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Cost of Compliance on Munitions Consolidation from Lualualei to West Loch

December 2017

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ABSTRACT

With the object of ensuring that all ordnance magazines in Hawaii are in compliance with NOSSA regulations, this project conducts a systematic cost of compliance analysis to identify the pros and cons of either constructing new magazines at West Loch and consolidating ordnance operations from Lualualei to West Loch, or only upgrading the ordnance magazines in Lualualei. This analysis is performed from the perspective of the Department of Defense in order to capture all costs and benefits associated with the Army and Navy, the main stakeholders in this study.

The project developed a cost of compliance decision support model in Excel to systematically examine the relative strengths and weaknesses of the available alternative options. The model identifies tangible costs and benefits to estimate a net present value for each option. To account for uncertainty, the researchers used Crystal Ball to implement simulated values for cost variables used in the Excel based model to validate the robustness of the average net present value and to show the probability of net costs exceeding the net benefits. The analysis conducted in this project point to consolidation as a better course of action to take in the long term.

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To Navy Munitions Command East Asia, thank you for giving us the opportunity to provide you a useful tool in the ordnance consolidation analysis for Hawaii. This project taught us many things not only about ordnance but how important decisions like these effect much higher echelons and the joint arena.

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LIST OF ACRONYMS AND ABBREVIATIONS

AGM	above ground magazine
AOR	area of responsibility
CBA	cost–benefit analysis
CINCPACFLT	commander in Chief, U.S. Pacific Fleet
CNRH	commander, Navy Region Hawaii
COA	courses of action
COR	contracting officers representative
CULT	common-user land transportation
DAU	Defense Acquisition University
DOD	Department of Defense
EAD	East Asia Division
ECM	earth-covered magazine
EPA	Environmental Protection Agency
ESQD	explosive safety quantity distance
FSRM	facilities, sustainment, restoration, and modernization
FY	fiscal year
HMLUMP	Hawaii Military Land Use Master Plan
IDS	intrusion detection system
LLL	Lualualei
LPS	lightning protection system
MCA	Military Construction, Army
MHE	materials handling equipment
MILCON	military construction

NAVSEA	Naval Sea Systems Command
NCTAMS	Naval Computer and Telecommunications Area Master Station
NMC	Navy Munitions Command
NOSSA	Naval Ordnance Safety and Security Activity
NPV	net present value
OMB	Office of Management and Budget
OSD	Office of the Security and Defense
PACFLT	Pacific Fleet
PACOM	U.S. Pacific Command
PCS	permanent change of station
PH	Pearl Harbor
TAD	temporary additional duty
T-AKE	dry cargo ammunition ship
WL	West Loch

I. INTRODUCTION

The Pacific Command (PACOM) Area of Responsibility (AOR) covers more than 50% of the earth's surface, encompassing over 100 million square miles. The mobility and flexibility of the Navy allows it to carry out and execute difficult missions (Pacific Fleet [PACFLT], 2003). In order to establish a strong forward presence, the Navy must establish a solid logistics infrastructure, which includes munitions, in order to sustain the fight. Hawaii provides not only a respite for sailors deployed across the PACOM AOR, but also a means to obtain much needed supplies and repairs.

In 1908, the U.S. Congress passed a bill to fund the construction of Naval Base Pearl Harbor, HI. Since then, Pearl Harbor has played a key role for U.S. military conflicts in the Pacific, including World War I, World War II, the Korean War, and Vietnam. Ordnance storage in Hawaii started in 1913, on Kuahua Island, with the construction of eight magazines for ammunition storage. Ordnance operations continued on Kuahua until 1933, when magazines were built in Lualualei and West Loch (Martin, 2017a). Since then, Lualualei has become the primary ammunition storage facility for the Army, while the Navy and Marine Corps operate mainly out of West Loch. In 1967, the Naval Ordnance Safety and Security Activity (NOSSA) came out with more restrictive safety standards mandating that the distance between each magazine must be greater than what is currently installed at West Loch (NAVSEA, 2017). Due to the lack of permissible net explosive weight allowed per the NOSSA standards, Navy Munitions Command East Asia Division Pearl Harbor (NMC EAD PH) has been using several magazines in Lualualei to store smaller-sized ordnance.

The 1995 Hawaii Military Land Use Master Plan (HMLUMP) recognized the importance of Hawaii's strategic location as a "bridge to Asia" and, as a result, recommended the release of the Lualualei Annex due to its aging magazines and its consolidation with West Loch pending construction of new facilities. However, the large estimated cost prevented the release of Lualualei and further consolidation to West Loch.

Events since September 11, 2001, have led to an increase in military operations in the Pacific, further emphasizing the value of Hawaii's location in the Central Pacific area. The 2002 Commander, Navy Region Hawaii (CNRH) Ordnance Facilities Plan, proposed a

significant investment in new ordnance infrastructure for new magazines near West Loch. Additionally, in 2003, PACFLT identified that only four out of 299 magazines in Hawaii are capable of storing modern missiles for naval destroyers and submarines. This means Hawaii's capability and capacity to store modern munitions has been decreasing over time (PACFLT, 2003).

At present, the U.S. Navy, Marine Corps, Army, and Coast Guard utilize the original magazines at Lualualei and West Loch, which were mostly built in 1933 (Martin, 2017a). The majority of the Lualualei magazines are used to store small arms and inert ordnance. Although the Lualualei and West Loch consolidation has been on the agenda for years, the project has lacked funding and support. There has been no urgency to move or consolidate, resulting in process inefficiencies and the storage of munitions in deteriorating pre-World War II magazines. The magazines at Lualualei are in dire need of repair or replacement, and there is a chokepoint highway between Lualualei and West Loch, which, if blocked, would result in the inaccessibility of munitions from Lualualei.

The munitions storage facilities at West Loch were identified as inadequate in a 2016 survey by a fleet area magazine study (Martin, 2017b). There are three main problems with this situation. The first problem is that munitions are stored in deteriorating magazines, as mentioned before. The second problem is that West Loch cannot store 100% of the ammunition mandated by PACOM's ordnance load plan. A third problem is that in the event of a massive ordnance offload by the homeported combatants, NMC EAD PH would not be able to properly store that ammunition within the allowable timeframe according to NOSSA standards. There is little wiggle room for West Loch to store additional modern munitions in the event of an increase in PACOM's ordnance load requirements.

This project aims to provide decision support on whether the proposed consolidation to West Loch or the upgrading of the Lualualei magazines is the most viable option. This is especially important because of Hawaii's increasingly significant military role in the Pacific theater.

Using a cost of compliance analysis approach, this project identifies and assesses two courses of action (COA) based on existing conditions and anticipated costs for continued

operations at the NMC EAD DET, Joint Base Pearl Harbor-Hickam, Lualualei Annex, located on the island of Oahu.

The two courses of action are as follows:

COA 1. Navy builds new magazines, Army builds new magazines, and both consolidate in West Loch in accordance with NOSSA standards.

COA 2. Current magazines at Lualualei are upgraded to NOSSA standards and current operations remain the same for Navy and Army.

The biggest benefit of building new facilities at West Loch will be the additional modern munitions storage capability in Hawaii. At present, the magazines at West Loch are at full capacity and cannot meet the PACOM ordnance load plan levels for the larger munitions, or any future additional load requirements by PACOM. Meeting the load plan requirements is especially important because of the rising tensions in the Pacific with China, North Korea, and Russia that could lead to additional combat operations in the Pacific. As part of contingency readiness, Hawaii's magazines will need to store additional pre-positioned munitions, hold ordnance for ships undergoing repairs, and resupply more deploying ships. Only COA 1 would provide additional magazine storage levels to comply with PACOM's ordnance load plan, but both COAs will satisfy the NOSSA requirement standards.

The final product of this research is a thorough cost of compliance analysis that highlights the relative strengths and weaknesses associated with each of the two proposed COAs.

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II. BACKGROUND

In 1992, a key forward munitions naval base at Subic Bay, Philippines, closed down. This significantly degraded the Navy's capability and flexibility in the Pacific. Subic Bay was a major ammunition depot, which was capable of handling almost any type of munitions. At present, Guam is the westernmost U.S. territory with a naval base, but its ordnance mission is to resupply transient ships and is not designed for significant combatant load outs (PACFLT, 2003). Other bases on foreign soil, such as in Japan and Korea, are subject to more stringent rules and regulations with regard to munition load outs, and their host countries are not as accommodating as the Philippines was. This leaves Hawaii as the only base west of the continental United States capable of performing major ammunition load outs.

In 1995, the HMLUMP identified a potential land reduction opportunity by consolidating Lualualei with West Loch (PACOM, 2002). The distance between Lualualei and West Loch is approximately 17 miles. The current authorized method of transporting munitions in Hawaii is by the Common User Land Transportation (CULT) assigned to the Army via PACOM. The location of West Loch and Lualaulei Annex are shown in Figure 1, along with the authorized driving route for the transportation of ammunition in order to minimize the threat to the civilian population. The plan also concluded that the Lualualei Annex will become unnecessary if new facilities are built at West Loch, which had the required amount of land to satisfy all storage requirements. The consolidation to West Loch is preferred over the current arrangement because of the existing ordnance handling piers, as well as the opportunity to drastically reduce the transportation of ordnance to and from the Lualualei Annex through local community roads and areas, as indicated on the HMLUMP 2002 update.

In 2003, the commander in chief, U.S. Pacific Fleet (CINCPACFLT) AOR Ordnance Infrastructure Plan, also identified a plan to consolidate Lualualei with West Loch as a potential land reduction action. The primary obstacle in executing the proposed consolidation was the price estimate of $300 million for the military construction (MILCON) project. (PACFLT, 2003).

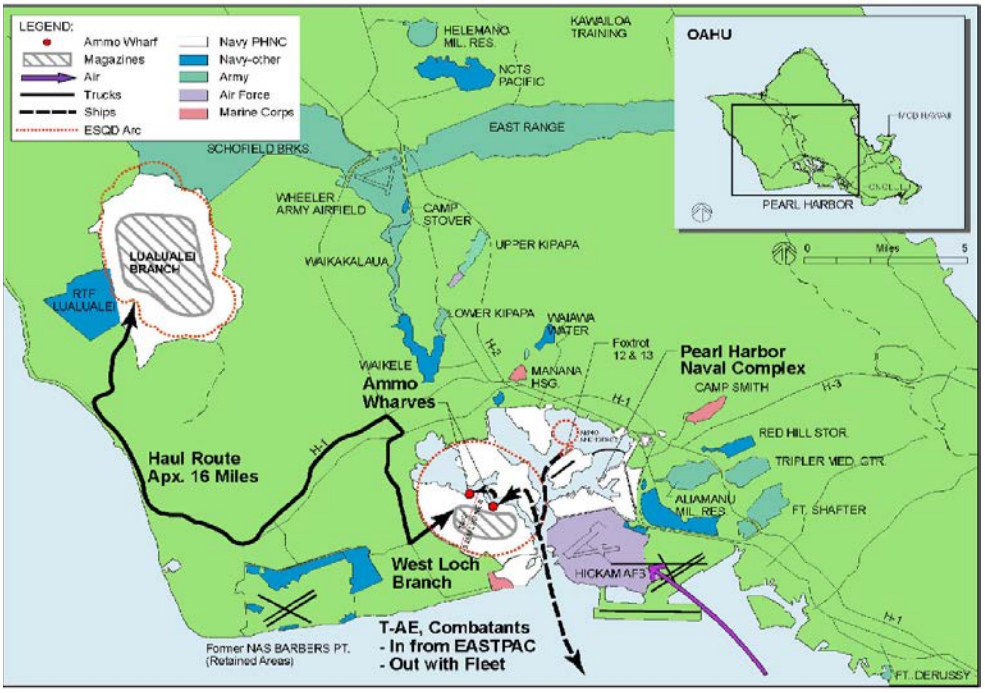

Figure 1. Geographical Locations of Lualualei and West Loch. Source: PACFLT (2003).

The Lualualei Annex has a total of 270 earth-covered magazines (ECMs) and above-ground magazines (AGMs). The main difference between an ECM and an AGM is the thickness of the earth cover (an AGM has less than two inches of earth cover). See Appendix A for pictures of magazines in Lualualei. See Figure 2 for the locations of the magazines in Lualualei. The Army is assigned 110 of these facilities (~40.7%), interspersed with facilities used by other Department of Defense (DOD) services (Navy, Marines, and Coast Guard). Because of the age of the ECMs and AGMs, which were constructed between 1932 and 1942, the Navy requested in 2012 that the Army conduct an assessment of the existing conditions and determine how to upgrade Lualualei to current standards (U.S. Army Corps of Engineers, 2013). According to LCDR Todd George (Officer in Charge, OIC of NMC EAD PH), it is important to note that even with a full upgrade of Lualualei magazines, it will still be impossible to store the larger modern weapons due to the large ammunition sizes and the small entry doors, which cannot fit any munitions over 10 feet long; a forklift is required to place the larger munitions inside the magazines.

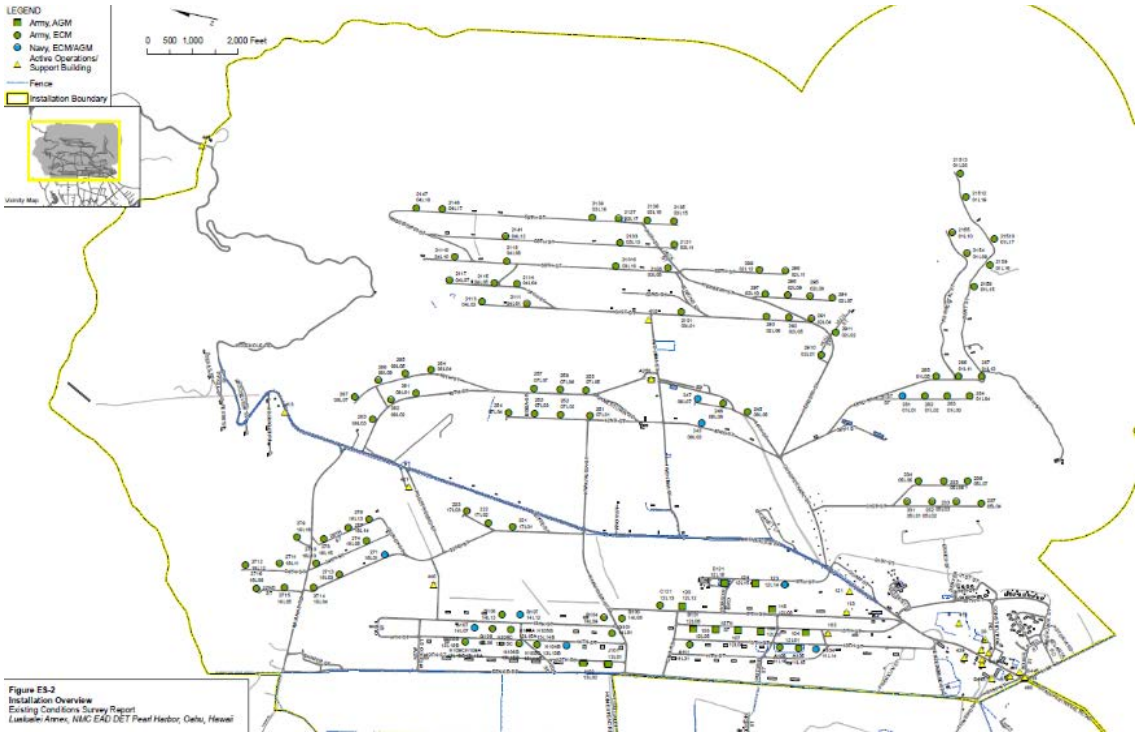

Figure 2. Magazine Layout of Lualualei Annex.
Source: U.S. Army Corps of Engineers (2013).

The West Loch Annex has a total of 131 magazines. The oldest was built in 1932, and the newest was built in 2011. Fourteen of the 131 magazines have been deemed unusable or have been condemned. Most of the munitions stored here are used by the Navy because this is where the dry cargo ammunition ships (T-AKE) load and offload their ammunition (PACFLT, 2003). See Figure 3 for the layout of West Loch and shows the explosive safety boundaries associated with ammunition operations. Unlike Lualualei, West Loch is closer to residential areas. Ordnance operations in both Lualualei and West Loch are contracted out and are renewed annually by the Navy. The contract is fully funded by the Navy and provides ordnance handling services to all military services that have ammunition stored in West Loch or Lualualei.

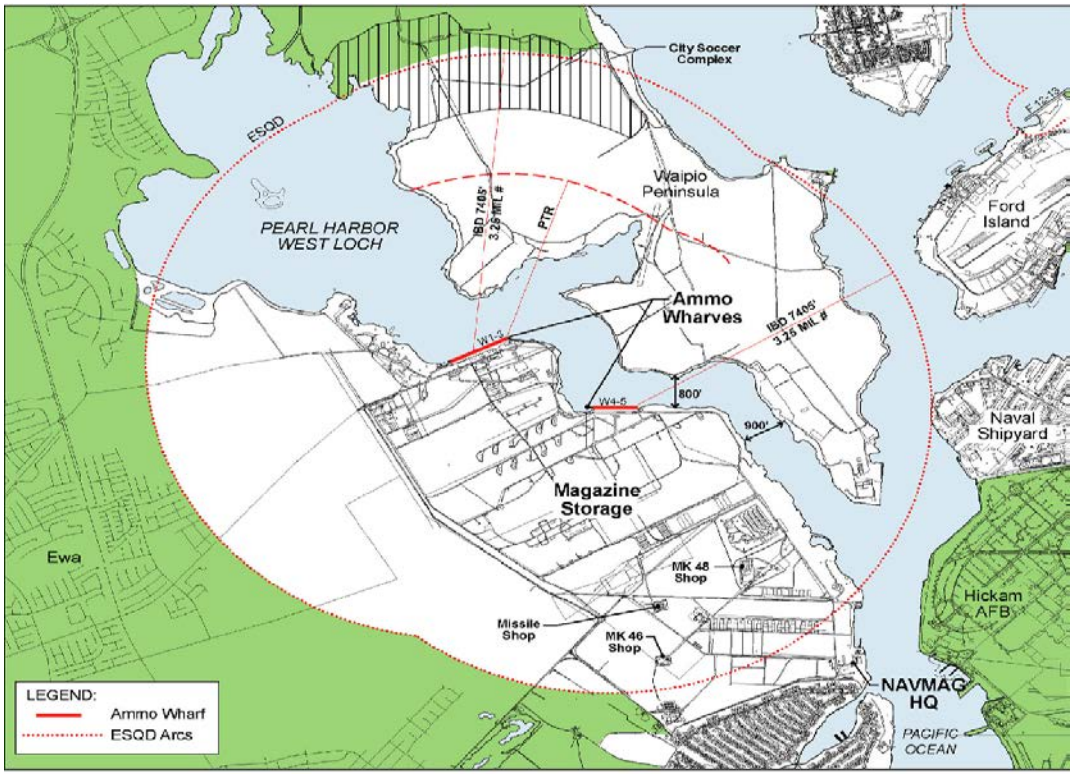

Figure 3. West Loch Layout. Source: PACFLT (2003).

Hawaii continues to be central headquarters for PACOM and PACFLT and is a significant homeport for submarines and surface combatants. In 2016, there were 49,347 active duty personnel assigned to the state of Hawaii (Governing, 2016). In 2011, the Obama administration announced the military's "pivot to Asia," recognizing the emerging threats in China, North Korea, and Russia (Green, 2016). Arguably, the U.S. military's presence in Hawaii is even more important now that the military's spotlight has moved from the Middle East to Asia.

In 2003, PACFLT identified some important questions with regard to ordnance in the Pacific, such as "How sustainable is the current ordnance delivery system?" and "What happens in the event of war with a major power?" There are issues with the transportation of munitions from the West Loch Annex to Lualualei and vice versa, such as the dependency on a single road and the availability of CULT trucks and/or drivers that could impede an expeditious response in a contingency operation.

This project supports a new concept for ordnance handling operations in Hawaii. The West Loch branch will be the consolidation location for the storage of all ordnance in order to reduce the munitions transportation over public highways to and from Lualualei Annex, and to maintain a higher level of readiness to distribute munitions to the fleet. This consolidation plan will also reduce the infrastructure costs for ordnance storage, maintenance, and personnel.

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III. LITERATURE REVIEW

In this chapter, the researchers review the most recent and relevant studies that inform our framework of analysis for this cost of compliance project. This chapter is also focused on the analysis in understanding the relevant, intangible, and tangible costs that need to be considered in this analysis.

The goal of this consolidation is to reduce overall operating and infrastructure cost in order to efficiently use resources in multiple installations in Hawaii. The consolidation is meant to reduce expenses in areas such as manpower, fuel, material handling equipment (MHE), maintenance, and utilities. A definition of *cost savings* is "any action(s) that result in a smaller-than projected level of costs to achieve a specific objective" (DAU, 2011, p. 1694). *Cost avoidance* is the "difference between two estimated cost patterns, one before the change and the one after" (DAU, 2011, p. 1674). These terms are used for determining whether a positive return on investment has been achieved based off the four courses of action proposed.

A. COST–BENEFIT ANALYSIS (CONCEPTS AND PRACTICE)

Cost-benefit Analysis (Concepts and Practice), the 2011 book by Boardman, Greenberg, Vining, and Weimer, lays the foundation for our cost of compliance analysis of the Navy Munitions Command's (NMC) consolidation project. Out of the four types of cost-benefit analysis (CBA) presented in the book, the researchers only focused on the project-specific decision-making type because the government typically has scarce resources, and this project will require a large amount of funding. Not all MILCON projects are funded every year because there are simply too many MILCON projects that compete at a global level among all services by the Office of the Security of Defense (OSD). The government is forced to prioritize which projects get funding, based on their level of importance, and the priority often changes. The main point of our analysis is to help the decision-maker view the breakdown of the relevant and monetized costs and to understand the pros and cons of such a consolidation to aid them in allocating resources.

With the current high-friction situations in the Pacific, specifically North Korea and the South China Sea, perhaps the only certainty about the future load plan of ordnance for the

Pacific area is uncertainty. It has not been long since former President Obama declared the military's pivot to Asia, but many things have changed since then. There is a saying—"We don't know what we don't know" ("Donald Rumsfeld," n.d.), which indicates that the best plans can easily change. To better analyze these situations of uncertainty, the researchers performed a sensitivity analysis. This cost of compliance study has many assumptions (which are documented in the excel simulation) in formulating usable numbers due to the lack of actual cost figures. Some costs are very difficult to monetize, such as the opportunity cost to store additional munitions in the event PACOM asks NMC EAD PH to adjust to wartime levels of inventory. The Army and Navy have not performed the necessary estimates of the costs that would be incurred if the consolidation were to happen. After reviewing historical data from the Bureau of Labor Statistics and the OMB Circular A-94, the researchers were able to assume certain inflation rates and discount rates, but in the past few years, interest rates are at a low point never before seen in American economics. Certainly, there are many unforeseen circumstances that could render the researcher's estimates inaccurate. Still, amid the uncertainty, the goal is to attempt to generate a net present value (NPV) to simplify the plausibility of the two courses of action.

In order to make the simulation model as realistic as possible, the researchers took into account for potential factors such as the time when consolidation may occur, inflation rates, and discount rates to account for the future value of today's dollars. Boardman et al. (2011) discuss how to apply and calculate the NPV of a future benefit or cost. They also discuss the current suggested discount rate of 7% by the government (as per OMB Circular A-94), which is what is used as the default discount rate in the simulation. The argument is that this figure is too high considering the current interest rates in the market. However, this figure used to be 10% when it was approximating the cost of capital. The researchers agree that perhaps 7% may be too high. The simulation the researchers used have an established range of possible discount range percentages to account for lower discount rates that may be reflective of the future.

Boardman et al. (2011) also discuss discounting costs in the future using the discount rate, as well as potential future benefits or cost savings for the analysis. The simulation applies inflation rates in all collected costs to show that the value of a dollar increases in time—just as the cost of a car today presumably is lower than the cost of a car in the future.

B. IDENTIFICATION OF RELEVANT COSTS IN THE DECISION TO CONSOLIDATE OR MAINTAIN TWO MARINE CORPS TRAINING

Jeremy Forrer's (2015) thesis identified all relevant, irrelevant, and sunk costs in the consolidation of two Marine Corp training depots, and provided four different alternatives for the reader to consider. He highlights and breaks down relevant and irrelevant costs into lower categories, including closure, construction, FSRM (facilities, sustainment, restoration, and modernization), base operations, and recruit training costs. This presents a complete picture to the decision-maker of all the variables that are affected during a consolidation of military structures.

Similar to Forrer's thesis, this thesis considers two possible COAs in the consolidation of Lualualei and West Loch, and in doing so, the goal is to identify all the relevant costs in each scenario.

According to Forrer (2015), closure costs deal with environmental cleanup, labor costs, materials required to bring the facility to EPA standards, civilian severance packages, PCS costs, the cost of transporting materials to the new location, administrative costs, and real property maintenance costs to bring it up to a usable condition.

Construction costs deal with the new buildings and infrastructure needed to house additional recruits at the consolidated training depot. This includes labor, material, permits, and possible acquisition of land. FSRM costs include civilian labor, sustainment activities, restoration, and modernization. These costs are labeled as fixed costs in the beginning and become variable in the long run (Forrer, 2015).

Base operation costs include civilian labor, utilities, building requirements (supply support, finance office, vehicle accident repair facility), environmental costs, grounds maintenance costs, and property control office. Recruit training costs include civilian labor, uniform alterations, recruit laundry, linen replacement, administrative costs, vehicle support costs, and custodial services. Irrelevant costs include commanding general costs not linked to recruit training, temporary additional duty (TAD) money, and personal support equipment. Sunk costs include all projects that were previously allocated for, such as base pay of all active duty members (Forrer, 2015).

The identification of relevant, irrelevant, and sunk costs is important in the analysis considering the consolidation of munitions from the Lualualei Annex into West Loch. It provides a framework of considerations that would be affected by a shift in base operations. The initial investment to build new magazines at West Loch is sizable, especially in an era of fiscal austerity. By carefully identifying and analyzing all costs and the length of the return on investment, the intent is to come up with best NPV for the decision-maker to consider. This project lists and breaks down all costs into several categories and produces a NPV for the two COAs. The project also conducts a sensitivity analysis in order to test and verify possible outcomes.

C. COST–BENEFIT ANALYSIS OF THE 2006 AIR FORCE MATERIEL COMMAND TEST AND EVALUATION PROPOSAL

The 2008 report of Thirtle et al. breaks down and lists all relevant costs to consider when shutting down certain facilities. Some of these costs include the number of employees, transition costs, recurring costs, and so forth. This report breaks down each facility's costs and benefits and provides a short analysis on things that need to be considered and coordinated during consolidation (Thirtle et al., 2008). This report is relevant because it examines action items required when considering the action required for different commands and different services. The Lualualei operation is also a hybrid munitions operation with the Army, Coast Guard, Navy, and Marine Corps as its customers. While the installation itself is run by the Navy, certain action items will require independent action specifically from the Army and the Navy before a true consolidation can occur.

This report highlights several key areas in the conduct of a cost of compliance analysis of the consolidation of different commands with multiple facilities. It is impossible to acquire all of the relevant information especially as some decisions have not yet been decided by the policy makers. Any possible combinations of possible outcomes is too much to enumerate and thus presents an implied risks and limitation in any cost analysis. Thirtle et al. highlights the importance of taking a stance, irrespective of the actual outcome, in order to deliver a good cost analysis and present the decision maker with a more concrete idea of the best way forward.

IV. METHODOLOGY OF ANALYSIS

Ordnance magazines are typically built for long-term use (over 75 years). They last longer than your average building infrastructure, as evidenced by the magazines that are still in use at the Lualualei Annex, which were built in the 1930s. Building modern magazines is expensive; however, they can yield a positive NPV if the total cost is spread out over a long period of time. The most likely value for inflation rate is at 3%, based on historical data and discount rate at 7% as recommended by the Office of Management and Budget (OMB) Circular No. A-94 (OMB, 1992). The excel simulation that the researchers made utilizes a maximum lifespan of 100 years for the new and existing magazines, based off the *Existing Conditions Survey Report* for Lualualei Annex conducted by the Army in 2013 (U.S. Army Corps of Engineers, 2013) and Bryan McCorkell (personal communication, May 19, 2017; see Appendix B, Figure B1).

A. HOW TO PERFORM A CBA

Our project is based off an A-94 study, or a CBA. A CBA is a decision support tool by which one attempts to quantify in monetary terms the impacts of a policy. In this project, the researchers followed the nine major steps for conducting a CBA outlined by Boardman et al. (2011).

The first step in a CBA is to "specify the set of alternative projects," which establishes the framework for analysis and shows the comparative courses of action in relation to the current situation, or the status quo (Boardman et al., 2011). This step compares each course of action against the status quo separately, and it also compares the net benefit of each course of action against the others. One key issue in establishing the framework for step one is to properly define the status quo and policy changes for the proposed courses of action. The purpose of step one is to ascertain whether the net benefits outweigh the net costs. This helps frame the follow-on question: "Is this proposed course of action worth the effort, or should we stay with the status quo?"

The second step is to "decide whose benefits and costs count (standing)" (Boardman et al., 2011). This step takes into consideration for which entities (society) have a standing. For instance, the researchers identified the government and the unemployed as two separate

standings when considering unemployment benefits (government standing which incurs costs, and the unemployed which benefits from unemployment checks). The entities (society) must be defined geographically to better illustrate the standing or stakeholder. The various standings or perspectives are global (everyone in the world, no matter where they live), national (everyone in a specific country), sub-national (everyone is a state, city, etc.), and institutional (everyone associated with an organization).

The third step in a CBA is to "identify the impact categories, catalogue them, and select measurement indicators" (Boardman et al., 2011). This step consists of identifying tangible impact categories of the proposed courses of action, annotating them accordingly as a benefit or cost, and then determining the measurement indicator for each impact category. This step also defines the terminology necessary to understand and more accurately predict the validity of a course of action.

The first set of definitions by Boardman et al. is for real benefits and costs versus transfers. Real benefits and costs are gains and losses to society. Transfers do not increase surplus and thus should not be included in a CBA. Direct benefits/costs are closely related to the main reason for the project. Indirect benefits/costs are by-products or spillovers or ripple effects. Tangible costs/benefits that can be identified in unit terms are tangible, otherwise they are intangible. Intangibles are hard to place dollar values on.

The fourth step for conducting a CBA is to "predict the impacts quantitatively over the life of the project" (Boardman et al., 2011). This step poses a high potential for making mistakes. Some common mistakes in this step are a lack of focus on the CBA due to focusing on quantifying specific costs and focusing on causation versus correlation.

The fifth step for conducting a CBA is to "monetize (attach dollar value to) all impacts" (Boardman et al., 2011). This step is easy to understand: Simply assign dollar values to each of the impacts. When an analyst assigns dollar values to impacts, there are controversial topics that are difficult to monetize. In step five it is imperative to clarify all of the assumptions and the methodology used to monetize the impacts.

The sixth step for conducting a CBA is to "discount benefits and costs to obtain present values" (Boardman et al., 2011). This step is to account for a project that has impacts

that occur over many years, and to aggregate the benefits and costs that occur in different years. Boardman et al. says the following:

> In a CBA, the future benefits and costs are discounted relative to present benefits and costs in order to obtain their present values. The need for a discount arises for two main reasons. First, there is an opportunity cost to the resources used in a project. Second, most people prefer to consume now rather than later. (Boardman et al., 2011)

Potential issues with the sixth step include determining the discount rate, inflation rate, any environmental impacts, and length of time needed for the project.

The seventh step in conducting a CBA is to "compute the net present value of each alternative" (Boardman et al., 2011). This takes "the net present value of an alternative which equals the difference between the present value of the benefits and the present value of the costs" (Boardman et al., 2011). The overall goal of this step is to choose an alternative with the highest NPV, and if there is no alternative with a positive NPV, then stay with the status quo.

The eighth step for conducting a CBA is to perform a sensitivity analysis (Boardman et al., 2011). The sensitivity analysis is solely based on the assumptions identified, and it is essential to know whether the assumptions are crucial for the recommendation or conclusion. In a complex CBA with many assumptions and variables, the researcher would indicate which set of assumptions generate the best and worst results in terms of NPV.

The ninth step and final step in conducting a CBA is to "make a recommendation" (Boardman et al., 2011). In this step, an analyst recommendations a course of action with the highest NPV, or determines if the status quo is the best option.

B. COST OF COMPLIANCE

The first step in conducting this compliance analysis is to narrow down two possible courses of action that would ensure that ordnance magazines in Lualualei and West Loch would comply with NOSSA standards.

The second step in conducting this compliance analysis is to identify the stakeholders—that is, the Army and the Navy. Since both COAs involve MILCON funds,

which are funded by the DOD, this analysis took the DOD's standing in evaluating the costs of compliance for each COA.

The third step in conducting this compliance analysis is to identify the tangible, intangible, relevant, and sunk costs. The distinction is important because tangible costs are monetized and included in the analysis. Intangible costs are those that are considered and identified but hard to monetize. Sunk costs are monetized, but are irrelevant to this study because these are costs that are incurred regardless of the course of action.

1. Relevant Costs

This section lists all tangible costs that are monetized and included in the Excel simulation.

a. Transportation (CULT) Costs

The Army is tasked to be the service lead in charge of all CULT movements in Hawaii, as directed by Pacific Command. Various bases throughout the island of Oahu, HI, initiate their ordnance requests through NMC EAD PH, which transfers munitions either out of West Loch or Lualualei and prepares the requested ammunition for delivery to the requester. The Lualualei Annex magazines have ammunition stored for the Army, Coast Guard, Navy, and Marine Corps, while the West Loch Annex only holds Navy and Marine Corps munitions.

All ordnance being delivered to Hawaii is normally received at West Loch via ship. If West Loch is at full capacity, or if the ordnance is designated for the Army or Coast Guard, then CULT transportation is required to store the ordnance at the Lualualei Annex. CULT transportation is also required when any ordnance stored at Lualualei is needed for transfer back at West Loch to be loaded onto ships or submarines.

The approximate costs for any one-way trip with a CULT truck in Hawaii is estimated to be at $450, regardless of origin, destination, or distance. In any given fiscal year, NMC EAD PH calculates the average number of ordnance movement requests at 1,000.

The savings in CULT transportation will be from the elimination of CULT movements to and from Lualualei and West Loch, if ordnance operations are consolidated at West Loch. Figure 4 provides a depiction of the distance from West Loch to Lualualei. These types of movements are normally conducted when ammunition is received at West Loch and needs to be stored at the Lualualei Annex, or when ammunition stored at the Lualualei Annex is needed at West Loch. These types of munitions movements represent about 90% of the total CULT movements within any fiscal year, according to the NMC EAD PH contracting officer representative (COR), Bryan McCorkell (personal communication, May 19, 2017; see Appendix B, Figure B1). CULT movements to any other military installations on the island of Oahu will still occur from West Loch. The researchers calculate CULT cost savings by the following methodology:

COA 1: The Navy and Army would no longer need to utilize CULT between Lualualei and West Loch, which would result in a 90% reduction in total CULT annual transportation movements.

COA 2: There are no transportation savings or changes in this COA.

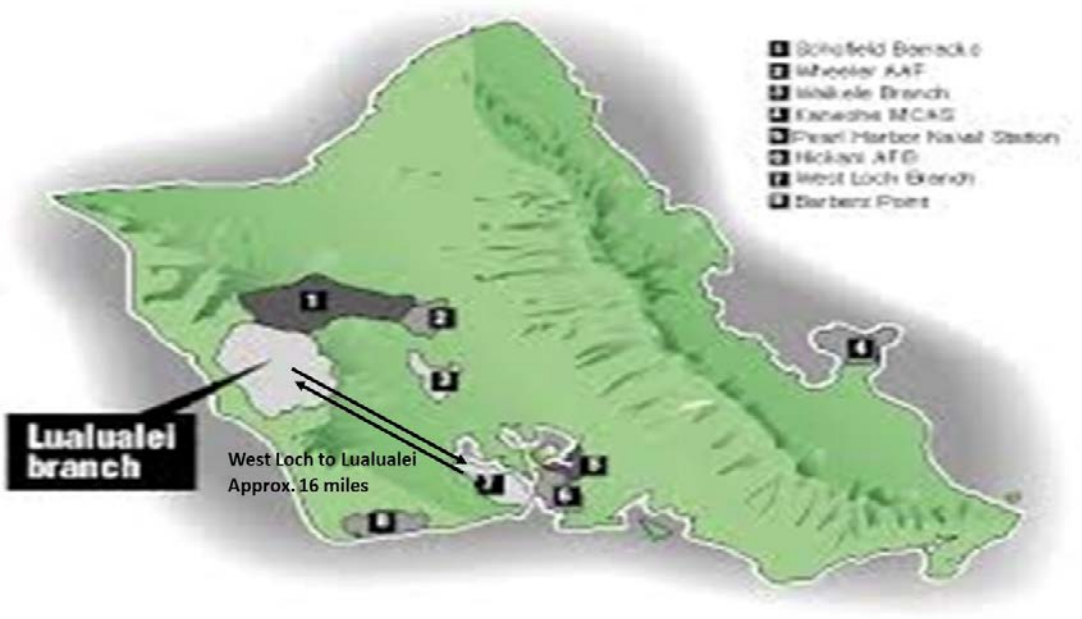


Figure 4. Distance between Lualualei and West Loch. Source: PACFLT (2003).

b. Cost of Maintenance for Magazines in Lualualei

Magazine maintenance at Lualualei was estimated to range between $4 and $13 million annually for 119 magazines, according to the *Existing Conditions Survey Report* conducted by the Army in 2013 (U.S. Army Corps of Engineers, 2013). Lualualei has 270 total magazines of which approximately 30 are condemned or incapable of storing munitions, thus 240 magazines can be used at any given moment in Lualualei currently.

The midpoint between $4 and $13 million is $8.5 million, which represents the annual maintenance cost for 119 magazines at Lualualei. The assumption here is that this would be the maintenance cost of these magazines if they were already up to NOSSA standards, which include Intrusion Detection Systems (IDSs) and a lightning protection system (LPS). There are approximately 240 usable magazines in Lualualei, which is double the 119 magazines that were included in the *Lualualei Existing Conditions Survey Report*. Therefore, the researchers multiplied the average maintenance cost of $8.5 million by 2 to arrive at an estimate of $17 million annual cost for magazine maintenance at Lualualei. Dividing $17 million by 270 magazines results in an average maintenance cost of $65,977.78 per magazine that is NOSSA compliant.

(1) How Magazine Maintenance Cost Savings Are Calculated in Excel

COA 1: The researchers estimate a 100% cost savings in magazine maintenance for Lualualei in this COA because the Lualualei Annex will be completely empty.

COA 2: The researchers estimate a 100% cost savings in magazine maintenance for newly constructed magazines in West Loch since MILCON projects would not get executed.

(2) Future Maintenance Cost if New Magazines Are Built in West Loch

Future Navy magazine maintenance cost at West Loch: The assumption is the average maintenance cost for newly constructed magazines is the same as the average maintenance cost of older magazines as long as they are both NOSSA compliant. The Navy desires to build 24 new box “D” magazines at West Loch.

Future Army magazine maintenance cost at West Loch: The assumption is the average maintenance cost for newly constructed magazines is the same as the average

maintenance cost of older magazines as long as they are both NOSSA compliant. The Army desires to build various types of magazines at West Loch, totaling 51.

c. Navy Contract Cost

The Navy contract cost is the amount funded by the Navy annually in order to pay for contractors to load and offload munitions in Hawaii. Table 1 shows the total contract cost for NMC East Asia Pearl Harbor for ordnance operations in West Loch and Lualualei since Fiscal Year (FY) 2010.

Table 1. Average Increase of the Total Contract Cost for Lualualei from FY10–FY17.

In thousands		Difference	
$8,927.00	FY17	$105.00	1%
$8,822.00	FY16	$73.00	1%
$8,749.00	FY15	$157.00	2%
$8,592.00	FY14	$672.00	8%
$7,920.00	FY13	$483.00	6%
$7,437.00	FY12	$1,305.00	21%*
$6,132.00	FY11	$182.00	3%
$5,950.00	FY10	*New Contract	
		Average	6.167%

Note. Source: K. A. Russell, personal communication (December 2, 2016). See Appendix B, Figure B4 for the actual personal communication that supports this table

The data for Table 1 was provided by the NMC EAD PH COR who oversees the munitions contract operations for the Lualualei Annex and West Loch. The researchers have identified the increases in cost since FY10 to FY17 in order to get the average rate of increase per year, which is 6.167%. NMC has indicated that the increase is expected to be about 1–2% per year from 2017 onward; however, the researchers decided to utilize the historical data in the analysis. If the increase in contract cost per year does follow the COR's prediction of 1–2%, then it will decrease the overall cost required in the long term for the DOD.

If COA 1 happens, then NMC EAD PH will push the Army to get its own contract for ordnance operations. NMC EAD PH anticipates a possible one-time reduction in cost for the

Navy contract by $1,388,020.46 (calculated in Table 2) due to the reduction in contractor personnel required for the additional ordnance transportation needs by the Army.

Table 2. Estimated NMC EAD PH Contract Reduction for COA 1. Source: Martin (2017b).

POSITIONS DISCONTINUED IF OPS CONSOLODATED TO WL						
Labor Rate Reference	**Labor Category**	**FY16 QTY**	**HOURLY**	**MANYEAR**	**4% for Hazardous pay**	**TOTAL**
Based on 1880 hours per manyear				1880	0.04	
MANAGEMENT						
BRANCH SUPERVISOR	11-3071	1	$43.99	$82,701.20		$82,701.20
WAREHOUSE CREW LEADER / QUALITY ASSUR INSPECTOR	511011	2	$29.41	$110,581.60	$4,423.26	$115,004.86
AMMO HANDLING DEPARTMENT						
WAREHOUSE SPECIALIST	21410	6	$20.84	$235,075.20	$9,403.01	$244,478.21
HEAVY EQUIPMENT MECHANIC	23430	1	$28.29	$53,185.20		$53,185.20
TRUCK DRIVER, HEAVY	31363	1	$18.27	$34,347.60	$1,373.90	$35,721.50
WOODWORKER	23980	1	$17.67	$33,219.60		$33,219.60
DISPATCHER, MOTOR VEHICLE	1060	1	$17.10	$32,148.00		$32,148.00
BASIC LABOR COST						$596,458.58
Fringe Benefits				60.00%		$357,875.15
Overhead				11.40%		$3,787.03
Fringe/Overhead						**$361,662.18**
TOTAL FOR LABOR COST						**$958,120.76**
General & Administration (G&A) on ODC 13.5%						$129,346.30
Total W/ADMIN						**$1,087,467.06**
Profit 10%						$108,746.71
Total Basic based on 12 months						**$1,325,560.07**
Tax use/Fee 4.712%						**$62,460.39**
Total 12 Month SAVINGS:						**$1,388,020.46**

d. Utilities Cost

The researchers assume that the approximate utilities cost savings that would be gained by moving out of Lualualei would be offset by the utilities expense that will need to be paid by constructing new facilities at West Loch and vice versa.

e. NMC MILCON Cost

Table 3 represents the anticipated cost and schedule for the MILCON projects submitted by NMC for the consolidation. This data was last updated in October 2017.

Table 3. NMC EAD MILCON Plan from Phase 1 to Phase 5. Source: Martin (2017c).

(Update as of OCT 2017)														
Purpose	Location Code	Facility Number	Supported Command	Activity Project Rank	Project ID No.	MILCON Projects Description	Status	FY Funds (Award)	COST ($M)	FY Funding	START Dte (Design Phase)	START Dte (Construction)	Project Completion	Notes
Phase 1 Magazine Consolidation	West Loch		NMCPAC EAD DET PH		P-033	Magazine Consolidation - Phase 1; Construct 4 Box "D" Magazines with roads and fence at West Loch (Long-Weapons Mags)	Updated 10/26/17		52	FY20				We are currently consolidating munitions from Lualualei to West Loch. If not completed prior to this MILCON beginning, completion of this MILCON will facilitate the final push to consolidate munitions to West Loch due to munitions currently being stored in older magazines at West Loch will be relocated to these new Box "D" magazines upon construction completion; thus freeing up additional space at West Loch in the vacated older magazines.
Phase 2 Magazine Consolidation	West Loch		NMCPAC EAD DET PH		P-034	Magazine Consolidation - Phase 2; Construct 5 Box "D" Magazines at West Loch (Long-Weapons Mags)	Updated 10/26/17		60	FY22				
Phase 3 Magazine Consolidation	West Loch		NMCPAC EAD DET PH		P-042	Magazine Consolidation - Phase 3; Construct 5 Box "D" Magazines at West Loch (Long-Weapons Mags)	Updated 10/26/17		35	FY24				
Phase 4 Magazine Consolidation	West Loch		NMCPAC EAD DET PH		P-043	Magazine Consolidation - Phase 4; Construct 5 Box "D" Magazines at West Loch (Long Weapons Mags)	Updated 10/26/17		35	FY26				
Phase 5 Magazine Consolidation	West Loch		NMCPAC EAD DET PH		P-4001	Magazine Consolidation - Phase 5; Construct 5 Box "D" Magazines at West Loch (Long Weapons Mags)	Updated 10/26/17		35	FY28				

As shown in Table 3, MILCON funding is anticipated every other year starting at FY20. These five phases are designed to construct a total of 24 box "D" magazines, which would be required in order to store 100% of the loan plan required by PACOM. The grand total for the Navy's MILCON projects is $217 million.

f. Army MILCON Cost

The Army's proposed magazine construction cost is divided into five phases (Military Construction, Army [MCA], 2016):

- Phase 1 (Total Cost $82,000,000)
- Phase 2 (Total Cost $78,000,000)
- Phase 3 (Total Cost $81,000,000)
- Phase 4 (Total Cost $79,000,000)
- Phase 5 (Total Cost $76,000,000)

Grand total: **$396,000,000**

The estimated construction start date is March 2023 with a completion date of March 2024 for all five phases. Therefore, the researchers assume that funding will be provided within one fiscal year with a completion date of one year once the MILCON projects have commenced.

g. Army Future Contract Cost

Since the Navy is able to reduce the contract cost by $1,388,020.46 in COA 1, as summarized in Table 2, the researchers estimate that the Army would need at least the same amount to establish its own ordnance handling operations contract.

h. Magazine Upgrade Cost in Lualualei

Per email correspondence with LCDR Todd George (OIC of NMC EAD PH), the estimated cost to install lightning protection to five magazines was $1,174,000 in 2009. Adjusting that number to FY17 results in a value of $1,339,530.08 (Bureau of Labor Statistics, n.d.). The researchers divide the present value by five magazines to arrive at an average cost of $267,906.02 to install a LPS at a magazine. See Figure B3 for the lightning protection invoice in 2009.

The cost to run power to six magazines, as required by NOSSA, is approximated at $250,000, according to LCDR George (personal communication, October 26, 2017; see Appendix B, Figure B2). Using this amount, the researchers arrive at an average cost to run power to a magazine at $41,667. To install an IDS, the researchers use an average cost of $27,500 per magazine. Therefore, the total cost to get a magazine upgraded to comply with NOSSA requirements is $337,073 each.

2. Sunk Costs

The current maintenance cost and upgrade cost for any magazines currently at West Loch are considered sunk costs. This has no bearing or effect on either COA and is required by NOSSA standards, which is why these are considered sunk costs.

The CULT cost to transport ordnance onto other installations in Hawaii from either West Loch or Lualualei is a sunk cost because this cost is incurred regardless of the COA that is followed. Other installations on Hawaii that obtain ordnance either from Lualualei or West Loch will still require their normal ordnance deliveries.

The cost of security at Lualualei is a sunk cost due to the presence of the Naval Computer and Telecommunications Area Master Station (NCTAMS) in Lualualei. NCTAMS

will not be able to vacate Lualualei due to the presence of two radio towers, which are mission-essential for submarine communications in the Pacific area.

The fire department personnel in Lualualei are only present on Lualualei during normal working hours when the NMC EAD PH contractors are conducting normal ordnance handling operations. During non-working hours and weekends, fire protection is provided by the state's local county fire department through a mutual agreement between the Navy and the state's local county fire department. There are no extra expenses associated with this mutual agreement per a phone conversation with the local county fire chief, Mr. Moriguchi, who is in charge of the fire department crew at Lualualei. The fire department crew that protects Lualualei normally comes from another nearby military fire department in the western region of Oahu, which is already being paid for by the Navy. Thus, there are no extra expenses incurred for fire protection for Lualualei, nor will there be additional fire department costs at West Loch, even with additional magazines.

3. Intangible Costs

There is a safety and security risk in transporting munitions from Lualualei to West Loch over 16 miles of publicly traveled roads. It is extremely difficult to monetize this risk, especially as a mishap has not happened during any transportation of munitions, at least in the past 50 years. However, if a mishap were to occur, the cost could be catastrophic depending on where the mishap occurred and the type of ammunition being transported. Even though this has not happened before, it does not mean that it could not happen in the future.

The operational impact of West Loch not being able to store 100% of large ordnance in accordance to the PACOM ordnance load plan is very difficult to monetize. There are many consequences and delays that could impact mission readiness in the event of a contingency. In the event of war, for example, ordnance plays a key role in the ability of combatants to perform missions. Timing and speed of execution is often associated with lives that could be saved by neutralizing the enemy's capability to fight. If the Navy runs out of ordnance in Hawaii to supply its combatants, then the Navy could see days or weeks of delays in supplies, which could result in many lives unnecessarily lost—among the military, U.S. citizens, or allies.

After examining the tangible, intangible, and sunk costs, the fourth step in conducting this compliance analysis is developing an Excel simulation to incorporate uncertainty in the value of critical parameters, and their impact on the cost estimate, based on the given data and assumptions of the researchers.

The fifth step in conducting this compliance analysis is monetizing all impacts, which the researchers were able to do by assigning dollar values in all of our identified variables, based on the given data and assumptions. An example would be the amount of ordnance handling labor that would be reduced by consolidating to West Loch.

The sixth step in conducting this compliance analysis is identifying the number of years to be considered, the default discount rate, and the realistic inflation rate. The inflation rate is applied for each year in consideration, and a present value is derived for each year and discounted to arrive at a NPV for the total number of years being considered. The default number of years being considered is a set interval range of 25 years, starting at 25 up to 100 years to ensure that NMC is not being too optimistic with its provided range of 75–100 years (see Appendix B, Figure B1). This is compared to the *Existing Conditions Survey Report* of 2013, which suggested that the remaining magazines at Lualualei have 87 years remaining, or until the year 2100. From 2013 through 2017, the standard inflation rate has been approximately 1–2%, but since this study covers a long period of time and the inflation rate has been unusually low in recent years, the researchers decided that 3% is a more realistic inflation rate. The default 7% discount rate mentioned before is based off the OMB (1992) A-94.

The seventh step in conducting this compliance analysis is calculating the overall NPV for each COA by calculating all costs and deducting costs savings that are applicable to each COA. The alternative with the lowest NPV of total costs, or probability to get a lower NPV of total costs, would be the best option from a pure monetary decision point.

The eighth step in conducting this compliance analysis is utilizing the Oracle Crystal Ball software to perform a sensitivity analysis for the Excel simulation model. The researchers used four sets of time variances in order to see the outcomes at 25, 50, 75, and 100 years in the future. The researchers also defined the variables that change, as shown in Table 4.

Table 4. Crystal Ball Value Ranges in Excel

	Minimum	Most Likely	Maximum
Inflation Rate	1%	3%	8%
Contract % increase in cost	2%	6.17%	8%
Discount Rate	2%	5%	7%
Maintenance cost at LLL	8,380,000	17,814,000	27,245,000
Maintenance cost at WL	2,474,166	4,948,333	7,422,499

Assumptions and methods on how the five Crystal Ball value ranges are calculated:

- Inflation Rate

This value range was taken from the Bureau of Labor and Statistics website. The lowest value represented was at 1% and the highest value that the researchers used was 8% with the average value over the last 60 years at 3.7%.

- Contract % increase in cost

This value range was taken from Kathleen Russell, the Executive Director at NMC EAD. The lowest value was at 2% which was given by the COR as the anticipated yearly increase for contract cost. The highest was at 8% which is reflected in Kathleen Russell's email (see Appendix B, Figure B4) with the average value at 6.167%.

- Discount Rate

The lowest value the researchers assumed is at 2% was taken from the Multpl website (Multpl, n.d.) and the highest value that the researchers used was 7% as suggested by OMB Circular A-94 with the average value at 5%. To improve the validity of the simulation, we ensured that the inflation rate and the discount rate were positively correlated.

- Maintenance cost at Lualualei (LLL)

To account for uncertainty, the researchers identified $17,814,000 as the most likely maintenance cost. The researchers divided $17,814,000 by 2 to get the lowest cost at $8,380,000. The researchers added $8,380,000 to $17,814,000 to get the highest value at $27,245,000.

- Maintenance cost at West Loch (WL)

The average maintenance cost for a magazine is $17,814,000 divided by 119 magazines as listed in the Existing Conditions Survey Report (Army Corp of Engineers, 2013). That average maintenance cost is $65,977.78 for a magazine. The number of magazines that should be built for both Army and Navy at West Loch totals to 75 magazines. The researchers multiplied 75 magazines with the average maintenance cost of $65,977.78 to arrive at an average value of $4,948,333. To get the lowest cost, the researchers divided by 2 and to get the highest cost the researchers added the lowest and the average cost.

Each of the five parameters was randomized according to a triangular probability distribution defined by the lowest, most likely and the highest values described above. The randomization was performed in Crystal Ball for 50,000 iterations to estimate the compliance cost of each COA according to four useful lives: 25, 50, 75, and 100 years.

The ninth step in conducting this compliance analysis is identifying the least costly course of action in order to ensure that all magazines in Lualualei conform to NOSSA standards.

V. ANALYSIS AND FINDINGS

A. CRYSTAL BALL RESULTS

The set of charts shown in Figure 5 represents the probability for COA 1 and COA 2 to have an overall NPV above zero. The timeframe used to run this test is for only 25 years. In this instance, COA 2 looks more favorable because there is a 26% chance that the benefits will outweigh the cost within 25 years. Furthermore, as shown in Table 5, the average NPV for COA 2 is only at $71,000 vice $433,000 for COA 1. The lower the dollar amount, the better, because the NPV represents total costs minus total benefits. For a 25-year timeframe, COA 2 is clearly the winner.

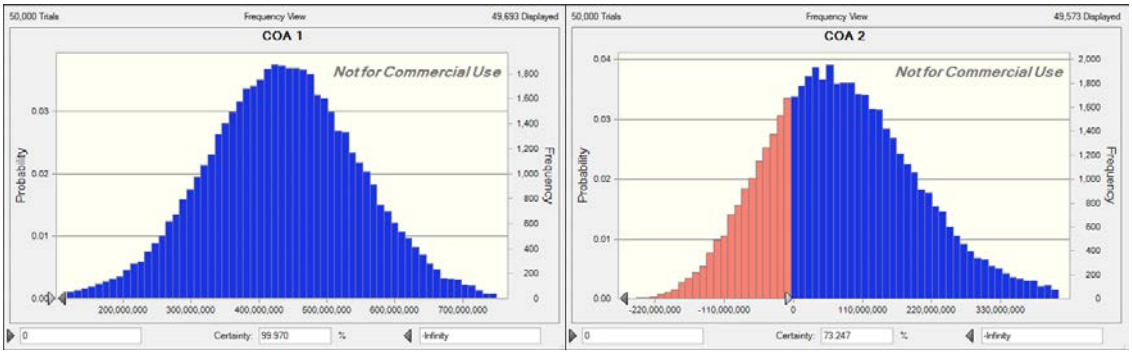


Figure 5. Crystal Ball Results for COAs 1 and 2 for a 25-Year Timeframe

The second set of charts, shown in Figure 6, shows similar information as Figure 6. The timeframe used to run this test is 50 years. What is unique in this instance is that COA 1 now looks slightly more favorable than COA 2 because there is now a 9.6% chance that the benefits will outweigh the costs for COA 1, while for COA 2, the chance is less than 0.5%. The average NPV for COA 1, as shown in Table 5, is $473,000 vice $650,000 for COA 2. For a 50-year timeframe, COA 1 has a slight advantage.

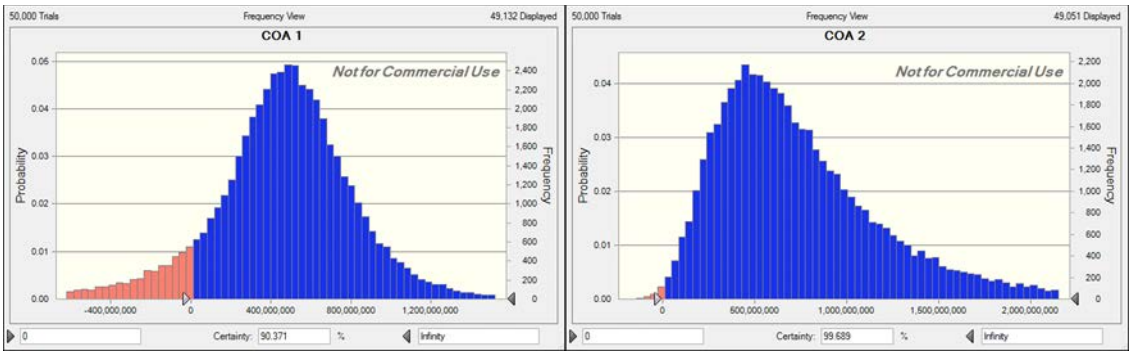


Figure 6. Crystal Ball Results for COAs 1 and 2 for a 50-Year Timeframe

Viewing the first three sets of figures, Figures 5–7, a pattern is evident: As the number of years being considered increases, the more the percentages and costs favor COA 1. In the third set of charts, shown in Figure 7, the timeframe used to run this test is for 75 years. COA 1 now looks more favorable than COA 2 because there is an 18% chance that the benefits will outweigh the costs for COA 1, while for COA 2, the cost will almost always outweigh the benefits. The average NPV according to Table 5 for COA 1 is $586,000 vice $1,303,000 for COA 2. For a 75-year timeframe, COA 1 is the clear winner.

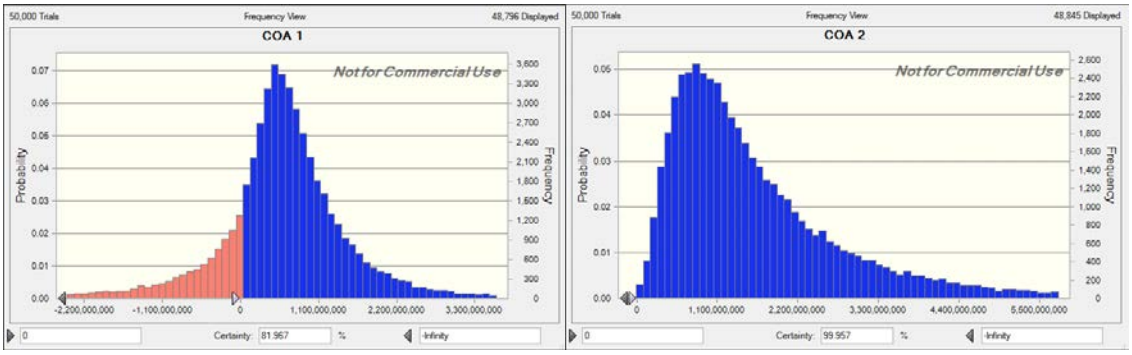


Figure 7. Crystal Ball Results for COAs 1 and 2 for a 75-Year Timeframe

The last set of charts, shown in Figure 8, reinforces the fact that as the number of years being considered goes up, COA 1 becomes more favorable. The timeframe used to run this test is 100 years. COA 1, in this instance, has a 21.5% chance that the benefits will outweigh the costs, while COA 2 is very costly. The average NPV according to Table 5 for

COA 1 is $751,000 vice $2,073,000 for COA 2. For a 100-year timeframe and beyond, COA 1 the best COA.

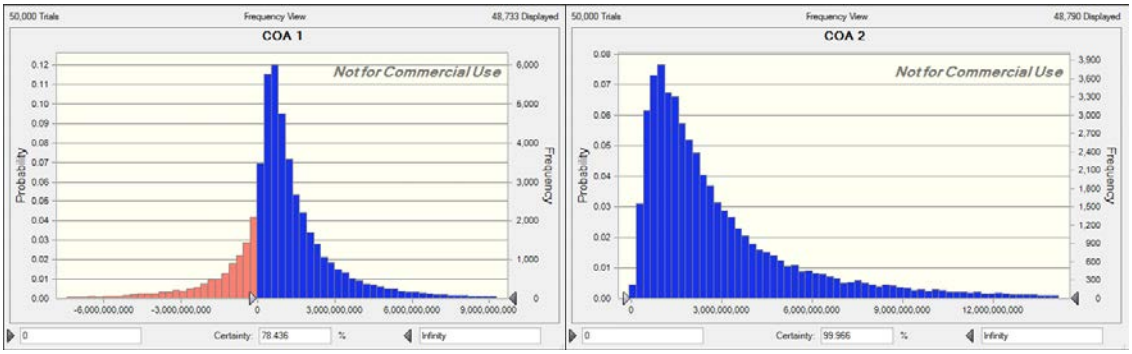


Figure 8. Crystal Ball Results for COAs 1 and 2 for a 100-Year Timeframe

The results of the Crystal Ball simulations are interesting because they initially showed COA 2 as the more favorable option, but only for a shorter time span—25 years or less. Once the researchers adjusted the simulation model to 50 years and beyond, COA 1 became more favorable. Even looking at Table 5 alone, a pattern emerged in which the average NPV for COA 1 climbed at a steady pace, while COA 2 climbed at a much more rapid pace. There are several reasons for this: COA 1 accounts for large MILCON costs, which, if spread over a shorter amount of time, lead to a higher cost per year, and the benefits per year are unable to equalize. However, the overall magazine maintenance cost of COA 1 is much lower than COA 2 because of the lower number of overall magazines to account for: 154 magazines for COA 1 to consider versus an additional 271 at Lualualei. COA 2 has a lower total overall cost than COA 1 in order to get magazines in Hawaii to conform to NOSSA standards but pays much higher maintenance costs for upkeep (about 3–4 times more than if new magazines were to be built). With the longer timeframe, the MILCON costs can be spread out over more years, resulting in much lower maintenance costs than COA 2. Therefore, it is safe to say that if the MILCON project end products are going to be used for at least 50 years, then COA 1 is the best option.

Table 5. Average Total Cost of Different Timeframes for COA 1 and 2

COA	25 years	50 years	75 years	100 years
1	$433,860,238	$473,360,088	$586,850,194	$751,731,479
2	$71,205,271	$651,870,430	$1,303,078,149	$2,073,989,159

B. IMPLICATIONS FOR FURTHER RESEARCH

In order to provide a more accurate simulation in comparing COAs 1 and 2, actual historical maintenance costs for magazines that are NOSSA compliant and historical utility costs for the Lualualei Annex would be needed. Furthermore, the cost of ordnance handling contract services to load and unload munitions for the Army needs to be estimated. The model developed in this study can be adjusted to incorporate additional or relevant updated data to support decision-making.

If PACOM and PACFLT can provide unclassified information about additional future munitions storage requirements for Hawaii and the Pacific AOR, the application of an opportunity cost would be a proponent for COA 1. Any additional increase in military forces in the Asian region would need additional support activities, including ordnance.

There might be other costs concerned with upgrading older magazines to NOSSA standards besides the installation of LPS and IDS that are not explored in this study. There have also been indications that not every magazine would need IDS to be installed due to NMC EAD PH deciding to condemn or not use specific types of magazines.

It would be helpful to know if the DOD is considering any other uses for the Lualualei Annex in the future so that other potential benefits for the use of this site could be taken into account, if Army and Navy ordnance operations fully consolidate to West Loch.

VI. CONCLUSIONS

A. CLOSING THOUGHTS AND CONSIDERATIONS

The driving purpose of this study was to explore the most sensible approach to ensuring that all magazines in Hawaii conform to NOSSA standards. The two options examined were to build new magazines at West Loch or to upgrade the existing magazines at Lualualei. However, only by building new magazines at West Loch will NMC EAD PH be able to store the required additional large ordnance, which has been missing from the load plan promulgated by PACOM. NMC EAD PH has been able to store 100% of the load plan's requirements for small munitions, but only 50% for the large munitions. It may seem obvious that only COA 1 is really feasible to satisfy the load plan requirements. However, the load plan has been deficient for quite some time and there have been no indications of major shortages at NMC EAD PH in response to customer demands. Therefore, this study still explored which COA would cost less overall, with the primary aim of complying with NOSSA regulations.

Another closing thought of this study is the following: Some costs were not included in this study because they were extremely difficult to monetize, such as explosive safety risk and PACOM's future intent on ordnance handling in the Pacific. There are many assumptions in this study that are soundly estimated based on the reports provided to the researchers, but having more accurate and historical data would be a great benefit for predicting which COA is best. The uncertainty factor over economic variables such as inflation rate and discount rate was somewhat mitigated with the use of Crystal Ball. This is an excellent tool for running thousands of simulations in order to arrive at a reasonable probability of a positive or negative NPV for the simulation model. Without Crystal Ball, it would have been very difficult to predict which COA was the better choice given that six variables were very sensitive to making the NPV values increase and decrease.

B. RECOMMENDATIONS

As mentioned previously, the primary question this study tried to answer is which COA would result in a lower NPV when considering the cost of compliance. The results of the simulation model—including the evaluation of all costs for 50 years or more—clearly

show that COA 1 looks more favorable, not only in average NPV, but also in the probability that the benefits might outweigh the costs. Furthermore, taking into consideration that COA 1 is the only choice that satisfies the PACOM ordnance load plan, which was not monetized as an opportunity cost, the research clearly shows that as long as these MILCON projects are expected to be used for more than 40 years, the COA 1 is the best recommendation.

APPENDIX A. MAGAZINE PICTURES

Figure A1. Pictures of an ECM Igloo Type Magazine in Lualualei, HI. Source: "Naval Ordnance" (2016).

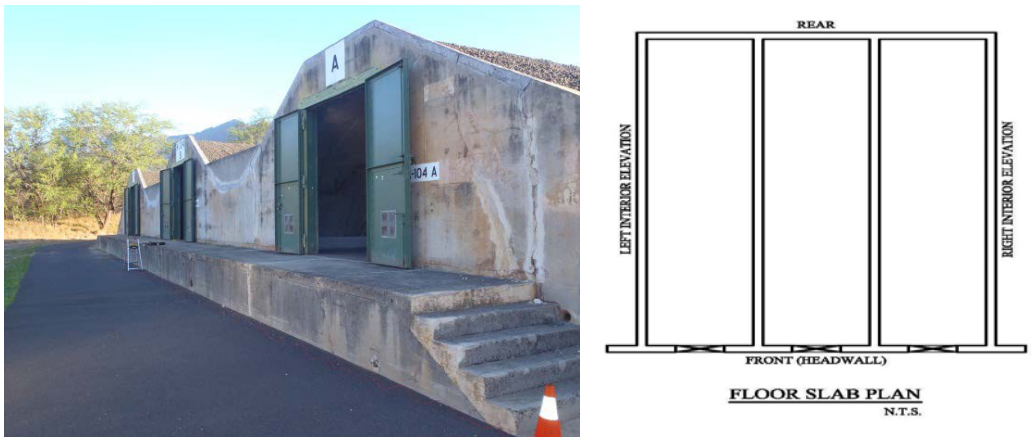


Figure A2. Picture and Layout of an ECM Tri Igloo Type Magazine in Lualualei, HI. Source: "Naval Ordnance" (2016).

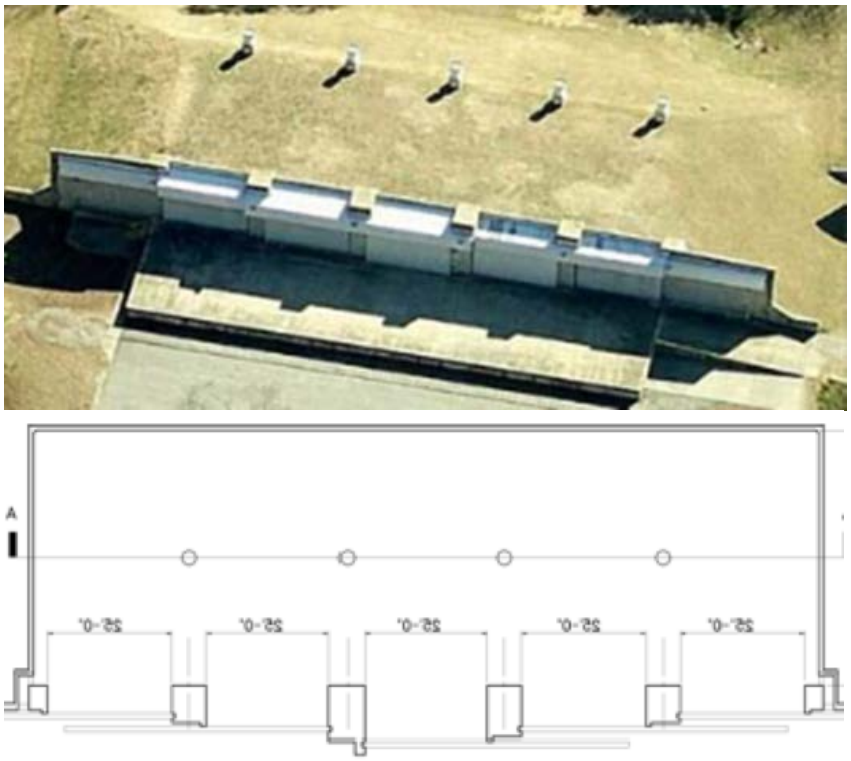
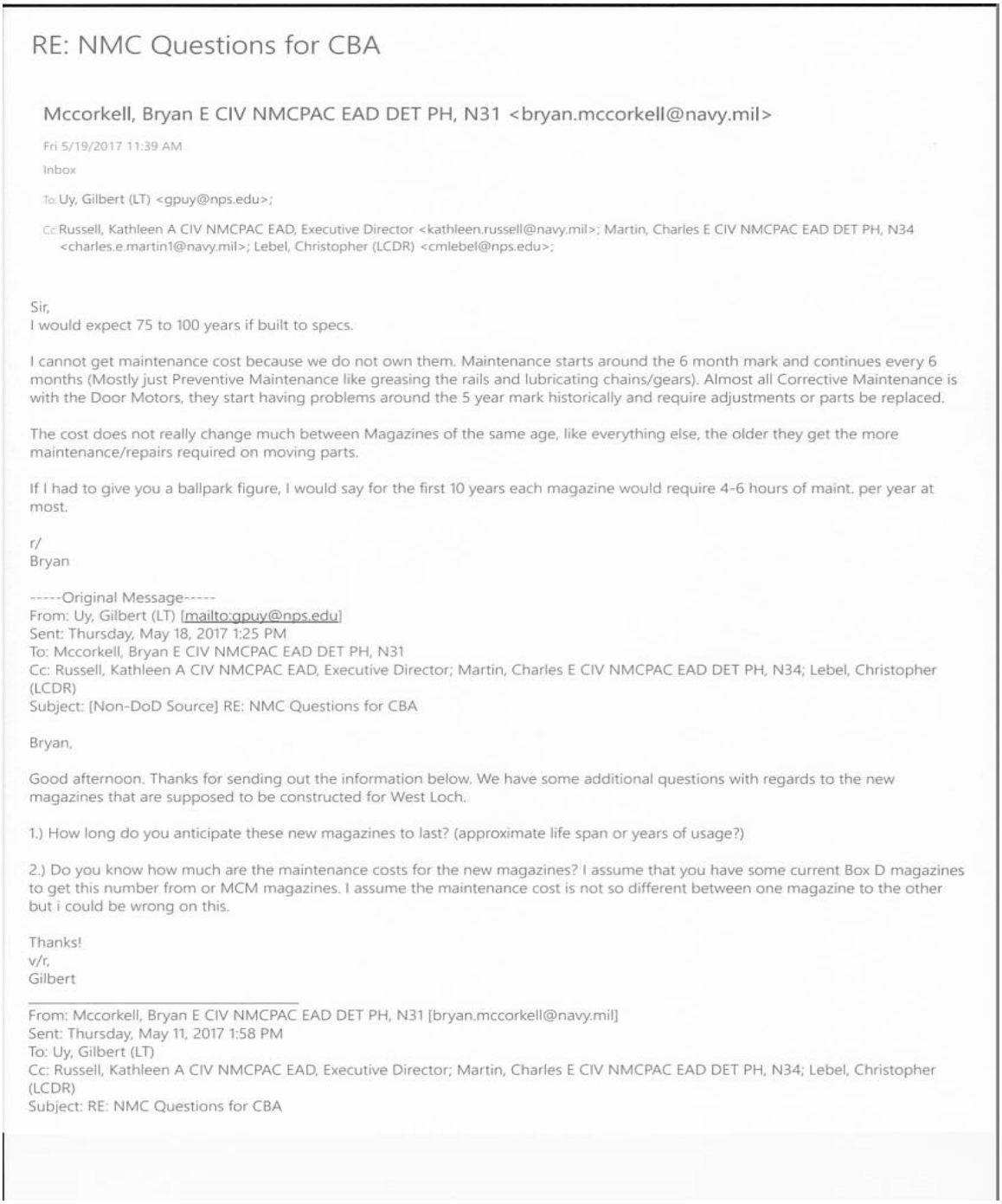


Figure A3. Picture and Layout of a Box D Magazine. Source: "Naval Ordnance" (2016).

APPENDIX B. EMAIL CORRESPONDENCE



RE: NMC Questions for CBA

Mccorkell, Bryan E CIV NMCPAC EAD DET PH, N31 <bryan.mccorkell@navy.mil>

Fri 5/19/2017 11:39 AM

Inbox

To: Uy, Gilbert (LT) <gpuy@nps.edu>;

Cc: Russell, Kathleen A CIV NMCPAC EAD, Executive Director <kathleen.russell@navy.mil>; Martin, Charles E CIV NMCPAC EAD DET PH, N34 <charles.e.martin1@navy.mil>; Lebel, Christopher (LCDR) <cmlebel@nps.edu>;

Sir,
I would expect 75 to 100 years if built to specs.

I cannot get maintenance cost because we do not own them. Maintenance starts around the 6 month mark and continues every 6 months (Mostly just Preventive Maintenance like greasing the rails and lubricating chains/gears). Almost all Corrective Maintenance is with the Door Motors, they start having problems around the 5 year mark historically and require adjustments or parts be replaced.

The cost does not really change much between Magazines of the same age, like everything else, the older they get the more maintenance/repairs required on moving parts.

If I had to give you a ballpark figure, I would say for the first 10 years each magazine would require 4-6 hours of maint. per year at most.

r/
Bryan

-----Original Message-----
From: Uy, Gilbert (LT) [mailto:gpuy@nps.edu]
Sent: Thursday, May 18, 2017 1:25 PM
To: Mccorkell, Bryan E CIV NMCPAC EAD DET PH, N31
Cc: Russell, Kathleen A CIV NMCPAC EAD, Executive Director; Martin, Charles E CIV NMCPAC EAD DET PH, N34; Lebel, Christopher (LCDR)
Subject: [Non-DoD Source] RE: NMC Questions for CBA

Bryan,

Good afternoon. Thanks for sending out the information below. We have some additional questions with regards to the new magazines that are supposed to be constructed for West Loch.

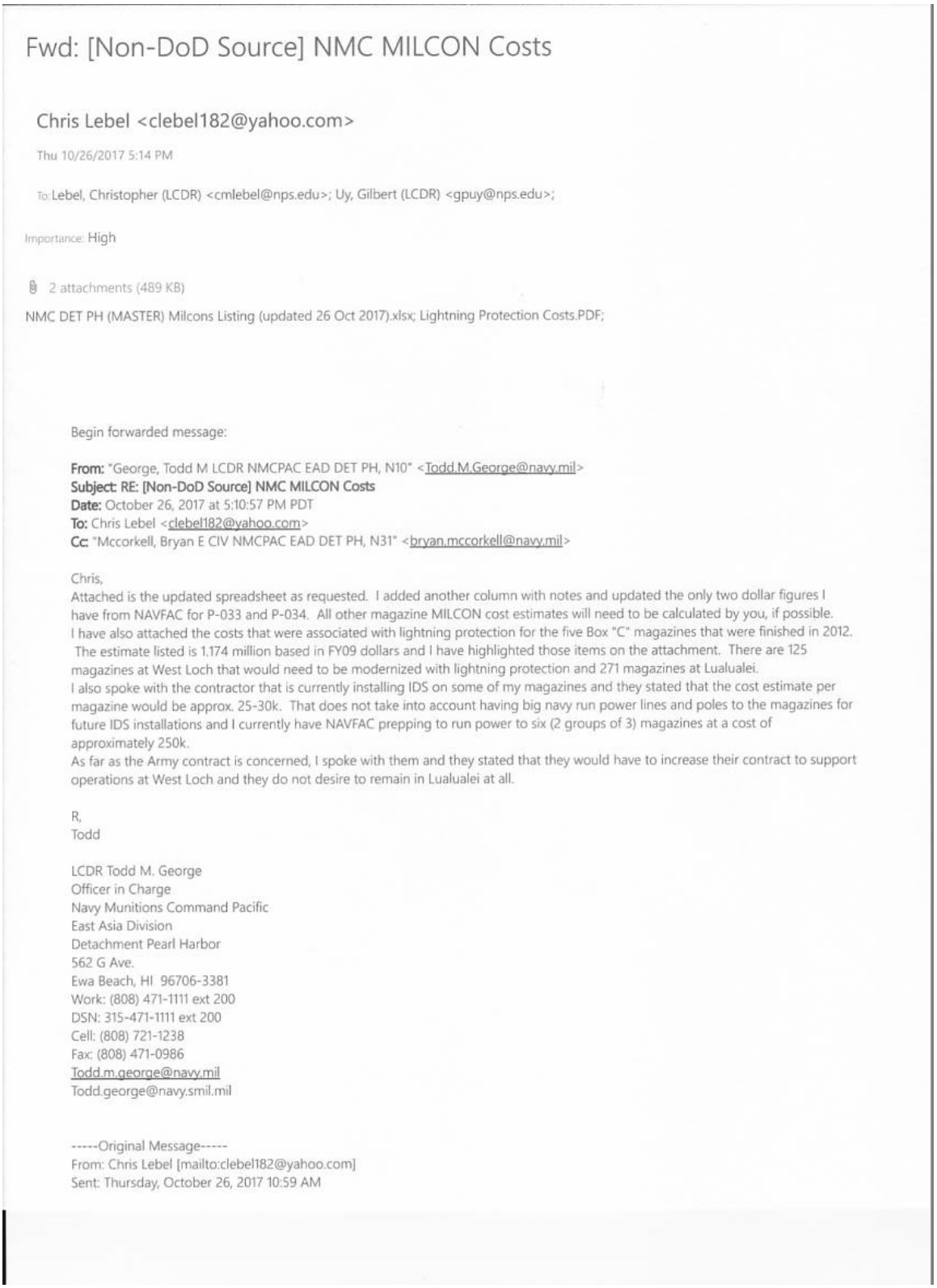
1.) How long do you anticipate these new magazines to last? (approximate life span or years of usage?)

2.) Do you know how much are the maintenance costs for the new magazines? I assume that you have some current Box D magazines to get this number from or MCM magazines. I assume the maintenance cost is not so different between one magazine to the other but i could be wrong on this.

Thanks!
v/r,
Gilbert

From: Mccorkell, Bryan E CIV NMCPAC EAD DET PH, N31 [bryan.mccorkell@navy.mil]
Sent: Thursday, May 11, 2017 1:58 PM
To: Uy, Gilbert (LT)
Cc: Russell, Kathleen A CIV NMCPAC EAD, Executive Director; Martin, Charles E CIV NMCPAC EAD DET PH, N34; Lebel, Christopher (LCDR)
Subject: RE: NMC Questions for CBA

Figure B1. Email from COR Bryan McCorkell. Personal communication (May 19, 2017).



Fwd: [Non-DoD Source] NMC MILCON Costs

Chris Lebel <clebel182@yahoo.com>

Thu 10/26/2017 5:14 PM

To: Lebel, Christopher (LCDR) <cmlebel@nps.edu>; Uy, Gilbert (LCDR) <gpuy@nps.edu>;

Importance: High

2 attachments (489 KB)

NMC DET PH (MASTER) Milcons Listing (updated 26 Oct 2017).xlsx; Lightning Protection Costs.PDF;

Begin forwarded message:

From: "George, Todd M LCDR NMCPAC EAD DET PH, N10" <Todd.M.George@navy.mil>
Subject: RE: [Non-DoD Source] NMC MILCON Costs
Date: October 26, 2017 at 5:10:57 PM PDT
To: Chris Lebel <clebel182@yahoo.com>
Cc: "Mccorkell, Bryan E CIV NMCPAC EAD DET PH, N31" <bryan.mccorkell@navy.mil>

Chris,
Attached is the updated spreadsheet as requested. I added another column with notes and updated the only two dollar figures I have from NAVFAC for P-033 and P-034. All other magazine MILCON cost estimates will need to be calculated by you, if possible.
I have also attached the costs that were associated with lightning protection for the five Box "C" magazines that were finished in 2012. The estimate listed is 1.174 million based in FY09 dollars and I have highlighted those items on the attachment. There are 125 magazines at West Loch that would need to be modernized with lightning protection and 271 magazines at Lualualei.
I also spoke with the contractor that is currently installing IDS on some of my magazines and they stated that the cost estimate per magazine would be approx. 25-30k. That does not take into account having big navy run power lines and poles to the magazines for future IDS installations and I currently have NAVFAC prepping to run power to six (2 groups of 3) magazines at a cost of approximately 250k.
As far as the Army contract is concerned, I spoke with them and they stated that they would have to increase their contract to support operations at West Loch and they do not desire to remain in Lualualei at all.

R,
Todd

LCDR Todd M. George
Officer in Charge
Navy Munitions Command Pacific
East Asia Division
Detachment Pearl Harbor
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Fax: (808) 471-0986
Todd.m.george@navy.mil
Todd.george@navy.smil.mil

-----Original Message-----
From: Chris Lebel [mailto:clebel182@yahoo.com]
Sent: Thursday, October 26, 2017 10:59 AM

Figure B2. Email from LCDR George. Personal communication (October 26, 2017).

BUDGET ESTIMATE SUMMARY SHEET

P-182 FY09

TITLE: CONSTRUCT 5 MISSILE MAGAZINES, WEST LOCH
INSTALLATION: NAVAL STATION, PEARL HARBOR
LOCATION: WEST LOCH, OAHU, HAWAII

PREPARED BY: Cost Engineering of Hawaii, Inc.

DATE: JANUARY 2006
DATE ESCALATED TO: SEPT 2009
DESIGN STATUS: EFD 1391
ESCALATION FACTOR: 1.08

AREA COST FACTOR: 1.69

DESCRIPTION	UNIT	QUANTITY	UNIT COST	ESCALATED COST ROUNDED ($000)	COST TRANSFERRED TO 1391 ($000)
CONSTRUCT 5 MISSILE MAGAZINES, WEST LOCH	LS	--	--	--	11,070
MISSILE MAGAZINES	M2	2515	4,349	10,938	(10,940)
TECHNICAL MANUALS	LS	--	--	132	(130)
SUPPORTING FACILITIES	LS	--	--	--	6,630
SPECIAL CONSTRUCTION FEATURES	LS	--	--	1,373	(1,370)
Concrete fill, probing & foundation	M3	--	--	1,373	
ELECTRICAL UTILITIES	LS	--	--	1,500	(1,500)
Electrical Distribution, Secondary	LS	--	--	326	
Grounding	LS	--	--	1,174	
MECHANICAL UTILITIES	LS	--	--	127	(130)
Storm Drainage	M	670	190	127	
PAVING & SITE IMPROVEMENTS	LS	--	--	3,375	(3,380)
Earthwork	M2	20225	125	2,520	
AC pavement	M2	558	91	51	
PCC pavement	M2	4682	166	775	
Landscaping	M2	12447	2	29	
DEMOLITION	LS	--	--	254	(250)
Remove/Reinstall Utilities	LS	--	--	254	
SUBTOTAL					17,700

Figure B3. Lightning Protection Invoice for 5 Magazines in 2009. Email from LCDR George. Personal communication (October 26, 2017).

From: Russell, Kathleen A CIV NMC EAD, Executive Director [kathleen.russell@navy.mil]
Sent: Friday, December 02, 2016 4:33 PM
To: Tran, Thanh-Nhunancy (Nancy) (LT)
Cc: Mcneal, Michael T CIV NMC EAD, N3/4/5
Subject: Pearl Harbor insourcing

Aloha Nancy,

Contract cost for the past 8 years:

FY17: $8,927K
FY16: $8,822K
FY15: $8,749K
FY14: $8,592K
FY13: $7,920K
FY12: $7,437K
FY11: $6,132K
FY10: $5,950K

Please don't hesitate to call or email if you have additional questions. We look forward to working with you.

Thanks for considering the Pearl Harbor insourcing project.

Best regards,

Kathy

Kathleen Russell
Executive Director
Navy Munitions Command East Asia Division
DSN: 315 471-1111 x 101
COMM: (808) 471-1111 x 101
CELL: (808) 226-0626
Email: Kathleen.russell@navy.mil
Kathleen.a.russell@navy.smil.mil

Figure B4. Email from Kathleen Russell. Personal communication (December 02, 2016).

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