DEPARTMENT OF THE NAVY
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CERTIFIED NO: 9489 0090 0027 6232 2381 87
Mr. Steven Linder, P.E.
U.S. Environmental Protection Agency, Region 9
75 Hawthorne Street
San Francisco, CA 94105

CERTIFIED NO: 9489 0090 0027 6232 2381 94
Ms. Roxanne Kwan
State of Hawaii Department of Health
Solid and Hazardous Branch
2827 Waimano Home Road
Pearl City, HI 96782

Dear Mr. Linder and Ms. Kwan,

SUBJECT: RISK AND VULNERABILITY ASSESSMENT PHASE 2 FOR THE RED HILL ADMINISTRATIVE ORDER ON CONSENT STATEMENT OF WORK SECTION 8, NOTICE OF DEFICIENCY AND OPPORTUNITY TO CURE

We are in receipt of your letter dated October 23, 2020 identifying the Notice of Deficiency and Opportunity to Cure the Statement of Work (SOW) for Phase 2 of the Risk and Vulnerability Assessment (RVA). This letter is in response to the request to resubmit the RVA SOW within 60 days.

As requested, Navy/DLA are submitting a revised proposed scope of work to complete Phase 2 of the RVA in accordance with the Administrative Order of Consent (AOC) SOW Section 8 and reference (1) within the 60-day timeframe as required.

a. The attached proposed SOW addresses the following four expectations outlined in reference (1) including:

(1) Development of a comprehensive range of plausible fuel release scenarios and associated release volumes and rates for each using realistic conservative justifiable assumptions along with their corresponding basis.

(2) Estimates of potential release rates, volumes, durations, locations, frequencies (including cascading scenarios.

(3) Evaluation and likelihood of release events that may result in the release of fuel to the environment impacting the quality or availability of the drinking water will be completed once associated AOC deliverables (e.g. groundwater flow model report, contaminant fate and transport model report and investigation and remediation of releases report) have been submitted and approved by EPA and DOH.

(4) As required by the schedule for AOC deliverables, Navy/DLA submitted the Investigation and Remediation of Releases Report (IRR) for review and comment on March 25th, 2020. Navy/DLA are in concurrence with the statement in your letter dated October 23, 2020 that "Tools including, but not limited to, the contaminant fate and transport model (CF&T) should be utilized to identify environmental consequences". However, in order to proceed with the CF&T, we will require acceptance of the groundwater flow model report submitted to EPA/DOH on March 25, 2020.

Navy/DLA have considered the recommendation that the revised approach be discussed with external stakeholders beyond the Regulatory Agencies. At this time, Navy/DLA do not intend to seek input from external stakeholders. However, Navy/DLA would be willing to consider input submitted to EPA/DOH on behalf of external stakeholders. This input can be discussed in the risk workshop proposed by EPA/DOH.

Navy/DLA would like to again reiterate our promise to protecting public health, the environment, and the nation. We believe our ongoing efforts at Red Hill show our commitment to doing so. If you have any questions, please contact Mr. Donald Panthen, the Red Hill Program Director at (808) 473-4148, or myself. We look forward to advancing this important work in the days ahead.

Sincerely,

J. G. MEYER
Captain, CEC, U.S. Navy
Regional Engineer
By direction of the
Commander

References: 1. Letter to CAPT Meyer from Mr. Linder and Ms. Kwan of October 23, 2020, Re: Risk and Vulnerability Assessment Phase 2 Proposed Scope of Work for the Red Hill Administrative Order on Consent Statement of Work Section 8, Notice of Deficiency and Opportunity to Cure

2. Letter to Mr. Omer Shalev and Ms. Roxanne Kwan from CAPT Delao of November 19, 2019, Subject: Risk and Vulnerability Assessment Phase 2 for the Red Hill Administrative Order on Consent Statement of Work Section 8

Enclosure: Revised Risk and Vulnerability Assessment Phase 2 Statement of Work of December 23, 2020

Section 8.2 - Risk/Vulnerability Assessment
Phase 2 Scope of Work

23 December 2020

Red Hill Bulk Fuel Storage Facility
NAVSUP FLC Pearl Harbor, HI

Joint Base Pearl Harbor-Hickam

Administrative Order on Consent
In the matter of Red Hill Bulk Fuel Storage Facility
EPA Docket No. RCRA 7003-R9-2015-01
DOH Docket No. 15-UST-EA-01

Prepared by: Naval Facilities Engineering Systems Command (NAVFAC) Hawaii

NAVFAC
Naval Facilities Engineering Systems Command
NAVFAC Hawaii

Note: Large Portions of Future Versions of Section 8 Documents will have portions removed with the statement: "FOR OFFICIAL USE ONLY: PRIVILEGED, subject to claim under 5 USC 552(b)(3); 10 U.S.C. 130(e). Contains information subject to a claim of privilege under 10 U.S.C 130e, such information and the pages containing such claims remain the property of the United States Navy and cannot be released without the review and written permission of the United States Navy."

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1. Background

This Scope of Work (SOW) has been developed as guidance for implementing Phase 2 of the Red Hill Bulk Fuel Storage Facility (RHBFSF) Risk and Vulnerability Assessment (RVA) in compliance with the RHBFSF Administrative Order on Consent (AOC).

Phase 1 involved a rigorous, comprehensive Quantitative Risk and Vulnerability Assessment (QRVA) of internal events only (without fire or flooding) as documented in ABS Consulting report number R-3751812-2043 dated 12 November 2018 and formally submitted to EPA/DOH on 29 May 2019. EPA/DOH approved this report in their letter dated 23 September 2019. The SOW for Phase 2 of the RVA was initially submitted to EPA/DOH on 19 November 2019. EPA/DOH issued a Notice of Deficiency/Opportunity to Cure letter on 23 October 2020, identifying four key components that should be included in the remaining RVA deliverables. EPA/DOH stated in their letter, they expected the remaining deliverables to address a list of specific items.

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2. Methods, Process, and Criteria for Data Quality

2.1 Purpose

The purpose of this proposed SOW is to complete Phase 2 of the RVA following input from AOC and other stakeholders to qualitatively identify the highest risks to the RHBFSF. Once the highest risks have been qualitatively identified, expert quantitative analyses will be prepared to estimate the level of risk posed by specific vulnerabilities or initiating events of concern. This process will allow the focus to be spent on identifying and mitigating the highest risks to the RHBFSF and not focusing on the accuracy of quantifying each risk.

2.2 Site Description and History

The RHBFSF site is located approximately 2.5 miles northeast of Pearl Harbor on the island of Oahu in Hawaii. The facility lies along the western edge of the Koolau Range and is situated on a topographic ridge that divides the Halawa Valley and the Moanalua Valley. The site is bordered to the south by the Salt Lake volcanic crater and occupies approximately 144 acres of land. The surface topography varies from approximately 200 feet to 500 feet above mean sea level.

The facility consists of twenty 12.5-million-gallon underground storage tanks (UST) constructed in the early 1940s. Currently, six USTs are out of service (T-1, T-13, T-14, T-17, T-18 and T-19). The facility currently stores Jet Propulsion Fuel No. 5 (JP-5), Jet Propulsion Fuel No. 8 (JP-8), and marine diesel (F-76). Historic fuel storage has included diesel oil, Navy Special Fuel Oil, Navy distillate, F-76, aviation gas, motor gas, JP-5, and JP-8.

There have been prior petroleum releases at the site and numerous environmental activities/studies performed for various reasons, including pipeline pressure testing and semi-annual tank tightness testing, release response, tank monitoring, as well as long-term monitoring.

In January 2014, approximately 27,000 gallons of JP-8 was released from T-5, which was being re-filled after having undergone inspections and repair. After completing another Clean, Inspect, Repair process, the Navy restored T-5 to service in May 2020. As a result of the fuel release from Tank 5 at the RHBFSF in January 2014, the U.S. Environmental Protection Agency (EPA) and the Hawaii Department of Health (DOH) brought an enforcement action against the Navy and the Defense Logistics Agency (DLA) to address past fuel releases and minimize the likelihood and impact of future releases. Regulatory experience has shown that a negotiated agreement, such as the AOC, is the appropriate enforcement tool to solve complex environmental problems since it allows for flexible and innovative solutions. The AOC goes beyond the scope of merely complying with current regulations.

2.3 Objectives

The four primary objectives of this SOW are as follows:

1. Develop a comprehensive list of plausible fuel release scenarios and associated release volumes and rates using conservative assumptions that include the basis and justification for said assumptions.
2. Develop estimates of potential release rates, volumes, durations, locations, frequencies and consequences (including cascading scenarios).
3. Evaluate the likelihood of release events that may result in the release of fuel to the environment that could impact the quality or availability of drinking water.
4. Identify potential mitigation measures for identified scenarios with potential to impact water quality or availability.

2.4 RVA Scope Determination

Phase 2 of the RVA will address the initiating events covered in Phases 2 through 4 of the original QRVA:

Phase 1 – Internal Events
Phase 2 – Internal and External Flooding and Fire
Phase 3 – Seismic Events
Phase 4 – Other External Events

The list of hazards to be addressed within the RVA was approved by EPA/DOH in Phase 1 of the QRVA. Industry experience, supplemented by industry standards for risk assessment, has established that a comprehensive RVA should generally consider risks from the following hazard sources, which are recommended to characterize the scope of hazards to be addressed in the Phase 2 RHBFSF RVA:

- Internal Flooding
- Internal Fires
- External Flooding (including tsunami and heavy precipitation)
- External Fires
- Seismic Events (earthquakes)
- Other External Events:
  - High Winds
  - Storms (tornados, hurricanes, etc.)
  - Landslides (or mud slides)
  - Proximity Transportation Accidents
  - Proximity Aircraft Crashes
  - External Hazardous Material or Chemical Spills or Releases
  - Extreme Weather (e.g., high temperature, etc.)

- Other Facility-Specific Hazards (often location-dependent hazards that can be special cases of other general hazard sources)

2.5 Boundaries of Assessment

The Navy/DLA propose to use the following component boundaries to qualitatively evaluate the above risks to the RHBFSF. Specific areas of concern would include:

- Nozzles
- Pipeline
- Tanks
- Overfill

By analyzing the risks from hazards to the above components, the Navy expects to identify the highest risks to the RHBFSF which can then be quantitatively analyzed to determine the estimated level of risk.

2.6 Procedural Approach

The proposed overall process for the RHBFSF Phase 2 RVA is summarized in the following table.

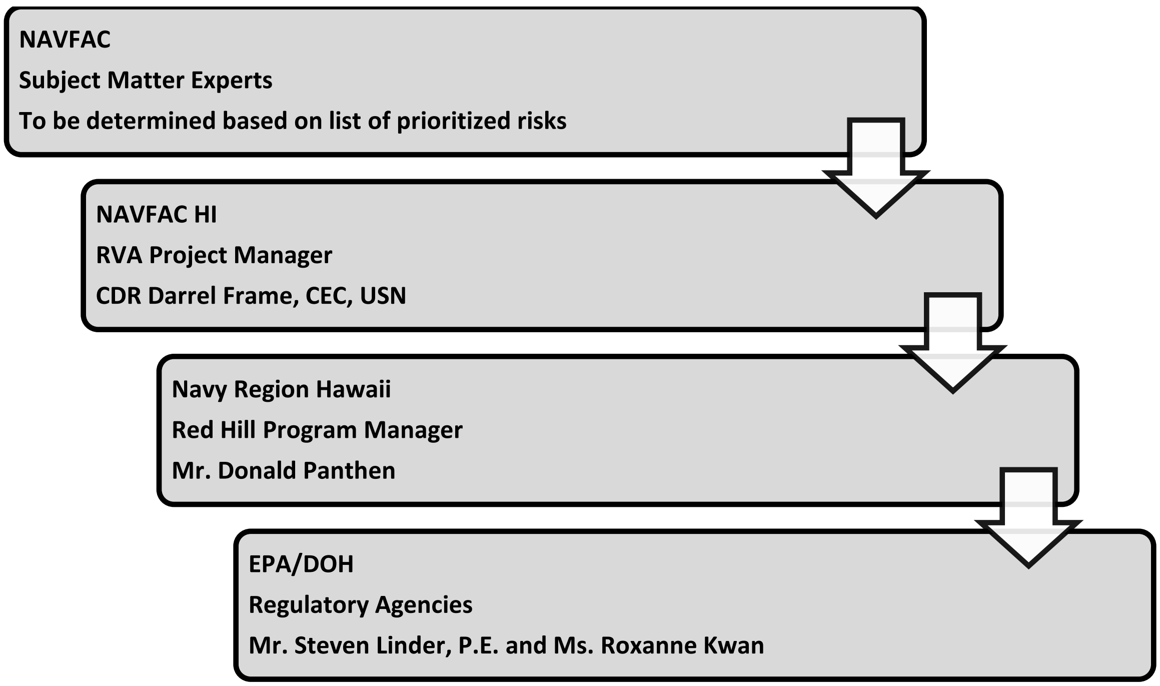
Table 2-1. RVA Process Overview

Event	Participants	Description
Risk Scenario Development	AOC stakeholders with input from non-AOC stakeholders	Develop list of risk scenarios for further evaluation.
Risk and Vulnerability Assessment Workshops	AOC stakeholders with input from non-AOC stakeholders	Consolidate list of risk scenarios from stakeholders and develop risk assessment matrix based on severity and/or likelihood.
Risk and Vulnerability Estimates	DOD subject matter experts	Estimate frequency, probability, flow rate, duration and volume of release of fuel to the environment for highest risks.
Current/Proposed Mitigation Strategies	DOD subject matter experts	Construct bow tie diagram to show both current and proposed mitigation strategies for each of the boundary components.
Contaminant Fate and Transport Evaluation	DOD environmental consultants	Determine if release scenarios will impact drinking water quality or availability

2.7 Communication

From a project management overview perspective, all communication on the project will come from the Navy's team of experts at NAVFAC to the NAVFAC Red Hill RVA Project Manager and communicated to AOC stakeholders via the Red Hill Program Manager at Navy Region Hawaii. See Figure 2-1 on the following page.

Figure 2-1. Project Communication Channels



All communication will be controlled as directed by the Navy. Information requests and product delivery will be submitted by subject matter experts to the Navy RVA Director and then communicated to the EPA/DOH through the Navy Region Hawaii Red Hill Program Manager. Communication will be made in written form, primarily via e-mail, but may, in some cases, involve formal letter communication via express mail or U.S. Post Office mail services.

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3. Risk and Vulnerability Assessment Approach

3.1 Description of RVA Methodology

The following section contains a more-detailed description of the proposed methodology for completing the Phase 2 RVA as summarized in Table 2-1. A conceptual overview of general RVA tasks is presented as follows:

- Risk Scenario Development
- RVA Workshop
- Risk and Vulnerability Estimates
- Current and Proposed Mitigation Strategies
- Contaminant Fate and Transport Evaluation

More detailed description of the above stages is described below.

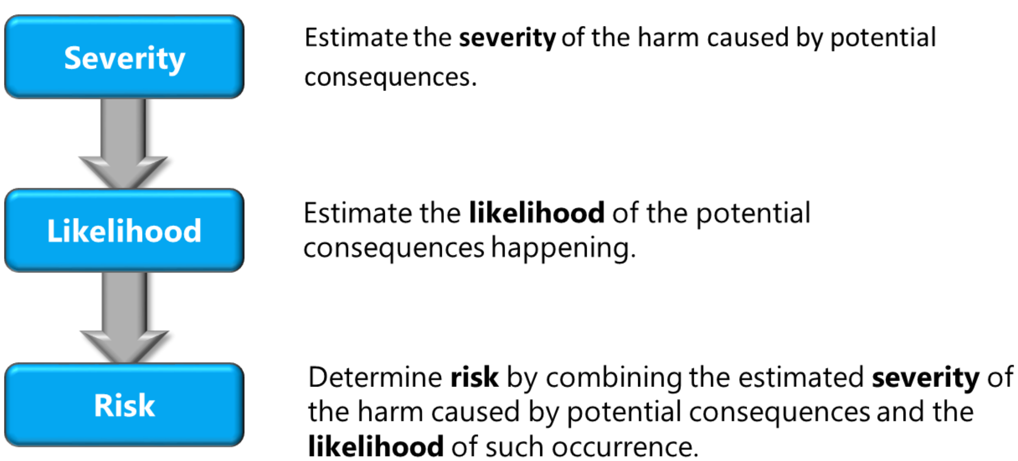
1. **Risk and Scenario Development**

   Prior to the RVA workshop, AOC stakeholders (with input from non-AOC stakeholders) will be asked to provide a list of plausible scenarios potentially leading to a release impacting the environment. These lists will be submitted to the Navy in advance of the RVA workshop and consolidated for ranking at the workshop after a comprehensive review has been completed by all stakeholders in attendance.

2. **RVA Workshop**

   Following development of the consolidated list of plausible scenarios potentially leading to release impacting the environment, stakeholders will meet to rank the list from highest risk to lowest risk. The ranking will be developed using a risk assessment matrix (RAM). The figure below shows the three-step process for developing the RAM.

Figure 3-1. Three-step Process for Developing RAM



The workshop will focus on conducting an analysis of potential scenarios, which are precipitated via the hazards considered within the scope of the RVA. For this RVA, these hazards are those identified in Section 2.4 of this work plan.

For this RVA, the primary undesired consequence is the loss of fuel inventory control within the RHBFSF. The workshop will be utilized to identify and evaluate RHBFSF vulnerabilities associated with each hazard within the scope of the RVA.

Step one involves estimating the severity of the risk. One example of a method used to qualitatively evaluate the severity of the risk is shown below.

Table 3-1. Qualitative Evaluation of Risk Severity

SEVERITY	CONSEQUENCES			
	People	Assets	Environment	Reputation
0	No injury or health effect	No damage	No effect	No impact
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact

This process can be used to effectively differentiate the harm to people, assets, environment and reputation (or PAER). An emphasis for the RVA will be placed on impacts toward people and the environment with less significance placed on assets and reputation. Developing a table similar to the one above will help to better estimate the severity of the harm caused by each potential scenario identified. This will not only consider what has happened previously but also what could happen, and the worst that could happen. This process will consider the worst credible harm to each category in the PAER separately for each credible/plausible release scenario.

Descriptions will be developed to define the meaning of each of the severity levels displayed in the matrix.

Once the severity has been estimated, step two involves estimating the likelihood of each scenario occurring.

An example of a table used to evaluate likelihood is shown in the following table.

Table 3-2. Likelihood Rating Scale

Increasing Likelihood				
A	**B**	**C**	**D**	**E**
Never heard of in industry	Heard of in industry	Has occurred in DOD before or more than annually in industry	Has occurred before at RHBFSF or more than annually at DOD facility	Occurs more than annually at RHBFSF

Likelihood is typically determined on actual historical data. However, in order to use historical data, subject matter experts will need to determine if such a scenario has occurred previously at RHBFSF, at DOD facilities world-wide or at fuel terminals anywhere in the world. Since historical data for a facility such as RHBFSF is generally very limited, an attempt will be made to assess likelihood based on past experiences at fuel terminals worldwide.

Once severity and likelihood have been determined, step three is to determine the risk rating by developing the RAM. A RAM is developed by combining the severity of consequences with the likelihood of a scenario occurring. A typical RAM is shown in the figure below.

Table 3-3. Risk Assessment Matrix

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
					A	B	C	D	E
	People	Assets	Environment	Reputation	Never heard of in industry	Heard of in industry	Has happened in the organisation or more than once per year in the industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact					
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact					
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

RAM is not intended to quantify risk but rather to prioritize how potential risk is handled. RAM ratings are typically developed without consideration of controls.

3. Risk and Vulnerability Estimates

Scenarios with a risk rating that falls within the limits of the red zone (i.e. 5C, 5D, 5E, 4D, 4E or 3E) will be evaluated quantitatively. Estimates of release rates, volumes and durations will be prepared along with estimates of probability and frequency. These estimates will be accompanied by assumptions.

Table 3-4. Risk Assessment Matrix Evaluation

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A Never heard of in industry	B Heard of in industry	C Has happened in the organisation or more than once per year in the industry	D Has happened at the Location or more than once per year in the Organisation	E Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact					
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact					
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

An example of the proposed output of a RAM evaluation is shown in the figure below. The results of the RAM are based on both severity and likelihood.

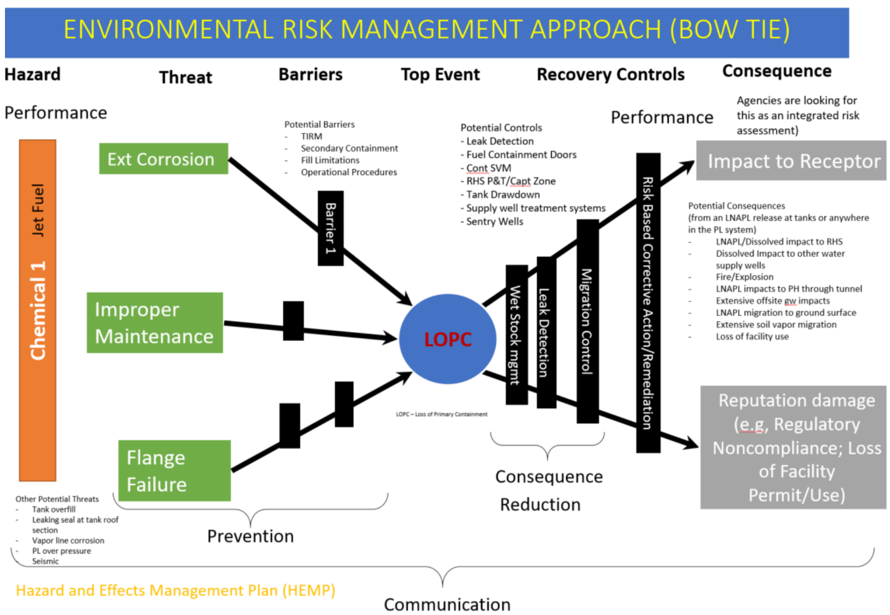
Table 3-5. Qualitative Risk Assessment Summary

Scenario	Nozzle	Pipeline	Tank	Overfill
Internal flooding	Low	Low	Low	Low
Internal fires	High	High	Medium	Low
Internal sabotage	N/A	N/A	N/A	N/A
External flooding	Low	Low	Low	Low
External fires	Low	Low	Low	Low
Seismic	Medium	Medium	Medium	Low
High winds	Low	Low	Low	Low
Landslides/mudslides	Low	Low	Low	Low
Proximity transportation accidents	Medium	Medium	Low	Low
Proximity aircraft crashes	Low	Low	Low	Low
External hazardous material/chemical spill/releases	Low	Low	Low	Low
Terrorist acts	High	High	Low	Medium

4. Current and Proposed Mitigation Strategies

Recommended risk mitigation alternatives and risk management actions for safety management associated with identified risk-dominating scenarios will be developed to reduce risk. Current and proposed mitigation strategies will be developed and documented using an industry recognized environmental risk management approach. This approach is sometimes referred to as a bow tie diagram. The use of the bow tie diagram can be helpful in easily demonstrating to a non-technical stakeholder audience the means by which risk is or can be successfully mitigated. An example of a bow tie diagram follows.

Figure 3-2. Environmental Risk Management (Bow Tie) Diagram



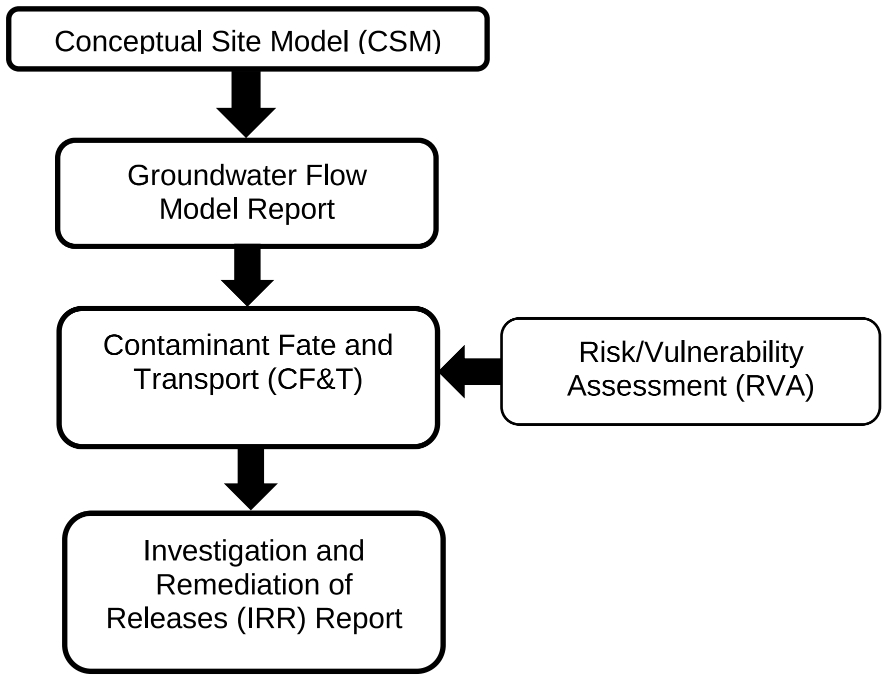
The bow tie diagram for the Phase 2 RVA will include barriers and recovery controls to address all scenarios (a.k.a. threats) that are quantitatively evaluated.

The results of the RVA will be documented in a report in terms that can support prudent decision-making for the facility.

5. **<u>Contaminant Fate and Transport Evaluation</u>**

The Navy/DLA concur with the approach recommended by the EPA/DOH to utilize the contaminant fate and transport (CF&T) model to estimate the impacts of a release on the quality and availability of the drinking water. However, before the CF&T model can be developed, there are still a number of predecessor milestones that must be achieved. A general process for completing the CF&T is summarized in the following figure.

Figure 3-3. Flowchart for Mitigating Risk of Red Hill Release to BWS and Navy Drinking Water Supply Wells



Navy/DLA are committed to utilizing the CF&T model to determine impacts of a release on the quality and availability of drinking water once the above process has been completed and approved by EPA/DOH. Since the IRR Report has already been submitted, Navy/DLA recommend reviewing the IRR following completion of the CF&T and revising as necessary to accommodate new information gained from the CF&T.

3.2 Definitions of Key Terms

The definitions of some key terms applied in RVA are presented in this section. Some definitions of fundamental RVA terms are presented as follows:

Risk: The combined answer to three questions that consider (1) what can go wrong? (2) how likely is it?, and (3) what are the potential consequences? Risk is a product of the estimated severity of the harm caused by potential consequences and the likelihood of such an occurrence.

Hazard: Anything that has the potential to initiate or cause an undesired sequence of events and/or conditions to occur that leads to an undesired consequence. Examples of RVA hazards are facility equipment failures, human errors, fires, floods, earthquakes, adverse weather, etc.

Vulnerability: Weakness in the design or operation of a system, component, or structure that could increase the probability of disabling its function and, thus, contribute, in a potentially significant way, to overall facility risk.

Initiating Event: An event that disturbs the steady state operation of the facility and could lead to an undesired facility condition. This is an event that can start or precipitate a sequence of additional events or conditions that ultimately result in an undesired consequence.

Scenario: An initiating event and associated facility conditions and response events (including both hardware failures and human errors) that could lead to an undesired consequence of interest for the RVA.

Probability: The likelihood that an event will occur as expressed by the ratio of the number of actual occurrences to the total number of possible occurrences.

Frequency: The actual (historical) or expected (future) number of occurrences of an event or accident condition expressed per unit of time.

3.3 Assumptions

The bases and assumptions associated with the RVA will be clearly documented in the RVA report. In RVA, every effort is made to develop and apply realistic “best estimate” event scenarios. In some cases, simplifying assumptions may be applied to simplify overall risk characterization. In cases, where simplifying assumptions are made in the RVA, these assumptions will be documented in the RVA report.

In conducting the risk and vulnerability assessment, the following assumptions should be considered:

1. Risk evaluation is not an exact science and engineering judgement is required to make valid assumptions.
2. Hazard release scenarios must be credible.
3. Consequences will be based on worst case scenarios of what might happen and not what will happen.

4. The risk and vulnerability assessment will be conducted by personnel with the appropriate range of experience and historical knowledge.

3.4 Evaluating and Prioritizing Events

In this RVA, event sequences and individual events will be evaluated and prioritized based on their evaluated contribution to overall facility risk. In some areas of the RVA, simplifying assumptions may be applied, which may be slightly conservative "locally" at the individual event or event sequence level of indenture, but which "globally" have no significant effect on the overall facility baseline risk. In cases where simplifying assumptions are applied, they will be documented in the RVA report.

Screening analyses will be applied in this RVA to effectively simplify the preliminary risk assessment. Any such screening analyses or evaluations applied in this RVA will be based on criteria for acceptable threshold of risk. These risk thresholds will be developed by the RHBFSF subject matter experts. The basis behind these risk thresholds will be documented in the RVA report for AOC and other stakeholder review.

3.5 Content and Format of Deliverables

The primary deliverable of the RVA for this project will be the RVA report (or multiple reports), which clearly documents the bases, assumptions, methodology, databases, calculations, and results of the RHBFSF Phase 2 RVA. Report content will be developed generally corresponding to the tasks identified above. The report(s) will be generated using standard software tools, such as Microsoft Word and Excel, and will be submitted in a Section 508-compliant Adobe Acrobat PDF file format. Items considered critical infrastructure or acquisition related will be redacted and the redacted format will be submitted to EPA/DOH for publishing electronically.

3.6 Coordination with Other AOC/SOW Sections

Coordination will be required to determine the final outcome from this work when volumes and flow rates are inputted into the Contaminant Fate and Transport model to determine if the model predicts there will be any impact to the drinking water quality or availability. Coordination of this communication will be implemented by the Navy RVA Project Manager using the lines of communication presented in Figure 2-1. It is anticipated that meetings and conference calls will be arranged and facilitated by the Navy to support work coordination, communication, and cooperation among AOC technical teams. For the RVA, these types of meetings and lines of communication will be established, controlled, and facilitated by the Navy RVA Project Manager, again via the lines of communication shown in Figure 2-1.

3.7 Quality Control/Assurance Process

This section describes the recommended quality assurance (QA) and quality controls practices to be applied to the RVA Phase 2 project. The Phase 2 RVA project will commit to operate consistent with applicable environmental legislation and regulations and to provide services consistent with international standards developed to avoid, reduce, or control pollution to the environment.

The Phase 2 RVA project will monitor performance as an ongoing activity, to strive for continual improvement, and to provide a framework for establishing and reviewing quality and environmental objectives and targets.

3.8 Phase 2 Activities

This section describes the activities to be accomplished during the Phase 2 RVA project.

1. Risk and Vulnerability Assessment Scope of Work for Phase 2

The following work scope outline is applied to the Phase 2 RVA Scope of Work:

Basis

- Simplified bounding assessment in lieu of a comprehensive quantitative assessment, which is complex and time consuming.
- Targeted analyses to identify potential facility improvements.
- White paper approach for initiating events with lower probabilities.
- Will not quantify or characterize the impact to the water table; assessment will be limited to consideration of likelihood of a loss of inventory control. The Phase 1 assessment will be the baseline for loss of inventory control (e.g., hole in liner, hole in nozzle, hole in the pipeline, etc.) that can be caused by the initiating events considered in Phase 2.

Internal and External Fire and Flood Events

These events will likely require additional ("secondary") conditions to result in a loss in inventory control, so a white paper approach will be used for the assessment.

- Internal Flooding (including an assessment of the potential impact of internal flooding on erosion of fuel handling pipeline support and brackets)
- Internal Fires
- External Flooding, Tsunami, and Heavy Precipitation
- External Fires

Seismic Events

A general review/discussion/summary of Oahu's seismic risks. Assessment of effects on other infrastructure at certain magnitude events for comparison with RHBFSF components. Establish seismic hazard criteria to be used for the facility assessment. Focus will be on the main fuel storage tanks and lower tunnel, as these were identified in Phase 1 and has the most potential risk of an inventory release. One tank structure will be selected for seismic evaluation as a representative example to establish similar risk for all of the other tanks. Nozzle configurations vary from tank to tank. Nozzle configurations will be documented and the seismic analysis will include current and proposed versions of the nozzle configuration.

- Seismic Hazard

- Seismic Hazard Caused by Ground Shaking Determined on a Probabilistic and Deterministic Basis in Accordance with established U.S. Geological Survey (USGS) Data but not less than seismic parameters of UFC 3-3-1-1 Structural Engineering.

- Seismic Risk Category in accordance with UFC 3-3-1-1 Structural Engineering and ASCE 7. Targeted Structural and Nonstructural Component Performance Level in accordance with ASCE 41.

The following assessments have been selected for simplified bounding assessment and targeted quantitative analysis:

- Effects of Wave Action within the Tank

  - Structural Analysis of Overall Concrete Tank Structure and Center Steel Tower for Seismic and Hydrodynamic (Impulsive and Convective) Loading in Accordance with ACI 350.3 Seismic Design of Liquid-Containing Concrete Structures and Commentary

- Seismic Effects on Tank Shell/Liner

  - Structural Analysis of Liner Elements for Seismic Loading

- Seismic Effects on Tank Nozzle that Could Lead to Large Releases of Fuel

  - Structural Analysis of Tank Nozzle and Buried Piping for Differential Movement

- Seismic Performance of Pipeline and Supports in the Lower Access Tunnel

  - ASCE 7 Minimum Design Loads for Buildings and Other Structures

  - ASCE 41 Seismic Evaluation and Retrofit of Existing Buildings

Additional External Events

These events will likely require additional ("secondary") conditions to result in a significant loss of inventory control, so a white paper approach will be used for the assessment:

- High Winds
- Storms (tornados, hurricanes, etc.)
- Landslides (or mud slides)
- Proximity Ground Transportation Accidents (e.g., chlorine or other hazardous chemical truck or rail car accidents)
- Proximity Aircraft Crashes
- External Hazardous Material or Chemical Spills or Releases
- Extreme Weather (e.g., high temperature, etc.)

The following events have been selected for simplified bounding assessment and targeted quantitative analysis:

- Rail Car or Golf Cart Accidents in the Lower Tunnel
- Vulnerabilities of the Pipelines in the Lower Tunnel
- Discussion of Potential Administrative Controls to Avoid Accidents
- Identify Potential Facility Improvement to Protect Pipeline
- Simplified Calculations of Potential Utility Train Derailment Events that Could Threaten Piping Integrity in the Lower Access Tunnel

Malicious acts (e.g., terrorism or insider threats) are not included in the assessment for security reasons.

Detailed Scope of Work

The overall general scope of work for each event type in the Phase 2 of the RHBFSF RVA is provided below.

For each event type, the Navy will memorialize the results of scoping discussions and workshops and develop a white paper style report characterizing the expected risk-dominating scenario of events (or top few, five or fewer, risk-dominating scenarios) based on the risk assessment, in general, and risk insights and knowledge about the RHBFSF obtained through conclusions of the Phase 1 QRVA. Each white paper will include the following major topical sections:

- Executive Summary
- List of Acronyms
- Introduction
- Assessment Approach
- Summary of Assessment Bases and Assumptions
- Evaluation Results and Conclusions
- Recommendations for Risk Management Option Consideration
- References
- Appendices (as required)

This RVA white paper report will be primarily qualitative in nature. Specifically, it will not include analyses previously included in the full scope QRVA, such as Initiating Event Data Analysis, Event Sequence Analysis, Systems Response Logic Modeling and Data Analysis, Human Action Response Logic Modeling and Data Analysis, Risk Quantification, or Uncertainty Analysis. However, it will include qualitative characterization of risk-dominating scenarios, identification of associated risk vulnerabilities, and recommendations for risk mitigation or risk management options or alternatives to be considered by the Navy for implementation over the remainder of facility life. The primary activities to be performed for development of these white paper reports are:

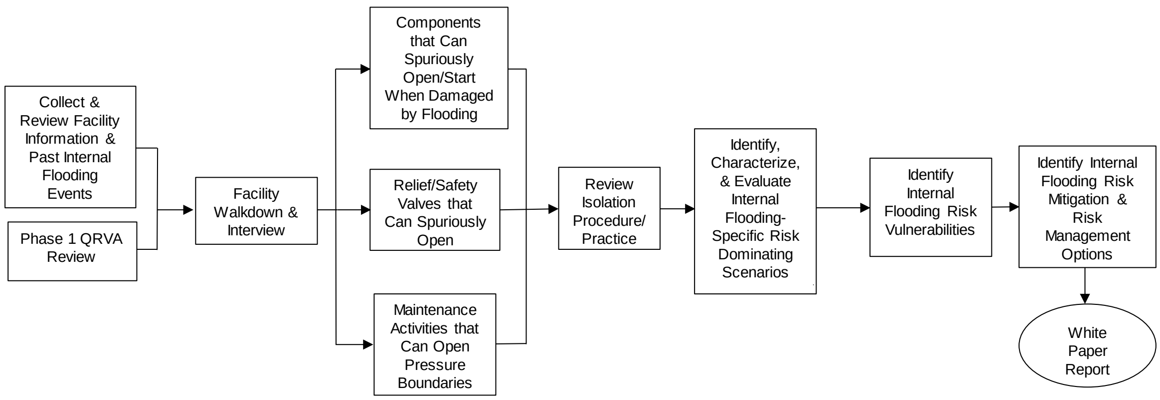
- Facility and Hazard Information Collection and Review
- Phase 1 QRVA Review
- SME Walkdown (likely combined with other hazard assessment walkdown[s])
- Summary of Assumptions
- Identification, Characterization, and Evaluation of Hazard-Specific Risk-Dominating Scenarios
- Identification of Hazard-Specific Risk Vulnerabilities
- Identification of Hazard-Specific Risk Mitigation and Risk Management Options
- Workshop Review of Findings and Recommendations
- Final Report Documentation

Final report documentation will be delivered in both Adobe PDF and Microsoft Word formats, as specified by the Navy.

The detailed process for evaluating each event type in the Phase 2 of the RHBFSF RVA is provided below.

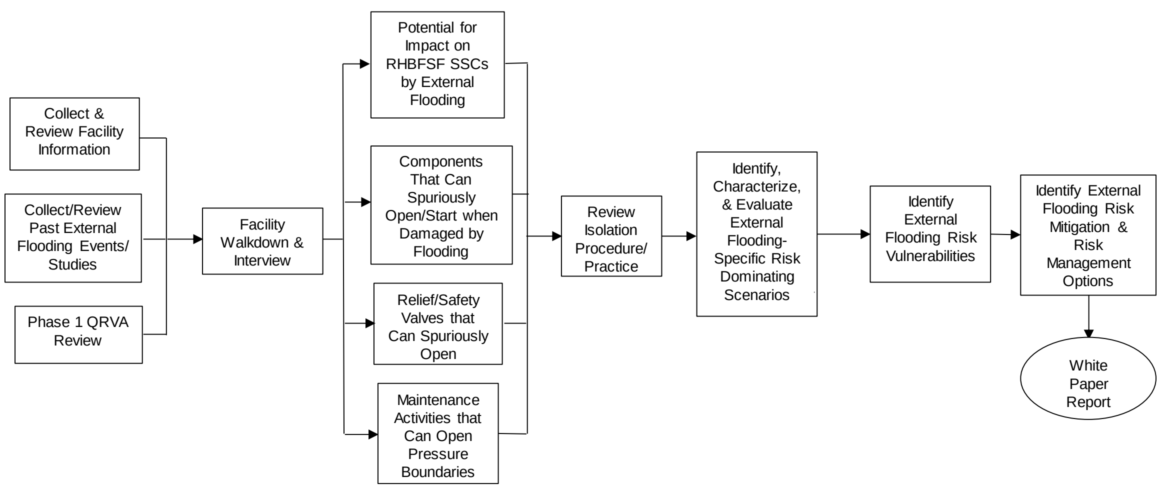
1. The Internal Flooding RVA will include an assessment of the potential impact of internal flooding on erosion of fuel handling pipeline support and brackets. A general process flow chart for the Internal Flooding RVA work is presented in Figure 3-4.

Figure 3-4. Internal Flooding RVA White Paper Approach Process Flow



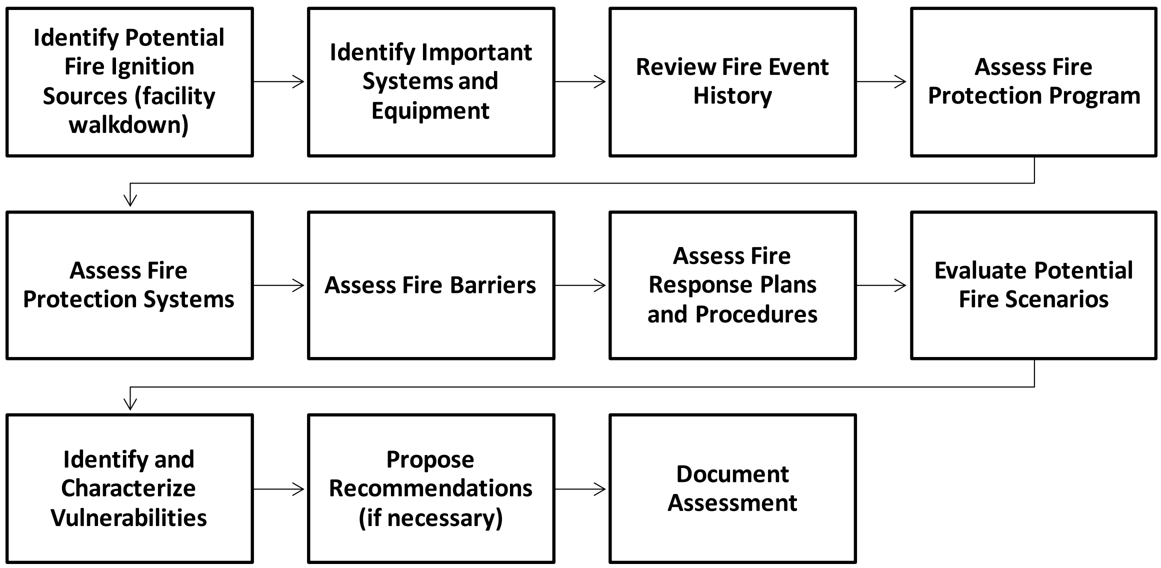
2. A general process flow chart for the External Flooding, Tsunami, and Heavy Precipitation RVA work is presented in Figure 3-5.

Figure 3-5. External Flooding RVA White Paper Approach Process Flow



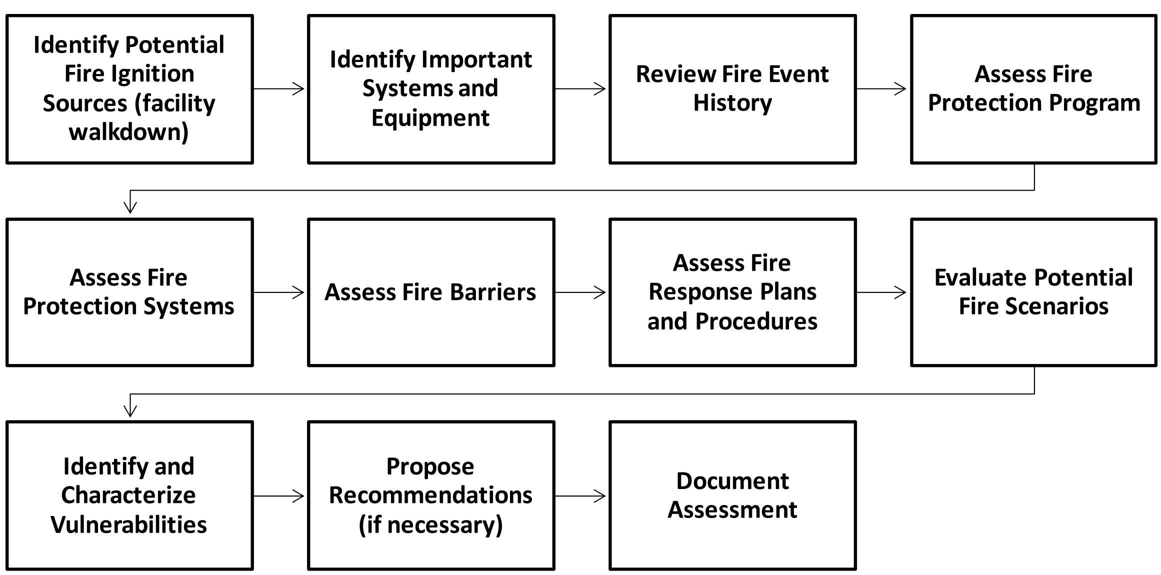
3. A general process flow chart for the Internal Fire RVA work is presented in Figure 3-6.

Figure 3-6. Internal Fires RVA Approach



4. A general process flow chart for the External Fire RVA work is presented in Figure 3-7.

Figure 3-7. External Fires RVA Approach



5. For the **<u>Seismic Events RVA</u>**, the RVA bounding analysis report will include probabilistic bounding analysis of seismic hazards under the assumption of an agreed analysis, seismic design basis (currently established as facility impacts consistent with an Oahu area earthquake resulting in peak ground acceleration and seismic motion frequency effects on the RHBFSF expected from a probabilistic and deterministic design basis earthquake hazard), and seismic analysis of the relevant structures and nonstructural components. No detailed soil-structure interaction analysis (e.g., for potential effects of earthquake-caused soil liquefaction) will be performed. Also, no detailed analysis of facility specific component fragility to earthquake ground motion intensity and/or frequency will be performed.

   This bounding analysis will include a general review/discussion/summary of Oahu's seismic risks. Assessment of effects on other infrastructure at certain magnitude events for comparison with RHBFSF components. Establish seismic hazard criteria to be used for the facility assessment. Focus will be on the main fuel storage tanks and lower tunnel, as these were identified in Phase 1 and has the most potential risk of an inventory release.

   - Seismic Hazard

   - Seismic Hazard Caused by Ground Shaking Determined on a Probabilistic and Deterministic Basis in Accordance with Established USGS Data but Not Less than Seismic Parameters of UFC 3-3-1-1 Structural Engineering

   Seismic Risk Category in accordance with UFC 3-3-1-1 Structural Engineering and ASCE 7. Targeted Structural and Nonstructural Component Performance Level in accordance with ASCE 41. We understand that the Navy will request inter-agency consultation with the USGS to provide additional input on seismic activity in the area of the RHBFSF.

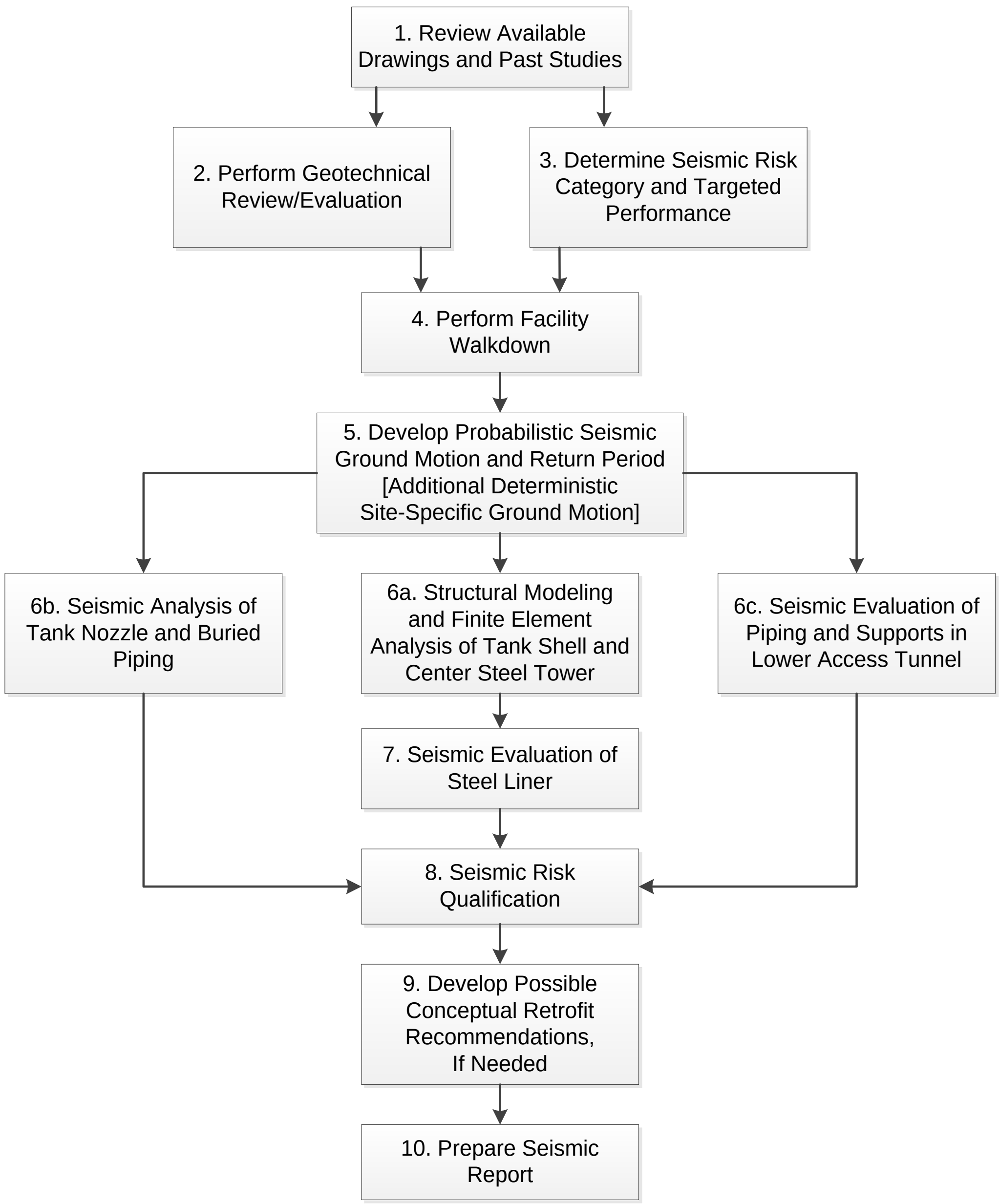
   The following assessments have been selected for simplified bounding assessment and targeted quantitative analysis:

   - Effects of Wave Action within the Tank
     - Structural Analysis of One Representative Overall Concrete Tank Structure and Center Steel Tower for Seismic and Hydrodynamic (Impulsive and Convective) Loading in Accordance with ACI 350.3 Seismic Design of Liquid-Containing Concrete Structures and Commentary
   - Seismic Effects on Tank Shell/Liner
     - Structural Analysis of Liner Elements for Seismic Loading
   - Seismic Effects on Tank Nozzle Including Distinct Variations that Could Lead to Large Releases of:
     - Structural Analysis of Tank Nozzle and Buried Piping for Differential Movement
   - Seismic Performance of Pipeline and Supports in the Lower Access Tunnel

- ASCE 7 Minimum Design Loads for Buildings and Other Structures
- ASCE 41 Seismic Evaluation and Retrofit of Existing Buildings

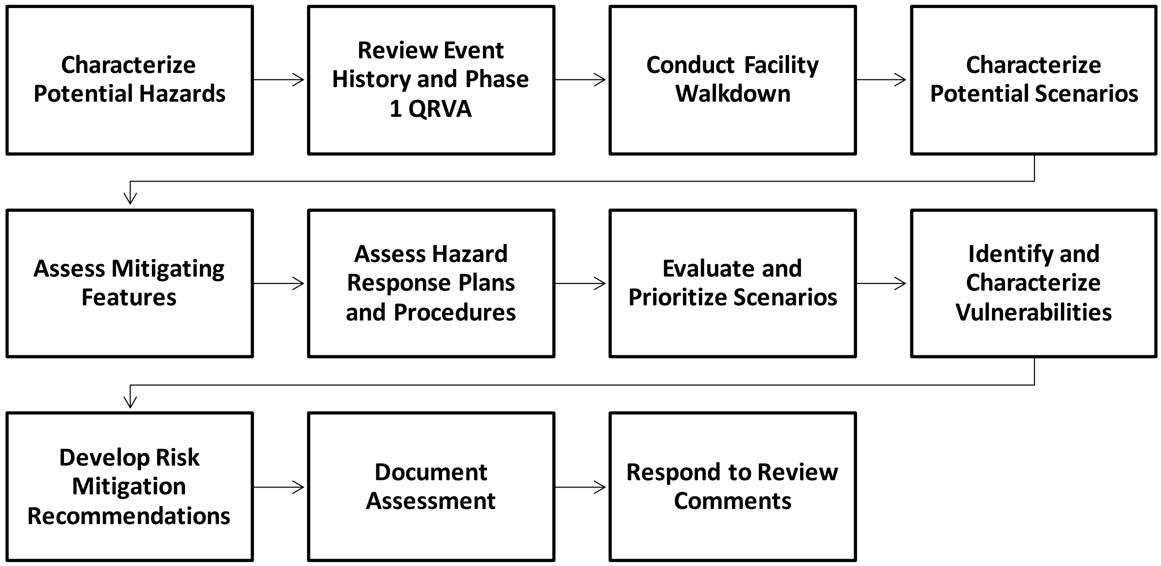
The seismic RVA bounding analysis will apply a demand-to-capacity ratio approach for decision support. A general process flow chart for the Seismic RVA work is presented in Figure 3-8.

Figure 3-8. Seismic Approach



A general process flow chart for the Other External Events RVA work is presented in Figure 3-9. This figure applies to the RVA process for <u>all other external event hazards</u>.

Figure 3-9. Other External Events RVA Approach



6. The above referenced flowchart is applicable for the following events:

   - Landslides (including Mud Slides)
   - Proximity Ground Transportation Accidents (e.g., chlorine or other hazardous chemical truck or rail car accidents)
   - Proximity Aircraft Accidents (e.g., accidental commercial or military aircraft crashes)
   - External Hazardous Material or Chemical Spills or Releases
   - Extreme Weather (e.g., high temperature, etc.)
   - Other Facility-Specific Hazards (e.g., internal utility train accidents)

7. The RVA will include simplified calculations of potential utility train derailment events that could threaten piping integrity in the Lower Access Tunnel. Such calculations consider utility train weight, size (height and width, including carried loads), speed, and center of gravity.

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4. Project Milestones and Schedule

The general list of proposed project milestones is presented in Table 4-1.

Table 4-1. Project Deliverable and Milestone Table

Deliverable/Milestone	Tentative Due Date
Scope of work submitted to EPA/DOH	December 23, 2020
Scope of work approved by EPA/DOH	February 26, 2021
List of scenarios submitted by stakeholders to Navy	March 26, 2021
Consolidated list of scenarios developed	April 16, 2021
Initial RVA workshop	April 30, 2021
Risk and vulnerability estimates complete	January 15, 2022
RVA white paper reports complete	April 15, 2022
Phase 2 RVA final report submitted to EPA/DOH	June 6, 2022

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5. References

1. Administrative Order on Consent for the Red Hill Bulk Fuel Storage Facility, U.S. Environmental Protection Agency, September 28, 2015 (https://www.epa.gov/red-hill/red-hill-administrative-order-consent).

2. Red Hill Bulk Fuel Storage Facility Quantitative Risk and Vulnerability Assessment Phase 1 (Internal Events without Fire and Flooding), NAVFAC Hawaii, November 12, 2018.

3. Letter from CAPT Marc Delao to Mr. Omer Shalev and Ms. Roxanne Kwan, Navy Region Hawaii, May 29, 2019

4. Section 8 of Red Hill AOC SOW Approval of Section 8.3 and Requirement to Complete Additional Work, EPA/DOH, September 23, 2019

5. RVA Phase 2 for the Red Hill AOC SOW Section 8, Navy Region Hawaii, November 19, 2019

6. Notice of Deficiency and Opportunity to Cure, EPA/DOH, October 23, 2020

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6. List of Acronyms and Abbreviations

Table 6-1 presents the acronyms used in RVA.

Table 6-1. List of Acronyms

Acronym	Term
ANS	American Nuclear Society
AOC	administrative order on consent
AOO	anticipated operational occurrences
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CTO	contract task order
DBD	design basis documentation
DOH	Department of Health
EPA	U.S. Environmental Protection Agency
EPRI	Electric Power Research Institute
F-76	marine diesel
JP-5	jet propulsion fuel no. 5
JP-8	jet propulsion fuel no.8
NAVFAC	naval facilities engineering command
NTP	notification to proceed
OBE	operating-basis earthquake
P&ID	piping and instrument diagrams
PM	project manager
PRA	probabilistic risk assessment
QRVA	quantitative risk and vulnerability assessment
RHBFSF	Red Hill Bulk Fuel Storage Facility
RVA	risk and vulnerability assessment
SSC	structure, system, or component
SME	subject matter expert
SOW	scope of work

Table 6-2. List of Acronyms (Continued)

Acronym	Term
USGS	U.S. Geological Survey
UST	underground storage tanks
WBS	work breakdown structure

Table 6-2 presents additional useful RVA abbreviations and acronyms.

Table 6-3. Additional Useful Abbreviations and Acronyms

Acronym	Term
AFRF	acute fuel release frequency
AOO	anticipated operational occurrences
APET	accident progression event tree
ASTM	American Society of Testing and Materials
BAPT	best available practicable technology
BDBA	beyond-design-basis accidents
BDBE	beyond-design-basis events
BE	basic event
BFR	binomial failure rate
CAFRP	conditional acute fuel release probability
CCDF	complementary cumulative distribution function
CCF	common cause failure
CCW	component cooling water
CD	complete dependence
CET	containment event tree
CLB	current licensing basis
CLOFICP	conditional loss of fuel inventory control probability
CMF	common-mode failure
CRM	configuration risk management
CRS	cable and raceway database system
CY	calendar year
DBA	design-basis accident
DBE	design-basis event
DI	dependence importance
DLA	Defense Logistics Agency
EAB	exclusion area boundary
EDG	emergency diesel generator
EOP	emergency operating procedure

Table 6-3. Additional Useful Abbreviations and Acronyms (Continued)

Acronym	Term
EP	emergency preparedness
ESD	event sequence diagram
ET	event tree
FEDB	Fire Events Database
FEP	fire emergency procedure
FM	failure mode
FMEA	failure modes and effects analysis
FOS	facility operating states
FRVA	fire RVA
FT	fault tree
FTR	fails to run
FTS	fails to start
GL	generic letter
HADA	human action dependency analysis
HD	high dependence
HCLPF	high confidence in low probability of failure
HEP	human error probability
HFE	human failure event
HLR	high-level requirement
HRA	human reliability analysis
HRR	heat release rate
HVAC	heating, ventilation, and air conditioning
IAEA	International Atomic Energy Agency
IAFRP	incremental acute fuel release probability
IM	importance measure
IPEEE	individual plant examinations for external events
LD	low dependence
LOFICF	loss of fuel inventory control frequency
LOFICP	incremental loss of fuel inventory control probability
LOIA	loss of inventory accidents

Table 6-3. Additional Useful Abbreviations and Acronyms (Continued)

Acronym	Term
LOOP	loss of offsite power
MCR	main control room
MD	medium dependence
MFF	master frequency file
MGL	multiple Greek letter
MLD	master logic diagram
MLE	maximum-likelihood estimate
ND	navy distillate
NEI	Nuclear Energy Institute
NRC	U.S. Nuclear Regulatory Commission
OG	owners' group
PORV	power-operated relief valve
PSD	partial system description
PSF	performance shaping factor
QA	quality assurance
QHO	quantitative health objectives
QRA	quantitative risk assessment
RA	risk achievement
RAW	risk achievement worth
RG	Regulatory Guide
RIDM	risk-informed decision making
SA	systems analysis
SB, SBO	station blackout
SDM	system dependency matrix
s.e.	standard error
SM	seismic margin
SOKC	state-of-knowledge correlation
SR	supporting requirement
SRVA	seismic RVA
ST	source term

Table 6-3. Additional Useful Abbreviations and Acronyms (Continued)

Acronym	Term
THERP	Technique for Human Error Rate Prediction
UFM	unplanned fuel movement
VA	vulnerability assessment
ZD	zero dependence
ZOI	zone of influence