure the privacy and security of the personal information of impacted individuals;

(C) the periodicity for data collection that takes into account the differences between health care practices among impacted individuals who are—

(i) members of the Armed Forces on active duty or spouses or dependents of such members;

(ii) members of the Armed Forces separating from active duty or spouses or dependents of such members;

(iii) veterans and other individuals with access to health care from the Department of Veterans Affairs; and

(iv) individuals without access to health care from the Department of Defense or the Department of Veterans Affairs;

(D) a description of methodologies to analyze data received from the study or studies to determine possible connections between exposure to water contaminated during the Red Hill Incident and adverse impacts to the health of impacted individuals;

(E) an identification of exposures resulting from the Red Hill Incident that may qualify individuals to be eligible for participation in the study or studies as a result of those exposures;

(F) steps that will be taken to provide individuals impacted by the Red Hill Incident with information on available resources and services; and

(G) a final determination on whether it is feasible to conduct an epidemiological health outcomes study.

II. BACKGROUND

A. THE NOVEMBER 20, 2021 RED HILL INCIDENT

The Red Hill Bulk Fuel Storage Facility, constructed in secret during World War II to support the U.S. Pacific Fleet, was completed in 1943 and includes 20 massive underground storage tanks with a combined maximum capacity of 250 million gallons (EPA, 2015 & 2023; Yoklavich et al., 2015). Historically, the facility has stored various kinds of fuel, including jet fuel (JP-5 and JP-8) and diesel (Yoklavich et al., 2015). The facility also features a fire suppression system designed

to protect the vast amounts of fuel there, including the use of Aqueous Film Forming Foam (AFFF) in more recent years (EPA, 2015 & 2023).

On November 20, 2021, there was a release of up to 5,542 gallons of JP-5 which entered the Red Hill shaft, a key groundwater source for the drinking water system that supplies JBPHH and the neighboring communities. This drinking water system, termed "Navy water system" in this report, is managed by the U.S. Navy (Naval Facilities Engineering Systems Command [NAVFAC], 2022). The November 2021 Incident (hereafter referred to as the Incident) created a toxicological hazard and has led to an ongoing public health crisis. Within days of the Incident, residents served by the Navy water system complained of a fuel-like odor coming from drinking water and on November 29, 2021, the Hawai'i State Department of Health (HDOH) issued a drinking water advisory to stop all drinking, bathing, and washing with contaminated water (HDOH, 2021; Miko et al., 2023). Water samples taken on December 5, 2021 from the Red Hill Shaft showed contamination with total petroleum hydrocarbons (TPH) over 350 times above the regulatory guideline, known as the environmental action level (Miko et al., 2023). Four months later (after implementing flushing and sampling of the water system), on March 18, 2022, the drinking water advisory was fully lifted by the HDOH (HDOH, 2022). According to the U.S. Environmental Protection Agency (EPA), approximately 93,000 Navy water system users across 9,600 households, schools, and workplaces were affected by the contaminated drinking water. These users included military personnel and their families, as well as civilians whose work, residence, school, or daycare used the Navy water system (EPA, 2024a; Miko et al., 2023).

B. TIMELINE OF KNOWN EXPOSURES FROM THE RED HILL BULK FUEL STORAGE FACILITY AT JOINT BASE PEARL HARBOR-HICKAM

Since its construction was completed in 1943, multiple fuel releases (in addition to the November 20, 2021 Red Hill Incident) have occurred at the Red Hill Bulk Fuel Storage Facility, contributing to water and environmental contamination affecting residents on the Navy water system. However, few are well-documented events. The first reported fuel release was on November 10, 1998, when petroleum-stained basalt cores were found beneath 19 of the 20 underground storage tanks (EPA, 2015; EPA, 2023). Another reported release was of 27,000 gallons of JP-8 fuel in 2014, prompting the EPA and the HDOH to enforce monitoring and infrastructure improvements (EPA, 2015). The release of AFFF in September 2020, described as 5,000 gallons of a mixture of water and fire-fighting suppression foam, was unreported for two years and became public when a similar AFFF release occurred in 2022, approximately a year after the Incident (Jedra, 2022). AFFF releases are concerning as the active ingredients are per- and polyfluoroalkyl substances (PFAS), some of which are believed to be carcinogens (Mazumder et al., 2023). Following the most recent AFFF release, soil samples taken in January 2023 indicated PFAS levels in exceedance of HDOH and EPA standards (DOH, 2023); however, the Navy maintained there were no PFAS exceedances in their groundwater monitoring (Commander, U.S. Pacific Fleet, 2023). Thus, there is a long history of environmental contamination incidents from Red Hill, as well as contradictory information across federal agencies about these spills.

C. KNOWN HEALTH EFFECTS OF JET FUELS

JP-5 is a colorless, flammable, kerosene-based liquid that is a complex mixture of hydrocarbons and additives primarily used in military aircraft (Agency for Toxic Substances and Disease

Registry [ATSDR], 2017; Miko et al., 2023). Despite its broad use and recognition as a hazardous substance, there is a limited understanding of the toxicity of jet fuels and their additives (ATSDR, 2017; Ritchie et al., 2003; Miko et al., 2023). Jet fuel exposure has been associated in the research literature with significant health conditions including increased rashes (dermatitis), negative effects on the central nervous system (e.g., brainstem and central auditory impairments), loss of kidney function (nephropathy), and increased adverse effects on the immune system (immunotoxicity) (Harris et al., 2000; Salam et al., 2020; Guthrie et al., 2022). Most research on this topic comes primarily from animal toxicology studies and a few human case studies. In human studies, the limited research on jet fuels predominantly examines men who were exposed from work, including skin (dermal) exposure from direct contact with the fuel or with clothing saturated with fuel, or due to respiratory exposure from fuel exhaust (Ritchie et al., 2003). A review on health effects of aircraft emissions suggests that aircraft emissions induce inflammation in the lungs and throughout the whole body, potentially contributing to cancer, asthma, respiratory conditions, and coronary heart disease (Bendtsen et al., 2021). This review also reported that vulnerable populations, such as children, older adults aged 65+ years, and those of lower socioeconomic status, are at a greater risk of asthma, as well as respiratory- and cardiovascular-related hospitalizations due to fuel exposures (Bendtsen et al., 2021). Anecdotal evidence of oral exposure to JP-5 among sailors includes reported symptoms of headache, diarrhea, and rashes (Chan, 2022). Accidental ingestion of kerosene is more commonly reported, with symptoms such as cough, difficulty breathing, abdominal pain, vomiting, drowsiness, restlessness, and seizures (ATSDR, 2017).

Furthermore, interactions between JP-5 and free chlorine during drinking water treatment can increase the formation of disinfection byproducts (DBPs). Some DBPs have been associated with adverse health effects, such as increased cancer risk, and liver, kidney or central nervous system damage (EPA, 2024b), while the health effects of many others are yet unknown (Brinkmann et al., 2024).

It is important to consider that some of the aforementioned health outcomes that have been associated with jet fuel components, including respiratory ailments, cardiovascular diseases, and cancer, take years to decades to develop following exposure. Overall, the insufficient information on the health effects associated with jet fuel exposures warrants epidemiological research to further understand long-term impacts. Notably, epidemiological studies on ingestion of and skin exposure to JP-5 are absent in the scientific literature, and studies of non-military subpopulations, such as the elderly, children, and pregnant women, are woefully inadequate to support an understanding of jet fuel exposure on long-term health.

D. IMMEDIATE HEALTH EFFECTS RELATED TO THE RED HILL INCIDENT

Individuals impacted by the Incident have reported numerous health effects (Miko et al., 2023). Within days of the contamination, the HDOH and Poison Control Center received hundreds of calls about headaches, diarrhea, abdominal pain, rashes, and nausea (Miko et al., 2023). The HDOH and ATSDR conducted the first Assessment of Chemical Exposures (ACE) survey in January and February of 2022 among 2,289 people from 1,389 impacted households (Troeschel et al., 2022). This survey provided critical insights into population exposure to JP-5. Results showed that ingestion of potentially contaminated water was common, with 72% of respondents having used the water for drinking, 71% for cooking, and 80% for oral hygiene (e.g., brushing teeth).

The survey also collected data on self-reported health outcomes experienced in the immediate period (approximately 2.5 months) after the Incident. Most survey participants (87%) experienced one or more new or worsened health symptoms after the Incident and 65% of the total sample (75% of those who initially reported symptoms) experienced persistent symptoms that lasted 30 days or longer (Troeschel et al., 2022). Figure 1 shows the percentage of respondents self-reporting health symptoms, grouped by physiological systems. Among the total sample of 2,289 participants in this first ATSDR ACE study, 959 individuals (42% of the total) reported persistent health symptoms (≥30 days) related to the nervous system such as headaches, fatigue, and difficulty concentrating (reported by 55%, 69%, and 72%, respectively, of those who reported those respective symptoms as new or worsened after the Incident and 32%, 30%, and 23%, respectively, of the total). Additionally, 865 participants (38% of the total) reported persistent mental health symptoms, including anxiety, difficulty sleeping, and agitation/irritability (reported by 80%, 79% and 79%, respectively, of those who reported those respective symptoms as new or worsened after the Incident and 29%, 26%, and 24%, respectively, of the total) (Troeschel et al., 2022).

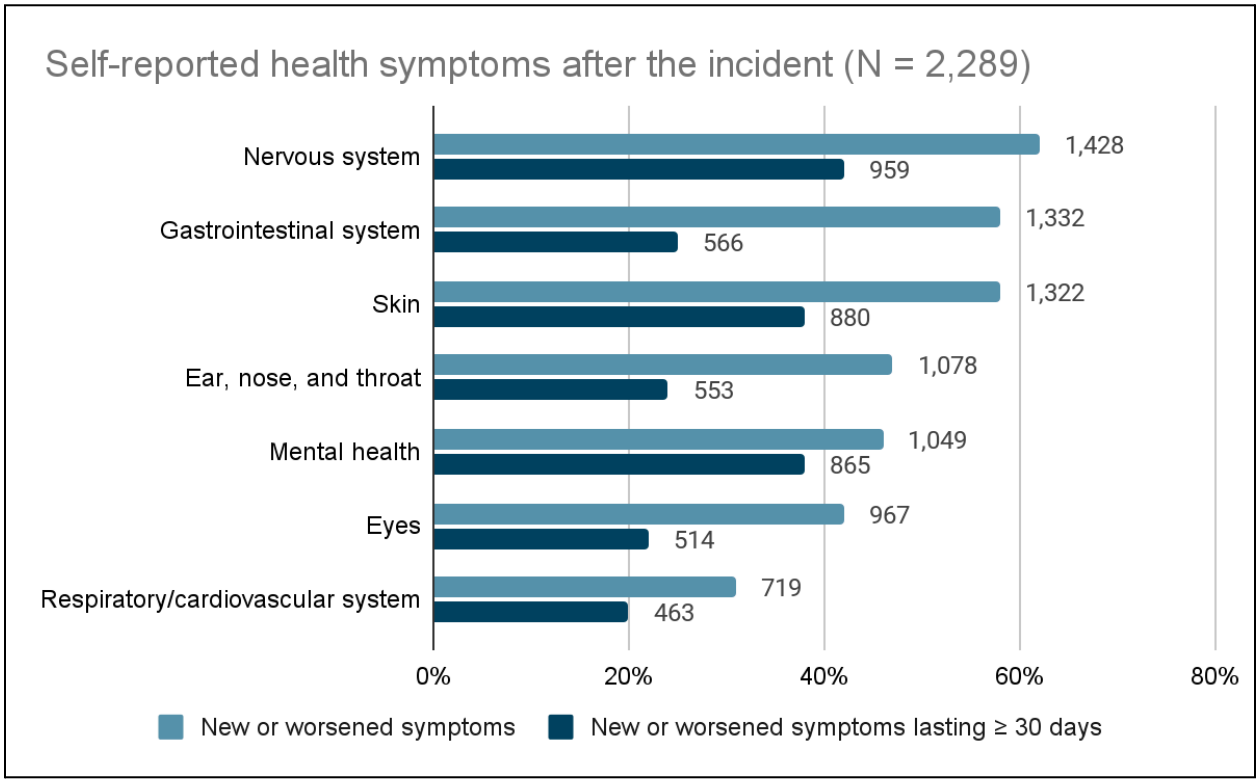

Figure 1. Percentage of respondents from the first ATSDR ACE study in January and February of 2022 self-reporting symptoms categorized by affected physiological systems following the Incident (based on Troeschel et al., 2022).

A subsequent ACE survey was conducted by ATSDR in September 2022. Of the 986 participants in that latter survey, 80% reported health symptoms in the previous 30 days. Of those that reported symptoms, 65% expressed high or very high confidence that the symptoms were related to the Incident, suggesting enduring health effects (HDOH, 2022). In the summer of 2023, researchers at UH conducted a small study of 174 participants who had also participated in the previous ACE studies. The preliminary results provided further evidence of persistent health

effects consistent with earlier findings and the symptoms reported were highly concordant with the two ACE studies (Bremer et al., 2024). A third ACE study, conducted in early 2023 by ATSDR, included an audit of 653 medical records to further assess health impacts. The majority of individuals were adults (63%), female (55%), and either dependents, retirees, or civilians (71%, versus 28% active duty military) (ATSDR, 2023a). Preliminary findings, obtained through a Freedom of Information Act request, showed that 55% (n=357) of individuals were flagged as having either worsening pre-existing or new persistent conditions or symptoms since the Incident. The most common conditions were migraine, chronic pain, and gastroesophageal reflux, while common symptoms included headache, rash, and anxiety. ATSDR (2023a) recommended continued monitoring for long-term health outcomes with systematic data collection and comparison to an appropriate control group.

E. RED HILL INDEPENDENT HEALTH REGISTRY

On June 11, 2024, the NCDMPH awarded the UH System a five-year cooperative agreement to establish the Red Hill Independent Health Registry ("Registry"). This Registry had been called for by members of Hawai'i's Congressional Delegation, ATSDR, HDOH, and the Defense Health Agency (DHA) in addition to many members of the community (Cocke, 2023; Kime, 2024; Miko et al., 2023).

The goals of the Registry are to:

1) Connect the community to needed services through a referral program;
2) Provide educational programs for healthcare providers and community members; and
3) Track participants' health statuses over time and gather information on how fuel exposures may impact health.

The Red Hill Registry is being modeled after the Flint Registry that was established to monitor the health effects of widespread lead contamination of the drinking water of Flint, Michigan (Flint Registry, 2024). After an initial planning year, the Red Hill Registry intends to open for formal enrollment in Fall 2025. Planning processes will be informed by intensive community engagement, including focus groups, key informant interviews, and/or community informational interviews, to ensure that community members are not only heard, but also serve as partners in co-developing the Registry such that it is supportive and helpful to the impacted community. Other planning year activities include setting up information technology infrastructure; hiring staff, including those from the impacted community; planning recruitment, communications and marketing activities; and ensuring a strong scientific foundation. The latter will include conducting thorough literature reviews, establishing sound scientific protocols, and enhancing/developing robust scientific networks across all relevant topic areas locally, nationally, and internationally.

Enrollment in the Registry will be completely voluntary and will require participants to opt in. Significant community input will be sought to co-design the eligibility criteria for enrollment and the baseline survey questions. Once eligibility has been established, participants will be asked to provide consent and complete a baseline questionnaire to collect information on such topics as demographics, health, exposure, development (for children), utilization of existing services and resources, needed services and resources, and more (see Section III. B. 3. for more about the Registry questionnaire). The collected information on needed resources will be used to connect participants with providers in areas such as healthcare, social services, housing services,

environmental assessments, and/or medical/legal services. Future surveys will occur at to-be-determined intervals in the years to come to monitor participants' health and social service needs. Community engagement and participant feedback will be used to guide these future activities.

Importantly, while the Registry receives funding from the Department of Defense (DoD) via NCDMPH, it explicitly and officially operates independently. While DoD and NCDMPH will provide input to the Registry, UH has full and final discretion over the data collected and housed by the Registry and will report only de-identified findings in aggregate to the public and to the funders (See Section III. B. 5. b. for more on data sharing).

The Registry is being established as a public health surveillance program that will be a repository for data from the impacted community. Thus, although the Registry is not tasked to perform epidemiological research, it is being designed to facilitate epidemiological research studies that will help to understand potential long-term health outcomes of exposures related to the Red Hill Incident. The Registry will also serve as a target population for research studies proposed by investigators at organizations external to UH and DoD. Participants in the Registry can be offered multiple tiered levels of consent that can enable them to consent to enrollment in the Registry, as well as consent, if desired, to being contacted for consideration in future studies. The resulting participant pool may later be contacted for additional epidemiological studies that build on the data collected through the Registry, including questionnaires or interviews on topics outside of the scope of the Registry, or biomonitoring studies of biological samples (such as blood, tissues, and hair) to guide in-depth exposure assessment. Because Registry participants would have already opted to be contacted for research purposes, the recruitment success is expected to be high.

F. NEED FOR FUTURE RED HILL-RELATED STUDIES

Despite evidence of significant adverse health outcomes associated with the Incident and the concordance of these reported health issues with the broader literature on the negative health impacts of jet fuels, and other possible contaminants, on human health, the existing research specific to Red Hill is limited by self-report, small sample sizes relative to the number of people affected, lack of comparison groups, and the use of convenience sampling methods. This underscores a need for additional studies, particularly those that address these limitations through more robust exposure assessments and epidemiological studies. Such studies are essential, as community members remain deeply concerned about the current impacts and potential long-term health risks of the Incident, as well as the cumulative impact of other lesser-known spills that have occurred historically and in recent years. High-quality scientific research and engagement is important not only to better understand these risks, but also to ensure that those experiencing symptoms are connected to, and can receive, proper health care and support services from providers and systems that are cognizant of health impacts and needs.

III. SPECIFIC RESPONSES TO FY24 NDAA REQUIREMENTS

A. STRATEGIES FOR RECRUITMENT, INCLUDING INCENTIVES (FY24 NDAA Sec. 1092(b)(2)(A))

This section discusses feasibility assessment element (A), "*a strategy to recruit impacted*

individuals to participate in the study or studies, including incentives for participation."

1. Foundation for Future Studies: Recruitment into Red Hill Registry

Recruitment strategies for an epidemiologic health outcomes study would be most efficient and effective if aligned with, first, recruitment into the Registry. An epidemiological health outcomes study (herein referred to as epidemiological study) about the Incident needs the infrastructure of the Registry to provide a foundation for a robust scientific study based on quality assessment of exposure and health outcomes, accurate identification of affected individuals, strong study design (including application of evidence-based recruitment and retention strategies), and analysis plans informed by state-of-the-art methods in causal inference and biostatistics.

2. Specific Recruitment Strategies

Ideally, given the mistrust from the Incident by the community, recruitment into the Registry and any future epidemiologic study on this topic should be community-driven with questions and procedures co-developed with community members. This approach would ensure a diverse and inclusive sample that includes both the military and civilian communities, as well as Native Hawaiian and Pacific Islander populations in both categories, who were exposed as well as measures and outcomes of relevance to the impacted communities. Given that Hawai‘i is considered an overseas duty station in the military, many active duty service members and their families have moved from Hawai‘i and have relocated across the continental United States and around the world since the Incident. Thus, enrollment of participants should be done with a global perspective and include outreach online, by phone, in person, or via mail to reach the most people possible. Additionally, special consideration must be given to the nuances of reaching different populations of exposed individuals, including impacted civilian communities, families who relocated following the Incident, families who did not relocate, service members who have moved into or out of the affected area, and service members who have separated from military service. These considerations include reliance on interagency relationships between the Registry staff, State and Federal partners, the DoD, community advocacy organizations, and utilizing a range of media forms to include print, video, radio, online, and social media platforms. Specifically, the Registry has a Data Sharing Agreement with DHA to securely share email addresses for those active duty military, DoD contractors, and DoD civilians who are tracked in the Defense Occupational and Environmental Health Readiness System (DOEHRS) Registry related to the Red Hill Incident, representing approximately 55,000 individuals that are already known to have been exposed and may then opt in, if desired, to the Registry.

Specific recruitment strategies that can be applied to the Registry and epidemiological studies also include: 1) direct outreach to schools, businesses, and the community (e.g., town halls, neighborhood board meetings, and community events); 2) partnering with the DoD to present information at DoD community and official events, to promote awareness through their print and online publications (e.g., Stars and Stripes, Airman Magazine), and to add enrollment flyers to materials distributed by DoD during in-processing or out-processing procedures for service members; 3) partnering with other Federal, State, and Community organizations, including the CDC/ATSDR and HDOH to disseminate information to those who participated in past ACE investigations; 4) presenting at local, national, and international conferences and events; 5) targeted marketing to direct traffic to the Registry website, including via social media groups and advertisements via internet search engines, television, radio, and buses; 6) using tools from the U.S. Postal Service or LexisNexis to track individuals who have relocated; and 7) recording

written, video, or in-person peer-to-peer testimonials from those who have already enrolled. All marketing and recruitment strategies should be culturally relevant to the diverse population of the impacted community.

3. Incentives

Small incentives are often provided to research participants as tokens of appreciation for their willingness to support research and for the time they dedicate to the research efforts. Per best practices in human subjects research, incentives should not be so large as to unduly affect the voluntary nature of participation (Bernstein & Feldman, 2015), but appropriate incentives have been demonstrated to improve recruitment success (Abdelazeem et al., 2022). Similar to the protocol of the Flint Registry, an incentive of a gift card with a monetary value of approximately $50 may be an effective mechanism to recruit participants into the Registry. Aside from the Registry, recruitment into an epidemiological study or studies may warrant another $50 gift card for an initial assessment, with $10 gift cards provided for subsequent assessments of participants over time.

Participant retention tools may include a project website with regular data reports, periodic short messages to participants via social media, and participant newsletters.

B. PROTOCOLS AND METHODOLOGIES FOR ASSESSING HEALTH OUTCOMES (NDAA Sec. 1092(b)(2)(B))

This section discusses feasibility assessment element (B), "*a description of protocols and methodologies to assess health outcomes from the Red Hill Incident, including data management protocols to secure the privacy and security of the personal information of impacted individuals.*"

The following protocols and procedures are proposed, which will be updated and revised based on community guidance.

1. Consent Protocol: Red Hill Independent Registry

The Red Hill Independent Registry intends to use a granular Institutional Review Board (IRB)-approved consent process that will enable participants to preferentially consent to the following: to participate in the Registry; to share information with referral agencies; to share medical, education, and service utilization data; to share data with data repositories; to be contacted for follow-up assessment; and to be included in possible future research. The Registry will establish protocols to ensure participants' privacy as well as to manage consent, preferences, and participants' rights.

2. Consent Protocol: Epidemiological Health Outcomes Studies

Once participants are recruited into the Registry and have consented to participate in future research studies, they may be invited to participate in epidemiological health outcomes studies. Epidemiological research that uses the Registry infrastructure should strictly adhere to best practices in human subjects research. Any research study of participants from the Registry must follow U.S. Department of Health and Human Services regulations at 45 C.F.R. 46 (Office for Human Research Protections [OHRP], 2024) and would require all study participants to provide informed consent. Study investigators must ensure that informed consent documentation is

written in clear and concise lay language. Researchers requesting Registry data will need to demonstrate that their project protocols have been reviewed and approved by an IRB before any data sharing agreements will be considered, among other requirements to ensure sound procedures that protect Registry data and participants.

3. Assessing Health Outcomes and Exposures from the Red Hill Independent Registry

The Registry is currently planning a baseline and follow-up questionnaire for enrollees. The baseline questionnaire plans to focus on current health status, a wide range of potential symptoms experienced immediately following exposure, as well as whether symptoms subsided or persisted. The baseline questionnaire will also collect information on pre-existing conditions, demographics, development (for children), utilization of services (including timing, frequency, and types of services used), a needs assessment of health and social services, contact information for friends and relatives (for follow-up purposes), and more.

It is important to understand the timeline of potential exposures, the chemicals of concern, potential routes of exposure (ingestion, dermal, and inhalation), timing and duration of exposures, and ways in which some impacted individuals may have been able to decrease their exposure. The direct release of jet fuel into groundwater and the subsequent widespread exposure of the general population through the drinking water distribution system is unprecedented (Miko et al., 2023). Therefore, understanding these parameters will be critical to study design and questionnaire design. The baseline questionnaire intends to explore these exposure topics as well as the setting (e.g., residential, child care center, school, work place) in which individuals were potentially exposed (see Section III. D. 3. and Section III. E. for more information about exposure assessment and exposure and eligibility considerations, respectively). The follow-up questionnaire will assess whether participants are still experiencing health/mental health effects to understand long-term impacts of their exposure.

Importantly, the current funding provided for the Registry supports limited data collection on exposed individuals and potential health effects. The Registry is a public health surveillance activity and not a research study. Additional funding is required to conduct rigorous research on mid-term and long-term changes in health status, developmental impacts, or collateral outcomes (e.g., educational attainment) due to jet fuel exposure. Future funding will be needed to sustain the Registry beyond the initial five year period.

4. Potential Future Epidemiological Health Outcomes Studies

The Registry will provide an opportunity for epidemiological research following protections and contingent on UH Office of Research Compliance - Human Subjects Program approval and participant consent. Additionally, future studies can build upon the Registry by exploring specific conditions in greater depth or assessing additional outcomes that may require supplementary questionnaires, validated assessment tools, medical records, biological samples, or linked systems. Individual epidemiological studies will determine the best metrics for the health/social outcomes of interest.

5. Data Management Plan

The goals of the Data Management Plan (DMP) are to: 1) organize data collected by the Registry, 2) provide well-documented, high-quality data for project evaluation, 3) ensure data security and confidentiality, and 4) support ease of data access and de-identified data sharing, as

appropriate, with Registry stakeholders. The DMP supports the overarching Registry goal to maximize the utility of Registry data to inform policy and administrative decisions for the benefit of those exposed through the Red Hill water crisis and the State of Hawai‘i. The DMP is a living document to be reviewed annually, updated as needed, and its changes communicated to Registry personnel. Epidemiological studies should generally follow the Registry DMP protocols below.

a. Data Management Protocols

Registry data shall be stored in a secure, controlled-access repository compliant with all applicable data security, privacy, and administrative regulations. Data shall be encrypted at rest and in transit. Any protected health information (PHI) shall be managed and processed in compliance with the Health Insurance Portability and Accountability Act (HIPAA).

Secure consent management systems shall be employed to store, track, and manage participant consent information. Furthermore, website user tracking data shall be collected and used in compliance with applicable General Data Protection Regulation (GDPR) and U.S. state (e.g., California Consumer Privacy Act [CCPA]) privacy regulations.

b. Registry Data Sharing

The Registry data repository shall be considered a “controlled-access repository” as described by the National Institutes of Health (NIH) Data Management and Sharing Policy. As such, strictly de-identified data would be made available for data-sharing subject to IRB approval, and as documented by a Registry-approved Data Sharing Agreement. Studies that incorporate Registry data into their datasets and plan to share the augmented data (secondary data sharing) shall require Registry approval and documentation in the data use agreement with the researcher. Although Registry data and other data collected through future research studies may not necessarily be governed by HIPAA provisions, the “Safe Harbor” method (45 CFR 164.514(b)(2)(i)) of removing the 18 identifiers shall be used as the standard for de-identification (Electronic Code of Federal Regulations, 2024).

C. PERIODICITY FOR DATA COLLECTION (FY24 NDAA Sec. 1092(b)(2)(C))

This section discusses feasibility assessment element (C), *“the periodicity for data collection that takes into account the differences between health care practices among impacted individuals who are— (i) members of the Armed Forces on active duty or spouses or dependents of such members; (ii) members of the Armed Forces separating from active duty or spouses or dependents of such members; (iii) veterans and other individuals with access to health care from the Department of Veterans Affairs; and (iv) individuals without access to health care from the Department of Defense or the Department of Veterans Affairs.”*

Initial participant enrollment into the Registry and subsequent baseline questionnaire completion is planned to occur between Fall 2025 and Spring 2027. Follow-up may take place 18 months to two years after the initial questionnaire and may continue at regular intervals thereafter, funding permitted. The impacted community is diverse, including active-duty service members and their dependents, individuals transitioning from active duty, veterans, and those without access to DoD or Department of Veterans Affairs (VA) healthcare. Despite differences in healthcare practices among these groups, standardized periodicity (i.e., the same time frame for questionnaires) is essential to ensure comparability between groups. For example, a service

member transitioning from active duty to veteran status may experience gaps in healthcare access, while a dependent child may face challenges in care continuity when aging out of the DHA healthcare system. Consistent data collection timelines and other protocols across all groups will capture these transitions and their impact on long-term health outcomes without introducing variability. Ultimately, this approach ensures that the Registry can provide robust, comparable data, addressing the full spectrum of healthcare access and practices across all affected populations. Standardized periodicity is crucial to understanding the full impacts of the Incident and address the full spectrum of healthcare access and practices, including health impacts. The Registry recognizes that access to health care and the type of access to care may be an important confounding aspect and as such it will be tracked in the questionnaire (see Section III. D. 4. for more on confounding). The Registry intends to employ a globally-oriented recruitment process to ensure that all impacted individuals have the opportunity to enroll (see also Section III. A. for more on recruitment). Standardized periodicity of Registry data collection is highly conducive to an epidemiological study, thereby enhancing feasibility.

D. METHODOLOGIES TO ANALYZE DATA (NDAA Sec. 1092(b)(2)(D))

This section discusses feasibility assessment element (D), *"a description of methodologies to analyze data received from the study or studies to determine possible connections between exposure to water contaminated during the Red Hill Incident and adverse impacts to the health of impacted individuals."*

Registry data can be used to examine associations between self-reported exposure to contaminated water and various self-reported health outcomes in the overall population, as well as among vulnerable subgroups, including pregnant women and children. By analyzing responses from the Registry questionnaires about water use and exposure setting (see Section III. D. 3. for more on exposure assessment, and Section III. E. for more information on exposure and eligibility), participants can be categorized by characteristics to allow for examining associations within the cohort. Additionally, the Registry is considering recruiting not only exposed individuals but full households, which could include both exposed and unexposed individuals. A household on the Navy water system may have members who were unexposed, for example, due to being out of the house for college, while a household off of the Navy water system may have members working or going to school in one or more of the exposure zones. Unexposed household members may be used as a comparison group of unexposed individuals. Future studies could also enroll a control group of a similar population; for example, residents or clerical workers of the Marine Corps Base Hawai'i in Kaneohe Bay, who were not directly affected or exposed to the jet fuel leak could be considered.

1. Study Design

Given the nature of the Registry, epidemiological studies to be conducted with this data could be cross-sectional or longitudinal in design. A cross-sectional study examines relationships between variables at a single point in time. These variables are described as exposures (i.e., independent variables) and outcomes (i.e., dependent variables). Longitudinal studies examine associations across time among the same participants, for example, between an exposure at baseline (i.e., the first time point of a study) and the occurrence or progression of outcomes over time. Longitudinal studies can be short in duration, such as a couple of months or years, or long in duration, spanning many decades. Given the current structure of the Registry, a longitudinal

study could include questionnaire data from at least two time points, at baseline and follow-up, encompassing 2-4 years. Additional funds will be needed to support the Registry for a longer period of time to both support impacted residents and allow for longitudinal studies to track the health of impacted residents that could extend for many more years.

In addition, both exposure-control (exposed vs. unexposed) and case-control (disease vs. no disease) studies could be designed in future epidemiological studies where an appropriate comparison group is identified.

2. Study Size and Power Calculations

Despite best efforts in recruitment, many affected community members may choose not to enroll in the Registry or participate in future studies for various reasons, including competing priorities or distrust (Bremer et al., 2024). The Registry has an estimated enrollment of approximately one-half of exposed individuals, or 45,000 participants, ensuring a robust sample for studies assessing the health impacts of the water contamination. Based on standard power calculations for epidemiological studies, even if only half of the targeted participants (around 22,500) enroll and are eligible for analysis, the Registry would still have the statistical power to detect differences as small as 1% across population proportions of a given health outcome. If enrollment were reduced to a quarter of the target (around 10,000 participants), differences of 2% could still be detected. Therefore, most epidemiological studies leveraging Registry data would remain sufficiently powered, particularly when using data from questionnaires to assess exposure-outcome associations that would address the research gaps identified in Section II. C. Irrespective, any proposed epidemiological study using Registry data, especially those focusing on subpopulations (i.e., pregnant women or children in specific age ranges), would be required to provide power calculations to demonstrate study feasibility given the smaller number of Registry participants in those groups.

3. Exposure Assessment

Understanding whether exposure to chemicals from the Incident leads to adverse health outcomes is a central aim of epidemiological studies that will use the Registry data. In environmental epidemiology, exposure refers to the contact between the human body and an environmental contaminant, such as JP-5 fuel. The June 2023 exposure assessment by HDOH (updated October 2023) provides the best available analysis of toxicants in the drinking water system following the JP-5 release at Red Hill Shaft, estimating reasonable maximum exposures through multiple pathways (Brewer, 2023). However, it does not account for other contaminants, including halogenated DBPs created by the chlorination of petroleum-contaminated water (Brinkmann et al., 2024) or the possible movement of other toxicants through the distribution system, which was also sourced from two other wells. These factors likely influenced toxicant concentrations, timing of exposure, and maximum exposure duration—elements that must be addressed through more comprehensive, modeling-based assessments that may be components of future epidemiological studies.

Exposure to toxicants in environmental epidemiology can be quantified through several methods, including environmental samples (water or air), environmental modeling, questionnaires, medical records, and biological samples (e.g., blood), or a combination of these approaches. Currently, there are a few key data sources that quantify exposure to JP-5 during or shortly after the Incident, described as follows: 1) during peak exposure, a few tap water samples from homes

were sampled and tested; 2) during and after the flushing period, there was extensive water sampling and testing (JBPHH, n.d.); 3) during and after the exposure period, the first two ACE studies and the smaller UH study gathered self-reported exposure data through questionnaires that included questions on behaviors (decisions to use the water for cooking, hygiene, cleaning or to switch to an alternative water source), that may have impacted exposure, though these studies had relatively small sample sizes (ATSDR, 2023b; Bremer et al., 2024; Miko et al., 2023). The Registry aims to expand this effort by collecting extensive questionnaire data about these practices from a larger population (See Section III. B. 3. for more information about the questionnaire and Section III. E. for detailed information about exposure and eligibility).

4. Confounding

In epidemiological studies, it is important to account for factors that might influence both the exposure and the outcome, as these can confound the observed quantitative association between them. That is, if these other factors are not considered, investigators may incorrectly conclude that their findings are causal, when they are not. Commonly considered confounding factors include age, sex, race/ethnicity, and access to and continuity of healthcare (see Section III. C. for more on access to and continuity of healthcare). These characteristics will be collected by the Registry and will be available to investigators conducting epidemiological studies in accordance with approved protocols.

Two confounders specific to the Incident are known and should be considered. The first is that the November 2021 fuel release coincided with a surge in the Delta variant of the SARS-CoV-2, the virus that causes COVID-19, and some of the health outcomes experienced by those affected by the fuel spills may be attributable to having COVID-19 during this phase of the pandemic (e.g., anxiety, respiratory problems, gastrointestinal issues). A symptom of COVID-19 also includes a loss of sense of smell and taste, and it is possible that individuals whose sense of smell was impaired due to COVID-19 could have experienced longer durations of exposure to contaminants before they were aware of it. The second specific confounder relates to chemical mixtures. One chemical in a mixture can be so highly correlated with another that it can be difficult to discern which is related to a health effect. Fuel additives and DBPs may also be correlated with JP-5, but it remains unclear whether PFAS are; these questions may also be primary topics of future epidemiological studies.

Some constituents of JP-5 can have other probable sources, both natural and introduced by humans. Future exposure studies should evaluate an unexposed control population to establish a baseline level of any potentially confounding substances that would exist in the absence of JP-5 exposure. In addition, causal inference diagrams, appropriate study design, and statistical methods are typically used to consider and control for confounding (Lash et al., 2021).

5. Data Analysis Methods

In epidemiology, it is a best practice to first analyze data by using descriptive statistics to summarize the distribution of the outcome variable(s) and the exposure variable(s) (Dicker, 2018). After these initial analyses, more advanced models can be constructed. For example, regression models (including the exposure alone or in addition to a number of independent variables to adjust for confounding) can be conducted. Links between exposures and outcomes are typically evaluated using 95% confidence intervals (CIs) to assess statistical significance, which is a standard measure of the potential margin of error. Additionally, there may be

justification to conduct stratified, or separate, analyses to estimate effects for different groups, such as for women compared to men or for different age groups.

Longitudinal epidemiological studies require particular types of statistical analyses. Specifically, a mixed-effects model framework is often applied to examine the relationship between exposure variables and outcomes and, if observed associations change over time, adjust for within-individual correlations within repeated measures. Generalized estimating equation models can also be used to analyze longitudinal data. Excellent statistical software programs exist for these types of analyses, such as *R* and *SAS* (R Core Team, 2023; SAS Institute Inc., 2022).

6. Missing data, imputation, and other potential challenges

In nearly all epidemiological studies, there are missing data. Sometimes participants do not know the answer to a given question or refuse to answer certain questions. In longitudinal studies, there may be participants who miss a follow-up data collection appointment or questionnaire, or they may drop out of the study altogether. Statistical methods exist for handling missing data, including exploring patterns of missingness in data and whether missingness is related to socio-demographics and any other predictors. There are multiple techniques to address the challenge of missingness, such as Multiple Imputation with Chained Equations (Bennett, 2001; Dong & Peng, 2013; Madley-Dowd et al., 2019; Schafer, 1999).

The sample of the Registry may pose another challenge. Because the Registry is opt-in, there may be important differences in the characteristics of those who agree to be a part of the Registry and those who do not. There are statistical and analytical techniques that can help address this limitation, such as propensity score analysis (Oakes & Johnson, 2006).

E. IDENTIFICATION OF EXPOSURES AND ELIGIBILITY (FY24 NDAA Sec. 1092(b)(2)(E))

This section will discuss feasibility assessment element (E), *"an identification of exposures resulting from the Red Hill Incident that may qualify individuals to be eligible for participation in the study or studies as a result of those exposures."*

Registry leadership, in a process to be co-designed with the community, will determine clear inclusion and exclusion eligibility criteria for the Registry. Although households are being considered (see Section III. D. for more on household inclusion), at this time the only certainty is that individuals who were exposed as a result of the November 2021 Incident will be invited to enroll in the Registry. This includes military personnel and civilians who live(d) and/or work(ed) in areas served by the Navy water system and its water sources. Given the complexity of the history at the facility, it is necessary to consider factors that may affect eligibility, including community input (see Section III. E. 1.), chemicals of concern (see Section III. E. 2.), and routes of exposure (see Section III. E. 3.).

The Registry will be designed to support a wide range of epidemiological studies. Aside from the Registry, each exposure or epidemiological health outcomes study will be required to establish sound protocols on inclusion/exclusion eligibility to address the given research question. Eligibility criteria for epidemiological studies may be based on data drawn from the Registry and should be designed to target specific scientific questions. Some examples include:

- **Population Segmentation:** Based on demographic factors such as age and pregnancy status.
- **Exposure Location:** Based on where individuals lived or worked during significant exposure periods.
- **Exposure Timing:** Based on different chemical exposures or exposure periods.

1. Community Concerns Regarding Eligibility for the Registry

The Registry recognizes, and respects, the concerns of the community regarding eligibility for enrollment. To address these concerns effectively, the Registry is committed to making decisions in collaboration with the Red Hill community. This will be achieved through dedicated community listening sessions and actively seeking feedback to ensure that the Registry meets the community's needs and expectations.

The Registry's approach will be transparent and inclusive, ensuring that eligibility criteria are established with direct input from those living or working on the Navy water system as well as other residents of Hawai'i, including Native Hawaiian residents who are also affected by the Incident due to this being their home island and their role as caretakers of this Land. The Registry acknowledges that eligibility decisions impact various aspects of a future study, including the financial implications of providing incentives to participants.

While the Registry is committed to offering incentives in the form of gift cards to participants, the overall costs and feasibility must be considered if eligibility criteria are expanded. Given the array of known and unknown spills, and subsequent potential exposures at the Red Hill Bulk Fuel Storage Facility (see Section II. B. for more information on the facility history), a screening questionnaire, administered prior to enrollment, could ask about the timing and nature of an individual's potential exposure(s). This tool would enable the Registry to better understand whether exposure occurred before, during, or after the November 2021 exposure window. Based on this screening, the Registry may offer varied incentives and tailor the length of full questionnaires to match participants' specific exposure timing. The Registry will rely on community input to determine the final eligibility criteria.

By maintaining a flexible data structure and collaboratively developing enrollment eligibility, the Registry aims to address community concerns effectively and ensure that the research provides valuable insights into the impacts of the Red Hill water contamination.

2. Chemicals of Concern

An exposure assessment should consider the movement and transformation of up to 5,542 gallons of JP-5, along with additives and other contaminants potentially mobilized by the Incident (Cavanaugh, 2022). These contaminants directly entered the JBPHH water distribution system through Red Hill Shaft, and were subsequently distributed through 250 miles of pipeline and chlorination units (National Enforcement Investigations Center [NEIC], 2022a, 2022b), providing water to 9,600 households, schools, and workplaces (Miko et al., 2023).

The primary chemicals of concern are constituents of JP-5, which is a refined petroleum fuel containing a mixture of hundreds of compounds, mostly hydrocarbons. Due to the complexity of this mixture, current analytical methods are unable to identify every single chemical constituent of JP-5. Therefore, quantitation is usually based on non-specific measurements of hydrocarbon ranges (i.e., TPH), in combination with a small number of specific individual chemicals that are

known components of the fuel and have well-documented adverse health effects. These may include: benzene, toluene, ethylbenzene, xylenes, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and n-alkanes. Additives to the fuel, including icing inhibitors, corrosion inhibitors, and antioxidants, which make up less than 1% of the fuel (Brewer, 2023), may also result in health effects that are similar to those of jet fuel. Additional chemicals that are not constituents of JP-5, but may influence an exposure assessment, include potential contaminants in the fuel and fire suppression lines, such as PFAS, methyl-tert-butyl ether (MTBE), and lead, as well as a large variety of DBPs formed by the interaction of JP-5 with free chlorine.

3. Exposures: Contact via Inhalation, Ingestion, and Direct Contact and Absorbed Dose

In the environment, components of JP-5 partition preferentially into different phases, with significantly different proportions resulting in contaminated air versus water. Thus, the chemicals to which a given population is exposed may vary significantly depending on the medium of the exposure. In this scenario, exposure to the chemicals of concern most likely occurred through multiple pathways, including: 1) ingestion of the contaminated water, 2) dermal (skin) contact from water used for hygienic purposes (such as showering, washing hands, and laundry), 3) inhalation of contaminated indoor air, and 4) inhalation of contaminated outdoor air during venting of the Red Hill tunnel immediately following the Incident and initial discharges of untreated contaminated water into open areas of base housing (Brewer, 2023).

It is generally agreed that higher doses of a chemical would be associated with increased health effects. There is limited quantitative data for the concentrations of the chemicals of concern from the Incident; thus, assessment of acute exposure may consider inputs from other data sources such as qualitative data, synthetic data (from lab-based experiments), and long-lived human biomarkers of these chemicals.

F. PROVIDING INFORMATION ON AVAILABLE RESOURCES AND SERVICES (NDAA Sec. 1092(b)(2)(F))

This section will discuss feasibility assessment element (F), *"steps that will be taken to provide individuals impacted by the Red Hill Incident with information on available resources and services."*

The Registry plans to utilize existing databases and software programs, supplemented with artificial intelligence technology, to develop and maintain an extensive list of health and social service resources, which will be accessible to all enrollees, regardless of their geographic location. The Registry's resource and referral program will follow a structured flow from enrollment to service delivery. Upon enrollment, participant needs will be identified through initial intake, the baseline questionnaire, and ongoing interactions. Enrollees will be able to engage with the Registry participant engagement staff, who will assist with identifying the most relevant services and supports available to them. Special considerations will be given in the areas of healthcare and social services, as the impacted community requires support in accessing general health and mental health care, recovering from disruptions in education, financial counseling, and housing services. After a set period, it is intended that participant engagement staff would follow up with enrollees to evaluate their experience and ensure the resources were helpful. All interactions would be logged for evaluation and improvement of the program.

The Registry also plans to launch a comprehensive outreach and education program aimed at

informing care providers (medical, mental, and social services) and the public about the Red Hill water contamination, covering the scientific understanding of the exposures, potential health effects, medical and social implications for affected individuals, and, if possible, treatment and support recommendations to assist individuals in making informed decisions about maintaining a healthy and safe living environment post-exposure. Education formats to be explored for care providers include print and online modules that may be developed in partnership with organizations offering continuing medical education credits. Additionally, following ATSDR guidelines, the community environmental health education program for the general public would feature meetings, educational videos, and podcasts that would be developed in collaboration with experts in exposure science, toxicology, and public health (ATSDR, 2023b). To assess the effectiveness of these efforts, the Registry will explore the use of knowledge, attitude, and behavior surveys related to environmental health as part of the baseline and follow-up questionnaires.

G. FINAL DETERMINATION OF FEASIBILITY (NDAA Sec. 1092(b)(2)(G))

This section will discuss feasibility assessment element (G), *"a final determination on whether it is feasible to conduct an epidemiological health outcomes study."*

This report has demonstrated the feasibility of conducting one or more epidemiological health outcomes studies to support the impacted population and the contribution of knowledge about the long-term health impacts after exposure to fuel from the Red Hill Incident.

Given the infrastructure that is in development by the Registry, numerous epidemiological studies, including those that are broad in scope or very specific, are indeed feasible following a questionnaire-based or modeling-based exposure assessment. A reasonable approach would be to focus first on individuals who experienced acute exposures via multiple exposure pathways in the November - December 2021 window, and build out a broader set of investigations as patterns and information emerges. As outlined in this report, a large number of individuals are affected by the Incident, which allows for numerous research studies of diverse health outcomes, ranging from the relatively rare to the fairly common. Moreover, as the entire population of the Navy water system was affected by the Incident, specific epidemiological studies of at-risk sub-populations, such as children or pregnant women, are feasible. Studies beyond using Registry data are also feasible pending additional funding, including: in-depth exposure or outcomes studies, particularly those that require biological samples; a large control population; contact with participants outside of the Registry's baseline and follow-up questionnaires; and studies that intend to follow participants beyond the Registry's current five-year funding period.

In summary, epidemiological health outcomes studies are feasible and critical to better understand the range of adverse health outcomes associated with the unprecedented, widespread exposure to jet fuel and contaminants associated with the Red Hill Incident. This understanding, and the subsequent informing of care needs for affected community members, will play a significant role in addressing gaps in existing knowledge as well as addressing community concerns.

IV. SUMMARY RECOMMENDATION

This feasibility assessment has provided a background on the Red Hill Incident, including context about the November 2021 spill, timeline of known exposures from the Red Hill Bulk Storage Facility at JBPHH, known health effects of jet fuels, immediate health effects related to the Red Hill Incident, and the new Registry. It has also provided specific responses to the elements of the feasibility assessment required by the FY24 NDAA regarding an epidemiological health outcomes study, including issues related to recruitment and incentives; protocols and methodologies; periodicity of data collection; data analysis methodologies; exposure identification; connecting impacted individuals with information on resources and services; and a final determination on the feasibility of such epidemiological health outcomes studies.

As above, the new establishment of the infrastructure for the Red Hill Registry provides the foundation from which multiple epidemiological health outcomes studies can be conducted. The continued support of the Registry by NCDMPH for the long term will be important to tracking health outcomes that take many years to develop. This report has outlined clear scientific and community-driven design considerations for these potential studies to be scientifically successful as well as impactful.

Exposure to jet fuel through the drinking water to the general population is unprecedented and little is known about the potential health effects, particularly in vulnerable populations such as children and pregnant women. Existing epidemiological studies on associations between jet fuel and health effects are useful, but insufficient to generalize findings to a broad population, as there are too few, they have been performed solely in occupational settings, and they do not include ingestion as an exposure route to humans. In addition, epidemiological health outcomes studies should be planned to assess long-term health outcomes, given that many outcomes of interest, including respiratory ailments, cardiovascular diseases, and cancer, take years to decades to develop following exposure. Epidemiological health outcomes studies are necessary in situations such as those of the Red Hill Incident to fill knowledge gaps and inform treatment plans, as well as to meet the needs of the scientific and medical communities (ATSDR, 2023a), the DHA, and the impacted community and public at large.

It is also necessary to incorporate the community in decision-making and reporting processes for all epidemiological health outcomes studies to ensure study success and to maintain trust with the community. Willing participation is required of all epidemiological studies and participant cooperation is imperative to gather nuanced self-reported information such as differences in affiliation to the military that may impact continuity of care. Extensive community engagement will help to ensure that the Registry, as well as future researchers working with impacted community members, are able to provide answers to the many questions regarding both immediate- and long-term concerns following the Incident.

In summary, one or more epidemiological health outcomes studies to assess health outcomes of impacted Red Hill Incident individuals are indeed both feasible and necessary. Ongoing funding to support the Red Hill Registry, as well as investments in future epidemiological health outcomes studies, would both help to repair relationships between the community and the DoD in Hawai‘i (a strategically important location for national security in the Indo-Pacific), and, ultimately, help to foster healing in both military and civilian communities that have been disproportionately impacted by this crisis.

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